

**Site Investigation and Remedial Action
Recommendations Midwest Plating Corporation
Conducted For
The Wisconsin Department of Natural Resources**

Work Plan

**Midwest Plating Corporation
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Appleton, Wisconsin 54914**

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EXECUTIVE SUMMARY

The following report outlines the work plan proposed by OMNNI Associates, Inc. (OMNNI) for additional investigation activities at the former Midwest Plating, Inc. (MPC) property located at 1315 West Fourth Street, Appleton, Wisconsin. (See Figure 1 – Site Location Map, Appendix 1.)

The Wisconsin Department of Natural Resources (WDNR) determined that a discharge was occurring from the MPC facility. The WDNR notified MPC of its responsibility to investigate and remediate contamination from the site. After some initial investigative activities, MPC's legal counsel and consultant notified WDNR that MPC was unable to proceed due to financial limitations.

Because MPC was unable to proceed, the WDNR procured funding and proceeded with a state funded response for the interim action, which removed contaminated soil that was a direct contact threat. The interim action was followed by the WDNR requesting the assistance of U.S. EPA's Emergency Removal Program to remove chemicals from the MPC buildings. The United States Environmental Protection Agency (U.S. EPA) not only removed the hazardous chemicals, but also razed the plating facility, removed contaminated soils, and installed a sump in the excavation to facilitate contaminated groundwater removal. The WDNR has recently hired OMNNI to conduct a complete site investigation and prepare a remedial action plan.

Prior investigative activities, the WDNR interim action, and the U.S. EPA removal encountered elevated levels of metal contamination in the soil and groundwater including, cadmium, chromium, cyanide, hexavalent chromium, and lead.

The purpose of the site investigation is to define and document the remaining degree and extent of the soil and groundwater contamination on and off the MPC property. Three monitoring wells will be installed during an initial phase of a ch. NR 716 Wisconsin Administrative Code (Wis. Adm. Code) site investigation to understand the extent of contaminants in the groundwater and to determine the groundwater elevation and flow direction. Upper level contamination will be defined with up to 10 direct push soil borings installed to a depth of 10 feet. Up to seven additional monitoring wells and four piezometers will be installed during a second phase of the investigation activities to define the extent of contaminants in the groundwater.

GENERAL INFORMATION

Project Title

Site Investigation and Remedial Action Recommendations Midwest Plating Corporation

Project Identification Numbers

Wisconsin Department of Natural Resources (WDNR) Bureau for Remediation and Redevelopment Tracking System (BRRTS) Number: 02-45-191769.

WDNR Contract Number 04RRFQ.

OMNNI Associates, Inc. Project Number: N1681A01/003.

Purpose

The purpose of the site investigation is to define and document the degree and extent of the soil and groundwater contamination on and off the MPC property. The site investigation generally consists of documenting the vertical and horizontal soil and groundwater conditions, the extent of the soil and groundwater contamination, and the groundwater flow conditions. The purpose of the remedial action recommendations is to recommend a remedial action or actions that will restore the soil to site-specific residual contaminant levels (SSRCLs) and the groundwater to standards outlined in Chapter (ch.) NR 140 Wisconsin Administrative Code (Wis. Adm. Code).

Contact Information

Responsible Party: Midwest Plating Corporation, Glenn Brandt Estate.

Regulatory Agency: Wisconsin Department of Natural Resources, Bureau of Remediation and Redevelopment, Ms. Roxanne Nelezen Chronert, Project Manager, 1298 Lombardi Avenue, Green Bay, WI 54307, Telephone: 920/492-5592, Fax: 920/492-5859, Mailing Address: 1125 N. Military Avenue, P.O. Box 10448, Green Bay, WI 54307-0448.

Regulatory Agency's Consultant: OMNNI Associates, Inc., Mr. Brian Wayner, Project Manager, One Systems Drive, Appleton, WI 54914-1654, Telephone: 920/735-6900, Fax: 920/830-6100.

Driller: Midwest Engineering Services, Inc., 1125 Tuckaway Lane, Suite B, Menasha, WI 54952; (920) 735-1200. Contact: Mr. John D. McAfee.

Direct Push Boring: Environmental Drilling Services, Inc., 3671 Monroe Road, De Pere, WI 54115; 800-236-0337. Contact: Mr. Tom Vande Yacht.

General Contractor: Environmental Services Plus, Ltd., W1732 County Road KK, Kaukauna, WI 54130; (920) 766-6756. Contact: Mr. Jesse Rose.

Analytical En Chem, Inc., 1241 Bellevue Street, Suite 9, Green Bay, WI 54302;
Laboratory: 1-800-736-2436. Contact: Ms. Laurie Woelfel.

Site Location

The MPC investigation encompasses five properties that may have been impacted by varying degrees of chromium, lead, and cadmium contamination. The project area is comprised of the MPC property, located at 1315 West Fourth Street, Appleton, Wisconsin, and four residential backyards located at 607, 619, 711, and 713 South Mason Street, Appleton, Wisconsin, which abut the MPC property. The project is located in the NE¼, NW¼, Section 34, T21N, R17E, Outagamie County. (See Figure 1 – Site Location Map, Appendix 1.)

Geographic coordinates of the site are 645609,421536 and were obtained from the on-line GIS Registry of Closed Remediation Sites at a scale of 1:1,297 using the Wisconsin Transverse Mercator '91 (WTM) coordinate system.

SITE INVESTIGATION SCOPING

Facility Description

The MPC property is an irregularly-shaped parcel approximately 0.4 acres in size located in a mixed development area of Appleton, with residential properties to the east and south and industrial/commercial properties to the north and west. (See Figure 1 – Site Location Map.) Two buildings were located on the property with the remainder of the property surfaced with gravel or asphalt pavement. The plating operations building contained an area for plating and polishing, an office, a shipping and receiving dock, a machine shop, and a product storage area. The plating operations building was removed as part of a time critical removal action conducted by the U.S. EPA. The second building is a garage, constructed in 1985, which contains an office and storage area. The garage covers approximately 1,100 square feet. Prior to plating operations, the property was used by a trucking company for shipping and receiving.

Chrome-plating operations began at the facility in 1963. The plating and polishing building, which covered approximately 6,000 square feet, was constructed in phases, with its most recent configuration completed in 1970. The plating and polishing building contained three in-ground hexavalent chromium electroplating tanks, with only one tank in use before the operations were shut down. Electroless nickel plating was also performed at this facility in three aboveground tanks.

Machine parts were prepared for plating by either soaking in a cleaning solution or by sandblasting. After the plating process was complete, the parts were rinsed over a concrete floor with water from a hose. The rinse water was expected to drain to a sump in the northeast corner of the building. The sump, which consisted of a plastic barrel embedded in the floor, operated on a float, and a sump pump sent rinse water to two aboveground plastic treatment tanks. Prior to the installation of the sump and treatment unit, a floor drain was present in this location. The floor drain was connected to a metal pipe, which drained to the sanitary sewer north of the plating building. In the early 1970s, it was discovered that the metal drainpipe had deteriorated and was replaced with a plastic pipe. No investigative or remedial activities associated with the drainpipe replacement were performed.



The property's parcel Identification number is 31-3-1341-00. The property's legal description is: Part of Lot-9, block 79, Third Ward Plat: Beginning West-line of Mason Street, 374 feet North of Southeast corner of block 79, West 120 feet to beginning, West 180 feet, North 41.2 feet, Northeast to a point 120 feet West of West-line of Mason Street, South to beginning part as described in volume 764 records page 299 Outagamie County records. The property is currently zoned M-2 General Industrial.

Site History

On May 13, 1998, the WDNR received a complaint from the Outagamie County Emergency Government office. The complaint concerned yellow water observed to be ponding in the backyard of a private residence located at 619 South Mason Street, adjacent to the MPC facility. WDNR staff inspected the property, observed a water sample previously collected by the homeowner, and determined that the source of the ponded liquid was the MPC facility.

Based on results of two surface soil samples (KR001 and KR002) collected on June 1, 1998, by WDNR staff, MPC was notified on July 14, 1998, by WDNR of its responsibility to investigate and remediate contamination from the site. An interim action was also required to eliminate exposure risks to residents from contaminated surface soil on and off the MPC property. The Wisconsin Department of Health and Family Services (WDHFS) advised several residents on July 16, 1998, to avoid contact with potentially contaminated soil on their properties. On July 27, 1998, the WDHFS collected surface soil samples (A01, A02, E01, K01, and L01).

Environmental Studies

A site investigation work plan was submitted to the WDNR by MPC's consultant on October 12, 1998, and the WDNR issued a conditional approval letter on October

14, 1998. Soil sampling was conducted on November 12, 1998. A total of 44 soil samples (locations M01 through M16) were collected from the MPC property and the three adjacent properties. The investigation is documented in a report dated January 1999, titled *"Site Investigation, Midwest Plating Corporation, Appleton, Wisconsin, ERP No. 02-45-191769."*

Additional surface soil sampling was required by the WDNR. On May 11, 1999, MPC's consultant collected 13 surface soil samples (RM01 through RM10 and RM13 through RM15). Representatives from the WDNR also collected split samples from the same 13 locations, including one additional sample (DNR001) collected at 711 South Mason Street. On January 3, 2000, three additional surface samples were collected from each of the three impacted residential properties bordering the MPC site (RD8 through RD10). In addition to collecting soil samples along the sanitary sewer line from two of the seven borings (TSP-01 and TSP-02), groundwater samples were collected from all borings (TSP-01 through TSP-07).

Sample analytical results, along with a remedial action plan (i.e. MPC's interim action plan for surface soil), were documented in a February 14, 2000 report titled *"Remedial Action Plan (Surface Soil), Midwest Plating Corporation, Appleton, Wisconsin, ERP No. 02-45-191769."*

On March 22, 2000, although the extent of the surficial soil contamination was not completely defined, the WDNR conditionally approved MPC's remedial action plan for surface soil. The SSRCLs for the MPC site were developed by MPC and also documented in their remedial action plan and addendum. The SSRCLs were conditionally approved by the WDNR. The SSRCLs for the MPC site: Chromium – 140 mg/kg, Lead – 96 mg/kg, Cadmium 8 mg/kg, Nickel - 1600 mg/kg, and Zinc – 23,000 mg/kg.

Additional soil samples were required prior to the interim action to completely define the degree and extent of surficial soil contamination. On March 30, 2000, eight additional soil samples were collected (P01 through P08). MPC's consultant presented additional information in their correspondence dated April 6, 2000, in response to the WDNR's conditional approval. The WDNR responded in correspondence dated April 10, 2000. In June 2000, MPC's legal counsel and consultant notified the WDNR that MPC was unable to proceed with a soil removal due to financial limitations. Because MPC was unable to proceed with the interim action, the WDNR procured funding and proceeded with a state funded response for the interim action at the site.

OMNNI was authorized by the WDNR on December 15, 2000, to implement the interim action. The scope of services associated with the interim action included:

- Limited surficial soil sampling to complete the definition of degree and extent of surficial soil contamination;

- Reevaluation of the contaminated surficial soil area and redefinition of the degree and extent;
- Preparation of a remedial design report and design plans and specifications for the selected interim action;
- Preparation of bid documents for the interim action;
- Oversight of the soil excavation and replacement of contaminated soil;
- Construction oversight of and direction to the construction contractor or their sub-contractors or employees;
- Proper sampling and characterization of interim action wastes and determination of handling, storage, and disposal location/requirements to be used by the construction contractor;
- Confirmation sampling;
- And documentation of the soil restoration project.

Additional soil samples were collected to define the degree and extent of the metals contaminated surface soils on the MPC property and the three adjacent residential properties. OMNNI collected soil samples from 33 locations during five sampling events. Sample locations OB1 through OB18 were collected on January 9, 2001. On January 15, 2001, a Geoprobe® type rig was utilized to collect samples from locations OB19 through OB23. A Geoprobe® type rig was also used to collect samples from locations OB24 through OB28 as well as collecting deeper samples from previous sampling locations on March 14, 2001. Samples were collected at greater depths at locations OB4 and OB5 on April 3, 2001. On April 26, 2002, samples were collected from OB29 through OB32 and analyzed for total cyanide. Although MPC stated that they did not use cyanide in their process, the disposal of the wastes required that the presence or lack of cyanide be verified.

On April 11, 2001, a release of yellow liquid was reported to the WDNR and found to be flowing from the northeast corner of the MPC building onto the backyard of the 619 S. Mason Street property. A concrete sidewalk, which ran the length of the 619 S. Mason Street property, was the preferential flow path for the yellow liquid. The yellow liquid flowed through an aboveground planter/retaining wall before entering Mason Street. The yellow liquid flowed north along Mason Street before entering a storm sewer inlet. The WDNR collected a sample of this liquid, S01, from the MPC property on April 11, 2001 and the chromium concentration from this sample was 81,000 µg/L. The yellow liquid was believed to be originating from clear storm water ponding on the southwest side of the MPC plating building foundation, traveling along the gravel backfill under the building slab, becoming contaminated when it came into contact with contaminated soils around the plating tanks, and draining out the northeast corner of the building onto the adjacent property. Gutters were subsequently installed by a contractor for the WDNR on the MPC buildings to redirect the water away from the plating building foundation. A grading plan on and off the MPC property was developed and was implemented as part of the interim action. The purpose of the grading plan was to redirect the surface water away from the southwest corner of the building.

Soil samples were also collected and analyzed by the toxicity characteristic leaching procedure (TCLP) to aid in characterizing soil for disposal purposes. Grab samples were collected from six locations to determine if hazardous soils existed at the site. TCLP analysis from the six sampling locations did not detect concentrations of the metals analyzed above the characteristic toxicity levels. However, sample results very close to the TCLP regulatory limit suggest that a total chromium concentration higher than some of the samples analyzed could meet or exceed the TCLP regulatory limit.

On January 21, 2002, OMNNI submitted the final Design Report, Plans, and Specifications to the WDNR for the Midwest Plating Corporation interim action surface soil restoration project. The report documented the additional sampling that had taken place and how the construction activities were to occur during the interim action.

In May 2002, the WDNR conducted a Pre-Liminary Assessment/Superfund Site Investigation (PA/SSI). The site scored greater than 28.5 requiring an Expanded Site investigation (ESI).

The interim action, which began in June 2002, consisted of excavating contaminated surface soils on the MPC property and the three adjacent residential properties and replacing the excavated soils with clean fill, topsoil, and sod. Chromium, lead, and cadmium contaminated soils associated with the MPC operations where the contaminant concentrations were greater than the approved SSRCLs were removed during the interim action. The interim action is documented in the *"The Midwest Plating Corporation Interim Action Surface Soil Restoration Project, Construction Documentation Report,"* dated November 12, 2002.

The WDNR initiated civil actions against MPC for failing to restore the environment and minimize harmful effects from hazardous substance discharges at the site. Glenn Brandt, the site owner and operator, was asked to sign a stipulation and order of judgment for investigation and cleanup of the site property and adjacent properties. The stipulation and order of judgment were drafted by the Wisconsin Department of Justice (WDOJ) and were to be signed by July 31, 2002. Mr. Brandt did not sign the stipulation and order of judgment. Mr. Brandt was required to stop operations by November 2002. Shortly after this requirement he abandoned the property. Therefore, WDNR requested the assistance of U.S. EPA in investigating and possibly eliminating hazardous substance discharges at the site.

On August 1 and 2, 2002, The U.S. EPA along with their contractor, Tetra Tech Superfund Technical Assessment and Response Team (START), conducted a site assessment at the MPC site. Numerous 55-gallon drums and miscellaneous containers and debris were observed throughout the plating and polishing building. Some of the containers had a layer of a blue-green solid on them that was thought to be copper. The chrome plating room contained three in-ground tanks; two were

no longer in use but still contained used chromic acid, the other was still operational. Pools of yellow liquid, numerous cracks in the concrete floor, and a black, sticky material were all observed on the concrete floor of the chrome plating room. Three additional tanks used for electroless nickel plating were observed in the nickel-plating room. The mortar and blocks of the exterior walls of the chrome plating room were stained green. Samples were collected from a sanitary sewer, a chromic acid tank, pools of liquid on the floor, piles of floor sweepings, soil, and a residential sump pump on August 2, 2002. Waste sample analytical results indicated the presence of the following compounds at the site: barium, cadmium, hexavalent chromium, total chromium, lead, nickel, silver, mercury, selenium, and cyanide. Soil sample analytical results indicated the presence of barium, cadmium, total chromium, lead, mercury, nickel, and cyanide in all or some of the samples.

On November 20, 2002 U.S. EPA returned to the site to conduct a second walk-through of the site and collect additional waste samples. The site was no longer operational at the time of the second walk-through. Fourteen 55-gallon drums filled with used chromic acid were staged in the truck bay area.

The southwest storage area had numerous drums and open containers observed in it. Some of the drums were labeled as containing cyanide. Samples were collected from a sulfuric acid tank, piles of floor sweepings, and pails containing solid waste material. Sample analytical results indicated that elevated concentrations of barium, chromium, copper, and lead existed at the site as well as TCLP chromium at a concentration exceeding the TCLP regulatory level.

In March 2003, the U.S. EPA approved the WDNR's request for an Other Clean-up Action (OCA) instead of an ESI.

During the summer and fall of 2003 the U.S. EPA removed chemicals and debris within the building, the plating operations building, and some underlying contaminated soil up to 18 feet below ground surface. The U.S. EPA removed 172 55-gallon drums; 224 tons of chromium-contaminated debris; 1,809 tons of chromium-contaminated soils; 350 cubic yards of hazardous waste solids and concrete debris; 221 tons of special waste; and 33,209 gallons of hazardous waste liquid. The plating and polishing building was razed, and additional soil removal took place.

The U.S. EPA set a 24-inch diameter groundwater extraction sump riser near the center of the excavation. The excavation floor was sloped to the center of the excavation. The bottom of the excavation was backfilled with approximately four feet of gravel. The site was then backfilled as such: a plastic liner was placed over the gravel, clay was used to backfill the excavation up to four feet from ground surface, a one foot layer of sand was placed over the clay, a 60 millimeter liner was placed over the sand and sealed with tape, a two foot layer of sand was placed over the liner, and the site was brought up to grade and sloped to the North. The time

critical removal action is documented in the "Removal Action Summary Report, Midwest Plating Corporation Site, Technical Direction Document No. S05-0212-001," dated March 6, 2004.

In April 2003, Mr. Brandt passed away followed by his wife in February 2004. The property remains in the Brandt's name. The property is tax delinquent. The 2002 and 2003 property taxes have not been paid. As of June 2004, the property tax balance was \$4,035.39.

Previous Reports

- Report titled **Site Investigation, Midwest Plating Corporation, Appleton, Wisconsin, ERP No. 02-45-191769**, dated January 1999, prepared by Earth Tech, Inc. for the Midwest Plating Corporation.
- Report titled **Remedial Action Plan (Surface Soils), Midwest Plating Corporation, Appleton, Wisconsin, ERP No. 02-45-191769**, dated February 14, 2000, prepared by Earth Tech, Inc. for the Midwest Plating Corporation.
- Report titled **The Midwest Plating Corporation Interim Action Surface Soil Restoration Project, Design Report, Plans, and Specifications**, dated January 21, 2002, prepared by OMNNI Associates, Inc. for the WDNR.
- Report titled **The Midwest Plating Corporation Interim Action Surface Soil Restoration Project, Construction Documentation Report**, dated November 12, 2002, prepared by OMNNI Associates, Inc. for the WDNR.
- Report titled **Removal Action Summary Report, Midwest Plating Corporation Site, Technical Direction Document No. S05-0212-001**, dated March 6, 2004, prepared by Tetra Tech EM, Inc. for the U.S. EPA.

Geology and Hydrogeology

The site is in the Fox-Wolf River basin of Wisconsin. Surficial deposits in this basin consist of glacial sediment deposited during the Wisconsin glaciation. The glaciers were present during the Pleistocene period. United States Geological Survey maps *Water Resources of Wisconsin – Fox-Wolf River Basin*, by Perry G. Alcott, 1968, indicate that the materials in the vicinity of the site are composed of glacial lake deposits consisting of silt and clay. The site overlies bedrock formed during the Ordovician Period and bedrock in this area is comprised of the undifferentiated Platteville Formation, Decorah Formation, and Galena Dolomite. Previous work completed at the site has identified the subsurface soils to be comprised of mostly silt (ML) with isolated occurrences of sand. Additional sampling by OMNNI identified red brown clay as the predominant subsurface soil type to a depth of four feet. According to the United States Department of Agriculture Soil Survey of Outagamie County, the surficial soils on-site and on adjacent properties to the south and east are mapped as Udorthents and Kewaunee Silt loam.

Topography across most of the site slopes to the north and east towards W. Fourth Street and S. Mason Street. Regionally, the topography is generally flat with an approximate elevation of 800 feet above MSL. Groundwater has been reported to be approximately five to seven feet below grade (fbg) in the area and regional flow is expected to be to the south-southeast toward the Fox River. The Fox River is located approximately ½ mile to the south-southeast of the site. The Fox River flows to the north. Groundwater elevation in the MPC sump riser has been observed to be approximately one and one-half to two fbg during the spring of 2004.

The site was serviced by City sewer and water, which may have influenced local groundwater flow direction as well as acted as potential contamination migration pathways. Changes in the groundwater depth and flow direction typically occur seasonally. Groundwater depth and flow direction have not been determined at the property; however, the pattern of deeper soil contamination data implies the local shallow water table may flow to the north and northeast.

Other Potential Sources of Contamination

The Mauthe site (BRRTS #02-45-000127) is located at 725 S. Outagamie Street, approximately 700 feet west of the MPC project. This site is a former electroplating facility that engaged in hard chrome plating. Results of the Remedial Investigation and Feasibility Study (RI/FS) revealed that the site was contaminated with zinc, cadmium, chromium, and cyanide. Organic compounds including 1,1,1-trichloroethane, trichloroethene, acetone, and other chlorinated hydrocarbons are also present. Remedial Design/Remedial Action (RD/RA) activities took place at the N.W. Mauthe site in a phased approach. Phase I of the RD/RA involved the excavation of contaminated soils and the installation of groundwater collection trenches. Phase II involved the construction of the existing groundwater treatment system which began operation in June 1997. Based on downgradient monitoring wells for the Mauthe project, it is not anticipated that contamination from the Mauthe site would have impacted the MPC study area.

The Christensen & Wisnet Bulk Oil Plant site (BRRTS #02-45-000382) is located at 702 S. Outagamie Street, approximately 400 feet west of the MPC project. Although this project has received closure from the Department of Commerce, petroleum soil and groundwater contamination remains on and off property. Based on downgradient monitoring wells for this project, it is not anticipated that contamination would have impacted the MPC study area.

There are several other leaking underground storage tank sites, spill sites, and sites in the environmental repair program located around the MPC study area. However, these sites have either had a minimum amount of reported contamination, or are located at a distance, which make them unlikely to have impacted the MPC study area.

Site Access

Access agreements are already in place with the MPC estate and the property owners of 607, 619, 711, and 713 S. Mason Street. Additional access agreements maybe necessary due to change in ownership or if the area requiring investigation is expanded beyond the properties with current access agreements.

Any additional access agreements will be prepared in accordance with the WDNR example used with previous property owners for this project and the access agreement attached to the WDNR Site Investigation Scope of Work. If we encounter difficulty in securing access to a property, we will request WDNR assistance.

Potential For Impacts

At this time the remaining contamination from the MPC property does not appear to be impacting: species, habitat, or ecosystems sensitive to the contamination; wetlands; outstanding resource waters; or sites or facilities of historic or archaeological significance.

SITE INVESTIGATION WORK PLAN

The site investigation will be performed in accordance with the requirements of chs. NR 712, NR 716 and NR 722 Wis. Adm. Code, guidelines provided in the most recent version of the *Guidance for Conducting Environmental Response Actions*, WDNR, PUBL SW-157-92, and additional information provided in the WDNR Site Investigation Scope of Work.

During the interim action at the site, OMNNI met with representatives from the City of Appleton utilities to have sewer and water utilities located. Additional meetings are anticipated and/or field reconnaissance to determine actual utility locations and construction details. Digger's Hotline also will be contacted prior to any drilling performed. If necessary, a contractor will be solicited to locate private utilities. Utility information will be included on figures in the final report.

Once the utilities have been located and the work plan approved, OMNNI proposes to coordinate the installation of three initial monitoring wells at the site. (See Figure 2 – Proposed Soil Boring/Monitoring Well Map, Appendix 1.) These initial three monitoring wells will determine the groundwater flow direction and depth to groundwater at the site. Although groundwater flow direction and groundwater depth from other sites in the immediate area (Mauthe and Christensen & Wisnet Bulk Oil Plant) are known, the Midwest Plating Corporation site maybe influenced by topography, utilities, residential sumps, the site sump, and infiltration from nearby properties. This initial investigation activity will provide valuable

information to ultimately define the horizontal and vertical extent of the contamination.

Following the installation of the three groundwater monitoring wells and obtaining data from those wells, direct push (Geoprobe® type) borings to define the horizontal and vertical extent of the remaining soil contamination will be installed. Temporary monitoring wells will be installed in the direct push borings to indicate groundwater conditions.

Based on data collected from the soil borings, temporary monitoring wells, and the three initial permanent monitoring wells, additional monitoring wells and piezometers will be installed to completely define the extent of the groundwater contamination.

Geologic borings, which will be installed by both drilled and direct push methods, will be conducted and documented as described in the WDNR Site Investigation Scope of Work. The entire recovered sample will be maintained until laboratory analysis has been obtained on the portion submitted. A similar procedure during the interim action was followed to allow for additional analysis from the samples taken without the cost of remobilizing for sample collection, resulting in significant cost savings.

After reviewing *The Midwest Plating Corporation Interim Action Surface Soil Restoration Project, Construction Documentation Report, the Removal Action Summary Report, Midwest Plating Corporation Site*, site data from nearby projects, and the groundwater elevation in the MPC sump riser, seven direct push borings to a depth of 10 feet and one hand boring are anticipated to be installed across the project area. The direct push borings will be constructed with temporary monitoring wells. (See Figure 2 – Proposed Soil Boring/Monitoring Well Map, Appendix 1.) Additional direct push borings maybe proposed as well as changes to the locations of the borings once data is collected from the three permanent monitoring wells.

Soil Boring Installation Procedures

Midwest Engineering Services, Inc. (MES) will be subcontracted for the drilling and Environmental Drilling Services, Inc. (EDS) will be subcontracted for the direct push borings during the investigation of the MPC project.

Samples from soil borings will be obtained from each boring continuously by split-spoon sampling according to ASTM D-1586. A portion of each sample will be field screened with a photoionization detector (PID) equipped with a lamp suitable for detecting vapors of petroleum and chlorinated solvents. At each sampling interval, a representative portion of the soil will also be collected for possible laboratory analysis. Up to two soil samples will be chosen from each of the sampled borings for laboratory analysis. Initial laboratory analysis will be conducted on samples

based on field evidence and previous analysis collected during the interim action and U.S. EPA removal. Soil borings not used for monitoring well installation will be abandoned according to section NR 141.25, Wis. Admin. Code.

Soil Sampling Procedures

Soil samples from the drilled borings will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc; and volatile organic compounds (VOCs).

Soil samples from the direct push borings will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc; and VOCs.

The hand boring will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc.

The soil sampling procedures are outlined in the Sampling and Analysis Plan for the project, which can be found in Appendix 3.

Monitoring Well Installation And Development Procedures

The permanent monitoring wells are typically constructed of two-inch, schedule 40, flush-thread polyvinyl chloride (PVC) casings and slotted well screens. Temporary monitoring wells are typically constructed of one-inch diameter, schedule 40 PVC casings and slotted screens. Prior to use, well parts are individually wrapped in plastic.

Permanent wells will be installed and developed according to chapter NR 141, Wis. Admin. Code, WDNR Groundwater Monitoring Well Requirements. Each well will be assigned a Wisconsin unique well number. The monitoring wells will be installed with ten-foot screens, which are placed in the borings to intersect the water table. Filter pack and annular space seal material are installed by gravity as the augers are withdrawn from the hole. Wells are cut to the required height using a PVC pipe cutter.

An as-constructed well and boring survey will be performed by OMNNI once fieldwork is complete. Elevations will be either based on a local datum of 100 feet, or a United States Geological Survey (USGS) elevation, assigned to a mark on a reference point located at the site. Ground elevation will be surveyed to the nearest 0.1 foot, and the top of the well casing to the nearest 0.01 foot.

A horizontal grid system will be established at the site with the origin of the grid set on the reference point. Wells and borings are located with respect to this grid system.

To properly develop each permanent monitoring well, water will be removed until a consistent water quality is obtained. Removing 10 times the water volume in the well and filter pack, removing water until it is free of sediment, or removing the water until the well is purged dry, does this. Water will be removed from the wells by bailing the water with as little agitation as possible. If the water level is unaffected by bailing and large amounts of water are to be removed, the well will be developed by using the surge and purge method with a centrifugal pump or equivalent. No water is added to the well during development. Temporary wells maybe developed by allowing the peristaltic pump to run until the water is as clear as possible. The development water will be placed into 55-gallon drums, pending the results of analytical testing.

Groundwater Sampling Procedures

The monitoring wells and piezometers will be opened to allow for equilibration before the depth to groundwater is determined. A water level meter will be used to measure water elevations. If the monitoring wells have free product on top of the water surface, depth to water and depth to product will be measured with a fiberglass reel tape with an interface probe at the end. The monitoring wells will be purged and samples will be collected with a disposable bailer or a peristaltic groundwater-sampling pump.

The monitoring wells will be sampled starting from the upgradient area and progressing toward the downgradient area of the site. As the degree of contamination becomes known, monitoring wells with the least contamination will be sampled first, followed by monitoring wells with increasing concentrations. Four water volumes within the well casing will be removed prior to sampling if using a bailer. If a peristaltic pump is used, groundwater will be removed for approximately 10 to 20 minutes by slow purging.

Groundwater samples from the temporary monitoring wells will be analyzed for total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc.

Groundwater samples from the permanent monitoring wells will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc; VOCs; and polycyclic aromatic hydrocarbons (PAHs).

The groundwater sampling procedures are outlined in the Sampling and Analysis Plan for the project, which can be found in Appendix 3.

Aquifer Testing

Hydraulic conductivity will be calculated using AQTESOLV™ based on the Bouwer-Rice solution for a bail-down test. Field data will be collected from at least three monitoring wells. A volume of groundwater will be removed from each monitoring

well and the groundwater level recovery in each monitoring well will be measured after specified time intervals. The field data will then be used in the model to calculate the hydraulic conductivity of the area surrounding each of the monitoring wells tested.

SITE SPECIFIC RESIDUAL CONTAMINANT LEVELS

The site-specific residual contaminant levels (SSRCLs) for total cadmium, total chromium, total lead, total nickel, and total zinc for the MPC project area were developed by MPC and documented in their remedial action plan and addendum. The SSRCLs were conditionally approved by the WDNR. The SSRCLs for the MPC site: Cadmium 8 mg/kg, Chromium – 140 mg/kg, Lead – 96 mg/kg, Nickel - 1600 mg/kg, and Zinc – 23,000 mg/kg.

The WDNR requested that SSRCLs for barium and cyanide also be calculated for the MPC project.¹ The U.S. EPA's *Soil Screening Guidance for Chemicals*² and the WDNR's *Determining Residual Contaminant Levels Using the EPA Soil Screening Level Web Site*³ were used in calculating the SSRCLs for barium and cyanide.

The ingestion pathway was considered to be the most conservative and relevant pathway for the SSRCL calculations of barium and cyanide. The SSRCLs for the ingestion pathway is more conservative than the inhalation of fugitive dust pathway for most metals⁴. Metals are not considered volatile so the inhalation of volatiles pathway does not apply. From the groundwater elevations observed in the sump riser, groundwater appears to be shallow and both permanent and temporary monitoring wells will be installed to determine if groundwater enforcement standards have been exceeded. Therefore, the soil to groundwater pathway is not relevant. Based on the ingestion pathway, the SSRCL for barium was calculated to be 1,100 mg/kg and for cyanide was calculated to be 313 mg/kg. (See Appendix 5 for SSRCL calculations.)

INVESTIGATIVE WASTE MANAGEMENT

The investigative waste from the MPC project will consist of soil cuttings from borings, well development and purge water, water generated from the pump tests, equipment decontamination, and sampling wastes. Groundwater pumped from the sump and site debris are wastes that will also be handled during this phase of the project. A Waste Management Plan for the project can be found in Appendix 6.

¹ WDNR correspondence dated December 18, 2003, Clarification on Site Investigation Scope of Work, Question/answer #7.

² <http://risk.lsd.ornl.gov/epa/ssl1.shtml>

³ WDNR Publication PUB-RR-682, January 11, 2002.

⁴ EPA Soil Screening Guidance: User's Guide, Publication 9355.4-23, July 1996

SCHEDULE

Major Task	Anticipated Date
Site Investigation	
Phase I – Three initial monitoring wells and direct push borings	
Installation of monitoring wells	July 5, 2004
Develop monitoring wells	July 26, 2004
Sample monitoring wells	August 17, 2004
Install direct push borings and temporary monitoring wells	August 31, 2004
Survey monitoring wells, borings, and sump	September 7, 2004
Phase II – Additional monitoring well and piezometer installation	
Installation of monitoring wells and piezometers	September 14, 2004
Develop monitoring wells and piezometers	September 28, 2004
Survey monitoring wells and piezometers	September 28, 2004
Sample monitoring wells and piezometers	October 12, 2004
Conduct aquifer testing	October 19, 2004
Third groundwater monitoring event	January 12, 2005
Fourth groundwater monitoring event	April 12, 2005
Remedial action plan	
Remedial technology screening	July 2004 – April 2005
Access technical /economical feasibility	July 2004 – April 2005
Report submittal and review	
Draft report	May 16, 2005
Final report	May 30, 2005

STANDARD OF CARE

The conclusions presented in this report were arrived at using generally accepted hydrogeologic and engineering practices. The conclusions presented herein represent our professional opinions, based on data collected at the time of the previous investigations and remedial work discussed in this report. Conditions at other locations on the property may be different than described in the previous work. The scope of this report is limited to the specific project and location described herein.

Prepared By: _____

Brian D. Wayner, P.E.
Project Manager

Reviewed By: _____

Dave Fries, P.G.
Hydrogeologist

"I, Brian D. Wayner, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

(Professional Engineer)

(P.E. Stamp)

"I, Dave Fries, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

(Professional Geologist)

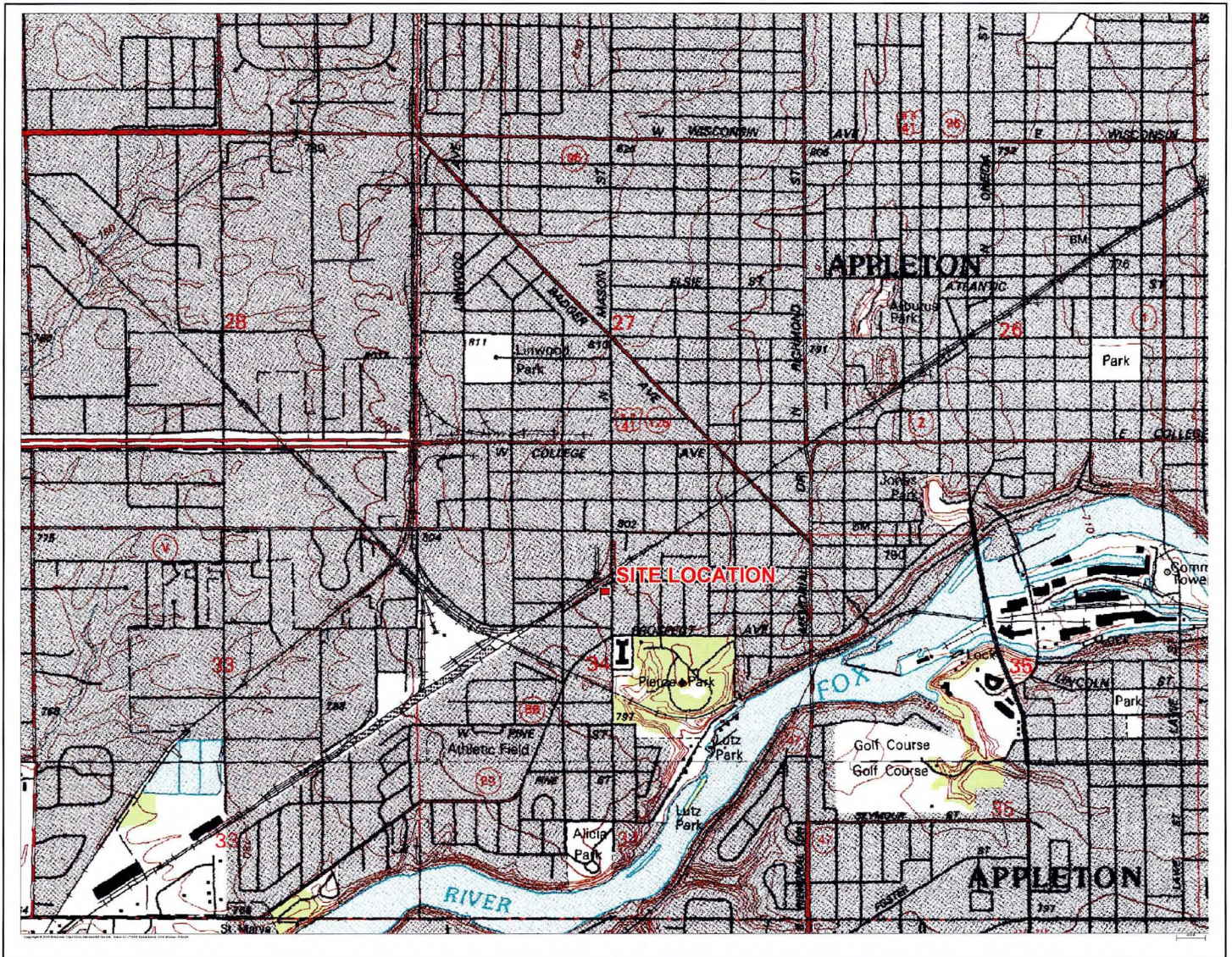
(P.G. Stamp)

DISTRIBUTION

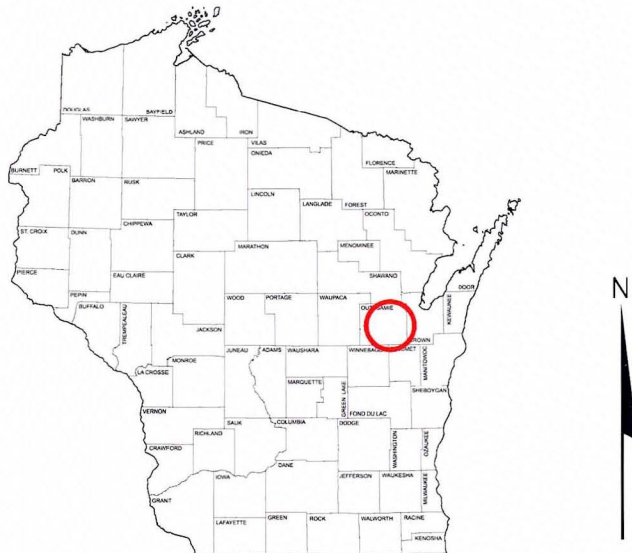
Wisconsin Department of Natural
Resources
Bureau of Remediation and
Redevelopment
Ms. Roxanne Nelezen Chronert,
Project Manager
1125 N. Military Road
P.O. Box 10448
Green Bay, WI 54307-0448

Wisconsin Department of Natural
Resources
Ms. Marie Stewart,
Contract Coordinator
101 S. Webster Street
P.O. Box 7921
Madison, WI 53707-7921

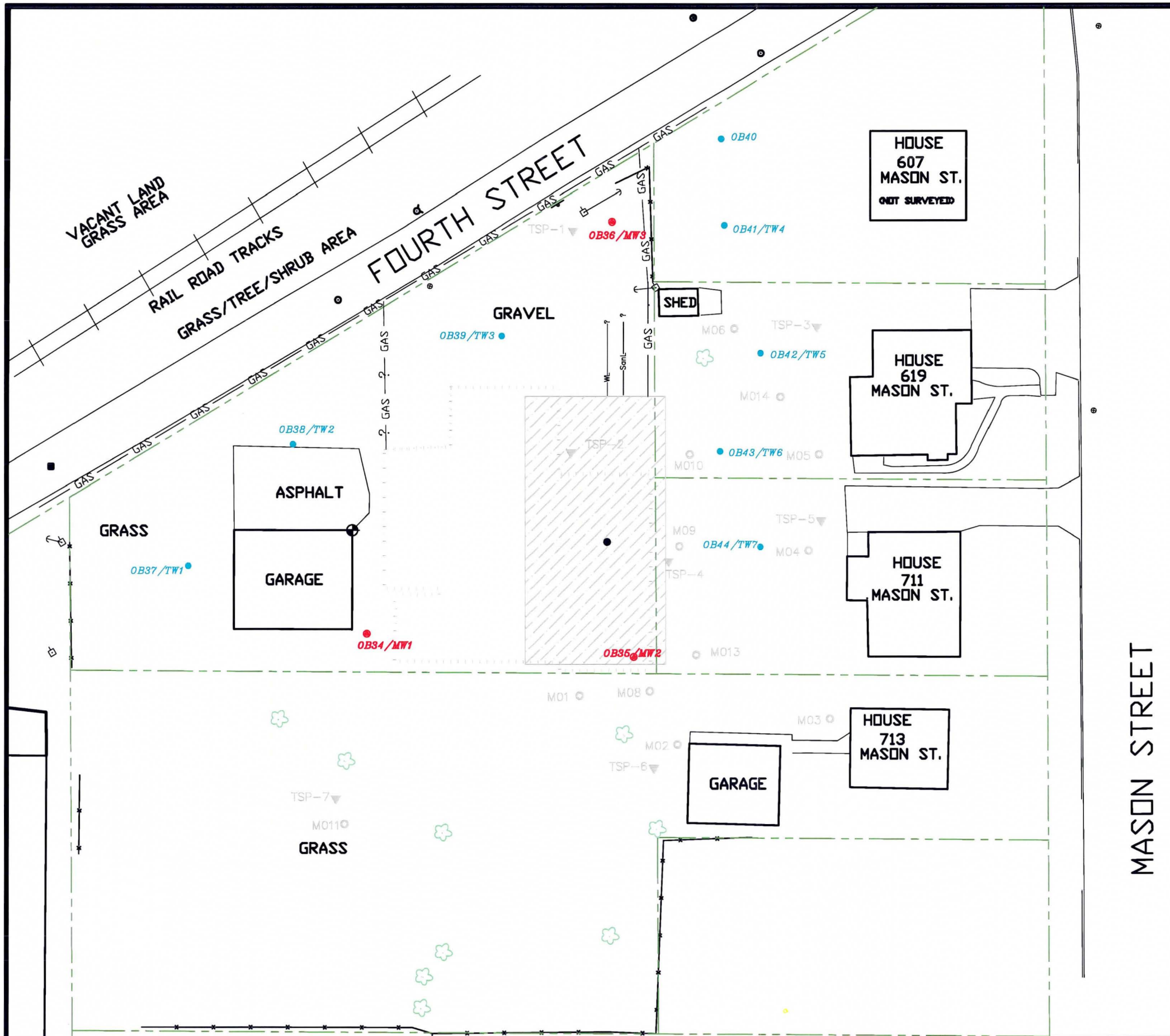
http://www.omni.com/ActiveProjects/Midwest_Plating.htm



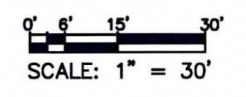
Source: 2000 DeLorme Topo Tools



<p>Figure 1 Site Location Map</p>	
<p>Midwest Plating Corporation 1315 West Fourth Street Appleton, Wisconsin</p>	
	<p>Project Number: N1681A01</p>
	<p>Date: June 21, 2004</p>
<p>One Systems Drive, Appleton, Wisconsin 54914-1654 Phone: (920) 735-6900 Fax: (920) 830-6100</p>	



LEGEND:



- Sump
- ⊙ Utility Manhole
- ⊙ Water Valve
- Storm Inlet
- ⊕ Hydrant
- ⊕ Utility Pole
- ⊕ Guy Wire
- ⊕ Sign
- ⊕ Deciduous Tree
- ⋯ Former Midwest Plating Corporation
- Fenceline
- Building Face
- Approximate Property Line
- ▨ Liner
- GAS — Gas Line
- 4" SanL — Sanitary Lateral
- WL — Water Lateral
- TSP-1 ▽ Temporary Groundwater Monitoring Well
MPC Consultant Sampled on 2/9/2000
- M01 ⊙ Soil Samples Taken Greater than 4 feet
- MW1 ● Proposed initial Monitoring Wells to determine groundwater elevation and flow direction.
- OB34/TW1 ● Proposed Direct push Soil Boring to assist with monitoring well placement.

**FIGURE 2
PROPOSED SOIL BORING/MONITORING
WELL MAP**

**MIDWEST PLATING CORPORATION
1315 WEST FOURTH STREET
APPLETON, WISCONSIN**

OMNI ASSOCIATES
 ONE SYSTEMS DRIVE
 APPLETON, WI 54914
 PHONE (920) 735-6900
 FAX (920) 830-6100

PROJECT MANAGER:	BDW	PROJECT NO:	N1681A01
PROJECT ENGINEER:	BDW	CAD FILE NO:	TOPO
DRAWN BY:	DLD	SCALE:	1" = 30'
REVIEWED BY:	DLF	DATE:	5/26/2004

SOIL

Table 1 - INTERIM INVESTIGATION ANALYTICAL SUMMARY

PARAMETER	SSRCL	KR002	M07-1	M07-2	M07-3	M07-3d	M12-1	M12-2	M16-1	M16-2	M16-2d	RM07	TSP-1-06	TSP-1-10	TSP-2-06	TSP-2-06d	TSP-2-09	P03	
SAMPLE DATE		6/1/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	5/11/99	2/3/00	2/3/00	2/3/00	2/3/00	2/3/00	3/30/00	
SAMPLER		WDNR	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	
SAMPLE DEPTH		0-1"	0-6"	2-3'	5-6'	5-6'	2-3'	5-6'	3-4'	7-8'	7-8'	4-5"	5-6'	9-10'	5-6'	5-6'	8-9'	0-1"	
METAL ANALYSIS (ng/kg)																			
CHROMIUM (total)	140	990	150	76	410	150	9900	980	15000	2100	2500	630	390	710	22	90	110	97	150
LEAD	96	410	41	33	26	41	11	4.2	4.8	3.7	3.9	360	110	5.6	2.5	4.1	4.4	4.5	66
CADMIUM	8	5.8	0.39	0.16	0.17	0.28	7.7	0.16	0.23	0.044	<0.043	1.9	0.9	<0.053	<0.055	<0.053	<0.053	<0.053	0.50
NICKEL	1600		13	16	11	11	30	15	29	16	19	12.0	17.0	16	7.6	14	15	16	9.9
ZINC	23000		37	550	40	23	450	23	80	28	35	150	100	33	12	23	25	25	52
ARSENIC			2.2	2.5	2.2	1.9	3.0	2.3	3.6	2.2	2.8	2.6		2.2	2.7	2.0	2.5	2.4	3.2
MERCURY		0.25	0.033	0.020	0.023	0.012	0.066	0.023	0.016	<0.0049	<0.0049	0.041		0.017	<0.0075	0.0083	0.0089	0.010	
CHROMIUM (hexavalent)			1.4	<0.91	36	53	960	160	2100	1200	1200	13	29		<0.47	31	35	58	

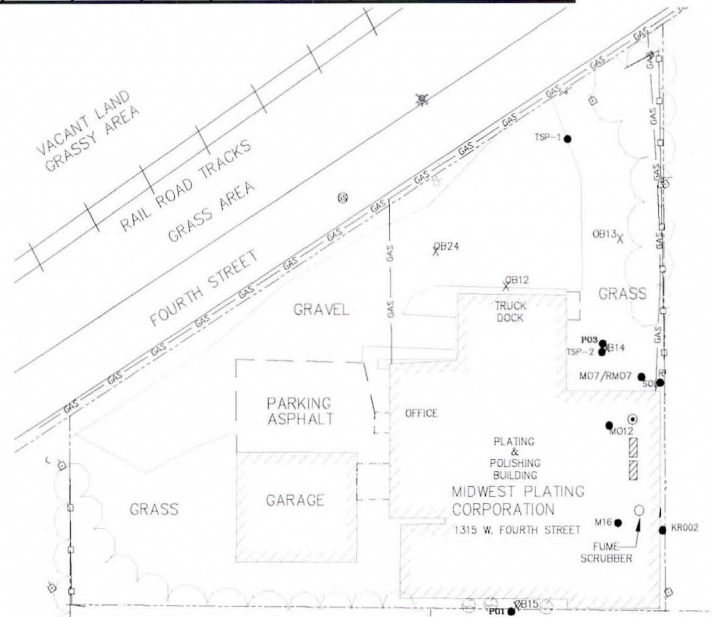
PARAMETER	SSRCL	OB12-0	OB12-1	OB12-2	OB12-3	OB13-0	OB14-1	OB14-2	OB15-1	OB15-2	OB15-3	OB15-4	OB24-0
SAMPLE DATE		1/9/01	1/9/01	3/14/01	3/14/01	1/9/01	1/9/01	1/9/01	1/9/01	1/9/01	3/14/01	3/14/01	3/14/01
SAMPLER		OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI
SAMPLE DEPTH (INCHES)		0-1	6-7	12-13	18-19	0-1	6-7	12-13	6-7	12-13	18-19	24-24	0-1
METAL ANALYSIS (ng/kg)													
CHROMIUM (total)	140	237	856	876	19	114	90	55	1130	629	45	36	11
LEAD	96	56	159	157	<6	44	33	61	235	208	40	<6	16"J"
CADMIUM	8	<1.2				<1.2							<1.2
NICKEL	1600	235				15							4.4
ZINC	23000	280				57							30

GROUNDWATER

PARAMETER	ES	PAL	TSP-01	TSP-02
SAMPLE DATE			2/9/00	2/9/00
SAMPLER			Earth Tech	Earth Tech
METAL ANALYSIS (µg/L)				
CHROMIUM	100	10	16	6.7
LEAD	15	1.5	<2.8	<2.8
CADMIUM	5	0.5	0.62	<0.50
ARSENIC	50	5	<6.8	<6.8

STORM WATER RUNOFF

PARAMETER	S01
SAMPLE DATE	4/11/01
SAMPLER	WDNR
METAL ANALYSIS (µg/L)	
CHROMIUM	81000
LEAD	42
CADMIUM	3
ARSENIC	<16
BARIIUM	49
NICKEL	130
ZINC	1100

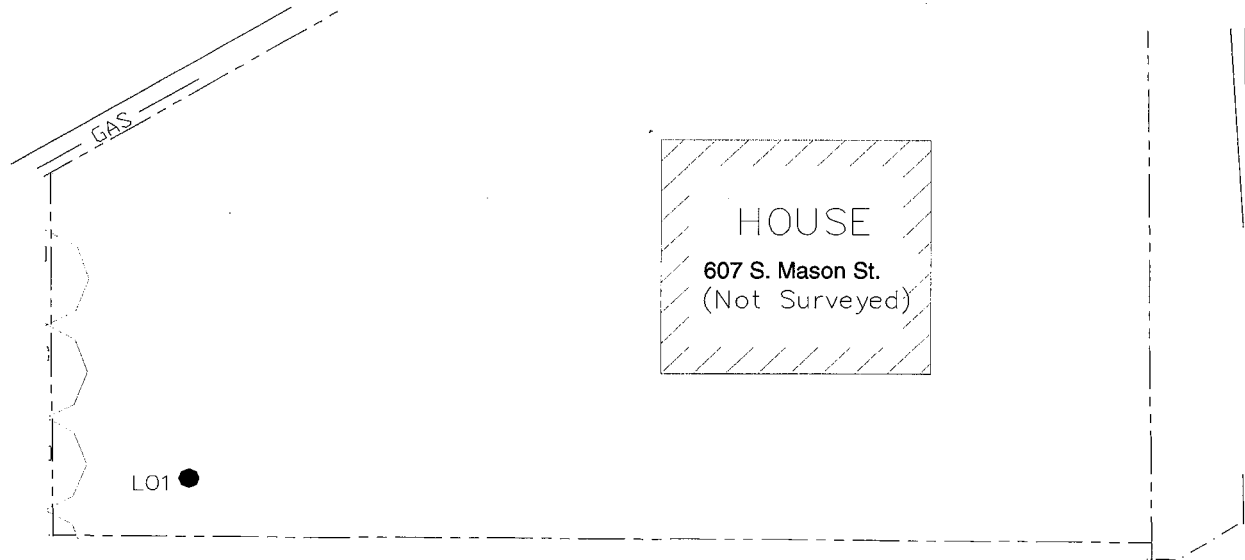


SSRCL = site specific residual contaminant level
 ES = enforcement standard
 PAL = preventive action limit

SOIL

Table 1 - INTERIM INVESTIGATION ANALYTICAL SUMMARY

PARAMETER	SSRCL	L01
SAMPLE DATE		7/27/98
SAMPLER		WDHFS
SAMPLE DEPTH	-	0-1
METAL ANALYSIS (mg/kg)		
CHROMIUM (total)	140	31
LEAD	96	25
CADMIUM	8	3.9
NICKEL	1600	10
ZINC	23000	51
ARSENIC		<3



SSRCL = site specific residual contaminant level

SOIL

Table 1 - INTERIM INVESTIGATION ANALYTICAL SUMMARY

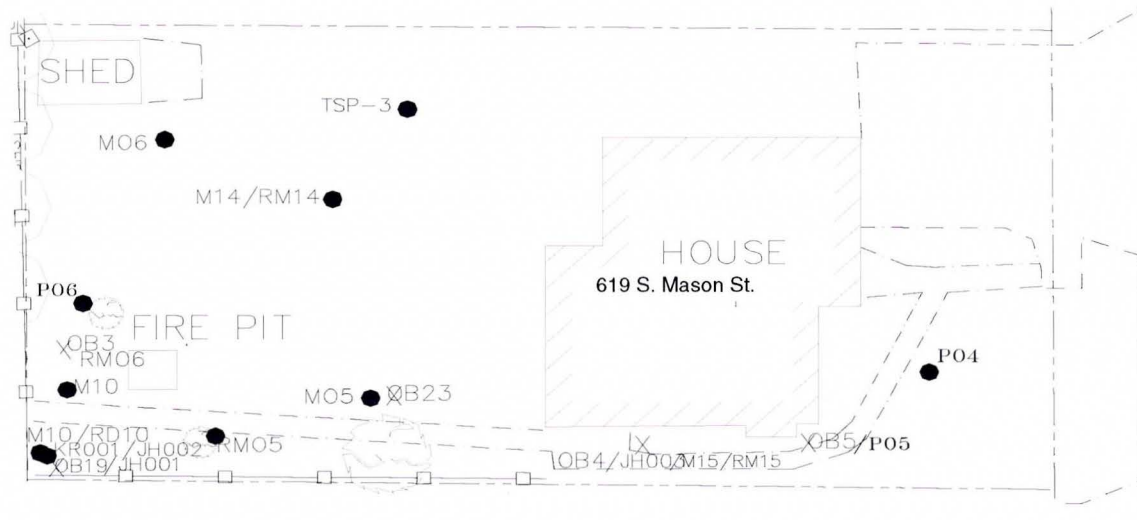
PARAMETER	SSRCL	KR001	K01	M05-1	M05-2	M05-3	M06-1	M06-2	M06-3	M06-3d	M10-1	M10-2	M10-3	M14-1	M14-2	M14-3	M15-1	RM05	RM06	RM10	RM10d	RM14	RM15	RD10	P04	P05	P06						
SAMPLE DATE		6/1/98	7/27/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	5/11/99	5/11/99	5/11/99	5/11/99	5/11/99	5/11/99	1/3/00	3/30/00	3/30/00	3/30/00						
SAMPLER		W05R	W05FS	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	W05R	Earth Tech	W05R	Earth Tech	W05R	Earth Tech	W05R	Earth Tech	Earth Tech	Earth Tech	Earth Tech					
SAMPLE DEPTH		0.1'	0.1'	0.6'	2.3'	5.6'	0.6'	2.3'	5.6'	5.6'	0.6'	2.3'	5.6'	0.6'	2.3'	5.6'	0.6'	0.1'	0.1'	0.1'	0.1'	0.1'	0.1'	0.1'	0.1'	0.1'	0.1'						
METAL ANALYSIS (ng/kg)																																	
CHROMIUM (total)	140	1700	290	180	300	29	19	30	29	52	710	160	46	80	33	22	560	1500	1800	180	190	1000	1700	740	2200	29	33	450	530	370	34	190	270
LEAD	96	60	52	7.8	5.2	4.3	27	6.2	3.9	4.2	85	4.7	4.0	14	4.4	3.3	160	60	83	39	44	35	248.6	40	134.3	20	23.16	280	319.9	44	72	61	
CADMIUM	8	9.6	3.1	0.047	0.44	<0.044	3.6	<0.041	<0.042	<0.042	11	<0.046	<0.043	0.81	<0.043	<0.043	8.7	5.6	7.1	1.9	2.1	4.0	7.2	2.7	10	1.9	2.1	10	10	3.7	4.4	3.3	
NICKEL	1600		17	16	14	17	9.9	15	16	19	15	28	18	23	19	15	19	22	17	13	16	11	17	7.3	21	13	16	17	22	12	14	14	
ZINC	23000		160	27	27	24	54	31	22	27	300	25	24	55	26	20	360	230	280	86	100	160	270	110	390	42	53	460	630	78	150	160	
ARSENIC			12	2.3	1.4	2.6	4.3	2.1	2.1	2.6	3.1	2.7	2.9	3.3	7.7	2.0	3.3	1.5		2.0		<0.84		<0.83		2.8		4.6		2.7	2.3	2.3	
MERCURY		0.062		0.049	0.016	0.013	0.087	0.015	0.017	0.011	0.10	0.024	0.013	0.021	<0.0049	<0.0049	0.12	0.12		0.098		0.030		0.029		0.044		0.26					
CHROMIUM (hexavalent)		2.90		1.7	1.1	<0.91	<0.93	<0.85	<0.88	<0.88	5.4	12	8.7	1.0	<0.89	<0.90	<0.99	<0.78	77	4.1	<3.8	50	66	32	60	<2.8	5.4	3.3	4.3	<0.43			

PARAMETER	SSRCL	OB3-1	OB3-2	OB3-3	OB3-4	OB3-5	OB3-6	OB3-7	OB4-1	OB4-2	OB4-3	OB4-3d	OB4-4	OB5-1	OB5-2	OB5-3	OB5-4	OB19-1	OB19-2	OB19-3	OB19-4	OB19-5	OB19-6	OB19-7	OB23-1	OB23-2	OB23-3	OB23-4	
SAMPLE DATE		1/9/01	1/9/01	1/9/01	3/14/01	3/14/01	3/14/01	3/14/01	1/9/01	1/9/01	4/3/01	4/3/01	4/3/01	1/9/01	4/3/01	4/3/01	4/3/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	
SAMPLER		0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	0505R	
SAMPLE DEPTH (INCHES)		6.7	12.13	18.19	24.25	30.31	36.37	42.43	6.7	12.13	18.19	18.19	24.25	6.7	12.13	18.19	24.24	6.7	12.13	18.19	24.24	30.31	36.37	42.43	6.7	12.13	18.19	24.25	
METAL ANALYSIS (ng/kg)																													
CHROMIUM (total)	140	164	231	336	405	467	63	47	241	201	92	106	88	175	65	58	61	3690	1720	723	305	152	148	199	442	168	98	52	
LEAD	96	33	22	18.7*	11.7*	<6	<6	<6	76	43	9.8**	13.7*	10.7*	62	23	13.7*	9.5**	386	45	16.7*	9.1**	<6	<6	<6	20	7.9**	<6	<6	
CADMIUM	8																												
NICKEL	1600																												
ZINC	23000																												

PARAMETER	SSRCL	JH001	JH002	JH003
SAMPLE DATE		5/7/01	5/7/01	5/7/01
SAMPLER		W05R	W05R	W05R
SAMPLE DEPTH (INCHES)		6.7	0.1	0.1
METAL ANALYSIS (ng/kg)				
CHROMIUM (total)	140	2000	3200	650
LEAD	96	425	132	165
CADMIUM	8	12	0.18	10
NICKEL	1600	20	25	24
ZINC	23000	430	410	450

GROUNDWATER

PARAMETER	ES	PAL	TSP-03
SAMPLE DATE			2/9/00
SAMPLER			Earth Tech
METAL ANALYSIS (µg/L)			
CHROMIUM	100	10	1.6
LEAD	15	1.5	<2.8
CADMIUM	5	0.5	1.1
ARSENIC	50	5	<6.8



SSRCL = site specific residual contaminant level
 ES = enforcement standard
 PAL = preventive action limit

SOIL

Table 1 - INTERIM INVESTIGATION ANALYTICAL SUMMARY

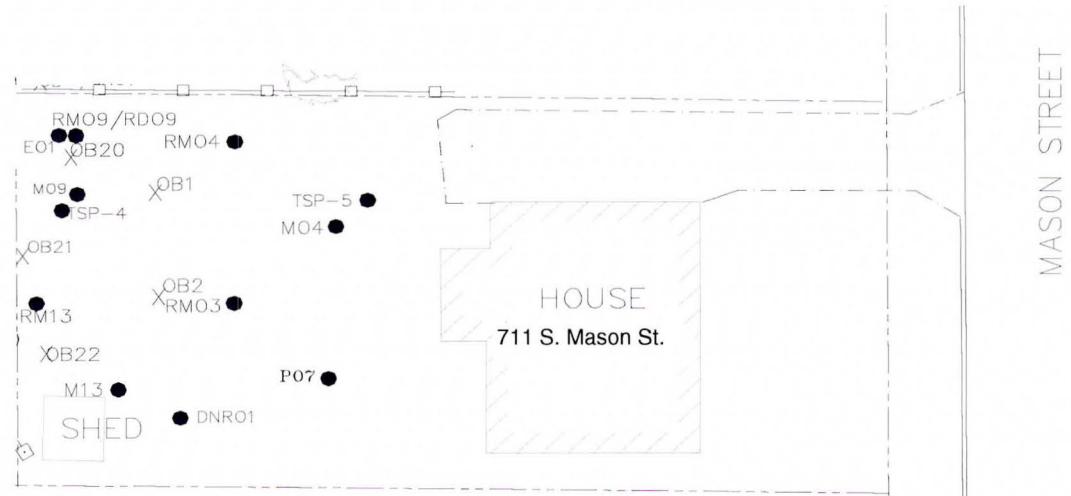
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SAMPLE DATE		7/27/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	5/11/99	5/11/99	5/11/99	5/11/99	5/11/99	1/3/00	3/30/00				
SAMPLER		WDHBS	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	WDSNR	Earth Tech	WDSNR	Earth Tech	WDSNR	Earth Tech	Earth Tech			
SAMPLE DEPTH		0-1"	0-6"	2-3"	5-6"	0-6"	2-3"	6-7"	6-7"	0-6"	2-3"	6-7"	0-1"	0-1"	0-1"	0-1"	0-1"	0-1"	0-1"	0-1"			
METAL ANALYSIS (mg/kg)																							
CHROMIUM (total)	140	110	34	35	24	700	140	89	78	43	31	25	63	73	71	82	140	130	310	280	66	100	64
LEAD	96	94	11	3.8	4.0	180	5.1	6.2	3.6	73	15	2.7	120	150	68	87	120	133.4	180	261.4	150		35
CADMIUM	8	1.7	0.45	0.048	<0.043	3.2	<0.046	<0.043	<0.043	1.4	0.15	<0.043	1.5	2.1	0.92	1.3	1.7	2.2	2.6	2.5	2.6		3.0
NICKEL	1600	16	17	13	16	17	20	16	16	13	12	11	12	16	15	18	14	14	14	16	16		16
ZINC	23000	150	38	20	23	180	34	23	22	130	37	16	160	200	110	130	190	200	640	610	240		71
ARSENIC		13	2.2	2.1	2.0	3.7	1.9	2.3	2.5	2.1	2.1	1.1	2.8		3.9		2.9		2.2				2.4
MERCURY			0.036	0.02	0.013	0.97	0.045	0.014	<0.0049	0.058	0.013	<0.0049	0.20		0.20		0.19		0.18				
CHROMIUM (hexavalent)			<0.94	<0.95	<0.89	<0.96	1.5	1.5	1.1	<0.92	0.96	<0.90	3.6	9.1	<0.61	<3.8	3.5	3.1	<3.6	5.7	<3.8	<0.61	

PARAMETER	SSRCL	OB1-1	OB1-2	OB1-2d	OB1-3	OB1-3d	OB2-1	OB2-2	OB2-2d	OB2-3	OB20-1	OB20-2	OB20-3	OB20-4	OB20-5	OB20-6	OB20-7	OB21-1	OB21-2	OB21-3	OB21-4	OB21-5	OB21-6	OB21-7
SAMPLE DATE		1/9/01	1/9/01	1/9/01	1/9/01	1/15/01	1/9/01	1/9/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01
SAMPLER		OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI
SAMPLE DEPTH (INCHES)		6-7	12-13	12-13	18-19	18-19	6-7	12-13	12-13	18-19	6-7	12-13	18-19	24-25	30-31	36-37	42-43	6-7	12-13	18-19	24-25	30-31	36-37	42-43
METAL ANALYSIS (mg/kg)																								
CHROMIUM (total)	140	24	93	59	298	329	34	24	19	30	204	330	976	576	258	250	124	227	450	650	783	303	312	363
LEAD	96	15"J"	59	60	257	328	122	8.6"J"	<6	15"J"	119	72	182	22	<6	<6	<6	91	112	268	26	<6	<6	<6
CADMIUM	8																							
NICKEL	1600																							
ZINC	23000																							

PARAMETER	SSRCL	OB22-1	OB22-2	OB22-3	OB22-4	OB22-5	OB22-6	OB22-7
SAMPLE DATE		1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01	1/15/01
SAMPLER		OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI	OMNNI
SAMPLE DEPTH (INCHES)		6-7	12-13	18-19	24-25	30-31	36-37	42-43
METAL ANALYSIS (mg/kg)								
CHROMIUM (total)	140	114	186	49	60	182	147	211
LEAD	96	260	335	44	20"J"	19"J"	<6	<6
CADMIUM	8							
NICKEL	1600							
ZINC	23000							

GROUNDWATER

PARAMETER	ES	PAL	TSP-04	TSP-04	TSP-05
SAMPLE DATE			2/9/00	2/9/00	2/9/00
SAMPLER			WDSNR	Earth Tech	Earth Tech
METAL ANALYSIS (ug/L)					
CHROMIUM	100	10	278,700	400,000	1.3
LEAD	15	1.5	1.0	<5.6	<2.8
CADMIUM	5	0.5	1.0	<0.50	<0.50
ARSENIC	50	5	<0.6	<1.4	<6.8
BARIIUM	2000	400	120		
COPPER	1300	130	9		
IRON	300	150	<0.01		
NICKEL	100	20	57		
SILVER	50	10	2,089		
ZINC	5000	2500	<8		



SSRCL = site specific residual contaminant level
 ES = enforcement standard
 PAL = preventive action limit

SOIL

Table 1 - INTERIM INVESTIGATION ANALYTICAL SUMMARY

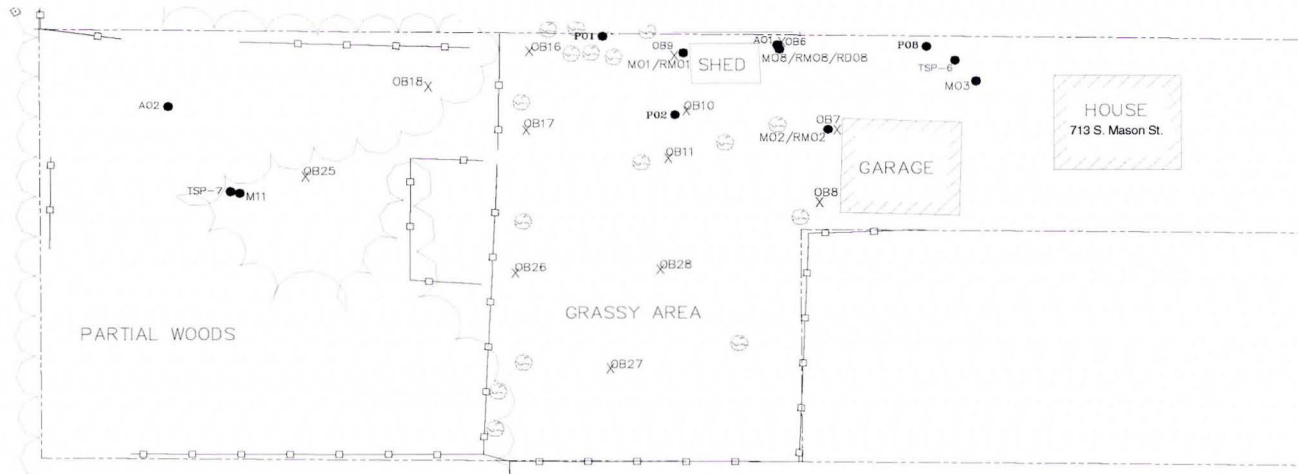
PARAMETER	SSRCL	A01	A02	M01-1	M01-2	M01-2d	M01-3	M02-1	M02-2	M02-3	M03-1	M03-2	M03-3	M08-1	M08-2	M08-3	M11-1	M11-2	M11-2d	M11-3	RM01	RM02	RM08	RM08d	RD08	P01	P02	P08				
SAMPLE DATE		7/27/98	7/27/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	11/12/98	5/11/99	5/11/99	5/11/99	5/11/99	1/3/00	3/30/00	3/30/00	3/30/00				
SAMPLER		WDHS	WDHS	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	Earth Tech	WDSR	WDSR	Earth Tech	WDSR	Earth Tech	Earth Tech	Earth Tech	Earth Tech			
SAMPLE DEPTH (INCHES)		0-1"	0-1"	0-6"	2-3"	2-3"	6-7"	0-6"	2-3"	6-7"	0-6"	2-3"	6-7"	0-6"	2-3"	6-7"	0-6"	2-3"	2-3"	6-7"	0-1"	0-1"	0-1"	0-1"	0-1"	0-1"	0-1"	0-1"	0-1"			
METAL ANALYSIS (mg/kg)																																
CHROMIUM (total)	140	1400	32	36	19	20	17	21	21	17	18	18	19	53	65	27	12	34	39	17	240	260	36	43	700	490	640	900	1300	3100	99	57
LEAD	96	880	96	58	7.5	9.2	3.7	30	5.7	3.1	22	3.4	4.0	23	4.9	3.8	13	4.5	5.2	3.7	810	1600	81	110	220	261.5	370	397.6	910	190	70	
CADMIUM	8	38	5.4	0.34	<0.043	<0.043	0.73	<0.046	<0.043	1.4	0.15	0.042	0.50	<0.046	<0.043	0.16	<0.045	<0.046	0.072	8.1	6.9	2.5	3.5	13	12	11	17	120	3.3	3.1		
NICKEL	1600	21	11	14	8.7	9.1	13	15	14	12	9.0	12	16	17	8.7	18	5.3	23	23	17	12	14	9.7	14	10	14	12	15	20	12	12	
ZINC	23000	1400	120	97	25	34	19	110	26	17	48	43	20	82	29	22	26	29	370	21	870	1300	150	200	540	550	480	720	1300	180	200	
ARSENIC		16	7	4.4	2.0	4.5	1.9	4.3	1.9	1.6	1.1	2.4	1.6	3.9	2.0	2.8	2.2	2.2	4.1	3.0	4.7		4.1		3.9		5.6		8.2	3.3	3.4	
MERCURY				0.073	0.017	0.015	0.011	0.11	0.42	0.0069	0.043	0.017	0.012	0.039	0.032	0.0099	0.031	0.028	0.013	0.010	0.21		0.091		0.10		0.11					
CHROMIUM (hexavalent)				<0.01	<0.90	<0.90	<0.89	<0.93	<0.95	<0.89	<0.91	<0.89	<0.88	<0.92	<0.96	<0.90	<0.93	1.0	1.3	<0.89	<6.8	<3.8	<3.3	<3.8	3.6	16	<3.4	3.3	<0.68			

PARAMETER	SSRCL	OB6-1	OB6-2	OB6-3	OB6-4	OB7-1	OB7-2	OB7-3	OB7-4	OB7-5	OB8-0	OB9-1	OB9-2	OB9-3	OB9-4	OB10-1	OB10-2	OB10-3	OB10-0	OB11-1	OB11-2	OB11-3	OB11-4	OB16-0	OB16-1	OB16-2	OB16-3	OB16-3d	OB17-0	OB17-1	OB17-2	
SAMPLE DATE		1/9/01	1/9/01	3/14/01	3/14/01	1/9/01	3/14/01	3/14/01	3/14/01	3/14/01	1/9/01	1/9/01	1/9/01	3/14/01	3/14/01	1/9/01	3/14/01	3/14/01	1/9/01	3/14/01	3/14/01	3/14/01	3/14/01	1/9/01	1/9/01	3/14/01	3/14/01	3/14/01	1/9/01	3/14/01	3/14/01	
SAMPLER		OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	
SAMPLE DEPTH (INCHES)		6-7	12-13	18-19	24-25	6-7	12-13	18-19	24-25	30-31	0-1	6-7	12-13	18-19	24-25	6-7	12-13	18-19	0-1	6-7	12-13	18-19	24-25	0-1	6-7	12-13	18-19	18-19	0-1	6-7	12-13	
METAL ANALYSIS (mg/kg)																																
CHROMIUM (total)	140	217	142	95	22	38	19	27	17	30	38	166	63	22	31	73	26	24	58	45	17	20	19	337	217	24	34	33	55	17	14	
LEAD	96	80	40	6.4**	<6	106	31	123	<6	<6	60	1043	226	34	<6	139	71	19**	150	258	150	96	29	204	130	207**	<6	6.5**	141	79	19**	
CADMIUM	8										3.1**								3.6**													
NICKEL	1600										10								12						21							
ZINC	23000										84								197						952							

PARAMETER	SSRCL	OB18-0	OB18-1	OB18-1d	OB18-2	OB25-0	OB25-1	OB25-2	OB25-3	OB25-4	OB26-0	OB27-0	OB28-0	OB28-0d	OB28-1	OB28-2	
SAMPLE DATE		1/9/01	3/14/01	3/14/01	3/14/01	3/14/01	3/14/01	3/14/01	3/14/01	3/14/01	3/14/01	3/14/01	3/14/01	4/3/01	4/3/01	3/14/01	3/14/01
SAMPLER		OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	OMNSI	
SAMPLE DEPTH (INCHES)		0-1	6-7	6-7	12-13	0-1	6-7	12-13	18-19	24-25	0-1	0-1	0-1	0-1	0-1	6-7	12-13
METAL ANALYSIS (mg/kg)																	
CHROMIUM (total)	140	121	45	53	30	37	30	29	17	29	29	19	56			36	14
LEAD	96	148	86	98	44	149	125	123	68	117**	95	53	322			114	67
CADMIUM	8	7.5											3.6**	4.3			
NICKEL	1600	12											9.7	10			
ZINC	23000	204											126	125			

GROUNDWATER

PARAMETER	ES	PAL	TSP-06	TSP-07
SAMPLE DATE			2/9/00	2/9/00
SAMPLER			Earth Tech	Earth Tech
METAL ANALYSIS (µg/L)				
CHROMIUM	100	10	1.3	2.5
LEAD	15	1.5	<2.8	<2.8
CADMIUM	5	0.5	<0.50	<0.50
ARSENIC	50	5	<6.8	<6.8



SSRCL = site specific residual contaminant level
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 PAL = preventive action limit

Midwest Plating Corporation
 Project Number 04RRFQ
 BRRTS Number 02-45-191769

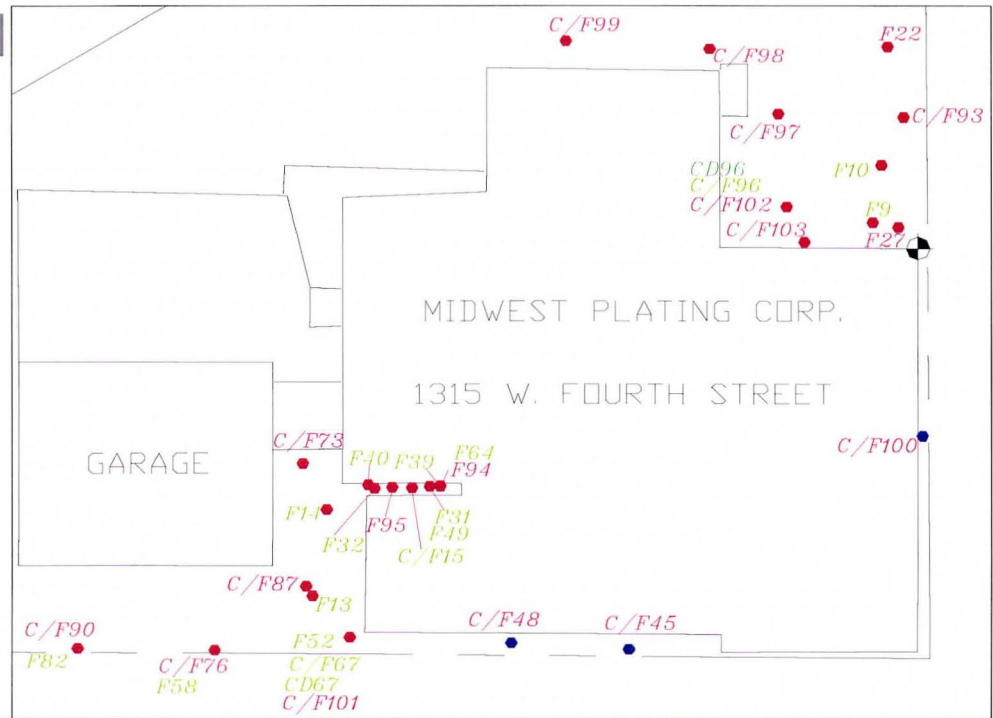
Table 2 - INTERIM FIELD AND CONFIRMATION SAMPLE SUMMARY

PARAMETER	SSRCL	F9	F10	F13	F14	F14RE	F15	F15RE	C15	F22	F27	F31	F32	F39	F39RE	F40	F45	C45	F48	C48	F49	F52	F58
SAMPLE DATE		6/24/02	6/24/02	6/25/02	6/25/02		6/25/02		6/25/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02		6/26/02	6/27/02		6/27/02		6/27/02	6/27/02	6/27/02
SAMPLE DEPTH	-	surface	surface	surface	surface		surface		surface	16 in	12 in	12 in	12 in		12 in	18 in		18 in		18 in	12 in	12 in	
CYANIDE (total)									4.0														
METAL ANALYSIS (mg/kg)																							
CADMIUM (total)	8	1	8	12	22	21	49	54	30	8	1	19	21	24	23	1	2	<0.7	3	<0.7	30	53	4
CHROMIUM (total)	140	272	477	900	2291	2668	6996	6864	5180	409	416	1812	2849	3227	3025	691	50	36	52	21	5290	49	46
LEAD (total)	96	12	266	574	317	376	675	692	405	116	126	180	499	237	225	124	12	11	7	3.9"J"	321	25	160
NICKEL (total)	1600	26	46	147	222	219	709	672	201	52	8	49	196	89	44	32	22	21	44	12	94	17	30
ZINC (total)	23000	133	205	1324	5636	6552	17257	16973	8240	261	170	4166	7100	6521	6297	2480	91	117	44	26	9405	85	327

PARAMETER	SSRCL	F64	F67	C67	CD67	F73	C73	F76	C76	F82	F87	C87	F90	C90	F93	C93	F94	F95	F95RE	F96	F96RE	C96	CD96
SAMPLE DATE		6/27/02	6/27/02		6/28/02		6/28/02		6/28/02	6/28/02	6/28/02		6/28/02	7/1/02	7/1/2002	7/1/02		7/1/02					
SAMPLE DEPTH	-	24 in	24 in		12 in		18 in		12 in	12 in	18 in		4 ft	28 in	23 in		18 in						
METAL ANALYSIS (mg/kg)																							
CADMIUM (total)	8	1	6			1		2		11	4		2					2			2	5	
CHROMIUM (total)	140	60	46	105	29	49	75	49	31	49	77	61	28	20	104	119	71	161	166	209	240	103	178
LEAD (total)	96	5	45	229	8.7"J"	21	38	22	11	82	34	42	38	55	13	31	15	8	15	80	77	61	115
NICKEL (total)	1600	41	25			24		14		53	9		34		6		29	41	48	24	27		
ZINC (total)	23000	91	99			82		70		161	66		108		51		92	151	157	132	116		

PARAMETER	SSRCL	F97	C97	F98	C98	F99	C99	F100	C100
SAMPLE DATE		7/1/02		7/1/02		7/1/02		7/9/02	
SAMPLE DEPTH	-	18 in		18 in		6 in		surface/12 in	
METAL ANALYSIS (mg/kg)									
CADMIUM (total)	8			1		5			<0.7
CHROMIUM (total)	140	44	56	74	38	52	12		273
LEAD (total)	96	13	9.2	13	<3	44	28		<3
NICKEL (total)	1600	48		36		16			19
ZINC (total)	23000	56		33		64			34

PARAMETER	SSRCL	F101	C101	F102	C102	F103	C103
SAMPLE DATE		7/9/02		7/9/02		7/9/03	
SAMPLE DEPTH	-	30 in		24 in		32 in	
METAL ANALYSIS (mg/kg)							
CADMIUM (total)	8						
CHROMIUM (total)	140		43	229		2370	
LEAD (total)	96		<3		<3	50	
NICKEL (total)	1600						
ZINC (total)	23000						

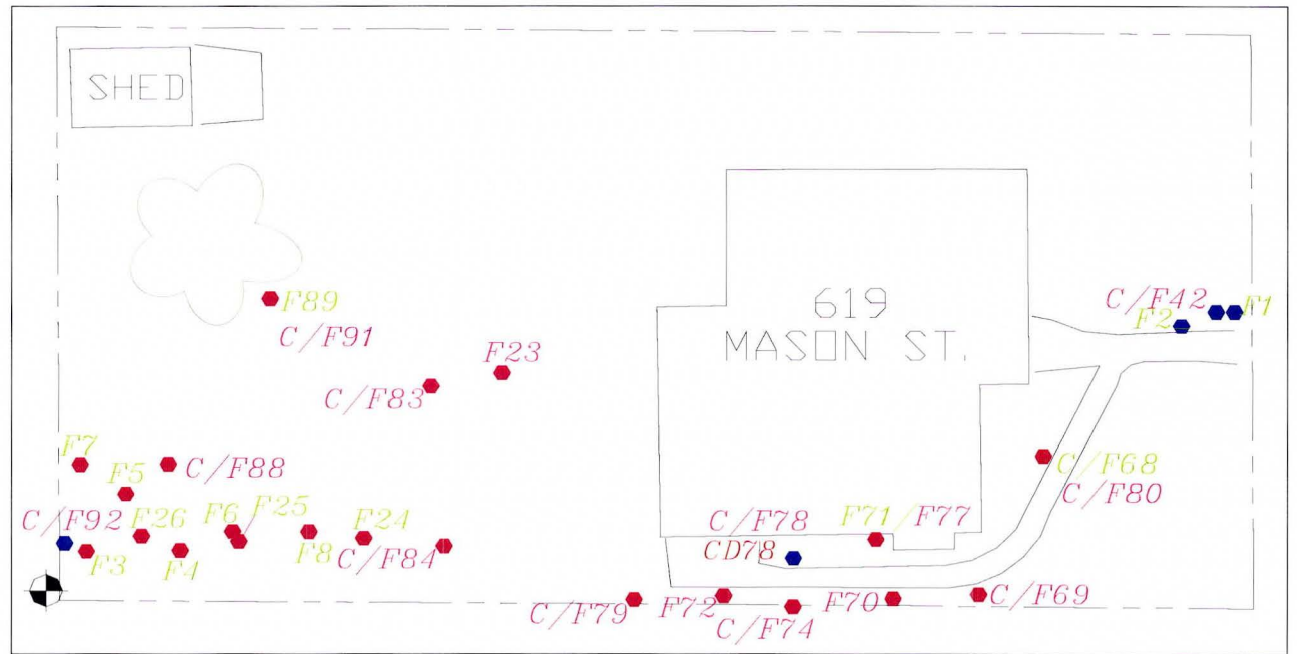


Project # 04RRFQ
 BRRTS # 02-45-191769
 F = field, RE = rerun
 C = confirmation, CD = confirmation duplicate
 SSRCL = site specific residual contaminant level
 Shaded cell = laboratory analysis indicates soil at the sampled location is above SSRCLs

Table 2 - INTERIM FIELD AND CONFIRMATION SAMPLE SUMMARY

PARAMETER	SSRCL	F1	F2	F3	F4	F5	F6	F7	F8	F23	F24	F25	F26	F42	C42	F68	C68	F69	C69	F70	F71	F72	
SAMPLE DATE		6/24/02	6/24/02	6/24/02	6/24/02	6/24/02	6/24/02	6/24/02	6/24/02	6/25/02	6/26/02	6/26/02	6/26/02	6/26/02		6/27/02		6/27/02		6/27/02	6/27/02	6/28/02	
SAMPLE DEPTH	-	surface	surface	surface	surface	surface	surface	surface	surface	surface	12 in	16 in	18 in	12 in below driveway		6 in		12 in		18 in	18 in	18 in	
METAL ANALYSIS (mg/kg)																							
CADMIUM (total)	8	4	6	39	3	4	16	5	14	8	1	2	2	2	<0.7	7						10	1
CHROMIUM (total)	140	107	755	3595	940	99	2020	352	2786	465	242	337	512	69	41	64	37	28	18	38	83	83	
LEAD (total)	96	31	106	174	19	34	124	41	133	43	15	17	23	97	16	50	30	11	11	23	67	13	
NICKEL (total)	1600	13	38	60	17	13	42	21	39	33	14	39	47	7	10	13				22	25	12	
ZINC (total)	23000	50	406	647	66	111	155	166	408	84	69	71	92	74	37	91		51		55	254	62	

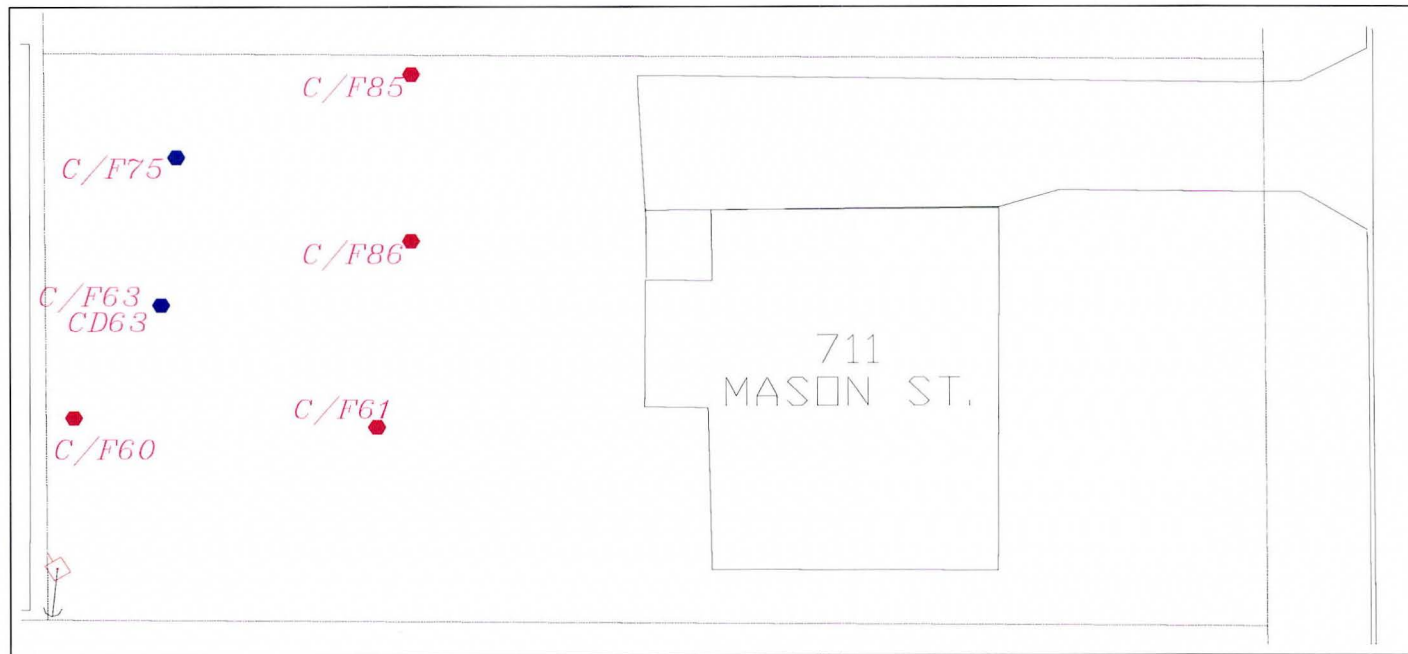
PARAMETER	SSRCL	F74	C74	F77	F78	C78	CD78	F79	C79	F80	C80	F83	C83	F84	C84	F88	C88	F89	F91	C91	F92	F92RE	C92	
SAMPLE DATE		6/28/02		6/28/02	6/28/02			6/28/02		6/28/02		6/28/02		6/28/02		6/28/02		6/28/02	7/1/02		7/1/02			
SAMPLE DEPTH	-	12 in		24 in	18 in			18 in		12 in		6 in		18 in		4 ft		6 in	15 in		4 ft			
METAL ANALYSIS (mg/kg)																								
CADMIUM (total)	8	1		4	2	<0.7	<0.7			3				2		2		1	2				3	<0.7
CHROMIUM (total)	140	61	43	81	90	38	129	41	29	62	37	80	66	52	38	195	53	140	67	40	188	181	344	
LEAD (total)	96	23	35	26	19	16	36	33	39	28	32	12	6.6"J"	13	6.8"J"	2	8.9"J"	9	9	6.0"J"	11	11	7.8"J"	
NICKEL (total)	1600	14		30	32	12	17			17		23		35		36		51	34		46	11	18	
ZINC (total)	23000	51		78	66	37	95	68		56		55		45		39		58	36		52	73	33	



Project # 04RRFQ
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Table 2 - INTERIM FIELD AND CONFIRMATION SAMPLE SUMMARY

PARAMETER	SSRCL	F60	C60	F61	C61	F63	C63	CD63	F75	C75	F85	C85	F86	C86
SAMPLE DATE		6/27/02		6/27/02		6/27/02			6/28/02		6/28/02		6/28/02	
SAMPLE DEPTH	-	4 ft		6 in		4 ft			4 ft		12 in		6 in	
METAL ANALYSIS (mg/kg)														
CADMIUM (total)	8	2		3		4	<0.7	<0.7		<0.7	1			
CHROMIUM (total)	140	160	295	42	25	100	180	51	51	34	62	31	67	49
LEAD (total)	96	20	29	10	13	6	11	6.4"J"	10	3.7"J"	12	8.7"J"	20	42
NICKEL (total)	1600	31		11		35	20	16	36	14	34		4	
ZINC (total)	23000	87		39		48	36	25	35	21	25		88	



Project # 04RRFQ
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 F = field, RE = rerun
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Table 2 - INTERIM FIELD AND CONFIRMATION SAMPLE SUMMARY

PARAMETER	SSRCL	F11	F12	F16	F16RE	F17	F18	F19	F20	F21	F28	F29	F30	F33	F33RE	C33	F34	C34	F35	C35	F36	C36
SAMPLE DATE		6/24/02	6/24/02	6/25/02	6/25/02	6/25/02	6/25/02	6/25/02	6/25/02	6/25/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02	6/26/02
SAMPLE DEPTH	-	surface	surface	surface	surface	surface	surface	surface	surface	surface	12 in	18 in	6 in	6 in	6 in	6 in	12 in	12 in	6 in	6 in	6 in	6 in
METAL ANALYSIS (mg/kg)																						
CADMIUM (total)	8	40	30	11	9	7	8	6	7	8	10	5	28	10	8					4		
CHROMIUM (total)	140	387	616	55	72	49	62	50	78	67	107	90	495	69	86	63	50	27	56	46	43	22
LEAD (total)	96	416	421	120	125	147	179	96	208	268	321	67	175	85	71	91	22	23	60	63	32	34
NICKEL (total)	1600	28	19	24	31	12	23	15	24	28	29	23	96	11	23		33		17		11	
ZINC (total)	23000	977	644	180	185	203	277	216	1056	391	467	148	903	181	167		47		63		72	

PARAMETER	SSRCL	F37	C37	F38	C38	F41	C41	F43	C43	F44	C44	F46	F47	F50	C50	CD50	F51	C51	F53	C53	F54	C54
SAMPLE DATE		6/26/02	6/26/02	6/26/02	6/26/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/2002	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02
SAMPLE DEPTH	-	6 in	6 in	6 in	6 in	12 in	6 in	6 in	6 in	12 in	6 in	6 in	6 in	6 in	6 in	6 in	12 in	12 in	6 in	6 in	12 in	12 in
METAL ANALYSIS (mg/kg)																						
CADMIUM (total)	8	6		5		1		6		3		5	4	3			8		1		2	
CHROMIUM (total)	140	58	24	36	18	42	23	31	18	59	18	51	86	42	26	25	62	30	24	16	16	34
LEAD (total)	96	112	102	74	56	43	48	78	76	81	62	177	150	68	105	104	97	85	17	20	56	69
NICKEL (total)	1600	49				28		6		39		17	28				31		25		24	
ZINC (total)	23000	142		228		91		131		270		258	256	126			123		50		92	

PARAMETER	SSRCL	F55	C55	F56	C56	C56	F57	F59	C59
SAMPLE DATE		6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02
SAMPLE DEPTH	-	6 in	6 in	18 in	18 in	18 in	18 in	6 in	6 in
METAL ANALYSIS (mg/kg)									
CADMIUM (total)	8	1		1			1		
CHROMIUM (total)	140	33	14	196	110	121	326	31	16
LEAD (total)	96	33	59	25	23	28	42	35	10
NICKEL (total)	1600	3		22			31	25	
ZINC (total)	23000	84		248			169	84	

PARAMETER	SSRCL	F62	C62	F65	C65	F66	C66	F81	C81
SAMPLE DATE		6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/27/02	6/28/02	6/28/02
SAMPLE DEPTH	-	36 in	36 in	12 in	12 in	12 in	12 in	12 in	12 in
METAL ANALYSIS (mg/kg)									
CADMIUM (total)	8	1	<0.7			1		3	
CHROMIUM (total)	140	126	70	32	17	40	40	19	16
LEAD (total)	96	10	4.7"J"	10	9.3	15	8.0"J"	35	30
NICKEL (total)	1600	28	24	36		31		3	
ZINC (total)	23000	53	32	45		57		49	



Project # 04RRFQ
 BRRTS # 02-45-191769
 F = field, RE = rerun
 C = confirmation, CD = confirmation duplicate
 SSRCL = site specific residual contaminant level
 Shaded cell = laboratory analysis indicates soil at the sampled location is above SSRCLs

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for the
Sampling and Analysis Plan**

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SAMPLING and ANALYSIS PLAN

Purpose

The purpose of the Sampling and Analysis Plan for the Midwest Plating Corporation (MPC) site investigation and remedial action recommendations project is to address the type of sampling needed along with the collection procedures and analysis necessary to document that the site investigation has achieved its goals. Sampling will be performed during the site investigation for three purposes: to define the degree and extent of soil and groundwater contamination; to collect information that will assist with evaluating remedial options; and to determine the appropriate disposal of the waste. The type of sampling that will be required at the MPC project includes soil, groundwater, groundwater collected from the sump, development water and decontamination fluids, and waste characterization.

Organizational Structure and Responsibility

The organizational structure and responsibilities of the project team are described in the Quality Assurance and Quality Control Plan, Appendix 4.

Sequence of Events

The MPC site investigation project will consist of installing soil borings and permanent and temporary monitoring wells to collect soil and groundwater samples for field and laboratory analysis. The soil borings and monitoring wells will be placed on the MPC property and four adjacent residential properties.

Three soil borings will be initially drilled on the MPC property, OB34, OB35, and OB36. (See Figure 2 – Proposed Soil Boring/Monitoring Well Map, Appendix 1.) Permanent groundwater monitoring wells (MW1, MW2, and MW3) will be installed in these borings to determine the groundwater elevation, flow direction, and chemical characteristics.

Following the installation of the three permanent groundwater monitoring wells and obtaining data from those wells, seven direct push (Geoprobe® type) borings and one hand boring (OB37 through OB44) will be installed to define the horizontal and vertical extent of the remaining soil contamination. Temporary monitoring wells will be installed in the seven direct push borings to indicate groundwater conditions.

Based on data collected from the soil borings, temporary monitoring wells, and the three initial permanent monitoring wells, additional monitoring wells and piezometers will be installed to completely define the extent of the groundwater contamination. Up to seven additional soil borings/monitoring wells and four piezometers were estimated to define the degree and extent of the soil and groundwater contamination.

The existing sump located on the MPC property is monitored weekly to determine the groundwater elevation in the sump. The sump will be pumped periodically to remove contaminated groundwater.

The schedule for the field activities can be found in the Design Report under the heading Schedule.

Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support decisions made during the site investigation. Different data uses may require different levels of data quality. EPA protocol specifies five analytical levels different data uses and the QA/QC effort and methods required to achieve the desired DQO. For field screening, DQO Level 1 is the common level of data quality desired. Field screening techniques that are associated with DQO Level 1 provide rapid results for determining which samples should be sent for off-site laboratory analysis. The data quality associated with the investigative samples sent to the off-site laboratory will be DQO Level 4, which provides the level of data quality used for determining if the soil has been impacted above the SSRCLs or the groundwater has been impacted above the groundwater enforcement standards. DQO Level 4 analyses require full laboratory program analytical and data validation procedures.

Types of Sampling and Analysis

Field Screening

A portion of each soil sample will be field screened with a photoionization detector (PID) equipped with a lamp suitable for detecting vapors of petroleum and chlorinated solvents.

Soil Laboratory Analysis

Select soil samples collected during the investigation will be submitted for laboratory analysis. Selection of soil samples for laboratory analysis will be based on field screening and historical information from the area in which the soil boring is being placed. Soil samples from the drilled borings will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc; and volatile organic compounds (VOCs). Soil samples from the direct push borings will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc; and VOCs. The approximate boring depth, approximate sample depth, and rationale behind the depths of the sample are described in Table 1 – Soil Borings, below.

Table 1 Soil Borings

Soil Boring	Approximate Depth of Boring (feet)	Approximate Sample Depth (inches)	Sample Depth Rational
OB34	13	36	Obtain soil data below previous EPA excavation.
OB35	13	72 & 120	Obtain saturated soil data below previous EPA excavation for remedial options evaluation.
OB36	13	60 & 120	Obtain soil data at and below sanitary lateral.
OB37	10	6 & 48	Limited historical soil data from this area. Six-inch sample will provide near surface conditions, 48-inch sample will assist in direct contact determination.
OB38	10	12 & 48	Limited historical soil data from this area. Twelve-inch sample will provide near surface conditions (below asphalt/base course), 48-inch sample will assist in direct contact determination.
OB39	10	12 & 48	Limited historical soil data from this area. Twelve-inch sample will provide near surface conditions (below base course), 48-inch sample will assist in direct contact determination.
OB40	0.5	6	Hand boring to determine near surface conditions.
OB41	10	6	Limited historical soil data from this area. Six-inch sample will provide near surface conditions.
OB42	10	72	Obtain saturated soil data for remedial options evaluation.
OB43	10	72	Obtain saturated soil data for remedial options evaluation.
OB44	10	48	Obtain additional soil data based on historical data.

The soil samples collected from the drilled borings that are not submitted for laboratory analysis will be placed in re-closeable plastic storage bags and labeled with the boring number, sample interval depth, and sample collection date. The samples will be kept for possible additional metals analysis.

The soil samples collected from the direct push borings that are not submitted for laboratory analysis will be sealed in their plastic sleeves and labeled with the boring number, sample interval depth, and sample collection date. The samples will be kept for possible additional metals analysis.

Groundwater Laboratory Analysis

Groundwater samples collected during the investigation will be submitted for laboratory analysis. Groundwater samples will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc; VOCs; and polycyclic aromatic hydrocarbons (PAHs). After the initial groundwater sampling results are received, a recommendation might be made to the WDNR project manager for a revision to the parameters that are being analyzed.

Temporary monitoring wells will be constructed in all the direct push borings. Groundwater samples from the temporary monitoring wells will be analyzed for: total barium, total cadmium, total chromium, total cyanide, total lead, total nickel, and total zinc; VOCs; and PAHs. The initial Groundwater Monitoring Plan is described in Table 2, below.

Table 2 Groundwater Monitoring Plan

Well Name	Laboratory Analysis									Field Analysis					
	Total Barium	Total Cadmium	Total Chromium	Total Cyanide	Total Lead	Total Nickel	Total Zinc	VOCs	PAHs	Water Level	Temp	Dissolve Oxygen	ORP	pH	Conductivity
MW1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW3	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
TW1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
TW2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
TW3	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
TW4	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
TW5	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
TW6	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
TW7	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Sump	Q	Q	Q	Q	Q	Q	Q	Q	Q	W	Q	Q	Q	Q	Q

Key:

VOCs = Volatile Organic Compounds
 PAHs = Polycyclic Aromatic Hydrocarbons
 DO = Dissolved Oxygen
 ORP = Oxidation Reduction Potential

W = Weekly
 Q = Quarterly
 S = Semi-annual

Waste Characterization

Soil with total chromium concentration greater than 2,800 mg/kg may fail the Toxicity Characteristic Leaching Procedure (TCLP) found in SW-846. Soil cuttings and excess sample material with this concentration or greater will be kept separate from soil containing less than this concentration during the site investigation. Segregation of the soil will be based on laboratory analysis.

Soil cuttings from the installation of borings will be containerized in 55-gallon steel drums or 5-gallon plastic pails and kept in the on-site garage until laboratory analysis is available. Cuttings from each boring will be kept separate to avoid mixing of potentially hazardous, contaminated, and uncontaminated material. The investigative waste will be handled as described in the Waste Management Plan, Appendix 6.

Decontamination Fluid, Purge Water, and Groundwater from the Sump

Liquid generated from decontamination activities, monitoring well development, and purge water will be segregated and containerized in 55-gallon steel drums or 5-gallon pails. The

containers will be stored in the on-site garage until they are properly characterized. Groundwater collected from the sump will be pumped directly into a tanker truck for transportation to a treatment facility.

General Waste

The sampling material wastes (disposable gloves, disposable bailers, cleaning supplies, plastic tubing, etc.) generated during the investigative activities and debris picked up on the MPC property will be removed from the property and disposed of as solid waste. Laboratory analysis of these materials is not anticipated.

Sample Collection Procedures

Soil Boring Installation Procedure

OMNNI proposes to use Midwest Engineering Services, Inc. (1125 W. Tuckaway Lane, Menasha, WI 54952) to advance the drilled borings and construct the monitoring wells and piezometers. OMNNI proposes to use Environmental Drilling Services, Inc. (3671 Monroe Road, De Pere, WI 54115) to advance the direct push borings. Borings intended to be converted to monitoring wells are advanced using 7.625-inche outside diameter (O.D.) x 4.5-inche inside diameter (I.D.) hollow stem augers or 6.25-inche O.D. solid stem augers powered by a truck-mounted drill rig. If bedrock drilling is required, borings are advanced using either air or mud-rotary drilling techniques. Soil borings not intended for monitoring wells are typically advanced using four-inch O.D. solid stem augers. The direct push boring technique typically advances a two-inch diameter hollow stem sleeve.

Samples from the drilled borings are typically obtained from each boring at 2.5-foot intervals by split-spoon sampling according to American Society for Testing and Materials (ASTM) Standard D 1586. Samples from direct push borings are typically obtained in two-foot or four-foot polyethylene tubes.

Field Screening Procedures

A portion of each sample will be field screened with a photoionization detector (PID) equipped with a lamp suitable for detecting vapors of petroleum and chlorinated solvents. A portion of soil from each interval is placed in a clean 4-oz. jar (approx. 1/2-filled), and sealed with aluminum foil and a teflon-lined lid. The headspace sample is then agitated for a minimum of 30 seconds and then allowed to equilibrate. Equilibration time will correspond to the following guidelines:

Sample Headspace Equilibration Time

Ambient outside air temperature at the time of sample collection:	Minimum amount of time sample must equilibrate at 70° F or greater temperature:
< 40° F	40 min.
41 – 55° F	20 min.
56 – 69°F	10 min.
> 70°F	5 min.

When the sample has completed equilibration, it is promptly field analyzed with a portable PID. OMNNI uses a Photovac Inc. Microtip HL-200 or ML-1000, equipped with an 11.2 ev lamp. A background reading is first taken. The PID probe is then inserted into the jar through a single hole in the aluminum foil. The instrument reading is measured at one-half the distance between the foil seal and the sample surface. The measured reading is then recorded.

Soil Sampling Procedures

Soil samples are collected from a split- spoon sampler or a polyethylene tube during environmental drilling/direct push installation. The sampler will wear clean, disposable, vinyl or latex gloves and use a decontaminated stainless steel trowel anytime a sample is physically collected or handled to decrease the risk of personal exposure and cross contamination. Samples will be placed in the laboratory supplied sampling containers. The samples will be analyzed for the parameters and according to the requirements identified in Table 3 – Parameters, Containers, Preservation, Analytical Methods, and Holding Time Requirements. The samples will be sent to En Chem for appropriate analysis.

Monitoring Well Installation and Development Procedures

The permanent monitoring wells are typically constructed of two-inch, schedule 40, flush-thread polyvinyl chloride (PVC) casings and slotted well screens. Temporary wells are constructed of one-inch diameter, schedule 40 PVC casings and slotted screens. Prior to use, well parts are individually wrapped in plastic.

Permanent wells are installed and developed according to chapter NR 141, Wis. Adm. Code. The monitoring wells are installed with ten-foot screens, which are placed in the borings to intersect the water table. Piezometers are installed with five-foot screens sealed beneath the water table. Filter pack and annular space seal material are installed by gravity as the augers are withdrawn from the hole. Wells are cut to the required height using a PVC pipe cutter.

To properly develop each permanent monitoring well, water is removed until a consistent water quality is obtained. Removing 10 times the water volume in the well and filter pack, removing water until it is free of sediment, or removing the water until the well is purged dry, does this. Water is removed from the wells by bailing the water with as little agitation as possible. If the water level is unaffected by bailing and large amounts of water are to be removed, the well is developed by using the surge and purge method with a centrifugal pump. No water is added to the well during development. Temporary wells may be developed by allowing the peristaltic pump to run until the water is as clear as possible.

Groundwater Sampling Procedures

The monitoring wells and piezometers will be opened to allow for equilibration before the depth to groundwater is determined. A Solonist 101 water level meter will be used to measure groundwater elevations. Monitoring wells requiring sampling will be purged and

samples will be collected with a disposable bailer or a peristaltic groundwater-sampling pump.

The monitoring wells will be sampled starting from the upgradient area and progressing toward the downgradient area of the site. As the degree of contamination becomes known, monitoring wells with the least contamination will be sampled first, followed by monitoring wells with increasing concentrations. Four water volumes within the well casing will be removed prior to sampling if using a bailer. If a peristaltic pump is used, groundwater will be removed for approximately 10 to 20 minutes by slow purging.

Dissolved oxygen, odor, turbidity, temperature, conductivity, oxidation-reduction potential (ORP) and pH will be determined on the unfiltered portions of the sample and recorded on the well specific field sheet.

The sampler will wear clean, disposable, vinyl or latex gloves and use decontaminated collection equipment and field instruments during sample collection. Samples will be placed in the laboratory supplied sampling containers. The samples will be analyzed for the parameters and according to the requirements identified in Table 3 – Parameters, Containers, Preservation, Analytical Methods, and Holding Time Requirements. The samples will be sent to En Chem for appropriate analysis.

Waste Characterization

Waste characterization sampling will be performed during the investigation to determine if the soil cuttings could exhibit the hazardous waste characteristic of toxicity if laboratory analysis for total chromium concentrations is greater than 2,800 mg/kg. A representative discrete sample will be collected from each drum containing soil cuttings with a concentration of total chromium greater than 2,800 mg/kg. The sampler will wear clean, disposable, vinyl or latex gloves and use a decontaminated stainless steel trowel anytime a sample is physically collected or handled. A representative sample will be collected according to ch. 9 of SW-846 from the segregated soil within the container(s). The samples will be analyzed for the parameters and according to the requirements identified in Table 3 – Parameters, Containers, Preservation, Analytical Methods, and Holding Time Requirements.

Testing, treatment, and disposal services for soil with total chromium greater than 2,800 mg/kg will be obtained from Onyx Environmental Services (Onyx) administered under the State of Wisconsin's Hazardous Waste Disposal Contract.

Decontamination Fluid, Purge Water, and Groundwater from the Sump

Characterization of the development water and purge water will be obtained from the monitoring well or temporary monitoring well groundwater analysis.

Liquid generated from decontamination activities will be sampled to determine the appropriate disposal method. A grab sample will be collected from the decontamination liquid. The sampler will wear clean, disposable, vinyl or latex gloves anytime a sample is

physically collected or handled. Samples will be placed in laboratory supplied sampling containers. The samples will be analyzed for the parameters and according to the requirements identified in Table 3 – Parameters, Containers, Preservation, Analytical Methods, and Holding Time Requirements.

Groundwater pumped from the sump will be analyzed to determine treatment/disposal options. The sampler will wear clean, disposable, vinyl or latex gloves anytime a sample is physically collected or handled. A dedicated bailer or peristaltic pump tubing will be used. Samples will be placed in laboratory supplied sampling containers. The samples will be analyzed for the parameters and according to the requirements identified in Table 3 – Parameters, Containers, Preservation, Analytical Methods, and Holding Time Requirements. Disposal of the liquid waste will follow the Waste Management Plan, Appendix 6.

Table 3 Parameters, Containers, Preservation, Analytical Methods, and Holding Time Requirements

Sample Type and Parameters	Container Size	Sample Size	Preservation	Analysis Method	Detection Limits ¹	Holding Times
Field Sampling (VOCs)	4 oz. Wide mouth glass jar	Approx. 2 oz.	None	Field Screening Procedures section	Ionization potential < 11.2 eV	N/A
Soil Sampling (Totals for barium, cadmium, chromium, cyanide, lead, nickel, and zinc)	4 oz. Wide mouth plastic jar (2 per sample)	8 oz.	Cooled to 4°C	SW-846-6010B	Ba mg/kg Cd 1.2 mg/kg Cr 0.55 mg/kg CN mg/kg Pb 6 mg/kg Ni 0.99 mg/kg Zn 1.04 mg/kg	6 months
VOCs	DNR approved soil syringe or 40 ml glass vial (2 per sample)	13 g (vial)	Cooled to 4°C (sample preserved by laboratory or methonal preservation during sample collection)	SW 846 8021	25 µg/kg	48 hours
Groundwater Sampling (Totals for barium, nickel, and zinc)	250 ml plastic bottle (2 per sample)	500 ml	Cooled to 4°C, 2 ml of HNO ₃ to a pH of <2	SW-846-6010B	Ba mg/L Ni 0.02 mg/L Zn 0.021 mg/L	6 months
(Totals for cadmium, chromium, and lead)				Graphite furnace atomic adsorption SW-846-(Cd)-7131A (Cr)-7191 (Pb)-7421	Cd 0.08 µg/L Cr 0.7 µg/L Pb 1 µ/L	

Cyanide, total	1 L amber bottle	1 L	Cooled to 4°C, NaOH to a pH > 12	Wet Chemistry Method	CN 0.012 mg/L	
Hexavalent chromium	250 ml plastic bottle (1 per sample)	250 ml	Cooled to 4°C	SW-846-6010B	Hex Cr 3.6 µg/L	24 hrs with advanced notice to lab
PAHs	1 L amber bottle (2 per sample)	2 L	Cooled to 4°C	SW-846-8310		7 days
Sump Sampling/ Decon. Fluid Better-Brite Facility (Totals for zinc)				SW-846-6010B	Zn 0.021 mg/L	
(Totals for arsenic, cadmium, and chromium)	250 ml plastic bottle (2 per sample)	500 ml	Cooled to 4°C, 2 ml of HNO ₃ to a pH of < 2	Graphite furnace atomic adsorption SW-846-(As)-7060A (Cd)-7131A (Cr)-7191 (Pb)-7421	As 1 µg/L Cr 0.7 µg/L	6 months
Cyanide, total	1 L amber bottle	1 L	Cooled to 4°C, NaOH to a pH > 12	Wet Chemistry Method	CN 0.012 mg/L	
Sump Sampling/ Decon. Fluid Appleton POTW Facility (Totals for aluminum, copper, nickel, and zinc)				SW-846-6010B	Al 0.04 mg/L Cu 0.02 mg/L Ni 0.02 mg/L Zn 0.021 mg/L	
Mercury, total	250 ml plastic bottle (2 per sample)	500 ml	Cooled to 4°C, 2 ml of HNO ₃ to a pH of < 2	Method 7470	Hg 0.2 µg/L	
(Totals for arsenic, cadmium, chromium, and lead)				Graphite furnace atomic adsorption SW-846-(As)-7060A (Cd)-7131A (Cr)-7191 (Pb)-7421	As 1 µg/L Cd 0.08 µg/L Cr 0.7 µg/L Pb 1 µ/L	6 months
Cyanide, total	1 L amber bottle	1 L	Cooled to 4°C, NaOH to a pH > 12	Wet Chemistry Method	CN 0.012 mg/L	
Hexavalent chromium	250 ml plastic bottle (1 per sample)	250 ml	Cooled to 4°C	SW-846-6010B	Hex Cr 3.6 µg/L	24 hrs with advanced notice to lab

Waste Characterization (totals for cadmium, chromium, and lead)	4 oz. Wide mouth plastic jar (2 per sample)	8 oz.	Cooled to 4°C	SW-846-6010B (extraction method 1311)	Cd 0.24 mg/L Cr 0.11 mg/L Pb 1.2 mg/L	Extract hold time 2 weeks.
General Wastes	N/A	N/A	N/A	N/A	N/A	N/A
1 The actual method detection limits are sample dependent and may vary as the sample matrix varies and dilution factors are applied.						

Sample Quality Assurance/Quality Control

Field Instruments

Isobutylene at a concentration of 100 ppm is used for field calibration gas for the PID. The PID meter is field calibrated at the following times: at the beginning of each day; after any significant change in temperature or humidity; every three hours; and after any repairs to the instrument are performed.

The YSI 550 handheld dissolved oxygen and temperature meter is calibrated following the manufacture's specifications prior to each groundwater-monitoring event. The dissolved oxygen sensor membrane and electrolyte solution are typically replaced quarterly (depending on the use of the meter) or if erratic readings are observed.

The Oakton pH/CON 10 portable pH, conductivity, and temperature meter is calibrated following the manufacture's specifications. The instrument is calibrated with a three-point pH calibration using standard pH buffers: 4.00, 7.00, and 10.00. The instrument is calibrated with a four-point calibration solution: 447 μ s, 1,413 μ s, 2,764 μ s, and 12,880 μ s.

The Oakton pH 300 portable pH, ORP, and temperature meter is calibrated following the manufacture's specifications. The instrument is calibrated with a three-point pH calibration using standard pH buffers: 4.00, 7.00, and 10.00.

Laboratory Samples

Samples will be placed on ice until refrigerated. The samples will be picked up by En Chem's courier for transportation to the laboratory as soon as possible, preferably the same day the samples were collected. A chain-of-custody will be filled out listing all samples collected, requested laboratory analysis, date and time of collection, and the name of the sample collector. This document remains with the samples at all times and bears the names of all persons handling the samples until the samples are received at the laboratory.

At least one trip blank will be taken per site visit. Trip blanks are poured, labeled, and sealed, then taken out in the field. Trip blanks are kept with all samples collected until reaching the field. If there is a possibility for field cross-contamination of samples, field

blanks may also be taken at the sample collector's discretion. Field blanks are poured, labeled, and sealed at the site. One temperature blank may be collected per batch of samples. Trip and field blanks each consist of one new 250 ml plastic bottle filled with distilled water and preserved with 2 ml of HNO₃ or to a pH of < 2.

Soil Matrix Samples

One duplicate sample will be collected for every 10 samples collected following the Sample Collection Procedures outlined above.

Liquid Samples

One duplicate sample will be collected for every 10 samples collected following the Sample Collection Procedures outlined above.

Laboratory Sampling by Method 6010B

Inductively coupled plasma-atomic emission spectrometry determines trace elements, including metals, in solution. The method is applicable to the metals that have been found at the MPC facility. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element specific emissions spectra are produced by a radio frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the emission lines are monitored by photosensitive devices.

All matrices, excluding filtered groundwater samples but including groundwater, aqueous samples, TCLP and EP extracts, industrial and organic wastes, soils, sludges, sediments, and other solid wastes, require digestion prior to analysis. Groundwater samples that have been prefiltered and acidified will not need acid digestion. Samples, which are not digested, must either use an internal standard or be matrix matched with the standards.

The laboratory quality assurance procedure will contain a standard operating procedure for Method 6010B. The standard operating procedures will specify the types of audits required (sample spikes, surrogate spikes, reference samples, controls, and blanks), the frequency of each audit, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria for these audits. The laboratory will document initial and ongoing instrument and analytical quality control functions have been met. Any samples analyzed in nonconformance with the quality control criteria will either be reanalyzed by the laboratory or noted as to the quality of the analytical results on the analysis documentation.

Sample Documentation

Data collections activities will be recorded on field notes. Field notes will include data collection activities described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory. The project name and project number will be clearly marked on each field sheet. Entries into the field notes will include at the start of each day, the date, page number, start time, general weather

conditions (estimated temperature, wind direction and speed, visibility, etc.), names of all team members present, level of personal protection being used, and signature of the person making the entry. All entries will be made in ink. If an incorrect entry is made, the information will be crossed out with a single strike mark, initialed, and dated. When a sample is collected or a measurement is made, a detailed description of the location of the station will be recorded. If a photograph is taken, the number of the station will be noted. All equipment used to make measurements will be identified, along with the date and results of calibration. Sample collection activities will document the time of sampling, sample description, sample identification number, depth at which the sample was collected, any quality control samples, measurements made and results collected.

Soil sampling locations will be identified starting with the letter "OB", for OMNNI boring, and followed by consecutive numbering starting with the number 34. The sample interval will also be included in the soil sampling description. (Examples: OB34-1, OB35-3, OB34-5.)

Groundwater samples from the monitoring wells will be identified starting with "MW", for monitoring well, and followed by monitoring well identification number. (Examples: MW1, MW2, MW3.)

Groundwater samples from the temporary monitoring wells will be identified starting with "TW", for temporary monitoring well, and followed by temporary monitoring well identification number. (Examples: TW1, TW2, TW3.)

Groundwater samples from the sump will be identified with the word "Sump".

Liquid samples will be identified with a description of the sample source. (Example: Decon1.)

Duplicate samples will be identified with the letter "D", for duplicate, within the already established sample designation for the type of sample being collected. (Examples: MW1D, TW2D, OB37-1D.)

Waste Characterization samples, if required, will be handled by Onyx.

Sample containers will be labeled with OMNNI's project number; date sampled was collected; sample identification number; analysis to be performed; type of preservative used (if any); and laboratory contact information.

A chain-of-custody form is filled out, listing all samples collected, requested laboratory analysis, date and time of collection, and the name of the sample collector. This document remains with the samples at all times and bears the names of all persons handling the samples until they are received at the laboratory.

Sample Packaging, Handling, Shipment, and Chain of Custody Procedures

Samples requiring laboratory analysis will be placed in the laboratory supplied sampling containers for the appropriate analysis. A separate signed chain of custody record enclosed in each sample box or cooler will accompany collected samples at all times. Samples will be picked up at OMNNI's office by the laboratory courier.

Decontamination Procedures

Decontamination is the process of removing and/or neutralizing contaminants that may have accumulated on personnel protective equipment and sampling equipment. Proper decontamination is a critical element in the control of hazards, which helps ensure safety of workers and the potential for cross contamination.

During the collection of the soil samples the split spoon will be cleaned between samples in a multiple rinse surfactant solution (soap and water or Alconox solution). Soil, which has accumulated around the boring, will be drummed. The drummed soil will be disposed of following the Waste Management Plan, Appendix 6.

Upon completion of the boring, the augers will be decontaminated by drilling contractors before they are used again. The following procedures are typically used when decontaminating drilling equipment: a decontamination basin lined with plastic is set up near the work area; contaminated equipment is placed in the decontamination basin; a pressurized steam cleaner is used to clean contaminated equipment; and following steam cleaning, the auger is removed from the decontamination basin. Upon completion of the job, the accumulated water in the decontamination basin is pumped out and placed in a drum. Wash water used for cleaning the split spoons is also added to the drum. The plastic used in the decontamination basin is disposed of as solid waste.

Samples will be collected while wearing new disposable vinyl or latex gloves. Used sampling gloves will be collected and disposed of as solid waste. If facilities are available, all exposed skin, such as hands, should be washed prior to leaving the site. Boots and clothing will be checked for excess soil, which if present, will be removed.

The sampling trowel will be decontaminated between sample locations in a surfactant wash (soap and water or Alconox solution) and a double rinse with tap water.

In the field groundwater-sampling equipment is rinsed with a 10% methanol solution and then flushed with distilled water between each monitoring point. Equipment that is still contaminated after field cleaning will be rinsed with tap water, washed off with detergent, rinsed with a 10% methanol solution, and flushed with distilled water.

QUALITY ASSURANCE and QUALITY CONTROL PLAN

Purpose

The purpose of the Quality Assurance and Quality Control Plan for the Midwest Plating Corporation (MPC) site investigation and remedial actions recommendations project is to address the quality assurance activities during the site investigation. Quality assurance refers to all activities designed to provide adequate documentation and confidence that materials and workmanship substantially meet the requirements of the project objectives. Quality control refers to those actions taken by the manufacturer, fabricator, or contractor to confirm that materials and workmanship meet requirements of the contract or purchase order and the applicable drawings and specifications. This plan will address the following: 1) identify the project's organizational structure and responsibility; 2) outline project communications; 3) define the observation of the installation methods for soil borings and monitoring wells; and 4) outline the documentation format.

Organizational Structure and Responsibility

WDNR – Ms. Roxanne Nelezen Chronert, Project Manager and Hydrogeologist, WDNR, Mailing Address: 1125 N. Military Avenue, P.O. Box 110448, Green Bay, WI 54307-0448, Office Location: 1298 Lombardi Avenue, Green Bay, WI, Telephone: 920-492-5592. The Wisconsin Department of Natural Resources (WDNR) is implementing this site investigation and remedial actions recommendations project as a department-funded state response action and is responsible for ensuring the project meets the site investigation objectives and the remedial action recommendation requirements.

Oversight Engineer – Mr. Brian Wayner, Project Manager and Engineer, OMNNI Associates, Inc., One Systems Drive, Appleton, WI 54914, Telephone: 920-735-6900. The Oversight Engineer's overall responsibility is for meeting the site investigation objectives. These objectives include technical, financial, and scheduling for the site investigation and remedial actions recommendations project. The Oversight Engineer reports directly to the WDNR Program Manager.

Hazardous Waste Disposal Contractor – Mr. Kyle Raabe, ONYX Environmental Services, W124 N9451 Boundary Rd, Menomonee Falls, WI, 53051, Telephone 262-255-6655 ext. 22. The hazardous waste disposal contractor, by way of the State of Wisconsin's Hazardous Waste Disposal Contract, is responsible for performing the testing, storage, transportation, treatment, and disposal services for soil with analysis for total chromium greater than 2,800 mg/kg. They will also be contracted to transport liquid waste to a treatment facility. The Hazardous Waste Disposal Contractor reports directly to the WDNR Program Manager.

Laboratory Analytical Services – Ms. Laurie Woelfel, En Chem, Inc., 1241 Bellevue Street, Suite 9, Green Bay, WI 54302, Telephone 800-736-2436. The laboratory is responsible,

through the Oversight Engineer, for maintaining quality control procedures in accordance with their contractual arrangements and appropriate laboratory analytical methods.

Drilling Services – Mr. John D. McAfee, Midwest Engineering Services, Inc., 1125 Tuckaway Lane, Suite B, Menasha, WI 54952, Telephone 920-735-1200. The driller is responsible, through the Oversight Engineer, for maintaining quality control procedures in accordance with their contractual arrangements and appropriate soil boring installation and monitoring well construction methods.

Direct Push Services - Tom Vande Yacht, Environmental Drilling Services, Inc., 3671 Monroe Road, De Pere, WI 54115; Telephone 800-236-0337. The direct push subcontractor is responsible, through the Oversight Engineer, for maintaining quality control procedures in accordance with their contractual arrangements and appropriate soil boring installation and temporary monitoring well construction methods.

Project Communications

A project web page has been set up to provide the public with contact information and project status 24 hours a day, anywhere Internet access is available. This web page can be accessed at http://www.omni.com/ActiveProjects/Midwest_Plating.htm.

For the WDNR project manager, a project status email with reference links will be established. This email link allows the WDNR project manager and other authorized individuals to access files on OMNI's server. These files can include draft reports, laboratory data, site data tables and figures, budget information, and project contact information. Access to these files is available 24 hours a day anywhere Internet access is available.



The WDNR project manager will also be updated on the project's status through email communications and monthly status reports.

Observation Of Soil Boring Installation And Monitoring Well Construction

The Oversight Engineer or authorized representative will document observations made during the soil boring installation and the monitoring well construction. Samples from soil borings will be obtained from each boring continuously by split-spoon sampling according to ASTM D-1586. The monitoring wells will be installed and developed according to ch. NR 141 Wis. Adm. Code groundwater monitoring well requirements. Each permanent monitoring well will be assigned a Wisconsin unique well number.

WDNR Form 4400-122 will be completed to document the installation of all soil borings. Soil borings not used for monitoring well construction will be abandoned and WDNR Form 3300-5, Well/Drillhole/Borehole Abandonment, will be completed. Monitoring well construction will be documented on the WDNR Monitoring Well Construction, Form 4400-113A and monitoring well development will be documented on the Monitoring Well Development, Form 4400-113B. General monitoring well information will be documented on the WDNR Groundwater Monitoring Well Information Form, Form 4400-89.

Documentation

All project quality assurance activities and quality control submittals pertaining to the contract specifications are to be documented. Maintaining complete, accurate records of all work is crucial to verifying conformance with the specifications and drawings. The Oversight Engineer will maintain the site investigation documentation file.

Test Results and Material Certification:

Results from all field tests, laboratory tests, material design evaluations and certifications, and material specification sheets will be submitted to the Oversight Engineer, who will review for conformance with contract documents, approve, and forward copies to the WDNR Project Manager.

Photographic Documentation:

A photographic record of the project will be made and kept as part of the quality assurance record. The Oversight Engineer will conduct a pre-investigation photographic record of the project area. The Oversight Engineer will use the photographic record to document investigation fieldwork and installation details. Each photograph will be marked with a sequence number, date, location, photographer, and description. A digital camera, video camera, or thirty-five millimeter color film will be used. Any of the observers may photograph work for record purposes. The Oversight Engineer will conduct a post-investigation photographic record of the project area. The Oversight Engineer will maintain the photographic record file.

Sump Groundwater Elevation Log:

The Oversight Engineer or authorized representative will maintain a sump groundwater elevation log at the site. The content of the log will include (where applicable) the date, time, groundwater elevation, name of person collecting the data, and comments.

Field Notes:

Data collection activities will be recorded in field sheets. Field notes will include data collection activities described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory. The project name and project number will be clearly marked on each field sheet. Entries into the field notes will include at the start of each day, the date, page number, start time, general weather conditions (estimated temperature, wind direction and speed, visibility, etc.), names of all team members present, level of personal protection being used, and initials of the person making the entry. All entries will be made in ink. If an incorrect entry is made, the

information will be crossed out with a single strike mark, initialed, and dated. When a sample is collected or a measurement is made, a detailed description of the location of the station will be recorded. If a photograph is taken, the number of the station will be noted. All equipment used to make measurements will be identified, along with the date and results of calibration. Sample collection activities will document the time of sampling, sample description, sample identification number, depth at which the sample was collected, any quality control samples, measurements made and results collected.

Document Transmittals:

Document transmittals between the project team members provide a record of communications and are necessary for keeping project team personnel informed of project requirements, progress, changes, and quality of work. To prevent misunderstandings and omissions, transmittals will be formally communicated with proper documentation and confirmation of submittal and receipt. Document transmittals include the following:

1. Change Order To Contract For Professional Services - This is the "Change Order" form for professional services contracts. A draft of the change of scope is usually prepared by the Oversight Engineer and submitted to the WDNR project manager. The WDNR project manager will review, modify and approve it and forward it to the Department Project Manager for review who then forwards it to the R&R Program Coordinator for processing. All major changes to the project must be documented using this form.
2. Invoice For Professional Services - This form is completed by the Oversight Engineer and submitted to the WDNR project manager for approval, along with a project status letter and any supporting invoices. The WDNR project manager will review, modify and approve it and forward it to the R&R Program Coordinator for processing.
3. Project Meeting Notes – This form is to be used to document all project meetings relating to the investigation activities.
4. Letter of Transmittal – This form is to be used if a cover letter does not accompany a transmittal for investigation related documentation.

Final Storage:

A summary of the investigation will be included in the investigation report. At the completion of the project, all files associated with the project including forms, records, reports, field logbooks, pictures, analytical data, chain-of-custody forms, and correspondence, will be kept in storage boxes in a secured, limited access area. The Oversight Engineer will keep a copy of the files for six years after project completion.

Soil Screening Guidance for Chemicals

Equation Values for Ingestion

Noncarcinogenic Parameter	Value	Carcinogenic Age-adjusted Parameter	Value	Carcinogenic Nonadjusted Parameter	Value
Target Hazard Quotient (unitless)	.2	Target Risk (unitless)	1.0E-7	Target Risk (unitless)	1.0E-6
Body Weight (kg)	15	Adult Body Weight (kg)	70	Body Weight (kg)	70
		Child Body Weight (kg)	15		
Exposure Duration (yr)	6	Adult Exposure Duration (yr)	24	Exposure Duration (yr)	25
		Child Exposure Duration (yr)	6		
Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	250
Intake Rate (mg/day)	200	Adult Intake Rate (mg/day)	100	Intake Rate (mg/day)	100
		Child Intake Rate (mg/day)	200		
		Average Lifetime (yr)	70	Average Lifetime (yr)	70
		Age-adjusted Ingestion Factor (mg-yr/kg-day)	114.29		

Soil Screening Levels for Ingestion (mg/kg)

Analyte Cas Number	Oral RfD	Oral Slope Factor	Noncarcinogenic	Carcinogenic (Age-adjusted)	Carcinogenic (Nonadjusted)
Barium 7440393	7.00E-02 ^a		1.10E+03		

This site is maintained and operated through a cooperative agreement between the EPA Office of Superfund and Oak Ridge National Laboratory. For questions or comments please contact the Office of Superfund.

Soil Screening Guidance for Chemicals

Equation Values for Ingestion

Noncarcinogenic Parameter	Value	Carcinogenic Age-adjusted Parameter	Value	Carcinogenic Nonadjusted Parameter	Value
Target Hazard Quotient (unitless)	.2	Target Risk (unitless)	1.0E-7	Target Risk (unitless)	1.0E-6
Body Weight (kg)	15	Adult Body Weight (kg)	70	Body Weight (kg)	70
		Child Body Weight (kg)	15		
Exposure Duration (yr)	6	Adult Exposure Duration (yr)	24	Exposure Duration (yr)	25
		Child Exposure Duration (yr)	6		
Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	250
Intake Rate (mg/day)	200	Adult Intake Rate (mg/day)	100	Intake Rate (mg/day)	100
		Child Intake Rate (mg/day)	200		
		Average Lifetime (yr)	70	Average Lifetime (yr)	70
		Age-adjusted Ingestion Factor (mg-yr/kg-day)	114.29		

Soil Screening Levels for Ingestion (mg/kg)

Analyte	Cas Number	Oral RfD	Oral Slope Factor	Noncarcinogenic	Carcinogenic (Age-adjusted)	Carcinogenic (Nonadjusted)
Cyanide (CN-)	57125	2.00E-02 ^a		3.13E+02		

This site is maintained and operated through a cooperative agreement between the EPA Office of Superfund and Oak Ridge National Laboratory. For questions or comments please contact the Office of Superfund.

WASTE MANAGEMENT PLAN

The purpose of the Waste Management Plan for the Midwest Plating Corporation (MPC) site investigation and remedial actions recommendations project is to address waste management activities for waste materials generated during the investigation, pumping groundwater from the sump, and removing debris from the site.

Investigative waste will be managed in accordance with the General Interim Guidelines for the Management of Investigative Wastes¹. The guidelines define investigative waste as any contaminated media generated as a result of investigative activities. The investigative waste at the MPC project will consist of soil cuttings from borings, well development and purge water, water generated from the pump tests, equipment decontamination, and sampling wastes. Groundwater pumped from the sump and site debris are wastes that will also be handled during this phase of the project. The WDNR will determine if these wastes are solid or hazardous, which must be handled according to the solid or hazardous waste regulations in chs. NR 500 or 600, Wis. Adm. Code, series. Waste management methods will be protective of human health and the environment and will comply with applicable laws and rules. Every effort will be made to minimize the amount of investigative waste generated.

Organizational Structure and Responsibility

The organizational structure and responsibilities of the project team are described in the Quality Assurance and Quality Control Plan, Appendix 4.

Solid Waste, Handling, Storage and Disposal

Soil cuttings from the installation of borings will be containerized in 55-gallon steel drums or 5-gallon plastic pails and kept in the on-site garage until laboratory analysis is available. Cuttings from each boring will be kept separate to avoid mixing of potentially contaminated and uncontaminated material, thus minimizing disposal or treatment costs. Drums and pails will be clearly labeled with the BRRTS number, date of collection, "OMNNI Associates," and waste type. Analysis will be performed as outlined in the Sampling and Analysis Plan, Appendix 3. Once laboratory data is available, a decision will be made regarding the final destination of the waste. If analytical data shows soil to be below site-specific residual contaminant levels (SSRCLs), then the material will be placed back on-site.

The sampling material wastes (disposable gloves, disposable bailers, cleaning supplies, plastic tubing, etc.) generated during the investigative activities and debris picked up on the MPC property will be removed from the property and disposed of as solid waste. This waste maybe temporarily stored in the on-site garage in a covered waste container or in plastic trash bags until off-site disposal.

¹ Wisconsin DNR Remediation and Redevelopment Program, General Interim Guidelines for Management of Investigative Waste, Publication RR-556, January 14, 1993.

Soil wastes generated that are not below SSRCLs or classified as hazardous will be handled, stored, transported, and disposed of as a special solid waste. These wastes will be stored on the MPC property or transported directly to a Subtitle D landfill. Segregation of the soil will be based on laboratory analysis. Soil with barium, cadmium, chromium, cyanide, lead, nickel, or zinc concentrations above the SSRCLs and below chromium concentration of 2,800 mg/kg will be considered as special solid waste.

Hazardous Waste Determination, Handling, Storage, Treatment, and Disposal

Soil samples were collected from the site during the interim action to determine if the excavated soil during the interim action could exhibit the hazardous waste characteristic of toxicity. At the MPC site, this characteristic would be based on the amount of cadmium, chromium, or lead that could be extracted from the laboratory soil sample following the Toxicity Characteristic Leaching Procedure (TCLP) found in SW-846. The TCLP regulatory limits for cadmium, chromium, and lead are 1.0 mg/l, 5.0 mg/l, and 5.0 mg/l, respectively. All of the results of the TCLP analyses during the interim action for cadmium and lead were well below the respective regulatory limits. Even though none of the chromium TCLP sample results exhibited the characteristic of toxicity, a regression analysis² of the data suggests that total concentrations of greater than 2,800 mg/kg may fail TCLP.

TCLP analysis for chromium will be performed on segregate soils with laboratory analysis for total chromium greater than 2,800 mg/kg. If the concentrations from the extract exceed TCLP regulatory limits, WDNR will notify EPA of hazardous waste generation activity. MPC's EPA identification number, WID006142228, will be used in manifesting the hazardous waste. The comments field of the manifest will identify that the investigation wastes are from a State-funded response action at the MPC site and that the wastes are not from a WDNR property or facility. The wastes are derived from WDNR acting in its regulatory capacity.

Segregated soil exceeding TCLP regulatory limits will be placed in a container(s) that meets the container requirements in NR 633.09, 640.08 to 640.12, 640.14 and 640.15, Wis. Adm. Code. The containers will also comply with the packaging, labeling, marking and placarding requirements of NR 615.10, Wis. Adm. Code. Prior to shipment and while stored on MPC property, appropriately trained personnel will inspect the containers at least weekly according to NR 615.05 and results of the inspection recorded accordingly. Within 90 days, all accumulated hazardous wastes must be shipped off site to a licensed hazardous waste facility. An authorized representative will sign the manifests. Onyx Environmental Services (Onyx), administered under the State of Wisconsin's Hazardous Waste Disposal Contract, will provide the services required for the shipment, storage, treatment, and disposal of the soil. The Land Disposal Restrictions (LDRs) apply and Onyx will treat the soil to meet these requirements before disposal.

Groundwater and Decontamination Fluid Handling, Storage and Disposal

² Regression analysis documented in The Midwest Plating Corporation Interim Action Surface Soil Restoration Project, Design Report, Plans, and Specifications, dated January 21, 2002.

Liquid generated from decontamination activities, monitoring well development, and purge water will be segregated and containerized in 55-gallon steel drums or 5-gallon pails. The containers will be stored in the on-site garage until they are properly characterized. Analysis will be performed as outlined in the Sampling and Analysis Plan, Appendix 3.

Liquids from different sources will be kept separate to avoid mixing of potentially contaminated and clean material, thus minimizing disposal or treatment costs. Drums and pails will be clearly labeled with the BRRTS number, date of collection, "OMNNI Associates," and waste type. Once laboratory data is available, a decision will be made regarding the final destination of the waste. If analytical data shows the liquids to be below ch. NR 140 Wis. Adm. Code preventive action limits (PALs), then the material will be placed back on-site. Liquids will not be placed on-site over an area known to be contaminated in order to avoid leaching of additional contaminants into the environment.

If concentrations of the contaminants in the liquids are above groundwater PALs but meet either the influent limitations of the Better Brite treatment facility located in De Pere, Wisconsin, or the City of Appleton's Publicly Owned Treatment Works (POTW) pretreatment effluent limitations, the WDNR will request permission from these facilities to accept the liquids. If the concentrations from the liquids are greater than can be accepted at either of these two treatment facilities, the WDNR will authorize Onyx to transport, treat, and dispose of the liquids under the statewide hazardous waste contract.

Parameters	Better Brite Treatment Facility Influent Limitations* (mg/l except as noted)	Appleton POTW Pretreatment Effluent Limitations (mg/l except as noted)
Aluminum, total		70
Arsenic, total		1
Cadmium, total	660 µg/l	0.3
Chromium, total	760	7.0
Chromium, hexavalent		4.5
Copper, total		3.5
Cyanide, total	11.7	1.0
Lead, total		2.0
Mercury, total		2.0 µg/l
Nickel, total		2.0
Zinc, total	33.7	10.0

* Robert Kennedy, Technical Services Supervisor, City of De Pere WWTP, provided the Better Brite influent limitations. The limitations are based on the maximum concentrations of influent the Better Brite treatment facility has treated as of May 2004.

Groundwater Pumped From The Sump

Groundwater will be pumped from the sump to evaluate the effectiveness of a pumping system as a treatment option. Approximately 5,000 gallons will be removed per pumping event. Pumping events are anticipated to occur monthly. Groundwater pumped from the sump will be transported by Onyx to the Better Brite Treatment facility located in De Pere,

Wisconsin.³ Transportation will be administered under the State of Wisconsin's Hazardous Waste Disposal Contract. Direct sewer discharge without pre-treatment to the Appleton POTW will be evaluated when the contaminant levels in the sump fall below Appleton's pretreatment effluent limitation requirements.

Schedule

The schedule for the site preparation and soil removal activities can be found in the Work Plan under the heading Schedule.

³ [REDACTED]

Site Health and Safety Plan

Purpose

The purpose of this site Health and Safety Plan (plan) is to define and inform OMNNI Associates (OMNNI) personnel, authorized site visitors, and regulatory personnel of policies and procedures while working on the Midwest Plating Corporation (MPC) site investigation and remedial actions recommendations project. The project area is comprised of the MPC property, located at 1315 West Fourth Street, Appleton, Wisconsin, and four residential backyards located at 607, 619, 711, and 713 Mason Street, Appleton, Wisconsin, which abut the MPC property. Any supplemental plans used by subcontractors, authorized site visitors, or regulatory personnel will conform to this plan as a minimum. This plan provides specific health and safety guidance for site operations on the MPC project.

The initial assessments at the Midwest Plating Corporation have indicated the presence of cadmium, chromium, and lead above site specific residual contaminant levels.

Safeguarding OMNNI employees is a key part of this project. Employees must make every initiative to protect their own safety and the safety of their fellow workers. If an employee has any questions about how a task shall be done safely, he or she will not begin the task until they discuss the situation with a supervisor. Together, they shall determine the safe way to do the task. All work will be conducted in accordance with applicable federal, state, and local regulations.

This Plan identifies procedures to be followed to minimize the potential for personal exposure to contaminants known or suspected of being present at this site. All OMNNI employees who perform fieldwork during this project will be required to read this Plan and acknowledge receipt and understanding of the Plan.

OMNNI has the primary responsibility for implementing the safety plan, which includes training its employees in safe operating procedures and advising the personnel on matters concerning the health and safety of employees or the public. OMNNI should also be consulted before any changes are made to the safety plan. Changes might include:

- Upgrading protection levels as required.
- Suspending work due to Plan violations, health related incidents, and other increased risk situation.
- Removing personnel from the work site if their actions endanger the health and safety of other field personnel.
- Authorizing personnel to enter the site based on medical and training requirements.

Project Objectives

- | | | |
|---|--|---|
| <input checked="" type="checkbox"/> Site characterization | <input checked="" type="checkbox"/> Drilling | <input checked="" type="checkbox"/> GW sampling |
| <input type="checkbox"/> Site preparation | <input checked="" type="checkbox"/> Excavation | <input checked="" type="checkbox"/> Soil sampling |
| <input checked="" type="checkbox"/> Drum sampling | <input type="checkbox"/> UST removal | <input type="checkbox"/> Spill response |
| <input type="checkbox"/> Construction | <input type="checkbox"/> Remediation | <input type="checkbox"/> Other (specify) |

Regulatory Agency

The Wisconsin Department of Natural Resources Project Manager for this project is Ms. Roxanne Nelezen Chronert, Mailing Address: 1125 N. Military Avenue, P.O. Box 110448, Green Bay, WI 54307-0448, Office Location: 1298 Lombardi Avenue, Green Bay, WI, Telephone: (920) 492-5592.

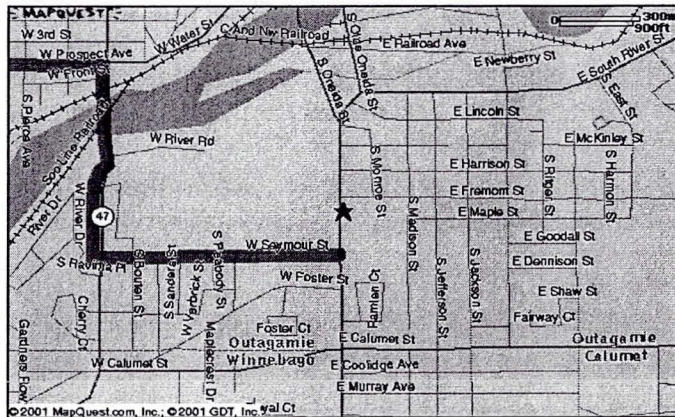
Medical Contacts

The nearest local hospital is St. Elizabeth Hospital, 1506 S. Oneida Street, Appleton, Wisconsin, telephone number 920/738-2000.

Directions to Hospital:

Go South on Mason Street. Turn left on W. Prospect Avenue and go East 0.5 miles. Turn right on Memorial Drive and go South 0.5 miles. Turn Left on Seymour Street and go East 0.5 miles. The hospital is located at the intersection of Seymour Street and South Oneida Street.

Distance – approximately 1.5 miles.
Travel time – approximately 5 minutes.



Emergency Contacts

The local Emergency contacts are:

Fire Department 911
Police Department 911
Ambulance Service 911
Poison Center 800/815-8855
Chem Trec 800/424-9300

Description of Contamination

The contamination at the MPC facility and the impacted residential properties is cadmium, chromium, and lead contaminated soil and groundwater.

Hazardous Materials Summary

- | | | |
|---|---|---|
| <input checked="" type="checkbox"/> Acids | <input type="checkbox"/> Halogenated Solvents | <input type="checkbox"/> PCBs |
| <input type="checkbox"/> Asbestos | <input checked="" type="checkbox"/> Metals | <input type="checkbox"/> Pesticides |
| <input type="checkbox"/> Fly Ash | <input type="checkbox"/> Non-Halogenated Solvents | <input type="checkbox"/> Petroleum Products |
| <input type="checkbox"/> Foundry Sand | <input type="checkbox"/> Oily Wastes | <input type="checkbox"/> Other |

Fire and Explosion Potential

High Medium Low Unknown

Waste Types

Liquid Solid Sludge Gas Unknown Other (specify)

Waste Characteristics

Corrosive Ignitable Volatile Toxic
 Reactive Unknown Other

Hazardous Assessment

The following have been identified, but not limited to, as possible hazards on this site:

- Physical hazards associated with excavation, construction, material handling, or the use of heavy equipment.
- Heat or cold stress.
- Inhalation of low concentrations of vapors, mists, or dust of hazardous materials.
- Limited skin or eye contact with hazardous materials.
- Fire hazard due to the presence of organic materials.
- Chemical reaction hazard due to the presence of acids, caustics, or oxidants.
- Drill rig or Geoprobe® operations.
- High-noise area.
- Vibration hazard.
- Overhead hazardous.
- Underground utilities.
- Confined space entry.
- Other (specify).

Overexposure to Specific Compounds

Type	Level @ site (mg/kg)	Exposure limit (mg/m ³) TWA	IDLH (mg/m ³)	Overexposure	Odor
Chromium	OB19: 3690	0.5	NE	irr eyes, skin, lung fib	odorless
Cadmium	P01: 120	0.005	Ca [50]	cough, pain, head, chills	odorless
Lead	RM01: 1600	0.1	700	Weak, lass, insom, irr eyes	odorless

TWA – Time weighted average
 IDLH – Immediately dangerous to life and health
 NA – Not applicable
 NAV – Not available

NE – No evidence found for existence of an IDLH
 Ca – Potential human carcinogens

Personal Protective Equipment

The appropriate personal protective equipment is important to protect against known or potential hazards on the MPC site investigation project. Protective equipment has been selected based on the types and concentrations of substances anticipated at the site and the possible routes of personnel exposure. OMNNI recommends level D protection onsite.

Level (A)

Air supplying respirator
Vapor/chemical protective suite, totally encapsulating
Gloves chemical resistant outer/inner
Safety boots, chemical resistant steel toe & shank
Disposable overbooties*
Safety glasses*
Hearing protection*
Hard hat*

Level (B)

Air supplying respirator
Hooded chemical resistant clothing
Gloves chemical resistant outer/inner
Safety boots, chemical resistant steel toe & shank
Disposable overbooties*
Safety glasses or chem. splash goggles
Hearing protection*
Hard hat*

* Where applicable

Level (C)

Air purifying respirator, full/half face
Hooded chemical resistant clothing
Gloves chemical resistant outer/inner
Safety boots, chemical resistant steel toe & shank
Disposable overbooties*
Safety glasses or chem. splash goggles
Hearing protection*
Hard hat*

Level (D)

Coveralls
Gloves
Safety boots/shoes
Safety glasses or chem. splash goggles
Face shield*
Hearing protection*
Hard hat*

Site Access

Access to the site will be limited to authorized personnel. Such personnel include the Contractor's employees, designated equipment operators, WDNR personnel, and designated union (owner) representatives.

Certain procedures may be followed to ensure suitable site control and limitation of access so that those persons who may be unaware of site conditions are not exposed to hazards. Site investigation may include the use of drill rigs and direct push equipment. Access to this equipment will be limited to the operators. Remediation may include excavation, so unattended excavations will be appropriately barricaded. All heavy machinery and equipment shall be locked or chained each evening upon completion of daily activities. Soil piles will be placed on plastic, covered, and identified when unattended. Drums and pails will be covered when unattended and identified with the contents. Roll off boxes will be covered when unattended and identified with the contents.

If traffic is deemed to be a hazard, the Contractor will be responsible for providing appropriate warning signs and lights.

Training Requirements

All employees who will perform fieldwork at the site must have completed a 40-hour hazardous waste site-training program as required under OSHA 29 CFR 1912.120.

Site Safety and Health Supervisor for OMNNI Associates Employees

OMNNI Associates Project Manager, Brian Wayner, or an authorized representative, will be assigned to be Site Safety and Health Supervisor. The Site Safety and Health Supervisor is responsible for assuring that day-to-day activities are performed in conformance with this plan. OMNNI Associates Safety Coordinator is Tim Bolwerk, telephone number 920/830-6150.

Personnel Decontamination

All employees assigned to the site will follow the following procedures for personnel decontamination prior to leaving the work site.

Latex gloves will be removed on site and disposed of in an appropriate container. If facilities are available, all exposed skin, such as hands, should be washed prior to leaving the site. Boots and clothing will be checked for excess soil, which if present, will be removed.

Site Standard Operating Procedures

Workers will be expected to adhere to established safety practices for their respective specialties (e.g., drum handling, sampling).

The need to exercise caution in the performance of specific work tasks is made more acute due to weather conditions, restricted mobility, and reduced peripheral vision caused by the protective gear itself. Work at this site will be conducted according to established procedures and guidelines for the safety and health of all involved.

Monitoring Program

Air monitoring will not be conducted since dust will be controlled by wetting surfaces and therefore, is not expected to be a factor at the site.

While at the site, the Subcontractor's employees will be required to monitor their own health and that of their co-workers. Visual observations include:

Behavioral changes	Irritated skin	Chest pain
Weakness	Coughing	
Facial pallor	Headache	

Any abnormalities or changes are to be reported to the physician and investigated immediately. Such aspects could be symptoms of toxic exposure and must not be allowed to persist without medical attention.

Health and Safety Plan Compliance Agreement

By my signature below, I affirm that I have read, understand, and agree to comply with the Health and Safety Plan for the Midwest Plating Corporation interim action surface soil restoration project, as well as all appendices relevant to my work assignment. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Name (printed)	Signature	Organization	Date

Signed for OMNNI Associates, Inc.:

(signature)

(date)

CHROMIUM

Also known as: Chrome, Chromate, Cr, Chrome III, Chrome VI, Hex Chrome, Tri Chrome
Chemical reference number (CAS): 7440-47-3

WHAT IS CHROMIUM?

Chromium is an element existing in several different forms. Metallic chromium is mined for use in steel and other metal products. Many chromium-containing compounds are used for plating, manufacturing paints and dyes, tanning leather and preserving wood.

"Trivalent" chromium is naturally occurring and is essential for good health. The normal intake from eating foods that are high in natural chromium is 70-80 micrograms per day and is considered safe.

In the home or office the less-toxic forms of chromium are used to make flooring materials, video and audio recording tapes, stainless steel, chrome-plated items and copy machine toner.

"Hexavalent" chromium does not occur naturally, but is produced by certain industrial processes. It is the most toxic form of chromium, and is shown to cause lung cancer when workers are exposed to high air levels for long time periods.

HOW ARE PEOPLE EXPOSED TO CHROMIUM?

Breathing: People can be exposed to chromium by breathing chromium dust or fumes. This is the route of exposure that is of greatest concern.

Drinking/Eating: Most human exposure to chromium occurs when people eat fresh vegetables, meats, fish, and poultry.

Drinking water is not normally a major source of exposure. Plants can absorb chromium and it can be passed to those who eat the plants.

Touching: Contact with contaminated soils can result in exposure to chromium. Exposure can be reduced by thorough washing of exposed skin and clothing to remove soil residues. Chromium can pass through the skin, but this is probably not a major route of exposure.

DO STANDARDS EXIST FOR REGULATING CHROMIUM?

Water: The state and federal drinking water standards for the total amount of all forms of chromium found in drinking water are set at 100 parts per billion (ppb). We suggest you stop drinking water containing more than 100 ppb of chromium.

Air: No standards exist for the amount of chromium allowed in the air of homes. We use a formula to convert workplace limits to home limits. Based on the formula, we recommend levels of hexavalent chromium in air be no higher than 0.0002 milligrams per cubic meter of air (mg/m^3). The lifetime cancer risk at this level is 1 in 8, or about 120,000 times higher than normal.

The Wisconsin Department of Natural Resources regulates the amount of chromium that can be released by industries.

WILL EXPOSURE TO CHROMIUM RESULT IN HARMFUL HEALTH EFFECTS?

The following health effects may occur immediately or shortly after exposure to high levels of chromium:

- Irritation to mouth, throat, lungs, and nose following inhalation of hexavalent chromium particles
- Skin irritation and allergic reactions
- Digestive problems, kidney damage, and liver damage after eating food or drinking water contaminated with hexavalent chromium

The following health effects can occur after several years of exposure to chromium:

Cancer: Lung cancer can develop after exposure to hexavalent chromium vapors or fumes.

Respiratory: Lung irritation resulting in asthma can be caused by hexavalent chromium.

Organ Systems: Chromium exposure can cause liver and kidney damage.

Immune System: Animal studies show changes in immune system function.

Reproductive Effects: Animal studies show damage to developing fetuses and lowered sperm production in males.

In general, chemicals affect the same organ systems in all people who are exposed. However, the seriousness of the effects may vary from person to person. A person's reaction depends on several things, including individual health, heredity, previous exposure to chemicals including chromium and medicines, and personal habits such as smoking or drinking. It is also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten.

CAN A MEDICAL TEST DETERMINE EXPOSURE TO CHROMIUM?

When a person is regularly exposed to chromium, the chemical can be monitored by testing hair, urine, blood serum and red blood cells. Most of the chromium that enters the body is eliminated within 24 hours. Chromium does not build up in the body.

Seek medical advice if you have any symptoms that you think may be related to chemical exposure.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to occupational exposure or emergency situations.


FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: <http://www.dhfs.state.wi.us/eh>



Prepared by the
Wisconsin Department of Health and Family Services
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(POH 4593 Revised 12/2000)

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Health Guidelines

Chromium III

Introduction

Recognition

Evaluation

Controls

Chromium III

CAS Number: 1308-38-9
Synonyms: Chromic oxide
chrome green
chrome oxide green
green cinnabar
dichromium trioxide

Recognition

- [NIOSH/OSHA Health Guideline](#). Summarizes pertinent information about for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs.

Evaluation

- [Health Hazards](#). Routes of exposure, summary of toxicology, signs and symptoms, emergency procedure.
- [Workplace Monitoring and Measurement](#).
- [Medical Surveillance](#). Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety or health, early detection of adverse health effects, and referral of workers for diagnosis and treatment.

Controls

- [Exposure Sources and Control Methods](#).
- [Personal Hygiene Procedures](#).
- [Respiratory Protection](#). Conditions for respirator use, respiratory protection program.
- [Personal Protective Equipment](#). Protective clothing should be worn to prevent any possibility of skin contact. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use.
- [Emergency Medical Procedures](#). Material Safety Data Sheets (MSDS's) include chemical specific information

on emergency medical and first aid procedures as referenced under the OSHA Hazard Communication standard, 29 CFR 1910.1200, (g)(2)(X). This standard requires chemical manufacturers and importers to obtain or develop an MSDS for each hazardous chemical they produce or import. Employers shall have an MSDS in the workplace for each hazardous chemical which they use.

- Storage.
- Spills and Leaks. In the event of a spill or leak , persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed.

Revision Date: 22 April 1999

USDO

Contact Information

Disclaimer

Occupational Health Guideline for Soluble Chromic and Chromous Salts (as Chromium)*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

APPLICABILITY

The general guidelines contained in this document apply to all soluble chromic and chromous salts. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Chromic sulfate hydrate

- Formula: $\text{Cr}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$ (approximately)
- Synonyms: None
- Appearance and odor: Violet or green, odorless solid.

Chromic potassium sulfate

- Formula: $\text{KCr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
- Synonyms: Potassium chrome alum; potassium chromium (III) sulfate
- Appearance and odor: Red-violet, odorless solid.

Chromous chloride

- Formula: CrCl_2
- Synonyms: None
- Appearance and odor: Colorless to gray, odorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for soluble chromic or chromous salts is 0.5 milligrams of soluble chromic or

chromous salts (as chromium) per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. Certain forms of chromium (VI) have been found to cause increased respiratory cancer among workers. Certain other forms of chromium (VI) are currently believed to be non-carcinogenic: They are the monochromates and bichromates (dichromates) of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, and chromium (VI) oxide (chromium acid anhydride). NIOSH has not conducted an in-depth study of the toxicity of chromium metal or compounds containing chromium in an oxidation state other than 6. NIOSH recommends that the permissible exposure limit for carcinogenic chromium (VI) compounds be reduced to $0.001 \text{ mg}/\text{m}^3$ and that these compounds be regulated as occupational carcinogens. NIOSH also recommends that the permissible exposure limit for non-carcinogenic chromium (VI) be reduced to $0.025 \text{ Cr (VI) mg}/\text{m}^3$ averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of $0.05 \text{ Cr (VI) mg}/\text{m}^3$ averaged over a 15-minute period. It is further recommended that chromium (VI) in the workplace be considered carcinogenic, unless it has been demonstrated that only the non-carcinogenic chromium (VI) compounds mentioned above are present. The NIOSH Criteria Documents for Chromic Acid and Chromium (VI) should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

• Routes of exposure

Soluble chromic or chromous salts can affect the body if they come in contact with the eyes or skin. They can also affect the body if they are swallowed.

• Effects of overexposure

Exposure to certain soluble chromic or chromous salts have been reported to cause an allergic skin rash.

• Reporting signs and symptoms

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to soluble chromic or chromous salts.

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to soluble chromic and chromous salts at potentially hazardous levels:

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from soluble chromic and chromous salts exposure.

—Skin disease: Chromic salts may cause an allergic dermatitis. Persons with pre-existing skin disorders may be more susceptible to the effects of these agents.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

The soluble chromic and chromous salts have no established toxicity. Since exposures are often mixed, consideration should be given to the possible exposure to hexavalent chromium, which is a more toxic form. The compound hexaaquachromium trichloride has been found to react with protein *in vitro*, indicating that it is not biologically inert. Of 35 rats implanted with chromic acetate in the thigh muscle, 1 developed sarcoma; this was considered to be evidence of weak carcinogenicity of this soluble trivalent compound. When taken by mouth, the trivalent compounds do not give rise to local or systemic effects and are poorly absorbed; no specific effects are known to result from inhalation. Animals ingesting chromic salts showed one-ninth as much chromium in the tissues as did animals ingesting equal amounts of chromates. Dermatitis from some chromic salts has been reported. Some investigators believe that all persons sensitized to hexavalent chromium are also sensitive to the trivalent form, although this has not been firmly established.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data—Chromic sulfate hydrate**

1. Molecular weight: 680 (approximately)
2. Boiling point (760 mm Hg): Decomposes at red heat
3. Specific gravity (water = 1): 1.7
4. Vapor density (air = 1 at boiling point of chromic sulfate hydrate): Not applicable
5. Melting point: 90 C (194 F) Loses water, residue does not melt
6. Vapor pressure at 20 C (68 F): Essentially zero (except water of crystallization)
7. Solubility in water, g/100 g water at 20 C (68 F): 84–120
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Chromic potassium sulfate**

1. Molecular weight: 499.4
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 1.83

4. Vapor density (air = 1 at boiling point of chromic potassium sulfate): Not applicable

5. Melting point: 89 C (192 F) Loses water, then melts at 400 C (752 F)

6. Vapor pressure at 20 C (68 F): Essentially zero (except water of crystallization)

7. Solubility in water, g/100 g water at 20 C (68 F): 19.6

8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Chromous chloride**

1. Molecular weight: 122.9
2. Boiling point (760 mm Hg): 1300 C (2372 F)
3. Specific gravity (water = 1): 2.93
4. Vapor density (air = 1 at boiling point of chromous chloride): Not applicable
5. Melting point: 820 C (1508 F)
6. Vapor pressure at 20 C (68 F): Essentially zero (except water of crystallization)
7. Solubility in water, g/100 g water at 20 C (68 F): Very soluble
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: None
2. Incompatibilities: Water (chromyl chloride)
3. Hazardous decomposition products: None
4. Special precautions: None

- **Flammability**

1. Most soluble chromic or chromous salts are not combustible. However, chromyl chloride reacts vigorously with water, forming chromic acid, chromic chloride, hydrochloric acid, and chlorine. Also, chromyl chloride causes ignition of ammonia, ethyl alcohol, turpentine, and other combustible materials.

- **Warning properties**

Grant states that "chromium compounds . . . are known to cause dermatitis, ulcers of the skin and mucous membranes, and perforation of the nasal septum." Chromium chloride is an example of the chromium compounds which Grant states produces these effects. Not all chromic and chromous salts produce eye irritation.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of soluble chromic or chro-

mous salts. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• **Method**

Sampling and analyses may be performed by collection of soluble chromic or chromous salts on a filter, followed by treatment with acid and atomic absorption spectrophotometric analysis. An analytical method for soluble chromic and chromous salts is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 6, 1980, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00369-6).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquids or solids containing soluble chromic or chromous salts.

• Clothing contaminated with soluble chromic or chromous salts should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of chromic or chromous salts from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the chromic or chromous salts, the person performing the operation should be informed of soluble chromic or chromous salts's hazardous properties.

• Non-impervious clothing which becomes contaminated with soluble chromic or chromous salts should be removed promptly and not reworn until the soluble chromic or chromous salts are removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of liquids or solids containing soluble chromic or chromous salts contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to liquids or solids containing soluble chromic or chromous salts, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

• Skin that becomes contaminated with soluble chromic or chromous salts should be promptly washed or showered to remove any soluble chromic or chromous salts.

• Employees who handle liquids or solids containing soluble chromic or chromous salts should wash their hands thoroughly before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to soluble chromic or chromous salts may occur and control methods which may be effective in each case:

Operation	Controls
Use in textile treatment in dyeing, printing, moth-proofing, and water-proofing; use in tanning of leather in gloves, garments, and shoe uppers	Local exhaust ventilation; personal protective equipment
Use in manufacture of pigments for green varnishes, inks, paints, and glazes	Local exhaust ventilation; personal protective equipment
Use for metal treatment and polishing	Local exhaust ventilation; personal protective equipment
Use in photographic fixing baths for hardening of emulsions; use as catalysts and in manufacture of catalysts	Local exhaust ventilation; personal protective equipment
Use in chemical synthesis; use as corrosion inhibitors	Local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If liquids or solids containing soluble chromic or chromous salts get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

• Skin Exposure

If liquids or solids containing soluble chromic or chromous salts get on the skin, promptly flush the contaminated skin with water. If liquids or solids containing soluble chromic or chromous salts penetrate through the clothing, remove the clothing promptly and flush the skin with water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of soluble chromic or chromous salts, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When liquids or solids containing soluble chromic or chromous salts have been swallowed give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If soluble chromic or chromous salts are spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing soluble chromic or chromous salts should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Soluble chromic or chromous salts may be disposed of in sealed containers in a secured sanitary landfill.

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on these chemicals and has concluded that they cause cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 2, 1973, and Volume 23, 1980.

RESPIRATORY PROTECTION FOR SOLUBLE CHROMIC AND CHROMOUS SALTS (AS CHROMIUM)

Condition	Minimum Respiratory Protection* Required Above 0.5 mg/m ³
Particulate Concentration	
2.5 mg/m ³ or less	Any dust and mist respirator, except single-use.**
5 mg/m ³ or less	Any dust and mist respirator, except single-use or quarter-mask respirator.** Any fume respirator or high efficiency particulate respirator.** Any supplied-air respirator.** Any self-contained breathing apparatus.**
25 mg/m ³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
250 mg/m ³ or less	A powered air-purifying respirator with a full facepiece and a high efficiency particulate filter. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 250 mg/m ³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**If eye irritation occurs, full-facepiece respiratory protective equipment should be used.

Occupational Health Guideline for Chromic Acid and Chromates*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

APPLICABILITY

The general guidelines contained in this document apply to all chromic acid and chromates. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Chromic acid

- Formula: CrO_3
- Synonyms: Chromic anhydride; chromium trioxide
- Appearance and odor: Dark red, deliquescent, odorless solid.

Sodium dichromate

- Formula: $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$
- Synonyms: Sodium bichromate (dihydrate)
- Appearance and odor: Red-orange, odorless solid.

Potassium chromate

- Formula: K_2CrO_4
- Synonyms: Chromate of potash
- Appearance and odor: Yellow, odorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for chromic acid or chromates is a ceiling of 0.1 milligram of chromic acid or chromates per cubic meter of air (mg/m^3). Certain

forms of chromium (VI) have been found to cause increased respiratory cancer among workers. Certain other forms of chromium (VI) are currently believed to be non-carcinogenic: The non-carcinogenic forms include the monochromates and bichromates (dichromates) of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, and chromium (VI) oxide (chromium acid anhydride). NIOSH has not conducted an in-depth study of the toxicity of chromium metal or compounds containing chromium in an oxidation state other than 6. NIOSH recommends that the permissible exposure limit for carcinogenic chromium (VI) compounds be reduced to $0.001 \text{ Cr (VI) mg}/\text{m}^3$ and that these compounds be regulated as occupational carcinogens. NIOSH also recommends that the permissible exposure limit for non-carcinogenic chromium (VI) be reduced to $0.025 \text{ Cr (VI) mg}/\text{m}^3$ averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of $0.05 \text{ Cr (VI) mg}/\text{m}^3$ averaged over a 15-minute period. It is further recommended that chromium (VI) in the workplace be considered carcinogenic, unless it has been demonstrated that only the non-carcinogenic chromium (VI) compounds mentioned above are present. The NIOSH Criteria Documents for Chromic Acid and Chromium (VI) should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

• Routes of exposure

Chromic acid or chromates can affect the body if they are inhaled or if they come in contact with the eyes or skin. They can also affect the body if they are swallowed.

• Effects of overexposure

1. *Short-term Exposure:* Chromic acid mist and chromate dusts may cause severe irritation of the nose, throat, bronchial tubes, and lungs. Chromic acid splashed in the eyes may cause severe injury. If swallowed, chromates and sodium and potassium dichromates may cause stomach and kidney problems. These

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

compounds, if swallowed, often cause vomiting. Skin exposure to chromic acid or chromates may cause ulceration of the skin.

2. Long-term Exposure: Repeated or prolonged exposure to chromic acid or chromate dust or mist may cause an ulceration and perforation of the nasal septum. Respiratory irritation may occur with symptoms resembling asthma. Liver damage with yellow jaundice has been reported. Prolonged or repeated exposure of the skin may cause a skin rash. Allergic skin rash may also occur. An increased amount of lung cancer has been found in employees in the chromate-producing industry.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to chromic acid or chromates.

• **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to chromic acid or chromates at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of asthma, allergies, or known sensitization to chromic acid or chromates would be expected to be at increased risk from exposure. Examination of the respiratory system, blood, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—A complete blood count: Chromates have been shown to cause blood changes in humans. A complete blood count should be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

—14" x 17" chest roentgenogram: Chromates may cause human lung damage and are associated with a high incidence of lung cancer. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Chromates are reported to cause decreased pulmonary function. Periodic surveillance is indicated.

—Urinalysis: Since chromates may cause kidney damage, a urinalysis should be obtained, including at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

—Liver function tests: Chromates may cause liver damage. A profile of liver function should be obtained by utilizing a medically acceptable array of biochemical tests.

—Skin disease: Chromates are defatting agents and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of these agents.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis. Emphasis should be placed on observation for

changes in the mucous membranes of the upper respiratory tract, ulceration of the skin, and surveillance for malignancy of the respiratory tract and lungs.

• **Summary of toxicology**

Chromic acid mist and chromate dusts are severe irritants of the nasopharynx, larynx, lungs, and skin. Chromium compounds, especially the hexavalent compounds are associated with a high incidence of lung cancer in humans. Administered subcutaneously to rabbits and guinea pigs, chromates produce kidney damage, with albuminuria and cylindruria; fatal nephritis occurred in a human treated with chromic acid to cauterize a wound. Workers exposed to chromic acid or chromates in concentrations of 0.11 to 0.15 mg/m³ developed ulcers of the nasal septum and irritation of the conjunctiva, pharynx and larynx, as well as asthmatic bronchitis. A worker exposed to unmeasured but massive amounts of chromic acid mist for 4 days developed severe frontal headache, wheezing, dyspnea, cough, and pain on inspiration; after 6 months there was still chest pain on inspiration and cough. In an industrial plant where the airborne chromic acid concentrations measured from 0.18 to 1.4 mg/m³, moderate irritation of the nasal septum and turbinates was observed after 2 weeks of exposure, ulceration of the septum after 4 weeks, and perforation of the septum after 8 weeks. A worker exposed to an unmeasured concentration of chromic acid mist for 5 years developed jaundice and was found to be excreting significant amounts of chromium; liver function in four other workers with high urinary chromium excretion was mildly to moderately impaired. Other studies of chromate workers have not found any unusual incidence of liver diseases or other systemic diseases except for lung cancer. Erosion and discoloration of the teeth has been attributed to chromic acid exposure. Blood changes were observed in chromate plant workers, including leukocytosis or leukopenia, monocytosis, and eosinophilia. A markedly increased incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust. The latent period is relatively short, suggesting the presence of a potent carcinogen. Calcium chromate and zinc chromate have been demonstrated to be carcinogenic in rats, and the risk of lung cancer is reportedly increased in chrome pigment workers. Papillomata of the oral cavity and larynx were found in 15 of 77 chrome platers exposed for an average of 6.6 years to chromic acid mist at air concentrations of chromium of 0.4 mg/m³. There is no positive evidence that chromic acid in the workplace has contributed to an increase in lung cancer, neither is there definitive evidence that absolves chromic acid. A concentrated solution of chromic acid in the eye causes severe corneal injury; chronic exposure to the mist causes conjunctivitis. Chrome ulcer, a penetrating lesion of the skin, occurs chiefly on the hands and forearms where there has been a break in the epidermis; it is believed to be due to a direct necrotizing effect of the chromate ion. The ulcer is relatively painless, heals slowly, and produces a characteristic depressed scar.

Prolonged exposure to chromic acid mist causes dermatitis, which varies from a dry erythematous eruption to a weeping eczematous condition. Cutaneous sensitization to chromate compounds is a common problem in industrial practice.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data—Chromic acid

1. Molecular weight: 100
2. Boiling point (760 mm Hg): Decomposes when it melts
3. Specific gravity (water = 1): 2.7
4. Vapor density (air = 1 at boiling point of chromic acid): Not applicable
5. Melting point: 197 C (387 F) (decomposes)
6. Vapor pressure at 20 C (68 F): Data not available (very low)
7. Solubility in water, g/100 g water at 20 C (68 F): 63
8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Sodium dichromate

1. Molecular weight: 298
2. Boiling point (760 mm Hg): 400 C (752 F) (decomposes)
3. Specific gravity (water = 1): 2.34
4. Vapor density (air = 1 at boiling point of sodium dichromate): Not applicable
5. Melting point: 357 C (674 F) (loses water at 85 C (185 F))
6. Vapor pressure at 20 C (68 F): Zero (except for water of crystallization)
7. Solubility in water, g/100 g water at 20 C (68 F): 236
8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Potassium chromate

1. Molecular weight: 194
2. Boiling point (760 mm Hg): Data not available
3. Specific gravity (water = 1): 2.7
4. Vapor density (air = 1 at boiling point of potassium chromate): Not applicable
5. Melting point: 971 C (1780 F)
6. Vapor pressure at 20 C (68 F): Zero
7. Solubility in water, g/100 g water at 20 C (68 F): 39
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity—Chromic acid or chromates

1. Conditions contributing to instability: None
2. Incompatibilities: Contact with any combustible, organic, or other readily oxidizable materials such as paper, wood, sulfur, aluminum, plastics, etc. may cause fires and explosions.
3. Hazardous decomposition products: None
4. Special precautions: Chromic acid or chromates will attack most forms of metals, cloth, leather, plastics, rubber, and coatings and may cause spontaneous igni-

tion.

• Flammability

1. Chromic acid is not combustible in itself, but is a powerful, oxidizing material. It will ignite on contact with acetic acid and alcohol.

• Warning properties

Grant states that "contact with the solid material or with concentrated solution (of chromic acid) by splash in the eye causes severe corneal injury characterized by infiltration, vascularization, and opacification of the cornea.

"More commonly, exposure to chromic acid occurs in less serious form as a result of spraying of fine droplets into the air from electroplating baths or by transfer to the eyes on the fingers. After chronic exposure to such conditions, the ocular changes seen are chronic conjunctival inflammation, analogous to the well-known irritation of the nasal mucosa which leads to perforation of the nasal septum." In addition, Grant states that "dichromates (bichromates) as ammonium, sodium, or potassium salts are water-soluble, crystalline substances which have a peculiar injurious effect on the cornea, causing great swelling of the corneal stroma."

The *Documentation of TLV's* states that "Vigliani and Zurlo reported . . . irritation of the mucous membranes of the larynx, pharynx, and conjunctiva . . . in a group of workers allegedly exposed to chromates or chromic acid in concentrations ranging from 0.11 to 0.15 mg/m³."

MONITORING AND MEASUREMENT PROCEDURES

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of chromic acid or chromates. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

Sampling and analyses may be performed by collection of chromic acid or chromates on a filter, followed by chemical treatment and colorimetric analysis. An analytical method for chromic acid and chromates is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental

concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with solids or liquids containing chromic acid or chromates.

- If employees' clothing may have become contaminated with solids or liquids containing chromic acid or chromates, employees should change into uncontaminated clothing before leaving the work premises.

- Clothing contaminated with chromic acid or chromates should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of substance from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the chromic acid or chromates, the person performing the operation should be informed of chromic acid or chromates' hazardous properties.

- Where there is any possibility of exposure of an employee's body to solids or liquids containing chromic acid or chromates, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

- Non-impervious clothing which becomes contaminated with chromic acid or chromates should be removed immediately and not reworn until the substance is removed from the clothing.

- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of solids or liquids containing chromic acid or chromates contacting the eyes.

- Where there is any possibility that employees' eyes may be exposed to solids or liquids containing chromic acid or chromates, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with chromic acid or chromates should be immediately washed or showered with soap or mild detergent and water to remove any such substance.

- Workers subject to skin contact with solids or liquids containing chromic acid or chromates should wash with soap or mild detergent and water any areas of the body which may have contacted such a substance at the end of each work day.

- Eating and smoking should not be permitted in areas where solids or liquids containing chromic acid or chromates are handled, processed, or stored.

- Employees who handle solids or liquids containing chromic acid or chromates should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

- Areas in which exposure to a carcinogenic form of chromium (VI) may occur should be identified by signs or other appropriate means, and access to these areas should be limited to authorized personnel only.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to chromic acid or chromates may occur and control methods which may be effective in each case:

Operation	Controls
Use in metal finishing in chrome plating, anodizing, conversion coatings, and for corrosion resistance	Local exhaust ventilation; personal protective equipment
Use in leather finishing for shoe uppers, glove and garment leathers, and bag leather	Local exhaust ventilation; personal protective equipment
Use as corrosion inhibitors in radiator coolants, internal combustion and gas turbine engines, refrigerator and air conditioning systems, and water-cooled nuclear reactors	Local exhaust ventilation; personal protective equipment
Use in photoreproduction processes as sensitizing agents for photoengraving, photography, lithography, and blueprinting	Local exhaust ventilation; personal protective equipment

Operation

Use as corrosion-inhibiting and coloring pigments, artists' colors, jointing pastes, inks, rubber, and ceramics, and color blending

Use in dyeing of fur, leather, fabrics, wool, and nylon; oxidizing of dyes; aftertreating on cotton, and in textile and paper printing; use in manufacture of glue used in shoes, furniture, and packaging

Use as fungicides; use in aqueous preservatives and fire retardants for wood; for protection of textiles and seed

Use in battery manufacture to increase shelf life; to provide corrosion resistance and for battery depolarization

Use in manufacture of safety matches and explosives

Use as a chemical reagent, oxidizing agent, catalyst, indicator, in bleaching of fats, oils, and waxes, in chemical synthesis, and in analytical chemistry

Use in manufacture and packaging of cement

Controls

Process enclosure; local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If solids or liquids containing chromic acid or chromates get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with these chemicals.

• Skin Exposure

If solids or liquids containing chromic acid get on the skin, immediately flush the contaminated skin with soap or mild detergent and water. If chromic acid soaks through the clothing, remove the clothing immediately and flush the skin with water. If irritation persists after washing, get medical attention. If chromates get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If solids or liquids containing chromic acid or chromates penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of chromic acid or chromates, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When solids or liquids containing chromic acid or chromates have been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If chromic acid or chromates are spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing chromic acid or chromates should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Chromic acid or chromates may be disposed of in sealed containers in a secured sanitary landfill.

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on these chemicals and has concluded that they cause cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 2, 1973, and Volume 23, 1980.

• Warning properties

RESPIRATORY PROTECTION FOR CHROMIC ACID AND CHROMATES

Condition	Minimum Respiratory Protection* Required Above 0.1 mg/m ³
Particulate Concentration	
5 mg/m ³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
30 mg/m ³ or less	A powered air-purifying respirator with a full facepiece and a high efficiency particulate filter. A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 30 mg/m ³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	A high efficiency particulate filter respirator. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

LEAD

Also known as: Lead flake, Orow (polish), Pb, CI pigment Metal 4
Chemical reference number (CAS): 7439-92-1

WHAT IS LEAD?

Lead is a naturally occurring toxic metal. It may be found in its pure form or in combination with other minerals. Lead has no nutritional value, but is very valuable in manufacturing. In industry, lead is used in the production of batteries, solder, paints, ammunition, sheet metal, and other metal alloys.

Lead is often found in paint sold before 1978. Since 1978, paint sold for residential use can contain no more than 600 parts per million lead. Most lead is now used to manufacture car batteries. Other lead sources include bullets, fishing weights, curtain weights, some glazed ceramics, and plumbing solders made before 1986. Less common sources include the solder on some imported canned goods, cosmetics (ceruse, surma or kohl), folk medicines (azarcon, Greta, Pay-loo-ah), and paints used on steel structures such as bridges or water towers.

HOW ARE PEOPLE EXPOSED TO LEAD?

Drinking/Eating: People can be exposed to lead when they ingest contaminated water or foods that are stored in lead-glazed ceramic dishware.

The most common route for lead exposure in children is by mouth. Young children like to put their fingers, toys and other objects in their mouths. They especially like to do this when they are teething. Dust or chips from lead-based paint can easily poison pre-school aged children.

Less common, but more dangerous exposures occur when children eat paint chips or soil containing lead. Lead tastes sweet, which makes it attractive to children, especially to hungry children.

People who work with lead products can expose their family to lead. Exposure may occur if they bring lead-covered work clothes home for laundering or wear their contaminated clothes around the home.

Lead can dissolve from the solder of water pipes, particularly if the water is heated or naturally soft. *Use cold water when cooking or when preparing infant formula. Hot water tends to dissolve lead from solder in pipes.*

Breathing: Lead in the air results from emissions from smelting operations or waste incinerators. Soil and dust may contain fine lead particles created by car exhaust (when burning leaded gasoline) or from sanding or grinding old lead paint. Soldering leaded glass, firing ceramic glazes that contain lead, melting lead or burning old lead paint can release hazardous metal fumes.

Touching: Lead is not readily absorbed through the skin.

DO STANDARDS EXIST FOR LEAD IN DRINKING WATER?

State and federal drinking water standards for lead are set at 15 parts per billion (ppb). We suggest you stop drinking water containing more than 15 parts per billion (ppb) of lead. If your plumbing system contains lead solder or lead pipes, running the cold water two to three minutes before using the water will usually lower the lead in the water to safe levels.

WHAT ARE THE SYMPTOMS OF LEAD POISONING?

The average person in the U.S. has less than 5 micrograms of lead per deciliter ($\mu\text{g}/\text{dL}$) of blood.

Lead is a tricky poison. At low or moderate levels of exposure, children often have no symptoms or they may have general symptoms like those of other common childhood illnesses. Health effects get more severe as blood lead levels increase. The following information describes the effects on human health at various levels of lead in blood.

Low Levels:

10-35 $\mu\text{g}/\text{dL}$ in Children or 10-40 $\mu\text{g}/\text{dL}$ in Adults

Usually there are no visible symptoms. These levels, if they persist, can cause subtle learning and behavior problems in children.

Moderate Levels:

35-50 $\mu\text{g}/\text{dL}$ in Children or 40-60 $\mu\text{g}/\text{dL}$ in Adults

There may be no symptoms. If symptoms are there, they may include general fatigue, irritability, difficulty concentrating, tremors, headaches, abdominal pain, anemia, vomiting, weight loss and/or constipation. These can be mistaken for other illnesses. Adults with elevated blood lead levels are also at risk for high blood pressure and kidney problems.

High Levels:

Over 50 $\mu\text{g}/\text{dL}$ in Children or over 60 $\mu\text{g}/\text{dL}$ in Adults

There may be no symptoms, or there may be symptoms as listed above under "Moderate." At very high levels, symptoms can include convulsions, paralysis, coma or death.

In general, chemicals affect the same organ systems in all people who are exposed. However, the seriousness of the effects may vary from person to person. It is also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten.

The effects of lead on adults are generally reversible. The effects on children under six years of age can be more severe and probably cannot be reversed. Children absorb up to 50% of the lead they eat, while adults absorb only about 10%. The nervous systems of children are more sensitive to damage from lead. The general health and nutrition of the exposed person, including iron or calcium deficiency and sickle cell disease, can affect the severity of symptoms.

CAN A MEDICAL TEST DETERMINE EXPOSURE TO LEAD?

A blood test can measure recent exposure to lead.

Seek medical advice if you have any symptoms that you think may be related to chemical exposure.

Children with blood lead levels as low as 10 $\mu\text{g}/\text{dL}$ can experience subtle learning and behavior problems. They should be periodically re-tested to see if the levels are going down or up. Their families should find out ways to reduce childhood lead exposure.

Children with blood lead levels of 20 $\mu\text{g}/\text{dL}$ or higher should be evaluated by a physician and have their environments assessed for lead hazards.

Children with blood levels of 45 $\mu\text{g}/\text{dL}$ or higher should have chelation therapy to remove lead from their bodies.

Children with blood levels of 70 $\mu\text{g}/\text{dL}$ or higher can have serious health problems. They should be immediately admitted to a medical treatment facility.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to work exposure or emergency situations

FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: <http://www.dhfs.state.wi.us/eh>



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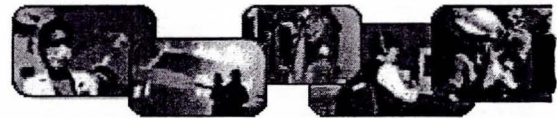
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Lead: Secondary Lead Smelter eTool. This eTool describes ways to reduce lead exposure to employees in Lead Smelter plants, specifically in the following operations: Raw Materials Processing, Smelting, Refining and Casting, Environmental Controls, and Maintenance.

Overexposure to lead is one of the most common overexposures found in industry. Lead overexposure is a leading cause of workplace illness. Therefore, OSHA has established the reduction of lead exposure to be a high strategic priority. OSHA's five year strategic plan sets a performance goal of a 15% reduction in the average severity of lead exposure or employee blood lead levels in selected industries and workplaces.

In general populations lead may be present at hazardous concentrations in food, water, and air. Sources include paint, urban dust, and folk remedies. It is also a major potential public health risk. Lead poisoning is the leading environmentally induced illness in children. At greatest risk are children under the age of six because they are undergoing rapid neurological and physical development.

Related Safety and Health Topics

- [Battery Manufacturing](#)
- [Construction: Lead](#)
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- [Hazard Communications](#)
- [Hazardous and Toxic Substances](#)
- [Welding, Cutting, and Brazing](#)

Recognition

Lead is commonly added to industrial paints because of its characteristic to resist corrosion. Industries with particularly high potential exposures include: construction work involving welding, cutting, brazing, blasting, etc., on lead paint surfaces; most smelter operations either as a trace contaminant or as a major product; secondary lead smelters where lead is recovered from batteries; radiator repair shops; and firing ranges. Oral ingestion may represent a major route of exposure in contaminated workplaces. Most exposures occur with inorganic lead. Organic (tetraethyl and tetramethyl) lead, which was added to gasoline up until the late 1970s, is not commonly encountered. Organic forms may be absorbed through the skin, while inorganic forms cannot.

Inorganic lead is not metabolized, but is directly absorbed, distributed and excreted. The rate depends on its chemical and physical form and on the physiological characteristics of the exposed person (e.g. nutritional status and age). Once in the blood, lead is distributed primarily among three compartments - blood, soft tissue (kidney, bone marrow, liver, and brain) and mineralizing tissue (bones and teeth). Absorption via the GI track following ingestion is highly dependent upon presence of levels of calcium, iron, fats and proteins.

- [OSHA Launches National Emphasis Program to Reduce Lead Exposure.](#) OSHA Trade News Release (2001, July 20), 2 pages. A national emphasis program aimed at reducing occupational exposure to lead, one of the leading causes of workplace illnesses.
- [Protecting Workers Exposed to Lead-Based Paint Hazards: A Report to Congress.](#) DHHS (NIOSH) Publication No. 98-112 (1997, January). Provides extensive information on lead, including health effects, exposure criteria, sampling and analysis, control methods, and other NIOSH recommendations.
- [OSHA Regulation 1926.62 App C. Medical Surveillance Guidelines.](#) Contains a detailed description of medical effects.
- [National Lead Information Center.](#) Gathers and provides information on environmental lead poisoning and prevention for health professionals and the public at large.
- [Lead and Compounds.](#) EPA (2001, May 7), 9 pages. This document presents a summary of occupational

lead hazards.

- Lead and compounds (inorganic) Integrated Risk Information System (IRIS), EPA Office of Research and Development, National Center for Environmental Assessment (1988, March 1), 10 pages. IRIS contains chemical health risk assessments and regulatory information.
- Public Health Statement: Lead. Agency for Toxic Substance and Disease Registry (ATSDR), Department of Health and Human Services (1997, August), 13 pages. Provides exposure risks, exposure limits, and health effects.

Evaluation

Standard particulate sampling techniques are used to evaluate lead exposures. Potential for lead ingestion can be indicated by wipe sampling.

- OSHA Sampling and Analytical Methods. OSHA. This page provide links to information developed by OSHA including validated methods for use by the Salt Lake Technical Center (SLTC) Laboratory. These standard methods have been adopted by many laboratories for the analysis of chemical compounds.
 - Lead (Pb) in Workplace Air by Niton 700 Series Field Portable X-Ray Fluorescence (XRF) Analyzer. OSHA Method OSA1 (2003, April), 13 pages.
 - Lead (Pb) on Surfaces by a Portable X-Ray Fluorescence (XRF) Analyzer. OSHA Method OSS1 (2003, April), 15 pages.
- Chemical Sampling Information database, OSHA.
 - Tetraethyl Lead (as Pb) (1993), 1 page.
 - Tetramethyl Lead (as Pb) (1993), 1 page.
 - Lead, Inorganic (as Pb) (1993), 1 page.
- OSHA Sampling and Analysis methods.
 - Metal and Metalloid Particulates in Workplace Atmospheres (Atomic Absorption Analysis), ID-121.
 - Metal and Metalloid Particulates in Workplace Atmospheres (ICP Analysis), ID-125G.
 - Metal/Metalloid Particulates from Solder Operations, ID-206.
- NIOSH Sampling and Analysis methods.
 - Lead by Flame Atomic Absorption Spectroscopy, 7082. WordPerfect 5.1 file in ZIP format.
 - Lead by Heated Graphite Atomizer Atomic Absorption Spectroscopy, 7105. WordPerfect 5.1 file in ZIP format.
 - Elements by ICP, 7300. WordPerfect 5.1 file in ZIP format.
 - Lead in Air by Chemical Spot Test, 7700. 15.6 KB PDF.
 - Lead by Ultrasound/Anodic Stripping Voltammetry (ASV), 7701. 24.6 KB PDF.
 - Lead by Field Portable X-ray Fluorescence (XRF), 7702. 25.5 KB PDF.
 - Lead in Blood and Urine, 8003. WordPerfect 5.1 file in ZIP format.
 - Lead in Surface Wipe Samples, 9100. WordPerfect 5.1 file in ZIP format.
- CDC Press Release. CDC Announces Issuance of Patent for Detecting the Presence of Lead (October, 2002).
- Lead. International Chemical Safety Cards (ICSCs), International Programme on Chemical Safety (IPCS), (2000, October 10), 3 pages. An ICSC summarizes essential health and safety information on chemicals for their use at the "shop floor" level by workers and employers in factories, agriculture, construction and other work places. Cards for additional lead compounds can be located in the list of chemicals.
- Employers who are required to perform biological monitoring for blood lead must use an OSHA-approved blood lead laboratory for analysis.
- OSHA Approved Blood Lead Laboratories: OSHA administers a program for approval of laboratories submitting data as required by the OSHA Regulation 1910.1025, and Lead Standards for General Industry.
- The American Industrial Hygiene Association conducts a program that accredits laboratories that perform industrial hygiene analyses. Though not a mandatory program, participation in this accreditation may provide additional confidence in the results obtained.
- Lead in Housing and related remediation work information is continued on a separate page.
- Also see the Safety and Health Topics page for Sampling and Analysis.

Control

- Use general procedures for particulate control. Particular attention should be paid to housekeeping and hygiene practices as specified in the OSHA standards.
- OSHA, Lead Industries Announce Voluntary Industry Initiative To Reduce Worker Exposures To Lead. OSHA National News Release (1996, October 30), 1 page.

Compliance

Due to amount of information, the Compliance section is on a separate page.

Training

- Brass and Bronze Ingot Manufacturing Industry. OSHA Outreach Materials for Special Emphasis Programs and Initiatives (1997). Contains eleven slides to be used in training towards this standard.
- The National Lead Information Center (NLIC) Web Site provides numerous documents which may be used in training employees and the public in the hazards of lead exposure.

Other

- The National Lead Information Center provide links to several sources of information regarding lead hazards.
- Occupational Lead Poisoning Prevention Program (OLPPP). State of California Department of Health Services. Provides a listing of many documents related to lead. These documents are available without cost to California residents.

Revised: 08 January 2004

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

CADMIUM

Also known as: Cadmium sulfate 10124-36-4, Cadmium chloride 10108-64-2, Cadmium oxide 1306-19-0, Cadmium acetate 534-090-8
Chemical reference number (CAS): 7440-43-9

WHAT IS CADMIUM?

Cadmium is a metal found naturally in the earth's crust. Pure cadmium is a soft, silver-white metal; however, it's unusual to find it in its pure form. It's commonly found in combination with other elements such as oxygen (cadmium oxide) or sulphur (cadmium sulphate).

Cadmium is also used in industry. The cadmium used in industry is a byproduct of zinc, lead, and copper refining. Industrial uses of cadmium include production of metal plating, rechargeable batteries, paint pigments, and plastics.

Cadmium can be found in dust. The body does not readily release cadmium once inhaled or ingested. Exposure to low doses of cadmium over a long time can build up to a toxic level.

HOW ARE PEOPLE EXPOSED TO CADMIUM?

Drinking/Eating: People can be exposed to cadmium when they eat plants grown in contaminated soil, or when they eat fish from contaminated water. Cadmium occurs naturally at low levels in many foods. The normal intake of cadmium (1-3 micrograms/day) does not appear to cause health problems. People can be exposed to increased amounts of cadmium by drinking contaminated water.

Contamination of drinking water typically results from improper disposal of industrial chemicals.

Breathing: Cadmium is found in smoke from burning fossil fuels, municipal wastes, and cigarettes. People who smoke cigarettes have higher cadmium levels in their bodies than nonsmokers. Industrial facilities that process metal can create high levels of cadmium in the air and significantly increase the exposure of people living or working near them.

Touching: Cadmium is not easily absorbed through the skin.

DO STANDARDS EXIST FOR REGULATING CADMIUM?

Water: The state and federal drinking water standards are both set at 5 parts per billion of cadmium. We suggest you stop drinking water that contains more than the standard.

Air: No standards exist for cadmium allowed in the air of homes. However, there are workplace limits. We use a formula to convert workplace limits to home limits; inhalation levels should be no higher than 0.0002 milligrams of cadmium per cubic meter of air (mg/m^3). Levels above $0.0035 \text{ mg}/\text{m}^3$ increase the chance of lung and kidney injury. Long-term exposure to air containing cadmium dust or fumes increases a person's lung cancer risk.

WILL EXPOSURE TO CADMIUM RESULT IN HARMFUL HEALTH EFFECTS?

The following symptoms may occur immediately or shortly after exposure to high levels of cadmium:

- Stomach irritation after ingestion of contaminated food or water.
- Lung irritation following inhalation of cadmium particles or fumes at levels greater than 300 mg/m³.

The following health effects can occur after several years of exposure to cadmium:

Cancer: Cancer can develop after long-term, high-level exposure to airborne cadmium.

Reproductive Effects: Human reproductive problems are not associated with exposure to cadmium.

Organ Systems : Lung disorders, including emphysema or bronchitis, can develop after long-term exposure to cadmium in air.

Kidney damage and/or kidney stones can form as a result of eating, drinking, or breathing elevated levels of cadmium.

In general, chemicals affect the same organ systems in all people who are exposed. However, the seriousness of the effects may vary from person to person. A person's reaction depends on several things, including individual health, heredity, previous exposure to chemicals including medicines, and personal habits such as smoking or drinking.

It is also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten

Seek medical advice if you have any symptoms that you think may be related to chemical exposure.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to work exposure or emergency situations.

FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: <http://www.dhfs.state.wi.us/eh>



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(POH 4591 Revised 12/2000)

Occupational Health Guideline for Cadmium Dust (as Cadmium)*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

APPLICABILITY

The general guidelines contained in this document apply to all cadmium dust. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Cadmium metal dust

- Formula: Cd
- Synonyms: None
- Appearance and odor: Odorless, gray powder.

Cadmium oxide dust

- Formula: CdO
- Synonyms: None
- Appearance and odor: Odorless, brown solid or blue-black solid.

Cadmium sulfide dust

- Formula: CdS
- Synonyms: Greenockite
- Appearance: Yellow-orange solid.

Cadmium chloride dust

- Formula: CdCl₂
- Synonyms: None
- Appearance: White solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for cadmium dust is 0.2 milligram of cadmium dust per cubic meter of air (mg/m³) averaged over an eight-hour work shift, with a ceiling level of 0.6 mg/m³. NIOSH has recommended that the permissible exposure limit be reduced to 40 micrograms of cadmium per cubic meter of air (µg/m³) averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 200 µg/m³ averaged over a 15-minute period. The recommendations in this guideline supplement the recommendations in the NIOSH Criteria Document for Cadmium, which should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

• Routes of exposure

Cadmium dust can affect the body if it is inhaled. It can also affect the body if it is swallowed.

• Effects of overexposure

1. *Short-term Exposure:* Cadmium dust may cause irritation of the nose and throat. If enough has been inhaled, after a delay of several hours, a person may also develop cough, chest pain, sweating, chills, shortness of breath, and weakness. Death may occur. Ingestion of cadmium dust may cause nausea, vomiting, diarrhea, and abdominal cramps.

2. *Long-term Exposure:* Repeated or prolonged exposure to cadmium dust may cause loss of sense of smell, ulceration of the nose, shortness of breath (emphysema), kidney damage, and mild anemia. Exposure to cadmium has also been reported to cause an increased incidence of cancer of the prostate in man. Injections of cadmium sulfate in animals have been reported to cause malformation in their offspring.

3. *Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to cadmium dust.

• Recommended medical surveillance

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

The following medical procedures should be made available to each employee who is exposed to cadmium dust at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system, liver, kidneys, prostate, and blood should be stressed.

—Urinalysis: Since kidney damage has been observed in humans exposed to cadmium, a urinalysis should be obtained to include, at a minimum, specific gravity, albumin, glucose, and a microscopic on centrifuged sediment. In addition, the urine should be examined for low molecular weight proteins by use of 3% sulfosalicylic or other acceptable techniques.

—14" x 17" chest roentgenogram: Cadmium causes human lung damage. Surveillance of the lungs is indicated.

—Liver function tests: Cadmium may cause liver damage. A profile of liver function should be obtained by utilizing a medically acceptable array of biochemical tests.

—FVC and FEV (1 sec): Cadmium is reported to cause decreased pulmonary function. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is considered necessary only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease. Urine protein measurements should be made available every four months.

• **Summary of toxicology**

Cadmium dust causes both acute and chronic effects. It is less toxic than cadmium fume, because dust has a larger particle size than fume; at high concentrations of the dust, physiologic effects similar to those arising from fume exposure could be expected. The acute effects primarily involve the lungs but may also affect other organ systems. Most acute intoxications have been caused by inhalation of cadmium fume at concentrations which did not provide warning symptoms of irritation. The average concentrations of fume responsible for fatalities have been 40 to 50 mg/m³ for 1 hour, or 9 mg/m³ for 5 hours. Non-fatal pneumonitis has been reported from concentrations of 0.5 to 2.5 mg/m³, while relatively mild cases have been attributed to even lower concentrations. Following an asymptomatic latent period of 4 to 10 hours, there is characteristic nasopharyngeal irritation followed by a feeling of chest constriction or substernal pain, with persistent cough and dyspnea; there may also be headache, chills, muscle aches, nausea, vomiting, and diarrhea. Pulmonary edema may then develop and progress rapidly, with decreased vital capacity and markedly reduced carbon monoxide diffusing capacity. Cyanosis may be intense. In about 20% of the cases the dyspnea is progressive,

accompanied by wheezing or hemoptysis, and may result in death within 7 to 10 days after exposure; at autopsy the lungs are markedly congested, and there is an intra-alveolar fibrinous exudate, as well as alveolar cell metaplasia. Among survivors, the subsequent course is unpredictable: most cases resolve slowly, but respiratory symptoms may linger for several weeks, while impairment of pulmonary function may persist for months. In experimental animals, cadmium exposure has caused pulmonary fibrosis, but this has not been documented in humans. In one fatal human case, in addition to lung abnormalities, there was renal cortical necrosis. Absorbed cadmium is retained to a large extent by the body, and excretion is very slow. Continued exposure to low levels of cadmium in air has resulted in chronic poisoning characterized by irreversible lung injury of an emphysematous type, with abnormal lung function and urinary excretion of a specific low-molecular-weight protein which may be associated with renal dysfunction. Clinical evidence of the cumulative effects of cadmium may appear after exposure has terminated; the disease then tends to be progressive. The frequency of occurrence of proteinuria increases with length of exposure: those exposed to cadmium compounds for less than 2 years had no proteinuria, whereas most of those exposed for 12 years or more had proteinuria with little other evidence of renal damage. The urinary excretion of cadmium bears no known relationship to the severity or duration of exposure and is only a confirmation of absorption. Other consequences of cadmium exposure are rhinitis, occasional ulceration of the nasal septum, damage to the olfactory nerve, and anosmia. The long-term ingestion of water, beans, and rice contaminated with cadmium has been proposed as the probable cause of a crippling condition among Japanese women who have had multiple pregnancies; severe pain in the back and joints, a waddly gait, osteomalacia, spontaneous fractures, and occasional fatal renal failure are characteristics of the disorder, which has been termed "itai-itai." Subcutaneous injection of cadmium metal suspended in fowl serum produced rhabdomyosarcomata in rats; cadmium sulfate in sterile distilled water produced sarcomata; and cadmium chloride solution produced pleomorphic sarcomata at the injection site. Increased incidence of prostatic cancer has been reported following occupational exposure to cadmium. Cadmium sulfate injected into the lingual vein of female hamsters on day 8 of pregnancy caused a high incidence of resorption and malformed offspring; acute necrosis of rat testes follows large doses orally or parenterally, but testicular effects have not been reported in humans.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data—Cadmium metal dust

1. Molecular weight: 112.4
2. Boiling point (760 mm Hg): 767 C (1412 F)
3. Specific gravity (water = 1): 8.642
4. Vapor density (air = 1 at boiling point of cadmium metal dust): Not applicable
5. Melting point: 321 C (609 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble

Insoluble

8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Cadmium oxide dust

1. Molecular weight: 128.4
2. Boiling point (760 mm Hg): 900 C (1652 F) (sublimes and decomposes)
3. Specific gravity (water = 1): 6.95 or 8.15
4. Vapor density (air = 1 at boiling point of cadmium oxide dust): Not applicable
5. Melting point: 900 C (1652 F) (sublimes and decomposes)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 0.0005

8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Cadmium sulfide dust

1. Molecular weight: 144.5
2. Boiling point (760 mm Hg): Sublimes in N₂ at 980 C (1796 F)
3. Specific gravity (water = 1): 4.82
4. Vapor density (air = 1 at boiling point of cadmium sulfide dust): Not applicable
5. Melting point: 1750 C (3182 F) at 100 atm.
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 0.0001

8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Cadmium chloride dust

1. Molecular weight: 183
2. Boiling point (760 mm Hg): 960 C (1760 F)
3. Specific gravity (water = 1): 4.047
4. Vapor density (air = 1 at boiling point of cadmium chloride dust): Not applicable
5. Melting point: 568 C (1054 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 140
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: None hazardous
2. Incompatibilities: Contact of cadmium metal dust with strong oxidizers or with elemental sulfur, selenium, and tellurium may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as cadmium oxide fume) may be released in a fire involving cadmium dust.

4. Special precautions: None

• Flammability

1. Flash point: Not applicable
2. Autoignition temperature: 250 C (482 F) (layer) (cadmium metal dust)
3. Minimum explosive dust concentration: Data not available

4. Extinguishant: Dry powder for metal fires

• Warning properties

Grant states that "cadmium is a very toxic metal which gives off fumes when burned or heated strongly. Characteristically these fumes cause dryness and irritation of the throat, followed in a few hours by nausea and diarrhea. Smarting of the eyes occurs relatively infrequently, and no injury to the eyes of human beings has been reported. Neither eye nor respiratory irritation is enough to prevent exposures which may cause serious systemic poisoning and damage to the lungs."

MONITORING AND MEASUREMENT PROCEDURES

• Eight-Hour Exposure Evaluation

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of cadmium dust. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

Sampling and analyses may be performed by collection of cadmium dust on a filter, followed by treatment with nitric acid, solution in hydrochloric acid, and atomic absorption spectrophotometric analysis. An analytical method for cadmium dust is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- If employees' clothing has had any possibility of being contaminated with cadmium dust, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing which has had any possibility of being contaminated with cadmium dust should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of cadmium dust from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the cadmium dust, the person performing the operation should be informed of cadmium dust's hazardous properties.
- Employees should be provided with and required to use dust-resistant safety goggles where there is any possibility of cadmium chloride dust contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to cadmium chloride dust, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Workers subject to skin contact with cadmium dust should wash with soap or mild detergent and water any areas of the body which may have contacted cadmium dust at the end of each work day.
- Eating and smoking should not be permitted in areas where cadmium dust is handled, processed, or stored.
- Employees who handle cadmium dust should wash their hands thoroughly with soap or mild detergent and water before eating or smoking.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to cadmium dust may occur and control methods which may be effective in each case:

Operation	Controls
Liberation from fabrication of cadmium-plated marine, aircraft, and motor vehicle equipment for corrosion-resistant coatings	Local exhaust ventilation; personal protective equipment
Liberation during processing of cadmium metal	Process enclosure; local exhaust ventilation; personal protective equipment
Liberation in synthesis of cadmium compounds	Process enclosure; local exhaust ventilation
Liberation in manufacture and fabrication of cadmium alloys; recovery from flue dusts during smelting of lead and zinc operations	Local exhaust ventilation; personal protective equipment
Liberation during manufacture of nuclear reactor rods	Process enclosure; local exhaust ventilation

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If cadmium dust gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If cadmium dust gets on the skin, wash the contaminated skin using soap or mild detergent and water. Be sure to wash the hands well before eating or smoking and at the close of work.

• Breathing

If a person breathes in large amounts of cadmium dust, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When cadmium dust or liquids containing cadmium dust have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the

person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of releases until cleanup has been completed.

• If cadmium dust is released in hazardous concentrations, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of release.
3. Collect released material in the most convenient and safe manner for reclamation or for disposal in sealed containers in a secured sanitary landfill.

• **Waste disposal method:**

Cadmium dust may be disposed of in sealed containers in a secured sanitary landfill.

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on these chemicals and has concluded that they cause cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 2, 1973, and Volume 11, 1976.

RESPIRATORY PROTECTION FOR CADMIUM DUST (AS CADMIUM)

Condition	Minimum Respiratory Protection* Required Above 0.2 mg/m ³
Dust Concentration	
1 mg/m ³ or less	Any dust respirator, except single-use.
2 mg/m ³ or less	Any dust respirator, except single-use or quarter-mask respirator. Any high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
10 mg/m ³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
40 mg/m ³ or less	A powered air-purifying respirator with a high efficiency particulate filter. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 40 mg/m ³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any dust respirator, except single-use. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.