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Final O&M Manual

Groundwater Treatment System

N.W. Mauthe
Appleton, Wisconsin

Submitted by

CH2MHILL

April 29, 1997

Contents

Contents, Continued

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SECTION 1

Introduction

This manual provides the plant operating staff with the information necessary to operate the N. W. Mauthe Groundwater Pretreatment System. The manual gives an overview of the system, the pretreatment goals, and functions of the process equipment. Startup and shutdown procedures are discussed along with other information related to the operation of the system. Requirements for sampling, monitoring, and reporting are also discussed. The manual includes the following sections:

- Section 1—Introduction
- Section 2—Site Background
- Section 3—Process and Instrumentation Description
- Section 4—Process Startup and Shutdown
- Section 5—Routine Process Operations and Inspections
- Section 6—Permit Limits, Monitoring, and Reporting
- Section 7—General Facility Information
- Section 8—Plant Safety
- Appendix A—Process and Instrumentation Diagrams (P&IDs)
- Appendix B—Equipment List
- Appendix C—Log Sheets
- Appendix D—Process Calculations
- Appendix E—Material Safety Data Sheets

This manual is intended only to provide an overview of operating the process. It does not present detailed descriptions or step-by-step programming/operation instructions of each piece of equipment. For specific information for a given piece of process equipment, as well as requirements for equipment maintenance, consult the manufacturer's O&M manual. Manufacturers' O&M manuals have been supplied for each piece of equipment and are located at the treatment facility.

SECTION 2

Site Background

Site Description

The N. W. Mauthe Company (Site) is a former electroplating facility located at 725 South Outagamie Street in the City of Appleton, in east-central Wisconsin. Approximately 1/2 acre in size and somewhat triangular in shape, the site is located in an area of mixed commercial, light industrial, and residential properties. The site is bordered by Melvin Street on the north, an asphalt parking lot owned by Miller Electric and Manufacturing Company on the west, and the Wisconsin Central Ltd. railroad right-of-way (owned by Fox Valley & Western, Ltd.) on the southeast. Private residences are located immediately southeast of the railroad tracks and on the north side of Melvin Street (see Figure 2-1).

Site History

Prior to their demolition in remedial action, the site contained two buildings—the Zinc and Chromium Buildings. Hard chromium plating was conducted in the Chromium Building from 1960 to 1976. Objects to be electroplated were rinsed with a chlorinated solvent to remove oils, then submerged in plating solution baths. A ventilating fan exhausted hydrogen gas and chromic acid vapors generated from the plating process from the building. Splashes, drips, and spills from the plating and degreasing activities were directed to a shallow floor trench and channeled into the sanitary sewer system.

Zinc, cadmium, copper, and possibly silver were electroplated in the Zinc Building from 1978 to 1987. A *Pretreatment Baseline Report* submitted by the N.W. Mauthe Company to the City of Appleton on January 4, 1985, states that the company used 1,1,1-trichloroethane (27 gallons per year) for several plating bath solutions in the electroplating process and for degreasing parts. Liquid wastes were untreated and discharged to the sanitary sewer system.

Site Investigations

Table 2-1 lists reference documents that describe site investigations and a feasibility study of the site if additional information is desired.

TABLE 2-1
Site Investigation and Feasibility Study Reports
N.W. Mauthe Site, Appleton, Wisconsin

Document Name	Date Printed	Author
Pretreatment Baseline Report	January 1985	N. W. Mauthe Co.
RI/FS Work Plan, N.W. Mauthe Site, Appleton, Wisconsin	March 1990	Warzyn Engineering, Inc.
Remedial Investigation Report, N.W. Mauthe Site, Appleton, Wisconsin	February 1993	CH2M HILL
Feasibility Study Report, N.W. Mauthe Site, Appleton, Wisconsin	May 1993	CH2M HILL
Phase I Remedial Action Closure Report, N.W. Mauthe Site, Appleton, Wisconsin	July 1996	CH2M HILL

I:\ 108200\DRAWINGS\FIGURES\FIG2-1.DGN

0+50E 1+00E 1+50E 2+00E 2+50E 3+00E 3+50E 4+00E 4+50E

4+00N
3+50N
3+00N
2+50N
2+00N
1+50N
1+00N
0+50N

CONNECT TO EXISTING WATER MAIN
CONNECT TO EXISTING SANITARY SEWER
CONNECT TO EXISTING GAS MAIN
¾" CARBON STEEL NATURAL GAS
6" PVC STORM SEWER
2" COPPER POTABLE WATER
4" CAST IRON PLANT EFFLUENT
PROPERTY LINE
ELECTRIC SUBSTATION
GROUNDWATER TREATMENT FACILITY
ELECTRICAL HANDHOLE
N 2 + 84
E 2 + 70
MANHOLE NO. 2
WEST GROUNDWATER COLLECTION TRENCH
ELECTRICAL WIRING
2" HDPE PLANT INFLUENT
4" HDPE OVERFLOW
ELECTRICAL WIRING
2" HDPE PLANT INFLUENT
RAILROAD RIGHT OF WAY
MANHOLE NO. 1
ELECTRICAL WIRING
ELECTRICAL HANDHOLE
ELECTRICAL TRANSFORMER
BLDG
GAR
GAR
HSE
HSE
HSE
TAVERN
TAVERN
SOUTHEAST GROUNDWATER COLLECTION TRENCH
CONC SDWK
BITUM
CONC
SAN
STM
W
G
P
N

0 20' 40' 60'

FIGURE 2-1
SITE OVERVIEW
N.W. MAUTHE SITE
APPLETON, WISCONSIN

CH2M HILL

SECTION 3

Process and Instrumentation Description

This section presents an overview and functional description of the groundwater collection and pretreatment system. Detailed operating procedures are presented in Sections 4 and 5. A Process Flow Diagram (PFD) for the treatment system is shown in Figure 3-1. The PFD provides an overview of the system in schematic form, defines each major process stream, and documents the expected hydraulic and mass loadings. Process and instrumentation diagrams (P&IDs), provided in Appendix A, present a detailed description of process equipment, valves, and controls. Table B (in Appendix B) lists and describes the equipment shown in the P&ID in addition to the manufacturer and model number.

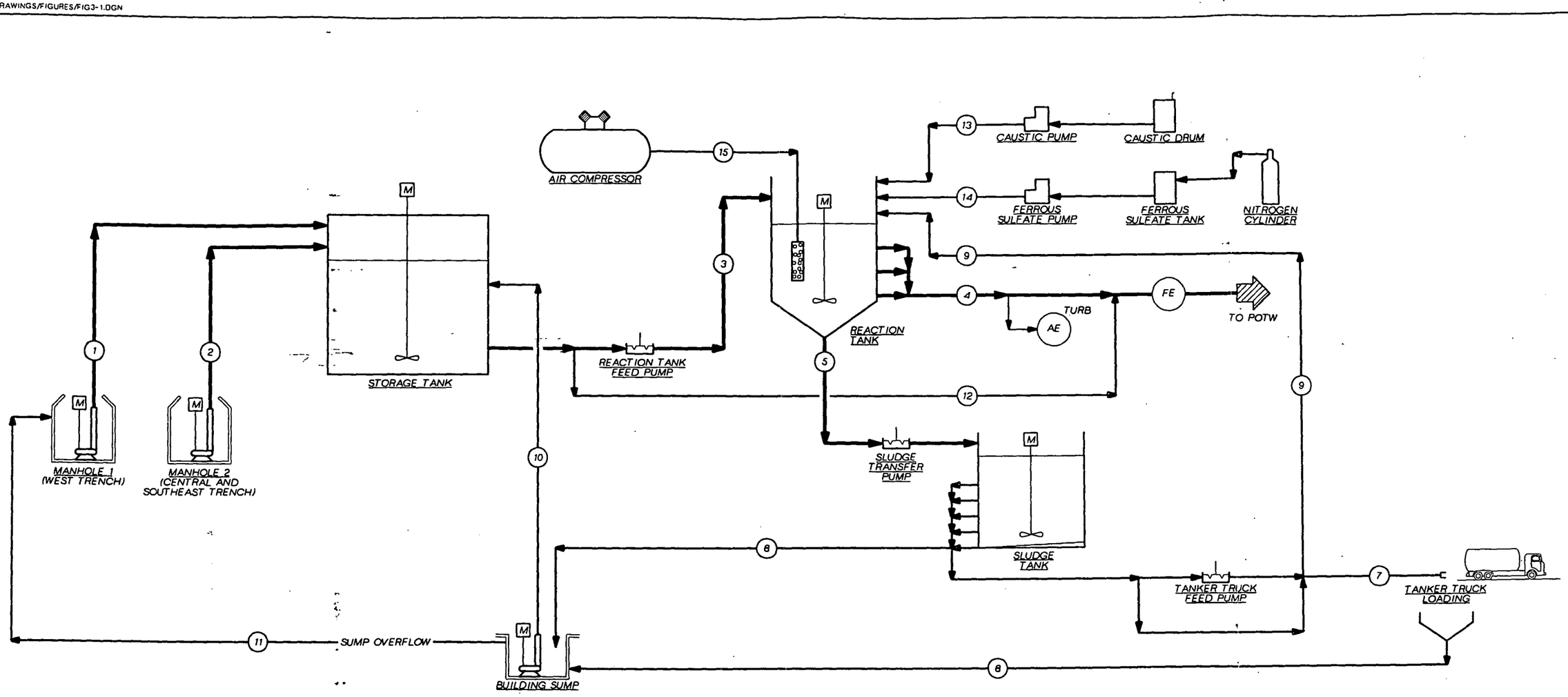
The purpose of the collection system, as stated in the USEPA and WDNR *Record of Decision* (dated March, 1994), is to "contain and/or control groundwater contamination with ultimate compliance with groundwater applicable or relevant and appropriate requirements (ARARs)." The collection system is designed to influence the extent of the groundwater plume that exceeds Wisconsin groundwater criteria for chromium. The groundwater is collected in a series of coarse sand-filled trenches, and then pumped to the groundwater pretreatment facility. Pretreated groundwater is discharged to the City of Appleton POTW. The purpose of the pretreatment facility is to treat groundwater for compliance with the City of Appleton POTW discharge requirements.

The contaminants of concern in groundwater at the site relative to City of Appleton POTW discharge requirements are total and hexavalent chromium.

Groundwater Collection System

The groundwater collection system is designed to capture groundwater-containing contaminants at concentrations greater than Wisconsin preventive action limits (PALs) (Wisconsin Administrative Code NR 140). The system is designed using a coarse sand-filled trench that influences groundwater flow. Groundwater will enter the trench on both sides of the trench wall, based on the head differential between the local water table and the level maintained in the trench. Perforated drain pipe in the bottom of the trench drains water from the trench to one of two manholes, after which the groundwater is pumped to the groundwater pretreatment system.

The collection trench system consists of the west, central, and southeast segments, which are approximately 200, 280, and 600 linear feet in length, respectively. The trenches, shown in cross-section in Figure 3-2, are constructed of coarse sand with perforated pipe at the base. The trenches are sealed from a depth of 3 feet to the surface to prevent infiltration of surface water. In normal operation, the water level in the trenches is maintained at or near the bottom of the trench. The trenches are sloped to promote drainage to the manholes, and in most parts of the trench, the water level will be near the bottom. As such, if the treatment system needs to be shutdown for repair or maintenance for a short period of time, the trenches will provide storage and will continue to act as a hydraulic barrier until the water in the trench rises to the level of the water table.



MAUTHE GROUNDWATER TREATMENT SYSTEM MASS BALANCE SUMMARY

ID	TYPE	PH	FLOW/VOLUME UNIT	FLOW/VOLUME AVG	FLOW/VOLUME MAX	INSTANTANEOUS FLOW UNIT	INSTANTANEOUS FLOW AVG	INSTANTANEOUS FLOW MAX	TSS, mg/L AVG	TSS, mg/L MAX
1	MANHOLE 1 EFFLUENT	6.0 - 8.0	GPD	1,300	1,300	GPM	43	43	5	30
2	MANHOLE 2 EFFLUENT	6.0 - 8.0	GPD	1,300	1,300	GPM	43	43	5	30
3	REACTION TANK INFLUENT	6.0 - 8.0	GPD	2,600	10,400	GPM	86	86	5	2000
4	REACTION TANK EFFLUENT	6.0 - 10.0	GPD	2,600	10,400	GPM	43	43	5	30
5	SLUDGE TANK INFLUENT	6.0 - 10.0	GAL/MON	500	1,500	GPM	4	12	1% SOLIDS	2% SOLIDS
6	SLUDGE TANK DECANT	6.0 - 10.0	GAL/MON	250	750	GPM	10	70	20	500
7	TANKER TRUCK INFLUENT	6.0 - 10.0	GAL/6 MON	1,500	4,000	GPM	10	70	2% SOLIDS	10% SOLIDS
8	TANKER TRUCK OVERFLOW	6.0 - 10.0	GAL/6 MON	-	4,000	GPM	-	30	2% SOLIDS	10% SOLIDS
9	SLUDGE RETURN	6.0 - 10.0	GAL/MON	-	1,050	GPM	-	35	2% SOLIDS	2% SOLIDS
10	BUILDING SUMP EFFLUENT	6.0 - 10.0	GPD	-	10,400	GPM	86	86	20	1% SOLIDS
11	BUILDING SUMP OVERFLOW	6.0 - 10.0	GPD	-	10,400	GPM	170	170	20	1% SOLIDS
12	STORAGE TANK BYPASS TO SEWER	6.0 - 8.0	GPD	10,000	10,000	GPM	170	170	5	30
13	SODIUM HYDROXIDE ADDITION (50%)	-	ml/D	260	950	ml/MIN	50	200	-	-
14	FERROUS SULFATE HEPTAHYDRATE ADDITION (25%)	-	ml/D	500	3,600	ml/MIN	50	300	-	-
15	REACTION TANK AERATION	-	SCFM	2	5	-	-	-	-	-

NOTE: TEMPERATURES ARE EXPECTED TO RANGE FROM 50 TO 70 DEGREES F BASED ON INFLUENT TEMPERATURE.

FIGURE 3-1
PROCESS FLOW DIAGRAM
N.W. MAUTHE SITE
APPLETON, WISCONSIN

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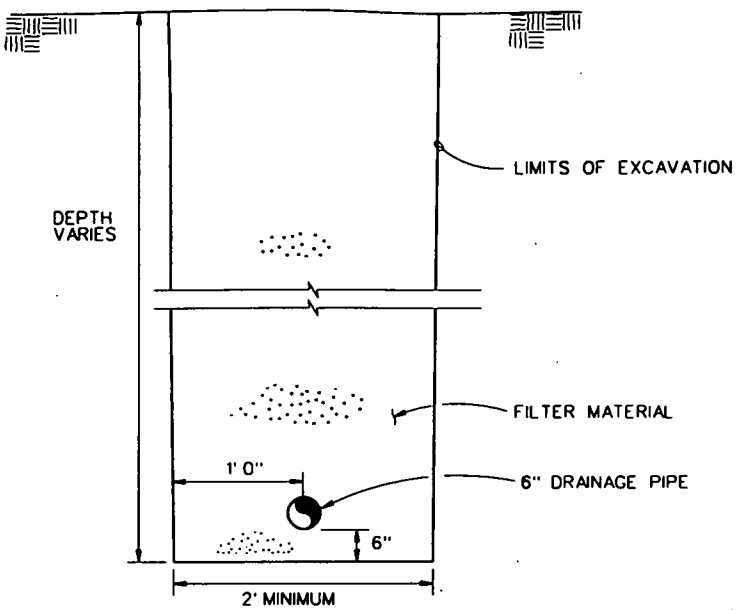
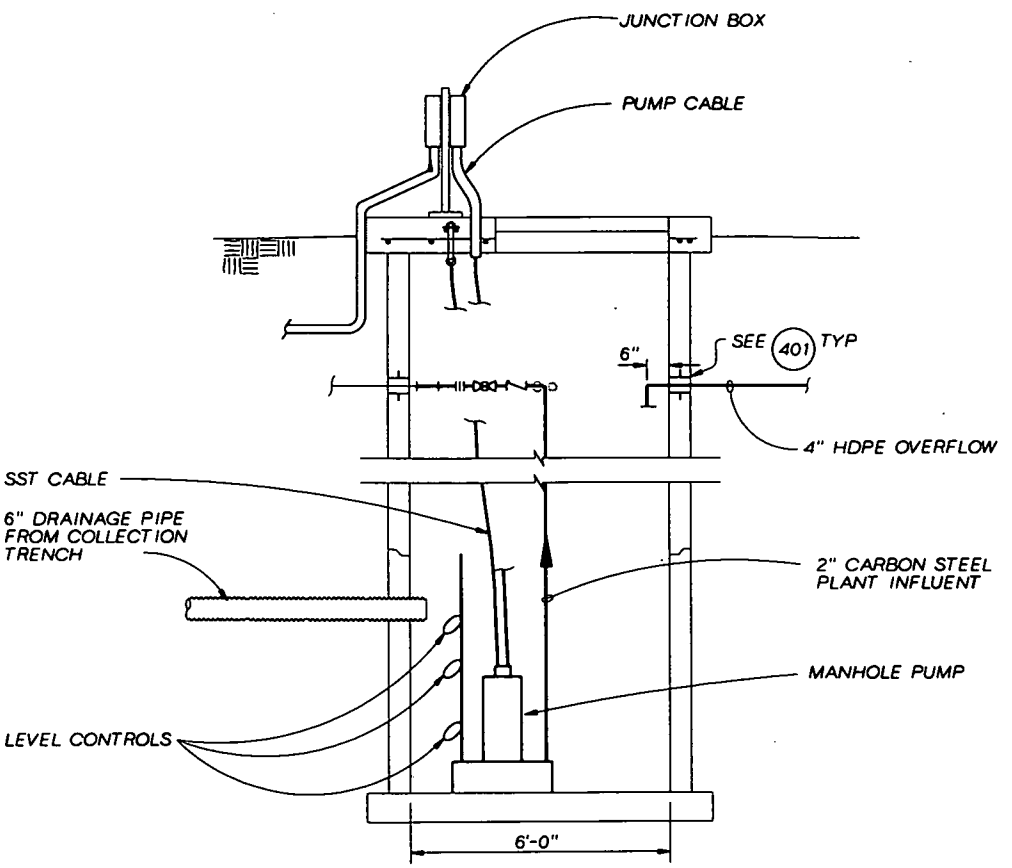


COLLECTION TRENCH DETAIL

NOT TO SCALE



MANHOLE DETAIL

FIGURE 3-2
TRENCH AND MANHOLE
N.W. MAUTHE SITE
APPLETON, WISCONSIN

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Three homes south of the facility have foundation drain systems that are connected to the groundwater collection system via gravity piping (801 S. Outagamie St., 1414 W. 2nd St., and 1410 W. 2nd St.). This piping includes a backwater valve to prevent back up of groundwater into the foundation drain systems. Primary responsibilities for these systems belongs to the residents, however, the homeowners should be notified if the system is down for an extended period of time and the groundwater elevation in the trenches rises to within 5 feet of ground surface.

Groundwater collected in the west trench flows by gravity to manhole No. 1 where the maximum depth of the trench extends about 32 feet below ground surface. Groundwater in the central and southeast trenches flows by gravity to manhole No. 2, where the maximum depth of the trench extends about 31 feet below ground surface. The pumps in manholes Nos. 1 and 2 pump groundwater to the pretreatment facility.

Groundwater Pretreatment System

The groundwater pretreatment system uses a fully automated batch treatment process designed for control of total chromium. Operator attention is required for system maintenance, monitoring, and in the event of a system failure, but not for routine operation. An important element of the system design is that a telemetry (autodialer) system is installed to contact offsite operations staff during alarm conditions.

Each batch operation treats 2,600 gallons of influent groundwater and takes about 6 hours to complete a cycle (i.e., from the start of filling the reaction tank to finishing the discharge to the POTW). The system was designed to treat a maximum of 10,000 gallons per day (gpd) (i.e., four batches per day), although the expected daily volume is approximately 2,600 gallons. Greater volumes could be treated if it is determined that reducing the time for one or more of the batch treatment steps is feasible while still meeting the pretreatment criteria.

Process Chemistry

The operator must have an understanding of system process chemistry in order to effectively operate the system and provide consistent treatment of total and hexavalent chromium. The two major chemical treatment process concepts the operator must understand are (1) hexavalent chromium reduction using ferrous sulfate, and (2) metal hydroxide precipitation and co-precipitation. These concepts are described below.

Hexavalent Chromium Reduction

Ferrous sulfate ($FeSO_4$) is used to reduce hexavalent chromium (Cr^{6+}) to trivalent chromium (Cr^{3+}). Ferrous iron reduction of hexavalent chromium at alkaline pH is described by the reaction below:

$$Cr^{6+} + 3e^- \rightarrow Cr^{3+}$$

$$3Fe^{2+} \rightarrow 3Fe^{3+} + 3e^-$$

$$Cr^{6+} + 3Fe^{2+} \rightarrow Cr^{3+} + 3Fe^{3+}$$

Notice that as hexavalent chromium is reduced to trivalent chromium, ferrous iron is oxidized to ferric iron. With every reduction reaction, there is a corresponding oxidation reaction of equivalent strength. Stoichiometrically, 3 moles of $FeSO_4$ are needed for every mole of Cr^{6+} reduced. Therefore, in theory, 3.2 mg of Fe^{2+} are needed for every 1.0 mg of Cr^{6+} in solution.

However, excess ferrous iron beyond the stoichiometric requirement is necessary because of competing reactions. Other ions and organic compounds in the groundwater also react with the ferrous iron. Therefore, some of the ferrous sulfate added to reduce hexavalent chromium is used up in other reactions. Since the competing reactions are often complex and the potential list of competing compounds is extensive and variable, it is nearly impossible to accurately calculate the actual required ferrous sulfate dosage.

A dosage safety factor must be applied to the calculated theoretical dosage requirement in order to ensure complete treatment of all hexavalent chromium. The safety factor can be developed from jar tests or full scale system performance. Jar tests conducted during the treatability study on groundwater from the Mauthe site showed that about 1.5 times the theoretical ferrous sulfate dosage was required to reduce all hexavalent chromium.

The analytical jar test procedure and the calculation needed for the determination of the required ferrous sulfate dosage and safety factor are described in Appendix D. Since actual required dosage will fluctuate with groundwater variability weekly, the operator should determine the actual required dosage on a weekly basis. The actual (stoichiometric) dosage required is determined by the PLC when the operator inputs the *Hach* Kit test result of the influent water hexavalent chromium analysis into the PLC.

Precipitation and Co-precipitation Reactions

Following the reduction of hexavalent chromium to the trivalent state, caustic (NaOH) is added to raise the pH and promote the formation of metal hydroxide precipitates. Metal ions have different solubilities at different pH values. Many metal ions that are soluble at neutral pHs will become insoluble and precipitate out of solution as the pH is increased. At the Site, the metallic ion that must be precipitated out of solution is trivalent chromium which precipitates as chromium hydroxide.

When precipitating out chromium, most of the other heavy metals in the groundwater will also precipitate as various metals hydroxide. Ferric iron (resulting from the ferrous sulfate addition step) will precipitate out as ferric hydroxide. The presence of ferric iron is an added benefit because it acts as a co-precipitant. As ferric hydroxide forms during the caustic addition, other metal hydroxides are trapped in the ferric hydroxide matrix which increases their removal from solution.

As the precipitates form, the solution is mixed to promote flocculation. The formation of larger particles is critical to the effectiveness of the settling process that follows. Small, discrete particles settle poorly and won't be removed from solution in an acceptable time frame. In addition, by keeping a portion of the ferric hydroxide sludge in the reaction tank during the precipitation and flocculation steps, the process is enhanced because the sludge acts as a nucleation (or crystallization) site, upon which the new precipitates can form.

Manhole Pumps

Pumps P-1-1 and P-1-2 in manholes MH- 1 and MH-2, respectively, convey groundwater from the collection trenches into the storage tank (T-2). Water levels in the manholes are controlled by float switches. The high level switch (3.33 feet for P-1-1 and 3.16 feet for P-1-2) activates the pump. The low level switch (0.75 feet for P-1-1 and P-1-2) shuts off the pump. A high-high level switch (4.0 feet for P-1-1 and P-1-2) in the manhole sends an alarm to the master control panel (MCP) and to the programmable logic controller (PLC) autodialer to notify the system operator of the excessively high water level condition in the manhole. The manhole pumps have a pumping capacity of 43 gallons per minute (gpm) each.

If the storage tank reaches, a level of 10.0 feet, a switch in the storage tank signals the PLC which shuts down the manhole pumps. When the level drops below 9.0 feet in the storage tank, the manhole pumps are reactivated.

Storage Tank and Mixer

The purpose of the storage tank (T-2) is to store water from the collection system prior to treatment and to provide hydraulic equalization of the groundwater. Equalization serves to minimize the contaminant concentration variability in the reaction tank influent resulting in more consistent treatment efficiency. This is particularly important since groundwater is collected and transferred to the storage tank from two independent collection systems which may have different contaminant concentrations at a given time.

The storage tank is a flat-bottom, 9,000-gallon FRP tank. The storage tank includes a top-mounted, turbine-type, constant speed mixer (M-2) for the purpose of providing complete mixing of the tanks contents and for keeping any solids in suspension.

The storage tank is also equipped with an ultrasonic level indicator that monitors water level in the storage tank and sends a signal to the PLC. Low level (4.0 feet) in the tank shuts off the mixer to prevent potential damage. High level (10.0 feet) in the tank will shut off the manhole pumps, which will prevent them from pumping water to the storage tank and causing an overflow. High-high level (10.5 feet) in the tank sends an alarm to the MCP and to the PLC autodialer to notify the system operator of the excessively high water level condition in the tank.

A 3-inch-diameter gravity line bypass pipeline allows the contents of the storage tank to be discharged directly to the sanitary sewer. The bypass of the treatment system can ONLY be used if the contents of the tank have been analyzed and shown to meet all City of Appleton POTW discharge criteria.

Reaction Tank Feed Pump

The reaction tank feed pump (P-4) transfers groundwater from the storage tank (T-2) to the reaction tank (T-5) for treatment. The reaction tank feed pump is an air-operated, double diaphragm pump with an 86-gpm capacity. The reaction tank feed pump is sized to fill the reaction tank working volume (2,600 gallons) in 30 minutes. A command from the PLC activates the pump to fill the reaction tank. When the working volume is attained in the reaction tank, the pump is shut off. Low air pressure at the pump (below 60 psi) sends an

alarm to the MCP and to the PLC autodialer to notify the system operator of the low-pressure condition.

Reaction Tank

The reaction tank (T-5) is a 6,100-gallon FRP tank with a conical bottom. The conical bottom allows for collection and transfer of sludge. The volume of groundwater treated and discharged is 2,600 gallons each batch. The remaining tank volume below the discharge port is for sedimentation and solids storage, as well as for providing 2 feet of water above the interface with the settled solids to prevent turbulence and resulting entrainment of solids in the decant stream.

All chemical and physical processes for the treatment of total and hexavalent chromium occur in the reaction tank (T-5). The PLC automatically controls these process steps. The treatment steps are shown in Table 3-1.

TABLE 3-1
Batch Process Operation

Step in Cycle	Description	Estimated Time (min)
Decant	Treated water from the previous batch is discharged to the City of Appleton POTW. The discharge is controlled by the PLC which opens the electronic flow control valve on the discharge pipe. The flow valve opens only after BOTH of the following conditions are met: (1) the required settling time has been reached [minimum allowable settling time entered by the operator at the PLC data access screen], and (2) the groundwater storage tank is full and another batch of groundwater is ready for treatment. When the water level in the reaction tank drains down to the lowest discharge port, the PLC closes the flow control valve in preparation for the fill cycle. Since the decant step does not begin until the storage tank reaches a minimum of 4.0 ft, discharge to the POTW can occur less than once per day if the actual flows are less than the design average flow (2,600 gpd).	60-120
Fill	After the previously treated batch is discharged and the water in the storage tank hits the high level mark, the PLC commands the reaction tank feed pump to fill the reaction tank with water from the storage tank (T-2). When the reaction tank is full, the PLC shuts down the reaction tank feed pump.	30-700 (depends upon the reaction tank feed pump flow rate)
Ferrous Sulfate Addition	The PLC commands the ferrous sulfate metering pump to deliver the ferrous sulfate volume required to reduce hexavalent chromium to trivalent chromium. The PLC will calculate the required ferrous sulfate volume based on the operator input of ferrous sulfate and hexavalent chromium concentrations at the control screen. The PLC then starts the reaction tank mixer (M-5) (the speed and duration of the mixing are entered by the operator at the PLC data access module). The mixing time entered must be sufficient to ensure a complete reaction occurs.	15-30

TABLE 3-1
Batch Process Operation

Step in Cycle	Description	Estimated Time (min)
Caustic Addition	After the ferrous sulfate addition, the PLC commands the caustic feed pump to deliver sodium hydroxide into the reaction tank until the pH set-point (input by the operator at the PLC data access module) is maintained. The elevated pH will cause precipitation of ferric hydroxide and chromium hydroxide. The PLC also commands the mixer to run at the speed and duration input by operator at the PLC data access module. Caustic addition stops when the set-point pH is reached and maintained within the allowable time window. The pH is measured by a dual pH probe system that has an additional feature in which an alarm will be triggered if the differential reading between the two probes exceeds a value of 1.4. The alarm will shut down the batch treatment process and will signal the autodialer to notify the system operator of the failure. Also, if the pH does not reach the set-point within 5 minutes after the start of the caustic addition step, the batch process will shutdown and the operator will be notified of the failure by the autodialer.	15-30
Aeration	During the same time as the caustic addition step, the PLC will activate the air diffuser in the reaction tank by opening a flow control valve on the air compressor line. Aeration of the reaction tank contents will oxidize any excess ferrous (soluble) iron remaining after the hexavalent chromium reduction to ferric (insoluble) iron. The aeration will continue for the length of time input by the operator at the PLC data access module for the caustic addition step, after which the flow control valve on the air compressor line will close.	15-30
Flocculation	After the caustic addition/aeration step the mixer will slow to a flocculation speed for a set time period (speed and duration input by operator at the control screen). Flocculation is typically set for 20 to 30 minutes. The flocculation step causes the precipitates to agglomerate and thereby improves settling.	20-30
Settling	Once the flocculation is complete, the PLC shuts the mixer off and allows the suspended particles to settle out of the bulk liquid and into the sludge holding area at the bottom of the reaction tank. The operator inputs the settling duration at the control screen. The PLC will not discharge the treated batch any sooner than the settling period input by the operator even if the storage tank is full.	120-240
Sludge Withdrawal	Occasional removal of a portion of the reaction tank sludge is required. Excess sludge will build up over time in the bottom of the reaction tank. Excess sludge is pumped from the reaction tank to the sludge tank (T-14) using the sludge transfer pump (P-13). The minimum and maximum sludge levels (after complete settling) are marked on the side of the reaction tank. The settled sludge volume should be maintained between these two marks. The operator can enter into the PLC data access module the frequency (i.e.,	Operator Choice

TABLE 3-1
Batch Process Operation

Step in Cycle	Description	Estimated Time (min)
	after a how many batches) and the sludge pump operation time to transfer sludge to the sludge tank. The PLC will operate the sludge pump based on the entered data. The operator can also operate the sludge pump manually.	

The reaction tank has three 2-inch-diameter discharge pipes at different elevations on the side of the tank. The multiple discharge pipes allow for a distributed discharge of flow, thereby reducing turbulence. The turbulence is minimized to prevent solids that are contained in the lower portion of the reaction tank from being entrained in the discharge flow. Additional tank components include a variable speed mixer, an ultrasonic water level indicator, two pH probes, and an air diffuser.

Reaction Tank Mixer

The mixer is a top-mounted, variable speed, turbine-type mixer. The mixer has two main functions during the batch process. First, the mixer provides high speed mixing during chemical addition (ferrous sulfate and caustic) phases to completely mix chemicals with the tank contents. Second, the mixer provides low shear mixing for flocculation of the metal hydroxide precipitates. The operator can adjust the mixer speed for each step of the batch process at the PLC data access module. The mixer speeds are entered in the PLC data access module in terms of percent of maximum speed. If the mixer does not turn on (when commanded to by the PLC), the batch process is automatically shutdown and an alarm is sent to the autodialer to notify the system operator.

Reaction Tank Level Detector

The ultrasonic level detector measures the water level in the reaction tank and inputs the level to the PLC. The PLC uses the level information to control the batch operations (e.g., controlling the flow control valve during decant and the reaction tank feed pump during the reaction tank fill operation). High-high level (5,000 gallons) in the tank suspends the batch operation, activates an alarm at the MCP, and keys the autodialer to notify the system operator of the excessive water level condition in the tank.

Reaction Tank Air Diffuser

The air diffuser is used to supply air (oxygen) to the reaction tank to oxidize any remaining ferrous iron not used during the reduction of hexavalent chromium. The diffuser is a fine-bubble, membrane-type diffuser and has a normal operating flow of up to 8 standard cubic feet per minute (scfm). The membrane sleeves can be replaced as they become fouled over time. The PLC provides air to the diffuser by opening a flow control valve on the reaction tank air line from the air compressor. The amount of air delivered from the air compressor to the air diffuser can be adjusted by manually opening or closing the hand valve upstream of the flow control valve on the reaction tank air line from the compressor.

Reactor Tank pH Monitor

The reaction tank contains a dual probe pH monitor. The system measures and locally indicates pH concentration and inputs the signal to the PLC. The average of the pH signals from the two probes is used to control caustic feed in the batch operation. If the pH measurement deviation between the two probes is greater than 1.4, the PLC suspends batch operations, activates an alarm at the MCP and the keys the autodialer to notify the system operator. The pH in the reaction tank is continuously recorded, along with the effluent flow rate, using a 3/4-inch per hour, two-pen recorder.

Air Compressor

All compressed air supplied to the diaphragm pumps and reaction tank air diffuser is supplied by the plant air compressor (M-17). The rotary screw type compressor can supply 55 scfm of air at 125 pounds per square inch gauge (psig). Low air pressure at the compressor sends an alarm to the MCP, and the PLC keys the autodialer to notify the system operator.

Ferrous Sulfate Feed System

Ferrous sulfate is a chemical reducing agent used to reduce hexavalent chromium to trivalent chromium. The ferrous sulfate is fed in liquid form (15-25 percent ferrous sulfate heptahydrate by weight) to the reaction tank using the ferrous sulfate feed system. The feed system consists of a 55-gallon drum of ferrous sulfate, a calibration column, a chemical metering pump, and a nitrogen tank with associated valves and pressure gauges.

A chemical supplier provides the ferrous sulfate solution in a 55-gallon drum which is placed on a secondary containment pallet. The appropriate volume of ferrous sulfate is pumped to the reaction tank when commanded by the PLC. The PLC calculates the correct volume the after operator inputs the hexavalent chromium and ferrous sulfate concentrations at the control panel. A weight switch under the ferrous sulfate drum detects low down weight and signals the PLC, which suspends the batch operation and keys the autodialer to notify the system operator of the empty drum.

The ferrous sulfate chemical metering pump (P-9) is a positive displacement diaphragm pump with both manual and automatic modes of operation. The pump contains a five-function valve including pressure relief, back pressure, anti-siphon, air bleed, and discharge drain. The pump is designed to deliver 5.0 gph at 60 psig. The metering pump can be calibrated using the 1,000 ml calibration column, as described in the Chemical Metering Pump Calibration Section of this manual.

The nitrogen gas system provides a low pressure, inert, nitrogen blanket over the ferrous sulfate solution in the 55-gallon drum. The nitrogen blanket is used because the ferrous iron readily oxidizes to ferric iron when exposed to oxygen. A two-stage regulator supplies low pressure (2 to 3 psig) to the ferrous sulfate drum so it is always under a slight positive pressure. A back pressure release valve prevents the ferrous sulfate drum pressure from exceeding 3 psig.

Caustic Feed System

Caustic (50 percent sodium hydroxide by weight) is added during the batch operation in order to increase the pH for the precipitation reaction. The sodium hydroxide is fed to the reaction tank in liquid form using the caustic feed system. The feed system consists of a 55-gallon drum of caustic, a calibration column, and a chemical metering pump.

A chemical supplier provides the caustic in a 55-gallon drum which is placed on a secondary containment pallet. The appropriate volume of caustic is pumped to the reaction tank as commanded by the PLC. When the pH set-point (or higher) is maintained for the required time window, the caustic addition is stopped. The system operator enters the pH set-point (typically pH 8.5) in the control panel. The pH of 8.5 achieves the required conditions to promote effective chromium hydroxide precipitation while minimizing the excess sludge production observed at higher pHs.

A weight switch under the caustic drum detects low drum weight and signals the PLC, which suspends the batch operation and keys the autodialer to notify the system operator of the empty drum.

The chemical metering pump (P-8) is a positive displacement diaphragm pump with both manual and automatic modes of operation. The pump contains a five-function valve including pressure relief, back pressure, anti-siphon, air bleed, and discharge drain. The pump is designed to deliver 5.0 gph at 60 psig. The metering pump can be calibrated using the 1,000 ml calibration column, as described in the following section.

Chemical Metering Pump Calibration

Prior to operation, the ferrous sulfate chemical metering pump should be calibrated using the 1,000 ml calibration columns. The calibration column is filled by opening both the valve upstream of the calibration column (downstream of the 55-gallon drum) and the valve at the bottom of the calibration column. Once the column is full, the valve upstream of the calibration column is closed. The pump is then turned on and the time required to pump the volume out of the chemical calibration column, as well as the volume pumped (ml), is recorded. The flow rate can then be calculated in terms of ml/min. and converted to L/min. This value is required for entry into the PLC data access model for the calculation of ferrous sulfate addition. However, this value is not required for the caustic addition since the caustic addition step is pH dependent and not volume dependent.

Sludge Transfer Pump

The sludge transfer pump (P-13) is used to transfer sludge from the reaction tank (T-5) to the sludge tank (T-14). The pump can be operated automatically by the PLC or manually by the operator. In automatic mode, the operator inputs the frequency (i.e., transfer after how many batches of groundwater treated) and the sludge pump operation time required to transfer the required volume of sludge to the sludge tank at the PLC data access screen. The sludge transfer pump is an air-operated, double diaphragm pump designed to pump metal hydroxide sludge (1 to 2 percent by weight) at 4 to 12 gpm.

In the automatic mode, the pump will shutdown when the desired volume of sludge has transferred to the sludge tank. High level (6.75 feet) in sludge tank will prevent the sludge

transfer pump from pumping to prevent an overflow. The tank pump will be activated only after the level in the sludge tank has been drawn down (below 6.5 feet).

Sludge Tank

The sludge tank (T-14) is a 4,800-gallon tank used to store and thicken sludge transferred from the reaction tank. Because the sludge tank is part of the treatment process it is not considered a RCRA hazardous waste storage unit. Therefore the tank is not subject to RCRA disposal frequency requirements. When the sludge tank is full a tanker truck will collect the thickened sludge for transportation to an offsite disposal facility. The tank has a sloped bottom to facilitate sludge withdrawal during loading of the tanker truck. The tank can be mixed, but will primarily be operated with no mixing to promote sludge thickening and to reduce the cost of offsite disposal. In normal operation, the tank will receive sludge and supernatant will periodically be drained.

Multiple manual decant ports are installed on the side of the sludge tank to allow for draining off the supernatant as the sludge thickens. Supernatant drained from the tank flows by gravity to the building sump where it will be returned to the storage tank (T-2) prior to treatment in the reaction tank (T-5).

The tank also contains a constant speed mixer and an ultrasonic level meter. The mixer (M-14) is a top-mounted, turbine-type, constant speed mixer used during sludge transfer operations. The mixer will be turned on before pumping the sludge to a tanker in order to homogenize the tank contents and improve pumpability.

The ultrasonic level indicator monitors water level in the sludge tank and sends a signal to the PLC. High level (6.75 feet) in the tank will shut off the reaction tank sludge transfer pump to prevent an overflow. High level in the tank is input to the PLC which activates an alarm at the MCP and keys the autodialer to notify the system operator of the high sludge level condition in the tank.

Tanker Truck Feed Pump

The tanker truck feed pump (T-16) is used to transfer sludge from the sludge tank (T-14) to a tanker truck for offsite treatment and disposal. The hauling contractor and the treatment and disposal facility must be fully licensed and certified to handle the sludge since it could potentially contain high concentrations of chromium.

The sludge transfer pump is an air-operated, double diaphragm pump. It is designed to pump metal hydroxide sludge (2 to 10 percent by weight) at 10 to 70 gpm. The pump is not tied into the PLC and can only be operated manually. The transfer pump should be able to fill a standard tanker truck in about 1 hour.

The transfer pump is also hard-piped to feed metal hydroxide sludge from the sludge tank back to the reaction tank when additional sludge is required in the reaction tank to promote co-precipitation.

Building Sump System

The building sump (T-18) collects spills and water from the building floor drains and includes air compressor drainage, tank drainage and overflow, and tanker truck loadout

drainage. The building sump is an FRP tank with a 400-gallon capacity. Water collected in the sump is returned to the storage tank (T-2) prior to treatment. The building sump pump (P-18) has a capacity of 83 gpm.

Water level in the building sump is controlled by three ball float mercury switches. The high level (2.9 feet) switch activates the sump pump. The low level (0.75 feet) switch shuts off the sump pump. A high-high level (3.33 feet) switch in the sump sends an alarm to the MCP and to the PLC autodialer to notify the system operator of the excessively high water level condition in the sump. If water is collected in the sump faster than it can be pumped out, the sump contains a 4-inch overflow pipe to divert the flow by gravity to the groundwater collection trench at manhole No. 1.

Effluent Discharge Monitoring

At the end of the batch cycle, the treated water is discharged from the reaction tank (T-5) to the City of Appleton POTW. The effluent flow rate is continuously monitored by an electromagnetic flow meter. The electromagnetic flow meter is integrated to give total flow volume discharged from the facility. The total flow volume is indicated locally, while the flow rate is continuously recorded at the MCP. The flow rate is continuously recorded, along with the effluent pH, using a 3/4-inch per hour, two-pen recorder.

The PLC receives a high flow signal during the decant step of the batch process when the flow is greater than 175 gpm or when the flow rate is in excess of 2 gpm during non-decant periods (to monitor if flow is being discharged when it should not be discharged). The PLC commands the autodialer alert channel and activates an alarm at the MCP when high flow is detected.

In addition to the on-line monitoring described herein, Section 6 of this manual describes other compliance and process-related sampling and monitoring.

Instrumentation and Control

This section describes the interaction of the instrumentation, the automated control system, and the process equipment. The PLC data access module at the MCP monitors and automatically controls most of the treatment processes and equipment. Only the tanker truck transfer pump and the air compressor are locally controlled. The system is intended to provide continuous batch process treatment dependent upon the presence of adequate process water, treatment chemicals, a functioning compressed air system, and PLC program. All equipment, with the exception of the reaction tank mixer, can be controlled locally in manual mode if necessary. The MCP includes the following:

- Annunciators that indicate an upset in the system and identify the location or type of the failure
- A strip chart recorder that continuously records reaction tank pH (average of 2 measurements) and effluent flow rate
- Data access module
- Autodialer
- PLC system
- Uninterruptable Power Supply (UPS)

The MCP is equipped with an audible alarm that will sound if there is an upset in the process or a failure of monitored equipment. Specific annunciators are listed below.

Annunciators

The annunciators are LED type indicators which have dedicated windows or indicators for the following conditions:

- Manhole No. 1 Level HIGH-HIGH
- Manhole No. 2 Level HIGH-HIGH
- Storage Tank or Reaction Tank MIXER MALFUNCTION
- Storage Tank Level HIGH (alarm at 10.5 feet, reset at 10.25 feet) or LOSS-OF-ECHO
- Reaction Tank Volume HIGH (alarm at 5,000 gallons, reset at 4,975 gallons) or LOSS-OF-ECHO
- EXCESS pH DEVIATION between reaction tank pH meters (greater than 1.4)
- Caustic Supply LOW
- Ferrous Sulfate Supply LOW
- Discharge Valve FAIL (greater than 60 seconds to open or close)
- Effluent Flow Rate HIGH (greater than 175 gpm during decant) or LEAK (greater than 2.0 gpm during non-decant steps)
- Sludge Tank Level HIGH (alarm at 6.75 feet, reset at 6.5 feet) or LOSS-OF-ECHO
- Air Compressor Pressure LOW (below 60 psi)
- Building Sump Level HIGH-HIGH
- pH Did Not Reach Setpoint During Caustic Addition (within 5 minutes)
- PLC Failure

System Alarm Conditions

The PLC activates the autodialer alarm and the MCP audible alarm (if enabled) in response to a number of alarms that correspond to either a system shutdown or a system alert.

System Shutdown

A system shutdown halts the batch treatment operations until an operator acknowledges the alarm, addresses the alarm condition, and physically resets the MCP by pressing the RESET button on the MCP (below the PLC Data Access Module). The following alarm conditions correspond to a system shutdown:

- Reaction Tank MIXER MALFUNCTION
- Storage Tank Level HIGH (alarm at 10.5 feet, reset at 10.25 feet)
- Storage Tank Level Transmitter Failure (LOSS-OF-ECHO)
- Reaction Tank Volume HIGH (alarm at 5,000 gallons, reset at 4,975 gallons)
- Reaction Tank Level Transmitter Failure (LOSS-OF-ECHO)
- EXCESS pH DEVIATION between reaction tank pH meters (greater than 1.4)
- Caustic Supply LOW
- Ferrous Sulfate Supply LOW
- Discharge Valve FAIL (greater than 60 seconds to open or close)
- Air Compressor Pressure LOW (below 60 psi)
- pH Did Not Reach Setpoint During Caustic Addition (within 5 minutes)

- PLC Failure

System Alert

A system alert will not shutdown the batch treatment operations but will activate the autodialer alarm, the MCP audible alarm (if enabled), and the appropriate MCP annunciator. The following alarm conditions correspond to a system alert:

- Manhole No. 1 Level HIGH-HIGH
- Manhole No. 2 Level HIGH-HIGH
- Storage Tank MIXER MALFUNCTION
- Sludge Tank Level HIGH (alarm at 6.75 feet, reset at 6.5 feet)
- Sludge Tank Level Transmitter Failure (LOSS-OF-ECHO)
- Building Sump Level HIGH-HIGH
- Effluent Flow Rate HIGH (greater than 175 gpm during decant) or LEAK (greater than 2.0 gpm during non-decant steps)

Data Access Module

When in AUTOMATIC mode, the functions of the batch treatment system are controlled by the PLC. System variables (e.g., pH set-points, variable speed mixer settings, durations of batch events, etc.) required to control batch operations are entered by the system operator at the data access module. The batch system setpoints were programmed into the data access module by the operator and the batch system variables are output on the data access module screens as shown in Table 3-2.

TABLE 3-2
Data Access Module Screens

Keypad F1	Batch Reaction Times
Decant Time	75 min. (minimum)
Aeration Time	20 min. (minimum)
Flocculation Time	20 min. (minimum)
Settling Time	120 min. (minimum)
Sludge Transfer Time	1 min. (minimum)
Keypad F2	**Batch Reaction Setpoints**
Reactor Batch Volume Level	4,800 gal (~2600 gal batch size)
Chromium Concentration	X mg/L (hexavalent chromium concentration as determined by the *Hach* colormetric test kit on the storage tank influent sample)
pH setpoint	8.5 (default)
Batches per sludge transfer	25 (default)
Keypad F3	**Ferrous Sulfate Data**
Safety Factor	1.5 (default)
Ferrous Sulfate Specific Gravity	1.24 (Based on MSDS)
Ferrous Sulfate Concentration	15% (Based on MSDS)
Ferrous Sulfate Pumping Rate	0.200 L/min. (calibrated at pump)

Keypad F4	Mixer Speed Settings (in terms of percent of maximum speed)
Ferric Addition	95%
Caustic Addition	70%
Flocculation	35%

The data access module also functions to provide the following:

Keypad F6	Batch Process Instrument Readings
pH probe 1	S.U.
pH probe 2	S.U.
Reaction Tank Effluent Flow	gpm
Time Remaining in Each Batch Step	min.

Keypad F7	Additional Batch Process Instrument Readings
Reaction Tank Volume	gal
Storage Tank Level	feet
Sludge Tank Level	feet
No. of Batches remaining until sludge transfer	
Time Remaining in Each Batch Step	min.

Keypad F8	Allows User to Scroll Through Screens

Keypad F10	Enable/Disable Batch Process

Note: The keypad screen also alerts the operator if the system is disabled or shutdown with a flashing message box in each screen.

Switches

Manual operation of process equipment is accomplished with ON/OFF/AUTO and OPEN/CLOSE/AUTO type selector switches which function external to the PLC logic and allow plant operation in the event of a PLC failure. The PLC also provides inputs to an autodialer which will notify the system operator of a failure by phone or voice pager. The autodialer provides ALERT, SHUTDOWN, SAFETY, and PLC FAIL messages depending on type of system failure. The PLC has a "watch-dog timer" circuit to detect failure of the PLC program execution.

The control system activates an audible alarm to notify the operator of a alarm condition when the facility is manned and the alarm horn enabled. An ENABLE/DISABLE switch at the entry door allows the operator to turn off the audible alarm when the facility is unattended.

Autodialer

The autodialer phone number is (414) 991-9412. By dialing this number the operator can determine which alarm condition exists by listening to the computer generated voice response and acknowledge that alarm condition by pressing 555. If the alarm is not acknowledged, the autodialer will continue dialing the list of phone numbers until an operator responds. The list of phone numbers that can be entered into the autodialer system can be as high as eight phone numbers and up to 32 digits for each number.

Future Modifications

The groundwater treatment facility is currently designed to operate based on the groundwater quality and flow information collected during remedial design activities. Some extra features have been included to allow for modification of the system in the future. These features include:

- Extra ports on the tanks
- A port for future direct discharge to the sanitary sewer (see Figure 3-3)
- A port for future addition of outside waste to the storage tank (see Figure 3-4)

The last two items were included in the facility layout to allow water from other locations be handled at this facility. Water can be brought by tanker to the site and input into the system from the truck bay. This would require a hole in the interior wall to accommodate additional piping into the facility. This hole could be located anywhere in the masonry wall.

In addition to the above features, the option for future onsite sludge dewatering was discussed during the planning stages of the wastewater treatment facility. If it is later determined that onsite sludge dewatering is necessary and cost effective, dewatering equipment could be installed in the truck bay. The sludge is currently piped from the sludge transfer pump to a quick disconnect located in the truck bay. This piping could be modified to direct the sludge to the dewatering equipment.

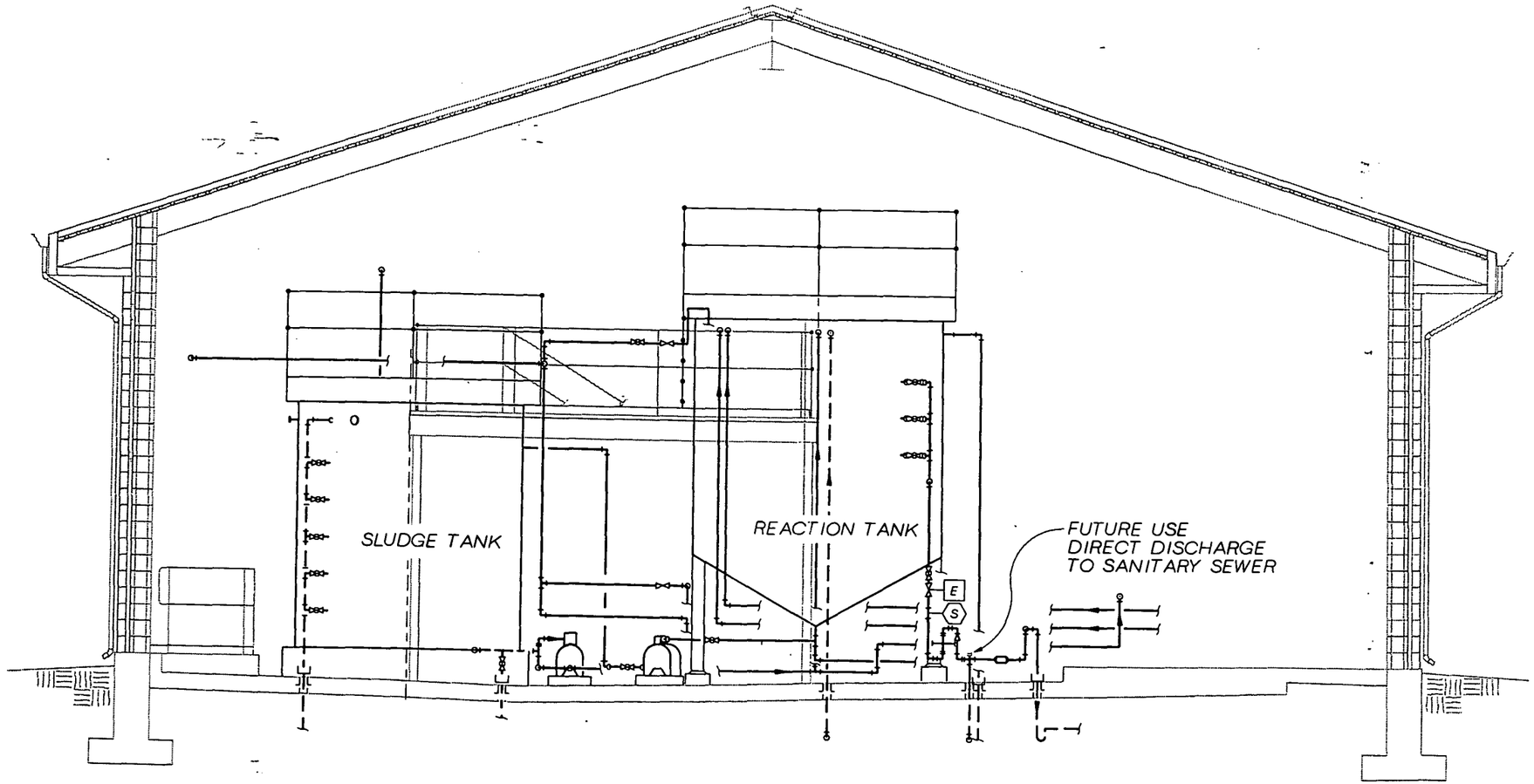


FIGURE 3-3
FUTURE SEWER DISCHARGE
N.W. MAUTHE SITE
APPLETON, WISCONSIN

CH2M HILL

11-FEB-1997
I: 104200/DRAWINGS/FIGURES/FIG3-4.DGN

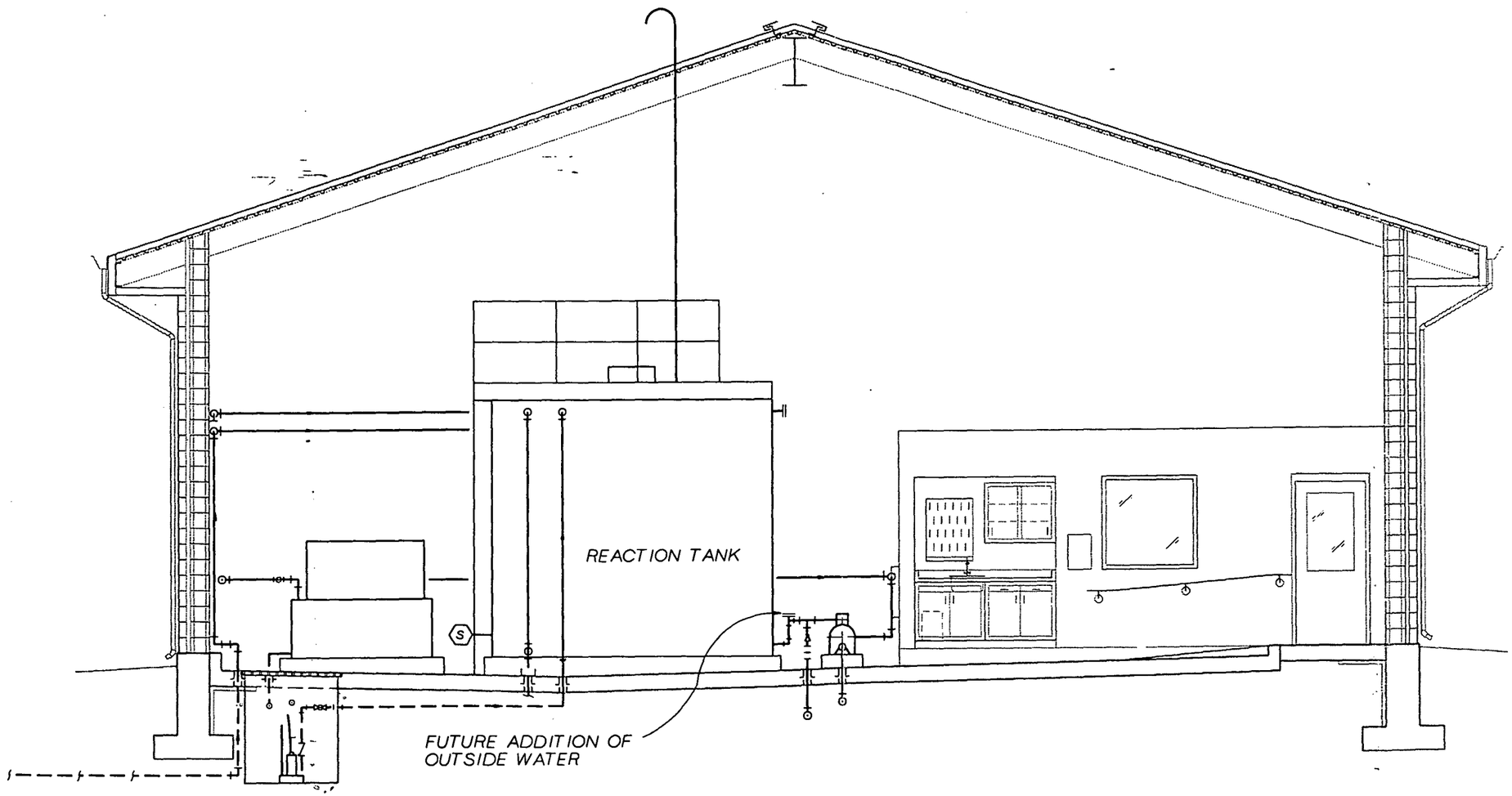


FIGURE 3-4
FUTURE WATER ADDITION
N.W. MAUTHE SITE
APPLETON, WISCONSIN

CH2MHILL

SECTION 4

Plant Startup and Shutdown

Introduction

This section provides the following information:

- Instructions on plant startup and shutdown
- Trouble shooting instructions in the event of a shutdown

Process Startup

The following instructions are provided for starting and operating the groundwater collection and treatment system. However, the automated batch process cycle will not start operation until the storage tank (T-2) is full of water.

1. Check that all breakers are energized at the motor control center (MCC)
2. Check that all local motor switches are in AUTO
3. Check that all drain and bypass valves for the tanks and process equipment are closed
4. Open the following valves shown below:

    - Storage tank discharge valves (two)
    - Reaction tank feed pump discharge valve
    - Reaction tank discharge valves (three discharge lines)
    - Flow control valve (precedes electronic flow valve)
    - Caustic feed line (two valves after tank and one after pump)
    - Ferrous sulfate feed line (two valves after tank and one after pump)
    - Nitrogen tank supply valve

5. Input the batch process variables at the PLC data access module (as shown in Table 4-1):

TABLE 4-1
Default Settings for Process Variables

Process variable	Default setting
Time period allowed for decant step	75 min.
Time period for aeration/caustic addition step	20 min.
Time period for flocculation step	20 min.
Time period for settling step	120 min.
Time of sludge pump operation for each sludge transfer (if using AUTO mode for sludge transfer).	1 min.
Reactor batch volume level	4800 gal.
Groundwater hexavalent chromium concentration for ferrous sulfate addition step (based on *Hach* Kit Test Results)	3.0 mg/L
pH setpoint for caustic addition step	8.5
Frequency for sludge transfers (if using AUTO mode for sludge transfer)	25 batches
Ferrous sulfate safety factor	2.0
Ferrous sulfate specific gravity (based on MSDS)	1.24
Ferrous sulfate feed concentration (as Fe^{2+}) for ferrous sulfate addition step (based on MSDS)	15%
Ferrous Sulfate Pump Rate (based on calibration column)	200 L/min.
Reaction tank mixer (M-5) speed for ferrous sulfate addition step	95%
Reaction tank mixer (M-5) speed for caustic addition step	70%
Reaction tank mixer (M-5) speed for flocculation step	35%

6. Inspect the nitrogen cylinder pressure, caustic tank, and ferrous sulfate tank levels to ensure they have adequate supply. Inspect the ferrous sulfate solution for signs of oxidation (reddish-brown coloration). Replace with a fresh batch of ferrous sulfate if oxidized by ordering and installing a new tank. Calibrate the caustic and ferrous sulfate feed pumps, if necessary. Refer to the feed pump manufacturer's O&M manual for calibration procedures.

7. Turn on and calibrate reaction tank pH meter after cleaning pH probes.

8. Turn on the plant air compressor at the local ON/OFF switch. Verify that the compressor is on by checking the pressure indicator on the compressor panel. The pressure should be nominally 80 to 110 psig.

9. Verify that the pH/discharge flow rate recorder at the MCP are on (should be on at all times). Visually inspect recorder to determine proper operation.

10. Place the following in AUTO mode at the local control location:

    - Building sump pump (P-18)
    - Reaction tank feed pump (P-4)
    - Caustic feed pump (P-8)
    - Ferrous sulfate feed pump (P-9)
    - Storage tank mixer (M-14)
    - Reaction tank mixer (M-5)
    - Electronic flow control valve (FV-10)

11. Start the batch process using the F10 ENABLE/DISABLE BATCH PROCESS keypad command at the data access module. The manhole pumps will not run unless (1) the level in the manhole is high enough to call the pump ON, and (2) the storage tank has available capacity. The reaction tank feed pump will not start until (1) the level in the storage tank is high enough to activate the HIGH level switch, and (2) the decant step from the previous batch is complete.

Plant Shutdown

Short-Term Routine Shutdown

A short-term routine shutdown (no more than 3 to 4 days) is for minor repair or replacement of minor equipment or other events that will cause short-term interruption of the process. For short-term routine shut down:

1. Shut off the batch process mode at the PLC data access module (Keypad F10).

2. Turn off the manhole pumps and reaction tank feed pump at the MCP. Lock out the pumps.

3. Turn off the storage tank and reaction tank mixers at the MCP. Lock out the mixers.

4. Turn off the caustic feed pump and the ferrous sulfate feed pump using the local ON/OFF switches at the pumps.

Long-Term Shutdown

A long-term shutdown (more than 3 to 4 days) is for major repair of equipment. A long-term shutdown would include any repair that necessitates draining of a tank or other repair that will take equipment out of service for more than a few hours. The following steps should be completed for a long-term shutdown.

1. Stop the batch operation command at the PLC (Keypad F10).

2. Turn off the Manhole Nos. 1 and 2 pumps at the MCP. Lock out the pumps.

3. Turn off the reaction tank feed pump at the MCP. Lock out the pump.

4. Turn off the building sump pump at the MCP. Lock out the pump.

5. Turn off the storage tank mixer, the reaction tank mixer and the sludge tank mixer at the MCP. Lock out the mixers.

6. Turn off the plant air compressor and release the excess pressure in the compressor tank according to manufacturer recommendations.

7. Turn off the caustic feed and ferrous sulfate feed pumps using the local ON/OFF switches at the pumps.

8. Close the valves on the caustic tank, ferrous sulfate tank feed lines.

9. If the storage tank needs to be drained, open the storage tank drain valve. This water will flow to the building sump. Since the building sump pump is turned off, the water will flow out the building sump overflow to manhole No. 1 (West Trench). Please note that if the building sump is not turned off, the water will be recirculated back to the storage tank.

10. If the reaction tank needs to be drained and treatment of the batch has been completed, drain the contents to the sanitary sewer down to the level of the lowest effluent decant port. Using the sludge transfer pump, transfer the remaining contents of the tank to the sludge tank. Decant supernatant off of the sludge in the sludge tank as required. If the sludge tank is near full, call the sludge disposal contractor for pickup.

If the reaction tank needs to be drained and the batch has NOT been treated, open the reaction tank drain valve. This water will flow to the building sump. In this instance, the building sump should be energized, and the reaction tank contents will be returned to the storage tank. The purpose of sending the reaction tank contents back to the storage tank is to avoid returning solids to the trench. If this is not possible, the contents will flow out of the building sump to manhole No. 1.

Emergency Shutdown

The annunciators indicate potential problems in the treatment system. Some problems will trigger automatic shutdown of the entire system. When a problem is suspected or the alarm on the control panel is on, the operator should first assess the problem by determining what annunciator lights are on. The batch treatment operation will be shutdown automatically for the following reasons:

- Reaction Tank MIXER MALFUNCTION
- Storage Tank Level HIGH (alarm at 10.5 feet, reset at 10.25 feet)
- Storage Tank Level Transmitter Failure (LOSS-OF-ECHO)
- Reaction Tank Volume HIGH (alarm at 5000 gallons, reset at 4975 gallons)
- Reaction Tank Level Transmitter Failure (LOSS-OF-ECHO)
- EXCESS pH DEVIATION between reaction tank pH meters (greater than 1.4)
- Caustic Supply LOW
- Ferrous Sulfate Supply LOW
- Discharge Valve FAIL (greater than 60 seconds to open or close)
- Air Compressor Pressure LOW (below 60 psi)
- pH Did Not Reach Setpoint During Caustic Addition (within 5 minutes)

- PLC Failure

Troubleshooting

HIGH-HIGH Level in the Manhole(s)

HIGH-HIGH level in one or both of the manhole(s) indicates water is not being pumped to the storage tank.

Operator response should include the following actions:

- Verify that batch operations have been enabled.
- Confirm that the level float switch(es) are operating correctly and that the water level is high enough to ensure that the level floats switch(es) are submerged.
- Verify the level in the storage tank is not HIGH (manhole pumps will not pump if storage tank is HIGH). Make sure level indication is accurate. If it is, treat batches to bring down the level of the storage tank. AUTO operation will continually treat batches as long as water is available in the storage tank.
- Verify that the valve(s) on the discharge side of the pump(s) (P-1-2 and P-1-2) is open.
- Verify that the manhole pump(s) is turned on and have power.
- Verify that the pumps are functioning properly.
- Verify that the effluent lines are not plugged with debris.

Air Diffuser System Failure

Loss of air flow to the air diffuser during batch operations will result in the failure of the system to oxidize excess ferrous (soluble) iron. Loss of air flow to the air diffuser may be noticed by lack of bubbles rising to the surface of the reaction tank.

Operator Response should include the following actions:

- Check that the air compressor is on. Check that the air compressor supply tank is at the proper pressure. If the air compressor is malfunctioning, contact the vendor for repair.
- Check that the isolation valve prior to the air flow valve (FV-6) is open.
- Check that the air flow valve (FV-6) is functional using the local control switch at the valve location.
- If the air compressor and air flow valve are functional, check the condition of the membrane on the diffuser head. If the membrane is fouled with precipitate, replace the membrane.

Hexavalent Chromium Exceeds Effluent Limits

If the hexavalent chromium in the system effluent is near or above effluent limits (based on the field *Hach* kit analysis), there is likely insufficient ferrous sulfate reduction. It is critical that the problem be corrected immediately to maintain compliance with the permit.

Operator Response should include the following actions:

- Inspect the ferrous sulfate feed pump to verify that it is on and working properly.
- Inspect the ferrous sulfate discharge lines to make sure the valves are open.
- Inspect the ferrous sulfate storage tank to make sure it is not empty.
- Check the local control switch to make sure the ferrous sulfate pump is in RUN mode.
- Check the data access module to make sure the hexavalent chromium concentration, the ferrous sulfate concentration and the dosing safety factor variables for the batch process have been input correctly.
- Inspect the contents of the ferrous sulfate storage tank to make sure the chemical has not oxidized. The ferrous sulfate is a clear, green liquid when in good condition. If the ferrous sulfate oxidizes, it will become reddish brown due to the presence of ferric iron. If the chemical has become oxidized, order a new batch immediately and suspend operations until the new chemical is online. Also, inspect the nitrogen blanket system to ensure that it is functioning properly and has sufficient nitrogen. If the ferrous sulfate has oxidized, it is likely that the nitrogen system is not working properly.
- Reanalyze the hexavalent chromium concentration in the storage tank to make sure it is not higher that originally estimated. If it is higher, reenter the hexavalent chromium concentration in the PLC.
- The operator may want to perform batch testing to confirm the required ferrous sulfate dosage. A brief outline of jar testing procedures in found in Appendix D.

High Effluent Solids

High effluent solids indicates a failure in the flocculation or sedimentation steps of the batch process. High effluent solids in the discharge is unacceptable because the solids may contain chromium which could result in exceedance of discharge limits.

Operator response should include the following actions:

- Check the PLC variable inputs for the proper settings for flocculation time, mixer flocculation speed, and minimum settling time.
- Verify that all three discharge port valves on the reaction tank are open.
- Observe the volume of seed sludge at the bottom of the reaction tank. If the level is too high (as marked on the tank), waste the excess sludge to the sludge tank. If the sludge level is too low, re-seed with sludge from the storage tank (to promote co-precipitation and improved settling characteristics of the sludge). Please note that the sludge level in the reaction tank should always be maintained at least 2 feet below the lowest effluent decant port.
- Observe the mixer speed during the flocculation step. High speed mixing may be shearing the floc which could result in poor settling. If high mixer speed is causing shear of the floc, reduce the mixer speed during the flocculation step.

- Increase the minimum settling time if it appears that the solids do not settle below the decant ports before discharge begins.

Building Sump Overflow

If the water level in the building sump reaches the level at which the water is flowing through the overflow pipe (to manhole No. 1), the cause would most likely be the failure of the sump pump, blockage of the effluent line, too high an inflow, malfunction of the storage tank level transmitter, storage tank overflowing to building sump, or plugged pump suction strainer.

Operator response should include the following actions:

- Visually inspect the discharge pipe to the storage tank to verify that it has not been blocked.
- Check the sump pump power circuit for signs of overload. Attempt to restart the sump pump from the local control panel.
- Check the sump pump suction strainer
- Check the storage tank, if the storage tank is overflowing back to the building sump, treat batches to bring down the level of the storage tank. AUTO operation will continually treat batches as long as water is available in the storage tank.

SECTION 5

Routine Process Operations and Inspections

Under normal operating conditions, inspections/monitoring must be performed daily or weekly to assess system operation. These operations are discussed below. Log sheets used to record normal operations of the plant are provided in Appendix C.

Manhole Nos. 1 and 2

Weekly

Lift each manhole cover and observe the appearance (e.g., depth, color, and clarity) of the water, and the condition of the pump and the level floats.

Storage Tank

As Necessary

Open the hatch on top of the tank and, using a flashlight, observe and record the appearance of the water in the tank. Also, inspect the condition of the mixer and the ultrasonic level meter.

Reaction Tank

Daily or During Each Discharge Event

- Inspect the operation of the discharge flow meter and recorder to ensure they are operating properly, record the total flow value from the flow totalizer.
- Record the pressure at the nitrogen tank (both tank pressure and discharge pressure) at the two stage regulators. If the tank pressure is getting low, order a new supply. If the discharge pressure exceeds 3 psi, adjust the regulator back to 2 psi. Observe the ferrous sulfate storage tank for excessive pressure or nitrogen leaks.

Weekly

- Check the condition of the reaction tank feed pump, record the reaction tank feed pump operating pressure.
- Clean both pH probes and calibrate the pH meter.
- Check the condition/color of the ferrous sulfate solution.
- Record the sludge depth at the edge of the reaction tank. If the sludge level is in excess of that desired for co-precipitation, waste the appropriate volume of sludge to the sludge tank.

If it is less than desired, modify the sludge wasting variables to decrease the amount of sludge wasted.

- Record the level of caustic sodium hydroxide in the Caustic Tank. When the Caustic Tank is 3/4 empty, order a new supply.
- Record the level of ferrous sulfate in the Ferrous Sulfate Tank. When the Ferrous Sulfate Tank is 3/4 empty, order a new supply. Observe the ferrous sulfate for signs of oxidation. The ferrous sulfate is a clear, greenish liquid. If the liquid becomes brownish, it has been oxidized and replacement is necessary.

As Necessary

- Inspect the condition of the air diffuser membrane. If the membrane is excessively fouled so as to inhibit efficient diffusion replace the membrane.
- Inspect the condition and operation of the mixer and the ultrasonic level meter.
- Calibrate and observe the condition of the caustic and ferrous sulfate feed pumps.

Sludge Tank

As Necessary

- Check the condition and operating pressure of the tanker truck feed pump.
- Record the volume of sludge in the sludge tank. If the supernatant level above the sludge is significant, drain it off using the decant ports on the sides of the sludge tank. If the tank is getting close to full, schedule a pickup for offsite treatment and disposal (see Performance Monitoring Requirements in Section 6).

Routine Inspection/Maintenance

For each piece of equipment, develop a maintenance schedule summary. Refer to manufacturers' O&M manuals for guidance.

SECTION 6

Permit Limits, Monitoring, and Reporting

The City of Appleton POTW Industrial User Permit (Permit No. 97-21) requires monitoring of the treatment system effluent and reporting in order to verify compliance. The POTW has designated the treatment system discharge as Outfall 001. Outfall 001 enters the City sewer at Manhole 30-14 on Melvin Street, between the intersections of Douglas Street and Outagamie Street.

This section presents the regulatory monitoring and reporting requirements for the system under the pretreatment permit received in 1996 prior to startup. Please note that regulatory requirements may change over time and that the operator is responsible for periodically reviewing the permit to ensure that monitoring and reporting requirements have not changed relative to the regulatory requirements in place at the time this manual was written.

Permit Limits

Permit discharge limitations for Outfall 001 (from Part 1 of the permit) are listed on Table 6-1. The system operator must read and understand the permit because it contains additional information not necessarily covered in this manual. Only local limits, not categorical limits, apply to the discharge since it is for groundwater remediation and the site is not an active production facility.

TABLE 6-1
Outfall 001 Effluent Limitations
Per City of Appleton POTW Limits for Permit No. 97-21

Parameter (units)	Daily Maximum Limit
pH (standard units)	5.0 to 12.4 (required range during discharge)
Aluminum, total (mg/L)	70.0
Arsenic, total (mg/L)	1.0
Cadmium, total (mg/L)	0.3
Chromium, total (mg/L)	7.0
Chromium, hexavalent (mg/L)	4.5
Copper, total (mg/L)	3.5
Cyanide, total (mg/L)	1.0
Lead, total (mg/L)	2.0
Mercury, total (µ/L)	2.0 *micrograms/L*
Nickel, total (mg/L)	2.0
Zinc, total (mg/L)	10.0

The discharge from Outfall 001 shall comply with Sections 20-81 and 20-83, Chapter 20, Utilities; and Part 5—PROHIBITIONS contained in the Industrial User Permit (No. 97-21)

Additional discharge prohibitions are listed in Part 5 of the Industrial User Permit. The basic categories of the prohibitions include:

- General Prohibitions (Pass Through and Interference)
- Specific Prohibitions (fire, explosion hazard, corrosivity, temperature, oil, toxics, odor, radioactive wastes, medical wastes, etc.)
- Dilution Prohibition
- Bypass Prohibition

The system operator should be familiar with these prohibitions to ensure compliance.

Monitoring

Monitoring the treatment system includes periodic sampling and analysis of the treated effluent. Monitoring of the treatment system is done to (1) verify compliance with the Industrial User Permit limits, and (2) assess the ongoing performance of the process equipment. This section is divided into compliance monitoring and performance monitoring.

Compliance Monitoring

Compliance monitoring requirements are listed in Part 2 of the Industrial User permit. Table 6-2 lists the parameters that must be sampled along with their required sampling frequency and analytical method. Monitoring will consist of collecting effluent samples for onsite and offsite analysis. The effluent discharge sampling port is shown on the P&ID

Onsite analysis includes collecting an effluent sample for each discharge event. The effluent samples are analyzed for hexavalent chromium using the onsite *Hach* colorimetric test kit. Onsite analyses will be performed by the system operator.

Offsite analyses include collecting effluent samples for all other parameters, as shown in Table 6-2. The offsite analyses will be completed by an offsite laboratory. The laboratory must be certified by the WDNR. The POTW will also perform sampling and analysis at the site twice per year for verification of the permittee's results. Specific monitoring requirements listed in the permit include the following:

- Monitoring shall represent production activities and discharges normally occurring during the reporting period.
- All equipment used for sampling and analysis must be routinely calibrated, inspected, and maintained to ensure their accuracy. Monitoring points shall not be changed without notification to or the approval of the Director of Utilities.
- All handling and preservation of collected samples and laboratory analyses of samples shall be performed in accordance with 40 CFR part 136, Table II or Ch. NR 219, Wis. Admin. Code unless other sampling and analytical techniques are approved by the Department of Natural Resources and specified in the monitoring conditions of this permit.
- All laboratory analyses of all required monitoring shall be performed in accordance with procedures and techniques set forth in 40 CFR part 136. Alternatively, laboratory

analyses shall be performed by laboratories certified by the WDNR under Ch. NR 149, Wisconsin Administrative Code.

- The permittee shall measure pH continuously when required by the Director of Utilities. When pH is measured otherwise, the permittee shall use either a portable pH meter or a grab sample free of acidic or alkaline preservatives. A minimum of four grab samples must be used for pH.

Performance Monitoring

Consistent monitoring of the treatment process is required to collect information that is used to optimize system performance. Efficient system performance is required for compliance with the permit limits, and will also reduce operation and maintenance costs. Onsite testing of the system will be done by the system operator.

The onsite laboratory equipment includes a *Hach* colorimetric test kit for hexavalent chromium field analysis. Also included is a total suspended solids (TSS) apparatus, oven, and scale for analysis of suspended solids concentrations and sludge percent solids. Operating instructions are supplied for each piece of equipment and should be consulted for equipment use and calibration. Log sheets should be used for recording sample results and kept onsite. A master copy of each log sheet can be found in Appendix C.

Performance monitoring for the treatment system includes periodically collecting an influent sample (collected at the storage tank) and an effluent sample (collected at the discharge from the reaction tank). Samples should be analyzed for hexavalent chromium and TSS. Also, the appearance (e.g., color, transparency, solids content) should be observed and recorded.

The sludge generated and stored in the sludge tank will also require analysis prior to offsite disposal. The company contracted to treat and dispose of the metal hydroxide sludge will require a Toxicity Characteristic Leaching Procedure (TCLP) analysis of the sludge and a percent solids analysis. Further tests of the sludge will depend on the requirements of the disposal company. Appropriate manifests for transportation and disposal of sludge will be required. Manifests should be signed by a CH2M HILL employee on behalf of the USEPA. Sludge management activities shall be performed in accordance with all applicable state and federal requirements

TABLE 6-2
Effluent Monitoring Requirements for Outfall 001
Per City of Appleton POTW Permit No. 97-21

Sample Parameter (units)	Sample Frequency	Sample Type	Analytical Method[1]
Process Compliance Parameters			
Flow (gpd)	Continuous	Meter[2]	
pH[3]	Continuous	Meter	
Chromium, hexavalent (mg/L)	During discharge	Grab	*Hach* Test Kit

TABLE 6-2
Effluent Monitoring Requirements for Outfall 001
Per City of Appleton POTW Permit No. 97-21

Sample Parameter (units)	Sample Frequency	Sample Type	Analytical Method[1]
Chromium, total (mg/L)	1/quarter	FPC[4]	200.7, 218.1, 218.2 or 218.3
Local Limit Compliance Parameters[5]			
Aluminum, total (mg/L)	1/year	FPC[4]	200.7, or 202.2
Arsenic, total (mg/L)	1/year	FPC[4]	206.2, 206.3, 206.4, or 206.5
Cadmium, total (mg/L)	1/year	FPC[4]	200.7, 213.1, or 213.2
Chromium, total (mg/L)	1/year	FPC[4]	200.7, 218.1, 218.2, or 218.3
Chromium, hexavalent (mg/L)	1/year	FPC[4]	218.4
Copper, total (mg/L)	1/year	FPC[4]	200.7, 220.1, or 220.2
Cyanide, total (mg/L)	1/year	Grab[6]	335.2
Lead, total (mg/L)	1/year	FPC[4]	200.7, 239.1 or 239.2
Mercury, total (µ/L) *micrograms/L*	1/year	FPC[4]	245.1 or 245.2
Nickel, total (mg/L)	1/year	FPC[4]	200.7, 249.1, or 249.2
Zinc, total (mg/L)	1/year	FPC[4]	200.7, 289.1, or 289.2

[1]These analytical methods are set forth in 40 CFR Part 136 or references cited in that regulation.
[2]Discharge flows are to be recorded from the permittee's flow meter. This data will be submitted quarterly to the Pretreatment Coordinator. The flow meter shall be calibrated annually to ensure its accuracy.
[3]Discharge high, low, and average pH values will be recorded, with any excursions beyond the limits set in the permit noted with an explanation of the cause of the excursion. This data will be submitted quarterly to the Pretreatment Coordinator.
[4]Flow Proportional Composite (FPC): the Director of Utilities may waive flow proportional composite sampling techniques for the permittee that demonstrates that flow proportional composite sampling is unfeasible. In such cases time proportional or grab sampling my be used.
[5]The permittee shall monitor at least once during the period January 1 through June 30 for the pollutants listed in Part 1, Section C of the permit. Pollutants monitored under the Process Compliance Parameters listed in the table above need not be resampled separately to verify compliance with Local Limits (i.e., Chromium, total is tested quarterly during the year and this will satisfy compliance with the 1/year Local Limit testing). The remaining pollutants not routinely monitored under the Process Compliance Parameters will have to be sampled to verify compliance with the Local Limit Compliance Parameters. The monitoring report is due July 15.
[6]At least four (4) grab samples must be used for pH and cyanide.

Reporting

Quarterly compliance reports must be submitted to the POTW summarizing the monitoring results (April 15, October 15, July 15 and January 15). The monitoring results must be reported to the POTW on the schedule shown in Table 6-3. Please note that these conditions may change over time, and the operator is responsible for periodically reviewing the permit

to ensure that monitoring and reporting requirements have not changed relative to the regulatory requirements in place at the time this manual was written.

TABLE 6-3
Annual Reporting Schedule for Outfall 001
Per City of Appleton POTW Permit No. 97-21

Report Submittal Date	Monitor Event Type	Parameters to be Monitored	Sample Period
April 15	Quarter 1–Process Compliance	Flow, pH, hexavalent chromium, total chromium	January 1 to March 31
July 15	Quarter 2—Process Compliance	Flow, pH, hexavalent chromium, total chromium	April 1 to June 30
July 15	Annual Local Limits	All local limit parameters	January 1 to June 30
October 15	Quarter 3–Process Compliance	Flow, pH, hexavalent chromium, total chromium	July 1 to September 30
January 15	Quarter 4–Process Compliance	Flow, pH, hexavalent chromium, total chromium	October 1 to December 31

The annual local limits are submitted with the July 15 quarterly report.

Required items for the report and the reporting address are discussed in Industrial User Permit, Part 4, items G through K. The report should include a cover letter, records of the sampling and analysis, a biannual flow meter calibration report, and a signatory statement. Copies of all analytical data and compliance reports must be kept onsite for at least 3 years. This period may be extended by request of the Director of Utilities.

Additional POTW reporting requirements are necessary for other events. The operator must read and understand the permit and be aware of all required reporting situations. Some of the additional events that require reporting include:

- **Report of Violation and Resampling.** Required if the permittee's wastewater analysis indicates that a violation of the permit has occurred. The permittee must (1) inform the Director of Utilities within 24 hours of the violation; and (2) repeat the sampling and analysis, and submit a report within 30 days of the first violation.

- **Report of Upsets, Spills, Slugs, and Other Emergencies.** The permittee shall notify the Director of Utilities immediately of an upset, spill, or other slug that has a reasonable potential to cause a violation of a pretreatment standard or has the potential to upset the POTW. The report shall contain the location, time, and date of the incident; the character and volume of the discharge; and the containment or corrective action taken by the permittee. Within 5 days of the report required above, the user shall submit a written report to the Director of Utilities describing the cause of the discharge, the duration of the discharge, and the measures to be taken to prevent similar discharges in the future.

- **Report of Changed Discharge.** The permittee shall promptly notify the Director of Utilities in advance of any substantial change in the volume or character of pollutants in

its discharge, including the listed or characteristic hazardous wastes for which the permittee has submitted initial notification.

- **Report of a Hazardous Waste Discharge.** See the Industrial User Permit, Part 4, item F for a complete description.

State and Federal Reporting Requirements

Monitoring and Reporting Requirements

Monitoring and reporting requirements for the pretreatment facility are established by the City of Appleton POTW in accordance with Federal reporting requirements addressed by 40 CFR Part 403.12 and State reporting requirements addressed by Wisconsin Administrative Code NR211.15. Sludge disposal should be performed and reported in accordance with all applicable state and federal regulations including NR211 and 40 CFR Parts 503 and 270.

Spills and Releases

The building sump collects spills and water from the building floor drains and includes air compressor drainage, tank drainage and overflow, tanker truck loadout drainage, and treatment process chemical spills. The building sump is an FRP tank with a 400-gallon capacity. Water collected in the sump is returned to the storage tank (T-2) prior to treatment. The building sump pump has a capacity of 83 gpm. If there is an uncontrolled release of hazardous waste or contaminated groundwater into the environment, the United States Environmental Protection Agency (USEPA) should be notified according to 40 CFR Part 403.12 and the Wisconsin Department of Natural Resources (WDNR) should be notified according to Wisconsin Administrative Code NR211.15.

SECTION 7

General Facility Information

The building is designed to adequately house the process equipment for the treatment system and to provide space for associated activities. This section describes the facilities. Information on facility maintenance should be obtained from the supplied maintenance manuals.

Heating, Ventilation, and Air Conditioning

The process building is heated with natural gas. Seven gas fired, ceiling-mounted unit heaters heat the building. Each heater is controlled by its own thermostat. An exhaust fan at the apex of the west wall of the building is used to ventilate the process building. Air dampers on the north and south walls of the building provide intake air as needed when the exhaust fan is operating. Ceiling fans are mounted around the process building to reduce thermal stratification. A wall-mounted air conditioner in the control room cools the office and control room. A small exhaust fan in the bathroom is designed to go on automatically when the lights are turned on. For a more detailed description of the heating, ventilating, and cooling (HVAC) system, the operator should consult the equipment manuals.

Electrical Supply

The building is supplied with 3-phase, 480-volt power. The electricity enters the building in the control room. A transformer steps down the voltage to 110 or 220 volts, depending on what voltage is needed.

Water Supply

Potable water is piped from the local water utility. Potable water is supplied to the bathroom sink and toilet, the laboratory sink, the safety shower, the water heater, and three hose bibs. The hose bibs are located at the reaction tank platform, in the tanker truck loading area, and next to the caustic feed system. The hose bibs can be used for general plant cleaning of floors and process equipment.

Sewage

All sewage from the toilet and sinks in the lavatory and laboratory drains to the City of Appleton POTW sanitary sewer. The sanitary wastes combine with the treatment system effluent at a pipe intersection under the floor of the treatment building after the final process monitoring point.

General Maintenance

General maintenance such as snow removal, grass cutting, cleaning, and site security will be the responsibility of the plant operator to perform or coordinate, unless otherwise contracted by the Wisconsin DNR.

SECTION 8

Plant Safety

Plant personnel are responsible for acquainting themselves with safety hazards and taking steps to eliminate them. This section on safety is intended to highlight significant plant safety issues and provide resources that supply more detailed information. Thus this section is intended to be used as a guide for accessing other safety manuals and resources. This section is not to be considered a comprehensive safety manual for the plant operation.

An effective safety program is the responsibility of everyone involved in the plant operation. The plant operating personnel are responsible for:

- Reading the reference material on safety
- Observing safety precautions
- Knowing and understanding safety precautions
- Knowing how to use safety equipment

There are two types of safety concerns associated with the operation of this plant. The first type includes the general plant safety concerns associated with operating any industrial facility. The second type pertains to specific hazards associated with the treatment of the groundwater contamination.

General Plant Safety Concerns

Numerous regulations and reference materials have been produced which set minimum safety standards for industrial facilities, and specifically for wastewater treatment plants. These include:

- *The Manual of Practice No. 1*, Safety in Wastewater Works, by the Water Pollution Control Federation.
- Federal regulations for industrial safety (40 CFR 29. 1910)
- *Safety in Operation of Wastewater Treatment Plants*, by OSHA

These manuals provide appropriate guidelines for eye, ear, head, foot and skin protection as well as guidelines for working near industrial equipment.

Plant personal are also instructed to consult the process equipment operation manuals for information pertaining to proper safety precautions.

Site Specific Safety

It will be the duty of the plant operating personal to develop a *Site Specific Health and Safety Plan* to address site specific safety precautions.

The health and safety plan must, at a minimum, address the following site specific hazards:

- Chemical hazards associated with the chemicals used as part of the treatment process. Material Safety and Data Sheets (MSDSs) for ferrous sulfate and sodium hydroxide are included in Appendix E. Hazards associated with compressed nitrogen gas cylinders should also be discussed.
- Safety precautions and Personal Protective Equipment (PPE) required for potential exposure to contaminated groundwater during various activities such as routine operation and equipment maintenance and cleaning. The contaminants of concern in the groundwater at this site are total and hexavalent chromium.

The health and safety plan should also include a discussion of the project organization and operator-specific information (e.g., occupational physician and operator-specific contact point).

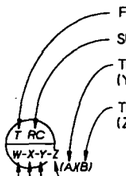
The health and safety plan must be updated when:

- new activities are conducted
- new contaminants are encountered or expected
- different contaminant concentrations (higher or lower) are encountered
- new personnel are used
- new chemical sources are used

Appendix A
Process and Instrumentation Diagrams (P&IDs)

INSTRUMENT IDENTIFICATION

EXAMPLE SYMBOLS



- FIRST LETTER (S)
- SUCCEEDING LETTERS
- THE TOTAL NUMBER OF UNITS PER SET (Y VARIES FROM 1 TO A)
- THE TOTAL NUMBER OF SETS OF UNITS (Z VARIES FROM 1 TO B)
- SET NUMBER (USED WHEN THERE ARE MULTIPLE SETS OF UNITS WITH THE SAME W-X-Y DESIGNATIONS)
- UNIT NUMBER (USED WHEN THERE ARE MULTIPLE UNITS WITH THE SAME W-X DESIGNATIONS)
- LOOP NUMBER
- UNIT PROCESS NUMBER

FIELD MOUNTED INSTRUMENT

REAR-OF-PANEL MOUNTED INSTRUMENT

PANEL MOUNTED INSTRUMENT

MOTOR CONTROL CENTER MOUNTED INSTRUMENT

INSTRUMENT SOCIETY OF AMERICA TABLE

LETTER	FIRST LETTER (S)		SUCCEEDING LETTERS		
	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS (+)		ALARM		
B	BURNER FLAME		USERS CHOICE (+)	USERS CHOICE (+)	USERS CHOICE (+)
C	CONDUCTIVITY			CONTROL	
D	DENSITY (S.G)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT		
F	FLOW RATE	RATIO			
G	GAUGE		GLASS	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT		INDICATE		
J	POWER	SCAN			
K	TIME OR SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION				MIDDLE
N	USERS CHOICE (+)		USERS CHOICE (+)	USERS CHOICE (+)	USERS CHOICE (+)
O	USERS CHOICE (+)		ORIFICE		
P	PRESSURE (OR VACUUM)		POINT (TEST CONNECTION)		
Q	QUANTITY OR EVENT(+)	INTEGRATE	INTEGRATE		
R			RECORD OR PRINT		
S	SPEED OR FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE (+)		MULTIFUNCTION (+)	MULTIFUNCTION (+)	MULTIFUNCTION (+)
V	VISCOSITY			VALVE OR DAMPER	
W	WEIGHT OR FORCE		WELL		
X	UNCLASSIFIED (+)		UNCLASSIFIED (+)	UNCLASSIFIED (+)	UNCLASSIFIED (+)
Y	USERS CHOICE (+)			RELAY OR COMPUTE (+)	
Z	POSITION			DRIVE, ACTUATE OR UNCLASSIFIED FINAL CONTROL ELEMENT	

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.

SPECIAL CASES

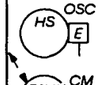
ON AND OFF EVENT LIGHTS

OPENED AND CLOSED POSITION LIGHTS

OPENED AND CLOSED POSITION SWITCHES

ON-OFF HAND SWITCH. MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).

STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).



ELECTRIC ACTUATOR WITH INTEGRAL OPEN-STOP-CLOSE MOMENTARY CONTACT CONTROL SWITCH.

FLOW INDICATING, COMPUTER/MANUAL CONTROL STATION.

FLOW INDICATING, COMPUTER/AUTO/MANUAL CONTROL STATION.

FLOW INDICATING SUPERVISORY SET POINT (BY COMPUTER) , AUTO/MANUAL CONTROL STATION.

TRANSDUCERS

A	ANALOG	I	CURRENT
D	DIGITAL	P	PNEUMATIC
E	VOLTAGE	PF	PULSE FREQUENCY
F	FREQUENCY	PD	PULSE DURATION
H	HYDRAULIC	R	RESISTANCE

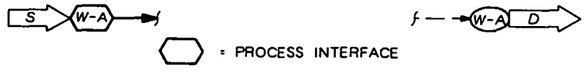
EXAMPLE:

CURRENT TO PNEUMATIC TRANSDUCER (BACK OF PANEL, IN A FLOW LOOP)

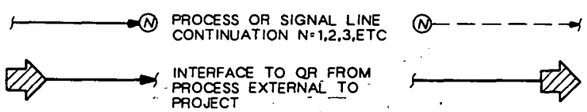
LINE LEGEND

- PROCESS (CLOSED CONDUIT, DASHED LINE INDICATES ALTERNATE FLOW STREAM)
- BUILDING OR FACILITY BOUNDARY
- PROCESS (OPEN CHANNEL)
- PARALLELING LINES (PARENTHETICAL NUMBER INDICATES THE NUMBER OF SIGNALS REPRESENTED)
- —A— ANALOG SIGNAL (4 TO 20 mAdc, ETC.)
- DISCRETE SIGNAL (ON/OFF, ETC.)
- –PD– PULSE DURATION SIGNAL
- CONNECTING LINES
- –PF– PULSE FREQUENCY SIGNAL
- PNEUMATIC SIGNAL
- NON-CONNECTING LINES
- FILLED SYSTEM SIGNAL
- HYDRAULIC SYSTEM SIGNAL

INTERFACE SYMBOLS



- = PROCESS INTERFACE
- = SIGNAL INTERFACE
- W = SOURCE UNIT PROCESS NO.
- A = INTERFACE LETTER
- D = DESTINATION DRAWING NO.
- S = SOURCE DRAWING NO.



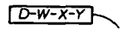
PROCESS OR SIGNAL LINE CONTINUATION N=1,2,3,ETC

INTERFACE TO OR FROM PROCESS EXTERNAL TO PROJECT

ABBREVIATIONS & LETTER SYMBOLS

AC	ALTERNATING CURRENT
ALKY	ALKALINITY
AM	AUTO-MANUAL
CAM	COMPUTER-AUTO-MANUAL
CCS	CENTRAL CONTROL SYSTEM
CL_2etc.	CHLORINE (TYPICAL: USE STANDARD CHEMICAL ELEMENT ABBREVIATION)
CM	COMPUTER-MANUAL
COD	CHEMICAL OXYGEN DEMAND
CP-X	CONTROL PANEL NO. X
DC	DIRECT CURRENT
DO	DISSOLVED OXYGEN
FCL_2	FREE CHLORINE RESIDUAL
FOS	FAST-OFF-SLOW
FOSA	FAST-OFF-SLOW-AUTO
FOSR	FAST-OFF-SLOW-REMOTE
FP-W-X	FIELD PANEL NO. WX (W = UNIT PROCESS NUMBER X = PANEL NUMBER)
FR	FORWARD-REVERSE
HDNS	HARDNESS
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
LEL	LOWER EXPLOSIVE LIMIT
LOE	LOSS OF ECHO
LOS	LOCKOUT STOP
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MBAS	METHYLENE BLUE ACTIVE SUBSTANCES
MC	MODULATE-CLOSE
MCC-X	MOTOR CONTROL CENTER NO. X
OC	OPEN-CLOSE (D)
OCR	OPEN-CLOSE-REMOTE
OCA	OPEN-CLOSE-AUTO
OIU	OPERATOR INTERFACE UNIT
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
OP	ORTHO PHOSPHORUS
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN-STOP-CLOSE
pH	HYDROGEN ION CONCENTRATION
PLC	PROGRAMMABLE LOGIC CONTROLLER
RM-X	REMOTE MULTIPLEXING MODULE NO. X
RTU-X	REMOTE TELEMETRY UNIT NO. X
SF	SLOWER-FASTER
SS	START-STOP
SSC	SUPERVISORY SET POINT CONTROL
TCL_2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANIC CARBON
TOD	TOTAL OXYGEN DEMAND
TURB	TURBIDITY
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
Δ	DIFFERENCE
Σ	SUM
X	MULTIPLY
÷	DIVIDE
f(x)	CHARACTERIZED
X^n	RAISE TO THE Nth POWER
$\sqrt{\ }$	SQUARE ROOT
AVG	AVERAGE
1:1	REPEAT OR BOOST
>	SELECT HIGHEST SIGNAL
<	SELECT LOWEST SIGNAL
±	BIAS
-%	GAIN OR ATTENUATE

SELF CONTAINED VALVE & EQUIPMENT TAG NUMBERS



D: ARV = AIR RELEASE VALVE
AVRV = AIR AND VACUUM RELEASE VALVE
E = EJECTOR
FCV = FLOW CONTROL VALVE
G = GATE
LCV = LEVEL CONTROL VALVE
M = MECHANICAL EQUIPMENT
P = PUMP
PRV = PRESSURE REGULATING VALVE
T = TANK
TCV = TEMPERATURE CONTROL VALVE

W = UNIT PROCESS NUMBER
X = LOOP NUMBER
Y = UNIT NUMBER

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A (◆) ARE TO BE PROVIDED UNDER SECTION INSTRUMENTATION AND CONTROLS.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (**) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THIS PROJECT.

INSTRUMENTATION AND CONTROL LEGEND

N.W.MAUTHE SITE
APPLETON, WISCONSIN

CH2M HILL

VALVE SYMBOLS

- GATE
- KNIFE GATE
- BUTTERFLY
- GLOBE
- BALL
- VEE- BALL
- PLUG
- SEAT PORT ECCENTRIC PLUG
- DIAPHRAGM
- PINCH
- NEEDLE
- SWING CHECK
- BALL CHECK
- SAMPLE
- MUD
- PRESSURE RELIEF
- AIR AND / OR VACUUM RELEASE
- REGULATED SIDE PRESSURE CONTROL
- MULTI-PORT VALVES (BALL VALVE SHOWN. FOR OTHER VALVES TYPES, APPROPRIATE VALVE SYMBOL SHOWN.) ARROWS INDICATE FLOW PATTERN. SEAT PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- HOSE VALVE
- REDUCED PRESSURE BACKFLOW PREVENTER

PRIMARY ELEMENT SYMBOLS

- PARSHALL FLUME
- WEIR
- ORFICE PLATE
- FLOW TUBE
- PITOT-STATIC
- VORTEX METER
- ROTAMETER
- ULTRASONIC FLOWMETER (INLINE)
- ELECTROMAGNETIC FLOWMETER
- PROPELLER OR TURBINE METER
- DENSITY METER (X: N = NUCLEAR, O = OPTICAL, U = ULTRASONIC)
- ULTRASONIC FLOWMETER (CLAMP-ON)
- LEVEL (ULTRASONIC)
- LEVEL (BUBBLER TUBE)
- LEVEL (FLOAT)

ACTUATOR SYMBOLS

- P Z XX — PNEUMATIC W/POSITIONER
- P S XX — PNEUMATIC W/SOLENOID
- E XX — ELECTRIC
- E Z XX — ELECTRIC W/POSITIONER
- EH XX — ELECTROHYDRAULIC
- H XX — HYDRAULIC
- P B XX — PNEUMATIC WITH VOLUME BOOSTER
- S — SOLENOID
- MANUAL

NOTE:
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL OR HYDRAULIC)
XX: FO =FAIL OPEN
FC =FAIL CLOSED
FLP=FAIL TO LAST POSITION

MISCELLANEOUS SYMBOLS

- SIGHT GLASS
- DIAPHRAGM SEAL
- BLIND FLANGE
- AIR GAP
- VENT TO ATMOSPHERE
- AERATOR
- PLUG
- RECEPTACLE
- SELF CONTAINED AIR SUPPLY
- SD D — COMPOSITE SAMPLER (DIPPER TYPE)
- SS — COMPOSITE SAMPLER (SUCTION TYPE)
- TV — TV CAMERA
- RADIO ANTENNA
- A ON-TD X-SEC B — "ON" TIME DELAY B "ON" X-SEC. AFTER A "ON". INSTANT "OFF".
- OFF-TD X-SEC — "OFF TIME DELAY B "OFF" X-SEC. AFTER A "OFF" INSTANT "ON"
- I — OR — INTERLOCK. SEE CONTROL DIAGRAMS
- A, B, S, R, C — MEMORY ELEMENT S= SET , R= RESET
- XP — PURGE SET X: W = WATER, A = AIR; SEE ○
- XX — AIR SET XX= SUPPLY PRESSURE IN PSIG.
- FILTER/ REGULATOR/ GAUGE SET
- 120V~ — 120 VOLT, 60 HZ POWER
- 480V~ — 480 VOLT, 60 HZ POWER
- ANNULAR DIAPHRAGM SEAL
- RUPTURE DISK
- PIG INSERT POINT
- OR — PIG CATCH POINT
- OR — MIXER
- M — ELECTRIC MOTOR
- PRESSURE GAUGE
- X — TONE TRANSMITTER NO. X
- X — TONE RECEIVER NO. X
- VOICE COMMUNICATION POINT
- TV — TV MONITOR
- A, B, AND, C — LOGIC ELEMENT: IF A AND NOT B THEN C
- A, B, OR, C — LOGIC ELEMENT: IF A OR B THEN C
- T, S, R — ON/OFF RELAY. INPUT IS CONNECTED TO OUTPUT WHEN SWITCHING SIGNAL IS PRESENT.
- T, S, R — SWITCHING SIGNAL; SWITCHING RELAY. INPUT WITH DOT IS CONNECTED TO OUTPUT WHEM SWITCHING SIGNAL IS PRESENT
- OTHER INPUT IS CONNECTED TO OUTPUT WHEN SWITCHING SIGNAL IS NOT PRESENT.
- F — FLUSHING CONNECTION; HOSE ADAPTOR
- S — SEAL WATER SET; SIGHT GLASS

PUMP AND COMPRESSOR SYMBOLS

NOTE: XX: AS = ADJUSTABLE SPEED
CS-1 = CONSTANT SPEED (SINGLE SPEED)
CS-2 = CONSTANT SPEED (TWO SPEED)

- CENTRIFUGAL PUMP (DRY PIT) XX
- CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP XX
- CHEMICAL FEED PUMP XX
- DIAPHRAGM PUMP XX
- GEAR PUMP OR BLOWER (POSITIVE DISPLACEMENT) XX
- PISTON PUMP XX
- PROGRESSIVE CAVITY PUMP XX
- SUBMERSIBLE SUMP PUMP XX
- COMPRESSOR (CENTRIFUGAL) XX BLOWER OR TURBINE
- COMPRESSOR (PISTON) XX
- EJECTOR

INSTRUMENTATION AND CONTROL LEGEND

N.W.MAUTHE SITE
APPLETON, WISCONSIN

CH2M HILL

MCP ◆

PLC SEE LOOP DESCRIPTIONS FOR SOFTWARE FUNCTIONS & BATCH PROCESSING STEPS

LAHH 1-2 · "ALERT CONDITION ACTIVE" · "SHUTDOWN CONDITION ACTIVE" · AUTODIALER · "SAFETY" · LAHH 1-1 · "WATCHDOG RESET" · OFF-TD 5-SEC · "PLC FAIL" · OA 2 MALF · "TANK LEVEL LOW, STOP MIXER" · "LOE" · LAH 3 · LAHH 18 · QIU DATA ACCESS MODULE · PAL 17 · "RUN" · 1 · (2) · "ON/AUTO"

120V · "ON" · "HIGH/LOE" · (2) · 120V · OOA · HS 2 · LITSH 3 · ALARM HORN ENABLE/DISABLE · HS x · OOA · HS 4 · PSL 17

M · CS-1 · M-2 · LE/TE 3 · VTR · S · FV 4 · ½"-AHP-CU · **

2"-PIF-HDPE · 2"-PIF-PVC · 2"-PIF-PVC · 3"-OF-PVC · 2"-PIF-PVC · 2"-PIF-PVC · A · A-2

"LEVEL HIGH HIGH" · "STOP" · "LEVEL HIGH HIGH" · "STOP" · 2"-PIF-HDPE

S · STORAGE TANK · T-2 · "LEVEL HIGH HIGH"

P-4 · REACTION TANK FEED PUMP** · 3"-PEF-PVC · B · A-2 · 1"-AHP-CU · C · A-2

480V · OOA · HS 1-2 · 1 · (2) · "MOTOR POWER" · 2"-PIF-CS · ** · LSHH 1-2 · ** · LSH 1-2 · ** · LSL 1-2 · CS-1 · MANHOLE 2 PUMP ** P-1-2 · CENTRAL TRENCH

480V · OOA · HS 1-1 · 1 · (2) · "MOTOR POWER" · 2"-PIF-CS · ** · LSHH 1-1 · ** · LSH 1-1 · ** · LSL 1-1 · CS-1 · MANHOLE 1 PUMP ** P-1-1

480V · OOA · HS 18 · 1 · (2) · "MOTOR POWER" · ** · LSHH 18 · ** · LSH 18 · ** · LSL 18 · 3"-PVC · BUILDING SUMP PUMP ** P-18 · BUILDING SUMP T-18

2"-DR-PVC · 1"-AHP-CU · 480V · AIR COMPRESSOR M-17 ** · 3"-PVC

SOUTHEAST TRENCH · WEST TRENCH · 4"-OF-HDPE · N-2 · D · 3"-PVC

FIGURE A-1
PROCESS INSTRUMENTATION AND CONTROL
N.W. MAUTHE SITE
APPLETON, WISCONSIN

CH2MHILL

11-FEB-1997
I:/104200/DRAWINGS/FIGURES/FIGA-2.DGN

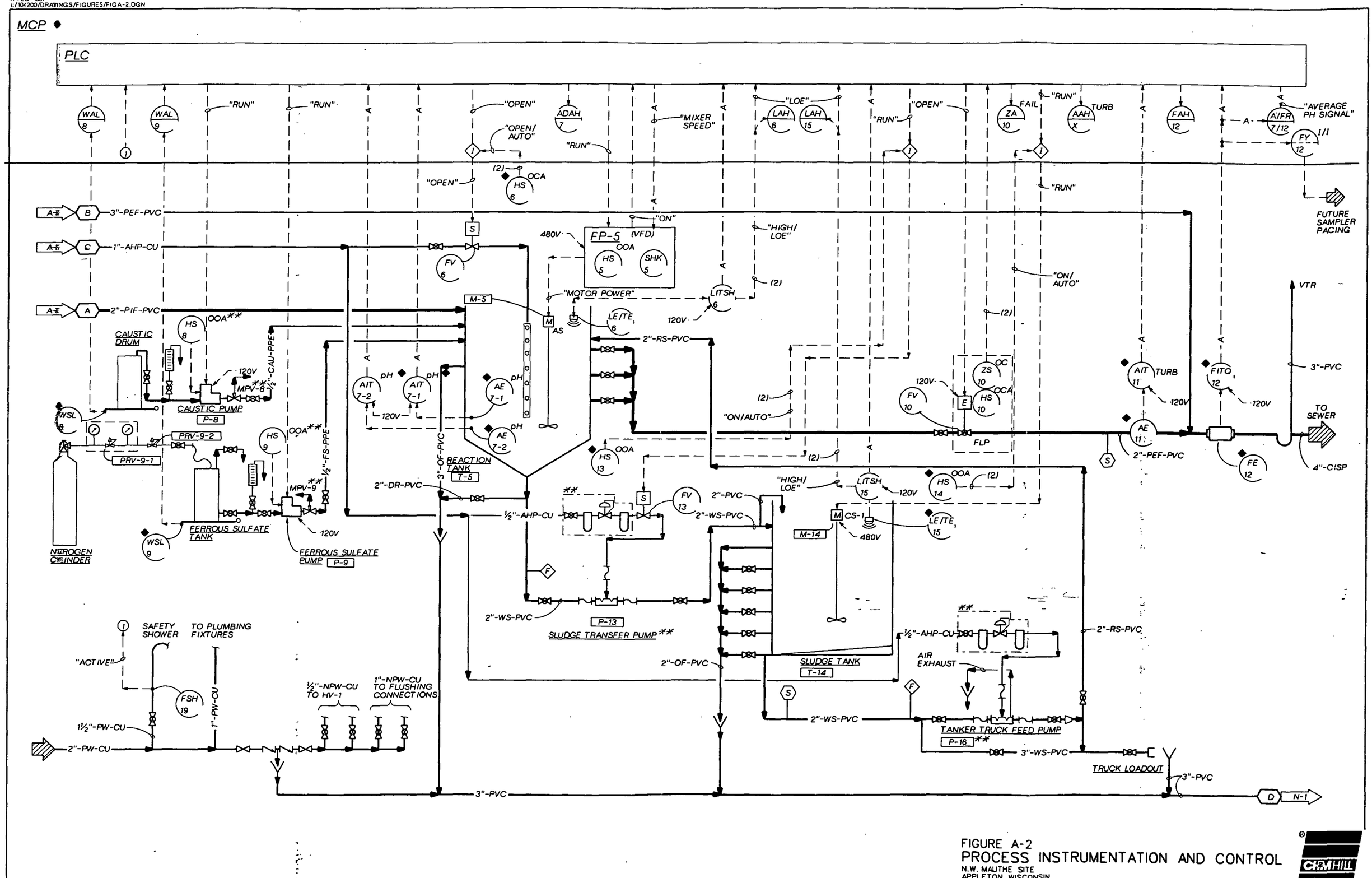


FIGURE A-2
PROCESS INSTRUMENTATION AND CONTROL
N.W. MAUTHE SITE
APPLETON, WISCONSIN

CH2MHILL

Appendix B
Equipment List

APPENDIX B
Equipment List
N.W. Mauthe Groundwater Pretreatment System

Item	Equipment Number	Description	Electrical	Manufacturer/Model/Phone
Air Compressor	M-17	Rotary screw compressor Air cooled Capacity: 50 scfm Receiver capacity: 120 gallons Horsepower: 15 hp	480 Volts 3 phase	
Air Diffuser Flow Control Valve	FV-6			
Building Sump	T-18	Fiberglass reinforced plastic 4'-6" x 4'-0" dia.		
Building Sump Pump	P-18	Submersible Capacity: 83 gpm @ 20 feet Tilting ball mercury float switch (3)	480 Volts 3 phase	
Caustic Pump	P-8	Positive displacement diaphragm pump Dial speed adjustment Turndown: 100:1 5 gph @ 60 psig Five function valve	120 Volt	
Effluent Flow Meter	FE/FITQ-12	Electromagnetic element (3 inch) Range: 0 to 200 gpm Totalizer unit value: 10 gal		
Effluent Flow Control Valve	FV-10			
Ferrous Sulfate Pump	P-9	Positive displacement diaphragm pump Dial speed adjustment Turndown: 100:1 5 gph @ 60 psig Five function valve	120 Volt	
Flow and pH Recorder	AR-7 (FR-12)	Two pen recorder Nominal 3/4 inch per hour		

APPENDIX B
Equipment List
N.W. Mauthe Groundwater Pretreatment System

Item	Equipment Number	Description	Electrical	Manufacturer/Model/Phone
Manhole No. 1 Pump	P-1-1	Submersible Capacity: 43 gpm @ 60 feet Tilting ball mercury float switch (3)	480 Volts 3 phase	
Manhole No. 2 Pump	P-1-2	Submersible Capacity: 43 gpm @ 60 feet Tilting ball mercury float switch (3)	480 Volts 3 phase	
Reaction Tank	T-5	Fiberglass reinforced plastic 120 degree conical bottom 12'-6" x 10'-0" dia. 6,100 gallons Open top w/ mixer platform		
Reaction Tank Feed Pump	P-4	Air operated double diaphragm Capacity: 86 gpm		
Reaction Tank Mixer	M-5	Top-mounted, variable speed, turbine type	480 Volts 3 phase	
Reaction Tank Air Diffuser	–			
Reaction Tank pH Monitor System	AE/AIT-7 (2)	Analytical pH element (2 probes) and transmitter		
Reaction Tank Volume System	LE/TE/LITSH-6	Ultrasonic level system Range: 0-6,100 gallons		
Sludge Transfer Pump	P-13	Air operated double diaphragm Capacity: 4 to 12 gpm		
Sludge Tank	T-14	Fiberglass reinforced plastic Sloped bottom 10'-0" x 9'-0" dia. 4,800 gallons Open top w/ mixer platform		

APPENDIX B
Equipment List
N.W. Mauthe Groundwater Pretreatment System

Item	Equipment Number	Description	Electrical	Manufacturer/Model/Phone
Sludge Tank Mixer	M-14	Top-mounted, constant speed, turbine type	480 Volts 3 phase	
Sludge Tank Level System	LE/TE/LITSH-15	Ultrasonic level system Measurement Range: 0-10 feet		
Storage Tank	T-2	Fiberglass reinforced plastic Flat bottom 11'-0" x 12'-0" dia. 9,000 gallons Open top w/ mixer platform		
Storage Tank Mixer	M-2	Top-mounted, constant speed, turbine type	480 Volts 3 phase	
Storage Tank Level System	LE/TE/LITSH-3	Ultrasonic level system Measurement Range: 0-11 feet		
Tanker Truck Feed Pump	P-16	Air operated double diaphragm Capacity: 10 to 70 gpm		

Appendix C
Log Sheets

Appendix C
Daily Log Sheet
Groundwater Pretreatment System
N.W. Mauthe Superfund Site

Week of:_____

Parameter	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
pH and Flow Data							
Inspect discharge flow meter and pH/flow recorder							
Effluent flow totalizer value (gal) [after each discharge event]							
High pH value [during each discharge event]							
Low pH value [during each discharge event]							
Average pH value [during each discharge event]							
Clean pH probes [weekly]							
Calibrate pH meter [weekly]							
Onsite Analytical Data							
Reaction tank effluent hexachrome concentration (mg/L) [during each discharge event]							
Storage tank hexachrome concentration (mg/L) [weekly]							
Reaction tank TSS (mg/L) [weekly]							
Storage tank TSS (mg/L) [as necessary]							
Chemical Feed System Information							
Nitrogen tank pressure (psi) [daily]							
Nitrogen tank discharge pressure (psi) [daily]							
Ferrous sulfate drum weight (lbs) [weekly]							
Caustic drum weight (lbs) [weekly]							

Appendix C
Weekly Log Sheet
Groundwater Pretreatment System
N.W. Mauthe Superfund Site

Month of:_____

Week:				
Observation Date:				
Parameter				
Manhole Sump No. 1				
Water depth (ft)				
Water color/clarity				
Manhole Sump No. 2				
Water depth (ft)				
Water color/clarity				
Storage Tank (As Necessary)				
Water depth (ft)				
Water color/clarity				
Mixer appearance/condition				
Ultrasonic Level Meter appearance/condition				
Reaction Tank Feed Pump				
Pump operating pressure (psi)				
Pump appearance/ performance				
Reaction Tank				
Depth of sludge (ft)				
Diffuser appearance/ performance				
Mixer appearance/condition				
Ultrasonic Level Meter appearance/condition				
Chemical Feed Systems				
Condition/color of ferrous sulfate solution				
Condition of pH probes				
Pumps (2) appearance/ performance				
Sludge Transfer Pump				
Pump operating pressure (psi)				
Pump appearance/ performance				
Sludge Tank				
Depth of Sludge (ft)				
Sludge Tanker Truck Feed Pump (As Necessary)				
Pump operating pressure (psi)				
Pump appearance/ performance				

All chromium analysis by Hach field test methods.
* Sample during discharge of treated batch to POTW (at discharge pipe sample port).

Appendix D
Process Calculations

APPENDIX D

Ferrous Sulfate Required Dosage Test Procedure

Objective:

Determine ferrous sulfate heptahydrate dosage required to reduce all hexavalent chromium to trivalent chromium.

Materials:

1. Fresh sample of ferrous sulfate heptahydrate feed solution
2. Four (4) 1-liter test jars
3. Jar mixing apparatus
4. Hexavalent chromium *Hach* kit
5. Liters of groundwater from the storage tank (T-2)

Procedure:

1. Analyze the hexavalent chromium concentration of the initial sample using the Hach field kit. Input the measured value into the PLC data access module.

2. Calculate and record the expected (theoretical) stoichiometric requirement of ferrous sulfate heptahydrate needed based on the hexavalent chromium concentration in the initial sample (See calculation method in the attached section of this appendix).

3. Fill four test jars with 1-liter of groundwater.

4. While mixing the jars on the stirring apparatus, SLOWLY add ferrous sulfate to each of the five jars at 1.00, 1.25, 1.50, and 1.75, 2.00 times the calculated stoichiometric requirements, respectively. These values represent the "dosage safety factors".

5. Stir the jars on the stirring apparatus for 20 minutes and then turn off apparatus.

6. Determine the hexavalent chromium concentration in each jar with the hexavalent chromium Hach kit and record the results.

7. Determine the jar that used the minimum ferrous sulfate dosage safety factor that reduced all hexavalent chromium to non-detect levels by the Hach test. Consider this requirement to be the "ferrous sulfate dosage safety factor" and input this value into the PLC data access module.

If the highest dose did not reduce all of the hexavalent chromium, rerun the test at higher dosages of ferrous sulfate until the minimum dosage that reduces all of the hexavalent chromium is determined.

Ferric Sulfate Dosage Calculations

1. Calculation of theoretical ferrous (Fe^{2+}) dosage:

Given: 3.2 mg Fe^{2+} required to treat 1.0 mg Cr^{6+}

Solution: X mg/L Cr^{6+} • [3.2 mg Fe^{2+} ÷ 1.0 mg Cr^{6+}] = X mg/L Fe^{2+} (theoretical)

Example:

Assume that there is 8.5 mg/L Cr^{6+} in the groundwater. What is the theoretical ferric dosage required to treat the groundwater?

8.5 mg/L Cr^{6+} • [3.2 mg Fe^{2+} ÷ 1.0 mg Cr^{6+}] = 27.2 mg/L Fe^{2+} (theoretical)

2. Calculation of the actual ferrous (Fe^{2+}) dosage given a "dosage safety factor" determined from a jar test:

Given:

a) Dosage safety factor = S.F. (Based on weekly jar tests - will change from week to week)
b) 3.2 mg Fe^{2+} required to treat 1.0 mg Cr^{6+}

Solution: X mg/L Cr^{6+} • [3.2 mg Fe^{2+} ÷ 1.0 mg Cr^{6+}] • S.F. = X mg/L Fe^{2+} (actual)

Example:

Assume that there is 9.2 mg/L Cr^{6+} in the groundwater (based on Hach Kit Analysis) Assume a "dosage safety factor" of 1.7 was determined from the weekly jar test. What is the actual ferric dosage required to treat the groundwater?

9.2 mg/L Cr^{6+} • [3.2 mg Fe^{2+} ÷ 1.0 mg Cr^{6+}] • 1.7 = 50 mg/L Fe^{2+} (actual)

3. Calculation of the volume of feed solution required to treat a 2,600 gallon batch of groundwater with the characteristics shown in number 2 above:

Given:

a) Feed solution strength = 25% by weight of ferrous sulfate heptahydrate ($FeSO_4 • 7\ H_2O$)
b) Specific Gravity of Solution (SG) = 1.15 (from MSDS sheet, a function of solution strength)
c) Density of water (d_W) = 8.34 lb/gal
d) Cr^{6+} concentration = 9.2 mg/L (Hach Kit results of storage tank sample)
e) Dosage safety factor = 1.7 (from weekly jar tests)
f) Reaction tank batch volume = 2,600 gallons
g) Molecular Weight (MW) of ($FeSO_4 • 7\ H_2O$) = 278

h) Molecular Weight (MW) of Fe = 56

Solution:

a) First, calculate the mass of $FeSO_4 \bullet 7\ H_2O$ in a given volume of feed solution (this will be different for different solution strengths):

$d_W \bullet SG \times$ % feed solution strength= X lb $FeSO_4 \bullet 7\ H_2O$/gal of soln

$8.34 \bullet 1.15 \times 25\% =$ 2.4 lb $FeSO_4 \bullet 7\ H_2O$/gal of soln

b) Next, calculate the mass of Fe^{2+} in the volume of feed solution:

X lb $FeSO_4 \bullet 7$ H2O/gal of soln $\bullet$ (MW $Fe^{2+} \div$ MW $FeSO_4 \bullet 7$ H2O)

$2.4 \bullet (56 \div 278) =$ 0.483 lb Fe^{2+} /gal of soln

Converting to mg/L:

$0.483 \bullet (4.536 \times 10^5$ mg/lb $\div$ 3.785 L/gal) = 57,900 mg Fe^{2+}/L of soln

c) Next, calculate the mass of Cr^{6+} in the reaction tank batch:

9.2 mg/L $Cr^{6+} \times$ 3.785 L/gal x 2,600 gal/batch = 90,537 mg Cr^{6+}/batch

d) Then, calculate the mass of Fe^{2+} required to treat this batch:

90,537 mg $Cr^{6+} \bullet$ [3.2 mg $Fe^{2+} \div$ 1.0 mg Cr^{6+}] $\bullet$ 1.7 (SF) =

492,522 mg Fe^{2+}/batch

e) Finally, calculate the volume (in Liters) of the ferrous sulfate feed solution required to treat this batch:

492,522 mg Fe^{2+}/batch $\div$ 57,900 mg Fe^{2+}/L of soln =

8.5 L of soln/batch

Appendix E
Material Safety Data Sheets

Ferrous Sulfate MSDS

Ferrous Sulfate Solution

MSDS

MATERIAL SAFETY DATA SHEET

For chemical emergencies—spill, leak, fire or exposure, call CHEMTREC (800)424-9300.

EAGLEBROOK, INC.

SECTION 1 CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

SUPPLIER	•	Eaglebrook, Inc. 1150 Junction Avenue Schererville, Indiana 46375
PHONE NUMBERS	•	(219) 322-2560, (800) 428-3311
EMERGENCIES	•	CHEMTREC (800) 424-9300
TRADE NAME	•	Ferrous Sulfate
CHEMICAL FAMILY	•	Inorganic salts
FORMULA	•	$FeSO_4$
SYNONYM	•	Iron (II) sulfate

SECTION 2 COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENT	PERCENT	ACGIH TLV	CAS NUMBER
Ferrous sulfate	13.0-16.3	1 mg/m³ TWA	7720-78-7
Sulfuric acid	<6	1 mg/m³ TWA	7664-93-9

SECTION 3 HAZARDS IDENTIFICATION

Emergency overview-irritating to skin, eyes, and mucous membranes.

NFPA RATINGS

Health	2
Flammability	0
Reactivity	1
Special Hazards	Corrosive

SECTION 4 FIRST AID MEASURES

INHALATION	Move to fresh air. Give artificial respiration if breathing has stopped. If breathing is difficult, give oxygen. Get medical attention.
EYE CONTACT	Flush with plenty of water. Get medical attention.
SKIN CONTACT	Wash with soap and water. Remove any contaminated clothing and wash before reuse. If irritation develops, get medical attention.
INGESTION	If conscious, drink water or milk of magnesia. DO NOT induce vomiting. Get medical attention.

SECTION 5 FIRE FIGHTING MEASURES

FLASH POINT	NA
FLAMMABLE LIMITS	NA
AUTOIGNITION	NA
HAZARDOUS COMBUSTION PRODUCT	Sulfur oxides
FIRE FIGHTING INSTRUCTIONS	Use whatever extinguishing media that is appropriate. Respiratory and eye protection required.
FIRE AND EXPLOSION HAZARDS	Sulfuric acid could react with metals to produce hydrogen.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Evacuate all unnecessary personnel from the area. Wear appropriate personal protective equipment, and contain and eliminate the release. Neutralize with lime, limestone, or soda ash. This will generate carbon dioxide, so additional ventilation may be necessary. Collect the residues for proper disposal. Notify the appropriate authorities.

SECTION 7 HANDLING AND STORAGE

Keep containers closed. Do not store in metal containers, because the metal will dissolve and generate hydrogen. Vent rubber lined steel containers to avoid pressure build up if the lining fails.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

VENTILATION	There should be enough local ventilation to keep the TLV below the ACGIH limits.
GLOVES	Use neoprene or equivalent. Never use leather.
EYES	Wear chemical goggles or a face shield.
RESPIRATOR	Use an approved respirator with acid mist cartridges, if necessary.
CLOTHING	Protective clothing, if necessary, should be neoprene or equivalent.

When cleaning, decontaminating or performing maintenance on tanks, containers, piping systems and accessories, and in any other situations where airborne contaminants and/or dust could be generated, use proper protective equipment to protect against ingestion or inhalation. HEPA or air supplied respirators, full Tyvek coveralls with head cover, gloves and boots (or chemical suits, gloves and boots) are suggested.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point	220-235°F
Specific Gravity (H_2O=1)	1.16-1.25
Vapor Pressure (mm Hg)	NA

Percent Volatile by Vol.	NA
Vapor Density (Air=1)	NA
Evaporation Rate (BuAc=1)	NA
Solubility in Water (%)	Infinite
Appearance	Blue green liquid, slight acidic odor
pH	<1
Freezing Point	Consult your Eaglebrook representative for cold weather handling recommendations.

SECTION 10 STABILITY AND REACTIVITY

STABILITY Stable above 50°F. Starts recrystalizing below 50°F.

HAZARDOUS POLYMERIZATION Does not occur.

HAZARDOUS DECOMPOSITION Produces sulfur oxides.

CONDITIONS TO AVOID Contact with bases or alkalies.

INCOMPATIBLE MATERIALS Metals and metal alloys.

SECTION 11 TOXICOLOGICAL INFORMATION

TOXICOLOGICAL FINDINGS Tests on laboratory animals indicate material may produce adverse mutagenic effects. Cited in RTECS.

SECTION 12 ECOLOGICAL INFORMATION

No data available.

SECTION 13 DISPOSAL CONSIDERATIONS

This material is an RCRA regulated hazardous waste upon disposal due to the corrosivity characteristic. Any residues and/or rinse waters from cleaning of tanks, containers, piping systems and accessories may be a hazardous characteristic waste and must be properly disposed of in accordance with all federal, state, and local laws. Recycle whenever possible.

SECTION 14 TRANSPORT INFORMATION

SHIPPING NAME Corrosive Liquids, Acidic, Inorganic, N.O.S., (Ferrous Sulfate)

HAZARD CLASS 8

DOT NUMBER UN3264

PACKING GROUP II

SECTION 15 REGULATORY INFORMATION

CERCLA RQ 6100-7600 liquid pounds. (Depending on ferrous sulfate concentration.)
Sulfuric acid is a reportable chemical under Section 313 of EPCRA (40 CFR 372).

CHRONIC HAZARD No

FIRE HAZARD No

SECTION 16 OTHER INFORMATION

The information in this document is considered to be reliable, but Eaglebrook does not accept any responsibility for its accuracy. This information is not intended as a warranty of the product's suitability for use with any other material or product, or in any application or process.

—Prepared by Michael M. Miller
September 3, 1996

Sodium Hydroxide MSDS

HYDRITE CHEMICAL CO.

00 N. PATRICK BLVD. (53045-5816)
DRAWER # 0948
BROOKFIELD, WI 53008-0948
OFFICE: 414/792-1450
FACSIMILE: 414/792-8721

January 2, 1997

CH0902
CH2M HILL
411 E. WISCONSIN STE 1600

MILWAUKEE, WI 532022211

ATTENTION: MSDS Coordinator

In the interest of worker safety, we have enclosed Material Safety Data Sheets (MSDS) for your review. (Please see attached list). The information contained in these Material Safety Data Sheets is designed to meet requirements under the OSHA Hazard Communication Standard (29 CFR 1910.1200). As a matter of policy, Hydrite Chemical Co. will distribute Material Safety Data Sheets with the first order for a product, upon any formal request, and whenever revisions are made.

These Material Safety Data Sheets contain necessary information about product hazards and proper handling. This data relates only to the specific material designated and does not relate to its use in combination with any other material or process. Hydrite Chemical Co. believes that the factual data contained in the enclosed sheets are correct. The opinions expressed in them are those of qualified experts regarding the results of tests conducted; however, since conditions of use are outside our control, they are not to be taken as a warranty or representation for which Hydrite Chemical Co. assumes legal responsibility.

Accompanying the MSDS is the Environmental Data Sheet (EDS) which contains additional regulatory information. The EDS must not be detached from the MSDS. Any copying and redistribution of the MSDS must include the EDS. Part 2 of the EDS contains notification of any substances contained in the product which are subject to the Environmental Protection Agency Toxic Chemical Reporting Requirements (SARA Title III), Section 313. Suppliers are required to notify all recipients of products containing chemicals subject to Section 313. You are also required to forward this notification to anyone you may distribute the product to.

Hydrite Chemical Co. strongly urges you, as is required by law, to provide the warnings and information in the enclosed Material Safety Data and Environmental Data Sheets to your employees, customers, handlers, people exposed to, or users of any of these products, and to properly train them in safe product handling.

If you have any questions, please contact either your Hydrite Sales or Customer Service Representative.

Sincerely,

Nancy O'Melia
Hydrite Chemical Co.
Technical Writer/Regulatory, Health & Safety

Enclosure

CH2M HILL
411 E. WISCONSIN STE 1600
MILWAUKEE ,WI 532022211

CH090-2
000

12-30-96

ATTN: MSDS Coordinator

Enclosed are the following Material Safety and Environmental Data Sheets for your review:

MSDS/EDS #	PRODUCT NAME
HY94-1 AL-0050-XX 1	CAUSTIC SODA LIQUID 50%

MATERIAL SAFETY DATA SHEET

12/30/96

PRODUCT NAME: CAUSTIC SODA LIQUID 50% PAGE 1

DISTRIBUTED BY: HYDRITE CHEMICAL CO.
300 N. PATRICK BLVD.
BROOKFIELD,WI 530080948
(414) 792-1450
24 HOUR EMERGENCY # - (414) 277-1311
CHEMTREC EMERGENCY # - (800) 424-9300

MSDS#:HY941AL0050XX

PREPARED BY:SMJ/NAO
04/25/94

MANUFACTURED BY: OCCIDENTAL, PPG, AND VULCAN

SECTION I - PRODUCT INFORMATION

TRADE NAME: CAUSTIC SODA LIQUID 50%
CHEMICAL NAME SYNONYMS: Sodium Hydroxide
Lye

C.A.S. REGISTRY #: 1310-73-2
CHEMICAL FAMILY: Alkali

FORMULA: 50% NaOH

DOT PROPER SHIPPING NAME: SODIUM HYDROXIDE SOLUTION

D.O.T. HAZARD CLASS: 8 (CORROSIVE MATERIAL)

D.O.T. IDENTIFICATION #: UN1824 D.O.T. LABEL: CORROSIVE

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENT	PERCENT	TLV LEVEL	PEL LEVEL
Sodium Hydroxide	50%	C 2 mg/m3	C 2 mg/m3

NOTE :C denotes Ceiling Limit.

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SECTION III - PHYSICAL DATA

BOILING POINT (DEG. F): 293
FREEZING POINT (DEG.F): 41 - 51
VAPOR PRESSURE (MM HG): 6.3 @ 104F
VAPOR DENSITY (AIR=1) : N.A.
SOLUBILITY IN WATER: Complete

SPECIFIC GRAVITY: 1.53 @ 60F
PERCENT VOLATILE BY VOLUME%: N.A
EVAPORATION RATE(N.A.): N.A.

APPEARANCE AND ODOR: Clear, colorless to slightly turbid liquid. No odor.

SECTION IV - FIRE EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED): None.

FLAMMABLE LIMITS LEL: N.A. UEL: N.A.

EXTINGUISHING MEDIA: For fires in area use appropriate media. For example: Water spray. Dry Chemical. Carbon Dioxide. Alcohol Foam.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate area of unprotected personnel. Wear protective clothing, chemical safety goggles and face shield. Cool fire-exposed containers with water spray. Product generates heat upon addition of water, with possible spattering. Run-off from fire control may cause pollution.

UNUSUAL FIRE EXPLOSION HAZARDS: Product may react with some metals (ex.: Aluminum, Zinc, Tin, etc.) to release flammable Hydrogen gas.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: C 2 mg/m3 (OSHA 29 CFR 1910.Z-1-A)
C 2 mg/m3 (ACGIH 1993-94)

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SECTION V - HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE

EYE CONTACT: CORROSIVE - Causes severe burns and destruction of tissues. Small quantities can result in permanent damage and loss of vision. Contact may cause blindness.

SKIN CONTACT: CORROSIVE - Irritating to skin. Corrosive action causes burns and frequently deep ulceration with ultimate scarring.

INHALATION: CORROSIVE - Causes burns to respiratory tract. Inhalation of dust or mists can cause damage to the upper respiratory tract and to the lung tissue depending upon the extent of exposure.

INGESTION: CORROSIVE - Ingestion can cause very serious damage to the mouth, esophogus, stomach, and other tissues with which contact is made, and may be fatal.

OTHER: ROUTES OF EXPOSURE: Product can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. TARGET ORGANS: Eyes. Skin. Respiratory System. MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Preexisting eye and skin disorders may be aggravated by exposure.

EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT: Immediately flush eyes with plenty of water for at least 15 minutes. Hold eyelids open during this flushing with water. Call a physician immediately.

SKIN CONTACT :Flush area with water while removing contaminated clothing and shoes. Follow by washing with soap and water. Do not reuse clothing or shoes until cleaned. If irritation

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SECTION V - HEALTH HAZARD DATA

persists, get medical attention. Do not apply oils or ointments unless ordered by the physician. If skin feels slippery, caustic may still be present in sufficient quantities to cause rash or burn. Continue washing skin until slick skin feeling is gone.

INGESTION: If conscious, drink a quart of water. DO NOT induce vomiting. CALL A PHYSICIAN immediately. If unconscious or in convulsions, take immediately to a hospital or a physician. NEVER induce vomiting or give anything by mouth to an unconscious victim. After dilution with water, fruit juice or diluted vinegar may be administered to accomplish neutralization. Several glasses of milk or several ounces of milk of magnesia may be given for their soothing effect.

INHALATION: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. CALL A PHYSICIAN.

SECTION VI - REACTIVITY DATA

STABILITY: _X_STABLE ___UNSTABLE
CONDITIONS TO AVOID: Contact with water may cause violent reaction with evolution of heat. To dilute: Add product slowly to lukewarm water; not water to product.

INCOMPATABILITY: Acids. Metals such as Aluminum, Zinc, Tin, etc. Organic Nitro Compounds. Chlorinated and Fluorinated Hydrocarbons, acetaldehyde, chlorine trifluoride, hydroquinone, maleic anhydride, phosphorous pentoxide, and tetrahydrofuran. Organic materials. Acrolein. Phosphorus. Trichloroethylene. Food sugars. Deadly carbon monoxide gas can form in enclosed or poorly ventilated areas or tanks when alkaline products contact food, beverage, or dairy products. Do not enter such areas until they have been well ventilated and carbon monoxide and oxygen levels have been determined to be within OSHA acceptable limits. If carbon monoxide and oxygen levels cannot be measured, wear NIOSH-approved,

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SECTION VI - REACTIVITY DATA

self-contained breathing apparatus.

HAZARDOUS DECOMPOSITION PRODUCTS: May react with certain metals to produce flammable Hydrogen Gas. May react with various food sugars to form Carbon Monoxide. Reacts with Phosphorus to form spontaneously flammable Phosphine. Reacts with Trichlorethylene to form spontaneously flammable Dichloroacetylene.

HAZARDOUS POLYMERIZATION: ___MAY OCCUR _X_WILL NOT OCCUR

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: CORROSIVE MATERIAL. Evacuate unprotected personnel from area. Maintain adequate ventilation. Use proper Safety Equipment. Contain spill, place into drums for proper disposal. Neutralize remaining residue with dilute Hydrochloric Acid solution and dispose of properly. Avoid direct discharge to sewers and surface waters. Notify authorities if entry occurs. CAUTION: Caustic Soda may react violently with acids and water.

WASTE DISPOSAL METHOD: Observe all Local, State, and Federal Regulations. Dispose of at approved Waste Treatment Facility. If approved, neutralize material and flush to sewer. DO NOT pressurize, cut, weld, braze, solder, drill, grind or expose empty containers to heat, flame, sparks or other sources of ignition.

SECTION VIII - SPECIAL PROTECTION INFORMATION

CONSULT SAFETY EQUIPMENT DISTRIBUTOR

RESPIRATORY PROTECTION: If recommended Exposure Limits are exceeded wear: NIOSH-Approved respirator for dusts and mists. NIOSH-Approved self-contained breathing apparatus. Do not exceed limits established by the respirator manufacturer. Respiratory

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SECTION VIII - SPECIAL PROTECTION INFORMATION

protection programs must comply with 29 CFR 1910.134.

VENTILATION: Maintain adequate ventilation. Do not use in closed or confined space. Keep levels below recommended Exposure Limits. To determine exposure levels, monitoring should be performed regularly. Avoid mist formation.

PROTECTIVE GLOVES: Rubber (Latex). Neoprene. Polyvinyl Chloride.

EYE PROTECTION: Chemical Safety Goggles. Face shield. Do not wear contact lenses.

OTHER PROTECTIVE EQUIPMENT: Eye-wash station. Safety shower. Rubber apron. Chemical safety shoes. Rubber boots. Protective clothing.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:
CORROSIVE MATERIAL. Store in cool, well-ventilated area, out of direct sunlight. Do not freeze. Keep containers tightly closed. Highly corrosive to most metals with evolution of Hydrogen Gas. Store away from incompatable materials. Do not store in unlabeled or mislabeled containers. *** ANSI/NSF Standard 60 Maximum Use Level = 100 mg/l ***

OTHER PRECAUTIONS: Avoid contact with skin and eyes. Do not swallow. Avoid dust or mist formation. Use with adequate ventilation. Avoid breathing mists or dusts. Wash thoroughly after handling. Do not eat, drink, or smoke in work area.

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SECTION X - SUPPLEMENTAL HEALTH INFORMATION

CARCINOGEN CONTENT

%	PPM	INGREDIENT	IARC	NTP	OSHA

NOTE : This product does not contain greater than 0.1% of the known or potential carcinogens listed in NTP, IARC, or OSHA.

LD50 ORAL : Rabbit: 1350 mg/kg (Oxy Chem)
LD50 SKIN : Rabbit 50 mg/24 H (Anhydrous NaOH)
LC50 INHALATION : No Data

** ** ** ** ** ** ** ** ** ** **

The data in this Material Safety Data Sheet relates only to the specific material designated and does not relate to its use in combination with any other material or process. The data contained is believed to be correct. However, since conditions of use are outside our control it should not be taken as a warranty or representation for which HYDRITE CHEMICAL CO. assumes legal responsibility. This information is provided solely for your consideration, investigation, and verification.

ENVIRONMENTAL DATA SHEET

INFORMATION CONTAINED MUST NOT BE DETACHED FROM THE MSDS AND ANY COPYING AND REDISTRIBUTION OF THE MSDS SHALL INCLUDE COPYING AND REDISTRIBUTION OF THE ENVIRONMENTAL DATA SHEET.

PRODUCT NAME: CAUSTIC SODA LIQUID 50% PAGE 1

EDS#: HY941-AL0050-XX-EDS
EMERGENCY NUMBER: (414) 792-1450
(414) 277-1311
CHEMTREC: (800) 424-9300

PART 1: PRODUCT/COMPOSITION

NO.	COMPONENT	CAS NUMBER	PERCENT
P	CAUSTIC SODA LIQUID 50%	1310-73-2	100%
	TYPICAL DISTRIBUTION		
1	Sodium Hydroxide	1310-73-2	50%

PART 2: SARA TITLE III INFORMATION

NO.	RQ (LBS) (*1)	TPQ (LBS) (*2)	SEC 313 (*3)	313 CATEGORY (*4)	311/312 CATEGORIES (*5)
P	*	N/A	N	N/A	A-C-R
1	1,000	N/A	N	N/A	A-C-R

NOTE:* RQ is dependent upon individual ingredients.

FOOTNOTES

*1 = REPORTABLE QUANTITY OF CERCLA HAZARDOUS SUBSTANCE, 40 CFR PART 302, TABLE 302.4
*2 = THRESHOLD PLANNING QUANTITY, EXTREMELY HAZARDOUS SUBSTANCE, SEC. 302
*3 = TOXIC CHEMICAL, SEC. 313
*4 = CATEGORY AS REQUIRED BY SEC 313 (40 CFR 372.42), MUST BE USED ON TOXIC RELEASE INVENTORY FORM
*5 = HAZARD CATEGORY FOR SARA SEC. 311/312 REPORTING
A = IMMEDIATE (ACUTE) HEALTH HAZARD
C = DELAYED (CHRONIC) HEALTH HAZARD
P = SUDDEN RELEASE OF PRESSURE HAZARD
F = FIRE HAZARD
R = REACTIVE HAZARD

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PART 2: SARA TITLE III INFORMATION

PART 3: CERCLA INFORMATION

EPA - COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT. UNDER EPA - CERCLA ("SUPERFUND") RELEASES TO AIR, LAND OR WATER MAY BE REPORTABLE TO THE NATIONAL RESPONSE CENTER, 800-424-8802 (CIRCUMSTANCES SURROUNDING THE RELEASE AND CLEANUP DETERMINE REPORTABILITY).

THE REPORTABLE QUANTITY FOR THIS PRODUCT IS: 2000# BASED ON SODIUM HYDROXIDE CONTENT.

PART 4: RCRA INFORMATION

REFER TO LATEST EPA OR STATE REGULATIONS REGARDING PROPER DISPOSAL.

HAZARDOUS WASTE NUMBER = D002 (40 CFR 261.22)

PART 5: HMIS/NFPA LABEL INFORMATION

	HMIS	NFPA	KEY
HEALTH:	3	3	0 - MINIMAL
FLAMMABILITY:	0	0	1 - SLIGHT
REACTIVITY::	2	1	2 - MODERATE
WARNING	N/A		3 - SERIOUS
WARNING	N/A		4 - SEVERE

PERSONAL PROTECTION RATING TO BE SUPPLIED BY USER DEPENDING ON USE CONDITIONS.

HMIS = HAZARDOUS MATERIALS IDENTIFICATION SYSTEM
NFPA = NATIONAL FIRE PROTECTION ASSOCIATION 704

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PART 5: HMIS/NFPA LABEL INFORMATION

HEALTH, FLAMMABILITY, AND REACTIVITY RATINGS SHOULD ONLY BE USED AS A GUIDE. THE MATERIAL SAFETY DATA SHEET FOR THE PRODUCT SHOULD BE CONSULTED WHEN ASSESSING HAZARD INFORMATION.

PART 6: PROPOSITION 65

IF YOUR BUSINESS RESIDES IN THE STATE OF CALIFORNIA OR IF YOU SUPPLY PRODUCTS DIRECTLY OR INDIRECTLY INTO CALIFORNIA, WE ARE PROVIDING THIS INFORMATION TO YOU PURSUANT TO THE CALIFORNIA SAFETY DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (COMMONLY KNOWN AS PROPOSITION 65). THIS LAW REQUIRES, IN PART, THAT "NO PERSON IN THE COURSE OF DOING BUSINESS SHALL KNOWINGLY AND INTENTIONALLY EXPOSE ANY INDIVIDUAL TO CHEMICAL KNOWN TO THE STATE TO CAUSE CANCER OR REPRODUCTIVE TOXICITY WITHOUT FIRST GIVING CLEAR AND REASONABLE WARNING TO SUCH INDIVIDUAL..." (SECTION 25249.6). THE ACT DOES NOT EXEMPT FROM THE WARNING REQUIREMENT "AN EXPOSURE FOR WHICH THE PERSON RESPONSIBLE CAN SHOW THAT THE EXPOSURE POSES NO SIGNIFICANT RISK..." (SECTION 25249.10).

IT HAS NOT BEEN FEASIBLE TO SUBJECT ALL PRODUCTS TO THE DETAILED ANALYSES REQUIRED TO DETERMINE WHETHER EACH OF THE MATERIALS KNOWN TO CALIFORNIA TO CAUSE CANCER OR REPRODUCTIVE TOXICITY IS PRESENT IN DETECTABLE QUANTITIES. HOWEVER, BASED ON AVAILABLE DATA, THE FOLLOWING CHEMICALS LISTED BY THE GOVERNOR OF CALIFORNIA MAY BE PRESENT IN THIS PRODUCT:

CHEMICAL		CONCENTRATION *
ASBESTOS	(FEB 27, 1987)	< .075 ppm
NICKEL	(OCT 1, 1987)	< 10 ppm
LEAD	(FEB 27, 1987)	< 10 ppm
ARSENIC	(FEB 27, 1987)	< 0.005 ppm
CADMIUM	(OCT 1, 1987)	< 0.005 ppm

* IMPURITY LEVELS

* NOT TO BE CONSTRUED AS SPECIFICATIONS UNLESS SO INDICATED.

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PART 6: PROPOSITION 65

NOTE: The date refers to the initial appearance of the chemical on the list. Based on the manufacturers' evaluation of the above concentration(s) of impurities present in the product's ingredients, the product is believed to not pose a hazard to human health if handled and used as directed on the Material Safety Data Sheet. This information is provided to assure compliance with the requirements of Proposition 65.

** ** ** ** ** ** ** ** ** ** ** **

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