Census and Statistical Characterization of Soil and Water Quality at Abandoned and Other Centralized and Commercial Drilling-Fluid Disposal Sites in Louisiana, New Mexico, Oklahoma, and Texas

Final Technical Report

by
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June 2003

DOE Award No. DE-AC26-99BC15225

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ABSTRACT

Commercial and centralized drilling-fluid disposal (CCDD) sites receive a portion of spent drilling fluids for disposal from oil and gas exploration and production (E&P) operations. Many older and some abandoned sites may have operated under less stringent regulations than are currently enforced. This study provides a census, compilation, and summary of information on active, inactive, and abandoned CCDD sites in Louisiana, New Mexico, Oklahoma, and Texas, intended as a basis for supporting State-funded assessment and remediation of abandoned sites. Closure of abandoned CCDD sites is within the jurisdiction of State regulatory agencies. Sources of data used in this study on abandoned CCDD sites mainly are permit files at State regulatory agencies. Active and inactive sites were included because data on abandoned sites are sparse. Onsite reserve pits at individual wells for disposal of spent drilling fluid are not part of this study.

Of 287 CCDD sites in the four States for which we compiled data, 34 had been abandoned whereas 54 were active and 199 were inactive as of January 2002. Most were disposal-pit facilities; five percent were land treatment facilities. A typical disposal-pit facility has fewer than 3 disposal pits or cells, which have a median size of approximately 2 acres each. Data from well-documented sites may be used to predict some conditions at abandoned sites; older abandoned sites might have outlier concentrations for some metal and organic constituents. Groundwater at a significant number of sites had an average chloride concentration that exceeded nonactionable secondary drinking water standard of 250 mg/L, or a total dissolved solids content of >10,000 mg/L, the limiting definition for underground sources of drinking

water source, or both. Background data were lacking, however, so we did not determine whether these concentrations in groundwater reflected site operations.

Site remediation has not been found necessary to date for most abandoned CCDD sites; site assessments and remedial feasibility studies are ongoing in each State. Remediation alternatives addressed physical hazards and potential for groundwater transport of dissolved salt and petroleum hydrocarbons that might be leached from wastes. Remediation options included excavation of wastes and contaminated adjacent soils followed by removal to permitted disposal facilities or land farming if sufficient on-site area were available.

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EXECUTIVE SUMMARY

A portion of drilling fluids used at oil and gas exploration and production (E&P) sites has been disposed of at Commercial and Centralized Drilling-fluid Disposal (CCDD) sites. Commercial facilities accept drilling fluid and other waste allowed by their disposal permit from any operator on a fee basis. Centralized facilities receive spent drilling fluid from several leases held by an operator or from several sites on the same lease. Centralized facilities are noncommercial sites with no commingling of waste from other operators. During the past few decades, the amount of spent drilling fluids sent offsite for disposal at CCDD sites has decreased from about 28 to 2 percent on a nationwide basis (American Petroleum Institute, 2000).

Drilling fluids used in E&P operations may be mixed with drilling additives, cuttings, formation water and crude oil. Although current regulations address the operation and closure of present-day drilling-fluid disposal sites, some older sites may have operated under less stringent regulation. Sites may have received wastes other than spent drilling fluids and may have been abandoned without proper closure. Prediction of constituent identities and concentrations at abandoned facilities is difficult because few compilations and summaries are available.

This study is a census, compilation, and summary of information on currently active, inactive, and abandoned CCDD sites in Louisiana, New Mexico, Oklahoma, and Texas. It also includes data from a few sites that received spent drilling-fluid in addition to their primary operations. Information was collected from State-agency files to develop and evaluate a multi-state information data base of credible technical data and provide a basis for making State-funded site assessment and remediation more cost effective. Because data on abandoned sites is sparse, we also examined permitted sites that are currently operating (active) or have been closed

(inactive) under State regulation. We tested the hypothesis that data from well-documented active or recently active sites could be used to predict conditions that at poorly documented abandoned sites.

CCDD sites in the four states included in the study differ both because of State regulation and industry practice as well as local and regional environmental conditions. New Mexico, for example, discourages off-site disposal of drilling waste. Differences in regulatory requirements and in industry practices result in variations in the abundances of data for CCDD sites in State agency files.

Data were collected and tabulated on 287 CCDD sites in Louisiana, New Mexico, Oklahoma, and Texas. Of these, 54 were active and 199 were inactive as of January 2002, and 34 had been abandoned. Most (95 percent) were disposal-pit facilities and the rest were used for land treatment of drilling fluids. The typical disposal-pit facilities have fewer than 3 disposal cells on site. The median size of a facility's pits is approximately 2 acres. Clay-lined earthen pits were found to be the most common repositories for drilling wastes. Treatment cells from 12 CCDD land-treatment facilities were also examined because they provided additional data on E&P waste composition and on-site groundwater characteristics. A few sites that were permitted as salt-water disposal or oil-reclamation facilities were also included where drilling fluid waste was identified on the site. There also are some data where drilling fluids had been discharged at an unauthorized site.

Standard laboratory were found referenced in data reports, although many data reports contained no reference to analytical method. Reports that did not specify analytical methodologies might have applied standard procedures. We assumed that data from different sites can be compared regardless of analytical method.

Data from well-documented sites may be used to predict some conditions at abandoned sites. Maximum average concentrations of constituents at abandoned sites and at well documented active and inactive CCDD sites are generally consistent. Older abandoned sites, however, might have outlier concentrations for some metal and organic constituents; differences may reflect a change in industry practice. Maximum average concentration of barium, chromium, lead, silver, TPH, or BTEX is greater at some abandoned sites than at active and inactive CCDD sites.

Groundwater at a significant number of sites had average chloride concentrations that exceeded unenforceable aesthetic U. S. Environmental Protection Agency (EPA) secondary drinking water standards (SMCL) of 250 mg/L, or total dissolved solids (TDS) concentrations that exceeded EPA standards of 10,000 mg/L for underground drinking water sources (USDW), or both.

Techniques used for site-assessment documented in case files ranged from visual inspections to comprehensive geological and geotechnical surveys. Survey measurements have included geophysical measurements; sampling and analyses of chemical composition of wastes, soil, groundwater, and surface water; measurement of water levels in monitoring wells; soil-gas measurement; radon detection; well tests of hydraulic conductivity; elevation surveys; and coring and description of drilled core. Such in-depth assessments are expensive, however, and may not be cost-effective for all sites.

Site remediation measures had been undertaken for several CCDD sites in Louisiana, Oklahoma, and Texas. Remediation techniques were recommended on the basis of site assessments. Remediation alternatives addressed physical hazards and potential for groundwater transport of dissolved salt and petroleum hydrocarbons that might be leached from wastes.

Recommended options included excavation of wastes and contaminated adjacent soils followed by either removal to permitted disposal facilities, or land farming (land spreading or land treatment) if sufficient on-site area were available. Groundwater remediation was not found to be necessary at any abandoned CCDD site in Texas as of December 2002. Installation of additional monitoring wells and continued monitoring of on-site groundwater were generally recommended; further monitoring may indicate a need for remediation. Assessments are continuing for most abandoned CCDD sites in our investigation and final determinations for remediation measures are pending.

INTRODUCTION

A portion of oil and gas exploration and production (E&P) drilling fluids has been sequestered in Commercial and Centralized Drilling-fluid Disposal (CCDD) sites. Commercial facilities accept on a fee basis from any operator drilling fluid and other waste allowed by their disposal permit. Centralized facilities receive spent drilling fluid from several leases held by an operator or from several sites on the same lease. Centralized facilities are noncommercial sites with no commingling of waste from other operators. The amount of spent drilling fluids sent offsite for disposal at CCDD sites has decreased from about 2 to 28 percent on a nationwide basis (Wakim, 1987a; American Petroleum Institute, 2000).

Drilling fluids used in oil and gas exploration and production (E&P) operations may be mixed with drilling additives, cuttings, formation water and crude oil. Although current regulations address the operation and closure of present-day drilling-fluid disposal sites, many older sites were operated under less comprehensive and, perhaps, less stringent regulation. As State regulations were developed for E&P waste disposal sites in the early to mid-1980s, many facilities were upgraded to be in compliance or closed by their operators, yet other sites were abandoned without proper closure. Some older sites may have received wastes other than spent drilling fluids. Without investigation of disposal sites, prediction of the quantity and character of constituents at abandoned facilities is difficult because few data compilations and summaries are available. Prediction of the quantity and character of constituents at these abandoned facilities is difficult because few compilations and summaries are available.

This study is a census, compilation, and summary of information on currently active, inactive, and abandoned CCDD sites in Louisiana, New Mexico, Oklahoma, and Texas (fig. 1). Closure of abandoned CCDD sites in these States is the jurisdiction of their regulatory agencies:

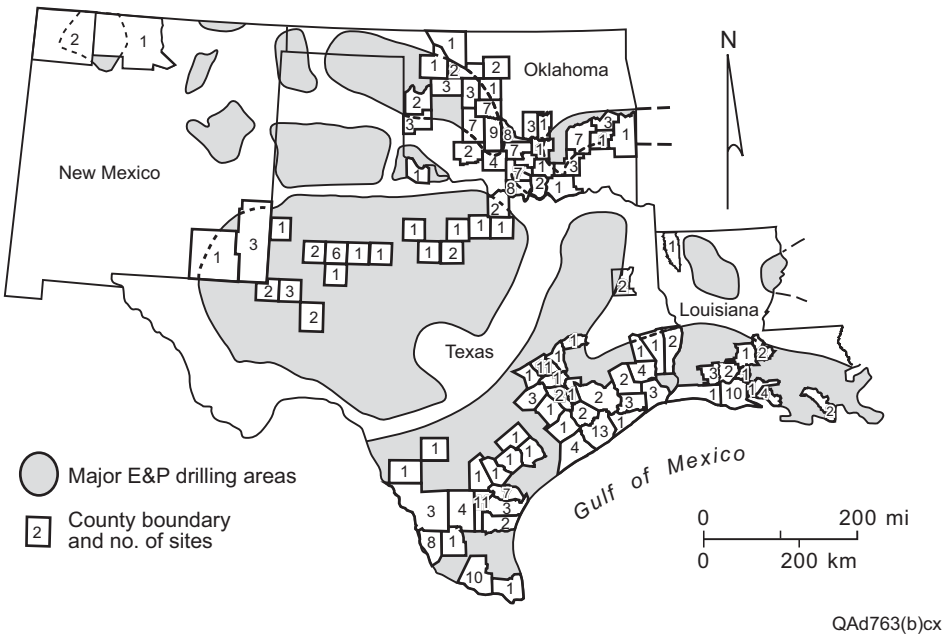

Figure 1. Commercial and centralized drilling-fluid disposal sites in the four-state study area, showing the number of inventoried CCDD sites located in each county or parish. Modified from Nance and Dutton (2002).

Louisiana Department of Natural Resources Office of Conservation (LOC); New Mexico Energy, Mineral, and Natural Resources Department Oil Conservation Division (NMEMNRD); Oklahoma Corporation Commission (OCC); and Railroad Commission of Texas (RRC). Building on the results of previous studies (Wakim, 1987a, b; American Petroleum Institute, 2000), this multistate database is intended to help address questions such as

- How many such abandoned CCDD sites are there in the four-state region?
- What is the range of concentrations of metals, salt, and hydrocarbons?
- How mobile are these contaminants, and do groundwater monitoring data show evidence of excursions of dissolved constituents?
- What is the most cost-effective approach for investigating such sites?
- What is the most cost-effective approach for site remediation?

Pooling data from these four states increases the sample of abandoned and other CCDD sites from which conclusions may be drawn.

Drilling fluid disposal sites are located within major hydrocarbon provinces. Many sites in Texas and Louisiana are located on the Gulf Coastal Plain (fig. 1), which is one of the most prolific hydrocarbon areas in the world (Bebout and others, 1982; Galloway and others, 1983; Kosters and others, 1989). Drilling-fluids delivered to CCDD sites have been deposited into mainly earthen pits that are lined with clay-rich materials whose laboratory-measured permeabilities are generally less than 10^{-8} cm/sec. Concerns are greatest for contamination of soils and groundwater at poorly documented sites that have been abandoned by operators, thus leaving regulatory agencies responsible for site clean-up. Better-documented sites, some of which are operating, are being assessed as potential analogs for sites where documentation is poor.

Sources of data on abandoned centralized and commercial disposal sites used in this study mainly are permit files at State regulatory agencies. Data are also included for a few non-CCDD sites that received spent drilling-fluid in addition to their primary operations. Onsite reserve pits at individual wells for disposal of spent drilling fluid are not part of this study. Examples of data from CCDD sites compiled in this study include ranges of contaminant constituents, concentration levels, and contaminant-plume characteristics, as well as hydrodynamic characteristics suggested by maps of water levels that were measured at on-site monitoring wells. Data include concentrations of (1) chloride and total petroleum hydrocarbons (TPH) in groundwater; (2) chloride, TPH, and benzene, toluene, ethylbenzene, and xylene (BTEX) in pit water; and (3) chloride, TPH, BTEX, and arsenic in sludge. Constituent concentrations are presented in the context of sufficiently documented sites.

Information compiled and analyzed in this multi-state data base on CCDD sites will provide a basis for making State-funded site assessment and remediation more cost effective and for improving regulation and remediation, especially of abandoned sites. Because data on abandoned sites are sparse, however, we also examined permitted sites that are currently operating (active) or have been closed (inactive) under State regulation. We tested the hypothesis that data from well-documented active or recently active sites could be used to predict conditions that at poorly documented abandoned sites.

CCDD sites in the four states included in the study differ both because of State regulation and industry practice as well as local and regional environmental conditions. New Mexico, for example, discourages off-site disposal of drilling waste. Off-site commercial disposal is permitted under special conditions, however, where sensitive environments would be otherwise impacted. Louisiana and Oklahoma allow no centralized pits and no commingling of drilling

waste on a noncommercial basis. Texas allows disposal of spent drilling fluid at both centralized and commercial sites.

REGULATION

Background

The 1980 Solid Waste Disposal Amendments to the Resource Conservation and Recovery Act (RCRA) exempted drilling fluids, produced water, and associated wastes from regulation as Subtitle C hazardous wastes (table 1). In 1988, the EPA confirmed the appropriateness of this exemption and decided not to recommend federal regulation of E&P wastes as hazardous wastes under Subtitle C of RCRA. The main reasons were: (1) Subtitle C does not provide flexibility to consider cost; (2) existing state and federal regulatory programs are generally adequate for controlling oil and gas wastes; (3) permitting delays would hinder oil and gas development; (4) Subtitle C regulation of these wastes could severely strain Subtitle C facility capacity; and (5) it is impractical and inefficient to implement Subtitle C for all these wastes (U.S. Environmental Protection Agency, 1988, p. 25453).

In general, E&P exempt wastes are generated in "primary field operations." Primary field operations include activities occurring at or near the wellhead and before the point where the oil is transferred from an individual field facility or a centrally located facility to a carrier for transport to a refinery. Activities include exploration, development, and the primary, secondary, and tertiary production of oil and gas. Crude oil processing, such as water separation, de-emulsifying, degassing, and storage at tank batteries associated with a specific well or wells, are specific examples of primary field operations. In 1993 EPA clarified the scope of the E&P

Table 1. Oil and gas wastes exempt from RCRA hazardous waste regulation

Produced water		Produced sand
Drilling fluids and drill cuttings		Packing fluids
Drilling fluids and cuttings from offshore operations disposed on-shore		Spent filters, filter media, and backwash
Hydrocarbon-bearing soil		Piping wastes from gathering lines
Workover waste		Rigwash
Wastes from subsurface gas storage and retrieval, except for the listed non-exempt waste		Constituents removed from produced water before it is injected or otherwise disposed of
Well completion, treatment, and stimulation fluid		Materials ejected from a producing well during blowdown
Basic sediment & water and other tank bottom sludge from storage facilities that hold product and exempt waste		Gases removed from the production stream, such as hydrogen sulfide and carbon dioxide, and volatilized hydrocarbons
Pit sludge and contaminated bottoms from storage or disposal of exempt wastes		Liquid hydrocarbons remove from the production stream but not from oil refining
Pipe scale, hydrocarbon solids, hydrates, and other deposits removed from piping and equipment prior to transportation		Gas plant dehydration wastes, including glycol-based compounds, glycol filters, filter media, backwash, and molecular sieves
Waste crude oil from primary field operations and production		Liquid and solid wastes generated by crude oil and tank bottom reclaimers
Cooling tower blowdown		Light organics volatilized from exempt wastes in reserve pits or impoundments or production equipment
Accumulated materials such as hydrocarbons, solids, sand, and emulsion from production separators, fluid treating vessels, and production impoundments		Gas plant sweetening wastes for sulfur removal, including amine, amine filters, amine filter media, backwash, precipitated amine sludge, iron sponge, and hydrogen sulfide scrubber liquid and sludge

exemption for waste streams generated by crude oil and tank bottom reclaimers, oil and gas service companies, crude oil pipelines and gas processing plants and their associated field gathering lines (U.S. Environmental Protection Agency, 1993). EPA stated that certain waste streams from these operations are "uniquely associated" with primary field operations and as such are within the scope of RCRA Subtitle C exemption. EPA's clarification cautioned, however, that these wastes might not be exempt if they are mixed with non-exempt materials or wastes, listed in table 2.

Spent drilling-fluids are classified as non-hazardous wastes and are exempt from RCRA regulations. However, States included in our study have different requirements for permitting, operation, and closure of drilling-fluid disposal sites (table 3). Differences in regulatory requirements and in industry practices result in variations in the abundances of data for CCDD sites in State agency files. No Texas regulations, for example, pertain specifically to CCDD sites. Texas has no general requirement for monitoring of sites, so the most abundant data are from detailed assessment of specific sites. The OCC has abundant data on groundwater for many sites because the OCC requires that several on-site monitoring wells be installed at each site. Louisiana currently has monitoring wells installed around all land treatment sites and has an abundance of monitoring data for historical disposal-pit sites. Most sites report data for chloride and total dissolved solids (TDS) in water. There are no actionable federal regulations for chloride concentrations in drinking water. The non-enforceable aesthetic EPA secondary drinking water standard (SMCL) for chloride is 250 mg/L; the EPA definition of an underground drinking water sources specifies a limit of 10,000 mg/L in TDS (U.S. Environmental Protection Agency, 2000).

Table 2. RCRA non-exempt oil and gas waste

Unused fracturing fluids or acids		Gas plant cooling tower cleaning waste
Painting waste		Used equipment lubricating oil
Vacuum truck and drum washwater from trucks and drums transporting or containing non-exempt waste		Oil and gas service company waste, such as empty drums, drum washwater, vacuum truck washwater, sandblast media, painting waste, spent solvents, spilled chemicals, and waste acid
Waste compressor lubrication oil		Waste compressor oil, filters, and blowdown
Used hydraulic fluid		Waste solvents
Waste in pipeline-related pits		Caustic or acid cleaner
Boiler cleaning waste		Boiler refractory brick
Boiler scrubber fluid, sludge, and ash		Incinerator ash
Laboratory waste		Sanitary waste
Pesticide waste		Radioactive tracer waste
Drums, insulation, and miscellaneous solids		

Table 3. State regulatory (LAC,1999; NMOCD, 1993; USEPA, 2000) guidelines (or limits) and comparison of site-averages of waste and groundwater constituents

	Solid E&P Waste (mg/kg)					
Constituent	Louisiana	No.*	New Mexico**†	No.*	Oklahoma**††	No.*
pH	6 - 9	0	-	-	-	-
TDS	-	-	-	-	-	-
Chloride	-	-	-	-	-	-
Arsenic	10	4	-	-	-	-
Barium	20,000	6	-	-	-	-
Cadmium	10	2	-	-	-	-
Chromium	500	0	-	-	-	-
Iron	-	-	-	-	-	-
Lead	500	0	-	-	-	-
Manganese	-	-	-	-	-	-
Mercury	10	1	-	-	-	-
Selenium	10	2	-	-	-	-
Silver	200	0	-	-	-	-
Zinc	500	1	-	-	-	-
TPH	-	-	100-5,000‡	-	50	11
Benzene	-	-	10	2	0.5	9
Ethylbenzene	-	-	-	3	15	0
Toluene	-	-	-	4	40	1
Xylenes	-	-	-	1	200	0
BTEX	-	-	50	-	-	-

* Total number of sites in four-state study area for which data show results exceeding various standards

** For hydrocarbon-contaminated soils

† Target levels

†† Action levels

‡ Depends on proximity to water table, water sources, and surface water bodies.

Table 3 (cont.). Comparison of site-averages of waste and groundwater constituents to regulatory guidelines or limits

	Groundwater (mg/L)											
Constituent	EPA MCL	No.	EPA secondary standard	No.*	EPA USDW	No.*	LA	No.*	NM†	No.*	OK	No.*
pH	-	-	6.5 - 8.5	0	-	-	-	-	6 - 9	1	-	-
TDS	-	-	500	34	10,000	7	-	-	1,000	28	-	-
Chloride	-	-	250	26	-	-	-	-	250	18	-	-
Arsenic	0.05	1	-	-	-	-	0.05	1	0.1	1	-	-
Barium	2.0	3	-	-	-	-	2.0	3	1.0	7	-	-
Cadmium	0.005	3	-	-	-	-	0.005	3	0.01	3	-	-
Chromium**	0.1	3	-	-	-	-	0.18	3	0.05	2	-	-
Iron	-	-	0.3	5	-	-	-	-	1.0	4	-	-
Lead	0.015	3	-	-	-	-	0.015	3	0.05	6	-	-
Manganese	-	-	0.05	5	-	-	-	-	0.2	5	-	-
Mercury	0.002	1	-	-	-	-	0.002	1	0.002	1	-	-
Selenium	0.05	0	-	-	-	-	-	-	0.05	0	-	-
Silver	0.1	0	0.1	0	-	-	-	-	0.05	0	-	-
Zinc	-	-	5.0	2	-	-	1.1	3	10	1	-	-
TPH	-	-	-	-	-	-	-	-	-	-	2	0
Benzene	0.005	3	-	-	-	-	0.005	3	0.01	2	0.005	3
Ethylbenzene	0.7	0	-	-	-	-	0.7	0	0.75	0	0.7	0
Toluene	1.0	0	-	-	-	-	1.0	0	0.75	0	1.0	0
Xylenes	10	0	-	-	-	-	10	0	0.62	0	10.0	0

* Total number of sites in four-state study area for which data show results exceeding various standards

† Cleanup levels

** For Louisiana, 37 mg/L for Cr^{+3} and 0.18 for Cr^{+6}. For New Mexico, 0.05 for total chromium

Texas Regulation of Oil and Gas Drilling Wastes

Statutory authority for the RRC to regulate the oil and gas industry and protect freshwater date from 1919 with passage of a law by the Texas Legislature giving the RRC broad enforcement powers (Interstate Oil and Gas Commission, 1993). Since 1919 RRC promulgated a number of Rules for protection of environmental quality. Rule 8 addresses water protection as part of E&P operations and Rule 91 covers cleanup of soil contaminated by a crude oil spill. Rule 8 requires that any method of disposal of any oil and gas waste not authorized by rule be permitted. Senate Bill 1103 (72nd Legislature, 1991) gave the RRC additional responsibility for cleanup of abandoned disposal sites related to oil and gas exploration and development (E&P) in Texas. Rules 8 and 91 sometimes are used as guidance for abandoned CCDD sites. No specific criteria have been established in rule for closing of CCDD sites. Disposal at municipal landfills in Texas is subject to additional criteria of constituent limitations (table 4). Rules 8 and 91 do not direct that TPH or saltwater impacted media be removed from an impacted site to a permitted facility.

Rule 8 specifies chloride concentration for landfarming and burial of drilling fluid and associated cuttings authorized by rule. Generally, RRC-issued permits for CCDD sites and landfarming sites have a chloride concentration limit of 3000 mg/L. Rule 8 does not specify a generally allowable chloride concentration for drilling-fluid disposal. Rule 8 also does not specify a TPH limit for E&P waste. The RRC does not object to the disposal of oil and gas waste at a facility with an operations permit issued by the Texas Commission on Environmental Quality (TCEQ), provided the TCEQ concurs and documentation regarding the shipment of waste is submitted by the operator to the district office following the disposal (J. Hybner, 2003, written communication). The guide states that the chloride concentration is considered on a case-by-case basis and does not

Table 4. Concentration limits of certain constituents of oil and gas wastes allowed in municipal solid-waste disposal landfills in Texas

Analyte	Total limit (mg/kg)	TCLP limit (mg/L)
Benzene	10	0.5
Arsenic	36	1.8
Barium	2,000	100
Cadmium	10	0.5
Chromium	100	5.0
Lead	30	1.5
Mercury	4	0.2
Selenium	20	1
Silver	100	5
TPH	1,500	-
TOX	50	-
PCBs	50	-
Chloride	3,000	-

require a chloride concentration of less than 3000 mg/kg. In addition, oil and gas wastes disposed of in Texas' municipal landfills do not have to test for all analytes shown in table 4. For example, the 1999 guide referenced above indicates that drilling muds require testing for barium, TPH and BTEX (J. Hybner, 2003, written communication).

Rule 91 specifies TPH limits that apply to the cleanup of soil in non-sensitive areas contaminated by crude oil spills. While not applicable to CCDD sites, these limits have been mentioned for comparison in the evaluation of waste materials at CCDD sites.

Although rules do not mandate analyses of RCRA non exempt waste, Rule 98 requires a person who generates an oil and gas waste determine whether such waste is nonhazardous either through testing or process knowledge. Any permit issued for non-exempt waste requires testing to determine that a waste is nonhazardous.

Although pits may be in compliance with State regulations, operators of disposal sites may not be exempt from civil liability for waste constituents in the event of sale of the property or discharge or excursion of pit materials, including impacted groundwater, to adjacent properties. For these reasons operators often have pit wastes analyzed for constituents, especially certain metals, in addition to TPH and chloride.

INDUSTRY PRACTICES AND REGULATION

Generation of Spent Drilling Fluid

Changes in the E&P industry over the past few decades include changes in the amount and characteristics of spent drilling fluid being generated and drilling-fluid disposal practices (American Petroleum Institute, 2000). Constituents of drilling-fluid waste found in abandoned

drilling-fluid disposal sites, most of which date from the 1970s and 1980s, therefore, should be expected to differ from those of more up-to-date drilling-fluid disposal sites.

Drilling fluid pumped into a well bore has a number of functions, not least of which is removal of cuttings from subsurface formations. Much but not all of the cuttings are removed at the surface for recycling of the drilling fluid and control of its properties. When drilling efficiency or mud properties become adversely affected, the whole batch may be disposed of and replaced by new fluid. In addition to drilling mud and formation cuttings, the discarded drilling wastes may include additives, formation water and produced hydrocarbons, rig washwater including soaps and oils, and wastes from cementing operations. Most (70 to 90 percent) of drilling waste is liquid, but drilling-fluid waste constitutes the majority of the solid waste generated in oil and gas E&P operations (American Petroleum Institute, 2000).

Two main types of drilling fluid are water based and oil based muds; other synthetic muds are also used (table 5). Use of various drilling muds differs by region as well as with drilling targets. Technology of drilling mud has changed over the past few decades to meet safety and cost requirements and environmental concerns. Various materials such as saltwater and lignosulfonate may be added to control interaction between the drilling fluid and formations. Saltwater is used where it is more economical or available than freshwater, or where needed to prevent excessive borehole enlargement when drilling through salt formations. Lignosulfonate mud was the most common water-based drilling mud during the 1970s and 1980s, both for onshore and offshore drilling. Lignosulfonate is a synthetic material derived from the wood-processing industry and lignosulfonate mud was particularly effective in deep drilling under high pressures and temperatures. Lignosulfonate mud often contained several volume percent of diesel oil for lubricity and 2 to 4 weight-percent chromium for thermal stability.

Table 5. Percentage of drilling waste by mud type. From Dutton and others (2000).

	Year	Freshwater based mud	Saltwater based mud	Oil based mud	Other
U.S. average	1985	64	23	7	6
U.S. average	1995	92.5	5.5	<1.5	0.5
Louisiana	1995	93		7	
New Mexico	1995	82	16		2
Oklahoma	1995	63		37	
Texas	1995	93	7		

Oil-based (usually 6 to 10 percent diesel by volume) muds may outperform water-based muds in a number of situations: oil muds can be more stable at high temperatures, have better lubricating properties, and better protect the drill string from becoming stuck in the borehole. A more refined, less toxic petroleum oil began to replace diesel oil as an additive circa 1980. Changes in oil-mud emulsifiers, wetting agents, and viscosifiers further improved the drilling performance of the mineral-oil muds. Mineral-oil-based drilling waste was regulated the same way as diesel-oil-based drilling waste. Other constituents identified in spent drilling fluid that could pose human health and environmental risks at abandoned sites include organics, such as benzene and other volatile organic hydrocarbons; metals, such as barium, chromium, lead, and zinc; saltwater; and naturally occurring radioactive materials (NORM) from pipe scale and tank sludge.

Between 1985 and 1995 the use of saltwater-based and oil-based drilling fluid decreased nationwide (table 5). The decrease reflects improved performance of water-based and new synthetic-based drilling muds and substitution of environmentally moderate materials where feasible (American Petroleum Institute, 2000).

Total onshore footage drilled in the U. S. decreased by more than 60 percent between 1985 and 1995 (American Petroleum Institute, 2000). Volume of drilling-fluid waste probably decreased by an even greater factor because of improvements in efficiency. In 1995, about 108 million barrels of drilling waste was generated in Louisiana, New Mexico, Oklahoma, and Texas (table 6). Less than three percent of onshore drilling waste nationwide was sent offsite for disposal in 1995, for example, to commercial disposal facilities (table 6). In comparison, in 1985, more than 25 percent of drilling waste was hauled offsite for disposal (American Petroleum Institute, 2000).

Table 6. Estimated volume (thousand barrels) of disposal of solid drilling waste. From Dutton and others (2000).

	Year	Total	Burial onsite	Land spread onsite	Land spread offsite	Commercial disposal facility	Reuse or recycle	Other
U.S. total	1995	139,602	29,732	3,104	389	2,926	394	870
Louisiana	1995	22,477	4,495	899		2,922		
New Mexico	1995	7,421	965	223				
Oklahoma	1995	13,162	6,581					
Texas	1995	65,367	8,533	197	65		394	65

Regional Characteristics of CCDD Sites

In Louisiana, disposal of E&P waste by multiple operators in a centralized company-owned facility is not allowed by Statewide Order No. 29-B. The rule also says that E&P waste must be taken to a commercial facility if taken offsite for disposal. Prior to 1981 Louisiana had no Statewide regulations for disposal of drilling fluids; a succession of regulations were issued between 1982 and 1990 pertaining to drilling waste disposal facilities. Louisiana now requires pits and land-treatment cells at commercial facilities to be registered and tested before closure. Some pits must be lined to prevent seepage and contamination of ground water. If closure or land farming is not permissible because toxic or otherwise hazardous materials are present, then hauling to a certified landfill is often necessary. This is expensive, and the liability for site closure and possible ground-water contamination from that landfill could return to the disposer.

In New Mexico, most disposal of spent drilling fluid is on site; special permission is needed to move spent drilling fluid offsite. Offsite disposal is allowed where onsite disposal may affect sensitive areas or where landowner restrictions apply. Oklahoma rules do not allow the use of centralized disposal facilities; all offsite disposal is at commercial facilities. Texas allows centralized and commercial facilities to be used for disposal of spent drilling fluid in accordance with State regulations (Railroad Commission of Texas Rule 8). Pits in operation before 1984 were grandfathered into Rule 8 and are referred to as Previous Authority drilling mud pits (PA pits).

Enforcement of new or additional State regulations during the mid-1980s coincided with both a decrease in drilling activity and more efficient use of drilling fluid, resulting in a decreased need for offsite disposal of spent drilling fluid. As regulatory agencies issued more stringent regulations during the 1980s, some operators of disposal facilities chose to revamp their operations

to come into compliance with the new rules. Earthen pits were commonly used for disposal of oil-field wastes up through the mid-1980s. Some permitted sites converted their pit operations to more sophisticated land treatment or land farming facilities. Other operators chose to close their sites following conventional methods such as landspreading, dilution burial, or solidification burial, or wastes were excavated and hauled to other waste disposal facilities. In some cases, however, sites were abandoned rather than closed under State regulation, for example, following bankruptcy. State agencies did not have special funding appropriated for State-sponsored cleanup of abandoned sites until the early to mid-1990s.

Information can be limited in State regulatory agency files on abandoned sites that have not yet been closed. State inspectors may have surveyed the sites and documented the location, number, and extent of disposal pits, but analytical results of soil or water samples are generally scant. Files for sites that have been closed under State-sponsored cleanup programs document the size of sites and volume of waste, complaints and other reasons for action to close the site, and constituents found in wastes during site investigation. Information on sites that operators have closed may also include the size and number of pits that had been present and a summary of actions taken to satisfy closure requirements. Information on active permitted E&P disposal sites is the most complete, for example, containing historical correspondence, permit applications, records of waste receipts, quarterly reports of monitoring data, as well as information on enforcement and cleanup actions related to permit violations. Changes in technology and regulation mean that a typical drilling waste now being sent to permitted disposal sites is different from the waste sent to such sites during the 1970s to mid-1980s. Changes include a decreased use of oil-based and high-chromate lignosulfonate muds, as well as adherence to regulations regarding mixing NORM, hydrocarbon-rich tank-bottom sediments, and other E&P waste with spent drilling mud. Some

constituents of spent drilling mud remain the same, however, although concentrations have changed. In addition, some permitted sites also contain older spent drilling fluid. Data for active or recently permitted sites, therefore, should have some transferability to predicting constituents and soil impacts at abandoned sites.

METHODS

Data Sources and Scope of Analyses

Data were collected and tabulated for 287 CCDD sites (fig. 1; table 7) from LOC, NMEMNRD, OCC, and RRC files. Data included:

(1) names and locations of sites;

(2) number of pits or land-treatment cells per site;

(3) size of disposal pits or land-treatment cells per site;

(4) chemical analyses of pit or cell sludge, pit water, sump water (land treatment), and groundwater sampled at monitoring wells (table 8); and

(5) groundwater elevations.

Each data type was not available for every site. The sites in our database do not compose an exhaustive list of all currently and previously operating CCDD sites, but rather are sites for which data were available during the data collection phase of our investigation.

In our survey clay-lined earthen pits were found to be the most common repositories for drilling wastes. Treatment cells from 12 CCDD land-treatment facilities were also examined (appendix A) because they provided additional data on E&P waste composition and on-site groundwater characteristics. A few sites that were permitted as salt-water disposal or oil-

Table 7. Data availability and census of CCDD sites in Louisiana, New Mexico, Oklahoma, and Texas.

Site summary

Number of sites in database:	286
Active as of January 2002:	55
Inactive as of January 2002:	197
Abandoned:	34
Disposal-pit facilities:	274
Land-treatment facilities:	12

State summary

State	No. of active sites	No. of inactive sites	No. of abandoned sites	Total no. of sites	Total* no. of pits or cells	Pit or cell area* (acres [km^2])
Louisiana	5	13	11	29	154	581 [2.35]
New Mexico	5	2	0	7	61	609 [2.46]
Oklahoma	22	71	9	102	322	492 [1.99
Texas	22	113	14	149	253	388 [1.57]
Total	54	199	34	287	790	2,070 [8.37]

* Minimum estimate pit count and pit area unspecified for all sites

Data summary

Data type	No. of sites providing data
No. of pits or cells per site	218
Area of pits or cells	215
Site map	34
Monitor-well map	21
Pit or cell sludge analyses	62
Pit or cell (sump) water analyses	75
Analyses of chemical composition of groundwater	64
Groundwater level measurements	15
Monitoring-well time series data*	24
Waste volume received**	21
Geotechnical data (liner permeability)	16
Analytical methods specified	41
Abandoned-site assessment data	22
Abandoned-site remediation data	3

* Monitor-well time-series data include records collected for ≥2 yr

** Generally continuous record over several years

Table 8. Number of sites in database with records on chemical analyses of sludge, pit or sump water, or groundwater. Listed by medium and constituent.

Constituent	Pit or cell sludge	Pit or sump water	Ground-water	Constituent	Pit or cell sludge	Pit or sump water	Ground-water
Aluminum	4	3	2	BTEX	3	0	2
Antimony	7	3	3	Benzene	23	17	14
Arsenic	42	30	27	Toluene	22	17	14
Barium	34	31	28	Ethylbenzene	23	17	13
Beryllium	8	3	3	Xylene	20	16	13
Bicarbonate	6	14	17	VOC, SVOC	8	7	0
Boron	3	13	15	TOC	1	5	5
Cadmium	34	23	15	O&G	10	11	14
Calcium	18	20	22	NORM	3	0	3
Carbonate	6	12	12	pH	nr	43	54
Chloride	30	64	57	TDS	na	35	44
Chromium	42	33	26	Specific conductance	nr	17	28
Cobalt	2	3	2				
Copper	10	3	4				
Fluoride	1	1	1				
Iron	9	10	5				
Lead	40	25	28				
Lithium	2	1	0				
Magnesium	17	29	22				
Manganese	8	7	5				
Mercury	33	23	11				
Molybdenum	2	1	0				
Nickel	9	3	3				
Nitrogen	3	15	17				
Palladium	1	1	0				
Phosphorus	2	1	0				
Potassium	11	15	16				
Rubidium	1	1	0				
Selenium	33	17	11				
Silver	31	22	9				
Sodium	17	26	35				
Strontium	2	1	1				
Sulfate	10	18	22				
Thallium	5	2	2				
Thorium	1	1	0				
Tin	2	3	1				
Titanium	2	1	1				
Uranium	1	1	0				
Vanadium	4	3	2				
Zinc	25	20	21				
Zirconium	1	1	0				
TPH	22	16	5				

nr - not reported; na – not applicable

reclamation facilities were also included where drilling fluid waste was identified on the site. There also are some data where drilling fluids had been discharged at an unauthorized site.

Standard laboratory procedures (U.S. Environmental Protection Agency, 1983, 1986; ALPHA-AWWA-WPCF, 1985) were found referenced in data reports, although many data reports contained no reference to analytical method. Reports that did not specify analytical methodologies might have applied standard procedures. We assumed that data from different sites can be compared regardless of analytical method.

The multi-state database contains information about the composition and distribution of constituents that can be mapped (appendix B). Most State files do not contain mapped data, but mapping of monitoring data provides a useful picture to show how site conditions vary through time. Data on water levels from site monitoring wells also were mapped as part of this analysis. Also, we obtained data on soil contamination outside of disposal areas or treatment cells only for two sites; findings, therefore, apply only to on-site conditions. Data were reported most commonly for dissolved chloride or TDS or both. We compared average constituent concentrations calculated for sites in the database with various State and EPA standards and guidelines.

Agency files also contain information on practices for site assessment and remediation of abandoned CCDD sites. There have been a number of recent or ongoing investigations at abandoned sites by the States: 9 in Louisiana, 10 in Oklahoma, and 11 in Texas. We identified no records of abandoned CCDD sites in New Mexico. RRC maintains a list of oil and-gas E&P sites in Texas that are or have been under investigation was provided by the RRC; but it did not distinguish CCDD from other types of sites. The count of abandoned CCDD sites in Oklahoma and Texas was compiled from information in agency files.

Limitations of CCDD Data

CCDD site data are generally limited to areas along and within site boundaries. This renders limits critical interpretations of constituent migration away from sites, or the recognition of off-site constituent sources. It is not possible to demonstrate from site data alone, in most cases, whether a source of constituents is on site or off site. Second, detailed stratigraphic control in on-site monitoring wells is generally lacking; maps of constituent gradients, therefore, may not completely capture complexities of constituent-plume structure that are sensitive to stratigraphy. Situations where constituent plumes have migrated to depths greater than the completion depths of monitoring wells, or where constituents may be concentrated within discrete strata, may go undetected. Third, samples of pit sludge are routinely collected on a regular grid but are then composited prior to analysis. Similarly, entire borings from individual sample locations may be composited. These practices yield a mean concentration value for the whole pit or boring, respectively. This practice can disguise the occurrences of locally extreme concentrations, although average values may be useful for evaluating remediation techniques.

Although chemical analytical data provide a basis for evaluating the potential or actual environmental impact of drilling fluid disposal at CCDD sites, data also should be evaluated for reliability. One simple test (figs. 2a-d) that reveals potential deficiencies in reported data is a comparison of chloride and TDS. For example, chloride concentration generally varies directly with TDS (figs. 2a and b) and chloride generally makes up the largest fraction of TDS. A gross deviation from concentration ratios in a ranked list of chloride and TDS values, therefore, is a flag that data should be examined more closely (figs. 2c and d). Samples where chloride values exceed TDS values (e.g., fig. 2c) include error.

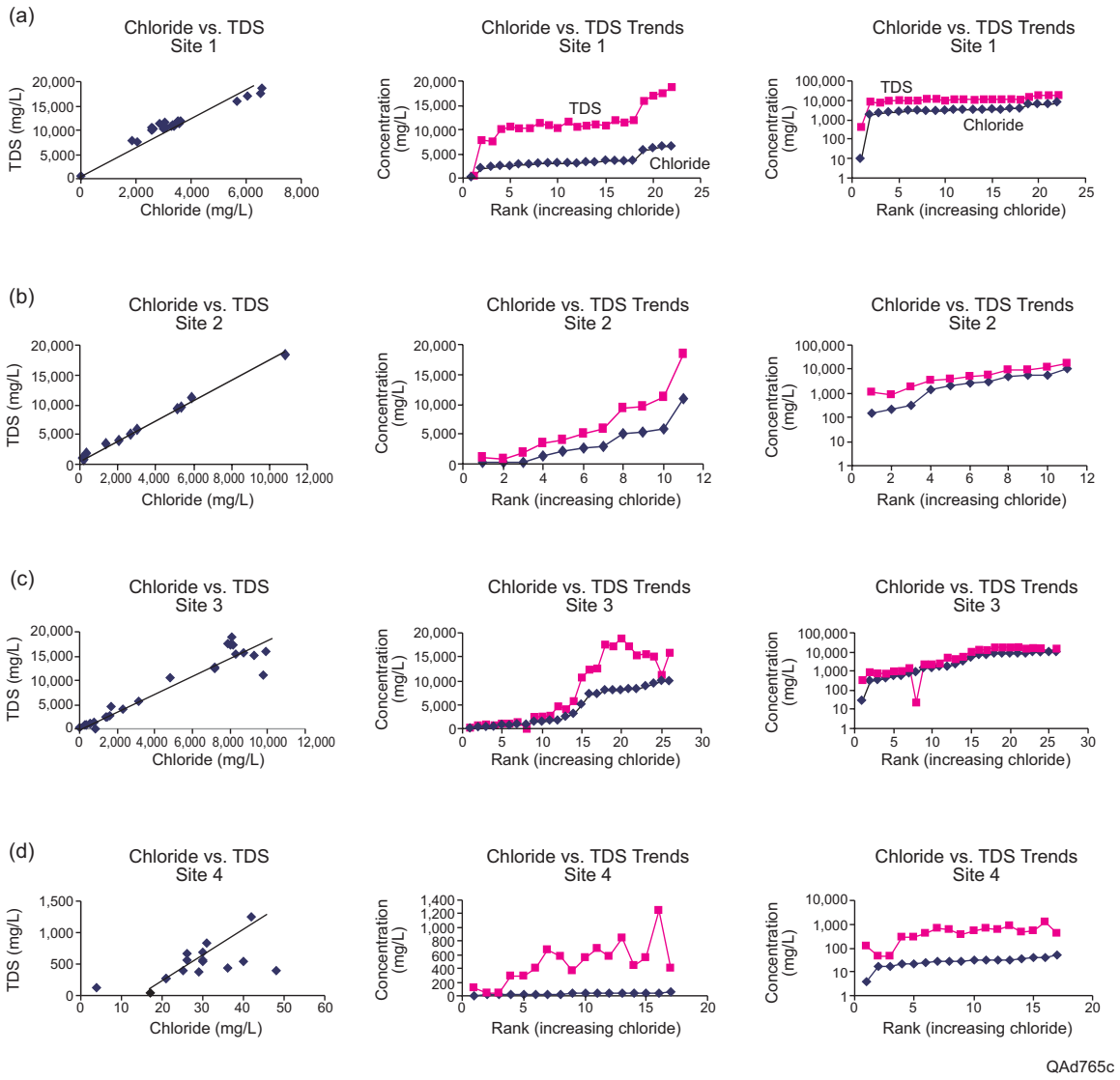

Figure 2. Chloride and TDS trends in groundwater for selected CCDD sites. Arithmetic (left hand and middle columns) and semi-log plots (right hand columns for trends are shown for comparison. (a) and (b) show expected close correspondence between trends; (c) and (d) show more irregular correspondences between trends. Analyses where chloride is greater than TDS (e.g., (c)) indicate analytical or other errors.

In spite of such limitations, these data appear to illustrate commonalties between most investigated sites and compose a set of examples from which insights can be generated regarding potential contamination at poorly-documented sites. Notably, some sites in the current database have shown concentrations of chloride in sludge and fluids well in excess of 3,500 mg/L. Accumulations of petroleum-related components at some sites were sufficiently high to have warranted regulatory attention in some cases.

Products generated during this investigation are, to varying extents, interpretative. For example, the sizes of some pits are based on rough sketches found in files. Maps, although constrained by data, are also necessarily interpretations because data is spatially limited. The maps in this report are offered as reasonable interpretations of data but are not necessarily the only possible interpretations.

RESULTS AND DISCUSSION

Census of CCCD Sites

The database compiled in this study includes 287 active, inactive, and abandoned CCDD sites in the four State area (fig. 1; table 7). The database indicates more than 790 individual pits whose cumulative areal coverage exceeds 2000 acres. The number of reported pits per site ranges from 1 to 25 (fig. 3). The number of pits for 23 percent of sites is unreported. Ninety-two percent of the remaining sites contain fewer than 9 pits; 46 percent of reported sites contain only one pit (fig. 3). The smallest pit at a single-pit site covers 13.9 m^2 (150 ft^2), whereas the largest site includes nine pits with a cumulative coverage of 0.88 km^2 (~217 acres) (fig. 4). Twenty-six percent of sites reported no data on areal coverage for pits.

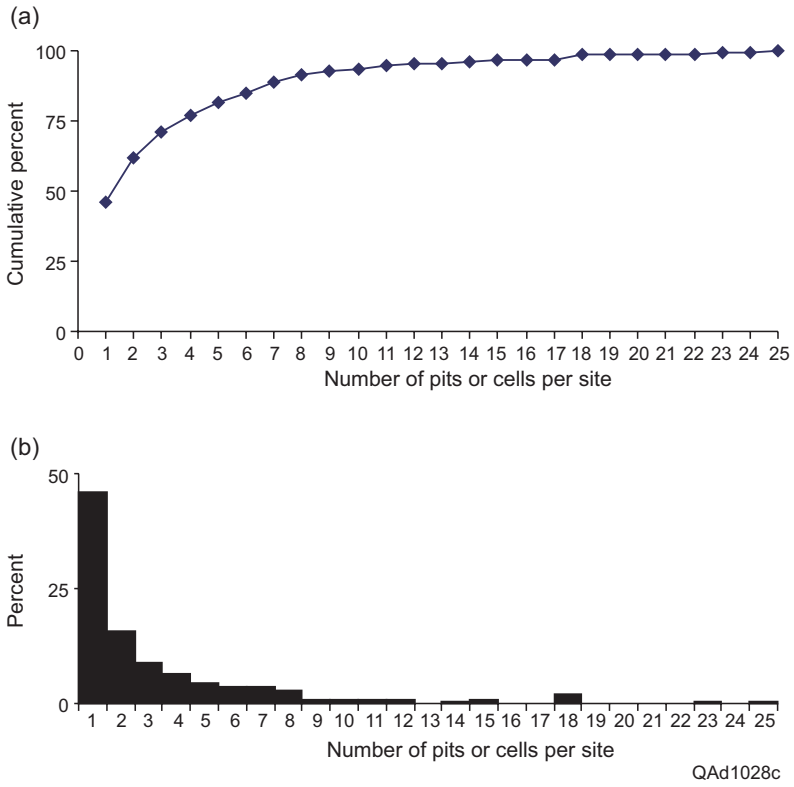

Figure 3. Cumulative (a) and frequency (b) graphs of numbers of pits per CCDD site in the database compiled to date.

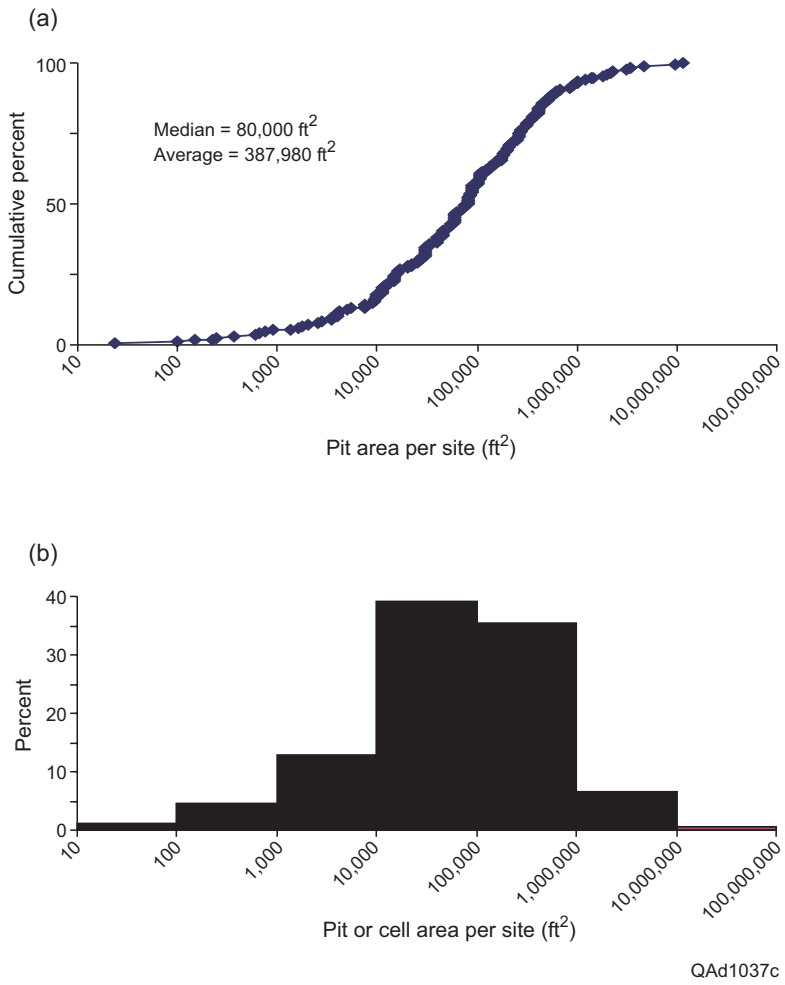

Figure 4. Cumulative (a) and frequency (b) graphs of areal coverage of pits per CCDD site in the database compiled to date.

Distribution Patterns of Constituents and Water Levels

File data show three basic hydrologic attributes of CCDD sites. The first attribute is the gradient interpreted from mapped constituent concentrations. Chemical gradients in plumes in groundwater suggest that constituents may leak from pits and migrate through soil and shallow aquifers. The second attribute is the inhomogeneous distributions of constituents in sludge, as evidenced at the few well documented sites. Pre-analysis compositing of multiple samples may not reveal the range in constituent concentration. The third attribute is that on-site water levels are complexly distributed and can include on-site mounding. Distributions of water levels and mounding suggest that flow paths may be complex and that disposal pits may act as focal points for groundwater recharge.

Chemical Data

CCDD sites are potential sources of inorganic and organic contamination to soils and groundwater. Constituents from sludge and fluids may percolate through the floor of an unlined pit or cell into shallow aquifers, or overflow berms and infiltrate soils outside of the permitted disposal area. Sludge solids may also provide leachable sources of constituents to shallow aquifers. Chemical analyses of pit or cell contents, therefore, provide a list of potential constituents that could leach to adjacent soil and groundwater. Groundwater chemical data provides information on the integrity of pits or land-treatment cells (for example, landfarm cells), and on the fate of contaminated groundwater. Most State-permitted CCDD sites have been limited to accepting only water-based drilling fluids with chloride concentrations of <3,500 mg/L (Interstate Oil and Gas Commission, 1992, 1993, 1994). Oil and grease concentrations are generally limited to one percent

or less in admixtures with soils at CCDD sites where land treatment is utilized. Sites used prior to establishment of current permitting requirements may not have observed these limits.

Agency files contain a variety of chemical data from analyses of waste solids (sludge), interstitial and freestanding liquids, and groundwater from on-site monitoring wells. Site-specific data for some sites includes only analyses for one constituent (usually chloride in groundwater). Data for other sites may include a comprehensive suite of inorganic and organic analyses of pit contents and groundwater. Although chemical analytical methodologies were not documented on lab reports in agency files from most of the sites, procedures were documented for 36 of the sites in the database. Methodologies specified EPA-approved methods including U.S. Environmental Protection Agency (1983, 1986) and (ALPHA-AWWA-WPCF, 1985).

Ranges, Medians, and Means of Constituent Concentrations

Figure 5 and table 9 report the statistical distribution among reporting sites of analytical values for several constituents. Applicable plots from figure 5 are also used as a basis for comparison for constituent data compiled for individual sites. Reported concentrations are mean values for specified constituents calculated at each documented site. Means represent as few as one value for a few sites to more than 100 values. All available data from sites showing detectable concentrations of specific constituents were used in statistical calculations. Concentrations reported to be below detection limits were not included in statistical calculations (i.e., values of zero were not used in calculation of the mean or median). Analytical values variously represent time-dependent measurements from one or more sample locations (for example, 10 measurements from one monitoring well collected over a time period), to one or more samples collected from numerous locations at a site (for example, one measurement taken at each of ten monitoring wells at a site).

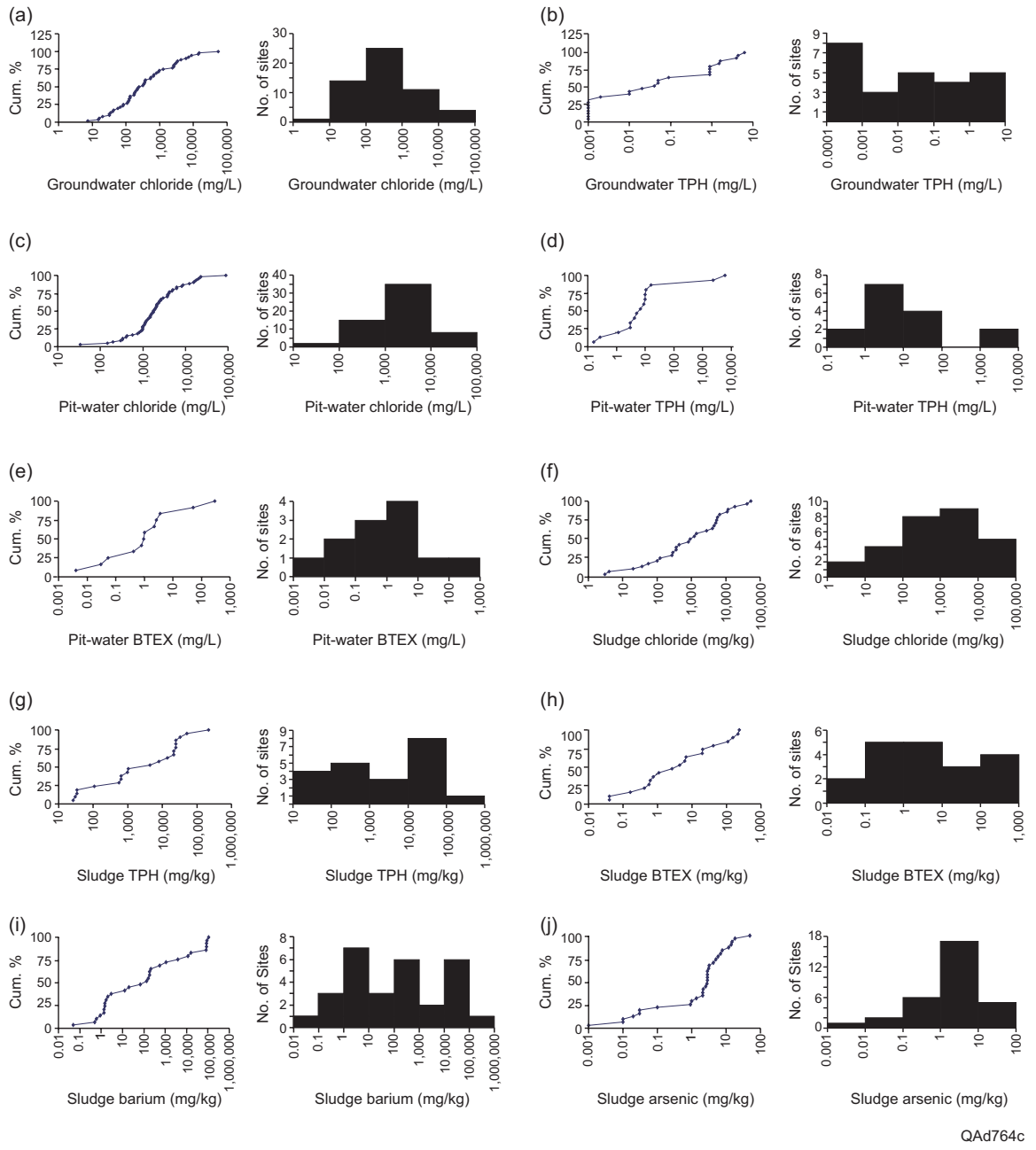

Figure 5. Cumulative and frequency graphs for selected constituents in groundwater and disposal pit contents: (a) chloride in groundwater, (b) TPH in groundwater, (c) chloride in sump water, (d) TPH in pit water, (e) BTEX in sump water, (f) chloride in sludge, (g) TPH in sludge, (h) BTEX in sludge, (i) arsenic in sludge, and (j) barium in sludge. Applicable plots are used (Figs. 6-37) as bases for comparison of individual sites with all sites in the database.

Table 9. Comparison between authorized and abandoned sites for site-average concentrations of constituents in pit sludge and groundwater. Boldface type indicates average is greater than maximum average for active and inactive sites.

Pit Sludge (mg/kg except pH)

	Active and inactive sites			Abandoned sites		
COC	No.	Range	Max Ave	No.	Range	Max Ave.
pH	–	NA	NA	–	NA	NA
TDS	–	NA	NA	–	NA	NA
Arsenic	23	ND-49.3	49.3	19	ND-15.5	15
Barium	15	0.05-105,975	105,975	19	0.5-162,750	**162,750**
Cadmium	15	ND-11.27	11.27	19	ND-4.5	4.5
Chloride	18	4-41,504	41,504	11	36-6,007	6,007
Chromium	22	ND-139.7	139.7	20	ND-286	**286**
Lead	20	ND-145.4	145.40	20	ND-176.2	**176.2**
Mercury	17	ND-271	271	15	ND-2.1	2.1
Selenium	15	ND-68.01	68.01	18	ND-39.7	39.7
Silver	16	ND-1.913	1.913	15	ND-5.5	**5.5**
Zinc	10	ND-1,382	1,382	15	ND-842	842
TPH	7	<0.0002-3.246	3.246	16	ND-40,329	**40,329**
BTEX	1	0.158	0.158	3	6.5-25.1	**25.1**
Benzene	13	<0.0002-14.6	14.6	9	ND-2.1	2.1
Toluene	13	ND-46.6	46.6	8	ND-1,071	1.071
Ethylbenzene	13	ND-22.4	22.4	9	ND-3.1	3.1
Xylene	9	0.0002-28	28	12	ND-15.5	15.5

Groundwater (mg/L except pH)

	Active and inactive sites			Abandoned sites		
COC	No.	Range	Max Ave	No.	Range	Max Ave.
pH	45	6.7-12.2	12.2	9	6.2-8.1	8.1
TDS	35	9-33,658	33,658	9	130-18,730	18,730
Arsenic	18	ND-0.14	0.14	9	<0.005-0.02	0.02
Barium	19	0.22-2.4	2.4	9	0.073-3.6	**3.6**
Cadmium	6	0.003-5	5	9	<0.005-0.025	0.025
Chloride	47	7-54247	54,247	10	125-13,859	13,859
Chromium	18	ND-16	16	8	<0.005-0.235	0.235
Lead	19	ND-0.49	0.49	9	<0.005-0.24	0.24
Mercury	3	<0.0001-0.09	0.09	8	<0.0005-0.002	0.002
Selenium	3	ND-0.104	0.104	8	<0.001-<0.1	<0.1
Silver	2	<0.002-0.003	0.003	7	<0.005-<0.02	<0.02
Zinc	16	0.01-95.6	95.6	5	0.04-0.24	0.24
TPH	3	0.043-0.138	0.138	2	ND-0.138	0.138
BTEX	0	NA	NA	2	ND-0.025	0.025
Benzene	11	ND-0.926	0.926	3	ND-0.019	0.019
Toluene	11	ND-0.557	0.557	3	ND-0.031	0.031
Ethylbenzene	11	ND-0.194	0.194	2	ND-0.004	0.004
Xylene	11	ND-0.082	0.082	2	ND-0.023	0.023

No. − Number of sites in database for which indicated analyses were available
NA − Not available
ND − Not detected

The distribution among CCDD sites of concentrations shown for specific constituents in figure 5 and table 9 span several orders of magnitude. Ranges of mean values are greatest for barium in sludge (fig. 5i), with a ratio of 2.1 million between the highest and lowest sludge barium average values, and are smallest for chloride in pit water, with a ratio of 7.3 thousand between the highest and lowest value. The constituent list in order of decreasing *range* (in terms of the ratio of the largest site-mean to the smallest site-mean) is:

(1) barium in sludge,

(2) BTEX in pit or sump water,

(3) arsenic in sludge,

(4) TPH in pit or sump water,

(5) chloride in sludge,

(6) TPH in sludge,

(7) chloride in groundwater,

(8) TPH in groundwater,

(9) BTEX in sludge, and

(10) chloride in pit or sump water.

Values at the upper limit of constituent concentration cause mean-concentration values to be significantly higher than median-concentration values for the same constituents. Divergence between mean and median values is greatest for barium in sludge (fig. 5i) with a ratio of 246:1 between the mean and median. Divergence is smallest for arsenic in sludge (fig. 5j) with a ratio of 2:1 between the mean and median. Arranged in order of decreasing *divergence between mean and median values* the constituent list becomes:

(1) barium in sludge,

(2) TPH in pit water,

(3) TPH in groundwater,

(4) TPH in sludge,

(5) BTEX in sludge,

(6) chloride in groundwater,

(7) chloride in sludge

(8) BTEX in pit water,

(9) chloride in pit water, and

(10) arsenic in sludge.

CCDD Site-specific Data

The following section presents graphical information for 33 drilling-fluid disposal sites for which sufficient information was available to produce maps of chloride distributions in groundwater. For 13 of these sites mappable water-level data were also available. Data for all constituents (depicted on histograms) were not available for every site. Similarly, time-dependent data, such as presented for two sites, was not available for every site.

Louisiana Sites

Bateman Island Site

The Bateman Island (fig. 6) is a landfarm near Bayou Boeuf in St. Mary's Parish, Louisiana. Drilling fluid wastes are treated in cells and then spread in a regulated manner over the landscape. The site consists of 15 treatment cells with a cumulative areal coverage of approximately 0.3 km^2 (3.4 million ft^2) and has 20 monitoring wells located within the site and

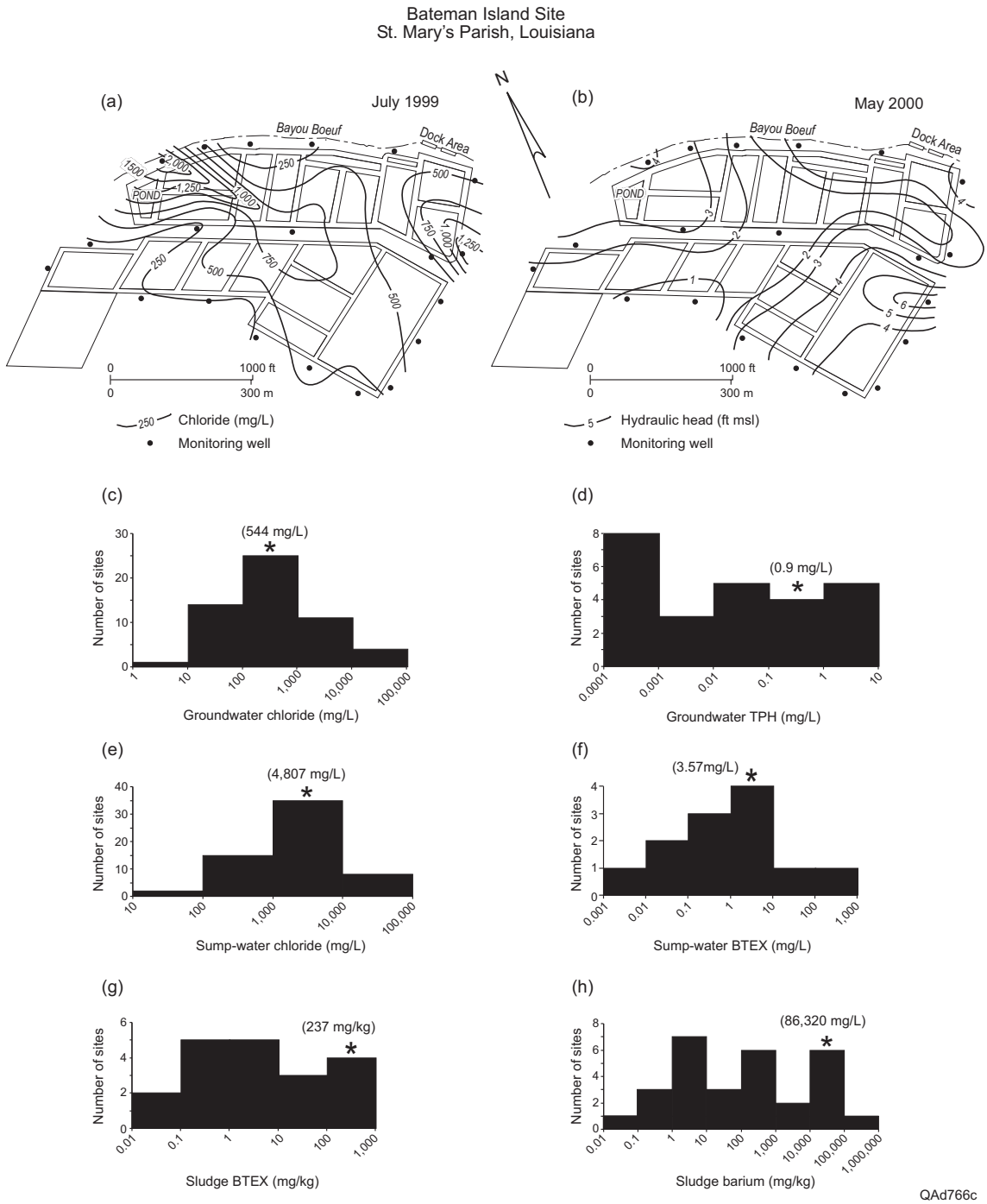

Figure 6. Bateman Island site, St. Mary's Parish, Louisiana: maps show (a) distribution of chloride in groundwater, and (b) water levels Histograms show (c) mean chloride in groundwater, (d) mean total petroleum hydrocarbons in groundwater, (e) mean chloride in pit water, (f) mean BTEX in pit water, (g) mean BTEX in pit sludge, (h) mean barium in pit sludge. Histograms in (c) to (h) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Bateman Island site. Mean concentration for site in parentheses.

along its perimeter. Comparisons of the Bateman Island site to all the other sites for chloride and TPH in groundwater; TPH and BTEX in sump water; and BTEX and barium in sludge are shown in figures 6 c-h. Distributions of chloride values in groundwater (fig. 6a) show local maximum concentrations (1,250 to over 2000 mg/L) in the east and north, near the margins of the site. These values exceed the SMCL for chloride in drinking water (250 mg/L). Chloride values may reflect the presence of two chloride plumes whose sources appear to be near the margins of the site where chloride values show local maximums. However, lack of off-site background chloride data precludes determination of an on-site chloride source. The water-level map (fig. 6b) shows mounding in the northern and southern corners of the site.

Big Diamond Site

Big Diamond site (fig. 7) is near Black Bayou in Cameron Parish, Louisiana. The site consists of five pits with a cumulative areal coverage of approximately 0.1 km^2 (1.42 million ft^2) and has 12 monitoring wells located along its perimeter. Comparisons of Big Diamond site to all the other sites for chloride in groundwater, chloride in pit water, TPH in sludge, and barium in sludge are shown in figures 7 c-f. Distributions of chloride values in groundwater (fig. 7a) show local maximum concentrations (5,000 to over 10,000 mg/L) in the south and northeast parts of the site, respectively. These values exceed the SMCL for chloride in drinking water (250 mg/L) and the high reported value exceeds the EPA's salinity limits (10,000 mg/L TDS) for an underground source of drinking water (USDW). Chloride values may reflect the presence of two chloride plumes whose sources appear to be near the margins of the site where chloride values show local maximums. However, lack of off-site background chloride data precludes determination of an on-site chloride source. The water-level map (fig. 7b) shows mounding in the northern part of the site.

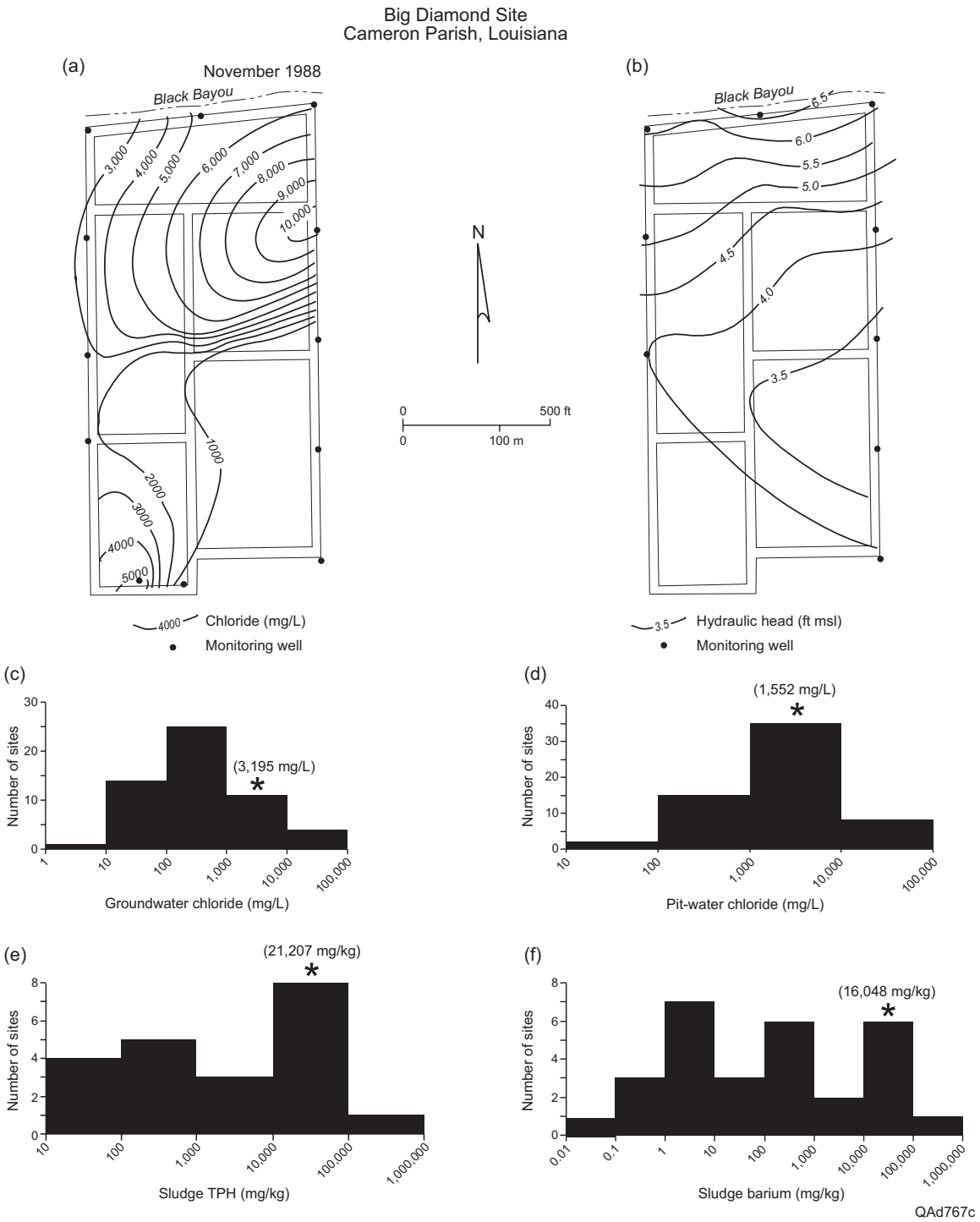

Figure 7. Big Diamond site, Cameron Parish, Louisiana: maps show (a) distribution of chloride in groundwater and (b) water levels. Histograms show (c) mean chloride in groundwater, (d) mean chloride in pit water, (e) mean TPH in pit sludge, (f) mean barium in pit sludge at CCDD sites. Histograms in (c) to (f) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Big Diamond site. Mean concentration for site in parentheses.

Bourg Site

The Bourg site (fig. 8) is on Louisiana State Highway 24 near Bayou Blue and St. Louis Canal in Lafrouche Parish, Louisiana. The site consists of 18 treatment cells with a cumulative areal coverage of approximately 0.3 km^2 (3.42 million ft^2) and has 14 monitoring wells located within the site and along its perimeter. Comparisons of the Bourg site to all the other sites for chloride in groundwater, TPH in groundwater, TPH in sump water, and barium in sludge are shown in figures 8 c-f. Distributions of chloride values in groundwater (fig. 8a) show local maximum concentrations (2,000 to over 2,250 mg/L) in the north and southeast parts of the site, respectively. These values exceed the SMCL for chloride in drinking water (250 mg/L). Notably, distributions of chloride values in groundwater define a low in chloride near the center of the site that corresponds to the location of a water-level maximum (fig. 8b). Correspondence of low chloride with the center of a groundwater mound suggests that constituents may be flushed toward the perimeter of the site by radial flow away from the center of the mound. However, lack of off-site background chloride data precludes determination of an on-site chloride source.

Elm Grove Site

The Elm Grove site (fig. 9) is in Bossier Parish, Louisiana. The site consists of ten treatment cells with a cumulative areal coverage of approximately 0.1 km^2 (1.35 million ft^2) and has six monitoring wells located along its perimeter. Comparisons of the Elm Grove site to all the other sites for chloride and TPH in groundwater, TPH in sump water, and TPH and barium in sludge are shown in figures 9 b-f. Distributions of chloride values in groundwater (fig. 9a) show local maximum concentrations (over 300 mg/L) in the north part of the site and may define a plume with a north-northwest to south-southeast axis. These values exceed the SMCL for chloride in drinking

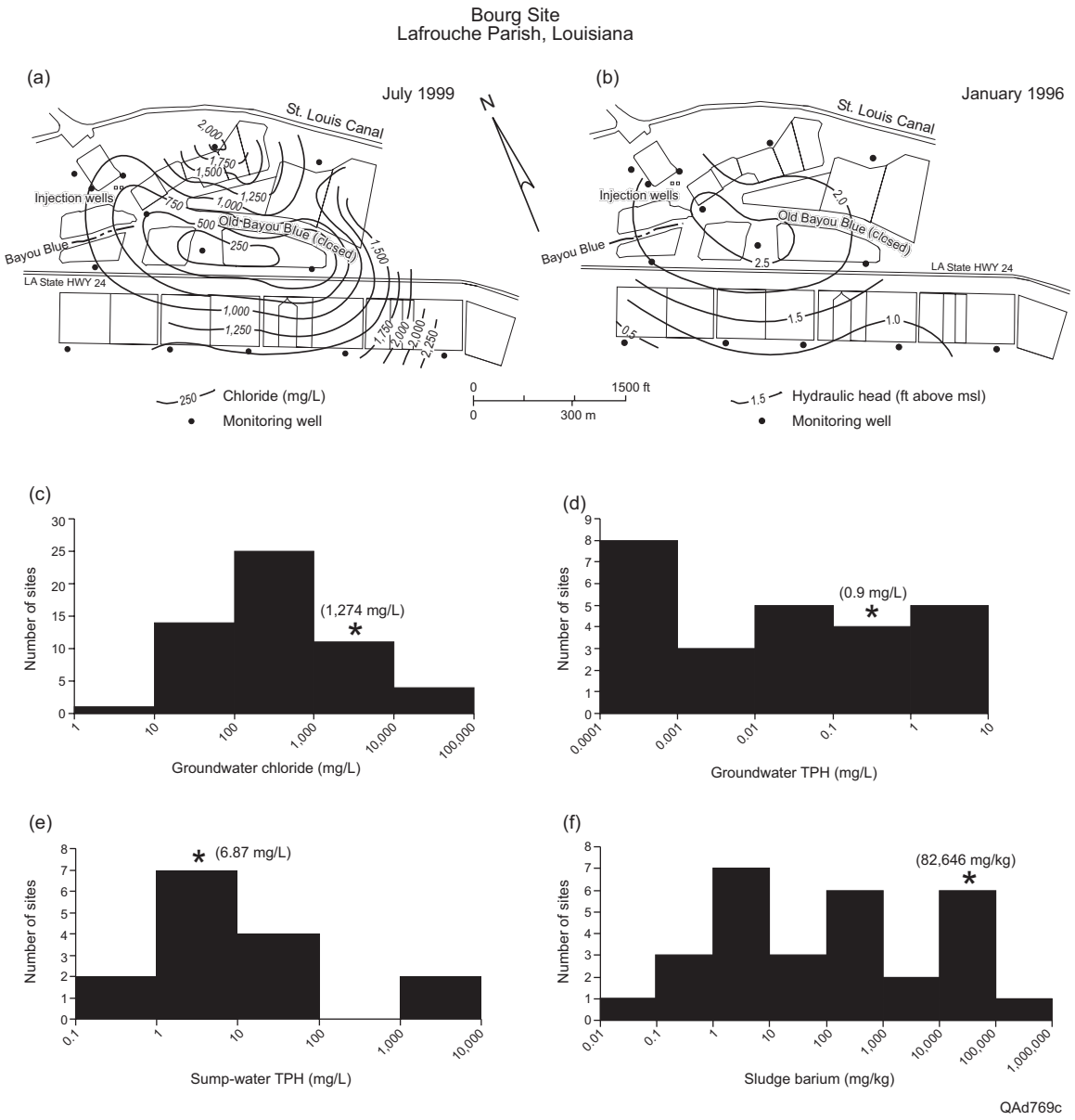

Figure 8. Bourg site, Lafrouche Parish, Louisiana: maps show (a) distribution of chloride in groundwater, and (b) water levels. Histograms show (c) mean chloride in groundwater, (d) mean TPH in groundwater, (e) mean TPH in sump water, and (f) mean barium in sludge. Histograms in (c) to (f) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Bourg site. Mean concentration for site in parentheses.

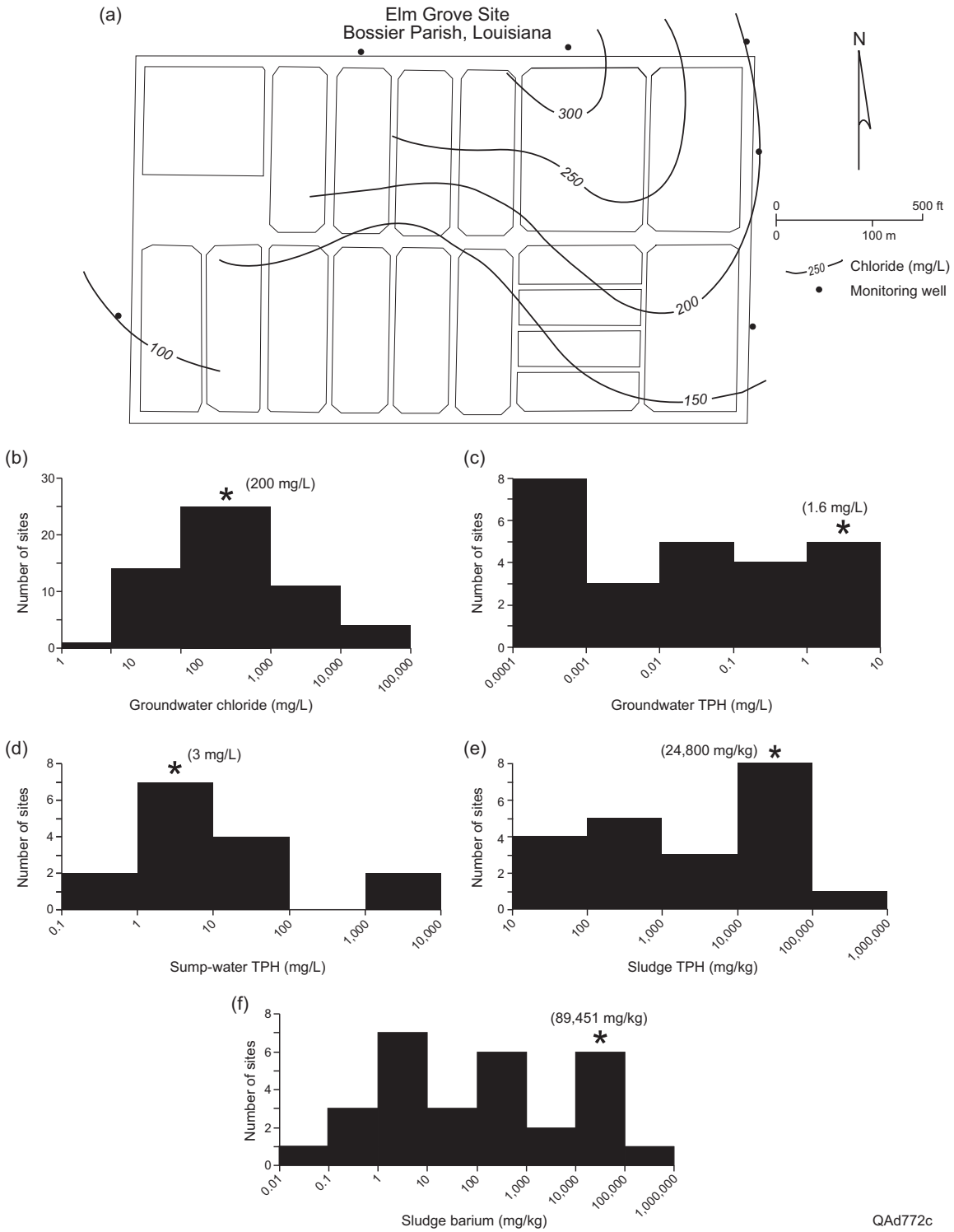

Figure 9. Elm Grove site, Bossier Parish, Louisiana: map shows (a) distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, (c) mean TPH in groundwater, (d) mean TPH in sump water, (e) mean TPH in sludge, and (f) mean barium in sludge. Histograms in (b) to (f) for all sites in the study sample (fig. 5). * mean for the Elm Grove site, mean concentration in parentheses.

water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

Laccassine Site

The Laccassine site (fig. 10) is in Jefferson Davis Parish, Louisiana. The site consists of 11 treatment cells with a cumulative areal coverage of approximately 0.6 km^2 (5.95 million ft^2) and has nine monitoring wells located along its perimeter. Comparisons of the Laccassine site to all the other sites for chloride in groundwater and sump water, and TPH in sludge are shown in figures 10 b-d. Distributions of chloride values in groundwater (fig. 10a) show local maximum concentrations (over 600 and 900 mg/L) in the southeast and southwest parts of the site, respectively, and may define two separate plumes, each apparently emanating from the locations of local maximum chloride concentrations. These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

Lafrouche Site

The Lafrouche site (fig. 11) is in Lafrouche Parish, Louisiana. The site consists of five treatment cells with a cumulative areal coverage of approximately 0.1 km^2 (1.31 million ft^2) and has 15 monitoring wells located within the site and along its perimeter. Comparisons of the Lafrouche site to all the other sites for chloride and TPH in groundwater are shown in figures 11 b-c. Distributions of chloride values in groundwater (fig. 11a) show local maximum concentrations (over 400-500 mg/L) in four separate locations, and may define four separate plumes, each apparently emanating from the locations of local maximum chloride concentrations in groundwater.

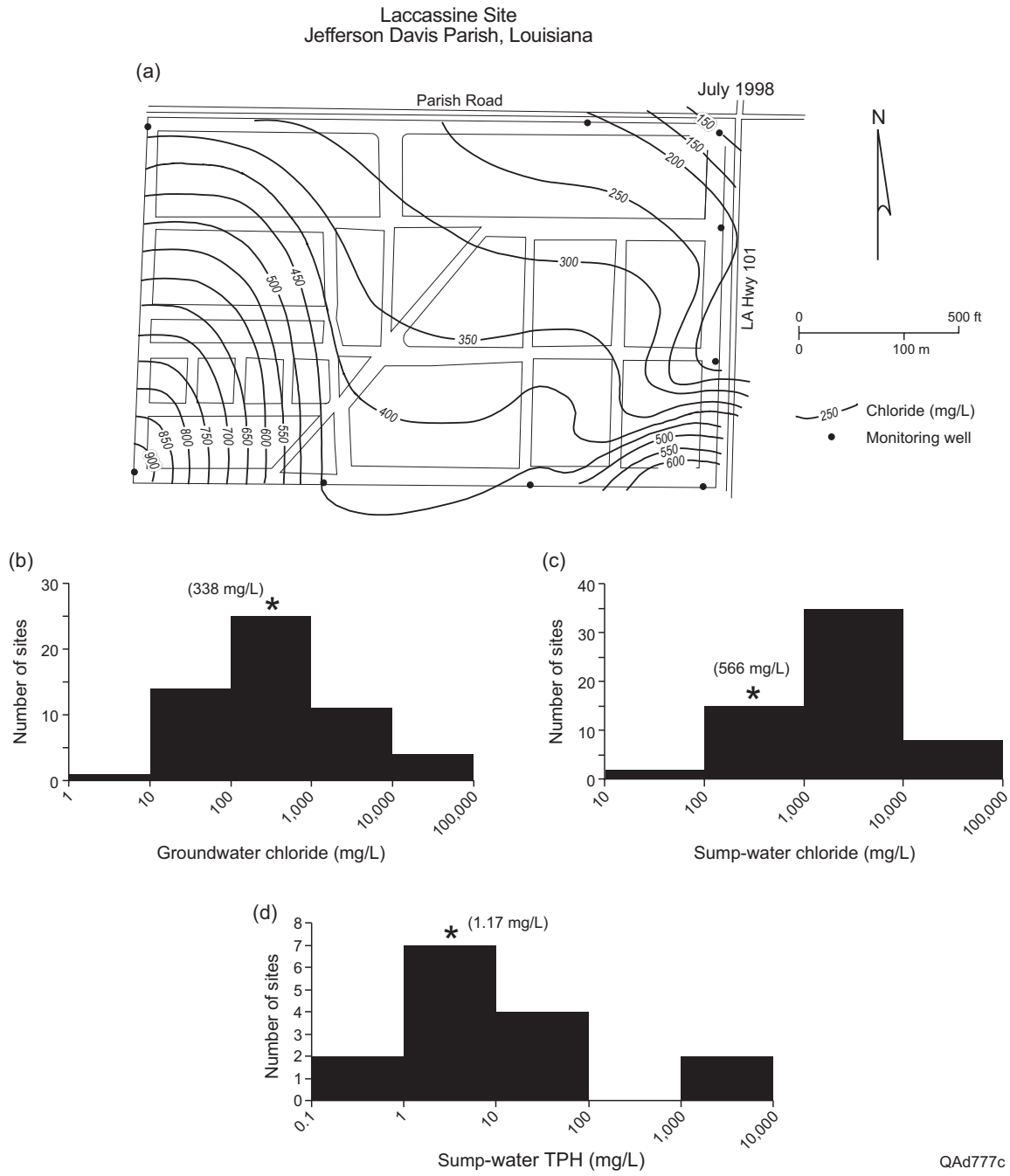

Figure 10. Laccassine site, Jefferson Davis Parish, Louisiana: map shows (a) distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, (c) mean chloride in sump water, and (d) mean TPH in sump water. Histograms in (b) to (d) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Laccassine site. Mean concentration for site in parentheses.

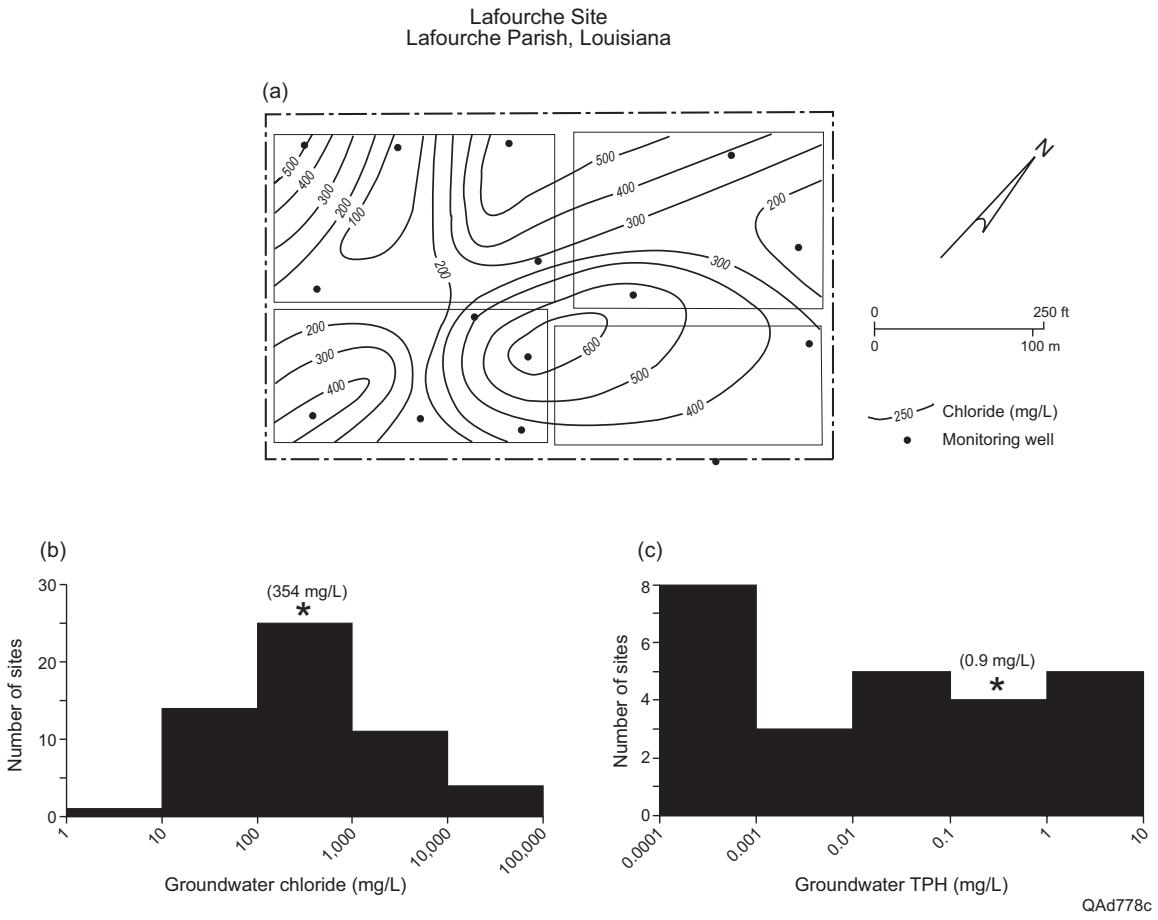

Figure 11. Lafrouche site, Lafrouche Parish, Louisiana: map shows (a) distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, and (c) mean TPH in groundwater. Histograms in (b) and (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Lafrouche site. Mean concentration for site in parentheses.

These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

MAR Site

The MAR site (fig. 12) is near Bayou Carancro and Coulee Croche in St. Landry Parish, Louisiana. The site consists of four treatment cells with a cumulative areal coverage of approximately 0.1 km^2 (1.3 million ft^2) and has 14 monitoring wells located within the site and along its perimeter. The site also includes a centrally located saltwater injection well. Comparisons of the MAR site to all the other sites for chloride in groundwater, TPH in groundwater, and TPH in sump water are shown in figures 12 c-e. Distributions of chloride values in groundwater (fig. 12a) show locally very high concentrations (over 25,000 mg/L) in the northwest and southeast parts of the site, and appear to define two separate plumes, each emanating from the locations of local maximum chloride concentrations. These values exceed the SMCL for chloride in drinking water (250 mg/L) and the high reported value exceeds the EPA's salinity limits (10,000 mg/L TDS) for an underground source of drinking water (USDW). However, lack of off-site background chloride data precludes determination of an on-site chloride source. None of the origins of higher salinity appear associated with the injection well. The water-level map (fig. 12b) shows a decrease in water levels, and thus a potential for flow, toward the site-bounding bayou and coulee. Corresponding plume gradients and water levels distributions may reflect discharge of chloride-enriched groundwater toward the two waterways.

Mermentau Site

The Mermentau site (fig. 13) is in Jefferson Davis Parish, Louisiana. The site consists of 25 treatment cells with a cumulative areal coverage of approximately 0.4 km^2 (4.7 million ft^2) and has

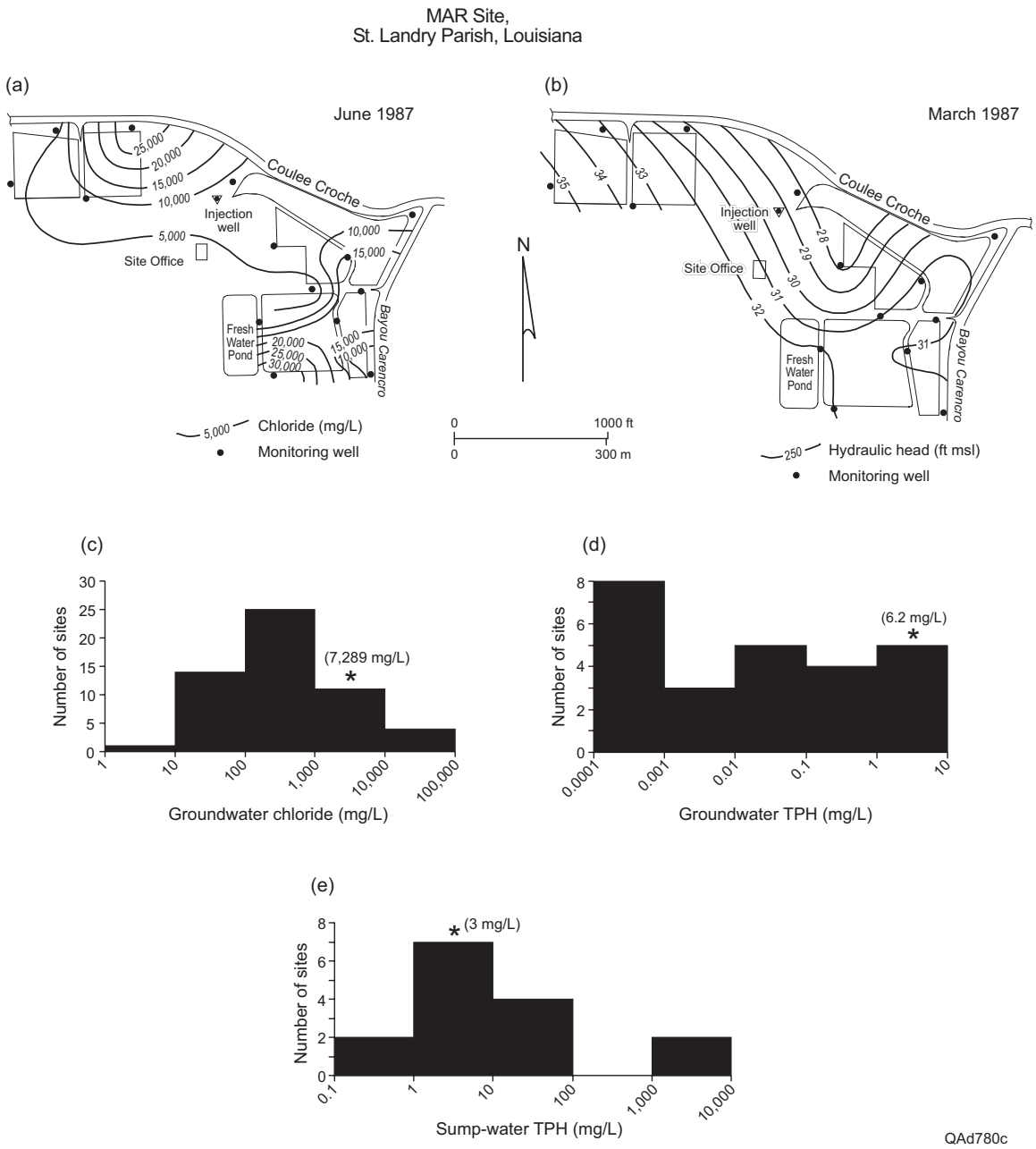

Figure 12. Mar site, St. Landry Parish, Louisiana: maps show (a) distribution of chloride in groundwater, and (b) water levels Histograms show (c) mean chloride in groundwater, (d) mean TPH in groundwater, and (e) mean TPH in sump water. Histograms in (c) to (e) for all sites in the study sample (fig. 5). Star (*) indicates mean for the MAR site. Mean concentration for site in parentheses.

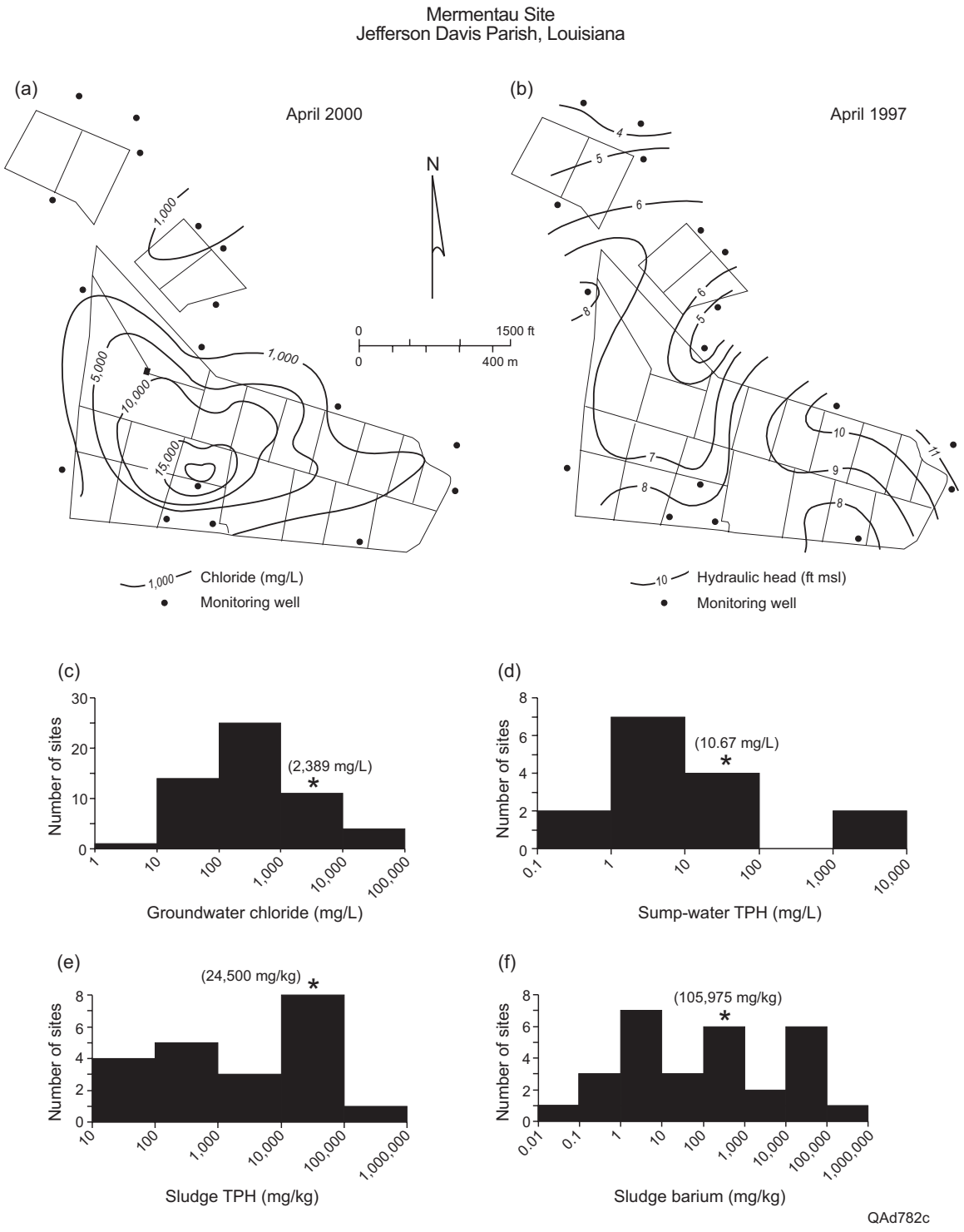

Figure 13. Mermentau site, Jefferson Davis Parish, Louisiana: maps show (a) distribution of chloride in groundwater, and (b) water levels. Histograms show (c) mean chloride in groundwater, (d) mean TPH in sump water, (e) mean TPH in sludge, and (f) mean barium in sludge. Histograms in (c) to (f) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Mermentau site. Mean concentration for site in parentheses.

17 monitoring wells located within the site and along its perimeter. Comparisons of the Mermentau site to all the other sites for chloride in groundwater, TPH in sump water, TPH in sludge, and barium in sludge are shown in figures 13 c-f. A locally very high concentration (almost 20,000 mg/L) occurs in the south-central part of the site (fig. 13a). The area within the 1,000-mg/L contour suggests the presence of a plume that is similar in shape to the area that contains the main group of pits and originates in the south-central part of the site. These values exceed the SMCL for chloride in drinking water (250 mg/L) and the high reported value exceeds the EPA's salinity limits (10,000 mg/L TDS) for an underground source of drinking water (USDW). However, lack of off-site background chloride data precludes determination of an on-site chloride source. The water-level map (fig. 13b) shows local mounding in the east and west parts of the site.

Reliable Site

The Reliable site (fig. 14) in Pointe Coupee Parish, Louisiana. The site consists of four treatment cells with a cumulative areal coverage of approximately 0.1 km^2 (1.1million ft^2) and has ten monitoring wells located within the site and along its perimeter. Comparisons of the Reliable site to all the other sites for chloride in groundwater, TPH in groundwater, chloride in sump water, and TPH in sump water are shown in figures 14 c-f. Distributions of chloride values in groundwater (fig. 14a) show a local maximum concentration (over 450 mg/L) in the southwestern part of the site and may define a plume that is concentrated in the southern part of the site and is elongate along an east-west axis. These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source. The water-level map (fig. 14b) shows local mounding in the west-central part of the site.

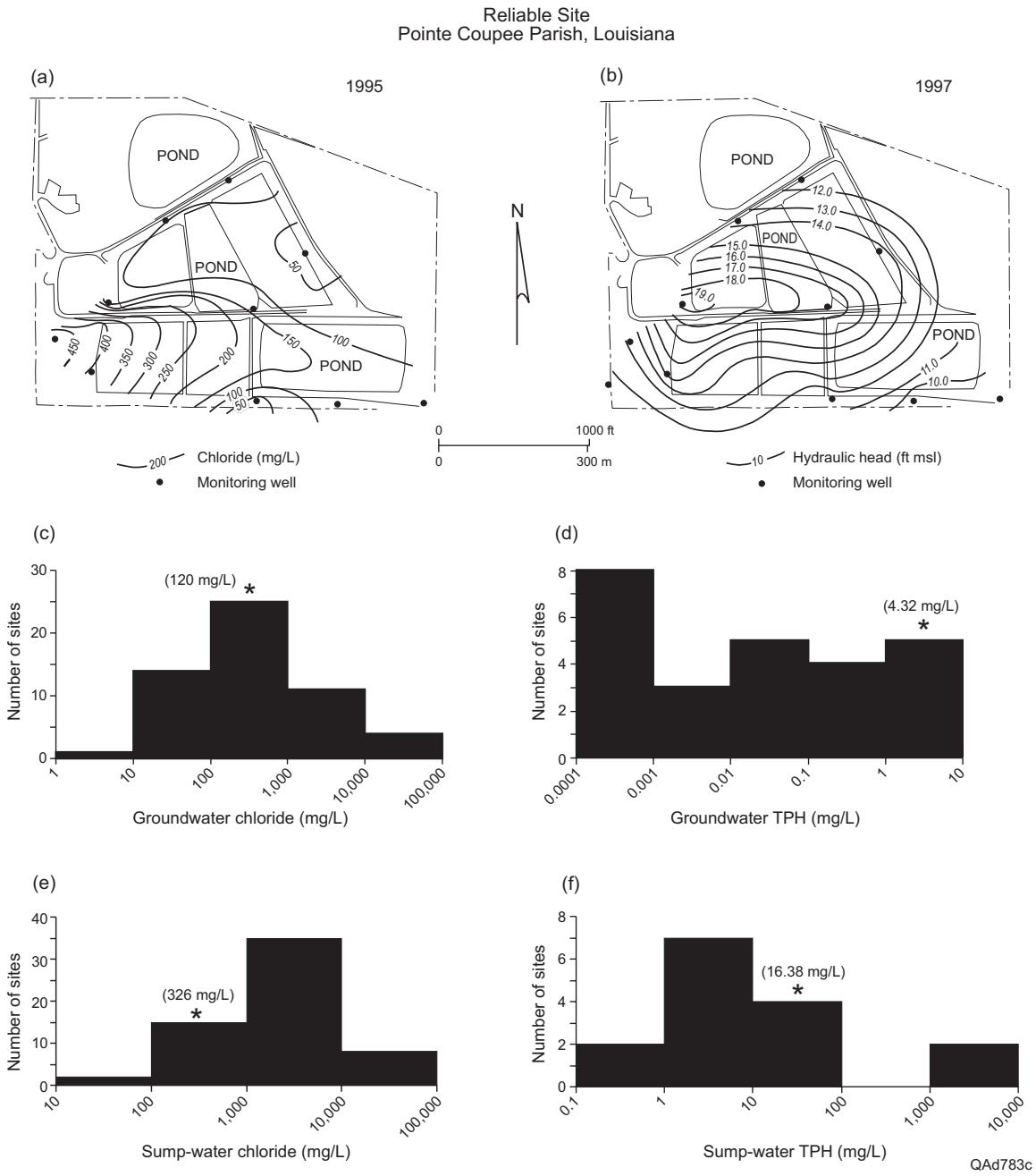

Figure 14. Reliable site, Pointe Coupee Parish, Louisiana: maps show (a) distribution of chloride in groundwater, and (b) water levels. Histograms show (c) mean chloride in groundwater, (d) mean TPH in groundwater, (e) mean chloride in sump water, and (f) mean TPH in sump water. Histograms in (c) to (f) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Reliable site. Mean concentration for site in parentheses.

Waguespack Site

The Waguespack site (fig. 15) is near Bayou Petite Anse in Iberia Parish, Louisiana. The site consists of seven pits with a cumulative areal coverage of approximately 0.04 km^2 (447,000 ft^2) and has eight monitoring wells located within the site and along its perimeter. Comparisons of the Waguespack site to all the other sites for chloride in groundwater and pit water are shown in figures 15c-d. Distributions of chloride values in groundwater (fig. 15a) show a local maximum concentration (over 600 mg/L) in the northern part of the site and appear to define a plume that is concentrated in the northern part of the site and has lobes extending toward the south and east. These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source. The Waguespack example demonstrates the shortcomings of evaluating a site with monitoring wells distributed around its perimeter; an off-site source could produce the distribution of chloride concentrations. However, the water-level map (fig. 15b) shows local mounding in the east-central part of the site. Implied flow is toward the north and south perpendicular to the steeper gradients, which can explain freshening of groundwater in those directions and maintenance of higher concentrations of on-site originated chloride beneath the west-northwest-trending mound axis.

New Mexico Sites

CRI Halfway Site

The CRI Halfway site (fig. 16) is near Laguna Plata in Lea County, New Mexico. The site consists of at least two pits with a cumulative areal coverage of approximately 1.1 km^2 (11.32 million ft^2) and has six monitoring wells located within the site and along its perimeter. Comparisons of the CRI Halfway site to all the other sites for chloride in groundwater, BTEX in

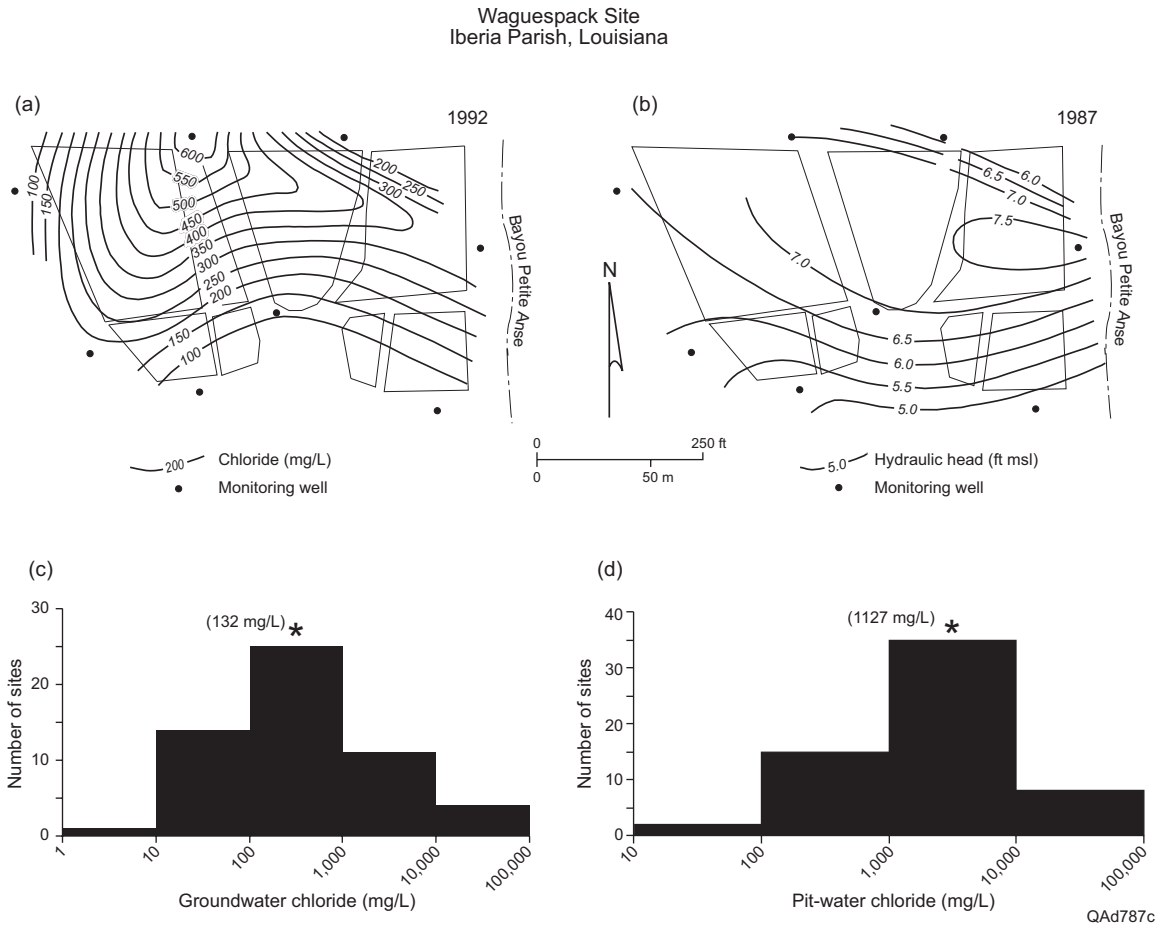

Figure 15. Waguespack site, Iberia Parish, Louisiana: maps show (a) distribution of chloride in groundwater, and (b) water levels. Histograms show (c) mean chloride in groundwater, and (d) mean chloride in pit water. Histograms in (c) and (d) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Waguespack site. Mean concentration for site in parentheses.

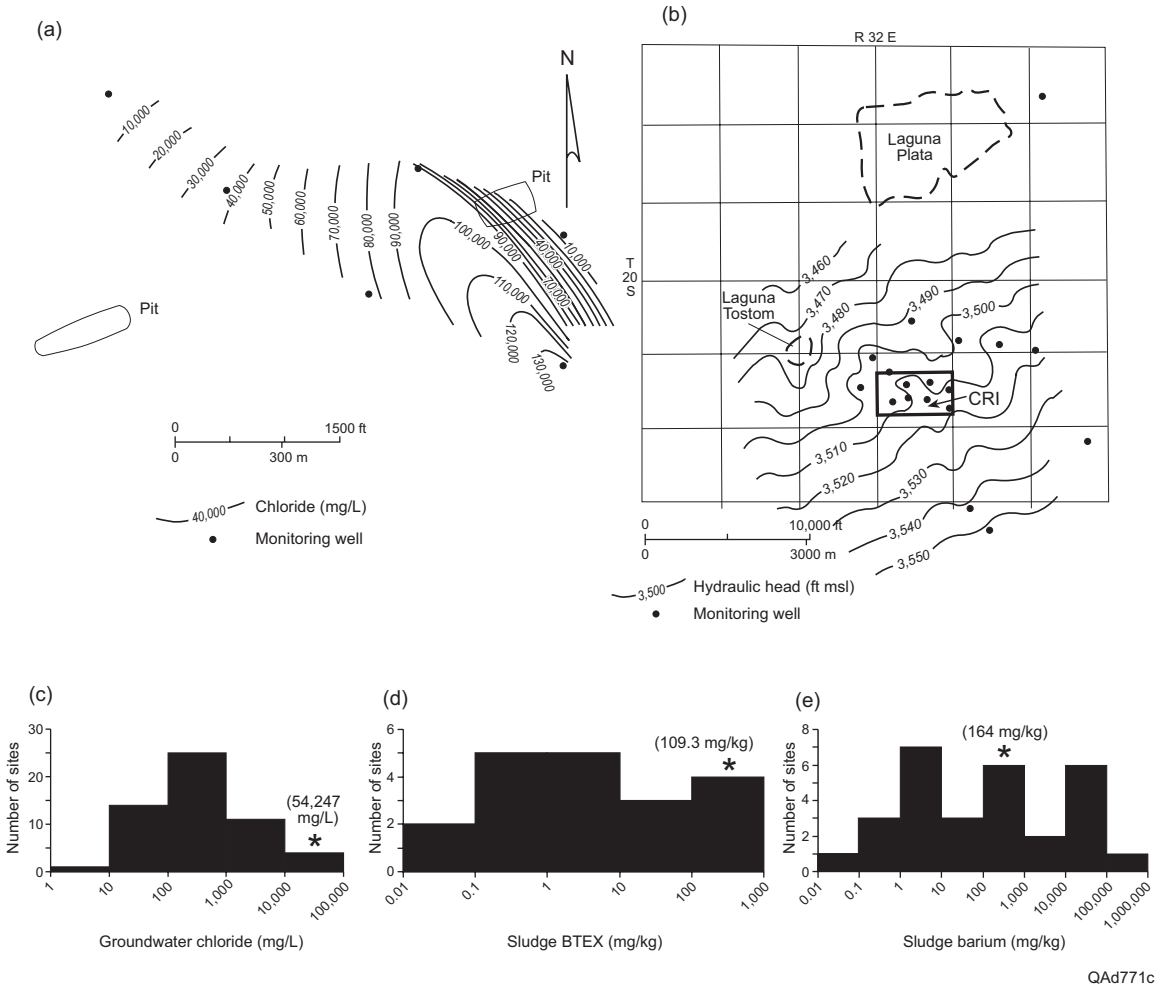

Figure 16. CRI Halfway site, Lea County, New Mexico: maps show (a) distribution of chloride in groundwater, and (b) water levels (map from agency files). Maps show (c) mean chloride in groundwater, (d) mean BTEX in pit sludge, and (e) mean barium in pit sludge. Histograms in (c) to (e) for all sites in the study sample (fig. 5). Star (*) indicates mean for the CRI Halfway site. Mean concentration for site in parentheses.

sludge, and barium in sludge are shown in figures 16c-e. Distributions of chloride values in groundwater (fig. 16a) show a locally very high concentration (over 130,000 mg/L) in the southeastern part of the site and may define a plume that is concentrated in the southeastern part of the site and is elongate along a northwestern-trending axis. These values exceed the SMCL for chloride in drinking water (250 mg/L) and the high reported value exceeds the EPA's salinity limits (10,000 mg/L TDS) for an underground source of drinking water (USDW). However, lack of off-site background chloride data precludes determination of an on-site chloride source. The regional water-level map (fig. 16b) covers an area about 15 times larger than the site and depicts local groundwater mounding over the sight.

Oklahoma Sites

Bluff Site

The Bluff site (fig. 17) is in Major County, Oklahoma. The site consists of two pits with a cumulative areal coverage of approximately 0.06 km^2 (613, 000 ft^2) and has ten monitoring wells located within the site and along its perimeter. The site also contains an injection well. Comparisons of the Bluff site to all the other sites for chloride in groundwater and TPH in sludge are shown in figures 17b and c. Distributions of chloride values in groundwater (fig. 17a) show a locally very high concentration (over 60,000 mg/L) in the northeastern part of the site and may define a plume that is concentrated in the northeastern part of the site and is elongate along a southwestern-trending axis. These values exceed the SMCL for chloride in drinking water (250 mg/L) and the high reported value exceeds the EPA's salinity limits (10,000 mg/L TDS) for an underground source of drinking water (USDW). However, lack of off-site background chloride data

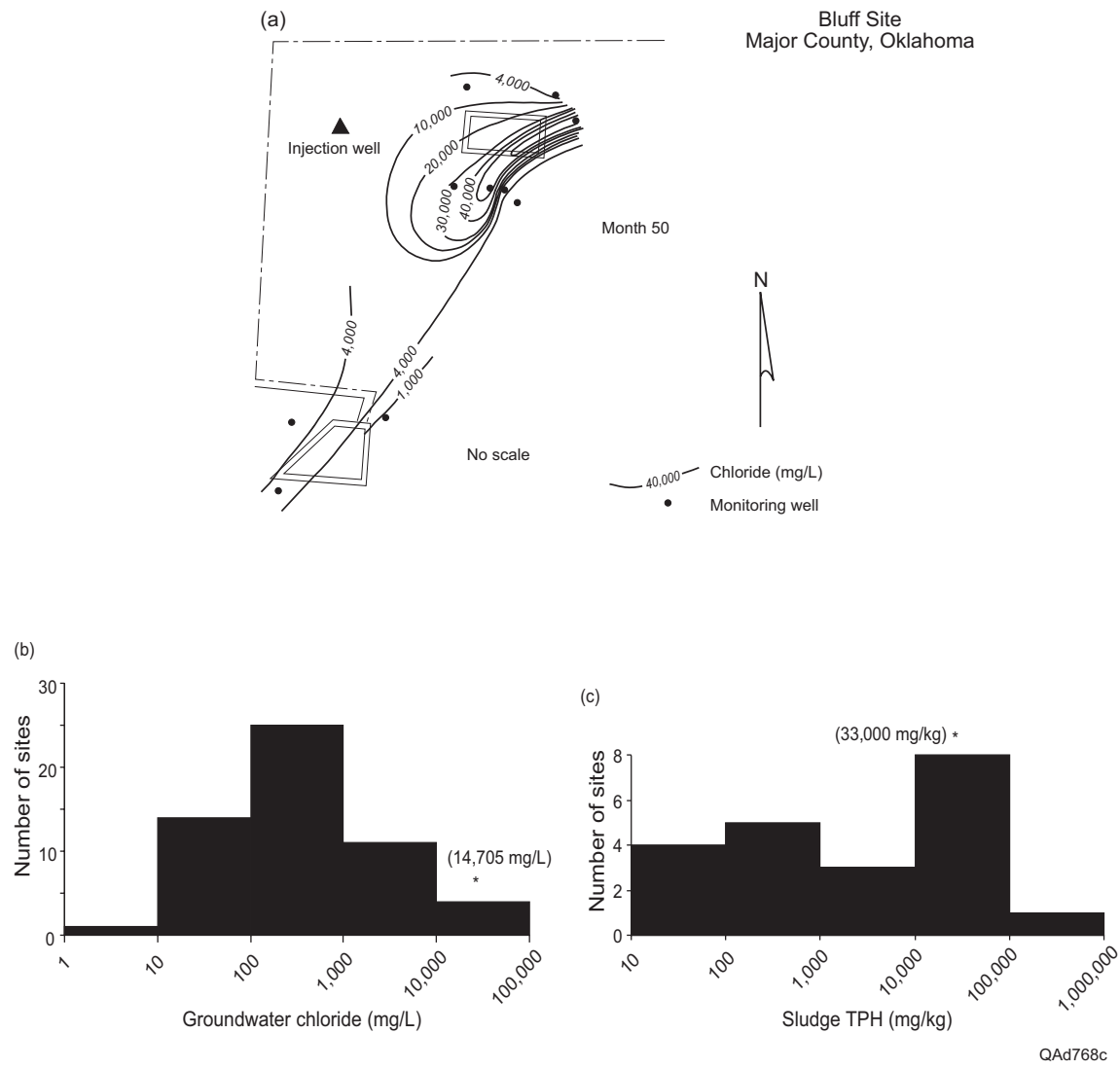

Figure 17. Bluff site, Major County, Oklahoma: (a) map shows distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, and (c) mean TPH in pit sludge at CCDD sites. Histograms in (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Bluff site. Mean concentration for site in parentheses.

precludes determination of an on-site chloride source. Chloride distributions show no influence of the injection well.

FPC Site

The FPC site (fig. 18) is in Canadian County, Oklahoma. The site consists of five pits with a cumulative areal coverage of approximately 0.04 km^2 (446,000 ft^2) and has five monitoring wells located within the eastern half of the site. The time-series graph of chloride concentrations measured at each monitoring well indicates that different wells receive peak concentrations of chloride at different times (fig. 18b). Comparisons of the FPC site to all the other sites for chloride in groundwater, TPH in groundwater, chloride in pit water, and barium in sludge are shown in figures 18c-f. Distributions of chloride values in groundwater (fig. 18a) show a maximum value (>400 mg/L) in the west-central part of the site and may define a relatively symmetrical plume that radiates from the location of maximum chloride concentration. These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

Gowen Site

The Gowen site (fig. 19) is near Pit Creek along US Highway 270 in Latimer County, Oklahoma. The site consists of one recorded pit with a cumulative areal coverage of approximately 0.001 km^2 (12,300 ft^2). Figure 19a shows seven other pits of unknown status that are in the area. Eleven monitoring wells are located within a mile of the Gowen site. Comparisons of the FPC site to all the other sites for chloride in groundwater and pit water, and barium in sludge are shown in figures 19b-d. Distributions of chloride values in groundwater (fig. 19a) show a maximum value

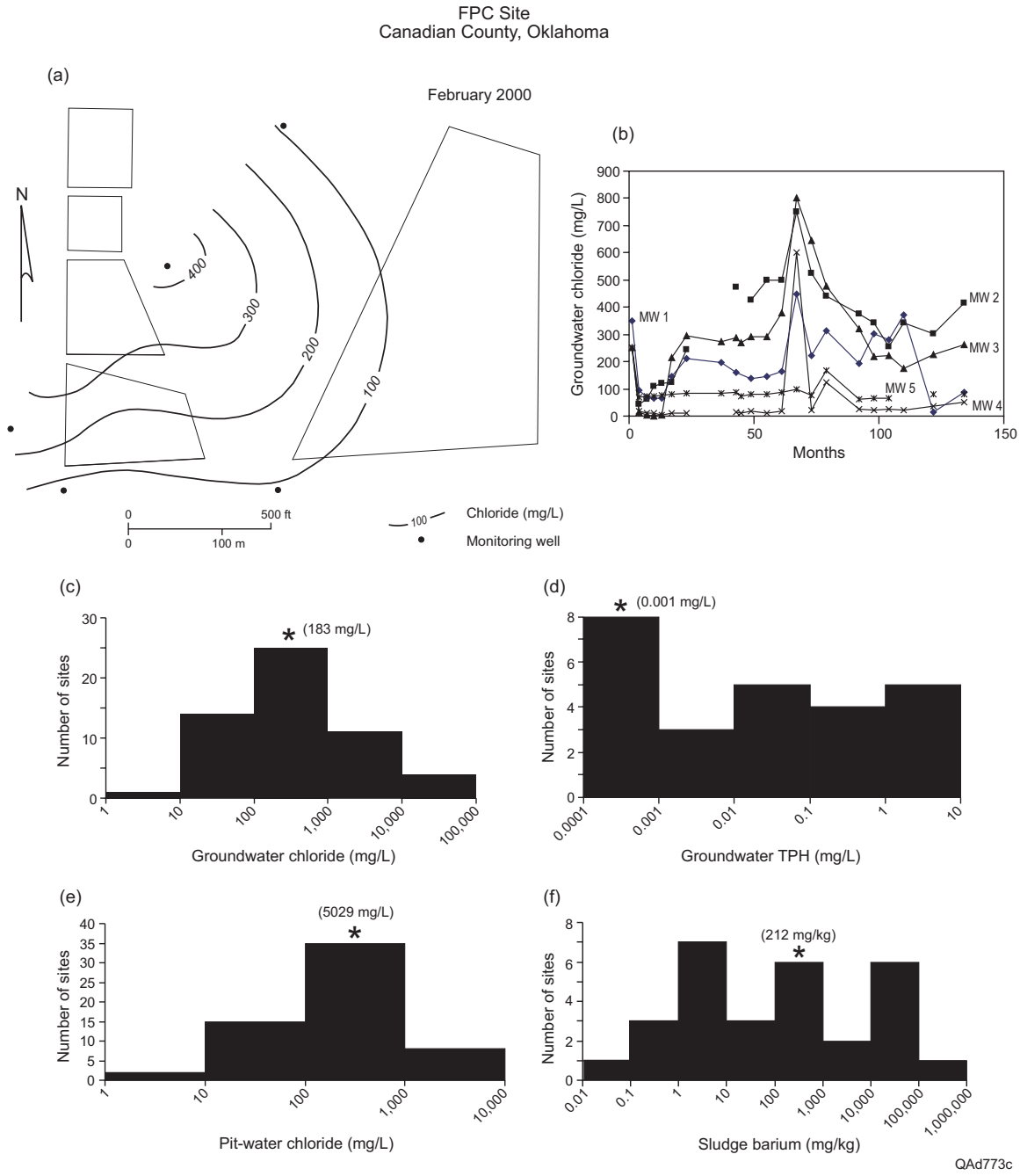

Figure 18. FPC site, Canadian County, Oklahoma: map shows (a) distribution of chloride in groundwater. (b) Time-series plot of chloride in groundwater by monitoring wells. Histograms show (c) mean chloride in groundwater, (d) mean TPH in groundwater, (e) mean chloride in pit water, and (f) mean barium in pit sludge. Histograms in (c) to (f) for all sites in the study sample (fig. 5). Star (*) indicates mean for the FPC site. Mean concentration for site in parentheses.

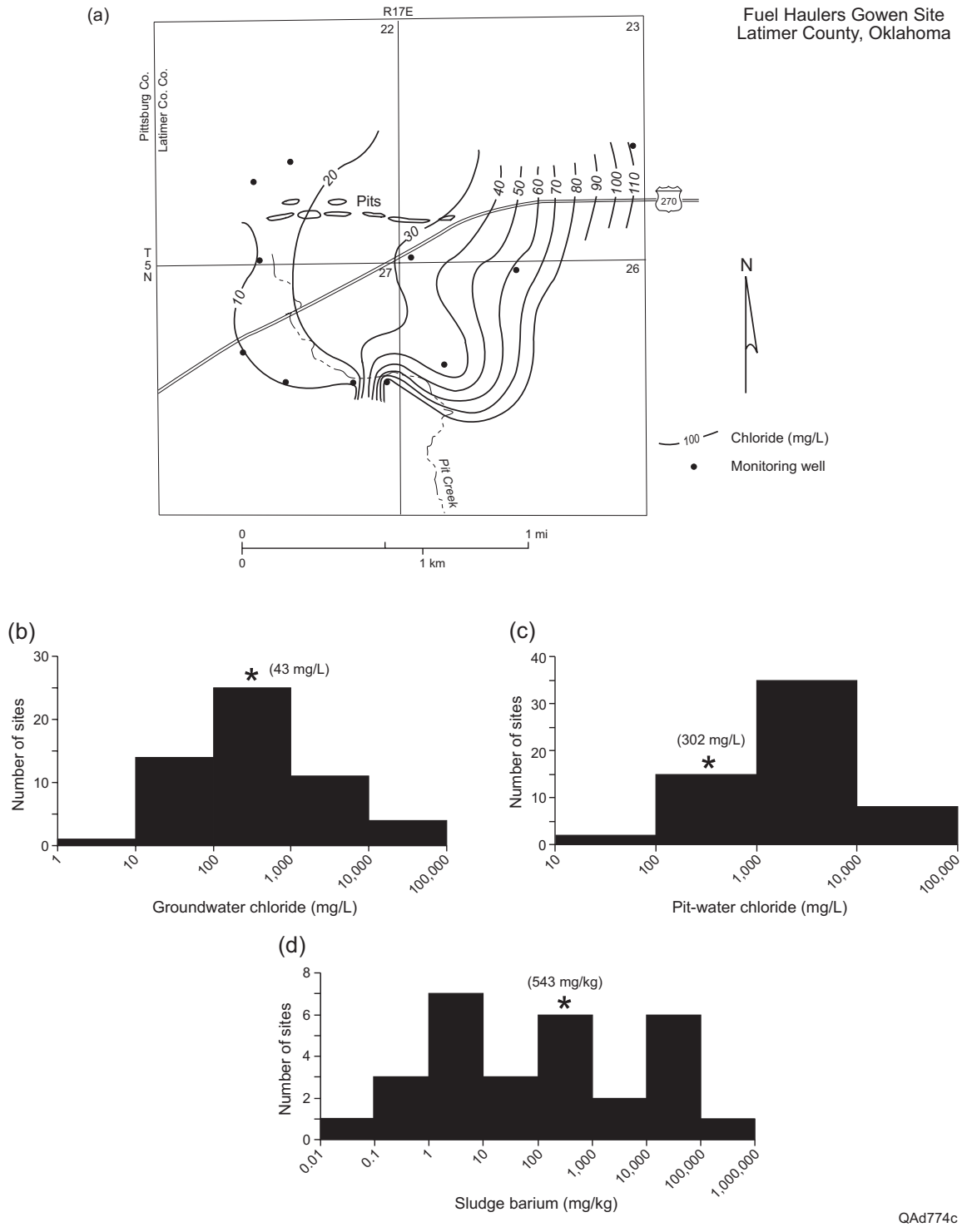

Figure 19. Gowen site, Latimer County, Oklahoma: (a) map shows distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, (c) mean chloride in pit water, and (d) mean barium in pit sludge. Histograms in (b) to (d) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Gowen site. Mean concentration for site in parentheses.

(>110 mg/L) about a mile east-northeast of the site with lower values (<30 mg/L) near the site. These data do not suggest that the Gowen site is a source of chloride contamination in the area.

Guard Site

The Guard site (fig. 20) is in Major County, Oklahoma. The site consists of three pits with a cumulative areal coverage of approximately 0.1 km^2 (1.22 million ft^2) and has seven monitoring wells located within and along the perimeter of the site. Comparisons of the Guard site to all the other sites for chloride and TPH in groundwater are shown in figures 20b and c. Distributions of chloride values in groundwater (fig. 20a) show a maximum value (>20,000 mg/L) in the southwestern part of the site and may define a plume that is elongate toward the north, with an associated lobe that extends toward the east across the middle of the site. These values exceed the SMCL for chloride in drinking water (250 mg/L) and the high reported value exceeds the EPA's salinity limits (10,000 mg/L TDS) for an underground source of drinking water (USDW). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

Kelly Site

The Kelly site (fig. 21) is in McClain County, Oklahoma. The site consists of five pits with a cumulative areal coverage of approximately 0.2 km^2 (1.8 million ft^2) and has several as yet unmapped monitoring wells. Comparisons of the Kelly site to all the other sites for chloride in groundwater and pit water, BTEX in pit water, TPH in sludge, BTEX in sludge, arsenic in sludge, and barium in sludge are shown in figures 21c-i. Samples of pit sludge were collected on a regular grid across the site and were not composited prior to analysis. The distributions of TPH and arsenic in sludge are shown in figures 21a and b. These distributions show that Kelly pit sludge is not

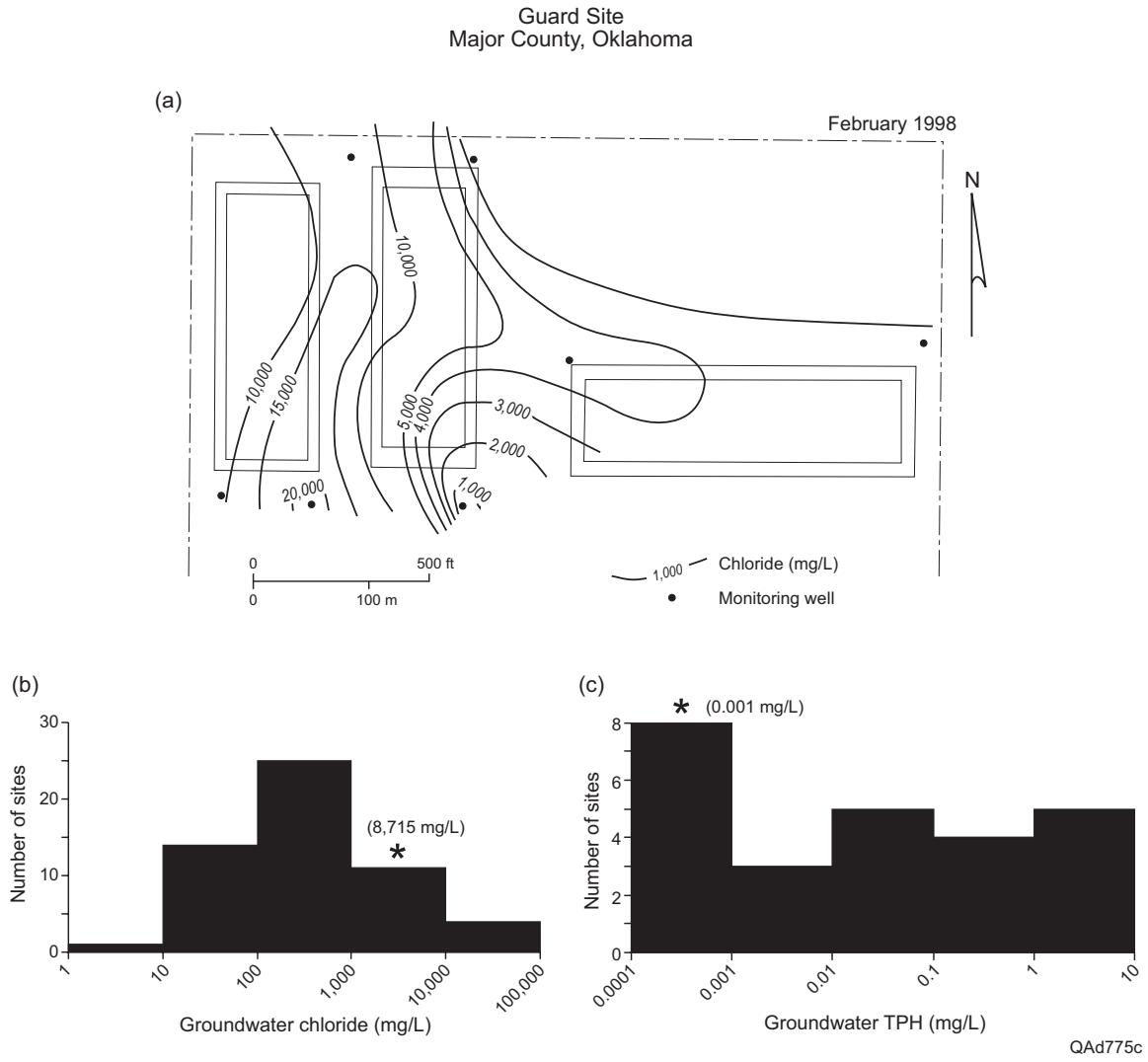

Figure 20. Guard site, Major County, Oklahoma: (a) map shows distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, and (c) mean TPH in groundwater. Histograms in (b) and (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Guard site. Mean concentration for site in parenthesis.

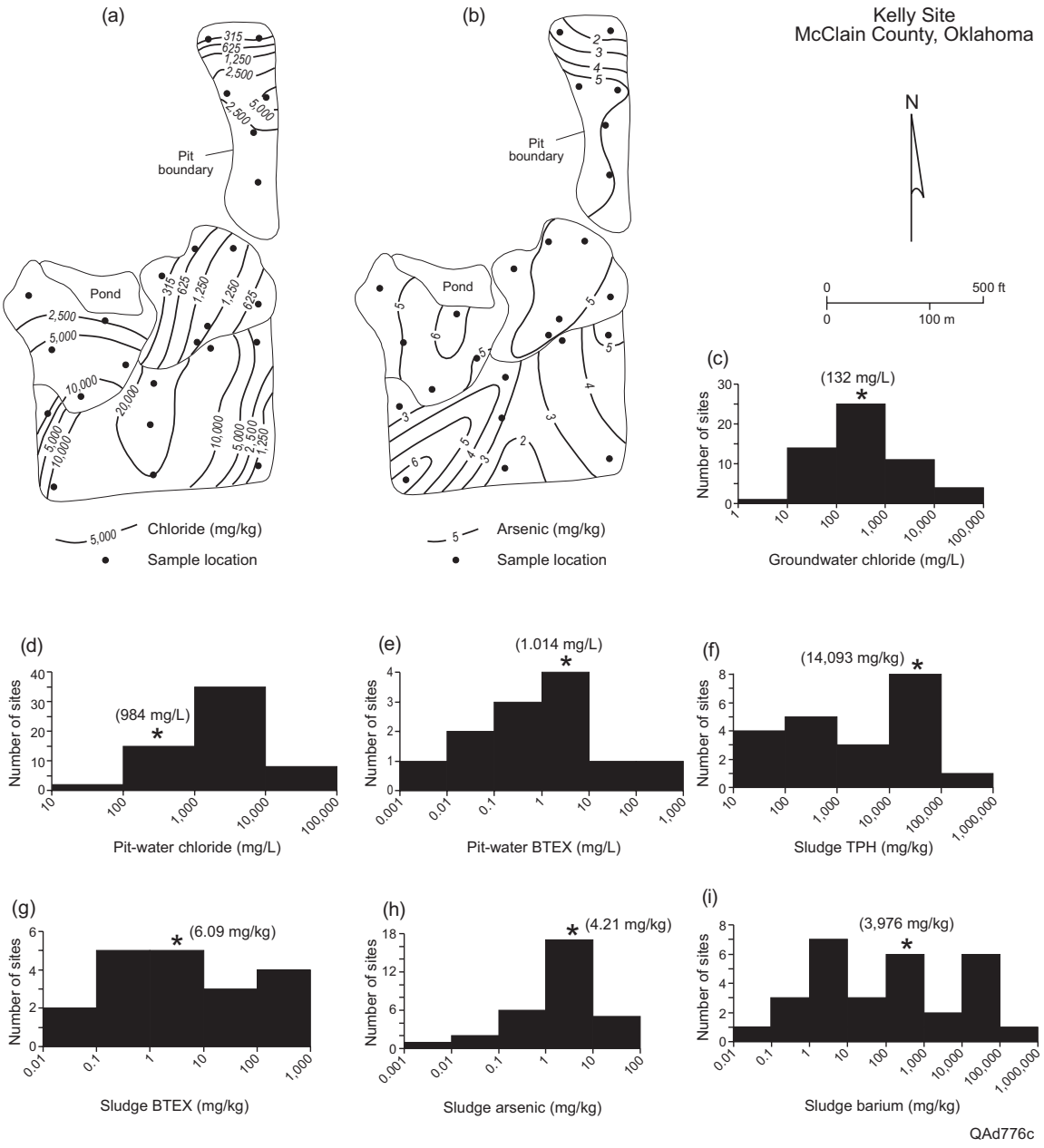

Figure 21. Kelly site, McClain County, Oklahoma: maps show (a) distribution of TPH in pit sludge, (b) Distribution of arsenic in pit sludge. Histograms show (c) mean chloride in groundwater, (d) mean chloride in pit water, (e) mean BTEX in pit water, (f) mean TPH in pit sludge, (g) mean BTEX in pit sludge, (h) mean arsenic in pit sludge, and (i) mean barium in pit sludge. Histograms in (c) to (i) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Kelly site. Mean concentration for site in parentheses.

homogeneous and that very high concentrations of TPH (>20,000 mg/kg) and elevated concentrations of arsenic (>6 mg/kg) are present locally.

Merkle Site

The Merkle site (fig. 22) is located in Pottawatomie County, Oklahoma. The site consists of 12 pits with a cumulative areal coverage of approximately 0.03 km^2 (293,000 ft^2) and has six monitoring wells located in pairs at the northwest and northeast corners and at the east- central margin of the site. Comparisons of the Merkle site to all the other sites for chloride and TPH in pit water, and TPH and barium in sludge are shown in figures 22b-f. The distributions of chloride values in groundwater (fig. 22a) show maximum concentrations (>150 mg/L) in the northwest part of the site. Chloride concentrations are reduced to less than 20 mg/L across the site but monitoring well distribution is inadequate to delineate a well-defined plume. Lack of off-site background chloride data precludes determination of an on-site chloride source.

Safe Earth Site

The Safe Earth site (fig. 23) is located in Roger Mills County, Oklahoma. The site consists of seven pits with a cumulative areal coverage of greater than 0.01 km^2 (>105,000 ft^2) and has 15 monitoring wells located within and along the perimeter of the site. Comparison of the Safe Earth site to all the other sites for chloride in groundwater is shown in figure 23b. The concentrations of chloride in groundwater is low compared to most other sites. However, the distributions of chloride values in groundwater (fig. 23a) show maximum concentrations (>60 mg/L) in the east-central part of the site and appear to define a two-lobe plume. Time-series mapping (not shown) suggests that constituents move from west to east across the site. However, lack of off-site background chloride data precludes determination of an on-site chloride source.

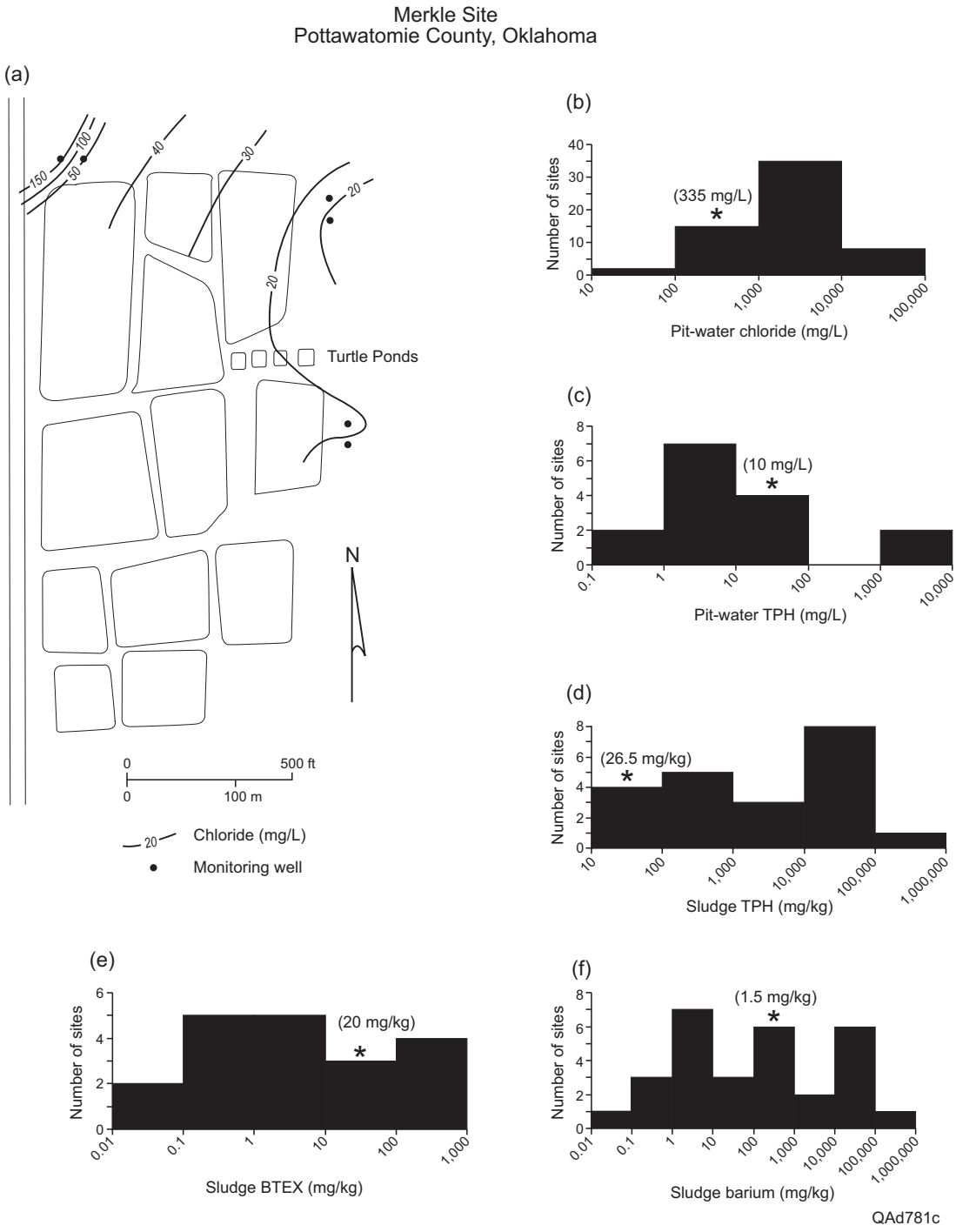

Figure 22. Merkle site, Pottawatomie County, Oklahoma: (a) map shows distribution of chloride in groundwater. Histograms show (b) mean chloride in pit water, (c) mean TPH in pit water, (d) mean TPH in pit sludge, (e) mean BTEX in pit sludge, and (f) mean barium in pit sludge. Histograms in (b) to (f) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Merkle site. Mean concentration for site in parentheses.

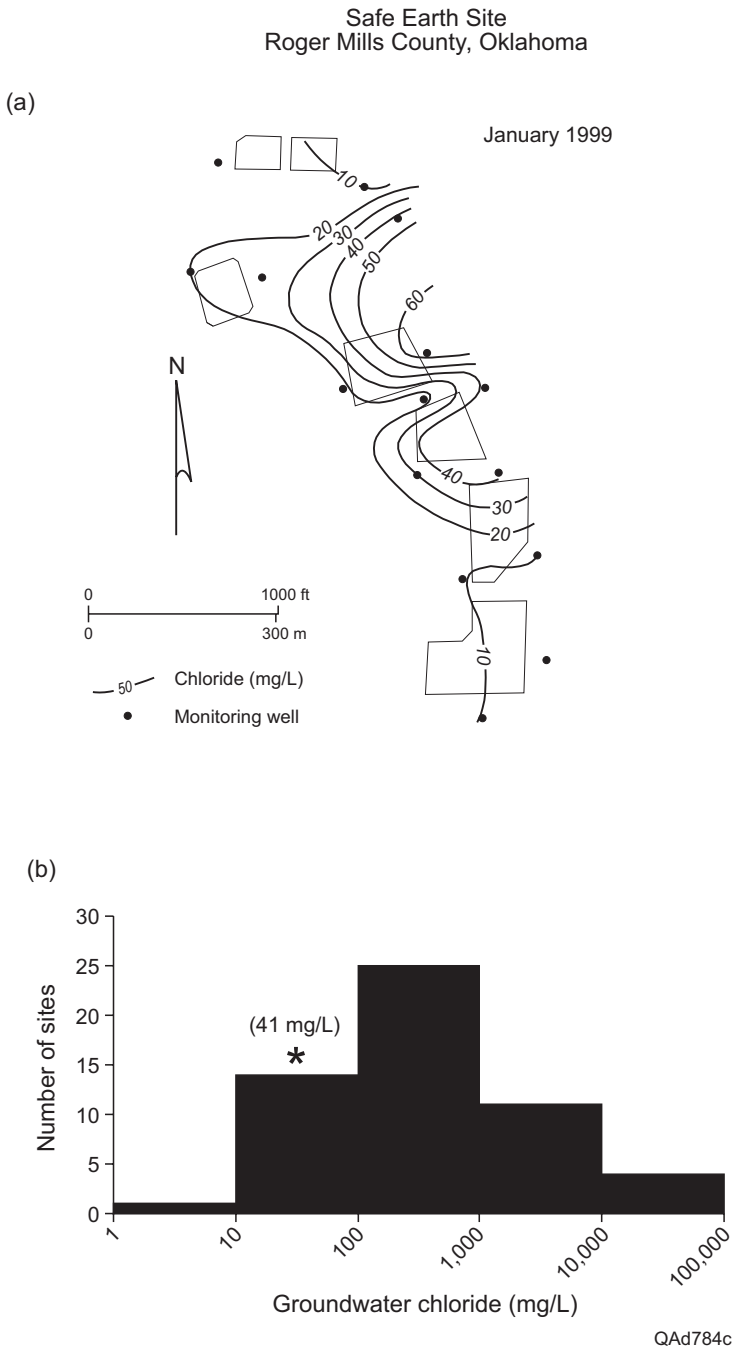

Figure 23. Safe Earth site, Roger Mills County, Oklahoma: maps show (a) distribution of chloride in groundwater, and (b) water levels. Histograms show (c) mean chloride in groundwater. Histograms in (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Safe Earth site. Mean concentration for site in parentheses.

Southard Site

The Southard site (fig. 24) is located in Blaine County, Oklahoma. The site consists of six pits with a cumulative areal coverage of greater than approximately 0.02 km^2 (>175,000 ft^2) and has four monitoring wells located along the perimeter of the site. Comparison of the Southard site to all the other sites for chloride and TPH in groundwater is shown in figures 24b and d. The time-series graph of chloride values in groundwater shows that the four monitoring wells maintain a consistent hierarchy regarding chloride concentrations (fig. 24c). Distributions of chloride values in groundwater (fig. 24a) show maximum concentrations (>12,000 mg/L) in the northwestern part of the site and, in conjunction with the time-series graph, may define a plume of varying overall concentration with its focal point maintained in the same part of the site over time. These values exceed the SMCL for chloride in drinking water (250 mg/L) and the high reported value exceeds the EPA's salinity limits (10,000 mg/L TDS) of an underground source for drinking water (USDW). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

T & S Site

The T & S site (fig. 25) is located in McClain County, Oklahoma. The site consists of two pits with a cumulative areal coverage of approximately 0.02 km^2 (178,500 ft^2) and has five monitoring wells located along the perimeter of the site. Comparisons of the Southard site to all the other sites for chloride and TPH in groundwater are shown in figures 25b and c. Distributions of chloride values in groundwater (fig. 25a) show maximum concentrations (>3,000 mg/L) in the east-central part of the site and may define a plume that is elongate along a southwest-trending axis. These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

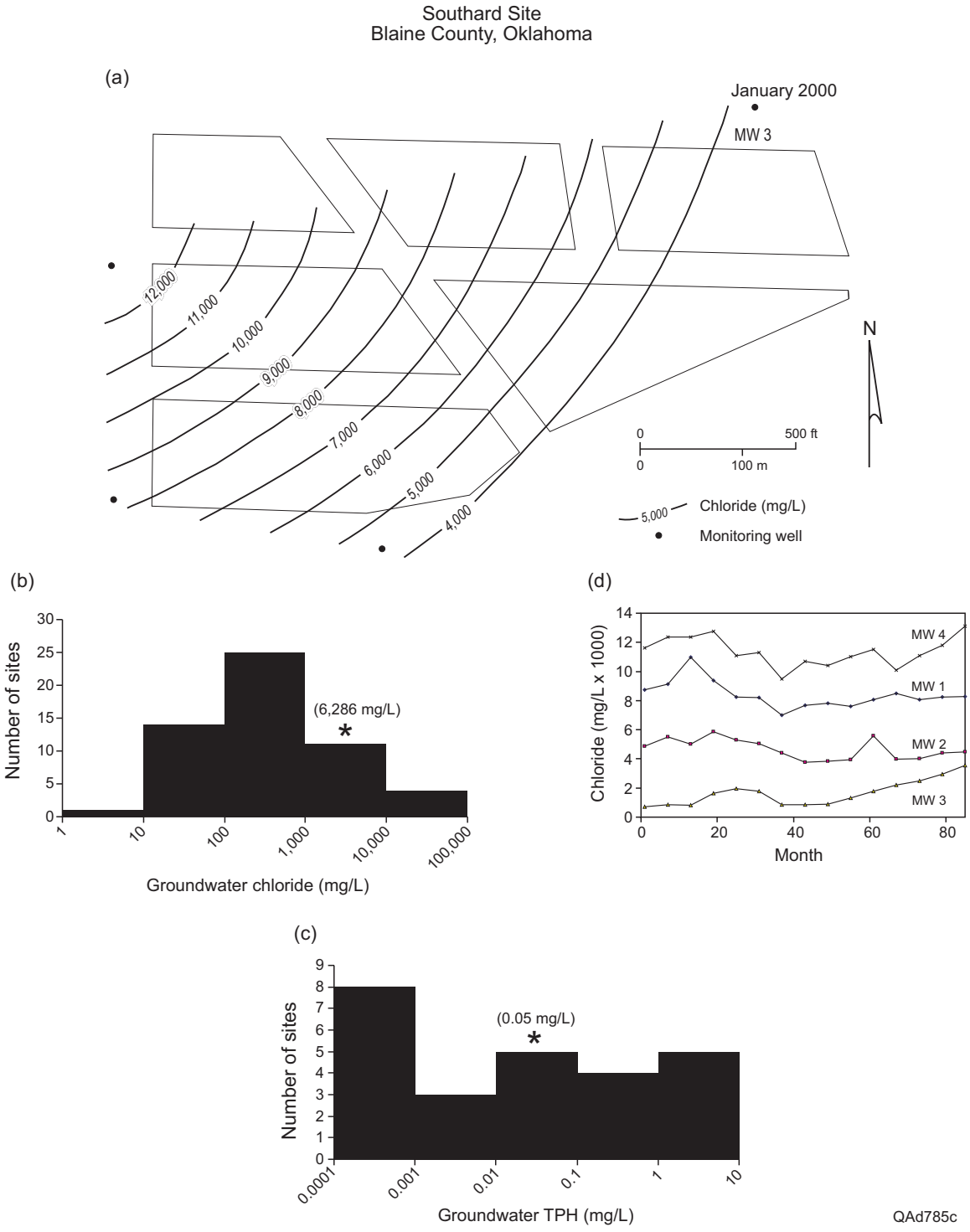

Figure 24. Southard site, Blaine County, Oklahoma: (a) map shows distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, and (c) mean TPH in groundwater. (d) Time-series plot of chloride in groundwater by monitoring wells Histograms in (b) and (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Southard site. Mean concentration for site in parentheses.

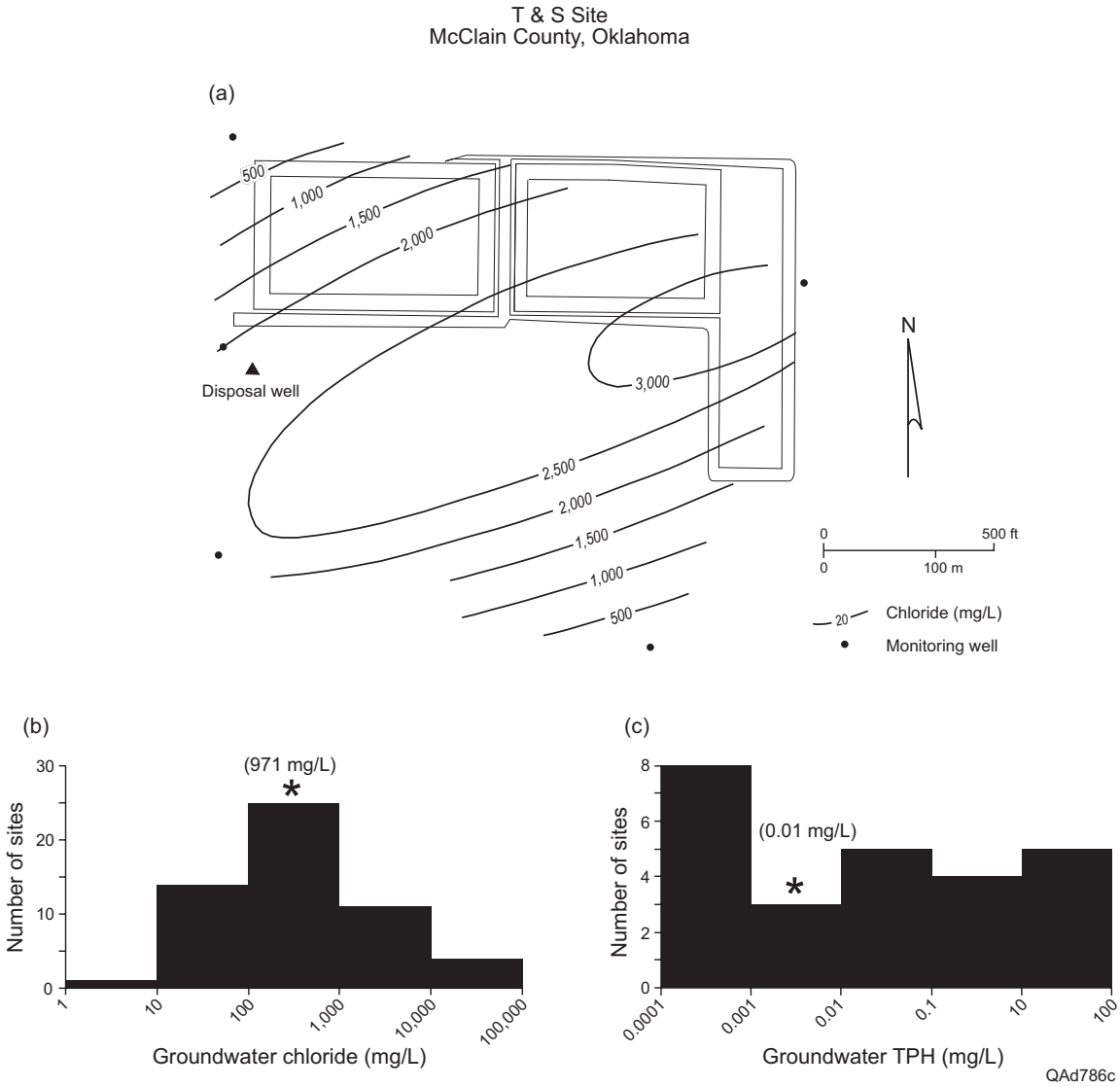

Figure 25. T & S site, McClain County, Oklahoma: (a) map shows distribution of chloride in groundwater. Histograms show (b) mean chloride in groundwater, and (c) mean TPH in groundwater. Histograms in (b) and (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for the T & S site. Mean concentration for site in parentheses.

Webb/Femco Site

The Webb/Femco site (fig. 26) is located in McClain County, Oklahoma. The site consists of at least three pits with a cumulative areal coverage of approximately 0.05 km^2 (520,000 ft^2) and has eight monitoring wells located along the perimeters of the three main pits. Two monitoring wells near the easternmost pit were dry during all measurements and provide no chemical data. Comparisons of the Webb/Femco site to all the other sites for chloride and TPH in groundwater, and chloride in pit water are shown in figures 26b-d. Distributions of chloride values in groundwater (fig. 26a) show maximum concentrations (>2,000 mg/L) in the northern part of the site, but the distribution of monitoring wells preclude delineation of a well-defined plume. These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source.

Texas Sites

Albany Tank Yard

The Albany Tank Yard site (fig. 27a) was 0.5 mi north of the North Fork of Hubbard Creek near Albany, Shackelford County, Texas. This abandoned oil reclamation site included six sludge pits, nine 110 to 500 bbl storage tanks, some equipment, and metal buildings that served various purposes. The site was permitted in September 1982. Beginning in 1992, there was a history of permit violations such as leaking tanks, improper discharge of basic sediment and sludge, chemicals leaking from containers, and debris piles. A site assessment in June 1999 included onsite environmental sampling followed with chemical and laboratory analyses of constituents of concern (COCs). Comparison of chloride, TPH, BTEX, barium, and arsenic in sludge at the Albany site to all sites in the study sample is shown in figure 27b-f. Site constituents generally are near the mean

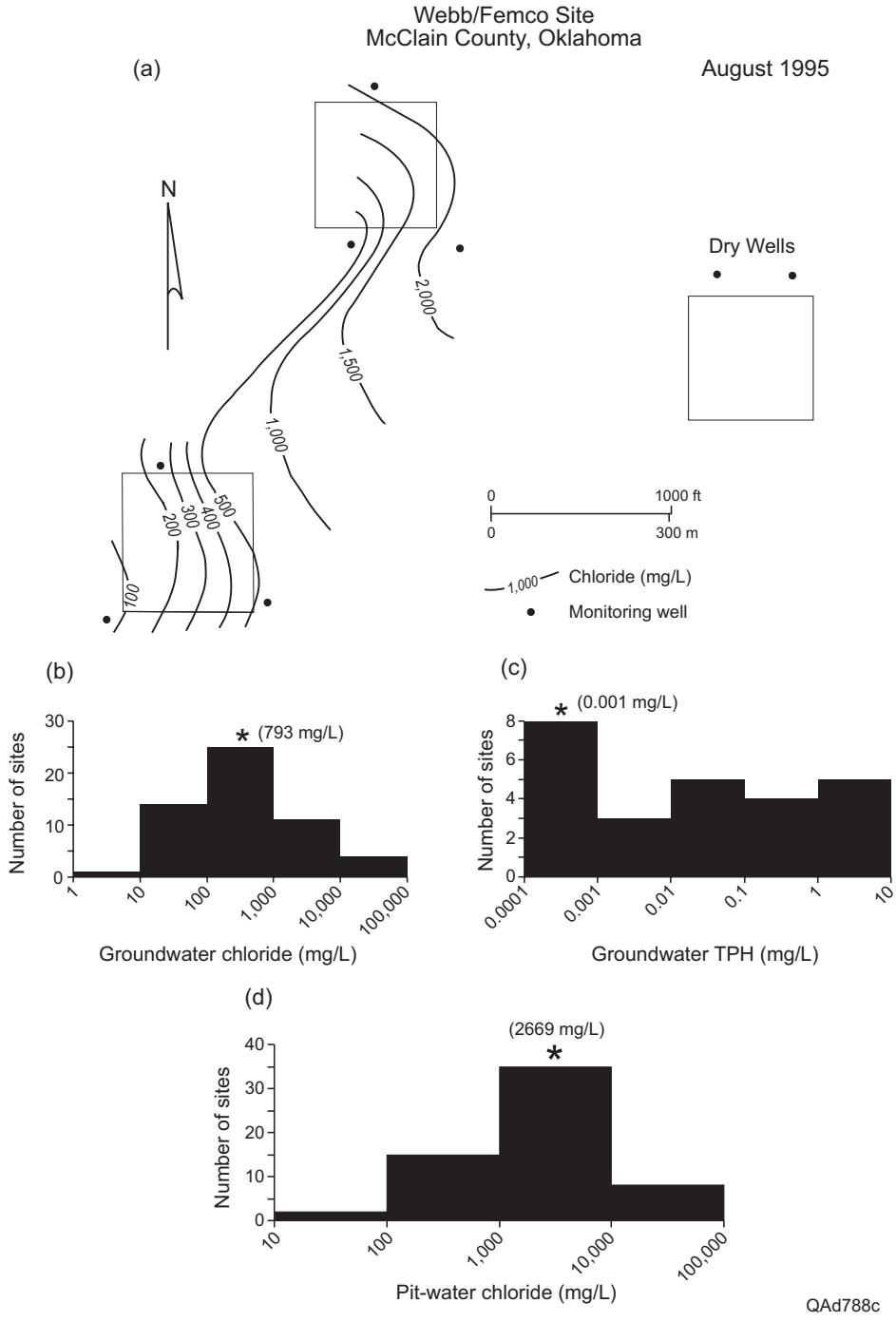

Figure 26. Webb/Femco site, McClain County, Oklahoma: (a) map shows distribution of chloride in groundwater Histograms show (b) mean chloride in groundwater, (c) mean TPH in groundwater, and (d) mean chloride in pit water. Histograms in (b) to (d) for all sites in the study sample (fig. 5). Star (*) indicates mean for the Webb/Femco site. Mean concentration for site in parentheses.

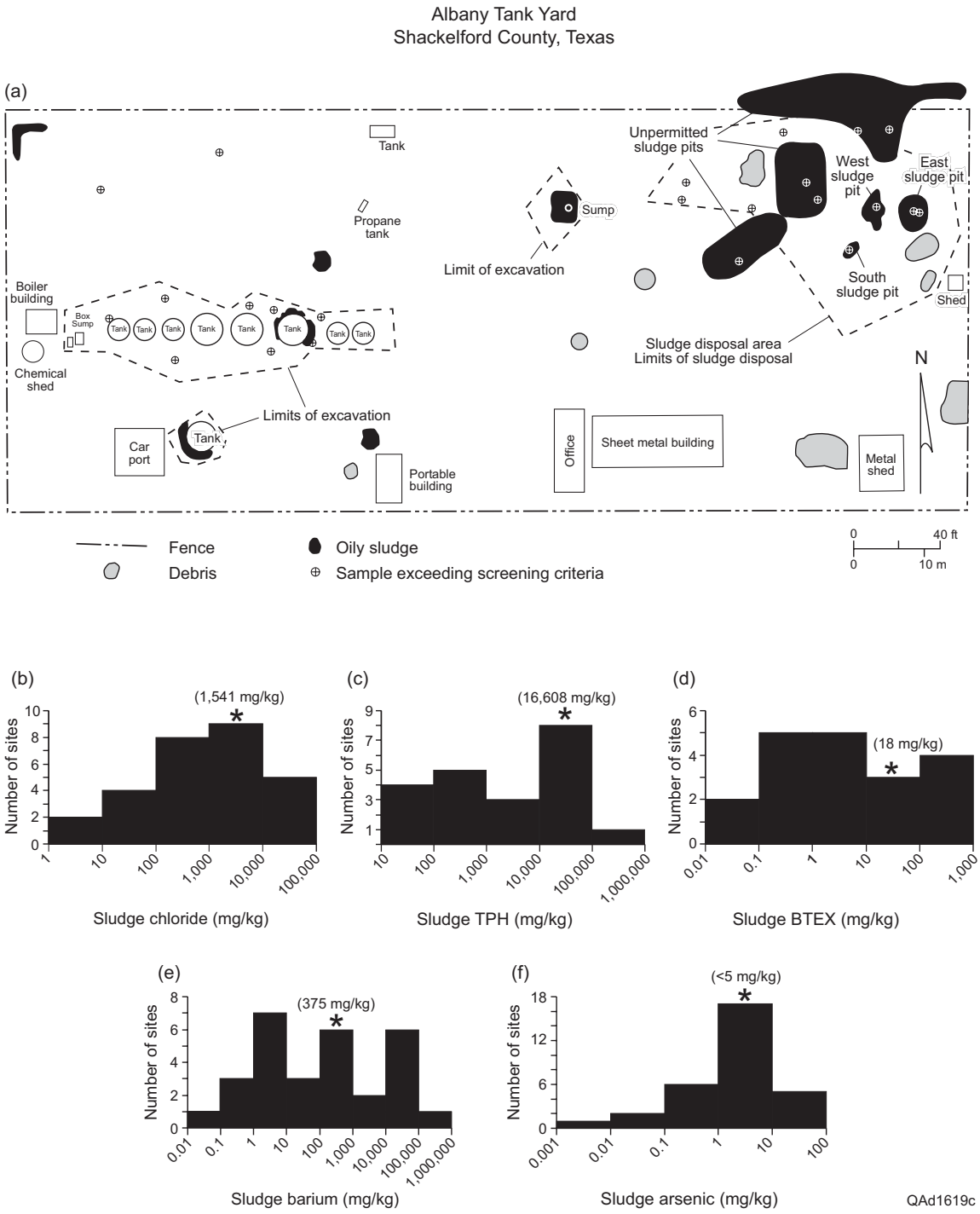

Figure 27. Albany Tank Yard site, Shackelford County, Texas: (a) map shows distribution of various elements of the facility, including pits and hydrocarbon contamination at the surface. Also shown are limits of remedial excavation of contaminated soils. Histograms show (b) mean chloride in sludge, (c) mean TPH in sludge, (d) mean BTEX in sludge, (e) mean barium in sludge, and (f) mean arsenic in sludge. Histograms in (b) to (f) for all sites in the study sample (fig. 5) Star (*) indicates mean for site. Mean concentration for site in parentheses.

of all CCDD sites in the sample set, except sludge BTEX and sludge TPH that may be somewhat above the mean.

Briggs Site

The Briggs site (fig. 28) is located in Matagorda County, Texas (Sullivan and others, 1999). The site consists of 1 pit with an areal coverage of approximately 0.03 km^2 (312,500 ft^2) and an adjacent outwash area. The site has three monitoring wells located along the perimeter of the site. Comparisons of the Briggs site to all the other sites for chloride in groundwater and sludge, and arsenic in sludge are shown in figures 28e-g. Distributions of chloride values in groundwater (fig. 28a) show a maximum concentration (>900 mg/L) in the western part of the site and may delineate a symmetrical plume radiating from the location of maximum concentration. These values exceed the SMCL for chloride in drinking water (250 mg/L). However, lack of off-site background chloride data precludes determination of an on-site chloride source. The water-level map (fig. 28b) shows an even gradient that suggests potential for flow toward the north. Samples of pit sludge were collected on a regular grid across the site and were not composited prior to analyses. Distributions of chloride and arsenic in sludge indicate that sludge is not homogeneous and that locally elevated concentrations of chloride (>10,000 mg/kg) and arsenic (>2 mg/kg) occur locally. The low on-site arsenic concentration poses no recognized environmental hazard. The outwash (overflow) area also shows heterogeneous distributions of chloride and arsenic, although at lower concentrations than the sludge. The outwash area is analogous to reported occurrences at some sites where berms have been breached by water from overfilled pits and some of their contents released to the surrounding landscape.

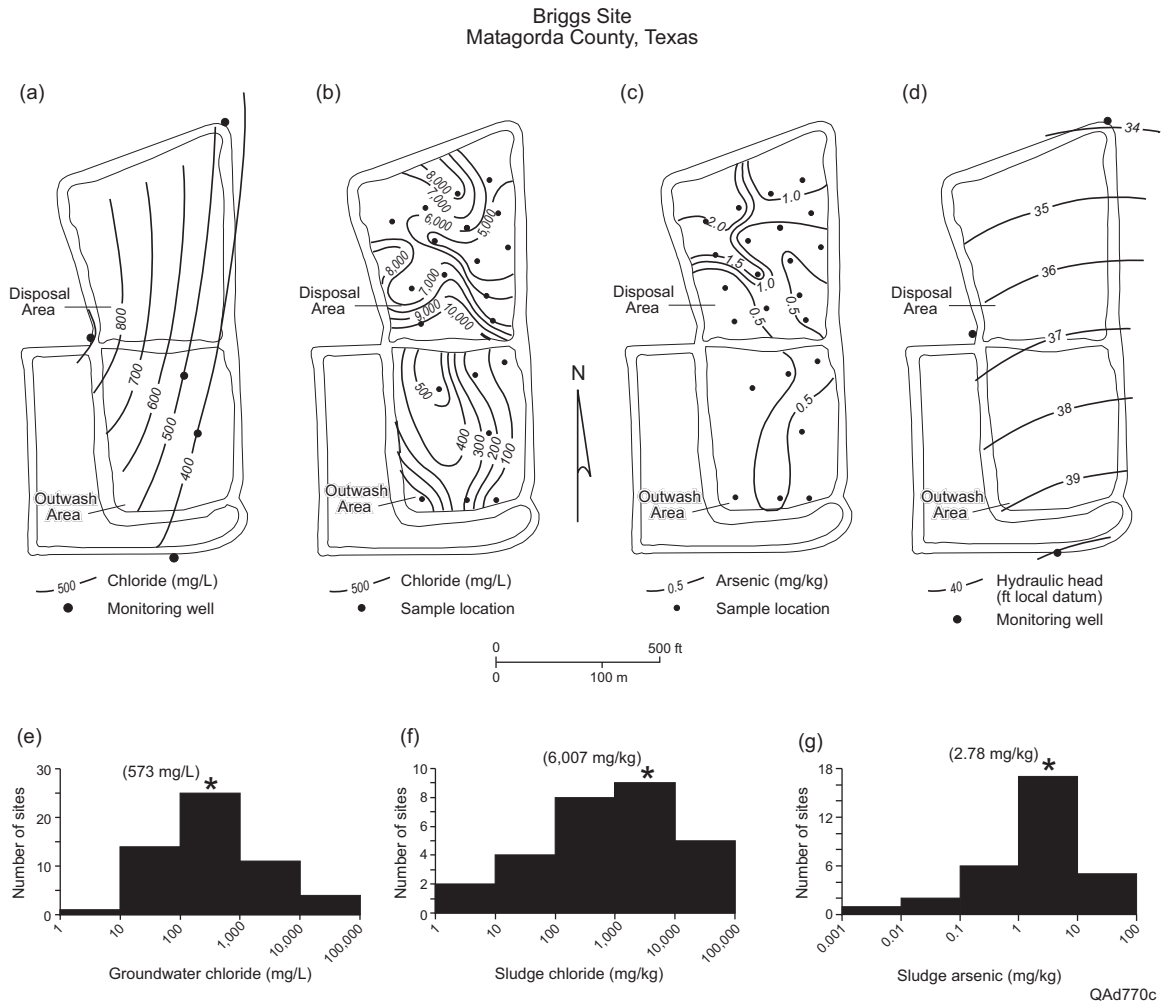

Figure 28. Briggs site, Matagorda County, Texas: maps show (a) distribution of chloride in groundwater, (b) distribution of chloride in pit sludge, (c) distribution of arsenic in pit sludge, and (d) water levels. Histograms show (e) mean chloride in groundwater, (f) mean chloride in pit sludge, and (g) mean arsenic in pit sludge. Histograms in (e) to (g) for all sites in the study sample (fig. 5). Star (*) indicates mean for Briggs site. Mean concentration for site in parentheses.

T. L. Carter Site

The Carter site is 4.5 mi southeast of Roby, Fisher County, Texas. It received basic sediment, produced water, and drilling fluid. The site contained five unlined pits of various sizes ranging in capacity from 3400 to 10,600 bbl. Depth to groundwater is approximately 20 ft, and distance to surface water, the Clear Fork of the Brazos River, is 1500 ft.

Fox Vacuum Site

The Fox Vacuum site (fig. 29a) is an abandoned site located 8 mi north of Buna, Jasper County, Texas. The site was used as a washout yard for trucks operated by an oil-field vacuum-service company and as a disposal site for waste drilling fluids. The site was probably abandoned around 1985 (Dutton and others, 1995). The site included 7 disposal pits with a combined areal extent of approximately 0.5 acres (22,233 ft^2) that contained an estimated 3,000 yd^3 (14,426 bbl) of crude-oil contaminated drilling mud. There were no monitoring wells at the site.

Comparisons of the Fox Vacuum site to all sites in the study sample for chloride, TPH, barium, BTEX, and arsenic in sludge are shown in figure 29b-f. Concentrations of sludge chloride, barium, and arsenic appear greater than the mean of other sites. There was no evidence that constituents from the site had affected a well located 350 ft east of the site. Wastes contained chloride concentrations of <3,000 mg/L and TPH concentration of <1 percent (Dutton and others, 1995).

Gober Disposal Site

The Gober Disposal site (fig. 30) near Bridgeport, Wise County, Texas, was a low chloride (<3000 mg/L) drilling fluid CCDD site located on the north side of the Boonesville Conglomerate oil field. Few details on the facility are available at the time of this study. Site maps showed three

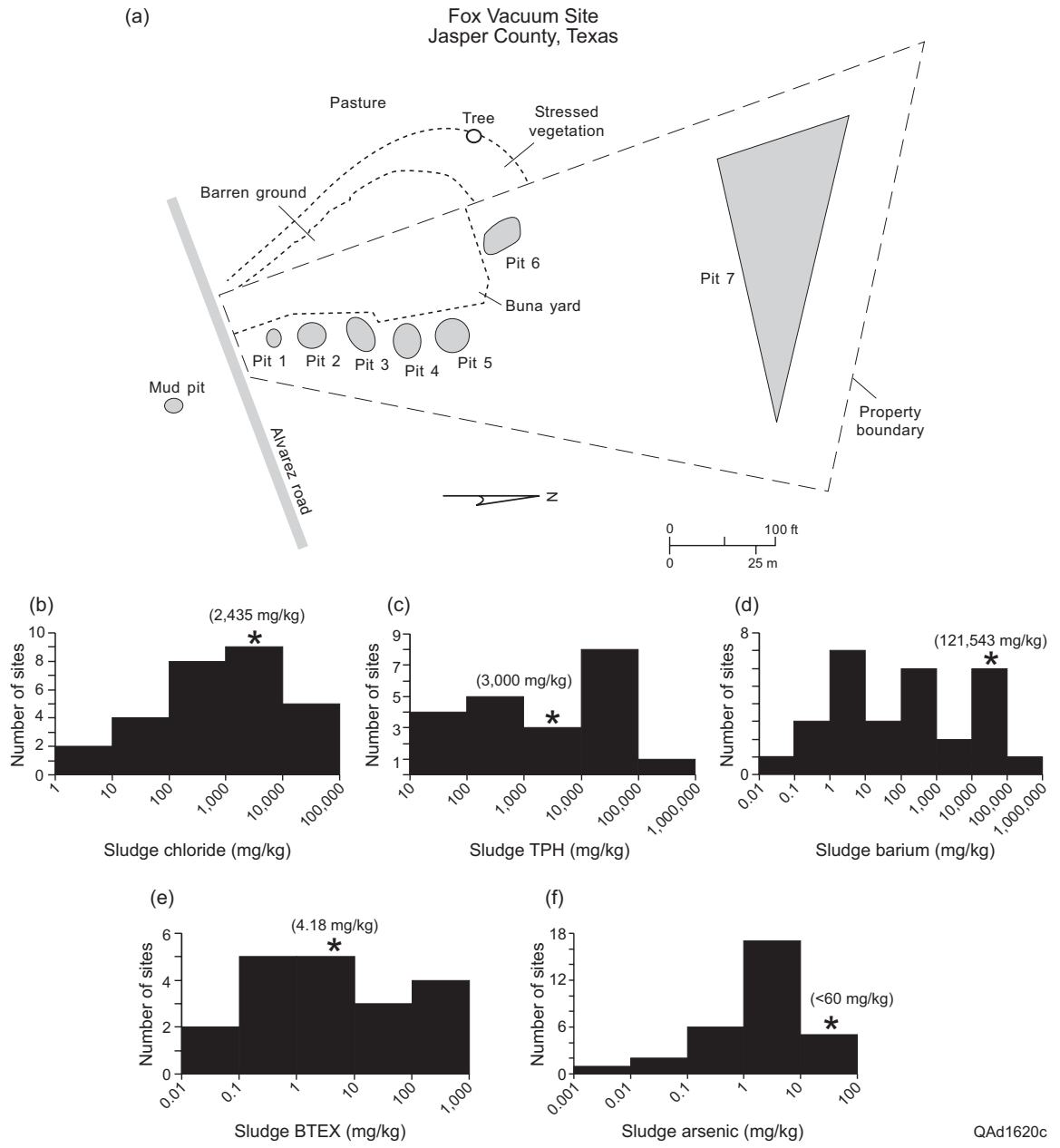

Figure 29. Fox Vacuum site, Jasper County, Texas: (a) map shows distribution of pits and area of barren soil. Histograms show (b) mean chloride in pit sludge, (c) mean TPH in pit sludge, (d) mean barium in pit sludge, (e) mean BTEX in pit sludge, and (f) mean barium in pit sludge. Histograms in (b) to (f) for all sites in the study sample (fig. 5). Star (*) indicates mean for site. Mean concentration for site in parentheses.

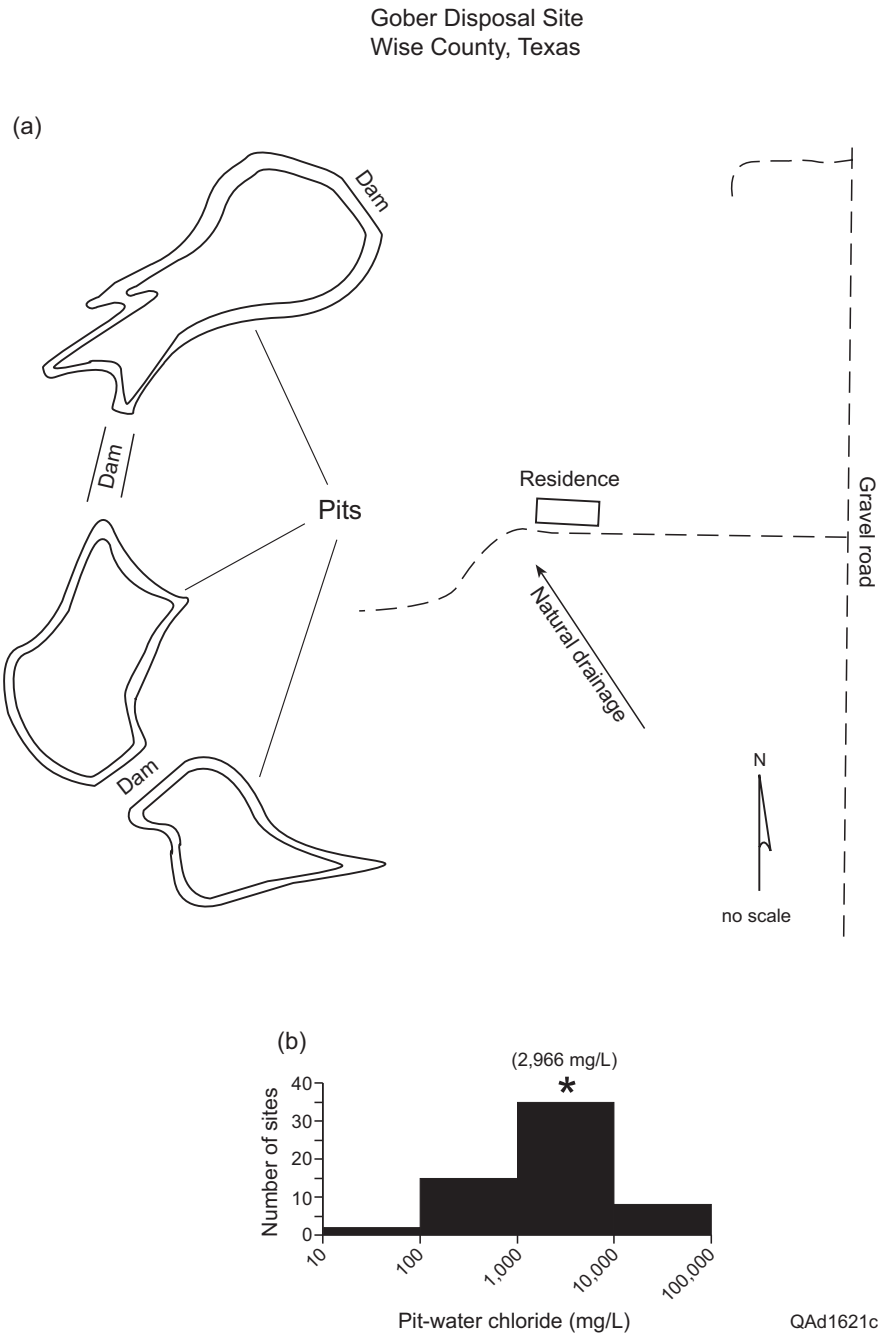

Figure 30. Gober Disposal site, Wise County, Texas: (a) map shows distribution of pits and natural direction of drainage. Histogram shows (b) mean chloride in pit water. Histogram in (b) for all sites in the study sample (fig. 5). Star (*) indicates mean for site. Mean concentration for site in parentheses.

irregularly shaped pits and a residential dwelling. Pit sizes were not determined since site maps lacked a map scale. The site was described as overgrown with trees and shrubs. Inspections in 1989 noted several permit violations including excessive chloride content in pits (15,000 mg/L). Figure 30b compares pit-water chloride sampled at the Gober site to all sites in the study sample; the mean measured value of 2,966 mg/L is similar to the mean of other sites.

Manvel Saltwater Disposal Site

The Manvel Saltwater Disposal site (fig. 31a) is an abandoned site located within the city limits of Manvel, Brazoria County, Texas. The site is a former saltwater disposal site in which crude oil and drilling waste have also been disposed (Kaiser and others, 1996). The site consists of 4 main waste disposal pits. Two main waste-disposal pits (A and B, fig. 31a-d) covered approximately 4.17 acres (181,448 ft^2) and two smaller ponds (C and D) that might have been waste disposal pits covered approximately 0.75 acres (32780 ft^2). Monitoring wells include 14 wells completed in an upper water-bearing zone, 4 wells completed in a deeper zone, 6 shallow monitoring wells about the site perimeter, and 8 offsite shallow monitoring wells. Of the 4 deep wells, 3 are located along the periphery and one is located within the site. There is a plugged saltwater disposal well and a plugged oil well on site. (Kaiser and others, 1996; Duke Engineering Services, Inc., 2001a).

Comparisons of chloride in groundwater and TPH, BTEX, barium, and arsenic in sludge at the Manvel site to all sites in the study sample are shown in figures 31e-i. Concentration of chloride in groundwater (fig. 31a, e) is more than 75,000 mg/L at the southeast side of the site and mean chloride (12, 715 mg/L) appears greater than the average for all sites.

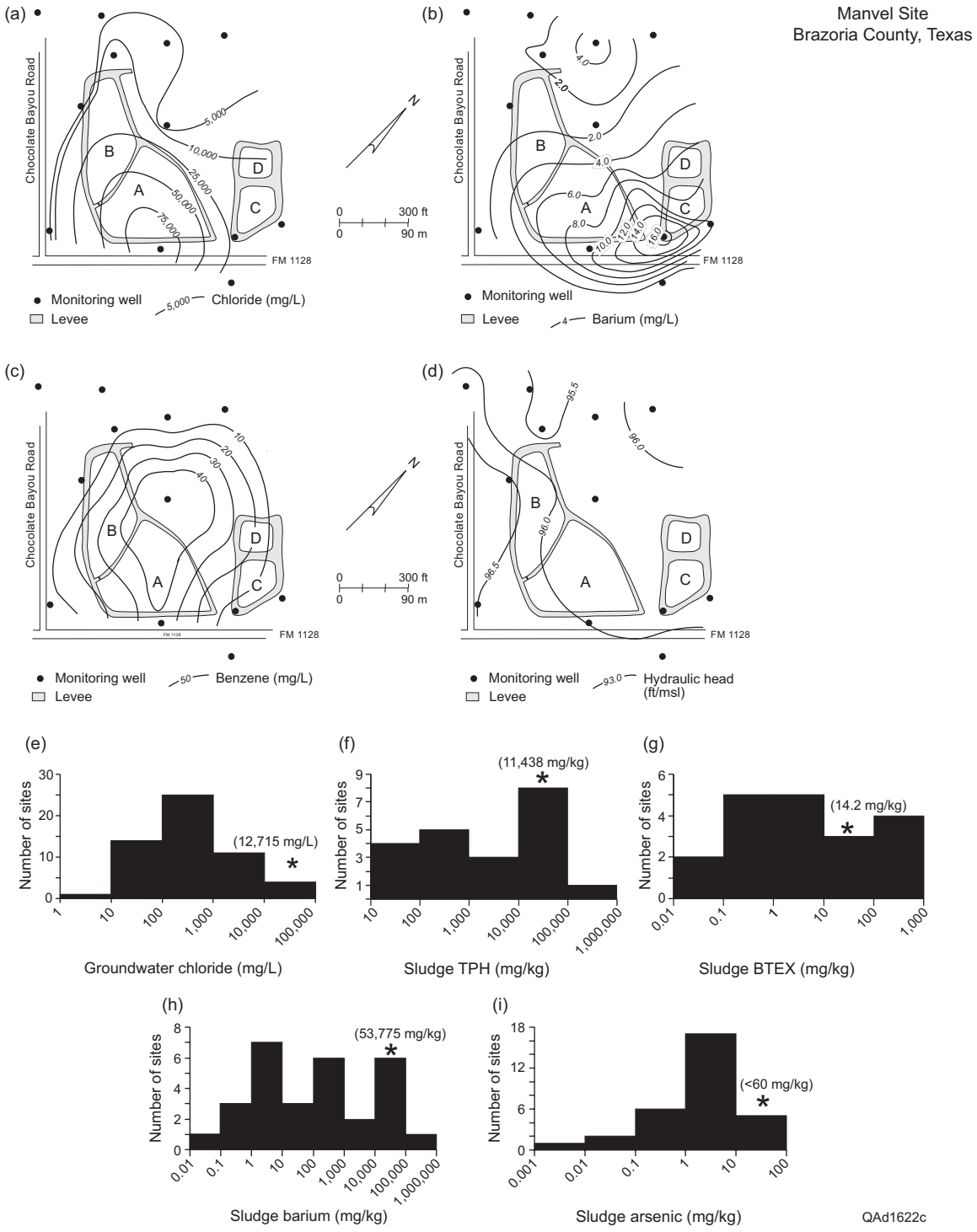

Figure 31. Manvel Saltwater Disposal site, Brazoria County, Texas: maps show (a) distribution of chloride in groundwater, (b) barium in groundwater, (c) benzene in ground water, and (d) water levels. Histograms show (e) mean chloride in groundwater, (f) mean TPH in pit sludge, (g) mean BTEX in pit sludge, (h) mean barium in pit sludge, and (i) mean arsenic in pit sludge. Histograms in (e) to (i) for all sites in the study sample (fig. 5). Star (*) indicates mean for site. Mean concentration for site in parentheses.

Munson Site

The Munson site (fig. 32a) is an abandoned site near Lyons, Burleson County, Texas. It was permitted as a low chloride drilling fluid disposal site in February 1982, after a history of operating non-permitted pits for disposal of oilfield drilling wastes. The site contained five disposal pits, only three of which were permitted. Figure 32a displays the general configuration of the site; file maps and records were insufficient to accurately reconstruct dimensions and orientations of the pits. Figure 32b compares pit-water chloride between the Munson site and all sites in the study sample; chloride in the pit water is near the mean of all sites.

Post Oak Site

The Post Oak site (fig. 33a-c) is located 8 mi east of Giddings, Lee County, Texas. The site is a former sandstone quarry where there had been unauthorized disposal of hydrocarbon-contaminated drilling fluids (Sullivan and others, 1998a). The quarry pit had an areal extent of approximately 2.3 acres (125,000 ft^2). The site contains an estimated 20,500-yd^3 of waste material, mainly drilling fluids. Two onsite monitoring wells were installed at the site as part of an assessment. Comparisons of chloride, TPH, barium, and arsenic in sludge at the Post Oak site to all sites in the study sample are shown in figures 33d-g.

Red River Oilfield Services Site

The Red River Oilfield Services site (fig. 34a) is an abandoned site near Tolbert, Wilbarger County, Texas. The site was permitted as a oil reclamation site in 1986. The predominant land use in the area is agriculture. The site included a 50-ft by 40-ft lined pit used for separation by skimming of oil from saltwater; and a 36 ft by 8 ft plastic-lined, partitioned steel holding pit used for temporary storage of separated saltwater prior to transfer to steel storage tanks before final

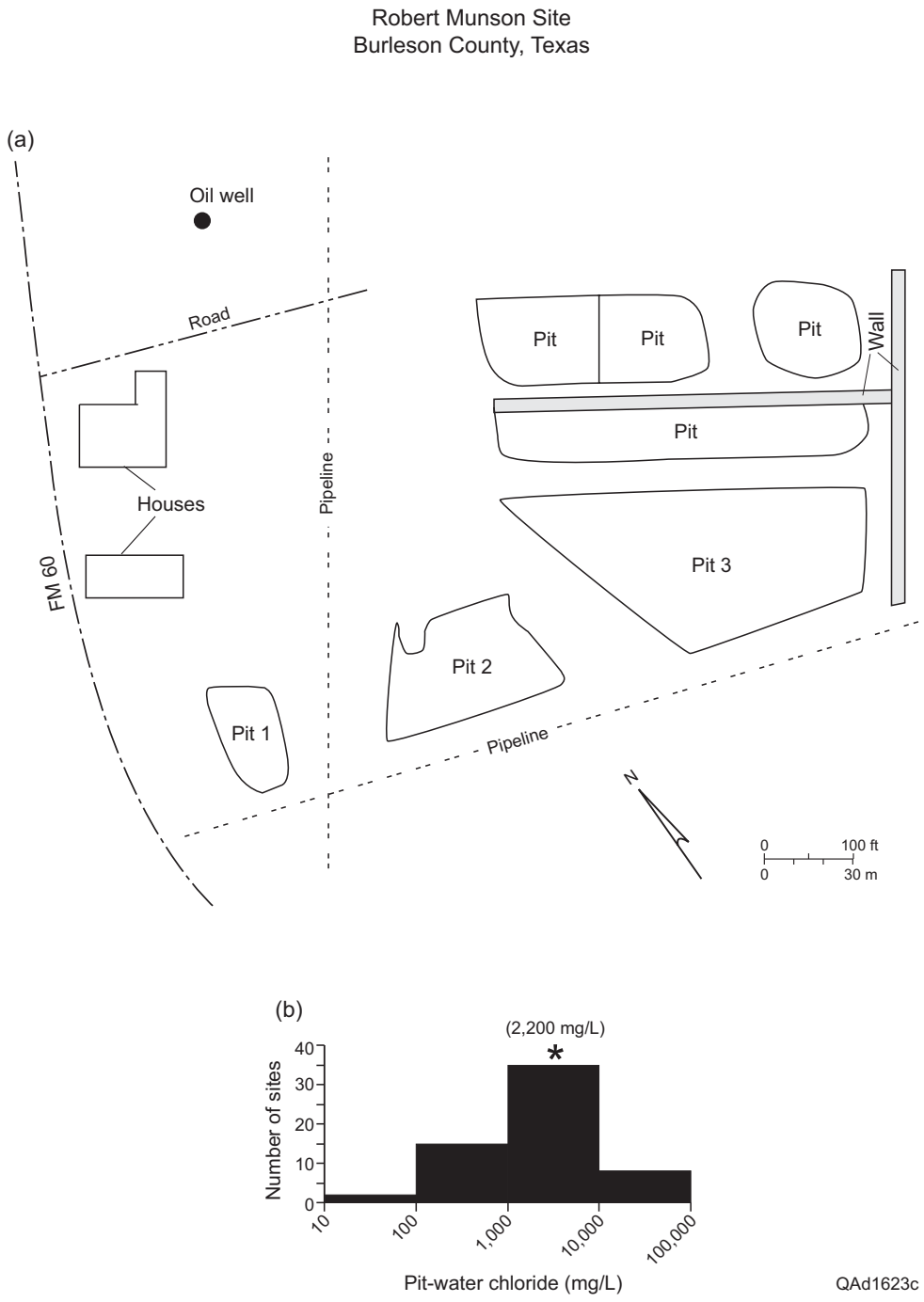

Figure 32. Robert Munson site, Burleson County, Texas: (a) map shows distribution of permitted pits (1, 2, and 3), non-permitted pits, and other site elements. Histogram shows mean chloride in pit water (b). Histogram in (b) for all sites in the study sample (fig. 5) Star (*) indicates mean for site. Mean concentration for site in parentheses.

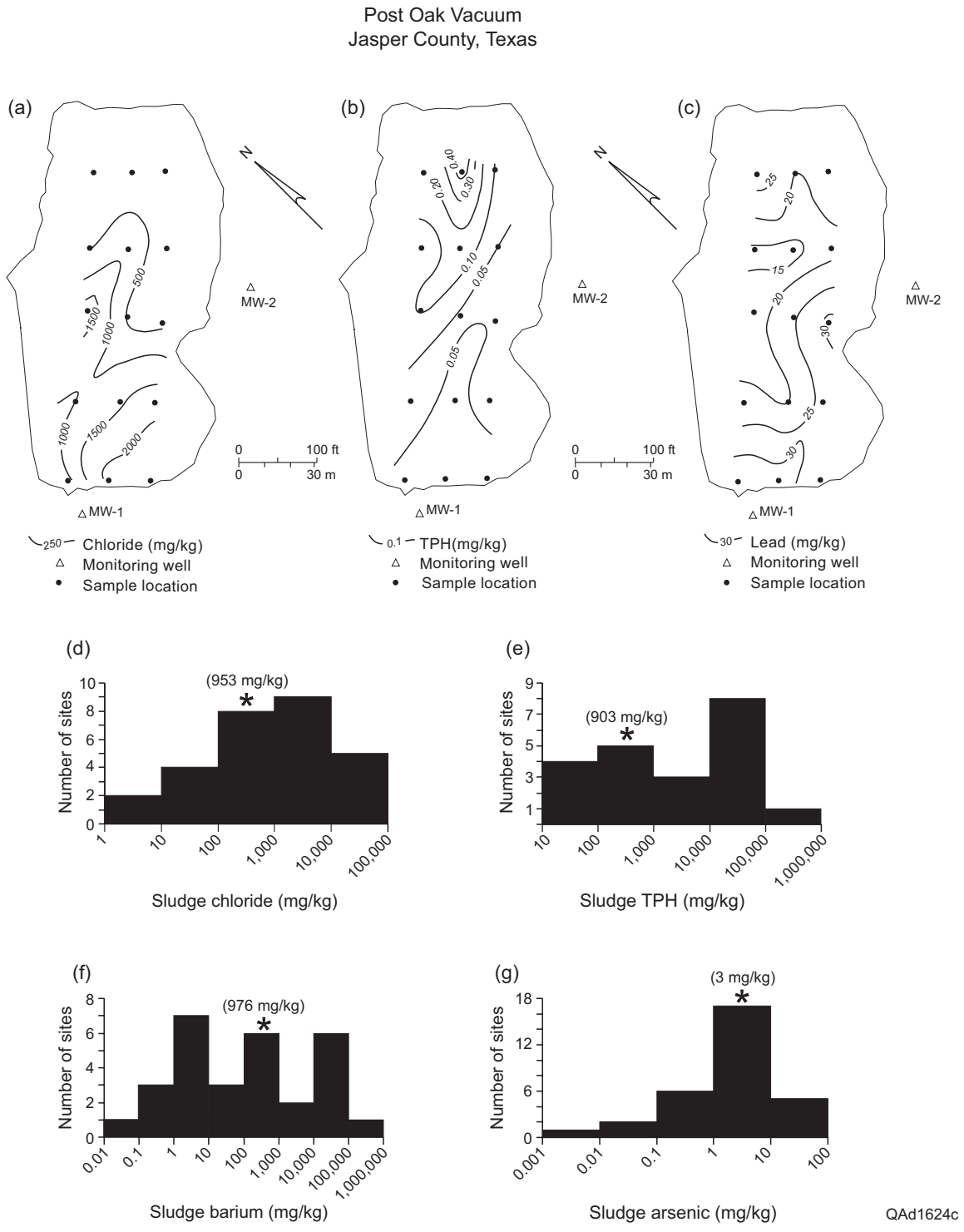

Figure 33. Post Oak site, Lee County, Texas: maps show (a) distribution of chloride in pit sludge, (b) distribution of TPH in pit sludge, and (c) distribution of lead in pit sludge. Histograms show (d) mean chloride in pit sludge, (e) mean TPH in pit sludge, (f) mean barium in pit sludge, and (g) mean arsenic in pit sludge. Histogram in (b) for all sites in the study sample (fig. 5). Star (*) indicates mean for site. Mean concentration for site in parentheses.

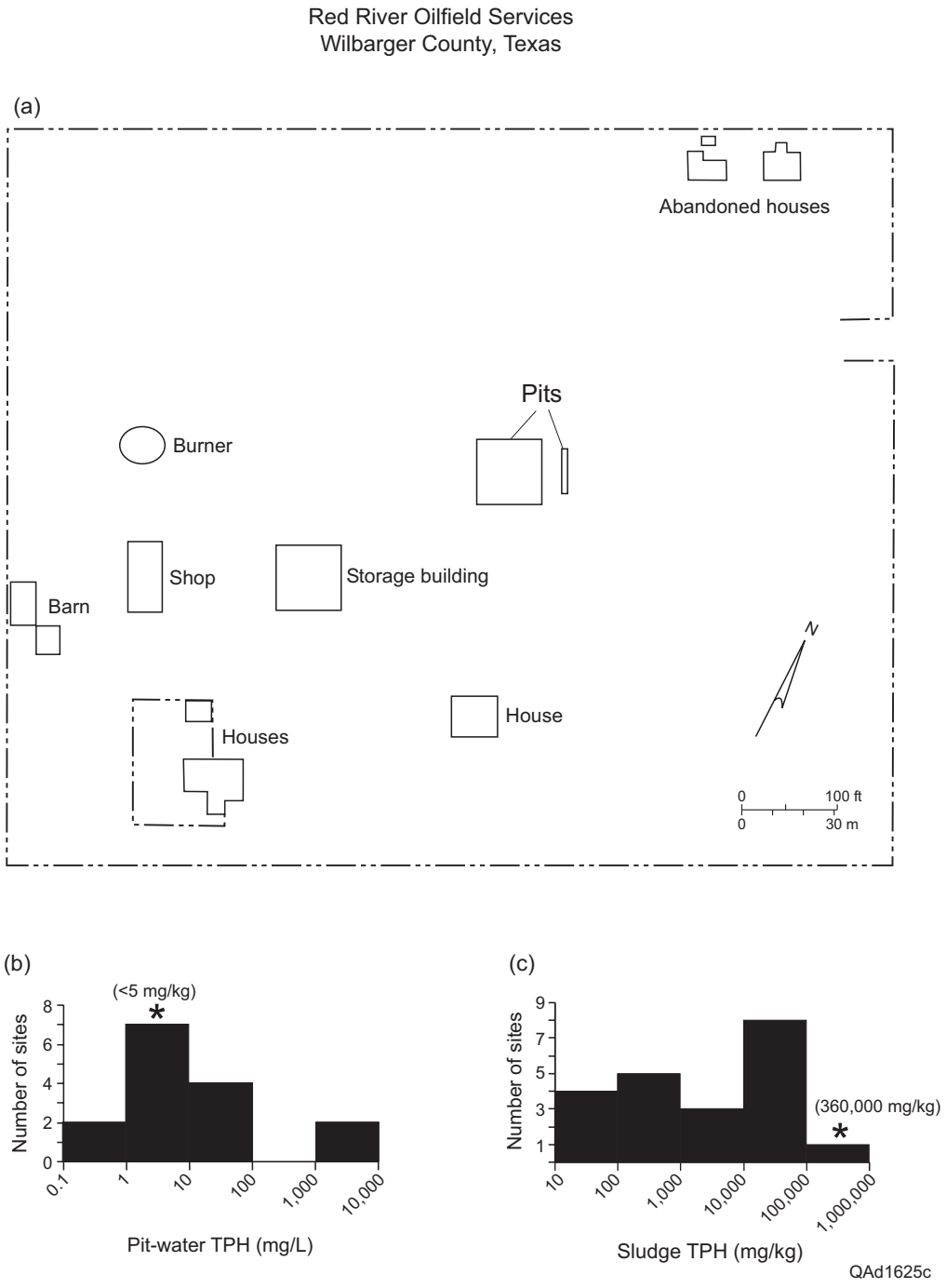

Figure 34. Red River Oilfield Services site, Wilbarger County, Texas: (a) map shows distribution of pits and other site elements. Histograms show (b) mean TPH in pit water and (c) mean TPH in sludge. Histogram in (b) and (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for site. Mean concentration for site in parentheses.

disposal. A steel tank of unreported dimensions was also at the site. Both pits were enclosed by 1.5 to 2-ft high dikes constructed from material excavated from pits to prevent inflow of storm water. Several operations-related buildings and abandoned dwellings also existed.

Roeling Vacuum Site

The Roeling Vacuum site (fig. 35a-c) is an abandoned site located 6 mi northeast of Liberty, Liberty County, Texas (Sullivan and others, 1998b). The site consists of two washout pits, 8 small pits with average dimensions of 11-ft diameter and 4-ft depth, and a larger irregularly shaped waste disposal area measuring approximately 600 ft by 200 ft wide. The site was originally a quarry for dirt for oil-field roads. The 8 waste pits contained an estimated 950 yd^3 of waste materials and the larger waste disposal cell contained an estimated 16,500 yd^3.

Chloride concentration in onsite groundwater ranged from 140 to 710 mg/L and averaged about 400 mg/L, exceeding the SMCL unenforceable aesthetic guideline (250 mg/L) in two of the three monitoring wells. Chloride concentration in the main waste disposal area and smaller side pits (fig.35a-c) averaged 5,653 mg/kg and was as high as 42,000 mg/kg. Mean chloride concentration in soil beneath the waste in the waste disposal area was 5,773 mg/kg. Comparison of chloride, TPH, barium, and arsenic in sludge at the Roeling Vacuum site to all study samples are shown in figure 35d-g.

Rule Tank Trucks Site

The Rule Tank Trucks site (fig. 36a) is an abandoned reclamation facility located in southeast Rule, Haskell County, Texas. The site was permitted as a facility to process produced saltwater and tank bottoms, but may have received other non-permitted drilling wastes. The site contained 13 storage tanks and a 60 yd^3 cinder-block-lined pit that contained debris including oil

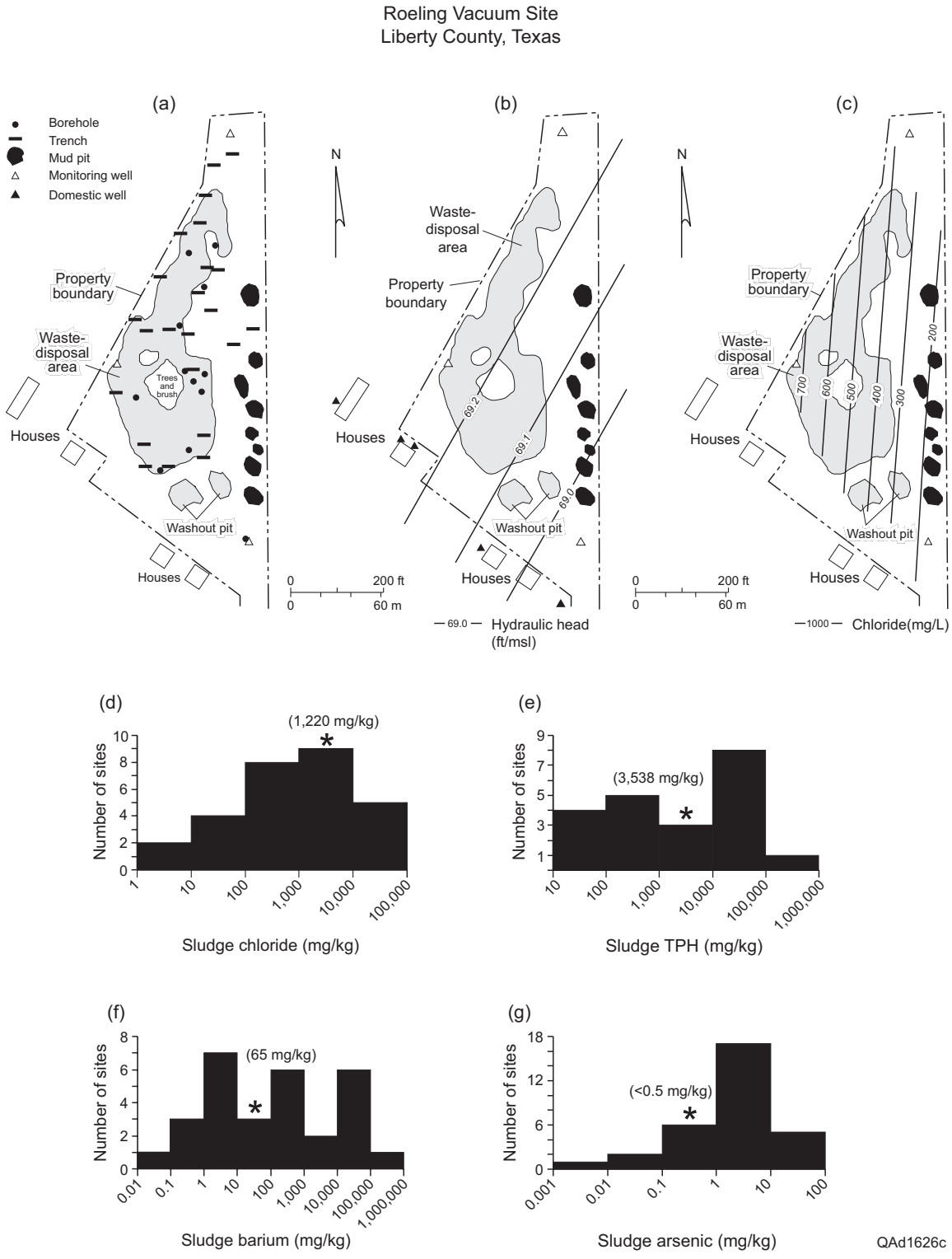

Figure 35. Roeling Vacuum site, Liberty County, Texas: maps of distribution of pits, sample locations, and other site elements, (b) water levels, and (c) chloride in groundwater. Histograms of (d) mean chloride in pit sludge, (e) mean TPH in pit sludge, (f) mean barium in pit sludge, and (g) mean arsenic in pit sludge; (d) to (g) for all sites in the study sample. * mean for Roeling Vacuum site; man concentration in parentheses.

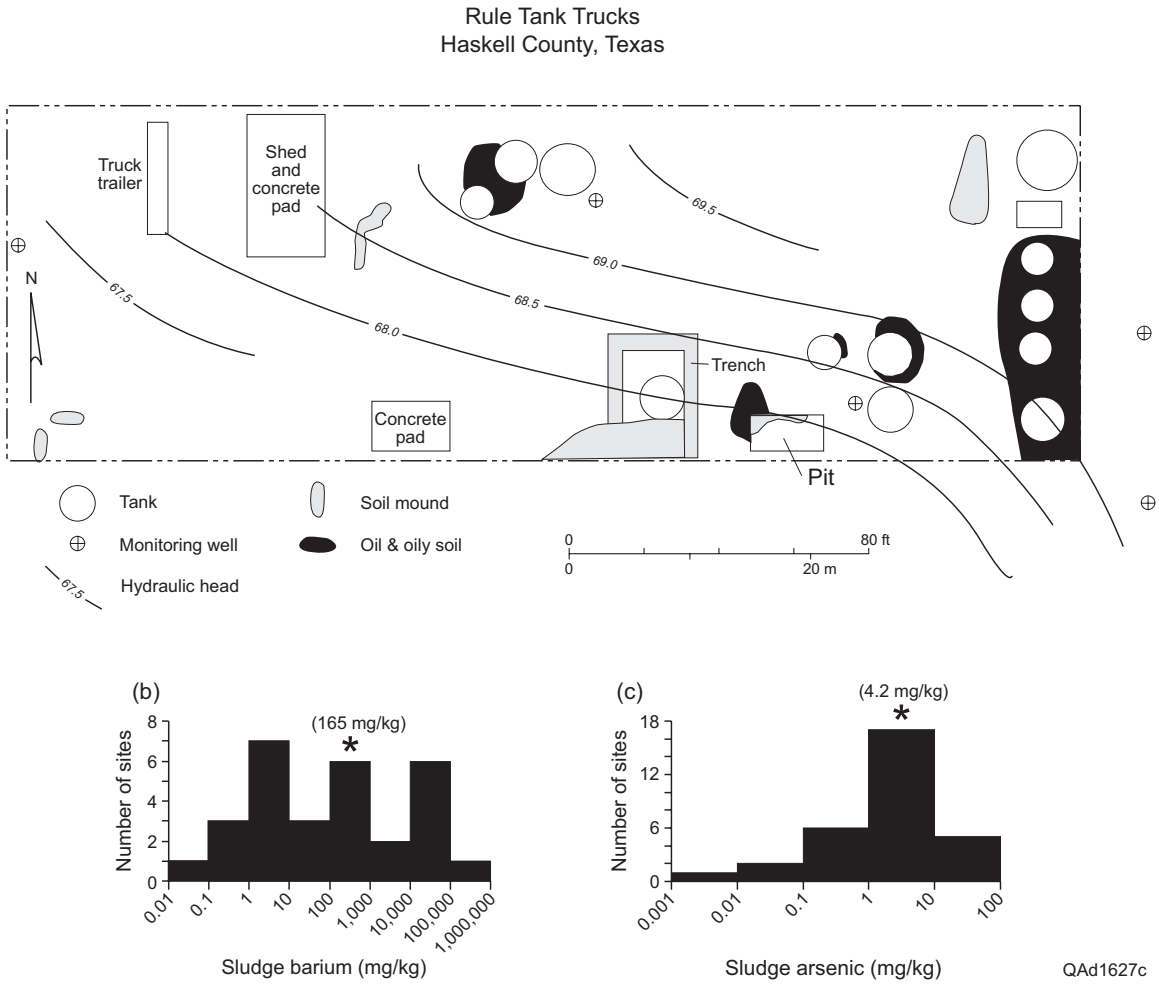

Figure 36. Rule Tank Trucks site, Haskell County, Texas: (a) map shows distribution of pits, oil-contaminated surface areas, water levels, and other site elements. Histograms show (b) mean barium in pit sludge and (c) mean arsenic in sludge. Histogram in (b) and (c) for all sites in the study sample (fig. 5). Star (*) indicates mean for site. Mean concentration for site in parentheses.

cans and oil filters, 2 yd^3 of sediment, and 18 bbl of water. A tank-truck trailer containing 35 bbl of liquid waste was also on site.

Five monitor wells were installed as part of an RRC-sponsored investigation (Duke Engineering Services, 2001b). Analyses confirmed that groundwater had not been significantly impacted (620 mg/L chloride; 1,100 mg/L TDS). TPH was 65,700 to 128,000 mg/kg in pit sludge, 135,000 to 417,000 mg/kg in tank sludge; and 10,700 mg/kg in sludge stored in the trailer tank. Lead content of sludge in one of the tanks was 690 mg/kg. Comparison of barium and arsenic in sludge at the Rule site with all study samples are shown in figure 36b-c. Mean barium and arsenic in site sludge was similar to the mean of all study samples.

Steve's Oilfield Services

The Steve's Oilfield Services site (fig. 37) is an abandoned reclamation site near Kingsville, Kleberg County, Texas, that accepted saltwater, tank-bottom sediment, and processed drilling mud for reuse. RRC sent the facility a forfeit order in August 1993 after receiving complaints about fluids overflowing onto cultivated lands that surround the site, and reports of illegal deliveries. The site was later abandoned. During site assessment, the site was found to have14 tanks, some of which were leaking, two 180- ft^2 concrete wash-out pits, 15 unlabeled drums containing unknown materials scattered about, 11 storage and 3 fracture media tanks, a building, six soil mounds, and patches of oil-stained soil.

Site Assessment and Remediation: Texas Examples

This review focuses on 12 of the previously summarized Texas sites for which potential environmental impacts were assessed by the RRC or its contractors, and for which recommendations for remediation measures were developed. Remediation measures, when deemed

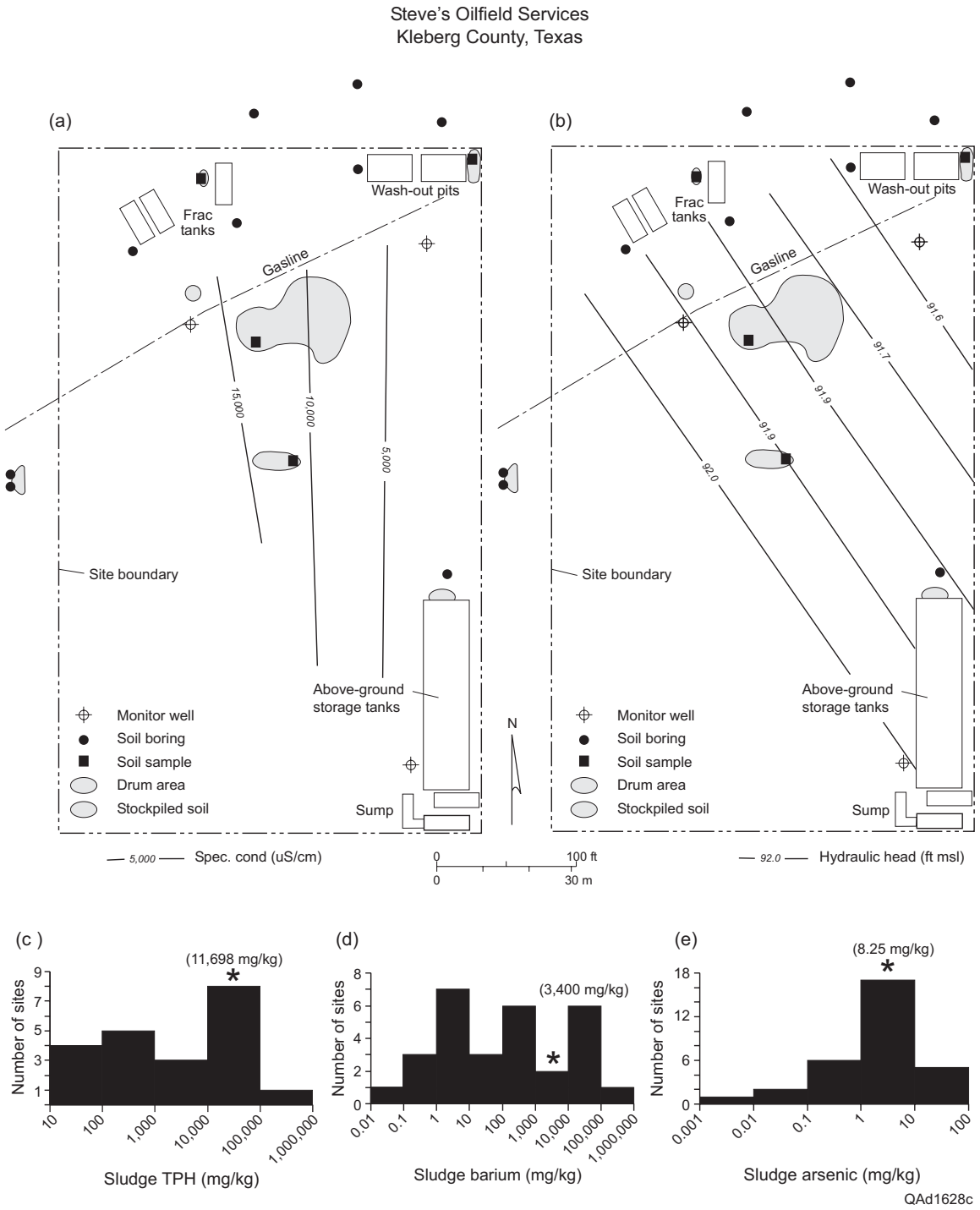

Figure 37. Steve's Oilfield Services site, Kleberg County, Texas: maps show (a) distribution of specific conductance in groundwater, and (b) water levels. Histograms show (c) mean TPH in sludge, (e) mean arsenic in pit sludge, (f) mean barium in pit sludge, and (g) mean arsenic in pit sludge. Histograms in (c) to (g) for all sites in the study sample (fig. 5). Star (*) indicates mean for Steve's site. Mean concentration for site in parentheses.

necessary, were undertaken for many of these sites. Most CCDD sites are still in the assessment phase.

We also reviewed available files on remediation assessments in Oklahoma. Most sites were not found to have environmental conditions warranting additional corrective measures. Site-specific information on procedures used prior to final closure of these CCDD sites in Oklahoma, such as de-watering and back filling of pits, were not discussed in available file documents. It is likely these remediation procedures had not been employed at the time information was gathered. No data on remediation of abandoned CCDD sites in Louisiana or New Mexico were available.

These Texas case examples may include aspects that are representative of abandoned CCDD sites elsewhere. Methods suggested or used for assessment and remediation also may be illustrative of present practice where environmental impacts are not great. Site complexity ranges from a single small pit at some sites to large, multi-pit facilities that also included oil-reclamation and saltwater disposal operations. Remediation requirements range from cases where no immediate action was found to be warranted to cases where complete dismantling of tanks, plumbing, and buildings along with extensive excavation and export of contaminated sludge and soils, and landscaping was required.

Since 1991, RRC personnel have identified and inventoried abandoned oil-field sites as candidates for cleanup. The RRC ranked sites by giving priority to contaminated sites that (1) have had observable releases, (2) occur in groundwater recharge zones with high soil permeability, (3) lie near surface-water bodies or water-supply wells, or both, (4) have high public profile and have received complaints, and (5) are near population centers. Straightforward solutions for cleanup are readily apparent for many of the sites. In the simplest cases inspection by RRC may be sufficient to satisfy requirements for environmental security of a site. In more complex cases consultants are

contracted for site assessment, determination of required remediation procedures, and estimate of cleanup costs.

Texas oversight of assessment and cleanup of CCDD sites has focused on assuring environmental security of the site, such that adjacent soils, surface water, and groundwater will not be contaminated after closure. Assessment of need for remediation at abandoned CCDD sites in Texas has used multiple guidelines drawn from State regulations and the EPA. Guidelines applied in Texas are from the RRC and the TCEQ (formerly Texas Natural Resource Conservation Commission [TNRCC]), including health-based standards (TNRCC, 1996, 1998, 1999; U.S. Environmental Protection Agency, 1996a, b). For example, the TPH standard of 1 percent dry weight mandated for crude-oil spills in non-sensitive areas (Rule 91) might be used as a guideline for determining whether specific remediation activities at a CCDD site is warranted, although the standard as written does not apply to such sites. Likewise, although Rule 8 does not specify a chloride concentration for drilling-fluid disposal, RRC-issued permits for landfarming sites generally stipulate a chloride concentration limit of 3000 mg/L. That limit might be taken as a guideline for consideration in closing a CCDD site.

The following 12 sites, summarized in the previous section, include a range of environmental categories and remediation applications. These sites do not make up a historically exhaustive list of abandoned CCDD sites in Texas but include well documented sites described in RRC remediation files. These sites have been abandoned over the last 20 years or more. Before 1984, CCDD sites operated under less stringent rules or guidelines. Many operators of those sites and of proposed sites where pits had already been excavated applied for RRC permits in 1984, but were refused for a variety of reasons. The RRC ordered CCDD operators to dewater, backfill, and close pits at many of these sites. Although not technically abandoned, the environmental impact of

these sites is not well known. Examples are presented in order of the apparently least complicated to the most complex.

Albany Tank Yard

The Albany Tank Yard site (fig. 27) was 0.5 mi north of the North Fork of Hubbard Creek near Albany, Shackelford County, Texas. This abandoned oil reclamation site included six sludge pits, nine 110 to 500 bbl storage tanks, some equipment, and metal buildings that served various purposes. Pit waste had levels of chloride at (3,270 to 10,845 mg/L) and TPH (as much as 15.2 percent). Lead (average of 551 mg/kg) and arsenic (average of 37.2 mg/kg) exceeded TCEQ limits such that TCLP tests would be required to characterize waste prior to approval for disposal in a municipal landfill under TCEQ authority. Benzo[a]pyrene (estimated at 3 mg/kg) exceeded the TCEQ risk-reduction program residential Tier 1 level (TNRCC, 1999). Monitor wells were dry and not sampled.

Recommendations for remediation included excavation and removal of impacted soil; disposal of debris and scrap metal; cleaning, dismantling and disposal of metal tanks; and excavation and removal of 2,400 yd^3 of soil to a depth of 7 ft from the sludge area. Further assessment of the site is ongoing. State expenditure for site investigation activities is approximately $138,700.

Briggs Site

The Briggs site (fig. 28) is an abandoned site east of Bay City, Matagorda County, Texas (Sullivan and others, 1999). The site consists of 1 pit with an areal coverage of approximately 0.03 km^2 (312,500 ft^2) and an adjacent outwash area.

Samples of pit sludge were collected on a regular grid across the site and not composited prior to analysis in order to assess spatial variability. Distributions of chloride and arsenic in the waste material (fig. 28d, c) confirm that constituents are nonuniformly distributed with locally elevated concentrations of chloride (average of 6,600 mg/kg, maximum >10,000 mg/kg) and arsenic (>2 mg/kg). The low onsite arsenic concentration posed no immediate environmental hazard. The outwash area also shows variation in chloride and arsenic levels at lower concentrations than the main disposal pit. The outwash area may be analogous at other sites where there has been a breach in pit berm and some migration of pit contents.

Assessment techniques used at the site included monitor well installation, water-level measurement, groundwater sampling, borehole and surface geophysical (EM) surveys, piston coring to sample the waste package and soils, a survey of naturally occurring radioactive materials (NORM) at ground surface, and a survey of area domestic wells. EM surveys showed minimal elevated ground conductivity suggesting there was no excursion of saltwater from the site. The EM survey did indicate a zone of elevated conductivity immediately beneath the site that appears to extend to a depth of 26 ft. Chromium and lead were detected in the waste material and in soils in a portion of the outwash area with concentrations above allowable limits for landfill disposal. The wastes exhibited low content of organic compounds and metals as measured by Toxicity Characteristic Leachate Procedure (TCLP) tests. Concentrations of organics and metals in soils did not exceed health-based criteria. Cadmium, lead, and chloride were detected above regulatory guidelines in onsite groundwater. However, it was concluded that groundwater required no remediation because there is little likelihood of contamination of nearby domestic wells, completed at greater depths in aquifers separated from the shallow groundwater.

Primary factors to be considered in remediation were the low compressive strength of the waste package and the elevated chloride levels. The site poses some potential physical hazard because as the 3- to 7-ft thick waste package has very little load-bearing strength. It was determined that the estimated 39,000 yd^3 waste package would require 48.4 acres for land farming, larger that the property dimensions. A recommended remediation option for the site was installation of an engineered soil-geomembrane cap to isolate the waste package from leaching by rainwater, coupled with continued monitoring, including installation of additional monitoring wells. These and other options were concluded to be impractical because of expense and not justified by constituent concentrations. Site monitoring is ongoing to determine whether any change in conditions warrant further action.

T. L. Carter Site

The Carter site is 4.5 mi southeast of Roby, Fisher County, Texas. It received basic sediment, produced water, and drilling fluid. The site contained five unlined pits of various sizes ranging in capacity from 3400 to 10,600 bbl. Depth to groundwater is approximately 20 ft, and distance to surface water, the Clear Fork of the Brazos River, is 1500 ft. A 1984 permit application was denied by RRC and closure of pits was ordered. In 1991 pits were still open; by 1993 only 1 pit had been partly backfilled. Close proximity to surface water and lack of space to dispose of pit materials by land treatment complicated efforts to backfill the pits. File information contained no data on waste or groundwater constituent concentrations. A preliminary cost estimate by RRC for remediation was approximately $48,000. Assessment of the site is still in progress.

Fox Vacuum Site

The Fox Vacuum site (fig. 29) is an abandoned site located 8 mi north of Buna, Jasper County, Texas. The abandoned site was used as a washout yard for trucks operated by an oil-field vacuum-service company and as a disposal site for waste drilling fluids. Remediation actions undertaken for the site included mixing contents of the 7 pits with berm material and clean soil, backfilling the pits, and leveling and compacting. State expenditures for site clean up, including other actions besides pit remediation, was approximately $13,000.

Gober Disposal Site

The Gober Disposal site (fig. 30) near Bridgeport, Wise County, Texas, was a low chloride (<3000 mg/L) drilling fluid CCDD site. A June 1990 RRC memo noted that natural degradation of the oil was in progress and suggested that no further cleanup was required. The site was administratively closed in September 1991. However, an April 1999 memo noted new violations including disposal of oil- and saltwater-contaminated drilling mud in unauthorized pits and pits permitted to receive only low chloride drilling fluid. The owner spread hay on remaining wastes to adsorb oil. The site was never reopened.

Manvel Saltwater Disposal Site

The Manvel Saltwater Disposal site (fig. 31) is an abandoned site located within the city limits of Manvel, Brazoria County, Texas. The site is a former saltwater disposal site in which crude oil and drilling waste have also been disposed.

Groundwater exceeds the SMCL unenforceable aesthetic guideline for chloride in drinking water in 12 of the shallow monitoring wells and exceeds the USDW limit for TDS in 8 of the shallow monitoring wells. Barium levels in groundwater are highest (16 mg/L) toward the eastern

side of the site (fig.31b). Barium in sludge (mean of 53,775 mg/kg) appears to exceed the average for all sites in the study sample and exceeds the TCEQ risk-reduction program residential Tier 1 level (TNRCC, 1999). Benzene levels in groundwater are highest (60.7 µg/L) just north of the disposal pits and appears to form a plume that is centered around the plugged oil well (Duke Engineering Services, Inc., 2001a). The TCEQ residential Tier 1 level for groundwater ingestion (TNRCC, 1999) for benzene is 5 µg/L. Benzene concentration appears to have decreased over time (Duke Engineering Services, Inc., 2001a). Samples collected from sludge in the 2 disposal pits showed TPH levels up to 4.1 percent, with an average of 1.2 percent (Kaiser and others, 1996). Samples of soil from beneath the pit sludge showed concentration levels below 1 percent. (Duke Engineering Services, Inc., 2001a). EM surveys indicated that saline water lies 3 to 6 ft beneath the surface around the perimeter of the site in a sand layer. The base of the saltwater appears to be at a depth of about 30 ft, where the sand is underlain by red clay (Kaiser and others, 1996).

Initial recommendations for clean up included monitoring, elimination of high-salt wastes in the pits, and natural dilution of saline groundwater. The plugged saltwater disposal well and oil well were not considered sources of documented groundwater salinity. Offsite sources of elevated salinity, chloride, and barium in groundwater, however, are possible at this site. It was recommended that pit fluids be discharged under permit to surface drainage to a nearby bayou. Onsite land treatment of high-TPH waste is preferred to removal because of the expense that would be incurred because the waste volume is great. Backfilling and leveling of pits (Kaiser and others, 1996) would require a U.S. Army Corps of Engineers wetland modification permit. Additional recommendations from a later site assessment included excavation and removal of drilling fluid wastes from the pit with the highest TPH (pit A) and testing for barium in the soil beneath the pit

(Duke Engineering Services, Inc., 2001a). Assessment of the site is still in progress. To date the RRC has expended approximately $221,100 on assessment of the site.

Munson Site

The Munson site (fig. 32) is an abandoned site near Lyons, Burleson County, Texas, permitted as a low chloride drilling fluid disposal site. In May of 1982 pits were inspected revealing seeping fluids. In 1986 complaints were received that a berm had eroded and fluids were escaping onto adjacent property. Approximately 50,000 bbl of drilling fluids discharged to the adjacent creek. Also in 1986 a vacuum-truck company attempted to dispose of wastes with chloride concentrations of 70, 000 mg/L. A 1994 RRC site assessment determined that the site was abandoned and that approximately 500,000 bbl were in the pits. Pits were found leaking at an undetermined rate. Assessment of the site is still in progress.

Post Oak Site

The Post Oak site (fig. 33) located east of Giddings, Lee County, Texas, is a former sandstone quarry where there had been unauthorized disposal of hydrocarbon-contaminated drilling fluids. Chloride concentration in one of the monitoring wells (550 mg/L) exceeded the SMCL unenforceable aesthetic guideline (250 mg/L); additional data were needed to define background concentration and establish whether the site was a source of chloride. Several other constituents exceeded regulatory guidelines. In both monitoring wells, EPA maximum contaminant levels (MCLs) for cadmium (0.005 mg/L) and chromium (0.1 mg/L) were exceeded. Cadmium ranged from 0.031 to 0.018 mg/L and chromium ranged from 0.15 to 0.32 mg/L. Lead was detected at 0.093 to 0.019 mg/L, above the EPA action levels of 0.015 mg/L. The action level is the concentration above which steps must be taken to reduce the concentration for drinking water.

Among organic constituents, only naphthalene in MW2 (0.042 mg/L) exceeded the TNRCC guideline limit for residential land use of 0.49 mg/L.

Samples of pit sludge were collected at 15 locations on a regular grid across the site; samples were not composited to allow an evaluation of spatial variation. Chloride, TPH, and lead in the waste material vary across the pit (fig. 33a-c). Mean chloride concentration (953 mg/kg; fig. 33d) is near the mean for all sites in the study sample; maximum measured chloride in sludge was about 2,500 mg/kg (fig. 33a). Mean sludge TPH concentration (903 mg/kg) was less than average (fig. 33e). An off-site background soil sample taken near the southwestern end of the pit shows a chloride concentration of 2 mg/kg and no TPH. Pit fluids had chloride levels of only 150 mg/L, well below the SMCL unenforceable aesthetic guideline for drinking water. Pit solids were determined to be appropriate for onsite land treatment.

Recommendations for site remediation included removal of the waste package from the pit for onsite land treatment. It was further recommended that a minimum of 6 additional monitoring wells be installed onsite to further evaluate potential for groundwater impact. It was estimated that waste removal and land treatment, installation of monitoring wells, and 5 years of monitoring would cost about $246,000. Site assessment is continuing.

Red River Oilfield Services Site

The Red River Oilfield Services site (fig. 34) near Tolbert, Wilbarger County, Texas, is an abandoned site previously permitted as a oil reclamation site. It was administratively closed in May 1992 after abandonment. In 1993 the RRC received complaints that rain-filled pits were overflowing. Site assessment by the RRC determined that the site contained approximately 2,000 bbl of liquid and solid waste material. Analyses of dry sludge from the pits documented oil and

grease content of 46 to 73 percent and TPH of 360,000 to 450,000 mg/kg (36 to 45 percent). Specific conductance of pit fluids was 5,450 to 22,600 μmhos/cm. Pit fluid samples also contained 1,772 to 8,169 mg/L chloride, 10 to 11 percent oil and grease, and an average of <5 mg/kg TPH. The skimming pit had a pH of 4.9 and the saltwater pit had a pH of 7.7. Sludge TPH had one of the highest average values (360,000 mg/kg) of all study samples

Site remediation included removal to a RRC-approved facility of all sludge, paraffin, tank bottom sediment, drilling mud, solids from pits and tanks, pit water and tank washwater, the liner from the skimming pit, disassembled components of the steel pit, steel tank and associated equipment, oil-stained soils, excavated soil from pit walls and bottoms, and various debris. Total State expenditure for site assessment and remediation was approximately $24,700.

Roeling Vacuum Site

The Roeling Vacuum site (fig. 35), located 6 mi northeast of Liberty, Liberty County, Texas, is an abandoned site with two washout pits, 8 small pits, and a larger irregularly shaped waste disposal area. The site was originally a quarry for dirt for oil-field roads.

Assessment methods had included an EM survey of the site, trenching and probing of the soil, installation of three monitoring wells and groundwater sampling, and an inventory and sampling of nearby domestic water-supply wells. Groundwater chloride and chloride, TPH, barium, and arsenic in sludge constituents appear at or somewhat less than the average values for all study samples. Other COCs were below regulatory guidelines.

A preliminary recommendation for remediation included excavation from the waste disposal area of high-chloride wastes and adjacent soils and removal to a RRC-approved site. There is insufficient volume of clean soil on-site to completely refill pit excavations, but partial back

filling and establishment of a wetlands area would be appropriate. There also were concerns for groundwater impacts resulting from excavation of the main disposal area. It was recommended that additional monitoring wells be installed including an upgradient well to determine background concentrations. Assessment of the site is still in progress.

Rule Tank Trucks Site

The Rule Tank Trucks site (fig. 36) an abandoned reclamation facility located in southeast Rule, Haskell County, Texas, was permitted as a facility to process produced saltwater and tank bottoms but may have received other non-permitted drilling wastes. Remediation consisted of removal of the hydrocarbon-contaminated wastes from tanks, the pit, and 580 yd^3 of soils excavated from around the pit and tanks to the Borden County Waste Disposal Facility. The tanks were cleaned, dismantled, and recycled. The five monitoring wells were to be plugged in March 2003. Total cost to the State for assessment and remediation was approximately $191,800. No further remedial activities were planned for this site.

Steve's Oilfield Services

The Steve's Oilfield Services site (fig. 37) is an abandoned reclamation site near Kingsville, Kleberg County, Texas. Site assessment consisted of a technical review of the site geology, soils, and regional hydrology. Neighbors were interviewed. Analyses were performed to characterize waste disposal requirements. It was concluded that there was no contamination of soils or groundwater. Pits were found to contain several barrels of water, sediment, some hydraulic oil, and drilling-mud polymer. Mean barium concentration (4,700 mg/L) in one pit, and barium concentration averaged for all pits (3,400 mg/kg), exceeded the TCEQ risk-reduction program residential Tier 1 level of 2,800 mg/kg (TNRCC, 1999). Clean up consisted of removal of all pit

contents and site equipment and hardware associated with the reclamation operation. Pits were back-filled, leveled, and compacted. Total expenditure by the State for assessment and clean up was approximately $196,300.

Discussion

For most sites in this survey, analyses of pit sludge were based upon composited samples representing one or more pits. Although they were often sampled on regular grids, most analyses of pit sludge do not reflect within-pit spatial variation of concentrations of COCs. For the few sites where analyses record sampling locations within individual pits, the distribution of analytes is shown to be nonuniform. Results in most cases appear to reflect where waste was discharged into the pit at its edge. Two sites where analyses are tied to specific locations within pits include the Royce Kelly site in Oklahoma and the Vernon Briggs site in Texas. Both these sites were abandoned by operators and became custody of the States, which initiated State-funded closure and cleanup operations.

Some inventoried sites, but not most, show that although concentrations of COCs change from one sampling event to the next, the rank or order of monitoring wells having the greatest and least concentrations remains unchanged. In these examples, even though absolute concentrations change, one well consistently maintains its prominence as the most contaminated well while another maintains its status as the least contaminated. Most of the studied sites show systematic changes in COC distribution patterns between sampling events.

Elevations of groundwater in the immediate vicinity of sites, based on monitoring-well measurements, generally do not show a uniform hydraulic gradient. Rather, a water-level mound is present within a site. Several sites display relatively consistent patterns of water levels in which

mounds in water-level elevation persist. At some sites water-level elevations consist of irregularly distributed highs and lows whose arrangement does not vary systematically between measurement events.

CONCLUSIONS

The objective of site assessment in these case examples was to identify the nature, sources, and extent of constituents of concern that resulted from disposal of drilling fluids, produced water, and associated E&P waste at CCDD sites. The most commonly occurring constituents of concern reported in pits at CCDD sites were hydrocarbons and saltwater mixed with drilling fluids. Detection of hydrocarbon constituents most commonly used TPH analysis. In some examples, BTEX or more specific analyses have been reported. Pit water with high chloride can be a source of increased salinity in soil, groundwater, and surface water. Analysis of concentrations of constituents, such as chloride and TPH, and determination of the gradient of hydraulic head in groundwater, have usually been conducted to assess water quality and the potential for migration of constituents. EM surveys have been employed where saltwater contamination is suspected.

We found records for 287 CCDD sites in Louisiana, New Mexico, Oklahoma, and Texas (table 1). Of these, 54 were active and 199 were inactive as of January 2002, and 34 had been abandoned. Most (95 percent) were disposal-pit facilities and the rest were used for land treatment of drilling fluids. The typical disposal-pit facility has fewer than 3 disposal pits on site (fig. 3). The median size of a facility's pits is approximately 2 acres (fig. 4). The sites in our database do not compose an exhaustive list of all currently and previously operating CCDD sites, but rather are sites for which data were available during the data collection phase of our investigation.

Histograms of the statistical distribution of typically measured constituents of concern at CCDD sites should provide a basis for evaluating the data from other sites (fig. 5). Many CCDD sites in the four States have samples of pit water or groundwater, or both, in which chloride concentrations or TDS that exceed respective standards: the 250 mg/L EPA unenforceable SMCL for chloride and the 10,000 mg/L TDS definition of an USDW (U.S. Environmental Protection Agency, 2000). Standard laboratory procedures are being used in the four states so data comparability is high, although we could not find specific analytical references for many reports. Some undocumented CCDD abandoned sites may also have levels that exceed these SMCL and TDS criteria. Applicable regulations do not require such sites, based solely on these criteria, to be remediated mainly because these chloride levels are normally not health based, but aesthetically based. In addition, available site data do not generally document the ambient concentration in the adjacent environment or determine if these constituent concentrations reflect contributions from onsite or from offsite. Remediation decisions for specific CCDD sites may require collection of additional onsite data on shallow groundwater quality and background data from upgradient of site operations.

Comparison of well documented active and inactive CCDD sites versus poorly documented abandoned sites shows that maximum average concentration of constituents are generally consistent (table 9). Constituent concentrations at abandoned sites generally are within the range for constituents at active and inactive sites. At some abandoned sites, maximum average concentration of barium, chromium, lead, silver, TPH, or BTEX, of constituents is greater than at active and inactive CCDD sites. Data from well-documented sites, therefore, may be used to predict conditions at abandoned sites, except that older abandoned sites might have outlier concentrations for some metal and organic constituents. Differences may reflect a change in industry practice.

Also, we obtained data on soil contamination outside of disposal areas or treatment cells only for two sites; findings, therefore, apply only to on-site conditions.

Data from Oklahoma and Texas indicate that techniques used for site-assessment ranged from visual inspections to comprehensive geotechnical and scientific surveys. Survey measurements have included geophysical measurements; sampling and analyses of chemical composition of wastes, soil, groundwater, and surface water; measurement of water levels in monitoring wells; soil-gas measurement; radon detection; well tests of hydraulic conductivity; elevation surveys; and coring and description of core. Louisiana has assessed and closed one abandoned CCDD site, is assessing one abandoned CCDD site, is developing plans to assess six sites, is in the process of remediating one abandoned CCDD site, and is developing plans to remediate three abandoned CCDD sites. Most assessments of abandoned CCDD sites in Oklahoma consisted of stratigraphic surveys and chemical analyses of solid wastes; historical data for surface water and groundwater were available for several sites. RRC conducted comprehensive assessments at some sites with stratigraphic surveys, chemical analyses of wastes, surface water, and groundwater, and geophysical measurements. Such in-depth assessments are expensive, however, and may not be cost-effective for all sites. At other Texas sites, assessments included inspection, mapping, and chemical analyses of soils, wastes, and groundwater.

Site remediation measures had been undertaken for one Louisiana CCDD site and three abandoned CCDD- and other sites in Texas as of this study. Remediation techniques were recommended on the basis of site assessments. Remediation alternatives address physical hazards and potential for transport of dissolved salt and petroleum hydrocarbons to the accessible environment. Recommended options included excavation of wastes and contaminated adjacent soils followed by either removal to permitted disposal facilities, or land farming (land spreading or

land treatment) if sufficient on-site area were available. Groundwater remediation was not found to be necessary at any abandoned CCDD site in Texas as of December 2002. Installation of additional monitoring wells and continued monitoring of on-site groundwater were generally recommended; further monitoring may indicate a need for remediation. Assessments are continuing for most abandoned CCDD sites in our investigation and final determinations for remediation measures are pending.

ACKNOWLEDGMENTS

This project was supported by U.S. Department of Energy Award No. DE-AC26-99BC15225 and Grant No. 00-0000-4064 from the American Petroleum Institute. Personnel at the offices of the Office of Conservation of the Louisiana Department of Natural Resources, the Oil Conservation Division of the New Mexico Energy, Mineral, and Natural Resources Department, the Oklahoma Corporation Commission and Oklahoma Energy Resources Board, and the Railroad Commission of Texas were extremely supportive and helpful during this project. They provided on-site office space, ready access to files, file data from ongoing investigations, staff time for discussing project files and agency rules and procedures, and photocopy services.

Rebecca C. Smyth, Jerry Mullican, and Yaguang Gu at the Bureau of Economic Geology assisted with research, data collection, and liaison with various State agencies. Illustrations were drafted by Jana Robinson under the supervision of Joel Lardon.

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Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Louisiana

Parish	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
Acadia	Chaddick	1	no data	no data	inactive
Acadia	Guillary	no data	no data	no data	inactive
Bossier	Folse Farms	no data	no data	no data	inactive
Cameron	Big Diamond	5	32.60	1,420,000	abandoned
Iberia	Waguespack	7	10.25	446,516	inactive
Jeff Davis	Castex	11	4.89	213,125	abandoned
St. Mary	Marine Vacuum	no data	no data	no data	inactive
St. Mary	Oil Base	1	no data	no data	inactive
St. Mary	Tidrow	1	no data	no data	inactive
Vermilion	Baudoin	1	no data	no data	inactive
Vermilion	Castex	11	4.89	213,125	abandoned
Vermilion	Gulf Coast Vacuum	no data	no data	no data	inactive
Vermilion	Leleux	no data	no data	no data	abandoned
Vermilion	Nunez	1	0.34	15,000	abandoned
Vermilion	PAB	4	9.37	408,000	abandoned
Vermilion	Tower	no data	no data	no data	abandoned
Vermillion	Fontenot	no data	no data	no data	abandoned
Vermillion	Pine	no data	no data	no data	abandoned
Vermillion	Simon	2	no data	no data	abandoned
Pointe Coupee	Romero	no data	no data	no data	inactive

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Louisiana (continued)

Land Treatment Facilities

Parish	Site	No. Cells	Cell Area (acres)	Cell Area (ft2)	Status
Bossier	Elm Grove	10	30.99	1,350,000	active
Bossier	Bossier Parish	10	no data	no data	active
Jeff Davis	Mermentau	25	107.90	4,700,000	active
Jeff Davis	Laccassine	11	136.59	5,950,000	inactive
Lafrouche	Bourg	23	79.43	3,460,000	active
Lafourche	Lafourche Constrn.	5	est 30.07	1,310,000 (est)	inactive
Pt. Coupee	Western Reliable	4	25.25	1,100,000	inactive
St. Landry	Mar Services	6	est 30.1	1,310,000	abandoned
St. Mary	Bateman Island	15	78.51	3,420,000	active

New Mexico

County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
Eddy	Laguna Quatro	4	2.50	108,900	inactive
Lea	Parabo	8	50.28	2,190,000	active
Lea	CRI Halfway	2	259.87	11,320,000	active
San Juan	Basin	18	6.17	268,800	inactive

Land Treatment Facilities

Lea	C & C Landfarm	9	217.63	9,480,000	active
Rio Arriba	TNT	6	no data	no data	active
San Juan	Tierra Crouch Mesa	14	72.08	3,140,000	active

Oklahoma

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
2	Blaine	BDK	4	22.96	1,000,000	inactive
2	Blaine	Southard	6	4.02	175,000	active
2	Blaine	Blehm	12	no data	no data	active
2	Bryan	Mitchell	no data	no data	no data	inactive
2	Canadian	Arrow 10-14-5	no data	no data	no data	inactive
2	Canadian	Arrow Tank Trucks	no data	no data	no data	active

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Oklahoma (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
2	Canadian	Courtney/Briggett	4	21.69	945,000	active
2	Canadian	FPC	5	10.23	445,625	active
2	Canadian	Scott, J.	3	9.80	427,000	active
2	Canadian	Samples	5	6.03	262,725	active
2	Canadian	Arrow/Calumet	7	2.59	112,750	inactive
2	Dewey	Richardson	4	4.39	191,250	inactive
2	Dewey	Day	2	0.69	30,000	inactive
2	Dewey	Day	2	0.69	30,000	active
2	Garfield	Gray Farms	7	12.72	554,000	inactive
2	Garfield	Gray	7	12.51	545,000	abandoned
2	Kingfisher	Great Basin	1	1.38	60,000	inactive
2	Major	Guard	3	28.01	1,220,000	active
2	Major	Bluff	3	14.08	613,320	active
2	Roger Mills	Trout	8	44.77	1,950,000	active
2	Roger Mills	Safe Earth	1	2.41	105,000	active
2	Woods	Lojo	no data	0.36	15,625	inactive
2	Woodward	Highfill	1	13.77	600,000	inactive
3	Beckham	Stowers 27-8-21	1	0.57	25,000	inactive
3	Beckham	Pettitt	no data	no data	no data	inactive
3	Beckham	Stowers 16-8-21	no data	no data	no data	inactive
3	Caddo	H. T. S.	1	2.37	103,125	abandoned
3	Caddo	Meeks	2	1.38	60,000	inactive
3	Caddo	Grenard	1	1.03	45,000	inactive
3	Caddo	Big Pasture	no data	no data	no data	inactive
3	Caddo	Big Pasture	no data	no data	no data	active
3	Caddo	Holderman	no data	no data	no data	inactive
3	Caddo	Triple S/Big Pastures	3	no data	no data	inactive
3	Carter	Suttles	2	51.65	2,250,000	abandoned
3	Carter	Walker	3	7.75	337,500	inactive
3	Carter	Hertzler 3-5-2	2	1.76	76,500	inactive

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Oklahoma (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
3	Carter	Hertzler 31-5-3	3	1.03	44,750	inactive
3	Carter	Hull 1-6-3	2	0.58	25,300	inactive
3	Carter	Hull 20-5-2	2	0.27	11,750	inactive
3	Carter	Kirk	5	no data	no data	inactive
3	Comanche	Shiflett	1	1.95	85,000	inactive
3	Comanche	Sullivan	no data	no data	no data	inactive
3	Garvin	Ball Ranch	4	9.37	408,000	inactive
3	Garvin	Peek & OMT	18	4.56	198,500	inactive
3	Garvin	S & M	6	1.62	70,500	abandoned
3	Garvin	Ferguson	1	0.17	7,500	inactive
3	Garvin	Pharoah	no data	no data	no data	inactive
3	Garvin	Eola	18	no data	no data	active
3	Garvin	Sable Mar	18	no data	no data	active
3	Grady	Giles	2	15.61	680,000	active
3	Grady	Gray	7	8.49	369,875	inactive
3	Grady	Washita	6	5.98	260,500	inactive
3	Grady	Bullard 28-3-7	4	1.86	80,900	inactive
3	Grady	Roadrunner	1	1.32	57,500	inactive
3	Grady	Falcon Ridge	no data	no data	no data	inactive
3	Grady	Moore	no data	no data	no data	inactive
3	Grady	Phelps	no data	no data	no data	inactive
3	Grady	Tash/Chitwood	6	no data	no data	inactive
3	Love	Scott, L.	2	3.96	172,500	inactive
3	Love	Bone 23-6-1	1	1.03	45,000	inactive
3	Love	Bone 15-7-2	1	0.69	30,250	inactive
3	Love	Banks	2	0.63	27,500	inactive
3	Love	Banks	2	0.63	27,500	active
3	Love	Smith, G.	1	0.52	22,500	active
3	Love	Buck	no data	no data	no data	inactive
3	Love	Ricketts	no data	no data	no data	inactive

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Oklahoma (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
3	McClain	Kelly	5	41.32	1,800,000	abandoned
3	McClain	Webb/Femco	5	11.94	520,000	active
3	McClain	S & K	3	11.08	482,500	inactive
3	McClain	York	6	7.49	326,250	abandoned
3	McClain	T&S	2	4.10	178,500	active
3	McClain	Hamilton	8	3.50	152,461	abandoned
3	McClain	A & A	2	no data	no data	inactive
3	McClain	Bebout & Albrect	no data	no data	no data	inactive
3	Stephens	Poteet	8	9.44	411,000	active
3	Stephens	Bullard 25-2-7	4	2.07	90,000	inactive
3	Stephens	Wright	1	1.43	62,500	inactive
3	Stephens	Getty	no data	no data	no data	inactive
4	Atoka	BC	5	7.85	342,100	inactive
4	Atoka	Mabray	4	1.72	74,750	inactive
4	Atoka	McAlister	no data	no data	no data	inactive
4	Haskell	Eastern Tank	1	2.20	96,000	inactive
4	Haskell	Bullard 21-8-22	1	0.75	32,500	inactive
4	Haskell	McCurtain	no data	no data	no data	inactive
4	Johnston	Stallings	no data	no data	no data	inactive
4	Latimer	Fluid Haulers 22-5-17	1	0.28	12,250	inactive
4	Leflore	Quick Lay Pipe	1	0.50	21,875	inactive
4	Marshall	Lee/Triple L	3	4.13	180,000	inactive
4	Marshall	Bullard 2-8-5	?	no data	no data	inactive
4	Pittsburg	Parent/Casey	3	7.23	315,000	inactive
4	Pittsburg	Smith & Williams	4	2.41	105,000	inactive
4	Pittsburg	Fluid Haulers 35-6-13	1	1.43	62,500	abandoned
2	Victoria	Superior Vacuum	1	0.31	13,600	inactive
4	Pittsburg	Fike	3	1.38	60,000	inactive
4	Pittsburg	Arrow 3-5-15	2	0.69	30,000	inactive
4	Pittsburg	Oilfield Services	3	0.46	19,875	inactive

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Oklahoma (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
4	Pittsburg	Sweetin & McAlister	no data	no data	no data	inactive
4	Pontotoc	Sutton	no data	no data	no data	inactive
4	Pottowatomie	O'Daniel	7	15.56	678,000	active
4	Pottawatomie	Merkel	12	6.71	292,500	abandoned
4	Pottawatomie	Little River Express	9	1.70	74,100	inactive
4	Seminole	Carr City	4	4.42	192,500	inactive

Texas

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
1	Dimmit	Wms Ranch/ Big Wells	1	0.08	3,500	inactive
1	Frio	Graham	1	0.03	1,350	inactive
2	Bee	Dahl	3	11.02	480,000	inactive
2	Burleson	Munson	5	1.89	82,300	abandoned
2	DeWitt	Koenig	1	2.48	108,000	inactive
2	Goliad	Curtis	1	0.92	40,000	inactive
2	Live Oak	R & L	1	0.26	11,500	inactive
2	Victoria	Superior Vacuum	1	0.31	13,600	inactive
3	Austin	A & R Lease	no data	no data	no data	inactive
3	Austin	Hardin-Racoon Bend	1	0.06	2,800	inactive
3	Brazoria	Allstate Vacuum	no data	2.75	120,000	inactive
3	Brazoria	Amoco	no data	no data	no data	inactive
3	Brazoria	Bloodworth	no data	no data	no data	inactive
3	Brazoria	Industrial Vacuum	1	0.23	10,000	inactive
3	Brazoria	K-Mac Vacuum	no data	1.38	60,000	inactive
3	Brazoria	K-Mac Vacuum	no data	1.38	60,000	inactive
3	Brazoria	Lesiker	2	5.05	220,000	inactive
3	Brazoria	Manvel	4	4.17	181,448	abandoned
3	Brazoria	Miles	1	0.66	28,750	inactive
3	Brazoria	Mudx	4	7.18	312,595	inactive
3	Brazoria	Reid Vacuum	3	0.04	1,800	abandoned
3	Brazoria	Salt Water	2	0.11	4,968	inactive
3	Brazoria	Yelderman	1	0.67	29,200	inactive

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Texas (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
3	Brazos	Kurten Vacuum	2	0.04	1,600	inactive
3	Burleson	Groce	1	0.22	9,500	inactive
3	Burleson	Hayton	no data	no data	no data	inactive
3	Burleson	Hopkins	no data	0.92	40,000	inactive
3	Burleson	McDaniel	no data	no data	no data	inactive
3	Burleson	Munson	5	6.43	280,000	inactive
3	Burleson	Palestine Contractors	7	2.75	120,000	inactive
3	Burleson	Porter No. 1	1	0.25	11,000	inactive
3	Burleson	Porter No. 2	1	0.25	11,000	inactive
3	Burleson	S.A.P. Vacuum	2	0.09	3,900	inactive
3	Burleson	Vollentine	no data	no data	no data	inactive
3	Chambers	Dalley Vacuum	1	0.01	600	inactive
3	Chambers	Ogden	no data	no data	no data	inactive
3	Chambers	Trant	1	9	399,360	
3	Colorado	Lundy Vacuum	no data	no data	no data	active
3	Fayette	Donco Vacuum	1	no data	no data	inactive
3	Fayette	Leuders	2	no data	no data	inactive
3	Fayette	Mica	6	3.35	146,140	inactive
3	Ft. Bend	Payne	no data	4.13	180,000	inactive
3	Ft. Bend	Subterranean	no data	no data	no data	inactive
3	Galveston	Gulf Vacuum	no data	8.26	360,000	inactive
3	Hardin	National Vacuum	no data	no data	no data	inactive
3	Hardin	Silsbee Vacuum	no data	no data	no data	inactive
3	Hardin	Smart	no data	0.34	15,000	inactive
3	Hardin	Teffoil	1	0.05	2,000	inactive
3	Harris	House	2	22.96	1,000,000	inactive
3	Harris	Vaca	no data	no data	no data	inactive
3	Jasper	L & H	4	0.002	100	inactive
3	Jefferson	Environmental	1	3.49	152,100	inactive
3	Jefferson	Hendon	9	12.24	533,000	inactive
3	Jefferson	T & L Vacuum	1	0.06	2,500	inactive
3	Lee	Roeling Vacuum	8	0.02	760	abandoned

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Texas (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
3	Liberty	Johnston	no data	3.10	135,000	inactive
3	Liberty	Liberty Petroluem	8	0.08	3,560	inactive
3	Madison	Donoho	no data	no data	no data	inactive
3	Matagorda	Briggs	1	7.17	312,500	abandoned
3	Matagorda	Fox Vacuum	7	3.49	152,233	abandoned
3	Matagorda	Sidney	no data	no data	no data	inactive
3	Matagorda	Steve's	1	0.01	240	inactive
3	Newton	Hendon	1	12.05	525,000	inactive
3	Newton	Longhorn	1	0.34	15,000	active
3	Tyler	Bilco	no data	0.23	10,000	inactive
3	Waller	Richter	no data	no data	no data	inactive
3	Washington	Mo-Vac	no data	no data	no data	inactive
3	Wharton	Loise Vacuum	2	0.02	654	inactive
4	Cameron	West-Stinchcomb	1	19.61	854,208	active
4	Duval	Rancho Nuevo	1	1.93	84,000	active
4	Duval	Rancho Nuevo	1	1.17	50,960	active
4	Duval	S. R.	2	2.1	91,500	abandoned
4	Duval	S. Texas Disposal	3	7.09	308,750	inactive
4	Hidalgo	Cactus Land	1	0.23	10,000	inactive
4	Hidalgo	Evins	1	1.38	60,000	inactive
4	Hidalgo	Freeman	1	no data	no data	inactive
4	Hidalgo	Ganaway	2	12.02	523,750	active
4	Hidalgo	Garza	1	8.26	360,000	inactive
4	Hidalgo	Mo-Vac	1	1.03	45,000	inactive
4	Hidalgo	Mo-Vac	1	0.09	4,000	inactive
4	Hidalgo	Pool	1	6.20	270,000	inactive
4	Hidalgo	Smith	1	6.00	261,352	inactive
4	Hidalgo	Texan	1	0.21	9,216	inactive
4	Jim Hogg	MIR-TEX	2	0.20	8,800	inactive
4	Jim Wells	Alice	1	2.05	89,500	active
4	Jim Wells	Alice	1	0.34	15,000	inactive

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Texas (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
4	Jim Wells	Cadena Ranch	1	4.52	196,800	active
4	Jim Wells	Cadena Ranch	1	0.23	10,000	inactive
4	Jim Wells	Drilling	2	32.37	1,410,000	inactive
4	Jim Wells	Garcia	1	20.00	871,203	active
4	Jim Wells	Garcia	3	0.36	15,830	active
4	Jim Wells	Gwosdz	no data	no data	no data	inactive
4	Jim Wells	Koenig	1	1.15	50,000	inactive
4	Jim Wells	Mo-Vac	1	2.05	89,500	inactive
4	Jim Wells	Stubbs	2	0.38	16,600	inactive
4	Kleberg	Circle C Vacuum	1	3.67	160,000	inactive
4	Kleberg	Steve's	3	0.02	1,050	abandoned
4	Nueces	Coastal IV	1	1.27	55,350	inactive
4	Nueces	Coastal V	1	0.36	15,750	inactive
4	Nueces	Coastal VI	1	0.70	30,600	inactive
4	San Patricio	Alice	1	2.34	102,000	inactive
4	San Patricio	Havelka	1	no data	no data	inactive
4	San Patricio	Hunt	1	no data	no data	inactive
4	San Patricio	Hunt	no data	no data	no data	inactive
4	San Patricio	Hunt	1	no data	no data	inactive
4	San Patricio	Mires	1	no data	no data	inactive
4	San Patricio	Sorenson Ranch	1	9.66	420,750	inactive
4	Webb	Canyon	1	0.77	33,750	inactive
4	Webb	Delco	2	2.30	100,000	inactive
4	Webb	Lobo	6	19.40	847,000	abandoned
4	Zapata	ARCO/Marshall	1	1.95	85,000	inactive
4	Zapata	ARCO/Marshall	1	1.87	81,250	inactive
4	Zapata	Bustamante	1	5.17	225,000	active
4	Zapata	Chihuahua	1	0.6	26,600	inactive
4	Zapata	Falcon Lake	2	5.02	218,488	inactive
4	Zapata	Fresh	5	0.56	25,500	inactive
4	Zapata	Nano Ranch No. 2	1	1.84	80,000	active
4	Zapata	Thrash	1	0.02	750	active

Appendix A. Locations, names, numbers of pits or cells, total area per site of pits or cells, and operational status of CCDD sites in the database

Texas (continued)

District	County	Site	No. Pits	Pit Area (acres)	Pit Area (ft2)	Status
6	Rusk	McNeel	2	0.17	7,500	inactive
6	Rusk	McNeel	1	0.08	3,431	inactive
7B	Fisher	T. L. Carter	5	1.77	76,931	abandoned
7B	Haskell	RLA	2	0.01	360	inactive
7B	Haskell	Rule	1	?	?	abandoned
7B	Shackelford	Albany	?	?	?	abandoned
7B	Stephens	Walker-Caldwell	1	0.92	40,000	inactive
7B	Stephens	Walker-Caldwell	1	0.46	20,000	inactive
7C	Upton	M & T	3	5.77	251,464	inactive
7C	Upton	M & T	1	0.01	225	inactive
8	Borden	Westex/Sacroc	2	1.84	80,000	active
8	Ector	Westex Notress	8	9.33	406,250	active
8	Ector	Westex Notress	1	1.55	67,600	active
9	Ector	Wright	1	1.65	71,700	inactive
8	Howard	Dorland	15	0.26	11,335	inactive
8	Winkler	Massey	2	5.74	250,000	inactive
8	Winkler	Massey	1	0.92	40,000	inactive
8A	Borden	Williams	no data	0.69	30,000	active
8A	Borden	Williams	1	2.04	89,000	active
8A	Borden	Williams	1	2.04	89,000	active
8A	Borden	Williams B "DM-2"	1	5.17	225,000	active
8A	Borden	Williams/Gail	1	1.24	54,000	active
8A	Dawson	W.E.F.	1	0.0006	24	inactive
8A	Scurry	Midwestern Vacuum	10	0.34	15,000	inactive
8A	Yoakum	Kidd	no data	0.17	7,500	inactive
9	Jack	Collie	1	0.12	5,400	inactive
9	Montague	Nunneley	3	14.30	623,000	inactive
9	Montague	QOS	1	0.09	3,900	active
9	Wilbarger	Red River	2	0.02	755	abandoned
9	Wise	Gober	3	6.89	300,000	abandoned
9	Young	Yang	1	0.25	11,070	inactive

Appendix B. Data summaries for CCDD sites in the database

Site: Baudoin
Location: Vermilion Parish, LA
Status: inactive
No. Pits: 1
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/80	1	6.8	6.8				
Calcium					2/80	1	60	60				
Chloride					2/80	1	1,100	1,100				

Site: Big Diamond
Location: Cameron Parish, LA
Status: abandoned
No. Pits: 5
Area: 32.6 acres (1.42 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	7/90-6/98	49	6.35-8.23	7.80					11/88-5/98	9	5.64-6.72	6.17
Conductivity (µ)	7/90-6/98	27	1,200-30,000	7,674	7/90	1	4,110	4,110	11/88-5/98	19	1,420-27,300	9,329
TDS									11/88	11	858-18,407	6,439
Arsenic	8/87-6/98	55	0.113-8.824	0.93	7/90	1	1.46	1.46	11/88	11	<0.01-0.01	<0.01
Barium	8/87-6/98	60	220-59,950	16,048	7/90	1	44,556	44,556	11/88	11	<0.01-0.57	0.17
Cadmium	8/87-6/98	42	0-1.72	0.29	7/90	1	0.28	0.28	11/88	11	<0.01	<0.01
Calcium	8/87-7/90	9	317-1,580	909								
Chloride					7/90	9	14.8-3,700	1,552	11/88-5/98	28	36.7-10,847	3,195
Chromium	8/87-6/98	55	5.86-177.9	56.2	7/90	1	156.9	156.9	11/88	11	<0.01-0.06	0.02
Copper	8/87	6	1.54-3,020	1.036								
Iron	8/87	6	520-7,270	3,533								
Lead	8/87-6/98	28	0-165.7	43.3					11/88	11	0.06-0.57	0.24
Magnesium	8/87-7/90	9	49-1,020	448								
Manganese	8/87	6	25-380	91.6								
Mercury	8/87-6/98	55	<0.0001-0.99	0.22	7/90	1	0.11	0.11	11/88	11	<0.002-0.003	0.002
Nickel	8/87	6	1.73	14.2								
Palladium	5/98	26	0.65-165.7	37	7/90	1	98.5	98.5				
Selenium	7/90-6/98	48	0.2.89	0.34	7/90	1	0.27	0.27	11/88	11	<0.001	<0.001
Silver	7/90-6/98	29	0-0.43	0.06	7/90	1	0.03	0.03	11/88	11	<0.01	<0.01
Sodium	7/90	3	836-3,256						11/88	11	144-3,000	932
Zinc	8/87-6/98	60	3.46-489.5	106.8	7/90	1	99.87	99.87	11/88	11	<0.01-2.48	0.24
O&G (%)	8/87-6/98	45	0-7.15	0.96	7/90	1	7.0	7.0	11/88-5/98	19	0.9-4	1.64
Benzene									11/88	1	<0.001	<0.001
Toluene									11/88	1	<0.005	<0.005
Bbls. Rec'd	1978-84		789,620									

Site: Castex
Location: Jefferson Davis Parish, LA
Status: abandoned
No. Pits: 11
Area: 4.9 acres (213,125 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	9/87-11/87	7	7.69-8.08	7.85					1/86-1/87	10	6.66-7.65	7.18
Conductivity (µ)	9/87-11/87	7	3,910-78,000	29,887					1/86-1/87	10	700-64,800	32,300
TDS									1/86-1/87	10	412-37,535	18,730
Arsenic	9/87-11/87	7	9.8-13.1	11.9								
Barium	9/87-11/87	7	9,800-13,200	11,468								
Cadmium	9/87-11/87	7	1.7-4.3	2.5								
Calcium	9/87-11/87	7	346.7-3,597	1130.8								
Chloride									10/82-6/87	14	100-22,867	13,859
Chromium	9/87-11/87	7	116-325	241.8								
Lead	9/87-11/87	7	72-252	176.2								
Magnesium	9/87-11/87	7	30.4-189.6	96.4								
Mercury	9/87-11/87	7	1.7-2.3	2.1								
Potassium	9/87	1	26	26								
Selenium	9/87-11/87	7	0.4-1.1	0.6								
Silver	9/87-11/87	7	1.9-2.4	2.1								
Sodium	9/87-11/87	7	430-5,956	3,246					1/86-1/87	10	81-14,120	6,341
Zinc	9/87-11/87	7	360-1,120	842.0								
Bbls. Rec'd	1982-84		75,000									

Appendix B. Data summaries for CCDD sites in the database

Site: Chaddick
Location: Acadia Parish, LA
Status: inactive
No. Pits: 1
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	1/81	1	<0.01	<0.01								
Beryllium	1/81	1	<0.005	<0.005								
Chromium	1/81	1	<0.003	<0.003								
Lead	1/81	1	<0.01	<0.01								
Zinc	1/81	1	0.3	0.3								
Benzene	1/81	1	1.5	1.5								
Ethylbenzene	1/81	1	0.1	0.1								
Toluene	1/81	1	1.06	1.06								
Other: Cyanide	1/81	1	0.07	0.07								

Site: Folse Farms
Location: Bossier Parish, LA
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (ppm)	Avg	Dates	n	Range (ppm)	Avg
Chloride					1/82	1	422.5	422.5				

Site: Gulf Coast Vacuum
Location: Vermilion Parish, LA
Status: active
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic									4/93	1	0.005-0.099	0.052
Barium									4/93	1	0.06-0.29	0.17
Cadmium									4/93	1	0.001	0.001
Copper									4/93	1	0.005-0.085	0.045
Iron									4/93	1	0.01-8.26	4.14
Lead									4/93	1	0.004	0.004
Manganese									4/93	1	0.01-1.07	0.54
Zinc									4/93	1	0.003-1.24	0.61

Appendix B. Data summaries for CCDD sites in the database

Site: Marine Vacuum
Location: St. Mary's Parish, LA
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Antimony	1/80	1	13.3	13.3								
Arsenic	1/80	1	49.29	49.29								
Beryllium	1/80	1	182	182								
Cadmium	1/80	1	11.268	11.268								
Chromium	1/80	1	139.667	139.667								
Copper	1/80	1	42.787	42.787								
Lead	1/80	1	84.62	84.62								
Mercury	1/80	1	<0.002	<0.002								
Nickel	1/80	1	23.042	23.042								
Selenium	1/80	1	68.01	68.01								
Silver	1/80	1	1.913	1.913								
Thallium	1/80	1	<0.01	<0.01								
Zinc	1/80	1	382.273	382.273								
Benzene	1/80	1	14.6	14.6								
Ethylbenzene	1/80	1	22.4	22.4								
Toluene	1/80	1	46.6	46.6								
Other: Phenol	1/80	1	6.4	6.4								
Naphthalene	1/80	1	22	22								
Methyl Chloride	1/80	1	9.6	9.6								
Acenaphthene	1/80	1	7.9	7.9								
Acenaphthylene	1/80	1	6.9	6.9								

Site: Mar-Low
Location: Acadia Parish, LA
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									9/83	2	7.9-8.02	7.96
Conductivity (µ)									9/83	2	420-985	702.5
TDS									9/83	2	292-351	321.5
Chloride									9/83	2	146-203	174.5

Site: Mud Pits
Location: Lafourche Parish, LA
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	9/80	1	5.86	5.86								
Copper	9/80	1	12.5	12.5								
Lead	9/80	1	38.25	38.25								
Benzene					9/80	2	0.96-153.2	77				
Ethylbenzene					9/80	2	0.1-69.8	35				
Toluene					9/80	2	0.95-361.5	181				

Site: Nunez
Location: Vermilion Parish, LA
Status: abandoned
No. Pits: 1
Area: 0.34 acres (15,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Aluminum	4/90	1	14,400	14,400					5/90-9/90	4	0.054-5.53	1.5
Antimony	4/90	1	<6	<6					5/90-9/90	4	<0.03	<0.03
Arsenic	4/90	1	283	283					5/90-9/90	4	<0.005	<0.005
Barium	4/90	1	186	186					5/90-9/90	4	1.02-3.07	1.7
Beryllium	4/90	1	<1	<1					5/90-9/90	4	<0.005	<0.005
Cadmium	4/90	1	<1	<1					5/90-9/90	4	<0.005	<0.005
Calcium	4/90	1	1,520	1,520					5/90-9/90	4	0.5-131	89.8
Chromium	4/90	1	16.8	16.8					5/90-9/90	4	<0.01-0.101	<0.01
Cobalt	4/90	1	6.4	6.4					5/90-9/90	4	<0.01	<0.01
Copper	4/90	1	8.3	8.3					5/90-9/90	4	<0.02-0.063	0.04
Iron	4/90	1	13,200	13,200					5/90-9/90	4	<0.054-6.36	1.72
Lead	4/90	1	7	7					5/90-9/90	4	<0.003-0.013	0.0055
Magnesium	4/90	1	2,420	2,420					5/90-9/90	4	0.163-46.2	31
Manganese	4/90	1	222	222					5/90-9/90	4	0.02-3.31	1.39
Mercury	4/90	1	<0.1	<0.1					5/90-9/90	4	0-0.0004	0.0003
Nickel	4/90	1	14.5	14.5					5/90-9/90	4	<0.02-0.034	0.024
Potassium	4/90	1	1,530	1,530					5/90-9/90	4	4-294	78.4
Selenium	4/90	1	<1	<1					5/90-9/90	4	<0.005	<0.005
Silver	4/90	1	<2	<2					5/90-9/90	4	<0.01	<0.01
Sodium	4/90	1	648	648					5/90-9/90	4	201-3,710	1,120
Thallium	4/90	1	<1	<1					5/90-9/90	4	<0.005	<0.005
Vanadium	4/90	1	26.9	26.9					5/90-9/90	4	<0.02	<0.02
Zinc	4/90	1	35.1	35.1					5/90-9/90	4	<0.03-0.082	0.056
Organics	4/90	1	nd	nd					5/90-9/90	4	nd	nd

Site: Oil Base
Location: St. Mary's Parish, LA
Status: inactive
No. Pits: 1
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Antimony	6/80	1	<0.01	<0.01								
Arsenic	6/80	1	0	0								
Beryllium	6/80	1	0	0								
Cadmium	6/80	1	<0.001	<0.001								
Chromium	6/80	1	0	0								
Copper	6/80	1	0	0								
Lead	6/80	1	0	0								
Mercury	6/80	1	<0.002	<0.002								
Nickel	6/80	1	<0.005	<0.005								
Selenium	6/80	1	0	0								
Silver	6/80	1	<0.002	<0.002								
Thallium	6/80	1	<0.01	<0.01								
Zinc	6/80	1	0	0								
Benzene	6/80	1	<0.01	<0.01								
Ethylbenzene	6/80	1	0	0								
Toluene	6/80	1	0	0								

Appendix B. Data summaries for CCDD sites in the database

Site: PAB
Location: Vermilion Parish, LA
Status: abandoned
No. Pits: 4
Area: 9.4 acres (408,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					10/80	1	7.3	7.30	10/80	2	6.9-7.1	7.00
Aluminum					10/80	1	0.24	0.24	10/80	2	<0.05	<0.05
Antimony	10/80	2	<7.3-<9	8.15	10/80	1	<0.02	<0.02	10/80	2	<0.02	<0.02
Arsenic	10/80	2	13.1-16.2	15	10/80	1	0.026	0.026	10/80	2	<0.01	<0.01
Barium					10/80	1	4.1	4	10/80	2	0.073-0.074	0.07
Beryllium	10/80	2	<14.6-<18	16	10/80	1	<0.02	<0.02	10/80	2	<0.002	<0.002
Boron					10/80	1	3.9	3.9	10/80	2	0.14-0.3	0.22
Cadmium	10/80	2	<14.6-<18	16	10/80-3/83	3	0.0001-0.049	0.016	10/80	2	<0.005	<0.005
Calcium					10/80	1	1,500	1500	10/80	2	33-36	34.5
Chloride					3/83	2	1982-2004	1993	10/80	2	38-212	125
Chromium	10/80	2	18.9-21.2	20	10/80-3/83	3	0.006-0.093	0.031	10/80	2	<0.01	<0.01
Cobalt					10/80	1	<0.01	<0.01	10/80	2	<0.01	<0.01
Copper	10/80	2	<14.6-<18	16	10/80	1	<0.011	<0.011	10/80	2	<0.01	<0.01
Fluoride					10/80	1	4.4	4.4	10/80	2	0.98-1	1
Iron					10/80	1	1.1	1.1	10/80	2	1.9-4.3	3.1
Lead	10/80	2	<21.9-<27	24	10/80-3/83	3	0.0002-0.039	0.0196	10/80	2	<0.04	<0.04
Magnesium					10/80	1	140	140	10/80	2	13	13
Manganese					10/80	1	0.083	0.083	10/80	2	0.26	0.26
Mercury					10/80	1	<0.001	<0.001	10/80	2	<0.001-0.0016	0.0013
Nickel	10/80	2	<14.6-<18	16	10/80	1	0.02	0.02	10/80	2	<0.02	<0.02
Nitrate					10/80	1	0.73	0.73	10/80	2	0.23-0.26	0.25
Selenium					10/80	1	0.086	0.086	10/80	2	<0.01	<0.01
Silver	10/80	2	<14.6-<18	16	10/80	1	<0.02	<0.02	10/80	2	<0.02	<0.02
Sodium					10/80	1	4,600	4,600	10/80	2	58-63	61
Sulfide					10/80	1	<0.05	<0.05	10/80	2	<0.05	<0.05
Thallium	10/80	2	<3.6-<4.5	4.10	10/80	1	0.24	0.24	10/80	2	<0.01	<0.01
Tin					10/80	1	0.68	0.68	10/80	2	0.04-0.047	0.04
Vanadium					10/80	1	0.09	0.09	10/80	2	0.01	0.01
Zinc	10/80	2	18.2-58.6	38.0000	3/83	2	0.0004-0.007	0.0007	10/80	2	0.011-0.26	0.14
TOC					10/80-3/83	3	2.5-44.5	24.2	10/80-3/83	4	<1-1.3	1.1
BTEX									10/80	2	nd	nd
Cyanide									10/80	2	<0.01	<0.01
bis(2-ethylhexyl)phthalate									10/80	3	nd-0.023	<0.023
Methyl Chloride									10/80	3	nd-0.025	<0.025
1,1,1-trichloroethane									10/80	3	nd-0.26	<0.26
Naphthalene	10/80	2	230-280	255								
C1 Naph., iso 1	10/80	2	450-500	475								
C1 Naph., iso 2	10/80	2	380	380								
C2 Naph., iso 1	10/80	2	450-530	490								
C2 Naph., iso 2	10/80	2	700-710	705								
C2 Naph., iso 3	10/80	2	240-270	255								
C3 Naph., iso 1	10/80	2	190-220	205								
C3 Naph., iso 2	10/80	2	440-560	500								
C3 Naph., iso 3	10/80	2	330-360	345								
C3 Naph., iso 4	10/80	2	230-320	275								
C3 Naph., iso 5	10/80	2	110-160	135								
Anphatic HC	10/80	2	major									
Kv (cm/s)			2E-5 - 1E-8									
Bbls. Rec'd.	1978-83		>99,063									

Appendix B. Data summaries for CCDD sites in the database

Site: Simon
Location: Vermilion LA
Status: abandoned
No. Pits: 2
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					6/80	4	7.2-7.5	7.4				
Aluminum					6/80	4	<0.005-0.67	0.22				
Antimony					6/80	4	<0.05	<0.05				
Arsenic					6/80	4	<0.001-0.024	0.01				
Barium					6/80	4	0.16-0.64	0.41				
Beryllium					6/80	4	<0.002	<0.002				
Boron					6/80	4	0.019-2.7	0.81				
Cadmium					6/80	4	<0.005	<0.005				
Calcium					6/80	4	41-445	28				
Chromium					6/80	4	<0.01-0.017	0.01				
Cobalt					6/80	4	<0.01	<0.01				
Copper					6/80	4	<0.01	<0.01				
Fluoride					6/80	4	0.2-1.0	1				
Iron					6/80	4	1.4-1.6	1.5				
Lead					6/80	4	<0.04-1.6	0.43				
Magnesium					6/80	4	14-35	20				
Manganese					6/80	4	0.036-1.4	0.38				
Mercury					6/80	4	<0.001	<0.001				
Nickel					6/80	4	<0.02-0.023	0.02				
Selenium					6/80	4	<0.01-0.045	0.02				
Silver					6/80	4	<0.02	<0.02				
Sodium					6/80	4	84-3,300	893				
Sulfide					6/80	4	<0.05	<0.05				
Thallium					6/80	4	<0.01-0.086	0.03				
Tin					6/80	4	<0.06-0.45	0.15				
Vanadium					6/80	4	<0.014-0.062	0.03				
Zinc					6/80	4	0.012-0.68	0.32				
TOC					6/80	4	<2	<2				

Site: Tidrow
Location: St. Mary Parish, LA
Status: inactive
No. Pits: 1
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Antimony	9/80	2	1.97-2.24	2.11								
Arsenic	9/80	2	1.46-2.69	2.08								
Beryllium	9/80	2	<0.005-11.22	5.6								
Cadmium	9/80	2	0,857-1.373	1.12								
Chromium	9/80	2	9.155-12.627	10.9								
Copper	9/80	2	9.69-13.572	11.6								
Lead	9/80	2	23.58-43.2	33.4								
Mercury	9/80	2	<0.002	<0.002								
Nickel	9/80	2	3.564-5.426	4.5								
Selenium	9/80	2	<0.01-0.64	0.32								
Silver	9/80	2	<0.002-0.593	0.3								
Thallium	9/80	2	<0.01	<0.01								
Zinc	9/80	2	53.88-107.97	80.9								
Benzene	9/80	1	0.01	0.01								
Ethylbenzene	9/80	1	0.01	0.01								
Toluene	9/80	1	0.02	0.02								
Other: Cyanide	9/80	1	0.28	0.28								
Phenol	9/80	1	16	16								
Chlor. Organics	9/80	1	6.81	6.81								

Appendix B. Data summaries for CCDD sites in the database

Site: Waguespack
Location: Iberia Parrish, LA
Status: inactive
No. Pits: 7
Area: 10.25 acres (446,516 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									5/84-8/94	56	6.27-7.68	7.10
Conductivity (µ)									5/84-8/94	56	300-2,420	991
TDS									5/84-8/94	56	15-1,644	374.00
Arsenic									8/92	8	0-0.005	0.001
Barium									8/92	8	0.057-1.16	0.66
Chloride					8/82-1/85	11	479-2,400	1,127	5/84-8/94	56	8-654	132.00
Chromium									8/92	8	0-<0.05	<0.05
Lead									8/92	8	<0.06	<0.06
Sodium									8/92	8	83-329	164.00
Zinc									8/92	8	0.009-0.094	0.03
O&G (%)									8/87-8/92	15	<1-6.25	2.29
Kv (cm/s)			6.9E-08-5.5E-09									

Site: Bateman Island Land Treatment
Location: St. Mary's Parish, LA
Status: active
No. Cells: 15
Area: 78.1 acres (3.4 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	7/99-4/00	39	7.4-8.7	8.00	7/99-5/00	32	7.4-8.7	7.60	7/99-5/00	80	6.2-7.6	6.9
Conductivity (µ)	7/99-4/00	39	3,100-59,000	18,692	7/99-5/00	32	400-88,000	11506	7/99-5/00	80	600-6,000	1,880
TDS					7/99-5/00	32	230-75,912	6476	7/99-5/00	80	72-3,620	1,273
Arsenic	7/99-4/00	39	2-3.5	2.83	7/99-5/00	32	<0.01	<0.01	7/99-5/00	80	<0.01	<0.01
Barium	7/99-4/00	39	541-160,409	86,322	7/99-5/00	32	<0.1-43.3	9.18	7/99-5/00	80	<0.1-2.4	0.67
Cadmium	7/99-4/00	39	0-0.8	0.41								
Chloride	7/99-4/00	39	14-635	99.5					7/99-5/00	80	43-2,526	544
Chromium	7/99-4/00	39	14-150	68.2	7/99-5/00	32	<0.05	<0.05	7/99-5/00	80	<0.05	<0.05
Lead	7/99-4/00	39	10-184	72.2	7/99-5/00	32	<0.05	<0.05	7/99-5/00	80	<0.05	<0.05
Mercury	7/99-4/00	39	0-0.9	0.45								
Selenium	7/99-4/00	39	0-0.9	0.2								
Silver	7/99-4/00	39	0-0.9	0.35								
Sodium									7/99-5/00	80	35-757	193
Zinc	7/99-4/00	39	15-333	133.6	7/99-5/00	32	<0.05	<0.05	7/99-5/00	80	<0.05	<0.05
O&G (%)	7/99-4/00	39	0.3-6.7	2.4	7/99-5/00	32	<1-24	2.8	7/99-5/00	80	<1-3	<1
TOC (%)	7/99-4/00	39	0.3-8.2	2.9								

Site: Bossier Parish Land Treatment
Location: Bossier Parish, LA
Status: active
No. Cells: 10
Area: NA

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									8/99-4/00	20	6.73-7.89	7.13
Conductivity (µ)									8/99-4/00	20	1,000-1,700	1,310
TDS									8/99-4/00	20	644-1,300	8.93
Arsenic									8/99-4/00	20	<0.005	<0.005
Barium									8/99-4/00	20	<0.05-0.84	<0.005
Lead									8/99-4/00	20	<0.02-0.25	0.49
Sodium									8/99-4/00	20	71-128	0.03
Zinc									8/99-4/00	20	<0.02-0.2	95.6
O&G									8/99-4/00	20	<5	0.07

Site: Bourg Land Treatment
Location: Lafourche Parish, LA
Status: active
No. Cells: 18
Area: 78.5 acres (3.42 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	7/99-4/00	36	7.4-9.8	8.00	7/99-4/00	56	6.4-8.8	7.1	7/99-4/00	52	6.5-7.9	7
Conductivity (µ)					7/99-4/00	56	100-18,100	5241	7/99-4/00	52	800-780,000	18,894
TDS					7/99-4/00	56	23-7,840	2548	7/99-4/00	52	400-4,040	2,201
Arsenic	7/99-4/00	36	0.3-3.2	2.58					7/99-4/00	39	<0.01	<0.01
Barium	7/99-4/00	36	39,643-122,763	82,646	7/99-4/00	56	0.4-12.4	2.5	7/99-4/00	51	<0.05-3.6	1.4
Bicarbonate	7/99-4/00	36	24.4-79.3	49.8								
Cadmium	7/99-4/00	36	0.2-1.00	0.458								
Calcium	7/99-4/00	36	280.6-4,128.3	1,213								
Carbonate	7/99-4/00	36	0-24.0	4.1								
Chloride	7/99-4/00	36	993-33,002	4,043.1					7/99-4/00	52	32-2,663	1,274
Chromium	7/99-4/00	36	10-271	72.11	7/99-4/00	56	<0.05	<0.05	7/99-4/00	39	<0.05	<0.05
Lead	7/99-4/00	36	9-236	65.3	7/99-4/00	56	<0.05	<0.05	7/99-4/00	39	<0.05	<0.05
Magnesium	7/99-4/00	36	97.25-206	126.5								
Mercury	7/99-4/00	36	0.1-9	0.32								
Selenium	7/99-4/00	36	0-0.3	0.15								
Silver	7/99-4/00	36	0.3-0.8	0.36								
Sodium	7/99-4/00	36	759-16,069	1,999.5					7/99-4/00	52	25-1,596	695
Sulfate	7/99-4/00	36	1,056.7-4,130.6	2,265								
Zinc	7/99-4/00	36	12-357	128.1	7/99-4/00	56	<0.05	<0.05	7/99-4/00	39	<0.05	<0.05
O&G (%)	7/99-4/00	36	0.1-7.2	2.45	7/99-4/00	56	<1-68	4.2	7/99-4/00	52	<1-1	<1
TOC (%)	7/99-4/00	36	0-9	3								

Site: Elm Grove Land Treatment
Location: Bossier Parish, LA
Status: active
No. Cells: 10
Area: 31 acres (1.35 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	4/00	5	7.71-8.85	8.04					4/00	5	7.40-7.89	7.7
Conductivity (µ)	4/00	5	12,100-81,200	16,244					4/00	5	1,200-1,700	1,360
TDS									4/00	5	800-1,300	1,038
Arsenic	4/00	5	2.8-3.0	2.9								
Barium	4/00	5	61,000-122,345	89,451					4/00	5	0.05-0.82	0.37
Bicarbonate	4/00	5	0.38-0.70	0.57								
Cadmium	4/00	5	0.31-0.42	0.36								
Calcium	4/00	5	34.4-112.7	69.3								
Carbonate	4/00	5	0.0.22	0.06								
Chloride	4/00	5	63-190	123.0					4/00	5	100-325	200
Chromium	4/00	5	60.2-182.1	105.6					4/00	5	0-0.03	0.006
Lead	4/00	5	46.6-120.7	81.2					4/00	5	0-0.03	0.014
Magnesium	4/00	5	9.3-12.0	10.4								
Mercury	4/00	5	0.263-0.866	0.435								
Selenium	4/00	5	0.11-0.18	0.13								
Silver	4/00	5	0.28-0.39	0.31								
Sodium	4/00	5	55-167	99.7					4/00	5	83-128	104
Sulfate	4/00	5	41.7-67	54.9								
Zinc	4/00	5	111.0-461.5	229.4					4/00	5	0.02-0.14	0.06
O&G (%)	4/00	5	0.67-8.89	1.80					4/00	5	1-3	1.6
TOC (%)	4/00	5	0.79-4.45	2.1								

Appendix B. Data summaries for CCDD sites in the database

Site: Lacassine Land Treatment
Location: Jeff Davis Parish, LA
Status: inactive
No. Cells: 11
Area: 136.6 acres (5.95 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					7/97-7/98	36	5.78-7.58	6.81	7/97-7/98	36	6.67-7.2	6.82
Conductivity (µ)									7/97-7/98	36	404-2,144	1,198
TDS					7/97-7/98	36	384-3,348	1,770	7/97-7/98	36	700-3,300	1703
Arsenic									7/97-7/98	27	<0.005	<0.005
Barium					7/97-7/98	36	<0.5-1.2	0.6	7/97-7/98	36	<0.5-0.8	<0.5
Chloride					7/97-7/98	36	0-1,330	566	7/97-7/98	36	310-950	338
Chromium									7/97-7/98	27	<0.02	<0.02
Lead					7/97-7/98	36	<0.01-0.07	0.02	7/97-7/98	36	<0.01-0.03	0.01
Sodium					7/97-7/98	36	86-739	355	7/97-7/98	36	78-401	183
Zinc					7/97-7/98	36	<0.02-0.6	0.06	7/97-7/98	36	<0.02-0.29	0.08
O&G (%)					7/97-7/98	36	<5	<5	7/97-7/98	36	<5	<5
Ra226 (pCi/l)									7/97-7/98	36	0-1.47	0.16
Ra228 (pCi/l)									7/97-7/98	36	0-1.11	0.10
Pb210 (pCi/l)									7/97-7/98	36	0-.23	0.07

Site: Lafourche Construction (land treatment)
Location: Lafourche Parish, LA
Status: inactive
No. Pits/Cells: 3/2
Area: 30.1 acres (1.31 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									12/93	14	6.7-7.5	7.1
Conductivity (µ)									12/93	14	510-3,020	1,920
TDS									12/93	14	410-2,274	1,474
Arsenic									12/93	14	nd	nd
Barium									12/93	14	0.9-5.1	2.4
Chloride									12/93	14	42-696	354
Chromium									12/93	14	nd	nd
Lead									12/93	14	nd	nd
Sodium									12/93	14	27.5-379.3	179
Zinc									12/93	14	nd-2.32	0.29
O&G (%)									12/93	14	<1-1	<1

Site: MAR Services (land treatment)
Location: St. Landry Parish, LA
Status: abandoned
No. Cells: 6
Area: 30.1 acres (1.31 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									10/63-12/90	251	10-9.7	7.41
TDS									10/63-12/90	229	9-73039	13,009
Cl									10/63-12/90	252	14-73,221	7,318
O&G (mg/L)									10/63-12/90	195	0.01-121	6.33
O&G (%)									10/63-12/90	195	<0.001	<0.001

Appendix B. Data summaries for CCDD sites in the database

Site: Mermentau Land Treatment
Location: Jeff Davis Parish, LA
Status: active
No. Cells: 25
Area: 107.9 acres (4.7 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	7/99-4/00	70	7.1-9.2	8.00					7/99-4/00	80	5.57-8.44	7.14
Conductivity (µ)	7/99-4/00	70	9,400-78,500	21,644					7/99-4/00	80	200-70,200	6,749
TDS									7/99-4/00	80	296-61,829	4,821
Arsenic	7/99-4/00	70	0.3-4.2	2.89					7/99-4/00	80	<0.03	<0.03
Barium	7/99-4/00	70	41,423-213,883	105,975					7/99-4/00	80	0.2-5.8	1.29
Bicarbonate	7/99-4/00	70	6.1-225.7	47.9								
Cadmium	7/99-4/00	70	0.3-0.9	0.5								
Calcium	7/99-4/00	70	220.4-8,563.1	1614.8								
Carbonate	7/99-4/00	70	0-96	7.59								
Chloride	7/99-4/00	70	1134-37,504	5,496.0					7/99-4/00	80	20-29,991	2,389
Chromium	7/99-4/00	70	16-331	105.4					7/99-4/00	80	<0.02-0.08	0.041
Lead	7/99-4/00	70	19-304	113.0					7/99-4/00	80	<0.02-0.41	0.05
Magnesium	7/99-4/00	70	77.8-899.6	175.7								
Mercury	7/99-4/00	70	0.1-2.3	0.54								
Selenium	7/99-4/00	70	0.1-3.7	0.3								
Silver	7/99-4/00	70	0.2-0.9	0.43								
Sodium	7/99-4/00	70	621-16,101	2459.5					7/99-4/00	80	18-38,119	1,856
Sulfate	7/99-4/00	70	1580-7498	2874								
Zinc	7/99-4/00	70	45-393	157.7					7/99-4/00	80	<0.02-1.14	0.26
O&G (%)	7/99-4/00	70	0.1-8.9	3.0					7/99-4/00	80	<5-5	<5
TOC (%)	7/99-4/00	70	0.1-12.2	3.1								

Site: Western Reliable Land Treatment
Location: Pointe Coupee Parish, LA
Status: inactive
No. Cells: 4
Area: 25.3 acres (1.1 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					3/99	4	6.8-7.0	6.90	3/99	11	6.9-7.2	7.10
Conductivity (µ)					3/99	4	2130-2640	2,235	3/99	11	677-2350	1,191
TDS					3/99	4	1160-17400	5,390	3/99	11	434-1300	689
Arsenic					3/99	4	<0.01	<0.01	3/99	11	<0.01-0.019	0.01
Barium					3/99	4	0.23-0.411	0	3/99	11	0.18-0.551	0
Chloride					3/99	4	292-372	326.0	3/99	11	10.6-399	120
Chromium					3/99	4	<0.01	<0.01	3/99	11	<0.01	<0.01
Lead					3/99	4	<0.0003	<0.0003	3/99	11	<0.003	<0.003
Sodium					3/99	4	109-250	164	3/99	11	34-87.9	51
Zinc					3/99	4	<0.02	<0.02	3/99	11	0-0.14	0.01
O&G					3/99	4	<5	<5	3/99	9	<5-8	5.50

Site: Basin
Location: San Juan Co., NM
Status: active
No. Pits: 2
Area: 6.17 acres (268,800 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/86-9/92	18	7.2-9.2	8.5				
TDS					2/86-9/92	9	9,615-38,000	18,939				
Arsenic					9/92	4	0.008-0.062	0.0155				
Barium					2/86-9/92	6	<0.1-2.1	0.62				
Cadmium					2/86-9/92	5	<0.1	<0.1				
Chloride					2/86-9/92	10	3,026-20,600	7998.5				
Chromium					2/86-9/92	6	<0.1	<0.1				
Lead					2/86-9/92	6	<0.1	<0.1				
Mercury					9/92	2	<0.0005	<0.0005				
Selenium					9/92	4	<0.005-<0.025	<0.005				
Silver					2/86-9/92	6	<0.1	<0.1				
Zinc					2/86-9/92	6	<0.1	<0.1				
TPH					2/86-9/92	13	700-26,700	7619				
Benzene	4/98	18	<0.05	<0.05	2/86-9/92	10	0.036-0.59	0.4274				
Ethylbenzene	4/98	18	<0.05	<0.05	2/86-9/92	8	ND-0.34	0.086				
Toluene	4/98	18	<0.05-0.09	0.04	2/86-9/92	12	0.057-5.7	1.14				
Xylene	4/98	18	<0.1-0.67	0.16	2/86-9/92	12	0.006-3.45	0.65				

Appendix B. Data summaries for CCDD sites in the database

Site: CRI Halfway
Location: Lea Co., NM
Status: active
No. Pits: 2
Area: 259.9 acres (11.3 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
TDS									2/90	2	1,190-1,925	1,576
Conductivity									2/90	5	1,700->50,000	>30,890
Arsenic	7/00	4	<5-66	19.5	6/00	1	<1	<1				
Barium	7/00	4	<5-410	163.3	6/00	1	1.7	1.7				
Cadmium	7/00	4	<2-2.7	1.43	6/00	1	<0.2	<0.2				
Chloride									2/90	5	568-136,675	54,247
Chromium	7/00	4	<5-70	21.5	6/00	1	<0.5	<0.5				
Lead	7/00	4	8.9-155	59.7	6/00	1	<1	<1				
Mercury	7/00	4	<0.19-3.37	0.84	6/00	1	0.00057	0.00057				
Selenium	7/00	4	<5	<5	6/00	1	<1	<1				
Silver	7/00	4	<2	<2	6/00	1	<0.5	<0.5				
Benzene	7/00	4	<0.02-0.44	0.36								
Toluene	7/00	4	0.14-30	8.14								
Ethylbenzene	7/00	4	<0.02-0.62	0.61								
Xylene	7/00	4	<0.02-1.74	0.66								

Site: Laguna Quatro
Location: Eddy Co., NM
Status: inactive
No. Pits: 4
Area: 2.5 acres (108,900 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH												
TDS					10/91	2	170,616-200,000	185308				
Arsenic	8/91	9	1.47-5.52	3.3	10/91	2	<0.500-2.4	1.4				
Barium					10/91	2	0.6-6.5	3.55				
Cadmium					10/91	2	<0.05	<0.05				
Chromium	8/91	9	5.2-52.4	32.02	10/91	2	<0.05	<0.05				
Lead	8/91	9	13.6-508	145.4	10/91	2	<0.5	<0.5				
Mercury					10/91	2	<0.0005-0.006	0.0032				
Selenium	8/91	9	0.53-1.87	1.01								
Silver	8/91	9	0.07-0.3	0.24	10/91	2	<1.0	<1.0				
Zinc					10/91	2	<1.0	<1.0				
TPH	11/95	1	3,246	3,246								
Benzene	8/91	6	<1	<1	10/91	2	0.38-0.52	0.45				
Toluene	8/91	6	<1-5	1.38	10/91	2	0.58-0.75	0.665				
Ethylbenzene	8/91	6	<1-9	4.7	10/91	2	<0.05-<0.1	<0.1				
Xylene	8/91	6	<1-31	8.53	10/91	2	0.39-0.5	0.445				

Appendix B. Data summaries for CCDD sites in the database

Site: Parabo
Location: Lea Co., NM
Status: active
No. Pits: 8
Area: 50.3 acres (219 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	1/99	7	2.7-16.3	8.07					1/99	5	0.0238-0.222	0.14032
Barium	1/99	7	239-2,570	951					1/99	5	0.454-3.6	1.8988
Cadmium	1/99	7	<0.04-0.25	0.11					1/99	5	<0.0006-0.0031	0.0016
Chloride									1/99	32	75-157,260	35,768
Chromium	1/99	7	6.3-34	17.06					1/99	5	0.0217-0.0637	0.0474
Lead	1/99	7	7.1-232	97.6					1/99	5	<0.0047-0.027	0.01244
Mercury			<0.05-1.7	0.89					1/99	5	<0.0001	<0.0001
Selenium									1/99	5	0.0389-0.175	0.10432
Silver									1/99	5	<0.0014-0.005	0.00268
Benzene									1/99	5	0.42-1.7	0.926
Toluene									1/99	5	0.007-1.4	0.5574
Ethylbenzene									1/99	5	0.12-0.29	0.194
Xylene									1/99	5	0.14-0.59	0.0816

Site: C & C Landfarm
Location: Lea Co., NM
Status: active
No. Cells: 9
Area: 217.6 acres (9.48 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/kg)	Avg
Arsenic	5/93	1	0.003	0.003								
Barium	5/93	1	0.2	0.2								
Cadmium	5/93	1	<0.005	<0.005								
Calcium	5/93	1	56	56								
Chloride	5/93	1	20	20								
Chromium	5/93	1	<0.05	<0.05								
Lead	5/93	1	<0.1	<0.1								
Magnesium	5/93	1	44	44								
Mercury	5/93	1	<0.008	<0.008								
Selenium	5/93	1	0.003	0.003								
Silver	5/93	1	<0.01	<0.01								
Sulfate	5/93	1	55	55								
TPH	5/98	10	16.4-62.4	29.8								
Benzene	5/99	10	<0.002	<0.002								
Toluene	5/99	10	<0.002	<0.002								
Ethylbenzene	5/99	10	<0.002	<0.002								
Xylene	5/99	10	<0.006	<0.006								

Site: Tierra Crouch Mesa Land Treatment
Location: San Juan Co.ɹan Co., NM
Status: active
No. Cells: 14
Area: 72.1 acres (3.14 million ft^2)

Medium	Cell Sludge				Sump Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	6/98	14	ND	ND								
Barium	6/98	14	8.1-37.3	39.8								
Cadmium	6/98	14	ND									
Calcium	6/98	14										
Chloride	6/98	14										
Chromium	6/98	14	1.88-3.79	2.66								
Lead	6/98	14	6.37-12.1	8.56								
Magnesium	6/98	14										
Mercury	6/98	14	ND	ND								
Potassium	6/98	14										
Selenium	6/98	14	ND	ND								
Silver	6/98	14	ND	ND								
Sulfate	6/98	14										
TPH	6/98	13	ND-1.2	0.45								
BTEX	6/98	15	ND-0.047	0.158								
Benzene	6/98	18	ND	0.048								
Toluene	6/98	18	ND	0.008								
Ethylbenzene	6/98	18	ND-0.056	0.011								
Xylene	6/98	18	ND-0.452	0.065								

Appendix B. Data summaries for CCDD sites in the database

Site: TNT Land Treatment
Location: Rio Arriba Co., NM
Status: active
No. Cells: 6
Area: NA

Medium	Cell Sludge				Sludge Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					7/88-2/99	6	7.7-8.9	8.19	8/91	4		
TDS					7/88-2/99	7	19,172-101,000	40,669	8/91	10		8434.5
Conductivity									8/91	4		19554.75
Arsenic					7/88-2/99	5	ND-0.13	0.098	8/91	1	ND	ND
Barium					7/88-2/99	6	0.6-1.7	0.98	8/91	4		0.2375
Bicarbonate									8/91	10		468
Cadmium					7/88-2/99	6	ND-<0.01	<0.01	8/91	3	ND-<0.1	<0.1
Chloride					7/88-2/99	7	9,050-54,000	19945.71429	8/91	10		3305.92
Chromium					7/88-2/99	6	ND-0.04	<0.1	8/91	4	ND-<0.1	<0.1
Lead					7/88-2/99	6	<0.1	<0.1	8/91	3	ND-<0.1	<0.1
Mercury					7/88-2/99	4	<0.01	<0.01				
Selenium					7/88-2/99	4	<0.1	<0.1	8/91	1	nd	nd
Silver					7/88-2/99	6	ND-<0.1	<0.1	8/91	4	ND-<0.1	
Zinc					7/88-2/99	3	<0.1	<0.1	8/91	4		0.205
Benzene					7/88-2/99	3	0.072-0.222	0.152666667	8/91	3	nd	nd
Toluene					7/88-2/99	3	0.082-0.45	0.302333333	8/91	3	nd	nd
Ethylbenzene					7/88-2/99	3	ND-0.028	0.009	8/91	3	nd	nd
Xylene					7/88-2/99	3	0.09-0.209	0.156	8/91	3	nd	nd

Site: A & A Tank Trucks
Location: McClain Co., OK
Status: inactive
No. Pits: 2
Area: NA

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Site: Arrow 3-5-15
Location: Pittsburg Co. , OK
Status: inactive
No. Pits: 2
Area: >0.7 acres (>30,000ft^2)

	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					3/92	3	7-8	7.6				
TDS	5/89	1	1849	1849	3/92	5	442-22,819	7401				
Arsenic	3/92	1	0.02	0.02								
Barium	3/92	1	0.6	0.6								
Bicarbonate					3/92	5	36-402	130				
Boron					3/92	2	0.03-0.1	0.07				
Cadmium	3/92	1	<0.005	<0.005								
Calcium	5/89	1	69	69	3/92	5	29-1,223					
Carbonate					3/92	3	0	0				
Chloride					3/92	5	168-11,820	3,766				
Chromium	3/92	1	0.22	0.22								
Lead	3/92	1	0.032	0.032								
Magnesium					3/92	5	6-646	199				
Mercury	3/92	1	<0.002	<0.002								
Nitrogen					3/92	2	0-40	20				
Selenium	3/92	1	0.004	0.004								
Silver	3/92	1	<0.01	<0.01								
Sodium	5/89	1	565	565	3/92	5	86-5,107	1,639				
Sulfate					3/92	5	8-90	48				

Site: Arrow/Calumet
Location: Canadian Co. , OK
Status: inactive
No. Pits: 7
Area: 2.6 acres (112,750 ft^2)

	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	11/93	1	8.4	8.4	3/89-11/93	8	7.3-9.3	8.18	3/89-11/93	9	7-8.4	7.5
TDS	11/93	1	429	429	3/89-11/93	8	277-14,520	76	3/89-11/93	9	482-4,249	2,440
Bicarbonate	11/93	1	190	190	3/89-11/93	7	84-661	261	3/89-11/93	9	168-514	347
Calcium	11/93	1	57	57	3/89-11/93	8	29-1,220	296	3/89-11/93	9	41-755	405
Carbonate	11/93	1	0	0	3/89-11/93	8	0-285	59	3/89-11/93	9	0	0
Chloride	11/93	1	55	55	3/89-11/93	8	54-8,500	3,807	3/89-11/93	9	7-1,469	660
Magnesium	11/93	1	49	49	3/89-11/93	8	40-5,420	2,692	3/89-11/93	9	22-574	280
Nitrogen	11/93	1	5	5	3/89-11/93	8	5-22	14	11/93	3	1-5	2
Potassium	11/93	1	12	12	3/89-11/93	8	3-58	24	3/89-11/93	9	40-113	74
Sodium	11/93	1	61	61	3/89-11/93	8	46-3,000	1,379	3/89-11/93	9	31-1,963	738
Sulfate	11/93	1	0	0	3/89-11/93	8	0-20	3	3/89-11/93	9	0-10	3
TOC	11/93	1	0.03	0.03	11/93	2	0-0.19	0.1				

Appendix B. Data summaries for CCDD sites in the database

Site: Ball Ranch
Location: Garvin Co. , OK
Status: inactive
No. Pits: 4
Area: 9.4 acres (408,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					8/90	5	6.9-8.3	7.72	1/87-1/97	36	6.4-8.4	7.8
TDS					8/90	5	6,344-8,527	7,746	1/87-1/97	32	391-904	576
Bicarbonate					8/90	4	92-156	139	1/87-1/97	31	0-790	341
Boron					8/90	4	7.72-9.43	7.7	1/87-1/97	32	0-0.78	0.32
Calcium					8/90	4	170-290	215	1/87-1/97	35	36-119	61
Carbonate									1/87-1/97	18	0-17	6.5
Chloride					8/90	5	3,100-4,900	4,240	1/87-1/97	37	8-183	52
Magnesium					8/90	4	40-60	50	1/87-1/97	33	24-64	39
Nitrogen					8/90	3	0-1	0.5	1/87-1/97	33	0-20	3.7
Potassium									1/87-1/97	14	1-8	4
Sodium					8/90	4	2,010-2,700	2,435	1/87-1/97	33	13-119	59
Sulfate					8/90	4	100-300	250	1/87-1/97	33	16-141	53
Kv (cm/s)			1E-6 - 1E-9									

Site: BC
Location: Atoka Co., OK
Status: inactive
No. Pits: 5
Area: 7.9 acres (342,100 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									6/96	3	7.37-8.11	7.72
Arsenic	12/94	1	<0.001	<0.001					6/96			
Barium	12/94	1	0.05	0.05					6/96			
Cadmium	12/94	1	<0.005	<0.005					6/96			
Calcium	2/95	6	31.6-56.9	41.2					6/96			
Chloride					7/96-5/93	33	78-7,575	2,677	6/96	22	5-780	224
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chromium	12/94	1	0.7	0.7					6/96			
Lead	12/94	1	<0.1	<0.1					6/96			
Magnesium	2/95	6	7.3-11.5	9.8					6/96			
Mercury	12/94	1	<0.002	<0.002					6/96			
Selenium	12/94	1	<0.002	<0.002					6/96			
Silver	12/94	1	<0.01	<0.01					6/96			
Sodium	2/95	6	1.8-5.3	3.4					6/96			

Site: Blehm
Location: Blaine Co., OK
Status: active
No. Pits: 8-12
Area: 30.3 acres (1.32 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	1/89	1	5.9	5.9	1/90-1/00	139	7.02-10.21	7.96	7/88-1/00	130	5.9-9.24	7.45
Conductivity (µ)	1/89	1	950	950	4/96	1	10,410	10,410	10/88-3/89	6	3,530-325,000	76,362
TDS					4/96-8/98	2	6,871-140,805	73,838	7/88-3/89	10	2,330-247,000	33,658
Arsenic	1/89	1	5	5					1/89	1	5	5
Barium	1/89	1	185.5	185.5	4/96	1	0	0	1/89	1	185.5	185.5
Bicarbonate					4/96	1	224	224				
Cadmium	1/89	1	5	5					1/89	1	5	5
Calcium					4/96-8/98	2	122-2,427	1,275	7/88-3/89	10	4-2,280	750
Carbonate					4/96	1	0	0				
Chloride	1/89	1	4	4	10/89-1/00	148	65-80,890	12,393	7/88-1/00	141	78-130,000	6,123
Chromium	1/89	1	16	16					1/89	1	16	16
Lead	1/89	1	1	1					1/89	1	1	1
Magnesium					8/98	1	520	520	3/89	2	100-740	420
Manganese					4/96	1	95	95				
Nitrogen					4/96-8/98	2	<1	<1	7/88-3/89	8	0-1,200	192
Potassium					4/96-8/98	2	89-628	359				
Sodium					4/96-8/98	2	2,196-49,750	25,973	7/88-3/89	9	365-90,620	13,532
Sulfate					4/96-8/98	2	434-6,590	3,512	7/88-3/89	8	1,460-5,600	2,914
Benzene									9/92	5	<0.002-0.087	0.019
Toluene									9/92	5	<0.002-0.149	0.031
Ethylbenzene									9/92	5	<0.002-0.012	0.004
Xylene									9/92	5	<0.002-0.108	0.023
TPH									9/92	5	<0.002-0.684	0.138
Bbls. Rec'd.	1989-99		2.82 MM									

Site: Bluff
Location: Major Co., OK
Status: active
No. Pits: 3
Area: 14.1 acres (613,320 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	2/97	2	7-7.1	7.05	12/92-1/00	12	7.5-8.2	7.8	1/93-8/99	143	6.82-12.8	8.39
Conductivity (µ)	2/97	2	381,000-531,000	456,000	7/95-1/00	11	22,700-167,000	75,818	1/93-8/99	137	1,600-121,900	37,339
TDS	2/97	2	251,460-350,460	300,960	10/90-1/00	30	525-181,645	45,855	10/90-8/99	160	3,379-116,787	30,039
Arsenic					8/91	1	0.00001	0.00001	2/91-8/91	7	<0.0005-0.0027	0.0004
Barium					8/91	7	0.1-1	0.34	2/91-8/91	6	0.1-4.2	0.88
Bicarbonate					2/91-8/91	14	25-460	215	2/91-1/93	19	91-630	268
Boron	2/97	2	6.37-11.37	9					1/93	9	3.92-5.86	4.78
Calcium	2/97	2	5,643-6,102	5,873	2/91-1/00	26	92.8-3,590	990.7	2/91-8/99	147	13-1,995	898
Carbonate									1/93	9	0-18	6
Chloride									10/90-8/99	160	6-67,606	14,705
Chromium					8/91	7	0.01-0.04	0.03	2/91-8/91	6	<0.05-0.04	0.04
Lead					8/91	7	<0.1	<0.1	2/91-8/91	7	<0.005	<0.005
Magnesium	2/97	2	668-954	811	2/91-1/00	26	0-5,400	593	2/91-8/99	147	0-1,680	342
Mercury					8/91	7	0.01-0.21	0.12	2/91-8/91	7	<0.0005-0.18	0.09
Nitrogen					2/95-1/00	11	0-13	1.4	1/93-8/99	137	0-8	1.9
Potassium	2/97	2	1,276-1,301	1289	2/91-1/00	24	5-510	112	2/91-8/99	147	0-1,203	166.1
Sodium	2/97	2	121,403-203,913	162658	2/91-1/00	26	23-61,670	13,001	10/90-8/99	150	130-40,070	9,424
Sulfate					2/91-1/00	25	30-26,500	4,370	2/91-8/99	148	34-9,000	3,618
Kv (cm/s)			1.1-8.5E-8									
Bbls. Rec'd	1992-97		1,000,000+									

Site: Bone 15-7-2
Location: Love Co., OK
Status: inactive
No. Pits: 1
Area: 0.7 acres (30,250 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					9/80-2/85	4	0-3,000	1,500				

Site: Bone 23-6-1
Location: Love Co., OK
Status: inactive
No. Pits: 1
Area: 1.03 acres (45,000 ft2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					9/80-2/85	4	1,200-3,000	2,125				

Site: Buck
Location: Love Co., OK
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									11/85	3	6.4-7.1	6.7
Chloride									11/85	3	6.8-30.3	21

Site: Bullard 2-8-5
Location: Marshall Co., OK
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									4/87-9/87	4	7.3-7.9	7.6
Chloride									4/87-9/87	4	7.5-63.5	40

Site: Bullard 28-3-7
Location: Grady Co., OK
Status: inactive
No. Pits: 4
Area: 1.9 acres (80,900 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					1/90	1	9.2	9.2	6/85-10/91	8	6.4-8.6	7.4
TDS					1/90	1	3,667	3,667	12/90	3	185-957	584
Chloride					1/90	1	751	751	6/85-10/91	8	47-2,145	379
Chromium					1/90	1	0.24	0.24				
Iron					1/90	1	1.88	1.88				
Magnesium					1/90	1	732	732	12/90	2	20-64	42
Potassium									6/85-12/90	6	7-89	28
Silver					1/90	1	2.1	2.1				
Kv (cm/s)			2.5E-5 - 4.2E-7									

Site: Carr City
Location: Seminole Co., OK
Status: inactive
No. Pits: 4
Area: 4.4 acres (192,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	9/94	5	6.5-9.1	7.7	2/86-9/94	9	8.1-8.7	8.4	7/85-12/94	31	6.3-8.9	7.5
TDS	9/94	5	80-2,880	917	2/86-9/94	9	285-3,900	1,230	7/85-12/94	16	280-1,252	552
Arsenic	9/94	5	1.29-6.86	3.19	3/86	1	<0.03	<0.03				
Barium	9/94	5	47-373	135	2/86	1	0.16	0.16				
Bicarbonate	9/94	1	720	720					7/85-1/86	27	171-744	302
Cadmium					2/86	1	<0.01	<0.01				
Calcium	9/94	1	4	4					7/85-1/86	27	26-Dec	19
Carbonate	9/94	1	0	0								
Chloride	9/94	5	30-900	285	2/86-9/94	9	14-700	199	7/85-1/86	31	4-350	69
Chromium	9/94	5	22.3-75.9	42.5	2/86	1	0.18	0.18				
Iron	9/94	1	4	4					7/85-1/86	0.06-1	0.3	
Lead	9/94	5	3.3-32.7	14.5								
Magnesium	9/94	1	1	1					7/85-1/86	27	0	0
Potassium	9/94	1	20	20								
Selenium	9/94	5	0.01-0.04	0.02								
Silver	9/94	3	0.25-0.5	0.36								
Sodium	9/94	1	400	400	2/86	1	600	600	9/94	1	52.5	52.5
Sulfate	9/94	1	1	1					7/85-1/86	27	8-160	84
O&G					2/86	1	9	9				
Benzene	9/94	5	0.0002	0.0002	9/94	3	<0.0002	<0.0002				
Toluene	9/94	5	0.0002	0.0002	9/94	3	<0.0002	<0.0002				
Ethylbenzene	9/94	5	0.0002	0.0002	9/94	3	<0.0002	<0.0002				
Xylene	9/94	5	0.0002	0.0002	9/94	3	<0.0002	<0.0002				
TPH	9/94	5	0.001	0.001	9/94	3	<0.001	<0.001				
Kv (cm/s)			5.E-08									

Site: Courtney/Briggett
Location: Canadian Co., OK
Status: active
No. Pits: 4
Area: 21.7 acres (945,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					4/88-8/99	38	7.4-9.2	8.1	4/88-8/99	44	6.7-8.3	7.6
TDS					4/88-8/99	30	1,148-44,682	6,682	4/88-8/99	22	146-10,116	4,278
Arsenic					11/93	2	0.019-0.03	0.02				
Bicarbonate					8/95-8/98	13	142-335	250	8/95-8/96	6	98-471	262
Boron					8/95-8/98	13	0.38-1.03	0.7	8/95-8/98	8	0.45-8.5	6
Calcium					4/88-8/99	30	45-930	218	4/88-8/99	22	8-575	332
Carbonate					8/95-8/98	13	0-17	2.2	8/95-8/96	6	0	0
Chloride					4/88-8/99	42	287-10,000	2,385	4/88-8/99	56	10-2,322	535
Chromium					11/93	2	u-0.06	0.03				
Magnesium					4/88-8/99	30	0-83	36	4/88-8/99	22	1-262	100
Nitrogen					4/88-8/99	29	0-1	0.5	4/88-8/99	22	0-18	2.4
Potassium					8/95-8/99	29	6-62	29	8/95-8/99	20	1-103	18
Sodium					4/88-8/99	30	317-11,970	1,995	4/88-8/99	22	14-2,723	899
Sulfate					4/88-8/99	30	310-5,300	1,010	4/88-8/99	22	15-6,322	2,113
Bbls. Rec'd.	1991-99		>586,090									

Appendix B. Data summaries for CCDD sites in the database

Site: Eastern Tank
Location: Haskell Co., OK
Status: inactive
No. Pits: 1
Area: 2.2 acres (96,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					7/93-2/94	6	7-8	7.5	2/87-7/96	20	6.7-7.9	7.2
Chloride					7/93-2/94	6	3-2,411	402	2/87-7/96	20	1.5-50	15

Site: Eola
Location: Garvin Co., OK
Status: active
No. Pits: 18
Area: 47.5 acres (2.07 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					1/91-1/99	146	6.6-9.4	8.2	1/91-1/99	66	6.3-11.6	7.8
TDS	9/98	1	19,506	19,506	6/91-9/97	80	596-20,000	3,614	1/91-1/96	32	116-1,720	766
Arsenic	9/98	1	1.38	1.38	9/97	1	<0.05	<0.05				
Bicarbonate					7/95-1/96	14	217-935	559	7/95-1/96	7	0-742	421
Boron					7/95-1/96	14	0.02-1.78	0.64	7/95-1/96	7	0-0.09	0.03
Calcium					7/95-1/96	14	23-65	41	7/95-1-96	7	2-109	54
Carbonate					7/95-1/96	14	0	0	7/95-1/96	7	0-204	47
Chloride					1/91-1/96	139	31-10,000	1,772	1/91-1/99	76	1.75-386	81
Chromium	9/98	1	34.8	34.8	7/96	1	2.06	2.06				
Magnesium					7/95-1/96	14	6-35	17.8	7/95-1/96	7	0-161	66.9
Nitrogen					7/95-1/96	14	0-1	0.71	7/95-1/96	7	0-1	0.14
Potassium					7/95-1/96	14	5-56	24.5	7/95-1/96	7	4-78	11.1
Sodium					7/95-1/96	14	148-1,808	830	7/95-1/96	7	19-122	88
Sulfate					7/95-1/96	14	20-526	170	7/95-1/96	7	16-494	187
O&G	9/98	1	8,030	8,030	9/97	1	35	35				
Benzene									10/92	7	<0.002	<0.002
Toluene									10/92	7	<0.002	<0.002
Ethylbenzene									10/92	7	<0.002	<0.002
Xylene									10/92	7	<0.002	<0.002
Bbls. Rec'd.	1990-96		1.5 MM+									

Site: Fuel Haulers 22-5-17
Location: Latimer Co., OK
Status: inactive
No. Pits: 1
Area: 0.3 acres (12,250 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	11/82-12/82	32	4.6-8	7	11/82-8/86	30	2.9-8	5.8	11/82-8/86	22	6-7.6	6.8
TDS					11/82-12/82	28	78-8,470	2,985	11/82-12/82	21	29-1,085	371
Arsenic	11/82-12/82	32	<3-35	18	11/82-8/86	30	<0.01-<0.5	0.08	11/82-8/86	22	<0.01-0.041	0
Barium	11/82-12/82	32	39-5,015	543	11/82-8/86	30	0.18-290	12.9	11/82-8/86	22	<0.02-3.6	1
Cadmium					8/86	2	0.001-0.005	0.003	8/86	1	0.003	0
Chloride	11/82-12/82	32	540-900	1,384	11/82-12/82	26	<10-1,399	302	11/82-12/82	21	<10-142	43
Chromium	11/82-12/82	32	13-861	172	11/82-8/86	30	<0.01-3.15	0.61	11/82-8/86	22	<0.01-0.073	0.015
Iron	12/82	4	16,500-32,500	24,500	12/82	3	1.41-810	278	12/82	4	<0.1-0.53	0.31
Lead	7/86	1	48.3	48.3	8/86	2	0.03-0.9	0.47	8/86	1	<0.02	<0.02
Magnesium					11/82-12/82	28	0.17-35.5	1.3				
Manganese	11/82-12/82	32	60-515	322					11/82-12/82	21	<0.02-9.7	1.04
Mercury	11/82-12/82	4	<0.05	<0.05	11/82	3	<0.0005-0.11	0.07	8/86	1	<0.002	<0.002
Selenium					8/86	2	0.008-0.072	0.04	8/86	1	0.0095	0.0095
Silver					8/86	2	<0.02-0.7	0.36				
Sodium	11/82-12/82	32	<500-21,950	5,829	11/82-12/82	27	<10-1,103	428	11/82-12/82	21	0.01-421	85
Sulfate	11/82-12/82	32	<2000-2000	<2000	11/82-12/82	28	20-6,433	1,427	11/82-12/82	21	<20-344	69
Zinc	11/82-12/82	32	7.5-320	151	11/82-12/82	19	0.004-40	3.96	11/82-12/82	17	0.004-58	9.3
TOC					11/82-12/82	28	<5-237.6	49.2	11/82-12/82	21	<5-53.9	10

Appendix B. Data summaries for CCDD sites in the database

Site: Fuel Haulers 35-6-13
Location: Pittsburg Co., OK
Status: abandoned
No. Pits: 1
Area: 1.4 acres (62,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	8/85-7/97	11	u-13	6.9	8/85-7/97	3	u-0.018	0.013				
Barium	8/85-7/97	13	1.78-7,690	1,104	8/85-7/97	3	1.17-3.3	2.4				
Cadmium	8/85-7/97	5	u-4.3	2	7/97	1	u-0.018	u				
Calcium	8/85	11	160-18,700	4,634	8/85	2	396-615	506				
Chloride	7/97	2	79-463	271	7/97	1	148	148				
Chromium	8/85-7/97	11	u-905	153	7/97	1	0.019	0.019				
Iron	8/85	11	4,900-61,000	30,018	8/85	2	0.215-1.49	0.85				
Lead	8/85-7/97	13	u-126	28	7/97	1	u	u				
Magnesium	8/85	11	1,800-7,640	4,057	8/85	2	308-624	466				
Manganese	8/85	11	178-960	425	8/85	2	0.761-2.22	1.49				
Mercury	8/85-7/97	6	u-0.44	0.17	7/97	1	u	u				
Potassium	8/85	10	993-3,840	2,371	8/85	2	32.2-39.2	35.7				
Selenium					7/97	1	u	u				
Silver	8/85-7/97	10	u-8.7	3.3	7/97	1	u	u				
Sodium	8/85	10	1,310-9,510	3,783	8/85	2	2,260-3,310	2,785				
Zinc	8/85-7/97	13	0.25-261	88	7/97	1	u	u				
Benzene	7/97	1	u	u	7/97	1	u	u				
Toluene	7/97	1	u	u	7/97	1	u	u				
Ethylbenzene	7/97	1	u	u	7/97	1	u	u				
Xylene	7/97	1	u	u	7/97	1	u	u				
TPH	7/97	1	u	u	7/97	1	u	u				
VOC, SVOC	7/97	1	u	u	7/97	1	u	u				
PCB					7/97	1	u	u				

Site: FPC
Location: Canadian Co., OK
Status: active
No. Pits: 5
Area: 10.2 acres (445,625 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/98-2/00	10	7.07-8.5	7.8	2/98-2/00	14	7.07-8.4	7.9
Conductivity (µ)					2/98-2/00	6	9,930-51,100	24,255	2/99-2/00	10	644-2,740	1,878
TDS					2/98-2/00	6	6,774-42,237	18,075	2/98-2/00	13	441-2,117	1,302
Arsenic	1/88	1	2.096	2.096								
Barium	1/88	1	212.4	212.4								
Bicarbonate					2/98-2/00	6	168-454	275.3	2/99-2/00	10	185-293	225
Boron					2/98-2/00	6	1.08-4.24	1.84	2/99-2/00	10	0.14-0.82	0.473
Cadmium	1/88	1	0.263	0.263								
Calcium					2/98-2/00	6	140-806	365	2/99-2/00	10	35-425	244
Carbonate					2/98-2/00	6	0-14	2.3	2/99-2/00	10	0-22	4
Chloride	1/88	1	2,749	2,749	1/89-2/00	64	355-33,100	5,029	1/879-2/00	107	1-800	183
Chromium	1/88	1	101.81									
Magnesium					2/98-2/00	6	9-187	63	2/99-2/00	10	16-97	72
Mercury	1/88	1	0.111	0.111								
Nitrogen					2/98-2/00	6	0-1	0.17	2/99-2/00	10	0-3	1.6
Potassium					2/98-2/00	6	29-118	58	2/99-2/00	10	1-4	2.9
Sodium					2/98-2/00	6	2,262-13,980	5,991	7/89-2/00	13	47-236	110
Sulfate					2/98-2/00	6	1,320-3,584	2,289	2/99-2/00	10	21-1,092	685
Benzene									10/92	3	<0.002	<0.002
Toluene									10/92	3	<0.002	<0.002
Ethylbenzene									10/92	3	<0.002	<0.002
Xylene									10/92	3	<0.002	<0.002
Kv (cm/s)			2.1-5.1E-8									
Bbls. Rec'd.	1987-99		3.91MM									

Appendix B. Data summaries for CCDD sites in the database

Site: Giles
Location: Grady County, OK
Status: active
No. Pits: 2
Area: 15.6 acres (680,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	1/96-2/00	10	7.1-9	7.9	8/96-1/98	4	7.6-9.3	8.1	10/95-2/00	22	6.3-9.4	7.9
Conductivity (µ)	8/96-2/00	9	12,960-72,300	26,129	8/96-1/98	5	13,400-16,400	14,650	10/95-2/00	22	635-24,300	14,664
TDS	8/96-2/00	9	8,554-47,718	17,406	8/96-1/98	5	9,999-38,902	17,289	10/95-2/00	22	419-18,644	11,310
Bicarbonate	8/96	1	844	844	8/92-2/97	4	56-207	125	10/95-2/97	3	83-168	111
Boron	8/96-2/00	9	0-2.86	1.46	8/96-1/98	5	1.8-14.73	10.59	10/95-2/97	3	8.09-10.69	9.76
Calcium	8/96-2/00	9	40-873	370.3	8/96-1/98	5	107-705	537	10/95-2/00	22	64-724	568
Carbonate	8/96	1	0	0	8/92-2/97	4	0	0	10/95-2/97	3	0	0
Chloride	8/96-2/00	9	2,007-20,683	5,690	8/96-1/98	5	1,938-30,962	8,717	10/95-2/00	22	9-6,573	3,395
Magnesium	8/96-2/00	9	2-184	36	8/96-1/98	5	5-171	124.8	10/95-2/00	22	15-182	127
Nitrogen	8/96	1	0	0	8/96-2/97	4	2-12	7.5	10/95-2/00	22	0-25	10
Potassium	8/96-2/00	9	31-345	89.1	8/96-1/98	5	14-62	32.6	10/95-2/00	21	3-370	89
Sodium	8/96-2/00	9	2,332-16,182	5,579	8/96-1/98	5	2,936-3,812	762	10/95-2/00	22	20-5,730	3,146
Sulfate	8/96	1	1,814	1,814	8/96-2/97	4	3,971-4,879	4,391	10/95-2/00	22	8-5,427	3,951
Benzene	12/97	1	<0.0002	<0.0002								
Toluene	12/97	1	<0.0005	<0.0005								
Ethylbenzene	12/97	1	<0.0002	<0.0002								
Xylene	12/97	1	<0.0003	<0.0003								
TPH	12/97	1	<0.0002	<0.0002								
Kv (cm/s)			4.5E-8									
Bbls. Rec'd.	1995-99		1.08MM									

Site: Gray
Location: Grady Co., OK
Status: abandoned
No. Pits: 7
Area: 8.5 acres (369,875 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Conductivity (µ)					7/97	2	2,620-9,070	5,845				
Arsenic	7/97	4	u	u	7/97	2	u	u				
Barium	7/97	4	0.68-1.7	1.35	7/97	2	0.65-0.85	0.75				
Cadmium	7/97	4	u	u	7/97	2	u	u				
Chloride	7/97	4	19.7-926	361	7/97	2	788-2,690	1,739				
Chromium	7/97	4	u-0.072	0.018	7/97	2	0.008	0.008				
Lead	7/97	4	u-0.37	0.15	7/97	2	u	u				
Mercury	7/97	4	u	u	7/97	2	u	u				
Selenium	7/97	4	u	u	7/97	2	u	u				
Silver	7/97	4	u	u	7/97	2	u	u				
Zinc	7/97	4	u-1.08	0.88	7/97	2	0.052-0.056	0.054				
Benzene	2/97	4	u-0.084	0.032	7/97	2	u	u				
Toluene	2/97	4	u-0.118	0.048	7/97	2	u	u				
Ethylbenzene	2/97	4	u-0.157	0.06	7/97	2	u	u				
Xylene	2/97	4	u-0.374	0.147	7/97	2	u	u				
TPH	2/97	4	u-1,130	342	7/97	2	u	u				
VOC, SVOC	2/97	5	u	u	7/97	2	u	u				
Herb, Pest	2/97	5	u	u	7/97	2	u	u				
PCB	2/97	5	u	u	7/97	2	u	u				

Site: Gray Farms
Location: Garfield Co., OK
Status: inactive
No. Pits: 7
Area: 12.8 acres (554,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/89-2/00	45	6.2-8.2	7.5	7/85-2/00	195	6.6-8.7	7.9
TDS					2/89-2/00	45	2,837-69,564	1,546	7/85-2/00	188	116-55,963	7,213
Conductivity (µ)					2/89-2/00	43	4,450-95,100	46,436	2/89-2/00	180	177-65,500	9,495
Arsenic	2/97	4	u	u								
Barium	2/97	4	0.68-1.7	1.35	2/97	2	0.65-0.85	0.75				
Bicarbonate					2/89-2/00	44	30-432	154	2/89-2/00	180	18-342	161
Boron					8/93-2/00	30	0-3.85	1.58	2/93-2/00	118	0-8.47	2
Cadmium	2/97	4	u	u	2/97	2	u					
Calcium					2/89-2/00	45	149-2,760	1,015	2/89-2/00	180	18-1,572	362
Carbonate					2/89-2/00	45	0-33	0.73	2/89-2/00	180	0-41	1.65
Chloride	2/97	4	20-926	361	2/85-2/00	49	788-53,000	17,894	7/85-2/00	202	6-27,703	2,631
Chromium	2/97	4	u-0.072	0.02	2/97	2	0.008	0.008				
Lead	2/97	4	u-0.37	0.15	2/97	2	u					
Magnesium					2/89-2/00	45	0-711	187	2/89-2/00	179	5-545	123
Mercury	2/97	4	u	u	2/97	2	u	u				
Nitrogen					2/89-2/00	45	0-40,000	1,143	2/89-2/00	179	0-51	1
Selenium	2/97	4	u	u	2/97	2	u	u				
Silver	2/97	4	u	u	2/97	2	u	u				
Sodium					2/89-2/00	45	164-27,000	12,191	7/85-2/00	190	8-18,770	2,038
Sulfate					2/89-2/00	45	0-9,370	2,712	7/85-2/00	190	8-9,091	1,764
Zinc	2/97	4	u-1.08	0.58	2/97	2	0.052-0.056	0.054				
Benzene	2/97	4	u-0.084	0.032	2/97	2	u	u	9/92	6	<0.002	<0.002
Toluene	2/97	4	u-0.118	0.048	2/97	2	u	u	9/92	6	<0.002	<0.002
Ethylbenzene	2/97	4	u-0.157	0.06	2/97	2	u	u	9/92	6	<0.002	<0.002
Xylene	2/97	4	u-0.374	0.147	2/97	2	u	u	9/92	6	<0.002	<0.002
TPH	2/97	4	u-1,130	342	2/97	2	u	u				
VOC, SVOC	2/97	5	u	u	2/97-8/97	4	u	u				
Herb, Pest	2/97	5	u	u	2/97-8/97	4	u	u				
PCB	2/97	5	u	u	2/97	2	u	u				
Kv (cm/s)			2.95-9.57E-7									
Bbls. Rec'd.	1998-99		>2.05 MM									

Site: Guard 23-22N-13W
Location: Major Co., OK
Status: active
No. Pits: 3
Area: 28.01 acres (1.22 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	8/97-1/00	14	5.5-12.4	8.3	8/90-2/98	5	7.3-8.1	7.6	5/90-1/00	62	6.6-8.5	7.7
Conductivity (µ)	8/97-1/00	12	34,980-170,700	116,223	1/97-2/98	3	6,650-92,000	54,950	5/90-1/00	40	6,160-67,600	26,233
TDS	8/97-1/00	12	23,087-120,050	82,881	1/97-2/98	3	5,473-82,814	46,886	5/90-1/00	42	5,428-46,747	21,298
Bicarbonate					1/97-2/98	3	0	0	5/90	2	57-64	60.5
Boron	8/97-1/00	12	0.55-17.75	4.48					5/90	2	4-5.21	4.6
Calcium	8/97-1/00	12	454-4,125	2,333	1/97-2/98	3	496-1,905	1,373	5/90-1/00	40	21-860	648
Carbonate					1/97-2/98	3	0	0	5/90	2	0	0
Chloride	8/97-1/00	19	353-107,614	41,504	8/90-7/98	17	549-45,473	22,881	5/90-1/00	100	68-28,000	8,715
Magnesium	8/97-1/00	12	12-1,089	257	1/97-2/98	3	176-597	358	5/90-1/00	39	105-422	269
Nitrogen	8/97	3	0	0	1/97-2/98	3	0-1	0.33	5/90-1/00	40	0-21	7.1
Potassium	8/97-1/00	12	154-464	276	1/97-2/98	3	13-165	99	5/90-1/00	38	5-64	21
Sodium	8/97-1/00	12	7,022-43,201	29,083	1/97-2/98	3	1,031-2,838	15,634	5/90-1/00	42	961-18,130	6773
Sulfate	8/97-1/00	3	3,718-6,300	4,579	1/97-2/98	3	3,207-6,294	4,491	5/90-1/00	42	2,344-8,900	5,411
Benzene									7/92	4	<0.002	<0.002
Toluene									7/92	4	<0.002	<0.002
Ethylbenzene									7/92	4	<0.002	<0.002
Xylene									7/92	4	<0.002	<0.002
Kv (cm/s)			1.9E-6 - 1.7E-8									
Bbls. Rec'd.	1990-99		2.28MM									

Site: Hamilton
Location: Mc Clain Co., OK
Status: abandoned
No. Pits: 8
Area: 3.50 acres (152,461 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	7/97	4	u	u								
Barium	7/97	4	1.35-3.64	2.04								
Cadmium	7/97	4	u	u								
Chromium	7/97	4	u-0.094	0.02								
Lead	7/97	4	0.04-0.2	0.12								
Mercury	7/97	4	u	u								
Selenium	7/97	4	u	u								
Silver	7/97	4	u	u								
Zinc	7/97	4	u-0.6	0.22								
Benzene	7/97	4	u-0.057	0.038								
Toluene	7/97	4	u-0.017	0.014								
Ethylbenzene	7/97	4	u-0.216	0.14								
Xylene	7/97	4	u-0.736	0.56								
TPH	7/97	4	u-879	594								
VOC, SVOC	7/97	4	u	u								
Herb, Pest	7/97	4	u	u								

Site: HTS
Location: Caddo Co., OK
Status: abandoned
No. Pits: 1
Area: 2.4 acres (103,125 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic					7/97	1	<0.03	<0.03				
Barium	7/97	2	2-3.73	2.9	7/97	1	0.33	0.33				
Cadmium	7/97	2	<0.005	<0.005	7/97	1	<0.005	<0.005				
Chloride	7/97	2	562-1,872	1,217	8/86-7/97	3	1,429-15,000	6,276				
Chromium	7/97	2	<0.005	<0.005	7/97	1	<0.005	<0.005				
Lead	7/97	2	<0.03-0.045	0.04	7/97	1	0.03	0.03				
Mercury	7/97	2	<0.0005	<0.0005	7/97	1	<0.0005	<0.0005				
Selenium	7/97	2	<0.04	<0.04	7/97	1	<0.04	<0.04				
Silver	7/97	2	<0.01	<0.01	7/97	1	<0.01	<0.01				
Zinc	7/97	2	0.24-0.71	0.48	7/97	1	<0.05	<0.05				
Benzene	7/97	2	30-906	468	7/97	1	<1	<1				
Toluene	7/97	2	331-1,810	1,071	7/97	1	<1	<1				
Ethylbenzene	7/97	2	1,300-4,880	3,090	7/97	1	<1	<1				
Xylene	7/97	2	5,610-25,300	15,455	7/97	1	<1	<1				
TPH					7/97	1		<1	9/92	5	<0.002-0.684	0.138
TPH	7/97	2	960-1,015	988	7/97	1	<1	<1				
VOC, SVOC	7/97	2	u	u	7/97	1	u	u				
Herb, Pest	7/97	2	u	u	7/97	1	u	u				

Site: Highfill
Location: Woodward Co., OK
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									5/95	1	7.2	7.2
TDS									5/95	1	7,465	7,465
Bicarbonate									5/95	1	75	75
Calcium									5/95	1	622	622
Chloride									5/95	1	2,600	2,600
Magnesium									5/95	1	1,930	1,930
Potassium									5/95	1	126	126
Sodium									5/95	1	2,962	2,962
Sulfate									5/95	1	2	2
TOC									5/95	1	0	0

Site: Hull 1-6-3
Location: Carter Co., OK
Status: inactive
No. Pits: 2
Area: 0.6 acres (25,300 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					3/81	2	600-1,200	900				

Site: Hull 20-5-2 — Carter Co., OK — inactive
2 pits, 0.27 acres (11,750 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					2/85	2	5,800-6,600	6,200				

Site: Kelly
Location: Mc Clain Co., OK
Status: abandoned
No. Pits: 5
Area: 41.3 acres (1.8 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	10/98	31							8/98-9/98	2	8-8.2	8.1
TDS					5/95	1	523	523	8/98-9/98	2	1,280-4,492	2,886
Aluminum	10/98	31	5,230-23,400	12,426								
Antimony									8/98-9/98	2	<0.35	<0.35
Arsenic	10/98	23	1.47-6.38	4.21	5/95	1	<0.005	<0.005	8/98-9/98	2	<0.06	<0.06
Barium	10/98	31	73.6-17,500	3,976	5/95	1	<0.001	<0.001	8/98-9/98	2	0.02-0.15	0.08
Beryllium									8/98-9/98	2	<0.01	<0.01
Bicarbonate									8/98-9/98	2	171-437	304
Boron									8/98-9/98	2	0.13-5.96	3
Cadmium					5/95	1	<0.01	<0.01	8/98-9/98	2	<0.005	<0.005
Calcium	10/98	31	1,490-36,700	19,011					8/98-9/98	2	53-164	109
Carbonate									8/98-9/98	2	0	0
Chloride					9/80-5/95	5	118-1,800	984	10/92	25	7.5-527	132
Chromium	10/98	31	9.29-176	43.8					8/98-9/98	2	<0.01	<0.01
Copper	10/98	17	2.16-48.5	16.8					8/98-9/98	2	<0.01	<0.01
Iron	10/98	31	5,880-189,000	21,593	5/95	1	0.74	0.74				
Lead	10/98	31	5.09-203	62.5	5/95	1	<0.002	<0.002	8/98-9/98	2	<0.05	<0.05
Magnesium	10/98	31	1,770-41,000	7,943	5/95	1	98	98	8/98-9/98	2	22-62	42
Manganese	10/98	31	81.4-1,440	378	5/95	1	<0.002	<0.002				
Mercury					5/95	1	1.2	1.2	8/98-9/98	2	<0.0005	<0.0005
Nickel	10/98	31	9.17-43.7	22					8/98-9/98	2	<0.025	<0.025
Nitrogen									8/98-9/98	2	1-27	14
Potassium	10/98	31	1,300-6,480	2,923					8/98-9/98	2	6-36	21
Selenium	10/98	1	1.44	1.44					8/98-9/98	2	<0.07	<0.07
Silver					5/95	1	0.08	0.08	8/98-9/98	2	<0.01	<0.01
Sodium	10/98	31	581-16,800	4,723					8/98-9/98	2	123-1,226	675
Sulfate									8/98-9/98	2	39-2,335	1,187
Titanium									8/98-9/98	2	<0.2	<0.2
Vanadium	10/98	19	14.5-29.1	20.7								
Zinc	10/98	31	14.4-173	75					8/98-9/98	2	0.005-0.074	0.04
TPH	10/98	24	70.9-24,548	5,192								
Benzene	6/98	3	u-6.3*	2.1								
Toluene	6/98	3	u-22*	7.3								
Ethylbenzene	6/98	3	u-67*	22.3								
M & P Xylene	6/98	3	180-940*	613								
O-Xylene	6/98	3	u-140*	46.7								
1,2,4-Trimethylbenzene	6/98	3	700*	700								
Naphthalene	6/98	3	92-920*	554								
Methylchloride	6/98	3	9.5-1,120*	743								
Bbls. Rec'd	1988-98		4.5MM									

Site: Kirk
Location: Carter Co., OK
Status: inactive
No. Pits: 5
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					4/83	3	9.5-9.7	9.6				
Chloride					4/83	3	429-1,446	960				
Chromium					4/83	1	0.012	0.012				
Mercury					4/83	1	13.6	13.6				
Silver					4/83	1	3.1	3.1				

Site: Lee/Triple L
Location: Marshall Co., OK
Status: inactive
No. Pits: 3
Area: 4.1 acres (180,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					5/89-4/91	13	6.3-8.0	7	11/91	3	6.6-7.3	6.9
TDS					4/91	5	420-3,473	1,583				
Chloride					3/89-11/91	16	54-3,360	2,170	3/89-11/91	10	39.1-1,540	366
Magnesium					11/90	1	300	300	11/90	3	138-168	152
O&G					5/89	1	1.1	1.1				

Site: Little River Express
Location: Pottawatomie Co., OK
Status: inactive
No. Pits: 9
Area: 1.7 acres (74,100 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/84-9/93	11	7-9.1	7.9	9/83-1/84	14	6.8-8.1	7.5
TDS					2/84-4/84	10	167-4,185	1,930	11/83-1/84	8	127-543	257
Arsenic									1/84	5	<0.01-0.01	<0.01
Barium					9/93	1	21	21	11/83	10	<0.2-0.38	0
Chloride					2/84-9/93	11	<10-2,401	825	9/83-1/84	17	<10-38	16
Chromium					2/84-9/93	5	0.02-4.3	1.3	9/83	9	<0.01-0.09	0.05
Lead									1/84	5	<0.02-0.167	0.06
Sodium					2/84-4/84	4	476-700	584				
Zinc									1/84	3	<0.004-2.72	0.93
TOC									1/84	5	<5-15.5	6.3
O&G					2/84-4/84	4	2-7	4.1	11/83	1	2.9	2.9

Site: Lojo
Location: Woods Co., OK
Status: inactive
No. Pits: NA
Area: >0.4 acres (>15,625 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Kv (cm/s)			2.7E-7 - 5.9E-8									

Site: Mabray
Location: Atoka Co., OK
Status: inactive
No. Cells: 4
Area: 1.7 acres (>74,750 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					7/89-7/94	39	850-3,200	1,878				

Site: Merkle
Location: Pottawatomie Co., OK
Status: abandoned
No. Pits: 12
Area: 6.7 acres (292,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH												
Arsenic	7/97	3	u	u	8/97	3	u	u				
Barium	7/97	3	1.36-1.82	1.5	8/97	3	0.15-0.24	0.19				
Cadmium	7/97	3	u	u	8/97	3	u	u				
Chloride	7/97	3	168-672	444	8/97	3	19.7-64.1	34.5				
Chromium	7/97	3	u	u	8/97	3	u-0.019	0.006				
Lead	7/97	3	u	u	8/97	3	u	u				
Mercury	7/97	3	u	u	8/97	3	u	u				
Selenium	7/97	3	u	u	8/97	3	u	u				
Zinc	7/97	3	0.1-0.22	0.14	8/97	3	u-0.055	0.02				
Benzene	7/97	3	u	u	8/97	3	u	u	7/97	6	u	u
Toluene	7/97	3	u	u	8/97	3	u	u	7/97	6	u-0.012	u
Ethylbenzene	7/97	3	u-0.005	0.002	8/97	3	u	u	7/97	6	u	u
Xylene	7/97	3	u-0.015	0.005	8/97	3	u	u	7/97	6	u	u
TPH	7/97	3	4-444	392	8/97	2	u	u	7/97	6	u	u
VOC, SVOC	7/97	2	u	u	8/97	2	u	u				
Herb, Pest	7/97	2	u	u								

Site: O'Daniel Gravel
Location: Maud, OK
Status: active
No. Pits: 7
Area: 15.6 acres (678,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					5/90-3/00	55	7.19-11.8	8.71	5/90-3/00	198	4.9-12.81	7.43
Chloride					5/90-3/00	59	132.1-2,400	983	5/90-3/00	208	1-1,534	175.2
Benzene					1/97	1	<0.005	<0.005	7/92	1	<0.002	<0.002
Toluene					1/97	1	<0.005	<0.005	7/92	1	<0.002	<0.002
Ethylbenzene					1/97	1	<0.005	<0.005	7/92	1	<0.002	<0.002
Xylene					1/97	1	<0.005	<0.005	7/92	1	<0.002	<0.002
TPH					1/97	1	0.266	0.266				
Kv (cm/s)			2.1E-6-2.4E-8									
Bbls. Rec'd.	1989-98		1.59MM+									

Site: Oilfield Services
Location: Pittsburg Co., OK
Status: inactive
No. Pits: 3
Area: 0.5 acres (19,875 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic					9/96	1	<0.005	<0.005				
Chloride					9/96	1	32	32				
Magnesium					9/96	1	16.8	16.8				
Silver					9/96	1	0.16	0.16				

Site: Parent/Casey
Location: Pittsburg Co., OK
Status: inactive
No. Pits: 3
Area: 7.2 acres (315,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					5/87-10/95	3	6.8-7.8	7.4	5/87-10/95	5	6.9-7.8	7.2
Chloride					5/87-10/95	6	310-2,849	1,149	10/95	5	2.5-80	34.7
Magnesium					10/95	2	113-125	119	10/95	2	28-32	30
TDS					3/91-10/95	5	848-5,118	2,018	10/95	2	627-704	666

Site: Peek & OMT
Location: Garvin Co., OK
Status: inactive
No. Pits: 18
Area: 4.6 acres (198,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									7/85-5/90	13	6.5-7.9	7
TDS									7/85-4/88	7	177-688	472
Bicarbonate									7/85	3	320-351	335
Calcium									7/85	3	175-224	205
Chloride					1/86-1/89	3	1,360-2,400	1,929	7/85-5/90	13	3.83-131	32
Magnesium									7/85	3	119-153	132
Nitrogen									7/85	3	0-1	0
Sodium									7/85	3	61-96	77
Sulfate									7/85	3	82-265	170
Kv (cm/s)			5.8E-5 - 3.1E-8									

Site: Pharoah
Location: Garvin Co., OK
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
TDS					3/93	1	1860	1860				
Chloride					1/85-3/93	2	972-2,274	1,623				
Chromium	3/93	1	<0.119	<0.119								
Iron	3/93	1	<0.904	<0.904								
Manganese	3/93	1	<0.0006	<0.0006								
Mercury	3/93	1	271	271								
Silver	3/93	1	0.135	0.135								

Site: Poteet Oil Ltd
Location: Stephens Co., OK
Status: active
No. Pits: 8
Area: 9.4 acres (411,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					1/96-3/00	32	7.26-8.77	7.93	9/95-12/99	30	6.9-8.28	7.42
Arsenic					3/00	2	u-0.032	0.016				
Barium					3/00	1	u	u				
Cadmium					3/00	2	u-3.64	1.82				
Chloride					9/95-3/00	40	292-4,900	1,062	9/95-12/99	30	2.25-450	84.2
Chromium					3/00	1	u	u				
TOC					3/00	1	18	18				
Kv (cm/s)			1.40E-08									
Bbls. Rec'd.	1988-99		1.81MM									

Site: Ricketts
Location: Love Co., OK
Status: inactive
No. Pits: NA
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
TDS					12/95	2	70-75	73				
Chloride					12/95	3	6-325	113				
Magnesium					12/95	3	4-273	94				

Site: S & M
Location: Garvin Co., OK
Status: abandoned
No. Pits: 6
Area: 1.6 acres (70,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	12/96	1	u	u	3/96	4	0.005-0.808	0.206				
Barium	12/96	1	0.92	0.92	3/96	4	0.31-1.04	0.6				
Cadmium	12/96	1	u	u	3/96	4	<0.002	<0.002				
Chloride					7/83-9/86	6	277-3,000	1,222				
Chromium	12/96	1	u	u	3/96	4	0.023-0.029	0.1				
Lead	12/96	1	u	u	3/96	4	<0.043-<0.43	0.14				
Mercury	12/96	1	u	u	3/96	4	<0.00018-0.004	0.0018				
Nitrogen					3/96	4	0.05-0.099	0.07				
Selenium	12/96	1	u	u	3/96	4	<0.002	<0.002				
Silver	12/96	1	u	u	3/96	4	<0.008	<0.008				
Zinc	12/96	1	u	u	3/96	4	0.04-0.07	0.05				
Benzene	12/96	3	u-0.01	u	3/96	4	<0.002	<0.002	9/92	5	<0.002-0.087	0.019
Toluene	12/96	3	0.01-0.087	0.05	3/96	4	<0.002	<0.002	9/92	5	<0.002-0.149	0.031
Ethylbenzene	12/96	3	0.018-0.44	0.17	3/96	4	<0.002	<0.002	9/92	5	<0.002-0.012	0.004
Xylene	12/96	3	0.084-0.869	0.387	3/96	4	<0.002	<0.002	9/92	5	<0.002-0.108	0.023
TPH	12/96											
TPH	12/96	3	25.5-34	30.4	3/96	4	<1	<1				
VOC, SVOC	12/96	1	u	u	3/96	4	u	u				
Bbls. Rec'd.	1989-99		2.82MM									

Site: Sable Mar
Location: Garvin Co., OK
Status: inactive
No. Pits: 18
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/89-7/94	11	7.44-8.75	8.09	4/86-1/93	6	7.4-8.3	7.9
TDS					1/91-1/95	2	4,095-5,800	4,948	4/86	2	380-440	410
Arsenic					2/95	1	0.02	0.02				
Calcium									4/86	5	34-51	39
Chloride					3/89-2/95	12	1,440-3,500	2,439	4/86-1/93	7	2-1,577	58
Chromium					2/95	1	0.59	0.59	4/86	5	<0.01-0.01	0.01
Lead									4/86	5	<0.01-0.1	0.1
Sodium									4/86	2	13-46	30
Zinc									4/86	5	<0.01-0.1	0
O&G					1/91-2/95	2	4-6	5				
Benzene									1/93	1	<0.002	<0.002
Toluene									1/93	1	<0.002	<0.002
Ethylbenzene									1/93	1	<0.002	<0.002
Xylene									1/93	1	<0.002	<0.002

Appendix B. Data summaries for CCDD sites in the database

Site: Safe Earth
Location: Roger Mills Co., OK
Status: active
No. Pits: 7
Area: 2.4 acres (>105,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	1/97-1/99	16	7.31-11.28	8.83	1/96-1/00	24	6.71-10.3	7.81	1/96-1/00	102	7.01-8.1	7.53
Cadmium					7/95	1	1.01	1.01				
Chloride	1/97-1/99	19	2,220-35,900	11,630	1/95	37	1,140-159,000	20,033	10/93-1/00	132	7.63-261	41
Bbls. Rec'd	1995-98		>850,000									

Site: Samples
Location: Canadian Co., OK
Status: active
No. Pits: 5
Area: 6.0 acres (262,725 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					4/81-2/83	3	7.2-7.7	7.47	3/83	3	6.5-9.3	7.7
TDS					2/83	1	2,429	2,429				
Arsenic					9/81-2/83	5	<0.01-<0.02	<0.01	3/83	4	<0.01-<0.1	<0.1
Barium					9/81-2/83	7	0.48-13.59	3.39	3/83-6/83	6	0.15-6.64	1.5
Boron					9/81	1	0.68	0.68				
Cadmium					5/81-2/83	5	0.003-<0.02	<0.02				
Chloride	6/93-8/93	4	<1000-15,504	5,151	4/81-12/95	24	273-6,767	2,125	3/83-4/92	13	22-2,847	912
Chromium					9/81-2/83	8	0.287-0.86	0.56	3/83-6/83	6	<0.1-0.11	<0.1
Lead					9/81	3	<0.02-0.029	<0.02	3/83	4	<0.2	<0.2
Magnesium					2/83	1	7,589	7,589				
Mercury					9/81	3	,0.0005-<0.005	<0.005				
Zinc					2/83	2	<0.04	<0.04	3/83	2	<0.04-2.39	1.2
Benzene	6/93-8/93	4	<0.008-<0.333	0.09					9/92	3	<0.002	<0.002
Toluene	6/93-8/93	4	<0.008-26.4	6.6					9/92	3	<0.002	<0.002
Ethylbenzene	6/93-8/93	4	<0.08-12.2	3.1					9/92	3	<0.002	<0.002
Xylene	6/93-8/93	4	<0.008-114	28					9/92	3	<0.002	<0.002
TPH	3/83	4	3.35-4,170	1,048					3/83	4	<0.1	<0.1

Site: Scott, J.
Location: Canadian Co., OK
Status: active
No. Pits: 3
Area: 9.8 acres (427,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					9/95-1/00	6	7.8-8.5	8.1	7/97-1/00	20	7.3-8.2	7.8
TDS					9/95-1/00	6	2,071-17,505	9,677	7/97-1/00	20	1,423-7,719	3,300
Conductivity (µ)					9/95-1/00	6	2,410-23,900	13,740	7/97-1/00	20	1,750-8,530	3,782
Bicarbonate					9/95-1/00	6	222-681	393	7/97-1/00	20	66-559	293
Boron					9/95-1/00	6	0.52-6.87	2.65	7/97-1/00	20	0.42-8.15	3
Calcium					9/95-1/00	6	145-598	301	7/97-1/00	20	154-636	348
Carbonate					9/95-1/00	6	0-12	2	7/97-1/00	20	0	0
Chloride					9/95-1/00	6	64-7,299	4,076	7/97-1/00	20	47-1,587	244
Magnesium					9/95-1/00	6	19-179	77	7/97-1/00	20	75-174	99
Nitrogen					9/95-1/00	6	0	0	7/97-1/00	20	0-12	2.8
Potassium					9/95-1/00	6	19-166	66	7/97-1/00	20	0-14	4.8
Sodium					9/95-1/00	6	252-6,029	3,114	7/97-1/00	20	132-1,913	531
Sulfate					9/95-1/00	6	1,023-2,963	1,638	7/97-1/00	20	615-4,833	1,799
Benzene					12/97	1	<0.0005	<0.0005				
Toluene					12/97	1	<0.0005	<0.0005				
Ethylbenzene					12/97	1	<0.0005	<0.0005				
Xylene					12/97	1	<0.0005	<0.0005				
TPH					12/97	1	<0.1	<0.1				
Kv (cm/s)			1.8E-6 - 6.7E-8									

Site: Scott, L.
Location: Love Co., OK
Status: inactive
No. Pits: 2
Area: 4.0 acres (172,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
TDS					5/95	1	523	523				
Arsenic					5/95	1	<0.005	<0.005				
Barium					5/95	1	<0.001	<0.001				
Cadmium					5/95	1	<0.01	<0.01				
Chloride					9/80-5/95	5	118-1,800	984				
Iron					5/95	1	0.74	0.74				
Lead					5/95	1	<0.002	<0.002				
Magnesium					5/95	1	98	98				
Manganese					5/95	1	<0.002	<0.002				
Mercury					5/95	1	1.2	1.2				
Silver					5/95	1	0.08	0.08				

Site: Shiflett
Location: Comanche Co., OK
Status: inactive
No. Pits: 1
Area: 2.0 acres (85,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					11/82	1	3000	3000				

Site: Smith, G.
Location: Love Co., OK
Status: active
No. Pits: 1
Area: 0.5 acres (22,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/91-1/00	18	7.04-10.29	8.8	1/90-1/00	77	5.8-8.72	7.33
Arsenic									9/92	3	<0.002	<0.002
Barium									9/92	3	<0.002	<0.002
Chloride					1/89-1/00	52	550-2,625	1,289	1/90-1/00	80	15-744	110
Chromium									9/92	3	<0.002	<0.002
Silver									9/92	3	<0.002	<0.002
O&G									9/92	3	<0.002	<0.002
Bbls. Rec'd	1988-99		157,160									

Site: Southard
Location: Blaine Co., OK
Status: active
No. Pits: 6
Area: >4.0 acres (>175,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					2/91-7/00	24	5.36-8.8	7.55	2/91-7/00	67	6.81-7.84	7.19
TDS					2/91	1	2,991	2,991	2/91	1	4,319	4,319
Conductivity (µ)					2/91	1	4,600	4,600	2/91	1	6,600	6,600
Bicarbonate					2/91	1	174	174	2/91	1	860	860
Boron									2/91	1	860	860
Calcium					2/91	1	602	602	2/91-7/00	70	608-13,100	6,376
Carbonate					2/91	1	0	0				
Chloride					2/91-7/00	37	340-25,300	16,207				
Magnesium					2/91	1	69	69				
Nitrogen									2/91	1	372	372
Potassium									2/91	1	82	82
Sodium					2/91	1	221	221	2/91	1	1,992	1,992
Sulfate					2/91	1	1,585	1,585	2/91	1	0	0
Benzene					2/91	1	<0.0005	<0.0005	2/92	3	<0.002-0.014	0.006
Toluene					2/91	1	<0.0005	<0.0005	2/92	3	<0.002	<0.002
Ethylbenzene					2/91	1	<0.0005	<0.0005	2/92	3	<0.002	<0.002
Xylene					2/91	1	<0.0005	<0.0005	2/92	3	<0.002	<0.002
TPH					2/91	1	<0.1	<0.1	2/92	3	<0.002-0.126	0.043
Bbls. Rec'd	1992-99		>934,927									

Appendix B. Data summaries for CCDD sites in the database

Site: Suttles
Location: Carter Co., OK
Status: abandoned
No. Pits: 2
Area: 51.7 acres (2.25 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	7/97	6	<0.03	<0.03								
Barium	7/97	6	0.32-4.81	1.67								
Cadmium	7/97	6	<0.005	<0.005								
Chloride	8/86-7/97	6	20-2,686	807								
Chromium	7/97	6	<0.005-0.18	0.037								
Lead	7/97	6	<0.03-0.59	0.17								
Mercury	7/97	6	<0.0005	<0.0005								
Selenium	7/97	6	<0.04	<0.04								
Silver	7/97	6	<0.01	<0.01								
Zinc	7/97	6	<0.05-1.78	0.48								
Benzene	7/97	6	<0.001-0.224	0.05								
Toluene	7/97	6	<0.001-0.345	0.07								
Ethylbenzene	7/97	6	<0.001-0.25	0.07								
Xylene	7/97	6	<0.001-1.1	0.36								
TPH	7/97	6										
TPH	7/97	6	<0.001-1.01	0.32								
VOC, SVOC	7/97	6	u	u								
Herb, Pest	7/97	6	u	u								

Site: T & S
Location: Mc Clain Co., OK
Status: active
No. Pits: 2
Area: 4.1 acres (178,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	1/00	1	10.91						12/96-1/00	7	10.42-12.8	12.2
TDS									12/96-7/97	3	2,343-10,296	6,064
Conductivity (µ)									12/96-7/97	3	3,550=15,600	9,033
Bicarbonate									12/96-1/00	3	0	0
Boron									12/96-7/97	3	0.26-2.28	1
Calcium									12/96-7/97	3	140-462	294
Carbonate									12/96-1/00	3	744-4,344	1,993
Chloride	2/98-1/00	2	2,000-7,050	4,525					12/96-1/00	12	u-3,320	971
Magnesium									12/96-1/00	3	1-8	3
Nitrogen									12/96-1/00	3	1-5	3
Potassium									12/96-1/00	3	107-1,025	640
Sodium									12/96-1/00	3	199-948	568
Sulfate									12/96-1/00	3	43-2,499	863
Benzene					12/97-6/98	2	0.0009-<0.01	<0.01				
Toluene					12/97-6/98	2	0.0012-<0.01	<0.01				
Ethylbenzene					12/97-6/98	2	<0.0002-<0.01	<0.01				
Xylene					12/97-6/98	2	0.002-<0.01	<0.01				
TPH					12/97	1	<0.00002	<0.00002				
Bbls Rec'd	1988-1998		6.69MM									

Site: Tash/Chitwood
Location: Grady Co., OK
Status: inactive
No. Pits: 6
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	8/89	11	5.8-7.9	6.8	9/84-6/93	34	6.3-8.6	7.7	12/87-12/97	24	7-8.2	7.4
TDS	8/89	11	60.8-4,256	1,074								
Arsenic	8/89	11	0.45-1.4	0.99	9/84	1	<0.05	<0.05				
Calcium					9/84	1	137	137				
Chloride	8/89	11	24.3-6,654	925	9/84-6/93	35	10.1-5,548	1,404	12/87-1/00	25	11.6-81	32
Chromium	8/89	11	2.6-779	103	9/84	1	1.45	1.45				
Lead					9/84	1	<0.1	<0.1				
Potassium					9/84	1	159.5	159.5				
Sodium					9/84	1	3,050	3,050				
O&G	8/89	11	<5-13,309	1,467								

Site: Triple S/Big Pasture
Location: Caddo Co., OK
Status: inactive
No. Pits: 3
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									11/83-6/87	27	4.3-8	7.4
TDS									10/83-6/84	34	289-8,812	1,456
Arsenic									10/83	6	<0.001-<0.02	<0.001
Barium									10/83-6/87	32	<0.14-2.3	0
Boron									10/83	1	<0.03	<0.03
Cadmium									10/83	6	<0.006-0.025	0
Calcium									4/84	1	26.8	27
Chloride									10/83-6/87	38	3-2,598	320
Chromium									10/83-6/87	30	<0.06-1.3	0.2
Iron									10/83	5	<0.03-16.6	4.8
Lead									10/83	5	<0.05	<0.05
Manganese									10/83	6	<0.02-0.8	0.21
Sodium									10/83-6/84	30	6-2,176	269
Sulfate									10/83	4	108-580	308
Zinc									10/83	4	<0.032-0.036	0.02
Kv (cm/s)			1E-6									

Site: Trout
Location: Roger Mills Co., OK
Status: active
No. Pits: 8
Area: 44.8 acres (1.95 million ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	11/92-7/99	11	7.09-12.37	9.9	3/93-1/00	50	5.9-8	6.9	2/89-1/00	182	5.2-12.84	7.51
TDS					8/98	1	7,166	7,166	2/89	1	2,726	2,726
Conductivity (µ)					8/98	1	8,680	8,680				
Bicarbonate					8/98	1	95	95				
Boron					8/98	1	0.9	0.9	2/89	1	4,130	4,130
Calcium					8/98	1	729	729				
Carbonate					8/98	1	0	0				
Chloride	11/92-7/99	10	<1000-17,500	11,010	1/89-1/00	87	180-53,600	15,497	2/89-1/00	245	u-3,150	114
Magnesium					8/98	1	287	287				
Nitrogen					8/98	1	0	0	2/89	1	55	55
Potassium					8/98	1	36	36	2/89	1	322	322
Sodium					8/98	1	1,201	1,201	2/89	1	10	10
Sulfate					8/98	1	2,704	2,704	2/89	1	227	227
TOC									2/89	1	370	370
Benzene					8/98	1	<0.0005	<0.0005				
Toluene					8/98	1	0.0535	0.0535				
Ethylbenzene					8/98	1	<0.0005	<0.0005				
Xylene					8/98	1	<0.0005	<0.0005				
TPH					8/98	1	0.16	0.16				

Site: Walker
Location: Carter Co., OK
Status: inactive
No. Pits: 3
Area: 7.8 acres (337,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH												
Chloride					8/83-8/85	2	180-7,500	3,840				

Site: Washita
Location: Grady Co., OK
Status: inactive
No. Pits: 6
Area: 6.0 acres (260,500 ft2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					2/85	1	1,500	1,500				

Site: Webb/Femco
Location: Mc Clain Co., OK
Status: active
No. Pits: 5
Area: 11.9 acres (520,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					1/91-1/00	61	6.95-9.39	8.14	4/90-7/96	67	6.8-8.39	7.48
Chloride					4/90-1/00	71	15-10,895	2,669	Apr-90	69	5-2,600	793
Bbls. Rec'd	1990-99		453,533									

Site: York
Location: Mc Clain Co., OK
Status: abandoned
No. Pits: 6
Area: >7.5 acres (>326,250 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	1/97-2/97	3	<0.001-<0.03	0.01	1/97	3	u-<0.03	<0.03				
Barium	1/97-2/97	3	<0.001-1.49	0.5	1/97	3	0.29-1.49	0.88				
Cadmium	1/97-2/97	3	<0.005-<0.01	0.006	1/97	3	u-<0.01	<0.01				
Chloride	1/97	1	36	36	1/97-2/97	22	4-53	34				
Chromium	1/97-2/97	2	<0.01-0.2	0.11	1/97	3	u-<0.01	<0.01				
Iron					1/97	3	0.73-1	0.86				
Lead	1/97-2/97	2	<0.03-0.1	0.07	1/97	3	u-<0.03	<0.03				
Mercury	1/97	1	<0.0005	<0.0005	1/97	3	u-<0.0005	<0.0005				
Potassium												
Selenium	1/97	1	<0.04	<0.04	1/97	3	u-<0.04	<0.04				
Silver	1/97	1	<0.01	<0.01	1/97	3	u-<0.01	u-<0.01				
Zinc	1/97	1	0.12	0.12	1/97	5	0.022-0.12	0.05				
Benzene					1/97	2	<0.001	<0.001				
Toluene					1/97	2	<0.001	<0.001				
Ethylbenzene					1/97	2	<0.001	<0.001				
Xylene					1/97	2	<0.001	<0.001				
TPH					1/97							
TPH					1/97	2	<1-757	379				
VOC					1/97	2	u	u				
Herb, Pest					1/97	2	u	u				

Site: Albany Tank Cleaning Yards
Location: Shackelford Co., TX
Status: abandoned
No. Pits: 6
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Arsenic	12/00	9	<5-8.2	4.50								
Barium	12/00	10	60-1,300	3.75								
Cadmium	12/00	10	<0.5-9.4	4.50								
Chloride	12/00	17	23-4,490	1,541								
Chromium	12/00	9	12.2-114	30.70								
Lead	12/00	10	5.1-240	14.30								
Mercury	12/00	10	<2-0.3	0.93								
Selenium	12/00	10	<5	<5								
Silver	12/00	10	<5-9.9	5.50								
TPH	12/00	17	<50-139,000	16,605								
Benzene	12/00	12	<0.005-0.014	<0.005								
Toluene	12/00	12	<0.005-0.009	<0.005								
Ethylbenzene	12/00	12	<0.005-0.45	<0.005								
Xylene	12/00	12	<0.010-0.669	<0.01								

Site: Briggs
Location: Matagorda Co., TX
Status: abandoned
No. Pits: 1
Area: 7.2 acres (312,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									6/96	3	5.94-6.74	6.36
Conductivity									6/96	3	1.2-3.8	2.4
TDS									6/96	3	760-2541	1100
Arsenic	6/96	16	0.4-7.7	2.80					6/96	3	<0.005-0.013	0.01
Barium	6/96	16	68-1,500	606.00					6/96	3	0.5-0.93	0.69
Cadmium	6/96	16	<0.5-0.86	0.51					6/96	3	0.016-0.027	0.02
Chloride	6/96	16	1,300-10,000	6007.00					6/96	3	360-910	573.00
Chromium	6/96	16	138-354	206.00					6/96	3	<0.005	<0.005
Lead	6/96	16	<0.5-82	22.00					6/96	3	<0.005-0.039	0.02
Mercury	6/96	16	<0.02-<0.1	<0.02					6/96	3	<0.002-0.001	0.00
Selenium	6/96	16	<0.1-<0.5	<0.1					6/96	3	<0.005-<0.1	<0.005
Silver	6/96	16	<0.1-0.5	<0.1					6/96	3	<0.005	<0.005
Sulfate									6/96	3	18-110	54
TPH	6/96	16	0.1-2.1	0.90								
TPH (%)	6/96	16		9.00E-05								

Site: Dahl
Location: Bee Co., TX
Status: inactive
No. Pits: 3
Area: 11.0 acres (480,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					6/87-8/87	4	3,000-8,000	4,713				

Site: Falcon Lake
Location: Zapata Co., TX
Status: inactive
No. Pits: 2
Area: 5.0 acres (218,488 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
O&G (%)					6/89	4	0.54-10	3.4				

Site: Fox
Location: Matagorda Co., TX
Status: abandoned
No. Pits: 7
Area: 0.5 acres (22,233 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Aluminum	8/95	4	17,300-29,860	36055								
Antimony	8/95	4	<160	<160								
Arsenic	8/95	4	<60	<60								
Barium	8/95	4	61,900-294,900	162,750								
Beryllium	8/95	4	1.1-2.4	1.8								
Cadmium	8/95	4	<2	<2								
Calcium	8/95	4	14,640-16,380	21,150								
Chloride	8/95	4	93-598	307								
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chromium	8/95	4	179-433	286								
Copper	8/95	4	14-36	25								
Iron	8/95	4	18,090-27,960	24,365								
Lead	8/95	4	106-426	305								
Lithium	8/95	4	<8-28	15								
Magnesium	8/95	4	523-6,800	3,801								
Manganese	8/95	4	274-502	380								
Molybdenum	8/95	4	<10	<10								
Nickel	8/95	4	<14-23	18.5								
Phosphorus	8/95	4	342-396	399								
Potassium	8/95	4	3,060-11,310	6,695								
Selenium	8/95	4	<138	<138								
Sodium	8/95	4	4,820-9,000	5,223								
Strontium	8/95	4	869-3,750	1769								
Sulfate	8/95	4	1,140-1,660	1,393								
Tin	8/95	4	<18	<18								
Titanium	8/95	4	816-2,540	1.727								
Vanadium	8/95	4	24-72	47								
Zinc	8/95	4	177-498	347								
TPH (%)	8/95	4	0.12-0.92	0.35								
O&G (%)	8/95	4	0.5-2.5	1.1								
BTEX	8/95	3	<0.4-12.5	6.5								

Appendix B. Data summaries for CCDD sites in the database

Site: Fresh
Location: Zapata Co., TX
Status: inactive
No. Pits: 5
Area: 0.6 acres (25,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride	9/96-1/98	226	100-6,000	5,360 (est)								
TPH	4/96	1	>16,600	>16,600								

Site: Gober
Location: Matagorda Co. Co., TX
Status: abandoned
No. Pits: 3
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					1/90	3	7.42-7.98	7.66				
TDS					1/90	3	1,691-6,165	4,358				
Conductivity					1/90	3	2,800-8,300	6,400				
Barium					1/90	3	2-5.71	4				
Calcium					1/90	3	98-295	224				
Chloride					1/90	3	1,087-4,324	2,966				
Chromium					1/90	3	<0.05	<0.05				
Iron					1/90	3	0.1-0.7	0.3				
Magnesium					1/90	3	23-53	35				
Potassium					1/90	3	22031	26				
Sodium					1/90	3	390-1,385	1,015				
Sulfate					1/90	3	21-154	66				

Site: Lobo
Location: Webb Co., TX
Status: Abandoned
No. Pits: 6
Area: 19.4 acres (847,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					8/2000	5	1,268-32,400	8,067				
O&G (%)					8/2000	5	0.01-9	2.6				

Site: Manvel Salt Water Disposal
Location: Brazoria Co., TX
Status: abandoned
No. Pits: 4
Area: 4.2 acres (181,448 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					11/95	6	7.55-8.66	8.18				
Conductivity	11/95	13	48-2,202	405	11/95	6	49.1-3,381	648.00	2/01	11	580-51,600	22689
TDS					11/95	6	326-20,816	3688.00	2/01	11	540-34,000	11136
Aluminum	11/95	4	24,000-34,420	21,105	11/95	6	<0.48	<0.48				
Antimony	11/95	4	<160	<160	11/95	6	<0.32	<0.32				
Arsenic	11/95	4	<60	<60	11/95	6	<1.2	<1.2	2/01	11	<0.05	<0.05
Barium	11/95	4	10,000-173,400	51,275	11/95	6	1.3-11.6	3.57	2/01	11	0.59-9.8	3.6
Beryllium	11/95	4	1.4-3.1	1.5	11/95	6	<0.02	<0.02				

Site: Manvel Salt Water Disposal (cont.)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Boron					11/95	6	0.09-0.83	0.38				
Bromide					11/95	6	9.3-2,200	398				
Cadmium	11/95	4	<2-4	2.3	11/95	6	<0.01	<0.01	2/01	1	<0.03	<0.03
Calcium	11/95	4	4,290-27,820	12,675								
Cesium	11/95	4	<110	<110	11/95	6	<2.2					
Chloride					11/95	6	69.1-10,000	1835	2/01	11	23-5,000	3,148
Chromium	11/95	4	50-245	97	11/95	6	<0.05	<0.05				
Cobalt	11/95	4	12-52	22.5	11/95	6	<0.06	<0.06				
Copper	11/95	4	10-48	18.5	11/95	6	<0.06	<0.06				
Fluoride					11/95	6	0.8-4.7	1.5				
Iron	11/95	4	10,620-68,740	23,313	11/95	6	<0.04	<0.04				
Lanthanum	11/95	4	22-45.5	22.8	11/95	6	<0.2	<0.2				
Lead	11/95	4	22-262	89	11/95	6	<0.01	<0.01	2/01	1	<0.1	<0.1
Lithium	11/95	4	7-24	12.5	11/95	6	0.12-0.45	0.17				
Magnesium	11/95	4	2,000-3,530	2,553	11/95	6	3.7-18.5	10.6				
Manganese	11/95	4	85-412	169	11/95	6	<0.01-0.17	0.05				
Mercury					11/95	6	<0.0002	<0.0002				
Molybdenum	11/95	4	<10	<10	11/95	6	0.1-1.72	0.37				
Nickel	11/95	4	<14-31	14.3	11/95	6	<0.140.63	0.17				
Phosphorus	11/95	4	115-402	202	11/95	6	<2.4	<2.4				
Potassium	11/95	4	5,060-6,970	6,248	11/95	6	2.2-185	38.2				
Rubidium	11/95	4	<1,000	<1,000	11/95	6	<28	<28				
Selenium	11/95	4	<138	<138	11/95	6	<0.2.8	<2.8				
Silver					11/95	6	<0.01	<0.01				
Sodium	11/95	4	4,980-6,420	5,168	11/95	6	78.6-5,010	933				
Strontium	11/95	4	174-1,250	525	11/95	6	0.44-25.2	5.36				
Sulfate					11/95	6	1.4-479	89				
Thorium	11/95	4	<76	<76	11/95	6	<1.52	<1.52				
Tin	11/95	4	<18	<18	11/95	6	<0.36	<0.36				
Titanium	11/95	4	1,170-2,330	1763	11/95	6	<1.0-0.5	0.38				
Uranium	11/95	4	<500	<500	11/95	6	<24	<24				
Vanadium	11/95	4	27-33	23	11/95	6	<0.08	<0.08				
Zinc	11/95	4	156-1380	489	11/95	6	<0.02-6.42	1.08	2/01	1	0.15	0.15
Zirconium	11/95	4	40-84.4	44.3	11/95	6	<0.28	<0.28				
BTEX	11/95	8	0.25-55.5	25.1					2/01	11	<0.003-0.142	0.025
SVOL	11/95	8	0.2-20	5								
C_6-C_{10}									2/01	11	<5.0	<5.0
C_{10}-C_{40}									2/01	11	<1.0	<1.0
C_6-C_{40}									2/01	11	<5.0	<5.0

Site: Munson
Location: Burleson Co., TX
Status: abandoned
No. Pits: 5
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					2/87	4	500-3,200	2,200				

Site: Post Oak Site
Location: Lee Co., TX
Status: abandoned
No. Pits: 1
Area: 2.3 acres (125,000 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					8/99	1	7.26	7.26	8/99	2	6.38-6.42	6.4
Conductivity	8/99	4	5.22-7.35	5.99	8/99	1	0.717	0.717	8/99	2	0.7-1.3	2
Arsenic	8/99	4	3.6-4.4	4.00	8/99	1	<0.005	<0.005	8/99	2	<0.005	<0.005
Barium	8/99	4	280-1200	627.50	8/99	1	0.61	0.61	8/99	2	0.082-0.190	0.136
Cadmium	8/99	4	0.19-0.42	0.30	8/99	1	<0.005	<0.005	8/99	2	0.018-0.03	0.025
Chloride	8/99	4	960-2,200	1390.00	8/99	1	150	150	8/99	2	110-550	330
Chromium	8/99	4	10990	17.25	8/99	1	<0.005	<0.005	8/99	2	0.15-0.32	0.235
Lead	8/99	4	18-33	22.50	8/99	1	<0.005	<0.005	8/99	2	0.019-0.09	0.056
Mercury	8/99	4	<0.004-0.06	0.02	8/99	1	0.009	0.009	8/99	2	<0.0002	<0.0002
Selenium	8/99	4	<0.1-0.33	0.16	8/99	1	<0.005	<0.005	8/99	2	<0.1	<0.1
Silver					8/99	1	<0.005	<0.005	8/99	2	<0.005	<0.005
TPH	8/99	4	130-700	0.05								
TPH (%)	8/99	4	0.013-0.07	542.50	8/99	1	0.54	0.54				
Napthalene									8/99	2	<0.005-0.042	0.024

Site: Red River Oilfield Services
Location: Wilbarger Co., TX
Status: abandoned
No. Pits: 2
Area: 0.02 acres (755 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					11/93	2	4.9-7.7	6.3				
Arsenic					11/93	2	<0.01	<0.01				
Barium					11/93	2	1-3	2				
Cadmium					11/93	2	<0.01	<0.01				
Calcium					11/93	2	236-1,249	742.5				
Chloride					11/93	2	1,1772-8,169	4,970.5				
Chromium					11/93	2	<0.05	<0.05				
Lead					11/93	2	<0.01	<0.01				
Magnesium					11/93	2	50-211	130				
Mercury					11/93	2	<0.0002	<0.0002				
Potassium					11/93	2	20-61	40				
Selenium					11/93	2	<0.01	<0.01				
Silver					11/93	2	<0.01	<0.01				
Sodium					11/93	2	933-4,241	2,587				
Sulfate					11/93	2	<1-2	1.4				
TPH	11/93	2	360,000-450,000	405,000	11/93	2	<5	<5				
TPH (%)	11/93	2	36-45	40.5	11/93	2	<5-36	20				
O&G					11/93	2	10-11	10.5				

Site: Roeling Vacuum
Location: Lee Co., TX
Status: abandoned
No. Pits: 8
Area: 0.02 acres (760 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH									9/99	3	6.78-7.15	6.99
Conductivity									9/99	3	0.94-2.8	1.71
TDS									9/99	3	712-1558	1055
Arsenic	9/99	36	<0.5-3.6	0.67					9/99	3	<0.005-0.043	0.02
Barium	9/99	36	5.5-1,045	163.21					9/99	3	0.3-0.65	0.43
Bromide									9/99	3	<0.1-<1	<1
Cadmium	9/99	36	<0.5	0.37					9/99	3	<0.005	<0.005
Calcium									9/99	3	80-250	160
Chloride	9/99	39	14-42,000	5653					9/99	3	140-710	403
Chromium	9/99	36	<0.5-237	63.26					9/99	3	<0.005-0.029	0.02
Lead	9/99	36	<0.1-150	11.63					9/99	3	<0.005	<0.005
Magnesium									9/99	3	6.6-20	11.83
Mercury	9/99	36	0.01-0.4	0.09					9/99	3	0.0006-0.0014	0.00
Potassium									9/99	3	1.2-6	3.87
Selenium	9/99	36	<0.1-0.43	0.35					9/99	3	<0.005	<0.005
Silver	9/99	8	<0.5	<0.5					9/99	3	<0.005	<0.005
Sodium									9/99	3	110-320	183
Strontium									9/99	3	0.15-0.61	0.37
Sulfate									9/99	3	<0.5-54	18
TPH	9/99	37	0-17,000	2,918								
TPH (%)	9/99	39	0.1-1.7	0.29								
O&G	9/99	30	0-2.6	0.27								

Site: Rule
Location: Haskell Co., TX
Status: abandoned
No. Pits: 1
Area: NA

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
TDS									NA	1	1,100	1,100
Chloride									NA	1	620	620
TPH	NA	2	65,700-128,000	96,850								
TPH (%)	NA	2	6.5-12.8	9.690								

Site: Sorenson Ranch
Location: San Patricio Co., TX
Status: inactive
No. Pits: 1
Area: 9.7 acres (420,750 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					2/89-4/99	3	2,200-48,000	21,200 (est)				

Site: S. Texas Disposal
Location: Duval Co. TX
Status: inactive
No. Pits: 3
Area: 7.1 acres (308,750 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					11/97	1	2,900	2,900				

Site: SR Service
Location: Duval Co., TX
Status: abandoned
No. Pits: 2
Area: 2.1 acres (91,500 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride					1/95	1	600	600				

Site: Steve's Oilfield Service
Location: Kleberg Co., TX
Status: abandoned
No. Pits: 2
Area: 0.001 acres (360 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH	9/00	2	7.3	7.3					9/00	3	6.71-7.9	7.18
Conductivity									9/00	3	2,230-19,100	0
TDS									9/00	3	130	130
Arsenic	9/00	2	7-9.5	8.25					9/00	2	<0.05	<0.05
Barium	9/00	2	2,100-4,700	3,400					9/00	2	<0.05-0.24	0.145
Cadmium	9/00	2	1.8-1.9	1.85					9/00	2	<0.03	<0.03
Chromium	9/00	2	43-45	44					9/00	2	<0.03	<0.03
Lead	9/00	2	11-160	85.5					9/00	2	<0.1	<0.1
Mercury	9/00	2	0.427-2.9	1.6635					9/00	2	<0.001	<0.001
Selenium	9/00	2	2.4-77	39.7					9/00	2	<0.050	<0.050
Silver	9/00	2	<0.75	<0.75								
C 6-10 (mg/kg)	9/00	3	243-595	475					9/00	3	<5	<5
C 10-28	9/00	3	2290-7640	5377					9/00	3	<1	<1
C 6-28	9/00	3	2530-8230	5847					9/00	3	<5	<5
Benzene	9/00	2	<1.0-1.3	1.1								
Ethylbenzene	9/00	2	3.65-4.54	4.095								
Isopropylbenzene	9/00	2	1.71-2.01	1.86								
p-isopropyltoluene	9/00	2	<1.0	0.9								
naphthalene	9/00	2	13.2-16.9	15.05								
n-propylbenzene	9/00	2	2.3-2.44	2.37								
1,2,4-trimthylbnzn	9/00	2	9.07-10.5	9.785								
1,3,5-trimthylbnzn	9/00	2	2.33-5.74	4.035								
m,p-xylene	9/00	2	<2.0-4.36	3.13								
Bis(2-ethlhxl)phthlte	9/00	2	15.9-<26.4	20.45								
Fluorene	9/00	2	3.97-<5.1	4.485								
2-mthylnaphthln	9/00	2	25.3-37.9	31.6								
Naphthalene	9/00	2	7.41-14.1	10.755								
2-nitrophenol	9/00	2	<5.1-6.88	5.94								
Phenanthrene	9/00	2	11.1-11.7	11.4								
Ra 226	9/00	2	15-30	22.5								
Ra 228	9/00	2	5.3-11.5	8.4								

Site: Trant
Location: Chambers Co., TX
Status: inactive
No. Pits: 1
Area: 9.2 acres (399,360 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
pH					6/90	1	8.16	8.16				
Conductivity					6/90	1	1,060	1,060				
TDS					6/90	1	585	585				
Barium					6/90	1	0.95	0.95				
Bicarbonate					6/90	1	172	172				
Calcium					6/90	1	34	34				
Chloride	6/90	1	350		6/90	1	189	189				
Chromium					6/90	1	0.05	0.05				
Iron					6/90	1	0.05	0.05				
Magnesium					6/90	1	2	2				
Potassium					6/90	1	10	10				
Sodium					6/90	1	187	187				
Sulfate					6/90	1	77	77				

Site: Wright
Location: Ector Co., TX
Status: inactive
No. Pits: 1
Area: 1.7 acres (71,700 ft^2)

Medium	Pit Sludge				Pit Water				Groundwater			
	Dates	n	Range (mg/kg)	Avg	Dates	n	Range (mg/L)	Avg	Dates	n	Range (mg/L)	Avg
Chloride	9/87	9	362-5,141	1,545								
Sulfate	9/87	7	<5-71	44								