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Investigation of Potential Polychlorinated Biphenyl (PCB) Contamination on Hanford Site Arc-Loop Roads

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A. T. Cooper
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September 1997

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

Two roads on the Hanford Site, which had been treated during past Site operations with oil for dust suppression, were analyzed for potential polychlorinated biphenyl (PCB) contamination. The general locations of these roads are 1) off Washington State Route 240, north of Horn Rapids Dam, and 2) between the 200 East and 200 West areas, south of the 200 Area fire station. Each road had an intact crust of oil/tar on top of the underlying soil surface. A set of control samples were collected at an untreated soil site near the Prosser Barricade air sampling station.

Samples were collected of the oil/tar surface crust, the soil immediately beneath the surface crust (0 - 3 cm below the crust), and a deeper soil sample (13 - 23 cm below the surface crust). Samples were collected at two locations on each road. The PCBs were extracted from the samples using a roller technique with methylene chloride, cleaned using column chromatography and high-pressure liquid chromatography, and analyzed by capillary gas chromatography using electron capture detection. The samples were analyzed for PCBs as the following technical mixtures: Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260.

All samples at all locations were less than the following detection limits: surface crust (41 ug/kg dry weight) and soil (2.1 ug/kg dry weight). These concentrations are below the U.S. Environmental Protection Agency (EPA) Region IX preliminary remediation goals for PCBs in residential soil (66 ug/kg) and well below the preliminary remediation goal for PCBs in industrial soil (340 ug/kg).[a]

(a) S. J. Smucker U.S. EPA Region IX, Region IX Preliminary Remediation Goals (PRGs) First Half 1995, February 1, 1995.

Acknowledgments

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Contents

Figure

Tables

1.0 Introduction

The U.S. Department of Energy's (DOE) Hanford Site is located in southeastern Washington. The Site was established in 1943 by the Manhattan Project to produce plutonium for nuclear weapons (Gosling 1994). The Site's mission diversified to include scientific research, waste management, and environmental restoration. Environmental surveillance for radionuclides and chemical contaminants in air, surface water, vegetation, soil, wildlife, and external radiological dose at Hanford is conducted by the Surface Environmental Surveillance Project (SESP) for estimating potential offsite impacts of Hanford operations.

In August 1996, the SESP conducted an investigative sampling for potential polychlorinated biphenyl (PCB) contamination of soil and road surface from two arc-loop roads on the Hanford Site. The arc-loop roads were constructed to access sampling locations on a large-scale atmospheric diffusion study area centered between the 200-East and 200-West areas (Ramsdell et al. 1985). These roads had been treated with oil for dust suppression during past operations. Based on past practice knowledge (R. G. Riley, personal communication) there was reason to suspect that PCBs may have been present in the dust suppression oil. Soil and road surface material were collected from duplicate locations on two arc-loop roads, where visual evidence of road-oiling still existed. Soil samples also were collected at a background location near the Prosser Barricade.

2.0 Background Information

Polychlorinated biphenyls (PCBs) are a group of 209 compounds with 1 to 10 chlorine atoms attached to biphenyl. The PCBs have tremendous commercial use and were widely used as dielectric fluids for capacitors and coolants for transformers, with other uses as plasticizers, hydraulic and heat transfer fluids, inks, paints, and adhesives (Erickson 1992). The PCBs were not produced as discrete compounds (referred to as congeners) but as technical mixtures of PCB congeners in varying proportions.

The production of PCBs in the United States from 1930 to 1974 is estimated at 590,000,000 kg, with most of the material marketed by Monsanto under the tradename Aroclor (National Research Council 1979). The U.S. production of PCBs peaked in 1970 (38,000,000 kg/yr), and production had essentially stopped by the late 1970s (Bidleman et al. 1990). World production of PCBs is estimated at 1,200,000,000 kg, with approximately 65% still in use or in landfills, 4% degraded or incinerated, and 31% released and cycling in the global environment (Bidleman et al. 1990).

Once released into the environment, the lipophilic PCBs are persistent, toxic at high doses, and possible human carcinogens. The environmental toxicology is complicated by the large number of congeners in the technical mixtures and the potential presence of other toxic compounds. One route of PCB exposure to the public is that waste transformer fluids containing PCBs were sometimes mixed with oil and applied to unimproved road surfaces for dust suppression.

Only limited data exist on the concentrations of PCBs in surface environmental media at the Hanford Site (Riley et al. 1986, Glantz and Laws 1990, Patton et al. 1994, Patton et al. 1997). In 1983, soil samples from some oil-treated roads on the Hanford site were collected by SESP personnel and analyzed by the Hanford Environmental Health Foundation (HEHF) for PCBs. Results from these samples were reported to PNNL in a letter (R. Scuderi, HEHF, February 7, 1984), with no individual Aroclor type materials identified. However, the letter stated that there were peaks in the chromatograms that appeared to be a mix of PCB-like material. The SESP considered these results to be only semi-qualitative and semi-quantitative and no additional samples were taken at that time (K. R. Price, personal communication). A review of chemicals of concern for environmental surveillance at the Hanford Site identified Aroclor 1254 as a possible candidate for additional monitoring (Blanton et al. 1995).

3.0 Sampling and Analytical Procedures

3.1 Sampling Techniques

The following subsections describe sampling locations and collection techniques for the investigation.

3.1.1 Sampling Locations

Road surface and soil samples were collected at two locations on the Horn Rapids arc-loop road and the 200-Areas arc-loop road. In addition, background soil samples were collected at the Prosser Barricade (Figure 3.1). Geographic positioning system (GPS) coordinates for the sample locations are given in Table 3.1.

The arc-loop road near the Horn Rapid Dam area was sampled on August 19, 1996. This road is located in an area of sandy soil. The road was primarily two sandy wheel tracks with patches of intact oil/sand crust on the road surface. Samples were collected in two areas of intact surface crust located in the middle of the road (i.e., between the wheel tracks).

The arc-loop road between the 200-Areas was sampled on August 21, 1996. This road had a heavy coat of oil/tar, and most of the road surface was intact. Samples were collected in two areas of intact surface crust located in the middle of the road.

The Prosser Barricade background soil sample was collected on August 19, 1996, in an area of undisturbed soil near the SESP Prosser Barricade air sampler.

3.1.2 Sample Collection

Three samples were collected at each arc-loop road location: road surface crust, soil directly below the road crust, and a deep soil composite sample. Surface soil and a deep soil composite were collected at the background location.

Samples of road surface crust (oil/tar/sand mixture) were collected using a trowel to lift the crust into a glass jar with a Teflon-lined screw cap lid. After removing the road surface crust, a sample of soil just below the road surface crust was collected by pressing a large metal cookie cutter into the soil to a depth of approximately 3 cm. The trowel was slid under the cookie cutter, and the soil sample was removed by lifting both the trowel and the cookie cutter. The soil sample was placed into a glass jar with a Teflon-lined screw cap lid.

After collecting the soil just below the road surface crust, a composite sample was collected of the deeper soil. A trowel was used to remove the soil to a depth of approximately 2-3 cm. Using a metal

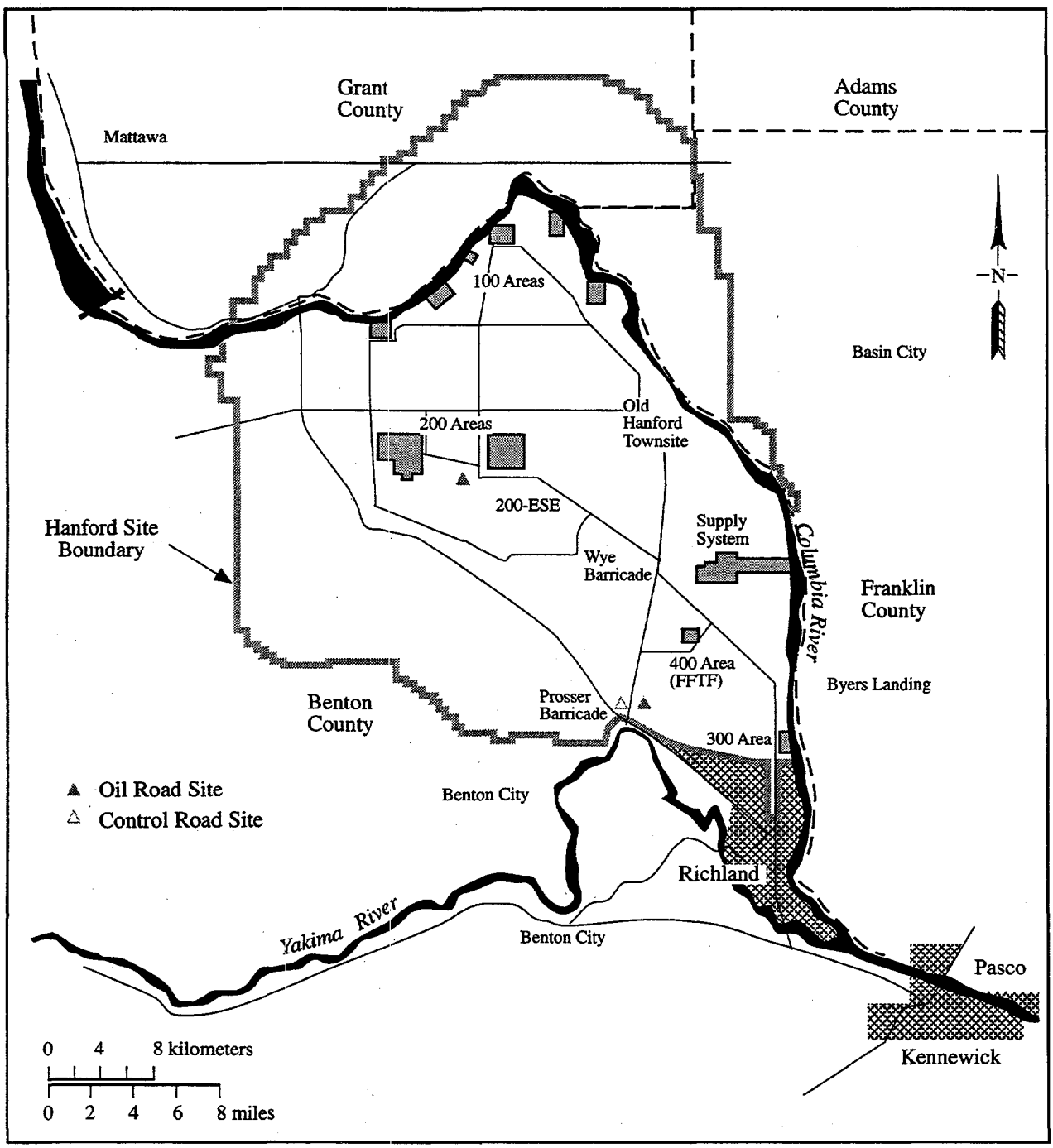

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Figure 3.1. Arc-Loop Road Sampling Locations

Table 3.1. Geographic Positioning System Coordinates for Sample Location

Location Name	Easting (X Position)	Northing (Y Position)	Altitude	Collection Time
200 Areas Arc Road Site#1	571035	134450	230	08/21/96 10:07:30am
200 Areas Arc Road Site#2	571767	135272	233	08/21/96 10:35:37am
Horn Rapids Arc-Road Site#1	585118	117029	148	08/19/96 02:22:56pm
Horn Rapids Arc-Road Site#2	584715	116709	134	08/19/96 02:42:09pm
Prosser Barricade (Background)	583669	118281	151	08/19/96 03:02:09pm
	Coordinate System	United States State Plane 1983		
	Coordinate Zone	Washington South 4602		
	Datum	NAD83 (Conus)		
	Coordinate Units	Meters		
	Altitude Units	Meters		
	Altitude Reference	HAE		

spoon, a soil sub-sample was placed into a glass jar with a Teflon-lined screw cap lid. Another 2-3 cm depth of soil was removed with the trowel, and a soil sub-sample was taken. These steps were repeated until a depth of approximately 20 - 23 cm had been sampled. The composite soil sample for 200 Area Arc Road Site #2 was only collected to a depth of approximately 13 cm because of difficulty in preventing the oiled surface crust from mixing with the rocky subsurface soil.

Samples were shipped to the Battelle Marine Sciences Laboratory, Sequim, Washington. The samples were stored frozen (-20°C) until sample extraction.

3.2 Analytical Techniques

Sample extraction and gas chromatography techniques are described in the following subsections. Quality Assurance/Quality Control methods also are described.

3.2.1 Sample Extraction

An aliquot of each soil sample (15.0 - 21.1 g) or oil/tar road surface sample (0.77 - 1.07 g) was spiked with two surrogate internal standards (PCB congeners 103 and 198). The samples were extracted with

methylene chloride using a roller technique based on the National Oceanic and Atmospheric Administration Status and Trends Program (Krahn et al. 1988). Sample extracts were cleaned using column chromatography with a mixed bed of acidified silica, non-acidified silica, and alumina, followed by a high-pressure liquid chromatography (HPLC) cleanup (Krahn et al. 1988). A portion of each sample was analyzed for water content by freeze drying a known weight of the solid and measuring the weight difference.

3.2.2 Gas Chromatography-Electron Capture Detection

Cleaned extracts were analyzed for Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260 using a capillary gas chromatography with electron capture detection method based on U.S. EPA Method 8080 (EPA 1986). All Aroclor mixtures were confirmed using a second analytical column with a different stationary phase. The compounds initially were separated on a DB-1701 capillary column, with a confirmational analysis using a DB-17 capillary column (both columns were 60-m x 0.25 mm I.D.). Results for each column must be within a factor of 2 to be considered a confirmed value.

3.2.3 Quality Assurance/Quality Control Samples

One method blank was extracted with each sample batch. One matrix spike sample was prepared by spiking a known amount of Aroclor 1254 onto a soil sample.

4.0 Results and Discussion

4.1 Quality Control Samples

No PCBs were detected above the method detection limit for the method blank sample. The matrix spike soil sample had 109% recovery for Aroclor 1254. Surrogate recoveries for road surface and soil samples ranged from 59% - 94% for PCB-103 and 16% - 98% for PCB-198. Average surrogate recoveries were 77% for PCB 103 and 71% for PCB 198.

4.2 Oiled Road Sample Results

Results for PCB and percent moisture analysis are given in Table 4.1. All samples at all locations were less than the following detection limits: surface crust (41 ug/kg dry weight) and soil 2.1 ug/kg dry weight). Percent moisture values were 0% for road surface crust samples and 1% to 2% for soil samples. These PCB concentrations are below the U.S. EPA Region IX preliminary remediation goals for PCBs in residential soil (66 ug/kg) and well below the preliminary remediation goal for PCBs in industrial soil (340 ug/kg).[a]

The preliminary remediation goals combine U.S. EPA toxicity values with maximum exposure factors to estimate the concentration in soil that is protective to humans, including sensitive individuals, over a lifetime of exposure. Soil concentrations below the preliminary remediation goals have associated risks that are less than 1×10^{-6} for carcinogenic risk and less than a hazard quotient of 1.0 for non-carcinogenic risk. The preliminary remediation goals are used as a screening tool to evaluate if additional monitoring or more detailed risk estimates should be undertaken.

(a) S. J. Smucker U.S. EPA Region IX, Region IX Preliminary Remediation Goals (PRGs) First Half 1995, February 1, 1995.

Table 4.1. Concentrations of PCBs and Moisture Percent in Arc-Loop Road Samples

Location	Sample Type	Moisture	PCB Concentration (ug/kg dry weight; as Aroclor Mixtures)			
			Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
Horn Rapids Arc-Road	Road Surface	0%	<31.3	<31.3	<31.3	<31.3
Location #1	Surface Soil	1%	<1.7	<1.7	<1.7	<1.7
	Deep Soil	1%	<1.6	<1.6	<1.6	<1.6
Horn Rapids Arc-Road	Road Surface	0%	<29.6	<29.6	<29.6	<29.6
Location #2	Surface Soil	1%	<2.1	<2.1	<2.1	<2.1
	Deep Soil	2%	<1.7	<1.7	<1.7	<1.7
200 Areas Arc-Road	Road Surface	0%	<41.1	<41.1	<41.1	<41.1
Location #1	Surface Soil	1%	<1.6	<1.6	<1.6	<1.6
	Deep Soil	2%	<1.5	<1.5	<1.5	<1.5
200 Areas Arc-Road	Road Surface	0%	<31.0	<31.0	<31.0	<31.0
Location #2	Surface Soil	1%	<1.6	<1.6	<1.6	<1.6
	Deep Soil	2%	<1.6	<1.6	<1.6	<1.6
Prosser Barricade	Road Surface	No Sample				
(Background)	Surface Soil	1%	<1.6	<1.6	<1.6	<1.6
	Deep Soil	1%	<1.6	<1.6	<1.6	<1.6

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Appendix A

Analytical Results

BATTELLE MARINE SCIENCES LABORATORY																					
1529 W. Sequim Bay Road																					
Sequim, WA 98382																					
(360) 683-4151		HANFORD ROAD SOILS STUDY																			
MSL Code		1003PCB *1		1003PCB *2		1003PCB *3		1003PCB *4		1003PCB *5		1003PCB *6		1003PCB *7		1003PCB *8		1003PCB *9			
Sponsor ID		53453-A1		53453-A2		53453-A3		53453-A4		53453-A5		53453-A6		53453-A7		53453-A8		53453-B1			
Location		HornRapids#1		HornRapids#1		HornRapids#1		HornRapids#2		HornRapids#2		HornRapids#2		P.Barricade		P.Barricade		200 Area #1			
Sample Amt. (g) wet wt.		1.01		19.1		19.7		15		1.07		19		20.2		19.3		0.77			
% Moisture		0%		1%		1%		1%		0%		2%		1%		1%		0%			
Matrix		ASPHALT		SOIL		SOIL		SOIL		ASPHALT		SOIL		SOIL		SOIL		ASPHALT			
Extraction Batch		1		1		1		1		1		1		2		1		1			
Units (wet wt)		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.			
AROCLORS																					
1242		31.3	U	1.7	U	1.6	U	2.1	U	29.6	U	1.7	U	1.6	U	1.6	U	41.1	U		
1248		31.3	U	1.7	U	1.6	U	2.1	U	29.6	U	1.7	U	1.6	U	1.6	U	41.1	U		
1254		31.3	U	1.7	U	1.6	U	2.1	U	29.6	U	1.7	U	1.6	U	1.6	U	41.1	U		
1260		31.3	U	1.7	U	1.6	U	2.1	U	29.6	U	1.7	U	1.6	U	1.6	U	41.1	U		
SURROGATE RECOVERIES																					
PCB 103		59.3		59.5		69.8		68.0		74.8		83.5		94.5		89.9		77.1			
PCB 198		58.2		64.0		70.0		75.7		44.7		84.0		98.0		91.2		15.9			
U Not detected at or above DL shown																					

BATTELLE MARINE SCIENCES LABORATORY													
1529 W. Sequim Bay Road													
Sequim, WA 98382		HANFORD ROAD SOILS STUDY											
(360) 683-4151													
MSL Code		1003PCB *10		1003PCB *11		1003PCB *12		1003PCB *13		1003PCB *14			
Sponsor ID		53453-B2		53453-B3		53453-B4		53453-B5		53453-B6			
Location		200 Area #1		200 Area #1		200 Area #2		200 Area #2		200 Area #2			
Sample Amt. (g) wet wt.		20.1		21.07		1.02		20.2		20.6			
% Moisture		1%		2%		0%		1%		2%			
Matrix		SOIL		SOIL		ASPHALT		SOIL		SOIL			
Extraction Batch		1		1		1		1		1			
Units (wet wt)		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.		ug/kg dry wt.			
AROCLORS													
1242		1.6	U	1.5	U	31.0	U	1.6	U	1.6	U		
1248		1.6	U	1.5	U	31.0	U	1.6	U	1.6	U		
1254		1.6	U	1.5	U	31.0	U	1.6	U	1.6	U		
1260		1.6	U	1.5	U	31.0	U	1.6	U	1.6	U		
SURROGATE RECOVERIES													
PCB 103		80.1		88.1		74.6		80.1		81.0			
PCB 198		63.9		95.5		71.5		75.6		84.6			
U Not detected at or above DL shown													

BATTELLE MARINE SCIENCES LABORATORY																		
1529 W. Sequim Bay Road																		
Sequim, WA 98382																		
(360) 683-4151		HANFORD ROAD STUDY										HANFORD ROAD STUDY						
						BS				MATRIX SPIKE BLANK		MATRIX SPIKE						
MSL Code		Blank1		Blank2		Blank1 Spk A		Spike	Percent	1003PCB *2		1003PCB *2			Spike	Percent		
Sponsor ID								Amount	Recovery	53453-A2		53453-A2			Amount	Recovery		
Location										Horn Rapids #1		Horn Rapids #1						
Sample Amt. (g) wet wt.		NA		NA		NA				19.1		19.1						
% Moisture		NA		NA		NA				1%		1%						
Matrix		SOIL		SOIL		SOIL				SOIL		SOIL						
Analytical Rep		1		2		1				1		1						
Units		ug/kg dry wt		ng/g		ug/kg dry wt		ug/kg dry wt	%	ug/kg dry wt.		ug/kg dry wt.			ng/g	%		
AROCLORS																		
1242		1.58	U	1.58	U	NA		NA	NA	1.7	U	1.68	U		NA	NA		
1248		1.58	U	10.9	U	NA		NA	NA	1.7	U	1.68	U		NA	NA		
1254		1.58	U	10.9	U	28.1		25	112%	1.7	U	28.90			26.5	109%		
1260		1.58	U	10.9	U	NA		NA	NA	1.7	U	1.68	U		NA	NA		
SURROGATE RECOVERIES																		
PCB 103		73.05		96.91		73.18		NA	NA	59.5		63.1			NA	NA		
PCB 198		75.1		99.18		71.9				64		66.6						
# Outside recovery limits of ±30																		
U Not detected at or above DL shown																		

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