Letter Health Consultation

PIERSON'S CREEK

NEWARK, NEW JERSEY

Prepared by
New Jersey Department of Health

DECEMBER 29, 2017

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

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Pamela Tames, P.E.
Remedial Project Manager
US Environmental Protection Agency
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New York, NY 10007

Dear Ms. Tames,

This Letter Health Consultation (LHC) was prepared by the New Jersey Department of Health (NJDOH) under a cooperative agreement with ATSDR to meet the requirements of conducting health assessment activities at Pierson's Creek site, located in Newark, Essex County, New Jersey. Volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs) and metals are present in the sediment and surface water of Pierson's Creek. This contamination is related to historical discharges and transport from both site and non-site-related sources. However, most of the creek flows through an underground pipe or is fenced in visible areas. Therefore, the creek is not accessible.

The NJDOH concludes that past and current exposures to VOCs, SVOCs, PCBs and metals in Pierson's Creek are not expected to harm people's health. This conclusion is based on available information and current site conditions. Although several contaminants are present at concentrations above health comparison values in creek sediment and surface water, there is no evidence that people are exposed.

Future exposures to creek sediments and surface water may occur if the current land use changes without remediation of the creek. Pierson's Creek eventually flows into Newark Bay, and available data indicate potential contamination of biota in Newark Bay. There may also be a potential for vapor intrusion into the Troy facility and nearby businesses. We do not have sufficient information to evaluate these potential exposure pathways.

Based on the information currently available, the NJDOH recommends the following:

- Restrict any remaining areas where the creek is accessible to the public to prevent future exposures to site contaminants;
- The USEPA continue to characterize and remediate the site; and

- The USEPA evaluate the potential for mercury and volatile organic compounds vapor intrusion at the Troy facility and nearby businesses.

Background and Statement of Issues

Pierson's Creek is located in an industrial area of Newark, Essex County, New Jersey. Pierson's Creek is a tidally influenced 1.5-mile waterbody that flows through a series of open channels and culverts. The creek historically originated to the north of an industrial facility known as Troy Chemical Corporation (Troy), bisecting this property through a concrete channel. Due to a drainage improvement project completed in 2007, the perennial portion of Pierson's Creek now begins just south of the Troy facility, where it receives storm water runoff from a large storm water culvert, and a ditch at the eastern border of the Troy property. Pierson's Creek flows from there through a series of open channels and culverts in a general south-southwesterly direction to the Port Newark Channel portion of Newark Bay.

Troy is an active facility that manufactures antimicrobial and antifungal paint additives. Troy has been operating since 1956 and has historically manufactured products containing mercury. Manufacturing processes at the Troy facility included purification of mercury metal, production of mercuric oxide from the mercury metal, and the manufacture of organic mercury compounds using mercuric oxide. The mercuric oxide manufacturing process was reported to be the primary source of mercury-bearing wastewater at the facility. The untreated mercury wastes were discharged directly to Pierson's Creek until 1965. The wastewater was then pretreated using sulfide precipitation from 1965 through 1976. In 1976, Troy connected to the Passaic Valley Sewerage Commission sewer system, and began diverting wastewater from the mercury pretreatment system to an overall plant wastewater treatment plant. Despite these additional levels of treatment, all mercury was not removed from the wastewater.

In addition to the facility wastewater discharges directed to Pierson's Creek, there are other reported instances of mercury-containing wastewater and storm water discharging from the Troy facility into Pierson's Creek after connection to the public sewer system in 1976. An inspection in July 1977 revealed numerous pipes discharging into the stream, none of which were depicted on the site plan for the facility. Analysis of water and sediment samples gathered in July 1979 by the USEPA verified the presence of VOCs on the Troy site. During an inspection in April 1980, New Jersey Department of Environmental Protection (NJDEP) observed storm water and wastewater flowing into Pierson's Creek and its unnamed tributary via runoff, pipes, cracks in the creek's concrete walls adjacent to a Troy building and tank farm, and overflow from Troy's industrial wastewater collection sump. These liquids flowing into Pierson's Creek and its tributary were found to contain mercury, including one that contained mercury droplets. Copper, lead, arsenic, and zinc were also detected. In 1981 and 1988, the monitoring wells on the Troy site showed the presence of several chlorinated VOCs, notably tetrachloroethene (PCE), 1,1,1-trichloroethane (TCA), and trichloroethene (TCE). Toluene, zinc, copper and mercury were also found. In January 1984, NJDEP observed cracks in a

concrete wall of the creek and a pipe discharging into the creek [USEPA 2013[1]]. Troy ended its use of mercury in their production processes and products in 1987. Samples collected in 1989 by Wehran contained VOCs, but at concentrations below non-residential cleanup criteria, and primarily in one sample in the north-central portion of the Troy site. This location also contained Hg above 2,000 parts per million as did a sample from the southern area of the facility.

Troy has been the focus of numerous investigations since the 1970s. However, actions to date have not addressed mercury contamination downstream. The NJDEP has taken enforcement actions against Troy in the past, and the USEPA settled with the corporation in 2001. At that time, the facility agreed to comply with chemical reporting requirements, reduce air and water pollution, and decrease the number of chemicals used in manufacturing. The USEPA investigated Pierson's Creek in October 2012 and confirmed the observed release of mercury to the creek sediments. Other hazardous substances, including volatile organic compounds (VOC), semi volatile organic compounds (SVOC), pesticides, and polychlorinated biphenyls (PCBs) were also detected at significant concentrations in sediment or surface water samples collected downstream of the Troy Chemical facility. Some of these substances might be attributable to historical releases from the facility, but they are not as uniquely connected to facility operations and there are other possible sources of these contaminants. Mercury was detected in sediment samples collected from the creek. Releases attributed to Troy have been documented approximately 0.25 mile downstream of the Troy facility. Most of the creek runs through an underground culvert beneath rail lines, a highway, and an airport parking lot before discharging into Newark Bay. Pierson's Creek is not easily accessed as most of the creek is not visible at the ground surface.

Site Visit

Staff from the NJDOH and ATSDR performed a site visit with the USEPA representatives on October 25, 2016. The purpose of the site visit was to gather current information about the site and surrounding area, including potential human exposure pathways to workers, trespassers, and residents. The site visit included a walkthrough of the Troy facility and of a vacant property at 429 Delancy Street where the creek is visible at the surface. The creek bisects the Troy Chemical facility through a concrete culvert which is covered with a tarp and sealed at both ends. It is unlikely that workers would be exposed to vapors from beneath the tarp sealed culvert. An unnamed tributary of the creek, located at the eastern edge of the Troy property, is overgrown with vegetation. Therefore, the contaminants in the creek and tributary are not easily accessible to site workers. The Troy facility is an active, secured facility and therefore access by trespassers would be unlikely.

The creek currently begins just south of the facility where it also receives storm water runoff from a large culvert. Moving north to south, the creek flows through the former Red Star

[1][USEPA] US Environmental Protection Agency, 2013. Hazard Ranking System (HRS) Package. Troy Chemical Corporation, Inc., Newark, New Jersey. December 2013.

property (currently occupied by Continental Hardware) and is visible again on Delancy Street. It is not accessible on either side of the street because of fencing and overgrown vegetation. Garbage and debris can be seen around the fences. The creek then flows through the vacant, former Engelhard property at 429 Delancy Street. This location is fenced, gated, and locked. Signs of transient vagrants were visible around the two abandoned buildings on-site; but, the creek located west is further fenced and locked. There is no evidence that the creek is being accessed.

The creek continues via a culvert beneath Conrail's Oak Island rail yard and private parking lots built on a former landfill within the Port of Newark. The creek flows through these properties for approximately one mile before being routed through culverts beneath Interstate 78, Newark International Airport, and New Jersey Turnpike. The creek ends in a general south-southwesterly direction at the Port Newark channel in Newark Bay. The nearest residential area is located to the north and west of the Troy facility.

Environmental Contamination/Discussion

Pierson's Creek is a major storm water conduit for the area. It serves as both a transport pathway for up-gradient influences and a mechanism for the migration of contaminants, namely mercury. The primary source under consideration is the historical disposal of mercury-containing wastewaters into Pierson's Creek by the Troy facility. Between 1979 and 2012, sediment, soil, surface and ground water sampling for mercury and other contaminants was conducted along Pierson's Creek by the USEPA. The results of these investigations indicated the creek is contaminated with mercury and other metals, volatile and semi-volatile organic compounds, pesticides, and polychlorinated biphenyls.

Data documenting the extent of contamination is provided in Tables 1 through 4 in Attachment A. This data has been included because it was part of the review and evaluation process. It includes all data available to the NJDOH and ATSDR. It was used to determine the likelihood of health effects from exposures to site contaminants. This data indicates the potential for exposures to elevated levels of site contaminants if the creek is not remediated and land use were to change where exposures might be possible. The data also support the potential for mercury and VOC vapor intrusion into area buildings and contamination of biota in Newark Bay. However, no data is available to evaluate of these exposure pathways.

ATSDR health comparison values were used for this evaluation. In the absence of a health ATSDR comparison value, the US EPA Regional Screening Levels were used. We assess health hazards by determining whether there is a completed exposure pathway from a contaminant source to a receptor population and whether exposures to contamination are high enough to be of a health concern.

Exposure Pathway Analysis

Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present or future. An exposure pathway consists of five elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure and an exposed population.

A completed exposure pathway exists if all five elements of a pathway are present. A potential exposure pathway exists if one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element. An eliminated exposure pathway is when one or more of the elements are absent.

Completed Exposure Pathways

Based on the available information and data reviewed for this LHC, there is no evidence of a completed exposure pathway for the site based on current site conditions. Several contaminants are present above ATSDR health comparison values. However, the creek is not easily accessible and therefore, a completed exposure pathway has not been identified.

Potential Exposure Pathways

Ingestion/Dermal Contact with soil, sediment, surface water and groundwater (past, future):
The contamination of Pierson's Creek has been documented (see Tables 1 –4, Attachment A) and is yet to be remediated. Presently, this is not an issue because of current land usage and the inaccessibility of the creek. Past exposures to creek sediment and surface water may have occurred prior to the visible areas of the creek being fenced. Groundwater is not currently used for potable purposes. There is a potential pathway for future exposures to the soil, sediment, surface and groundwater if there is a land use change.

Ingestion of biota from Newark Bay (past, present, and future): Troy is one of several potential sources of contamination to Pierson's Creek and Newark Bay. There are signs posted in the Newark Bay area warning people to not consume fish from these waters. However, due to the lack of specific site-related biota data and the multiple contaminant sources contributing to contamination in Newark Bay, it is not possible to characterize the public health implications for this pathway.

Inhalation of mercury and volatile organic compounds by area workers and residents (past, present, and future): Due to the elevated levels of volatile organic compounds historically detected in groundwater monitoring wells at the Troy facility, there is a potential for area buildings, including the Troy facility, to be impacted by vapor intrusion. Indoor air sampling at the on-site buildings has been conducted, but is limited in scope and could not be used to fully assess the exposure. As such, the NJDEP requested that additional sampling be conducted.

Currently, there are no nearby residences. However, if the land use changes, future residences may be impacted by vapor intrusion.

Eliminated Exposure Pathways

Incidental ingestion of contaminated sediment and surface water from Pierson's Creek (present): Based on the site visit conducted in October 2016, Pierson's Creek is not accessible. There is no evidence that the creek is being accessed. The creek areas are fenced and locked and covered with vegetation. Additionally, the portion of the creek that bisects the Troy facility is covered with a tarp in a concrete channel and therefore is not accessible to workers at the facility.

The exposure pathways for site-related contaminants are summarized in Table 5, Attachment A.

Conclusions and Recommendations

There is a residual presence of mercury in the sediments and surface waters of Pierson's Creek. The mercury is related to historical discharges and transport from both site and non-site-related sources. The creek flows through an underground pipe or is fenced off in visible areas. Therefore, the creek is not accessible.

Based on available information and current site conditions, the NJDOH concludes that past and current exposures to mercury and other site-related contaminants in Pierson's Creek is not expected to harm people's health. Although several contaminants are present at concentrations above health comparison values in sediment and surface water, there is no evidence of a completed exposure pathway.

Future exposures to creek sediments and surface water may occur if the current land use were to change without remediation of the creek. Pierson's Creek eventually flows into Newark Bay and available data indicate that biota may be contaminated in Newark Bay.

There may also be a potential for mercury and VOC vapor intrusion in the Troy building and nearby businesses. We do not have sufficient information to evaluate these potential exposure pathways.

Based on the information currently available, the NJDOH recommends the following:

- Restrict any remaining areas where the creek is accessible to the public to prevent future exposures to site contaminants;
- The USEPA continue to characterize and remediate the site to ensure that site contaminants do not continue to impact the Newark Bay;
- The USEPA evaluate the potential for vapor intrusion at the Troy facility and nearby businesses. This is based on historic groundwater contamination containing elevated levels of mercury and volatile organic compounds.

The NJDOH is available to review and evaluate any additional data and provide further guidance as appropriate. If you have any questions regarding the findings presented in this letter, please contact Alicia C. Stephens or Christa Fontecchio at 609-826-4984 or by email at Alicia.Stephens@doh.nj.gov.

Sincerely,

Alicia C. Stephens, M.S.
Research Scientist
Environmental and Occupational Health Surveillance
Consumer, Environmental, and Occupational Health Services

c: Leah Graziano, Senior Regional Representative, ATSDR Region II
Eva McLanahan, Technical Project Officer, ATSDR

Attachment A

Tables

Table 1. Sediment Sampling Results of Pierson's Creek, 1979 - 2012

Analyte	No. of Analysis	No. of NDs[a]	Concentration (parts per million)				COPC[c]
			Minimum	Maximum	Mean	Environmental Guideline CV[b]	
Volatile Organic Compounds							
1,1,1-Trichloroethane	73	1	ND	96	20	11,000 (RMEG[d])	No
1,1,2-Trichloroethane	24	0	0.1	84	19	6.6 (CREG[e])	**Yes**
1,1-Dichloroethane	63	1	ND	123	22	120 (RSL[f])	**Yes**
1,1-Dichloroethene	30	0	0.1	84	26	510 (EMEG[g])	No
1,2,4-Trichlorobenzene	22	0	0.1	95	24	570 (EMEG)	No
1,2-Dichlorobenzene	18	0	0.3	93	21	5,100 (RMEG)	No
1,2-Dichloroethene	22	0	0.2	78	13	510 (EMEG)	No
1,4-Dichlorobenzene	11	0	0.2	59	16	4,000 (EMEG)	No
2-Butanone	31	0	1	82	37	34,000 (RMEG)	No
4-Methyl-2-Pentanone	4	0	0.3	5.2	3	6,300 (RSL)	No
Acetone	5	0	0.6	12	4	51,000 (RMEG)	No
Benzene	25	0	0.1	582	33	6.8 (CREG)	**Yes**
Chlorobenzene	17	0	0.1	75	12	1,100 (RMEG)	No
Chloroethane	12	2	ND	42	9	14,000 (RSL)	No
Chloroform	8	2	ND	22	8	570 (EMEG)	No
cis-1,2-Dichloroethene	15	1	ND	72	7	110 (RMEG)	No
Ethylbenzene	17	2	ND	33	5	5,700 (RMEG)	No
Methylene Chloride	6	1	ND	37	15	60 (CREG)	No
Tetrachloroethene	17	0	0.2	56	10	180 (CREG)	No
Toluene	20	2	ND	91	11	4,600 (RMEG)	No
Trichloroethene	12	1	ND	61	19	5.7 (CREG)	**Yes**
Vinyl Acetate	2	0	0.4	3.4	2	78,000 (RSL)	No
Vinyl Chloride	9	2	ND	33	10	0.085 (CREG)	**Yes**

Xylene	18	2	ND	92	10	11,000 (EMEG)	No
Semi-Volatile Organic Compounds							
1,2-Dichlorobenzene	1	0	1.5	1.5	1.5	5,100 (RMEG)	No
1,3-Dichlorobenzene	1	0	1.6	1.6	1.6	4,000 (EMEG)	No
1,4-Dichlorobenzene	1	0	5.2	5.17	5.2	4,000 (EMEG)	No
2,4-Dimethylphenol	1	0	89	89	89	1,100 (RMEG)	No
2-methylphenol	1	0	56	56	56	2,900 (RMEG)	No
2-methylnaphthalene	9	0	0.5	67	16	230 (RMEG)	No
Acenaphthene	3	0	0.2	0.8	0.5	3,000 (RMEG)	**Yes**
Acenaphthylene	50	2	ND	21	1	NA[h]	**Yes**
Anthracene	38	0	0.1	62	3	17,000 (RMEG)	No
Benzo(a)anthracene	43	0	0.2	11	1.8	0.15 (RSL)	**Yes**
Benzo(a)pyrene	44	0	0.2	9.4	1.9	0.016 (CREG)	**Yes**
Benzo(b)fluoranthene	43	0	0.1	11	2.8	0.15 (RSL)	**Yes**
Benzo(g,h,i)perylene	14	0	0.2	2.6	1	NA	**Yes**
Benzo(k)fluoranthene	42	0	0.1	11	2.2	0.15 (RSL)	**Yes**
Bis(2-ethylhexyl)phthalate	17	0	0.5	111	30	35 (RSL)	**Yes**
Butylbenzylphthalate	11	0	0.4	62	7	11,000 (RMEG)	No
Carbazole	6	0	0.4	1.8	0.8	NA	**Yes**
Chrysene	45	0	0.3	46	4	15 (RSL)	**Yes**
Dibenz(a,h)anthracene	24	0	0.2	1.1	0.5	0.015 (RSL)	**Yes**
Diethylphthalate	2	0	0.5	2	1.2	46,000 (RMEG)	No
Di-n-Butylphthalate	6	0	0.4	24	5	5,700 (RMEG)	No
Di-n-Octylphthalate	13	0	0.3	21	6	780 (RSL)	No
Fluoranthene	49	0	0.1	19	4	2,300 (REMG)	No
Fluorene	39	0	0.1	7	0.9	2,300 (RMEG)	No
Indeno(1,2,3-cd)pyrene	34	0	0.1	2.7	1	0.15 (RSL)	**Yes**
Naphthalene	6	0	0.4	3.5	1.5	1,100 (RMEG)	No
Phenanthrene	48	0	0.1	24	3.5	NA	**Yes**

Naphthalene	36	0	0.1	31	3.8	1,100 (RMEG)	No
Pyrene	46	0	0.1	21	4	1,700 (RMEG)	No
Metals							
Antimony	32	0	1	598	42	23 (RMEG)	**Yes**
Aluminum	13	0	16	628	169	57,000 (EMEG)	No
Arsenic	64	0	0.3	847	154	0.25 (CREG)	**Yes**
Barium	13	0	33	381	224	11,000 (EMEG)	No
Beryllium	42	0	0.1	21.6	2	110 (EMEG)	No
Cadmium	53	0	0.2	381	36	5.7 (EMEG)	**Yes**
Chromium	47	0	1	928	143	51 (EMEG)	**Yes**
Cobalt	18	0	1.5	456	84	23 (RSL)	**Yes**
Copper	63	0	9	958	349	3,100 (RSL)	No
Diphenyl mercury	1	0	12	12	12	7.8 (RSL)	**Yes**
Lead	72	0	6.2	1946	368	400 (RSL)	**Yes**
Manganese	13	0	3	557	215	2,900 (RMEG)	No
Mercury	95	0	0.4	1170	252	6.7 (RSL)	**Yes**
Nickel	52	0	0.7	948	74	1,100 (RMEG)	No
Selenium	15	0	1.5	138	18	290 (EMEG)	No
Silver	46	4	ND	647	55	290 (RMEG)	**Yes**
Thallium	5	0	1.4	357	185	5.1 (RSL)	**Yes**
Vanadium	13	0	24.1	77.8	54	390 (RSL)	No
Zinc	59	0	2	2563	365	17,000 (EMEG)	No
PCBs							
4,4'-DDT	19	0	0.15	56	14	1.1 (CREG)	**Yes**
Aldrin	12	0	1.6	44	9	0.022 (CREG)	**Yes**
alpha-BHC	25	0	0.5	57	10	0.059 (CREG)	**Yes**
Aroclor-1242	1	0	2.3	2.3	2.3	0.19 (CREG)	**Yes**
Aroclor-1254	1	0	0.7	0.7	0.7	0.19 (CREG)	**Yes**
Aroclor-1221	1	0	0.2	0.2	0.2	0.19 (CREG)	**Yes**

Aroclor-1232	3	0	0.1	2	0.8	0.19 (CREG)	**Yes**
Aroclor-1248	3	0	0.1	0.2	0.1	0.19 (CREG)	**Yes**
Aroclor-1254	1	0	0.67	5.22	2.95	0.19 (CREG)	**Yes**
Aroclor-1260	22	0	0.1	7.4	1.4	0.19 (CREG)	**Yes**
Aroclor-1262	15	0	0.1	1	0.4	0.19 (CREG)	**Yes**
Aroclor-1268	24	0	0.1	7.1	1.0	0.19 (CREG)	**Yes**
beta-BHC	20	0	0.1	3.5	0.7	0.21 (CREG)	**Yes**
Chlordane	1	0	1.9	2	1.9	1.1 (CREG)	**Yes**
delta-BHC	1	0	0.1	0.1	0.1	0.21 (CREG)	No
Dieldrin	16	0	0.1	5.8	1.1	0.023 (CREG)	**Yes**
gamma-BHC(Lindane)	2	0	1	18	9.5	17 (RMEG)	**Yes**
Heptachlor	1	0	66	66	66	0.083 (CREG)	**Yes**

[a]Not Detected; [b]Health Comparison Values; [c]Contaminant of Potential Concern; [d]ATSDR Reference Media Evaluation Guide for chronic exposure for child; [e]ATSDR Cancer Risk Evaluation Guide for chronic exposure; [f]USEPA Regional Screening Level; [g]ATSDR Environmental Media Evaluation Guide for chronic exposure for child; [h]Not available.

Table 2. Surface Water Sampling Results of Pierson's Creek, 1988 - 1996

Analyte	No. of Analysis	No. of NDs[a]	Concentration (parts per billion)				COPC[c]
			Minimum	Maximum	Mean	Environmental Guideline CV[b]	
Volatile Organic Compounds							
1,1,1-Trichloroethane	20	6	ND	210	30.8	14,000 (RMEG[d])	No
1,1,2,2-Tetrachloroethane	3	0	1.5	2.9	2.4	140 (RMEG)	No
1,1,2-Trichloroethane	10	5	ND	3	1.5	0.43 (CREG[e])	**Yes**
1,1-Dichloroethane	19	4	ND	129	17.9	14 (RSL[f])	**Yes**
1,1-Dichloroethene	15	7	ND	5.8	1.3	63 (EMEG[g])	No
1,2-Dichloroethane	14	5	ND	2.9	1.4	0.27 (CREG)	**Yes**
1,2-cis-Dichloroethene	5	0	12	110	60.4	14 (RMEG)	**Yes**
1,2-trans-Dichloroethene	4	0	34	91	63.8	140 (RMEG)	No
1,2-Dichloroethene	10	3	ND	299	55	NA[h]	**Yes**
4-methyl-2-Pentanone	2	0	2	4	3	NA	**Yes**
Acetone	7	1	ND	204	52.4	6,300 (RMEG)	No
Benzene	21	2	ND	160	34.3	0.44 (CREG)	**Yes**
Carbon Disulfide	2	0	1	3	2	70 (RMEG)	No
Chlorobenzene	18	5	ND	7.3	2.8	140 (RMEG)	No
Chloroethane	15	6	ND	84.2	16.1	140 (RMEG)	No
Chloroform	20	6	ND	78.1	16.8	70 (EMEG)	**Yes**
Dichloromethane	4	0	3.9	4.9	4.5	93 (RSL)	No
Ethylbenzene	17	7	ND	11	2.2	700 (RMEG)	No
Methylene Chloride	19	7	ND	460	28.5	6.1 (CREG)	**Yes**
Tetachloroethene	21	6	ND	60	14.3	12 (CREG)	**Yes**
Toluene	21	6	ND	57	11	560 (RMEG)	No
Trichloroethene	20	5	ND	100	21	0.43 (CREG)	**Yes**
Vinyl Chloride	19	4	ND	46.7	12.9	0.0086 (CREG)	**Yes**
Xylenes	9	3	ND	18	6.2	1,400 (EMEG)	No
Semi-Volatile Organic Compounds							
1,2-Dichlorobenzene	7	6	ND	1.2	0.17	630 (RMEG)	No
1,3-Dichlorobenzene	7	6	ND	0.7	0.10	600 (LTHA[i])	No

1,4-Dichlorobenzene	7	6	ND	2.8	0.39	490 (RMEG)	No
2,4-Dinitrophenol	7	6	ND	1	0.14	14 (RMEG)	No
2-Methylnaphthalene	8	6	ND	9	1.23	280 (RMEG)	No
2-Methylphenol	7	5	ND	2.2	0.51	NA	**Yes**
4-Methylphenol	7	5	ND	5	1.3	NA	**Yes**
4-Nitroaniline	7	6	ND	1	0.14	3.9 (RSL)	No
Acenapthalene	9	4	ND	0.1	0.04	420 (RMEG)	No
Aniline	7	6	ND	4.7	4.7	4.3 (CREG)	**Yes**
Anthracene	11	7	ND	7	0.64	2,100 (RMEG)	No
Benzo(a)Anthracene	5	3	ND	1	0.2	0.034 (RSL)	**Yes**
Benzo(a)Pyrene	12	9	ND	3	0.34	0.0017 (CREG)	**Yes**
Benzo(b)fluoranthene	6	3	ND	2	0.68	0.034 (RSL)	**Yes**
Benzo(g,h,i)perylene	10	9	ND	0.7	0.07	NA	**Yes**
Benzo(k)flouranthene	11	10	ND	3	0.27	0.34 (RSL)	**Yes**
bis(2-Ethylhexyl)Phthalate	12	3	ND	65	19	1.7 (CREG)	No
Butylbenzylphthalate	8	6	ND	4	0.88	1,400 (RMEG)	No
Chrysene	13	10	ND	3	0.39	3.4 (RSL)	**Yes**
Dibenz(a,h)anthracene	12	11	ND	0.8	0.08	0.0034 (RSL)	**Yes**
Diethylphthalate	7	4	ND	1.9	0.64	5,600 (RMEG)	No
Di-n-Butylphthalate	9	3	ND	2.3	1.1	700 (RSL)_	No
Di-n-Octylphthalate	8	5	ND	3	0.75	200 (RSL)	No
Fluoranthene	7	6	ND	6	0.86	280 (RMEG)	No
Fluorene	6	2	ND	1	0.2	280 (RMEG)	No
Indeno(1,2,3-cd)pyrene	12	11	ND	3	3	0.034 (RSL)	**Yes**
Naphthalene	13	4	ND	48	4.1	400 (RSL)	No
Phenanthrene	12	7	ND	0.8	0.08	NA	**Yes**
Phenol	7	6	ND	2.1	0.31	2,100 (RMEG)	No
Pyrene	14	6	ND	8	1.2	210 (RMEG)	No
Metals							
Aluminum	7	0	122	1,110	555	7,000 (EMEG)	No
Arsenic	15	1	ND	2,710	650	0.016 (CREG)	**Yes**
Barium	7	0	ND	471	299	1,400 (EMEG)	No
Beryllium	14	7	ND	6	1.6	14 (EMEG)	No

Cadmium	14	2	ND	31	12	0.7 (EMEG)	**Yes**
Chromium	13	5	ND	97	35.4	6.3 (EMEG)	**Yes**
Cobalt	13	7	ND	2,440	680	6 (RSL)	**Yes**
Copper	16	6	ND	1,000	402	800 (RSL)	**Yes**
Lead	25	1	ND	1,000	189	15 (EPA MCL[j])	**Yes**
Manganese	7	0	39.40	2,410	852	140 (RMEG)	**Yes**
Mercury	26	6	ND	7,500,000	288,755	2 (EPA MCL)	**Yes**
Nickel	13	6	ND	1,000	538.46	35 (RMEG)	**Yes**
Selenium	14	7	ND	1,000	218.5	0.5 (EPA MCL)	**Yes**
Silver	14	7	ND	1,000	500	35 (RMEG)	**Yes**
Thallium	13	6	ND	270	59	2 (EPA MCL)	**Yes**
Zinc	20	0	78	78,500	5,780	2,100 (EMEG)	**Yes**
Polychlorinated Biphenyls							
gamma-BHC(Lindane)	5	3	ND	0.2	0.05	0.07 (RSL)	**Yes**
Aroclor 1248	12	10	ND	16.5	1.5	0.039 (RSL)	**Yes**
Aroclor 1254	12	10	ND	17.5	1.6	0.14 (EMEG)	**Yes**
Aroclor 1260	12	10	ND	28.3	2.6	0.039 (RSL)	**Yes**
gamma-Chlordane	7	6	ND	0.05	0.01	0.069 (RSL)	**Yes**
Dieldrin	12	11	ND	0.2	0.02	0.0015 (CREG)	**Yes**

[a]Not Detected; [b]Health Comparison Values; [c]Contaminant of Potential Concern; [d]ATSDR Reference Media Evaluation Guide for chronic exposure for child; [e]ATSDR Cancer Risk Evaluation Guide for chronic exposure; [f]USEPA Regional Screening Level; [g]ATSDR Environmental Media Evaluation Guide for chronic exposure for child; [h]Not available; [i]EPA Lifetime Health Advisory for drinking water; [j]EPA Maximum Contaminant Level.

Table 3. Soil Sampling Results of Pierson's Creek 1988 - 1996

Analyte	No. of Analysis	No. of NDs[a]	Concentration (parts per million)				COPC[c]
			Minimum	Maximum	Mean	Environmental Guideline CV[b]	
Volatile Organic Compounds							
1,1,1-Trichloroethane	11	9	ND	0.04	0.01	11,000 (RMEG[d])	No
1,1,2,2-Tetrachloroethane	1	0	0.01	0.01	0.01	6.6 (CREG[e])	No
1,1-Dichloroethane	11	8	ND	0.01	0.001	120 (RSL[f])	No
1,2-Trichloroethane	10	9	ND	0.01	0.001	110 (RMEG)	No
1,2-Dichloroethene	11	8	ND	0.01	0.002	110 (RMEG)	No
2-Butanone	13	7	ND	26	2.5	34,000 (RMEG)	No
2-Hexanone	10	8	ND	0.05	0.01	290 (RMEG)	No
Acetone	11	3	ND	2.40	0.26	51,000 (RMEG)	No
Benzene	16	3	ND	3.00	0.41	6.8 (CREG)	No
Carbon Disulfide	12	8	ND	0.004	0.001	5,700 (RMEG)	No
Chlorobenzene	10	6	ND	0.12	0.018	1,100 (RMEG)	No
Chloroethane	10	9	ND	0.01	0.001	14,000 (RSL)	No
Chloroform	10	9	ND	0.66	0.066	570 (EMEG[g])	No
Ethylbenzene	13	3	ND	0.43	0.054	5,700 (RMEG)	No
Methylene Chloride	11	9	ND	0.32	0.04	60 (CREG)	No
Octane	3	1	ND	4.3	1.7	NA[h]	**Yes**
Styrene	10	9	ND	0.004	0	11,000 (RMEG)	No
Trichloroethene	14	8	ND	3.9	0.29	5.7 (CREG)	No
Tetrachloroethene	14	6	ND	0.65	0.074	180 (CREG)	No
Toluene	13	3	ND	0.65	0.119	4,600 (RMEG)	No
Xylenes	2	0	3.1	13	8.1	11,000 (EMEG)	No
Semi-Volatile Organic Compounds							
1,2-Dichlorobenzene	4	3	ND	0.12	0.03	5,100 (RMEG)	No
1,4-Dichlorobenzene	4	3	ND	0.20	0.05	4,000 (EMEG)	No
2,4,5-Trichlorophenol	4	3	ND	16	4	7,800 (RSL)	No
2-methylnaphthalene	6	1	ND	320	7	230 (RMEG)	**Yes**
4-chloroaniline	4	3	ND	0.17	0.043	3.5 (RSL)	No

4-Methylphenol	4	3	ND	0.11	0.028	2,900 (RMEG)	No
Acenapthalene	5	1	ND	11	2.3	NA	Yes
Anthracene	5	0	0.2	20	4.3	17,000 (RMEG)	No
Benzo(a)anthracene	5	0	0.027	24	5.3	0.15 (RSL)	**Yes**
Benzo(a)pyrene	5	0	0.026	21	4.7	0.016 (CREG)	**Yes**
Benzo(b)fluoranthene	5	0	0.021	18	4.2	0.15 (RSL)	**Yes**
Benzo(g,h,i)perylene	4	0	0.014	3	0.89	NA	**Yes**
Benzo(k)fluoranthene	5	0	0.018	16	3.8	0.15 (RSL)	**Yes**
Benzoic Acid	4	3	ND	0.54	0.54	310,000 (RSL)	No
bis(2-ethylhexyl)phthalate	3	0	0.083	0.48	0.23	35 (RSL)	No
Chrysene	5	0	0.03	25	5.6	15 (RSL)	**Yes**
Dibenzo(a,h)anthracene	5	2	ND	1.40	0.29	0.015 (RSL)	**Yes**
Dibenzofuran	4	1	ND	12	3.1	78 (RSL)	No
Diethylphthalate	1	0	0.013	0.013	0.013	46,000 (RMEG)	No
Di-n-Butylphthalate	1	0	0.10	0.10	0.10	5,700 (RMEG)	No
Fluoranthene	6	0	0.06	55	10.1	2,300 (RMEG)	No
Fluorene	5	1	ND	16	3.3	2,300 (RMEG)	No
Indeno(1,2,3-cd)pyrene	5	0	0.013	3.8	0.94	0.15 (RSL)	**Yes**
Naphthalene	6	0	0.01	52	15.8	1,100 (RMEG)	No
N-Nitrosodiphenylamine	4	2	ND	15	4.2	140 (RSL)	No
Pentachlorophenol	4	3	ND	4.1	1.025	0.94 (CREG)	**Yes**
Phenanthracene	7	0	0.06	73	14.39	NA	**Yes**
Pyrene	5	0	0.046	2.1	0.662	1,700 (RMEG)	No
Metals							
Aluminum	21	0	1,170	15,700	6,292	57,000 (EMEG)	No
Antimony	21	0	1	44.3	5.9	23 (RMEG)	**Yes**
Arsenic	25	0	0.80	2,185	180	0.25 (CREG)	**Yes**
Barium	24	0	28.70	3,380	450	11,000 (EMEG)	No
Beryllium	23	0	0.20	43.2	0.35	110 (EMEG)	No
Cadmium	22	0	0.55	87.8	9.4	5.7 (EMEG)	**Yes**
Chromium	23	0	6.10	798	106	51 (EMEG)	**Yes**
Cobalt	27	2	1.60	570	27.91	570 (EMEG-I)	**Yes**
Copper	28	0	10.30	4,010	443	570 (EMEG-I)	**Yes**

Lead	37	0	9.30	10,800	1,298	400 (RSL)	**Yes**
Manganese	21	0	16.50	2,040	280	2,900 (RMEG)	No
Mercury	33	0	0.58	4,290	762	6.7 (RSL)	**Yes**
Nickel	23	0	3.90	1,860	19	1,100 (RMEG)	No
Selenium	21	0	0.84	8.5	2.9	290 (EMEG)	No
Silver	23	3	ND	48.4	2.7	290 (RMEG)	No
Thallium	20	18	ND	2	0.195	5.1 (RSL)	No
Vanadium	22	0	7.90	148	25.7	390 (RSL)	No
Zinc	35	0	5.8	127,000	5,311	17,000 (EMEG)	No
Pesticides							
4,4'-DDD	2	1	ND	0.03	0.017	1.6 (CREG)	No
4,4'-DDE	2	1	ND	0.01	0.004	1.1 (CREG)	No
4,4'-DDT	2	1	ND	0.03	0.017	1.1 (CREG)	No
Aldrin	1	0	1	0.17	0.17	0.022 (CREG)	**Yes**
o,p-DDT	2	1	ND	0.03	0.013	1.1 (CREG)	No

[a]Not Detected; [b]Health Comparison Values; [c]Contaminant of Potential Concern; [d]ATSDR Reference Media Evaluation Guide for chronic exposure for child; [e]ATSDR Cancer Risk Evaluation Guide for chronic exposure; [f]USEPA Regional Screening Level; [g]ATSDR Environmental Media Evaluation Guide for chronic exposure for child; [h]Not available.

Table 4. Groundwater Sampling Results of Pierson's Creek, 1981-2000

Analyte	No. of Analysis	No. of NDs[a]	Concentration (parts per billion)				COPC[c]
			Minimum	Maximum	Mean	Environmental Guideline CVs[b]	
Volatile Organic Compounds							
0-Chlorotoluene	5	4	ND	0.03	0.006	140 (RMEG[d])	No
1,1,1-Trichloroethane	49	38	ND	16,000	626	14,000 (RMEG)	**Yes**
1,1,2-Trichloroethane	5	4	ND	0.01	0.002	0.43 (CREG[e])	No
1,1,2-Trichloromethane	12	11	ND	6	0.5	1.4 (RSL[f])	**Yes**
1,1-Dichloroethane	40	29	ND	3,400	215	14 (RSL)	**Yes**
1,1-Dichloroethene	35	28	ND	3,100	163	63 (EMEG[g])	**Yes**
1,2-cis-Dichloroethene	27	23	ND	2,700	0.0019	14 (RMEG)	**Yes**
1,2-trans-Dichloroethene	12	11	ND	24	24	140 (RMEG)	No
1,2-Dichloroethene (total)	5	4	ND	7	7	NV[h]	No
1,3,5-Trimethylbenzene	5	3	ND	0.06	0.015	70 (RMEG)	No
2,3-Benzofuran	5	4	ND	0.01	0.002	20 (RSL)	No
Acetone	10	5	ND	12,0000	29,577	6,300 (RMEG)	**Yes**
Benzene	48	24	ND	8,800	688	0.44 (CREG)	**Yes**
Bromomethane	12	11	ND	0.7	0.058	9.8 (RMEG)	No
Chlorobenzene	49	42	ND	36	1.3	140 (RMEG)	No
Chloroethane	35	30	ND	1,200	197	140 (RMEG)	**Yes**
Chloroform	18	15	ND	157	9.2	70 (EMEG)	**Yes**
Cyclopropylbenzene	5	4	ND	0.3	0.064	2000 (RSL)	No
Ethylbenzene	49	38	ND	90	4.4	700 (RMEG)	No
Methylene Chloride	35	33	ND	190	10	6.1 (CREG)	**Yes**
n-Propylbenzene	5	4	ND	0.041	0.0082	2,000 (RSL)	No
p-Chlorotoluene	5	4	ND	0.021	0.004	100 (LTHA[i])	No
p-Dichlorobenzene	5	3	ND	0.033	0.008	490 (EMEG)	No

sec-Butylbenzene	5	4	ND	0.029	0.006	2,000 (RSL)	No
tert-Butylbenzene	5	4	ND	0.02	0.005	2,000 (RSL)	No
Styrene	18	17	ND	6.6	0.3671	1,400 (RMEG)	No
Tetrachlorethene	49	32	ND	33,000	1028	12 (CREG)	**Yes**
Toluene	48	30	ND	46	2.7	560 (RMEG)	No
Trichloroethene	49	30	ND	14,000	719	0.43 (CREG)	**Yes**
Vinyl Chloride	35	31	ND	500	21.9	0.0086 (CREG)	**Yes**
Xylene	38	28	0.006	313	17.7	1,400 (EMEG)	No
Semi-Volatile Organic Compounds							
2-Chlorophenol	2	1	ND	6.9	3.45	100 (RSL)	No
Acenaphthene	7	5	ND	4	0.714	420 (RMEG)	No
Anthracene	5	1	ND	2	0.640	2,100 (RMEG)	No
Benzo(a)anthracene	5	3	ND	3	0.740	0.034 (RSL)	**Yes**
Benzo(a)pyrene	5	3	ND	3	0.800	0.0017 (CREG)	**Yes**
Benzo(b)fluoranthene	5	3	ND	3	0.780	0.034 (RSL)	**Yes**
Benzo(g,h,i)perylene	5	4	ND	0.7	0.140	NA	**Yes**
Benzo(k)flouranthene	5	3	ND	3	0.760	0.34 (RSL)	**Yes**
Chrysene	5	3	ND	3	0.780	3.4 (RSL)	No
Dibenzofuran	5	4	ND	2	0.400	20 (RSL)	No
Di-octylphthalate	5	3	ND	0.6	0.240	200 (RSL)	No
Fluorene	5	2	ND	2	0.680	280 (RMEG)	No
Fluoroanthene	5	2	ND	8	2.18	280 (RMEG)	No
Indeno(1,2,3-cd)pyrene	5	4	ND	0.8	0.160	0.034 (RSL)	**Yes**
Naphthalene	5	2	ND	2	1	400 (RSL)	No
Phenanthrene	5	1	ND	7	2.3	NA	**Yes**
Phenol	5	3	ND	12	2.5	2,100 (RMEG)	No
Pyrene	5	2	ND	4	1.14	210 (RMEG)	No
Metals							
Aluminum	16	2	ND	11,700	3,018	7,000 (EMEG)	**Yes**

Antimony	13	12	ND	9.6	0.738	2.8 (RMEG)	**Yes**
Arsenic	29	2	ND	3,510	436	0.016 (CREG)	**Yes**
Barium	8	0	21	21	21	1,400 (EMEG)	No
Beryllium	13	10	ND	23	5	14 (EMEG)	**Yes**
Cadmium	29	14	0	28.7	3.3	0.7 (EMEG)	**Yes**
Chromium	26	6	0	1,130	127	6.3 (EMEG)	**Yes**
Copper	24	4	ND	2,950	277	800 (RSL)	**Yes**
Lead	41	8	ND	11,800	620	15 (EPA MCL[j])	**Yes**
Mercury	62	8	ND	2,460	97	2 (EPA MCL)	**Yes**
Nickel	20	5	ND	799	95	140 (RMEG)	**Yes**
Selenium	19	17	ND	9	0.472	35 (EMEG)	No
Silver	16	11	ND	15	2.2	35 (RMEG)	No
Thallium	15	12	ND	12	2.32	2 (EPAMCL)	**Yes**
Vanadium	4	0	34	104	72	100 (RSL)	**Yes**
Zinc	41	0	0.13	4,030	354	2,100 (EMEG)	**Yes**
Polychlorinated Biphenyls							
alpha-BHC	2	1	ND	0.23	0.115	0.00389 (CREG)	**Yes**
Aroclor-1254	10	8	ND	0.008	0.002	0.14 (EMEG)	No

[a]Not Detected; [b]Health Comparison Values; [c]Contaminant of Potential Concern; [d]Reference Media Evaluation Guide for chronic exposure for child; [e]ATSDR Cancer Risk Evaluation Guide for chronic exposure; [f]USEPA Regional Screening Level; [g]ATSDR Environmental Media Evaluation Guide for chronic exposure for child; [h]Not available; [i]EPA Lifetime Health Advisory for drinking water; [j]EPA Maximum Contaminant Level.

Table 5. Exposure Pathways Pierson's Creek

Pierson's Creek	Medium	Point of Exposure	Exposure Route	Exposed Population	Exposure Pathway Classification		
					Past	Present	Future
Upstream (Troy Chemical)	Groundwater	Troy Site	Ingestion Dermal	Employees, Trespassers	P	E	P
	Soil				P	E	P
	Indoor Air (vapor intrusion)	Troy Buildings	Inhalation		P	P	P
	Surface Water Sediment	Concrete Channel	Ingestion Dermal		P	E	P
		Tributary					
Downstream	Surface Water Sediment	Pierson's Creek	Ingestion Dermal	Fishermen, Trespassers, Employees	P	E	P
	Biota	Pierson's Creek	Ingestion		P	P	P
	Groundwater	Surrounding Areas	Ingestion Dermal	Employees, Residents	P	P	P

C=completed; E=eliminated; P=potential