HRS DOCUMENTATION RECORD–REVIEW COVER SHEET

Name of Site: PROTECO

EPA ID No.: PRD000831487

Date Prepared: May 2018
Date Modified: May 2019

Contact Persons

Documentation Record: James Desir (212) 637-4342
U.S. Environmental Protection Agency
New York, NY

Pathways, Components, or Threats Not Scored

The surface water migration pathway, soil exposure and subsurface intrusion pathway, and air migration pathway were not scored as part of this Hazard Ranking System (HRS) evaluation. These pathways were not included because a documented release to these media would not significantly affect the overall score and because the ground water migration pathway produces an overall score above the minimum requirement for the PROTECO site to qualify for inclusion on the National Priorities List (NPL).

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HRS DOCUMENTATION RECORD

Name of Site:	PROTECO	Date Prepared: May 2018
EPA ID No.:	PRD000831487	Date Modified: May 2019
EPA Region:	2	
Street Address of Site:*	Road 385, Km 4.4, Bo. Tallaboa	
County and State:	Peñuelas, Puerto Rico 00624 General	

Location in State: Central southern coast, west of Ponce

Topographic Map: Peñuelas, PR

Latitude:* 18° 0' 54.72" North (18.0152°) Longitude:* -66° 42' 1.08" West (-66.7003°)

Site Reference Point: Abandoned leachate collection sump (within Source 1)

[**Figures 1 and 2**; Ref. 3, p. 1; 4, p. 1; 5, p. 17; 8, pp. 1, 2]

* The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area the site is located. They represent one or more locations EPA considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, disposed, or placed, or has otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under CERCLA. Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed as to where the contamination has come to be located.

<u>Scores</u>

Ground Water[1] Pathway	72.67
Surface Water Pathway	Not Scored
Soil Exposure and Subsurface Intrusion Pathway	Not Scored
Air Pathway	Not Scored
HRS SITE SCORE	36.33

[1] "Ground water" and "groundwater" are synonymous; the spelling is different due to "ground water" being codified as part of the HRS, while "groundwater" is the modern spelling.

WORKSHEET FOR COMPUTING HRS SITE SCORE
PROTECO

	S	S^2
1. Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	72.66	5,279.4756
2a. Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	Not Scored	
2b. Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	Not Scored	
2c. Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	Not Scored	
3a. Soil Exposure Component Score (S_{se}) (from Table 5-1, line 22)	Not Scored	
3b. Subsurface Intrusion Component Score (S_{ssi}) (from Table 5-11, line 12)	Not Scored	
3c. Soil Exposure and Subsurface Intrusion Pathway Score (S_{sessi}) (from Table 5-11, line 13)	Not Scored	
4. Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	Not Scored	
5. Total of $S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2$	5,279.4756	
6. **HRS Site Score** Divide the value on line 5 by 4 and take the square root	36.33	

GROUND WATER MIGRATION PATHWAY SCORESHEET
PROTECO

GROUND WATER MIGRATION PATHWAY Factor Categories & Factors	MAXIMUM VALUE	VALUE ASSIGNED
Likelihood of Release		
1. Observed Release	550	550
2. Potential to Release		
2a. Containment	10	not scored
2b. Net Precipitation	10	not scored
2c. Depth to Aquifer	5	not scored
2d. Travel Time	35	not scored
2e. Potential to Release [lines 2a(2b+2c+2d)]	500	not scored
3. Likelihood of Release	550	550
Waste Characteristics		
4. Toxicity/Mobility	*	10,000
5. Hazardous Waste Quantity	*	10,000
6. Waste Characteristics	100	100
Targets		
7. Nearest Well	50	5
8. Population		
8a. Level I Concentrations	**	0
8b. Level II Concentrations	**	0
8c. Potential Contamination	**	94
8d. Population (lines 8a+8b+8c)	**	94
9. Resources	5	5
10. Wellhead Protection Area	20	5
11. Targets (lines 7+8d+9+10)	**	109
12. Aquifer Score (lines 3x6x11 divided by 82,500)	100	72.66
13. Ground Water Migration Pathway Score (Sgw)	100	72.66

* Maximum value applies to waste characteristics category.
** Maximum value not applicable.

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6.	WESTON, Region 2 SAT. Servicios Carbareon Site Logbook W0471.3B.01350; with attached well survey data sheets and supporting documentation. June 13–16, 2017. [46 pages]
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46.	EPA. Memorandum. Subject: Incorrect Statement, HRS Reference 7. From: G. Gilliland, Principal Project Scientist, Weston Solutions, Inc., EPA Region 2 SAT. To: PROTECO HRS Site File. February 18, 2019. 1 Page.

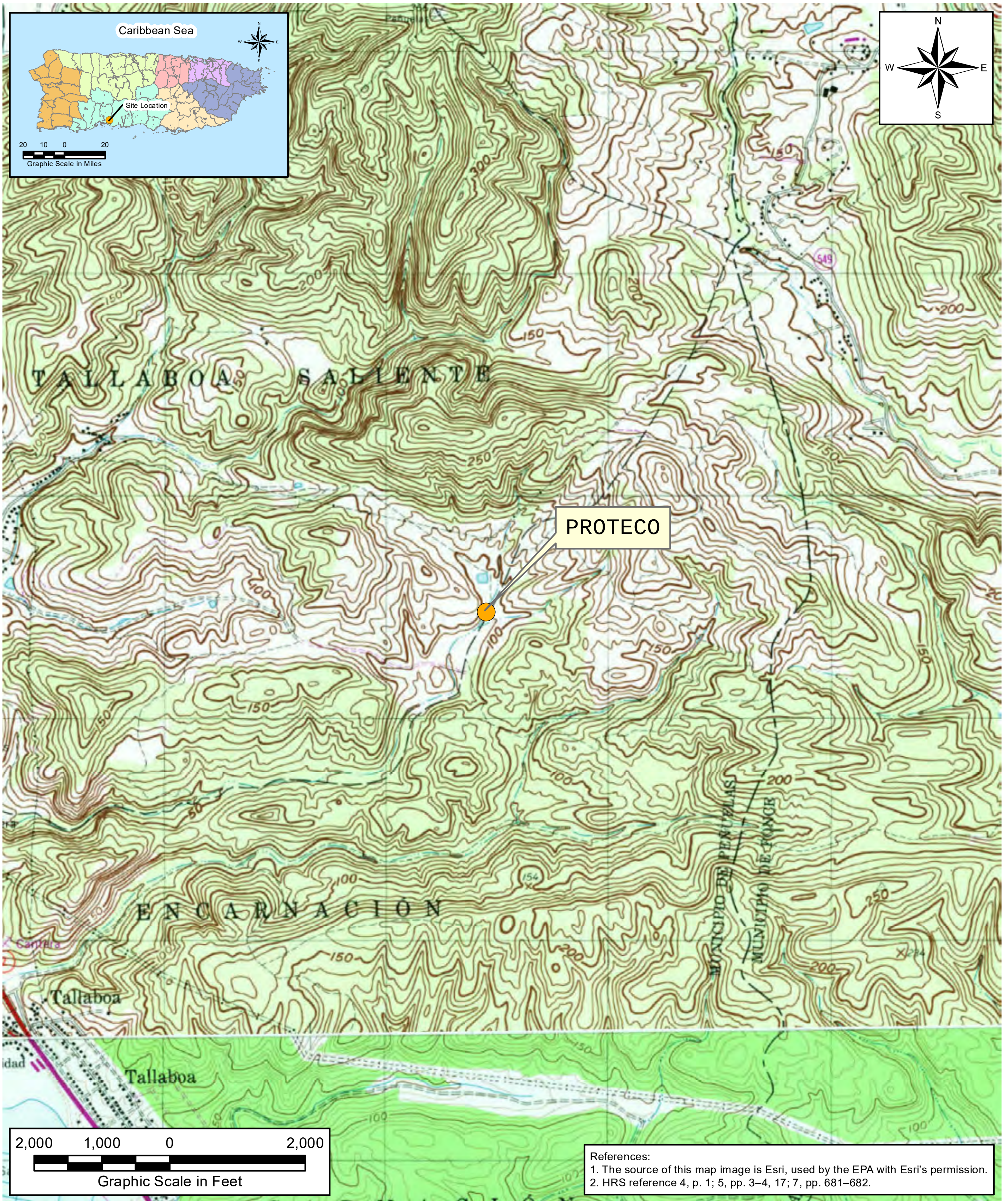
SITE SUMMARY

The PROTECO site as scored for HRS purposes, consists of three sources of hazardous substances, two of which consist of aggregated sub-sources (Source 1 and Source 2), at the former PROTECO landfill in Peñuelas, Puerto Rico, as well as groundwater contaminated with mercury and chlorinated volatile organic compounds (VOC) as a result of releases from site sources. PROTECO was a treatment, storage, and disposal facility (TSDF) for hazardous and nonhazardous wastes [Ref 7, p. 61]. Historical documents prepared by and on behalf of PROTECO document the presence of VOCs, semivolatile organic compounds (SVOC), pesticides, and inorganic constituents in waste materials deposited at the site, as well as the presence of VOCs and mercury in groundwater that meet the criteria for observed release by chemical analysis [see **Sections 2.2 and 3.1.1**]. For the PROTECO site, EPA is evaluating the ground water migration pathway. The sources are evaluated as landfills (Source 1 and Source 3) and surface impoundments (Source 2), as further discussed in **Section 2.2**. Sampling and analysis of groundwater by PROTECO documents the presence of 1,1-dichloroethane (1,1-DCA); 1,2-DCA; 1,1–dichloroethylene (1,1-DCE); trans-1,2-DCE; tetrachloroethylene (PCE); 1,1,1-trichloroethane (1,1,1-TCA); trichloroethylene (TCE); and mercury at levels that meet the criteria for observed release [see **Section 3.1.1**]. An apportioned population of 3,109 people obtain drinking water from groundwater wells within 2 miles of Sources 1, 2, and 3; these target populations are evaluated as being subject to potential contamination [see **Section 3.3**].

The PROTECO site is located at PR Road 385, Kilometer (Km) 4.4, Barrio Tallaboa, Peñuelas, Puerto Rico [Ref. 3, p. 1; 32, p. 1502; Ref. 46, p.1]. The former TSDF occupies property of approximately 35 acres in a valley surrounded by undeveloped, vegetated hills east of the Río Tallaboa valley [**Figures 1 and 2**; Ref. 7, pp. 58, 61, 185]. Two separate, active Resource Conservation and Recovery Act (RCRA) Subtitle D nonhazardous industrial waste landfills border the property to the east and west [**Figure 2**; Ref. 7, pp. 103, 104; 9, pp. 1, 2; 10, pp. 7-10; 11, pp. 67, 68; 12, pp. 7-12; 13, pp. 87, 88]. The Seboruco residential area lies approximately 1.5 miles to the west [Ref. 7, p. 185]. A Site Location Map is presented in **Figure 1**.

The PROTECO facility (i.e., the TSDF) conducted waste management activities from 1975 until 1999 [Ref. 7, pp. 4–8, 58, 62; 32, p. 7]. Operations began in 1975 under the name Servicios Carbareon, Inc.; in 1985, the name was changed to Protección Técnica Ecológica (i.e., PROTECO), which was succeeded by Resources Management, Inc. doing business as (d/b/a) PROTECO [Ref. 7, pp. 4, 656; 32, p. 7]. During its years of operation, the TSDF accepted a variety of wastes from multiple sources, including electroplating sludge, wastewater treatment plant sludge, slurries, petroleum wastes, pesticide wastes, and pharmaceutical and manufacturing wastes [Ref. 7, pp. 5, 53, 58, 62, 98–100]. Hazardous and nonhazardous wastes brought to the TSDF were deposited or stored in one or more of 17 waste units: Units 1, 2, 3, and 5 (drum burial areas); Unit 4 (aboveground drums and containers storage area); Unit 6 (surface landfill); Units 7 and 17 (neutralization surface impoundments); Unit 8 (solid waste landfill; former drum storage); Unit 9 (oil lagoon used for deposition of heavy oils and tars); Units 10, 11, and 16 (immobilization units [i.e., surface impoundments]); Unit 12 (land treatment area); Unit 13 (rainwater lagoon used to capture overflow and supernatant from Waste Unit 9); Unit 14 (industrial solid waste landfill); and Unit 15 (aboveground storage tank [AST]) [Ref. 7, pp. 22, 23, 49–53, 62, 63, 186, 187; 32, pp. 33–35; 33, p. 16]. The waste units are underlain by native silt and clay, but were not designed with liner systems or leachate collection systems [Ref. 7, pp. 7, 8, 312–355]. A Site Map is presented in **Figure 2**.

In October 1987, EPA and PROTECO entered into a Consent Decree stipulating that PROTECO would perform injunctive relief with respect to RCRA violations [Ref. 16, pp. 1, 2]. In November 1997, EPA and PROTECO entered into an Amended Consent Decree (ACD) (i.e., an amendment to the October 1987 Consent Decree) requiring the former TSDF to meet RCRA closure and post-closure care requirements, based on PROTECO's violations of RCRA regulations and of provisions of the original Consent Decree [Ref. 16, pp. 1–36; 30, p. 1]. PROTECO conducted closure of waste units from November 1997 to February 1999; some were closed in place by capping, while others were excavated for disposal into an on-site corrective action management unit (CAMU) [Ref. 7, pp. 657–659]. PROTECO conducted some post-closure maintenance, but stopped performing post-closure care altogether sometime between 2001 and 2009; since then, the site has been abandoned, it has become overgrown by secondary vegetation, and it has seen the establishment of a cattle growing operation on the premises [Ref. 5, p. 4; 30, pp. 1–2]. PROTECO strongly opposed post-closure groundwater monitoring and has not performed any of the RCRA-required groundwater monitoring activities [Ref. 30, p. 1]. The site still does not have a groundwater monitoring system as required for hazardous waste facilities closed with waste in place, despite EPA's repeated efforts to compel these actions [Ref. 30, pp. 1–2]. Observations made by EPA in June 2017 confirm that PROTECO is not maintaining the site and is out of compliance with post-closure care provisions of the ACD [Ref. 5, pp. 3–6, 12, 16–21; 16, pp. 7, 11, 12, 31]. Based on these considerations (PROTECO's unwillingness to carry out corrective action), in November 2017 EPA's Caribbean Environmental Protection Division (CEPD) referred the site from the RCRA program to the CERCLA program for evaluation of potential releases [Ref. 30, pp. 1–2].



LEGEND:

Site Reference Point (Abandoned Leachate Sump) 18.0152° N -66.7003° W

TITLE:

Site Location Map
PROTECO
Peñuelas, Puerto Rico

PROJECT: 0004/1707-02

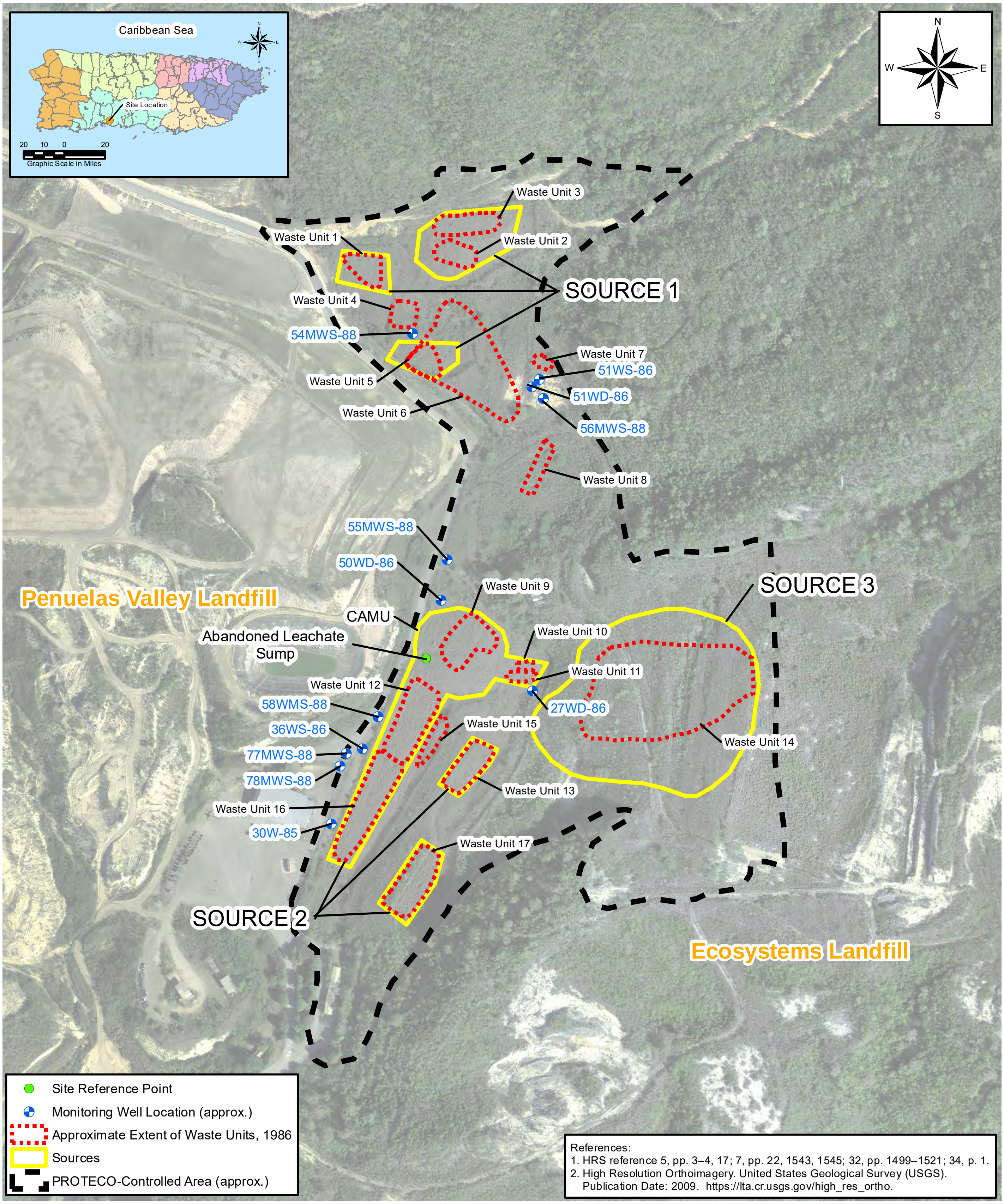
CLIENT NAME: EPA

WESTON SOLUTIONS

DATE: March 2018

FIGURE #: 1

P:\SAT2\2017_PR_Sites\Servicios Carbareon (0471)\MXD\20810_Servicios Carbareon_Site_Location_Map_HRS.mxd



P:\SAT2\2017_PR_Sites\Servicios Carbareon (0471)\MXD\21838_Servicios Carbareon_Site_Map_HRS.mxd

LEGEND:

400 200 0 400

Graphic Scale in Feet

TITLE:

Site and Sources Map
PROTECO
Peñuelas, Puerto Rico

PROJECT: 0004/1707-02

CLIENT NAME: EPA

WESTON SOLUTIONS

DATE: March 2018

FIGURE #: 2

During its operational period, the TSDF accepted a variety of RCRA characteristic and listed hazardous wastes, including ignitable wastes (RCRA Waste Code D001); corrosive wastes (RCRA Waste Code D002); wastes containing metals, including chromium (RCRA Waste Code D007), lead (RCRA Waste Code D008), and mercury (RCRA Waste Code D009); wastes containing lindane (RCRA Waste Code D013); spent halogenated and nonhalogenated solvent wastes (RCRA Waste Codes F001, F002, F003, and F005); electroplating wastes (RCRA Waste Codes F006, F007, and F009); and a variety of discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (RCRA P-listed and U-listed wastes) [Ref. 7, pp. 62, 98–100; 19, pp. 33–36, 43, 47–49, 57–67; 32, pp. 34–35]. Petroleum refining waste and other waste materials derived from petroleum hydrocarbons were also deposited at the site [Ref. 7, pp. 5, 372, 373, 485, 588, 659; 19, p. 40]. The petroleum wastes deposited in site sources are listed hazardous wastes under RCRA and are subject to CERCLA response authority. The petroleum hydrocarbons are commingled with other hazardous substances in site sources and include benzene, toluene, xylene, and polycyclic aromatic hydrocarbons (PAH) [Ref. 7, pp. 329–333, 347; 19, pp. 40, 167; 32, pp. 34–35; 35, pp. 1–6]. In addition, benzene, toluene, and xylene are specifically listed as wastes that were deposited in unlined waste units at the site [Ref. 7, pp. 330, 333, 347; 19, pp. 51, 57; 32, pp. 34–35; 33, p. 380].

Drums brought to the former TSDF were stored directly on the ground surface, were buried directly in the ground, or had their contents transferred to surface impoundments for treatment [Ref. 7, pp. 5, 49–53]. Two waste treatment processes were conducted at the site: a neutralization process in which the pH of the waste was adjusted to between 6.0 and 9.0 by combining the liquid with acidic or alkaline materials; and a stabilization and fixation process, in which liquid wastes were mixed with lime, fly ash, cement kiln dust, or soil and allowed to solidify [Ref. 7, p. 62; 32, p. 34]. Throughout the years, inspections of the site conducted by EPA and Puerto Rico Environmental Quality Board (PREQB) revealed numerous violations of federal and state environmental regulations, including unpermitted waste disposal activity, inadequate groundwater monitoring, lack of runoff control, waste deposition in unlined waste units, corroded and improperly labeled drums leaking contents onto exposed soil, and mixing of potentially incompatible wastes [Ref. 7, pp. 47, 49–54, 60, 107, 120; 29, pp. 3–4, 26, 80].

In September 1997, the CEPD Waste Management Division approved a closure plan for the TSDF [Ref. 7, p. 182]. Closure activities were conducted from November 1997 to February 1999 under the authority of RCRA Subtitle C [Ref. 7, pp. 104, 662]. One of the main features of the TSDF closure was construction of the CAMU, a lined landfill cell used for disposal of waste materials excavated from Waste Unit 4 (aboveground drum storage area contaminated soil), Waste Unit 7 (neutralization impoundment), and Waste Unit 9 (oil lagoon) [Ref. 7, pp. 657, 658, 666; 32, p. 8]. The CAMU was constructed at the location of Waste Unit 9 while waste materials that had been excavated from Waste Units 4 and 9 were being temporarily stored on the surfaces of Waste Units 12 and 16; waste materials from Waste Unit 7 were placed directly in the CAMU [Ref. 32, pp. 8, 329, 337]. The base and slopes of the CAMU were lined with a 2-foot thick layer of laboratory-confirmed, low-permeability soil; a geosynthetic clay liner; and a high-density polyethylene (HDPE) liner [Ref. 7, pp. 667, 668]. After construction of the liner was completed, waste materials from Waste Units 4, 7, and 9 were placed in the CAMU [Ref. 7, p. 668]. The stabilized material deposited in the CAMU contained leachable levels of several organic and inorganic hazardous substances [Ref. 32, pp. 182, 189–257]. A leachate collection system consisting of a sand drainage layer, leachate collection sump, and riser pipe were installed at the base of the lined cell to capture the contaminated landfill leachate [Ref. 7, p. 682; 32, pp. 22–23, 93, 112–113].

The final cover for the CAMU consisted of the following layers (in ascending order): backfilled and compacted common soil obtained from on-site borrow sources, compacted clay, geosynthetic clay, HDPE flexible membrane, geotextile, compacted common soil, and a cover layer of soil and rock [Ref. 7, pp. 662–664, 668]. Closure of the remaining hazardous waste management units included a cover system similar to the one used for the CAMU; however, waste materials were left in place without installing a liner beneath them [Ref. 7, pp. 662–665]. Due to the proximity of the CAMU to Units 9, 10, 11, 12, and 16, these waste units were closed together in conjunction with the CAMU under the same continuous cover system (i.e., the CAMU final cover) [Ref. 7, pp. 668, 669; 32, pp. 8, 1499, 1501]. Units 2 and 3 were also closed under one cover system, whereas Units 1, 5, 13, and 17 were closed individually under separate cover systems [Ref. 32, pp. 8, 1499–1501]. Units 6, 8, and 14 were managed as nonhazardous solid waste landfills during the closure; the materials from Units 6 and 8 were excavated and placed into Unit 14, which according to PROTECO had ceased landfilling operations and was undergoing closure activities [Ref. 7, pp. 6, 7, 323, 342, 584, 657–659; 32, pp. 33–34]. A large basin was constructed to capture stormwater from the covered waste units, surrounding drainage areas, and adjacent landfill facilities; the unit was designed to allow solids to settle out of runoff before the aqueous portion was discharged through an outfall [Ref. 7, p. 664].

Sampling of on-site monitoring wells and hydrogeological studies indicate that VOC contamination has migrated to the aquifer beneath the site [Ref. 7, pp. 516, 1521, 1533]. However, post-closure groundwater monitoring required by EPA as part of the TSDF closure has not been implemented [Ref. 7, p. 13]. Hydrogeological studies suggest that there is a westward groundwater flow component toward the Río Tallaboa valley, where there are public and domestic drinking water wells, as well as groundwater springs that have been used for drinking water supply [Ref. 7, pp. 634, 635, 642, 596].

On June 13, 2017, representatives from EPA and PREQB conducted a reconnaissance of the site [Ref. 5, pp. 3–6, 12, 16–21]. A representative from the adjacent Peñuelas Valley Landfill (PVL), who was previously employed at PROTECO, was present to provide background information on former operations and site features [Ref. 5, p. 4]. Information obtained and observations made during the reconnaissance indicate that operators abandoned the site circa 2001 [Ref. 5, p. 4]. Since that time, there has been no maintenance of the landfill surfaces, capped waste units, or run-on/runoff controls; no post-closure groundwater monitoring; and no removal of leachate from the CAMU [Ref. 5, pp. 4, 16–19]. The entire source area has become overgrown with secondary forest growth consisting of small and a few mature hardwood trees, making it difficult or impossible to distinguish site features and likely compromising the integrity of the caps put in place during the RCRA closure [Ref. 5, pp. 5, 16, 18]. The source areas are located on a hillside that slopes north to south [**Figures 1 and 2**]. Evidence of severe erosion was noted in the drainage ditch that runs along the western edge of the former landfill, indicating that run-on/runoff control measures put in place during the RCRA closure have been compromised due to lack of maintenance since the operators abandoned the site in 2001 [Ref. 5, pp. 4, 5, 20].

The waste units are surrounded by an incomplete barbed wire fence of minimal proportions [Ref. 5, pp. 3–5]. Cattle were observed to be entering and grazing in the central and southern portions of the subject property [Ref. 5, p. 19]. Although the former landfill is in a remote area with restricted access through a guarded gate, it is accessible to trespassers [Ref. 5, pp. 3, 19, 21]. Some site monitoring wells observed by the reconnaissance team were either severely damaged or destroyed [Ref. 5, pp. 5, 17, 19]. The EPA reconnaissance team observed four monitoring wells to be intact; however, they are unsecured and are believed to have been that way since the site was abandoned in 2001 [Ref. 5, p. 5]. Follow-up reconnaissance activities by EPA in December 2017 indicate that Hurricane Maria (September 2017) affected site conditions, including evidence of high volumes of runoff in the site drainage ditches from the massive amounts of rainfall and uprooted trees leaving voids in the cover soil [Ref. 30, p. 2; 31, pp.1–4].

The PROTECO site is located within the Peñuelas–Guánica region of the South Coast Groundwater Province, where the typical landforms include limestone hills (some with karst features), alluvium-filled valleys, and coastal plains [Ref. 7, p. 3; 22, pp. 10, 16; 23, pp. 11–12, 28]. The aquifer being evaluated is the Ponce-Juana Díaz aquifer, which consists of the Tertiary-age Juana Díaz Formation and Ponce Limestone [Ref. 23, pp. 29, 30; 24, p. 1]. These formations show karst features such as voids and solution channels in the site vicinity [Ref. 7, pp. 595, 633–635, 1529; 23, p. 30; 25, pp. 19–20, 35; 26, p. 18]. The aquifer is most productive in the Río Tallaboa valley about 1 to 2 miles west of the site, where alluvium of the Tallaboa alluvial aquifer directly overlies and is hydraulically connected to both the Juana Díaz Formation and the Ponce Limestone, and where there are several active drinking-water wells [Ref. 17, pp. 2–3, 5; 22, p. 19; 23, p. 30; 24, p. 1; 25, pp. 20, 23, 35; 26, pp. 12, 21]. Due to this aquifer interconnection within 2 miles of site sources, the Ponce-Juana Díaz aquifer and Tallaboa alluvial aquifer are evaluated as a single hydrologic unit for HRS scoring purposes [Ref. 1, Section 3.0.1.2].

Groundwater wells within 2 miles of site sources are known to be used for public and private drinking-water supply. A 4-Mile Radius Map is presented in **Figure 3**. An apportioned population of 2,892 people, consisting of residents, workers, and students, utilize groundwater withdrawn from the Carlos Andinos public supply well operated by Puerto Rico Aqueduct and Sewer Authority (PRASA) [**Figure 3**; Ref. 17, pp. 2, 3]. The Carlos Andinos well, which produces 380,000 gallons per day (gpd), is screened from 50 to 80 feet bgs in the alluvium and from 80 to 110 feet bgs in weathered limestone [Ref. 17, pp. 2–3, 5; 27, pp. 1, 3, 5]. Other active drinking-water supply wells and irrigation wells located in the Río Tallaboa valley west and northwest of the site have finished depths ranging up to 200 feet [Ref. 6, pp. 16–41]. Three domestic wells serve approximately 10 people within the Seboruco and Cuebas communities, and the Puerto Rico Electrical Power Authority (PREPA) operates four wells within the Río Tallaboa valley that provide drinking water to 207 employees [**Figure 3**; Ref. 17, pp. 2, 3]. The Carlos Andinos well, the domestic wells, and the PREPA wells are on the eastern side of the Río Tallaboa valley 1 to 2 miles west-northwest of the site [**Figure 3**].

LEGEND

- Site Reference Point (Abandoned Leachate Sump) -Longitude: -66.7003 -Latitude: 18.0152
- Domestic Well
- Industrial Well (used for drinking water supply)
- PRASA Well

References:
1. High Resolution Orthoimagery. United States Geological Survey (USGS). Publication Date: 2009. https://lta.cr.usgs.gov/high_res_ortho.
2. Weston Solutions, Inc., Region 8 START IV, Site Assessment Team. Servicios Carbareon Site Logbooks W0471.3B.01313 and W0471.3B.01350. June 13-16, 2017.
3. HRS reference 5, pp. 3–4, 17; 17, pp. 1–6; 32, pp. 1499–1521.

DRAWING TITLE:
4-Mile Radius Map
PROTECO
Peñuelas, Puerto Rico

FIGURE:	3
SCALE:	1 " = 2,200 '
DATE:	March 2018
CLIENT NAME:	EPA
PROJECT NAME:	TDD 0004/1707-02
PROJECT MANAGER:	S. Snyder
CHECKED BY:	G. Gilliland
CONTRACT No.	
DRAWN/MODIFIED BY:	J. Heaton/ H. Bravo-Ruiz
DATE CREATED:	3/28/2018
REPORT DATE:	March 2018
DRAWING:	21842_SC0471_4Mile_Radius_HRS.mxd
PATH:	P:\SAT2\2017_PR_Sites\Servicios Carbareon (0471)\MXD\
REVISION No.	0
WORK ORDER No.	20408.012.004.0507.00

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2.2 SOURCE CHARACTERIZATION

Number of the source: 1

Source Type of the source: Landfill

Name and description of the source: Waste Units 1, 2, 3, and 5

Source 1 consists of four unlined drum burial landfills (Waste Units 1, 2, 3, and 5), where drums containing hazardous substances were buried directly above native soil and were not removed during landfill closure (i.e., the drum burial areas were capped in place) [Ref. 5, p. 4; 7, pp. 7, 312–317, 322, 328, 584, 656, 657, 662–664; 33, p. 12]. As shown in this section and in **Section 2.4.1** below, the four drum burial areas can be classified as the same source type (i.e., landfill) with the same containment for the ground water migration pathway (i.e., no liner). They contain substances available to the pathway with similar waste characteristics factor values, and, as shown in **Section 3.0**, they overlie the same aquifer system (i.e., the Ponce-Juana Díaz aquifer) and pose a threat to the same target populations for the pathway. Based on these considerations, Waste Units 1, 2, 3, and 5 are aggregated and considered as one discrete source (i.e., Source 1) for evaluation of the ground water migration pathway.

A variety of waste types are known to have been deposited in the drum burial areas, including ignitable wastes (RCRA waste code D001); corrosive wastes (RCRA waste code D002); wastes containing metals, including chromium (RCRA waste code D007), lead (RCRA waste code D008), and mercury (RCRA waste code D009); wastes containing lindane (RCRA waste code D013); spent halogenated and nonhalogenated solvent wastes (RCRA waste codes F001, F002, F003, and F005); electroplating wastes (RCRA waste codes F006, F007, and F009); and a variety of discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (RCRA P-listed and U-listed wastes) [Ref. 7, pp. 7, 62, 98–100, 187, 313, 315, 316, 322, 328; 14, pp. 11–13, 17, 18; 15, pp. 2, 4, 5, 7;; 19, pp. 33–36, 43, 47–49, 57–67; 32, pp. 34–35]. Analytical results for soil and drum samples collected by PROTECO during its Phase III Soils Investigation provide additional evidence of the hazardous substances present in the Source 1 drum burial areas at the site [Ref. 33, pp. 4–16, 35-46, 327–328, 330, 358–362, 375, 396]. A summary of the specific hazardous substances known to be present in Source 1, based on their respective RCRA waste codes or their presence in samples collected within the waste units, is presented in **Table 1** [see **Section 2.4.1**, below**]**.

Waste Units 1, 2, and 3 operated from 1975 to circa 1979, and Waste Unit 5 operated from 1975 to circa 1980 [Ref. 7, pp. 7, 294–296]. The reported depths of these waste units range from 5 to 18 feet; a total of approximately 8,670 drums of various waste types were buried in these areas [Ref. 7, pp. 7, 297, 312, 315, 316, 322, 328, 657; 32, p. 34]. Waste Unit 1 is a 0.31-acre drum disposal area that contains approximately 5,800 drums (approximately 317,000 gallons) of various waste materials; Waste Unit 2 is a 0.06-acre drum disposal area that contains approximately 450 drums (approximately 22,900 gallons) of various waste materials; Waste Unit 3 is a 0.26-acre drum disposal area that contains approximately 1,700 drums (approximately 92,600 gallons) of various waste materials; and Waste Unit 5 is a 0.2-acre area that contains at least 720 drums (approximately 39,600 gallons) of sodium hydroxide [Ref. 7, p. 322; 32, p. 34; 33, p. 378]. The EPA waste code designations for the materials buried in Waste Units 1, 2, and 3 are D001, D002, D008, D009, D054, F001, F003, F005, F006, K046, P012, U002, U044, U108, U112, U113, U117, U122, U134, U144, U154, U162, U188, U210, U211, U220, U225, and U226, and the waste code designation for the sodium hydroxide buried in Waste Unit 5 is D002 [Ref. 7, p. 322; 32, p. 34]. See **Section 2.4.1** below for the specific hazardous substances associated with these waste code designations.

PROTECO gathered additional evidence of conditions and the hazardous substances in the drum burial areas during its Phase III Soils Investigation at the site from July to September 1987, which included metal detection, perimeter test pitting, soil sampling, and sampling of drum contents in the drum burial areas [Ref. 33, pp. 4–16, 327–328, 330, 358–362, 375, 396]. PROTECO observed leaking or damaged drums, soil contamination, and migration of hazardous substances in all four drum burial areas (i.e., Waste Units 1, 2, 3, and 5) [Ref. 33, pp. 35-46, 122–133, 141–145, 396]. The RCRA closure of Waste Units 1, 2, 3, and 5 included capping with a combination of soil, geosynthetic clay, HDPE flexible membrane, and geotextile; there was no removal of drums or adjacent contaminated soil, nor was there installation of liners, prior to installation of the landfill caps [Ref. 7, pp. 662–664]. See **Section 2.4.1** below for the hazardous substances present in Source 1 based on the analytical results for drum contents and soil samples collected from Waste Units 1, 2, 3, and 5 during the Phase III Soils Investigation.

Location of the source, with reference to a map of the site:

The waste units (Waste Units 1, 2, 3, and 5) evaluated collectively as Source 1 are located in the northern portion of the site [Ref. 7, p. 23; 32, p. 1499; 34, p. 1], as shown in **Figure 2**.

Containment

<u>Release to groundwater:</u>

Drums were buried directly above native soil in all four drum burial landfills (i.e., Waste Units 1, 2, 3, and 5), without installation of liners or leachate collection systems [Ref. 7, pp. 5, 7, 9, 10, 23, 38, 49, 50, 322, 540; 32, p. 64]. During its Phase III Soils Investigation in 1987, PROTECO observed leaking or damaged drums, soil contamination, and migration of hazardous substances in all four units; engineered liners were not present in any of the waste units [Ref. 33, pp. 35-46, 122–133, 141–145, 396]. The RCRA closure of Waste Units 1, 2, 3, and 5 consisted of capping only; there was no removal of drums or adjacent contaminated soil, nor was there installation of liners, prior to installation of the landfill caps [Ref. 7, pp. 662–664]. PROTECO stopped performing post-closure care at the site sometime between 2001 and 2009; since then, the site has been abandoned and the landfill covers for all the waste units at the site, including the drum burial areas, have not been maintained [Ref. 5, pp. 3–6, 12, 16–21; 30, pp. 1–2].

Based on the lack of containment measures in all four drum burial areas, in particular no liners, a containment factor value of 10 is assigned to Source 1 in the ground water migration pathway [Ref. 1, Table 3-2].

2.4.1 Hazardous Substances

TABLE 1 – SOURCE 1 HAZARDOUS SUBSTANCES		
Hazardous Substance	**Waste Code/Description and Phase III Soil Data**	**Reference(s)**
Acetone	U002: Acetone [**Waste Units 1, 2, 3**]	19, p. 51; 32, p. 34
Arsenic	P012: Arsenic oxide (Arsenic trioxide) [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Units 1, 5**]	19, p. 47; 33, pp. 35–37, 43–46, 127, 145; 32, p. 34
Benzene	Phase III soil/waste samples [**Waste Unit 5**]	33, pp. 43–45, 141
Bromoform	U225: Bromoform [**Waste Units 1, 2, 3**]	19, p. 52; 32, p. 34
Carbon tetrachloride	U211: Carbon tetrachloride [**Waste Units 1, 2, 3**]	19, p. 52; 32, p. 34
Chloroethane	Phase III soil/waste samples [**Waste Unit 5**]	33, pp. 43–45, 141
Chloroform	U044: Chloroform [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Unit 1**]	19, p. 52; 32, p. 34; 33, pp. 35–37, 122
1,1-Dichloroethane	Phase III soil/waste samples [**Waste Unit 1**]	33, pp. 35–37, 122
1,2-Dichloroethane	Phase III soil/waste samples [**Waste Unit 1**]	33, pp. 35–37, 122
1,1-Dichloroethylene	Phase III soil/waste samples [**Waste Unit 1**]	33, pp. 35–37, 122
1,4-Dioxane	U108: 1,4-Dioxane [**Waste Units 1, 2, 3**]	19, p. 60; 32, p. 34
Ethyl acetate	U112: Ethyl acetate [**Waste Units 1, 2, 3**]	19, pp. 54, 60; 32, p. 34
Ethyl acrylate	U113: Ethyl acrylate [**Waste Units 1, 2, 3**]	19, pp. 54, 60; 32, p. 34
Ethylbenzene	Phase III soil/waste samples [**Waste Units 1, 3, 5**]	33, pp. 35–37, 40-45, 122, 131, 141
Ethyl ether	U117: Ethyl ether [**Waste Units 1, 2, 3**]	19, pp. 54, 60; 32, p. 34
Formaldehyde	U122: Formaldehyde [**Waste Units 1, 2, 3**]	19, p. 54; 32, p. 34
Hydrofluoric acid	U134: Hydrofluoric acid [**Waste Units 1, 2, 3**]	19, pp. 54, 61; 32, p. 34
Lead	D008: Solid waste exhibiting toxicity due to containing lead above regulatory level [**Waste Units 1, 2, 3**] K046: Wastewater treatment sludges associated with lead-based initiating compounds [**Waste Units 1, 2, 3**] U144: Lead acetate [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Units 1, 5**]	19, pp. 35, 40, 54, 167; 32, p. 34; 33, pp. 35–37, 43–46, 127, 145
Mercury	D009: Solid waste exhibiting toxicity due to containing mercury above regulatory level [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Unit 5**]	19, p. 35; 32, p. 34; 33, pp. 43–46, 145
Methanol	U154: Methanol [**Waste Units 1, 2, 3**]	19, p. 55; 32, p. 34
Methyl methacrylate	U162: Methyl methacrylate [**Waste Units 1, 2, 3**]	19, p. 55; 32, p. 34
Methylene chloride	Phase III soil/waste samples [**Waste Unit 1**]	33, pp. 35–37, 122
Naphthalene	Phase III soil/waste samples [**Waste Unit 1**]	33, pp. 35–37, 122–124
Phenol	U188: Phenol [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Unit 1**]	19, p. 56; 32, p. 34; 33, pp. 35–37, 122–123
Silver	Phase III soil/waste samples [**Waste Units 1, 5**]	33, pp. 35–37, 43–46, 127, 145
Tetrachloroethylene	U210: Tetrachloroethylene [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Unit 1**]	19, p. 57; 32, p. 34; 33, pp. 35–37, 122
Toluene	U220: Toluene (aka Methyl benzene) [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Units 1, 3, 5**]	19, p. 57; 32, p. 34; 33, pp. 35–37, 43–45 122, 131, 141

TABLE 1 – SOURCE 1 HAZARDOUS SUBSTANCES		
Hazardous Substance	**Waste Code/Description and Phase III Soil Data**	**Reference(s)**
1,1,1-Trichloroethane	U226: 1,1,1- Trichloroethane [**Waste Units 1, 2, 3**] Phase III soil/waste samples [**Waste Unit 1**]	19, p. 57; 32, p. 34; 33, pp. 35–37, 122
1,1,2-Trichloroethane	Phase III soil/waste samples [**Waste Unit 1**]	33, pp. 35–37, 122
Trichloroethylene	Phase III soil/waste samples [**Waste Unit 1**]	33, pp. 35–37, 122

2.4.2 Hazardous Waste Quantity

2.4.2.1.1 Tier A – Hazardous Constituent Quantity

The hazardous constituent quantity for Source 1 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.1]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, Hazardous wastestream quantity [Ref. 1, Section 2.4.2.1.1].

Hazardous Constituent Quantity (C) Value: Not scored

2.4.2.1.2 Tier B – Hazardous Wastestream Quantity

Source 1 contains a total of 472,100 gallons of waste, as follows: Waste Unit 1 – 317,000 gallons of waste, Waste Unit 2 – 22,900 gallons of waste, Waste Unit 3 – 92,600 gallons of waste, and Waste Unit 5 – 39,600 gallons of waste [Ref. 7, p. 322; 32, pp. 34, 322]. The hazardous wastestream quantity (W) for the source is calculated by converting volume to mass according to the conversion of 200 gallons equals 2,000 pounds (i.e., 1 gallon = 10 pounds) [Ref. 1, Table 2.5 and Section 2.4.2.1.2]. The resulting value for W (4,721,000 pounds) is divided by 5,000 to determine the assigned hazardous wastestream quantity value [Ref. 1, Section 2.4.2 and Table 2-5]. Based on these calculations, Tier B – Hazardous Wastestream Quantity is assigned a value of 944.2 for Source 1

Hazardous wastestream quantity (W) = 472,100 gal x 10 lbs/gal = 4,721,000 lbs
Hazardous Wastestream Quantity Value = 4,721,000/5,000 = 944.2

2.4.2.1.3 Volume (Tier C)

The volume measure is not evaluated and is assigned a value of 0 for Source 1 because the hazardous wastestream quantity for the source is adequately determined—that is, total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is known or is estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.2].

Volume (V) Assigned Value: 0

2.4.2.1.4 Area (Tier D)

The area measure is not evaluated and is assigned a value of 0 for Source 1 because the hazardous wastestream quantity for the source is adequately determined—that is, total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is known or is estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.2].

Area (A) Assigned Value: 0

2.4.2.1.5 Source Hazardous Waste Quantity Value

The source hazardous waste quantity value for Source 1 is 944.2 for Tier B –Hazardous Wastestream Quantity [Ref. 1, Section 2.4.2].

Source Hazardous Waste Quantity Value: 944.2

2.2 SOURCE CHARACTERIZATION

Number of the source: 2

Source Type of the source: Surface Impoundment (buried/backfilled)

Name and description of the source: Waste Units 9, 10, 11, 12, 13, 16, and 17

Source 2 consists of seven unlined surface impoundments (Waste Units 9, 10, 11, 12, 13, 16, and 17) that were used for the disposal of liquid wastes containing hazardous substances [Ref. 7, pp. 8, 325–341, 345–355, 451, 584–585, 658, 659; 32, p. 35]. As shown in this section and in **Section 2.4.1** below, these waste units can be classified as the same source type (i.e., surface impoundment [buried/backfilled]) with the same containment for the ground water migration pathway (i.e., no liner). They contain substances available to the pathway with similar waste characteristics factor values, and, as shown in **Section 3.0**, they overlie the same aquifer system (i.e., the Ponce-Juana Díaz aquifer) and pose a threat to the same target populations for the pathway. Based on these considerations, Waste Units 9, 10, 11, 12, 13, 16, and 17 are aggregated and considered as one discrete source (i.e., Source 2) for evaluation of the ground water migration pathway. Waste Units 9, 10, 11, 12, and 16 were closed together and make up the source area under the CAMU final cover, whereas Waste Units 13 and 17 were closed individually under separate cover systems [**Figure 2**; Ref. 7, pp. 668, 669; Ref. 32, pp. 8, 1499–1501].

A variety of waste types are known to have been deposited in the Source 2 surface impoundments at the site, including ignitable wastes (RCRA waste code D001); corrosive wastes (RCRA waste code D002); wastes containing metals, including arsenic (RCRA waste code D004), chromium (RCRA waste code D007), lead (RCRA waste code D008), mercury (RCRA waste code D009), selenium (RCRA waste code D010), and silver (RCRA waste code D011); wastes containing lindane (RCRA waste code D013); spent halogenated and nonhalogenated solvent wastes (RCRA waste codes F001, F002, F003, and F005); electroplating wastes (RCRA waste codes F006 and F009); and a variety of discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (RCRA P-listed and U-listed wastes) [Ref. 7, pp. 330, 336, 451, 659; 19, pp. 33–36, 40, 43, 47–49, 57–67; 32, p. 35; 33, pp. 380–383]. Sludge in Waste Unit 9 was known to contain VOCs, such as benzene, PCE, TCE, 1,1,1-TCA, and carbon tetrachloride, as well as heavy oils and tars [Ref. 7, pp. 23, 423, 451, 588]. Analytical results for soil and waste samples collected by PROTECO during its Phase III Soils Investigation and during its post-excavation sampling for Waste Unit 9 provide additional evidence of the hazardous substances present in the Source 2 surface impoundments [Ref. 32, pp. 329, 756–871, 872–883; 33, pp. 4–18, 46–83, 317–372]. A summary of the specific hazardous substances known to be present in Source 2, based on their respective RCRA waste codes or their presence in samples collected within the waste units, are presented in **Table 2** [see **Section 2.4.1**, below**]**.

Waste Unit 9 was an unlined surface impoundment used for the deposition of oily wastes, waste oils, and tars [Ref. 7, pp. 23, 584, 588]. Waste materials deposited in Waste Unit 9 contained acetone, chloroform, ethyl acetate, heptane, methanol, methylene chloride, toluene, 1,1,1-TCA, and xylene; large amounts of liquids were placed in the unit and might have migrated before being stabilized [Ref. 7, pp. 329–334, 353]. The waste material in the unit consisted of approximately 477,700 gallons of liquid and approximately 300,000 gallons of sludge; during the fall of 1994, soil was added and mixed with the liquid in the lagoon to produce a solid matrix [Ref. 32, p. 35]. As part of the site closure, approximately 19,000 cubic yards (yd^3) of waste materials were excavated from Waste Unit 9 for placement into the CAMU lined landfill cell, which was later constructed in the former Waste Unit 9 location [Ref. 7, p. 658; 32, pp. 8, 35, 329, 337]. However, the final post-excavation samples, collected from Waste Unit 9 in April 1998, showed the continuing presence of several hazardous substances, including acenaphthene, acenaphthylene, anthracene, 1,2-benzoanthracene, chrysene, 2,4-dinitrotoluene, ethylbenzene, fluoranthene, fluorene, methylene chloride, naphthalene, 4-nitrophenol, phenanthrene, phenol, pyrene, PCE, and toluene; the CAMU liner was emplaced above these contaminated waste materials [Ref. 32, pp. 329, 756–871, 872–883]. Due to the continuing presence of hazardous substances beneath the CAMU liner, Waste Unit 9 is evaluated as having non-zero containment (i.e., no liner) for the ground water migration pathway. The excavated material that was placed in the CAMU lined landfill cell is not included in the calculation of hazardous waste quantity.

Waste Unit 10 is an immobilization impoundment that was active until approximately 1981; during its operation, Waste Unit 10 was used for the disposal of 15,965 gallons of wastes, including D008, D009, and F001 wastes [Ref. 7, pp. 296, 336–337]. Waste Unit 10 consists of a buried mixture of black waste and soil, which emitted organic vapors during the Phase III Soils Investigation; analytical results for samples of the waste-soil mixture collected during the Phase III investigation show the presence of chloroform, PCE, toluene, TCE, arsenic, barium, chromium, lead, and silver in Waste Unit 10 [Ref. 33, pp. 69–71, 174, 177]. Upon closure, Waste Unit 10 was reported to contain approximately 950 yd^3 of waste materials [Ref. 32, p. 35].

Waste Unit 11 is an immobilization area that was used until August 1982 for the deposition of 201,450 gallons of waste [Ref. 7, p. 338]. Waste Unit 11 contains approximately 5,800 yd^3 of waste materials consisting of waste code designations D001, D002, D008, D009, D013, F001, F002, F006, F009, U044, U138, U140, U144, U151, U154, U156, U188, U201, U210, U226, and U239 [Ref. 7, p. 338; 32, p. 35; 33, p. 381]. Waste Unit 11 consists of buried, black to gray waste mixed with soil with a thickness of up to 22.5 vertical feet; the waste material emitted organic vapors during the Phase III Soils Investigation [Ref. 33, pp. 72, 76]. Analytical results for samples of the waste-soil mixture collected during the Phase III investigation show the presence of acenaphthene, acenaphthylene, acetone, benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, alpha-BHC, beta-BHC, delta-BHC, chloroform, chrysene, 1,2-dichlorobenzene, ethylbenzene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, pyrene, styrene, PCE, toluene, trans-1,3-dichloropropene, TCE, xylenes, arsenic, barium, cadmium, chromium, lead, and silver in Waste Unit 11 [Ref. 33, pp. 72–75, 178–182, 185].

Waste Unit 12 contains approximately 17,800 yd^3 of waste materials consisting of waste code designations D001, D002, D013, and F003 [Ref. 7, p. 658; 32, p. 35]. Waste Unit 12 was designated as a land treatment area measuring approximately 250 feet by 120 feet, but it consists of buried waste mixed with soil to a depth of 15 feet, and PROTECO observed a solvent odor in native soils beneath the waste at a depth of 20 feet [Ref. 32, p. 1499; 33, pp. 80, 82]. Waste Unit 12 operated until July 1982; in November 1986, four years after the unit stopped operating, EPA observed that it still lacked vegetative cover [Ref. 7, pp. 8, 146]. Analytical results for waste and soil samples collected during the Phase III investigation show the presence of gamma-BHC, PCE, toluene, arsenic, barium, cadmium, chromium, lead, and silver in Waste Unit 12 [Ref. 33, pp. 80–83, 187, 189, 192–193]. RCRA closure activities included installation of an engineered cover on the surface on Waste Unit 12 that was contiguous with the CAMU; however, no other engineered containment features, such as a liner or leachate collection system, were put in place at closure or known to be in place during the operational periods of the land treatment areas [Ref. 7, pp. 662–664, 668, 669].

Waste Unit 13 was used as an unlined holding basin for supernatant water pumped from Waste Unit 9, and it also received runoff from multiple waste areas [Ref. 7, pp. 23, 147, 658]. The supernatant, categorized by PROTECO as nonhazardous, was decanted and pumped from Waste Unit 9 into Waste Unit 13; therefore, Waste Unit 13 contains the same wastes as Waste Unit 9 [Ref. 7, pp. 147, 297, 341; 32, p. 35; 33, p. 382]. The maximum amount of waste stored in Waste Unit 13 was 80,000 to 100,000 gallons [Ref. 7, p. 147; 32, p. 35]. Analytical results for samples collected from Waste Unit 13 during the Phase III Soils Investigation show the presence of ethylbenzene, phenols, and toluene [Ref. 33, pp. 54–56, 194, 198].

Waste Unit 16 is an immobilization area that contains approximately 29,700 yd^3 of waste materials; the waste codes applicable to the materials within the unit are D001, D002, D004, D006, D007, D008, D009, D010, D011, D013, F001, F002, F003, F005, F006, F007, K052, K062, U002, U019, U021, U044, U080, U112, U122, U138, U144, U151, U154, U188, U201, U210, U220, U226, U228, U230, and U239 [Ref. 7, pp. 345–353; 32, p. 35; 33, pp. 382–383]. Waste Unit 16 consists of buried, dark-brown to black waste mixed with soil, which emitted strong organic vapors during the Phase III Soils Investigation [Ref. 33, p. 76]. Analytical results for samples of the waste-soil mixture collected during the Phase III investigation show the presence of hazardous substances in Waste Unit 16, including acetone, gamma-BHC, 2-butanone, chloroform, 1,2-DCA, 1,2-dichloropropane, ethylbenzene, 4-methyl-2-pentanone, styrene, PCE, toluene, 1,1,1-TCA, xylenes, arsenic, barium, cadmium, chromium, lead, and silver [Ref. 33, pp. 76–79, 209–218].

Waste Unit 17 is a neutralization impoundment that received aqueous solutions of salts and metals, and wastewater treatment sludge from tuna processing [Ref. 7, p. 354]. The unit contains approximately 30,200 gallons of waste materials with waste code designations D001, D002, and D003; actual waste disposed included ferric chloride, sodium hydroxide, caustic soda, waste acid, phosphoric acid, and other acids and bases added for pH adjustment [Ref. 7, pp. 354–355; 32, p. 35]. The Phase III Soils Investigation showed that Waste Unit 17 contains orange sludge underlain by a green waste mixed with soil, as well as some black waste mixed with soil; analytical results for samples collected from Waste Unit 17 during the Phase III investigation show the presence of arsenic, barium, cadmium, chromium, and silver [Ref. 33, pp. 58–64, 223–224]. PROTECO has indicated that orange liquid waste has migrated approximately 250 feet laterally from Waste Unit 17, and that green staining beneath the waste material provides evidence of vertical migration [Ref. 33, p. 62].

Location of the source, with reference to a map of the site:

The surface impoundments (i.e., Waste Units 9, 10, 11, 12, 13, 16, and 17) that are evaluated as Source 2 are located in the southern portion of the TSDF [Ref. 32, p. 1499; 34, p. 1], as shown in **Figure 2**.

Containment

Release to groundwater:

The surface impoundments at the site do not have liners [Ref. 7, p. 8]. During its Phase III Soils Investigation in 1987, PROTECO observed waste mixed with soil directly above native soil, as well as soil staining and contamination, in the surface impoundments, confirming that liners are not present in any of the waste units [Ref. 33, pp. 46–83]. RCRA closure of the unlined surface impoundments did not include installation of liners, with the exception of the CAMU lined landfill cell where the excavated wastes from Waste Units 4, 7, and 9 are encapsulated at the former location of Waste Unit 9 [Ref. 7, pp. 662–669]. As described above, the Waste Unit 9 wastes were not fully excavated and hazardous substances remain beneath the CAMU liner [Ref. 32, pp. 329, 756–871, 872–883]. Due to the proximity of the CAMU to waste Units 9, 10, 11, 12, and 16, these waste units were closed together in conjunction with the CAMU under the same continuous cover system (i.e., the CAMU final cover) [Ref. 7, pp. 668, 669; 32, pp. 8, 1499, 1501]. Waste Units 13, and 17 were closed individually under separate cover systems [Ref. 32, pp. 8, 1499–1501]. Although closure activities did include improved run-on/runoff control and an enlarged and redesigned sediment basin to accommodate runoff from the surface of the closed units, information obtained and observations made during the June 2017 EPA reconnaissance indicate that site operators abandoned the site in 2001 and there has been no maintenance of the site surface or capped waste units since that time [Ref. 5, pp. 4, 16–18; 7, pp. 664, 665]. The entire site has become overgrown with secondary forest growth consisting of small and a few mature hardwood trees, making it difficult or impossible to distinguish site features and likely compromising the integrity of the caps put in place during the RCRA closure [Ref. 5, pp. 16–19]. Evidence of severe erosion was noted in the drainage ditch that runs along the western side of the site, showing that the run-on/runoff control measures put in place during the RCRA closure have been compromised due to lack of maintenance [Ref. 5, pp. 5, 20].

Historically, there have been observations that suggest waste migration from some of the waste units. Evidence of liquid migration from Waste Unit 13 was observed at depths of 12.5 to 16.5 feet in a downslope soil boring [Ref. 7, p. 542]. Evidence of vertical and horizontal seepage from Waste Unit 9 was also observed; soil borings advanced adjacent to Waste Unit 9 exhibited oily staining to depths up to 41 feet bgs, and liquid waste from Waste Unit 9 was observed to have migrated horizontally as far as 360 feet to the southwest [Ref. 7, p. 542].

Based on the lack of containment measures in all the surface impoundments, in particular no liners, a containment factor value of 10 is assigned to Source 2 in the ground water migration pathway [Ref. 1, Table 3-2].

2.4.1 Hazardous Substances

TABLE 2 – SOURCE 2 HAZARDOUS SUBSTANCES		
Hazardous Substance	**Waste Code/Description and Phase III Soil Data**	**Reference(s)**
Acenaphthene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–180
Acenaphthylene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–180
Acetone	U002: Acetone [**Waste Unit 16**] Phase III soil/waste samples [**Waste Units 11, 16**]	7, p. 347; 19, p. 51; 33, pp. 72–79, 178, 211
Anthracene	Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883
Arsenic	D004: Solid waste exhibiting toxicity due to containing arsenic above regulatory level [**Waste Unit 16**] Phase III soil/waste samples [**Waste Units 10, 11, 12, 16, 17**]	7, p. 347; 19, p. 35; 33, pp. 58–64, 69–83, 177, 185–186, 192–193, 217–218, 223–224
Barium	Phase III soil/waste samples [**Waste Units 10, 11, 12, 16, 17**]	33, pp. 58–64, 69–83, 177, 185–186, 192–193, 217–218, 223–224
Benzene	U019: Benzene [**Waste Unit 16**] Phase III soil/waste samples [**Waste Unit 11**]	19, p. 51; 32, p. 35; 33, pp. 72–75, 178
Benzidine	U021: Benzidine [**Waste Unit 16**]	7, p. 347; 19, p. 52
Benzo(a)anthracene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–181
Benzo(a)pyrene	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178–181
Benzo(b)fluoranthene	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178–181
Benzo(k)fluoranthene	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178–181
Benzo(g,h,i)perylene	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178–181
BHC, alpha-	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178
BHC, beta-	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178
BHC, delta-	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178
2-Butanone	Phase III soil/waste samples [**Waste Unit 16**]	33, pp. 76–79, 211
Cadmium	D006: Solid waste exhibiting toxicity due to containing cadmium above regulatory level [**Waste Unit 16**] Phase III soil/waste samples [**Waste Units 11, 12, 16, 17**]	7, p. 347; 19, p. 35; 33, pp. 58–64, 72–83, 185–186, 192–193, 217–218, 223–224
Chloroform	U044: Chloroform [**Waste Units 11, 16**] Phase III soil/waste samples [**Waste Units 10, 11, 16**]	7, p. 347; 19, p. 52; 32, p. 35; 33, pp. 69–79, 174, 182, 209, 211

TABLE 2 – SOURCE 2 HAZARDOUS SUBSTANCES		
Hazardous Substance	**Waste Code/Description and Phase III Soil Data**	**Reference(s)**
Chromium	D007: Solid waste exhibiting toxicity due to containing chromium above regulatory level [**Waste Unit 16**] K062: Spent pickle liquor generated by steel finishing operations of facilities within the iron and steel industry; basis for listing as hazardous waste—hexavalent chromium, lead [**Waste Unit 16**] Phase III soil/waste samples [**Waste Units 10, 11, 12, 16, 17**]	19, p. 35; 32, p. 35; 33, pp. 58–64, 69–83, 177, 185–186, 192–193, 217–218, 223–224
Chrysene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–181
Cyanide	F007: Spent cyanide plating bath solutions from electroplating operations [**Waste Unit 16**] F009: Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process [**Waste Unit 11**]	19, p. 36; 32, p. 35
1,2-Dichlorobenzene	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178–180
1,2-Dichloroethane	Phase III soil/waste samples [**Waste Unit 16**]	33, pp. 76–79, 211
1,2-Dichloropropane	Phase III soil/waste samples [**Waste Unit 16**]	33, pp. 76–79, 211
2,4-Dinitrotoluene	Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883
Ethyl acetate	U112: Ethyl acetate [**Waste Unit 16**]	7, p. 347; 19, pp. 54, 60
Ethylbenzene	Phase III soil/waste samples [**Waste Units 11, 13, 16**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 54–56, 72–79, 178, 194, 211
Fluoranthene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–181
Fluorene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–180
Formaldehyde	U122: Formaldehyde [**Waste Unit 16**]	7, p. 347; 19, p. 54
Indeno(1,2,3-c,d)pyrene	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178–181
Iodomethane	U138: Iodomethane (aka Methyl iodide) [**Waste Units 11, 16**]	7, p. 347; 19, p. 55; 32, p. 35
Isobutyl alcohol	U140: Isobutyl alcohol [**Waste Unit 11**]	19, p. 61; 32, p. 35
Lead	D008: Solid waste exhibiting toxicity due to containing lead above regulatory level [**Waste Units 10, 11, and 16**] K052: Tank bottoms (leaded) from the petroleum refining industry; basis for listing as hazardous waste—lead [**Waste Unit 16**] K062: Spent pickle liquor generated by steel finishing operations of facilities within the iron and steel industry; basis for listing as hazardous waste—hexavalent chromium, lead [**Waste Unit 16**] U144: Lead acetate [**Waste Units 11, 16**] Phase III soil/waste samples [**Waste Units 10, 11, 12, 16**]	7, pp. 336, 347; 19, pp. 35, 40, 54, 167; 32, p. 35; 33, pp. 69–83, 177, 185–186, 192–193, 217–218
Lindane (aka gamma-BHC)	D013: Solid waste exhibiting toxicity due to containing lindane above regulatory level [**Waste Units 11, 12, and 16**] Phase III soil/waste samples [**Waste Units 12, 16**]	7, p. 347; 19, p. 35; 33, pp. 76–83, 189, 211–212

TABLE 2 – SOURCE 2 HAZARDOUS SUBSTANCES		
Hazardous Substance	**Waste Code/Description and Phase III Soil Data**	**Reference(s)**
Mercury	D009: Solid waste exhibiting toxicity due to containing mercury above regulatory level [**Waste Units 10, 11, and 16**] U151: Mercury [**Waste Units 11, 16**]	7, p. 336; 19, pp. 35, 55; 32, p. 35
Methanol	U154: Methanol [**Waste Units 11, 16**]	19, p. 55; 32, p. 35
Methyl chlorocarbonate	U156: Methyl chlorocarbonate [**Waste Unit 11**]	19, p. 55; 32, p. 35
4-Methyl-2-pentanone	Phase III soil/waste samples [**Waste Unit 16**]	33, pp. 76–79, 211
Methylene chloride	U080: Methylene chloride [**Waste Unit 16**] Post-excavation samples, April 1998 [**Waste Unit 9**]	7, p. 347; 19, p. 55; 32, pp. 329, 872–883
Naphthalene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–180
4-Nitrophenol	Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883
Phenanthrene	Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883
Phenol	U188: Phenol [**Waste Units 11, 16**] Phase III soil/waste samples [**Waste Unit 13**] Post-excavation samples, April 1998 [**Waste Unit 9**]	19, p. 56; 32, pp. 35, 329, 872–883; 33, pp. 54–56, 198
Pyrene	Phase III soil/waste samples [**Waste Unit 11**] Post-excavation samples, April 1998 [**Waste Unit 9**]	32, pp. 329, 872–883; 33, pp. 72–75, 178–181
Resorcinol	U201: Resorcinol [**Waste Units 11, 16**]	7, p. 347; 19, p. 56; 32, p. 35
Selenium	D010: Solid waste exhibiting toxicity due to containing selenium above regulatory level [**Waste Unit 16**]	7, p. 347; 19, p. 35
Silver	D011: Solid waste exhibiting toxicity due to containing silver above regulatory level [**Waste Unit 16**] Phase III soil/waste samples [**Waste Units 10, 11, 12, 16, 17**]	7, p. 347; 19, p. 35; 33, pp. 58–64, 69–83, 177, 185–186, 192, 217–218, 223–224
Styrene	Phase III soil/waste samples [**Waste Units 11, 16**]	33, pp. 72–79, 178, 211
Tetrachloroethylene	U210: Tetrachloroethylene [**Waste Units 11, 16**] Phase III soil/waste samples [**Waste Units 10, 11, 12, 16**] Post-excavation samples, April 1998 [**Waste Unit 9**]	19, p. 57; 32, pp. 35, 329, 872–883; 33, pp. 69–83, 174, 178, 182, 187, 209, 211
Toluene	U220: Toluene (aka Methyl benzene) [**Waste Unit 16**] Phase III soil/waste samples [**Waste Units 10, 11, 12, 13, 16**] Post-excavation samples, April 1998 [**Waste Unit 9**]	19, p. 57; 32, pp. 35, 329, 872–883; 33, pp. 54–56, 69–83, 174, 178, 182, 187, 189, 194, 209, 211, 213
Trans-1,3-dichloropropene	Phase III soil/waste samples [**Waste Unit 11**]	33, pp. 72–75, 178
1,1,1-Trichloroethane	U226: 1,1,1- Trichloroethane [**Waste Units 11, 16**] Phase III soil/waste samples [**Waste Unit 16**]	19, p. 57; 32, p. 35; 33, pp. 76–79, 211
Trichloroethylene	U228: Trichloroethylene [**Waste Unit 16**] Phase III soil/waste samples [**Waste Units 10, 11**]	7, p. 347; 19, p. 57; 33, pp. 69–75, 174, 178, 182
Xylene	U239: Xylene [**Waste Units 11, 16**] Phase III soil/waste samples [**Waste Units 11, 16**]	7, p. 347; 19, p. 57; 32, p. 35; 33, pp. 72–79, 178, 211

2.4.2 Hazardous Waste Quantity

2.4.2.1.1 Tier A – Hazardous Constituent Quantity

The hazardous constituent quantity for Source 2 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.1]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, Hazardous wastestream quantity [Ref. 1, Section 2.4.2.1.1].

Hazardous Constituent Quantity (C) Value: Not scored

2.4.2.1.2 Tier B – Hazardous Wastestream Quantity

The hazardous wastestream quantity for Source 2 could not be adequately determined according to the HRS requirements; that is, the mass of the hazardous wastestreams plus the mass of any additional CERCLA pollutants and contaminants in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.2]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of the wastestream plus the mass of all CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous wastestream quantity for Source 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, Volume [Ref. 1, Section 2.4.2.1.2].

Hazardous Wastestream Quantity (W) Value: Not scored

2.4.2.1.3 Volume (Tier C)

The volume for Source 2 can be adequately determined based on facility records [As discussed previously, the waste material excavated from Waste Unit 9 (19,000 yd^3) is within the CAMU lined landfill cell and is not considered in the evaluation of hazardous waste quantity due to the difference in containment]. Source 2 contains a total of 54,801 yd^3 of waste materials, as follows: Waste Unit 10—950 yd^3, Waste Unit 11—5,800 yd^3, Waste Unit 12—17,800 yd^3, Waste Unit 13—400 yd^3, Waste Unit 16—29,700 yd^3, and Waste Unit 17—151 yd^3 (Note: volumes for Waste Units 13 and 17 were converted from gallons using the conversion of 200 gallons = 1 yd^3) [Ref. 1, Table 2-5; 7, pp. 658, 659; 32, p. 35]. The source type is "Surface Impoundment (buried/backfilled)", so the volume (V) of the source (54,801 yd^3) is divided by 2.5 to assign a hazardous waste quantity factor to the volume measure [Ref. 1, Section 2.4.2 and Table 2-5]. Based on these calculations, Tier C – Volume is assigned a value of 21,920.4 for Source 2 [Ref. 1, Section 2.4.2 and Table 2-5].

Volume (V) of source in yd^3 = 54,801
Volume Assigned Value = 54,801/2.5 = 21,920.4

2.4.2.1.4 Area (Tier D)

As the volume of Source 2 is adequately determined, an area measure value of 0 is assigned [Ref. 1, Section 2.4.2.1.3].

Area (A) Value: 0

2.4.2.1.5 Source Hazardous Waste Quantity Value

The source hazardous waste quantity value for Source 2 is 21,920.4 for Tier C – Volume [Ref. 1, Section 2.4.2.1.5].

Source Hazardous Waste Quantity Value: 21,920.4

2.2 SOURCE CHARACTERIZATION

Number of the source: 3

Source Type of the source: Landfill

Name and description of the source: Waste Unit 14

Source 3 consists of Waste Unit 14, a 10-acre, unlined landfill that accepted industrial and special wastes generated by industries and commercial establishments within Puerto Rico [Ref. 7, p. 146; 32, p. 33]. Prior to its use as a landfill, the unit was used as a landfarm for sludges designated as nonhazardous [Ref. 7, pp. 146, 342]. As of July 1999, Waste Unit 14 had ceased landfilling operations and was undergoing closure activities [Ref. 32, p. 34]. In June 2017, a former PROTECO employee informed EPA that Waste Unit 14 was capped with geosynthetic clay and soil when site operations ceased [Ref. 5, p. 4].

The solid and industrial wastes deposited in Waste Unit 14 included: asbestos; inorganic salts; liquid waste, including organic dextrose solutions and sera; industrial sludges, metallic sludges, publicly owned treatment works (POTW) sludges, wastewater treatment plant (WWTP) sludges, and septic tank sludges; waste motor oils; hydrocarbon-contaminated soils; demolition debris; food products; consumer/household products; solid waste from pharmaceutical companies and other industries; putrescible wastes generated from USDA inspections; and grease and oils from cafeterias and restaurants [Ref. 7, p. 146; 32, pp. 33–34]. PROTECO reported that, prior to deposition in Waste Unit 14, sludges and liquid wastes were mixed with soil or cement kiln dust in a staging area until the waste/solids combinations were absent of free liquids [Ref. 32, pp. 33–34]. However, during a 1985 RCRA inspection, EPA observed a viscous sludge discharging from the ground in Waste Unit 14, which PROTECO identified as K051 separator sludge [Ref. 7, p. 146]. During later inspections in March and May 1992, EPA observed waste pits containing black liquid and emitting a strong odor on top of the Waste Unit 14 landfill, which at that time was the only active unit at PROTECO [Ref. 7, p. 543].

Analytical results for composite soil samples collected from Waste Unit 14 in March 1984 revealed the presence of hazardous substances including benzene; bis(2-ethylhexyl)phthalate; chloroform; 1,1-DCA; 1,2-DCA; 1,1-DCE; ethylbenzene; fluoranthene; fluorene; gamma-BHC; methylene chloride; naphthalene; phenanthrene; pyrene; PCE; toluene; 1,1,1-TCA; and TCE [Ref. 7, p. 420, 423, 429]. Results for waste samples collected during the Phase III Soils Investigation showed the presence of chlorobenzene, chloroform, ethylbenzene, PCE, and toluene [Ref. 33, pp. 84–86, 199, 203].

In January 1998, Waste Unit 14 received the rinse water, residues, and metal debris generated during the closure of Waste Unit 15, a 5,000-gallon AST that contained shampoo contaminated with lindane and 1 to 2 inches of solid residue [Ref. 7, pp. 672, 949, 950; 32, p. 35]. The tank closure included removal of collected solids from the bottom of the tank, application of a degreaser, and pressure washing [Ref. 7, pp. 672, 937]. The waste materials from Waste Units 6 and 8 (solid waste landfills) were also placed into Waste Unit 14 after being excavated during the RCRA closure activities at PROTECO [Ref. 5, p. 4; 7, p. 375; 32, p. 33]. The waste materials originally deposited in Waste Unit 6 included electroplating sludge, WWTP sludge from tuna processing, intravenous solution, metals slurry, 16,000 yd^3 of power plant sludge, and 6,888 pounds of lead-containing asbestos brake linings [Ref. 7, p. 323; 32, p. 33]. Waste Units 6 and 8 consisted of buried black waste mixed with soil, and Waste Unit 8 also contained asbestos- containing material; analytical results for samples of the waste-soil mixtures showed the presence of arsenic, barium, cadmium, chromium, lead, mercury, and silver in the Waste Units 6 and 8 waste materials [Ref. 33, pp. 87–94; 152– 155, 166–167].

Location of the source, with reference to a map of the site:

Source 3 (i.e., Waste Unit 14) is located in the eastern portion of the site [Ref. 7, p. 1545; 34, p. 1]. The location is shown in **Figure 2**.

Containment

Release to groundwater:

Waste Unit 14 is an unlined landfill that accepted industrial and special wastes and was previously used as a landfarm for sludges [Ref. 7, pp. 146, 342; 32, p. 33]. During its Phase III Soils Investigation in 1987, PROTECO observed waste mixed with soil directly above native soil, as well as soil staining, in Waste Unit 14; there was no liner present [Ref. 33, pp. 84–86]. Results for waste samples collected during the Phase III Soils Investigation showed the presence of chlorobenzene, chloroform, ethylbenzene, PCE, and toluene [Ref. 33, pp. 84–86, 199, 203].

Because there is no liner in the landfill, a containment factor value of 10 is assigned to Source 3 in the ground water migration pathway [Ref. 1, Table 3-2].

2.4.1 Hazardous Substances

The specific hazardous substances known to be present in Source 3, based on facility records or detections in samples collected from Waste Unit 14, include the following:

Asbestos
Benzene
Bis(2-ethylhexyl)phthalate
Chlorobenzene
Chloroform
1,1-DCA
1,2-DCA
1,1-DCE
Ethylbenzene
Fluoranthene
Fluorene
Gamma-BHC
Methylene chloride
Naphthalene
Phenanthrene
Pyrene
PCE
Toluene
1,1,1-TCA
TCE

[Ref. 7, pp. 342, 420, 423, 429; 32, p. 33; 33, pp. 84–86, 199, 203].

The specific hazardous substances known to be present in Source 3, based on their presence in samples of waste materials in Waste Units 6 and 8 that later went into Waste Unit 14, include the following:

Arsenic
Asbestos
Barium
Cadmium
Chromium
Lead
Mercury
Silver

[Ref. 33, pp. 87–94; 152–155, 166–167].

2.4.2 Hazardous Waste Quantity

2.4.2.1.1 Tier A – Hazardous Constituent Quantity

The hazardous constituent quantity for Source 3 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.1]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, Hazardous wastestream quantity [Ref. 1, Section 2.4.2.1.1].

Hazardous Constituent Quantity (C) Value: Not scored

2.4.2.1.2 Tier B – Hazardous Wastestream Quantity

The hazardous wastestream quantity for Source 3 could not be adequately determined according to the HRS requirements; that is, the mass of the hazardous wastestreams plus the mass of any additional CERCLA pollutants and contaminants in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.2]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of the wastestream plus the mass of all CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous wastestream quantity for Source 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, Volume [Ref. 1, Section 2.4.2.1.2].

Hazardous Wastestream Quantity (W) Value: Not scored

2.4.2.1.3 Volume (Tier C)

Waste Unit 14 is a 10-acre landfill, but the depth is unknown [Ref. 32, p. 33]. As the volume cannot be determined, Source 3 is assigned a value of 0 for the volume measure [Ref. 1, Section 2.4.2.1.3].

Volume Assigned Value = 0

2.4.2.1.4 Area (Tier D)

Waste Unit 14 covers an area of 10 acres, which equates to 435,600 square feet (ft^2) using the conversion 1 acre = 43,560 ft^2 [Ref. 32, p. 33]. The source type is “Landfill”, so the area (A) of the source (435,600 ft^2) is divided by 3,400 to assign a hazardous waste quantity factor to the area measure [Ref. 1, Section 2.4.2 and Table 2-5]. Based on these calculations, Tier D – Area is assigned a value of 128.1 for Source 3 [Ref. 1, Section 2.4.2.1.4].

Area (A) of source in ft^2 = 435,600
Area Assigned Value = 435,600/3,400 = 128.1

2.4.2.1.5 Source Hazardous Waste Quantity Value

The source hazardous waste quantity value for Source 3 is 128.1 for Tier D – Area [Ref. 1, p. Section 2.4.2.1.5].

Source Hazardous Waste Quantity Value: 128.1

SITE SUMMARY OF SOURCE DESCRIPTIONS

TABLE 3 – HAZARDOUS WASTE QUANTITY AND CONTAINMENT					
Source Number	**Source Hazardous Waste Quantity Value**	**Containment**			
		Ground Water	**Surface Water**	**Air (Gas)**	**Air (Particulate)**
1	944.2	10	NS	NS	NS
2	21,920.4	10	NS	NS	NS
3	128.1	10	NS	NS	NS

NS = Not Scored

Additional Areas of Concern

Waste Unit 4 (former location)

Waste Unit 4 was an aboveground drum storage area [Ref. 7, pp. 584, 670]. In 1987, a spill of mercury was observed with an area of approximately 9 ft^2 in Waste Unit 4 [Ref. 7, p. 50]. Approximately 1,000 drums containing various waste materials were reportedly removed from the unit in 1994 and transported to a permitted disposal facility in the U.S. mainland [Ref. 7, p. 584]. The top two feet of soil, an estimated 1,500 cubic yards (yd^3) of impacted soil, were excavated and placed in the CAMU [Ref. 7, pp. 584, 670]. It is not clear if any wastes remain in this area.

Waste Unit 7 (former location)

Waste Unit 7 was a neutralization impoundment for corrosive solids and liquids (waste code D002) in the northern portion of the site [Ref. 7, pp. 325–327]. The impoundment contained an aqueous solution of salts and metals, including ferric chloride; acids and bases had been added for pH adjustment [Ref. 7, p. 326]. Waste Unit 7 became inactive in November 1985, and PROTECO allowed existing liquids to evaporate [Ref. 7, pp. 296, 326]. Approximately 2,700 cubic yards of waste materials were excavated from Waste Unit 7 and placed in the CAMU lined landfill cell during the RCRA closure activities [Ref. 32, pp. 8, 35]. It is not clear if any wastes remain in this area.

Additional Hazardous Substances

A 1985 RCRA Facility Assessment (RFA) of the PROTECO facility was prepared by EPA Region 2 using information obtained from the TSDF's RCRA Part B Permit Application, Exposure Information Report, and closure plans, and from information contained within EPA and PREQB files [Ref. 7, p. 292]. The RFA provides a list of hazardous substances managed at the TSDF that includes specific chemical compounds that are not assigned to any specific source [Ref. 7, pp. 463–484]. As drum contents were often transferred to the surface impoundments for treatment, it is considered probable that Source 1 (i.e., the drum burial areas) and Source 2 (i.e., the surface impoundments) contain additional hazardous substances that are not specifically listed in this HRS documentation record [Ref. 7, p. 5].

3.0 GROUND WATER MIGRATION PATHWAY

3.0.1 GENERAL CONSIDERATIONS

<u>Ground Water Migration Pathway Description</u>

The aquifers being evaluated are the Ponce-Juana Díaz aquifer, which consists of the Tertiary-age Juana Díaz Formation and Ponce Limestone, and the Tallaboa alluvial aquifer located west of the site [Ref. 7, pp. 1529–1534; 23, pp. 29–30; 24, p. 1] [note that only the Ponce-Juana Díaz aquifer is evaluated for the observed release in **Section 3.1.1**]. As shown on *Geologic Map of the Peñuelas and Punta Cuchara Quadrangles, Puerto Rico* (USGS, 1978), the alluvium abuts both the Juana Díaz Formation and the Ponce Limestone in the Río Tallaboa valley and in the tributary valleys west of the site [Ref. 24, p. 1]. The Tallaboa alluvial aquifer is recharged with groundwater from the Ponce-Juana Díaz aquifer (i.e., the aquifers are hydraulically connected) [Ref. 7, pp. 1529–1534; 22, p. 19; 23, pp. 29–30; 24, p. 1; 25, pp. 23, 35; 26, pp. 12, 21]. Due to the aquifer interconnection within 2 miles of site sources, the carbonaceous Ponce-Juana Díaz aquifer and the Tallaboa alluvial aquifer are combined into a single hydrologic unit for HRS scoring purposes [Ref. 1, Section 3.0.1.2]. This combined aquifer is most productive in the Río Tallaboa valley about 1 to 2 miles west of the site, where there are several active drinking-water wells [Ref. 17, pp. 2–3, 5; 22, p. 19; 23, p. 30; 24, p. 1; 25, pp. 20, 23, 35; 26, pp. 12, 21]. The most productive wells in the Río Tallaboa valley straddle the formation interface and withdraw water from both the alluvium and the carbonaceous rocks [Ref. 23, p. 30; 25, pp. 20, 23]. For example, the Carlos Andinos public supply well, which produces 380,000 gpd and serves 2,892 people, is screened from 50 to 80 feet bgs in the alluvium and from 80 to 110 feet bgs in the limestone [Ref. 17, pp. 2–3, 5; 27, pp. 1, 3, 5]. Other active drinking-water supply wells, irrigation wells, and industrial wells located in the Río Tallaboa valley west and northwest of the site have finished depths ranging up to 200 feet [Ref. 5, pp. 7–10; 6, pp. 4–41].

The site is located within the watershed of the Río Tallaboa, and the general topographic and water-table profiles slope downward from the site west to the Río Tallaboa valley [Ref. 7, pp. 75, 79, 413; 25, p. 17]. On-site monitoring wells screened in the limestone have been observed to have hydraulic head elevations declining from approximately 204 to 188 feet above mean sea level (MSL) in a northerly direction [Ref. 7, pp. 491, 504, 524, 640, 1530, 1538]. Groundwater in the limestone aquifer also has a westerly to northwesterly flow component along the strike of the rock, as well as a northwesterly component toward a limestone outcrop that discharges into a Río Tallaboa tributary valley [Ref. 7, pp. 277, 283, 299, 596, 640; 25, p. 19]. Based on these factors, overall groundwater flow in the aquifer is west-northwesterly toward the Río Tallaboa valley [Ref. 7, pp. 633–635, 1538–1539; 17, pp. 2–3, 5].

<u>Regional Geology/Aquifer Description</u>

The PROTECO site is located within the Peñuelas–Guánica region of the South Coast Groundwater Province, where the typical landforms include limestone hills (some with karst features), alluvium-filled valleys, and coastal plains [Ref. 7, p. 3; 22, pp. 10, 16; 23, pp. 11–12, 28]. The Juana Díaz Formation and Ponce Limestone show karst features such as voids and solution channels in the region [Ref. 7, pp. 595, 633–635, 1529; 23, p. 30; 25, pp. 19–20, 35; 26, p. 18]. Regionally, the total thickness of Juana Díaz Formation limestone facies ranges from approximately 150 to 600 meters (about 490 to 1,970 feet), and the thickness of the Ponce Limestone is more than 200 meters (about 650 feet) [Ref. 23, p. 18; 24, p. 1]. The Ponce Limestone consists of chalky, thin to medium-bedded limestone with local beds of shale and sandstone [Ref. 44, p. 14]. The alluvium in the Río Tallaboa valley, the primary river valley in the region, ranges in thickness from 12 to 60 meters (about 40 to 200 feet) [Ref. 7, p. 65; 24, p. 1].

<u>Site Geology/Aquifer Description</u>

The geologic strata that have been encountered during investigations at the site predominantly consist of calcareous silty clay (a.k.a. mudstone or claystone, which has undergone a facies change) and reef limestone components of the Ponce-Juana Díaz aquifer; the silty clay deposits were presented in PROTECO's reporting as two units (gray silty clay overlain by brown silty clay), however, PROTECO's boring logs show that the color change is gradational and that the deposits contain varying amounts of clay, silt, sand, limestone clasts, fractures, gypsum veins, and calcareous deposits throughout the stratigraphic column at the site [Ref. 7, pp. 3, 493–495, 499, 503; 36, pp. 122–353]. Based on these considerations, the silty clay deposits described by PROTECO are hereinafter referred to collectively as "calcareous silty clay" and are considered to represent the altered mudstone-claystone component of the Juana Diaz Formation. The calcareous deposits are presumed to be erosional remnants of the underlying limestone [Ref. 44, p. 14]. Small deposits of alluvium occur sporadically as surface or near-surface deposits at the site [Ref. 7, pp. 491, 497, 503, 506, 524; 36, p. 376]. Groundwater at the site occurs in the alluvial deposits at depths of 10 to 20 feet bgs, discontinuously in the calcareous silty clay deposits at depths ranging from 30 to 70 feet bgs, and continuously in the reef limestone at depths of approximately 100 to 200 feet bgs [Ref. 7, pp. 76, 491, 497, 499, 503– 504, 537–539]. The alluvium is only a few feet thick where it occurs on the site [Ref. 7, pp. 65, 497]. The total thickness of the calcareous silty clay deposits at the site ranges up to 220 feet, but it is relatively thin beneath the drum burial areas (Waste Units 1, 2, and 3) and it pinches out against limestone outcrops north of the waste units at the site [Ref. 7, pp. 537–538, 544, 549–550]. The reef limestone lies at a depth of less than 20 feet bgs to approximately 220 feet bgs, directly beneath the silty clay deposits; the on-site thickness is reported to be 60 feet [Ref. 7, pp. 491, 524–527; 42, p. 9]. The site is surrounded by limestone hills, and limestone forms some of the ridges (i.e., outcrops) at the site [Ref. 7, pp. 40, 299, 538; 22, p. 16; 33, p. 84].

Site-specific hydrogeologic information indicates that there is hydraulic connection between the calcareous silty clay and the underlying reef limestone, and that there is significant downward gradient from upper water-bearing zones to the limestone [Ref. 7, pp. 544, 634, 640–641, 1530]. The presence of groundwater in the calcareous silty clay deposits is associated with gypsum veins, which act as preferential pathways for groundwater to flow to the adjacent or underlying strata [Ref. 7, pp. 86, 499, 634, 639; 43, p. 8]. Groundwater might also flow preferentially through the alluvium, which has a hydraulic conductivity of 10^{-3} centimeter per second (cm/s) [Ref. 1, Section 3.1.2.4, Table 3-6; 7, pp. 86, 508, 527, 541]. Permeability testing at the site indicates hydraulic conductivities ranging from 10^{-9} cm/s to 10^{-3} cm/s for both the calcareous silty clay deposits and the limestone, further indicating the presence of heterogeneity (i.e., preferential pathways) in the subsurface [Ref. 7, pp. 329, 508, 638–639].

<u>Aquifer Interconnections/Distance from Source</u>

The calcareous silty clay is relatively thin (10–15 feet) beneath the drum burial areas (Waste Units 1, 2, and 3); and it pinches out against limestone outcrops north of the waste units at the site [Ref. 7, pp. 299, 500, 524, 537–538, 541, 544, 549–550; 33, p. 84; 36, p. 376]. Additionally, gypsum veins in the calcareous silty clay at the site act as preferential pathways for groundwater to flow to the adjacent or underlying strata, including the limestone and alluvium [Ref. 7, pp. 86, 499, 634, 639]. The boreholes and screen/gravel-pack intervals for some on-site monitoring wells straddle the boundaries between the calcareous deposits and underlying limestone, providing man-made conduits between the units [Ref. 45, pp. 7, 11].

Man-made conduits (i.e., wells) across the aquifer boundaries lead to aquifer interconnection between the Ponce-Juana Díaz aquifer and the Tallaboa alluvial aquifer, where present—the most productive wells in the Río Tallaboa valley straddle the formation interface and withdraw water from both the alluvium and the carbonaceous rocks [Ref. 23, p. 30; 25, pp. 20, 23]. For example, the Carlos Andinos public supply well is screened from 50 to 80 feet bgs in the alluvium and from 80 to 110 feet bgs in the limestone [Ref. 17, pp. 2–3, 5; 27, pp. 1, 3, 5]. Other active drinking-water supply wells, irrigation wells, and industrial wells located in the Río Tallaboa valley have finished depths ranging up to 200 feet [Ref. 5, pp. 7–10; 6, pp. 4–41]. Groundwater in the on-site limestone aquifer also has a westerly to northwesterly flow component along the strike of the rock and a northwesterly component toward an outcrop that discharges into a Río Tallaboa tributary valley, where it reaches the alluvial aquifer [Ref. 7, pp. 277, 283, 299, 596, 640; 25, p. 19].

<u>Aquifer Discontinuities within Target Distance Limit</u>

The areal extent of the aquifer being evaluated is continuous between the site and the wells being scored as targets, but it is limited south of the site near the coast, where groundwater is present as a freshwater lens overlying saltwater; the interface creates an aquifer boundary beyond which there are no drinking water wells, as shown in **Figure 3** [Ref. 7, pp. 1529–1534; 17, pp. 1–4; 24, p. 1; 26, p. 20].

Stratum 1 (shallowest)
Stratum/Aquifer Name: Alluvial deposits

Description: Small deposits of alluvium occur sporadically as surface or near-surface deposits at the site; the alluvial deposits consist of sand- to gravel-size, subangular limestone clasts within a clay matrix [Ref. 7, pp. 491, 497, 503, 506]. The alluvium is only a few feet thick where it occurs on the site, however, in the Río Tallaboa valley it ranges in thickness from 12 to 60 meters (about 40 to 200 feet) [Ref. 7, pp. 65, 497; 24, p. 1]. Groundwater at the site occurs in the alluvial deposits at depths of 10 to 20 feet bgs [Ref. 7, pp. 491, 497, 503–504, 537–539]. Groundwater in on-site limestone flows toward the alluvium in the Río Tallaboa valley via a westerly to northwesterly flow component [Ref. 7, pp. 277, 283, 299, 596, 640; 25, p. 19].

Stratum 2 (intervening layer)
Stratum/Aquifer Name: Juana Díaz Formation – calcareous silty clay (a.k.a. mudstone or claystone)

Description: The uppermost geologic stratum that has been encountered during investigations at the site predominantly consists of brown and gray, calcareous silty clay, which is mudstone or claystone of the Juana Díaz Formation that has undergone a facies change; this unit contains varying amounts of clay, silt, sand, limestone clasts, fractures, gypsum veins, and calcareous deposits [Ref. 7, pp. 3, 493–495, 499, 503; 36, pp. 122–353]. The total thickness of the calcareous silty clay at the site ranges up to 220 feet, but it is relatively thin beneath the drum burial areas (Waste Units 1, 2, and 3) and it pinches out against reef limestone outcrops north of the waste units at the site [Ref. 7, pp. 500, 506, 524, 537–538, 541, 544, 549–550]. Groundwater at the site occurs discontinuously in the calcareous silty clay at depths ranging from 30 to 70 feet bgs [Ref. 7, pp. 76, 491, 497, 499, 503–504, 537–539]. The presence of groundwater in the calcareous silty clay deposits is associated with gypsum veins that act as preferential pathways for groundwater flow into adjacent or underlying strata [Ref. 7, pp. 86, 499, 634, 639].

Stratum 3 (deepest)
Stratum/Aquifer Name: Juana Díaz Formation – reef limestone

Description: The reef limestone component of the Juana Díaz Formation consists of coralline and algal limestone formed as fringing reefs; the water-bearing zone is highly fossiliferous, very weathered, and fractured [Ref. 7, pp. 3, 493–495, 500, 503]. The reef limestone lies at a depth of approximately 9.5 to 250 feet bgs at the site, directly beneath the calcareous silty clay; the on-site thickness is reported to be 60 feet [Ref. 7, pp. 491, 524–527; 33, p. 84; 36, pp. 364, 372, 373, 376, 378, 379]. Regionally, the total thickness of Juana Díaz Formation limestone facies ranges from approximately 150 to 600 meters (about 490 to 1,970 feet) [Ref. 23, p. 18]. Groundwater at the site occurs continuously in the reef limestone at depths of approximately 100 to 200 feet bgs [Ref. 7, pp. 76, 491, 497, 499, 503–504, 537–539].

SUMMARY OF AQUIFER(S) BEING EVALUATED

Aquifer No.	Aquifer Name	Is Aquifer Interconnected with Upper Aquifer within 2 miles? (Y/N/NA)	Is Aquifer Continuous within 4-mile TDL? (Y/N)	Is Aquifer Karst? (Y/N)
1	Ponce-Juana Díaz Aquifer	Y	Y	N
2	Tallaboa Alluvial Aquifer	Y	N	N

3.1 LIKELIHOOD OF RELEASE

3.1.1 Observed Release

Aquifer Being Evaluated: Ponce-Juana Díaz aquifer

An observed release by chemical analysis is documented for the site. PROTECO installed 44 monitoring wells at the site from 1981 to 1988 [Ref. 7, pp. 152, 159–163, 501–504, 520–522]. Groundwater samples for chemical analyses were collected from selected site monitoring wells by EPA in 1984 and by PROTECO from 1986 to 1994 [Ref. 7, pp. 431, 445, 541; 18, pp. 8–13, 121–122; 28, p. 24]. During a site-wide groundwater assessment by PROTECO in May 1994, several wells could not be sampled due to having been destroyed, damaged, or plugged; subsequent investigations, including the June 2017 reconnaissance by EPA, indicate that site wells are abandoned, destroyed, buried, damaged, inaccessible, or unsecured, and are no longer viable for sampling [Ref. 5, pp. 5, 17, 19; 7, pp. 4, 12–13, 1521, 1545; 18, pp. 8, 15]. Based on these considerations, the chemical analytical results for groundwater samples collected from site monitoring wells from 1986 to 1994 are used to document the presence of hazardous substances in the aquifer being evaluated [see "Chemical Analysis", below].

Direct Observation

Information provided to EPA by PROTECO documents an observed release by direct observation to the aquifer being evaluated. Groundwater at the site occurs in the alluvial deposits at depths of 10 to 20 feet bgs, where present, and is known to be present in the general vicinity of Waste Unit 9 as evidenced in shallow/alluvial wells [**Figure 2**; Ref. 7, pp. 76, 491, 496-497, 524, 537, 539, 1539]. Waste Unit 9 is reportedly in direct contact with alluvial deposits [Ref. 28, p. 3]. Per PROTECO's Unit 9 Investigation Work Plan, dated September 23, 1988, subsurface data collected during the Phase III Soils Investigation conducted between July 18 and September 8, 1987 indicate that Unit 9 was constructed partially in the alluvial deposits, and additional subsurface data confirmed that the underlying reef limestone is present at a shallow depth (less than 20 feet bgs) below a portion of Unit 9 [Ref. 42, pp. 8, 9]. Also according to the work plan, the principal water bearing zone occurs at depths of approximately 40 feet bgs in the area of Waste Unit 9 [Ref. 42, p. 14]. In its Unit 9 Investigation Work Plan PROTECO stated that oily liquids attributed to Waste Unit 9 had been observed in alluvial deposits and gypsum veins at depths as great as 42 feet bgs, which would indicate an observed release by direct observation to the alluvial zone and possibly the principal water bearing zone has occurred [Ref. 7, pp. 542, 1543; 28, pp. 3, 28; 42, pp. 11, 14]. Previous analyses of the oily liquids in Waste Unit 9 had shown that it contained hazardous substances. On March 21-22, 1984, EPA conducted a RCRA sampling inspection of the site, including an evaluation of Waste Unit 9 [Ref. 7, p. 419–420]. One grab aqueous sample collected from Waste Unit 9 (Sample No. 66057) was analyzed for VOCs, SVOCs, pesticides, PCBs, dioxin, and metals by the EPA laboratory in Edison, NJ [Ref. 7, pp. 419–423, 425]. The VOCs detected in the oily liquid from Waste Unit 9 included, among other hazardous substances, several halogenated solvents, including 1,1-DCA at 9,300 µg/L; PCE at 120,000 µg/L; 1,1,1-TCA at 280,000 µg/L; and TCE at 26,000 µg/L [Ref. 7, p. 423]. These halogenated solvents are known to have been deposited into Waste Unit 9, and they continue to be present beneath the CAMU liner [Ref. 7, pp. 451, 460, 588, 658; 32, pp. 329, 756–871, 872–883].

Chemical Analysis

A Hydrogeologic Data Interpretation prepared on behalf of PROTECO in 1992, which included a review of available groundwater sampling results and a presentation of hazardous substance concentrations in site monitoring wells, states and shows that VOCs were present in the upper water-bearing zone (i.e., the alluvial deposits and calcareous silty clay), and had migrated to the reef limestone portion of the aquifer [Ref. 7, pp. 488–528]. The supporting data for the observed releases to the upper water-bearing zone and to the reef limestone are presented below.

Upper water-bearing zone (alluvial deposits and calcareous silty clay):

Groundwater at the site occurs in the alluvial deposits at depths of 10 to 20 feet bgs and in the calcareous silty clay deposits at depths ranging from 30 to 70 feet bgs [see **Section 3.0 of the HRS documentation record**]. Monitoring wells 30W-85, 36WS-86, and 58MWS-88, were screened in the calcareous silty clay and were located hydraulically downgradient of Source 2 [Ref. 7, pp. 507, 644, 1543]. Sample analyses performed in 1988 via EPA-approved test methods show that VOCs are present in the upper water-bearing zone at those monitoring well locations, representing an observed release [Ref. 7, pp. 513–515, 532–534, 558, 563, 566; 37, pp. 22, 41–42; 38, pp. 21, 44–45; 39, pp. 19, 49–50; 40, pp. 41, 45–46; 41, pp. 30, 46]. Analytical results for samples collected by PROTECO from monitoring wells 77MWS-88 and 78MWS-88 in 1994 and analyzed for VOCs via EPA Method 624 showed the continuing presence of the same VOCs in shallow groundwater at the site; wells 77MWS-88 and 78MWS-88, screened in alluvial deposits, were the only shallow wells sampled for VOC analyses during the 1994 sampling event [Ref. 18 pp. 9–17, 22, 107, 108]. Site monitoring wells 51MWS-86, 54MWS-88, 55MWS-88, and 56MWS-88 are also screened in the upper water-bearing zone; these wells are hydraulically upgradient or side-gradient of the aforementioned monitoring wells and of site sources, and are therefore evaluated as representing background conditions [Ref. 7, pp. 504, 507, 1543; 18, pp. 9–12, 15–17]. Background and release samples were all collected according to standard procedures, sample chain of custody was maintained by field sampling and laboratory personnel, and the laboratory (Environmental Quality Laboratories, Inc. [EQL]) analyzed the samples following EPA-approved methods [Ref. 18, pp. 9–17, 22, 64, 65, 107, 108, 121; 37, pp. 1–42; 38, pp. 1–50; 39, pp. 1–50; 40, pp. 1–54; 41, pp. 1–64]. It is possible that other hazardous substances have migrated from site sources to groundwater, but there is limited analytical data.

Available information for the background and release monitoring wells screened in the upper water-bearing zone, and for the background and release samples, are shown in the tables below:

TABLE 4 – WELL SPECIFICATIONS, UPPER WATER-BEARING ZONE					
Well ID	**Ground Surface Elevation (ft ±MSL)**	**Screened Depth Interval (ft bgs)**	**Screened Elevation Interval (ft ±MSL)**	**Water-Table Elevation (ft ±MSL)**	**References**
Background Wells					
51WS-86 (a.k.a. 51MWS-86)	333.32	50.0–60.0	283.32–273.32	313.57–312.31	7, pp. 503, 504; 36, pp. 64–65
54MWS-88 (a.k.a. 54MWS-87)	345.88 *	48–58 **	295–285 **	313.55	7, p. 507; 18, pp. 15, 63
55MWS-88 (a.k.a. 55WS-88)	326.68	37–47 **	288–278 **	294.43	7, p. 507; 18, p. 15
56MWS-88	330 **	41–51 **	289–279 **	unknown	7, pp. 505, 507; 18, p. 15
Wells Showing Observed Release					
30W85	282.44	44.0–54.0	238.44–228.44	273.96–252.88	7, pp. 503, 504; 18, p. 15; 36, pp. 64–65
36WS-86	289.19	41.0–51.0	248.19–238.19	271.88–262.64	7, pp. 503, 504; 18, p. 15; 36, pp. 64–65
58MWS-88	292 **	30–40 **	262–252 **	unknown	7, pp. 505, 507; 18, p. 15
77MWS-88	292.78 *	13–23 **	277–267 **	270.59	7, p. 507; 18, pp. 15, 64
78MWS-88	290.74 *	13–23 **	275–265 **	266.84	7, p. 507; 18, pp. 15, 65

* Ground surface elevation not available; top-of-casing (TOC) elevation is used [Ref. 18, pp. 15, 63, 64, 65].
** Approximate elevations and depths interpolated from PROTECO's monitoring well specification chart dated May 1992; exact values are not listed in the available documentation [Ref. 7, pp. 502–507].

TABLE 5 – BACKGROUND LEVELS AND RELEASE CONCENTRATIONS, UPPER WATER-BEARING ZONE									
Well ID	**Sampling Date**	**1,1-DCA (µg/L)**	**1,2-DCA (µg/L)**	**1,1-DCE (µg/L)**	**Trans-1,2-DCE (µg/L)**	**PCE (µg/L)**	**1,1,1-TCA (µg/L)**	**TCE (µg/L)**	**References**
Background Levels									
51WS-86 (a.k.a. 51MWS-86)	2/26/1988	ND (5)	ND (5)	ND (5)	ND (5)	no data	ND (5)	ND (5)	7, pp. 513, 559; 37, pp. 25–26
	3/25/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 559; 38, pp. 24–25
	4/28/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 559; 39, pp. 22–23
	5/27/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 559; 40, pp. 66–67
54MWS-88 (a.k.a. 54MWS-87)	2/26/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, pp. 513, 560; 37, pp. 29–30
	3/25/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 560; 38, pp. 28–29
	4/28/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 560; 39, pp. 45–46
	5/27/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 560; 40, pp. 70–71
55MWS-88	2/26/1988	ND (5)	ND (5)	ND (5)	no data	ND (5)	ND (5)	ND (5)	7, pp. 513, 561; 37, pp. 33–34
	3/25/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 561; 38, pp. 40–41
	4/28/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 561; 39, pp. 36–37
	5/27/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 561; 40, pp. 74–75
56MWS-88	2/26/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, pp. 513, 562; 37, pp. 37–38
	3/25/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 562; 38, pp. 32–33
	4/28/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 562; 39, pp. 28–29
	5/27/1988	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	ND (5)	7, p. 562; 40, pp. 78–79
Release Concentrations									
30W85	2/25/1988	7 (5)	75 (5)	8 (5)	---	---	---	---	7, p. 558
	5/27/1988	5 (1)	---	---	11 (1)	---	18 (1)	---	7, p. 558; 40, pp. 46, 94
36WS-86	2/25/1988	---	30 (5)	---	---	---	---	---	7, p. 566
	9/15/1988	---	13 (2.1)	---	---	---	---	---	7, p. 566; 41, pp. 46-47
58MWS-88	2/26/1988	7 (5)	---	8 (5)	110 (5)	320 (5)	---	69 (5)	7, pp. 513, 563; 37, pp. 41–42
	3/25/1988	9 (5)	---	11 (5)	140 (5)	500 (5)	---	93 (5)	7, p. 563; 38, pp. 44–45
	4/28/1988	9 (5)	---	11 (5)	150 (5)	600 (5)	---	95 (5)	7, p. 563; 39, pp. 49–50
	5/27/1988	7 (5)	---	11 (5)	130 (5)	640 (5)	---	100 (5)	7, p. 563; 40, pp. 82–83
77MWS-88	2/26/1988	---	14,000	50	---	---	34	---	7, p. 514
	5/18/1994	42 (5)	23 (5)	---	---	9 (5)	---	21 (5)	18, pp. 64, 73, 107, 121
78MWS-88	2/26/1988	---	12,000	70	---	---	---	---	7, pp. 514, 522
	5/18/1994	10 (5)	11 (5)	---	---	77 (5)	---	78 (5)	18, pp. 15, 65, 73, 108, 121

ND = Not detected

--- Indicates that results did not show observed release for the substance in the listed well; these results were non-detect, below quantitation levels, or unreported in the available documentation [Ref. 7, pp. 514, 558, 566; 18, pp. 107, 108; 37, p. 41; 38, p. 44; 39, pp. 49–50; 40, pp. 82–83, 94; 41, pp. 46–47].

Note: Values in parentheses indicate the detection limits (DL), which are used in place of sample quantitation limits (SQL) because the analyses were not performed under the EPA Contract Laboratory Program and the SQLs cannot be determined from the available data [Ref. 1, Section 1.1 and Table 2-3].

Reef limestone:

Available background information for the PROTECO site indicates that there is an observed release to the reef limestone component of the aquifer being evaluated. Based on the northwesterly groundwater flow direction in the reef limestone, as discussed in **Section 3.0.1**, monitoring well 50WD-86 was located about 200 feet downgradient of Waste Unit 9, monitoring well 27WD-86 was located about 200 feet upgradient, and monitoring well 51WD-86 was located about 550 feet side-gradient [Ref. 7, pp. 503, 640, 1545]. As all three wells are screened at similar elevations within the same stratum, and with similar construction, upgradient monitoring well 27WD-86 and side-gradient monitoring well 51WD-86 represent background conditions, whereas downgradient monitoring well 50WD-86 represents release conditions [Ref. 7, pp. 503, 1545].

The available background information indicates that reef limestone monitoring wells 27WD-86 and 50WD-86 have not been viable sampling locations since at least 1994 [Ref. 7, pp. 544, 1583]. During a site-wide groundwater assessment in May 1994 by PROTECO, it was discovered that both wells were obstructed; more recently, both wells are reported as having been abandoned or destroyed [Ref. 7, pp. 1521, 1545; 18, pp. 8, 15]. PROTECO did collect a groundwater sample from monitoring well 51WD-86 during the May 1994 groundwater assessment; results confirm the background levels of VOCs in that well, showing non-detect at a DL of 5 µg/L for 1,1-DCE, 1,1-DCA, trans-1,2-DCE, TCE, and PCE [Ref. 18, pp. 61, 72–73, 106]. Prior to their destruction or abandonment, the reef limestone monitoring wells were subject to limited sampling and analytical episodes.

Monitoring wells 27WD-86, 50WD-86, and 51WD-86 were screened in the reef limestone as follows:

TABLE 6 – WELL SPECIFICATIONS, REEF LIMESTONE				
Well ID	**Ground Surface Elevation (ft ±MSL)**	**Screened Depth Interval (ft bgs)**	**Screened Elevation Interval (ft ±MSL) ***	**References**
Background Wells				
27WD-86	334.47	171.5-181.5	162.97-152.97	7, p. 503; 36, p. 364
51WD-86	332.93	202.0-212.8	130.93-120.13	7, p. 503; 36, p. 378
Well Showing Observed Release				
50WD-86	310.38	190.0-200.0	120.38-110.38	7, p. 503; 36, p. 376

* Screened elevation intervals are calculated from ground elevation and depth data.

The reef limestone monitoring wells were sampled by PROTECO in 1986 and the samples were analyzed for mercury according to EPA method 245.1 [Ref. 7, pp. 533–534, 541, 565, 567, 568; 28, p. 7, 14, 19, 24; 36, pp. 69–75]. Results for a sample collected from monitoring well 50WD-86 on October 30, 1986 showed the presence of mercury at a concentration of 1.80 µg/L; samples collected from well 27WD-86 on August 21, 1986 and from well 51WD-86 on October 30, 1986 both showed non-detect levels at the reporting limit of 0.20 µg/L [Ref. 7, pp. 565, 567, 568; 28, p. 19; 36, pp. 465, 475, 478].

Samples collected from the reef limestone monitoring wells on behalf of PROTECO on January 29, 1988 were analyzed for organic compounds; VOC analyses for the PROTECO project were performed according to EPA Methods 601/602 [Ref. 7, pp. 510, 522, 533–534, 544, 565, 567–569, 1583; 36, p. 74]. Sampling results for monitoring well 50WD-86 indicated the presence of 1,1-DCE (680 µg/L), 1,1-DCA (100 µg/L), trans-1,2-DCE (860 µg/L), TCE (270 µg/L), and PCE (2,400 µg/L) [Ref. 7, pp. 271–272, 503, 510, 516, 524, 533, 568]. Sampling results for monitoring wells 27WD-86 and 51WD-86 showed non-detect levels [Ref. 7, pp. 503, 541, 565, 567, 644].

There is considered to be an adequate degree of sample similarity among the background and release samples. The samples were collected during the same timeframe (August-October 1986), from similar relative depths within the same aquifer (i.e., the upper portion of limestone), and by PROTECO via the same sampling and analytical procedures [Ref. 36, pp. 364, 376, 378, 465, 475, 478].

The background levels and release concentrations (in µg/L) are presented in **Table 7** below.

TABLE 7 – BACKGROUND LEVELS AND RELEASE CONCENTRATIONS, REEF LIMESTONE								
Well ID	**Sampling Date**	**Mercury**	**1,1-DCA**	**1,1-DCE**	**Trans-1,2-DCE**	**PCE**	**TCE**	**References**
Background Levels								
27WD-86	8/21/1986	ND (0.20)	NA	NA	NA	NA	NA	7, p. 565; 28, p. 19; 36, p. 465
	1/29/1988	NA	ND	ND	ND	ND	ND	7, p. 565
51WD-86	10/30/1986	ND (0.20)	NA	NA	NA	NA	NA	7, p. 567; 28, p. 19; 36, p. 478
	1/29/1988	NA	ND	ND	ND	ND	ND	7, p. 567
Release Concentrations								
50WD-86	10/30/1986	1.80 (0.20)	NA	NA	NA	NA	NA	7, p. 568; 28, p. 19; 36, p. 475
	1/29/1988	NA	100	680	860	2,400	270	7, p. 568

NA – sample was not analyzed for the substance.

Attribution:

During its years of operation, the PROTECO TSDF accepted a variety of wastes, including electroplating sludge, wastewater treatment plant sludge, slurries, petroleum wastes, pesticide wastes, and pharmaceutical and manufacturing wastes, from multiple sources [Ref. 7, pp. 58, 62, 98–100]. Hazardous wastes brought to the site were deposited in one or more of 17 unlined waste units [Ref. 7, pp. 22, 23]. The TSDF accepted a variety of RCRA characteristic and listed hazardous wastes, including spent halogenated and nonhalogenated solvent wastes (RCRA Waste Codes F001, F002, F003, and F005) and wastes containing mercury (RCRA Waste Code D009) [Ref. 7, pp. 656–659; 19, p. 36]. The halogenated solvents known to be present in site sources include 1,1-DCA; 1,2-DCA; 1,1-DCE; trans-1,2-DCE; PCE; 1,1,1-TCA; and TCE [Ref. 7, pp. 320, 478, 479, 484]. Mercury is known to be present in all three site sources, as shown in **Sections 2.2**.

Drums brought to the TSDF were stored directly on the ground surface, were buried directly in the ground, or had their contents transferred to surface impoundments [Ref. 7, pp 5, 49–53]. Throughout the years, inspections of the TSDF conducted by PREQB and EPA revealed numerous violations of state and federal environmental regulations, including unpermitted waste disposal activity, inadequate groundwater monitoring, lack of runoff control, waste deposition in unlined waste units, drums leaking contents onto exposed soil, and mixing of potentially incompatible wastes [Ref. 7, pp. 47, 49–54, 60, 107, 120]. Evidence of vertical and horizontal seepage from Waste Units was observed. Soil borings advanced adjacent to Waste Unit 9 exhibited oily liquid waste as deep as 42 feet bgs; subsurface investigations performed on behalf of PROTECO revealed that Waste Unit 9 is in direct contact with alluvial deposits and possibly the principal water bearing zone between the alluvial deposits and reef limestone [Ref. 7, pp. 542, 1543; 28, pp. 3, 28; 42, pp. 8, 11, 13-14]. Liquid waste from Waste Unit 9 was observed to have also migrated horizontally as far as 360 feet to the southwest and more than 160 feet to the southeast [Ref. 7, p. 542]. Based on the northwesterly groundwater flow direction in the reef limestone, monitoring well 50WD-86 was located about 200 feet downgradient of Waste Unit 9 and downgradient of the areas where migration of liquid waste is documented [Ref. 7, pp. 503, 640, 1539, 1543, 1545]. PROTECO's September 23, 1988 Unit 9 Investigation Work Plan acknowledges that the shallow, alluvial, principal, and reef limestone water bearing zones appear to have been impacted in the vicinity of Waste Unit 9 [Ref. 42, p. 8]. As shown in **Section 2.2**, halogenated VOCs and mercury are known to be present in Source 2.

On October 15, 1998, legal counsel for PROTECO submitted information to EPA regarding requirements for post-closure groundwater monitoring at the site [Ref. 7, pp. 271–286]. The cover letter for the submittal indicated that monitoring well MW-50D, prior to being destroyed, contained elevated concentrations of VOCs, including 1,1,-DCA; 1,1-DCE; TCE; and PCE [Ref. 7, pp. 271, 272]. Sampling results for monitoring well 50WD-86, which was screened in the reef limestone at depths of 190 to 200 feet near Waste Unit 9, indicated the presence of 1,1-DCE (680 µg/L), 1,1-DCA (100 µg/L), trans-1,2-DCE (860 µg/L), TCE (270 µg/L), and PCE (2,400 µg/L) [Ref. 7, pp. 271, 272, 503, 510, 516, 533]. Although this submittal contested whether the Juana-Diaz formation constitutes an aquifer, the disclosure of contamination to EPA on behalf of PROTECO does not dispute the accuracy of the VOC data or attribution of these VOCs to the PROTECO site [Ref. 7, pp. 271–286]. As shown above and in **Section 2.2**, the VOCs listed in the submittal (i.e., halogenated solvents) are attributable to sources associated with the PROTECO site.

The calcareous silty clay is relatively thin beneath the drum burial areas (Waste Units 1, 2, and 3) [**Table 7**; Ref. 7, pp. 500, 506, 524, 573, 538, 541, 544, 549, 550; 36, p. 376]. Deep monitoring well 27WD-86 is screened in the reef limestone [Ref. 7, pp. 541, 1538]. Based on water hydraulic head elevations observed at the site, this well is hydraulically upgradient of monitoring well 50WD- 86 [Ref. 7, pp. 524, 640, 1530, 1538]. As both wells are screened in the same formation, have similar construction and water level elevations, monitoring well 27WD-86 is evaluated as representing background conditions. A review of available background information for the site does not indicate there have been detections of VOCs in 27WD-86 [Ref. 7, p. 565; 28, p. 19; 36, p. 465].

Technical reviews of previous site hydrogeologic reports performed on behalf of and by EPA conclude that there is a connection between the upper water-bearing zone and the reef limestone [Ref. 7, pp. 273–276, 633–635, 637–642]. This conclusion was based on the significant differences in hydraulic head elevations between the uppermost deposits and the reef limestone; the relative EC measurements recorded for groundwater in the surficial deposits and the underlying reef limestone; and the detection of VOC contamination in monitoring well 50WD-86 [Ref. 7, pp. 633–635, 637–642]. EPA concluded that EC data from groundwater within the uppermost deposits and the reef limestone indicates that groundwater within the upper water-bearing deposits is being flushed by low conductivity precipitation, and that recharge to the underlying reef limestone is through preferential pathways formed by fractures and the dissolution of carbonates within the calcareous silty clay [Ref. 7, pp. 634, 639, 642].

<u>Other Possible Non-Site Sources:</u>

Two separate, active RCRA Subtitle D nonhazardous industrial waste landfills border the site to the east (Ecosystems, Inc.[Ecosystems]) and west (Peñuelas Valley Landfill [PVL]) [**Figure 2**; Ref. 9, pp. 1, 2; 10, pp. 1–6; 11, pp. 6, 7, 67-69; 12, pp. 1–12; 13, pp. 11, 12]. As opposed to RCRA Subtitle C landfills which accept hazardous waste, RCRA Subtitle D landfills (e.g., PVL and Ecosystems) are authorized to accept only nonhazardous solid waste, such as municipal solid waste (i.e., household waste), organic waste, construction and demolition debris, and coal combustion residue [Ref. 9, pp. 1, 2; 10, pp. 1–5; 11, pp. 6, 7, 67-69; 13, pp. 10–16]. Ecosystems is a relatively new facility having been granted a construction permit in 2012 [Ref. 12, pp. 1–12], long after the observed release from PROTECO was documented. PVL began operations in 1999. There are no indications that the operations at the PVL facility are out of compliance with the RCRA permits issued to the facility or that PVL has received hazardous waste. Given the association of the hazardous substances in the observed release with the site sources, the high volume of hazardous wastes deposited in unlined Waste Units at PROTECO and the position of the groundwater release nearer to and downgradient of site sources, and the admission by PROTECO that the contamination is site-related, the release of hazardous substances to the aquifer being evaluated is at least partially, if not wholly, attributable to the PROTECO site. The remainder of the area within approximately 1 mile of site sources remains undeveloped; see **Figures 2 and 3**.

<u>Hazardous Substances Released:</u>

1,1-Dichloroethane (1,1-DCA)	CAS No. 75-34-3
1,2-Dichloroethane (1,2-DCA)	CAS No. 107-06-2
1,1-Dichloroethylene (1,1-DCE)	CAS No. 75-35-4
Mercury	CAS No. 7439-97-6
Tetrachloroethylene (PCE)	CAS No. 127-18-4
Trans-1,2-Dichloroethylene (trans-1,2-DCE)	CAS No. 156-60-5
1,1,1-Trichloroethane (1,1,1-TCA)	CAS No. 71-55-6
Trichloroethylene (TCE)	CAS No. 79-01-6

3.2 WASTE CHARACTERISTICS

3.2.1 Toxicity/Mobility

TABLE 8 – TOXICITY/MOBILITY

Hazardous Substance	Source Numbers/Observed Release	Toxicity Factor Value	Mobility Factor Value	Toxicity/ Mobility	Reference(s)
Acenaphthene	2	10	2.0×10^{-3}	0.02	2, p. 2
Acenaphthylene	2	1	2.0×10^{-3}	0.002	2, p. 3
Acetone	1, 2	1	1	1	2, p. 4
Anthracene	2	10	2.0×10^{-7}	2.0×10^{-6}	2, p. 5
Arsenic	1, 2, 3	10,000	1.0×10^{-2}	100	2, p. 6
Asbestos	3	10,000	---	---	2, p. 7
Barium	2, 3	1,000	1.0×10^{-2}	10	2, p. 8
Benz(a)anthracene	2	100	2.0×10^{-9}	2.0×10^{-7}	2, p. 9
Benzene	1, 2, 3	1,000	1.0×10^{-2}	10	2, p. 10
Benzidine	2	10,000	1.0×10^{-2}	100	2, p. 11
Benzo(a)pyrene	2	10,000	2.0×10^{-9}	2.0×10^{-5}	2, p. 12
Benzo(g,h,i)perylene	2	0	2.0×10^{-9}	0	2, p. 13
Benzo(b)fluoranthene	2	---	---	---	33, p. 181
Benzo(k)fluoranthene	2	10	2.0×10^{-9}	2.0×10^{-7}	2, p. 15
Bis(2-ethylhexyl)phthalate	3	100	2.0×10^{-7}	2.0×10^{-5}	2, p. 16
Bromoform	1	---	---	---	32, p. 34; 19, p. 52
Cadmium	2, 3	10,000	1.0×10^{-2}	100	2, p. 17
Carbon tetrachloride	1	1,000	1	1,000	2, p. 18
Chlorobenzene	3	100	1.0×10^{-2}	1	2, p. 19
Chloroethane (a.k.a. Ethyl chloride)	1	10	1	10	2, p. 32
Chloroform	1, 2, 3	100	1	100	2, p. 20
Chromium	2, 3	10,000	1.0×10^{-2}	100	2, p. 21
Chromium, hexavalent	2	10,000	1.0×10^{-2}	100	2, p. 22
Chrysene	2	10	2.0×10^{-9}	2.0×10^{-8}	2, p. 23
Cyanide	2	1,000	1	1,000	2, p. 24
1,2-Dichlorobenzene	2	---	---	---	33, p. 180; 19, p. 59
1,1-DCA	1, 3, OR	10	1	10	2, p. 25
1,2-DCA	1, 2, 3, OR	100	1	100	2, p. 26
1,1,-DCE	1, 3, OR	10	1	10	2, p. 27
trans-1,2-DCE	OR	100	1	100	2, p. 28
1,2-Dichloropropane	2	1,000	1	1,000	2, p. 29
trans-1,3-Dichloropropene	2	---	---	---	33, pp. 72–75, 178
2,4-Dinitrotoluene	2	---	---	---	33, p. 881; 19, p. 60
1,4-Dioxane	1	100	1	100	2, p. 31
Ethyl acetate	1, 2	---	---	---	32, p. 34; 19, p. 60
Ethyl acrylate	1	---	---	---	32, p. 34; 19, p. 60
Ethyl ether	1	---	---	---	32, p. 34; 19, p. 60
Ethylbenzene	1, 2, 3	10	1.0×10^{-2}	0.1	2, p. 33
Fluoranthene	2, 3	100	2.0×10^{-7}	2.0×10^{-5}	2, p. 14
Fluorene	2, 3	100	2.0×10^{-5}	2.0×10^{-3}	2, p. 34
Formaldehyde	1, 2	---	---	---	32, p. 34; 19, p. 60
Hexachlorocyclohexane, alpha- (a.k.a. alpha-BHC)	2	10,000	2.0×10^{-3}	20	2, p. 35
Hexachlorocyclohexane, delta- (a.k.a. delta-BHC)	2	---	---	---	33, pp. 72–75, 178

TABLE 8 – TOXICITY/MOBILITY					
Hazardous Substance	**Source Numbers/Observed Release**	**Toxicity Factor Value**	**Mobility Factor Value**	**Toxicity/ Mobility**	**Reference(s)**
Hexachlorocyclohexane, beta- (a.k.a. beta-BHC)	2	1,000	2.0×10^{-5}	0.2	2, p. 36
Hydrofluoric acid	1	---	---	---	32, p. 34; 19, p. 61
Indeno(1,2,3-cd)pyrene	2	100	2.0×10^{-9}	2.0×10^{-7}	2, p. 37
Iodomethane	2	---	---	---	32, p. 35; 19, p. 61
Isobutyl alcohol	2	---	---	---	32, p. 35; 19, p. 61
Lead	1, 2, 3	10,000	1.0×10^{-2}	100	2, p. 38
Lindane (a.k.a. gamma-Hexachlorocyclohexane or gamma-BHC)	2, 3	10,000	2.0×10^{-3}	20	2, p. 39
Mercury	1, 2, 3, OR	10,000	1	10,000	2, p. 40
Methanol	1, 2	---	---	---	32, pp. 34–35; 19, p. 61
Methyl chlorocarbonate	2	---	---	---	32, p. 35; 19, p. 61
Methyl ethyl ketone (a.k.a. 2-Butanone)	2	1	1	1	2, p. 41
Methyl isobutyl ketone (a.k.a. 4-Methyl-2-pentanone)	2	1	1	1	2, p. 41
Methyl methacrylate	1	---	---	---	32, p. 34; 19, p. 61
Methylene chloride	1, 2, 3	100	1	100	2, p. 43
Naphthalene	1, 2, 3	1,000	2.0×10^{-3}	2	2, p. 44
4-Nitrophenol	2	---	---	---	32, p. 881; 19, p. 62
Phenanthrene	2, 3	1	2.0×10^{-5}	2.0×10^{-5}	2, p. 45
Phenol	1, 2	10	1.0×10^{-2}	0.1	2, p. 46
Pyrene	2, 3	100	2.0×10^{-7}	2.0×10^{-5}	2, p. 47
Resorcinol	2	---	---	---	32, p. 35; 19, p. 62
Selenium	2	100	1	100	2, p. 48
Silver	1, 2, 3	100	1	100	2, p. 49
Styrene	2	10	1.0×10^{-2}	0.1	2, p. 50
PCE	1, 2, 3, OR	100	1	100	2, p. 51
Toluene	1, 2, 3	10	1.0×10^{-2}	0.1	2, p. 52
1,1,1-TCA	1, 2, 3, OR	1	1	1	2, p. 53
1,1,2-TCA	1	1,000	1	1,000	2, p. 54
TCE	1, 2, 3, OR	1,000	1	1,000	2, p. 55
Xylene	2	100	1.0×10^{-2}	1	2, p. 56

OR = Observed release
--- indicates factor values are not currently listed in Superfund Chemical Data Matrix (SCDM)
* Mobility factor values are conservatively based on non-liquid, non-karst

3.2.2 Hazardous Waste Quantity

TABLE 9 – HAZARDOUS WASTE QUANTITY, GROUND WATER PATHWAY		
Source Number	**Source Hazardous Waste Quantity (HWQ) Value (Section 2.4.2.1.5)**	**Is source hazardous constituent quantity data complete? (yes/no)**
1	944.2	No
2	21,920.4	No
3	128.1	No
Sum of Values:	22,993 (rounded to nearest integer as specified in HRS Section 2.4.2.2)	

The sum corresponds to a hazardous waste quantity factor value of 10,000 in Table 2-6 of the HRS [Ref. 1, Section 2.4.2.2]. Therefore, a hazardous waste quantity factor value of 10,000 is assigned for the ground water pathway [Ref. 1, Section 2.4.2.2].

Hazardous Waste Quantity Factor Value: 10,000

3.2.3 Waste Characteristics Factor Category Value

Mercury corresponds to the toxicity/mobility factor value of 10,000, as shown previously (see **Section 3.2.1**).

Toxicity/Mobility Factor Value (10,000) x Hazardous Waste Quantity Factor Value (10,000): 1×10^8

The product (1×10^8) corresponds to a Waste Characteristics Factor Category Value of 100 in Table 2-7 of the HRS [Ref. 1, Section 2.4.3.1; 1a, Section 2.4.3].

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Waste Characteristics Factor Category Value: 100

3.3 TARGETS

There are private and public water supply wells located between 1 and 2 miles of Sources 1 and 2 that withdraw water from the Tallaboa river valley alluvial aquifer and the underlying Juana Díaz formation [see **Sections 3.0 and 3.1 of the HRS documentation record; Figure 3**]. As detailed below, PRASA, PREPA, as well as three private residences operate wells utilized for drinking water within the Tallaboa river valley west of the site. No Level I or Level II concentrations attributable to the site have been documented at this time; therefore, the target wells are evaluated as being subject to potential contamination.

PRASA

The PRASA-operated Peñuelas Urbano water system consists of two surface water sources and the active Carlos Andinos well, which is screened at depths of 50 to 110 feet bgs across the contact between the Tallaboa valley alluvium and decomposed limestone of the Juana Díaz formation [**Figure 3;** Ref. 17, pp. 2, 10, 14, 15; 27, p. 5]. According to PRASA, the surface water components of the Peñuelas Urbano system consist of water from Río Peñuelas via the Peñuelas Filtration Plant (PFP) and the Garzas Reservoir via Guayanes Filtration Plant (GFP) [Ref. 17, pp. 2, 10, 14, 15]. The maximum production values (i.e., the capacity) of these two inputs is 1.2 million gallons per day (MGD) and 0.8 MGD, respectively [Ref. 17, pp. 14, 15]. The maximum production value for Carlos Andinos is 0.38 MGD [Ref. 17, pp. 14, 15, 19]. As the PFP contributes greater than 40 percent (%) of total system production, the population for each input is apportioned based on each input's relative contribution, as follows: PFP: 50.4%; GFP: 33.6%; and Carlos Andinos: 16% [Ref. 17, pp. 2, 23]. According to PRASA, a population of approximately 17,039 people are served by the Peñuelas Urbano system [Ref. 17, pp. 14, 15]. In addition to the general population, EPA has identified a worker and student population of 1,036 people that are known to be served by the Peñuelas Urbano system [Ref. 17, pp. 2, 25, 26, 29, 30, 32, 37, 84, 87, 118, 119, 121, 122]. According to the HRS, workers and students may be counted in addition to residents in evaluating the population factor [Ref. 1, Section 3.3.2; 17, p. 23]. Therefore, a known total population of 18,075 people is established for the Peñuelas Urbano system [Ref. 17, p. 2]. Based on the 16% relative contribution of Carlos Andinos, a population of 2,892 is apportioned to this well [Ref. 17, p. 2].

PREPA

PREPA operates four wells (Well Nos. 8, 9, 10, and 13) that provide industrial process and drinking water to 207 employees on a rotating basis [**Figure 3**; Ref. 17, pp. 3, 55, 59–61, 82, 98]. All four wells are in close proximity to each other within 1 to 2 miles west of Sources 1 and 2 and within the Tallaboa river valley; the wells are completed at similar depths [**Figure 3**; Ref. 17, pp. 101, 102]. As the wells are operated on a rotating basis and are located within the same target distance category, the population count of 207 is apportioned for the entire system.

Domestic Wells

During the June 2017 reconnaissance, EPA identified three active domestic drinking water wells within 1 to 2 miles west of Sources 1 and 2 [**Figure 3**; Ref. 17, pp. 3, 52, 58, 59, 79, 89–97]. Two of the domestic wells (households identified as Tallaboa Saliente #8 [depth: 200 feet] and Tallaboa Saliente #9 [depth: 85 feet]) were identified in the Seboruco community and one domestic well (church identified as Cuebas #1 [depth: 100 feet]) was identified on the Cuebas community [**Figure 3**; Ref. 17, pp. 3, 52, 58, 59, 79, 89, 90, 92, 93, 96]. All three wells are located along the eastern edge of the Tallaboa river valley and serve populations of three, six, and one person(s), respectively [**Figure 3**; 24, p. 1; 17, pp. 89-96].

TABLE 10 – TARGETS, GROUND WATER PATHWAY						
Well	**Distance from Sources (mi.)***	**Population**	**Level I Conc. (Y/N)****	**Level II Conc. (Y/N)****	**Potential Contam. (Y/N)**	**Reference(s)**
Carlos Andinos	1.7	2,892	N	N	Y	**Figure 3**; Ref. 17, pp. 2, 6, 14, 15, 19, 23, 25, 26, 30, 32, 37, 121, 122.
PREPA Well 8	1.9	207	N	N	Y	**Figure 3**; Ref. 8, p. 2; 17, pp. 3, 55, 59–61, 82, 98, 101.
PREPA Well 9	1.8		N	N	Y	
PREPA Well 10	1.7		N	N	Y	
PREPA Well 13	1.8		N	N	Y	
Tallaboa Saliente #8	1.4	3	N	N	Y	**Figure 3**; Ref. 8, p. 2; 17, pp. 3, 58, 79, 92, 93.
Tallaboa Saliente #9	1.5	6	N	N	Y	**Figure 3**; Ref. 8, p. 2; 17, pp. 3, 58, 89, 90.
Cuebas #1	1.9	1	N	N	Y	**Figure 3**; Ref. 8, p. 2; 17, pp. 52, 59, 95, 96.
Total		3,109				

* Distance is measured from drum burial area access gate [**Figure 3**; Ref. 8, p. 2; 17, p. 6].

An additional possible target well not evaluated as part of this HRS documentation record is the PRASA-operated Blasini well, which is a standby well for a residential complex within the Ponce Urbano system [Ref. 17, pp. 2, 42, 53]. As Blasini is located between 3 and 4 miles east of the site, it could be considered subject to potential contamination; however, it is unknown if the well is screened in the aquifer being evaluated, and the apportioned population (538) would not make a significant contribution to the ground water migration pathway score [Ref. 1, Table 3-12; 17, pp. 3, 53, 71].

3.3.1 <u>Nearest Well</u>

As identified in **Section 3.3**, the active drinking water supply wells operated by PRASA and PREPA, as well as the three domestic wells, are subject to potential contamination. The nearest known drinking water well (i.e., Tallaboa Saliente #8) is located between 1 and 2 miles from site sources; therefore, a nearest well factor value of 5 is assigned [**Figure 3**; Ref. 1, Section 3.3.1, Table 3-11].

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Nearest Well Factor Value: 5

3.3.2 <u>Population</u>

3.3.2.2 Level I Concentrations

Level I concentrations attributable to the site are not documented at this time; therefore, a Level I Concentrations factor value of 0 is assigned.

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Level I Concentrations Factor Value: 0

3.3.2.3 Level II Concentrations

Level II concentrations attributable to the site are not documented at this time; therefore, a Level II Concentrations factor value of 0 is assigned.

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Level II Concentrations Factor Value: 0

3.3.2.4 Potential Contamination

As identified in **Section 3.3**, the active drinking water supply wells operated by PRASA and PREPA, as well as the three domestic wells are subject to potential contamination. All target wells are located within the 1–2 mile distance category. The populations assigned to these wells are presented in **Section 3.3**.

TABLE 11 – POTENTIAL CONTAMINATION DISTANCE-WEIGHTED POPULATION (OTHER THAN KARST)				
Distance Category	**Population**	**Population Range**	**Distance-Weighted Population Value**	**References**
1 – 2 mile	3,109	3,001 to 10,000	939	**Figure 3**; Ref. 1, Section 3.3.2.4; 17, p. 3.

Therefore, the distance-weighted population value (W_i) is 939 [Ref. 1, Section 3.3.2.4, Table 3-12].

Potential Contamination Factor (PC) = $(W_i + K_i)/10$ = (939+0)/10 = 93.9 (round to the nearest integer) = 94

Potential Contamination Factor Value: 94

3.3.3 Resources

Available background information indicates that groundwater use for agriculture, including irrigation of crops and watering of livestock, is significant in the Peñuelas area [Ref. 7, pp. 3, 36, 45, 300; 22, pp. 14, 17; 25, pp. 46–47; 26, p. 22]. Information provided to PREQB and to EPA by well owners confirm that wells within 4 miles of the PROTECO site are utilized for irrigation of commercial crops and for livestock watering [Ref. 6, pp. 8, 33–34; 7, pp. 3, 45]. Based on the use of groundwater drawn from target wells for irrigation of commercial crops and for watering of commercial livestock, a resources factor value of 5 is assigned [Ref. 1, Section 3.3.3].

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Resources Factor Value: 5

3.3.4 Wellhead Protection Area

Puerto Rico's Wellhead Protection Program, approved by EPA in 1991, grouped Puerto Rico's aquifers into seven groundwater provinces; the aquifer being evaluated is within the South Coast Province [Ref. 20, pp. 1, 7, 8; 21, p. 1; 23, pp. 28–30]. Wellhead protection areas (WHPA) within the South Coast Province are defined by a fixed radius of 1,500 feet around each potable supply well [Ref. 20, pp. 7, 8, 10, 12]. There are two PRASA-operated wells within 4 miles of the site and within the South Coast Province; therefore, there are designated WHPAs within 4 miles of the site and a WHPA factor value of 5 is assigned [**Figure 3**; Ref. 1, Section 3.3.4].

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Wellhead Protection Area Factor Value: 5