# HEALTH CONSULTATION

## The Former Duval Plating and Supply Company Site

## Jacksonville, Florida

DEP Site # FLD982081085

March 16, 2018

Prepared by:
Florida Department of Health
Bureau of Environmental Health
Under Cooperative Agreement with
U. S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

## Foreword

The Florida Department of Health (Department) evaluates the public health threat of hazardous waste sites through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR) in Atlanta, Georgia. This health consultation is part of an ongoing effort to evaluate health effects from contaminated soil and groundwater at the former Duval Plating and Supply Company site. Department health assessors evaluate site-related public health issues through the following processes:

*Evaluating exposure:* Health assessors begin by reviewing available information about environmental conditions at the site. We find out how much contamination is present, where it is on the site, and how human exposures might occur. The Florida Department of Environmental Protection (DEP) and the Department provided the information for this assessment.

*Evaluating health effects:* If health assessors find evidence that exposures to hazardous substances are occurring or might occur, we determine whether those exposures could be harmful to human health. We base our determinations on existing scientific information.

*Developing recommendations*: Health assessors outline our conclusions about potential health threats from contaminated groundwater. We also recommend ways to reduce or eliminate human exposures to contaminants. If health assessors find an immediate health threat exists or is about to happen, we will issue a public health advisory warning people of the danger, and we will work to resolve the problem.

*Soliciting community input:* The evaluation process is interactive. Health assessors start by asking for information from various government agencies, individuals, and organizations responsible for cleaning up the site. We evaluate the information and share conclusions about the site with the groups and organizations who provided the information. After health assessors prepare an evaluation report, we seek feedback from the people living near the site.

*If you have questions or comments about this report, we encourage you to contact us.*

*Please write to:* Division of Disease Control and Health Protection
Bureau of Environmental Health, Public Health Toxicology
Florida Department of Health
4052 Bald Cypress Way, Bin # A-08
Tallahassee, FL 32399-1720

*Or call us at:* 850-901-6898 or toll free at 877-798-2772

## Summary


INTRODUCTION

At the former Duval Plating and Supply Company (Duval Plating) site, the Department's top priority is to ensure nearby residents have the best information to safeguard their health.

The one-third acre Duval Plating site is at 2161 Commonwealth Avenue, Jacksonville, Florida. Duval Plating operated from 1981 until June 2013. They cleaned, plated, and polished metal products. Leaking solvent containers and poor housekeeping polluted soil and shallow groundwater. DEP sampled soil and groundwater onsite and obtained two offsite soil samples.

While several Department surveys found no private drinking water wells within one-half mile of the site, chemicals in the groundwater would be a public health risk if people drank this water in the future.

The Department reached four conclusions.

CONCLUSION #1

In the future, drinking water from new on-site wells could harm health.

BASIS FOR CONCLUSION #1

Ingestion of hexavalent chromium at the levels measured in shallow groundwater could be fatal.

NEXT STEP #1

The Department recommends against installing drinking water wells on the site.

CONCLUSION #2

The lack of groundwater quality data southeast (downgradient) of the site is a data gap.

NEXT STEP #2

The Department recommends testing of groundwater southeast of the site for metals and cyanide.

CONCLUSION #3

The vapor intrusion exposure pathway is currently incomplete.

BASIS FOR CONCLUSION #3

Bromoform is the only volatile chemical of concern in groundwater. The highest level of bromoform measured is insufficient to cause indoor air vapor intrusion in a future on-site residence. The area of bromoform contamination is small and does not extend off site.

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|---|---|
| CONCLUSION #4 | The Department cannot conclude whether past exposures to site chemicals harmed workers' health. |
| BASIS FOR CONCLUSION #4 | The Department lacks data for site worker's exposures. |
| LIMITATIONS OF FINDINGS | To varying degrees, all risk assessments require the use of assumptions, judgments, and incomplete data. These contribute to the uncertainty of final risk estimates. Some more important sources of uncertainty in this health consultation include environmental sampling and analyses, exposure parameter estimates, modeled exposure doses, and toxicological knowledge.<br><br>Because of these uncertainties, health assessors might have overestimated or underestimated risks. Therefore, this public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the Duval Plating site. |
| FOR MORE INFORMATION | If you have concerns about your health or the health of your children, you should contact your health care provider.<br><br>For further health information about the Duval Plating site, you can contact the Department at (850) 901-6898, or call us toll free at 877-798-2772. |

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## Statement of Issues

In 2017, the Department of Environmental Protection (DEP) found cleaning and plating metals in surface soil and groundwater at the former Duval Plating and Supply Company (Duval Plating) site. The Department of Health (Department) initiated this evaluation of the public health risk.

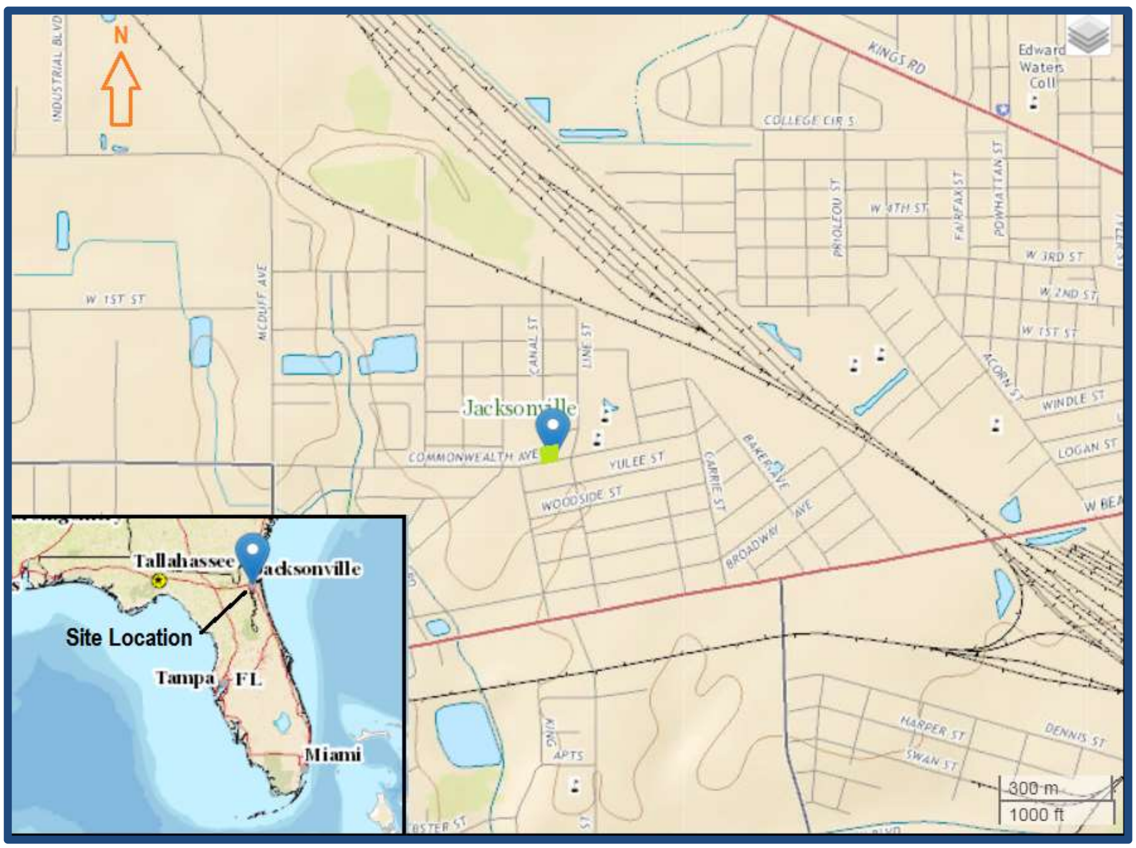
The Department prepared this report with assistance and funding from the Agency for Toxic Substances and Disease Registry (ATSDR), part of the United States Department of Health and Human Services. The Department reviewed available environmental data, exposure pathways, and community health concerns to evaluate the public health threat. The assumptions, judgments, and data in this report are sources of uncertainty.

## Background

### Site Description

The one-third acre former Duval Plating site is at 2161 Commonwealth Avenue, in northwestern Jacksonville, Florida (Figure 1).

***Figure 1. Former Duval Plating site***




*[USGS 2017]*

The 5,200 square-foot building on the site is concrete block and brick, with metal doors and barred windows (Figure 2). Much of the roof has fallen in and the City of Jacksonville has condemned the building. Grass and trees border the street and the side and rear yards are paved with asphalt.

***Figure 2. Former Duval Plating site, looking north from Commonwealth Avenue.***

***[Department Photo June 2017]***

Residences and the West Jacksonville Elementary School are east of the site. Commonwealth Avenue and residences are south. FMX Trucking is north and west of the site (Figure 3).

***Figure 3. Former Duval Plating site, aerial view.***

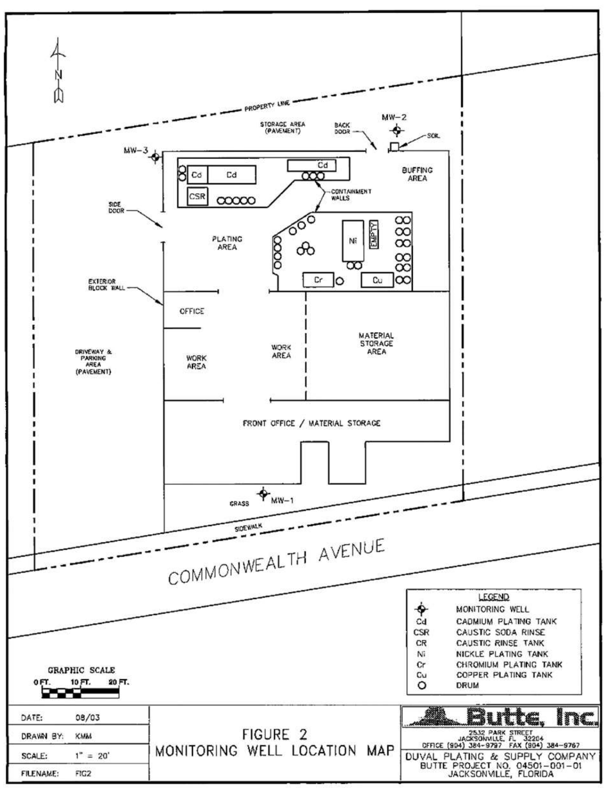

***[DEP 2017]***

**Site Visit**
Department staff visited the site June 9, 2017. We observed several City of Jacksonville condemnation notices on the building. Although the building roof was in very poor condition, the property appeared secure. The front door was locked, the windows were barred, the property-fencing was locked and intact. The site shares its western boundary with FMX Trucking. It appears FMX Trucking is using the back of the site for parking.

**Site History and Operations**
In 1953, Dandee Foods Company constructed the site building. Duval Plating owned and operated the site from 1981 until June 2013.

Duval Plating cleaned metal parts, plated them, and cleaned and polished the finished products. Workers used methylene chloride-based solvents, sulfuric acid, muriatic acid, and sodium cyanide to remove paints, rust, scale and previously plated surfaces from metal parts. They used electrical current in acid plating baths to apply copper, nickel, chrome, cadmium, brass, and silver coatings to steel and brass [Butte 2003]. The facility produced approximately 10,000 pounds of various types of plating waste per year. Inspectors observed evaporation and other onsite waste treatment but were unable to find disposal documentation [DEP 2017]. Figure 4 shows the locations of the various plating vats.

***Figure 4. Vat locations inside the Duval Plating and Supply building***




***[Butte 2003]***

DEP and City of Jacksonville inspectors found spills, leaking containers, poor housekeeping, lack of secondary containment, and outdoor discharge of rinse waters. Levels of metals and solvents in shallow groundwater and levels of chromium in soil exceeded regulatory standards [Butte 2003].

**Site Remediation**

On October 29, 2014 EPA found incompatible wastes under a collapsing roof (Figure 5) [EPA 2015a]. They determined a release had the potential to impact the health of students attending the nearby school and nearby residents.

***Figure 5. Collapsing roof conditions at the Duval Plating building***

***[COJ 2014]***

Between October 31, 2014 and January 26, 2015, EPA disposed of:

- 4,000 gallons of chromic acid,
- 1,375 gallons of waste cyanide,
- 275 gallons of waste nitric acid,
- 3,500 gallons of chromium and cadmium wastes (neutral pH),
- 4 cubic yards of cyanide waste, and
- 4 cubic yards of chromic acid waste.

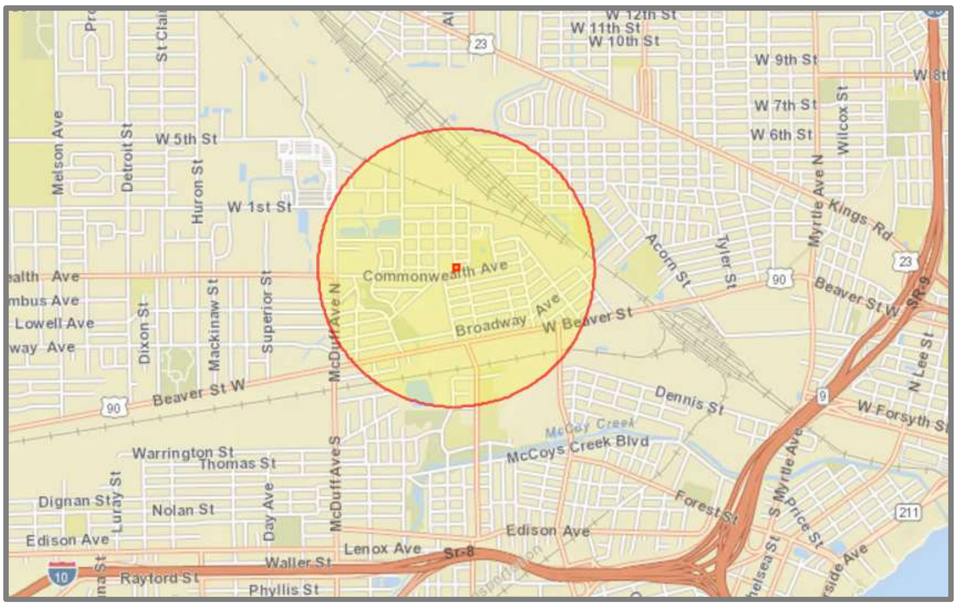
**Land Use**

Mixed residential and industrial properties surround the site. West Jacksonville Elementary School and Newtown neighborhood are east, Commonwealth Avenue and Mixon Town neighborhood are south, and FMX Trucking and Woodstock neighborhood are west. FMX also borders the site on the north with Robinson's Addition neighborhood, CSX switching yard, and College Garden neighborhoods farther north [DEP 2017, Google Maps 2017].

### Demographics

In 2010, 2,379 people lived within one-half mile of the site (Figure 6). Of the total, 90% were black, 8% were white, 2% reported two or more races, and 2% reported as Hispanic, a Spanish cultural association that does not reflect race [EPA 2017a]. Fifty percent of those eligible completed high school and 62% of households earn less than 25,000 dollars a year. As young children are often the most sensitive to exposure, the Department looks for daycare facilities (including churches) and schools near the site. We located the Word of Life Community Church one-half mile west of the site, West Jacksonville Elementary 300 feet east of the site, and Smart Pope Livingston Elementary one-half mile east of the site [Google Maps 2017].

***Figure 6. Area within one-half mile of the former Duval Plating site***




*[EPA 2017a]*

## Discussion

### Evaluation Process

To evaluate the risk for harm to public health from site-related chemicals, health assessors determine the contaminated media and the relative contamination levels. Health assessors screen the site-related data using ATSDR's comparison values (CVs) [ATSDR 2017a]. Each CV is a concentration for a chemical in the environment (water or soil) below which health assessors do not expect harm to health. Health assessors identify contaminants higher than their CVs for further evaluation (explained in Appendix A). Health assessors list the contaminant ranges found in Appendix B.

Next health assessors look at ways people could be exposed to contaminated media, called exposure pathways. Health assessors also consider future exposure pathways on the site. Finally, health assessors discuss completed exposure pathways in the Public Health Risk section.

**Environmental Data**

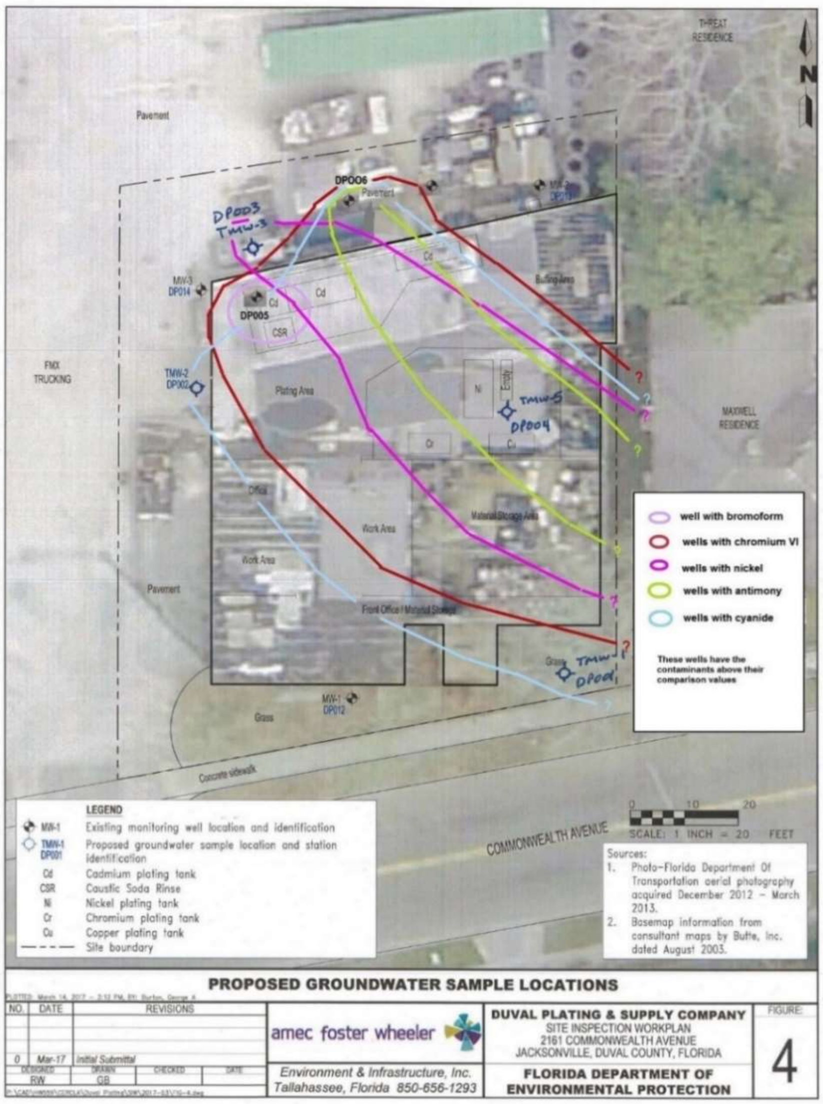
In 2017, DEP shared unpublished soil and groundwater laboratory reports with the Department. In the following sections, the Department discusses on-site and off-site contamination separately.

***On-site environmental data***

***Groundwater environmental data***

DEP collected samples from 6 on-site shallow groundwater monitor wells (screened 2 to 12 feet deep). EPA tested the groundwater samples for cyanide, mercury, volatile organics, and metals (Jim McCarthy, DEP, unpublished laboratory reports, March 2017). Levels of antimony, bromoform, chromium, cyanide, and nickel were above ATSDR's CVs (Table B-3). Figure 7 shows sample locations and areas with groundwater contamination.

***Figure 7. Duval Plating site groundwater contamination***

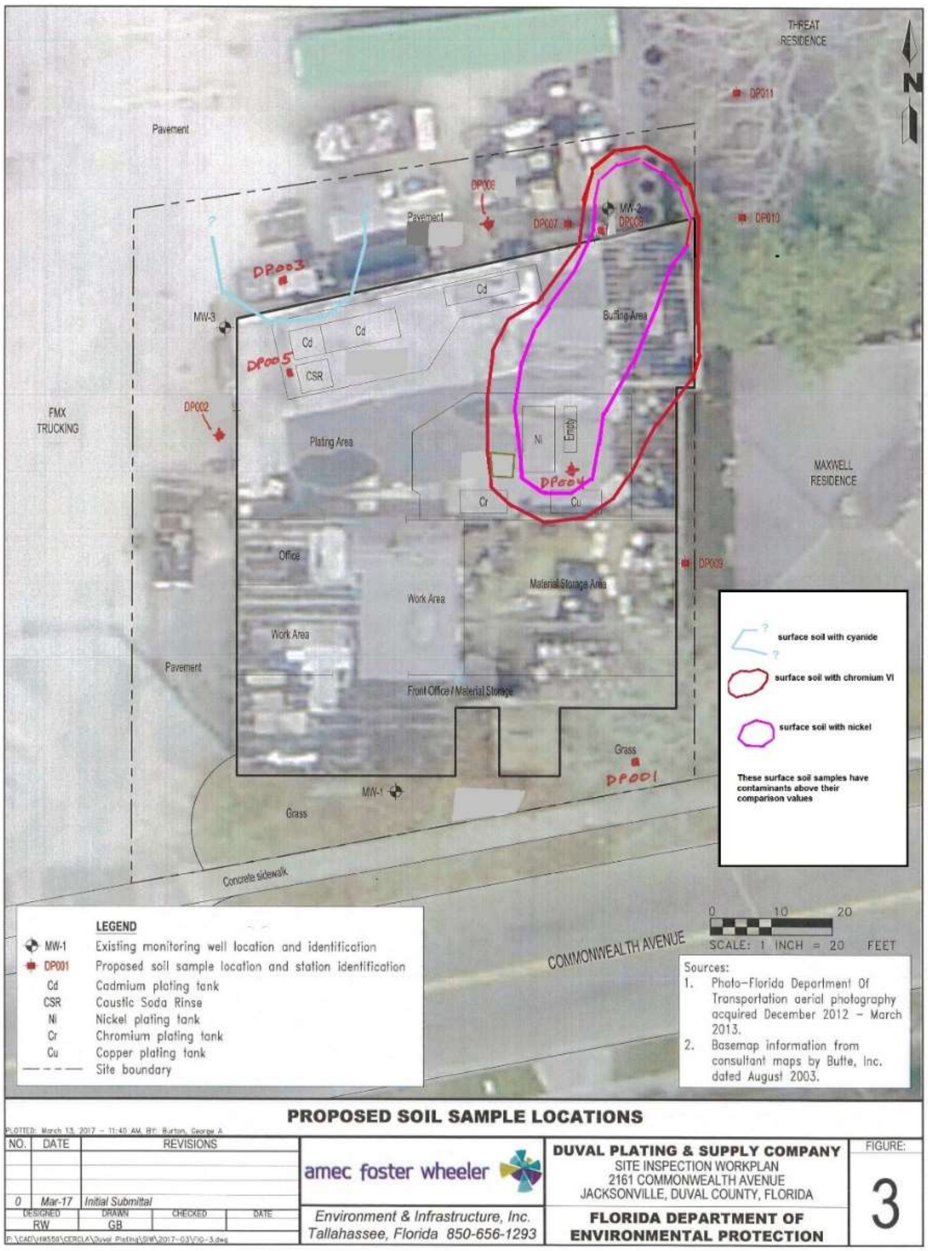



(Jim McCarthy, DEP, unpublished map, March 2017)

### *Soil environmental data*

EPA tested 11 surface soil samples (0 to 6 inches deep) for cyanide, mercury, (volatile organic analysis), and metals (Jim McCarthy, DEP, unpublished laboratory reports, March 2017). Levels of chromium, cyanide, and nickel were above ATSDR CVs (Table B-4). DEP collected 2 surface soil samples off site and 9 on site. Two of the on-site samples were under the building and five were under the asphalt. Figure 8 estimates the extent of surface soil contamination.

***Figure 8. Duval Plating site surface soil contamination***




(Jim McCarthy, DEP, unpublished map, March 2017)

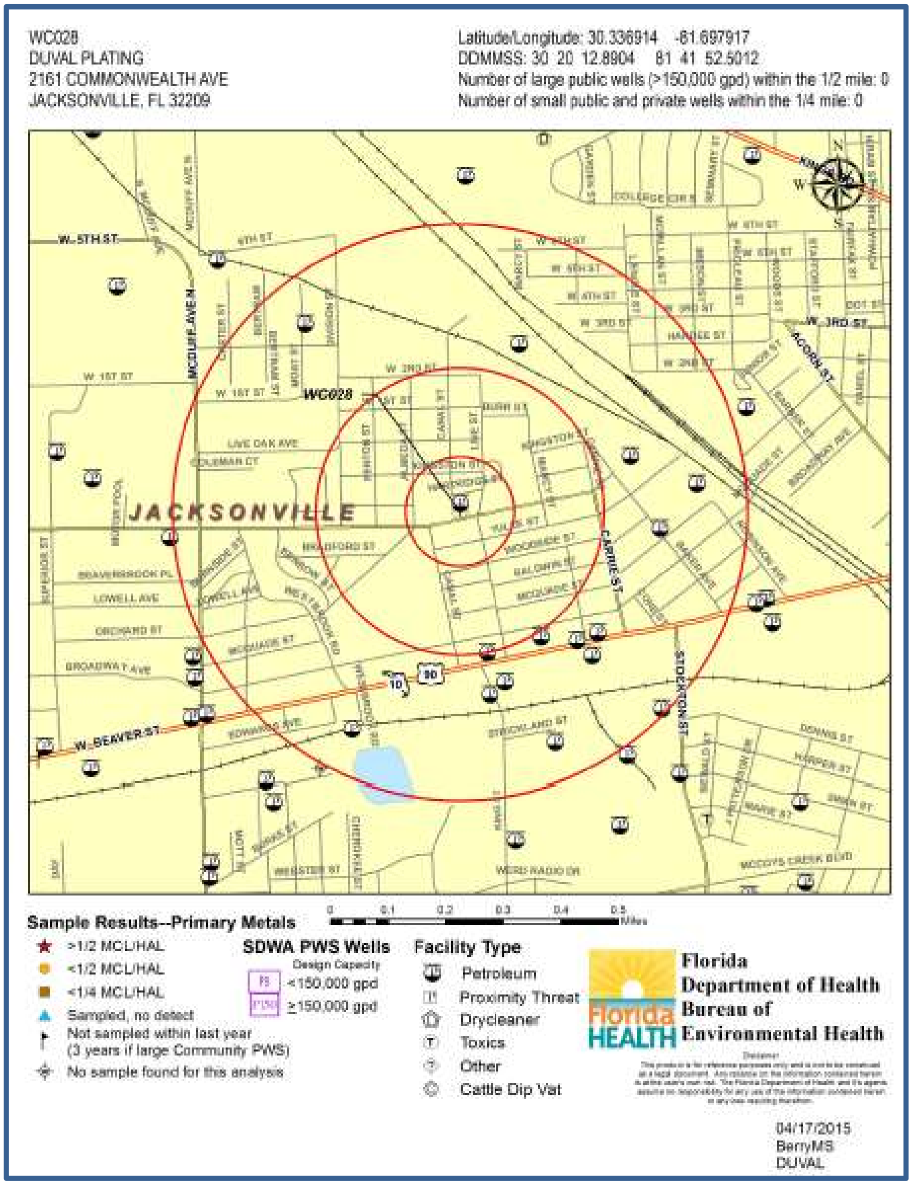
***Off-site environmental data***

***Groundwater environmental data***

Neither Butte, Inc. nor DEP sampled off-site groundwater [Butte 2003, DEP 2017]. Based on high levels of hexavalent chromium and other metals measured in onsite groundwater (Jim McCarthy, DEP unpublished laboratory reports, 2017), off-site movement of contaminants might have occurred. Lack of groundwater quality data southeast (downgradient) of the site is a data gap. Therefore, the Department recommends sampling groundwater southeast of the site [USGS 1998].

No private wells are within one-quarter mile of the site and no public wells are within one-half mile of the site (Figure 9) [DOH 2015].

***Figure 9. Private and public wells near the former Duval Plating site***




***[DOH 2015]***

***Soil environmental data***

EPA tested two off-site surface soil samples for cyanide, mercury, VOAs, and metals (Figure 8) (Jim McCarthy, DEP unpublished laboratory reports, 2017). Levels of antimony, chromium, cyanide, and nickel were not above ATSDR CVs (Table B-5). For this report, off-site soil testing is adequate.

## Pathway Analyses

Exposures occur if a *contamination source* (a chemical above its CV*)* has each of the following:

- an *environmental medium* to hold or transport it; such as air, soil, or water;
- an *exposure point* where people contact it;
- an *exposure route* through which it enters the body; and
- an *exposed population* who contact it.

Spills, leaking containers, poor housekeeping, lack of secondary containment, and outdoor discharge of rinse waters are the *sources of contamination* for the following exposure pathways. The identification of an exposure pathway does not necessarily mean that harm to health will occur.

***Completed exposure pathways***

The Department is not aware of any current completed exposure pathways. Even though the site shows signs of trespassers — *graffiti inside the building* — trespassers currently have no access to contamination. Soil contamination is under concrete/asphalt and groundwater contamination is underground.

***Potential exposure pathways***

Exposures to site contamination might occur in the future if someone built a home on the site and removed the concrete and asphalt. Exposure might also occur if they installed a private well (Table B-1).

***Private Wells***

New private wells on or near the site are potential future pathways. The extent of off-site groundwater contamination is unknown. *Source transport* is the movement of contaminants of concerns into groundwater, the *environmental media*, which may move contaminated groundwater off-site. Future *exposure points* would be household taps that dispense groundwater. The *exposure timeframe* would be in the future, if new residents install private wells.

Future residents who use well water, would be the *exposed population*. Ingestion (drinking) would be the *exposure route.* Metals or cyanide in groundwater would be the *contamination*.

***On-Site Surface Soil***

Surface soil on the site is a potential exposure pathway. The *exposure points* would be places people could touch contaminated surface soil, if the asphalt or building foundation were removed. Young children mouthing toys that had been on the ground or adults eating or smoking after gardening without washing their hands could result in an incidental ingestion (swallowing) *exposure route*. Future residents would be the *exposed population*. The *exposure timeframe* would be in the future.

### *Eliminated exposure pathways*

#### *Private Wells*

People in this area use and have used City of Jacksonville water. Several surveys failed to identify any private wells near the site (Table B-2 and Figure 9). Therefore, a private well exposure pathway currently does not exist and likely did not exist in the past.

#### *Surface Water*

The site has no surface water and no known off-site drainage pathways (Table B-2).

#### *Vapor Intrusion*

Of the groundwater contaminants, only bromoform is volatile and might move into overlying buildings. The levels of bromoform in groundwater are too low, however, to cause vapor intrusion (Appendix A).

#### *Off-Site Surface Soil*

The levels of contaminants of concern in the two surface soil samples northeast of the site were below the ATSDR CVs. The easternmost surface soil on the site and for the surface soil sample on the site in front of the building were also below the ATSDR CVs. Because this sampling brackets soil contamination to areas below and behind the site building, where surface soil is covered and therefore not subject to movement by storm water, we can eliminate off-site soil as an exposure pathway.

## Public Health Risk

### *Contaminants of Concern*

Antimony, bromoform, hexavalent chromium, cyanide, and nickel are contaminants of concern in onsite groundwater. Hexavalent chromium, cyanide, and nickel are contaminants of concern in onsite surface soil.

### *Potential Exposure Pathways*

Tables B-6 through B-13 present doses for the highest levels of contaminants of concern measured in site groundwater and soil. These doses approximate an amount of chemical per body weight for the following:

- Future residents who might use the site shallow groundwater for drinking and other household uses — from a future well they might install on the site
- Future residents who might incidentally ingest surface soil if asphalt or concrete foundations are removed to build a home

Calculated doses for the maximum levels of bromoform in groundwater (Table B-7) and chromium in surface soil (Table B-11) did not exceed their minimal risk levels. As minimal risk levels are doses likely to be without appreciable risk of adverse non-cancer health effects, we don't discuss doses calculated for these chemicals further [ATSDR 2017b].

#### *Groundwater Exposures*

The following sections evaluate the health risk for individual chemicals which might be ingested through drinking and household uses of a future well accessing onsite shallow groundwater.

**Antimony**
Comparison of estimated doses (Table B-6) to the reference dose study shows potential exposure levels would be unlikely to cause harm to health. The highest estimated dose, 0.00010 mg/kg/day for one-year-old children, is 350 times lower than the lowest observable adverse effect level 0.35 mg/kg/day that caused decreased longevity, altered cholesterol levels, and decreased blood glucose in rats [Schroeder et al, 1970, EPA 2017b].

The ability of antimony to cause cancer is unknown [ATSDR 2017c].

**Hexavalent Chromium**
Comparison of estimated hexavalent chromium doses (Table B-8) to a dose causing death (4.1 milligrams per kilogram per day (mg/kg/day)) [Saryan and Reedy 1988, ATSDR 2012] shows these potential doses are too high to rule out the risk of death from exposure by the future private well exposure pathway.

- Doses for 11 to 16-year-olds (0.54 to 1.7 mg/kg/day) are 2 to 8 times less than 4.1 mg/kg/day
- Doses for adults (0.74 to 1.9 mg/kg/day) are 2 to 6 times less than 4.1 mg/kg/day
- Childrens' reasonable maximum exposure (RME) dose from birth to less than one year (6.8 mg/kg/day) is nearly 2 times greater than 4.1 mg/kg/day

Although breathing hexavalent chromium can cause cancer, the ability of ingested hexavalent chromium to cause cancer is unknown [EPA 2017c].

**Cyanide**
Comparison of estimated potential cyanide doses (Table B-9) to the reference-dose study lowest observable adverse effect level indicates harm to health would be unlikely for the future private well exposure pathway. Doses for age groups starting at age 16 (0.0012 to 0.016 mg/kg/day) are 442 to 1,118 times less than the 1.9 mg/kg/day dose causing male reproductive effects in an intermediate rat study [NTP 1993, EPA 2017d].

Cyanide's ability to cause cancer from ingestion is unknown [ATSDR 2006].

**Nickel**
Comparison of estimated potential nickel doses (Table B-10) to the reference-dose study lowest observable adverse effect level indicates harm to health would be unlikely for the future private well exposure pathway. Childrens' maximum doses are 714 to 2,272 times lower than the 50 mg/kg/day dose showing decreased body weights in both sexes, and significantly higher heart-to-body weights ratios and lower liver-to-body weight ratios in females in the reference dose rat study [Ambrose et al. 1976, EPA 2017e].

Soluble salts of nickel as a class of compounds' ability to cause cancer from ingestion is unknown [ATSDR 2005].

***Surface Soil Exposures***
This section evaluates the health risk for future residential use of the site assuming removal of the existing building foundation and asphalt parking lot and no soil clean up. We assumed exposure to the highest measured level because the site is small.

**Cyanide**
Comparison of estimated potential cyanide doses (Table B-12) to the reference-dose study lowest observable adverse effect level indicates harm to health would be unlikely for the future residential yard — surface soil — exposure pathway. Doses for age groups starting at age 16 (0.000041 to 0.0034 mg/kg/day) are 442 to 1,118 times less than the 1.9 mg/kg/day dose causing male reproductive effects in an intermediate rat study [NTP 1993, EPA 2017d].

The ability of cyanide to cause cancer is unknown [ATSDR 2006].

**Nickel**
Comparison of estimated potential nickel doses (Table B-13) to the reference-dose study indicates harm to health would be unlikely for the future residential yard (surface soil) exposure pathway. The maximum dose for children in the future would be more than 100 times lower than the 5 mg/kg/day dose that does not cause any decrease in body or organ weight in rats [Ambrose et al. 1976, EPA 2017e].

Soluble salts of nickel as a class of compounds ability to cause cancer from ingestion is unknown [ATSDR 2005].

***Vapor Intrusion***

Levels of bromoform in the groundwater are not likely to accumulate in the air of overlying buildings (vapor intrusion) at levels that cause illness. The highest level of bromoform in the shallow groundwater (5.6 ug/L) is less than the estimated screening level for vapor intrusion (42 ug/L) (Appendix A).

## Site Specific Limitation of Findings

The lack of air monitoring prevents an evaluation of the past health risk for workers.

## Community Health Concerns

On October 27, 2014, the Superintendent of the Jacksonville School District asked the state to secure and remove hazardous chemicals from the site [DEP 2015], which the EPA did between October 31, 2014 and January 26, 2015.

The Department is unaware of other community health concerns.

## Conclusions

The Department reached four conclusions:

1. In the future, drinking water from new on-site wells could harm health. Ingestion of hexavalent chromium at the levels measured in shallow groundwater could be fatal.

2. Lack of groundwater quality data southeast (downgradient) of the site is a data gap. Based on high levels of hexavalent chromium and other metals in onsite groundwater, off-site movement of contaminants might have occurred.

3. The vapor intrusion exposure pathway is currently incomplete. Bromoform is the only volatile chemical of concern in groundwater. The highest level of bromoform is insufficient to cause indoor air vapor intrusion in a future on-site residence. The area of bromoform contamination is small and does not extend off site.

4. The Department cannot conclude whether past exposures to site chemicals harmed workers' health. Exposure data for site workers is lacking.

## Recommendations

1. The Department recommends against installing drinking water wells on the site.

2. The Department recommends testing of groundwater southeast of the site.

## Public Health Action Plan

### Actions Undertaken

1. At an October 24, 2014 fire prevention meeting, the City of Jacksonville Environmental Quality and the Jacksonville Fire and Rescue staff determined site conditions posed a risk of explosion and fire, which could impact the health of nearby residents and children from the elementary school 600 feet east of the site.

2. EPA, DEP, the City of Jacksonville's Environmental Quality Division, and the Jacksonville Fire and Rescue Department coordinated a multi-agency response on October 29, 2014. EPA issued a notice of Federal Assumption of Response Actions.

3. The Department surveyed the area for private wells in 2009, 2010, 2015, and 2016 but did not find any within one-quarter mile of the site.

4. Department staff visited the site in June 2017 and documented the proximity of homes and schools, the locked and fenced status of the site, and the poor condition of the site building's roof with photographs.

**Actions Planned**

1. The Department will continue to collaborate with DEP and the Department of Health in Duval County.

2. The Department will consider reviewing additional data on request.

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http://viewer.nationalmap.gov/basic/?basemap=b1&category=histtopo,ustopo&title=Map%20View#startUp.

## Preparers of the Report

Department health assessors prepared this health consultation for the Duval Plating site under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. The findings and conclusions in this report are those of the Department and do not necessarily represent the views of ATSDR or DHHS. ATSDR has not revised or edited this document. Nevertheless, the Department prepared it in accordance with approved ATSDR methods, policies, and procedures.


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## Appendices

## Appendix A: Explanation of Evaluation Process

### Screening Process

In evaluating these data, health assessors used comparison values (CVs) to determine which chemicals to examine more closely. Health assessors used CVs to screen contaminants for further evaluation. CVs are health-based contaminant concentrations found in a specific media (soil or water). They incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone might inhale or ingest each day in a residential-type exposure.

As health-based thresholds, ATSDR sets CVs at concentrations below which known or anticipated adverse human health effects are expected to occur. ATSDR develops different CVs for cancer and noncancer health effects. For chemicals that have cancer and noncancer CVs exist, health assessors use the lower CV level to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

Health assessors list the CVs used in preparing this document below:

*Cancer Risk Evaluation Guides (CREGs)* — ATSDR's estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in 1 million persons exposed over a lifetime. CREGs are calculated from EPA cancer slope factors.

*Environmental Media Evaluation Guides (EMEGs)* — ATSDR calculates EMEGs like CVs, but sets levels for specific durations. ATSDR defines 14 days or less as acute exposures, 15 days to 1 year as intermediated exposures, and longer that 1 year as chronic exposures. Health assessors use children's EMEGs because they the most protective.

*Maximum Contaminant Levels (MCLs)* — EPA sets enforceable drinking water standards for the highest level of a contaminant allowed in drinking water. EPA sets MCLs as close to MCL goals (the level of a contaminant in drinking water below which there is no known or expected risk to health) as feasible using the best available treatment technology and taking cost of remediation into consideration.

***Minimal Risk Level (MRLs) – Developed by ATSDR***

A minimal risk level is an estimate of daily human exposure, by a specified route and length of time, to a dose of chemical that is likely to be without a measurable risk for adverse, noncancerous effects. A minimal risk level should not be used as a predictor of adverse health effects. A list of minimal risk levels can be found at http://www.atsdr.cdc.gov/mrls/index.html.

### Estimation of Exposure Dose

For this report, Health assessors estimate the *exposure dose*, or the amount of contaminant that might get into a person's body for the ingestion pathway. Health assessors express dose in milligrams of contaminant per kilogram of body weight of the person exposed, per day (mg/kg/day). These units allow us to compare site-related doses with toxicological studies.

To do these estimates, health assessors use Public Health Assessment Site Tool (PHAST) software that uses assumptions about weight and other body characteristics of children and adults exposed, how they might be exposed, and how often they might be exposed to allow estimation of site-specific and pathway-specific exposure dose [ATSDR 2016b]. We use assumptions for residential exposure; this means people who might be exposed daily, throughout the year, and for years at a time. Assumptions for residents' exposures result in higher calculated doses than those that would result from workers' or visitors' exposure assumptions.

The following sections details the exposure assumptions and calculation of exposure dose for the pathways evaluated in this report using PHAST software.

***Ingestion of chemicals in drinking water***

The PHAST spreadsheet calculates estimated exposure doses for users of private well water assuming the average weights and drinking water ingestion rates listed in Table A-1 below. The PHAST spreadsheets use the drinking water equations shown in the example that follows and the highest chemical concentration measured in groundwater. Health assessors list the dose results for the chemicals of concern in Tables B-6 through B-10.

***Table A-1. Future on-site private well pathway, Duval Plating site, Jacksonville, FL Estimates for body weight and drinking water ingestion***

| Age group | Body weight in kilograms (weight in pounds) * | Ingestion of drinking water in liters per day (approximate 8-ounce glasses per day)† | |
|---|---|---|---|
| | | High-end | Average |
| 6 weeks to 1 year | 9.2 kg (20 lb.) | 1.1 L/day (5 glasses/day) | 0.5 L/day (2 glasses/day) |
| 1 year to 2 years | 11.4 kg (25 lb.) | 0.9 L/day (4 glasses/day) | 0.4 L/day (2 glasses/day) |
| 2 years to 3 years | 13.8 kg (30 lb.) | 0.9 L/day (4 glasses/day) | 0.5 L/day (2 glasses/day) |
| 3 years to 6 years | 18.6 kg (41 lb.) | 1.0 L/day (4 glasses/day) | 0.6 L/day (2.5 glasses/day) |
| 6 years to 11 years | 31.8 kg (70 lb.) | 1.4 L/day (6 glasses/day) | 0.5 L/day (2 glasses/day) |
| 11 years to 16 years | 56.8 kg (125 lb.) | 2 L/day (8 glasses/day) | 0.6 L/day (2.5 glasses/day) |
| 16 years to 21 years | 71.6 kg (158 lb.) | 2.5 L/day (11 glasses/day) | 0.8 L/day (3.5 glasses/day) |
| 21 years or older | 80 kg (176 lb.) | 3.0 L/day (13 glasses/day) | 1.2 L/day (5 glasses/day) |

kg = kilogram; lb. = pound; L/day = liters per day.
* Weight for children and adults obtained from Table 8-1 of [EPA 2011], recommended values for body weight (males and females combined). (Weighted averages used to obtain body weight for specific age ranges listed in this table.)
† Ingestion rates obtained from Tables 3-1 and 3-3 of [EPA 2011], consumers-only ingestion of drinking water, High-end = 95th percentile, Average = mean. (Weighted averages used to obtain ingestion for specific age ranges listed in this table.)

For example, a child younger than 1 year old (average weight 7.8 kg), drinking 1.1 liters of water (about five 8-ounce glasses), containing the highest concentration of hexavalent chromium (48 mg/L), every day will receive a dose calculated as follows:

$$Dose = (48\ mg/L \times 1.1\ L/day)/\ 7.8\ kg = 6.8\ mg/kg/day$$

**Evaluating Noncancer Groundwater Ingestion Health Effects**
Health assessors use this formula to calculate potential groundwater doses in the PHAST spreadsheet and list those doses by age group in Tables B-6 through B-10 [ATSDR 2016b].

If the estimated exposure dose for a chemical is less than the health guideline value, then the exposure is unlikely to cause a noncancer health effect in that specific situation. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared to known toxicological values for that chemical and is discussed in more detail in the public health assessment. Health guidelines are doses derived from human and animal studies from the ATSDR *Toxicological Profiles* (available at https://www.atsdr.cdc.gov/toxprofiles/index.asp). A direct comparison of site-specific exposures and doses to study-derived exposures and doses that cause adverse health effects is the basis for deciding whether health effects are likely or not.

For our example, health assessors compared the calculated exposure dose, 6.8 mg/kg/day (for RME exposed children 0 to 1 year old), to the hexavalent chromium minimal risk level, 0.0009 mg/kg/day [ATSDR 2017b]. Our calculated dose is 1,111 times higher than the chronic minimal risk level, and is nearly twice the lethal lowest observable effect level, 4.1 mg/kg/day, [Saran ad Reedy 1988].

***Ingestion of Chemicals in Surface Soil***
The PHAST spreadsheet calculates estimated exposure doses for incidental or accidental ingestion of contaminated soil using the weights and soil ingestion rates in Table A-2 below.

***Table A-2. Future soil exposure pathway, Duval Plating and Supply site, Jacksonville, Florida. Estimates for body weight and soil ingestion***

| Age group (years) Birth to <1 | Body Weight in Kilograms (Weight in Pounds) | Ingestion of Soil in Milligrams per Day | |
|---|---|---|---|
| | | High-end | Average |
| 1 to <2 | 9.2 kg (20 lb.) | 100 mg/day | 60 mg/day |
| 2 to <3 | 11.4 kg (25 lb.) | 200 mg/day | 100 mg/day |
| 3 to <6 | 17.4 kg (38 lb.) | 200 mg/day | 100 mg/day |
| 6 to <11 | 31.8 kg (70 lb.) | 200 mg/day | 100 mg/day |
| 11 to <16 | 56.8 kg (125 lb.) | 200 mg/day | 100 mg/day |
| 16 to <21 | 71.6 kg (158 lb.) | 200 mg/day | 100 mg/day |
| ≥21 | 80 kg (176 lb.) | 100 mg/day | 50 mg/day |

kg = kilogram; lb. = pound; L/day = liters per day.
* Weight for children and adults obtained from Table 8-1 of [EPA 2011], recommended values for body weight (males and females combined). (Weighted averages used to obtain body weight for specific age ranges listed in this table.)
† Ingestion rates obtained from Tables 3-1 and 3-3 of [EPA 2011], consumers-only ingestion of drinking water, High-end = 95th percentile, Average = mean. (Weighted averages used to obtain ingestion for specific age ranges listed in this table.)

The PHAST spreadsheet calculates the residential soil exposure dose using the equation:

$$\text{Dose} = (C \times IR \times EF \times CF)/BW\text{, where;}$$

C = Concentration in soil
IR = Ingestion Rate from Table A-2
EF = Exposure Factor
CF = Conversion Factor
BW = Body Weight from Table A-2

For example, a child younger than 1 year old (average weight 9.2 kg), incidentally ingesting 100 mg of soil per day (about ½ a postage stamp's weight) containing the highest concentration of cyanide (260 mg/kg), every day, will receive a dose calculated as follows:

$$Dose = (260\ mg/kg \times 100\ mg/day \times 0.000001\ kg/mg)/\ 9.2\ kg = 0.002\ mg/kg/day$$

**Evaluating Noncancer Soil Ingestion Health Effects**

Health assessors use this formula to calculate potential soil doses in the PHAST spreadsheet and list those doses by age group in Tables B-11 through B-13 [ATSDR 2016b]. We then compare the calculated exposure doses to an appropriate health guideline for that chemical, in this case the cyanide RfD, 0.00063 mg/kg/day [ATSDR 2017b]. This dose is higher than the RfD.

**Evaluating Cancer Health Effects (for bromoform in groundwater)**

The estimated risk for developing cancer resulting from exposure to the contaminants was calculated by multiplying the estimated cancer dose by an appropriate cancer slope factor (EPA cancer slope factors can be found at http://www.epa.gov/iris). The result estimates the increase in risk for developing cancer after 33 years of continuous exposure to the contaminant, averaged over a 78-year lifetime.

The actual increased risk for cancer might be lower than the calculated number, which gives an estimated risk for excess cancer. The methods used to calculate cancer slope factors assume that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The methods also assume that no safe level exists for exposure. Little experimental evidence is available to confirm or refute those two assumptions. Lastly, most methods compute the upper 95th percentile confidence limit for the risk. The actual cancer risk can be lower, perhaps by orders of magnitude [ATSDR 2005].

Because of uncertainties involved in estimating cancer risk, ATSDR employs a weight-of-evidence approach in evaluating relevant data [ATSDR 1993]. Therefore, the increased risk for cancer is described in words (qualitatively) rather than giving a numerical risk estimate only. Numerical risk estimates must be considered in the context of the variables and assumptions involved in calculating those estimates and in the broader context of biomedical opinion, host factors, and actual exposure conditions.

**Only one of the chemicals of concern, bromoform, is carcinogenic via the ingestion exposure route**. Cancer risk calculation (health assessors assume exposures of 21 years at various childhood weights and 12 years, from age 21 to age 33, at adult weight, for our calculations).

$$\text{Dose} = (C \times IR \times EF \times CF)/BW$$
$$EF = (F \times ED)/AT$$
$$\text{Cancer risk} = CSF \times \text{dose}$$

Assumptions:
C = concentration = 0.0056 mg/kg
IR = ingestion rate (see Table A-2 for child and young adult ingestion rates)
BW = body weight (see Table A-2 for child and young adult body weights)
EF = exposure factor = 0.45
F = frequency =350 days per year
ED = exposure duration = 33 years
CF = conversion factor ($10^{-6}$ kg/mg)
AT = averaging time = 25,500 days (78 years)
CSF = cancer slope factor = 130,000 $(\text{mg/kg/day})^{-1}$

The PHAST spreadsheet calculates cancer risk doses (but doesn't report them), then multiplies the cancer risk dose for RME exposures by age group and reports a summed dose for childrens' exposures and a single dose for adults' exposures.

The PHAST RME cancer risk total is a sum of childrens' 21 year RME cancer risk and 12-year adults' RME exposure at the same residence. The PHAST spreadsheet multiplies the adult 33 year RME cancer risk ($7.2 \times 10^{-7}$) by 12 and divides by 33 to get $2.6 \times 10^{-7}$, the adult 12-year exposure risk. The PHAST spreadsheet adds the adults' 12-year RME cancer risk ($2.6 \times 10^{-7}$) to childrens' 21-year exposure ($5.7 \times 10^{-7}$) to get the 33-year RME cancer risk, 8.4 $\times 10^{-7}$ (reported in Table B-7):

$$\text{RME total cancer risk} = 8.4 \times 10^{-7}$$

**Evaluation of potential for vapor intrusion from contaminated surficial aquifer groundwater [ATSDR 2016a]**

Bromoform is the only volatile contaminant of concern [EPA 2016]. Health assessors used ATSDR's air CVs, EPA's recommended screening attenuation factors [EPA 2015b] and the following equation to derive a screening level for bromoform in surficial aquifer groundwater. This equation allows us to determine the bromoform level in shallow groundwater that might lead to vapor intrusion in a building above it at its CV.

$CV_{gw} = CV_{air} / (H' * \alpha_{gw})$,

Where $CV_{gw}$ = screening level in groundwater,

$CV_{air}$ = ATSDR's air CV,

H' = unitless Henry's Law constant for bromoform (0.0219) [EPA 2016], and

$\alpha_{gw}$ = EPA's recommended screening groundwater attenuation factor 0.001 [EPA 2015b]

$CV_{gw} = (0.91\ ug/m^3) / (0.0219 * 0.001)$

$CV_{gw} = 0.91\ ug/m^3/0.0000219$

$CV_{gw} = 41{,}552.5\ ug/m^3$

As you want groundwater concentrations in µ/L, multiply by 0.001 $m^3/L$, thus:

$CV_{gw} = 41{,}552.5\ ug/m^3 * 0.001\ m^3/L = 41.55\ \mu g/L$ bromoform in surficial groundwater will equal the CV of 0.91 $ug/m^3$

The highest measured bromoform value in shallow groundwater was 0.0056 mg/L or 5.6 µg/L, this amount is 7.4 times less than 41.55 µg/L: if a home was built above this shallow groundwater, vapor intrusion would be unlikely.

**Appendix B. Tables**

*Table B-1. Potential human exposure pathways, Duval Plating site*

| Pathway Name | Exposure Pathway Elements | | | | | Timeframe |
|---|---|---|---|---|---|---|
| | **Source** | **Environmental Media** | **Point of Exposure** | **Route of Exposure** | **Potentially Exposed Population** | |
| Future private wells | Waste disposal on the Duval Plating site | Groundwater | Water taps of residences using private wells | Ingestion | Future residents | Future |
| On-site surface soil | Waste disposal on the Duval Plating site | Surface soil | On-site source areas | Ingestion | Future residents | Future |

*Table B-2. Eliminated human exposure pathways, Duval Plating site*

| Pathway Name | Exposure Pathway Elements | | | | | Timeframe |
|---|---|---|---|---|---|---|
| | **Source** | **Environmental Media** | **Point of Exposure** | **Route of Exposure** | **Exposed Population** | |
| Past and present private wells | Waste disposal on the Duval Plating site | Groundwater | Water taps of nearby residences using private wells | Ingestion | None | Past and present |
| Surface water | Waste disposal on the Duval Plating site | No surface water | None | None | None | --- |
| Vapor intrusion | Waste disposal on the Duval Plating site | Indoor air | Inside on- and off-site buildings | Inhalation | Nearby residents and workers | Past, present, and future |
| Off-site surface soil | Waste disposal on the Duval Plating site | Soil | Off-site yards | Ingestion | None | --- |

*Table B-3. Contaminants of concern in Duval Plating site groundwater*

| Contaminants | Concentration Range (mg/L) | Screening Guideline* (mg/L) | Source of Screening Guideline | # Above Screening Guideline/Total # |
|---|---|---|---|---|
| antimony | 0.001U – 0.0072 | 0.0028 | ATSDR $C^{\#}$ RMEG | 2/6 |
| bromoform | 0.005U – 0.0056 | 0.0031 | ATSDR CREG | 1/5** |
| chromium VI | 0.001U – 48 | 0.0063 | ATSDR $C^{\#}$ EMEG | 3/6 |
| cyanide | 0.0063 – 0.71 | 0.0044 | ATSDR $C^{\#}$ RMEG | 3/4*** |
| nickel | 0.01U – 0.500 | 0.14 | ATSDR $C^{\#}$ RMEG | 3/6 |

ATSDR = Agency for Toxic Substances and Disease Registry
$C^{\#}$ = Screening level for children
CREG = ATSDR cancer risk evaluation guide for $10^{-6}$ excess cancer risk
EMEG = ATSDR Environmental Media Evaluation Guide
RMEG = Reference Dose Media Evaluation Guide
mg/L = milligrams per liter
* Health assessors use screening guidelines only to select chemicals for further scrutiny, not to the judge the risk of health impact
** 4 samples did not detect bromoform at the level of 0.005 mg/L which is above the CV; therefore; the actual amount of bromoform in these samples (below 0.005 mg/L) cannot be compared to the screening guideline, and 1 well was not sampled for bromoform
*** 1 sample did not detect cyanide at the level of 0.01 mg/L which is above the CV, therefore the actual amount of cyanide in this sample (below 0.01 mg/L) cannot be compared to the screening guideline, and 2 wells were not sampled for cyanide
**Source of data:** (Jim McCarthy, DEP unpublished data, 2017)

*Table B-4. Contaminants of concern in Duval Plating on-site surface soil*

| Contaminants | Concentration Range (mg/kg) | Screening Guideline* (mg/kg) | Source of Screening Guideline | # Above Screening Guideline/Total # |
|---|---|---|---|---|
| antimony | 4.1 – 6.2U | 23 | ATSDR C# RMEG | 0/9 |
| bromoform | 5.5J – 7.9U | 47 | ATSDR CREG | 0/9 |
| chromium | 3.5 – 1,200 | 51 | ATSDR C# EMEG | 2/9 |
| cyanide | 0.31J – 260 | 36 | ATSDR C# RMEG | 1/9 |
| nickel | 1.9 – 1,400 | 1,100 | ATSDR C# RMEG | 1/9 |

ATSDR–Agency for Toxic Substances and Disease Registry
C# = Screening level for children
CREG = ATSDR cancer risk evaluation guide for $10^{-6}$ excess cancer risk
EMEG = ATSDR Environmental Media Evaluation Guide
RMEG = Reference Dose Media Evaluation Guide
mg/kg = milligrams per kilogram
* Health assessors use screening guidelines only to select chemicals for further scrutiny, not to the judge the risk of health impact
**Source of data:** (Jim McCarthy, DEP unpublished data, 2017)

*Table B-5. Contaminants of concern in off-surface soil*

| Contaminants | Concentration Range (mg/kg) | Screening Guideline* (mg/kg) | Source of Screening Guideline | # Above Screening Guideline/Total # |
|---|---|---|---|---|
| antimony | 0.50J – 0.58J | 23 | ATSDR C# RMEG | 0/2 |
| bromoform | 7.1U – 10U | 47 | ATSDR CREG | 0/2 |
| chromium | 7.8 – 22 | 51 | ATSDR C# EMEG | 0/2 |
| cyanide | 0.5J – 0.57J | 36 | ATSDR C# RMEG | 0/2 |
| nickel | 27 – 31 | 1,100 | ATSDR C# RMEG | 0/2 |

ATSDR–Agency for Toxic Substances and Disease Registry
C# = Screening level for children
CREG = ATSDR cancer risk evaluation guide for $10^{-6}$ excess cancer risk
EMEG = ATSDR Environmental Media Evaluation Guide
RMEG = Reference Dose Media Evaluation Guide; a reference dose is the EPA's maximum acceptable oral dose of a toxic substance
mg/kg = milligrams per kilogram
* Health assessors use screening guidelines only to select chemicals for further scrutiny, not to the judge the risk of health impact
**Source of data:** (Jim McCarthy, DEP unpublished data, 2017)

***Abbreviations and explanations for the ATSDR Public Health Assessment Site Tool (PHAST), source of tables that follow***

Health assessors used PHAST to calculate doses for potential residential site use. PHAST generated tables B-6 through B-13. We explain the abbreviations, footnotes, and assumptions used on these tables here.

**Chronic** = Daily exposures, lasting longer than one year. Generally, the default for residential exposure scenarios.
**CSF** = cancer slope factor, explained in Appendix A.
**CTE =** central tendency exposure, explained in Appendix A.
**ED** = exposure duration.
**Intermediate =** Daily exposures, lasting 14 to 365 days. Generally, implies greater toxicity than for chronic exposures.
**mg/kg/day** = dose expressed as milligrams per kilogram of body weight per day.
**mg/L** = milligrams per liter.
**MRL** = minimal risk level: An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk for harmful (adverse), noncancerous effects.
**NA** = not available.
**NA[1]** = Carcinogenicity not determined. Cancer risk was not calculated; calculation is not available.
**NA[2]** = No cancer slope factor. Cancer risk was not calculated; calculation is not available.
**NC** = Not calculated.
**RfD** = The EPA defines an oral reference dose as an estimate, with uncertainty spanning perhaps an order of magnitude, of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
**RME =** reasonable maximum exposure, explained in Appendix A.
[§] Cancer risk (CR) is derived for both CTE (12 years) and RME (33 years) residential occupancy periods. For children, CRs are derived for a combined child receptor: CTE (12 years) and RME (21 years) at a given residence. For the CTE child CR, the combined child is the sum of the cancer risks for each age group for the first 12 years of exposure only. The RME CR for the combined child is derived by summing all the cancer risks for each age group from birth to < 21 years. The adult CR assumes living at the residence for 12 (CTE) or 33 (RME) years, explained in Appendix A.
[Ω] Cancer risks are not calculated for pregnant women and lactating women. Their cancer risks are like an adult woman exposed for 33 years. Calculating cancer risks for pregnant women and lactating women, required site-specific scenario information.

Where hazard quotients exceed one (shaded cells) the doses exceed the minimal risk level or reference dose; levels at which no harm to health is expected; therefore, we further evaluate the chemical.

*Table B-6. Estimated antimony doses for future residential use of Duval Plating groundwater*

| Exposure Group | Default Residential Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk[§] | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **ANTIMONY (maximum concentration: 0.0072 mg/L; Chronic RfD: 0.0004 mg/kg/day; CSF: NA[1])** | | | | | | | | |
| Birth to < 1 year | 0.00047 | 0.0010 | 1.2 | 2.6 | NC | 1 | NC | 1 |
| 1 to < 2 years | 0.00019 | 0.00056 | 0.49 | 1.4 | | 1 | | 1 |
| 2 to < 6 years | 0.00016 | 0.00040 | 0.39 | 1.0 | | 4 | | 4 |
| 6 to < 11 years | 0.00012 | 0.00032 | 0.29 | 0.79 | | 5 | | 5 |
| 11 to < 16 years | 0.000081 | 0.00025 | 0.20 | 0.63 | | 1 | | 5 |
| 16 to < 21 years | 0.000077 | 0.00025 | 0.19 | 0.61 | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.00011 | 0.00028 | 0.28 | 0.70 | NC | 12 | NC | 33 |
| Pregnant Women | 0.000086 | 0.00026 | 0.22 | 0.64 | NC | | | |
| Lactating Women | 0.00016 | 0.00035 | 0.41 | 0.88 | NC | | | |

*Table B-7. Estimated bromoform doses and cancer risks for future residential use of Duval Plating groundwater*

| Exposure Group | Default Residential Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk[§] | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **BROMOFORM (maximum concentration: 0.0056 mg/L; Chronic MRL: 0.02 mg/kg/day; CSF: 0.0079 $(mg/kg/day)^{-1}$)** | | | | | | | | |
| Birth to < 1 year | 0.00036 | 0.00080 | 0.018 | 0.040 | 1.5E-7 | 1 | 5.7E-7 | 1 |
| 1 to < 2 years | 0.00015 | 0.00044 | 0.0076 | 0.022 | | 1 | | 1 |
| 2 to < 6 years | 0.00012 | 0.00031 | 0.0061 | 0.016 | | 4 | | 4 |
| 6 to < 11 years | 0.00009 | 0.00025 | 0.0045 | 0.012 | | 5 | | 5 |
| 11 to < 16 years | 0.00006 | 0.00019 | 0.0031 | 0.0097 | | 1 | | 5 |
| 16 to < 21 years | 0.00006 | 0.00019 | 0.0030 | 0.0096 | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.00009 | 0.00022 | 0.0043 | 0.011 | 1.0E-7 | 12 | 7.2E-7 | 33 |
| Pregnant Women | 0.00007 | 0.00020 | 0.0033 | 0.0099 | NC [Ω] | | | |
| Lactating Women | 0.00013 | 0.00028 | 0.0064 | 0.014 | NC [Ω] | | | |
| Birth to < 21 years + 12 years during adulthood | Do not use this cancer risk unless you have a scenario where children are likely to continue to live in their childhood home as adults. | | | | | | 8.4E-7 | 33 |

*Table B-8. Estimated hexavalent chromium doses for future residential use of Duval Plating groundwater*

| Exposure Group | Default Residential Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk§ | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **CHROMIUM, HEXAVALENT (maximum concentration: 48 mg/L; Chronic MRL: 0.0009 mg/kg/day; CSF: NA[2]; ADAF mutagen)** | | | | | | | | |
| Birth to < 1 year | 3.1 | 6.8 | 3,400 | 7,600 | NC | 1 | NC | 1 |
| 1 to < 2 years | 1.3 | 3.8 | 1,400 | 4,200 | | 1 | | 1 |
| 2 to < 6 years | 1.0 | 2.7 | 1,200 | 3,000 | | 4 | | 4 |
| 6 to < 11 years | 0.77 | 2.1 | 860 | 2,400 | | 5 | | 5 |
| 11 to < 16 years | 0.54 | 1.7 | 600 | 1,900 | | 1 | | 5 |
| 16 to < 21 years | 0.52 | 1.6 | 570 | 1,800 | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.74 | 1.9 | 820 | 2,100 | NC | 12 | NC | 33 |
| Pregnant Women | 0.57 | 1.7 | 640 | 1,900 | NC | | | |
| Lactating Women | 1.1 | 2.4 | 1,200 | 2,600 | NC | | | |

*Table B-9. Estimated cyanide doses for future residential use of Duval Plating groundwater*

| Exposure Group | Default Residential Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk § | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **CYANIDE (maximum concentration: 0.11 mg/L; Chronic RfD: 0.001 mg/kg/day; CSF: NA[1])** | | | | | | | | |
| Birth to < 1 year | 0.0071 | 0.016 | 11 | 25 | NC | 1 | NC | 1 |
| 1 to < 2 years | 0.0030 | 0.0086 | 4.7 | 14 | | 1 | | 1 |
| 2 to < 6 years | 0.0024 | 0.0062 | 3.8 | 9.8 | | 4 | | 4 |
| 6 to < 11 years | 0.0018 | 0.0049 | 2.8 | 7.7 | | 5 | | 5 |
| 11 to < 16 years | 0.0012 | 0.0038 | 2.0 | 6.1 | | 1 | | 5 |
| 16 to < 21 years | 0.0012 | 0.0038 | 1.9 | 6.0 | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.0017 | 0.0043 | 2.7 | 6.7 | NC | 12 | NC | 33 |
| Pregnant Women | 0.0013 | 0.0039 | 2.1 | 6.2 | NC | | | |
| Lactating Women | 0.0025 | 0.0054 | 4.0 | 8.6 | NC | | | |

*Table B-10. Estimated nickel doses for future residential use of Duval Plating groundwater*

| Exposure Group | Default Residential Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk § | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **NICKEL (maximum concentration: 0.5 mg/L; Chronic RfD: 0.02 mg/kg/day; CSF: NA[2])** | | | | | | | | |
| Birth to < 1 year | 0.032 | 0.071 | 1.6 | 3.6 | NC | 1 | NC | 1 |
| 1 to < 2 years | 0.014 | 0.039 | 0.68 | 2.0 | | 1 | | 1 |
| 2 to < 6 years | 0.011 | 0.028 | 0.54 | 1.4 | | 4 | | 4 |
| 6 to < 11 years | 0.0080 | 0.022 | 0.40 | 1.1 | | 5 | | 5 |
| 11 to < 16 years | 0.0056 | 0.017 | 0.28 | 0.87 | | 1 | | 5 |
| 16 to < 21 years | 0.0054 | 0.017 | 0.27 | 0.85 | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.0077 | 0.019 | 0.38 | 0.97 | NC | 12 | NC | 33 |
| Pregnant Women | 0.0060 | 0.018 | 0.30 | 0.89 | NC | | | |
| Lactating Women | 0.011 | 0.025 | 0.57 | 1.2 | NC | | | |

***Table B-11. Estimated chromium doses for future residential exposure to Duval Plating surface soil***

| Exposure Group | Default Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk § | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **CHROMIUM (maximum concentration: 1,200 mg/kg; Chronic MRL/RfD: NA; CSF: NA[1])** | | | | | | | | |
| 6 weeks to < 1 year | 0.0093 | 0.015 | NC | NC | NC | 0.88 | NC | 0.88 |
| 1 to < 2 years | 0.011 | 0.022 | NC | NC | | 1 | | 1 |
| 2 to < 6 years | 0.0073 | 0.014 | NC | NC | | 4 | | 4 |
| 6 to < 11 years | 0.0041 | 0.0078 | NC | NC | | 5 | | 5 |
| 11 to < 16 years | 0.0023 | 0.0045 | NC | NC | | 1 | | 5 |
| 16 to < 21 years | 0.0019 | 0.0036 | NC | NC | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.00081 | 0.0016 | NC | NC | NC | 12 | NC | 33 |

*Table B-12. Estimated cyanide doses for future residential exposure to Duval Plating surface soil*

| Exposure Group | Default Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk § | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **CYANIDE (maximum concentration: 260 mg/kg; Chronic RfD: 0.00063 mg/kg/day; CSF: NA[1])** | | | | | | | | |
| 6 weeks to < 1 year | 0.0020 | 0.0033 | 3.2 | 5.2 | | 0.88 | | 0.88 |
| 1 to < 2 years | 0.0024 | 0.0047 | 3.8 | 7.4 | | 1 | | 1 |
| 2 to < 6 years | 0.0016 | 0.0031 | 2.5 | 4.9 | NC | 4 | NC | 4 |
| 6 to < 11 years | 0.00088 | 0.0017 | 1.4 | 2.7 | | 5 | | 5 |
| 11 to < 16 years | 0.00051 | 0.00097 | 0.81 | 1.5 | | 1 | | 5 |
| 16 to < 21 years | 0.00041 | 0.00077 | 0.65 | 1.2 | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.00018 | 0.00034 | 0.28 | 0.54 | NC | 12 | NC | 33 |

*Table B-13. Estimated nickel doses for future residential exposure to Duval Plating surface soil*

| Exposure Group | Default Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Chronic Dose (mg/kg/day) | | Chronic Hazard Quotient | | Cancer Risk § | | | |
| | CTE | RME | CTE | RME | CTE | ED (years) | RME | ED (years) |
| **NICKEL (maximum concentration: 1,400 mg/kg; Chronic RfD: 0.02 mg/kg/day; CSF: NA[2])** | | | | | | | | |
| 6 weeks to < 1 year | 0.025 | 0.032 | 1.3 | 1.6 | NC | 0.88 | NC | 0.88 |
| 1 to < 2 years | 0.026 | 0.039 | 1.3 | 1.9 | | 1 | | 1 |
| 2 to < 6 years | 0.018 | 0.027 | 0.92 | 1.3 | | 4 | | 4 |
| 6 to < 11 years | 0.013 | 0.017 | 0.64 | 0.86 | | 5 | | 5 |
| 11 to < 16 years | 0.0092 | 0.012 | 0.46 | 0.58 | | 1 | | 5 |
| 16 to < 21 years | 0.0079 | 0.0099 | 0.40 | 0.49 | | 0 | | 5 |
| Total exposure duration for child cancer risk | | | | | | 12 | | 21 |
| Adult | 0.0027 | 0.0036 | 0.14 | 0.18 | NC | 12 | NC | 33 |

**Appendix C: Chemical Toxicity Information**

The toxicological summaries for the chemicals of concern provided in this appendix are from ATSDR's Toxicological Profiles. These summaries include health effects for all levels of exposure. **Health assessors do not expect the effects listed.**

**The health effects discussed in the Public Health Section might only be expected for exposures in the future; if the concrete and asphalt on the site are removed and people could contact contaminated soil, or if a drinking water well is installed and people use it for their household water source.**

For chemicals with potential doses above their minimal risk levels, the chance that a health effect might occur will be dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons. Although bromoform is a contaminant of concern, it's not included in this section because calculations showed no doses above the bromoform minimal risk level.

**Antimony.** Based on site records, workers may have used antimony for silver-plating metal. Antimony is a naturally occurring metal found in rocks. It is mixed with other metals to form antimony alloys, because antimony metal is too brittle to use by itself. Testing only found antimony above its CV in groundwater on the site.

High levels of antimony in drinking water can cause vomiting and abdominal pain. These effects have also been reported by antimony workers. Stomach ulcers have been seen in animals exposed to antimony in drinking water for several months. Long-term animal studies have reported liver damage and blood changes when animals ingested antimony. Antimony can irritate the skin if it is left on it [ATSDR 2017b].

Antimony can have beneficial effects when used for medical reasons. It has been used as a medicine to treat people infected with parasites.

Lung cancer has been observed in some studies of workers, and mice breathing high concentrations of antimony. The International Agency for Research on Cancer has determined that antimony trioxide is possibly carcinogenic to humans (group 2B) and antimony trisulfide is not classifiable as to its carcinogenicity (group 3). Antimony has not been classified for cancer effects by the Department of Health and Human Services or the EPA.

Little information is available addressing whether children would be more susceptible to antimony toxicity than adults. Studies in rats have shown that antimony can slow developing rats' growth and can damage their developing cardiovascular systems.

**Chromium.** Chromium is a naturally occurring element found in rocks, animals, plants, and soil. The three main forms of chromium are chromium(0), chromium(III) (trivalent form), and chromium(VI) (hexavalent form). Valence refers to the number of bonding sites a chemical has available. Chromium can change from one form to another in water and soil, depending on the conditions present. Small amounts of chromium(III) are a necessity for human health. Chromium (III) is an essential nutrient that occurs naturally in food and helps the body process sugar, protein, and fat [ATSDR 2012].

Chromium compounds are stable in the trivalent state, and occur in nature most commonly at this oxidation level. Hexavalent chromium compounds are the next most stable form; however, these rarely occur in nature and are typically associated with industrial sources. The hexavalent form of chromium is much more toxic than the trivalent form. Chromium(VI) is used in liquid form to electroplate metals.

The main health problems seen in animals following ingestion of chromium(VI) compounds are to the stomach and small intestine (irritation and ulcer) and the blood (anemia). Ingestion of hexavalent chromium can cause stomach ulcers, convulsions, kidney and liver damage, and, at high concentrations, death. Sperm damage and damage to the male reproductive system have also been seen in laboratory animals ingesting chromium(VI). Chromium(III) compounds are much less toxic and do not appear to cause these problems.

The most common health problem in workers exposed to chromium involves the respiratory tract. These health effects include irritation of the lining of the nose, runny nose, and breathing problems (asthma, cough, shortness of breath, wheezing). Workers have also developed allergies to chromium compounds, which can cause breathing difficulties and skin rashes.

After inhalation, some forms of chromium can remain in the lungs for several years or longer. A small percentage of ingested chromium will enter the body through the digestive tract. When skin contacts chromium, small amounts of chromium will enter the body. Most of the chromium leaves the body in the urine within a week, although some may remain in cells for several years or longer.

The International Agency for Research on Cancer (IARC) has determined that chromium(VI) compounds are carcinogenic to humans. The National Toxicology Program 11$^{th}$ Report on Carcinogens classifies chromium(VI) compounds as known to be human carcinogens. In workers, inhalation of chromium(VI) has been shown to cause lung cancer. An increase in stomach tumors was observed in humans exposed to chromium(VI) in drinking water. In laboratory animals, chromium(VI) compounds have been shown to cause tumors to the stomach, intestinal tract, and lung.

There are no studies that have looked at the effects of chromium exposure on children. It is likely that children would have the same health effects as adults. Health assessors do not know whether children would be more sensitive than adults to the effects of chromium.

There are no studies showing that chromium causes birth defects in humans. In animals, some studies show that exposure to high doses during pregnancy may cause miscarriage, low birth weight, and some changes in development of the skeleton and reproductive system. Birth defects in animals may be related, in part, to chromium toxicity in the mothers.

**Cyanide.** Dissolved cyanide salts are used in electroplating. Cyanides are mobile in soil. At high concentrations, cyanide becomes toxic to soil microorganisms. Because these microorganisms can no longer change cyanide to other chemical forms, cyanide can pass through soil into groundwater.

The severity of the harmful effects following cyanide exposure depends in part on the form of cyanide. Some of the first indications of cyanide poisoning are rapid, deep breathing and shortness of breath, followed by convulsions (seizures) and loss of consciousness. These symptoms can occur rapidly, depending on the amount eaten. Exposure to high levels of cyanide for a short time harms the brain and heart and can even cause coma and death. The health effects of large amounts of cyanide are similar, whether you eat, drink, or breathe it.

Workers who inhaled low levels of hydrogen cyanide over a period of years had breathing difficulties, chest pain, vomiting, blood changes, headaches, and enlargement of the thyroid gland. Cyanide uptake into the body through the skin is slower than these other means of exposure. Skin contact with hydrogen cyanide or cyanide salts can cause irritation and produce sores.

There are no reports that cyanide can cause cancer in people or animals. EPA has determined that cyanide is not classifiable as to its human carcinogenicity.

Effects reported in exposed children are like those seen in exposed adults. Children who ate large quantities of apricot pits, which naturally contain cyanide as part of complex sugars, had rapid breathing, low blood pressure, headaches, and coma, and some died.

Cyanide has not been reported to directly cause birth defects in people. However, among people in the tropics who eat cassava root, children have been born with thyroid disease because of the mothers' exposure to cyanide and thiocyanate during pregnancy. Birth defects occurred in rats that ate cassava root diets, and harmful effects on the reproductive system occurred in rats and mice that drank water containing sodium cyanide.

**Nickel**. Nickel is a natural element. Pure nickel is a hard, silvery-white metal. Nickel can be combined with other metals, such as iron, copper, chromium, and zinc, to form alloys. Nickel compounds are used for nickel plating. Nickel plating improves corrosion resistance. It may also be decorative, provide wear resistance, or be used to build up worn or undersized parts for salvage purposes [ATSDR 2015].

People working in nickel refineries or nickel-processing plants have experienced chronic bronchitis and reduced lung function. These persons breathed amounts of nickel much higher than levels found normally in the environment. Damage to the lung and nasal cavity has been observed in rats and mice breathing nickel compounds.

Workers who drank water containing high amounts of nickel had stomach ache and suffered adverse effects to their blood and kidneys. Eating or drinking large amounts of nickel has caused lung disease in dogs and rats and has affected the stomach, blood, liver, kidneys, and immune system in rats and mice, as well as their reproduction and development.

The most common harmful health effect of nickel in humans is an allergic reaction. Approximately 10-20% of the population is sensitive to nickel. People can become sensitive to nickel when jewelry or other things containing it are in direct contact with the skin for a long time. Once a person is sensitized to nickel, further contact with the metal may produce a reaction. The most common reaction is a skin rash at the site of contact. The skin rash may also occur at a site away from the site of contact.

Less frequently, some people who are sensitive to nickel have asthma attacks following exposure to nickel. Some sensitized people react when they consume food or water containing nickel or breathe dust containing it.

The International Agency for Research on Cancer (IARC) has determined nickel is not carcinogenic via the ingestion pathway although some nickel compounds are carcinogenic to humans via inhalation.

It is likely that the health effects seen in children exposed to nickel will be like those seen in adults. Health assessors do not know whether children differ from adults in their susceptibility to nickel. Human studies that examined whether nickel can harm the fetus are inconclusive. Animal studies have found increases in newborn deaths and decreased newborn weight after ingesting very high amounts of nickel. Nickel can be transferred from the mother to an infant in breast milk and can cross the placenta.

## Appendix D: Response to Public Comments

This section addresses questions and comments received by FDOH during the public comment period for the Former Duval Plating and Supply Company Health Consultation. The following were comments and questions received:

- A resident inquired about the reason for filling out the survey form and if it was mandatory to do so.
    - This resident was informed that filling out the survey is an option and the purpose is for outreach to the community to inform and help residents understand environmental issues that may or may not be affecting them.

- A resident gave information about the west side of Jacksonville in the Beaver-Commonwealth Edgewood area and how residents have been fighting a long time to get environmental issues resolved but nothing has been done. This resident mentioned that many complaints were given to the City of Jacksonville and ex-Councilman Jones to address issues like the Duval Plating hazardous waste site, going back as far as 2000. The resident also, mentioned abandoned old homes which fill with water causing mosquitos to be heavily present.

- A resident is concerned about ditches that flood around the site and if those flooded ditches near the site cause contaminated surface water to run into yards nearby. She also has mentioned complaining to the City of Jacksonville since 2014.
    - Based on the data received, it was determined that the site did not have surface water (water that collects on the surface of the ground) present, and thus no known drainage pathways to move the soil from the site to nearby yards by storm water and flooding.

- A resident inquired about the safety of cooking with the water in the homes and who performed tests wells in the area.
    - The resident was informed that the water in homes near the site are safe to use for cooking, taking showers, etc. Residents near the city are all on city water which is monitored and tested by the City of Jacksonville. However, private wells are tested by count health department personnel.

- Two residents mention the health conditions such as high blood pressure, fluid around the heart, lupus, fibromyalgia, respiratory issues like bronchitis and difficulty breathing, issues with the thyroid and bladder disease.
    - Many of the contaminants mentioned in the report have various ways in which they may affect the body, however, it is important to point out that groundwater, except for southeast of the site, and soil contamination issues off-site were not found. Another important factor to mention is that samples were not taken while the business was in use and there is no groundwater, soil or air quality data available for that time. While it is possible that residents near this site have experienced and are experiencing health issues, it may or may not be because of the former business.

- A resident is concerned with the drinking water and the soil. Mentions experiencing headaches, lung irritation and breathing in fumes while the former business was in operation. Also, the resident's children had respiratory health issues and constant headaches. Eight dogs have also been owned by the resident and each dog died. The resident even bought "truckloads of soil" and has laid sod in the yard. Also, grass will not grow.
    - The contaminants of concern in the report were tested in groundwater and soil and it was found that groundwater, except for southeast of the site, and soil contamination issues off-site were not found. Also, fumes and air samples were not available when sampling took place and we are not able to retrieved past data. As mentioned in the report, inhalation from some of the contaminants found could cause health issues from inhalation, but the data to back that up is not available.

- A resident would like to know how he/she and neighbors will know if health issues have been due to contamination at site. Are there are tests that can be done to determine levels in body? Will county health departments help to get testing done?
    - The only way to determine if certain contaminants are present in the body is to have tests completed. There are tests available which can measure the levels of the contaminants mentioned in the report. Some of the tests can be performed using urine, feces, and/or blood after exposure; however, the body can remove chemicals from the body quickly and tests should be completed soon after exposure occurs. These tests sometimes cannot tell how much of a contaminant a person has been exposed to or whether he or she will experience any health effects. To determine if the county health department is willing to conduct testing, residents should contact them and inquire about it.

- A resident is concerned about the inhalation of chemicals from the former company. Also, health of tenants and workers of owned property, and elderly neighbors. Tenants, workers and neighbors complained of asthma, shortness of breath, collapsed lungs, fluid around the lungs, heart issues, headaches and COPD. The resident also mentioned that when her and her daughter move into property to get it ready for renting purposes, they have symptoms of shortness of breath and severe headaches.
    - The contaminants of concern in the report were tested in groundwater and soil and it was found that groundwater, except for southeast of the site, and soil contamination was not found off-site. Also, fumes and air samples were not available when sampling took place and we are not able to retrieved past data. As mentioned in the report inhalation from some of the contaminants found could cause health issues, but without the data it is not possible to determine this.