Letter Health Consultation

PRECISION NATIONAL PLATING SITE
CLARKS SUMMIT, LACKAWANNA COUNTY, PENNSYVANIA

Public Health Evaluation of
Surface Water and Sediment Data
at the Glenburn Pond Site

October 2019

Bureau of Epidemiology, Division of Environmental Health Epidemiology
625 Forster Street | Room 933 | Health and Welfare Building
Harrisburg, PA 17120-0701

A Disclaimer

This report was supported in part by funds provided through a cooperative agreement with ATSDR. The findings and conclusions in this report are those of the authors and do not necessarily represent the official views of ATSDR or the U.S. Department of Health and Human Services. This document has not been revised or edited to conform to ATSDR standards.

Contact Information

You may contact PADOH by phone at 717-787-3350 or by email at Env.health.concern@pa.gov, or visit our website at https://www.health.pa.gov/topics/envirohealth/Pages/Assessment.aspx

Pennsylvania Department of Health
Division of Environmental Health Epidemiology
Harrisburg, PA
717-787-3500

10/21/2019

Robert Lewis
Environmental Group Manager
Pennsylvania Department of Environmental Protection
Wilkes-Barre, PA

Re: Review of DEP 2010 surface water and sediment data at the Precision National Plating Site, Glenburn Pond Site

Dear Mr. Lewis,

Per your request in April 2019, the Pennsylvania Department of Health (DOH) prepared this letter health consultation to evaluate historical surface water and sediment sampling information to help address ongoing community concerns. The surface water and sediment data available for review were collected by the Pennsylvania Department of Environmental Protection (DEP) on August 24, 2010. DOH worked on this evaluation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

In the absence of more recent sampling information, for the purposes of this public health review DOH assumed the concentrations detected in 2010 are representative of current exposures. However, this is a conservative assumption and it is more likely that environmental concentrations of chromium from the site are lower now. Due to ongoing cleanup activities at this site, conditions in the site area have continued to improve. There has been no additional contamination from the source of concern since the data were collected.

BACKGROUND

The Precision National Plating Site is a former chromium electroplating facility that closed in 1999. Under an April 1998 U.S. Environmental Protection Agency (EPA) Administrative Order, Precision 1) performed an investigation of groundwater impacts due to hexavalent chromium contamination 2) conducted an ecological risk assessment and 3) installed collection and treatment systems at all chromium impacted seeps at the site. With oversight by DEP and EPA, the former plating building was demolished in the fall of 2000.

In August 2002, EPA issued a notice to Precision requiring additional mitigation on-site. In February 2003, EPA required Precision to respond to a release of chromium-contaminated water. The release demonstrated that sources of chromium were still present on the site property. In

August 2004 Precision submitted a report to EPA defining the horizontal and vertical extent of hexavalent chromium source areas. In July 2006, Precision began injecting calcium polysulfide (CaSx) into source areas to reduce hexavalent chromium to a relatively non-toxic form that will remain in the soil matrix. In March 2007, Precision began excavation of the basement of the former chromium electroplating facility.

In the fall of 2007 and February–March 2008, further on-site sampling confirmed residual contamination sources. From August 2008 to January 2009, Precision conducted additional in-situ chemical injections using CaSx to treat these residual areas of contamination in the shallow bedrock. Perimeter air sampling during the injections monitored hydrogen sulfide levels. Since January 2009, Precision has conducted quarterly sampling on the site with the goals of determining the effectiveness of the injections and whether additional remediation work is needed. In October 2010, a third round of CaSx injections into groundwater sources was initiated with a fourth round conducted in October 2011.

Hexavalent chromium from Precision was found to impact surface water and sediment near the site. In 2007, DEP Division of Dam Safety determined that the nearby Glenburn Pond dam was a high hazard dam and Natural Land Trust completed a controlled partial breach of the dam. In August 2010, DEP collected samples at the Glenburn Pond site to evaluate the levels of hexavalent chromium and total chromium in surface water and sediments of Glenburn Pond and nearby sections of Ackerly Creek located along Route 6 (see Figure 1). These samples were collected to evaluate any possible threats associated with a final breach of the dam.

As of EPA's June 2018 progress report, EPA contractors are continuing the operation of on-site treatment systems, conducting in situ chemical reduction injections, monitoring the site and performing general site maintenance activities.

Appendix A presents a two-page handout summarizing the timeline of health agency activities at Precision National Plating Site.

CHROMIUM

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. Chromium occurs in the environment predominantly in one of two valence states: trivalent chromium [Cr(III)], which occurs naturally and is an essential nutrient, and hexavalent chromium [Cr(VI)], which, along with the less common metallic chromium [Cr(0)], is most commonly produced by industrial processes. Exposure may occur from natural or industrial sources of chromium. Trivalent chromium is much less toxic than hexavalent chromium. The International Agency for Research on Cancer (IARC) classified hexavalent chromium as *carcinogenic to humans* and trivalent chromium as *not classifiable as to their carcinogenicity to humans* (ATSDR, 2012). The body can detoxify some amount of hexavalent chromium to trivalent chromium (EPA, 2000).

In U.S. fresh waters, chromium concentrations typically range from <1 to 30 parts per billion (ppb), with a median value of 10 ppb. U.S. soil levels of chromium range from 1 to 2,000 parts per million (ppm), with a mean level of 37 ppm (ATSDR, 2012). EPA's regional screening level for chromium assumes that the trivalent to hexavalent chromium ratio is 1:6 (EPA, 2019). EPA has a drinking water standard of 100 ppb for total chromium, which includes all forms of chromium, including hexavalent chromium (EPA, 2017).

Health effects of chromium compounds can vary with route of exposure, with certain effects specific to how they enter the body. For example, respiratory effects are associated with inhalation of chromium compounds, but not with oral and dermal (i.e. skin) exposures, and gastrointestinal effects are primarily associated with oral exposure (ATSDR, 2012). ATSDR expects that health effects due to dermal exposure via bathing or wading with hexavalent chromium-contaminated water to be minimal. Low dermal absorption and the reductive capacity of the skin result in insignificant exposure from skin contact relative to other exposure routes (ATSDR, 2012).

SURFACE WATER AND SEDIMENT SAMPLING

On August 24, 2010, surface water and sediment samples were collected at 12 different locations along Ackerly Creek, including locations upstream of the pond (east of Route 6), within the former pond area, and immediately downstream of the dam (Figure 1). One additional surface water sample was also collected immediately upstream of the dam structure.

SAMPLE RESULTS

Laboratory results for the surface water and sediment samples are summarized in Tables 1 and 2 and presented in Figure 1, the sampling location map.

Total chromium (non-speciated) was detected in all the surface water samples at estimated concentrations ranging from 0.79 parts per billion ppb to 3.8 ppb. Hexavalent chromium in surface water was not detected at a laboratory method detection limit of 5.0 ppb for all sample locations.

Total chromium was detected in sediment samples at concentrations ranging from 15.5 parts per million to 466 ppm. Hexavalent chromium was detected in four sediment samples at concentrations ranging from 3.2 ppm (lab-estimated due to low detection level) to 29.7 ppm.

No samples exceeded 2010 environmental standards for hexavalent chromium in the surface water and sediment (See Tables 1 and 2).

EXPOSURE PATHWAY

This public health evaluation assesses if exposure to chromium in surface water or sediment at the site at the concentrations detected in 2010 could harm people's health. The exposure pathway of concern is dermal contact that would occur while recreating in areas of contaminated water, soil

and sediment and/or ingestion of contaminated sediment by young children exhibiting pica behavior.

Exposure to contaminants of concern is determined by examining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination (e.g., industrial facilities utilizing hazardous materials);
2. An environmental medium that can hold or move the contamination (e.g. water, soil, or air);
3. An exposure point at which people could come into contact with a contaminated medium (e.g., private residential well water);
4. An exposure route (e.g., ingestion or inhalation); and
5. A population that could come in contact with the contaminants.

For a completed pathway, all five parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur (ATSDR, 2005). For this evaluation, dermal contact and ingestion are the exposure pathways of concern. The five parts of the exposure pathway that are present or could be present at the site are as follows:

1. Source: Chromium impacts to Ackerly Creek and the Glenburn Pond site occurred as a result of contaminated groundwater infiltration into Ackerly Creek from the Precision National Plating site located approximately 3,000 feet to the southeast of the pond.
2. Environmental medium: Surface water and sediment are mediums that can hold and transport the contaminants.
3. Exposure point: A person could become exposed while recreating in the Glenburn Pond area.
4. Exposure route: A person's skin could be exposed to contamination while recreating in the Glenburn Pond area. A child exhibiting pica behavior could ingest contaminated sediment.
5. Population: The residents living near the site who might visit regularly are the potentially exposed population of concern.

This investigation sought to determine if chromium contamination was present in the Glenburn Pond area at concentrations that could harm people's health.

DATA EVALUATION

DOH screened the sampling data against appropriate ATSDR comparison values (CV), which are health-based guidelines. ATSDR CVs are conservative estimates of contaminant levels below which no health effects would be expected. Concentrations found to be above a CV do not necessarily mean they are harmful but that they require further evaluation to determine if adverse health effects are likely. Contaminants that exceed a CV are further evaluated using other standards and/or scientific studies, where appropriate, to determine whether adverse health effects are likely.

DOH used ATSDR's Public Health Assessment Site Tool (PHAST) to screen the contaminants and to calculate the potential cancer risks from dermal and ingestion exposure. Appendix B

presents the screening results using the maximum detected contaminant levels or the detection limits for trivalent and hexavalent chromium. Appendix B also presents the exposure parameters and risk calculations.

PUBLIC HEALTH IMPLICATIONS

This section provides exposure evaluations for the contaminant of concern. All exposure scenarios are assumed to be recreational.

Non-cancer health effects from exposure to hexavalent chromium

Surface water: Dermal exposure is not a significant exposure pathway for hexavalent chromium in water. Hexavalent chromium was not detected in the surface water. Additionally, the laboratory detection limit of 5 ppb (see Table 1) is below any ATSDR health-based screening values for non-cancer health effects. For this evaluation, the laboratory detection limit was used to represent the highest concentration of hexavalent chromium possible without being detected. No non-cancer health effects are expected related to dermal exposure to hexavalent chromium in surface water.

Sediment: The maximum hexavalent chromium detection of 29.7 ppm (see Table 2) was above the ATSDR intermediate environmental media evaluation guides (EMEG) for pica behavior in children (27 ppm). The intermediate EMEG for pica is a screening value used to represent the concentration of hexavalent chromium in sediment to which a child may be exposed for a period of 15 days to 1 year without experiencing adverse health effects. This maximum detection was a duplicate of sample number SED-12, which was non-detect.

Non-cancer health effects from exposure to total chromium

Surface water: Using the assumed 1:6 ratio of hexavalent to trivalent chromium as discussed in the "Chromium" section on page 4, the highest total chromium detection of 3.8 ppb (see Table 1) would consist of 3.26 ppb trivalent chromium, which is below the ATSDR reference dose media evaluation guide (RMEG) comparison values for trivalent chromium in water (11,000 ppb for children and 39,000 ppb for adults). The RMEG represents the concentrations of trivalent chromium in water to which humans may be exposed without experiencing adverse health effects. No non-cancer health effects are expected related to exposure to hexavalent or trivalent chromium in surface water.

Sediment: The maximum total chromium detection was 466 mg/kg (see Table 2), which would comprise 399.43 ppm of trivalent chromium using the assumed 1:6 ratio. Alternatively, subtracting the detected level of hexavalent chromium in the sample (29.7 ppm) from the total chromium value leaves 436.3 ppm trivalent chromium (assuming that only the trivalent and hexavalent forms are present in the total chromium sample). Both 399.43 and 436.3 ppm are below the ATSDR RMEG comparison value for trivalent chromium in soil/sediment (78,000 mg/kg for children and

1,200,000 mg/kg for adults). No non-cancer health effects are expected related to exposure to hexavalent or trivalent chromium in sediment.

Cancer Risk Evaluation

Cancer risk estimates for exposure to hexavalent chromium in surface water and sediment were calculated using ATSDR's PHAST. Trivalent chromium is not classified as *carcinogenic to humans* and was therefore not evaluated for cancer risk. Hexavalent chromium was not detected in surface water at a detection limit of 5 ppb, therefore cancer risk was calculated based on exposure at the detection limit. For sediment, cancer risk was calculated based on the maximum exposure concentration of 29.7 ppm. Both of these levels for surface water and sediment are above ATSDR's cancer risk evaluation guide (CREG) values for hexavalent chromium, which are media-specific CVs used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population.

Surface water: The chronic exposure calculations for dermal exposure to surface water assumed a swimming scenario, which accounts for dermal exposure in addition to potential ingestion of water (50 microliters [ml] per day for children and adults). The exposure frequency was assumed to be one exposure event per day for one hour at a time, one day per week, twelve weeks per year, for ten years. The estimated cancer risk associated with this level of exposure at the highest possible hexavalent chromium concentration (5 ppb) is 1.8×10^{-6} for children and 2.2×10^{-7} for adults. See Appendix B for detailed inputs and results tables.

These cancer risk estimates are within or below the EPA acceptable cancer risk range of between 1×10^{-4} and 1×10^{-6}. This range means that regular exposure to a substance would lead to one additional case of cancer per 10,000 to one additional case of cancer per 1,000,000 people exposed, which is an acceptable level of risk. While hexavalent chromium was not detected in the surface water at the Glenburn Pond area, exposure to surface water containing hexavalent chromium at the detection limit (5 ppb) would not be expected to cause an increased risk of cancer.

Sediment: The chronic exposure calculations for dermal exposure to sediment assumed an exposure frequency of one exposure event per day for one hour at a time, one day per week, twelve weeks per year, for ten years. Ingestion exposure was included in this calculation to account for young children exhibiting pica behavior. The estimated cancer risk associated with this level of exposure at the highest detected hexavalent chromium concentration (29.7 ppm) is 7.4×10^{-6} for children and 2.4×10^{-7} for adults using reasonable mean exposure (RME) or high-end conditions. See Appendix B for detailed inputs and results tables.

These cancer risk estimates are within or below the EPA acceptable cancer risk range of between 1×10^{-4} and 1×10^{-6}. There is no apparent increased cancer risk from exposure to hexavalent chromium in sediment at the levels detected.

LIMITATIONS

The data evaluated in this document were collected in October 2010. It is assumed that chromium contamination at the Glenburn Pond site would have reduced in concentration since the 2010 sampling event, as a result of the ongoing environmental remediation activities that have continued to clean up the site. Therefore, conditions are likely to have improved since 2010.
Therefore, these data likely overestimate current conditions.

CONCLUSIONS AND RECOMMENDATIONS

- Dermal exposure to surface water and sediment as well as ingestion exposure to sediment contaminated with hexavalent chromium at the levels detected at the Glenburn Pond site in 2010 are not expected to cause adverse health effects or increased cancer risk.
- Considering the remediation work that has been done by EPA at the Precision National Plating site and in Ackerly Creek since these data were collected in 2010, DOH does not recommend additional sampling of the Glenburn Pond area.
- DOH is available for further consultation related to activities at or near Precision National Plating site if necessary.

Please contact me with any questions you may have regarding this letter health consultation.

Sincerely,

Bevin S. Durant Fidler, MPH
Epidemiology Research Associate
Pennsylvania Department of Health
bdurantfid@pa.gov

Cc: Farhad Ahmed, MBBS, MPH; DOH
Anil Nair, PhD, MPH; DOH

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Table 1: Surface Water Sampling Results - Glenburn Pond Site, 8/24/2010; ppb

Sample Location	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	SW-9	SW-10	SW-11	SW-12	SW-DAM	SW-DUP-1	SW-DUP-2	SW-DUP-3	Comparison Values	
																	CREG	WQS
Chromium (dissolved)	0.79 J	0.8 J	1.2 J	1.1 J	1.8 J	1.1 J	1.4 J	2.70	2.50	2.90	3.50	3.80	1.0 J	1.1 J	1.8 J	3.5	—	—
Hexavalent Chromium - Cr(VI)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	0.024	10

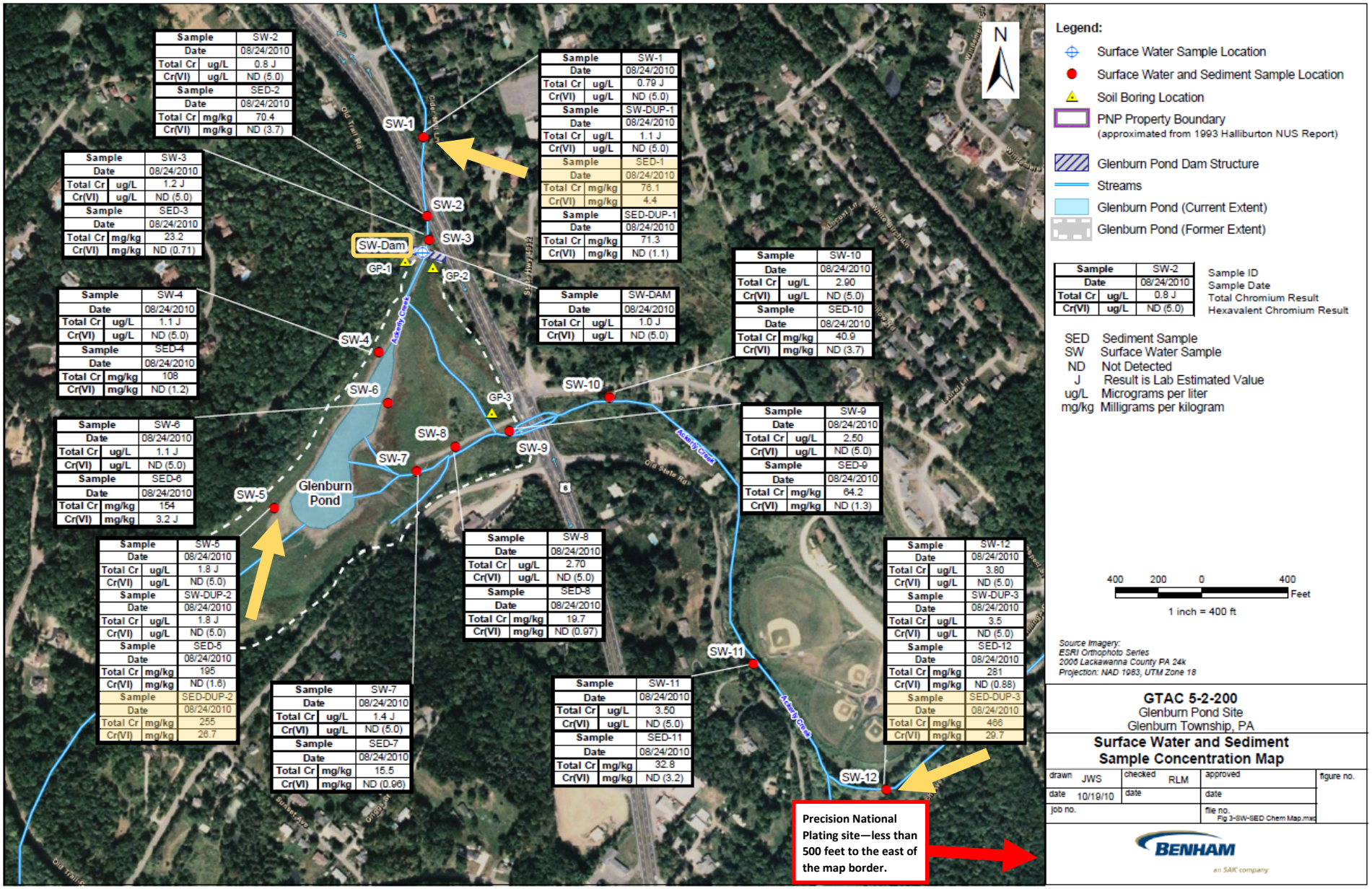
ppb = parts per billion; J = result is lab-estimated due to low detection level; ND = not detected at the laboratory method detection limit provided; CREG = Cancer Risk Evaluation Guide (ATSDR); WQS = Water quality standards for toxic substance criteria—continuous concentrations; SW-DUP-1 = duplicate sample collected at SW-1; SW-DUP-2 = duplicate sample collected at SW-5; SW-DUP-3 = duplicate sample collected at SW-12;

Table 2: Sediment Sampling Results - Glenburn Pond Site, 8/24/2010; ppm

Sample Location	SED-1	SED-2	SED-3	SED-4	SED-5	SED-6	SED-7	SED-8	SED-9	SED-10	SED-11	SED-12	SED-DUP-1	SED-DUP-2	SED-DUP-3	Comparison Values	
																CREG	MSC
Chromium (dissolved)	76.1	70.4	23.2	108	195	154	15.5	19.7	64.2	40.9	32.8	281	71.3	255	466	—	—
Hexavalent Chromium - Cr(VI)	**4.4**	ND (3.7)	ND (0.71)	ND (1.2)	ND (1.6)	3.2 J	ND (0.96)	ND (0.97)	ND (1.3)	ND (3.7)	ND (3.2)	ND (0.88)	ND (1.1)	**26.7**	**29.7**	0.22	94

ppm: parts per million; J = result is lab-estimated due to low detection level; ND = not detected at the laboratory method detection limit provided; CREG: Cancer Risk Evaluation Guide (ATSDR); MSC = Medium specific concentrations in soil—direct contact (PADEP); Values in bold text = Exceeded ATSDR CREG value; SED-DUP-1 = duplicate sample collected at SED-1; SED-DUP-2 = duplicate sample collected at SED-5; SED-DUP-3 = duplicate sample collected at SED-12;

Figure 1: Surface Water and Sediment Sample Concentration Map



Sample	SW-2
Date	08/24/2010
Total Cr ug/L	0.8 J
Cr(VI) ug/L	ND (5.0)
Sample	SED-2
Date	08/24/2010
Total Cr mg/kg	70.4
Cr(VI) mg/kg	ND (3.7)

Sample	SW-1
Date	08/24/2010
Total Cr ug/L	0.79 J
Cr(VI) ug/L	ND (5.0)
Sample	SW-DUP-1
Date	08/24/2010
Total Cr ug/L	1.1 J
Cr(VI) ug/L	ND (5.0)
Sample	SED-1
Date	08/24/2010
Total Cr mg/kg	76.1
Cr(VI) mg/kg	4.4
Sample	SED-DUP-1
Date	08/24/2010
Total Cr mg/kg	71.3
Cr(VI) mg/kg	ND (1.1)

Sample	SW-3
Date	08/24/2010
Total Cr ug/L	1.2 J
Cr(VI) ug/L	ND (5.0)
Sample	SED-3
Date	08/24/2010
Total Cr mg/kg	23.2
Cr(VI) mg/kg	ND (0.71)

Sample	SW-4
Date	08/24/2010
Total Cr ug/L	1.1 J
Cr(VI) ug/L	ND (5.0)
Sample	SED-4
Date	08/24/2010
Total Cr mg/kg	108
Cr(VI) mg/kg	ND (1.2)

Sample	SW-DAM
Date	08/24/2010
Total Cr ug/L	1.0 J
Cr(VI) ug/L	ND (5.0)

Sample	SW-10
Date	08/24/2010
Total Cr ug/L	2.90
Cr(VI) ug/L	ND (5.0)
Sample	SED-10
Date	08/24/2010
Total Cr mg/kg	40.9
Cr(VI) mg/kg	ND (3.7)

Sample	SW-6
Date	08/24/2010
Total Cr ug/L	1.1 J
Cr(VI) ug/L	ND (5.0)
Sample	SED-6
Date	08/24/2010
Total Cr mg/kg	154
Cr(VI) mg/kg	3.2 J

Sample	SW-9
Date	08/24/2010
Total Cr ug/L	2.50
Cr(VI) ug/L	ND (5.0)
Sample	SED-9
Date	08/24/2010
Total Cr mg/kg	64.2
Cr(VI) mg/kg	ND (1.3)

Sample	SW-5
Date	08/24/2010
Total Cr ug/L	1.8 J
Cr(VI) ug/L	ND (5.0)
Sample	SW-DUP-2
Date	08/24/2010
Total Cr ug/L	1.8 J
Cr(VI) ug/L	ND (5.0)
Sample	SED-5
Date	08/24/2010
Total Cr mg/kg	195
Cr(VI) mg/kg	ND (1.6)
Sample	SED-DUP-2
Date	08/24/2010
Total Cr mg/kg	255
Cr(VI) mg/kg	26.7

Sample	SW-8
Date	08/24/2010
Total Cr ug/L	2.70
Cr(VI) ug/L	ND (5.0)
Sample	SED-8
Date	08/24/2010
Total Cr mg/kg	19.7
Cr(VI) mg/kg	ND (0.97)

Sample	SW-12
Date	08/24/2010
Total Cr ug/L	3.80
Cr(VI) ug/L	ND (5.0)
Sample	SW-DUP-3
Date	08/24/2010
Total Cr ug/L	3.5
Cr(VI) ug/L	ND (5.0)
Sample	SED-12
Date	08/24/2010
Total Cr mg/kg	281
Cr(VI) mg/kg	ND (0.88)
Sample	SED-DUP-3
Date	08/24/2010
Total Cr mg/kg	466
Cr(VI) mg/kg	29.7

Sample	SW-7
Date	08/24/2010
Total Cr ug/L	1.4 J
Cr(VI) ug/L	ND (5.0)
Sample	SED-7
Date	08/24/2010
Total Cr mg/kg	15.5
Cr(VI) mg/kg	ND (0.96)

Sample	SW-11
Date	08/24/2010
Total Cr ug/L	3.50
Cr(VI) ug/L	ND (5.0)
Sample	SED-11
Date	08/24/2010
Total Cr mg/kg	32.8
Cr(VI) mg/kg	ND (3.2)

APPENDIX A

PRECISION NATIONAL PLATING SITE: TIMELINE OF HEALTH AGENCY ACTIVITIES

PENNSYLVANIA DEPARTMENT OF HEALTH (DOH) AND AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY (ATSDR)

1997

Oct and Nov:
DOH, ATSDR and the Environmental Protection Agency (EPA) met with area residents to discuss their health concerns.

1998

Feb: On-site public meeting to discuss health-related site activities.

Apr: DOH's article was published in the Lackawanna County Medical Society newsletter.[A]

Sep: ATSDR and DOH met with residents in their homes.

Oct–Nov: Health Consultations No. 1[B], No. 2[C] and No. 3[D] issued.

1999

Mar: Health Consultation No. 4 issued.[E]

May: ATSDR and DOH met with residents who attended an EPA Public Availability Session on site.

Sep: Health Consultation No. 5 issued.[F]

Oct: Health Consultation No. 6 issued.[G]

Dec: Health Consultation No. 7 issued.[H]

2000

Mar: ATSDR and DOH distributed a Q&A document.[I]

Apr: ATSDR and DOH hosted a public availability session.

Jun: ATSDR arranged for a second medical opinion for select residents.

Sep: DOH released public comment version of Health Consultation No. 8 and shared findings at township meeting.

Oct–Nov: DOH and ATSDR provided health education to residents and health care providers at multiple events.[J]

2001

Jan: One resident had a second medical opinion at the UPenn clinic following ATSDR's June 2000 offer. The physician proposed a medical records review for residents who lived close to Precision; ATSDR subsequently agreed to fund this medical records review.

Apr: Final version of Health Consultation No. 8 issued.[K]

Aug. 8: Health Consultation No. 9 issued.[L]

2005

Mar: The University of Pennsylvania (UPenn) released "Medical Records Review of a Group of Residents near the Precision National Plating Services Site."[M]

2006

Jun: ATSDR Record of Activity issued.[N]

Jul: ATSDR Record of Activity issued.[O]

2007

Sep: ATSDR Record of Activity issued.[P]

2011

Nov: Health Consultation No. 10 issued.[Q]

- See the reverse side for more details on events with superscript letters.
- Please send questions/comments to env.health.concern@pa.gov.

A – The article reviewed activities at the site and provided resources for physicians about chromium toxicity.

B – Health Consultation No. 1 was prepared to determine if residents near the site were being exposed to hexavalent chromium in their well water that would harm their health and identify locations of monitoring wells to delineate contaminated groundwater (https://response.epa.gov/sites/2425/files/10-15-1998%20Health%20Consultation%20No%201.PDF).

C – Health Consultation No. 2 was prepared to review the groundwater sampling data collected by Pennsylvania Department of Environmental Protection (DEP) recommended in Health Consultation No. 1 (https://response.epa.gov/sites/2425/files/11-05-1998%20Health%20Consultation%20No%202.PDF).

D – Health Consultation No. 3 was prepared to recommend soil and sediment sampling locations in response to residents' requests (https://response.epa.gov/sites/2425/files/10-14-1998%20Health%20Consultation%20No%203.PDF).

E – Health Consultation No. 4 was prepared to review the soil and sediment sampling data collected by DEP recommended in Health Consultation No. 3 (https://response.epa.gov/sites/2425/files/03-01-1999%20Health%20Consultation%20No%204.PDF).

F – Health Consultation No. 5 was prepared to determine if residents are being exposed to hexavalent chromium in their private well water at levels that would harm their health (https://response.epa.gov/sites/2425/files/09-30-1999%20Health%20Consultation%20No%205.PDF).

G – Health Consultation No. 6 was prepared to review soil sampling results from a residential yard (https://response.epa.gov/sites/2425/files/10-18-1999%20Health%20Consultation%20No%206.PDF).

H – Health Consultation No. 7 was prepared to review private residential well sampling results from wells within one mile of the site (https://response.epa.gov/sites/2425/files/12-21-1999%20Health%20Consultation%20No%207.PDF).

I – The Q&A document addressed medical testing and other health questions at the request of the Glenburn Township Board of Supervisors (https://response.epa.gov/sites/2425/files/03-27-2000%20PADOH%20Fact%20Sheet.PDF).

J – Oct. 4: DOH and ATSDR met with the local medical society to provide education to health care providers about chromium, hair analysis in environmental medicine, and general information about the site. Oct. 5: ATSDR arranged a public presentation by experts on hair analysis. Public health experts were available to the residents for individual consultation before the presentation. November: DOH continued to provide health education to residents and health care providers.

K – The final version of Health Consultation No. 8 was prepared to evaluate historic soil, sediment, surface water, and private residential well sample results to determine if chromium was historically present at levels that could have harmed people's health (https://response.epa.gov/sites/2425/files/04-27-2001%20Health%20Consultation%20No%208.PDF).

L – Health Consultation No. 9 was prepared to review residential well sampling data for antimony recommended in Health Consultation No. 8 (https://response.epa.gov/sites/2425/files/08-08-2001%20Health%20Consultation%20No%209.PDF).

M – This report documents UPenn's clinical evaluation of the medical records for occupants of nine residences that are in closest proximity to the site to determine whether individual cases or a cluster of health outcomes was found which would warrant further assessment or action.

N – This document provided EPA with information on ambient air action levels for hydrogen sulfide (https://response.epa.gov/sites/2425/files/2006%206%2023%20AROA%20ATSDR%20Precision%20H2S%20air.PDF).

O –This document reviewed water, sediment and fish data for Glenburn Pont (https://response.epa.gov/sites/2425/files/2006%207%2019%20AROA%20ATSDR%20Precision%20GlenburnPond.pdf).

P –This document reviewed current discharged effluent from two seep treatment areas for any public health concerns (https://response.epa.gov/sites/2425/files/2007%209%205%20AROA%20ATSDR%20Precision%20Effluent.pdf).

Q – Health Consultation No. 10 was prepared to review soil samples collected from an adjacent property and determine if concentrations of hexavalent chromium or total chromium pose a public health threat (https://response.epa.gov/sites/2425/files/2011%2011%208%20HC%20PADOH%20Precision%20No%2010_redacted.pdf).

APPENDIX B

PHAST Results

CV SCREENS

Hexavalent Chromium in Surface Water, CV Screen:

Contaminant Name / CASRN	Conc	Unit	Above or Equal to Rec ATSDR CV?	Above or Equal to Other CV?	Above or Equal to MCL?	CREG	Chronic EMEG Child	Chronic EMEG Adult	Int EMEG Child	Int EMEG Adult	RMEG Child	RMEG Adult	Acute EMEG Child	Acute EMEG Adult	MCL
CHROMIUM, HEXAVALENT 018540-29-9	5	ppb	Yes [1]	No	NA	0.024 [1]	6.3	23	35	130	21	78	NA	NA	NA

[1] Recommended ATSDR CV met or exceeded.

Trivalent Chromium in Surface Water, CV Screen:

Contaminant Name / CASRN	Conc	Unit	Above or Equal to Rec ATSDR CV?	Above or Equal to Other CV?	Above or Equal to MCL?	CREG	Chronic EMEG Child	Chronic EMEG Adult	Int EMEG Child	Int EMEG Adult	RMEG Child	RMEG Adult	Acute EMEG Child	Acute EMEG Adult	MCL
CHROMIUM, TRIVALENT 016065-83-1	3.26	ppb	No	No	NA	NA	NA	NA	NA	NA	11,000 [#]	39,000	NA	NA	NA

[#] Recommended ATSDR CV.

Hexavalent Chromium in Soil/Sediment, CV Screen:

Contaminant Name / CASRN	Conc	Unit	Above or Equal to Rec ATSDR CV?	Above or Equal to Other CV?	CREG	Chronic EMEG Child	Chronic EMEG Adult	Int EMEG Child	Int EMEG Adult	RMEG Child	RMEG Adult	Acute EMEG Pica Child	Int EMEG Pica Child
CHROMIUM, HEXAVALENT 018540-29-9	29.7	ppm	Yes [1]	No	0.22 [1]	47	720	260	4,000	160	2,400	NA	27 [3]

[1] Recommended ATSDR CV met or exceeded.
[3] Acute/Intermediate pica ATSDR CV met or exceeded.

Trivalent Chromium in Soil/Sediment, CV Screen:

Contaminant Name / CASRN	Conc	Unit	Above or Equal to Rec ATSDR CV?	Above or Equal to Other CV?	CREG	Chronic EMEG Child	Chronic EMEG Adult	Int EMEG Child	Int EMEG Adult	RMEG Child	RMEG Adult	Acute EMEG Pica Child	Int EMEG Pica Child
CHROMIUM, TRIVALENT 016065-83-1	399.43	ppm	No	No	NA	NA	NA	NA	NA	78,000 [#]	1,200,000	NA	NA

[#] Recommended ATSDR CV.

CANCER EVALUATION

Cancer risk equation:

CR = (D × CSF) × (ED / LY)

CR = Cancer Risk, **D** = Age-Specific Dose (mg/kg/day), **CSF** = Cancer Slope Factor ((mg/kg/day)$^{-1}$), **ED** = Age-Specific Exposure Duration (years), **LY** = Lifetime in Years (78 years)

Surface water evaluation:

Input parameters table:

Contaminant Information

Contaminant Name	Entered Concentration	Unit	Type	Converted Concentration	GI Absorption Factor (ABS_{GI})	DA_{event}
CHROMIUM, HEXAVALENT	5	ppb	Maximum	0.005 mg/L	0.025	1E-08 mg/cm²/event

Exposure Parameters

Surface Water Ingestion Exposure Dose Equation

$D = (C \times IR \times t_{event} \times EV \times EF) / BW$

D = Exposure Dose (mg/kg/day), C = Contaminant Concentration (mg/L), IR = Intake Rate (L/hr), t_{event} = Event Duration (hr/event), EV = Event Frequency (events/day), EF = Exposure Factor (unitless), BW = Body Weight (kg)

Surface Water Dermal Absorbed Dose Equation

$ADD = (DA_{event} \times SA \times EV \times EF) / (BW \times ABS_{GI})$

ADD = Administered Dermal Dose (mg/kg/day), DA_{event} = Absorbed Dose per Event (mg/cm²/event), SA = Surface Area Available for Contact (cm²), EV = Event Frequency (events/day), EF = Exposure Factor (unitless), BW = Body Weight (kg), ABS_{GI} = Gastrointestinal Absorption Factor (unitless)

Exposure Group	Body Weight (kg)	Age-Specific Exposure Duration (years)	Intake Rate (L/hr)			Combined Skin Surface Area (cm²)	Notes
			CTE	RME	Custom		
Birth to < 1 year	7.8	1			0.050	3,992	
1 to < 2 years	11.4	1			0.050	5,300	
2 to < 6 years	17.4	4			0.050	7,225	
6 to < 11 years	31.8	4			0.050	10,800	
11 to < 16 years	56.8	0			0.050	15,900	
16 to < 21 years	71.6	0			0.050	18,400	
Adult	80	10			0.050	19,811	

Exposure Factors

Duration	Days	Weeks	Years	Non-Cancer Exposure Factor	t_{event}	EV	
Acute				1	1	1	**EF cancer:** EF non-cancer x Age-Specific Exposure Duration (years)/78 years
Intermediate	1	12		0.14	1	1	
Chronic	1	12	10	0.033	1	1	

Results table for dermal and ingestion exposure to surface water; Chronic exposure:

Exposure Group	Site-Specific Scenario			
	Chronic Dose (mg/kg/day)	Chronic Hazard Quotient	Cancer Risk	ED (yrs)
CHROMIUM, HEXAVALENT (EPC: 0.005 mg/L; Chronic MRL: 0.0009 mg/kg/day; CSF: 0.5 $(mg/kg/day)^{-1}$; ADAF mutagen)				
Birth to < 1 year	7.8E-06	0.0086	1.8E-6	1
1 to < 2 years	6.8E-06	0.0076		1
2 to < 6 years	5.9E-06	0.0066		4
6 to < 11 years	4.7E-06	0.0052		4
11 to < 16 years	3.8E-06	0.0043		0
16 to < 21 years	3.5E-06	0.0039		0
Total exposure duration for child cancer risk				10
Adult	3.4E-06	0.0037	2.2E-7	10

Sediment (PHAST uses the same process to evaluate soil and/or sediment exposure):

Input parameters table:

Contaminant Information

Contaminant Name	Entered Concentration	Unit	Type	Converted Concentration	Dermal Absorption Fraction	GI Absorption Factor (ABS_{GI})	Bioavailability Factor
CHROMIUM, HEXAVALENT	29.7	ppm	Maximum	29.7 mg/kg	0.01	0.025	1

Exposure Parameters

Soil Ingestion Exposure Dose Equation
D = (C * IR * EF * CF) / BW
D = Exposure Dose (mg/kg-day), C = Contaminant Concentration (mg/kg), IR = Intake Rate (mg/day),
EF = Exposure Factor (unitless), CF = Conversion Factor (10-6 kg/mg), BW = Body Weight (kg)

Soil Dermal Absorbed Dose Equation
DAD = (C * EF * CF * AF * ABSd * SA) / BW * ABSGI
DAD = Dermal Absorbed Dose (mg/kg-day), C = Contaminant Concentration (mg/kg), EF = Exposure Factor (unitless), CF = Conversion Factor (10^{-6} kg/mg),
AF = Adherence Factor to Skin (mg/cm^2-event), ABSd = Dermal Absorption Fraction to Skin (unitless), SA = Skin Surface Area Available for Contact (cm^2),
BW = Body Weight (kg), ABSGI = Gastrointestinal Absorption Factor (unitless)

Exposure Group	Body Weight (kg)	Age-Specific Exposure Duration (years)	Intake Rate (mg/day)			Adherence Factor to Skin (mg/cm^2-event)	Combined Skin Surface Area (cm^2)	Notes
			CTE	RME	Custom			
Birth to < 1 year	7.8	1	55	150		0.2	1,772	
1 to < 2 years	11.4	1	90	200		0.2	2,299	
1 to < 2 years (pica)	11.4	NA	5,000	NA		0.2	2,299	
2 to < 6 years	17.4	4	60	200		0.2	2,592	
2 to < 6 years (pica)	17.4	NA	5,000	NA		0.2	2,592	
6 to < 11 years	31.8	4	60	200		0.2	3,824	
11 to < 16 years	56.8	0	30	100		0.2	5,454	
16 to < 21 years	71.6	0	30	100		0.2	6,083	
Adult	80	10	30	100		0.07	7,325	

Exposure Factors

Duration	Days	Weeks	Years	Non-Cancer Exposure Factor
Acute				1
Intermediate	1	12		0.14
Chronic	1	12	10	0.033
Pica	1			0.14

EF cancer: EF non-cancer x Age-Specific Exposure Duration (years)/78 years

EF dermal: The dermal absorbed dose equation includes a 1 event/day EF parameter.

Results table for combined exposure (dermal and ingestion) to sediment; Chronic exposure:

Exposure Group	Site-Specific Scenario						
	Chronic Dose (mg/kg/day)		Chronic Hazard Quotient		Cancer Risk		
	CTE	RME	CTE	RME	CTE	RME	ED (yrs)
CHROMIUM, HEXAVALENT (EPC: 29.7 mg/kg; Chronic MRL: 0.0009 mg/kg/day; CSF: 0.5 (mg/kg/day)$^{-1}$; ADAF mutagen)							
Birth to < 1 year	2.5E-05	3.7E-05	0.027	0.041	5.1E-6	7.4E-6	1
1 to < 2 years	2.3E-05	3.3E-05	0.026	0.037			1
2 to < 6 years	1.5E-05	2.3E-05	0.017	0.025			4
6 to < 11 years	1.1E-05	1.6E-05	0.012	0.017			4
11 to < 16 years	8.0E-06	9.2E-06	0.0089	0.010			0
16 to < 21 years	7.0E-06	8.0E-06	0.0078	0.0089			0
Total exposure duration for child cancer risk							10
Adult	2.9E-06	3.7E-06	0.0032	0.0041	1.8E-7	2.4E-7	10