Historical Assessment of Chlorinated Volatile Organic Compounds (CVOCs) and Phthalates Contamination in the Northern Karst Aquifer of Puerto Rico Using GIS

Prepared by

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I. Abstract

Contamination in Puerto Rico (PR) is extensive with more than 150 contaminated sites and a vast contamination of water resources. Among the most impacted areas is the northern coast karst aquifer. This project (1) evaluates the extent of contamination of chlorinated volatile organic compounds (CVOCs) and phthalates in the karst groundwater in northern PR; and (2) provides recommendation for the selection of representative wells and spring to sample near contaminated areas. In order to determine the extent of CVOC and phthalate contamination, historical sampling data has been obtained and analyzed using GIS tools. The historical information is obtained from the EPA, USGS, PR Department of Health, and PR Environmental Quality Board. It includes water quality of wells and springs and potential sources of contamination, including superfunds, landfills and RCRA Corrective Action sites. Preliminary assessment indicates a wide extend of contamination that has been sustained through decades. Recommendations are made for sampling sites based on proximity to major contamination sources, previous contaminant detection, water and site use, status of wells, site accessibility and possible groundwater path. Most of the recommended sites have been added to a sampling network and are being sampled by UPRM. Results from these sites are analyzed in this project.

II. Resumen

La contaminación en Puerto Rico (PR) es extensa con más de 150 lugares contaminados y una gran parte de recursos de agua que también han sido afectados. Una de las áreas más afectadas es el acuífero de la zona kárstica en la costa norte. Este proyecto evalúa (1) la extensión de contaminación por solventes Clorinados Volátiles Orgánicos (CVO) y talatos en la zona kárstica de la costa Norte de Puerto Rico y (2) provee recomendaciones en la selección de pozos y manantiales representativos para muestrear cerca de las áreas contaminadas. Para poder determinar la extensión de la contaminación de CVO y talatos, se recopilo datos de muestreo histórico y se analizó utilizando la herramienta de Sistemas de Información Geográfica (SIG). Los datos de muestreo fueron obtenidos de agencias como la EPA (por sus siglas en inglés), el USGS (por sus siglas en inglés), el Departamento de Salud, y la Junta de Calidad Ambiental en PR. Estos datos incluyen muestreo en pozos, manantiales y fuentes de contaminación, que incluyen los superfondos, vertederos y RCRA (por sus siglas en inglés) Acción Correctiva. Análisis preliminares indican una gran extensión de contaminación que ha estado sostenida por décadas. Se realizaron recomendaciones de los puntos de muestreo basados en la proximidad a las mayores fuentes de contaminación, detecciones previas de contaminación, tipo de uso del agua y del sitio, accesibilidad al sitio y posible dirección del agua subterránea. La mayoría de los puntos de muestreo recomendados han sido añadidos a la red de muestreo y están siendo muestreados por UPRM (por sus siglas en inglés). Los resultados de estos puntos de muestreo fueron analizados en este proyecto.

III. Dedication

I dedicate this entire project to the two main reasons and motivation of my life, to my husband Rolando Collazo and my daughter Rocelys. First, my husband for believing in me from the beginning to the end and beyond. His support, patience, unconditional love and cheers have always been there no matter how the hard and desperate times were. Rocelys has been a blessing of our love and gift from God. She has been hearing about CVOCs, phthalates, and preterm since she was in the belly. Hearing “Stay there until you are ready, we love you and will wait to know you at the right time”. She presented at an oral presentation at a SRP conference while she was in the belly, was born and gave her first step seeing mommy working on this project. From day one she gave us strength, hugs and smiles are always the reason and the novel cause of assessment of contamination and preterm studies like PRoTECT efforts.

I want also to dedicate this work to the ONE responsible of all these and the ONE that put in my way my soul mate (my husband) and who gave me strength, love, patience, wisdom and motivation to pursue my goals…God, you are the best and I always will thank you even in hard times because everything that happens teach me and make me a better person.

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Finally, I want to acknowledge the sources of funding that allowed me to pursue this dream. This include: the 2011 KC Donnelly Externship Award; the U.S. Department of Energy, Savannah River, Grant No.DE-FG09-07SR22571; NEU/UPRM IGERT fellowship; and National Institute of Environmental Health Sciences (NIEHS), Grant Award No P42ES017198. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Environmental Health Sciences or the National Institutes of Health.

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VIII. Acronyms

AR –Administrative Record

RCRA- Resource Conservation and Recovery Act

RCRA CA- Resource Conservation and Recovery Act Corrective Action

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act

NPL- National Priorities List

TCE – Trichloroethene = Trichloroethylene

PCE – Tetrachloroethene = Tetrachloroethylene

1,1-DCA - 1,1-Dichloroethane

1,1-DCE - 1,1-Dichloroethylene = 1,1- Dichloroethene

1,2-DCA- 1,2-Dichloroethane

trans 1,2-DCE - 1,2-Trans-dichloroethylene

cis 1,2-DCE - 1,2-cis-dichloroethylene

1,1,1-TCA - 1,1,1 Trichloroethane

1,1,2-TCA - 1,1,2-Trichloroethane

1,1,1,2-TeCA – 1,1,1,2-Tetrachloroethane

VC – Vinyl Chloride = Chloroethene

CCl_4 – Carbon tetrachloride

DCM - Methylene Chloride

TCM – Chloroform

CVOCs – Chlorinated Volatile Organic Compounds

VOCs – Volatile Organic Compounds

BBP – Benzyl n-butyl phthalate

DEP – Di-ethyl phthalate

DEHP –Di (2-ethyl hexyl) phthalate = Bis (2-ethyl hexyl) phthalate

DMP – Di-methyl phthalate

DBP – Di-n-butyl phthalate

DNOP – Di-n-octyl phthalate

EPA- Environmental Protection Agency

PRDoH – Puerto Rico Department of Health

PREQB – Puerto Rico Environmental Quality Board

USGS - United States Geological Survey

PRASA – Puerto Rico Aqueduct and Sewer Authority

MCL – Maximum Contaminant Level

MCLG – Maximum Contaminant Level Goal

HAL – Health Advisory Level

DWEL – Drinking Water Level

BDL – Below Detection Level

ND – No Detection

GW- Ground water

Epi – Epidemiology

GIS - Geographic Information System

PTB - Pre-term birth

HBL – Water Health Based Limits

RfD- Reference Dose

1 Introduction

The north coast karst aquifer (Figure 1), which comprises 19% of the Island, is the most extensive and productive freshwater aquifer in Puerto Rico (Lugo et al., 2001; Veve and Taggart, 1996). This aquifer serves as a significant source of water for domestic, industrial, and agricultural uses (DNER, 2008). Groundwater in the region also discharges to surface water features, contributing to the ecological integrity of streams, wetlands, costal lagoons, and estuaries.

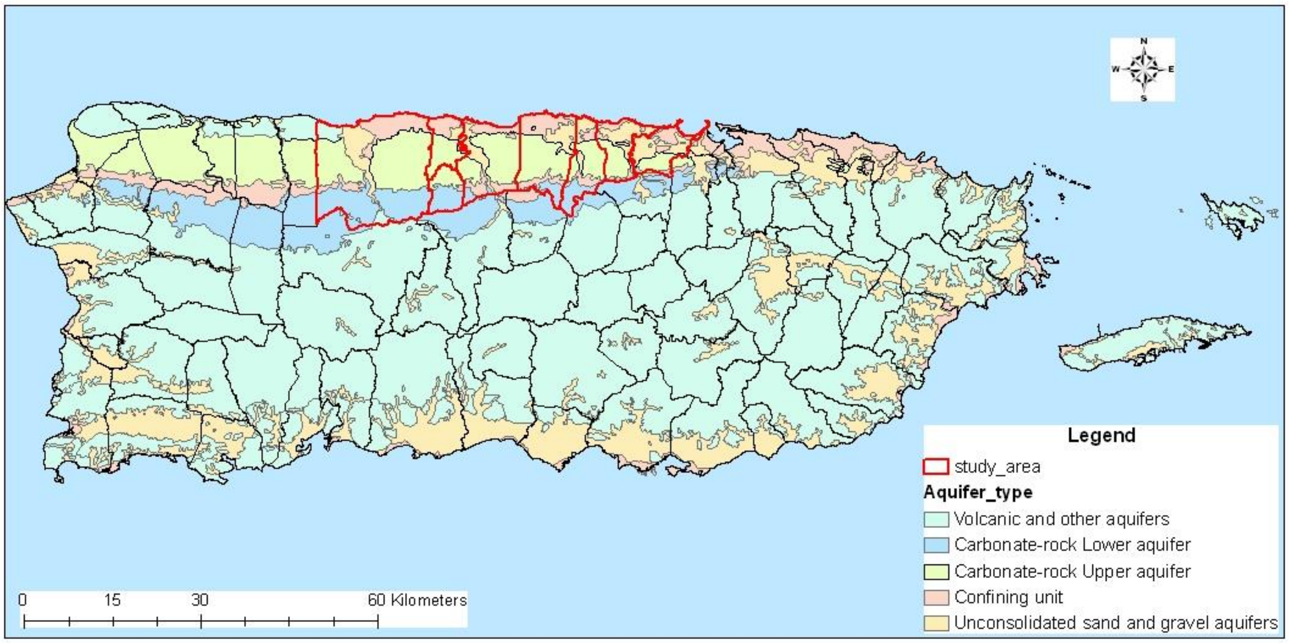

Figure 1 Hydrogeology Map and Arecibo-La Plata Study Area (shown in Red)

The high productivity of the northern karst aquifers is imparted by well-developed conduit porosity and highly transmissive zones developed by dissolution of soluble rocks, primarily limestone and dolomite, in which groundwater flows (Figure 2). Dissolution processes create surface and subsurface features, such as fissures, sinkholes, underground streams, and caves (Figure 2), that limit the filtration and attenuation capacity of the system (Ford and Williams, 2007). As a consequence, pollutants can easily enter and contaminate the groundwater system.

Because the aquifer productivity, among other reasons, many pharmaceutical, chemical, and manufacturing industries settled in the North Coast of Puerto Rico, with subsequent growth in population and urban development. Many of these industries rely on the use of hazardous materials, which can enter the karst groundwater from accidental spills and deliberate disposal. Urban growth brought construction of municipal landfills and clandestine waste disposal sites. Many of the landfills are unlined and improperly designed, resulting in the percolation of waste by-products and landfill leachates into the ground. Many of the clandestine sites were developed in sinkhole depressions, which serve as a direct route of contaminants into the underlying groundwater formations. The unintended consequence of the industrial and urban development has therefore been an extensive contamination of the groundwater resources in the northern karst aquifer (Padilla et al., 2011).

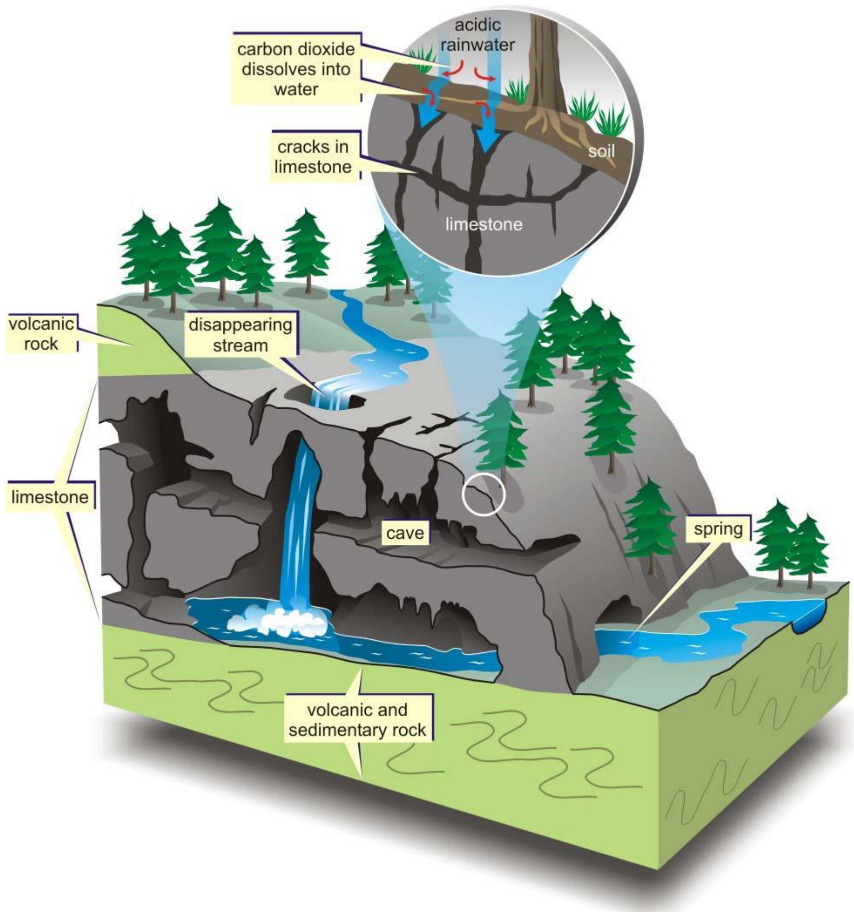

Figure 2 Typical Cross Section of a Karstic Groundwater System (Vancouver Island University, 2006)

Contamination in Puerto Rico is extensive with hundreds of contaminated sites that include a listing of 22 superfunds sites (16 active and 6 inactive) in the National Priority List (NPL) from 1983 to 2012 (USEPA, 2014). The distribution of landfills and superfund sites in Puerto Rico from 1983 to 2012 (Figure 3) shows that the area with the highest density of superfund sites is in the Arecibo-La Plata study area (highlighted with diagonal black lines), which covers the municipalities of Arecibo, Barceloneta, portions of Florida, Manatí, Vega Baja, Vega Alta, Dorado and Toa Baja. The Arecibo-La Plata study area is within a larger area used for epidemiologic study (Epi_Study_Area, Figure 3) by the Puerto Rico Testsite for Exploring Contamination Treat (PRoTECT) for assessment of potential relationship between contamination and adverse health impact (NEU, 2014).

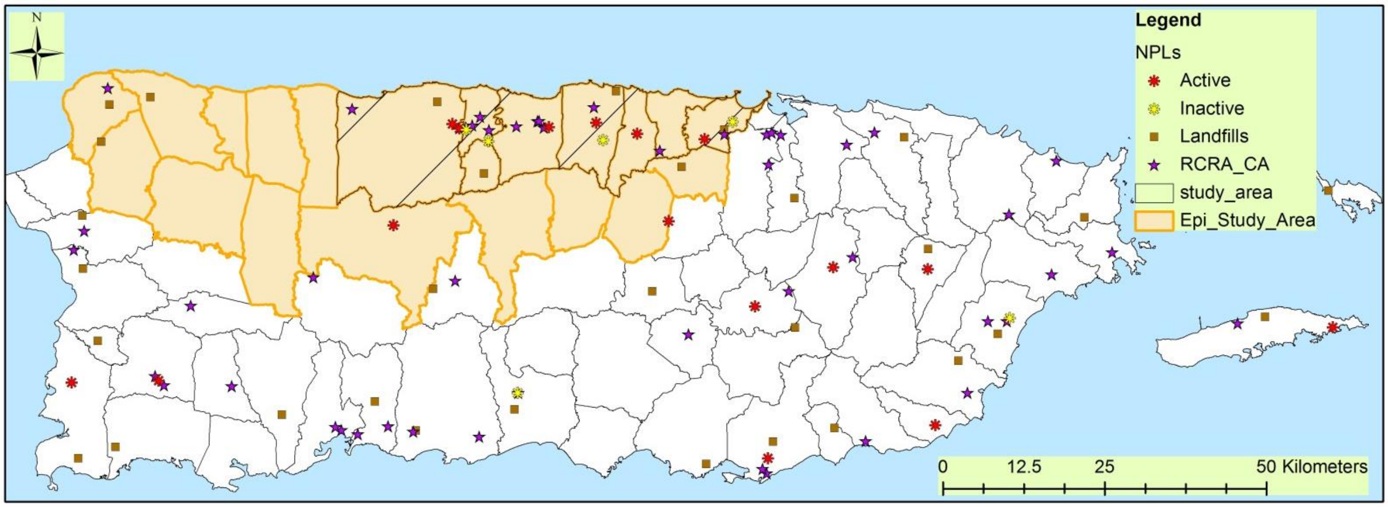

Figure 3 Distribution of National Priority List (NPLs), RCRA Corrective Action (CA) Sites, and Landfills in PR (1983-2012)

Several types of contaminants have been detected at superfund sites in Puerto Rico, including: volatile organic compounds (VOCs), pesticides, heavy metals, and contaminants of emerging interest, such as pharmaceuticals and phthalates. Of particular interest are the industrial chlorinated solvents and plastic by-products. These contaminants have been known to cause cancer and/or reproductive problems (ATSDR, 2011), such as pre-term birth (CERHR, 2006).This problem is discussed in more detail in Section 2.4.

Having a long and extensive history of contamination, a high vulnerability for further contamination, and a high potential for exposure creates a strong need for assessment of potential exposure, related adverse health impacts, and effective strategies to reduce exposure and protect public health and the environment in the northern karst region of Puerto Rico. Exposure and strategies to reduce exposure are intimately related to the release, mobility, and persistence of contaminants in this environment. Protection of public health, therefore, requires thorough understanding of the fate and transport processes controlling contaminant exposure in karst groundwater systems. To begin understanding it is necessary that we assess the historical contamination of groundwater resources that has resulted from the extensive industrial and subsequent urban development in the northern karst region of Puerto Rico.

2 Literature Review

Karst groundwater systems are composed of limestone and dolomite rocks (Ford and Williams, 2007). These rocks suffer considerable dissolution of joints, fractures, bedding planes, and other openings in which groundwater flow. These terrains show distinctive surface and subsurface features associated with sinkholes, springs, caves, sinking, losing, and gaining streams (Figure 2). These characteristics make groundwater systems in karst areas highly productive and important freshwater resources for human consumption and ecological integrity of streams, wetlands, and coastal zones. Karst areas occupy large areas of the planet's ice-free continental areas (20%) and provide roughly 20-25% of the global population water needs (Ford and Williams, 2007).

In Puerto Rico, karst terrains are characterized by well-developed conduit porosity and highly transmissive zones (Giusti, 1978). These characteristics make the Northern Coast groundwater systems an important water resource but at the same time prone to contamination. Groundwater in the region discharges to surface water features, contributing to the ecological integrity of stream, wetlands, costal lagoons, and estuaries (Giusti, 1978).

The same characteristics that make karst groundwater systems highly productive and apt for industrial development make them highly vulnerable to contamination (Göppert and Goldscheider, 2008), and impart an enormous capacity to store and convey contaminants from sources to potential exposures zones (Padilla et al., 2011). As a result, karst aquifers serve as an important route for contaminants exposure to humans and wildlife.

2.1 Arecibo-La Plata Study Area Characteristics and Previous Studies

The Arecibo-La Plata study area extends from Río La Plata watershed on the east to the Río Grande de Arecibo watershed on the west (Figure 4). On the north, the area is bound by the Atlantic Ocean and on the South it is limited to the extent of the lower limestone outcrop, as previously shown in Figure 1. The Arecibo–La Plata study area includes four major rivers: the

Río Grande de Arecibo, Río Grande de Manatí, Río Cibuco, and Río La Plata (Figure 4) and it is overlaid by the North Coast Limestone Aquifer System. The groundwater in the study possesses strong interactions with surface water (Giusti, 1978). The Arecibo-La Plata study area has a total population of 405,436 (U.S. Department of Commerce, 2010).

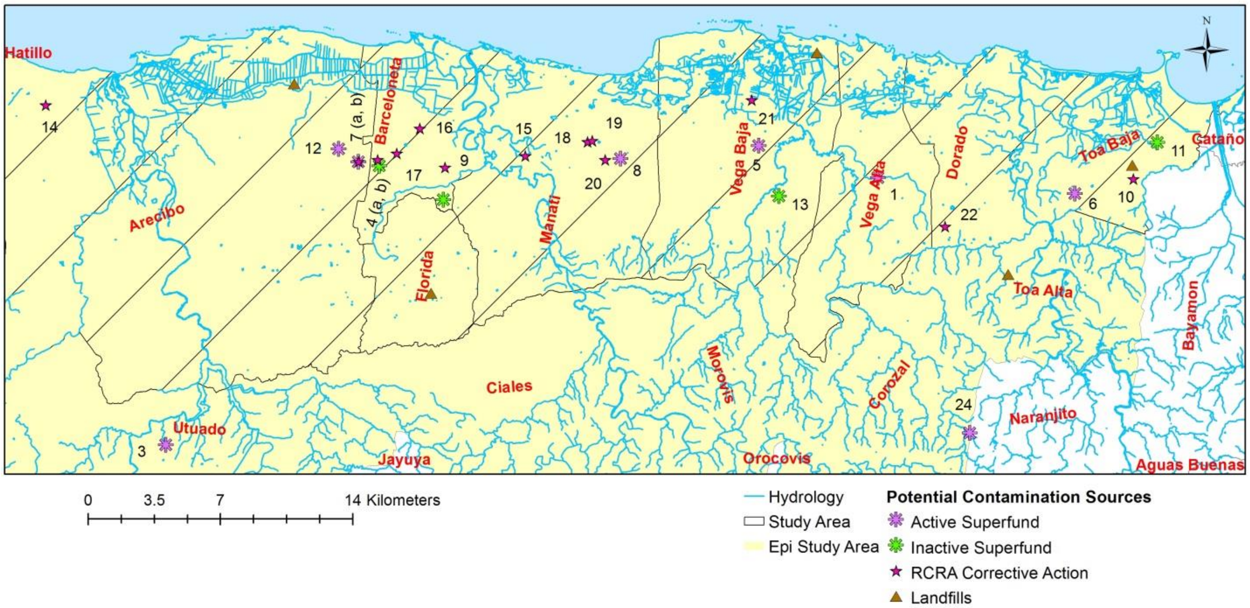

Figure 4 Study Area Surface Hydrology and Potential Sources of Contamination. Number refer to idenfiers in Table 1

There are two main aquifer systems in the study area: the upper aquifer, which is unconfined and is connected to the surface throughout most of its outcrop area; and the lower aquifer, which is a confined aquifer towards the coastal zone (Renken et. al, 2002). The upper aquifer is mainly composed of the Aymamon and Aguada Limestone Members. This aquifer extends from the land surface to depth up to 1,075 ft below land surface (Rodríguez-Martínez, 1994). The lower aquifer is composed of the Lares, San Sebastian and Montebello Limestone Members and outcrops to the south of the upper aquifer, where it is recharged. These two aquifers are separate by the Cibao Formation confining unit. Figure 5 shows a typical geology cross-section of the study area. Figure 6 shows the outcrop area and surface geology of the upper and lower aquifers. Groundwater in both aquifers flows from recharge areas in the southern part of the system toward discharge areas near the coast, streams, wetlands, springs, and other surface-water features (Renken et al., 2002). Groundwater is mostly extracted from the upper aquifer because it is the most accessible for drilling and pumping, but several industrial wells (and a few public water supply wells) tap the lower aquifer. The municipalities in the Arecibo-La Plata hydro-geophysical region are among the areas with highest groundwater extraction (Molina and Gómez-Gómez, 2008). The upper unconfined aquifer is the most vulnerable to contamination as it is in direct contact with the surface. The confined aquifer is vulnerable to contamination at the outcrop areas where it is recharged from the surface. It has also been impacted by liquid-waste injections made prior to the 1970s (Zack et al., 1987), when these injections were banned.

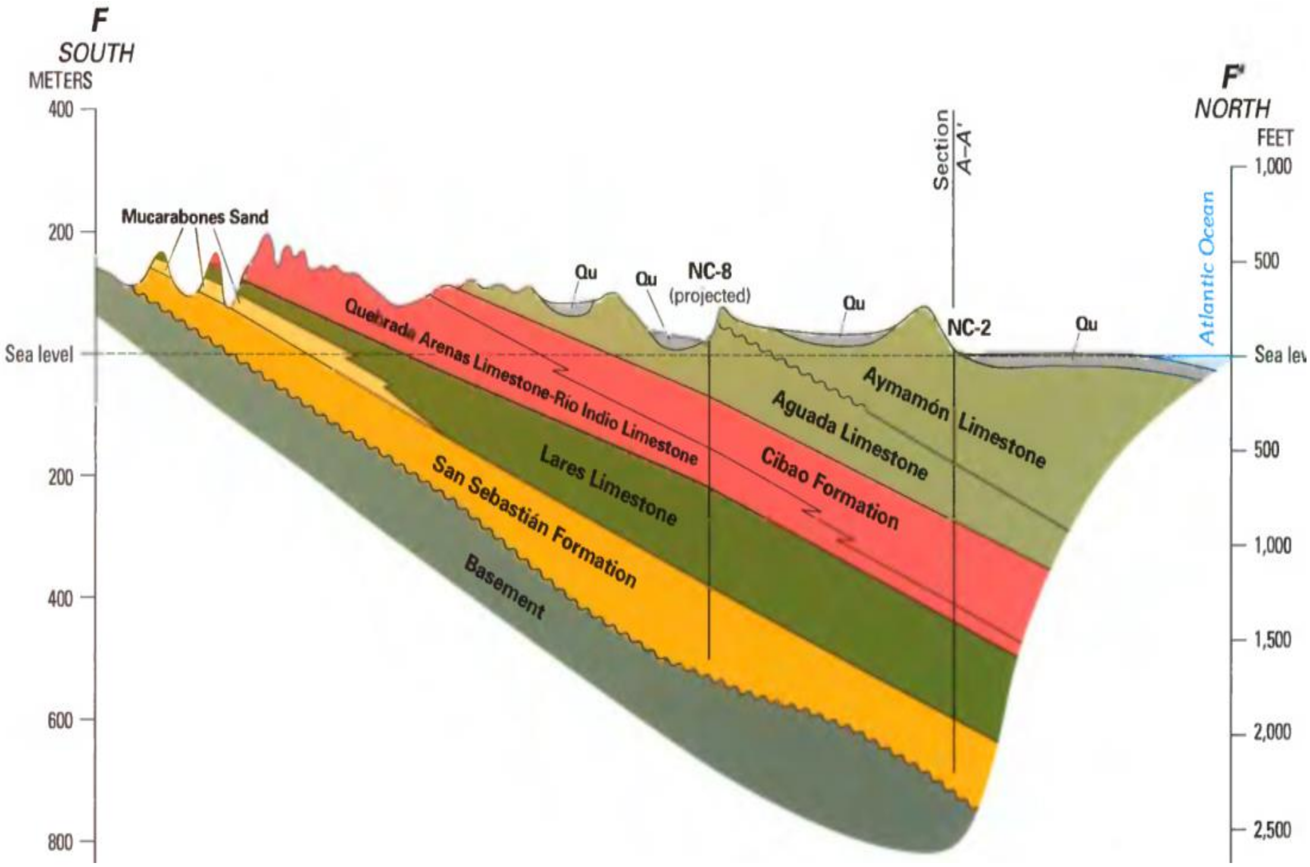

Figure 5 Geology Cross-Section From South to North in the Toa Alta to Dorado Area (Renken et al., 2002)

Several groundwater flow models have been developed in the study area. Cherry (2001) simulates the groundwater flow from Manatí to Vega Baja area; Torres-Gonzales et al. (1996) simulates the groundwater flow from Rio Camuy to Rio Grande de Manatí area; (Torres-Gonzalez, 1985) simulates the groundwater flow near the Barceloneta area. These models were developed for water resources assessment and do not contain the resolution for modeling fate and transport processes. Sepúlveda (1999) developed a flow and transport model in the Vega Alta to simulate the transport of TCE emerging from the Vega Alta Public water supply superfund site.

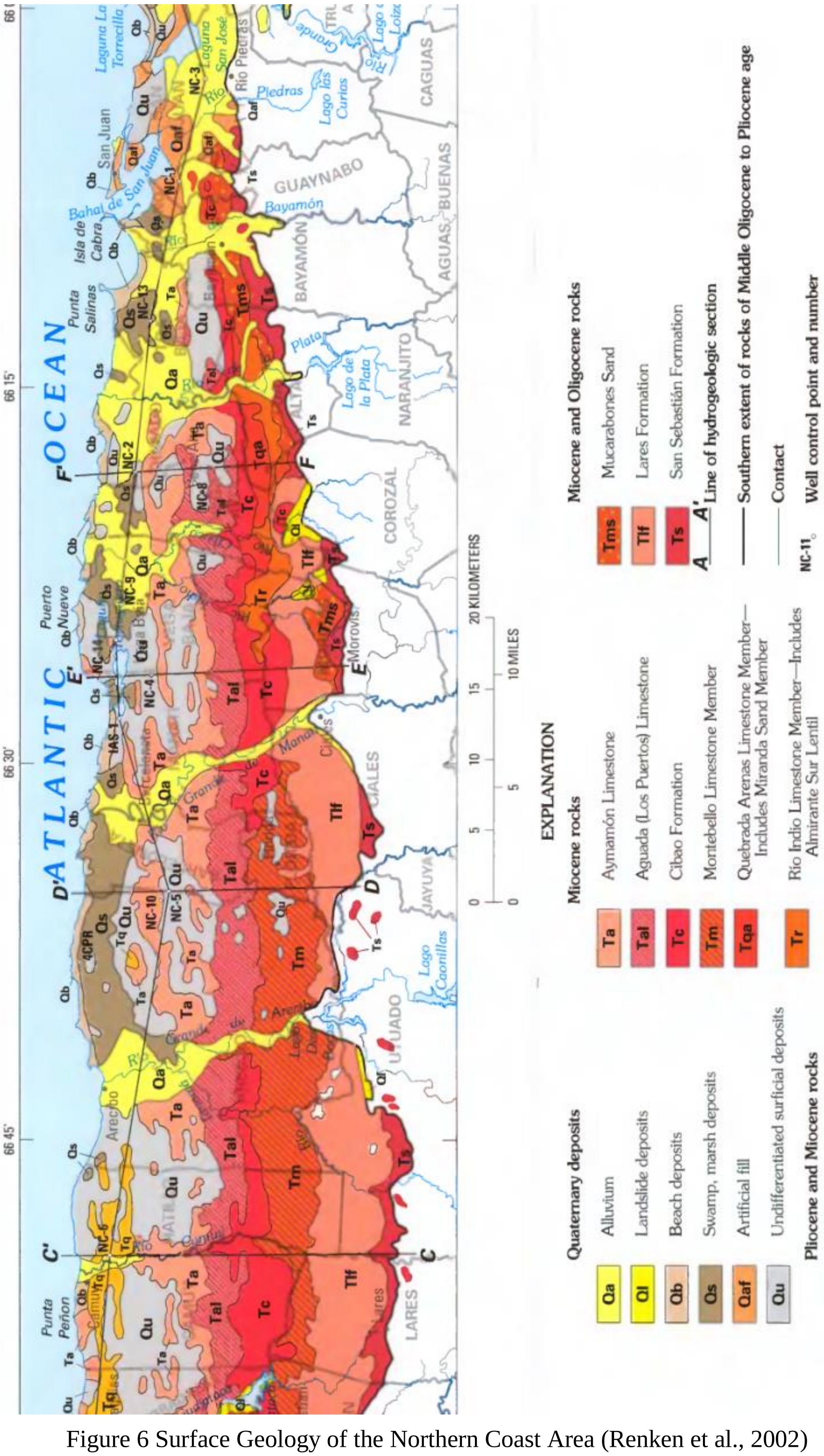

Figure 6 Surface Geology of the Northern Coast Area (Renken et al., 2002)

2.2 Sources of Contamination in the Arecibo-La Plata Study Area

The municipalities of Arecibo, Barceloneta, Vega Baja, Vega Alta, and Toa Baja have been affected by a long history of toxic spills and chemical waste and industrial solvent release into the subsurface (Hunter and Arbona, 1995; Zach et al., 1987). The municipalities in the Arecibo-La Plata hydrogeophysical region are coincidentally among the areas with highest groundwater extraction (Molina and Gómez-Gómez, 2008). Serious contamination has prompted inclusion in the National Priority List (NPL) of 12 sites within Arecibo-La Plata hydrogeophysical region since 1983 (Figure 4, Table 1) and 13 corrective action sites within the Resource Conservation and Recovery Act Corrective Action (RCRA CA) (USEPA, 2014 and USEPA CO, 2011). Site location and description in Table 1 and Figure 4 were obtained from (USEPA, 2014). An identification number (IDN) is included for reference in site description (Table 1) and the sites' spatial distribution (Figure 4). Table 1 shows a wide range of contaminants across sites. The NPL includes highly contaminated sites that pose significant risk to the population and the environment and are among national priority for cleanup in the United States and its territories. If evenly-distributed along an east-to-west line in the study area (1,014.7 km^2, 391.8 mi^2), there will be 12 NPL sites along a 63.4 km (39.4 mi) distance with a linear density of 1 NPL sites every 5.28 km (3.3 mi). This makes the study area one with the highest densities of superfund sites in the nation. Nine of the NPL sites in the study area are still active, but the others could have contributed to contamination at the system level. Several types of contaminants have been detected at the superfund sites, including chlorinated VOCs (CVOCs), pesticides, heavy metals, as well as emerging contaminants, such as phthalates (Table 1). Of particular interest for this work are the CVOCs and phthalates.

Table 1 Superfund and RCRA Corrective Action Sites Near Study Area

IDN*	Site Name	Municipality	Cleanup Type	Contamination Date			Detected Contaminants
				Source or 1st operation	Listed or 1st cleanup	Deleted or Under Control	
1	Vega Alta Public Supply Wells	Vega Alta	NPL	1983	9/21/1984	N/A	CVOCs (TCE, TCA, PCE, DCE, DCA, trans1,2-DCE, 1,1,1-TCA, TCM)
2	Barceloneta Landfill	Florida	NPL-Inactive	1973	9/8/1983	10/3/2011	CVOCs (DCA, DCE, TCE, TCM), metals(Hg, Ni, Cr), toluene, Phthalate (DEHP)
3	Papelera Puertorriqueña Inc.	Utuado	NPL	1984	9/23/2009	N/A	Benzene, toluene, CVOC (PCE, TCE) and ethyl benzene in soil and surface water
4 a	RCA Del Caribe	Barceloneta	NPL-Inactive	1982	9/8/1983	6/17/2005	CVOC (PCE), Ferric chloride, metals (Cr, Be, Se, Fe)
4 b	RCA Del Caribe	Barceloneta	RCRA CA	-	-	-	CVOC (PCE), Ferric chloride, metals (Cr, Be, Se, Fe) in soil
5	Vega Baja Solid Waste Disposal Site	Vega Baja	NPL	1948	7/22/1999	N/A	Heavy metals (As, Pb, Cr, Mn), CVOC (TCM, 1,1,1-TCA), Phthalate (DEHP)
6	Scorpio Recycling, Inc. Site	Toa Baja	NPL	1972	2/4/2004	N/A	Lead, vanadium and barium Metals (Pb, V, Ba, Cr), CVOC (TCE), Phthalate (DEHP)
7 a	Upjohn Facility	Arecibo	NPL	1982	9/21/1984	N/A	CVOC (Carbon Tetrachloride, TCM), Acetonitrile, metals
7 b	Pharmacia & Upjohn Caribe, Inc.	Arecibo	RCRA CA	1973	1991	1999	Contaminated soil with CVOC (Carbon Tetrachloride), acetonitrile
8	Pesticide Warehouse III	Manatí	NPL	1954	4/30/2003	N/A	Pesticides (Malathion, Diuron, Toxophene, Heptachlor, Aldrin,Dieldrin, Encrin, Chlordane), Phthalate (DEHP)

IDN*	Site Name	Municipality	Cleanup Type	Contamination Date			Detected Contaminants
				Source or 1st operation	Listed or 1st cleanup	Deleted or Under Control	
9	Merck, Sharp & Dohme Quimica de Puerto Rico	Barceloneta	RCRA CA	1971	1986	2007	Chlorinated and non-chlorinated solvents, heavy metals, and residues from waste incineration.
10	Boricua Wood Processing, Inc.	Toa Baja	RCRA CA	1957	1995	1999	Arsenic and chromium in soil
11	Naval Security Group Activity	Toa Baja	NPL-Inactive	1950	10/4/1989	10/7/1998	Paints, solvents, waste oil, battery acid, pesticides, PCBs, metals, arsenic, lead
12	Pesticide Warehouse I (PWI)	Arecibo	NPL	1996	9/27/2006	N/A	Pesticides (DDE, Dieldrin, Aldrin, Endrin, Chlordane, Diuron, Heptachlor)
13	V&M/Albaladejo	Vega Baja	NPL-Inactive	1989	12/16/1996	10/22/2001	Heavy Metals (Sb, Cd, Cu, Ag, Pb)
14	Thermo King	Arecibo	RCRA CA	-	-	-	CVOCs (1,1,1-TCA, 1,1-DCE)
15	Safety Kleen	Manatí	RCRA CA	-	-	-	CVOCs (CCl_4, 1,1,2-TCA, 1,1-DCA, CA, TCM, cis1,2-DCE, DCM, PCE, VC)
16	Pfizer Cruce Davila	Barceloneta	RCRA CA	-	-	-	-
17	Pfizer Pharmaceuticals, LLC	Barceloneta	RCRA CA	1972	1988	2007	CVOC (TCM), Chlorobenzene, Benzene, In soil: phthalates, DCM, Acetone, Toluene
18	Basf Agricultural	Manatí	RCRA CA	-	-	-	-
19	Davis & Geck Limited	Manatí	RCRA CA	-	-	-	-
20	Roche Products	Manatí	RCRA CA	-	-	-	-
21	Caribe GE Power Breaks	Vega Baja	RCRA CA	-	-	-	-
22	Safety Kleen	Dorado	RCRA CA	-	-	-	-
23	Corozal well	Corozal	NPL	-	-	-	PCE at GW and surface water

Information sources (USEPA, 2014)
* IDN = Identification number in reference to Figure 4
- Unknown Information, N/A – Do not appl

CVOCs include Trichloroethene (TCE), Tetrachloroethene (PCE), Chloroform (Trichloromethane, TCM), 1,1,2-Thrichloroethane (1,1,2-TCA), Carbon tetrachloride (CCl_4), Methylene Chloride (DCM), 1,1-Dichloroethane (1,1-DCA), 1,1,1 Trichloroethane (1,1,1-TCA), 1,2-Dichloroethane (1,2-DCA), 1,1-Dichloroethylene (1,1-DCE), and 1,2-Trans-dichloroethylene (trans 1,2-DCE). These are commonly used as industrial solvents, degreasers, and paint and spot removers. Several CVOCs can enter the environment directly as a source or as a degradation by-product (Figure 7). For instance, PCE can degrade to TCE, DCE, and Vinyl Chloride, whereas CT can degrade to TCM and DCM (Figure 7).

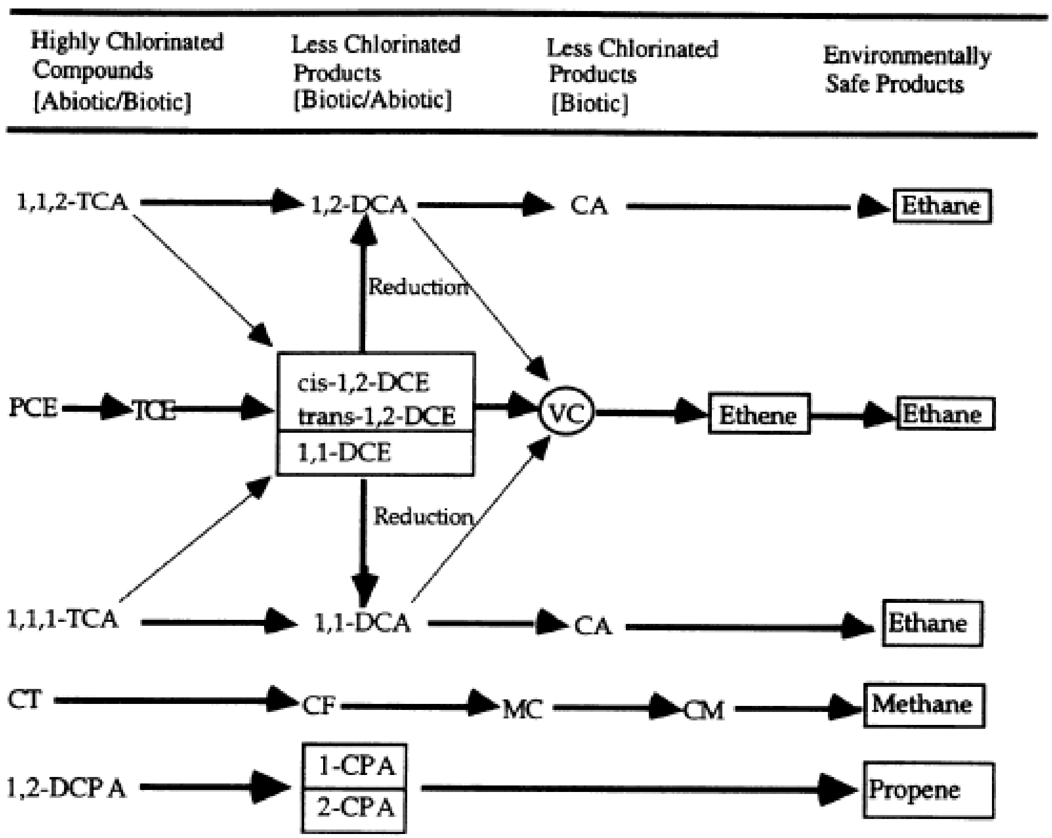

Figure 7 Environmental Transformation Pathways for Selected Chlorinated VOC (Fathepure and Tiedge, 1999)

Many phthalates are contained in commonly used products, including plastics, food packaging, home furnishings, paints, clothing, medical devices, and cosmetic products (NIH, 2006). In landfills, phthalate-containing materials can degrade and serve as a potential source of phthalate contamination for groundwater. Indeed, phthalates have been commonly found in landfill leachates (Andreassen, 2008), including many listed in the NPL.

Seven (58%) of the NPL sites in the study area sites (Barceloneta Landfill, Scorpio Recycling, Upjohn, Vega Alta Water Supply, Vega Baja Landfill, Papelera Puertoriqueña, and Corozal well) have been contaminated with CVOCs, including: TCE, Dichloroethene, Chloroform, Carbon tetrachloride, tetrachloroethene, tetrachloroethane, and dichloroethane, and methylene chloride. Four (33%) of the NPL sites (Pesticide Warehouse III, Scorpio Recycling, and the Vega Baja Landfill, and the Barceloneta Landfill) have reported phthalate contamination, mostly with Dibutyl phthalate (DBP) and Di(2-ethylhexyl) phthalate (DEHP). Unofficial information from EPA suggests that more sites are being considered in the area for further inclusion in the list, mostly associated with unlined landfills. Recently, the EPA issued orders to close landfills in Toa Baja, Florida, Vega Baja, Aguadilla, and Santa Isabel, due mainly to substantial concern of the drinking water quality associated with the landfills (USEPA, 2006). Also, in the northern area of PR, these landfills are typically located on karst where pollutants can get directly to the groundwater.

2.2.1 Major Superfund Events

The historical context of several superfund sites in the study area is provided in this section. The sites presented reflect a large magnitude of contamination and are among those sites with reported target contaminants (CVOCs and phthalates). These include: Vega Alta Public Supply Wells (PSWs), Upjohn Company (UJ), Barceloneta Landfill (BL) and Scorpio Recycling (SR). This information mainly comes from the online available data sheets (USEPA, 2014) and reports (see Appendix B) and includes a summary of the most reliable information for the purpose of this study.

2.2.1.1 Upjohn Superfund Site

In 1982 the Upjohn Company accidentally released approximately 57.92 m^3 (15,300 gallons) of Carbon Tetrachloride (CCl_4) and it degradations by-products from an underground storage tank. The Upjohn Company sampled 6 wells shortly after the incident, including 3 PRASA well, one well from the Puerto Rico Land Authority (PRLA), and 2 industrial wells. One of the industrial wells localized in the A.H. Robins property just north of the Upjohn superfund site, was converted to a recovery well for CCl_4 extraction. The others were taken out of service. In 1983, UJ installed 22 observation wells and a replacement well to substitute the Garrochales #3 Puerto Rico Aqueduct and Sewer Authority (PRASA) well and connect to the public supply system. During the period of 1982 and 1983 the population was given alternative water supplies but this new well provided by Upjohn Company replaced portion of the population supply. The Upjohn site was finally listed in the NPL in 1984. In 1985, the tank farm area of the facility was covered with fiber glass-reinforced concrete pat to prevent rainwater from seeping into the ground and mobilizing the contamination. An extraction well downgradient of the spill area was installed to intercept the majority of contaminated groundwater and 19 vacuum extraction wells were added to extract CCl_4 from soil. More than 45.42 m^3 (12,000 gallons) of CCl_4 were removed from groundwater and soil (by 1985). If initial estimate of the spill was correct, a total of 12.49 m^3 (3,300 gallons) of CCl_4 remain in the subsurface. The Upjohn Company ceased all use of CCl_4 in 1986 and entered into a Consent Order with the EPA to clean up the contamination in 1987. In 1988, the EPA selected the following actions (1) constructing a new public supply well to replace Garrochales #3 PRASA well; (2) applying pump and treat technologies using one extraction well, treating the water by air stripping, and discharging the effluent in to a sinkhole at the Upjohn site; (3) adding more extraction wells if other wells prove successful in removing contamination; (4) installing long-term monitoring wells to ensure effective remediation; (5) and re-evaluating the site in five years to determine further remedial needs. In 1989, the EPA issued a unilateral Administrative Order requiring Upjohn to design and conduct selected cleanup remedies. The Garrochales #3 replacement well was drilled in 1992 and connected to PRASA in 1994. The design of the expanded pump and treat systems was approved in 1993 and constructed and tested in 1994. During January of 1996, EPA approved the plans for a second expansion of pump and treat activities. The expanded system was constructed and tested by 1997, and placed in operation by 1998. During its first five-year review (1993-1997), the EPA concluded that remedial action is protective of human health and the environment and issue a preliminary close-out report for the site. In 1999, the EPA approved the Operational and Maintenance Manual for the groundwater extraction and treatment systems. In September of 2003, the EPA issued another five-year (1998-2002) review report, in which it concluded that the remedial action continues to be protective of human health and the environment, and will continue to be operated, maintained, and monitored until cleanup standards for CCl_4 in groundwater are attained (USEPA, 2014 and Appendix B).

2.2.1.2 Vega Alta Public Supply Wells (PSWs) Superfund Site

The Vega Alta Public Supply Wells (PSWs) site was listed in the NPL in 1984 after a USGS study in 1983 (Guzmán and Quiñones, 1984) reported CVOCs (TCE and PCE) contamination in the Ponderosa PRASA well in the Vega Alta area. In 1984, PRASA installed an air stripper at the Ponderosa well removing contaminants by forcing a stream of air through the water. The air stripping operated in the Ponderosa well until 1985, when technical issues caused it to stop working. The Ponderosa and GE PRASA wells were closed, and the Bajura #3 well was constructed to supply the water demand. In 1987, the EPA selected the following actions: (1) Installing treatments air stripping systems on GE #1, GE #2, and Bajura # 3 and discharging to PRASA distribution system; (2) treating the Ponderosa well with air stripping and discharging to Honda Creek; (3) shutting down Monterrey #2 and G&M private wells and providing (hooking up) PRASA connection to affected residents; and (4) conducting investigations of sources of contamination. During 1989 PRASA closed GE #2 and Bajura #3 due to no compliance with MCLs standards and Maguayo wells were installed to supply water demand. During this year the EPA modified the 1987 remedial action at the urging of the Environmental Quality Board (EQB) to discharge the treated water from all the wells to Honda Creek. A second Unilateral Administrative Order was issued by EPA in August 1990 to General Electric (GE), Motorola, Harman Automotive, West Company, and the Puerto Rico Industrial Development Company (PRIDCO), Potential Responsible Parties (PRPs), to investigate the contamination source and groundwater plume that migrated to public supply wells treatment area. Between 1989 and 1992 the PRPs designed the specifications for the well treatments systems, which were approved in 1992. The pump and treat system at the Ponderosa well was completed in 1993 and the groundwater treatment started in July 1994. The connection of the G&M private user to the PRASA distribution system was completed on October of 1993. Due to changes in pumping conditions, the configurations of contamination plume changed (by 1993) and the GE #1, GE #2 and Bajura #3 wells, also called well A, were no longer effective on capturing the plume. On September of 1994, the EPA issue an Explanation of Significant Difference that modified the selected remedial action by requiring the installation of extraction well in a new location to substitute the previously called well A. New developments and information caused EPA to consider placing well A in the down gradient of plume instead of as previously recommended at the center of the plume called the Centroid Well (CAW). In September 1997, the Record of

Decision (ROD) documents the selection of soil vapor extraction as the remedial action to address a source of contamination from soil in the PRIDCO industrial park and to prevent further migration to groundwater. By December of 1997 another Explanation of Significant Difference was issued to modify the selected remedial action. This required a well or a series of wells (known as a Source Area Wells - SAWs) located in close proximity to the source of contamination, in the PRIDCO industrial park area. The Final Remedial Design Work plan was submitted to EPA on November 1998 and a Preliminary Remedial Design Report was submitted to EPA on February 1999. After EPA's approval a Final Remedial Design Report was submitted to EPA in January 2000 and approved on June 2000. A five-year Review Report was submitted and signed in April 1999. The Remedial Action Work Plan was submitted to EPA on September 2000 and approved on December 2000. Field activities for the installation of the groundwater treatment system were initiated in April 2001. Construction of SAWs systems and the Soil Vapor Extraction System (SVE) was completed in December 2001. SAWs began operation in December 2002. The SVE System, comprised of 10 nested wells in Area A and 6 nested wells in Area B/C, was brought on-line full time in December 2002. A second Five-Year Review Report of groundwater was signed in August 2005. In terms of remediation progress, approximately 75,708.2 m^3 (20,000,000 gallons) of water have been treated each month and as of January of 2002, approximately 5,299,576.5 m^3 (1.4 billion gallons) of contaminated groundwater have been treated and discharged to Honda Creek (USEPA, 2014 and Appendix B).

2.2.1.3 Barceloneta Landfill

The Barceloneta Landfill (BL) site was designated a superfund site in 1982, although no sampling events were reported. This site had approximately 300 tons of hazardous wastes placed into three sinkholes, some of them 100 ft deep, in the landfill area. Notice Letters were sent to potentially responsible parties (PRPs) in September 1983. In 1988, an additional search for PRPs identified several other parties that had used the landfill. In September 1990, eight industries, a transporter, the municipality of Barceloneta and EPA signed an Administrative Order of Consent in which the parties agreed to complete the site investigation. The Remedial Investigation (RI) was completed in May 1995 and the Feasibility Study submitted in October 1995. EPA issued a Proposed Plan on December 1995, which described a preferred alternative for capping the landfill, and held public meetings to discuss it. The Record of Decision (ROD) was signed in July 1996. The selected remedy required the capping of the three disposal areas by installing a low permeability cover system meeting the requirements of Puerto Rico regulations for landfill closure. A Consent Decree (CD) for Remedial Design and Remedial Action of the remedy selected in the ROD was signed in September 1997. In January 1998, Department of Justice (DOJ) lodged the CD for implementation of EPA's selected remedy pursuant to the ROD in January 8, 1998 with ten Settling Defendants. In September 1999, the EPA approved the Remedial Design Report and approved early Remedial Actions that were carried-out before the approval of the final Remedial Design Report. These Remedial actions included (1) excavation and stockpiling of clay and (2) excavation and relocation of waste from another discovered waste area. In December 1999, the Remedial Actions Work Plan to implement the ROD, was summited by the settling Defendants and approved by the EPA. On-site construction started in January of 2000 and completed in August 2000. The Operation and Maintenance and Post Remediation Monitoring well Manual was approved and implemented in March 2000. It includes 30 years of groundwater wells monitoring programs. In September 2000, the EPA signed the Preliminary Site Close Out Report. The first Five-year review report, which was signed in August 2005 found that remedial action was constructed in accordance with the requirements of the ROD and that is functioning as designed. It was concluded that the threats have been addressed and the remedial action is protective in the short term. In order for the remedy to be protective in the long-term, final institutional controls (deed restrictions), are being implement by the PRPs (USEPA, 2014 and Appendix B).

2.2.1.4 Scorpio Recycling

Scorpio Recycling is an operating metal recycling company that buys all types of metals and sells it to foundries in the USA, Brazil, Spain and Japan. It started its operation in 1972 as Astur Metals and renamed in 1989 as Scorpio Recycling Inc. The main concern for this site is the release of contaminants to the soil, in particular within the former battery crushing area and a sinkhole into which waste material, including drums, tanks and containers containing sulfuric acid were directly discharged. During October 1991 and July 1993 representatives of EPA collected soil samples that show high concentration of barium (120.2 ppm), lead (9,530 ppm) and vanadium (1,312 ppm). Surface runoff showed concentration of 57,300 ppb of lead, 330 ppb of barium and 339 ppb of vanadium. During April 1999 EPA collected soil samples at the site as part of an Expanded Site Investigation. High concentrations of lead (109,000 ppm) with an average concentration of 18,735 ppm were found in the former battery crushing area. As a result of these investigations, the site was added to the NPL in October 1999. In 2002, the EPA began removal action to excavate and remove the battery cases, miscellaneous debris and soil contamination in the southwest portion of the site and the sinkhole. Contaminated soil was stabilized with trisodium phosphate (TSP) prior to disposal at a landfill. The entire source area was not excavated. Waste remains buried under the Rosa del Monte storage shed building and portions of the adjacent paved Rosa del Monte parking lot. No removal action was performed in the large scrap pile areas. In June 2004, the removal action ceased. Based on findings from the Remedial Investigation (RI) and the Baseline Human Health Risk Assessment (BHHRA), EPA determined in September of 2006, that the groundwater did not pose an unacceptable risk to public health or the environment and a No-Action ROD was issued (USEPA, 2014, Appendix B).

Although the main contamination concern in the Scorpio Recycling site is not CVOCs, small concentration of CVOCs like DCM, 1,1-DCA, TCE, PCE and TCM is reported. Preliminary assessment of EPA reports and sampling data from 1994 on the PRASA wells downstream of the site discovered low concentrations of DCM (See Appendix B).

2.3 Groundwater Contamination in the Northern Karst Region

Water quality surveys in Puerto Rico have shown extensive contamination of the northern karst aquifer (Guzman-Rios, et al., 1986; Guzmán-Rios and Quiñones- Márquez, 1984; Guzmán-Rios and Quiñones-Márquez, 1985; Sepulveda, 1999; and Conde-Costas and Rodríguez-Rodríguez, 1997; Zack et al., 1987). Although a wide range of contaminants (Table 1) has been reported, of particular concern is the frequent presence of CVOCs, which has been measured in a large percentage of sampled wells. Although phthalates have been detected in superfund sites (Barceloneta Landfill, Vega Baja Solid Waste Disposal, Pesticide Warehouse III and Scorpio Recycling sites), there has not been reports of contamination with phthalate in groundwater in

Puerto Rico prior to this study. Extensive contamination has resulted in the closure of 41% of drinking water supply wells in the north coast aquifer had been closed by 1987 (Zack et al., 1987). Since then, there have been more closures (PRDoH, 2011).

2.4 Public Health Concerns of CVOCs and Phthalates

This work focuses on CVOCs and phthalate because they are ubiquitous in the environment, are present in superfund sites, and have potential health impacts. Phthalates are considered endocrine disruptors, and have recently been associated with decreased gestation length (Latini, 2003), reproductive and neurological damage, and the rise of preterm birth (CERHR, 2006). Exposure to TCE has been related to several adverse health effects, including cardiac, neurological, hepatic, renal, dermal, immunological, and reproductive effects, increased birth defects, perinatal mortality, cancer, decreased birth weights (ATSDR, 2011), and risk for spontaneous abortion (Lipscomb and Fenster, 1991; Khattak, 1999; Ha and Cho, 2002). With these kinds of health effects of CVOCs and Phthalate contamination and the high potential of exposure to this type of contamination in a karsts aquifer system, it is necessary to study the extent of CVOCs and phthalate contamination; it is a potential threat to human health and has to be addressed.

Studies are being conducted to determine potential relationships between CVOCs and phthalate contamination and pre-term birth in Puerto Rico (NEU, 2014). Puerto Rico has the highest rate of pre-term birth (PTB) in the United States, with an average of 19.6% (March of Dimes, 2010). The known factors for prematurity (e.g., late prenatal care, tobacco use, lack of maternal education, socioeconomic status, fertility treatment) however, do not explain the marked increase of the rate (March of Dimes, 2007), and work is being conducted to determine if contamination is a factor (NEU, 2014).

2.5 Use of GIS in Contamination-Related Studies

Geographic Information System (GIS) technologies are used for capturing, organizing, storing, editing, analyzing and managing geographically-referenced information (Steele, 2011). It permits integration of multiple sets of spatially related data.

Several studies have applied GIS techniques to develop monitoring schemes (Bajarska et al., 2004), relate contamination to health risks (Kamilova et al., 2007; Harris, 1997), and assess vulnerability for contamination and exposure risk in groundwater (Antonakos and Lambrakis, 2007; Dixon, 2005; FDH, 2003), and surface water (Kelsey et al., 2004; Sauer et al., 2007). Harris (1997) used GIS technologies to analyze potential human exposure pathways caused by flooding of hazardous material sites in Georgia after the Alberto Flood of 1994. The analysis required the identification of flooded areas followed by step-by-step analysis integrating the source, transport media, exposure points, routes of exposure, and receptor population.

Hargrove et. al (1996) generated a GIS-based risk evaluation. They found that one challenge for the effective spatial presentation of environmental risk was the juxtaposition of multiple variables within a recognizable spatial context. Risk analyses must deal with widely disparate types of data, including multiple contaminants sampled from multiple locations at different intervals (Hargrove et al., 1996). An approach used to convey multivariate data spatially was to create a series of hybrid maps that combine charts and maps. Another approach was to collapse the multiple dimensions of contaminant data down to the single common currency of human health risk. The ultimate extrapolation of this collapsing approach resulted in a “Map Spreadsheet", in which arrays of maps of risk are spatially summed across rows and columns (Hargrove et al., 1996).

Steele (2011) developed a method to define potential exposure pathways of contaminants in karst groundwater systems. Potential flow paths for the Vega Alta region in northern Puerto Rico were defined by applying a very simple analysis using Arc-GIS and Spatial Analyst. Initial assessment indicates a much greater dispersion around a potential source of contamination than accounted by fickian dispersion. The analysis assumed steady flow conditions, and did not incorporate dispersion caused by varying velocity fields in magnitude and direction. It concluded that incorporation of temporal changes in flow and detection would significantly enhance the analysis. It was also likely that more than one source has contributed to the contamination, and historical potential sources needed to be incorporated (Steele, 2011).

2.6 Generalized Fate and Transport Process of Contamination in Subsurface Systems

Fate and transport process affecting the spatial and temporal distribution of contaminants in subsurface environments include advection, dispersion, sorption, degradation reactions, and mass transfer. Advection involves the movement of contaminants with advecting fluid, in this case groundwater in karst systems. Dispersion describes the movement of contaminants from regions of high to low concentration and tends to disperse the contamination. Sorption describes the interaction of contaminants with solid surfaces, and may cause retardation (slow lag) of contaminants. Degradation reactions affect the mass and type of contaminants. Mass transfers among the different components in the subsurface (gas, water, rock, stagnant water, sediments) affect the mobility and storage of contaminants in the system. Although this work does not intend to assess transport processes in the karst systems, these processes are affecting the spatial and temporal distribution of the contaminants and must be considered within a holistic context.

3 Objectives

The overall goal of this research is to assess the historical contamination of groundwater resources in the northern karst region of Puerto Rico using GIS technologies. The work focus on CVOCs and phthalates contamination within the Arecibo to La Plata study area because they are ubiquitous in the environment, are present in superfund sites, and have potential health impacts.

Specifically, this project aim to:

- Generate the data necessary for assessment of fate and transport processes in karst system;
- Assess sampling and detection distribution of CVOCs and phthalates in the Arecibo-La Plata study area;
- Apply GIS technologies to analyze the historical and spatial distribution of CVOCs in the upper aquifer of the study area;
- Assess spatial and temporal changes in CVOC contamination pattern within the study area;
- Apply the knowledge gained on historical and spatial contamination distribution to select sampling sites for monitoring purposes.

4 Methodologies

The primary goal of this project is to assess the historical contamination of groundwater resources in the northern karst region of Puerto Rico (Figure 1) from 1982 to 2013. The work focuses on CVOCs and phthalates contamination within the Arecibo-La Plata study area (Figure 3 and Figure 4), although some data is also presented for phthalate. The study area for groundwater contamination is within, but does not extend to the area of the epidemiologic study conducted under the PROTECT study (NEU, 2014). The epidemiologic study area is included in this work for reference purposes, but except for the groundwater study area, not included in the assessment. The objectives of this work are attained through integration of hydrogeologic and historical contamination data in space and time using GIS technologies. GIS is also used to assist in the selection of sites for establishing a network of groundwater sampling sites. This chapter describes the methods applied to perform the historical contamination assessment and recommend potential sites for groundwater sampling.

4.1 Historical Contamination Assessment

Historical assessment of groundwater contamination in the northern karst region of Puerto Rico involved: collecting, categorizing, and compiling data; geo-referencing site locations; and analyzing detection and concentration of contaminants spatially and temporally in reference to known and to potential contamination sites. Spatial analysis involved overlying characteristic data over a number of base maps using GIS technology ArcGIS version 9.2 and version 10.1, which provides intelligent data models for representing geography and provides all the tools necessary for creating and working with the geographic data (ESRI, 2001). Temporal analysis was performed graphically and statically using InfoStat (Di Rienzo et. al., 2008).

4.1.1 Data Collection

Historical water quality (since 1982) and spatial data was collected for the wells, springs and major potential sources of contamination. Water quality data included measurements of CVOC and phthalate concentrations. Major contamination sources included NPL, RCRA CA, and landfill sites. Landfills were incorporated because they have been identified as potential sources of contamination by local EPA authorities, and might provide a significant source of phthalates and other contaminants. The data collected focused on groundwater contaminants in the upper unconfined aquifer in the Arecibo-La Plata study area, but also included some data from the lower confined aquifer. Water quality and site information and location was collected from: Steele (2011); U.S. Geological Survey data base (USGS, 2008) and reports (Guzman-Rios, et al., 1986; Guzmán-Rios and Quiñones- Márquez, 1984; Guzmán-Rios and Quiñones-Márquez, 1985; Sepulveda, 1999; and Conde-Costas and Rodríguez-Rodríguez, 1997); EPA data base (USEPA, 2008); Caribbean Environmental Protection Agency (CEPA) local office (see Appendix B); Puerto Rico Environmental Quality Board (PREQB) (PREQB, 2011); University of Puerto Rico, Mayaguez Campus (UPRM); and Puerto Rico Department of Health (PRDoH). The data collected from these sources is described below.

Water quality data from USGS included data from their own surveys and studies. The USGS database (USGS, 2008) served as one of the principal sources of information for well location.

Data from the EPA (see Appendix B) included water quality data related to superfund and RCRA sites. Available data was collected for major superfund and RCRA CA sites in the study area, including: Vega Alta Public Supply Wells (1), Upjohn Facility (7a), Barceloneta Landfill (2), Scorpio Recycling (6), RCA del Caribe (4a), Vega Baja Solid Waste (5), Pesticide Warehouse I (12), Papelera Puertorriqueña (3), Thermo King (14), Safety Kleen (15), Basf Agricultural (18) and Merck, Sharp & Dohme Quimica (9). Superfund and RCRA CA data was collected from a series of reports residing in various locations. Report tittles and locations are given in (see Appendix B).

Data from PRDoH included water quality for PRASA and NON-PRASA drinking water systems. PRASA data included water quality for point water sources in the distribution system, and was collected quarterly for compliance with drinking water regulations. NON-PRASA drinking water systems have been defined as those that are not supplied by PRASA and contain more than 25 people and 5 connections. NON-PRASA data included water quality for PRASA independent point water sources that may serve industries or rural communities. Because of the cost of water quality analysis, which is a responsibility of the users, most NON-PRASA communities did not have data for CVOCs or phthalates. Thus, most of the NON-PRASA data came from industries. The data collected, which was scanned from hard copies, was segregated at the PRDoH office by systems and by method of analysis. Data was collected for wells and Drinking Water Treatment (DWT) in the following systems: Arecibo (internal ID ending in 2), Metropolitan (internal ID ending in 7) and West (internal ID ending in 3). Data for CVOCs and phthalate was extracted for methods EPA 524.2 and EPA 502.2; and EPA 525.2, respectively. All available data from 1992 to 2011 was collected, but only 44 % has been entered into the database and used in this project. Complete records were entered for data from 1992 to 2000, whereas partial records have been entered for the rest of the data records collected.

Data from the PREQB included water quality measurements from their monitoring stations (Steele, 2011). They only have a few monitoring wells within the study area. The PREQB, superfund division provided some special monitoring events of Scorpio Recycling and limited amount of data from Pesticide Warehouse I.

The University of Puerto Rico, Mayaguez (UPRM) has been conducting a groundwater sampling campaign in up to 21 sites (4 springs, 17 wells) in the study area (Torres et al., 2012). The samples have been analyzed for phthalates, CVOCs, and common ions (Na^{+1}, Ca^{+1}, Mg^{+1}, K^{+}, Cl^{-}, SO_4^{-}, CO_3^{-}, HCO_3^{-}). Results from sample analysis were entered in to the database (not available to the public at the moment). Although not in the scope of this project, a brief description of the UPRM sampling campaign is provided below.

The UPRM groundwater sampling campaign involved sampling from the sites twice a year, one during the dry season (generally February- March) and the other during the wet season (generally October-November). CVOCs and phthalates were analyzed using EPA Method 551.1

(USEPA, Method 551.1) and EPA method 8270 (USEPA, Method 8260 c), respectively. Common ions were analyzed by ion chromatography (Method 300.1, USEPA Method 300.1). Only data for CVOCs and phthalates were used in this study.

Several base maps (Table 2) and shapefiles were collected and used in the project to integrate location of wells, streams, and geographical features with contamination data, superfund sites (active and inactive), RCRA CA, and landfills. These base maps included: land use, groundwater potentiometric levels (Figure 8), aerial photos (Figure 9), municipalities (Figure 10a), surface hydrology (rivers, wetlands, coast) (Figure 10b), hydrogeology (Figure 10c), and topographic maps (Figure 11). The sources for the base map information and shapefiles are listed in (Table 2).

Table 2 Base maps used in this study and their sources.

Base Maps	**Source**
Topographic Map	(USDA-NRCS, 2007)
Surface Geology	(PRWEI, 2007)
Hydrogeology	(PRWEI, 2007)
Aerial photos	(USDA-NRCS, 2007)
Puerto Rico Municipalities	(PRWEI, 2007)
Surface Hydrology	(PRWEI, 2007)

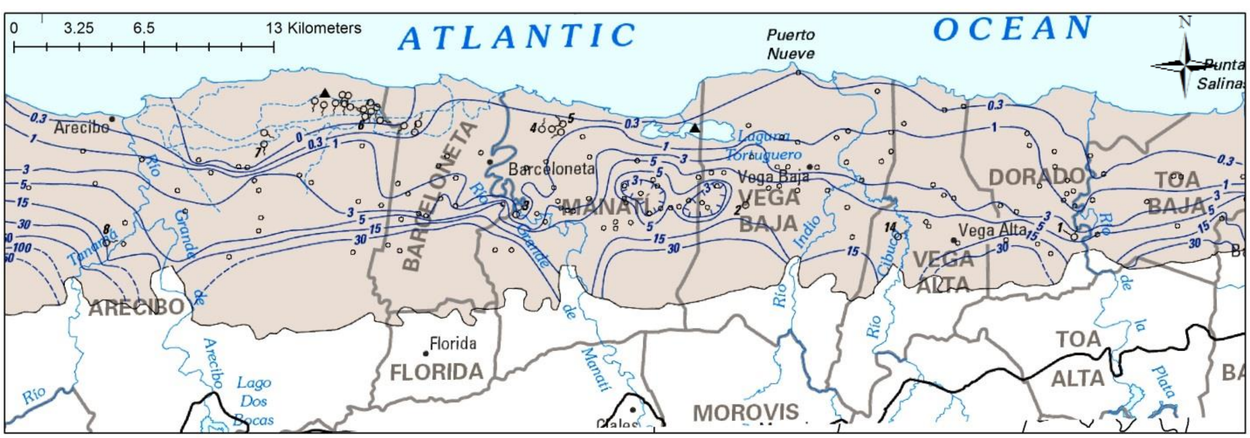

Figure 8 Georefenciated Potentiometric Contour Map of Upper Aquifer (Renken et al., 2002)

Figure 9 Aerial Map of Study Area (NRCS, 2007)

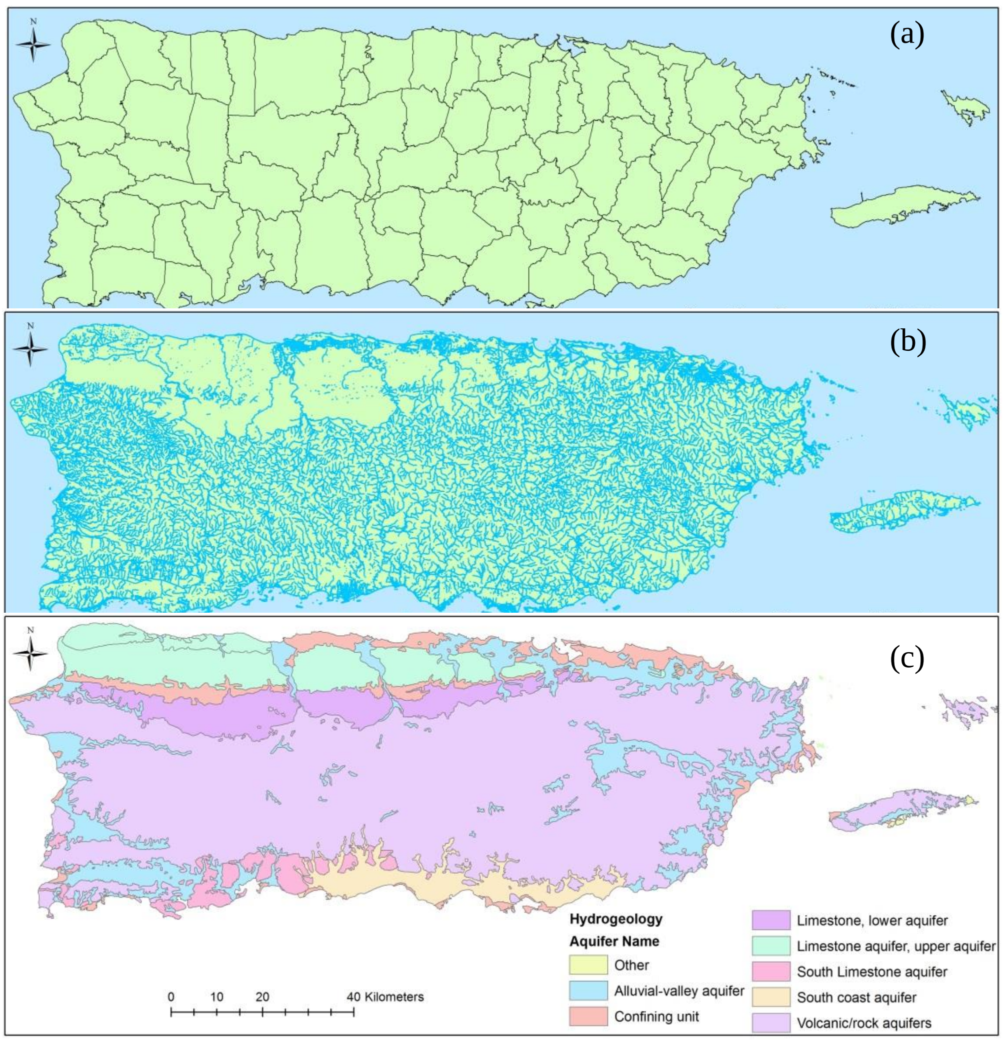

Figure 10 Base Maps for Puerto Rico and Municipalities (a), Surface Hydrology (b) and Hydrogeology (c) (PRWEI, 2007)

Figure 11 Topographic Map of Study Area (USDA-NRCS, 2007)

4.1.2 Data Categorization and Compilation

Once collected, data was classified and segregated (categorized) into data characteristics representing categories and indices used to describe historical distribution of contaminants in the area of study. Characteristic parameters included: aquifer system (lower, upper), groundwater discharge type (well, spring), water use (agricultural, domestic, industrial, public supply) and status (active, destroyed, and abandoned), contaminant presence (or absence) and concentration ranges, contaminant types (e.g., chlorinated hydrocarbons, phthalates), detection limits, and information source (UPRM, USGS, EPA, Reports).

4.1.3 Data Georeferenciation

Spatial analysis required the geographical location of the sites (groundwater sites, contamination sites, etc.) and all locations must be used in the same Geographic Coordinate System (GCS). This study used NAD 83 GCS. NAD 83 coordinates for wells and spring were initially obtained from the 2008 USGS database (USGS, 2008). Well site coordinates not available in the USGS database were obtained from various sources, including PRASA and NON-PRASA from the PRDoH, Office of Drinking Water. PRDoH coordinate data were available in NAD 27 GCS, and had to be converted to NAD 83. Well location data from EPA NPL reports (see Appendix B) were mostly provided in hard copy maps, and the images had to be geo-referenced in ArcGIS using topographic or other layers that could serve as a geo-reference. Once geo-referenced the well locations were digitalized into a shapefile and location extracted from ArcGIS.

Site locations were given a unique identification for data protection purposes. The unique identification number followed the same protocol used by the USGS. This protocol uses coordinates in degrees, minutes and seconds, two digits for each one, (DDMMSS), in NAD 27 GCS. The ID first used the latitude in DDMMSS, then a 0 followed by the longitude in DDMMSS and a 00 to identify sites with repeated USGS ID. For example a location that had latitude of 18°25’18.6’’ and a longitude of 66°03’25.4’’ would have an ID of 182519066032500, if this ID is unique. If this ID was already on the database and only one ID existed, the new one incorporated a 01 after the longitude. For the purpose of well location, the format and reference GCS were in decimal degrees and NAD 83, respectively.

4.1.4 General Assumptions

Integration of data into a main database required uniformity of the data. Because the data used in this project was collected from several information sources with different monitoring objectives, there was an inherent variability in the information obtained. Several assumptions had, therefore, to be made to integrate the data in a uniform manner. The assumptions, which depended on the type of data, are provided below.

1. Sampling dates for samples reported during a period of time were assumed to be the mid-day of the reported period. This was particular important for the concentration data obtained from (USGS, 2014), which reported sampling dates as periods and not specific days and time. If more than one sample were taken, the period was divided in equal periods. For example, if there were three samples taken on a period of time, the period of time was divided in three equal intervals. The first date corresponded to the first sample, the second date to the second, etc.
2. Sampling dates for samples only reporting month and year were assumed to be in the middle of the month.

3. Samples with no defined contaminants were assumed to refer to the contaminants that have been detected in the same source of information.
4. For samples with no reported Detection Limit (DL), the DL was assumed to be the same as that reported by the same source of information (but for other samples). If no DL was available for any samples for a source of information, the DL was reported in the database as "unavailable/not given". For the purpose of the database a value of -9999, was assigned to unavailable data.
5. Samples reporting BDL (Below Detection Limit) concentration, were assumed to be "zero" and assumed No Detected (ND) for statistical purposes.
6. Samples reporting "< # " concentrations were assumed to be BDL, but concentration was assumed to be (1/2)(DL).
7. Sample concentrations reported as below the Quantification Limit (QL) were assumed to be detected and the concentration was assumed to be as reported. The sample was identified as "below QL" in the "comments section".
8. Only when a DL value was not available the QL has been used as the DL.
9. Specific notes included with the sample reports were included in comments sections.

4.1.5 Water Quality Standards

Water quality concentrations were compared to regulatory water quality standards, which were considered to be the Maximum Contaminant Levels (MCLs) established by the EPA. For contaminants with no federal MCL, the MCL was taken as that applied to any state. For example, the CVOC 1,1-Dichloroethane (1,1-DCA) has no federal regulatory level, but the state of California (CA) does, so the MCL was considered to be that of CA. If a MCL had not been established for any state, water quality standard were considered to be the EPA MCLG (Maximum Contaminant Level Goal). If there was no MCLG, the water quality standard was considered to be the HAL (Health Advisory Level) or ultimately the HBL (Water Health Based Limits). Water quality standard for Disinfection-by-Products (DBPs) and CVOCs are provided in Table 3 and Table 4, respectively. Water quality standards for phthalates are presented in Table 5. For the purpose of classification of contaminants, the DBPs were classified as CVOCs. In addition all tables present main synonyms. All data were classified in reference to their standard, variations in standard through time were not considered to simplify the classification and the standards were considered during all the period of time (1982 to 2013).

Table 3 DBPs Abbreviations and MCLs Values

Type of DBPs Name	**GIS Abbreviation**	**Standard Used**	**Level** *(ug/L)*
BromoForm = Tribromomethane	BF*	MCL	80**
BromoDiChloroMethane	BDCM*	MCL	80**
ChloroDiBromoMethane	CDBM*	MCL	80**

*MCL as sum of THMs (DBPs), TCM + BF + BDCM + CDBM. For TCM only use the MCLG provided.

Table 4 CVOCs Abbreviations and MCLs Values

Type of CVOCs Name	**GIS Acronym**	**Standard Used**	**Level** *(ug/L)*
Tetrachloroethylene = Tetrachloroethene	PCE	MCL	5**
Trichloroethylene = Trichloroethene	TCE	MCL	5**
1,1-Dichloroethane	1,1-DCA	MCL California DoH	5****
1,1-Dichloroethylene = 1,1-Dichloroethene	1,1-DCE	MCL	7**
1,2-Dichloroethane	1,2-DCA	MCL	5**
Trans-1,2-dichloroethylene=Trans-1,2-Dichloroethene	trans 1,2-DCE	MCL	100**
Cis-1,2-dichloroethylene	cis 1,2-DCE	MCL	70**
1,1,2-Trichloroethane	1,1,2-TCA	MCL	5**
1,1,1 Trichloroethane	1,1,1-TCA	MCL	200**
1,1,1,2-Tetrachloroethane	1,1,1,2-TeCA	HAL	1***
1,1,2,2-Tetrachloroethane	1,1,2,2-TeCA	HAL	1***
Vinyl Chloride = Chloroethene	VC	MCL	2**
Carbon tetrachloride = Tetrachloromethane	CCl_4	MCL	5**
Chloroform = Trichloromethane (**part of DBPs**)	**TCM***	MCLG	70**
Methylene Chloride=Dichloromethane	DCM	MCL	5**
Chloroethane	CA	HAL	12***
Chloromethane	CM	HAL	2.7***

*MCL as sum of THMs (DBPs), TCM + BF + BDCM + CDBM. For TCM only use the MCLG provided.
** (USEPA, January, 2011), *** (Florida DoH , 2011), **** (USEPA, 2008)

Table 5 Phthalates Abbreviations and MCL (Maximum Contaminant Level) Values

Type of Phthalate Name	**GIS Acronym**	**Standard Used**	**Level** *(ug/L)*
Di (2-ethyl hexyl) phthalate = Bis (2-ethyl hexyl) phthalate	DEHP	MCL	6**
Benzyl n-butyl phthalate = Butyl Benzyl phthalate	BBP	HAL	140***
Di-ethyl phthalate (D, not classified as to health carcinogenicity)	DEP	HAL	5,600***
Di-n-butyl phthalate (D)	DBP	HAL	700***
Di-methyl phthalate (D)	DMP	HAL	70,000***
Di-n-octyl phthalate	DNOP	HBL	700*****

** (USEPA, January, 2011), *** (Florida DoH , 2014), **** (USEPA, 2008)
***** (USEPA, Attachment D Regulatory and Human Health Benchmarks Used for SSL Development, 1996)

4.2 Data Analysis

Analysis of CVOCs and phthalates spatiotemporal distribution involved assessment of: the quantity of data and their information sources; the number of detections by samples, by wells, and by type of contaminant; and spatial historical detection distribution by contaminants group (CVOCs and phthalate). Detail spatial and temporal data analysis was only performed for CVOCs because of the large amount of data available for this group of contaminants. It involved temporal concentration distributions by well; spatial concentration distribution of principal individual and total (sum of principal species) for the total period of analysis (1982-2013). Individual principal CVOCs species included TCE, PCE, CCl_4, TCM and DCM. In addition, spatiotemporal concentrations distribution of total CVOCs (sum of all CVOCs species) is included by year. Temporal concentration distribution of total CVOCs and the principal CVOCs (TCE, PCE, CCl_4, TCM and DCM) was analyzed statistically using InfoStat (IS) version 2013p (Di Rienzo et. al., 2008) and involved generating box plot and bar graphs of time and information sources vs. concentration. Spatial analysis was performed using GIS technologies (ArcGIS 9.2 and 10.1; ESRI, 2006 and 2012).

Spatial and temporal distribution of contaminant detection and concentrations were presented in reference to: the potential sources of contamination (superfund sites, RCRA CA and Landfills); MCL; the hydrogeology of study area; the sources of information; remedial activities; and potential fate and transport processes.

4.2.1 Detections

Contaminants detection was evaluated statistically and spatially. Basic statistical analysis was performed on the number of contaminants detection by samples (number of samples detected) and by groundwater sites (number of site with detections) in reference to the number of samples taken. The analysis is presented in pie charts in terms of percent of detection and percent of No Detection (ND) of each group of contaminants. Basic statistics are also presented for mixtures of contaminants, including, ND of CVOC and detection of phthalate, detection of CVOCs but ND of phthalate, and the ND of both CVOC and phthalate. Spatial distributions of contaminants detection are presented in maps.

4.2.2 Spatial Distribution of Principal CVOC Species Average Concentrations

Spatial distributions of CVOCs were analyzed as average detected concentrations over a period of time for the unconfined karst aquifer system of northern Puerto Rico. Only wells and springs tapping the unconfined system were considered for the spatial distribution analysis. These include wells and spring located within the following zones (Figure 12):

- Outcrop of the lower confined system. This area serves as the recharge zone for the lower aquifer and is not confined by a confining unit.
- Cibao formation at Renken et al (2002) profiles did not distinguish between the upper and the lower cibao, so it was assumed that wells and springs tapping this unit were part of the upper aquifer systems.
- Upper aquifer outcrop and above the cibao formation.

Wells located within the upper aquifer outcrop area but bellow the cibao formation (Figure 12) were considered as part of the lower confined system and not included in the spatial distribution analysis of CVOCs but are been considered in the detections analysis described at previous section.

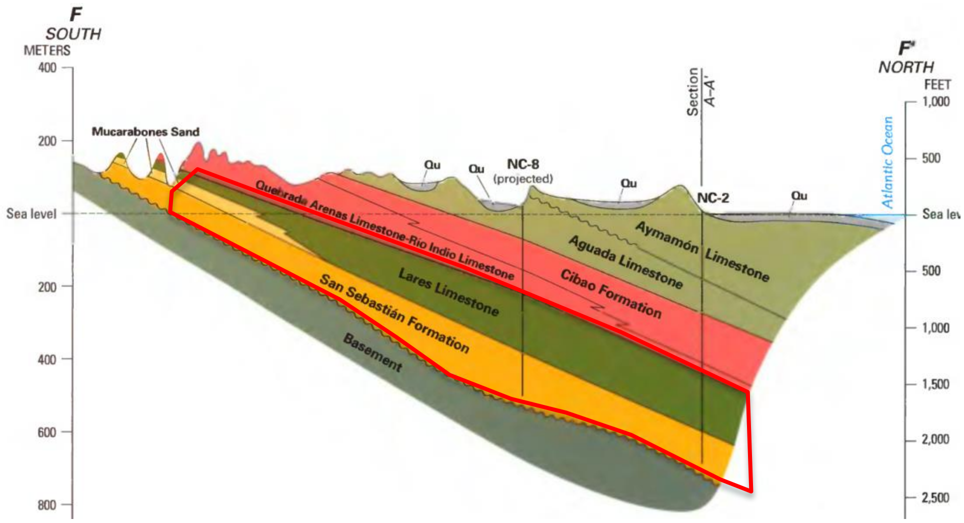

Figure 12 Geologic Cross-Section. Lower Confined System Delineated Within the Red Polygon

Average concentrations were calculated using all concentrations above detection limit for each well/spring site having at least one detection for the period of time, and integrated all the historical data collected from the different sources for each site. Samples having concentrations BDL were considered as ND, and were not included in the average calculations. Well and springs having ND throughout the entire analysis period were considered to have zero concentration.

Average concentrations for each individual contaminant type (TCE, PCE, DCM, TCM, and CCl_4) were calculated by first extracting the above detection data from the database using the ArcGIS "selection query" tool into a shapefile. Average concentration at each site was thereafter calculated using the ArcGIS "summarize" tool.

Because the data used was collected from multiple sources having different sampling objectives, there were expected average concentration ranges for the different sources. The variability among sources of data was assessed using InfoStat (IS) version 2013p (Di Rienzo et. al., 2008). IS program was used to generate sources versus average concentrations box plot and bar graphs.

Spatial distribution maps of individual contaminant type for the entire period of analysis (1982 – 2013) were developed using ArcGIS versions 9.2 and 10.1 as follows:

- Shapefiles were created for average concentrations (having at least one detection) and for sites with zero concentrations by each species.
- The southern and northern physical limits of the aquifer system were integrated as zero concentration data points because the system does not extend beyond these limits. The southern physical limit was delineated as the southern boundary of the lower aquifer outcrop (i.e., contact between volcanoclastic/rock and the limestone lower aquifer; Figure 13). The coastal line on the north was delineated as the northern boundary. A shapefile of zero concentration boundaries was created.

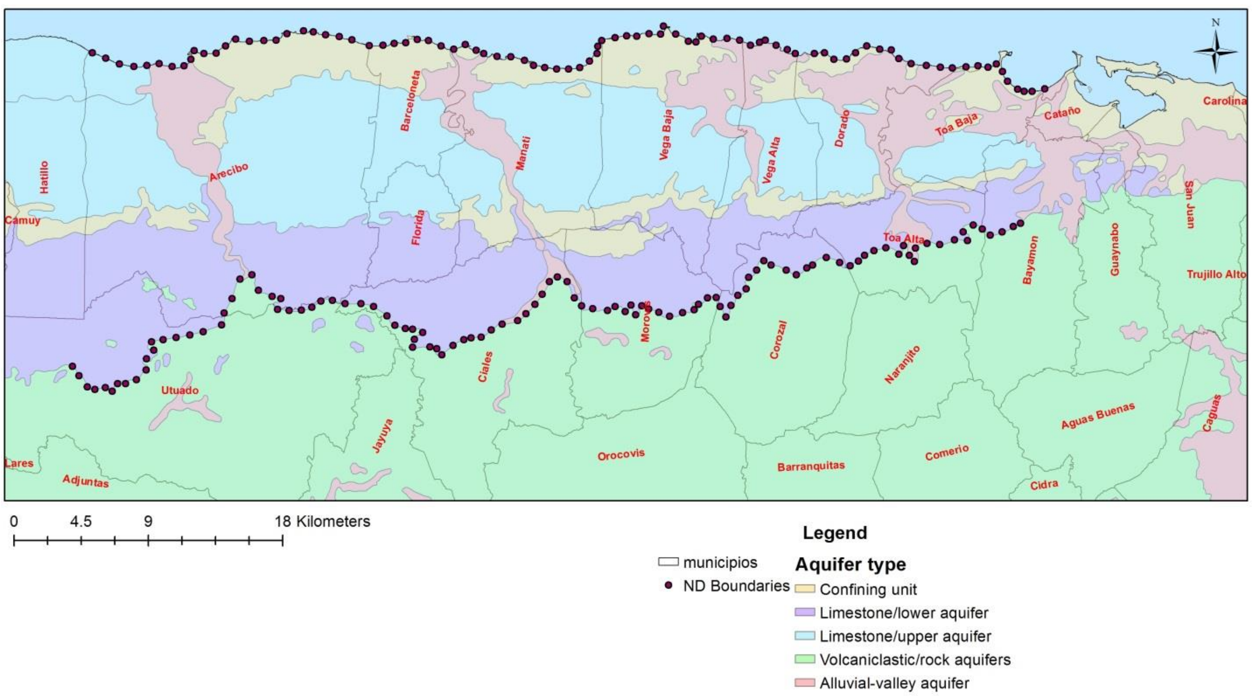

Figure 13 Spatial Distribution Analysis Area and Surface Hidrogeology. Dotted Line Delineates Southern and Northern Limits of Analysis Area

- Shapefiles for the average and zero concentrations sites and the zero concentration boundaries were combined into a final shapefile for each contaminant by using the “Merge” tool within the “General Setting” menu on the ARC toolbox of ArcGIS.
- Raster distribution of concentrations was conducted for each contaminant type by using “IDW” (Inverse Distance Weighed) interpolation tool method within “interpolation” on the “Spatial Analyst Tools” menu on the ARC toolbox of AcrGIS.

- Total of principal 5 CVOC concentrations distribution was calculated by adding the individual raster distribution of each contaminant type.

4.2.3 Temporal Distribution of CVOCs Average Concentrations

The temporal distribution of CVOC average concentrations for each contaminant type (TCE, PCE, CCl_4, TCM, DCM) and total of CVOC species was analyzed using InfoStat (IS) version 2013p (Di Rienzo et. al., 2008). IS program was used to generate time vs. concentration box plot and bar graphs using the average contaminants concentrations automatically calculated in the program. Similar to the spatial distribution assumption, only the detections (above detection limit) concentrations were considered to calculate the averages.

Total CVOCs for each sample was calculated by adding all detected CVOC concentrations measured in a sample. The CVOCs included in the summation are those listed in Table 3 and Table 4.

4.2.4 Spatiotemporal Distribution of CVOCs Concentrations

Spatiotemporal concentration maps were developed for total CVOCs including the DBPs by year following the same assumptions used for the average concentration maps. Maximum, average and location of highest CVOC concentration were assessed by year. Average total CVOCs per site was obtained by first calculating total CVOCs by sample (as describe in Section 4.2.3) and applying the ArcGIS "summarize" tool. This tool averaged all thee total CVOC calculated per sample for each site. The average was performed for the period of time used in the analysis. (e.g., for yearly averaged, it used total CVOCs for the given year).

4.3 Sampling Site Selection

Integration of the data compiled into spatial and temporal categories was done to select potential sampling sites. Detection data was incorporated within potentiometric maps developed by Renken et al. (2002) to assess potential paths of contamination. Using preliminary assessment of historical contamination data and all the information mention above, the sites is been selected considering proximity to sources of contamination and possible path of flow of groundwater. Some of the first group of selected sampling sites was eliminated after field visits because the sites were remediated and/or closed or destroyed due to close proximity to contamination. Other limitations like the availability of well owners to participate in sampling events make the preference of domestic/agricultural wells over the industrial wells. Because of this, the majority of wells are domestic and only a few are industrial.

Preliminary assessment of contamination data was integrated with potentiometric maps (Figure 8) developed by Renken et al. (2002) and sources of contamination (Figure 4) to select sites for sampling. Although this project provided recommendations for sampling sites, it was not the scope of this work to neither sample the sites nor analyze the water samples. However CVOCs and phthalate results were considered in this project until 2013 (see Table 9) Potentiometric maps were used to assess potential paths of contamination. Initial recommended sites were based on visual proximity to sources of contamination, preliminary assessment of historical detections of contamination, possible path of groundwater and well use (agricultural, public water supply, industrial, domestic, etc.). The recommended sites were visited to determine their availability for sampling. If available and permitted by owners, the sites were incorporated into a sampling network. Availability depended on well status (destroyed vs. not destroyed) and pump status (present, operational). Preference was given to domestic, agricultural and industrial wells because water quality data for PRASA water supply wells could be obtain from PRDoH. Industrial wells were limited number, and accessibility because the industrial owners would not give permission for sampling.

5 Results and Discussion

This section presents the results and discussion of the historical assessment of CVOCs and phthalate contamination in the northern karst region of Puerto Rico (Figure 1 and Figure 4). A general temporal evolution of the major contaminated sites shown in Figure 4 and described in Table 1 is initially presented to provide a comparative framework for the historical assessment of spatiotemporal distribution of the groundwater contamination in the study area from the data collected. This is followed by a numerical description of the collected data, spatial distribution of contaminant sampling and detection sites, and detection frequencies of CVOCs and phthalates. A detail assessment of spatiotemporal CVOC distribution is then provided. Finally, the results for the selection of the UPRM sampling sites are presented and explained.

5.1 Temporal Evolution of Major Contaminated Sites

Data collected from the EPA (see Appendix B) and summarized in Figure 4 and described in Table 1 indicate that the number of contaminated sites in the study area have increase since the establishment of CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) and RCRA (Resources Conservation and Recovery Act) regulations in 1980 and 1976, respectively. A temporal evolution of these sites Figure 14 shows that 18 sites were added between 1983 and 2012 at a rate of approximately 2 sites every 1.3 years. The first deletion of sites occurs in 1999, thirteen years after the listing of the first site. Only 8 sites were deleted between 1983 and 2012, with 55.6 % of the total added sites still active. The number of sites containing CVOCs has also increased through time, and comprises approximately 50% of the total number of sites. Although no major phthalate contamination has been reported, four (22 %) NPL sites (Scorpio Recycling, Pesticide Warehouse III, Barceloneta Landfill, and Vega Baja Solid Waste superfund sites) have reported presence of phthalates. Temporal evolution data of contaminated sites including those containing CVOCs (Figure 14) indicate that there has been over 30 years of potential contamination. Because there is a lag time between the discovery of the contamination and the listing of the contamination as a superfund site, the actual contamination could have occurred years before the listing date.

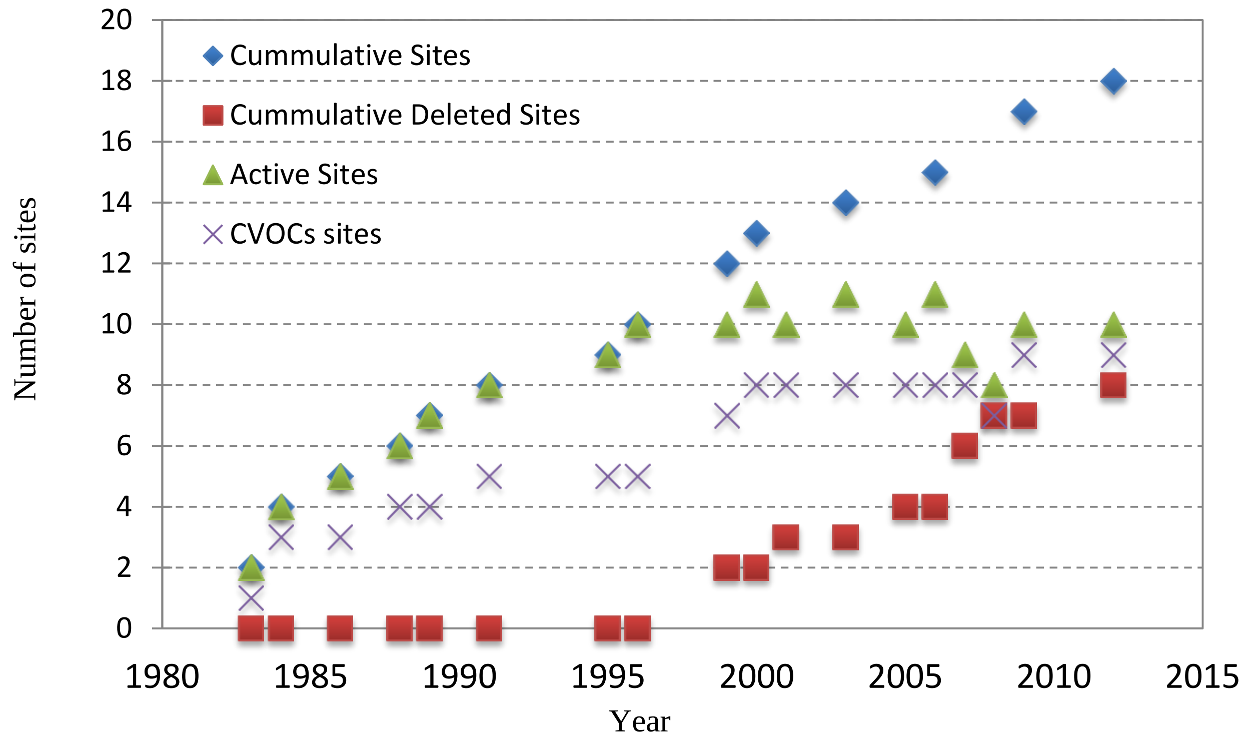

Figure 14 Temporal Evolution of Superfund and RCRA CA Sites in the Study Area (1982 – 2012)

5.2 Characteristics of Collected Data

Summaries of the data collected for phthalates (Table 6) and CVOCs (Table 7) includes the total of samples, the percentage by information source and the agency or precedence of the sampling information. As shown CVOCs occurred with the highest amount of sampling data and more quantity and diversity of information sources of the total number of samples (7805), 89 % correspond to CVOC data and only 11% correspond to phthalate data Table 6 and Table 7). The data summary also shows that CVOC data (Table 7) comes from a much wider range of information sources than phthalate data Table 6). Percent distribution of information sources for phthalate (Figure 15) and CVOC (Figure 16) show that the majority of the phthalate data comes from PRASA data with 59 %, followed by UPRM with 23.4 %, whereas mostly (over 65 %) of CVOC data comes from two principal superfund sites followed by PRASA data (≈ 22 %). The two principal data contributing superfund sites for CVOCs are the Upjohn superfund site, with 36.2 % and the Vega Alta Public Supply Wells (Vega Alta PSWs) superfund site, with 29.1 %. Because the highest amount of data and information sources correspond to the CVOCs data, this study focuses on this type of contaminants. Phthalate sampling data is evaluated only in terms of detections and its sites locations within the study area.

Table 6 Number of Samples per Information Source of Phthalate Data

Phthalate Samples			
Information Source	**Agency or Related Source**	**Number of Samples**	**% of Total**
NWIS (USGS, 2008)	USGS	20	2.3%
(Guzmán and Quiñones, 1984)		18	2.1%
(Conde and Rodriguez, 1997)		19	2.2%
STORET (USEPA, 2008)	EPA	7	0.8%
SCORPIO Superfund		37	4.3%
PRASA	PRDoH	507	59.0%
NON-PRASA		50	5.8%
UPRM	PRoTECT	201	23.4%
Total number of Samples		859	

Table 7 Number of Samples per Information Source of CVOC Data

CVOC Samples				
Source ID	**Information Source**	**Agency or Related Source**	**Number of samples**	**% of Total**
NWIS	NWIS Data Base (USGS, 2008)	USGS	29	0.4%
U R1	(Guzmán and Quiñones, 1984)		18	0.3%
U R2	(Guzmán and Quiñones, 1985)		41	0.6%
U R3	(Guzmán et al., 1986)		110	1.6%
U R4	(Conde and Rodriguez, 1997)		26	0.4%
U R5	Sepúlveda (Sepúlveda, 1999)		228	3.3%
STORET	STORET Data Base (USEPA, 2008)	EPA	20	0.3%
UJ	Upjohn Superfund		2,512	36.2%
VA	VA PSW Superfund		2,022	29.1%
BL	BL Superfund		99	1.4%
SR	SCORPIO Superfund		40	0.6%
PRASA	PRASA	PRDoH	1,502	21.6%
NON PRASA	NON-PRASA		90	1.3%
PREQB	PREQB	PREQB	19	0.3%
UPRM	UPRM	PRoTECT	190	2.7%
Total number of Samples			6,946	

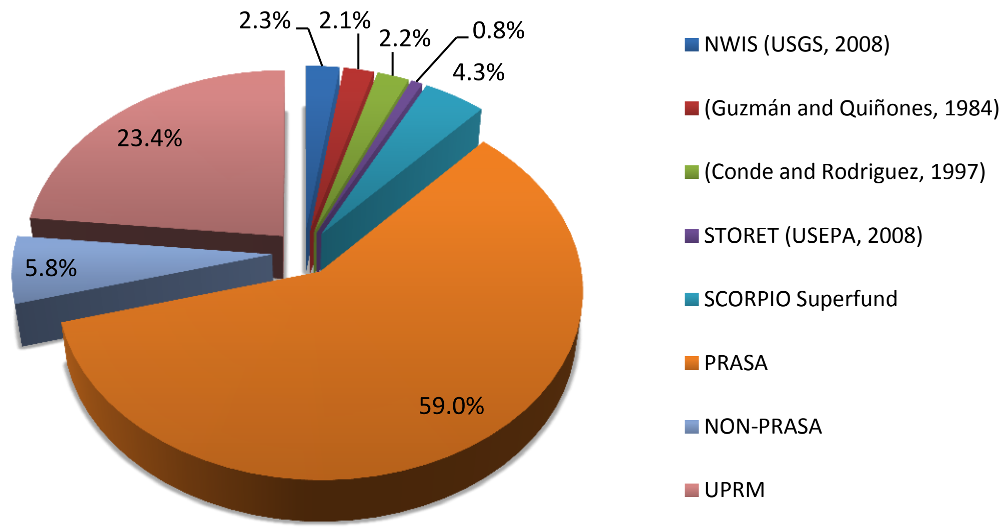

Figure 15 Percent Distribution of Phthalate Samples per Source of Information

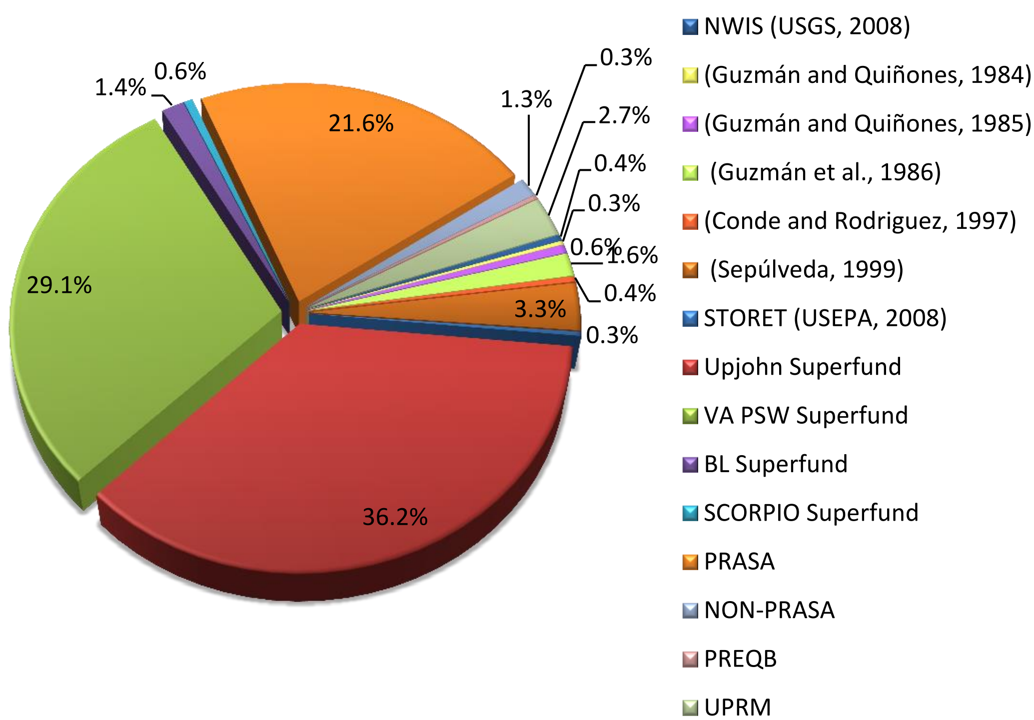

Figure 16 Percent Distribution of CVOCs Samples per Source of Information

5.3 Contaminant Detection in Groundwater

Analysis of the data indicates that there is detection of CVOCs and phthalate in the study area during the period of analysis (1981-2013). Generally, the number of detections varies with the level of contamination and with number of samples (i.e., greater number of detection with greater number of samples), but the percent of detection (number of samples over total number of samples analyzed for each contaminant group) represents the level of contamination by each group or contaminant. In general, though, there are a greater number of samples taken for contaminants that show higher levels of detection, yielding a higher level of confidence in the data.

5.3.1 Detection of Phthalates

Analysis of the data indicates that 859 samples in 176 numbers of sites were analyzed for phthalate between 1981 and 2013 in the study area. Of the total samples, 87.3% show No Detection (ND) and 12.7 % show Detection (Det) (Figure 17). Of those detected, 23 % show more than one type of phthalate. Of the total number of sites sampled, 20 % show phthalate detection (Figure 18). Although the number of phthalate detection seems small, it is a significant number considering that no major phthalate contamination has been reported in the study area.

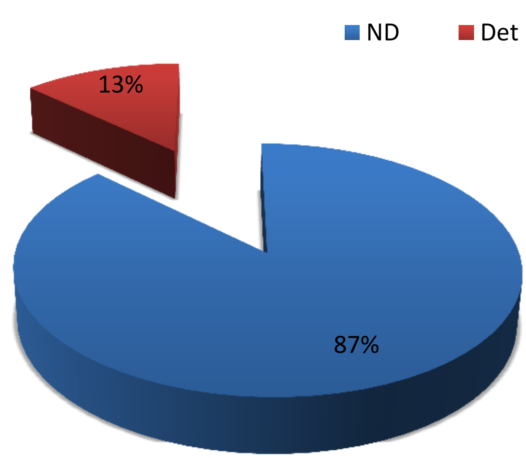

Figure 17 Percent Phthalate Detection by Samples

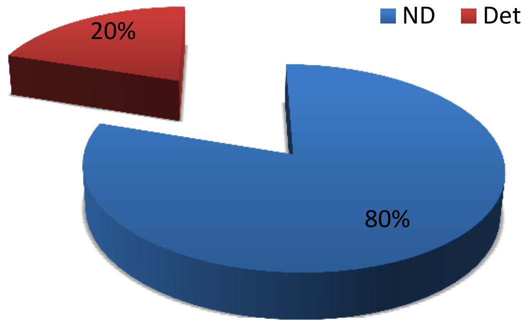

Figure 18 Percent Phthalate Detection by Groundwater Site

The location of the sites where phthalates were sampled for and detected is shown in Figure 19 (a) and Figure 19 (b), respectively. Detection of phthalate occur throughout the study area but some of them seem to cluster near and downstream of contamination sources. The most

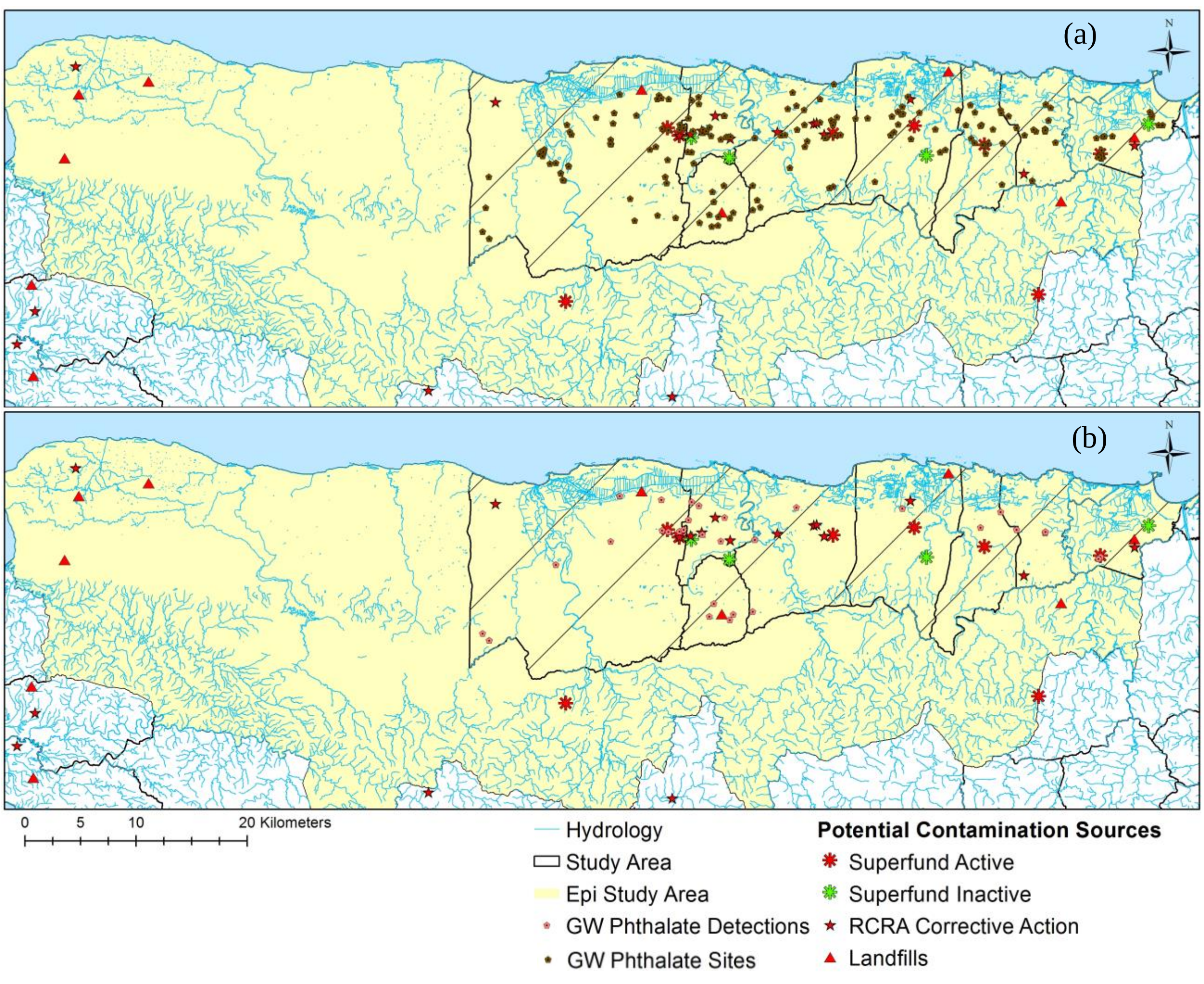

Figure 19 Phthalate Sampling (a) and Detection (b) Sites in the Groundwater Study Area

commonly phthalate detection by sample is DEHP (6.6 %), mostly because this is the only target compound regulated under the Drinking Water Act and other species do not require sampling and analysis. Other phthalates detected include DBP (6.2 %), DEP (3.4 %) and DNOP (0.1 %). Mixtures of DBP and DEP with DEHP observed were 32% and 45 % of the detections, respectively also included DEHP.

5.3.2 Detection of CVOCs

The collected data show a much greater number of samples were collected for analysis of CVOCs (6,946; Table 7) than phthalate (859; Table 6) for the period of study (1982-2013). The number of groundwater sites sampled is also much higher for CVOCs (303) than phthalate (176). The higher number of samples and sampled sites for CVOCs results mostly from the additional sampling requirements imposed for superfund and RCRA CA sites with major CVOC contamination sources. This is supported by the fact that most of the collected CVOC data comes from the Upjohn and the Vega Alta PSWs superfund sites (Table 7). High percent detection of CVOCs in groundwater samples (65.5%; Figure 20) and sampled sites (77.6 %; Figure 21) reflect the impact of the CVOC-contaminated sites on the environmental health of the system.

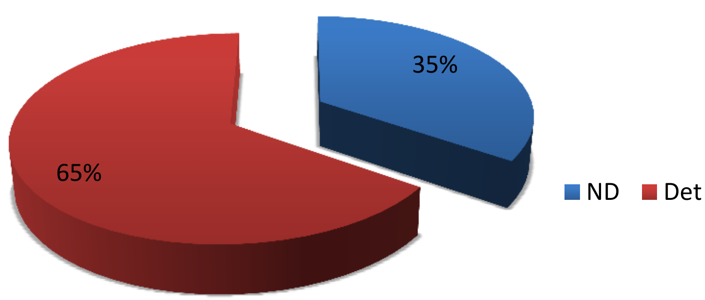

Figure 20 Percent CVOCs Detection and No Detections by Samples

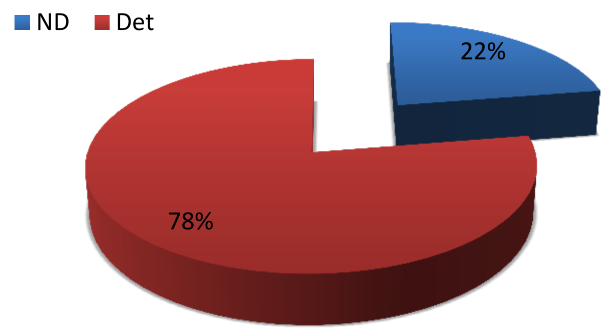

Figure 21 Percent CVOCs Detection and No Detections by Well

Several CVOCs are detected in the study area between 1982 and 2013. The CVOCs detected, are listed in Table 8 with their respective maximum (Max.) and minimum (Min.) concentrations, MCLs (Table 3 and Table 4), total number of detected samples (Total Number), percent of detection (% Det), number of detected samples above MCL (Above MCL), percent of samples detected above MCL (% Det Above MCL) and total number of samples (Total Samples).

The most detected CVOC in the study area is TCE (52.5 %), followed by PCE (39.0 %), 1,1-DCE (30.4 %), cis1,2-DCE (30.2 %), CCl_4 (26 %), TCM (22 %), 1,1-DCA (15.3 %) and DCM (9 %). The detection distribution among the different CVOCs (which is discussed later in this chapter) is generally associated with major sources of contamination, although data analysis suggests other potential sources of CVOC contamination. Some CVOCs may also be formed as degradation or Disinfection By-Products (DBPs). For instance: TCM and DCM may be formed as degradation products of CCl_4; TCE may be formed as degradation of PCE; DCE and VC may form from degradation of PCE and TCE (Figure 7).

Of the total number of CVOC sample detection, 46.5 % have more than one contaminant whereas 29.1% of the sites show more than one detection of CVOC. This suggests a larger number of CVOC contaminants (type) over a smaller number of groundwater sites.

The highest CVOC concentration (Figure 7) is for CCl_4, followed by TCE, then 1,1-DCE, TCM, DCM, and PCE. CVOCs with the lowest concentration include 1,1,1,2-TeCA and 1,1,2,2-

TeCA. TCE shows higher number and percentage of samples above MCL, followed by CCl_4, PCE, 1,1-DCE and DCM. Considering the percentage of detected samples the highest percentage correspond to TCE, then PCE, 1,1-DCE, cis-1,2 DCE, CCl_4 and TCM.

Table 8 Summary of CVOCs Detected Within the Study Area (1982 – 2013)

Type of CVOC	Concentrations (ug/L)			Samples Detected				Total Samples
	MAX	MIN	MCL	Total Number Samples	% Det	Above MCL	% Det Above MCL	
1,1-DCA	110	0.13	5	558	15.34	40	7.17	3,638
1,2-DCA	26	0.2	5	25	0.63	4	16.00	3,973
1,1-DCE	1800	0.17	7	1184	30.38	295	24.92	3,897
1,1,1-TCA	227	0.2	200	26	0.67	1	3.85	3,905
1,1,2-TCA	4	0.8	5	8	0.21	0	0.00	3,841
TCE	8500	0.069	5	2293	52.46	1506	65.68	4,371
PCE	310	0.066	5	1614	39.02	405	25.09	4,136
TCM	690	0.063	70	842	21.97	6	0.71	3,832
CCl_4	16396	0.02	5	1655	26.00	1196	72.27	6,365
DCM	330	0.3	5	362	8.99	138	38.12	4,028
1,1,2,2-TeCA	0.7	BDL, ND	1	1	0.03	0	0.00	3,379
trans-12-DCE	20	4	100	135	3.47	0	0.00	3,886
cis-12-DCE	320	0.5	70	1058	30.19	34	3.21	3,505
VC	1.1	BDL, ND	2	19	0.52	2	10.53	3,666
BF	21	0.5	80*	69	2.01	7	10.14	3,437
BDCM	56.3	0.2	80*	127	3.68	8	6.30	3,451
CDBM	0.7	0.6	80*	87	2.52	8	9.20	3,450
CA	0.7	0.6	12	6	0.18	0	0.00	3,424
CM	18	0.621	2.7	61	1.80	9	14.75	3,397
1,1,1,2-TeCA	BDL	ND	1	0	0.00	0	-	3,186
Total number of CVOCs samples by individual species =								76,767

The distribution of sites sampled for and showing detection of CVOCs depict the high percentage of CVOCs in the study area (Figure 22). A lower detection density is observed in the southern region of the study area, where there are fewer potential sources of contamination. A higher detection density is observed near or down gradient of the major superfund sites, but some detection occurs in areas not associated with major contamination sources. This suggests, as already indicated, other potential sources of contamination.

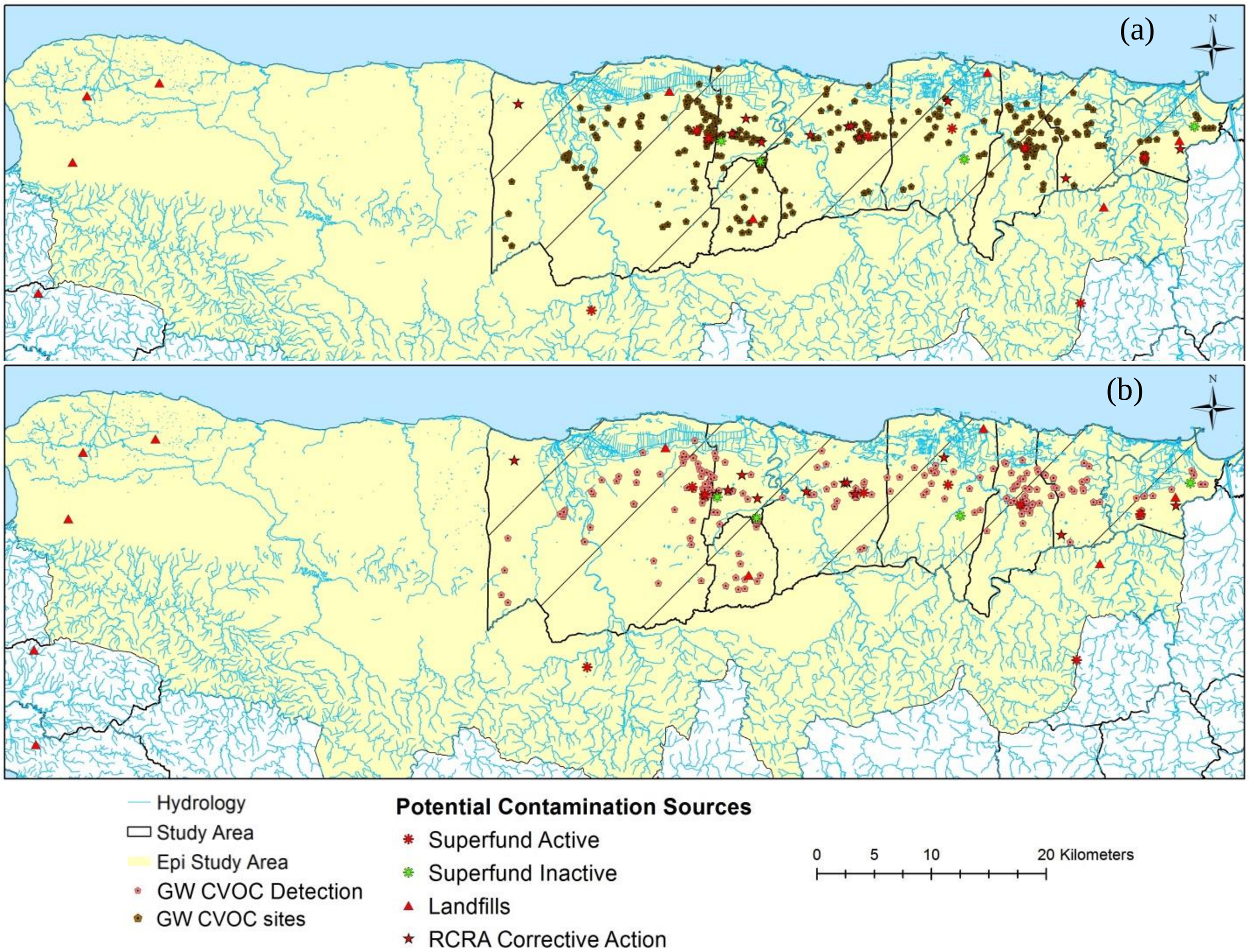

Figure 22 CVOC Sampling (a) and Detection (b) Sites in the Groundwater Study Area

5.3.3 Detection of CVOCs and Phthalates Mixtures

A total of 160 groundwater sites have been sampled for both, CVOCs and phthalates (Figure 23). When compared with the total amount of samples for each type of contaminant, only 16 sites (9 %) of those sampled for phthalate are not sampled for CVOCs, whereas 143 wells (47%) of the sites sampled for CVOCs are not sampled for phthalate. With 110 wells sampled for phthalates (62.5 %), the majority of the sites sampled for both CVOCs and phthalates are PRASA wells.

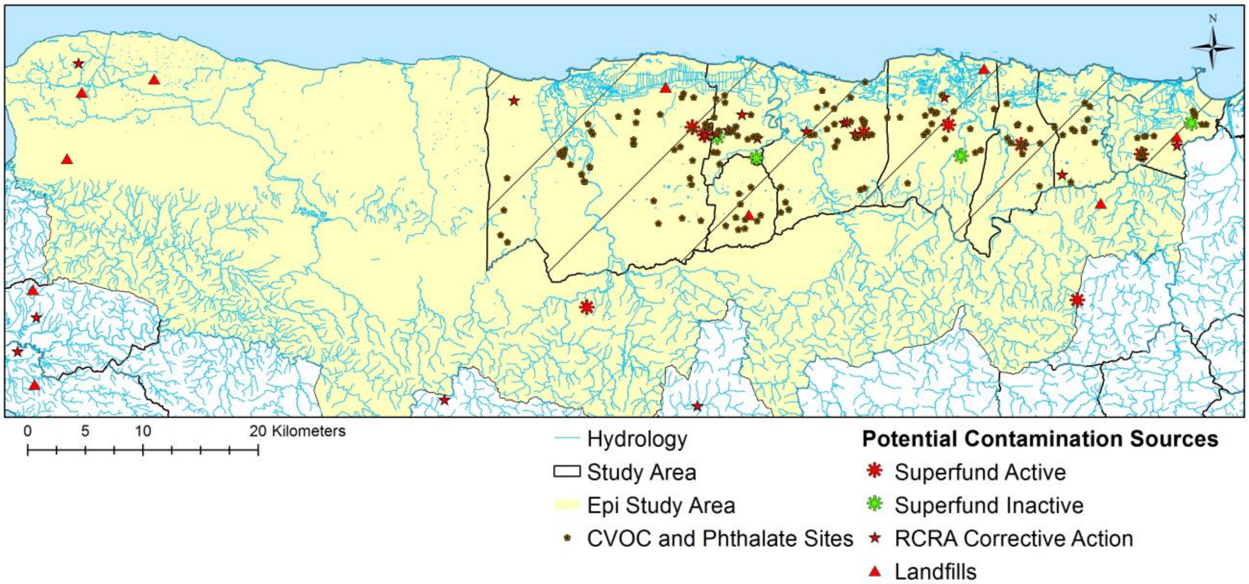

Figure 23 Groundwater Sites Sampled for both CVOCs and Phthalates

Of the 160 groundwater sites sampled for both CVOCs and Phthalate, 22 (13.75 %) show detection for both, 3 (1.9 %) show phthalate detection but ND for CVOCs, 106 (66.25 %) show ND for phthalate but detection for CVOCs and 29 (18.1%) show ND for both contaminants (Figure 24).

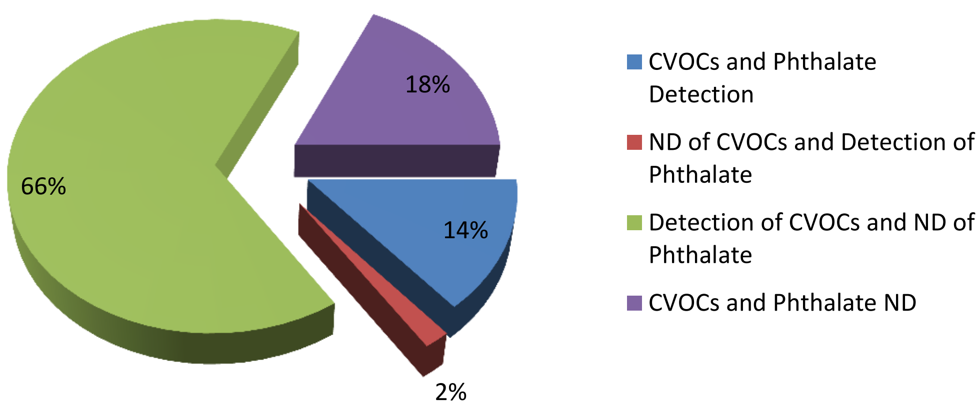

Figure 24 Detection for Wells Been Sampled for Both Phthalates and CVOCs

5.4 Temporal Characteristics of CVOCs Data

As the majority of the samples and detections are from CVOCs contaminants, the temporal and spatial analysis focuses on these contaminants. Because the data come from a diverse number of sources, a temporal analysis of the sources of CVOC data information is conducted. This analysis shows data availability, temporal gaps of information, and is used to assess if there are biases in the data distributions resulting from the sources of information. Table 9 shows the sources of information by year from 1982 to 2013. EPA derived data include superfund data (UJ = Upjohn site; VA = Vega Alta Public Supply Wells site; BL = Barceloneta Landfill site; SR= Scorpio Recycling site) and data from EPA database (STORET; USEPA, 2008). All other details of IDs and source reference are available in Table 7.

Table 9 Detail of CVOCs Information Source by Year

Year	EPA NPL (Superfund)				EPA	USGS	USGS Reports					PRDoH		PREQB	UPRM
	UJ	VA	BL	SR	STORET	NWIS	U R1	U R2	U R3	U R4	U R5	PRASA	NON PRASA		
1982	X					X	X								
1983	X						X	X							
1984	X	X			X				X						
1985	X								X						
1986	X					X									
1987	X					X									
1988					X	X									
1989	X	X				X									
1990	X	X				X					X				
1991	X														
1992	X					X				X	X	X			
1993	X											X			
1994	X			X								X			
1995	X	X				X						X			
1996	X	X										X			
1997	X	X			X							X			
1998	X	X										X	X		
1999	X	X		X								X	X		
2000	X	X										X	X		
2001	X	X										X	X	X	
2002	X	X	X	X									X	X	
2003	X	X	X										X	X	
2004	X	X	X										X		

Year	EPA NPL (Superfund)				EPA	USGS	USGS Reports					PRDoH		PREQB	UPRM
	UJ	VA	BL	SR	STORET	NWIS	U R1	U R2	U R3	U R4	U R5	PRASA	NON PRASA		
2005	X	X		X									X		
2006	X	X		X									X		
2007	X	X											X	X	
2008	X	X										X	X	X	
2009	X	X										X	X		
2010	X	X										X	X		
2011	X												X		X
2012															X
2013															X

*Details of information sources IDs are given in Table 7

Temporal distribution of samples and detection data (Figure 25 and Figure 26) show that the quantity of total samples, detections and percent of detections vary through time. In the early 1980s limited amount comes from Superfund sites sampling events, USGS database and reports, and EPA database. Although there is little amount of data (Figure 25), percent detections are more than 40% (Figure 26). In the mid-1980s (1986-1988) data comes mainly from the Upjohn superfund site and the EPA and USGS databases. Sampling during this period is more focus on contaminated sites, and shows high percent detections of CVOCs, ranging between 86 and 100%. The year with the least amount of data is 1988, when there is no data reported from the Upjohn superfund site reported. In the early 1990s (1990-1991), the sampling events increase at superfund sites. Superfund site data is also complemented by data from the USGS (Sepulveda, 1999), report that model the contamination of TCE in the Vega Alta Public Supply Wells superfund site. During the 1990s (1992-2000), data is also collected for the PRASA wells. Although the number of samples increase during this period, the percent detections are lower than 70 % (except for 1996 and 1997), with 1993 and 1994 showing less than 50 % detections. A lower detection during this period may result from the addition of PRASA data. PRASA data may show lower detections because wells would be shut off if detection occurs above MCLs to avoid health issues. Because of time limitations, PRASA well data has only entered partially for the period between 2001 and 2011 (1^{st} quarter data of 2001, 2008, 2009, and 2010). The data in this period show detection above 70 %, except for 2002. In this year, data from Scorpio Superfund site is included. Although several CVOC detections are reported for the Scorpio site, the major concern in this site is with metal contamination. A lower detections in 2011 are attributed to various potential reasons, including: (1) lower overall detections in contaminated sites; (2) inclusion of NON-PRASA data; (3) exclusion of data such as Vega Alta PSWs superfund site (not available when data was collected); (4) and lower number of samples considered. Exclusion of data and lower number of sample data considered results from the time limitation for the analysis.

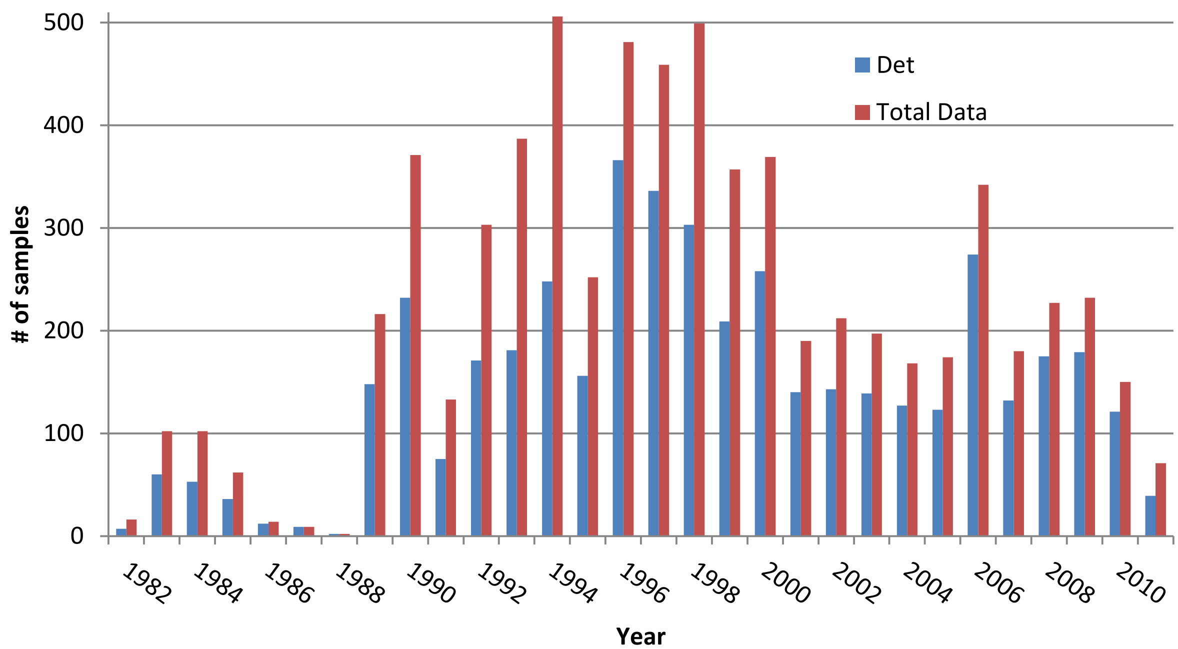

Figure 25 Total Numbers of CVOCs Samples With Detections and Total Samples per Year

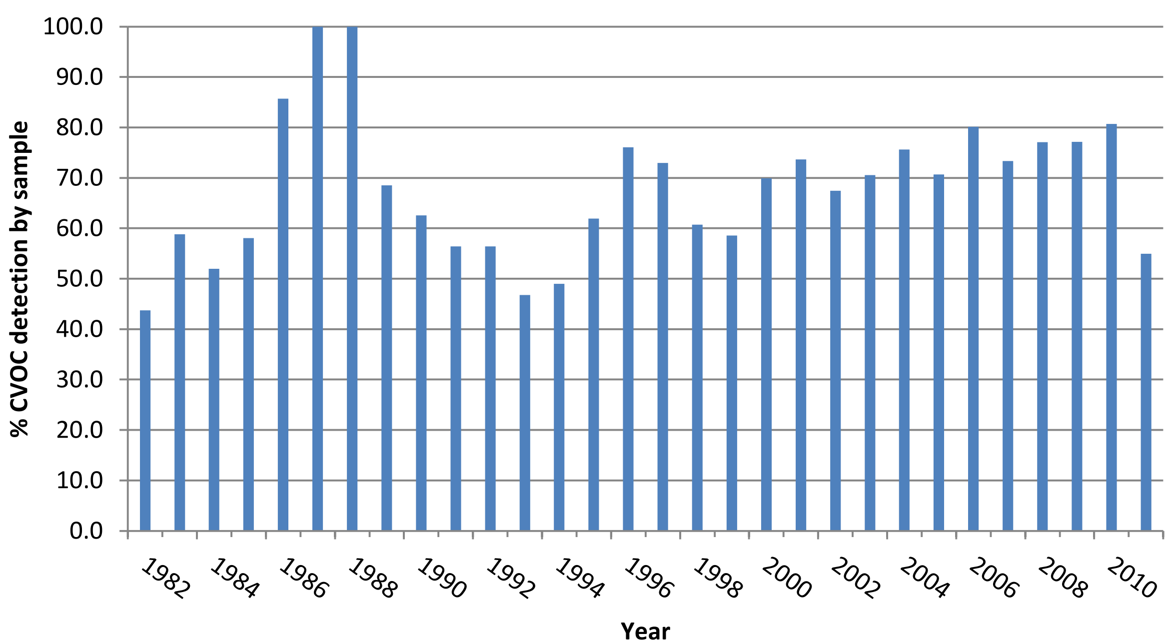

Figure 26 Graph of Percent of CVOCs Detections by Sample per Year

5.5 Spatial Distribution of Principal CVOC Species Average Concentrations

The analysis of spatial distribution of selected CVOCs is conducted for the most common contaminants of concern, including TCE, PCE and CCl_4. These contaminants represent the highest maximum concentrations, the contaminants with the highest amount of samples exceeding MCL standards, and the highest percent detections. TCM and DCM contaminants are also analyzed Spatial-temporally to assess the interactions or possible precedence of these contaminations as they could come from other sources, the degradation of CCl_4, or from the formation of DBPs. TCM and DCM have the 4^{th} or 5^{th} highest concentration and among the highest amount of samples exceeding MCL standards.

Spatial concentration distributions of selected CVOCs integrate the average concentrations over the entire analysis period (1982-2013) for groundwater sampled sites in reference to the potential sources of contamination like superfund sites, RCRA CA and landfills. Spatial concentration distribution for PCE, TCE and a combination of PCE plus TCE are shown in Figure 27. The highest PCE (Figure 27 a) and TCE (Figure 27 b) average concentrations are associated with the Vega Alta PSWs superfund site. PCE and TCE concentrations near and downstream of the site are likely coming from this superfund site. Comparison of the PCE and TCE spatial distribution with the aquifer's potentiometric distribution (Figure 8) supports that some of the contamination found northeast of the Vega Alta PSWs could also come from this site as the potential groundwater flow near this site is to the northeast. Some of the PCE and TCE contamination in this and several other areas could come from other sources of contamination. In the Vega Alta PSWs superfund site area pump and treat systems is been extracting contaminate groundwater since 1980's and soil vapor extraction since 2002. PCE could be degrading to TCE in areas where both contaminants are been found. There are also areas where only one of the contaminants is found and a clear relationship between them is not been observed. However, both contaminants contribute to a higher PCE + TCE concentration (Figure 27 (c)).

It is important to point out that the spatial concentration distributions are developed through isotropic interpolation of concentration data, thus does not take into account the flow direction of groundwater. As a result, interpolations are made equally in all directions. This may induce a sense that there are appreciable detections upstream of major sources, when indeed it could be result of the interpolation and not detection. As such, recommendations are made to perform directional interpolation taking groundwater flow direction into account in future studies. For this work, detection sites are included in the spatial concentration distribution for the

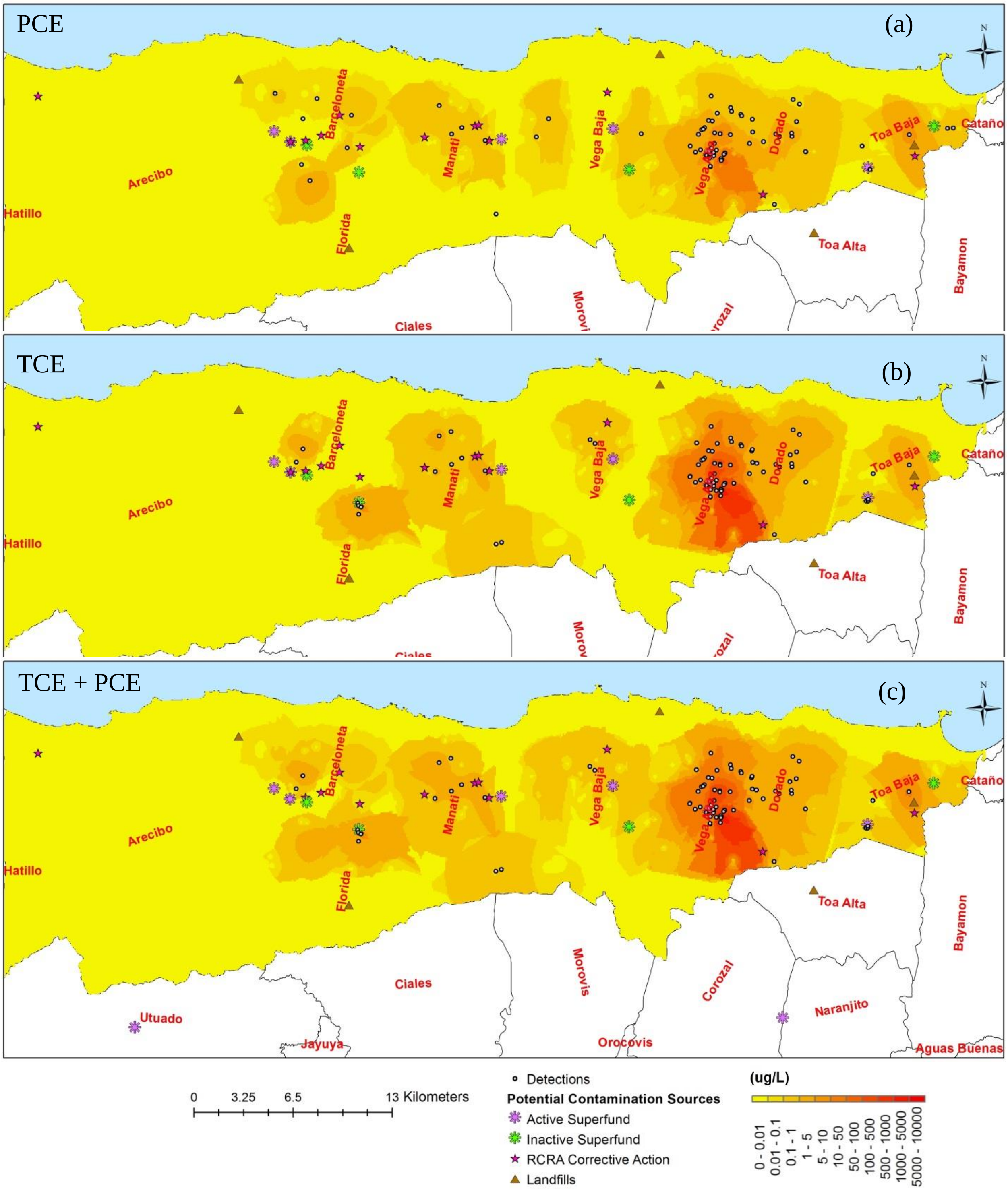

Figure 27 Spatial Concentration Distribution for PCE (a), TCE (b) and TCE + PCE (c)

assessment. Spatial concentration distributions for CCl_4, TCM, and DCM are shown in Figure 28. TCM distribution is analyzed with CCl_4 because it can be degradation by-product of CCl_4. DCM is a degradation by-product of TCM. Although CCl_4, like PCE and TCE although to a lower extent, can be found throughout the study area, the highest CCl_4 concentrations are

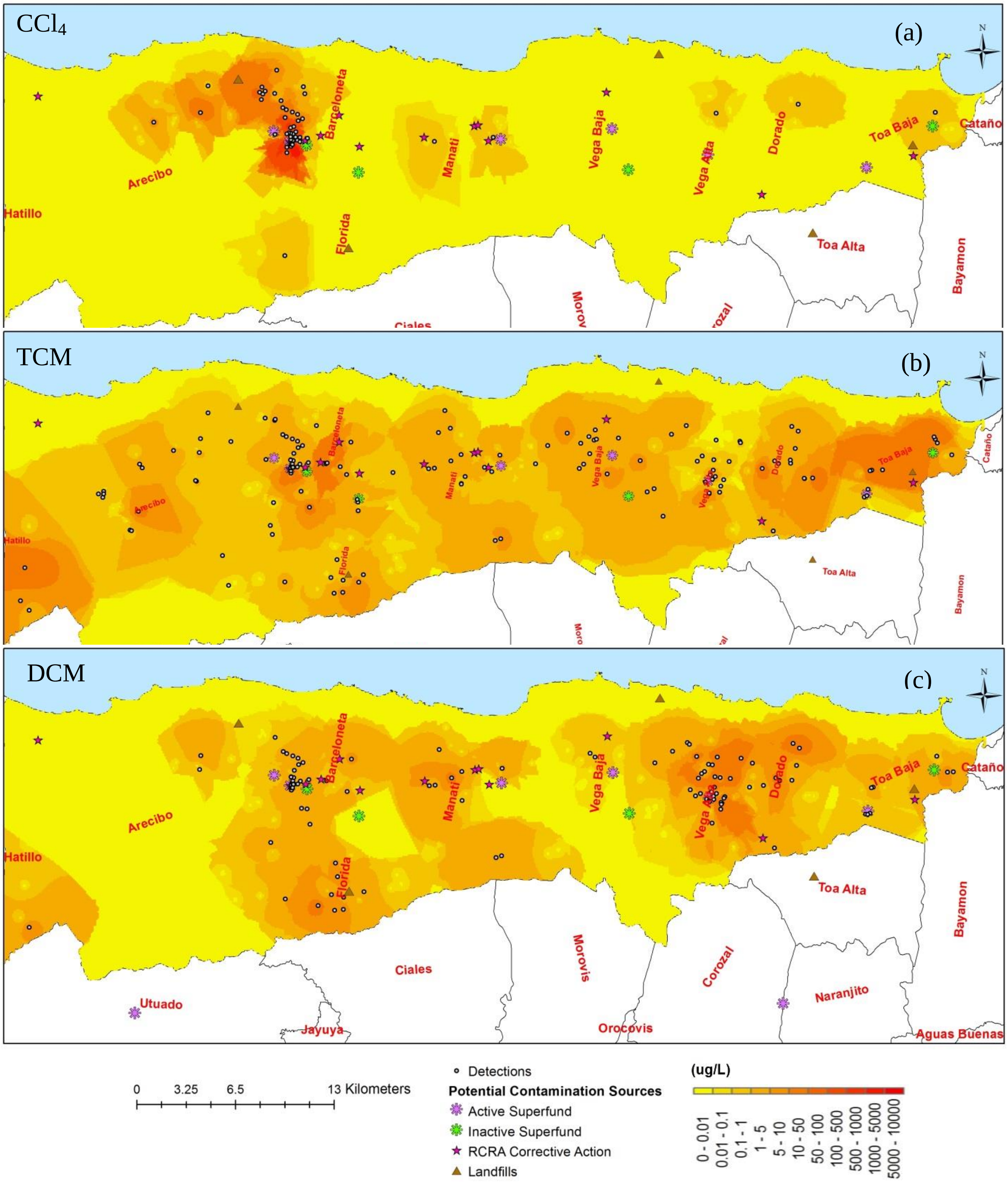

Figure 28 Spatial Concentration Distribution for CCl_4 (a), TCM (b) and DCM (c)

observed near the Upjohn superfund site in the Arecibo/Barceloneta area. Areas with CCl_4 concentration to the west of the Upjohn superfund site and to the southwest of Arecibo near Florida are likely influenced by other sources of contamination.

The spatial concentration distribution of TCM (Figure 28 b) show that this contaminant is found widely distributed throughout the study area. The highest TCM concentrations are found near the Upjohn site and near the Naval Security superfund site in the Toa Baja area (Figure 28 b) and are most likely associated with the CCl_4 contamination, either as an additional source or as a degradation by-product of CCl_4. Many areas of TCM concentrations are, however, not associated with CCl_4 contamination. In these areas, contamination may come from other unknown sources. DCM concentrations are widely distributed throughout the study area Figure 28 (c). Although to a lower extent than TCM, DCM spatial concentration distribution follows similar patterns as TCM, suggesting some association between the two. High concentrations of DCM near the Vega Alta area, where TCM concentrations are relatively low, suggest additional sources of DCM (i.e., other than source and degradation by-product of TCM). Combination of CCl_4, TCM and DCM spatial distributions show a significant extent of groundwater contamination with this family of CVOCs (Figure 29). This combination include the sums of CCl_4 and TCM (Figure 29 a), TCM and DCM (Figure 29 (b)), and the combination of the three of them (Figure 29 (c)).

The spatial concentration distribution of the sum of the principal five contaminants (PCE, TCE, CCl_4, TCM, and DCM) shows that the concentration of these contaminants is widespread in the study area (Figure 30). Concentrations in many areas surpass MCL standards. There are data gaps where there are not groundwater samples available to better assess the contamination, and areas where the contamination and sampling events may exist but have not been entered in the database and analyzed. For example, the RCRA sites Thermo King northwest of Arecibo (IDN = 14, Table 1, Figure 4) and the Safety Kleen at Manatí (IDN = 15, Table 1, Figure 4) have known to release CVOCs, but the data is not yet available for analysis.

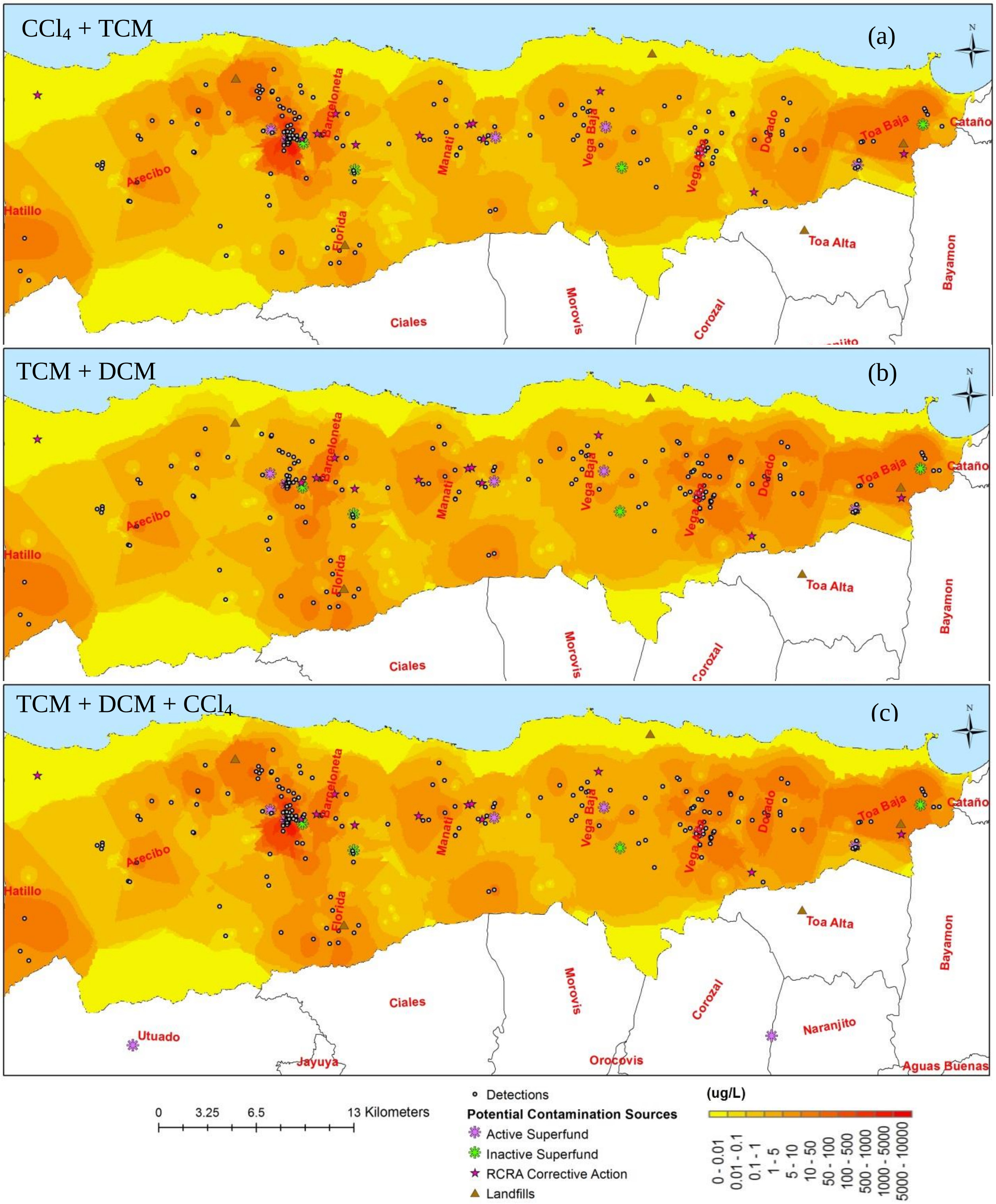

Figure 29 Spatial Concentration Distribution for CCl_4 + TCM (a), TCM + DCM (b), and TCM+ DCM + CCl_4 (c)

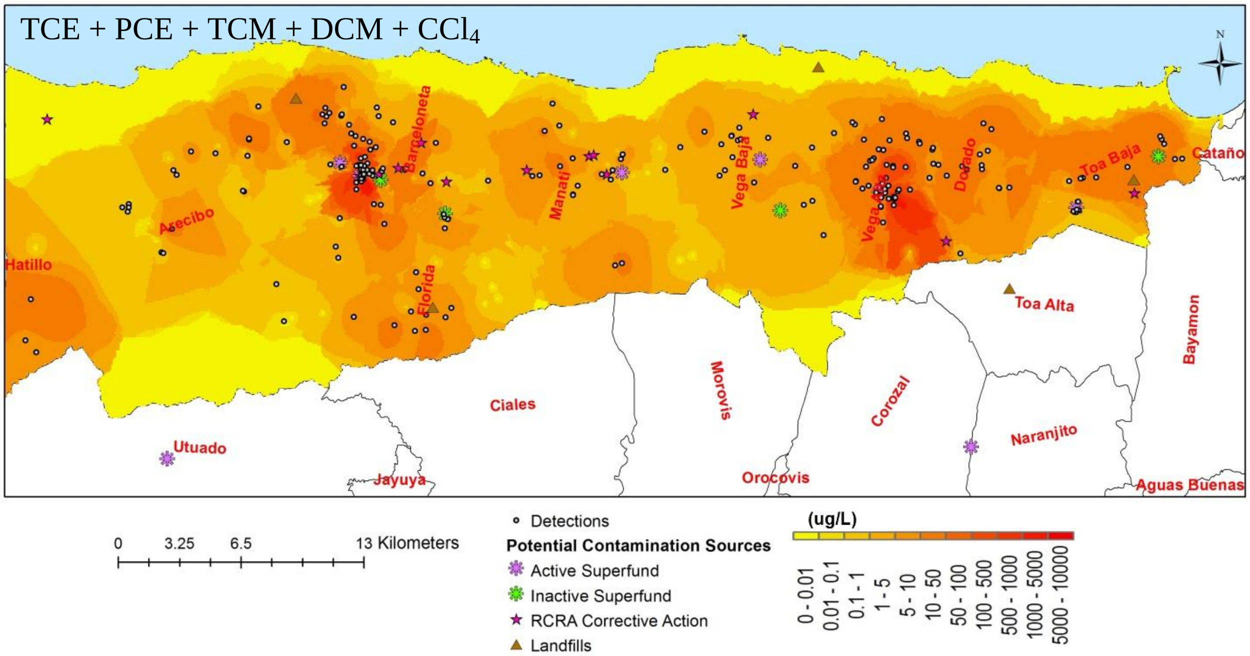

Figure 30 Spatial Concentration Distribution of the Total Sum of TCE, PCE, TCM, DCM and CCl_4

5.6 Temporal Distribution of Spatially-Averaged CVOC Concentration

Temporal concentration maximums and minimums for total and point-of-maximum CVOCs (Table 10) show the variability of groundwater contamination through time. The point-of-maximum concentration refers to the well having the maximum concentration each year, and is identified with its source of information. It can be seen that maximum concentrations are mostly reported for wells associated with superfund sites. In general, maximum concentrations of CVOCs tend to decline in time, because the principal sites associated with maximum CVOCs have been subjected to active remedial activities. It is important to note that, even with active remediation, maximum concentrations are still above MCL.

Table 10 Maximum and Minimum CVOC Concentration (1982-2011)

Year	Total CVOC (ug./L) **			Point of Maximum Concentration ***			
	Max	Min	Max Avg.	Species Conc Max (ug/L)	Max Species	Source Max	Max Det ID *
1982	490	7.6	490	480	TCE	USGS report	182515066194000
1983	16,396.1	0.1	5,360.9	16,396.1	CCl_4	Upjohn	182542066352400
1984	3,651	0.3	2,863	3,651	CCl_4	Upjohn	182611066352400
1985	4,635.8	0.02	4,635.8	4,635.8	CCl_4	Upjohn	182547066352100
1986	211.9	15.9	211.9	211.9	CCl_4	Upjohn	182625066351700
1987-88	144.7	1	144.7	144.7	CCl_4	Upjohn	182705066354100
1989	515.3	0.4	206.5	440	TCE	VA PSWs	182536066194000, 182526066195000
1990	598	0.5	289	530	TCE	VA PSWs	182526066195000
1991	51	2	5.9	51	CCl_4	Upjohn	182555066351900, 182625066351700
1992	2,800	0.7	1,032.5	2,800	TCE	Sepulveda	182502066192000
1993	56	0.5	37.7	56	CCl_4	Upjohn	182555066351900
1994	1,809.2	0.5	134.8	1,809.2	1,1-DCE	PRASA	182604066292500
1995	2,672	0.5	1,360.8	2,300	TCE	VA PSWs	182502066192000
1996	9,080	0.3	4,174.7	8,500	TCE	VA PSWs	182459066192000
1997	5,100	0.5	2,238	4,500	TCE	VA PSWs	182448066192500
1998	2,388	0.5	708.3	2,100	TCE	VA PSWs	182502066192000
1999	3,250	0.5	880	2,700	TCE	VA PSWs	182502066192000
2000	1,940	0.5	656	1,600	TCE	VA PSWs	182502066192000
2001	690	0.21	345.5	690	TCM	NON-PRASA	182603066340200
2002	362.4	0.5	214.6	340	TCE	VA PSWs	182502066192000
2003	305.1	0.5	207.9	283	TCE	VA PSWs	182502066192000
2004	389.2	0.57	220.1	360	TCE	VA PSWs	182502066192000
2005	239.3	0.091	131.6	220	TCE	VA PSWs	182502066192000
2006	2400	0.45	556.3	2,200	TCE	VA PSWs	182459066192000
2007	258.7	0.56	187.8	240	TCE	VA PSWs	182502066192000
2008	1,091.69	0.53	742	1,000	TCE	VA PSWs	182459066192000
2009	226.8	0.063	174.8	210	TCE	VA PSWs	182502066192000
2010	253.8	0.54	175.4	230	TCE	VA PSWs	182502066192000
2011	21	0.13	18	21	CCl_4	Upjohn	182555066351801

* ID used in PROTECT Database
** Maximum (Max), minimum (Min), and maximum average (Max Ave) concentrations for Total CVOC
*** Concentration of species having maximum (Species Conc Max), species of maximum concentration (Max Species), information source of maximum (Source Max), site ID (Max Det ID) of Point of maximum concentration

Temporal concentration distributions for CCl_4 in Upjohn well UE #1 show that concentrations vary with time from a maximum concentration in 1985, to lower concentrations in the late 2000s (Figure 31). Still concentrations are above the MCL for CCl_4. Similar trends are observed for TCE in the multiport well #22, which show maximum TCE concentrations in the 1990s, with lower concentrations after 2000 (Figure 32). PCE concentrations in that well vary from a maximum concentration of 92 ug/L in 1992 to 8 ug/L in the late 2000s. The well shows an increase in cis1,2-DCE concentration through time, suggesting degradation of PCE and TCE over periods of decades. Decreasing of major source concentrations through time in the Upjohn and Vega Alta PSWs superfund sites respond to remediation activities, transport of contaminants away from the site, and degradation processes. Temporal concentrations for other sites are given in Appendix A.

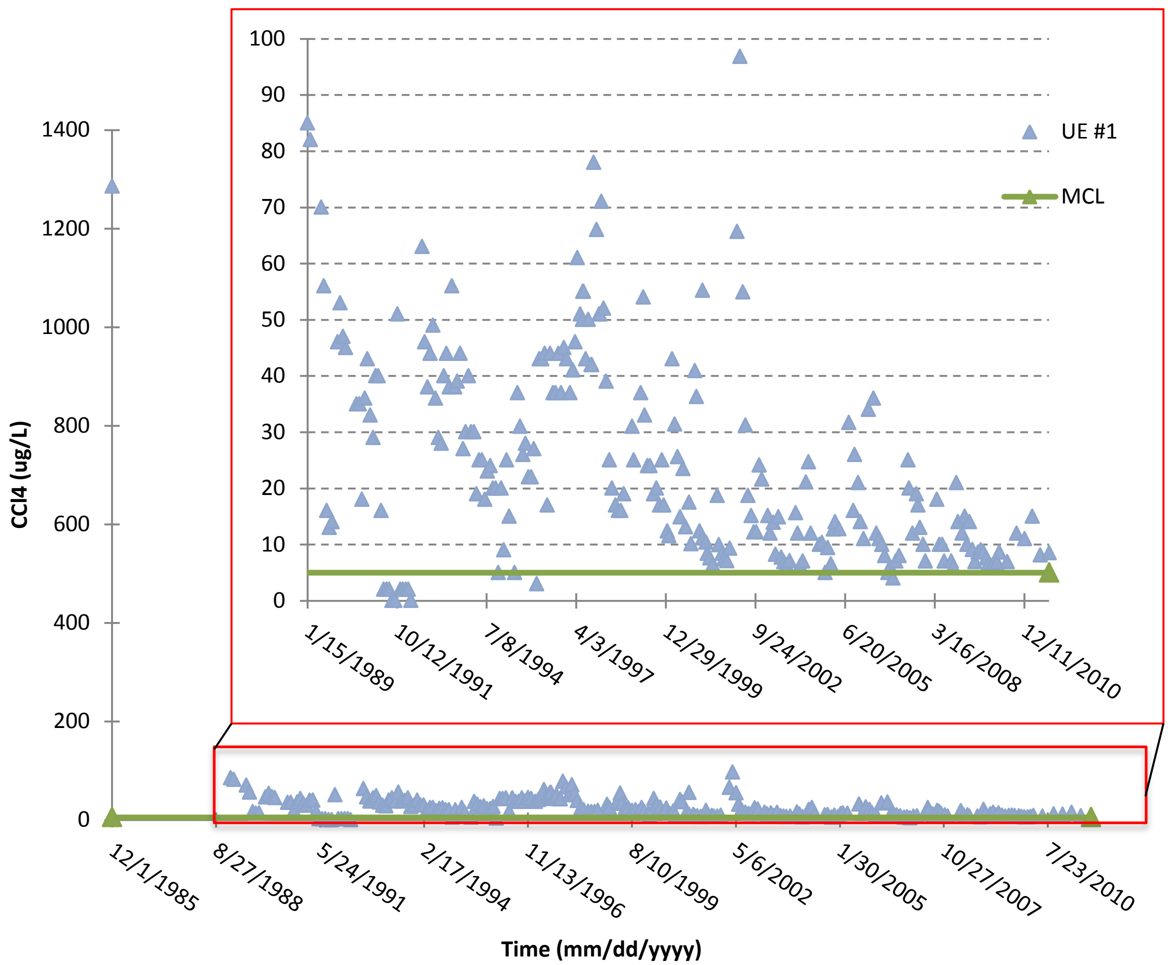

Figure 31 Temporal CCl_4 Concentration Changes in Upjohn Extraction Well #1 (UE #1)

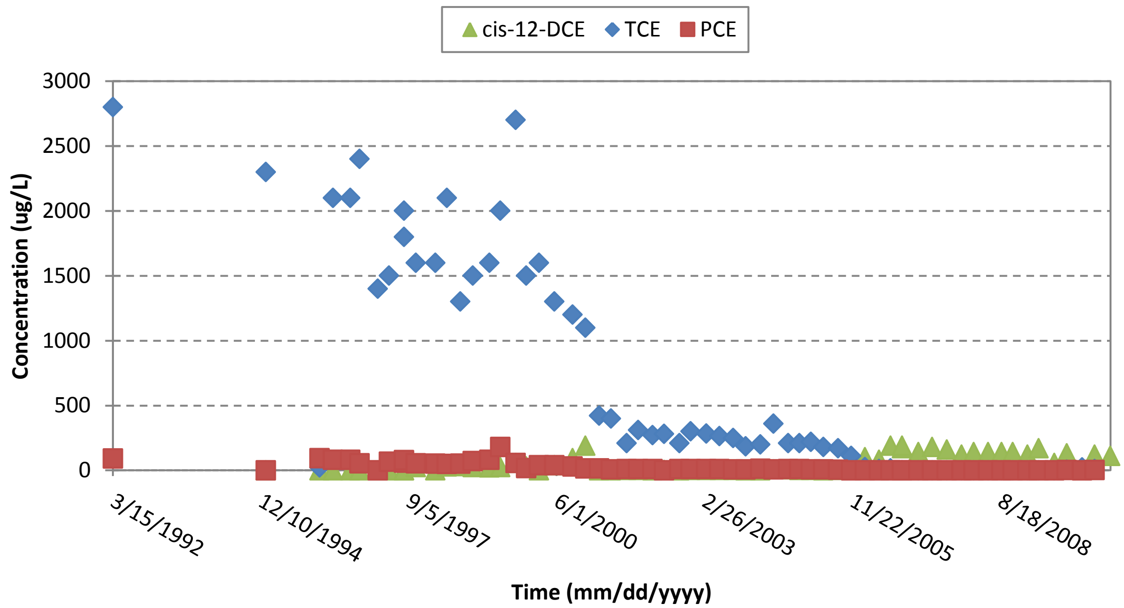

Figure 32 Temporal of TCE, PCE and cis-1,2DCE Concentrations in the Vega Alta Multiport Well #22 Zone 8 (Multi well 22)

Variability of temporal concentration distributions are well captured in the temporal box plots and bar graphs of the data. Box plot show the most extreme values in the data set, quartiles (25 %, 50 % = median, 75 %, 95 %) and the average. Temporal box plots for total CVOC ($\sum CVOC_i$) show high variability through the year, with highest maximum concentration in 1983 (Figure 33 a). Annual concentration ranges tend to decrease from highest values in the early 1980s, to the lowest values in the early 1990s (Figure 33 b), which coincide with low detection frequencies (Figure 25). Higher concentration ranges around a seemly constant median are observed after the early 1990s. Low concentrations and detections frequencies during the early 1990s are attributed to the addition of PRASA well data (as previously discussed). Relatively constant concentration median reflect long-term storage capacity of the aquifer, influenced by rate-limiting mass transfer processes. The median values are generally above MCL for most of the CVOC contaminants. Higher concentrations values in 1983, 1984, 1985, 1992, 1994-2000, 2006, and 2008 are associated with data from the Upjohn and Vega Alta PSWs superfund sites.

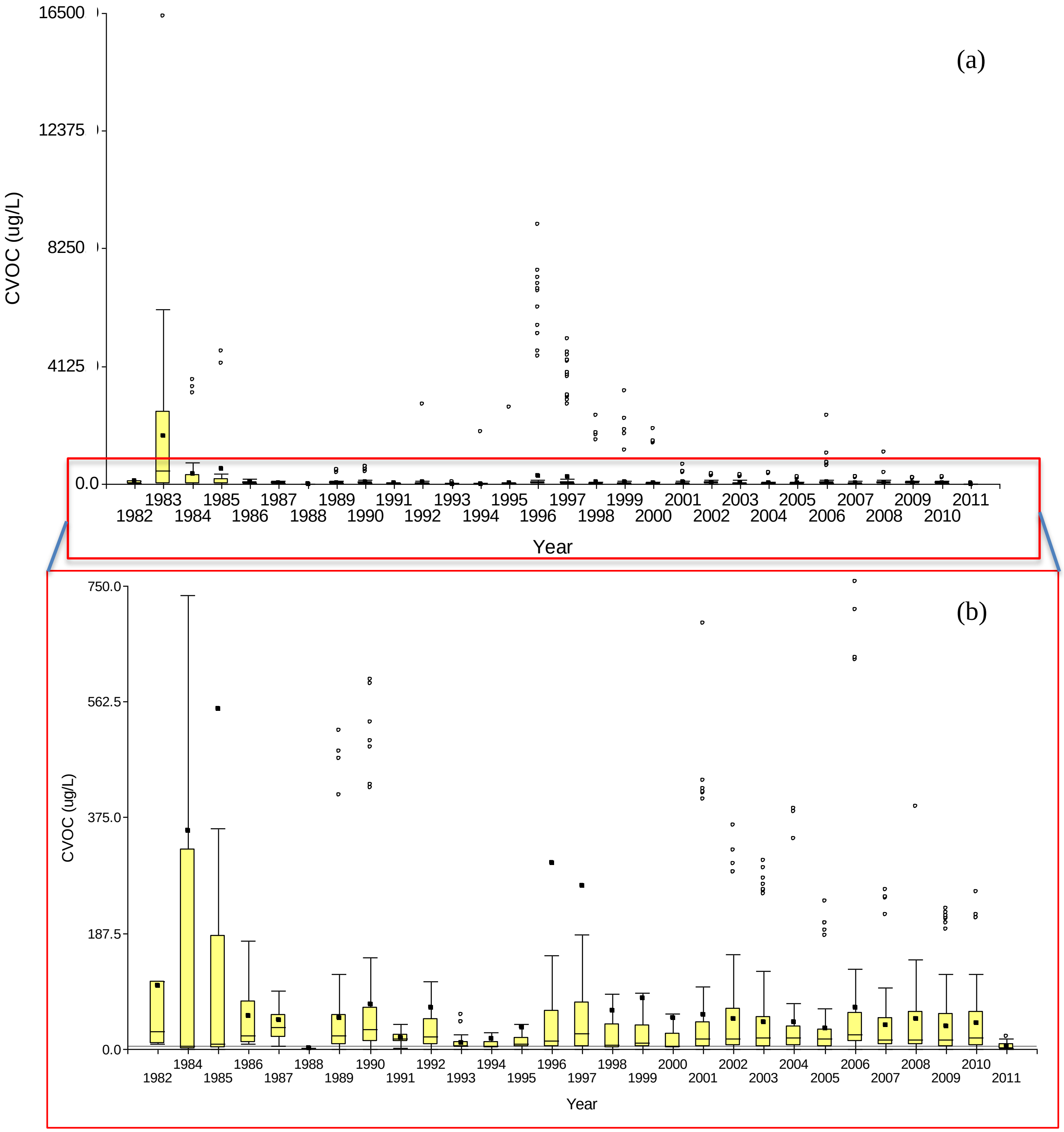

Figure 33 Box Plot of Total CVOC Concentrations by Year for All Data (a) and All Year Except 1983 (b). Error Bars Represent the 95 % Percentile

Bar graphs of the average values of total CVOC concentrations (Figure 34) show, like the box plots, higher values for early 1980s and mid-1990s (1996-1997). Low average values are observed for years with limited data observations (e.g., 1988 and 2011). In other years CVOC concentrations vary between 1,032 ug/L and 0.063 ug/L.

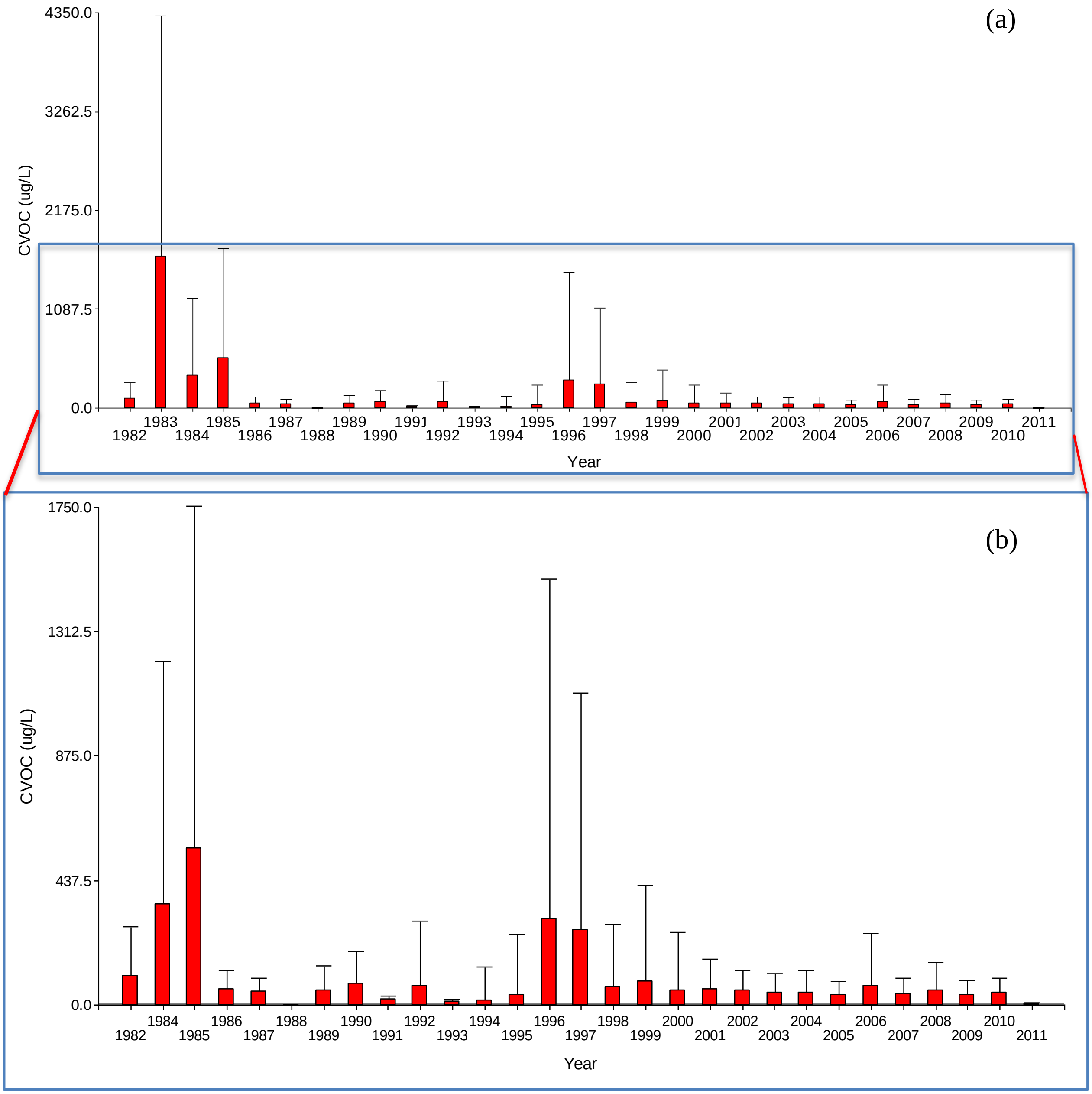

Figure 34 CVOC Bar Graph With Upper Level Standard Deviation by Year for All Data (a) and All Years Except 1983 (b). Error Bars Represent the Standard Deviation of Total Concentrations

5.7 Temporal Distribution of Spatially-Averaged CVOC Concentration by Contaminant

This section presents the temporal concentration variation of the five principal CVOCs found in the study area: TCE, PCE, CCl_4, TCM and DCM. Box plot of TCE temporal concentration distribution (Figure 35) show peak concentrations in 1996. These maximum concentrations are mostly associated with the Vega Alta PSWs superfund site (see Table 10). High TCE concentrations (above 500 ug/L) observed for 1992, 1995-2000, 2006 and 2008 are also associated with the Vega Alta PSWs superfund site, and are mostly found in multiport wells at Vega Alta PSWs superfund area. TCE median concentrations tend to increase through time,

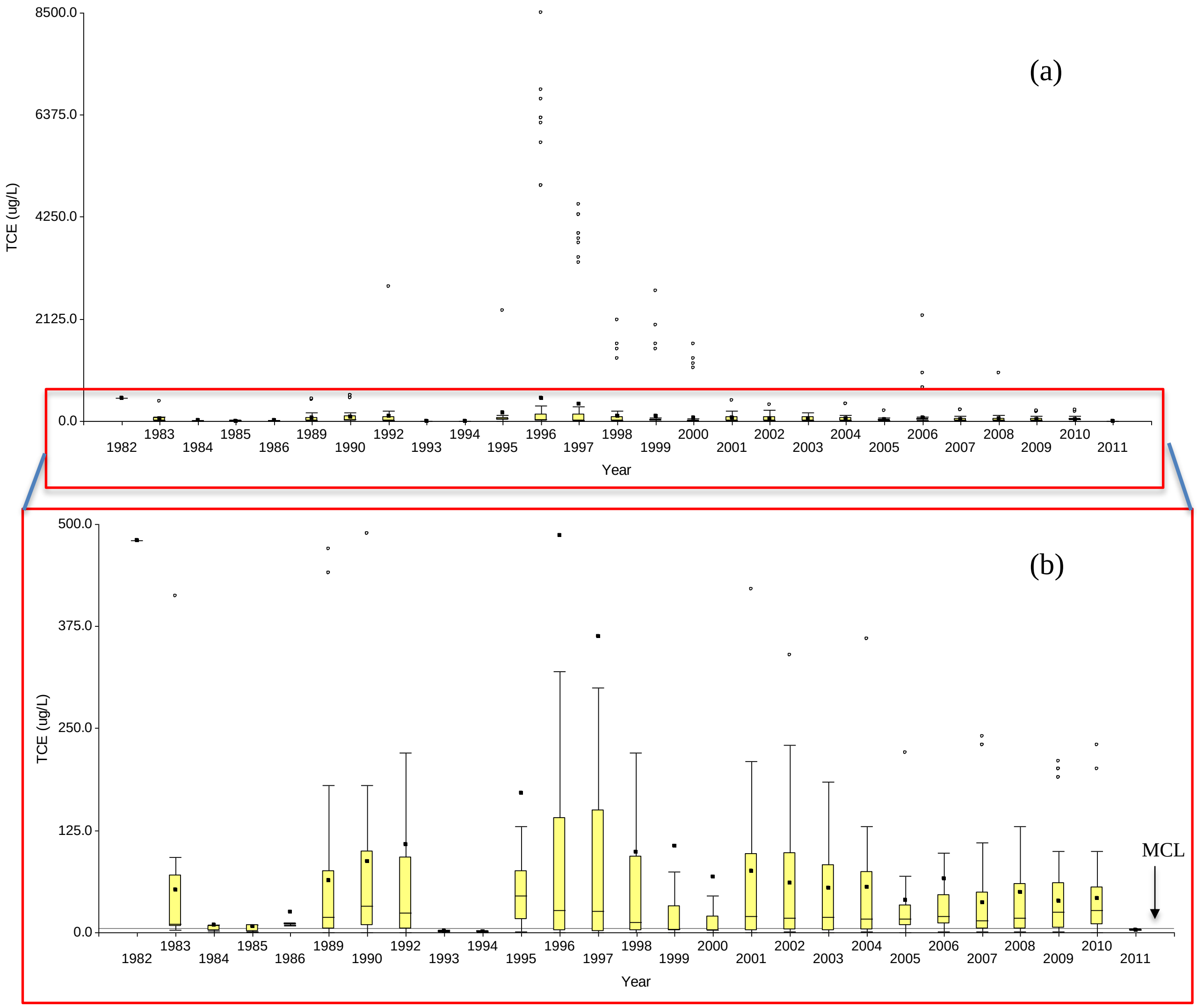

Figure 35 Box Plot of TCE Concentration by Year of All Data (a) and Concentration Data up to 500 ug/L (b). Error Bars Represent the 95 % Percentile

from 1986 to 1995 (except for 1993-1994 because of limited data) and decrease thereafter to nearly constant values between 2001 and 2010. All median values exceed the MCL of 5 ug/L all years except for 1993, 1994, and 2011, which are years with limited data for TCE. Indeed, more than 75% of the annual TCE concentration distribution exceeds the MCL for years 1983, 1986, 1989, 1990, 1992, 1995, and 2005-2010. Low TCE median concentrations in 1984, 1985, 1993, and 1994 reflect the limited amount of data available from the Vega Alta PSWs superfund site since only 4 sampling sites are reported for 1984, 2 sites for 1985, and no samples are reported 1993-1994, for which only data from operational (i.e., not shut off) PRASA wells is available in the area (at Dorado, northwest of the Vega Alta PSWs superfund site). Data in 2011 is limited to 4 sites with TCE concentration (of a total of 17 sites sampled by UPRM in the study area).

Average annual TCE concentrations are the highest for 1982 and mid-1990s (Figure 36). Highest variability is observed for mid 1990s because this is when a large number of outliers occur (Figure 35). Low average TCE concentrations in 1984, 1985, 1993, 1994 and 2011 (Figure 36 b) are mostly due to limited availability of data from the superfund sites during these years. Average concentrations in all other years exceed MCL values. Even 1984 and 1985 seems to have small concentration when compared with other years; the average concentration also exceeds MCL. In general, average TCE concentration tends to increase from 1984 to the mid-1990s, when peak average concentrations are reached. TCE concentrations tend to decrease to a nearly constant value in the late 2000s (2005-2010).

Similar to TCE (Figure 35), although at lower concentrations, PCE maximum concentrations peak in 1996-1997 and decrease thereafter (Figure 37). Concentration distributions of PCE are the highest for 1983, when concentration are all above MCL of 5 ug/L (Figure 37 b), and tend to decrease thereafter. Less than 50 % of the annual concentration data after 1983 fall above MCL, with a much lower percentage after 2006. Higher concentrations of PCE are mostly associated to the Vega Alta PSWs superfund site. Lower concentration values observed in 1984-1988, 1992-1994, and 2011 are mostly associated with limited data available from the Vega Alta PSWs superfund site during those years. Higher average PCE concentrations and variability (as show by standard deviations) are associated with highest maximum concentrations in 1996 and 1997 (Figure 38). High PCE concentrations are also observed in early and late 1980s when average concentrations are above MCL. In general, PCE average concentrations follow similar trends to TCE, but at much lower concentrations. Lower PCE concentrations are mainly attributed to lower PCE fractions at the source.

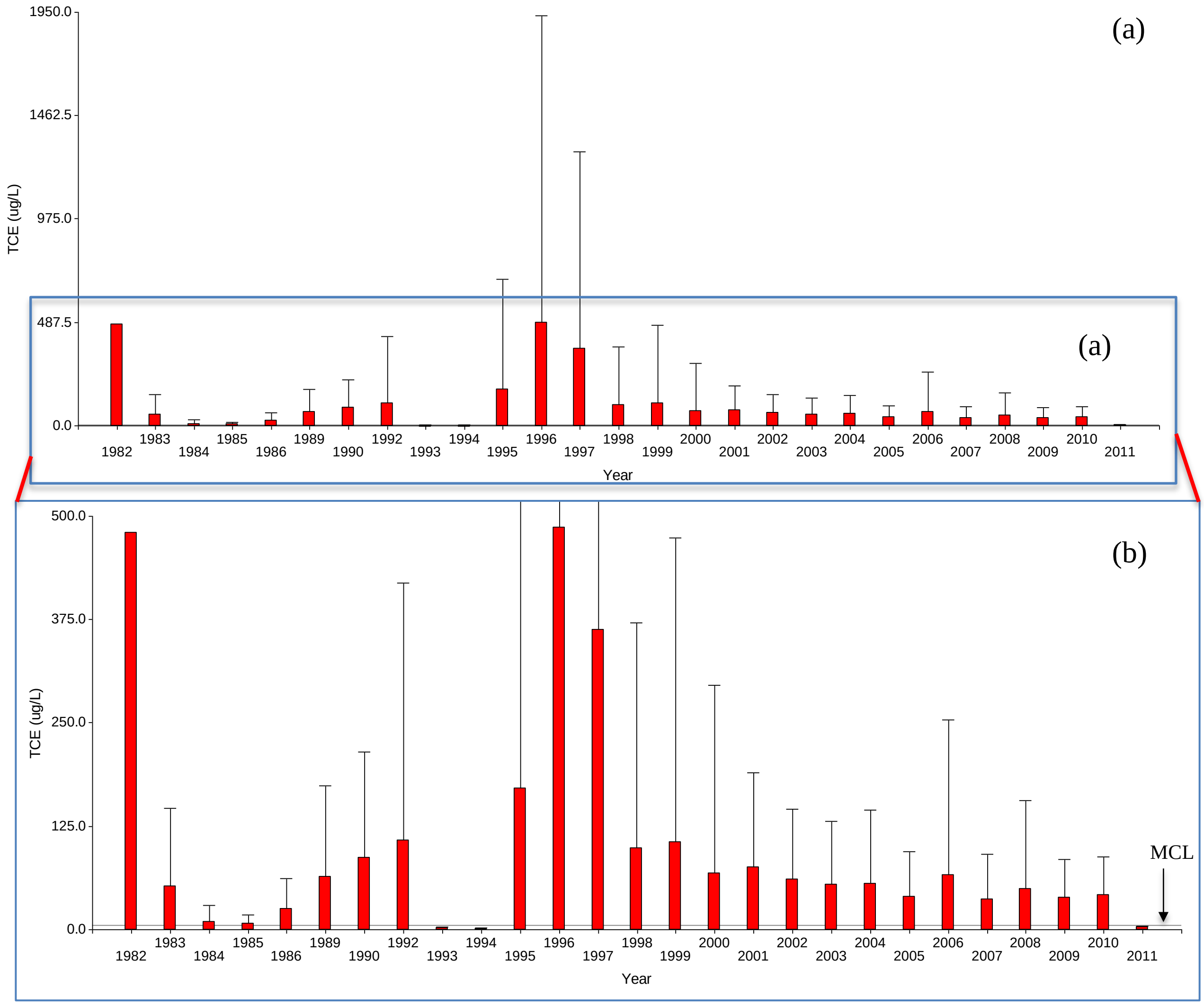

Figure 36 TCE Average Concentrations Bar Graph by Year With Upper Level Standard Deviation of All Data (a) and all Years Data up to 500 ug/L (b). Error Bars Represent the Standard Deviation of Total Concentrations

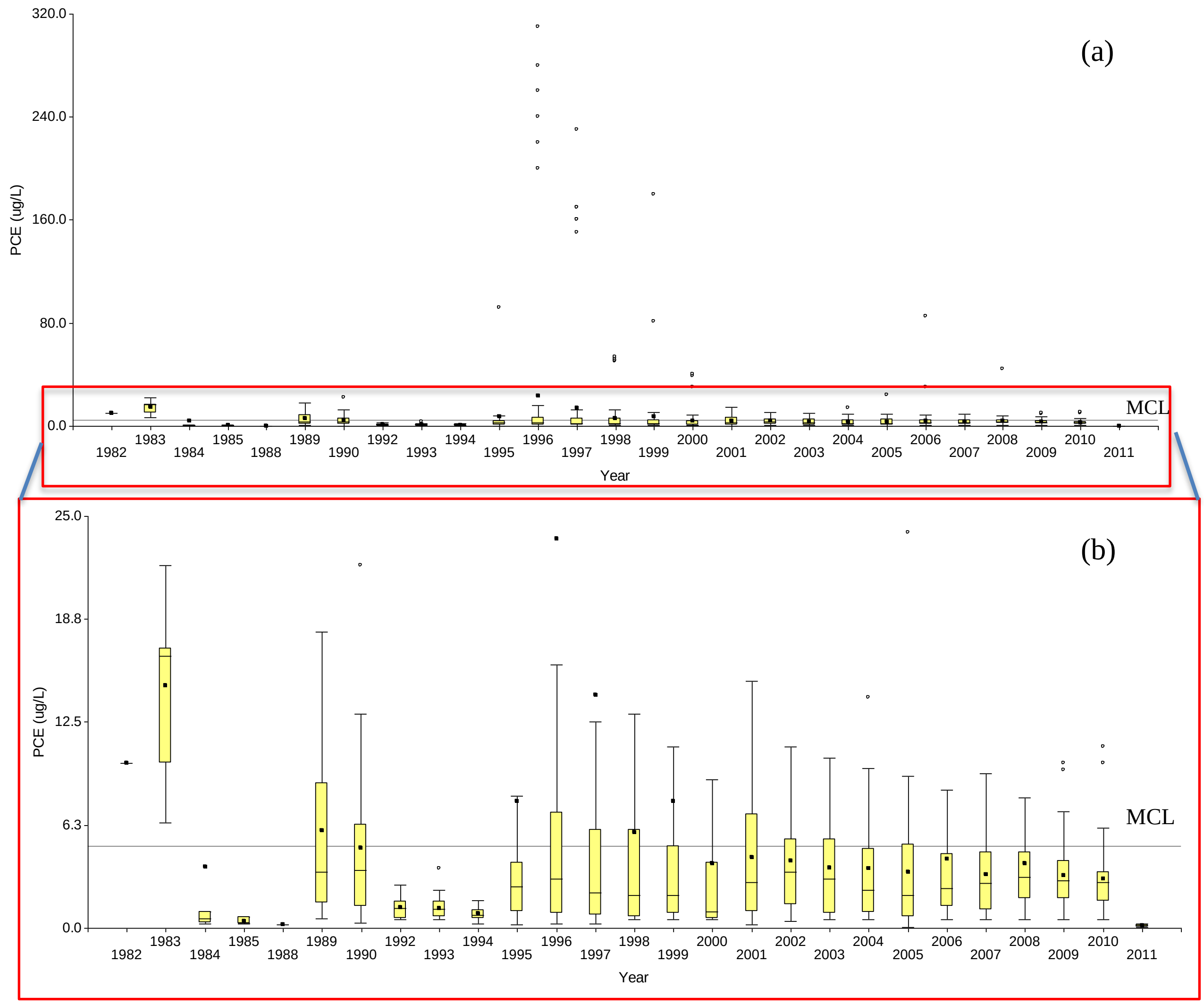

Figure 37 Box Plot of PCE Concentration by Year of All Data (a) and Concentration Data up to 25 ug/L (b). Error Bars Represent the 95 % Percentile

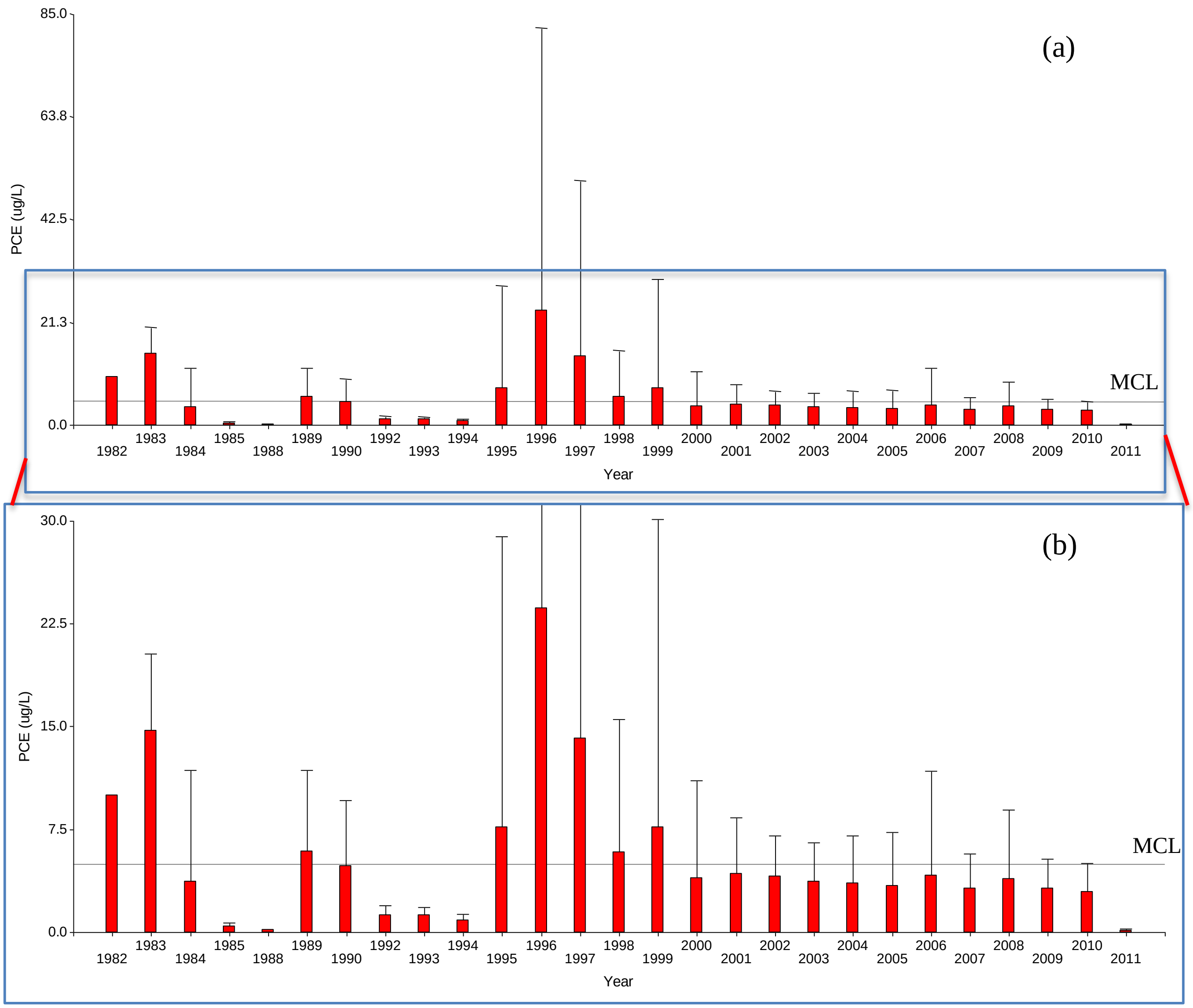

Figure 38 PCE Average Concentrations Bar Graph by Year With Upper Level Standard Deviation of All Data (a) and all Years Data up to 500 ug/L (b). Error Bars Represent the Standard Deviation of Total Concentrations

Temporal concentration distributions of CCl_4 (Figure 39) show the highest values in the early 1980s. These values are mostly associated with the Upjohn superfund site (see Figure 28 a). In general, CCl_4 concentrations tend to decrease from maximum values in 1983 (Figure 39 and Figure 40), a year after the CCl_4 spill at Upjohn. The temporal concentrations distribution (Figure 39 and Figure 40) shows that CCl_4 concentrations decrease until 1995, when concentration increased and later decrease again. Overall decrease in concentrations is attributed to lower CCl_4 near the Upjohn superfund site as a result of active remediation. Annual concentration distributions of CCl_4 are mostly above the MCL of 5 ug/L for most of the analysis period, except for 2011.

CCl_4 show higher maximum concentrations than TCE (Figure 35) only in 1983, when concentrations reached 16,396 ug/L. Average CCl_4 concentrations (Figure 40) in the early 1980s are higher than the highest average TCE concentrations (Figure 35) in the mid-1990s, but they have continued to decline since. In comparison, TCE average concentrations have reached an almost constant value in the late 2000s.

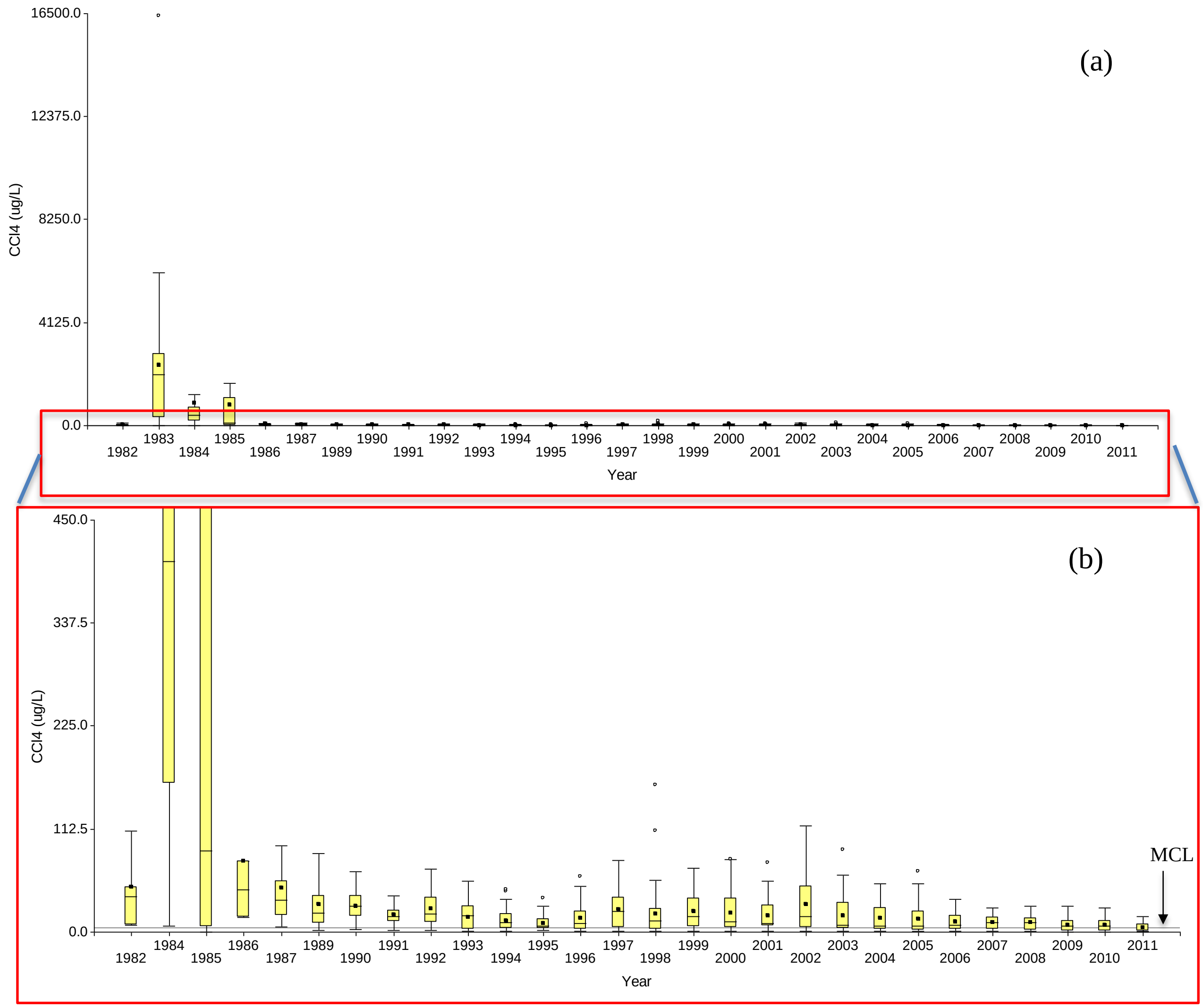

Figure 39 Box Plot of CCl_4 Concentration by Year of All Data (a), and All Years Except 1983 (b). Error Bars Represent the 95 % Percentile

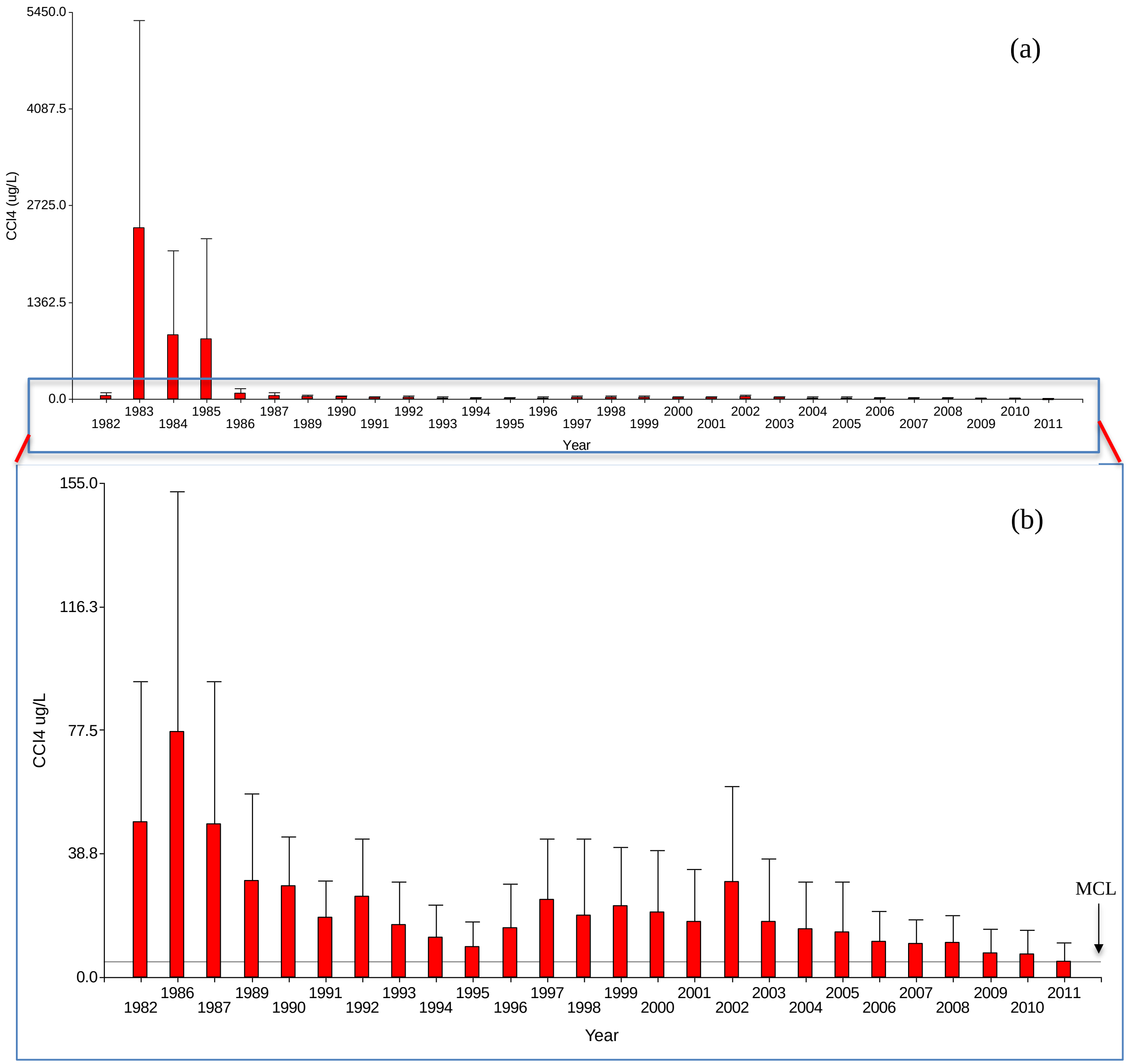

Figure 40 CCl_4 Average Concentrations Bar Graph by Year With Upper Level Standard Deviation of All Data (a) and all Years Except 1983, 1984, and 1985 (b). Error Bars Represent the Standard Deviation of Total Concentrations

In contest to TCE, PCE, and CCl_4 (Figure 35, Figure 37, and Figure 39), TCM concentrations distribution (Figure 41) show a tendency to increase since 1993, with highest concentration values in 1994, 1997, and 2001. Highest TCM concentrations are measure in NON-PRASA industrial well in Barceloneta (see 2001, Table 10) and PRASA wells in Toa Baja (1994 and 1997). TCM is also detected in the Upjohn and Vega Alta PSWs superfund sites but concentrations do not exceed MCL (70 ug/L), although a few concentrations were close to MCL at the Upjohn site (64.5 ug/L). Maximum concentrations tend to increase slightly to peak values

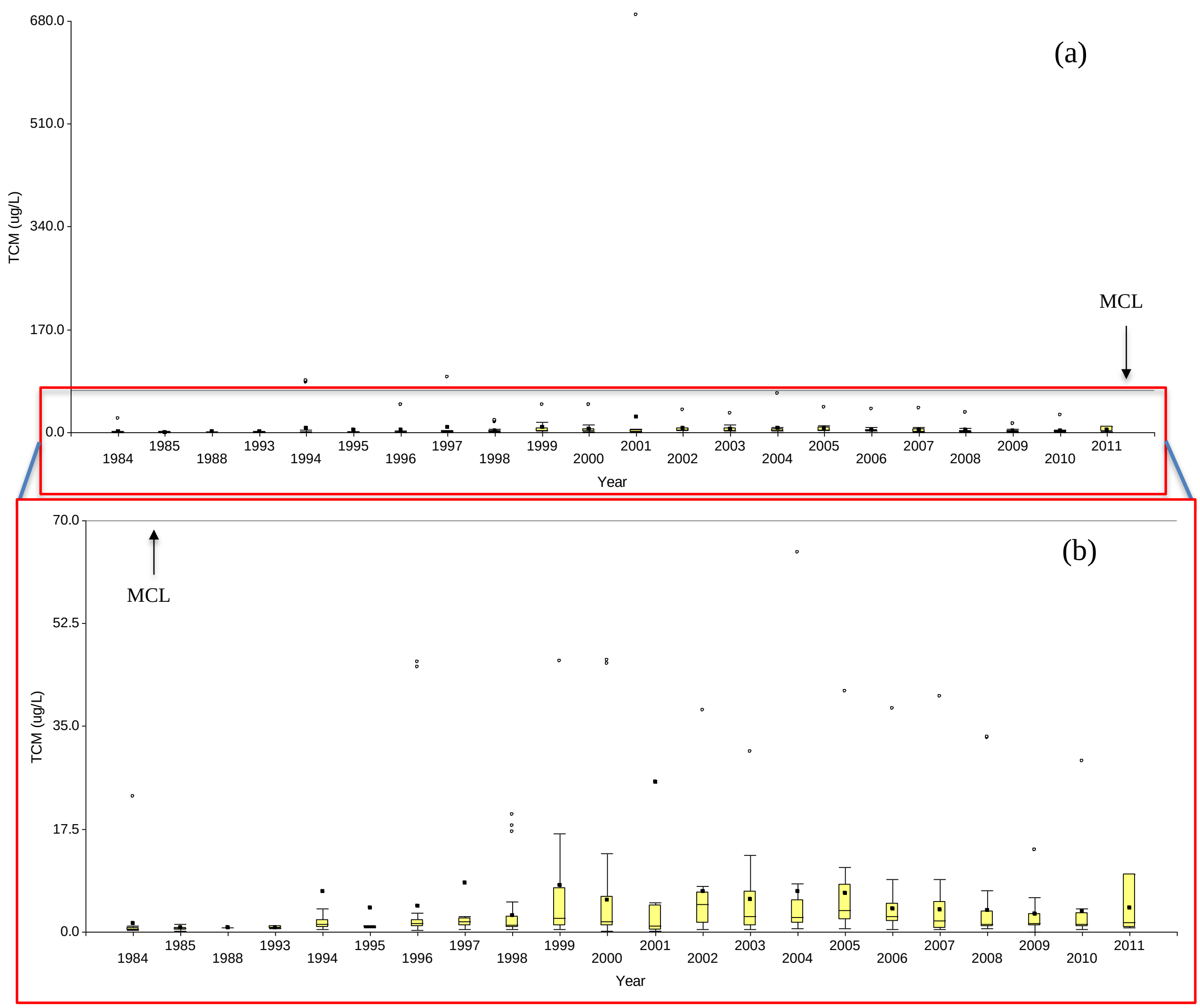

Figure 41 Box Plot of TCM Concentration by Year of All Data (a) and Concentration Data up to 70 ug/L (b). Error Bars Represent the 95 % Percentile

around the period between 2000 and 2005, and decreased slightly thereafter. All TCM concentrations are below the MCL, except for maximum values in 1994, 1997 and 2001. Average annual TCM concentrations (Figure 42), are lower than TCE (Figure 36) and CCl_4 (Figure 40), but not PCE (Figure 38).

TCM concentrations may come from a source (e.g., industrial solvent), or can result from the degradation of CCl_4 or the formation of DBPs. The widespread distribution of average TCM in the study area (Figure 28 b) suggest that a small fraction may come from the degradation of CCl_4 in the Upjohn superfund site, is also present in the Vega Alta PSWs superfund site wells, and some is also coming from unknown sources and/or DBPs formation.

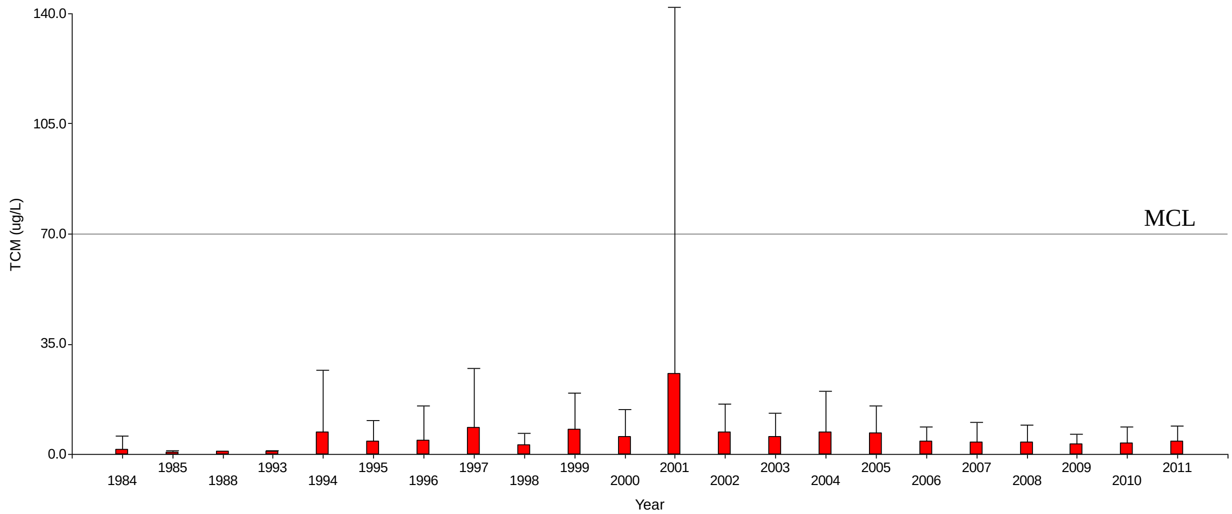

Figure 42 TCM Average Concentrations Bar Graph by Year With Upper Level Standard Deviation of All Data. Error Bars Represent the Standard Deviation of Total Concentrations

Temporal concentration distributions of DCM (Figure 43) show that concentrations tend to increase since 1983 to peak values in 1996-1997. Concentrations decrease thereafter until 2002-2003, when concentrations rise again before decreasing in the late 2000s. A large number of samples show DCM concentrations above the MCL of 5 ug/L for the period between 1990 and 2003, except for the period between 1998 and 2001.

Although DCM is a degradation product of TCM, their temporal concentration distributions do not show similar patterns as TCM (Figure 41). It does, however, follow similar temporal trends as TCE (Figure 35). DCM average annual concentrations (Figure 44) show similar temporal trends as TCE (Figure 36) up to 2000, thereafter it seems to be more related to the CCl_4 average annual concentrations (Figure 40).

The similarity in temporal trends with TCE is attributed to well concentrations near the Vega Alta PSWs superfund site. This can be observed when comparing spatial average concentration distributions for DCM (Figure 28 c) and TCE (Figure 27 b). These results suggest that the source of TCE contamination in this area, most likely also had a sources of DCM since DCM is not considered a degradation product of TCE. DCM in the Barceloneta area may be associated with the CCl_4 contamination at the Upjohn superfund site, and could indicate degradation of the CCl_4 into DCM. This hypothesis must be further evaluated in future studies.

DCM may be potentially related to spatial TCM distribution near the Florida area near the south-central part of the study area (see Figure 28 b and Figure 28 c). In this case, DCM may either be degradation by product of TCM or be present as an additional component in the contamination source in this area.

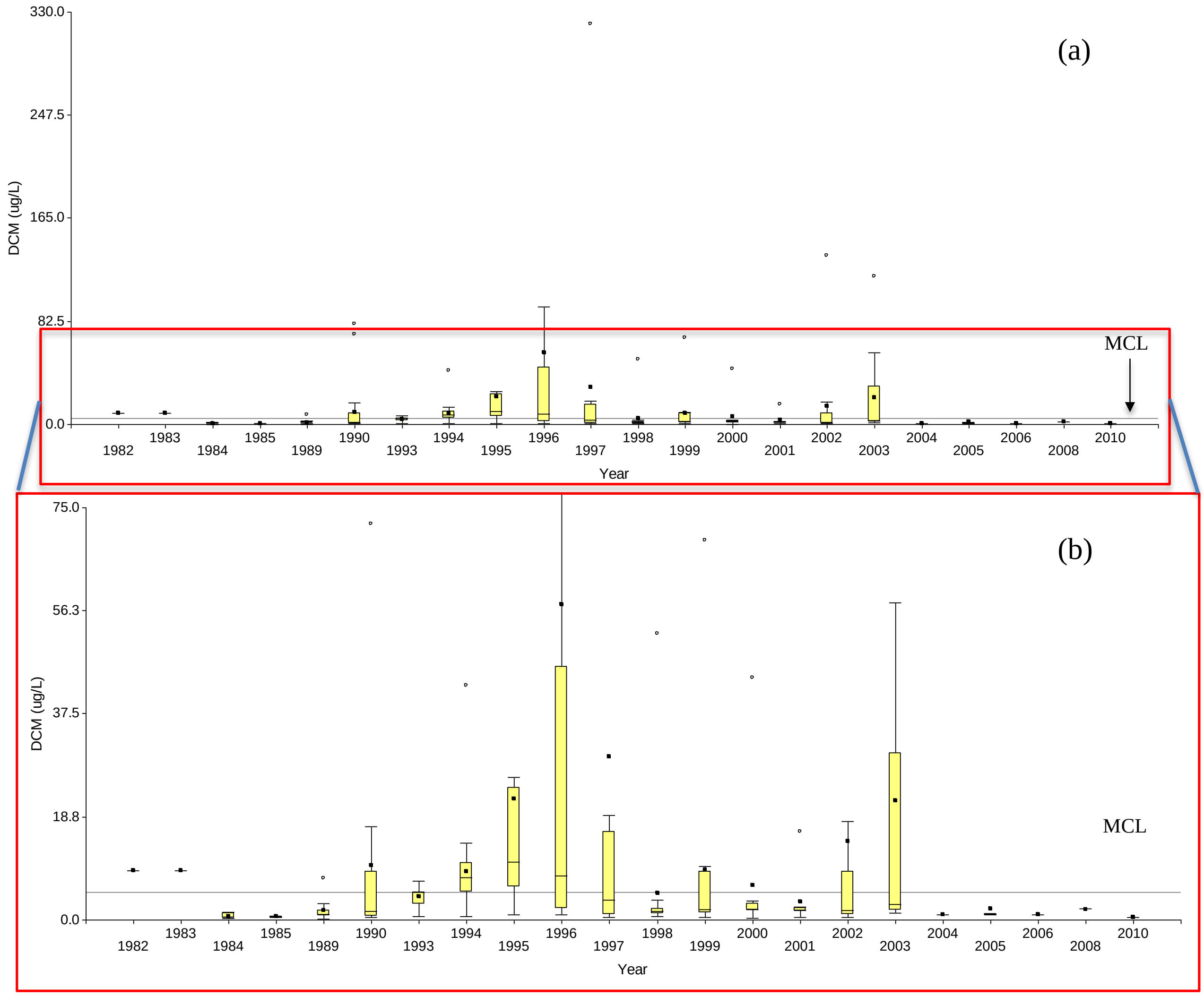

Figure 43 Box Plot of DCM Concentration by Year of All Data (a) and Concentration Data up to 75 ug/L (b). Error Bars Represent the 95 % Percentile

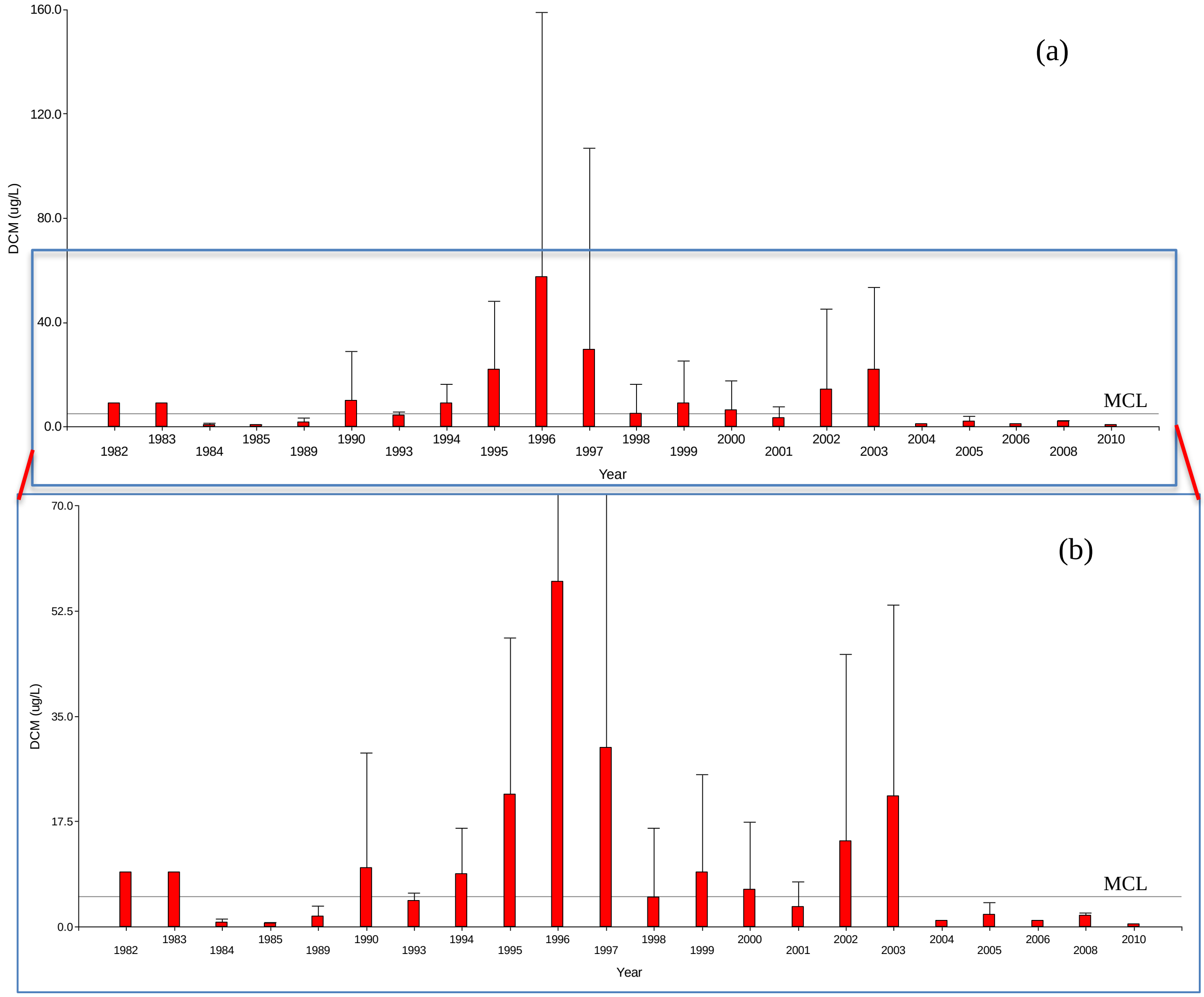

Figure 44 DCM Average Concentrations Bar Graph by Year With Upper Level Standard Deviation of All Data (a) and all Years Data up to 70 ug/L (b). Error Bars Represent the Standard Deviation of Total Concentrations

5.8 Distribution of CVOC Averaged Concentration by Information Source

Previous results and discussion suggest that the measured level of contamination in groundwater (either by detection or concentration) not only depend on the level of actual contamination, but also on the amount and source of data collected. Distribution CVOC concentrations by source of information (Figure 45) indicate that higher concentrations are associated with measurements taken near superfund sites, particularly those associated with the Vega Alta PSWs and the Upjohn superfund sites. This information includes data collected for

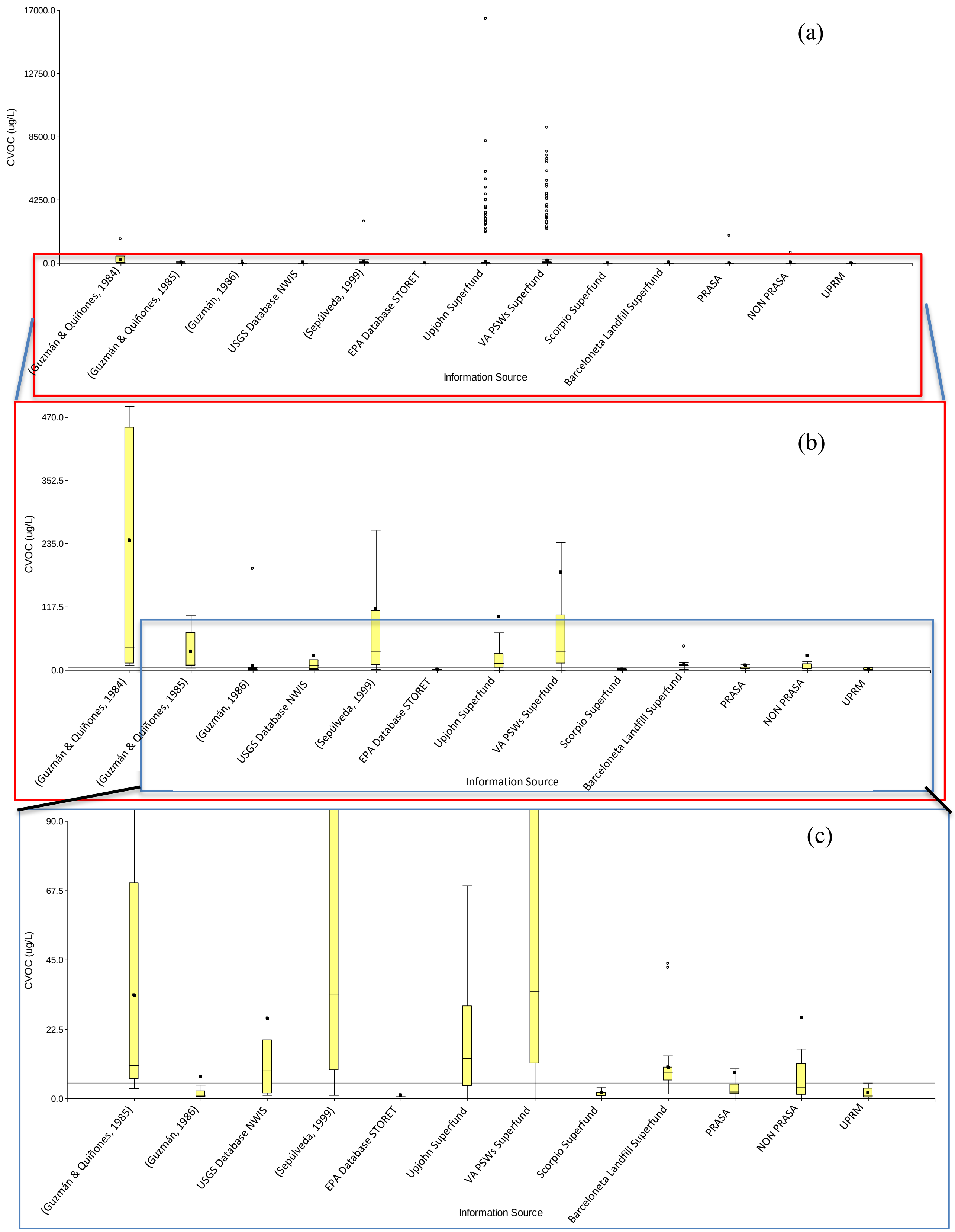

Figure 45 Box Plot of CVOC Concentration by Information Source of All Data (a), Data With CVOC Concentrations up to 470 ug/L (b) and With Concentrations up to 90 ug/L (c). See Table 7 for Information Sources Details

those sites (Upjohn and Vega Alta PSWs) and from (Guzmán and Quiñones, 1984; Guzmán and Quiñones, 1985; and Sepúlveda, 1999). Lower concentration ranges are generally obtained for data from USGS NWIS database (USGS, 2008), EPA STORET database (USEPA, 2008), PRASA, NON-PRASA, UPRM, USGS report (Guzmán et al., 1986), and the Scorpio and Barceloneta Landfill superfund sites. High CVOCs concentration ranges for the sites associated with the Upjohn and Vega Alta PSWs superfund sites is expected because this is where known focus contamination occurs, and the data does not integrate values from other areas. Low concentration ranges for the USGS NWIS and EPA STORET results from integration of concentrations data from many sites, contaminated and not, into their databases. Low CVOC concentrations from UPRM are related to the limited amount of data collected at the time of this analysis and because UPRM sampling schedules begins after major contamination events and implementation of remedial action in focus contamination areas. Low concentration ranges in PRASA wells are a result of shutting-off of the wells after high concentrations are measured. CVOC concentrations are low in the Scorpio superfund site because even though there is CVOC contamination at this site, their major concern is with metals. Average CVOC concentrations and their variability by source of information (Figure 46) indicate that a wider range of concentrations is obtained near major superfund sites.

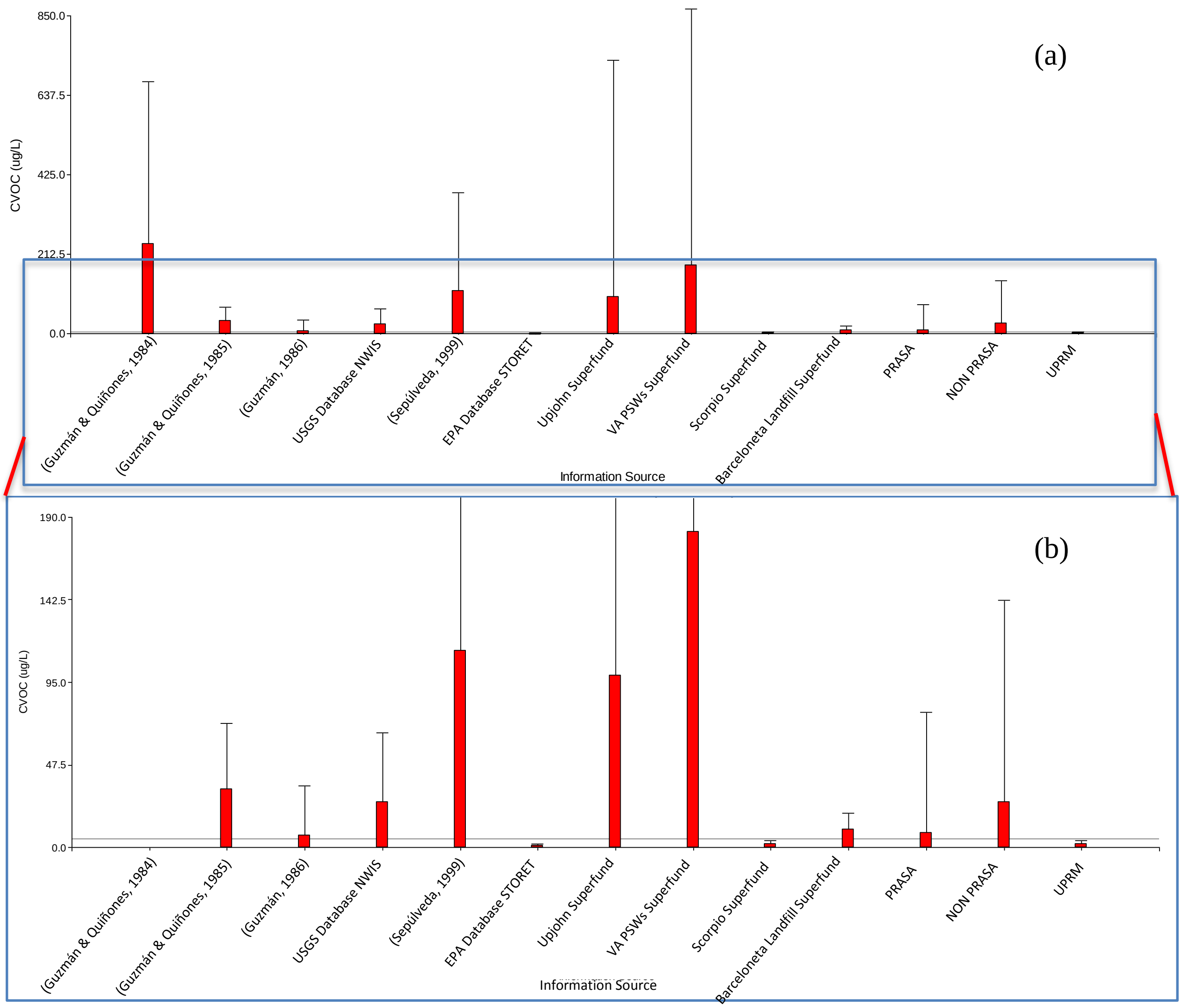

Figure 46 Average CVOC Concentration by Information Source With Upper Level Standard Deviation for All Data (a) and All Data up to CVOC Concentrations of 190 ug/L (b)

5.9 Spatiotemporal Distribution of CVOC Concentrations

This section presents the spatiotemporal analysis of the annual average of the total sum of 20 CVOCs (Table 4). Spatial contamination patterns for each year (Figure 47- Figure 56) are presented with detections sites during that year and, the main sources of contamination from superfund sites.

It is important to keep in mind that spatial concentration patterns are a product of 2D interpolation methods that do not integrate directional groundwater flow. Interpolation results may therefore yield concentration patterns that are not aligned with the principal direction of groundwater flow as this is beyond the scope of this project. It is recommended that the future spatiotemporal analysis integrates groundwater flow principal components.

Spatial total CVOC concentrations patterns in the early 1980s (Figure 47) show major centers of contamination in Barceloneta, Manatí, Vega Alta, Dorado, and Toa Baja. Highest concentration are observed in the Barceloneta and Vega Alta and are associated with CCl_4 from the Upjohn superfund site and TCE and PCE from (what is known as) the Vega Alta PSWs superfund site, respectively. Highest CVOC concentrations are reported in Vega Alta for 1982 and in Barceloneta during 1983 and 1984. Lower CVOC concentration in Barceloneta than Vega Alta in 1982 is most likely due to limited sampling associated with the Upjohn superfund site during this year. Wells sampled by Upjohn in 1982 are located downstream and far from the source and do not represent the concentrations at the source. In 1983 and 1984, Upjohn samples closer to the source and reports higher concentrations. In 1984, lower concentrations to the south of the main contamination sources correspond to TCM with the exception of the detection far to the south in Manatí (that only detect DBPs). TCM is also detected in the Toa Baja area, Dorado, Vega Alta, Vega Baja and Manatí north area. In addition to the Vega Alta PSWs, TCE is detected in Dorado, Vega Baja, and to the north of Manatí. PCE is detected in the Dorado and Vega Alta areas. Sources of contamination affecting the Manatí, Dorado, and Toa Baja areas have yet not been identified. Although comparison of spatial concentration and head contour (Figure 8) patterns suggest that the contamination in the Dorado area may be related to that in Vega Alta.

Spatial concentrations pattern of total CVOCs in the mid-to-late 1980s (Figure 48) suggest a decreasing extension of the contamination, relative to the early 1980s (Figure 47). The apparent decrease is, however, caused by limited sampling schedules. Data during this period is mostly collected by Upjohn near the Upjohn superfund site and a few other PRASA wells are monitored by the USGS (Guzmán et al., 1986 and USGS, 2008). USGS sampling events during this period are, however, less than the early 1980s and are significantly reduced by 1988. This is indeed the period with the lowest sampling densities during the period considered in this study (Figure 26). Upjohn adds sampling wells near the source in 1985, but eliminates the sampling sites used in the early 1980s to the northwest of the Upjohn superfund site. As a consequence

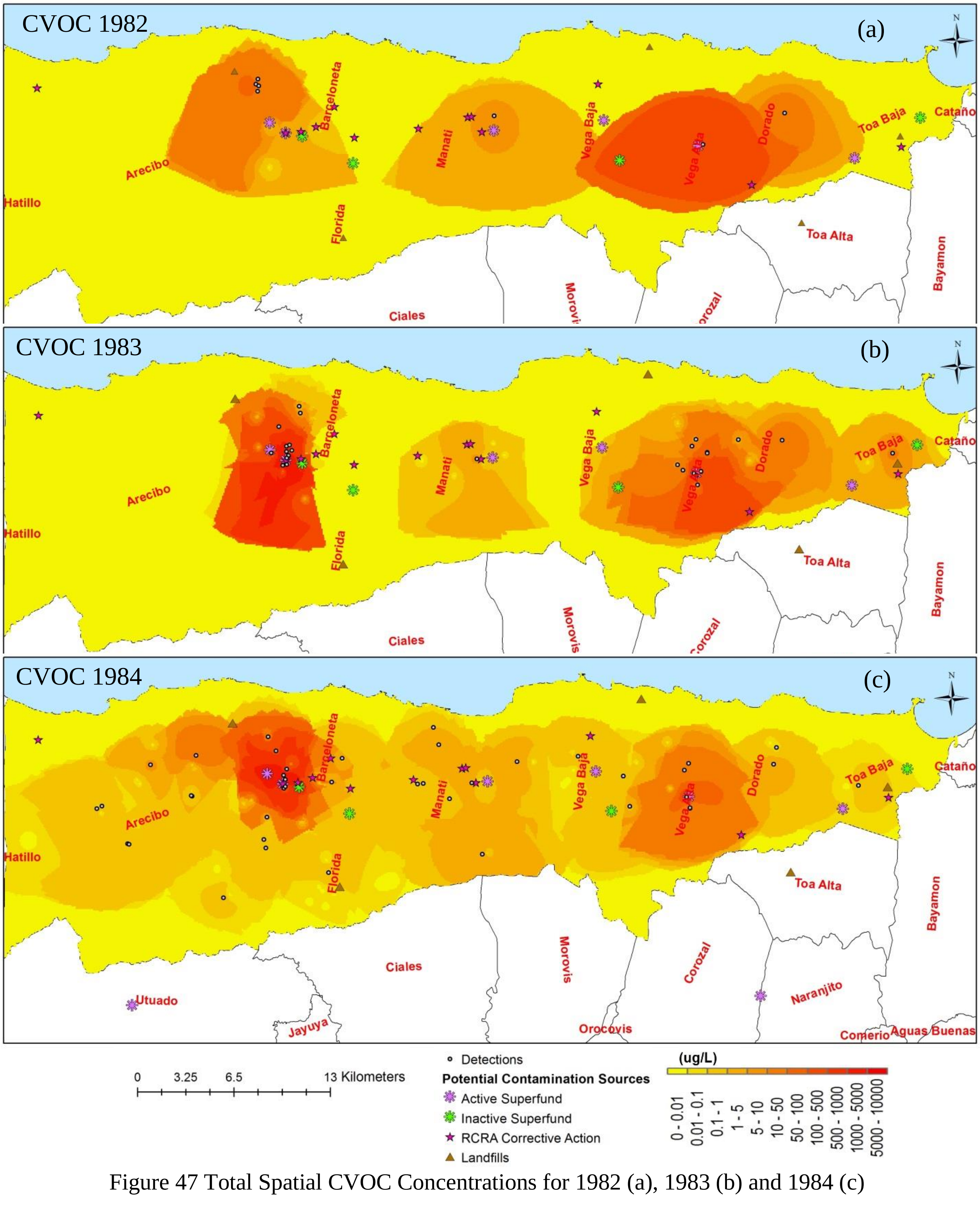

Figure 47 Total Spatial CVOC Concentrations for 1982 (a), 1983 (b) and 1984 (c)

Upjohn superfund site reduces the number of sampling sites and concentrates sampling near the site, limiting the assessment of contamination extent beyond the sampling area. Limiting sampling by USGS in the rest of the study area, including the Vega Alta area, also result in an

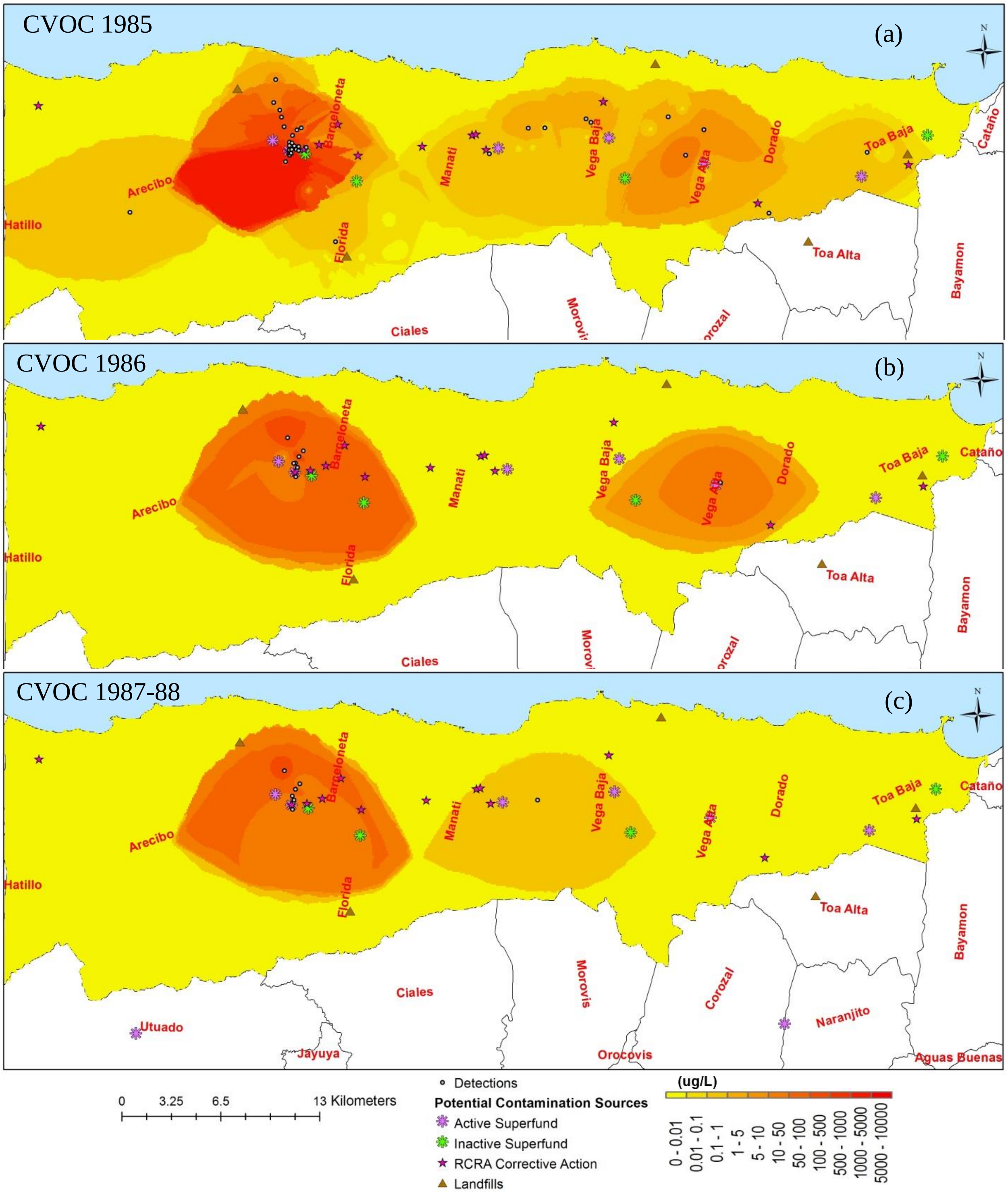

Figure 48 Total Spatial CVOC Concentrations for 1985 (a), 1986 (b) and 1987-88 (c)

apparent decrease in the extent of contamination. In fact, only one well is sampled in the Vega Alta during 1987 and 1988, and no sampling is reported for 1987. As a result, it appears as if there is no contamination in the Vega Alta area during 1987 and 1988 (Figure 48 c). In general, high concentrations are again observed after 1989 (Figure 49 - Figure 56), when sampling densities are increased in the Vega Alta area. As discussed in Section 2.2.1.2, air stripping was applied at the Ponderosa well in Vega Alta from 1984 to 1985, when it was halted. The impact of air stripping on the system cannot, however, be address with the available data.

Highest CVOC concentrations during the mid-to-late 1980s are associated with the CCl_4 contamination at Upjohn superfund site in Arecibo/Barceloneta area (Figure 48). CCl_4 concentrations appear to be higher near the contamination source in 1985, but become higher to the north most of the Upjohn superfund site during 1986-1988. This is attributed to migration of the contaminant from the site. High TCE and PCE concentrations are observed near Vega Alta in 1985 and 1986. It is suspected that much higher TCE and PCE exist in the Vega Alta area, but they are not captured by sampling scheme, which concentrated on PRASA wells away from the contamination source and did not include sampling near the source. Lower CVOC concentrations mostly associated with TCM are observed during 1985 in Arecibo, Florida, Manatí, Toa Baja, Vega Baja and near the southern border of Dorado (Figure 48 a). Some sites in these areas also show the DBP Bromoform (BF), TCE and DCM.

CVOC data for 1989, 1990, and 1992 is supplemented with data collected as part of the monitoring plan for the Vega Alta PSWs superfund site, two USGS studies (Conde and Rodriguez, 1997; USGS, 2008; and Sepúlveda, 1999), and data collected from the PRDoH (Table 9). As a result, spatial concentration distribution can be better defined (Figure 49 and Figure 50 a). Highest CVOC concentrations in 1989, 1990, and 1992 are associated with TCE and PCE at the Vega Alta PSWs superfund site. In 1989, higher CVOC concentrations follow a northeast distribution from the source area in the Vega Alta PSWs superfund site. There is also high concentrations in a well directly to the north of the source area. High CVOC concentration in these areas prompted the closure of several wells, including Monterrey, GE #2, and Bajura #3 (which is near the well encircled in green in Figure 49 a). Sampling events in the Vega Alta PSWs superfund site, which increased during 1990, show a higher CVOC concentration distribution to the north of the site (Figure 49 b) and suggest two plumes: one toward the north and one toward the northeast. TCE and PCE concentration at this time are detected in the Maguayo #2 PRASA well near Dorado (near the blue circle in Figure 49 b), which is further away from the contamination source in the Vega Alta PSWs superfund site and suggest an expanding extent of the contamination. TCE and PCE concentration continue to be detected in

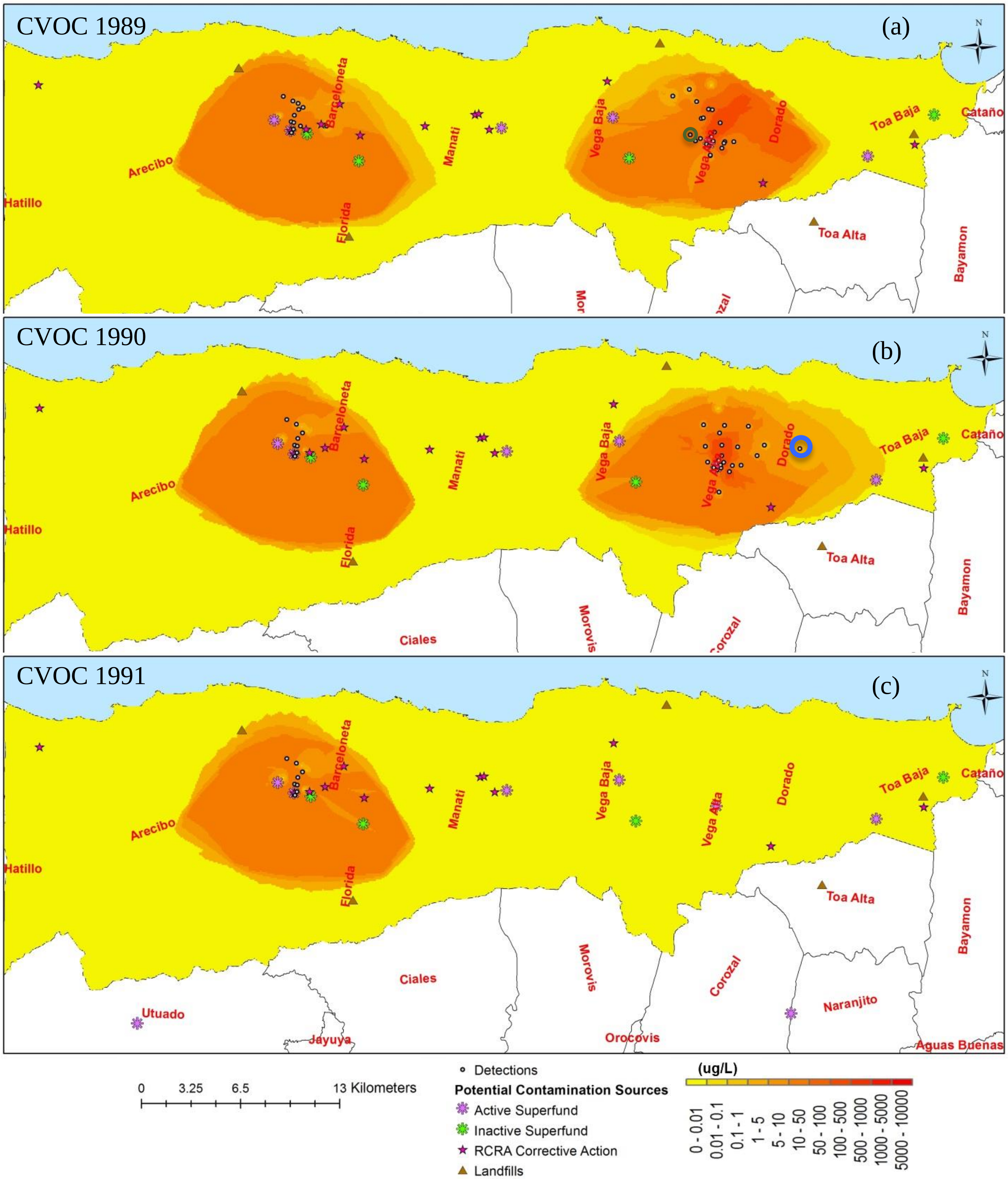

Figure 49 Total Spatial CVOC Concentrations for 1989 With Bajura #3 Well Encircle in Green (a), 1990 With Maguayo #2 Encirle in Blue (b) and 1991 (c)

the Dorado area after 1990. CVOC data from 1992 show a higher concentration distribution toward the northwest of the Vega Alta PSWs superfund site (Figure 50 a).

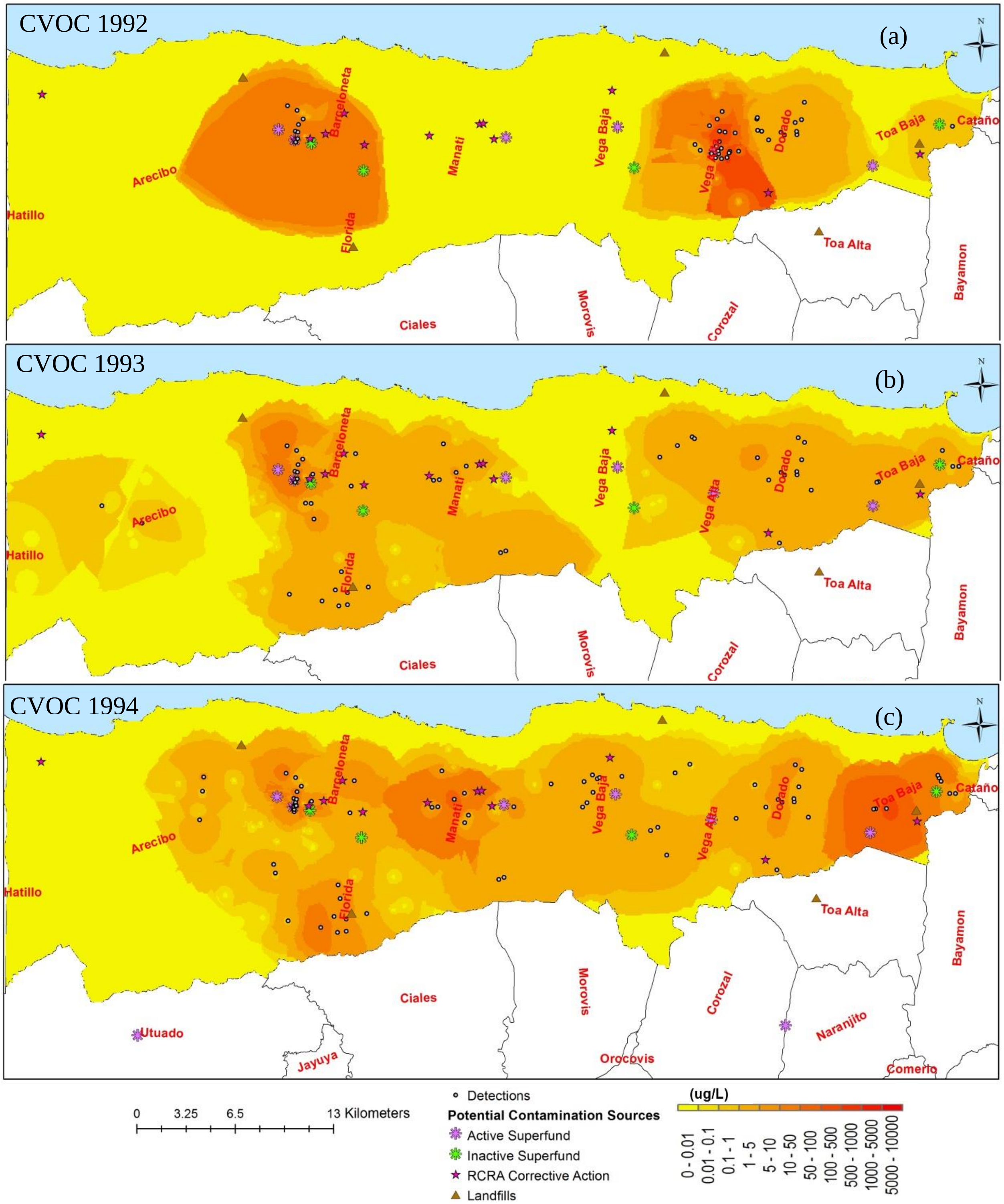

Figure 50 Total Spatial CVOC Concentrations for 1992 (a), 1993 (b) and 1994 (c)

During the 1989 to 1991 period, highest CVOC concentrations associated with the Upjohn superfund site in the Arecibo/Barceloneta area are found to the northwest of the site, at some wells where highest concentrations were measured in 1987 and 1988. The concentrations in these wells are; however, lower than in the 1985-1988 period. CCl_4 concentration in the Arecibo/Barceloneta area appear to be decreasing during this period, except for an area north of the site, near the Upjohn monitoring well #23, which show slight increase in concentration. In 1992, higher concentrations are observed in almost all wells except for one well (Upjohn monitoring well # 101).

CVOC concentration distribution for 1993 and 1994 includes data from the Upjohn superfund site the Scorpio superfund site, and the PRDoH (Table 9). No data from Vega Alta PSWs superfund site is reported. Data from the PRASA wells obtained from the PRDoH help in defining the extent of the contaminants. CVOC concentrations associated with the CCl4 contamination at the Upjohn superfund site continue to decrease during this period, except for one well (UE #1). Higher concentrations densities are found near the source and to the north and northwest of the Upjohn superfund site (Figure 50 b and c).

Detection from the PRASA wells throughout the study area in 1993 and 1994 (Figure 50 b and c) shows a broader extent of CVOC contamination than previous years. It is necessary to keep in mind, however, that the total CVOC spatial distribution includes all 20 CVOCs and distribution for a particular CVOC may not be as continues as the total CVOC. DCM is found through the study area near or above MCL. Other CVOCs (not associated with the Upjohn site) are found more sparsely. In 1993, the Arecibo-Barceloneta-Florida show detection of DCM at and above MCL in the wells south and near east of the Upjohn superfund site and north of the Barceloneta Landfill superfund site; TCM and BDCM (a DBP) are detected at low ppb concentrations in the Arecibo area west of Upjohn; and PCE is detected at 1.5 ug/L north of the Barceloneta Landfill superfund site. In the Manatí area most wells show detection of DCM near MCL. One well (Manatí #3), shows detections of DCE, TCE, PCE, DCM, VC, and TCM. Two wells show DCM near MCL and CCl_4 at low ppb concentrations, and one well show detection of TCE and, PCE at low ppb concentrations. Wells located south of Manatí show detection of TCE, DCE, and PCE at low ppb concentrations. Highest CVOC concentrations in the eastern area is found in Dorado at Los Puertos well, which shows detections of DCM (5 ug/L), 1,1-DCE (0.65 ug/L), TCE (6.01 ug/L) and PCE (1.1 ug/L). Most wells in the Dorado area show detections of TCE and 1,1-DCE, although some also shown detection DCM and CCl_4. In Toa Baja, the eastern most region of the study area, wells located downstream (north) of the Scorpio superfund site show detection of DCM, 1,1,1-TCA, CCl_4 and PCE. In contrast to 1993, 1994 show the highest CVOC concentrations in the Toa Baja and Manatí areas. The Campanilla #8 well in Toa Baja include detections of CM (2.6 ug/L), TCM (83 ug/L), BF (2.1 ug/L), BDCM (33.2 ug/L) and CDBM (13.9 ug/L). Total DBPs add up to 132.2 ug/L, which is higher than the MCL of 80 ug/L for DBPs. In the Manatí area, 1,1-DCE, TCE, PCE, DCM, VC, and TCM are detected in the Manatí #3 well at higher concentrations than 1993. DCM continues to be at near or above MCL concentrations in the Manatí, Vega Baja, and Florida, Dorado, Toa Baja and Arecibo areas. TCM is found west of Upjohn in the Arecibo area, and in the Vega Baja, Toa Baja, and Dorado areas. TCE is found in most wells in the Dorado area.

Data for the period between 1995 and 1997 (Figure 51) includes information from the Upjohn and Vega Alta superfund sites, and PRASA wells. Data is also available from NWIS USGS (USGS, 2008) and from EPA STORET (USEPA, 2008) databases for 1995 and 1997, respectively. All data available from PRASA wells in 1996 and 1997 is included in the data set, that for 1995 does not include all available data from PRASA wells (some still needs to be entered, including entire data for the Dorado and Toa Baja area). It is observed in Figure 51 that better definition of concentration distribution at the regional level is obtained when all PRASA data is included with the Vega Alta PSWs and Upjohn superfund sites.

The highest CVOC concentrations for the period between 1995 and 1997 are found in the Vega Alta area and related to the Vega Alta PSWs superfund site. Highest concentrations, however, vary within specific locations and time. Similar to 1992, the Multiport well #22 in Vega Alta show the highest concentrations in 1995. This well show concentrations of 2,300 ug/L for TCE, 92 ug/L for PCE, 9 ug/L for DCM, 0.6 ug/L for cis-1,2 DCE, and 280 ug/L for 1,1-DCE, respectively. Higher concentrations far to the north of Vega Alta PSWs superfund site in year 1992 seems to be migrating downstream this year. For instance, concentrations in Multiport #2 (well at this high concentration) increase from 51.8 in 1992 to 118 ug/L in 1995. Higher concentrations in 1996 are observed in Multiport GM #2 (4,147 ug/L), GM #3 (3,112.9 ug/L) and GM #1 (1,831.6 ug/L). GM #2 and GM #3 are located near but upstream of Multiport #22. In 1996, Multiport well #22 continued to be high but lower than the concentration presented at 1995 with an actual concentration of 718.4 ug/L. A decrease in concentration is observed in almost all the wells that have been sampled for both during 1995 and 1996 with the exception of

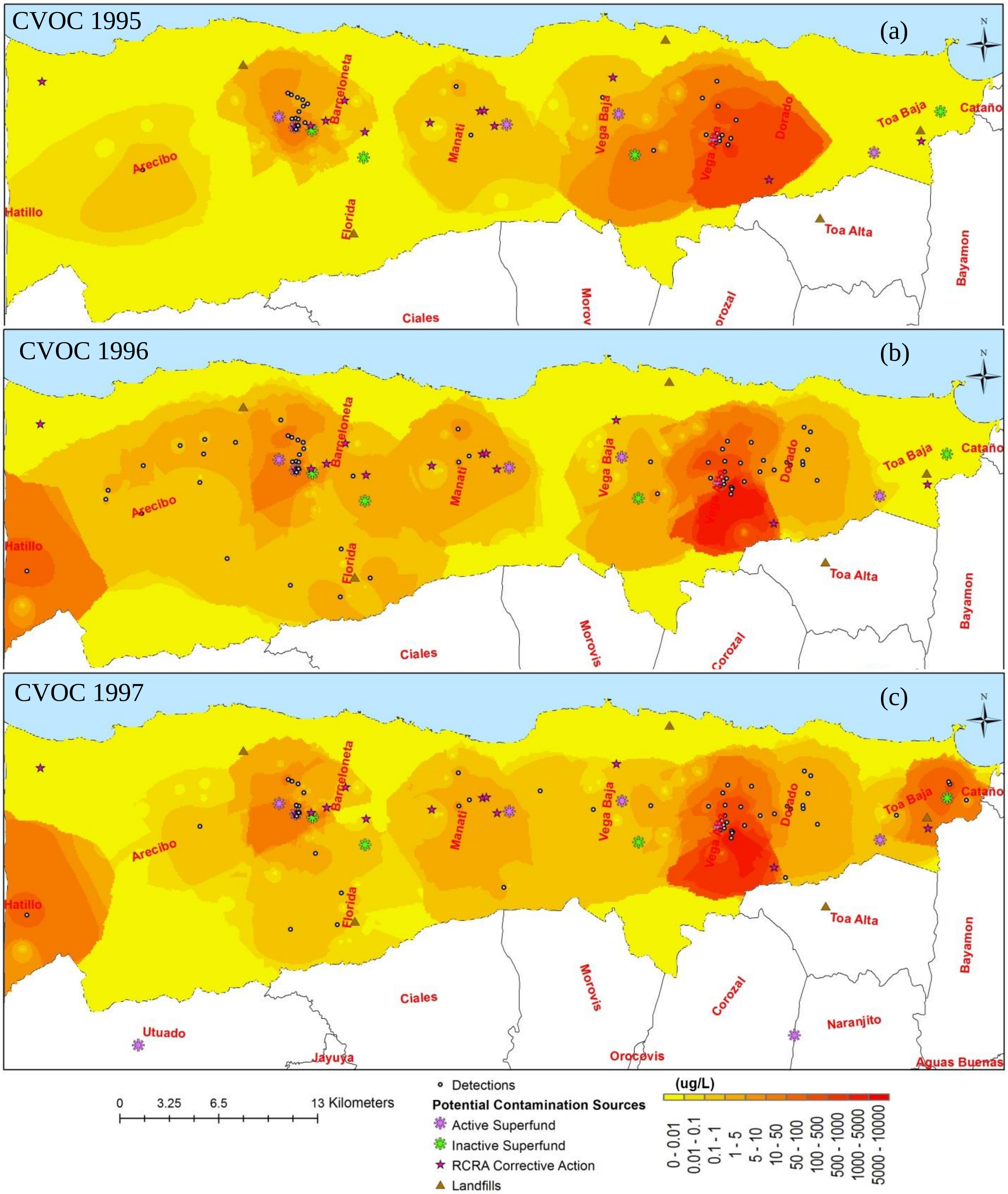

Figure 51 Total Spatial CVOC Concentrations for 1995 (a), 1996 (b) and 1997(c)

a small increase in Multiport well # 11 (75 ug/L to 75.2 ug/L), which is localized northwest of the source area and downstream from northern highest concentration area. When compared with the sampling scheme from 1995, the number of sampling sites in 1996 increases in the northern area. The increase in sampling density in this area results in a much wider spread of high concentration; with the highest concentration present in the centroid of this area. Concentrations are present above MCL in almost every portion of Vega Alta and a slight portion of western Dorado, where the Maguayo # 3 well reaches 5.3 ug/L with a maximum concentration of 6.7 ug/L in 1996. Multiport #17 well, which is at Dorado near Vega Alta (to the northwest of Vega Alta PSWs superfund site source area), reaches a concentration of 44.9 ug/L. In 1997 (Figure 51 (c)), the highest concentration is near the Vega Alta PSWs superfund site more to the south, with Multiport GM #3 showing concentration of 2,238 ug/L, followed by Multiports GM #2 (2,041.7 ug/L) and GM #1 (1,464.6 ug/L). Although Multiport #22 continues to be lower than the GMs wells with a concentration of 917.7 ug/L, the concentration in this well increases in 1997, while the concentrations in the GM wells tend to decrease. CVOC concentrations in 1997 are lower than previous year in areas northwest, northeast, and center of the Vega Alta PSWs superfund site (Multiport #4 decrease from 154.1 to 29.6 ug/L), stay about the same in the wells to the east. Multiport #9 (which is the left detection at the north highest concentration area) decrease by 1.9 ug/L and a well to the west (near Dorado) increase from 101 to 153.3 ug/L. An increase in concentrations is also observed to the south and north of Multiport #9.

Highest concentrations in 1995 at the Upjohn superfund site near Barceloneta are associated with the Extraction well UE #1, which increases from 21.6 to 22.5 ug/L. Other wells in this area show decreasing concentrations suggesting a more effective capture of the CCl_4 contamination compared with the Vega Alta area. Increasing CCl_4 concentrations in the Arecibo/Barceloneta area are observed near the northern boundary of the plume, but at decrease in observed north of this, suggesting some migration of the plume. Highest concentration near the Upjohn superfund site in the 1996 and 1997 continue to be in the same area where the extraction wells UE #1 and UE-2 are located. The UE #2 extraction well begins operation in 1997 near UE #1 and to the east of monitoring well MW-302. Concentrations in UE #1 increase from 36.4 ug/L (1996) to 51.2 ug/L (1997). Concentration in UE-2 reaches 33.1 ug/L in 1997. During this last year the majority of the detections are lower concentrations but exceed the MCL.

Although limited by sampling, other areas show CVOC detections in the study area between 1995 and 1997. In 1995, BDCM is detected at 0.5 ug/L in an area southwest of the Upjohn superfund site; the Manatí area shows detections of TCM (0.8 ug/L); and the Vega Baja higher concentration area show detections of TCM (14 ug/L) and DBPs like BF (1.8 ug/L), BDCM (17 ug/L) and CDBM (7.8 ug/L). The other detection includes low concentration of TCM (1 ug/L). TCM and the DBP CDBM are also detected in Vega Baja in 1996. In addition to TCM, which continues to be detected in 1997, 1,1-DCE and PCE are detected at low concentrations (0.8 ug/L) in the Vega Baja area. The Manatí area shows detection of DBPs and low concentration of TCE (0.8-0.9 ug/L) and TCM (10 ug/L) in 1996. A PRASA well, Manatí #3, in this area show detection of several CVOCs, incliding: TCE, TCM, 1,1-DCE (2.1 ug/L), PCE (0.8 ug/L), cis 1,2-DCE (0.6 ug/L) and CM (5.1 ug/L), which exceeds the MCL. In 1997, all CVOC detections in the Manatí area show TCM (highest at Manatí #3 well). In this area, TCE is found at low concentrations in almost all the wells. Highest concentration in 1997 are found in the Manatí #3 well, which in addition to the previously detected CVOCs, has CM concentration exceeding the MCL at 20 ug/L, PCE, cis 1,2 DCE and the DBPs BF and BDCM. With the exception of the wells related to the Upjohn superfund site and the Manatí detections, all other detections in 1996 are related mainly to TCM, DBPs, and CM. The highest concentration in southwest Arecibo include: DBPs (exceeding MCL) and TCM, with concentrations of up to 46 ug/L. DBPs exceeding MCL and high concentrations of TCM (45 ug/L) are found in this area in 1997. TCM is also detected southeast of the Upjohn superfund site, southeast of Arecibo, and northern Florida in 1997. PCE is also found south of the Upjohn superfund site. Increase in concentration and number of contaminant detected in this year suggest the presence of an unidentified source of contamination in this area. The Dorado area also shows increased CVOC detection and concentrations in 1997. TCE in Maguayo #3 reaches concentrations near MCL, and Maguayo #2 shows detections of TCE, PCE, and DBPs. All the others PRASA wells in Dorado area have TCE and PCE detections. In Toa Baja, the highest concentration area include two wells with DBPs exceeding MCL and one of them also exceeding MCL of TCM (91.6 ug/L). The other well also shows high concentration of TCM (34 ug/L). Campanilla #8, which is downstream from Scorpio Recycling site, has TCM (0.6 ug/L) and the lowest concentration to the west include a detection of PCE (0.5 ug/L).

In 1998 (Figure 52 (a)), the available sources of information include data from the Upjohn and Vega Alta PSWs superfund sites, and PRASA and NON-PRASA wells. The highest concentration is the Vega Alta area, where Multiport well #22 has a concentration of 708.3 ug/L, which is slightly lower than the previous year. In the past, the GM Multiport wells had shown the

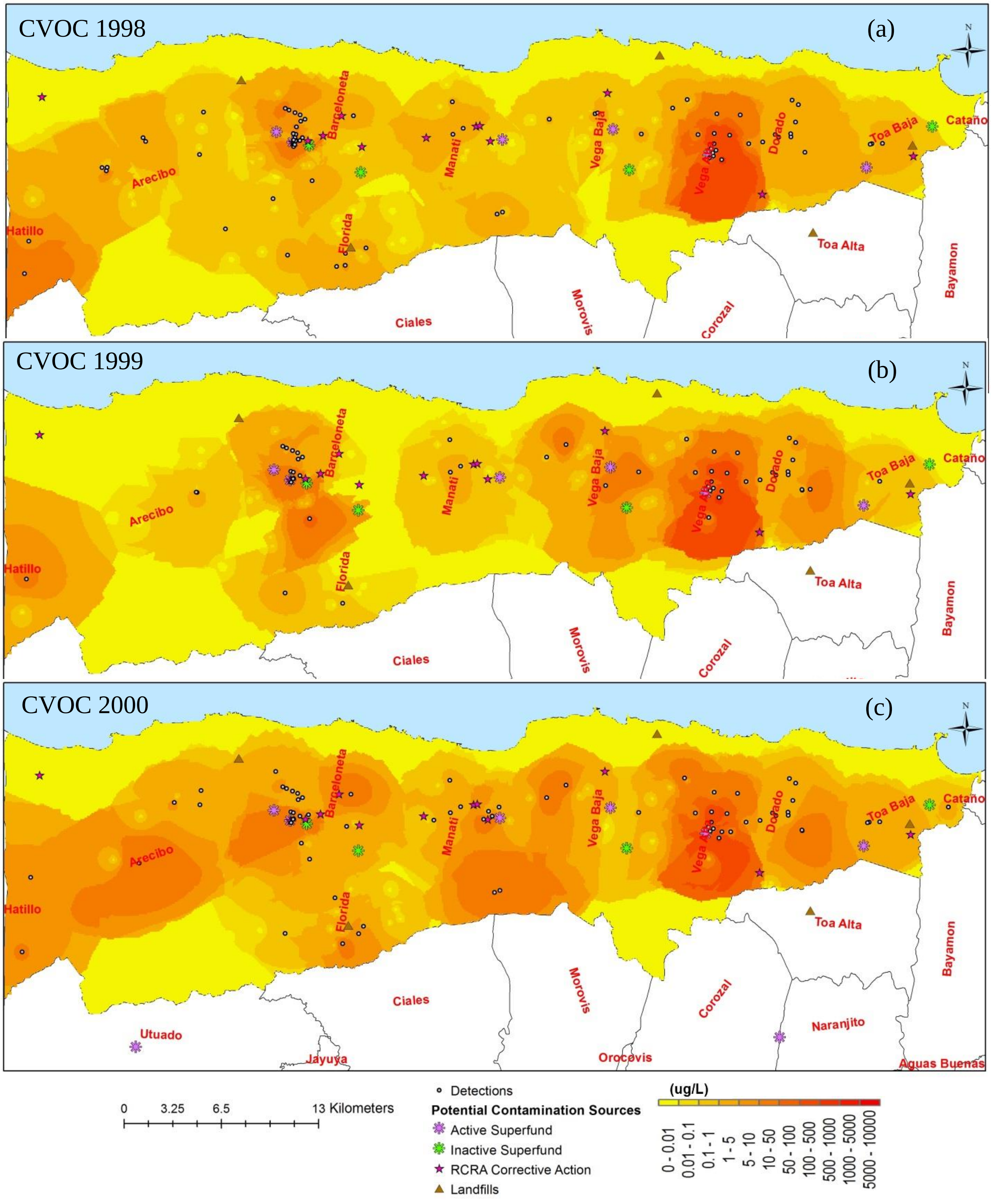

Figure 52 Total Spatial CVOC Concentrations for 1998 (a), 1999 (b) and 2000 (c)

highest concentration, but they were not sampled in 1998. As a result, the concentrations tend to be lower than in 1997. Similar distribution is observed in 1998 in the high concentration area at the north but with lower concentration at wells Multiport #8 and #9 (123.1 and 148.4 ug/L).

Higher concentration is observed to the south of Multiport # 9, where Multiport #3 and Multiport #12 has 226.1 and 176.4 ug/L. An increase is also observed to the south of Superfund location on Multiport #1, which increases from 1.4 to 19.5 ug/L and a small increase has been observed to the west of Multiport #12 at Multiport #11 (68.6 to 71.7 ug/L). The other wells present a decrease in concentration. In terms of the Upjohn site, an increase in the sampling site is observed, resulting in better plume definition. This time, the higher concentration is between the two extraction wells at MW #302 with 52.6 ug/L, which is higher than past years, following by extraction well UE #2 with 40.6 ug/L (also higher than past years). The extraction well UE #1 and the close well #301B present a concentration decrease between 32.5 and 13.5 ug/L respectively. An increase in concentration is observed at the southwest well MW #1 that increases from 5.3 to 21.2 ug/L. Similar but lower concentration is observed to the south at MW #10 (19.2 ug/L) that has not been sampled during the last years. Other increases are also observed in the north. One of the wells with high concentration includes the MW #16. During the past year this well had No Detection; this year it has 14.8 ug/L but to the north well #22 a decrease from 7.4 to 3.4 ug/L was observed. In terms of PRASA wells data, there is still presence of TCM (46 and 18 ug/L) and DBPs southwest of Arecibo, but this time it is observed in two wells and the concentration does not exceed MCL. Moving to the east there are three detections having low concentrations of TCM and the higher concentration also includes CA (0.6 ug/L) and CM (18 ug/L) detections. The next two detections also include TCM (3.5 and 2.1 ug/L), one (north one) also has 1,1-DCE (1.1 ug/L) and the other the DBP BDCM (2.3 ug/L). The high concentration to the south of Upjohn, similar to last year, also has TCM (0.8 ug/L) and PCE (4 ug/L). All the others detections in Arecibo and Florida only include TCM concentrations ranging from 0.5 to 6.6 ug/L. North of Barceloneta there is 1,1-DCE (0.5 ug/L) and TCM (1.5 ug/L). In the southern area of Manatí there is detection of TCM (2.3 and 0.6 ug/L) and the detections at the north continue to have TCE (0.6 to 0.8 ug/L), two sites with PCE (0.7 to 0.9 ug/L), two with TCM (1 to 2 ug/L) and one has the DBP BDCM (0.5 ug/L). Similar to past years, Manatí #3 also includes detections of 1,1-DCE (1.2 ug/L) and cis 1,2-DCE (0.6 ug/L). In Vega Baja (mostly northwest) all detections also include TCM ranging from 0.6 to 1.8 ug/L). The two detections closest to the west side of Vega Baja include one PCE (1.2 ug/L) and the other TCE (2.5 ug/L). In the Dorado area, PCE and TCE has been detected, where wells more to the west and north Dorado contain higher concentrations of TCE and the majority include lower concentrations of both. Maguayo #3 has the highest TCE concentration with 6.4 and 5.2 ug/L (above MCL values); there is also 1,1-DCE (1.1 ug/L) and CM (1 ug/L). In addition, there are two wells nearby that also have CM (0.8 and 1.1 ug/L), three wells with TCM (0.5 to 3.6 ug/L) of which two also have DBPs, and two additional wells which present DBPs but no TCM has been detected. Moreover, San Antonio # 3, at the northeast, has CCl_4 (1.1 ug/L) that has been detected in addition of the PCE, TCE, TCM and DBPs. In Toa Baja, all the detections include TCM ranging from 0.8 to 2 ug/L.

Available information sources for the year of 1999 Figure 52 (b) include Upjohn, Vega Alta PSWs and Scorpio superfund sites and PRASA and NON-PRASA data. The highest concentration is consistently present in the Vega Alta area, where Multiport well #22 currently has a concentration of 880 ug/L, resulting higher than the past year. Similar distribution is observed in the high concentration area to the north but with higher concentration on wells Multiport #8 (from 123.1 to 241 ug/L), similar concentration on Multiport #9 (from 148.4 to 141.7 ug/L) and lower concentration is observed to the south of Multiport #9, where Multiport #3 and Multiport #12 has 105 and 57.4 ug/L. These last two wells now have a different hence lower area classification. Moreover, slightly higher concentration is observed to the south of Multiport #12 on Multiport #6 (17.7 to 18.4 ug/L), west of Multiport #9, at Multiport #4 (24.3 to 36.9 ug/L), to the northeast at Multiport #17 (10.6 to 11.3 ug/L), and to the east at Multiport #13 (3.1 to 5.8 ug/L). In terms of the Upjohn superfund site, the highest concentration continued to be between the extraction wells area at MW #302 with 69.5 ug/L, which is still higher than past years, following by UE #2 with 40 ug/L (similar to last year). The extraction well UE #1 and the close well #301B present a decrease in concentration between 27.6 and 6.3 ug/L respectively. Concentration to the north decreases at the high concentration of past year but increases in some portions. When considering the PRASA wells detections, there are still detections of TCM (7.1 ug/L) and DBPs to the southwest of Arecibo, but with lower concentrations. CM (0.5 ug/L) has also been detected. To the southeast of the Arecibo and Florida area, TCM has been detected with concentrations of 2.4 and 0.6 ug/L respectively. To the west of the Upjohn area TCM (1 ug/L) and the DBP BDCM (0.9 ug/L) has been detected and to the south TCM (46.1 ug/L) and the DBPs BDCM (0.9 ug/L) and CDBM (4.1 ug/L) has been detected. In the Manatí area, all the detections include TCE (range of 0.6 to 0.8 ug/L) and the two closest detections also include PCE (0.7 and 0.9 ug/L). Similar to the past year, the detection more to the south (Manatí #3) includes TCM (1.6 ug/L), 1,1-DCE(1.4 ug/L) and cis 1,2-DCE (0.6 ug/L) but also includes 1,1-

DCA (1.3 ug/L). In the Vega Baja area, the detection more to the west includes PCE (0.5 ug/L). The following detection to the west includes DBPs BF, CDCM and BDBM. The next detection to the west has TCM (6.3 ug/L), DBPs, BDCM, and CDBM. The last detection in the Vega Baja area includes TCM (12.5 ug/L) and all the main DBPs. At northwest Vega Alta, the detection only includes the DBP BF (2 ug/L). In the Dorado area, the detection closest to the west (Maguayo #3) continues to include a TCE (5.7 ug/L) concentration exceeding MCL as well as PCE (1 ug/L), and 1,1-DCE (0.5 ug/L). With the exception of the highest concentration in Dorado, which only has TCM (21 ug/L) and DBP BDCM (14 ug/L), all others have TCE detected at slightly higher concentrations and PCE. Maguayo #6 (one of the detections in the center area) also include sTCE detection exceeding MCL with 5.1 ug/L. The detection found to the north (San Antonio #2) also has TCM and BDCM and, to the south of this well (San Antonio #2) the same detections are observed. San Antonio #2 also includes CM, CDBM, and BF detections. Almost at the same location of San Antonio #2 there is San Antonio #3, which has CCl_4 (1.9 ug/L) at a higher concentration from the past year. In the Toa Baja area, only CM (0.621 ug/L) has been detected.

In 2000 (Figure 52 (c)), the available information sources include Upjohn and Vega Alta PSWs superfund site, PRASA and NON-PRASA data. The highest concentration continues to be in the Vega Alta area where Multiport well #22 has a concentration of 656 ug/L, resulting lower than last year. Similar distribution is observed in the high concentration area at the north but with higher concentration on wells Multiport #3 (from 105 to 200.1 ug/L), Multiport #12 (from 57.4 to 66.3 ug/L) and lower concentration is observed on Multiport #8 and Multiport #9, which has 101.7 and 137.3 ug/L. These last two wells now have a smaller concentration area surrounding them while Multiport #3 is now part of the northern area with the highest concentration. In addition, slightly higher concentration is observed to the north of Multiport #9 at Multiport #5 (2.9 to 3.4 ug/L), to the northeast at Multiport #17 (11.3 to 13.3 ug/L), and to the east of Multiport #13 in Maguayo #3 (3.8 to 4.4 ug/L). These last wells are part of the PRASA wells in Dorado area, which for the last three years, have had at least one or two samples of TCE exceeding MCL. This year it includes concentrations exceeding MCL of 5 and 5.8 ug/L. Similar to findings of previous years, at Dorado area, the wells includes 1,1-DCE and PCE detections. With the exception of three detections that have PCE or TCE, all the other wells include TCE and PCE detections. From north to south, the third well (Higuillar #1) has one sample of TCE reaching MCL been exactly 5 ug/L. Five of the detections have TCM (ranging from 0.5 to 15.8 ug/L), two have 1,1-DCE (0.5 and 1 ug/L), one has CM (2 ug/L), and two have DBPs. At the Toa Baja area all the detections include TCM (ranging from 0.5 to 2 ug/L), the two detections at the center also include DBPs and the detection more to the east also include PCE (0.8 ug/L). In terms of the Upjohn site, only a small increase has been reported at extraction well UE #2 (40 to 41.3 ug/L) and the near observation well MW #301B (6.3 to 7.8 ug/L), at the south well UJ #1 (16.6 to 17.4 ug/L) and at the north at wells Pollera Ochoa, MW #102 and MW #204. The maximum concentration continued to be at MW # 302 been this year 59.8 ug/L and to the north area continued to be MW #23 but decreases from 9.2 to 6.7 ug/L. Of the remaining detections, almost every other detection in the study area includes TCM with the exception of the following detection: the first detection is found from north to south in Arecibo (which only has DBPs), the detection at the southeast corner in Arecibo (which only has CCl_4 (0.8 ug/L)), and the closest three detections to the Pesticide Warehouse superfund at Manatí (which all has DBPs and one also has CCl_4 (2 ug/L)). DBPs have also been detected at the following detections: the southwest corner of Arecibo, the following two detections moving to the east, the two detections in Florida (closer to the west), the detection at the highest concentration area at Barceloneta, both detections at the highest concentration area at Vega Baja (one also includes PCE at 1 ug/L), and both detections on the southeastern area of Manatí. In addition, at least three detections in the Manatí area have additional detections: two have PCE, two have 1,1-DCEand one also has TCE. There are two detections to the south of Upjohn area where PCE (1.9 ug/L) and DCM (0.25 ug/L) has been detected.

As shown on Figure 53 (a), in 2001, the available sources include Upjohn, Barceloneta and Vega Alta PSWs superfund site, PREQB, NON-PRASA and some PRASA data from the first quarter. This year, the highest concentration is located at a NON-PRASA well in the Barceloneta area. This detection only includes TCM with concentration reaching 690 ug/L, which exceeds the MCL standard. The following highest concentration is in the area of Vega Alta where Multiport well #22 continues to be the highest concentration area with 265.8 ug/L, a result that shows decrease from the past year. General concentration distribution continues to be similar to that of the last year but increases have been reported at the north high concentration area in Multiport wells #9 and #8, which has 170.9 and 109.9 ug/L respectively. Additional increases have been observed to the south of these concentration areas in the wells of Multiport

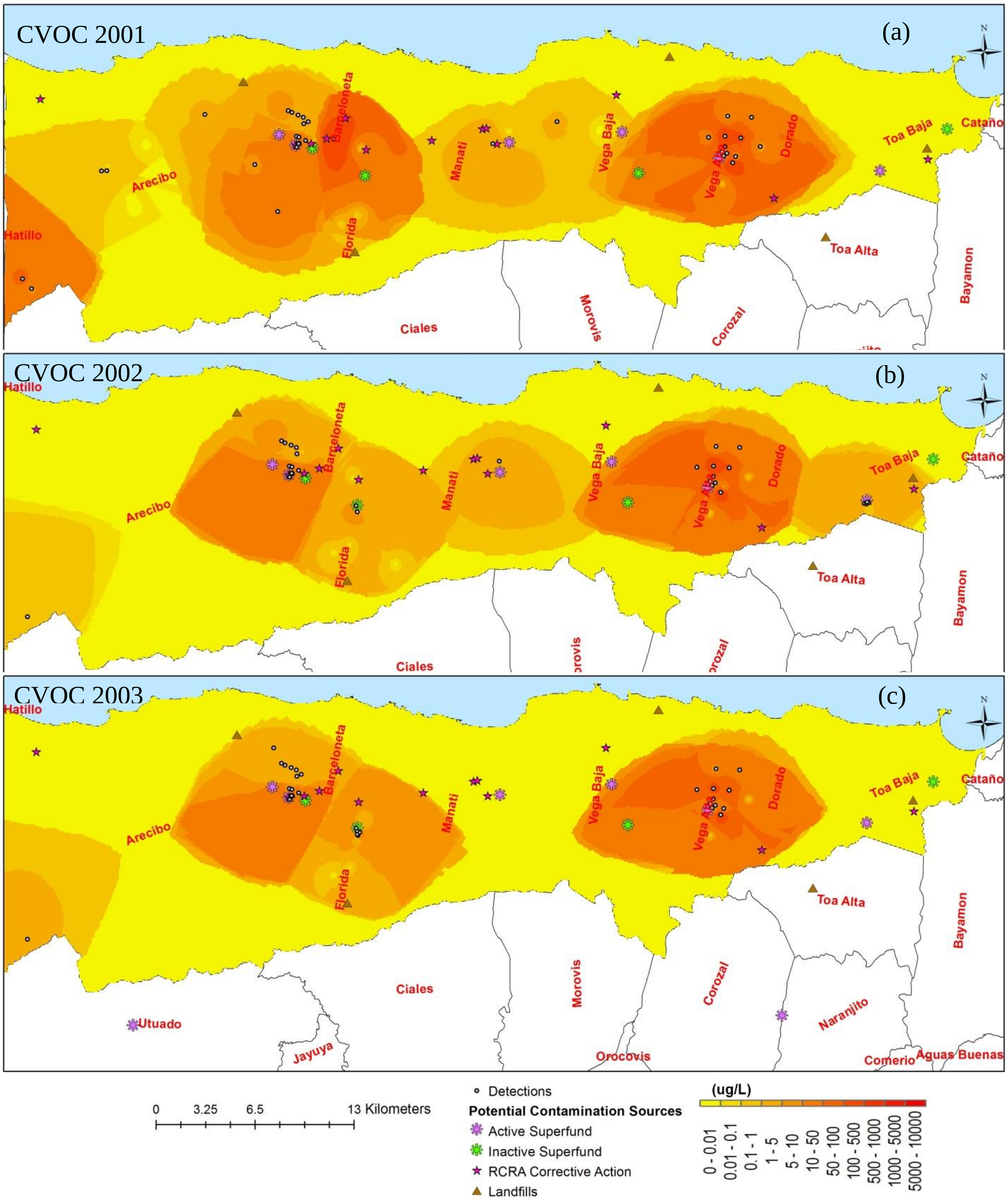

Figure 53 Total Spatial CVOC Concentrations for 2001 (a), 2002 (b) and 2003 (c)

#11 and #6, which is to the south of first one, with concentrations of 41.9 and 10.4 ug/L. Small increase has also been reported on Multiport #4, which is to the west of Multiport #9, and Multiport #19 to the north of Multiport #22. In terms of other detections, in the Vega Baja area.1.2 ug/L of PCE has been detected, in Manatí #3 PCE (1.4 ug/L), and TCM (1.9 ug/L). In Arecibo, the closest detections to Upjohn area contain DBPs BF (1.3 ug/L) in the northern one and CDBM (7.9 ug/L) at the other. To the south the detection includes TCM (17 ug/L) and DBP CDBM (5.1 ug/L). The two low concentration detections to the west contain TCM and to the southwest both have TCM. However, the north one has the highest concentration with 25 ug/L and also includes DBPs BDCM and CDBM. In addition, the south one has DCM exceeding MCL with 14.5 ug/L. Finally, at the Upjohn site, the highest concentration continues to be in MW #302 with 50.5 ug/L, which results to be lower than data reported last year. Similar concentration distributions have been reported, when compared with past year, but with increases in UJ MW #1 (17.4 to 25.4 ug/L), in northern highest concentration at MW #23 (6.7 to 8.7 ug/L), to the north of Extraction wells at MW#18 (8.6 to 9.6 ug/L), and small increase at MW #22, which is to the south of Pollera well.

Considering the year 2002 (Figure 53 (b)) the available sources include Upjohn, Barceloneta Landfill, Scorpio and Vega Alta PSWs superfund site, PREQB, and NON-PRASA. During this year the Vega Alta area resulted has to have the highest concentration similar to the majority of past years at Multiport # 22 (214.6 ug/L), which continues to be decreasing. General concentration distribution continues to be similar from past year but with increases at the north high concentration area at Multiport wells #9, which increases that range from 170.9 to 177.0 ug/L, to the west of this well at Multiport #4 (29 to 49.2 ug/L), and a significant increase to the northeast at Multiport #17 (1 to 12.4 ug/L). In the Barceloneta Landfill area, the south detection (monitoring well BL #3) has 1,1-DCE (14 ug/L, which exceeds the MCL) and at the north (BL #6) it has TCE (2.4 ug/L), and TCM (6.7 ug/L). In terms of the Upjohn area, the highest concentration continues to be at MW #302 (79.5 ug/L), which results to be higher than past year. In general, increases have been reported at and near extraction wells UE #2 (34.3 to 54.9 ug/L), UE #1 (13.8 to 36 ug/L), and MW 301B (1.9 to 13 ug/L); and to the south of monitoring well UJ #1 (25.4 to 37.8 ug/L). Moreover, similar to past year increases have been reported at the northern highest concentration in MW #23 (8.7 to 10.9 ug/L), to the north of extraction wells at MW#18 (9.6 to 10.1ug/L). At the Scorpio Recycling superfund site at Toa Baja, three wells contain DCM (ranging from 0.6 to 2 ug/L), two have TCM (0.5 and 3 ug/L) and one of them also has CA (0.7 ug/L). In the Manatí area a NON-PRASA well has a detection of TCM (3.2 ug/L). Finally, the detection at the southwestern Arecibo (Arecibo Observatory) has DCM (0.5 ug/L).

Available information sources for 2003 data (Figure 53 (c)) include Upjohn, Barceloneta Landfill and Vega Alta PSWs, PREQB and NON-PRASA data. This year the Vega Alta area continues to have the highest concentration, which is consistent with data from the past year at Multiport # 22 (207.9 ug/L); it continues to decrease. General concentration distribution is somewhat different from past year where the maximum concentration at the north present reduces in area and the detection to the south (Multiport #3) now corresponds to a lower concentration area. There are increases on the west side of the north high concentration area in Multiport well #4 (which increases from 49.2 to 55.7 ug/L) and to the northeast at Multiport #17 (12.4 to 17.1 ug/L). In addition, small increases have been reported at Multiport #8 (104 to 106 ug/L), two wells to the south of Multiport #9, at Multiport #11 (30 to 32 ug/L), and to the north of Multiport #22, at Multiport #19, which this years present detection with 1.1 ug/L. In terms of the Upjohn site, the highest concentration continues to be at MW #302 with 48 ug/L, which results to be lower than past year. Concentration distribution tends to be lower than past year with small increases on the northern area of Pollera Ochoa. The highest concentration in the north continues to have concentrations above MCL (5.3 ug/L). Monitoring wells BL #3 and BL #6 located in the Barceloneta Landfill superfund area continue to have similar detections but 1,1-DCE at BL #3 is lower with 4.9 ug/L. The highest concentration at this site is located to the northeast of BL #3 at BL #4 (previously having ND) which has 1,1-DCE (22.95 ug/L), and TCE (20.72 ug/L) both exceeding MCL. To the north of this well, BL #5 has TCE (1.6 ug/L) and TCM (6 ug/L). At BL #2 (south of BL #3) there is CM (6.9 ug/L) concentration that exceeds the MCL. Finally, to the southwest corner of Arecibo only TCM (2.1 ug/L) has been detected.

Available sources for 2004 data (Figure 54 (a)) are: Upjohn, Barceloneta and Vega Alta PSWs superfund site and NON-PRASA. The area of Vega Alta continues to have the highest concentration at Multiport # 22 (220.1 ug/L), which is higher than past year. General concentration distribution is somewhat different from last year where the maximum concentration at the north present reduce in area and only Multiport #9 has been part of it presenting a increase from 134.2 to 139.6 ug/L. In addition, the next lower concentration area at the north also presents a decrease in area where the Multiport #4 has been classified at a lower concentration area with a decrease from 55.7 to 21.6 ug/L. Increases in concentrations have been reported at: south of highest concentration area at north at Multiport #3 (82.6 to 88.3 ug/L), to the north at Multiport #5 (1.8 to 7 ug/L), to the west corner at Multiport #13 (which this time

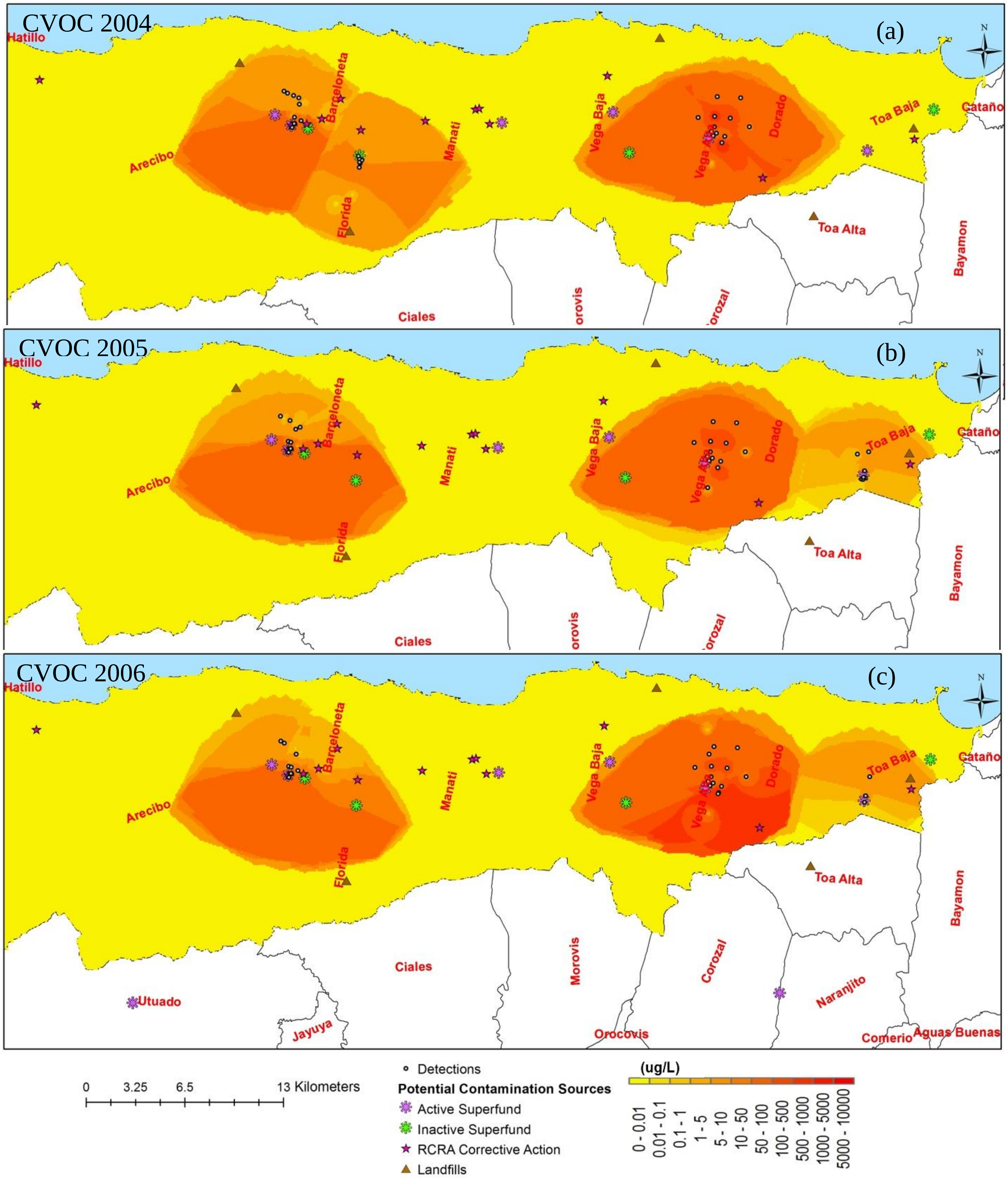

Figure 54 Total Spatial CVOC Concentrations for 2004 (a), 2005 (b) and 2006 (c)

present detection with 5.7 ug/L), and at the north of Vega Alta superfund location at Multiport #6 (7.7 to 8.8 ug/L). In terms of the Upjohn site, the highest concentration continues to be at MW #302 well (52.6 ug/L), which results to be higher than in the past year. Concentration distribution tends to increase when compared to other data. Increases are observed in wells MW #102 (1.9 to

2.2 ug/L), two wells to the northwest at MW#204 (2.2 to 3.6 ug/L), and at MW #9 (1.4 to 1.5 ug/L). In addition, an increase has been reported to the southwest of extraction wells at monitoring well UJ #1 (22.7 to 33.6 ug/L) been the second highest concentration at the area. This time the north present a uniform concentration distribution and MW #23 have concentrations below MCL with 3.9 ug/L. No detection (ND) has been reported at Pollera Ochoa, at MW# 301B (which is one of the closest wells from extraction wells), and AHR well. Finally, in the Barceloneta Landfill superfund area, the highest concentration is located south at BL #3 (highest) and BL #1 (previously having ND and been located south of BL #2). Both include 1,1-DCE which has been higher at BL #3 (16 ug/L), exceeding MCL, and BL #1 also include TCE (2.1 ug/L) and TCM (7.3 ug/L). Similar to past year detections, reports show BL #6 which has 1,1-DCE (1.1 ug/L) and TCM (7.1 ug/L), in BL #5 there is TCE (1.4 ug/L), BL #4 has 1,1-DCE (4 ug/L) and at BL #2 has 1,1-DCE (2.4 ug/L).

In 2005 (Figure 54 (b)), the area of Vega Alta continues to have the highest concentration in Multiport #22 with a lower concentration (131.6 ug/L). This concentration is similar to the highest concentration up north, which is at Multiport #9 well (114.6 ug/L). General concentration distribution slightly differs from last year where maximum concentrations present are reduced in area and Multiport #3 was given a lower concentration area with a decrease from 88.3 to 33 ug/L. Increases in concentrations have been reported west of the highest concentration area at Multiport #8 (79.4 to 83 ug/L); to the north (of the same area) in Multiport #5 (7 to 28.7 ug/L), at Multiport #17 (15.5 to 20.1 ug/L); and at Multiport #6 (8.8 to 16.5 ug/L). In addition, even the downstream well Multiport #20 presents a small detection of 1,1-DCA (0.5 ug/L). In terms of Upjohn superfund site, the highest concentration continues to be in MW #302 (50.8 ug/L), which reflects a decrease when compared to last year. Concentration distribution tends to be reduced when compared to last year but there are increases at UE #1 (12.4 to 18.2 ug/L) and slight increases west of this well at MW #301B and AHR (at the lower concentration to the north of extraction wells). However, this year both present detections of 3 and 2 ug/L respectively. In addition, minor increases have been observed southeast of AHR at MW # 18 (4 to 4.3 ug/L) and at Pollera Ochoa with detections of 1.1 ug/L this year. Concentrations to the north have been gives No detection (ND) at wells MW #102, MW#204 and MW #9. At Scorpio Recycling area, small concentrations of TCE have been detected in three wells with a maximum of 0.5 ug/L, one of them also has 1,1-DCA (0.42 ug/L) and one has PCE (0.11 ug/L) and BF (1.4 ug/L). Closer to the north, the Pepsi #2 well has TCM (2 ug/L) and closer to the northern area PRASA well Campanilla #1 has 1,1-DCA (0.139 ug/L) and PCE (0.066 ug/L); and Campanilla #7 (the highest concentration) has TCM (7.5 ug/L), TCE (0.069 ug/L) and 1,1-DCE (1 ug/L).

In 2006, (Figure 54 (c)) the Vega Alta area continues to have the highest concentration but this time the Multiport GM # 2 was sampled and has the highest concentration with 563.3 ug/L, followed by the Multiport # 22 with 144.8 ug/L (higher than past year). General concentration differs from the past year due to a decrease at Multiport #9, from 114.6 ug/L to 89.6 ug/L, but continues to be the highest value up north. In addition, the concentration at GM #2 causes the concentration areas to be higher, but as this well is really close to Multiport #9 the interpolation limitations and data gaps tend to disperse equally. Increases in concentration have been observed at Multiport # 4 (18.1 to 23.7 ug/L), at Mutltiport #5 (28.7 to 43.1 ug/L), and small increases at Multiport #19 (1.2 to 1.4 ug/L), and Multiport #13 (0.5 to 2 ug/L). In terms of Upjohn site, the highest concentration continues to be at MW #302 (26.5 ug/L), which results to be lower than last year. Concentration distribution tends to be a slightly decrease when compared to other areas. Minor increases are observed at MW #9 (ND to 2 ug/L), MW#204 (ND to 1 ug/L), MW # 23 (2.3 to 3 ug/L), MW #301B (3 to 5 ug/L), and MW # 18 (4.3 to 5.3 ug/L). Concentrations to the north have been identified as No detection (ND) at well Pollera Ochoa and at MW #102. At Scorpio Recycling area, only one well has 1,1-DCA (0.16 ug/L), 1,1-DCE (1.1 ug/L), and the other monitoring wells give ND. Close to the north, the Pepsi #2 well continues to have TCM (2.6 ug/L) and more to the north PRASA well Campanilla #7 has 1,1-DCA (0.31 ug/L) and TCM (4.5 ug/L).

Available sources for 2007 (Figure 55 (a)) include Upjohn and Vega Alta PSWs superfund site, and NON-PRASA. The Vega Alta area continues to have the highest concentration, but this time the Multiport GM # 2 has NOT been sampled,. Therefore, Multiport # 22 has the highest concentration with an increase from 144.8 to 187.8 ug/L. General concentration changed from past year due to an increase in Multiport #5 from 28.7 to 43.1 ug/L, because of this, the wells were classified with the same concentration area as Multiport #9 and Multiport #8 (which presents an increase) with concentrations of 83.3 and 70 ug/L respectively. Increases in concentration have been observed at Multiport # 17 (17.6 to 21.3 ug/L) and small increases at Multiport #6 (10.6 to 11.2 ug/L) and at Multiport #19 (1.4 to 1.6 ug/L). In terms of

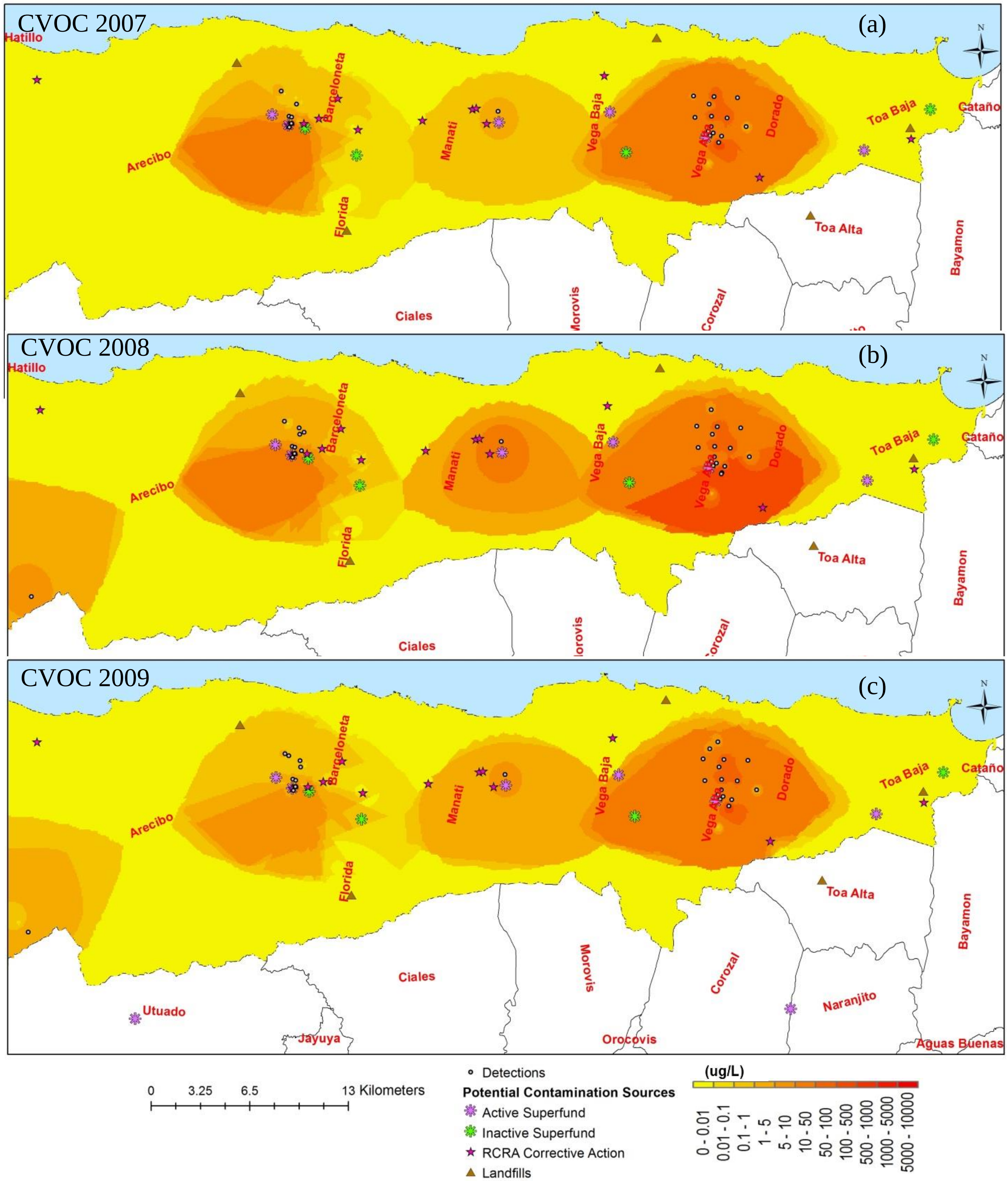

Figure 55 Total Spatial CVOC Concentrations for 2007 (a), 2008 (b) and 2009 (c)

the Upjohn site, the highest concentration continues to be at MW #302 (25.8 ug/L), which results to be lower than past year. Again, concentration distribution tends to be slightly lower than past year but with minor increases at UE #1 (14.2 to 14.3 ug/L) and at MW #1 (ND to 1 ug/L).

Concentrations to the north have been giving No detection (ND) when in the past year it presents increases at well MW #9, MW #204 and ND (similar to past years at Pollera Ochoa) and at MW #102. Finally, the other two detections correspond to NON-PRASA wells, which only have TCM of 1.5 and 0.58 ug/L.

In 2008, (Figure 55 (b)) available sources include Upjohn and Vega Alta PSWs superfund site, PREQB, some data from PRASA 1st Quarter and NON-PRASA. The area of Vega Alta continues to have the highest concentration, yet this time Multiport GM # 2 has been sample and has the highest concentration with 742 ug/L, which is higher than in 2006. Multiport # 22 has shown an increase from 187.8 to 204.8 ug/L but this time it is the second highest concentration. General concentration does not vary significantly from past year but an increase is definitely observed in almost every well with the exception of Multiport #12 and #8 which show slight decrease. The same limitations of 2006 are present due to the significant difference between the two highest concentrations, which are very close to each other. At the Upjohn superfund site, the highest concentration continued to be at MW #302 (30.8 ug/L), which is higher than last year. Concentration distribution tends to be somewhat higher than last year with slight increases at MW #18 (3 to 6 ug/L), at AHR (1 to 3 ug/L), MW #22 (1 to 1.5 ug/L), and MW #23 with an increase of 0.1 ug/L. Concentrations are now observed to the north of source area at wells Pollera Ochoa, MW #102 (both 2 ug/L) and at MW #9 (1 ug/L). Finally, the other two detections have been found in NON-PRASA wells; both have a TCM of 33.2 ug/L (detection at Manatí) and 1.3 ug/L (Arecibo Observatory). The Arecibo observatory well also has low concentrations of all the DBPs.

As shown on Figure 55 (c), 2009 information sources include: Upjohn and Vega Alta PSWs superfund sites, some data from PRASA 1st Quarter and NON-PRASA. The area of Vega Alta continues to have the highest concentration. Multiport # 22 (174.8 ug/L) has the highest concentration, even though it is lower than last year. The GMs wells do not include sampling events, wells that tend to have the highest concentrations. The second highest is located north in Multiport # 9 with 80 ug/L. General concentration does not vary when compared to last year with the exception of highest concentration area. Increases have been within and near the northern highest concentration area, at the south wells Multiport #12 (2.9 to 3.7 ug/L) and Multiport #6 (13.5 to 15.8 ug/L), west of wells Multiport #4 (25.9 to 29.2 ug/L), and Multiport

#2 (40.4 to 47.1 ug/L), within Multiport #5 (69.2 to 73.2 ug/L), and to the east at Multiport #17 (24.4 to 25.1 ug/L). In addition, increase has also been observed to the north of Multiport #4 at Multiport #16 (7.7 to 11.1 ug/L). In terms of Upjohn site, the highest concentration continues to be at MW #302 with 29.2 ug/L, which results to be lower than past year. This time concentration distribution tends to be much lower than past year with NO increases and with the exception of wells UE #2 (12.5 ug/L) and UE #1 (9.5 ug/L) all others have concentrations below 1.3 ug/L. Finally, all the other three detections correspond to NON-PRASA wells show a TCM of 6.8 and 0.063 ug/L, and only low concentrations of DBPs in the southwest corner of Arecibo.

During 2010 (Figure 56 (a)) Vega Alta area continues to have the highest concentration at Multiport # 22 (175.4 ug/L), which is higher than that of last year. Again, GMs multiport wells have not been sampled. The highest concentration area at the north grows this year adding Multiport #2 (47.1 to 57.8 ug/L). The highest concentration in this area is at the north in Multiport #5 (73.2 to 87.3 ug/L). In addition, increases have been observed in wells Multiport # 17 (25.1 to 31.1 ug/L), Multiport #13 (1 to 1.2 ug/L), Multiport #15 (2.9 to 4.7 ug/L), and north of Multiport #22 at Multiport #6 (13.5 to 15.8 ug/L). In terms of the Upjohn site, the highest concentration continues to be at MW #302 (26.2 ug/L), which is lower than the past year. This time, sampling events were more focused near the source area. Increases in concentration have been observed at the down gradient well MW #1 (1.5 to 10.8 ug/L), being the third highest concentration. Additional increases are been observed at UE #2 (12.5 to 15.2 ug/L), UE #1 (9.5 to 10.3 ug/L), MW #301 B (1 to 2.9 ug/L), and a small increase at MW #18 (0.9 to 1.6 ug/L). In addition, increases have been observed in MW #6 (2.7 ug/L) and MW #9 (1.4 ug/L) Finally, all other three detections correspond to NON-PRASA wells: TCM (0.61 and 0.54 ug/L) in Barceloneta and, TCM (1.1 ug/L) and DBPs (16 ug/L) at the southwest Arecibo.

Available sources in 2011 (Figure 56 (b)) are: Upjohn, NON-PRASA and UPRM. No sampling data has been obtained from the Vega Alta PSWs, therefore maximum concentration has been given to the Upjohn superfund site. In this site, the maximum concentration continues to be at MW #302 with 18 ug/L, resulting lower than past year. With the exception of a small increase at UE #1, which increased from 10.3 to 10.5 ug/L (2nd highest concentration), all the other wells present a decrease in concentration. High concentrations are only focused near the extraction wells where the other two wells (UE #2 and MW #301B) have concentrations of 9 and

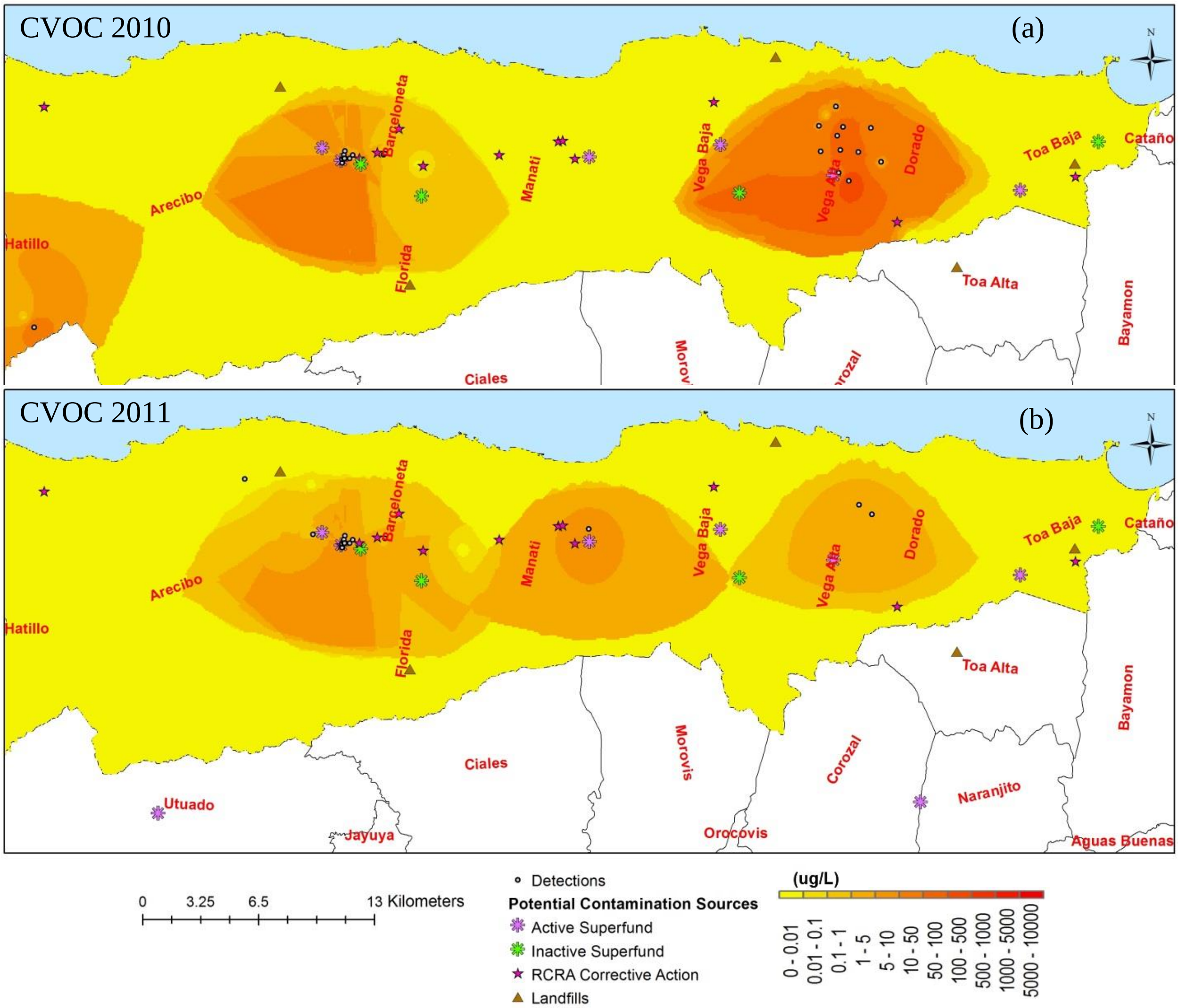

Figure 56 Total Spatial CVOC Concentrations for 2010 (a) and 2011 (b)

4.3 ug/L. Similar to the year 2009, all the other wells have concentrations below 1.3 ug/L. In terms of the other detections, in the Manatí and Barceloneta area there are NON-PRASA wells having TCM detections of 9.8 and 1.6 ug/L respectively. The other detections correspond to UPRM sampling efforts and include CCl_4 (0.13 ug/L) north of Arecibo, TCM (0.8 ug/L) at west of Pesticide Warehouse I, and in Vega Alta area both have PCE and TCE detections. The one to the north has maximum concentrations of 0.21 ug/L of PCE and 3.13 ug/L of TCE, and the other has 0.259 ug/L of PCE and 4.8 ug/L of TCE.

5.9.1 Integration of Spatiotemporal Data Analysis

Spatiotemporal analysis of CVOC concentrations distribution in the northern karst region of Puerto Rico, from 1982 to 2011, show that there is wide variation in the temporal and spatial extent of the contamination. The distribution and variability of total CVOCs depend on the sources and magnitude of contamination, remedial actions, transport processes, and sampling densities. Low sampling densities limit the resolution and definition of the temporal and spatial concentrations distributions of total CVOCs. The use of total CVOCs in the analysis aids the resolution and definition of the concentration distribution, but limits the details of the individual CVOC species. It is recommended that spatiotemporal distribution be developed for individual and combined species in later studies.

Overall, the analysis indicates that concentration distributions are dominant by data related to Upjohn and Vega Alta PSWs superfund sites. Several reasons for this: (1) there is high level of contamination in these sites; and (2) more data is collected for this site. Data from PRASA wells, which are widespread throughout the study area, provides information to better defined major areas of information, generally at the outskirts of the major areas of contamination where concentration are at the low end. In areas when concentrations are above MCL, the wells are shut-off and samples become limited. Data from PRASA wells also provide information for many other contaminants that are not monitored as part of superfund or RCRA CA sites.

In general, CVOC contamination in the Upjohn superfund site is principally related to CCl_4, TCM, and DCM. Concentrations are the highest in this area in the 1980s and tend to decrease thereafter. Concentration increased slightly in the early to mid-2000s, and decreased again. Decrease in concentration is associated with source reduction, remedial actions, and natural attenuation.

CVOC contamination related to the Vega Alta PSWs is mostly related to TCE, and PCE, although 1,1-DCE, DCM, TCM, cis-12-DCE, and 1,1-DCA are also found in the area. Contamination related to this site extends beyond Vega Alta to other municipalities, including Dorado. Spatiotemporal distributions of CVOCs in this area are influenced by the sampling schedule, which has not been consistent. As a result of this, the concentration distribution of total

CVOCs in the area show very high concentrations in the early 1980s, but appear to decrease until the mid-1990, when high concentrations are reported again. The apparent decrease is only an illusion of limited sampling. Much better concentration distributions are observed after 1995, when a more aggressive sampling plan is implemented. Total CVOC concentrations after 1995, show similar concentration ranges, with slight decrease toward the end of the 2000s.

In addition to the areas related to the Upjohn and Vega Alta PSWs superfund sites contamination, some level of contamination is occasionally observed in Manatí (central part of study area) and Arecibo (south west part of the study area) areas. Detected CVOCs in Manatí include TCM, TCE, DCM, CM, PCE, 1,1-DCE, cis 1,2-DCE, and some CCl_4, whereas those in Southwest corner of Arecibo mostly include TCM, DCM, and DBPs. The sources of contamination for these areas have not yet been identified. But there is information obtain from RCRA CA that identified a potential source of contamination in the Manatí area (Safety Kleen, ID = 15 in Table 1 and Figure 3).

Overall, the spatiotemporal assessments of CVOC concentration distributions indicate that the contamination in the northern karst region is spatially and temporally extensive. The widespread spatial extension of the contamination reflects high capacity of the system to transport contaminants away from the source to other areas. The temporal extent of the contamination, which span over 30 years in several sites, reflect the high capacity of the karst system to store and slowly release contaminants.

5.10 Summary of Spatiotemporal Data Analysis

A summary of data characteristics and results are given below:

- Sampling data and water quality information is available from several sources, including the PRDoH, EPA, USGS, and the PREQB. The amount and type of data, however, varies spatially and temporally. Data for PRASA wells from the PRDoH is available from 1992 through the present, but some data still needs to be collected (2011 to present), and some data still needs to be compiled, categorized, entered, integrated and analyzed (1995, 2001-2010). USGS data is available for the following years: 1982 to 1985, 1990, and

1992. EPA provided the most amount of data from EPA STORET (USEPA, 2008), and data related to the Upjohn and Vega Alta PSWs superfund sites. The greatest amount of data is available for 1994, followed by 1998, 1996, and 1997. The year with the highest amount of samples detected is 1996, followed by 1997, 1998 and 2006. In addition, the highest percent of detections correspond to 1987 and 1988, but these years also include the smallest amount of samples available, followed by 1986, 2010 and 2006.

- From the data analyzed, majority of CVOCs samples come from the Upjohn superfund site, followed by Vega Alta PSWs superfund site. The majority of the phthalate data comes from PRASA wells, followed by UPRM. For the wells sampled for both contaminants, 14 % give detections of both but the majority only include CVOC detections. The highest number of samples, information, and detections are associated with CVOCs data. CVOC also show more continuous temporal information, for this reason the CVOC data is analyzed in detail.
- The CVOC with the highest maximum concentrations corresponds to CCl_4, followed by TCE, 1,1-DCE, TCM, and DCM. The highest amount of samples detected is for TCE, followed by CCl_4, PCE, and 1,1-DCE. The greatest amount of samples exceeding the MCL standard is also for TCE, followed by PCE, 1,1-DCE, and cis-1,2DCE. CCl_4 has the highest amount of samples, followed by TCE, PCE and DCM.
- Spatial distribution of the principal CVOCs (PCE, TCE, CCl_4, TCM and DCM), indicate that TCM is the most spread CVOC, followed by DCM, TCE, PCE, and CCl_4. Higher CVOC concentrations are localized near the Upjohn superfund site, which has CCl_4 (mainly), TCM and DCM, followed by the area affected by the Vega Alta PSWs superfund site, which has TCE (mainly), PCE, DCM and TCM. Figure 30 shows that the broadest area affected by the total principal CVOC is related to the Vega Alta PSWs, although almost the entire area is impacted.
- Temporal distribution of spatially average CVOC show maximum concentrations near Vega Alta PSWs superfund for almost every year except 1984, when only preliminary data was taken, and 2001, when the maximum concentration were in a NON-PRASA well. In addition, the Vega Alta PSWs superfund site shows highest average concentration for 1982, when the USGS sampling events first detected TCE at the Ponderosa #1 PRASA well. For other years, the majority of the maximum concentrations

correspond to the Upjohn superfund site, which also has the highest concentration of all the period of study, with the exception of 1992, when maximum concentrations are reported by Sepulveda (1999) in relation to the Vega Alta PSWs superfund site, and 1994 that is related to PRASA well Manatí #3. The maximum concentration for Vega Alta PSWs superfund site is TCE, for the Upjohn superfund site CCl_4, for the NON-PRASA well is TCM, and for the PRASA well is 1,1-DCE. Temporal analysis of concentration in wells near the principal two superfund sites (Upjohn and Vega Alta PSWs) show that concentrations change over time, with a general decreasing trend near the source areas. Concentrations are decreasing more near the Upjohn superfund area. Near the source area in Vega Alta PSWs superfund site, concentration is decreasing, but degradation by-products of TCE, including cis1,2-DCE, are formed.

  - Temporal analysis by contaminants shows that TCE media exceeds MCL every year except for years with no sampling events at the Vega Alta PSWs superfund site (1993, 1994 and 2011). CCl_4 also exceeds MCL every year except 1995, but smaller concentrations are found. PCE show similar behavior to TCE but at lower concentrations, with the exception of year 1982 and 1983. DCM shows maximum concentrations in 1982, 1983, 1994 (not related to Vega Alta PSWs superfund site), 1995, and 1997. MCLs for DCM are generally exceeded more frequently than PCE. TCM shows the lower concentrations of the selected CVOCs, but three outliers exceed the MCL in 1994, 1997, and 2001.

- Spatiotemporal analysis of CVOCs shows that during 1980s the available data is limited by the sampling. The Upjohn superfund site includes the most complete sampling data. This site also shows the higher reduction in CVOC concentrations, although concentrations are still above MCLs. In comparison to the Upjohn superfund site, the Vega Alta PSWs superfund site had a slower response for initial assessment and sampling efforts and less initial collaborations of PRPs. This resulted in a greater transport of contaminants away from the source and higher storage. Spatiotemporal analysis of PRASA data shows that contamination is sustained during a long period of time given rise to long potential for exposure.

5.11 Selection of UPRM Sampling Sites

Based on preliminary analysis of the data collected, two major areas were initially recommended for groundwater sampling: Arecibo-to-Barceloneta and Vega Alta. The main reason to select these areas is because of their extensive level of contamination. These areas have had the highest CVOC concentration, and have shown considerable amount of phthalates detection. After cross-areas referencing data and information on the contaminant detection, well status and use, and proximity to major sources of contamination, several sampling sites were recommended (Table 11). Some of the recommended sites were not available for sampling and could not be added to the sampling campaign. Those that were available for sampling are listed as final in Table 11 and shown in Figure 57. All final wells and springs have been sampled at least once and some are presently sampled by UPRM.

Table 11 List of Final and Proposed UPRM Sampling Sites.

Municipality	Site Name	Site Type	Status
Barceloneta	Mita	Domestic Well	Final
	Martinez E.	Agricultural Well	Final
	Pollera Ochoa	Agricultural Well	Final
	Mena A.	Agricultural Well	Final
	A.H. Robins	Industrial Well	Proposed
	Pfizer	Industrial Well	Proposed
	Ramos	Agricultural Well	Final
	Fortuna	PRASA Well	Final
Arecibo	Rosa R. #1	Agricultural Well	Final
	Zanja Fria	Spring	Final
	Hillside Motel	Commercial Well	Final
	San Pedro	Spring	Final
	La Cambija	Spring	Proposed
Vega Alta	Owens Illinois #1	Industrial Well	Proposed
	Owens Illinois#2	Industrial Well	Final
	Maguayo #2	PRASA well	Final
	Maguayo #4	PRASA well	Final
	Maguayo #6	PRASA well	Final
	Arenas Procesadas	Commercial Well	Final
	Monterey #2	Agricultural Well	Final
	Tropigardens	Commercial Well	Final
	Santa Rosa # 1	Agricultural Well	Final
Manatí/Barceloneta	Ojo de Guillo	Spring	Final

After a more extensive analysis data, it is also recommended to add sampling sites in the Manatí and southwest Arecibo near Hatillo area. Particular well points for sampling in these areas still need to be identified. It is recommended that the selection is based in the same process used in this study, which cross links detections, measure concentration, status of wells, use of sites, and proximity to potential sources of contamination.

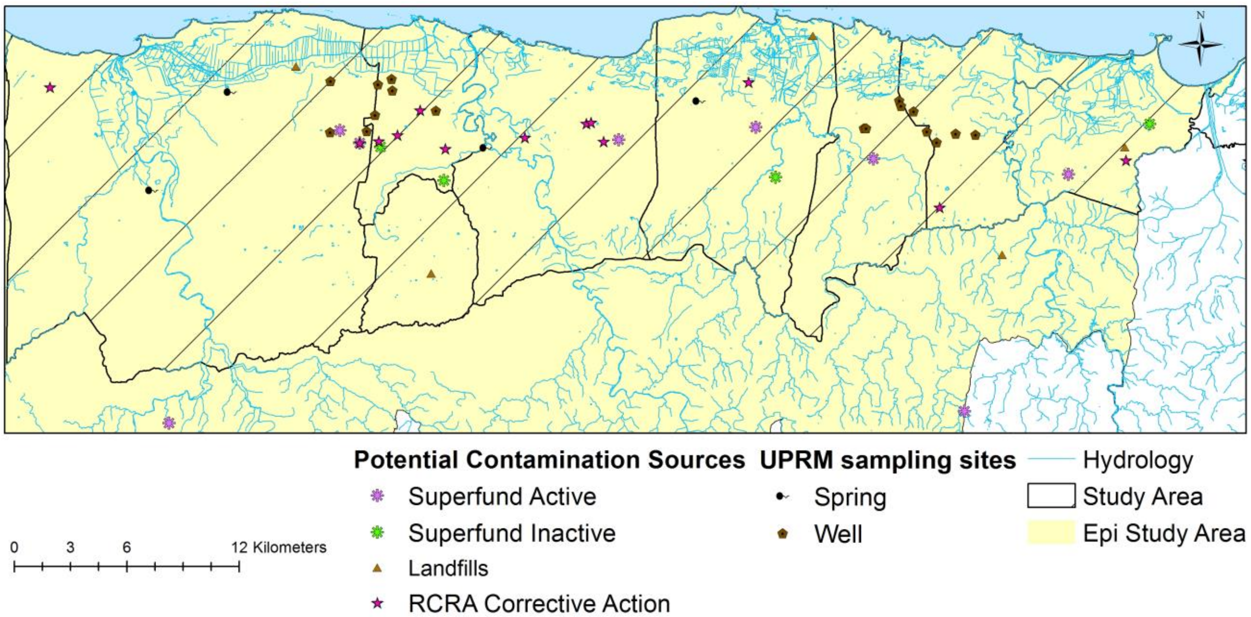

Figure 57 Final Sampling Wells and Springs

6 Conclusions

Analysis of historical contamination data in the karst groundwater system of northern PR shows significant extent of contamination in space and time. The contamination comes from multiple sources and extends beyond the demarked sources of contamination. This contamination may reach drinking water systems used for human consumption and areas of significant ecological value.

Historical assessment shows that data gaps and limitations on the availability of sampling data affect in the ability to define contaminant distribution assessment of contamination. This could be seen in the spatiotemporal assessment where or when only limited amount of PRASA, USGS, and superfund sites data is available. The Vega Alta PSWs superfund site shows particular data limitations, even for years when there are sampling events, due to the hydrogeologic complexity and lack of characterization of the site, as well as the slow response to initial contamination. Unlike the Upjohn superfund site, when there was a rapid monitoring and remedial response to the contamination, the Vega Alta PSWs superfund site could have been contaminated long before the contamination was detected. This shows that well defined spatial and temporal sampling scheme is necessary for complex sites, such as those in karst systems. The scheme must be based on proper characterization of the site. Even with limited data, is however shown that there is a larger extent of contamination.

For the Upjohn superfund site, the early response of remediation efforts by the responsible company and the superfund cleanup results in reduced concentrations more rapidly than the Vega Alta PSWs superfund site. Extraction wells near the source area, has continued to show concentrations above MCL. This is due to the system complexity were contamination is been retarded, stored and slowly release over extended periods of time.

Data from PRASA wells and the spatiotemporal contaminant distribution reveal a significant amount of CVOCs detections, with some areas exceeding MCL. MCL is exceeded for certain sampling events through the years for contaminants like TCE, TCM, DBPs, DCM, and

1,1-DCE. The most frequent CVOCs exceeding MCL include DBPs, DCM, and TCE. In addition, other contaminants are detected through time including PCE; CM; cis1,2-DCE; 1,1-DCA; 1,1,2,2-TeCA and CA. Additional future assessment is required because only limited amount of data is analyzed beyond the year 2000. In general, spatiotemporal analysis of PRASA data shows contamination sustained during long periods of time, even if it is below the MCL.

Based on proximity to major contamination sources, previous contaminant detection, water and site use, status of wells, site accessibility and possible groundwater path. Twenty three sites are recommended for sampling, of which 19 (83% of the recommended sites) are being sampled at least once by UPRM and analyzed for CVOCs and phthalate.

7 Recommendations and Future Work

It is highly recommended to integrate groundwater samples from different local and federal agencies in databases like the one created in this project. This integration allows for better assessment of historical and current paths of contamination and can led to enhanced predictive capabilities of potential exposure and more effective design of remedial actions. It is important to assess contamination in PRASA wells because, although the data is skewed to low concentrations, it helps defined the distribution of contaminants and assess the capability of the system to spread and store contamination for long periods of time. It is extremely important to encourage prevention of contamination and early response of responsible parties that handle hazardous wastes.

It is recommended that future work:

- Continues collection, compilation, categorization, and indexing of historical groundwater quality data, including:
    - Collection of PRDoH PRASA data from 2011 to present, and
        - EPA superfund sites information besides Administrative Record (AR)documents at RCA del Caribe, Vega Baja Solid Waste, Papelera Puertorriqueña, V&M/Albadejo, Naval Security. RCRA CA sites: Former Abraxis (Pfizer Cruce Davila), and Basf Agricultural (American Cynamid).
    - Compilation, categorization, and indexing of historical groundwater quality data
        - PRDoH include the PRASA sampling events from 2000 to the present.
        - EPA superfund sites Papelera Puertorriqueña, RCA del Caribe, Pesticide Warehouse III, Vega Baja Solid Waste (AR) and RCRA CA sites Basf Agricultural, Thermo King, V&M/Albadejo (AR) and Merck Sharp and Dohme…
- Analyze spatial and temporal groundwater quality trends using the most updated information. Perform spatiotemporal analysis by each CVOC species.
- Identify future wells or springs areas that could serve as potential exposure routes.
- Expand monitoring in the Manatí region.

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9 Appendix A

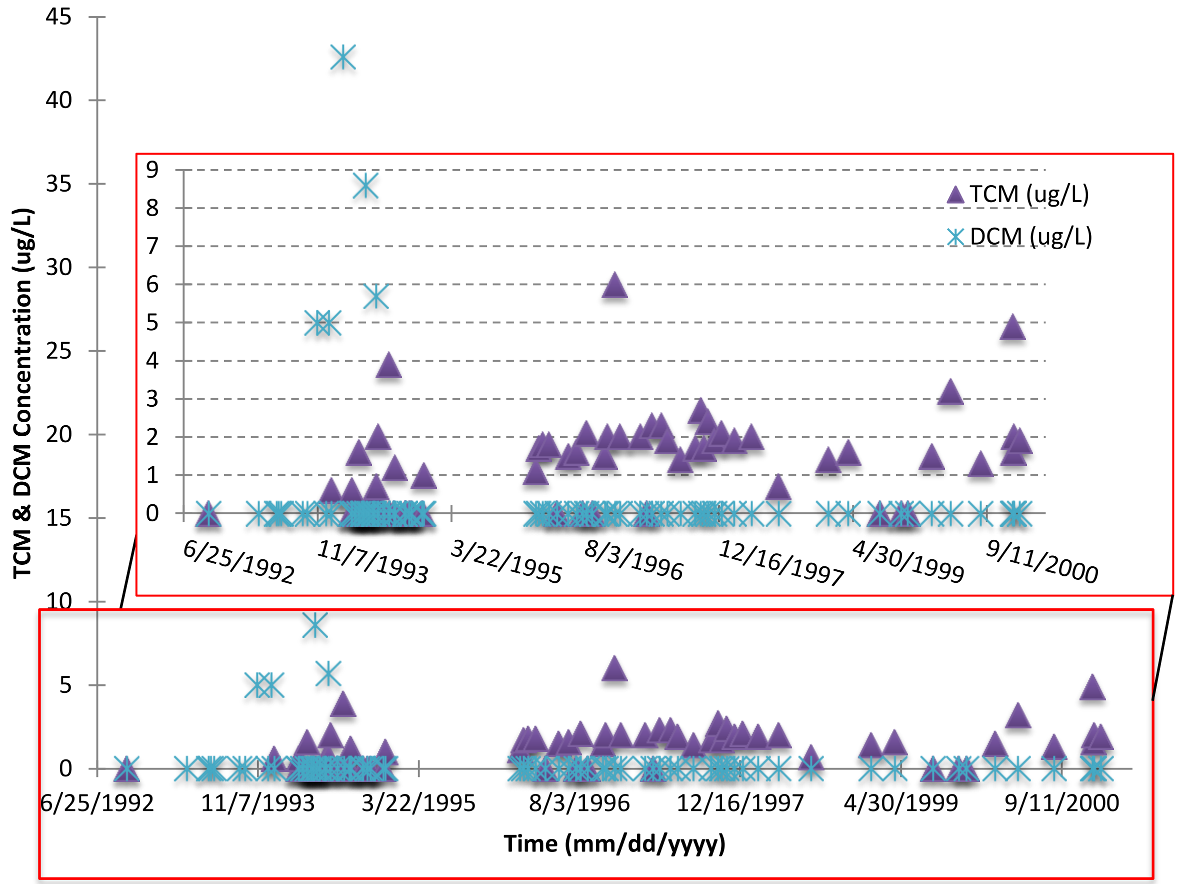

Figure 58 TCM and DCM Temporal Concentration of Manatí #3 PRASA Well (ID = 182604066292500)

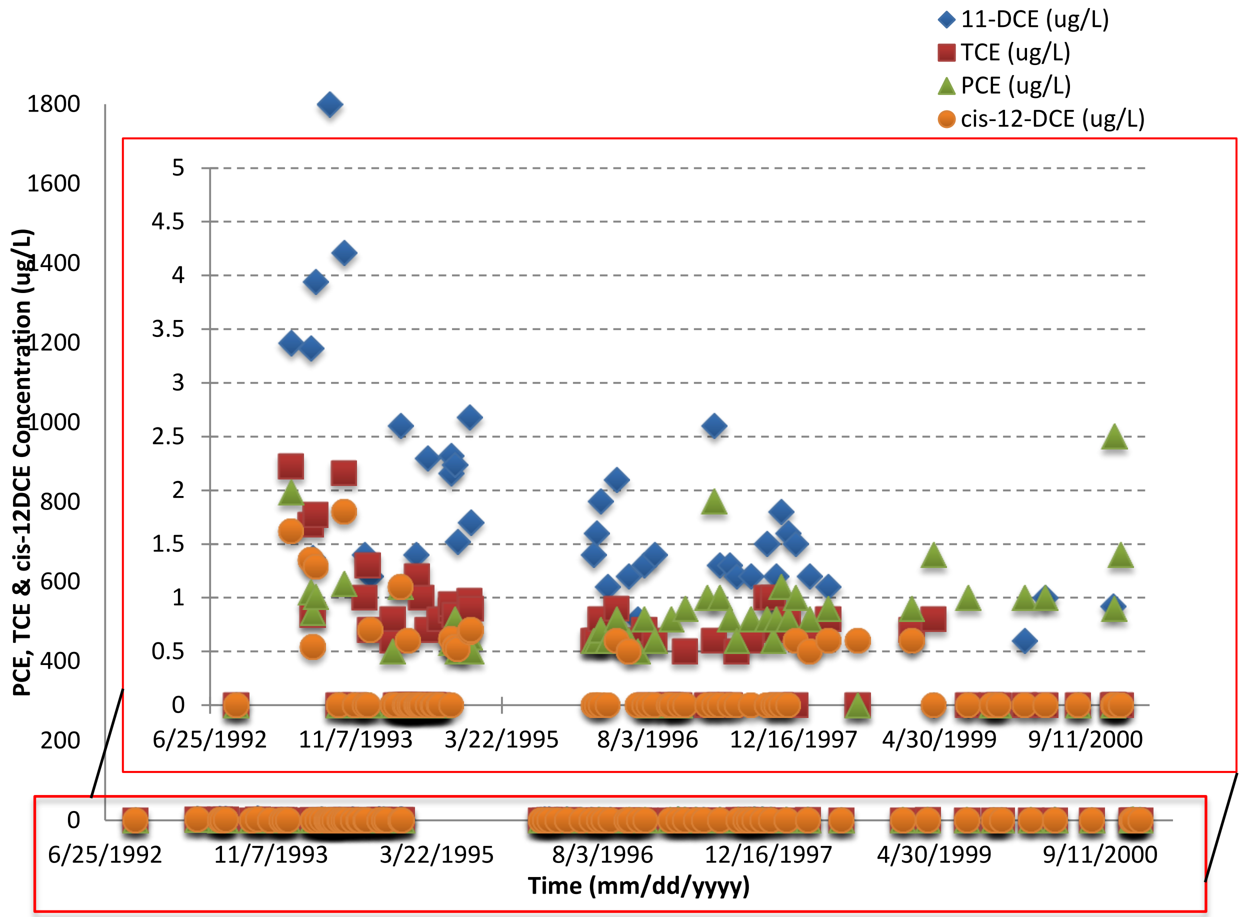

Figure 59 PCE, TCE, and cis1,2-DCE Temporal Concentation in Manatí #3 PRASA Well (ID = 182604066292500)

10 Appendix B

Table 12 Uphjohn Superfund Site Information Sources Details

Title	Doc. Date	Pages	File Format	Comment
Technical Memorandum I-Phase II-Remedial Design Report-Jan 10, 1996	1/10/96	287	PDF	Report
TFI Semi-Annual Progress Report No. 1 Apr to Sept 2010	10/29/10	192	PDF	Progress Report
SVE Semi-Annual Report No. 2 Sept 2010 to Feb 2011	4/21/11	181	PDF	Progress Report
TFI Semi-annual Report No. 2 Oct 2010 to Mar 2011	4/29/11	209	PDF	Progress Report
TFI Semi-Annual Report No. 3 Apr to Sept 2011	10/28/11	196	PDF	Progress Report
TFI Historical GW Jan 1998-Sept 2011		14	Word	Tables
Draft Report Draft Feasibility Study UMC Section 7.0 29-Jun-1988	6/29/88	15	PDF	CDM Report
Draft Tech Mem II UE-2 Well Inst and Pumping Test-Phase II RDR Nov 3, 1997	11/3/97	345	PDF	Report
Additional Well & Merck Water Level Anomaly Report-May 29, 1998	5/29/98	365	PDF	Report
Figures 2, 7, 8 & 9 Additional Well and Merck Well Water Level Anomaly Report		8	PDF	Figures
Tables 1 to 12 - CCl_4 Jan 1989 to Dec 1998		13	Word	Tables
TFI Quarterly Progress Report Tables Jan-Feb-Mar 1999	4/30/99	8	Word	Since this report the following data is included: field data; water level readings; rainfall; extraction wells and aeration tower P&U data.
TFI Quarterly Progress Report Tables Apr-May-Jun 1999	7/30/99	10	Word	Tables
TFI Quarterly Progress Report Tables Jul-Aug-Sept 1999	10/29/99	10	Word	Tables
TFI Quarterly Progress Report Tables Oct-Nov-Dec 1999	1/28/00	10	Word	Tables
TFI Quarterly Progress Report Tables Jan-Feb-Mar 2000	4/28/00	11	Word	Tables
TFI Quarterly Progress Report Tables Apr-May-Jun 2000	7/31/00	12	Word	Tables
TFI Quarterly Progress Report Tables Jul-Aug-Sept 2000	10/31/00	12	Word	Tables
TFI Quarterly Progress Report Tables Oct-Nov-Dec 2000	1/31/01	12	Word	Tables
TFI Quarterly Progress Report No. 1 Jan-Feb-Mar 2001	4/30/01	59	PDF	Progress Report
TFI Quarterly Progress Report No. 2 Apr-May-Jun 2001	7/31/01	60	PDF	Progress Report
TFI Quarterly Progress Report No. 3 Jul-Aug-Sept 2001	10/30/01	61	PDF	Progress Report

Title	Doc. Date	Pages	File Format	Comment
TFI Quarterly Progress Report No. 4 Oct-Nov-Dec 2001	1/31/02	60	PDF	Progress Report
TFI Quarterly Progress Report No. 1 Tables Jan-Feb-Mar 2002	4/30/02	14	Word	Tables
TFI Quarterly Progress Report No. 2 Tables Apr-May-Jun 2002	7/31/02	14	Word	Tables
TFI Quarterly Progress Report No. 3 Tables Jul-Aug-Sept 2002	10/31/02	14	Word	Tables
TFI Quarterly Progress Report No. 4 Tables Oct-Nov-Dec 2002	1/30/03	14	Word	Tables
TFI Quarterly Progress Report No. 1 Jan-Feb-Mar 2003	4/30/03	71	PDF	Progress Report
TFI Quarterly Progress Report No. 2 Apr-May-Jun 2003	7/31/03	72	PDF	Progress Report
TFI Quarterly Progress Report No. 3 Jul-Aug-Sept 2003	10/30/03	69	PDF	Progress Report
TFI Quarterly Progress Report No. 4 Oct-Nov-Dec 2003	1/30/04	68	PDF	Progress Report
TFI Quarterly Progress Report No. 1 Jan-Feb-Mar 2004	4/30/04	68	PDF	Progress Report
TFI Quarterly Progress Report No. 2 Apr-May-Jun 2004	7/28/04	71	PDF	Progress Report
TFI Quarterly Progress Report No. 3 Jul-Aug-Sept 2004	10/27/04	75	PDF	Progress Report
TFI Quarterly Progress Report No. 4 Oct-Nov-Dec 2004	1/31/05	73	PDF	Progress Report
TFI Quarterly Progress Report No. 1 Tables Jan-Feb-Mar 2005	4/29/05	17	Word	Tables
TFI Quarterly Progress Report No. 2 Tables Apr-May-Jun 2005	7/29/05	17	Word	Tables
TFI Quarterly Progress Report No. 3 Tables Jul-Aug-Sept 2005	10/24/05	17	Word	Tables
TFI Quarterly Progress Report No. 4 Tables Oct-Nov-Dec 2005	1/31/06	17	Word	Tables
TFI Quarterly Progress Report No. 1 Tables Jan-Feb-Mar 2006	4/28/06	18	Word	Tables
TFI Quarterly Progress Report No. 2 Tables Apr-May-Jun 2006	7/31/06	18	Word	Tables
TFI Quarterly Progress Report No. 3 Tables Jul-Aug-Sept 2006	10/31/06	18	Word	Tables
TFI Quarterly Progress Report No. 4 Tables Oct-Nov-Dec 2006	1/31/07	18	Word	Tables
TFI Quarterly Progress Report No. 1 Tables Jan-Feb-Mar 2007	4/30/07	19	Word	Tables
TFI Quarterly Progress Report No. 2 Tables Apr-May-Jun 2007	7/31/07	19	Word	Tables

Title	Doc. Date	Pages	File Format	Comment
TFI Quarterly Progress Report No. 3 Tables Jul-Aug-Sept 2007	10/31/07	19	Word	Tables
TFI Quarterly Progress Report No. 4 Oct-Nov-Dec 2007	1/31/08	73	PDF	Progress Report
TFI Quarterly Progress Report No. 1 Jan-Feb-Mar 2008	4/30/08	75	PDF	Progress Report
TFI Quarterly Progress Report No. 2 Apr-May-Jun 2008	7/30/08	75	PDF	Progress Report
TFI Quarterly Progress Report No. 3 Jul-Aug-Sept 2008	10/31/08	75	PDF	Progress Report
TFI Quarterly Progress Report No. 4 Oct-Nov-Dec 2008	1/30/09	71	PDF	Progress Report
TFI Quarterly Progress Report No. 1 Jan-Feb-Mar 2009	4/30/09	148	PDF	Progress Report
TFI Quarterly Progress Report No. 2 Apr-May-Jun 2009	7/31/09	143	PDF	Progress Report
TFI Quarterly Progress Report No. 3 Jul-Aug-Sept 2009	10/30/09	149	PDF	Progress Report
TFI Quarterly Progress Report No. 4 Oct-Nov-Dec 2009	1/29/10	153	PDF	Progress Report
TFI Quarterly Progress Report No. 1 Jan-Feb-Mar 2010	4/30/10	164	PDF	Progress Report
Endargemrment Assessment for the UMC Site-CDM-21-Sept-1988	9/21/88	79	PDF	Report
November 1992-October 1993 Monthly and Weekly Reports UMC	Various	45	PDF	Progress Reports
Remedial Investigation Report and Feasibility Study-May 1984	5/18/84	227	PDF	Report

Table 13 Barceloneta Landfill and Scorpio Superfund Sites Information Sources Details

Tittle	Author	Source	Year
Barceloneta Landfill Site Administrative Record File	Ms. Kristen K. Stout	U.S. EPA	1982
Final Feasebiliry Study Barceloneta Landfill Site	Ms. Susan Guilliland	U.S. EPA	September 1995
Third Year, Second Half Groundwater Monitoring Report	James J. Malot	U.S. EPA	March 2005
Fourth Year, Firth Half Groundwater Monitoring Report	James J. Malot	U.S. EPA	September 2005
Fourth Year, Second Half Groundwater Monitoring Report	James J. Malot	U.S. EPA	March 2006
Seventh Year, Third Annual Groundwater Monitoring Report Barceloneta Landfill Superfund Site	Cali A. Rodríguez and Juan C. Mercado	U.S. EPA	October 2009

Tittle	Author	Source	Year
Eigth Year, Fourth Annual Groundwater Monitoring Report Barceloneta Landfill Superfund Site	Cali A. Rodríguez and Juan C. Mercado	U.S. EPA	March 2010
Proposed Closure Plan Barceloneta Landfill	Antonio Santiago Vazquz	U.S. EPA	December 1994
Barceloneta Landfill Revised Sampling and Analysis Plan Part 1: Groundwater Sampling, Remedial Investigation/ Feasibility Study	Paul C. Rizzo	U.S. EPA	June 1993
Environmental Site Assessment American Cyanamid Company Manatí, Puerto Rico Facility	Malcolm Pirnie	U.S. EPA	March 2000
Barceloneta Landfill Third Year, First Half Groundwater Monitoring Report		U.S. EPA	September 2004
Barceloneta Landfill First Quater Grounwater Monitoring Report	James J. Malot	U.S. EPA	June 2002
Barceloneta Landfill First Semi-Anniual, Second Year Grounwater Monitoring Report	James J. Malot	U.S. EPA	October 2003
Barceloneta Landfill Second Quater Grounwater Monitoring Report	James J. Malot	U.S. EPA	September 2002
Barceloneta Landfill Third Quater Grounwater Monitoring Report	James J. Malot	U.S. EPA	December 2002
Barceloneta Landfill Fourth Quater Grounwater Monitoring Report	James J. Malot	U.S. EPA	March 2003
Barceloneta Landfill Sixth Quarterly Grounwater Monitoring Report	James J. Malot	U.S. EPA	December 2003
Barceloneta Landfill Eighth Quartery Grounwater Monitoring Report	James J. Malot	U.S. EPA	June 2004
Scorpio Recycling, Inc. Site OU II- Soils. Remedial Investigation/ Feasibility Study, Toa Baja, PR	Jeanne Litwin	RCRA	2008
EPA Superfund Record of Decision: Scorpio Recycling, Inc.	George Pavlou	U.S. EPA	2006

Table 14 Vega Alta PSWs Superfund Site Information Sources Details

Title	Author Org	For	Operable Unit	Date	Comments
Volume II, Results of the 1991 Field Effort Caribe General Electric Ground-Water Investigation Vega Alta, Puerto Rico. Appendices A Through K	Geraghty & Miller, Inc		UNIT I	Nov-91	

Title	Author Org	For	Operable Unit	Date	Comments
Decommissioning and Demolition Work Plan, Ponderosa Groundwater Remediation System, Vega Alta Public Supply Wells Superfund Site, Vega Alta, Puerto Rico	ARCADIS U.S., Inc	Vega Alta Steering Committee	UNIT I	19-Mar-10	PDF file on CD
GE GW Investigation Report, Appendix A, GROUNDWATER VOLATILE ORGANIC COMPOUNDS, DATA BASE	GE Company		UNIT I	Dec-90	
Vega Alta Public Supply Wells Site Revised Supplemental Revised Supplemental Groundwater Remedial Design Work Plan	BLASLAND, BOUCK & LEE. INC. (BBL), engineers & scientists	Vega Alta Steering Committee	UNIT I	Nov-98	
REMEDIAL CONSTRUCTION REPORT VEGA ALTA PUBLIC SUPPLY WELLS SITE, OPERABLE UNIT I, VEGA ALTA, PUERTO RICO	WRS Infrastructure & Environment, Inc.	Vega Alta Steering Committee	UNIT I	Sep-03	
A REVIEW OF THE FINAL HUMAN HEALTH RISK ASSESSMENT OF THE VEGA ALTA PSWS PREPARED BY CDM FEDERAL PROGRAMS CORPORATION	Kenneth G. Symms, Ph.D., DABT, ENVIRONMENT AL STANDARDS, INC.	Vega Alta Steering Committee	UNIT I	Jul-97	
REVISED SAMPLING, ANALYSIS AND MONITORING PLAN, MARCH 2010, VEGA ALTA PUBLIC SUPPLY WELLS SUPERFUND SITE, VEGA ALTA, PUERTO RICO	Leggette, Brashears & Graham (LBG), Inc., Professional Ground-Water and Environmental Engineering Services	Vega Alta Steering Committee		Mar-10	
DRAFT RESPONSE TO COMMENTS ON THE AMENDMENT TO THE 1998 REVISED SAMPLING, ANALYSIS AND MONITORING PLAN, VEGA ALTA PUBLIC SUPPLY WELLS SUPERFUND SITE, VEGA ALTA, PUERTO RICO	Leggette, Brashears & Graham (LBG), Inc., Professional Ground-Water and Environmental Engineering Services	Vega Alta Steering Committee		May-08	
First-quarter 1995 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and Geraghty & Miller, Inc. (G&M)	Vega Alta Steering Committee	UNIT I	May-95	scan from hard copy

Title	Author Org	For	Operable Unit	Date	Comments
Ground Water Sampling Report, Second Quarter 1995 Vega Alta Well Field Site, Puerto Rico	Unisys Corporation (Unisys) and Geraghty & Miller, Inc. (G&M)	Vega Alta Steering Committee	UNIT I	Jun-95	scan from hard copy
Third-quarter 1995 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and Geraghty & Miller, Inc. (G&M)	Vega Alta Steering Committee	UNIT I	Nov-95	scan from hard copy
Fourth-Quarter 1995 Ground Water Sampling Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and Grabowsky & Poort, Inc.	Vega Alta Steering Committee	UNIT I	Apr-96	scan from hard copy
First-quarter/annual 1996 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and Grabowsky & Poort, Inc.	Vega Alta Steering Committee	UNIT I	Jul-96	scan from hard copy
Second-Quarter 1996 Ground Water Sampling Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and Grabowsky & Poort, Inc.	Vega Alta Steering Committee	UNIT I	Aug-96	scan from hard copy
Third-quarter 1996 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and Grabowsky & Poort, Inc.	Vega Alta Steering Committee	UNIT I	Nov-96	scan from hard copy
Fourth-quarter 1996 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico.	Unisys Corporation (Unisys) and Grabowsky & Poort, Inc.	Vega Alta Steering Committee	UNIT I	Feb-97	scan from hard copy
First-quarter 1997 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and J. F. and Associates	Vega Alta Steering Committee	UNIT I	Jul-97	scan from hard copy
Second-quarter 1997 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and J. F. and Associates	Vega Alta Steering Committee	UNIT I	Oct-97	scan from hard copy
Third-quarter 1997 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and J. F. and Associates	Vega Alta Steering Committee	UNIT I	Mar-98	scan from hard copy

Title	Author Org	For	Operable Unit	Date	Comments
Fourth-quarter 1997 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and J. F. and Associates	Vega Alta Steering Committee	UNIT I	Apr-98	scan from hard copy
First-quarter 1998 ground water sampling and analysis results for the Vega Alta Public Supply Wells Site, located in Vega Alta, Puerto Rico	Unisys Corporation (Unisys) and IMMAC Environmental Consultants, Inc. (IMMAC)	Vega Alta Steering Committee	UNIT I	Jul-98	scan from hard copy
Second-Quarter 1998 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Oct-99	scan from hard copy
Third-Quarter 1998 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Dec-99	scan from hard copy
Fourth-Quarter 1998 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Dec-99	scan from hard copy
First-Quarter 1999 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Mar-00	scan from hard copy
Second-Quarter 1999 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Sep-00	scan from hard copy
Third-Quarter 1999 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Oct-00	scan from hard copy
Fourth-Quarter 1999 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Oct-00	scan from hard copy

Title	Author Org	For	Operable Unit	Date	Comments
First-Quarter 2000 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Dec-00	scan from hard copy
Second-Quarter 2000 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	UNISYS Corporation and IMMAC Environmental Services (IMMAC)	Vega Alta Steering Committee	UNIT I	Mar-01	scan from hard copy
Third Quarter 2000 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL) and IMMAC Environmental Services	Vega Alta Steering Committee	UNIT I	May-02	scan from hard copy
Fourth Quarter 2000 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	May-02	scan from hard copy
First-Quarter 2001 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Jul-02	scan from hard copy
Second-Quarter 2001 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Jul-02	scan from hard copy
Third Quarter 2001 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Jul-02	scan from hard copy
Fourth Quarter 2001 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Jul-02	scan from hard copy
First-Quarter 2002 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Oct-02	scan from hard copy
Second-Quarter 2002 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Jan-03	scan from hard copy
Third Quarter 2002 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Apr-03	scan from hard copy
Fourth Quarter 2002 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Apr-04	scan from hard copy

Title	Author Org	For	Operable Unit	Date	Comments
First-Quarter 2003 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Jun-04	scan from hard copy
Second-Quarter 2003 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Aug-04	scan from hard copy
Third Quarter 2003 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Aug-04	scan from hard copy
Fourth Quarter 2003 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Blasland, Bouck, & Lee, Inc. (BBL)	Vega Alta Steering Committee	UNIT I	Aug-04	scan from hard copy
First-Quarter 2004 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Dec-04	PDF file on CD
Second-Quarter 2004 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Oct-05	PDF file on CD
Third Quarter 2004 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Feb-06	PDF file on CD
Fourth Quarter 2004 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Feb-06	PDF file on CD
First-Quarter 2005 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Feb-06	PDF file on CD
Second-Quarter 2005 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Apr-06	PDF file on CD
Third Quarter 2005 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Apr-06	PDF file on CD
Fourth Quarter 2005 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Apr-06	PDF file on CD
First-Quarter 2006 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Jun-06	PDF file on CD

Title	Author Org	For	Operable Unit	Date	Comments
Second-Quarter 2006 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Oct-06	PDF file on CD
Third Quarter 2006 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Jan-07	PDF file on CD
Fourth Quarter 2006 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Mar-07	PDF file on CD
First-Quarter 2007 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Sep-07	PDF file on CD
Second-Quarter 2007 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Oct-07	PDF file on CD
Third Quarter 2007 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Feb-08	PDF file on CD
Fourth Quarter 2007 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Jul-08	PDF file on CD
First-Quarter 2008 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Sep-08	PDF file on CD
Second-Quarter 2008 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Dec-08	PDF file on CD
Third Quarter 2008 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Mar-09	PDF file on CD
Fourth Quarter 2008 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Mar-09	PDF file on CD
First-Quarter 2009 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Jun-09	PDF file on CD
Second-Quarter 2009 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Sep-09	PDF file on CD

Title	Author Org	For	Operable Unit	Date	Comments
Third Quarter 2009 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Mar-10	PDF file on CD
Fourth Quarter 2009 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Jul-10	PDF file on CD
First-Quarter 2010 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Aug-10	PDF file on CD
Second-Quarter 2010 Ground Water Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Jan-11	PDF file on CD
Third Quarter 2010 Groundwater Monitoring Report, Vega Alta Public Supply Wells Site, Vega Alta, Puerto Rico	Leggette, Brashears & Graham, Inc. (LBG)	Vega Alta Steering Committee	UNIT I	Mar-11	PDF file on CD
DRAFT REMEDIAL CONSTRUCTION REPORT VEGA ALTA PUBLIC SUPPLY WELLS SITE OPERABLE UNIT II, VEGA ALTA, PUERTO RICO	Leggette, Brashears & Graham (LBG), Inc., Professional Ground-Water and Environmental Engineering Services	Vega Alta Steering Committee	UNIT II	Jan-02	
FINAL REMEDIAL DESIGN REPORT (100% COMPLETION) VEGA ALTA PUBLIC SUPPLY WELLS SITE, OPERABLE UNIT II, VEGA ALTA, PUERTO RICO	Leggette, Brashears & Graham (LBG), Inc., Professional Ground-Water and Environmental Engineering Services	Vega Alta Steering Committee	UNIT II	Sep-00	
INITIAL TESTING PLAN - DRAFT VEGA ALTA PUBLIC SUPPLY WELLS SITE OPERABLE UNIT II VEGA ALTA, PUERTO RICO	Leggette, Brashears & Graham (LBG), Inc., Professional Ground-Water and Environmental Engineering Services	Vega Alta Steering Committee	UNIT II	Aug-01	

Title	Author Org	For	Operable Unit	Date	Comments
DRAFT REVISED REMEDIAL ACTION REPORT VEGA ALTA PUBLIC SUPPLY WELLS SITE, OPERABLE UNIT II, VEGA ALTA, PUERTO RICO	Leggette, Brashears & Graham (LBG), Inc., Professional Ground-Water and Environmental Engineering Services	Vega Alta Steering Committee	UNIT II	15-Sep-08	

Table 15 Vega Alta PSWs Superfund Site Information Sources Details of Administrative Record

Title	Author Org	Date	Phase Act
NOTIFICATION OF HAZARDOUS WASTE ACTIVITY	GENERAL ELECTRIC (GE) CO		PRE-REMEDIAL
LOCATION OF SAMPLING WELLS			REM INVESTIGATION / FEAS STUDY
LOCATIONS OF MONITORING WELLS			REM INVESTIGATION / FEAS STUDY
PUBLIC NOTICE : ANNOUNCEMENT OF REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA)	EPA		RECORD OF DECISION
ATTENDANCE SHEET FROM PUBLIC MEETING			RECORD OF DECISION
NATIONAL PRIORITIES LIST (NPL) SITE INFORMATION	EPA		RECORD OF DECISION
NEWSPAPER ARTICLE : GROUNDWATER CONTAMINATION			PUBLIC / CONGRESSIONA L INVOLVE
10 POINT DOCUMENT IMMEDIATE REMOVAL REQUEST			REM INVESTIGATION / FEAS STUDY
INDEX, DOCUMENT NUMBER ORDER, VEGA ALTA PUBLIC SUPPLY WELLS, OPERABLE UNIT 1 DOCUMENTS.	EPA		RECORD OF DECISION

Title	Author Org	Date	Phase Act
VEGA ALTA PUBLIC SUPPLY WELLS SUPERFUND SITE, ADMINISTRATIVE RECORD, EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD), DECEMBER 1997.	EPA		RECORD OF DECISION
VEGA ALTA, ADMINISTRATIVE RECORD - ESD, JULY 1995.	EPA		RECORD OF DECISION
LISTING OF INDUSTRIES		1980-01-01	PRE-REMEDIAL
NOTIFICATION OF HAZARDOUS WASTE ACTIVITY	GENERAL ELECTRIC CONTROLS INC	1980-08-05	PRE-REMEDIAL
NOTIFICATION OF HAZARDOUS WASTE ACTIVITY	GENERAL ELECTRIC CONTROLS INC	1980-08-05	PRE-REMEDIAL
ACKNOWLEDGEMENT OF NOTIFICATION OF HAZARDOUS WASTE ACTIVITY	EPA	1980-11-07	PRE-REMEDIAL
ACKNOWLEDGEMENT OF NOTIFICATION OF HAZARDOUS WASTE ACTIVITY	EPA	1980-11-07	PRE-REMEDIAL
HAZARDOUS WASTE PERMIT APPLICATION	GENERAL ELECTRIC CONTROLS INC	1980-11-10	PRE-REMEDIAL
INDUSTRIAL AND HAZARDOUS WASTE COLLECTOR AND SEPTIC TANK CLEANER CERTIFICATE OF REGISTRATION	EPA	1980-11-10	PRE-REMEDIAL
RCRA INSPECTION CHECKLIST	EPA	1981-02-04	PRE-REMEDIAL
REQUEST FOR FAVORABLE RULING ON PERMIT TO TRANSPORT WASTE	GENERAL ELECTRIC CONTROLS INC	1981-05-12	REM INVESTIGATION / FEAS STUDY
ACKNOWLEDGEMENT OF NOTIFICATION OF HAZARDOUS WASTE ACTIVITY	EPA	1981-05-18	PRE-REMEDIAL

Title	Author Org	Date	Phase Act
RCRA INTERIM STATUS INSPECTION OF CLEAR AMBIENT SERVICES FOR WORK PERFORMED ON 8/13/81	ENVIRONMENTAL QUALITY BOARD	1981-09-03	PRE-REMEDIAL
RCRA INTERM STATUS INSPECTION OF CLEAR AMBIENT SERVICES FOR WORK PERFORMED ON 8/11/81	ENVIRONMENTAL QUALITY BOARD	1981-10-23	PRE-REMEDIAL
RCRA HAZARDOUS WASTE REPORT FORMS	GENERAL ELECTRIC PILOT DEVICES INC	1982-03-17	PRE-REMEDIAL
RCRA HAZARDOUS WASTE REPORT FORMS	GENERAL ELECTRIC PILOT DEVICES INC	1982-03-17	PRE-REMEDIAL
PARTIAL RESULTS OF ORGANIC ANALYSES FROM SELECTED WELLS		1982-08-01	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF GROUNDWATER SAMPLING RESULTS THROUGHOUT PR	US DEPT OF INTERIOR	1983-01-17	REM INVESTIGATION / FEAS STUDY
REQUEST FOR INFORMATION REGARDING HAZARDOUS WASTE ACTIVITIES AND REQUEST FOR RCRA PART B PERMIT APPLICATION	EPA	1983-04-07	REM INVESTIGATION / FEAS STUDY
NEWSPAPER ARTICLE : CRB SIGNS BILL SETTING WASTE SITE NORMS	SAN JUAN STAR	1983-04-13	PUBLIC / CONGRESSIONAL INVOLVE
HAZARD RANKING SYSTEM (HRS) SCORE & WORKSHEETS (CONFIDENTIAL)	EPA	1983-06-07	PRE-REMEDIAL
POTENTIAL HAZARDOUS WASTE SITE INSPECTION REPORT	EPA	1983-06-07	PRE-REMEDIAL
REPORT OF TELEPHONE CONVERSATION WITH SERAFIN ACEVEDO REGARDING RESULTS OF ORGANIC ANALYSES OF WELLS	EPA	1983-06-24	REM INVESTIGATION / FEAS STUDY
CONTAMINATION OF DRINKING WATER SUPPLY WELLS	DEPT OF HEALTH AND HUMAN SERVICES	1983-06-29	REM INVESTIGATION / FEAS STUDY
LIST OF INSPECTIONS (9/7/83 COVER LETTER ATTACHED)	PR ENVIRONMENTAL QUALITY BOARD	1983-08-01	PRE-REMEDIAL

Title	Author Org	Date	Phase Act
NEWSPAPER ARTICLE : VEGA ALTA RESIDENTS FEEL OFFICIALS MISLED THEM	SAN JUAN STAR	1983-08-07	PUBLIC / CONGRESSIONAL INVOLVE
DRAFT REPORT OF PONDEROSA WELL CONTAMINATION SOURCES	ENVIRONMENTAL QUALITY BOARD	1983-08-10	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF PONDEROSA WELL POLLUTION SOURCES REPORT	ENVIRONMENTAL QUALITY BOARD	1983-08-16	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF PONDEROSA WELL POLLUTION SOURCES REPORT	ENVIRONMENTAL QUALITY BOARD	1983-08-17	REM INVESTIGATION / FEAS STUDY
104(E) LETTER (LIST OF ADDRESSES ATTACHED)	EPA	1983-08-29	GENERAL ENFORCEMENT
FACT SHEET : VEGA ALTA PUBLIC WELL FIELD SAMPLING PROGRAM	EPA	1983-09-01	REM INVESTIGATION / FEAS STUDY
REGIONAL DRINKING WATER SAMPLING PLAN	EPA;TECHNICAL ASSISTANCE TEAM (TAT)	1983-09-06	REM INVESTIGATION / FEAS STUDY
104(E) RESPONSE - INLAND CONTAINER CORP	INLAND CONTAINER CORP	1983-09-09	GENERAL ENFORCEMENT
CONFIRMATION OF EXTENSION OF 104(E) RESPONSE DATE - MOTOROLA INC	MOTOROLA INC	1983-09-12	GENERAL ENFORCEMENT
104(E) RESPONSE - ABLE MANUFACTURING	ABLE MANUFACTURING	1983-09-14	GENERAL ENFORCEMENT
104(E) RESPONSE - EL MORRO CORRUGATED BOX CORP AND INLAND PAPER CO	EL MORRO CORRUGATED BOX CORP	1983-09-20	GENERAL ENFORCEMENT
CONFIRMATION OF EXTENSION OF 104(E) RESPONSE DATE - BEATRICE FOODS	BEATRICE FOODS CO	1983-09-20	GENERAL ENFORCEMENT
104(E) RESPONSE - GENERAL ELECTRIC CONTROLS INC	GENERAL ELECTRIC CONTROLS INC	1983-09-22	GENERAL ENFORCEMENT

Title	Author Org	Date	Phase Act
104(E) RESPONSE - PHILIPPE GUEX TOOLING & FASTENING SYSTEMS OF AMERICA	PHILIPPE GUEX TOOLING & FASTENING SYSTEMS OF AMERICA	1983-09-28	GENERAL ENFORCEMENT
104(E) RESPONSE - HARMON INTERNATIONAL	HARMON INTERNATION AL	1983-09-29	GENERAL ENFORCEMENT
COMMENTS ON REVIEW OF CLOSURE PLAN	EPA	1983-10-01	REM INVESTIGATION / FEAS STUDY
104(E) RESPONSE - DEL TORO RENTAL EQUIPMENT	DEL TORO RENTAL EQUIPMENT	1983-10-06	GENERAL ENFORCEMENT
REQUEST FOR COPIES OF DRINKING WATER TEST RESULTS	CEPEDA SANCHEZ - BETANCES & SIFRE	1983-10-07	REM INVESTIGATION / FEAS STUDY
104(E) RESPONSE - MOTOROLA INC	MOTOROLA INC	1983-10-10	GENERAL ENFORCEMENT
ATTENDANCE SHEET FROM 11/29/83		1983-11-29	PRE-REMEDIAL
104(E) RESPONSE - OWENS ILLINOIS	OWENS ILLINOIS	1983-12-19	GENERAL ENFORCEMENT
WORK PLAN REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS) OF ALTERNATIVES	N U S CORP	1984-01-01	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF PROPOSED WORK EFFORT AND COST ESTIMATE	EPA	1984-01-05	REM INVESTIGATION / FEAS STUDY
ACTION TAKEN STATUS REPORT FEBRUARY 1984	EPA	1984-02-01	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF WATER SUPPLY STATUS REPORT FEBRUARY 1984	EPA	1984-02-14	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
PUBLIC NOTICE : INTENT TO TERMINATE INTERIM STATUS, OPPORTUNITY FOR HEARING, AND CLOSURE PLAN	EPA	1984-03-01	PRE-REMEDIAL
SUMMARY OF SITE STATUS		1984-03-01	REM INVESTIGATION / FEAS STUDY
COMMUNITY RELATIONS PLAN (CRP)	N U S CORP	1984-06-01	REM INVESTIGATION / FEAS STUDY
STATEMENT OF BASIS DRAFT RCRA PERMIT APPLICATION	EPA	1984-06-01	PRE-REMEDIAL
PUBLIC NOTICE : INTENT TO TERMINATE INTERIM STATUS, OPPORTUNITY FOR HEARING, AND CLOSURE PLAN	EPA	1984-06-01	REMOVAL
VOLATILE ORGANICS ANALYSIS SUMMARY	N U S CORP	1984-06-07	REM INVESTIGATION / FEAS STUDY
SUMMARY OF GROUNDWATER CONTAMINATION INVESTIGATION	EPA	1984-06-13	REM INVESTIGATION / FEAS STUDY
SUMMARY OF 5/31/84 FACILITY VISIT TO INVESTIGATE WELLS ON PROPERTY	EPA	1984-06-18	REM INVESTIGATION / FEAS STUDY
REQUEST FOR PROPOSAL FOR NEW HYDROGEOLOGICAL SAMPLING INVESTIGATION	EPA	1984-06-20	REM INVESTIGATION / FEAS STUDY
NOTIFICATION OF RETENTION OF DAMES & MOORE AS CONSULTANT AND PLANNED PROPOSAL DATE	MOTOROLA INC	1984-06-26	REM INVESTIGATION / FEAS STUDY
GROUNDWATER CONTAMINATION INVESTIGATION PROGRESS REPORT JULY 1984	EPA	1984-07-01	REM INVESTIGATION / FEAS STUDY
VOLATILE ORGANICS ANALYSIS SUMMARY PHASE I SUBSURFACE INVESTIGATION	N U S CORP	1984-07-07	REM INVESTIGATION / FEAS STUDY
104(E) LETTER - GENERAL ELECTRIC CO	EPA	1984-07-27	GENERAL ENFORCEMENT

Title	Author Org	Date	Phase Act
104(E) LETTER - HARMON INTERNATIONAL	EPA	1984-07-27	GENERAL ENFORCEMENT
104(E) LETTER - MOTOROLA INC	EPA	1984-07-27	GENERAL ENFORCEMENT
TRANSMITTAL OF PROPOSAL FOR THE INVESTIGATION	MOTOROLA INC	1984-07-31	REM INVESTIGATION / FEAS STUDY
ATTENDANCE SHEET FROM 8/1/84 UPDATE MEETING		1984-08-01	REMOVAL
NOTICE OF 8/26/86 PUBLIC MEETING TO DISCUSS RESULTS OF THE REMEDIAL INVESTIGATION (RI) (IN SPANISH)	EPA	1984-08-01	REM INVESTIGATION / FEAS STUDY
104(E) RESPONSE - MOTOROLA INC	MOTOROLA INC	1984-08-07	GENERAL ENFORCEMENT
ATTENDANCE SHEET FROM 8/15/84 MEETING		1984-08-15	REM INVESTIGATION / FEAS STUDY
NOTIFICATION OF INTENTION TO COOPERATE WITH REMEDIAL INVESTIGATION (RI)	GENERAL ELECTRIC CONTROLS INC	1984-08-16	REM INVESTIGATION / FEAS STUDY
SUMMARY OF 8/15/84 MEETING REGARDING FACILITY INVESTIGATION	EPA	1984-08-30	REM INVESTIGATION / FEAS STUDY
LIST OF DOCUMENTS FOR HYDROGEOLOGICAL INVESTIGATION SUBMITTED BY MOTOROLA		1985-04-03	REM INVESTIGATION / FEAS STUDY
REPORT OF CONVERSATION WITH JOSE FONT AND GRANT KIMMEL REGARDING SOIL SAMPLES, NUS REPORT, AND MOTOROLA NOT RESPONDING TO EPA LETTER	EPA	1985-05-14	REM INVESTIGATION / FEAS STUDY
104(E) RESPONSE - MOTOROLA INC	MOTOROLA INC	1985-05-14	GENERAL ENFORCEMENT
FOIA REQUEST FOR ALL RECORDS CONCERNING HYDROLOGY AND WATER QUALITY	LAW ENVIRONMENTAL SERVICES	1985-06-21	PUBLIC / CONGRESSIONAL INVOLVE

Title	Author Org	Date	Phase Act
OUTLINE OF PROPOSED MONITORING PROGRAM FOR PUBLIC WATER SUPPLY	N U S CORP	1986-01-03	REM INVESTIGATION / FEAS STUDY
104(E) RESPONSE - TELEDYNE PACKAGING	TELEDYNE PACKAGING	1986-03-10	GENERAL ENFORCEMENT
104(E) RESPONSE - WEST CO	WEST CO	1986-03-17	GENERAL ENFORCEMENT
REMEDIAL INVESTIGATION (RI) REPORT VOLUME I	N U S CORP	1986-05-01	REM INVESTIGATION / FEAS STUDY
REMEDIAL INVESTIGATION (RI) REPORT VOLUME II (APPENDICES)	N U S CORP	1986-05-01	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-07-21	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-07-21	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-07-21	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-07-21	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-07-21	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-07-21	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REMEDIAL INVESTIGATION (RI)	US DEPT OF INTERIOR	1986-08-06	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-08-11	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-08-11	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-08-11	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-08-11	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-08-11	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REMEDIAL INVESTIGATION (RI) VOLUME I AND II	EPA	1986-08-11	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-11	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLSS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
INVITATION TO 8/26/86 MEETING TO DISCUSS WORK STATUS OF REMEDIAL INVESTIGATION (RI) STUDY FOR PUBLIC SUPPLY WELLS	EPA	1986-08-13	REM INVESTIGATION / FEAS STUDY
THANK YOU FOR MEETING INVITATION	PR GOVERNOR OFFICE	1986-08-19	REM INVESTIGATION / FEAS STUDY
NEWSPAPER ARTICLE : IDENTIFICAN A 4 CONTAMINANTES (IN SPANISH)	EL NUEVO DIA	1986-08-25	PUBLIC / CONGRESSIONA L INVOLVE
COMMENTS ON REMEDIAL INVESTIGATION (RI) REPORT TO BE INCLUDED IN THE FINAL PRELIMINARY NATURAL RESOURCE SURVEY REPORT	US DEPT OF INTERIOR	1986-08-25	REM INVESTIGATION / FEAS STUDY
FACT SHEET : VEGA ALTA PUBLIC SUPPLY WELLS	EPA	1986-08-26	REM INVESTIGATION / FEAS STUDY
NEWSPAPER ARTICLE : LA CONTAMINACION AMENAZA A 17000 PERSONAS (IN SPANISH)	EL NUEVO DIA	1986-08-27	PUBLIC / CONGRESSIONA L INVOLVE
COMMENTS ON REMEDIAL INVESTIGATION (RI) REPORT	PR DEPT OF HEALTH	1986-08-29	REM INVESTIGATION / FEAS STUDY
NO DATA ON FARMING CONTRIBUTION TO THE CONTAMINATION AT SITE	DEPT OF AGRICULTUR E	1986-09-02	REM INVESTIGATION / FEAS STUDY
DRAFT FEASIBILITY STUDY (FS) WITH REFERENCES AND APPENDICES (7/17/87 COVER LETTER ATTACHED)	N U S CORP	1987-07-01	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
DRAFT WORK PLAN FOR FEASIBILITY STUDY (FS)	N U S CORP	1987-07-01	REM INVESTIGATION / FEAS STUDY
FACT SHEET : PROPOSED REMEDIAL ACTION PLAN (PRAP)	EPA	1987-08-01	RECORD OF DECISION
FACT SHEET : PLAN PROPUESTO PARA ACCION REMEDIAL (IN SPANISH)	EPA	1987-08-01	RECORD OF DECISION
MEETING ATTENDANCE SHEET FOR 8/19/87 PUBLIC MEETING		1987-08-19	RECORD OF DECISION
RECORD OF DECISION (ROD)	EPA	1987-09-29	RECORD OF DECISION
PRESS RELEASE : EPA SELECTS $12.8 MILLION SUPERFUND REMEDY FOR VEGA ALTA WATER SUPPLY	EPA	1987-11-04	RECORD OF DECISION
TRANSCRIPT OF 8/1/9/87 PUBLIC HEARING ON PROPOSED PLAN FOR REMEDIAL ACTION	EPA	1997-08-19	PUBLIC / CONGRESSIONA L INVOLVE
CONCURRENCE WITH EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD)	COMMONWE ALTH OF PR	1997-09-30	RECORD OF DECISION
AMENDMENT TO ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-90302 (EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD) AND SUPPLEMENTAL STATEMENT OF WORK (SOW) ATTACHED)	EPA	1997-12-05	RECORD OF DECISION
PUBLIC NOTICE : UNA EXPLICACION DE CAMBIOS SIGNIFICATIVOS LUGAR DE LOS POZOS DE ABASTECIMIENTO PUBLICO (IN SPANISH)	EPA	1997-12-22	RECORD OF DECISION
CLARIFICATION OF EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD) (SUMMARY OF 1/9/98 UNILATERAL ORDER CONFERENCE ATTACHED)	EPA	1998-01-22	RECORD OF DECISION
NOTIFICATION OF 2/26/98 PUBLIC MEETING TO DISCUSS THE EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD)	EPA;EPA	1998-02-17	RECORD OF DECISION

Title	Author Org	Date	Phase Act
PUBLIC NOTICE : INFORMAL AVAILABILITY SESSION ON 2/26/98	EPA	1998-02-19	RECORD OF DECISION
DRAFT 10 POINT DOCUMENT IMMEDIATE REMOVAL REQUEST			REM INVESTIGATION / FEAS STUDY
RESPONSE ACTION NEEDED FOR WATER			REM INVESTIGATION / FEAS STUDY
WATER QUALITY DATA			REM INVESTIGATION / FEAS STUDY
ATTENDANCE LIST			RECORD OF DECISION
PUBLIC NOTICE : ANNOUNCEMENT OF REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA)	EPA		REMEDIAL DESIGN
FACT SHEET : REMEDIAL INVESTIGATION (RI) RESULTS	EPA		REM INVESTIGATION / FEAS STUDY
COMMENTS ON PROPOSED PLAN (8/27/97 COVER LETTER ATTACHED)	BAYH CONNAUGHT ON & STEWART		RECORD OF DECISION
COMPANY QUESTIONNAIRE WITH RESPONSES	PHILLIPPE GUEZ TOOLING & FASTENING SYSTEMS OF AMERICA		REM INVESTIGATION / FEAS STUDY
VEGA ALTA PSWS, OPERABLE UNIT TWO, ADMINISTRATIVE RECORD INDEX, INDEX OF DOCUMENTS.	EPA		RECORD OF DECISION
VEGA ALTA PUBLIC SUPPLY WELLS SUPERFUND SITE, ADMINISTRATIVE RECORD, EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD), DECEMBER 1997.	EPA		RECORD OF DECISION
VEGA ALTA PUBLIC SUPPLY WELLS SUPERFUND SITE, OPERABLE UNIT TWO, ADMINISTRATIVE RECORD FILE - UPDATE, FEBRUARY 1998, INDEX OF DOCUMENTS.	EPA		RECORD OF DECISION
VEGA ALTA PUBLIC SUPPLY WELLS, OPERABLE UNIT TWO, ADMINISTRATIVE RECORD FILE UPDATE, INDEX OF DOCUMENTS.	EPA		RECORD OF DECISION

Title	Author Org	Date	Phase Act
HAZARDOUS RANKING SYSTEM (HRS) PACKAGE (CONFIDENTIAL)		1983-06-07	PRE-REMEDIAL
APPLICATION OF CERCLA IN PUERTO RICO AN OPTIONS PAPER	EPA	1983-07-07	PRE-REMEDIAL
REPORT OF WELL CONTAMINATION (COVER LETTER, LIST, AND TABLE ATTACHED)	ENVIRONMENTAL QUALITY BOARD	1983-08-17	PRE-REMEDIAL
FACT SHEET : SUMMARY OF SAMPLING PROGRAM (RELATED DOCUMENTS ATTACHED)	EPA	1983-09-01	REMEDIAL DESIGN
REQUEST FOR AUTHORIZATION TO PROCEED WITH REMEDIAL PLANING ACTIVITIES (AUTHORIZATION MEMOS FOR REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS) ATTACHED)	EPA	1983-09-19	REM INVESTIGATION / FEAS STUDY
NOTIFICATION INTERIM STATUS TERMINATION (NOTICE ATTACHED)	EPA	1984-10-03	REM INVESTIGATION / FEAS STUDY
PRELIMINARY ASSESSMENT (PA) REVIEW (RELATED DOCUMENTS ATTACHED)	EPA	1984-11-07	PRE-REMEDIAL
RECORD OF DECISION (ROD) FOR OPERABLE UNIT 1	EPA	1987-09-29	RECORD OF DECISION
HYDROLOGY AND EFFECTS OF DEVELOPMENT OF WATER TABLE AQUIFER IN THE VEGA ALTA QUADRANGLE	NONE;NONE	1988-01-01	REM INVESTIGATION / FEAS STUDY
ENVIRONMENTAL AND PRP STATUS REVIEW OF TELEDYNE PACKAGING (CONFIDENTIAL)	ENVIRONMENTAL STRATEGY CORP	1988-01-25	REM INVESTIGATION / FEAS STUDY
SAMPLING AND ANALYTICAL METHODS (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1988-02-09	REM INVESTIGATION / FEAS STUDY
ANALYTICAL QUALITY ASSURANCE (QA) REVIEW (COVER LETTER ATTACHED)	DECHERT PRICE & RHOADS	1988-02-10	REM INVESTIGATION / FEAS STUDY
ANLYTICAL DATA REPORT	COMPUCHEM LABORATORIES	1988-03-01	REM INVESTIGATION / FEAS STUDY

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ENFORCEMENT ACTION ACTIVITIES AND PR ENVIRONMENTAL QUALITY BOARD (PREQB) RESPONSIBILITIES (2/25/88 LETTER ATTACHED)	JUNTA DE CALIDAD AMBIENTAL	1988-06-16	REM INVESTIGATION / FEAS STUDY
ADDITIONAL SOILS INVESTIGATIONS (CONFIDENTIAL)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1988-07-08	REM INVESTIGATION / FEAS STUDY
REQUEST TO POSTPONE MEETING TO DISCUSS CONSENT DECREE UNTIL 8/1/88	ENVIRONMENTAL QUALITY BOARD	1988-07-12	REM INVESTIGATION / FEAS STUDY
DRAFT SITE INSPECTION REPORT FIELD INVESTIGATION TEAM ACTIVITIES AT UNCONTROLLED HAZARDOUS SUBSTANCES FACILITIES ZONE 1	N U S CORP	1988-09-12	PRE-REMEDIAL
REQUEST FOR ENDORSEMENT OF LETTER REGARDING PR ENVIRONMENTAL QUALITY BOARD (PREQB) CONSENT DECREE ACTIVITIES	EPA	1988-09-21	REM INVESTIGATION / FEAS STUDY
ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-80217	EPA	1988-09-30	GENERAL ENFORCEMENT
REVISED PAGES OF ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-80217 (COVER LETTER ATTACHED)	EPA	1988-10-03	GENERAL ENFORCEMENT
SUMMARY OF MEETING REGARDING SITE ACTIVITIES (RELATED DOCUMENTS ATTACHED)	PALMER & DODGE;PR AQUEDUCT AND SEWER AUTHORITY	1988-10-31	REM INVESTIGATION / FEAS STUDY
TELEDYNE PACKAGING PERFORMANCE OF PHASE II SOURCE CONTROL REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS)	PEPPER HAMILTON & SCHEETZ	1988-11-02	REMEDIAL DESIGN
RESPONSE TO REQUIRED ACTIVITIES OF THE ADMINISTRATIVE ORDER AND REQUEST THAT THE ADMINISTRATIVE ORDER BE WITHDRAWN	PEPPER HAMILTON & SCHEETZ	1988-11-04	REMEDIAL DESIGN
COMMENTS ON ADMINISTRATIVE ORDER (RELATED DOCUMENTS ATTACHED)	SIDLEY & AUSTIN	1988-11-08	REMEDIAL DESIGN
COMMENTS OF THE WEST CO OF PR INC ON ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-80217 (COVER LETTER ATTAHCED)	DECHERT PRICE & RHOADS;DECHART PRICE & RHOADS	1988-11-09	GENERAL ENFORCEMENT

Title	Author Org	Date	Phase Act
SUSPENSION OF EFFECTIVE DATE OF ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-80217	EPA	1988-11-23	GENERAL ENFORCEMENT
NOTICE OF SUPPORT FOR COMMENTS DISPUTING ORDER INCLUSION IN THE ADMINISTRATIVE RECORD (AR)	KIRKLAND & ELLIS	1988-11-23	REMEDIAL DESIGN
REQUEST FOR CONFIRMATION OF SUSPENSION OF ADMINISTRATIVE ORDER	FARER SIEGAL & FERSCO	1988-11-28	GENERAL ENFORCEMENT
STATUS OF REMEDIAL ACTIVITIES UNDER RECORD OF DECISION (ROD) AND UNILATERAL ORDER	EPA	1988-12-22	REMEDIAL DESIGN
STATUS OF ACTIVITIES AND MEETINGS UNDER ADMINISTRATIVE ORDER AND REQUEST FOR NOTIFICATION OF NEW ADMINISTRATIVE ORDER	SIDLEY & AUSTIN	1989-01-25	REMEDIAL DESIGN
SUMMARY OF GROUNDWATER VOLATILE SYNTHETIC ORGANIC CHEMICALS (COVER LETTER ATTACHED)	US DEPT OF INTERIOR	1989-02-10	REM INVESTIGATION / FEAS STUDY
DRINKING WATER SOURCES FOR RESIDENTS (10/17/88 LETTER REGARDING DRINKING WATER ATTACHED)	ENVIRONMENTAL QUALITY BOARD	1989-03-21	REM INVESTIGATION / FEAS STUDY
ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-90302	EPA	1989-03-22	GENERAL ENFORCEMENT
RESPONSE TO CONCERNS REGARDING ADMINISTRATIVE ORDER (12/22/88 LETTER ATTACHED)	EPA	1989-03-23	REMEDIAL DESIGN
PACKET OF GENERAL ELECTRIC PRESENTATION MATERIAL GIVEN TO EPA	GENERAL ELECTRIC (GE) CO	1989-04-03	REM INVESTIGATION / FEAS STUDY
OUTLINE OF MEETING PRESENTATION REGARDING ADMINISTRATIVE ORDER	SIDLEY & AUSTIN	1989-04-12	REMEDIAL DESIGN
SUMMARY OF 4/13/89 MEETING TO DISCUSS ACTIVITIES OF UNILATERAL REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA) ORDER	EPA	1989-04-19	REMEDIAL DESIGN
RESPONSE TO 4/13/89 LETTER REGARDING HARMAN AUTOMOTIVE OF PR INC ACTION (PARTIAL DETAIL VIEW OF PRIDCO ATTACHED)	HARMAN AUTOMOTIVE INC	1989-04-26	REMEDIAL DESIGN

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NOTIFICATION OF STATUS TO COMPLY WITH ORDER (PRESENTATION ATTACHED)	SIDLEY & AUSTIN	1989-05-08	REMEDIAL DESIGN
DRAFT SAMPLING ANALYSIS AND MONITORING PLAN	GENERAL ELECTRIC (GE) CO	1989-05-12	REM INVESTIGATION / FEAS STUDY
COMMENTS AND RECOMMENDATIONS ON DRAFT WORK PLAN FOR REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS)	US DEPT OF INTERIOR	1989-05-25	REM INVESTIGATION / FEAS STUDY
STATUS OF SAMPLING ANALYSIS AND MONITORING PLAN REVIEW (7/31/89 LETTER ATTACHED)	KIRKLAND & ELLIS	1989-08-08	REMEDIAL DESIGN
COMMENTS ON UNILATERAL REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA) ORDER SAMPLING ANALYSIS AND MONITORING PLAN	EPA	1989-09-26	REMEDIAL DESIGN
OUTLINE OF STEPS NECESSARY TO COMPLY WITH UNILATERAL REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA) ORDER	EPA	1989-09-26	REMEDIAL DESIGN
COMMENTS ON PROGRESS REPORTS DATED 8/4/89 AND 9/7/89	EPA	1989-10-06	REMEDIAL DESIGN
SAMPLING ANALYSIS AND MONITORING PLAN	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1989-10-11	REM INVESTIGATION / FEAS STUDY
SPECIAL NOTICE LETTER - MOTOROLA INC, HARMAN AUTOMOTIVE PR INC, WEST CO, TELEDYNE PACKAGING, CARIBE GENERAL ELECTRIC PRODUCTS INC, PR INDUSTRIAL DEVELOPMENT CO	EPA	1989-11-20	GENERAL ENFORCEMENT
REVISED SAMPLING ANALYSIS AND MONITORING PLAN	EPA	1989-11-27	REM INVESTIGATION / FEAS STUDY
FINAL STATEMENT OF WORK (SOW) FOR REMEDIAL DESIGN (RD)	GENERAL ELECTRIC (GE) CO	1990-01-08	REMEDIAL DESIGN
NOTIFICATION OF REQUIREMENTS FOR COMPLIANCE WITH UNILATERAL REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA) ORDER	EPA	1990-01-16	REMEDIAL DESIGN
TECHNICAL MEMORANDUM TO EVALUATE CHANGES IN VOLATILE ORGANIC COMPOUNDS IN EXISTING PRIVATE AND PUBLIC WELLS SINCE THE PHASE I REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS) (2/26/90 COVER LETTER ATTACHED)	BECHTEL ENVIRONMENTAL INC	1990-02-01	REM INVESTIGATION / FEAS STUDY

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WESTBAY MULTIPORT WELLS PART I BASIS FOR SELECTION	BEAK CONSULTANTS LIMITED	1990-03-01	REM INVESTIGATION / FEAS STUDY
RESPONSE TO SPECIAL NOTICE LETTER - TELEDYNE PACKAGING	PEPPER HAMILTON & SCHEETZ	1990-03-14	GENERAL ENFORCEMENT
REVISED TABLES FOR WESTBAY MULTIPORT WELLS PART I BASIS FOR SELECTION REPORT (COVER LETTER ATTACHED)		1990-04-30	REM INVESTIGATION / FEAS STUDY
AUTHORIZATION TO DISCHARGE PURGE WATER INTO HONDA CREEK (RELATED DOCUMENTS ATTACHED)	ENVIRONMENTAL QUALITY BOARD;ENVIRONMENTAL QUALITY BOARD;PR COMMONWEALTH OF	1990-05-09	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF DRAFT STATEMENT OF WORK (SOW) FOR REMEDIAL DESIGN (RD)	EPA	1990-06-13	REMEDIAL DESIGN
CONFIRMATION OF 45 DAY EXTENSION FOR IMPLEMENTATION OF SAMPLING ANALYSIS AND MONITORING PLAN	EPA	1990-06-13	REMEDIAL DESIGN
IMPLEMENTATION OF SAMPLING ANALYSIS AND MONITORING PLAN (AUTHORIZATION AND TABLE OF EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS ATTACHED)	DECHART PRICE & RHOADS	1990-06-20	REMEDIAL DESIGN
FINAL WORK PLAN OPERABLE UNIT 02 (OU2) AND SUPPLEMENTAL GROUNDWATER INVESTIGATIONS	EBASCO SERVICES INC	1990-07-27	REM INVESTIGATION / FEAS STUDY
OUTLINE OF ISSUES REGARDING DRAFT STATEMENT OF WORK (SOW) FOR REMEDIAL DESIGN (RD) (WITH CONCURRENCES)	EPA	1990-08-17	REMEDIAL DESIGN
REQUEST FOR EXTENSION TO RESPOND TO STATEMENT OF WORK (SOW) FOR REMEDIAL DESIGN (RD) (8/10/90 LETTER ATTACHED)	DECHART PRICE & RHOADS	1990-08-31	REMEDIAL DESIGN
ANALYTICAL RESULTS OF PURGED WATER (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1990-09-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT AUGUST 1990	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1990-09-21	REM INVESTIGATION / FEAS STUDY

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ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-00301	EPA	1990-09-27	GENERAL ENFORCEMENT
CHANGES IN PROCESS TO ELIMINATE FLOW OF PROCESS WASTEWATER	GENERAL ELECTRIC (GE) CO	1990-09-28	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT SEPTEMBER 1990	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1990-10-22	REM INVESTIGATION / FEAS STUDY
HARMAN AUTOMOTIVE RESPONSE TO ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-00301 (10/24/90 FAX COVER SHEET ATTACHED)	FARER SIEGAL & FERSCO	1990-10-22	REMEDIAL DESIGN
WEST CO RESPONSE TO ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-00301 (10/23/90 LETTER ATTACHED)	DECHART PRICE & RHOADS	1990-10-24	REMEDIAL DESIGN
TELEDYNE PACKAGING RESPONSE TO ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-00301 (10/29/90 COVER LETTER ATTACHED)	PEPPER HAMILTON & SCHEETZ	1990-10-24	REMEDIAL DESIGN
GROUNDWATER INVESTIGATION REPORT VOLUME 1 OF 5 CHAPTERS 1-3	BEAK CONSULTANTS LIMITED;BECHTEL ENVIRONMENTAL INC;ENVIRONMENTAL SOLUTIONS INC	1990-11-01	REM INVESTIGATION / FEAS STUDY
APPENDICES IN SUPPORT OF GROUNDWATER INVESTIGATION REPORT VOLUME 5 OF 5 APPENDICES G-L	BECHTEL ENVIRONMENTAL INC;ENVIRONMENTAL SOLUTIONS INC;BEAK CONSULTANTS LIMITED	1990-11-01	REM INVESTIGATION / FEAS STUDY
APPENDICES IN SUPPORT OF GROUNDWATER INVESTIGATION REPORT VOLUME 3 OF 5 APPENDICES A-E	ENVIRONMENTAL SOLUTIONS INC;BEAK CONSULTANTS LIMITED;BECHTEL ENVIRONMENTAL INC	1990-11-01	REM INVESTIGATION / FEAS STUDY

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GROUNDWATER INVESTIGATION REPORT VOLUME 2 OF 5 CHAPTERS 4-6	BEAK CONSULTANTS LIMITED;BECHTEL ENVIRONMENTAL INC;ENVIRONMENTAL SOLUTIONS INC	1990-11-01	REM INVESTIGATION / FEAS STUDY
APPENDICES IN SUPPORT OF GROUNDWATER INVESTIGATION REPORT VOLUME 4 OF 5 APPENDIX F	ENVIRONMENTAL SOLUTIONS INC;BECHTEL ENVIRONMENTAL INC;BEAK CONSULTANTS LIMITED	1990-11-01	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF SAMPLING AND ANALYSIS PLAN AND HELATH AND SAFETY PLAN UNDER ADMINISTRATIVE ORDER	GENERAL ELECTRIC (GE) CO	1990-11-17	REM INVESTIGATION / FEAS STUDY
ANALYTICAL RESULTS OF PURGED WATER SAMPLES (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1990-11-27	REM INVESTIGATION / FEAS STUDY
GROUNDWATER INVESTIGATION REPORT TECHNICAL SUMMARY	ENVIRONMENTAL SOLUTIONS INC;BECHTEL ENVIRONMENTAL INC;BEAK CONSULTANTS LIMITED	1990-12-01	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT NOVEMBER AND DECEMBER 1990 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1990-12-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT OCTOBER AND NOVEMBER 1990	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1990-12-31	REM INVESTIGATION / FEAS STUDY
GROUNDWATER INVESTIGATION REPORT EXECUTIVE SUMMARY	ENVIRONMENTAL SOLUTIONS INC;BEAK CONSULTANTS LIMITED;BECHTEL ENVIRONMENTAL INC	1991-01-01	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT OCTOBER AND NOVEMBER 1990	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-01-04	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF REPORT OF ANALYSIS FOR SOIL SAMPLES AND RESULTS OF ANALYTICAL TEST ON WASTEWATER IN SEPTIC TANK	PR COMMONWEALTH OF	1991-01-18	REM INVESTIGATION / FEAS STUDY
STATUS OF PILOT TESTING OF MULTI STAGE REVERSE OSMOSIS PROCESS (FLOW DIAGRAM AND WASTEWATER MANAGEMENT PLAN ATTACHED)	GENERAL ELECTRIC (GE) CO	1991-01-22	REM INVESTIGATION / FEAS STUDY
SOIL VAPOR EXTRACTION TECHNOLOGY REFERENCE HANDBOOK	EPA	1991-02-01	REM INVESTIGATION / FEAS STUDY
COMPLICATIONS DURING 1/91 GROUNDWATER SAMPLING	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-02-12	REM INVESTIGATION / FEAS STUDY
POSSIBLE COMPLICATIONS IN IMPLEMENTATION OF RECORD OF DECISION (ROD) AND REQUEST FOR TREATABILITY STUDY	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-03-05	RECORD OF DECISION
OUTLINE OF REPORT ON NEED FOR TREATABILITY STUDY, REQUEST FOR EXTENSION OF REMEDIAL DESIGN (RD) SUBMITTAL AND REQUEST FOR MEETING	FARER SIEGAL & FERSCO	1991-03-05	REMEDIAL DESIGN
ANALYTICAL QUALITY ASSURANCE (QA) REPORT GROUNDWATER SAMPLES COLLECTED 10/22/90-10/24/90	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-03-08	REM INVESTIGATION / FEAS STUDY
ANALYTICAL RESULTS OF PURGED WATER SAMPLES (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-03-18	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JANUARY 1991	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-03-22	REM INVESTIGATION / FEAS STUDY
COMMENTS ON CLOSURE PLAN FOR INJECTION WELL (RELATED DOCUMENTS ATTACHED)	PR COMMONWEALTH OF	1991-04-04	REM INVESTIGATION / FEAS STUDY
INFORMATION NEEDS TO COMPLETE REMEDIATION PROJECT (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-04-05	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT FEBRUARY AND MARCH 1991	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-04-08	REM INVESTIGATION / FEAS STUDY
SUMMARY OF EPA POSITION ON COMPLIANCE WITH ADMINISTRATIVE ORDER FOR REMEDIAL DESIGN (RD)	EPA	1991-05-09	REMEDIAL DESIGN
PROGRESS REPORT APRIL AND MAY 1991 (APPENDICES A AND B)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-06-18	REM INVESTIGATION / FEAS STUDY
STATUS OF MOTOROLA AND WEST CO REMEDIAL DESIGN (RD) PHASE	DECHART PRICE & RHOADS	1991-06-21	REMEDIAL DESIGN
SUMMARY OF 4/18/91 MEETING DISCUSSING CONCERNS ABOUT SELECTED REMEDY	EPA	1991-06-28	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JUNE 1991 (APPENDICES A AND B ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-07-29	REM INVESTIGATION / FEAS STUDY
NOTIFICATION OF VIOLATION OF UNILATERAL REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA) ORDER (REVIEW OF 30% DESIGN REPORT ATTACHED)	EPA	1991-08-01	REMEDIAL DESIGN
REQUEST FOR REMEDIAL INVESTIGATION / FEASIBILITY STUDY DOCUMENTATION (8/27/91 FAX COVER SHEET ATTACHED)	DECHART PRICE & RHOADS	1991-08-23	REM INVESTIGATION / FEAS STUDY
ESTIMATE OF PROBABLE CONSTRUCTION COST FOR GROUNDWATER REMEDIATION (CONFIDENTIAL)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-08-26	REM INVESTIGATION / FEAS STUDY
TECHNICAL SPECIFICATIONS FOR GROUNDWATER REMEDIATION	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-08-26	REMEDIAL DESIGN
CONSTRUCTION PLAN FOR GROUNDWATER REMEDIATION	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-08-26	REMEDIAL DESIGN
DESIGN ANALYSIS REPORT	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-08-26	REMEDIAL DESIGN

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OPERATING AND MAINTENANCE PLAN	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-08-26	LONG TERM RESPONSE, O & M, DEL
TRANSMITTAL OF GENERAL ELECTRIC CO ANNUAL REPORT TO SATIFY FINANCIAL ASSURANCE REQUIREMENTS	SIDDLEY & AUSTIN	1991-10-01	REMEDIAL DESIGN
PROGRESS REPORT THIRD QUARTER 1991	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-10-03	REM INVESTIGATION / FEAS STUDY
REVISIONS FOR GROUNDWATER SAMPLING (ANALYTICAL QUALITY ASSURANCE (QA) REPORT ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-10-11	REM INVESTIGATION / FEAS STUDY
QUALITY ASSURANCE PROJECT PLAN (QAPP) OPERABLE UNIT 02 (OU2) AND SUPPLEMENTAL GROUNDWATER INVESTIGATION	GERAGHTY & MILLER INC	1991-11-01	REM INVESTIGATION / FEAS STUDY
HEALTH AND SAFETY PLAN	GERAGHTY & MILLER INC	1991-11-01	REM INVESTIGATION / FEAS STUDY
FIELD SAMPLING PLAN OPERABLE UNIT 02 (OU2) AND SUPPLEMENTAL GROUNDWATER INVESTIGATION	GERAGHTY & MILLER INC	1991-11-01	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF INFORMATION REGARDING MODELING ASSUMPTIONS AND SCENARIOS	SIDLEY & AUSTIN	1991-11-27	REMEDIAL DESIGN
PROGRESS REPORT OCTOBER AND NOVEMBER 1991	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1991-12-09	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT NOVEMBER AND DECEMBER 1991 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1991-12-10	REM INVESTIGATION / FEAS STUDY
RESPONSE TO REQUEST FOR LIST OF WELLS TO BE SAMPLED (TABLE ATTACHED)	GERAGHTY & MILLER INC;GERAGHTY & MILLER INC;GERAGHTY & MILLER INC	1991-12-17	REM INVESTIGATION / FEAS STUDY
CHANGE IN ORDER OF WELLS FOR GROUNDWATER SAMPLING	GERAGHTY & MILLER INC;GERAGHTY & MILLER INC	1991-12-19	REM INVESTIGATION / FEAS STUDY

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COMMENTS ON 90% REMEDIAL DESIGN (RD) REPORT	EPA	1991-12-26	REMEDIAL DESIGN
COPY OF REVISED PAGE OF 11/19/91 SHORT FORM FOR REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS) (COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1991-12-31	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT DECEMBER 1991 (COVER LETTER ATTTACHED)	GENERAL ELECTRIC (GE) CO	1992-01-10	REM INVESTIGATION / FEAS STUDY
JUSTIFICATION FOR REQUEST OF EXTENSION FOR TIME TO BEGIN CONSTRUCTION (1/13/92 LETTER ATTACHED)	DECHART PRICE & RHOADS	1992-01-15	REMEDIAL DESIGN
ESTIMATE OF CONSTRUCTION COST FOR GROUNDWATER REMEDIATION (CONFIDENTIAL)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-01-17	REMEDIAL DESIGN
CONSTRUCTION PLAN FOR GROUNDWATER REMEDIATION	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-01-17	REMEDIAL DESIGN
TECHNICAL SPECIFICATIONS FOR GROUNDWATER REMEDIATION	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-01-17	REMEDIAL DESIGN
OPERATIONS AND MAINTENANCE PLAN	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-01-17	LONG TERM RESPONSE, O & M, DEL
DESIGN ANALYSIS REPORT	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-01-17	REMEDIAL DESIGN
REQUEST FOR ACCESS TO PROPERTY AND NOTIFICATION THAT SURVEYS WILL BE CONDUCTED ON 2/17/92	GERAGHTY & MILLER INC;GERAGHTY & MILLER INC	1992-02-13	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT DECEMBER 1991 AND JANUARY 1992	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-02-27	REM INVESTIGATION / FEAS STUDY
COMMENTS ON DRAFT SUMMARY TECHNICAL REVIEW REPORT CONCERNING PRP GROUNDWATER INVESTIGATION DOCUMENTS (REPORT ATTACHED) (CONFIDENTIAL)	CDM FEDERAL PROGRAMS CORP	1992-03-02	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT FEBRUARY 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-03-10	REM INVESTIGATION / FEAS STUDY
COMMENTS AND APPROVAL OF 100% REMEDIAL DESIGN (RD) REPORT (WORK SUMMARY AND SCHEDULE ATTACHED)	EPA	1992-03-19	REMEDIAL DESIGN
PROGRESS REPORT FEBRUARY 1992	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-03-26	REM INVESTIGATION / FEAS STUDY
GROUNDWATER FLOW AND TRANSPORT MODEL (TRANSMITTAL LETTER FOR SUMMARY OF INITIAL FIELD ACTIVITIES ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-04-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT MARCH 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-04-10	REM INVESTIGATION / FEAS STUDY
ANNUAL REPORT FOR HISTORICAL VOLATILE ORGANIC COMPOUND (VOC) DISTRIBUTION IN GROUNDWATER	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-04-17	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT MARCH 1992	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-04-28	REM INVESTIGATION / FEAS STUDY
RESPONSE TO REQUEST FOR LIST OF STATUS OF CLP DATA FOR SPLIT SAMPLES	CDM FEDERAL PROGRAMS CORP	1992-04-30	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT APRIL 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-05-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT APRIL 1992	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-05-12	REM INVESTIGATION / FEAS STUDY
NOTIFICATION OF CHANGE IN PROJECT COORDINATOR (ADDRESSEE LIST AND RESUME ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-05-20	REM INVESTIGATION / FEAS STUDY
WELL SAMPLE ANALYSIS (TABLES ATTACHED)	ENVIRON CORP	1992-05-21	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT MAY 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-06-10	REM INVESTIGATION / FEAS STUDY
DELAYS RELATED TO REMEDIAL EFFORTS	KIRKLAND & ELLIS	1992-06-19	REM INVESTIGATION / FEAS STUDY
GROUNDWATER MODEL FOR ADDITIONAL SCENARIOS	GENERAL ELECTRIC (GE) CO	1992-06-29	REM INVESTIGATION / FEAS STUDY
COMMENTS ON 6/23/92 MEETING MINUTES (MINUTES ATTACHED) (CONFIDENTIAL)	CDM FEDERAL PROGRAMS CORP	1992-07-01	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JUNE 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-07-08	REM INVESTIGATION / FEAS STUDY
SUMMARY OF 7/2/92 MEETING REGARDING REMEDIAL ACTION (RA) (RELATED DOCUMENTS ATTACHED)	EPA	1992-07-09	REMEDIAL ACTION
NOTIFICATION OF CONTINUING OBLIGATIONS FOR UNILATERAL ADMINISTRATIVE ORDER (UAO) (9/21/92 FAX COVER SHEET ATTACHED)	EPA	1992-07-10	REMEDIAL DESIGN
PROGRESS REPORT MAY AND JUNE 1992 (APPENDICES A AND B ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-07-24	REM INVESTIGATION / FEAS STUDY
SUMMARY OF 7/21/92 MEETING REGARDING SITE PROGRESS	KIRKLAND & ELLIS	1992-07-30	REM INVESTIGATION / FEAS STUDY
NOTIFICATION OF SUBSTITUTION OF LEGAL COUNSEL FOR MOTOROLA INC	MOTOROLA INC	1992-07-30	REMEDIAL DESIGN
LIST OF SITE ADDRESSEES		1992-07-30	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JULY 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-08-06	REM INVESTIGATION / FEAS STUDY
PLANNED REMEDIATION ACTIONS	KIRKLAND & ELLIS	1992-08-14	REM INVESTIGATION / FEAS STUDY

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COMMENTS ON CONTINGENCY PLAN	KIRKLAND & ELLIS	1992-08-14	REM INVESTIGATION / FEAS STUDY
REVIEW OF TECHNICAL MEMORANDUM SUMMARY OF INITIAL FIELD ACTIVITIES REPORT (COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1992-08-20	REM INVESTIGATION / FEAS STUDY
TRANSMITTAL OF GROUNDWATER FLOW AND TRANSPORT MODEL (DISTRIBUTION LIST ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-08-20	REM INVESTIGATION / FEAS STUDY
REMEDIAL ACTION (RA) TO AVOID LIQUID HAZARDOUS WASTE CONTAMINATION OF DRINKING WATER SOURCES IS EXEMPT FROM ENVIRONMENTAL IMPACT REVIEW PROCESS	PR ENVIRONMENTAL QUALITY BOARD	1992-09-03	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT AUGUST 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-09-07	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JULY AND AUGUST 1992	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-09-09	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REVISED PRELIMINARY INVESTIGATION REPORT	ENVIRONMENTAL RESOURCE MANAGEMENT INC;ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-09-11	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REVIEW OF TECHNICAL MEMORANDUM SUMMARY OF INITIAL FIELD ACTIVITIES	EPA	1992-09-11	REM INVESTIGATION / FEAS STUDY
REVISED COMMENTS ON PRELIMINARY INVESTIGATION REPORT (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC;ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-09-15	REM INVESTIGATION / FEAS STUDY
RESOLUTION FOR WATER EXTRACTION FRANCHISE (COVER LETTER AND SPANISH TRANSLATION ATTACHED)	FIDDLER GONZALEZ RODRIGUEZ ATTORNEYS	1992-09-22	REMEDIAL DESIGN

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COMMENTS ON REVIEW OF TECHNICAL MEMORANDUM SUMMARY OF INITIAL FIELD ACTIVITIES (FAX COVER SHEET ATTACHED)	CDM FEDERAL PROGRAMS CORP	1992-09-25	REM INVESTIGATION / FEAS STUDY
PRELIMINARY RESULTS OF GROUNDWATER SAMPLING (5/18/90 AND 7/9/90 COVER LETTERS ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-10-05	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT SEPTEMBER 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-10-08	REM INVESTIGATION / FEAS STUDY
RESPONSE TO TECHNICAL MEMORANDUM (COVER LETTER ATTACHED)	GERAGHTY & MILLER INC;GERAGHTY & MILLER INC	1992-10-14	REM INVESTIGATION / FEAS STUDY
RESPONSE TO TECHNICAL MEMORANDUM (10/15/92 COVER LETTER ATTACHED)	GERAGHTY & MILLER INC;GERAGHTY & MILLER INC	1992-10-14	REM INVESTIGATION / FEAS STUDY
STATUS OF MONTERREY 2 WELL	KIRKLAND & ELLIS	1992-10-16	REM INVESTIGATION / FEAS STUDY
REQUEST FOR ADDITIONAL INFORMATION FOR SALTWATER INTRUSION STUDY	CDM FEDERAL PROGRAMS CORP	1992-10-22	REM INVESTIGATION / FEAS STUDY
COMMENTS ON GROUNDWATER MODELING (COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1992-10-22	REM INVESTIGATION / FEAS STUDY
REQUEST FOR ADDITIONAL INFORMATION FOR SALTWATER INTRUSION STUDY (REQUEST ATTACHED)	EPA	1992-10-22	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT SEPTEMBER 1992	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-10-26	REM INVESTIGATION / FEAS STUDY
RESOLUCION (IN SPANISH)	ESATADO LIBRE ASOCIADO DE PR	1992-10-30	REM INVESTIGATION / FEAS STUDY
NOTIFICATION OF SAMPLES AND ANALYSES TO BE COLLECTED AT BOREHOLE INVESTIGATION	GERAGHTY & MILLER INC;GERAGHTY & MILLER INC	1992-10-30	REM INVESTIGATION / FEAS STUDY

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PROPOSED CHANGE IN LOCATION OF BORING NO. 36 (DIAGRAM AND SAMPLING INFORMATION ATTACHED)	CDM FEDERAL PROGRAMS CORP	1992-11-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT OCTOBER 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-11-10	REM INVESTIGATION / FEAS STUDY
NOTICE TO PROCEED WITH CONSTRUCTION OF REMEDIAL SYSTEM AT PONDEROSA WELL (11/13/92 COVER LETTER ATTACHED)		1992-11-11	REMEDIAL DESIGN
REQUEST TO CHANGE BORING NO. 36 (SAMPLING DATA ATTACHED)	GERAGHTY & MILLER INC;GERAGHTY & MILLER INC	1992-11-19	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT OCTORBER 1992	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1992-11-24	REM INVESTIGATION / FEAS STUDY
FOLLOW UP TO MEETING REGARDING DISSEMINATION OF INFORMATION ON THE COMMUNITY	ENVIRON CORP	1992-12-04	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT NOVEMBER 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1992-12-10	REM INVESTIGATION / FEAS STUDY
ANALYTICAL RESULTS FOR SOIL BORING (12/17/92 FAX COVER SHEET ATTACHED)		1992-12-12	REM INVESTIGATION / FEAS STUDY
MINUTES FROM 12/8/92 MEETING REGARDING GROUNDWATER REMEDY (COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1992-12-22	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT NO. 1 (RELATED DOCUMENTS ATTACHED)	JAFER CONSTRUCTION	1993-01-08	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT DECEMBER 1992 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-01-10	REM INVESTIGATION / FEAS STUDY
CHANGE IN LOCATION OF BORING NO. 4 (DATA ATTACHED)	CDM FEDERAL PROGRAMS CORP	1993-01-12	REM INVESTIGATION / FEAS STUDY
COMMENTS ON INITIAL PROGRESS SCHEDULE, BAR CHART, CLASSIC REPORT, AND SCHEDULE OF VALUES (RELATED DOCUMENTS ATTACHED) (CONFIDENTIAL)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-01-13	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT DECEMBER 1992 (APPENDICES A AND B ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-01-19	REM INVESTIGATION / FEAS STUDY
OUTLINE SITE STATUS ON THE RECORD OF DECISION (ROD)	EPA	1993-02-03	RECORD OF DECISION
PROGRESS REPORT JANUARY 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-02-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JANUARY 1993	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-02-17	REM INVESTIGATION / FEAS STUDY
SUMMARY OF FIELD OVERSIGHT ACTIVITIES (3/16/93 COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1993-03-01	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT FEBRUARY 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-03-09	REM INVESTIGATION / FEAS STUDY
REQUEST FOR ADDITIONAL WORK TO INSTALL MORE MONITORING WELLS UNDER THE REMEDIAL INVESTIGATION (RI) (DATA ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-03-11	REM INVESTIGATION / FEAS STUDY
LOCATIONS OF PROPOSED ADDITIONAL WELLS	CDM FEDERAL PROGRAMS CORP	1993-03-22	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT FEBRUARY 1993	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-03-29	REM INVESTIGATION / FEAS STUDY
CONSTRUCTION SCHEDULE FOR INSTALLATION OF PONDEROSA WELL	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-03-31	REM INVESTIGATION / FEAS STUDY
SUMMARY OF CORRESPONDENCE REGARDING GROUNDWATER REMEDIAL SCHEME	EPA	1993-04-08	REMEDIAL DESIGN
PROGRESS REPORT MARCH 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-04-08	REM INVESTIGATION / FEAS STUDY

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COMFIRMATION THAT EPA REPRESENTATIVE WILL BE PRESENT DURING CONSTRUCTION OF AIR STRIPPER	ENVIRON CORP	1993-04-20	REM INVESTIGATION / FEAS STUDY
CANCELLATION OF GROUNDWATER SAMPLING	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-04-23	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT APRIL 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-05-04	REM INVESTIGATION / FEAS STUDY
SUMMARY OF 5/5/93 MEETING REGARDING SITE STATUS	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-05-07	REM INVESTIGATION / FEAS STUDY
RESPONSE TO QUESTION REGARDING THE BREAKDOWN OF CERTAIN CHEMICALS (LIST OF REFERENCES CITED ATTACHED)	CDM FEDERAL PROGRAMS CORP	1993-05-24	REM INVESTIGATION / FEAS STUDY
SCHEDULE FOR THE INITIAL MECHANICAL CHECKOUT	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-06-03	REM INVESTIGATION / FEAS STUDY
COMMENTS ON CONDITIONS FOR PROPOSED REMEDIAL METHOD	NONE	1993-06-04	REMEDIAL DESIGN
PROGRESS REPORT MAY 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-06-08	REM INVESTIGATION / FEAS STUDY
PROCEDURE OUTLINE FOR MECHANICAL CHECKOUT (COVER LETTER ATTACHED)		1993-06-09	REM INVESTIGATION / FEAS STUDY
DELAYS FOR SUBSTANTIAL COMPLETION (RELATED DOCUMENTS ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-06-18	REM INVESTIGATION / FEAS STUDY
OPERATIONS REPORT FOR MECHANICAL CHECKOUT (7/8/93 LETTER OF TRANSMITTAL ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-07-07	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT MAY 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-07-09	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
DISPOSITION OF TREATED AND DISCHARGED WATERS	EPA	1993-07-16	REM INVESTIGATION / FEAS STUDY
STATUS OF CONSTRUCTION OF TREATMENT SYSTEM AT PONDEROSA WELL	EPA	1993-07-16	REM INVESTIGATION / FEAS STUDY
STATUS OF CONTRUCTION OF PONDEROSA AIR STRIPPER SYSTEM (FAX COVER SHEET ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-07-16	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT APRIL, MAY, AND JUNE 1993	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-07-19	REM INVESTIGATION / FEAS STUDY
ANALYTICAL RESULTS OF INFLUENT AND EFFLUENT SAMPLES COLLECTED DURING MECHANICAL CHECKOUT OF THE PONDEROSA SYSTEM ON 6/11/93 (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-07-27	REM INVESTIGATION / FEAS STUDY
FINAL COMPLETION INSPECTION FOR THE PONDEROSA WELL AIR STRIPPER SYSTEM	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-08-02	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JULY 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-08-09	REM INVESTIGATION / FEAS STUDY
PRESUMPTIVE REMEDIES POLICY AND PROCEDURES OSWER DIRECTIVE NO. 9355.0-47FS (PRESUMPTIVE REMEDIES SOIL CHARACTERIZATION AND TECHNOLOGY SELECTION FOR CERCLA SITES WITH VOLATILE ORGANIC COMPOUNDS IN SOILS OSWER DIRECTIVE NO. 9355.0-48FS ATTACHED)	EPA	1993-09-01	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JULY AND AUGUST 1993	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-09-02	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT AUGUST 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-09-09	REM INVESTIGATION / FEAS STUDY
COMMENTS ON INITIAL TESTING PROGRAM	EPA	1993-10-01	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT SEPTEMBER 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-10-07	REM INVESTIGATION / FEAS STUDY
COMMENTS ON ENVIRONMENTAL ASSESSMENT (EA) FOR CONSOLIDATION OF MANUFACTURING OPERATIONS	EPA	1993-10-08	REM INVESTIGATION / FEAS STUDY
INITIAL TESTING PROGRAM REPORT (COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-10-22	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT SEPTEMBER 1993	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-11-01	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT OCTOBER 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-11-09	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REVISED INITIAL TESTING PROGRAM	EPA	1993-11-15	REM INVESTIGATION / FEAS STUDY
SUMMARY OF WORK PERFORMED DURING OCTOBER 1993 (RELATED DOCUMENTS ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-11-19	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT OCTOBER 1993	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1993-11-19	REM INVESTIGATION / FEAS STUDY
RAW ANALYTICAL DATA OF 50% AND 75% WATER FEED RATES (COVER MEMO ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC;LANCASTER LABORATORIES INC	1993-12-03	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT NOVEMBER 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1993-12-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT DECEMBER 1993 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-01-10	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT NOVEMBER AND DECEMBER 1993	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-01-18	REM INVESTIGATION / FEAS STUDY
CONFIRMATION OF TIME EXTENSION FOR SUBMISSION OF INITIAL TESTING PROGRAM REPORT	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-01-18	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JANUARY 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-02-10	REM INVESTIGATION / FEAS STUDY
RESPONSE TO REQUEST FOR DOCUMENTS REGARDING SITE	EPA	1994-02-18	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JANUARY 1994	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-02-22	REM INVESTIGATION / FEAS STUDY
REQUEST FOR MODIFICATION OF DISPOSAL PROCEDURES FOR PURGE WATER	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-02-23	REM INVESTIGATION / FEAS STUDY
DRAFT INITIAL TESTING PROGRAM AIR STRIPPER SYSTEM (2/22/94 COVER LETTER ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-02-25	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT FEBRUARY 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-03-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT FEBRUARY 1994 (APPENDICES A-C ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-03-10	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REVISED EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD) TO 1987 RECORD OF DECISION (ROD) AND DRAFT REMEDIAL DESIGN / REMEDIAL ACTION (RD/RA) STATEMENT OF WORK (SOW)	EPA	1994-04-08	RECORD OF DECISION
PROGRESS REPORT MARCH 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-04-08	REM INVESTIGATION / FEAS STUDY
EVALUATION OF THE POTENTIAL NEED TO PERFORM AN ECOLOGICAL ASSESSMENT (COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1994-04-21	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT APRIL 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-05-09	REM INVESTIGATION / FEAS STUDY
COMMENTS ON INITIAL TESTING PROGRAM REPORT	EPA	1994-05-18	REM INVESTIGATION / FEAS STUDY
COMMENTS ON 1/94 DRAFT REMEDIAL INVESTIGATION (RI)	ECKERT SEAMANS CHERIN & MELLOT	1994-05-23	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION REPORT (REFERENCES ATTACHED)	EPA	1994-05-25	REM INVESTIGATION / FEAS STUDY
RESPONSE TO 5/18/94 LETTER REGARDING INITIAL TESTING PROGRAM REPORT	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-05-26	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT MAY 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-06-06	REM INVESTIGATION / FEAS STUDY
FIELD OVERSIGHT SUMMARY (9/9/94 COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1994-06-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT MARCH, APRIL, AND MAY 1994	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-06-20	REM INVESTIGATION / FEAS STUDY
APPROVAL OF WELL GROUNDWATER TREATMENT SYSTEM START UP (7/8/94 LETTER ATTACHED)	EPA	1994-06-28	REM INVESTIGATION / FEAS STUDY
RESPONSE TO COMMENTS ON REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION REPORT	EPA	1994-06-30	REM INVESTIGATION / FEAS STUDY
PUMPING, TREATING, AND WASTING POTABLE WATER (NEWSPAPER ARTICLES AND COURT MEMORANDUM IN SUPPORT OF GENERAL ELECTRIC MOTION TO SUSPEND AND PARTIALLY VACATE EPA ORDER ATTACHED)	SIDLEY & AUSTIN	1994-07-06	REMEDIAL DESIGN
PROGRESS REPORT JUNE 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-07-08	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT JUNE 1994	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-07-11	REM INVESTIGATION / FEAS STUDY
PACKET OF TES V DOCUMENTS (COVER LETTER ATTACHED) (CONFIDENTIAL)	CDM FEDERAL PROGRAMS CORP	1994-07-14	REM INVESTIGATION / FEAS STUDY
GENERAL ELECTRIC HANDLING ACTIVITIES REQUIRED UNDER FIRST ADMINISTRATVIE ORDER	KIRKLAND & ELLIS	1994-08-05	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JULY 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-08-09	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION REPORT	ENVIRONMENTAL QUALITY BOARD	1994-08-12	REM INVESTIGATION / FEAS STUDY
ANNOUNCEMENT OF EXPLANATION OF SIGNIFICANT DIFFERENCES (ESD) (COVER MEMO ATTACHED)		1994-08-30	RECORD OF DECISION
AMENDMENT TO ADMINISTRATIVE ORDER - INDEX NO. II-CERCLA-90302 (COVER LETTER ATTACHED)	EPA	1994-09-01	GENERAL ENFORCEMENT
PROGRESS REPORT AUGUST 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-09-09	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JULY AND AUGUST 1994 (APPENDICES A-E ATTACHED)	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-09-15	REM INVESTIGATION / FEAS STUDY
OUTLINE OF PROCEDURE FOR DISCHARGE OF PURGE WATER (DATA AND RELATED DOCUMENTS ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-09-27	REM INVESTIGATION / FEAS STUDY
GROUNDWATER SAMPLING TO BE PERFORMED ON 10/17/94 AT EIGHT MONITORING LOCATIONS	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1994-10-05	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT SEPTEMBER 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-10-06	REM INVESTIGATION / FEAS STUDY

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COMMENTS AND RECOMMENDED MODIFICATION TO SUPPLEMENTAL GROUNDWATER REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN (FAX COVER SHEET AND COVER LETTER ATTACHED)	BURNS AND ROE INDUSTRIAL SERVICES CO	1994-11-01	REM INVESTIGATION / FEAS STUDY
LIST OF ANALYTICAL DETECTION LIMITS (11/8/94 FAX COVER SHEET ATTACHED)	TRILLIUM INC	1994-11-07	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT OCTOBER 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-11-09	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN (LETTER ATTACHED)	ECKERT SEAMANS CHERIN & MELLOT	1994-11-14	REMEDIAL DESIGN
PROGRESS REPORT SEPTEMBER AND OCTOBER 1994 (APPENDICES A AND B ATTACHED)	ENVIRONMEN TAL RESOURCE MANAGEMEN T INC	1994-11-22	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT NOVEMBER 1994	ENVIRONMEN TAL RESOURCE MANAGEMEN T INC	1994-11-30	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT NOVEMBER 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1994-12-08	REM INVESTIGATION / FEAS STUDY
COMMENTS ON ENVIRONMENTAL IMPACT STATEMENT	EPA	1994-12-09	REM INVESTIGATION / FEAS STUDY
ANALYTICAL QUALITY ASSURANCE (QA) REPORT GROUNDWATER SAMPLES COLLECTED 10/17/94-10/20/94	ENVIRONMEN TAL RESOURCE MANAGEMEN T INC	1995-01-03	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT DECEMBER 1994 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1995-01-09	REM INVESTIGATION / FEAS STUDY
REVIEW OF RESPONSE TO COMMENTS ON REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION REPORT	EPA	1995-01-15	REM INVESTIGATION / FEAS STUDY
REVIEW OF RESPONSE TO COMMENTS ON REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION (FAX COVER SHEET ATTACHED)	EPA	1995-01-15	REM INVESTIGATION / FEAS STUDY

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PROGRESS REPORT DECEMBER 1994 (RELATED DOCUMENTS ATTACHED)	UNISYS CORP;UNISYS CORP	1995-01-19	REM INVESTIGATION / FEAS STUDY
REQUEST FOR 30 DAY EXTENSION AND SUBMITTAL OF RESPONSE TO COMMENT LETTER	GENERAL ELECTRIC (GE) CO	1995-02-03	REM INVESTIGATION / FEAS STUDY
REVIEW OF REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN (RELATED DOCUMENTS ATTACHED)	CDM FEDERAL PROGRAMS CORP	1995-02-09	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JANUARY 1995 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1995-02-09	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT JANUARY 1995	UNISYS CORP;UNISYS CORP	1995-02-13	REM INVESTIGATION / FEAS STUDY
RESPONSE TO EPA COMMENTS ON THE SUPPLEMENTAL GROUNDWATER REMEDIAL DESIGN (RD) WORK PLAN AND SUPPLEMENTAL SAMPLING ANALYSIS AND MONITORING PLAN SUBMISSION (4/6/95 COVER LETTER ATTACHED)	UNISYS CORP;GENERAL ELECTRIC (GE) CO	1995-03-01	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT FEBRUARY 1995	UNISYS CORP;UNISYS CORP	1995-03-10	REM INVESTIGATION / FEAS STUDY
ANALYTICAL RESULTS FROM WATER SAMPLES RECEIVED ON 3/22/95 (COVER LETTER ATTACHED)	INCHCAPE TESTING SERVICES AQUATEC LABORATORIES	1995-03-28	REM INVESTIGATION / FEAS STUDY
NOTIFICATION THAT GROUNDWATER SAMPLING WILL BE PERFORMED ON 4/10/95	UNISYS CORP	1995-03-31	REM INVESTIGATION / FEAS STUDY
OPERABLE UNIT 02 (OU2) REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION VOLUME I OF IV CHAPTER 1-8	GERAGHTY & MILLER INC	1995-04-01	REM INVESTIGATION / FEAS STUDY
OPERABLE UNIT 02 (OU2) REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION VOLUME II OF IV FIGURES	GERAGHTY & MILLER INC	1995-04-01	REM INVESTIGATION / FEAS STUDY
OPERABLE UNIT 02 (OU2) REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION VOLUME IV OF IV APPENDICES I-J	GERAGHTY & MILLER INC	1995-04-01	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
OPERABLE UNIT 02 (OU2) REMEDIAL AND SUPPLEMENTAL GROUNDWATER INVESTIGATION VOLUME III OF IV APPENDICES A-H	GERAGHTY & MILLER INC	1995-04-01	REM INVESTIGATION / FEAS STUDY
COMMENTS ON SAMPLING ANALYSIS AND MONITORING PLAN AND SUPPLEMENTAL GROUNDWATER REMEDIAL DESIGN (RD) WORK PLAN	COMMONWEALTH OF PR	1995-04-10	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT MARCH 1995	ENVIRONMENTAL RESOURCE MANAGEMENT INC	1995-04-10	REM INVESTIGATION / FEAS STUDY
NOTIFICATION OF SECOND QUARTER 1995 GROUNDWATER SAMPLING (SAMPLING DATA ATTACHED)	UNISYS CORP;UNISYS CORP	1995-04-10	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN	ECKERT SEAMANS CHERIN & MELLOT	1995-05-03	REMEDIAL DESIGN
SUMMARY OF GROUNDWATER SAMPLING AND ANALYSIS RESULTS (RELATED DOCUMENTS ATTACHED)	UNISYS CORP	1995-05-05	REM INVESTIGATION / FEAS STUDY
PROPOSED CLOSURE OF UNUSED GROUNDWATER WELL	CARIBE GENERAL ELECTRIC PRODUCTS INC	1995-05-10	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN (COVER LETTER ATTACHED)	ECKERT SEAMANS CHERIN & MELLOT	1995-05-11	REMEDIAL DESIGN
PROGRESS REPORT APRIL 1995	UNISYS CORP;UNISYS CORP	1995-05-15	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REVIEW OF SUPPLEMENTAL GROUNDWATER REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN (COVER LETTER ATTACHED)	CDM FEDERAL PROGRAMS CORP	1995-05-23	REM INVESTIGATION / FEAS STUDY
COMMENTS ON REVIEW OF SUPPLEMENTAL GROUNDWATER REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN	EPA	1995-06-09	REM INVESTIGATION / FEAS STUDY
RESULTS OF MAY 1995 GROUNDWATER SAMPLING (SAMPLING RESULTS ATTACHED)	UNISYS CORP;UNISYS CORP	1995-06-14	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
SAMPLING ANALYSIS AND MONITORING PLAN	UNISYS CORP	1995-06-21	REM INVESTIGATION / FEAS STUDY
SUPPLEMENTAL GROUNDWATER REMEDIAL DESIGN (RD) WORK PLAN	UNISYS CORP	1995-06-23	REMEDIAL DESIGN
MONTE REY FARM AND EMPRESAS FONALLEDAS COMMENTS ON DRAFT OPERABLE UNIT 02 (OU2) FEASIBILITY STUDY (FS) (COVER LETTER ATTACHED)	ECKERT SEAMANS CHERIN & MELLOT	1995-06-30	REM INVESTIGATION / FEAS STUDY
FACT SHEET : REMEDIAL INVESTIGATION (RI) RESULTS (IN SPANISH)		1995-07-01	REM INVESTIGATION / FEAS STUDY
COMMENTS ON DRAFT FEASIBILITY STUDY (FS)	EPA	1995-07-24	REM INVESTIGATION / FEAS STUDY
SUMMARY OF SITE ACTIVITIES (DIAGRAMS ATTACHED)	UNISYS CORP	1995-07-24	REM INVESTIGATION / FEAS STUDY
DATA VALIDATION PACKAGES FOR GROUNDWATER SAMPLING LOCATIONS (COVER LETTER ATTACHED)	VEGA ALTA STEERING COMMITTEE	1995-07-25	REM INVESTIGATION / FEAS STUDY
COMMENTS ON SUPPLEMENTAL GROUNDWATER REMEDIAL DESIGN (RD) WORK PLAN AND SAMPLING ANALYSIS AND MONITORING PLAN	ECKERT SEAMANS CHERIN & MELLOT	1995-07-31	REMEDIAL DESIGN
REVISED FEASIBILITY STUDY (FS) (8/10/95 COVER LETTER ATTACHED)	UNISYS CORP	1995-08-11	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT AUGUST 1995 (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO	1995-09-09	REM INVESTIGATION / FEAS STUDY
SEPTEMBER 1995 FIELD SUMMARY REPORT	CDM FEDERAL PROGRAMS CORP	1995-09-22	REMEDIAL DESIGN
PROGRESS REPORT AUGUST 1990	VEGA ALTA STEERING COMMITTEE; VEGA ALTA STEERING COMMITTEE	1995-09-27	REM INVESTIGATION / FEAS STUDY
PROGRESS REPORT SEPTEMBER 1990	VEGA ALTA STEERING COMMITTEE;	1995-10-30	REM INVESTIGATION / FEAS STUDY

Title	Author Org	Date	Phase Act
SUMMARY OF GROUNDWATER SAMPLING (FORTH QUARTER SAMPLING ZONE CHART ATTACHED)	UNISYS CORP	1995-10-31	REM INVESTIGATION / FEAS STUDY
RECOMMENDATION FOR FINAL LOCATION OF REMEDIAL WELL A (FIGURES 1 AND 2 ATTACHED)	VEGA ALTA STEERING COMMITTEE; VEGA ALTA STEERING COMMITTEE	1995-11-15	REMEDIAL DESIGN
ASSESSMENT OF THE PLACEMENT OF WELL A (11/20/95 COVER LETTER ATTACHED)	UNISYS CORP	1995-11-21	REMEDIAL DESIGN
FINAL HUMAN HEALTH RISK ASSESSMENT (RA) VOLUME I OF II	CDM FEDERAL PROGRAMS CORP	1995-12-07	REM INVESTIGATION / FEAS STUDY
FINAL HUMAN HEALTH RISK ASSESSMENT (RA) VOLUME II OF II	CDM FEDERAL PROGRAMS CORP	1995-12-07	REM INVESTIGATION / FEAS STUDY
SOIL VAPOR EXTRACTION PERFORMANCE TEST RESULTS	GROUNDWATER TECHNOLOGY INC	1996-02-01	REM INVESTIGATION / FEAS STUDY
PROPOSED PLAN	EPA	1997-07-01	RECORD OF DECISION
PROPUESTO PLAN (IN SPANISH)	EPA	1997-07-01	RECORD OF DECISION
CONCURRENCE WITH PROPOSED PLAN	ENVIRONMENTAL QUALITY BOARD	1997-07-16	RECORD OF DECISION
PUBLIC NOTICE : EPA INVITA A COMENTARIO PUBLICO SOBRE EL PROPUESTO PLAN (IN SPANISH)	EPA	1997-07-30	RECORD OF DECISION
PUBLIC NOTICE : EPA INVITES PUBLIC COMMENT ON PROPOSED PLAN	EPA	1997-07-30	RECORD OF DECISION
TRANSCRIPT FROM 8/20/97 PRESENTACION DEL PLAN PROPUESTO SOBRE ACCION REMEDIADORA (IN SPANISH)	EPA	1997-08-20	RECORD OF DECISION
COMMENTS ON PROPOSED PLAN (COVER LETTER ATTACHED)	ENVIRONMENTAL QUALITY BOARD	1997-08-26	RECORD OF DECISION

Title	Author Org	Date	Phase Act
COMMENTS ON PROPOSED PLAN	NIXON HARGRAVE DEVANS & DOYLE	1997-08-29	RECORD OF DECISION
STEERING COMMITTEE COMMENTS ON PROPOSED PLAN (COVER LETTER ATTACHED)	GENERAL ELECTRIC (GE) CO;VEGA ALTA STEERING COMMITTEE	1997-08-29	RECORD OF DECISION
CONCURRENCE WITH THE RECORD OF DECISION (ROD)	ENVIRONMENTAL QUALITY BOARD	1997-09-24	RECORD OF DECISION
RECORD OF DECISION (ROD)	EPA	1997-09-30	RECORD OF DECISION
PUBLIC NOTICE : REUNION INFORMATIVA 2/26/98 (IN SPANISH)	EPA	1998-02-19	RECORD OF DECISION

11 Appendix C

POZOS CERRADOS POR CONTAMINACION

MUNICIPIO	NOMBRE DEL POZO	FECHA DE CIERRE	RAZON DEL CIERRE
Camuy	Zanjas I	1980	Bacteriología
Camuy	Zanjas III	1980	Bacteriología
Camuy	Zanjas IV	1980	Bacteriología
Cayey	Minillas I	1980	-----
Bayamón	Río Plantation I	Enero 1981	Contaminación Hg
Guayama	Fibers II	1982	Contaminación VOC
Guayama	Fibers III	1982	Contaminación VOC
Guayama	Fibers IV	1982	Contaminación VOC
Guayama	Fibers V	1982	Trihalometanos
Patillas	Planta Alc. (Pozo #2)	1982	Contaminación THM
Arecibo	Garrochales I	1983	Tetracloruro de Carbono
Arecibo	Garrochales II	1983	Tetracloruro de Carbono
Toa Baja	Campanilla 5	1983	Sodio y Cianuros
Toa Baja	Campanilla 2	Octubre 1983	Sodio y Cianuros
Toa Baja	Campanilla 4	Octubre 1983	Sodio y Cianuros
Vega Alta	Bajura 1	Aprox. 1984	Contaminación VOC
Vega Alta	Bajura 2	Aprox. 1984	Contaminación VOC
Vega Alta	Bajura 4	Aprox. 1984	Contaminación VOC
Toa Baja	Levittown 2	1985	Sodio y Cianuros
Arecibo	Santana I	1986	Solubles
-----	Minimas II	1986	Contaminación VOC
Vega Alta	Ponderosa	22 abril 1986	Contaminación VOC
Vega Alta	Bajura 3	Noviembre 1986	Contaminación VOC
Barceloneta	Vila	1987	Contaminación Hg
San Juan	Miguel Such	1987	Contaminación VOC
San Juan	Pozo Truman	1987	Contaminación VOC
Cayey	La Ley	1988	Contaminación VOC
Vega Alta	Regadera	15 marzo 1989	Contaminación VOC
Vega Alta	Regadera	15 marzo 1989	Contaminación VOC
Manatí	Cotto Sur II (Esc. Ramirez)	1990	Nitratos
Manatí	Cotto Sur III (Roche)	1990	Nitratos
Quebradillas	Soler	1991	Bacteriología
Vega Alta	Bajura 5	1 noviembre 1991	Contaminación VOC
Vega Alta	Vega Alta	26 mayo 1991	Contaminación VOC
Vega Alta	Vega Alta	26 mayo 1991	Contaminación VOC
Vega Alta	Vega Alta 2	20 abril 1991	Contaminación VOC
Dorado	Los Puertos	5 agosto 1993	Contaminación VOC
Ciales	Rossy I	1994	Tetracloroetileno

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Figure 60 PRDoH List of Closed PRASA Wells

POZOS CERRADOS POR CONTAMINACION

MUNICIPIO	NOMBRE DEL POZO	FECHA DE CIERRE	RAZON DEL CIERRE
Ciales	Rossy II	1994	Hierro y Manganeso
Yabucoa	La Maloja	13 octubre 1994	Bacteriología
San Juan	Los Pollitos	22 diciembre 1994	Bacteriología
Cidra	Pozo #4 Padilla Final	Marzo 1996	Tetracloroeteno
Cidra	Pozo #8 Cementerio	Octubre 1996	Tetracloroeteno
Hormigueros	Pozo Hormigueros 1	8 junio 1997	Tetracloroeteno
Aibonito	Llanos	1999	VOC (1,1 dicloroeteno)
Vega Alta	Pugnado 3	1999	Nitratos
Cidra	Pozo #3 (Alcantarillado)	Febrero 1999	Tetracloroeteno
San Juan	Dos Pinos	2000	TCE
Cidra	Pozo #6 (Baldorioty)	Agosto 2000	Tetracloroeteno
Manatí	Coto Sur 1	2001	Nitratos
Manatí	Coto Sur IV	2001	Nitratos
Hatillo	Paloma 2	2002	Nitratos
Arecibo	Pozo Factor	2002	Plaguicidas
Ciales	Río Arriba 2	2003	Gross Alpha
Aguas Buenas	Jácanas	2003	Nitratos
Dorado	Pozo Higuillar	2004	Contaminación VOC
Barranquitas	Olla Honda	2004	Nitratos
Juana Díaz	Villa Esperanza	2004	Nitratos
Caguas	Hacienda San José	2004	Contaminación VOC
San Germán	Pozo El Retiro	19 enero 2006	VOC (Tetracloroeteno)
Barceloneta	Tiburones I	----	Contaminación VOC
Manatí	Montebello I	----	Bacteriología
Juana Díaz	Autopista	----	Contaminación VOC
Ponce	Col. Tecnológico	----	Contaminación VOC
Ponce	Oliver Viejo	----	Contaminación VOC
Ponce	Saurí	----	Contaminación VOC
Ponce	Vocacional	----	Nitratos
Cabo Rojo	5A	----	Arsénico
Cabo Rojo	Weko	----	Contaminación Hg
Juana Díaz	Santo Domingo	----	Contaminación VOC