ARCS V

Remedial Activities at Uncontrolled Hazardous Waste Sites in Region V

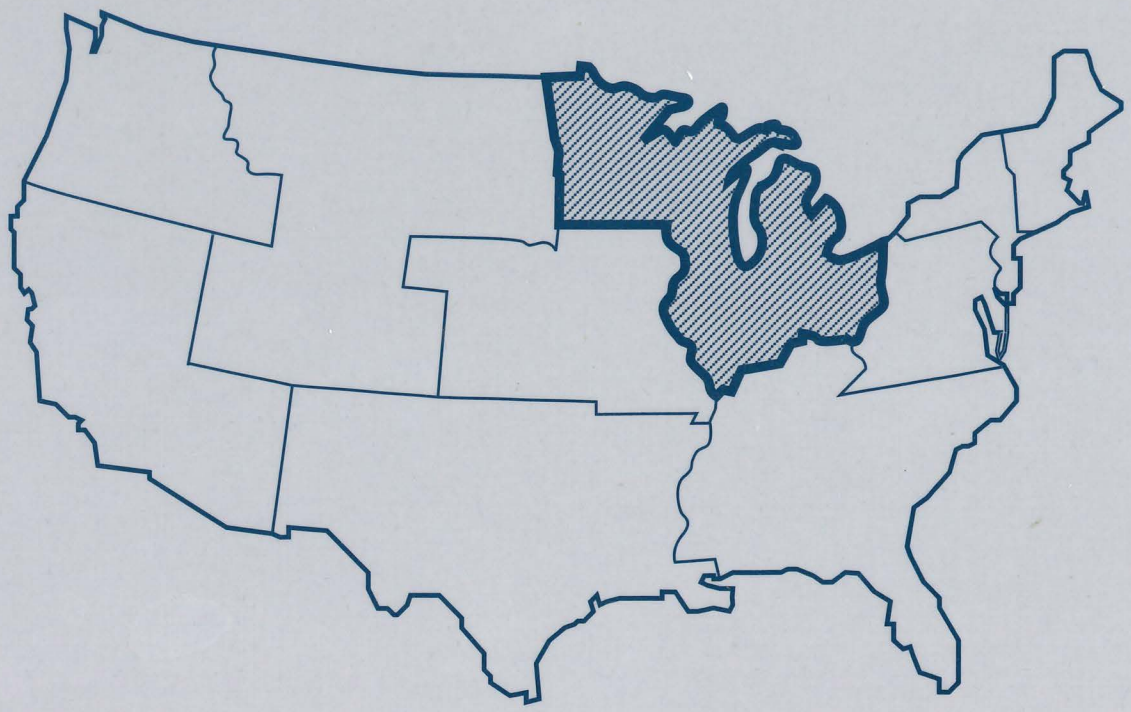
EPA United States Environmental Protection Agency

Groundwater Monitoring Plan
Revision 1

Onalaska Municipal Landfill Site
Onalaska, Wisconsin

WA 47-5RL5 / Contract No. 68-W8-0040

June 1995



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MKE100140CC.WP5

Onalaska Groundwater Monitoring Plan

Introduction

This plan describes the long-term groundwater monitoring program for the Onalaska Municipal Landfill site located in Onalaska Township, Wisconsin (Figures 1 and 2). The monitoring program is a necessary part of the remedial action plan outlined in the U.S. Environmental Protection Agency's (EPA) Record of Decision (ROD). The groundwater monitoring program was designed to monitor the effectiveness of the groundwater collection and monitoring systems in meeting the requirements of the ROD and potential adverse impacts on nearby wetlands. Although not specifically addressed as a ROD requirement, monitoring of adjacent surface water and sediments is included as part of the groundwater monitoring plan. Monitoring of treated groundwater discharge will be addressed in a separate plan [1].

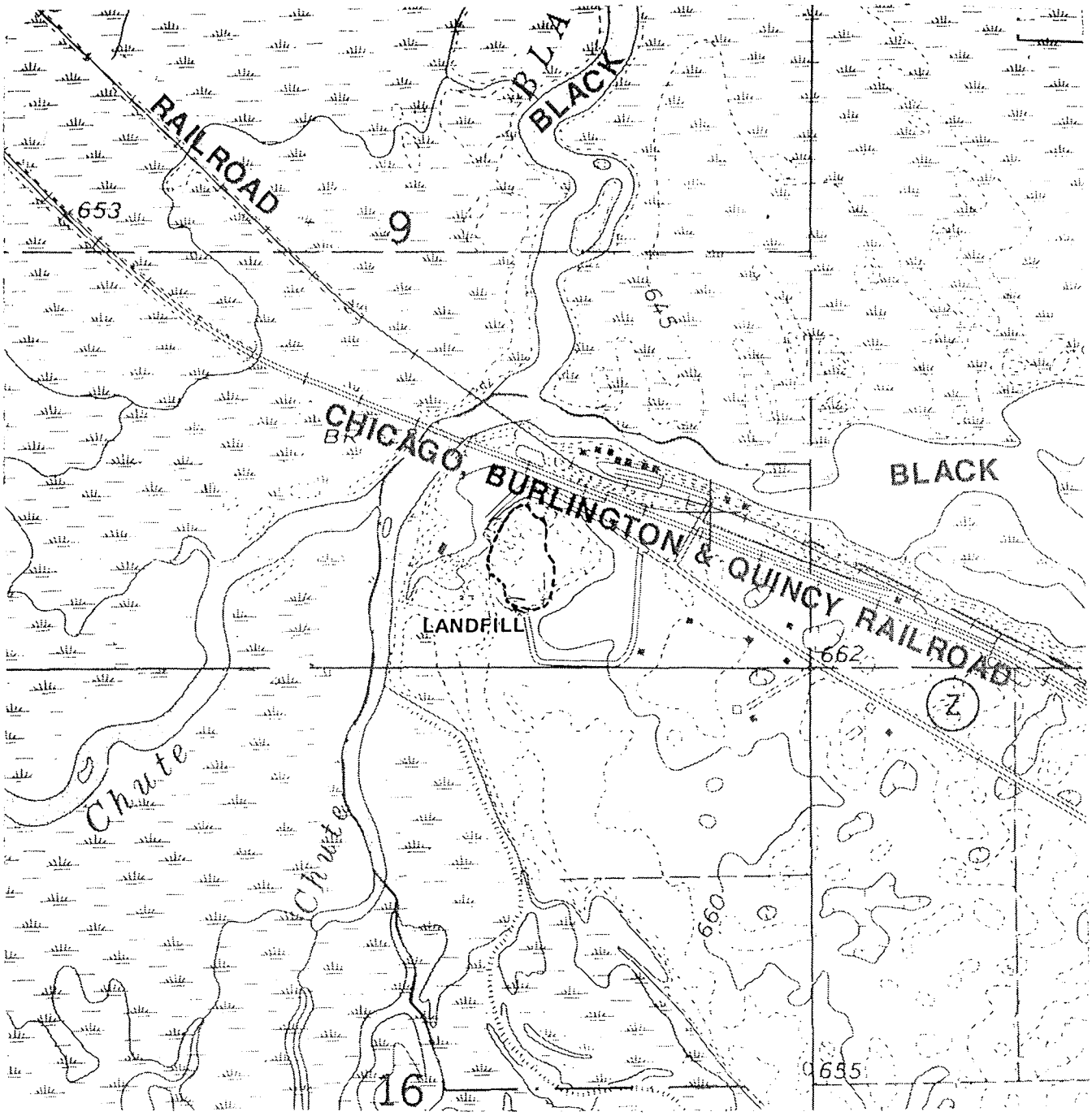
Contaminants Found in Groundwater During the Remedial Investigation

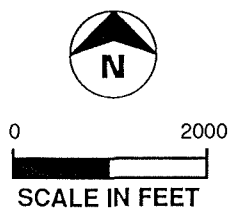
Groundwater samples were collected from monitoring wells during the Remedial Investigation (RI) in the spring and summer of 1989. Contaminant concentrations in the groundwater at individual monitoring well locations within the landfill or at the landfill boundary exceeded one or more standards or criteria. The Safe Drinking Water Act maximum contaminant levels (MCLs) for arsenic; barium; benzene; 1,1-dichloroethene; toluene; 1,1,1-trichloroethane (1,1,1-TCA); trichloroethene (TCE); and xylene were exceeded at one or more monitoring well locations. The Wisconsin Groundwater protective action limits (PALs) for benzene; arsenic; barium; chromium; 1,1-dichloroethene; 1,1,1-TCA; TCE; toluene; and xylene were exceeded at one or more monitoring well locations.

A series of shallow groundwater samples were collected during the RI and were analyzed using a close support laboratory. The primary objectives of the shallow groundwater analysis were to determine the extent of the floating non-aqueous phase and to help select groundwater monitoring well locations. The close support laboratory analyzed a total of 81 samples for the following organic compounds:

- Toluene
- Total xylenes
- 1,1,1-TCA
- TCE
- Perchloroethylene (PCE)

These compounds were selected on the bases of historical groundwater analyses, site history, and their chemical properties (e.g., mobility). Measured concentrations of





SOURCE: U.S. Geological Survey, Trempealeau, 15' Quadrangle.

FIGURE 1
SITE LOCATION MAP
ONALASKA
QAPP

GLE56572.RA.QS Site Loc Map Border 5/31/95kmw/tll

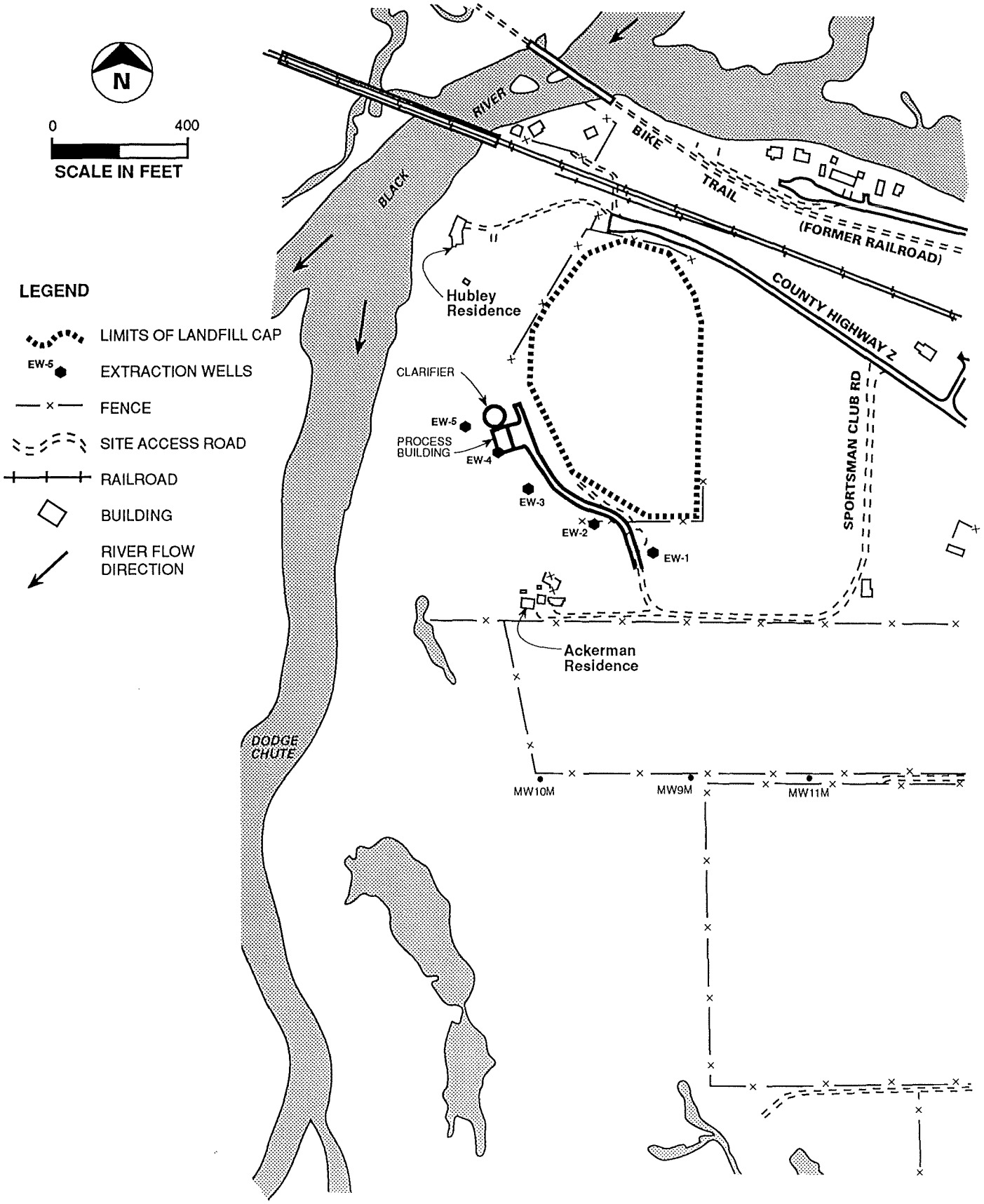


FIGURE 2
SITE MAP
ONALASKA LANDFILL
QAPP

GLE65672.RA.OS Site Map 5/15/95kmw

toluene were as high as 43,000 μg/L. Of the three chlorinated compounds analyzed for, 1,1,1-TCA was the most prevalent, and was found at concentrations as high as 730 μg/L.

Two rounds of groundwater sampling for contract laboratory analysis were conducted. These samples were analyzed for the complete target compound list (TCL) and 13 special analytical services (SAS) parameters.

Volatile organic compounds (VOCs) were generally observed to be present at concentrations much greater than semivolatile organic compounds (SVOCs), sometimes more than an order of magnitude greater. The majority of the VOCs detected during the RI were found in shallow monitoring wells (MW-5S, MW-3S, and B-4S) and were BTEX compounds. The vertical extent of BTEX and chlorinated compound contamination is mostly confined to the upper 10 to 20 feet of the aquifer. Ethylbenzene, 1,1-DCA and chloroethane were detected, however, at depths up to 50 to 60 feet below the water table. The vertical extent of SVOC contamination is also mostly confined to the upper 10 to 20 feet of the aquifer. There were no SVOCs detected in any of the deep monitoring wells.

Monitoring wells along the southwestern edge of the landfill and southwest of the landfill exhibited the most occurrences of inorganic chemicals in concentrations above background levels. These are primarily shallow and medium wells that included MW-2S, MW-2M, MW-3S, MW-4S, MW-B4S, MW-5S, and MW-8S. Four chemicals, barium, iron, manganese, and sodium, were detected above background with greater frequency than the other inorganic chemicals. The higher concentrations of these four chemicals tend to occur in wells along the southwestern edge of the landfill or southwest of the landfill.

Record of Decision Goals

The ROD, signed August 14, 1990, defines the selected remedy and addresses the goals of the remedial action. The ROD goals and selected remedy are consistent with the RI/FS and Proposed Plan. The selected action for the remedy includes the following remedial actions for groundwater:

- Extraction and treatment of the groundwater contaminant plume to meet Federal Safe Drinking Water Act (SDWA) drinking water standards and State of Wisconsin groundwater quality standards

- Periodic monitoring of the groundwater contaminant plume

- Deed restrictions limiting surface and groundwater use at the Onalaska Municipal Landfill site

- Continued reliance on state institutional controls governing groundwater use within the proximity of landfills

The groundwater remedial action goals stated in the ROD are to achieve Federal drinking water standards under the SDWA (Maximum Contaminant Levels [MCLs] or non-zero Maximum Contaminant Level Goals [MCLGs]) and the more stringent State of Wisconsin groundwater quality standards under Ch. NR 140, Wisconsin Administrative Code (Preventive Action Limits [PALs]).

The MCLs and non-zero MCLGs must be met at the landfill waste boundary and the more stringent Wisconsin standards (PALs) must be met at any point beyond the property boundary or the design management zone (DMZ).

If, after a minimum of 5 years of operation, it becomes apparent that it is technically or economically infeasible to achieve a Wisconsin PAL, then a Wisconsin alternative cleanup standard (WACL) may be considered.

If it becomes apparent that it is technically impractical to achieve the groundwater cleanup standards, including any WACL established, then alternate methods of controlling the groundwater plume or source would be considered. If those alternate methods are not able to attain the groundwater cleanup standards or WACL, then a Comprehensive Environmental Response and Compensation Liability Act (CERCLA) waiver may be considered.

Purpose

The purpose of this plan is to recommend procedures for periodic monitoring of the groundwater, surface water, and sediments over time. Periodic monitoring is necessary to verify that the groundwater collection system is containing the contaminated groundwater and preventing its migration, to evaluate whether adjacent wetlands and river are being impacted from the extraction of groundwater, and to determine whether the system is reducing the level of contaminants in the plume.

This plan discusses the following:

- Well monitoring network
- Groundwater sampling frequency at each well
- Groundwater Cleanup Standards
- Compounds to be analyzed for
- Supplementary sampling of adjacent surface water and sediments
- Sampling procedures, analytical programs, methods of analyses, Quality Assurance/Quality Control (QA/QC) protocols for CLP analyses
- Procedures for field measurements

- Reporting procedures
- Quality Assurance Project Plan (QAPP)
- Operation and Maintenance (O&M) of the wells

The guidelines presented in this groundwater monitoring plan are based on the best available information at the time of design and may not account for unanticipated field conditions. Therefore, the results of each data set collected shall be evaluated in the context of satisfying the intent of the ROD.

Sampling Rationale and Intended Data Use

The objectives of the groundwater monitoring program are to:

- Provide data to evaluate the effects of hydraulic gradient control and collection of contaminated groundwater within the aquifer
- Provide data to evaluate reduction of groundwater contaminant concentrations in the aquifer onsite in relation to associated cleanup criteria
- Provide data to evaluate reduction of groundwater contaminant concentrations in the aquifer offsite between the landfill and the Black River
- Monitor water levels in the wetlands adjacent to the site to ensure water levels are not lowered so as to adversely affect the wetlands.

These data shall be used to evaluate the effectiveness of the remedial action design and determine when groundwater extraction may cease.

Groundwater Monitoring Network

The groundwater monitoring network was designed to provide groundwater quality data for the site and adjacent area and is comprised of wells constructed during the RA and during the RI. The groundwater monitoring network consists of six new water table piezometers, one new monitoring well, six existing monitoring wells, and five new extraction wells. The selected monitoring wells are primarily located hydraulically downgradient to the south, southeast, and west of the landfill site. One monitoring well is located upgradient of the landfill to provide background groundwater quality. The rationale for selection of each well and piezometer is summarized in Table 1. These wells will permit evaluation of the hydraulic gradient control and groundwater quality in the aquifer. Well and piezometer locations are shown in Figure 3.

Table 1
Monitoring Well Network Rationale
Sheet 1 of 2

Well Designation	Rationale
PZ-01	Monitor groundwater level west of westernmost extraction well to determine if necessary capture zone is being attained
PZ-02 (New)	Monitor groundwater level between wetlands and extraction system to determine if wetlands water levels are being lowered
PZ-03	Monitor groundwater level between wetlands and extraction system to determine if wetlands water levels are being lowered
PZ-04	Monitor groundwater level between wetlands and extraction system to determine if wetlands water levels are being lowered
PZ-05 (New)	Monitor groundwater level east of easternmost extraction well to determine if necessary capture zone is being attained
PZ-06 (New)	Monitor groundwater level east of easternmost extraction well to determine if necessary capture zone is being attained
MW-1S	Monitor shallow background groundwater quality upgradient of the landfill and the extraction system to allow statistical evaluation of background groundwater characteristics
MW-6S	Monitor shallow groundwater quality and water levels downgradient of landfill and extraction system to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
MW-6M	Monitor intermediate groundwater quality and water levels downgradient of landfill and extraction system to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
MW-8S	Monitor shallow groundwater quality and water levels downgradient of landfill and extraction system to determine if contaminated groundwater has been captured (compliance point for Wisconsin PALs)

Table 1
Monitoring Well Network Rationale
Sheet 2 of 2

Well Designation	Rationale
MW-8M	Monitor intermediate groundwater quality and water levels downgradient of landfill and extraction system to determine if contaminated groundwater has been captured (compliance point for Wisconsin PALs)
MW-12S	Monitor shallow groundwater quality and water levels east of easternmost extraction well to determine if necessary capture zone is being attained and whether contaminated groundwater has been captured (compliance point for Wisconsin PALs)
MW-14S	Monitor shallow groundwater quality and water levels west of westernmost extraction well to determine if necessary capture zone is being attained and whether contaminated groundwater has been captured (compliance point for Wisconsin PALs)
EW-1	Groundwater extraction well——water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
EW-2	Groundwater extraction well——water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs).
EW-3	Groundwater extraction well——water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs).
EW-4	Groundwater extraction well——water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
EW-5	Groundwater extraction well——water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)

GLE65672.RA.QS MW & Piez Net 6/23/95kmw

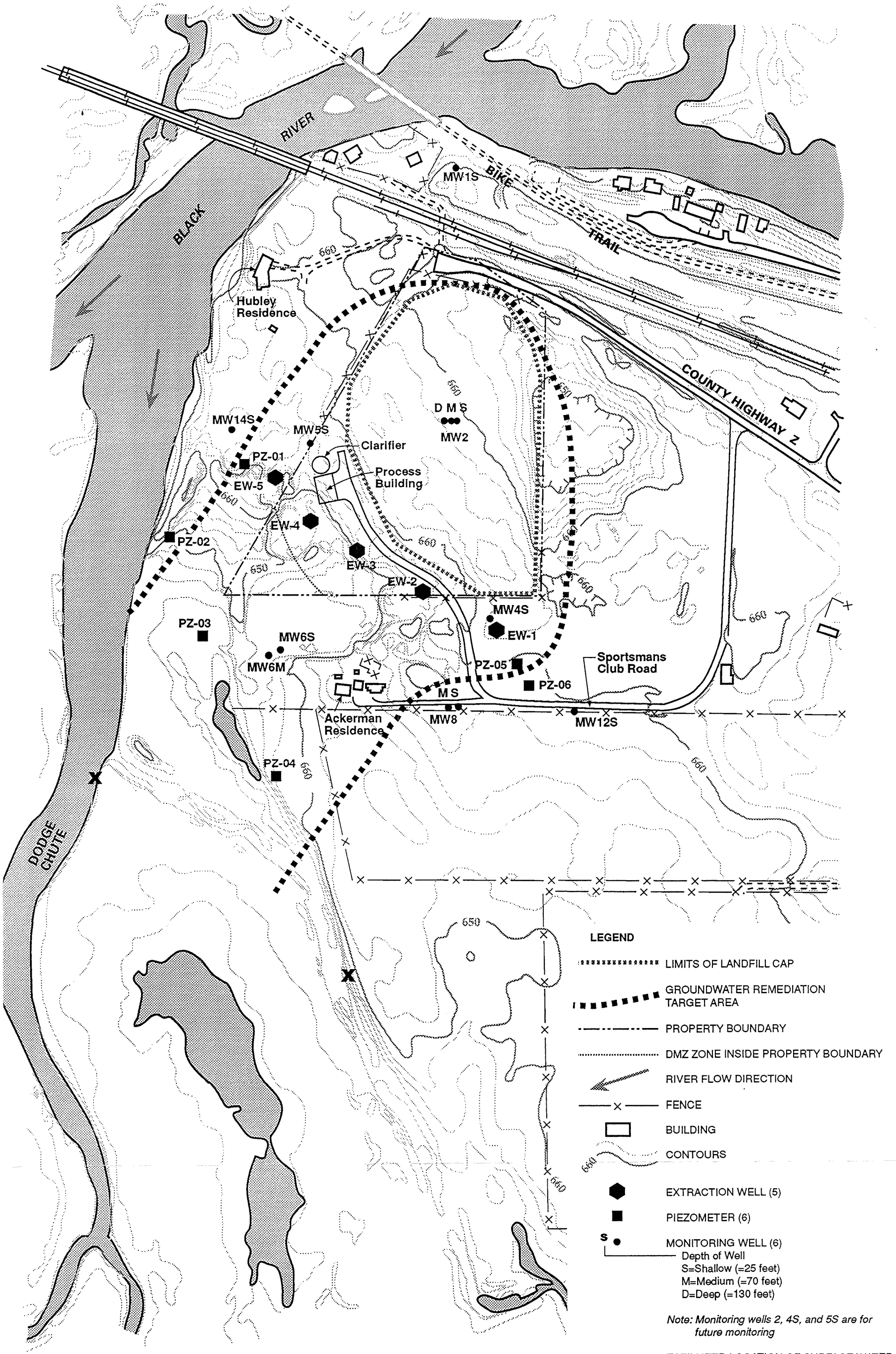


FIGURE 3
MONITORING WELL, EXTRACTION WELL, AND PIEZOMETER NETWORK
ONALASKA
QAPP

Piezometers

Six piezometers were installed for the purposes of determining the impact of groundwater pumping on the wetlands area to the south of the site, and to ensure that the plume of contaminated groundwater is being captured by the system of extraction wells. Potential adverse impacts on the wetlands will be evaluated using pre- and post-pumping groundwater elevation data collected at the two piezometers (PZ-03 and PZ-04) located in the wetlands area. Plume capture will be determined by the horizontal hydraulic gradients, as defined by the water table elevations in the piezometers and in the monitoring wells, such as MW-14S, which is located near the edge of the plume. Piezometer PZ-01 has been installed to measure the inward gradient along the western boundary of the plume. When installed, piezometers PZ-05 and PZ-06 will be used to measure the inward gradient along the eastern boundary of the plume. The rate of groundwater pumpage can be varied to provide the groundwater gradients necessary to capture the plume.

Monitoring Wells

The monitoring wells (MW-1S, MW-6S, MW-6M, MW-8S, MW-8M, MW-12S and MW-14S) shall be used to monitor:

- If contaminated groundwater has been captured successfully (contaminants of concern are below action levels at point of compliance)

- Groundwater quality changes downgradient of the collection system capture zone (i.e., how quickly concentrations of contaminants of concern decrease after the extraction system is functioning)

- Hydraulic gradient control (contaminated groundwater plume is moving toward the extraction wells)

Groundwater quality downgradient of the landfill and extraction well network will be monitored in shallow wells MW-6S (new) and MW-8S and in intermediate wells MW-6M and MW-8M. These well locations were selected to place wells outside of the capture zone. MW-12S and MW-14S are located on the periphery of the capture zone and will be used to monitor groundwater quality and hydraulic gradient control east and west of the extraction well network. MW-1S will be used to monitor background groundwater quality upgradient of the landfill.

Monitoring using only shallow and intermediate wells is proposed. The majority of the VOCs detected during the Remedial Investigation were found in shallow monitoring wells (MW-5S and former wells MW-3S and B4S). The vertical extent of BTEX and chlorinated compounds contamination is mostly confined to the upper 10 to 20 feet of the aquifer. Ethylbenzene, 1,1-DCA and chloroethane were detected, however, at depths up to 50 to 60 feet below the water table. The vertical extent of semivolatile organic

compounds (SVOCs) contamination is also mostly confined to the upper 10 to 20 feet of the aquifer. There were no SVOCs detected in any of the deep monitoring wells.

To verify that groundwater contaminants are not migrating vertically to lower depths, MW-2D will be sampled periodically for VOCs.

Extraction Wells

A series of five extraction wells have been installed in locations that capture the contaminant plume prior to offsite groundwater discharge. The extraction well network has been designed to extract approximately 800 gallons per minute (gpm) of contaminated groundwater for treatment. The rate of pumpage for each well can be varied during operation, based on results of monitoring wells and piezometers. Groundwater from the extraction wells will be monitored to assess the degree that contaminant cleanup is occurring.

Potential Additional Monitoring for Compliance with Groundwater Standards

The expected reduction in contaminant concentrations within the plume capture zone will be monitored by sampling the five extraction wells. If the contaminant concentrations in these wells decline to the groundwater cleanup standards, wells along the landfill waste boundary would require monitoring. The alternative wells to be monitored are shown in Figure 3 and include MW-4S and MW-5S. These wells represent the compliance point defined in the ROD (the landfill waste boundary) for MCLs and non-zero MCLGs. The compliance point for the PALs (any point beyond the property boundary or DMZ) are represented by monitoring wells MW-4S, MW-6S, MW-6M, MW-8S, MW-8M, MW-12S, and MW-14S and the extraction wells. The groundwater standards and compliance points are discussed in more detail later in this document.

Surface Water and Sediments

The groundwater beneath the site generally flows in a south-southwesterly direction toward the wetlands bordering the Black River. Although no site-derived contamination was detected in the surface water and sediment samples collected during the Remedial Investigation (RI), surface water and sediments will be sampled annually to monitor for potential offsite contaminant migration during performance of the remedial action. Surface water and sediment grab samples will be collected from the wetland area and Dodge Chute by the Wisconsin DNR.

Sampling Schedule and Frequency

The groundwater monitoring plan includes startup and quarterly sampling events from monitoring wells and extraction wells, and collection of quarterly groundwater elevation data from the six piezometers and monitoring wells. In addition, surface water and sediment samples will be collected by the WDNR from two or more locations.

The sampling schedule will be evaluated annually and adjusted as needed depending on the analytical results and the operation of the extraction and treatment system. The frequency of sampling will be re-evaluated annually. The sampling plan is described below.

Quarterly Sampling and Elevation Measurements

The primary purpose of the quarterly sampling and elevation measurements is to continue to evaluate the groundwater extraction and treatment system for reliable operation and monitor the reduction of contaminant concentrations in the aquifer. The quarterly sampling will also identify any seasonal fluctuations in groundwater quality. Quarterly groundwater samples from the seven monitoring wells, extraction wells number EW-1, EW-3, and EW-5, and two residential wells will be collected at the end of March, June, September, and December. The residential wells are at the Hubley and Ackerman homes. Extraction wells number EW-2 and EW-4 will be sampled biannually (during the months of June and December).

Quarterly groundwater elevation measurements will be taken from the piezometers and monitoring wells. Elevation measurements will also be taken from the extraction wells by the operator on a routine basis. The need for elevation data from the other existing monitoring wells will be evaluated after the first year.

Depending on the analytical results from the quarterly sampling and the absence of operational problems, the sampling schedule may be modified further. After 5 years of operation of the groundwater extraction and treatment system, the groundwater quality will be evaluated to determine if the groundwater standards are being met. In addition to the evaluation of results of quarterly samples collected over the 5-year period, a full priority pollutant scan will be performed to determine if additional parameters should be added to the compounds listed in Table 2. If the groundwater goals (or WACLs, if established) have not been met, sampling will continue until the cleanup goals are achieved. The frequency of sampling will be evaluated based on the trends observed in the first 5 years. If an applicable and appropriate requirements (ARAR) waiver is established, the groundwater goals and the need or frequency of further sampling will be addressed as part of the waiver process.

Table 2
Groundwater Monitoring Analyte List
and Action Levels

Target Analytes	Units	PAL[a]	MCL	MCLG	Detection Limit
ROD Compounds					
Benzene	µg/L	0.5	5	0	1.0
Toluene	µg/L	68.6	1,000	1,000	1.0
Xylenes	µg/L	124	10,000	10,000	1.0
Ethylbenzene	µg/L	140	700	700	1.0
Trichloroethene	µg/L	0.5	5	0	1.0
1,1-Dichloroethane	µg/L	85			1.0
1,1,1-Trichloroethane	µg/L	40	200	200	1.0
1,1-Dichloroethene	µg/L	0.7	7	7	1.0
Arsenic	µg/L	5	50	50	5
Barium	µg/L	400	2,000	2,000	200
Lead	µg/L	1.5	15	0.0	1.5
Others					
Tetrachloroethylene	µg/L	0.5	5	0	1
Chloride	mg/L	125			5
Total Organic Carbon (TOC)	mg/L	[b]			0.5
Total Dissolved Solids (TDS)	mg/L	[b]			20
Oil and Grease	mg/L				0.4
Alkalinity	mg/L	[b]			2
Hardness	mg/L	[b]			1
Iron	mg/L	0.15			0.1
Chemical Oxygen Demand (COD)	mg/L	[b]			5
Specific Conductance	µmhos/cm	[b]			
Manganese	mg/L	0.025			0.01
Color	color units	7.5			1
Turbidity	[c]				1
Odor	TON[d]	1.5			1

[a] Public Welfare Groundwater Quality Standard, NR 140.
[b] To be established from 8 rounds fo background data.
[c] Nephelometric turbidity units.
[d] Threshold odor number.

Annual Surface Water and Sediment Sampling

Annual surface water samples will be collected from the Black River, Dodge Chute, or wetland areas downgradient from the site. Specific locations will be determined by the WDNR. The primary purpose of these samples is to monitor for any unusual increase in contaminant concentrations that may be attributed to remedy implementation activities.

Analytical Procedures

Groundwater samples from the monitoring and extraction wells will be analyzed for the compounds listed in Table 2. Table 2 consists of compounds identified in Table 3B of the ROD as the "Chemicals of Concern" and additional parameters that were added to the ROD list in order to better monitor the landfill or as a means to meet Town of Onalaska and WDNR sampling and reporting requirements. The additional parameters are:

- Chloride and total dissolved solids (TDS) analyses will be used to indicate the relative strength of the leachate contributed by the landfill.

- Total organic carbon (TOC) analyses will be used to evaluate the organic strength of the leachate and help to monitor the diminishing contaminant concentrations in the plume.

- Oil and Grease analyses will be used to monitor for the presence of the nonaqueous phase contaminants detected in the RI.

- Tetrachloroethylene (PCE), total alkalinity, manganese, iron, chemical oxygen demand (COD), color odor, and turbidity were added to Table 2 to fulfill a Town of Onalaska requirement for semi-annual monitoring of these parameters. WDNR also requires that hardness and specific conductance be included for monitoring of groundwater downgradient from sanitary landfills.

Groundwater samples will be analyzed for the listed compounds, VOCs and inorganic chemicals in accordance with the analytical procedures specified in the quality assurance project plan (QAPP). Field temperature, pH, and specific conductance will also will be recorded for each well during sampling events. Field sampling procedures, methods of analyses, and QA/QC protocols for analyses will be conducted in accordance with the QAPP.

Groundwater Cleanup Standards

Under the remedy selected in the ROD, the following cleanup standards were adopted:

- Groundwater contaminant plume located at any point beyond the property boundary or DMZ:
  - Preventive Action Limits (PALs) from Wisconsin Administrative Code Chapter NR 140
- Groundwater contaminant plume located at landfill waste boundary:
  - Maximum Contaminant Levels (MCLs) from the Safe Drinking Water Act, 40 CFR 141.61 and 40 CFR 143
  - Maximum Contaminant Level Goals (MCLGs) above zero Safe Drinking Water Act, 40 CFR 141.50

The ROD requires that the more stringent Wisconsin standards promulgated in NR 140, WAC, be achieved "at any point beyond the property boundary or beyond the 3-dimensional design management zone, whichever is closer to the waste boundary." The DMZ as defined in NR 140 is a 3-dimensional boundary surrounding a regulated facility. The boundary extends from the ground surface through all saturated geological strata. The DMZ defined for the Onalaska site extends 250 feet horizontally from the waste boundary as shown in Figure 3. Because the property boundary is generally closer than the DMZ to the waste boundary, the PALs apply at the property boundary with the exception of the southwest corner of the property where the PALs apply to the DMZ.

The monitoring wells included in the groundwater monitoring network are located beyond the waste boundary shown in Figure 3. The analytical results from the groundwater samples will be compared to the groundwater contaminants of concern listed in Table 2.

If it is determined after 5 years of implementation of the remedial action that PALs cannot be met feasibly, a Wisconsin alternative concentration limit (WACL) may be proposed.

Data Analysis and Evaluation

Background Monitoring

Background groundwater quality will be measured in monitoring well MW-01S located upgradient of the landfill. Background monitoring will be conducted during seasonal high and low groundwater levels as indicated by historical groundwater level data and concurrent piezometer water elevation. Background concentrations from groundwater

will be established by statistical evaluation of eight sample results from the background well. For parameters that do not have a PAL established per NR 140.11 (Table 1), the PAL shall be the background value plus 3 standard deviations or the background value plus the increase in that parameter listed in Table 3 of NR 140.20, whichever is greater. Exceptions include field pH (PAL=1 unit above background) and field temperature (add/subtract 3 standard deviations or 10°F, depending on which is greater). The background concentrations will be evaluated to determine if regional groundwater quality exceeds PALs. If background concentrations exceed PALs, alternative concentration limits (ACLs) may be developed and used in lieu of PALs to evaluate if remedial action goals have been achieved.

Baseline Monitoring

Baseline monitoring was conducted in November of 1993 prior to commencement of the remedial action. Three discrete samples were collected and analyzed from monitoring wells MW-1S, MW-4S, MW-6S, MW-6M, MW-8S, MW-8M, MW-5S, MW-12S, and MW-14S in the monitoring program to develop baseline concentrations. Results from the baseline analyses will be used to establish initial conditions and spatial variability of quality in the sampled groundwater.

The mean and maximum will be calculated for all compounds analyzed for each well. These data will be used for the initial database to assess any future trends. The analytical results will be compared to background concentrations. Compounds that are detected above background concentrations will be compared to the Wisconsin PALs, MCLs, and MCLGs shown in Table 2.

Quarterly Monitoring and Evaluation

Quarterly samples will be analyzed for the VOCs, inorganic constituents and conventional parameters. Results from these analyses will be compiled and used to assess the implementation, operation, and maintenance of the groundwater extraction and treatment system, and to troubleshoot and improve system operation.

After each quarterly sampling round, the analytical results from each well will be compiled and used to monitor aquifer concentrations and evaluate the performance of the groundwater extraction and treatment system. These data will be used to identify and implement any corrective action required to maintain reliable operation. At the end of each year of quarterly sampling, the analytical results will be compiled and compared to the groundwater standards shown in Table 2 and evaluated for changes in the aquifer contaminant concentrations in the aquifer. Current Wisconsin DNR guidance [2] on methods for calculating compliance with groundwater quality regulations will be used to prepare these comparisons and evaluation of changes in concentrations.

Annual Evaluation of Quarterly Results

The quarterly results of the sampling and analysis program will be compiled annually. The analytical results will be averaged and the data evaluated to examine spatial and temporal trends. This analysis will also include groundwater elevation readings. The types of spatial and temporal trends conducted will be evaluated after each year of sampling. Initially, the analysis will include:

- Plots of mean concentration versus time for each parameter analyzed for the individual wells
- Plots of concentration versus time of moving averages for each parameter analyzed for individual wells
- Regression analyses on plots of moving average concentration versus time to determine direction of trends

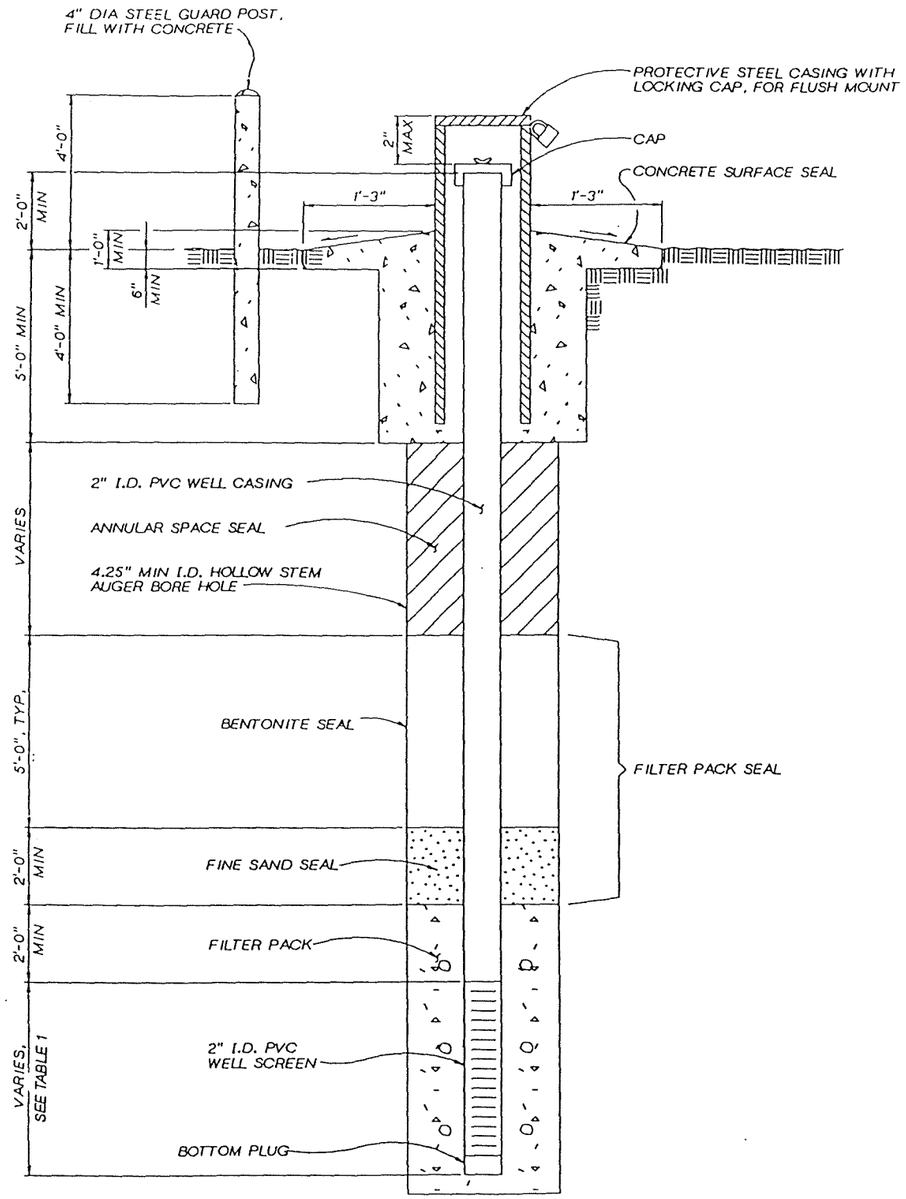
The entire monitoring program also will be reevaluated annually. Specific adjustments to the program that may be necessary include:

- Analyte list—Do analytes need to be added or deleted?
- Sampling frequencies—Are quarterly sampling and groundwater elevation readings adequate or excessive?
- Monitoring well network—Is the monitoring well network adequate? Does any well need to be replaced? Should additional wells be installed? Can some of the monitoring wells be deleted from the sampling program?
- Sampling program—Do the analytical data indicate that the overall concentrations are decreasing? Should the monitoring program continue?

At the end of the fifth year, all sampling results will be compiled. These analytical results will be averaged and evaluated for temporal trends. Compound concentrations will be compared with groundwater standards and evaluated.

Sampling Equipment and Procedures

General procedures for measuring water levels, performing field tests, and collecting water quality samples are described below. Additional details related to specific sampling and decontamination procedures, sampling frequencies, and analytical requirements are discussed in the QAPP.



TYPICAL WELL SECTION DETAIL
NTS

ABBREVIATIONS

FMC = FLUSH MOUNT COVER

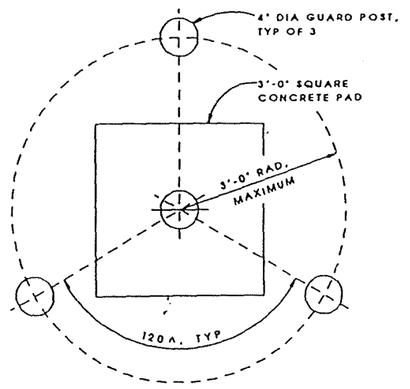
PSC = PROTECTIVE STEEL CASING

NOTE:

1. MONITORING WELL DEPTHS AND INSTALLATION DETAILS SHOWN ARE APPROXIMATE AND/OR ESTIMATED. ACTUAL DEPTHS AND FINAL INSTALLATION DETAILS WILL BE DETERMINED BY THE ENGINEER IN THE FIELD.

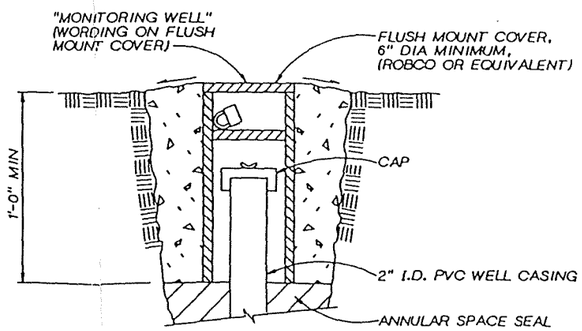
TABLE 1
PIEZOMETER AND MONITORING WELL DEPTHS AND INSTALLATION DETAILS

MONITORING WELL NUMBER	APPROXIMATE TOTAL DEPTH (FT)	APPROXIMATE WELL CASING LENGTH (FT)	WELL SCREEN LENGTH (FT)	TYPE OF PROTECTIVE COVER
PZ-01	30	20	10	PSC
PZ-02	30	20	10	PSC
PZ-03	30	20	10	PSC
PZ-04	30	20	10	PSC
PZ-05	30	20	10	PSC
PZ-06	30	20	10	PSC
MW-65	30	20	10	PSC



PLAN

CONCRETE PAD AND GUARD DETAIL
NTS



FLUSH MOUNT DETAIL
NTS

FIGURE 4
PIEZOMETER AND MONITORING WELL CONSTRUCTION DETAILS
ONALASKA LANDFILL GM

GLO5602.DS.GM F5 BORDER 1-27-92mms

All wells will be sampled using the same equipment and procedures. Wells installed during the remedial investigation were constructed using both PVC and stainless steel riser and screens. The single well and the piezometers installed during remedial action were constructed using 2-inch Schedule 40 PVC. Typical well and piezometer construction details are shown in Figure 4.

All surface water and sediment samples will be collected using the equipment identified below.

Field Equipment

The following equipment is required to sample the wells:

- Equipment needed to open the wells
  - Key to unlock wells
  - Organic vapor detector (HNu or OVA)
- Equipment for measuring water levels
  - Electronic water level indicator
- Equipment for purging wells
  - Bailer
  - Nylon cord
  - Buckets or containers of known volume to measure purge water quantity
- Sample collection and field testing equipment
  - Bailer (dedicated bailers are in most wells)
  - Sample containers with preservatives and labels provided by the analytical laboratory
  - Ice chest, ice
  - Thermometer (0° to 50°C range)
  - Conductance and pH meter
  - Groundwater quality field test data sheets

- Decontamination solutions, containers, brushes, etc.

- Sample Records

  - Daily activity logs and field notebooks
  - Laboratory log sheets and chain-of-custody forms

Preventive Maintenance

Well Covers and Protection

The well covers and surface protection (bumper posts) require minimum maintenance. The protective steel casings require periodic painting to prevent rusting. Damaged locks on well covers will be replaced as needed. Damaged concrete surface pads around wells will be repaired or replaced as needed.

Field Equipment

Each piece of field equipment will be tested prior to each use to verify it is in proper working order before it is sent to the site. Only properly-working equipment will be sent to the site. The instrument operator's manual will dictate the frequency of calibration and maintenance.

Groundwater Sampling and Measurements

Each well consists of a 2-inch-diameter Schedule 40 PVC well riser and well screen. The general sampling procedures and sequence described below are recommended as a guide to sampling each well. Groundwater measurements and sampling will proceed in the following sequence:

1. Organize and decontaminate sampling equipment and calibrate instruments

2. Remove padlock

3. Open well cover and remove well riser cap

4. Monitor inside well casing with an organic vapor detector

5. Measure and record static water level relative to top of casing per procedures summarized below (see Groundwater Elevation Measurements)

6. Calculate and record the volume of water in the well in accordance with the following formula:

   - Wellbore water volume = $\pi \times r^2 \times h$,

where h = height of water column
r = radius of well bore

(Note: Units must be consistent in all calculations)

7. Purge well per procedures summarized below (see Procedures to Purge Wells)

8. Perform field analyses; record pH, specific conductance and temperature readings

9. Collect water samples per procedures outlined below (see Water Sample Collection Procedures)

10. Preserve samples for storage and laboratory analyses

11. Complete sample records and chain-of-custody forms and seals

12. Ship samples via overnight courier to analytical laboratory

Groundwater Elevation Measurements

Determine the depth to water in the well to the nearest 0.01 foot using an electronic water level indicator. When the electrode or probe comes into contact with the water, an electrical circuit is completed, activating the meter light and beeper. Determine the depth of water using the following steps:

1. Lower the electrode or probe into the well by pulling the cable from the hand-held reel.

2. Continue lowering until completion of the circuit is indicated by illumination of the small light, a beep, or deflection of the ammeter needle.

3. Measure the length of cable in the well from the marked edge on the top of casing to the probe (depth to the water table) to the nearest 0.01 foot and subtract this length from the top of the casing elevation to determine the water table elevation.

4. Record depth on Groundwater Sampling Field Data Record sheet (shown in Figure 5).

Procedures to Purge Wells

Prior to sampling, wells will be purged by removing three to five standing water column volumes as calculated previously. The amount of purge water will be measured by filling

and counting 5-gallon buckets. Disposal of purge water will follow procedures in the waste disposal plan discussed below.

Water Sample Collection Methods

Samples will be collected after the requisite volume has been purged from the well. Volatile organic analysis (VOA) vials will be filled first; containers for filtered metals will be filled last. Collect VOA samples first. Place the mouth of the VOA vial at the end of the bailer and allow bottle to fill slowly. Fill vial in a steady, gentle stream with a minimum of agitation. Fill until a meniscus forms on the mouth of the VOA vial. Cap vial and check for air bubbles by inverting vial and tapping on the palm of the hand. If bubbles are present, repeat procedure until a bubble-free sample is obtained.

Fill remaining sample containers to the shoulder. Filtered metals samples should be field filtered. Field filtering procedures are described in Appendix D of this document or in the QAPP.

Sample Shipping

Coolers will be used to transport samples from the field to the analytical laboratory. Samples requiring preservation by cooling will be kept cold and uniform at all times.

All shipments will be accompanied by a chain-of-custody record identifying the contents. The original record will accompany the shipment, and a copy will be retained by the sampler.

The copy of the airbill accompanying each shipping container will be retained as part of the permanent documentation. Commercial carriers are not required to sign the custody form as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact.

Waste Disposal

Wastes generated during sampling will consist of well purge water, wastes from decontamination, and protective clothing.

If HNu reading (or equivalent photoionization device) exceeds 1 ppm, the water will be treated in the onsite groundwater treatment system. If HNu headspace readings are less than 1 part per million (ppm), purge water will be discharged to the ground.

Decontamination

Field equipment used in well sampling will be decontaminated between wells with a TSP and distilled water solution, followed by a 10 percent methanol and distilled water

solution, followed by a distilled water rinse. At the conclusion of the sampling event, sampling equipment will be decontaminated again with this procedure.

Corrective Action

Field Corrections

Deviations from routine procedures and subsequent corrective measures will be documented in a field log book and reported to the appropriate agency. Because possible deviations are dependent upon unknown field conditions, corrective measures cannot be specified. For field measurements, the corrective action must be suited to the situation and may include:

- Repetition of measurement to check the error
- Checking batteries
- Recalibration of the instrument
- Replacement of the instrument

Reporting

Quarterly

The quarterly report will consist of a Technical Memorandum (TM) to the U.S. EPA and Wisconsin Department of Natural Resources. The major components of the report will be:

- Date of the monthly sampling events
- Personnel involved in the sampling event(s) and their respective responsibilities
- List of the wells sampled during the event or monthly events
- Summary of the procedures used during the sampling event, including any noted deviations
- List of pertinent observations taken during the sampling events
- Summary of the analytical data with QA/QC qualifiers
- List of contaminants of concern detected and their concentrations
- Comparison of results to groundwater standards

GROUNDWATER SAMPLING FIELD DATA RECORD

GENERAL INFORMATION

SITE _____ WELL NUMBER _____

SAMPLE TEAM _____

WEATHER CONDITIONS _____

EQUIPMENT LOG

	Make/Model	Serial/ID No.	Calibration Date	Calibration Time	Calibration Initials	Comments
pH Meter						
Conductivity Meter						
Water Level Ind.						
Pump						

WELL CONDITION, ELEVATIONS/DEPTHS (1)

Locked Yes	Locked No	Comments (General Observations/Exceptions	Depth of Well Original	Depth of Well Current	Depth to Water	Elev. of Riser	Elev. of Water	Wellbore Water Volume (2)

PURGE INFORMATION

Date	Time	Volume (3)	Temp. (4)	pH (4)	Cond. (4)	HNu/OVA	Comments (Odor, Clarity, etc.)

SAMPLE INFORMATION

Date	Time	Sample Number	Comments (Include Modifications to QAPP/SP)

REMARKS

_____

Notes:
(1) All depths in feet from northern rim of the top of well riser, unless otherwise noted. All elevations in feet above mean sea level (N.G.V.D.), unless otherwise noted.
(2) Wellbore water volume = $\pi r^2 h$, where r=radius of well and h=height of water column for a 2-inch diameter well, volume=.022xh.
(3) Cummulative volume of water in feet.
(4) Readings required at least once for each wellbore water volume purged.

FIGURE 5
FIELD SHEET
ONALASKA LANDFILL GM

- Data table of groundwater elevation data

The TM will be delivered within 30 days following receipt of all analytical data and QA reviews.

Annual

The annual report to the U.S. EPA and Wisconsin Department of Natural Resources will consist of:

- Date and time of the sampling events
- Personnel involved in the sampling events and their respective responsibilities
- List of the wells sampled during the event
- Summary of the procedures used during the sampling event, including any deviations from standard procedures
- List of pertinent observations taken during the sampling event
- Summary of the analytical results received from the laboratory and the validated results
- Comparison of the initial database with analytical results
- Temporal and spatial trends of the contaminant plume concentrations
- A summary of average concentrations (for each well) for the contaminants of concern
- Recommendations of changes to monitoring program including additions to the contaminants of concern
- Appendix containing quarterly TMs
- Appendix addressing the analytical data and the QA/QA evaluations of the laboratory data

Data attachments to the annual report will include:

- Data validation report
- Chain-of-custody forms

- Data table of compiled potentiometric values (groundwater elevation measurements) for all monitoring wells

- Field parameter sheets

- Potentiometric surface map (groundwater contour map) drawn using the potentiometric values collected during the sampling event

The annual report will be delivered within 60 days after receipt of all analytical data and quality assurance (QA) reviews for the annual sampling round. The reports for the quarterly and semi-annual sampling rounds will be delivered separately within the reporting period, and also will be incorporated into the annual report.

References

[1] *Operation and Maintenance Summary Manual, Groundwater Treatment Remedial Action.* CH2M HILL. August 1994.

[2] *Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal Facilities.* Wisconsin Department of Natural Resources. January 1989.

[3] *Quality Assurance Project Plan, Onalaska Municipal Landfill, Onalaska, Wisconsin, Groundwater Remedial Action.* March, 1995.

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APPENDIX A
GROUNDWATER QUALITY STANDARDS WISCONSIN ADMINISTRATIVE CODE NR 140

Chapter NR 140

GROUNDWATER QUALITY

Subchapter I — General

NR 140.01 Purpose. The purpose of this chapter is to establish groundwater quality standards for substances detected in or having a reasonable probability of entering the groundwater resources of the state; to specify scientifically valid procedures for determining if a numerical standard has been attained or exceeded; to specify procedures for establishing points of standards application, and for evaluating groundwater monitoring data; to establish ranges of responses the department may require if a groundwater standard is attained or exceeded; and to provide for exemptions for facilities, practices and activities regulated by the department.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85.

NR 140.02 Regulatory framework. (1) This chapter supplements the regulatory authority elsewhere in the statutes and administrative rules. The department will continue to exercise the powers and duties in those regulatory programs, consistent with the enforcement standards and preventive action limits for substances in groundwater under this chapter. This chapter provides guidelines and procedures for the exercise of regulatory authority which is established elsewhere in the statutes and administrative rules, and does not create independent regulatory authority.

(2) The department may adopt regulations which establish specific design and management criteria for regulated facilities or activities, if the regulations will ensure that the regulated facilities and activities will not cause the concentration of a substance in groundwater affected by the facilities or activities to exceed the enforcement standards and preventive action limits under this chapter at a point of standards application. The department may adopt more stringent regulations under authority elsewhere in the statutes based on the best currently available technology for regulated activities and practices which ensure a greater degree of groundwater protection or when necessary to comply with state or federal laws.

(3) Preventive action limits serve to inform the department of potential groundwater contamination problems, establish the level of groundwater contamination at which the department is required to commence efforts to control the contamination and provide a basis for design and management practice criteria in administrative rules. Preventive action limits are applicable both to controlling new releases of contamination as well as to restoring groundwater quality contaminated by past releases of contaminants. Although a preventive action limit is not intended to always require remedial action, activities affecting groundwater must be regulated to minimize the level of substances to the extent technically and economically feasible, and to maintain compliance with the preventive action limits unless compliance with the preventive action limits is not technically and economically feasible.

(4) The department may take any actions within the context of regulatory programs established in statutes or rules outside of this chapter, if those actions are necessary to protect public health and welfare or prevent a significant damaging effect on groundwater or surface water quality for present or future consumptive or nonconsumptive uses, whether or not an enforcement standard and preventive action limit for a substance have been adopted under this chapter. Nothing in this chapter authorizes an impact on groundwater quality which would cause surface water quality standards contained in chs. NR 102 to 105 to be attained or exceeded.

History: Cr. Register, January, 1992, No. 433, eff. 2-1-92; reprinted to restore dropped copy, Register, March, 1992, No. 435.

NR 140.03 Applicability. This subchapter and subch. II apply to all facilities, practices and activities which may affect groundwater quality and which are regulated under ch. 85, 93, 94, 101, 144, 145, 146 or 147, Stats., by the department of agriculture, trade and consumer protection, the department of industry, labor and human relations, the department of transportation, or the department of natural resources, as well as to facilities, practices and activities which may affect groundwater quality which are regulated by other regulatory agencies. Health-related enforcement standards adopted in s. NR 140.10 also apply to bottled drinking water manufactured, bottled, sold or distributed in this state as required by s. 97.34 (3) (b), Stats., and to determining eligibility for the well compensation program under s. 144.027, Stats. Subchapter III applies to all facilities, practices and activities which may affect groundwater quality and which are regulated by the department under ch. 144, 146 or 147, Stats. This chapter does not apply to any facilities, practices or activities on a prospecting site or a mining site because those facilities, practices and activities are subject to the groundwater quality requirements of chs. NR 131, 132 and 182. The department may promulgate new rules or amend rules governing facilities, practices or activities regulated under ss. 144.80 to 144.94, Stats., if the department determines that the amendment or promulgation of rules is necessary to protect public health, safety or welfare. The requirements of this chapter are in addition to the requirements of any other statutes and rules.

Note: This chapter does not apply to public water systems except for the purpose of determining eligibility for well compensation as stated above. Chapter NR 809 contains maximum contaminant levels applicable to public water systems. Drinking water maximum contaminant levels and health advisory levels may take into account such factors as treatment costs and feasibility for public water systems.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85.

NR 140.05 Definitions. (1) "Accuracy" means the closeness of a measured value to its generally accepted value or its value based upon an accepted reference standard.

(1m) "Alternative concentration limit" means the concentration of a substance in groundwater established by the department for a site to replace a preventive action limit or enforcement standard or both, from Table 1 or 2, when an exemption is granted in accordance with s. NR 140.28.

(2) "Attain or exceed" means that the concentration of a substance is determined to be equal to or greater than the preventive action limit or enforcement standard for that substance.

(3) "Background water quality" or "background concentration" means groundwater quality at or near a facility, practice or activity which has not been affected by that facility, practice or activity.

(4) "Certified laboratory" means a laboratory which performs tests for hire in connection with a covered program and which receives certification under s. 144.95 (7), Stats., or receives reciprocal recognition under s. 144.95 (5), Stats.

(5) "Department" means the department of natural resources.

(6) "Design management zone" means a 3-dimensional boundary surrounding each regulated facility, practice or activity established under s. NR 140.22 (3).

(7) "Enforcement standard" means a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.07, Stats., and s. NR 140.10 or s. 160.09, Stats., and s. NR 140.12.

(8) "Facility, practice or activity" means any source or potential source of a substance which is detected in or has a reasonable probability of entering the groundwater resources of the state.

(9) "Groundwater" means any of the waters of the state, as defined in s. 144.01 (19), Stats., occurring in a saturated subsurface geological formation of rock or soil.

(10) "Indicator parameter" means a substance for which a preventive action limit has been established under s. NR 140.20, which is used to indicate the potential for a preventive action limit established under s. NR 140.10 or 140.12 to be attained or exceeded and for which an enforcement standard has not been established under s. NR 140.10 or 140.12.

(11) "Land disposal system" means a facility for disposing of liquid wastes consisting of:

(a) An absorption or seepage pond system,

(b) A ridge and furrow system;

(c) A spray irrigation system,

(d) An overland flow system,

(e) A subsurface field absorption system,

(f) A land spreading system, or

(g) Any other land area receiving liquid waste discharges.

(12) "Limit of detection" means the lowest concentration for an analytical test method and sample matrix at which the presence of a substance can be identified in an analytical sample, with a stated degree of confidence, regardless of whether the concentration of the substance in the sample can be quantified.

(13) "Limit of quantitation" means the lowest concentration for an analytical test method and sample matrix at which the quantity of a particular substance can be measured with a stated degree of confidence.

(14) "Monitoring" means all procedures used to collect data on groundwater, surface water or soils.

(15) "Point of standards application" means the specific location, depth or distance from a facility, activity or practice at which the concentration of a substance in groundwater is measured for purposes of determining whether a preventive action limit or an enforcement standard has been attained or exceeded.

(16) "Precision" means the closeness of repeated measurements of the same parameter within a sample.

(17) "Preventive action limit" means a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.15, Stats., and s. NR 140.10, 140.12 or 140.20.

(18) "Property boundary" means the boundary of the total contiguous parcel of land owned or leased by a common owner or lessor, regardless of whether public or private roads run through the parcel.

(19) "Registered laboratory" means a laboratory which is registered under s. 144.95 (8), Stats., or receives reciprocal recognition under s. 144.95 (5), Stats.

(20) "Regulatory agency" means the department of agriculture, trade and consumer protection, the department of industry, labor and human relations, the department of transportation, the department of natural resources and other state agencies which regulate activities, facilities or practices which are related to substances which have been detected in or have reasonable probability of entering the groundwater resources of the state.

(20h) "Remedial action" means a response which is taken to achieve compliance with groundwater quality standards established under this chapter. This term includes, but is not limited to, actions designed to prevent or minimize the further discharge or release of substances to groundwater and actions designed to renovate or restore groundwater quality.

(20m) "Response" means any action taken to respond to an attainment or exceedance of a preventive action limit or enforcement standard as required by s. NR 140.24 or 140.26.

Note: A response may include a remedial action.

(21) "Substance" means any solid, liquid, semisolid, dissolved solid or gaseous material, naturally occurring or man-made chemical, parameter for measurement of water quality or biological organism which, in its original form, or as a metabolite or a degradation or waste product, may decrease the quality of groundwater.

(22) "Wastewater and sludge storage or treatment lagoon" means a natural or man-made containment structure, constructed primarily of

earthen materials for the treatment or storage of wastewater or sludge, which is not a land disposal system.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; cr. (1m), am. (7), (17) and (18), Register, October, 1988, No. 394, eff. 11-1-88; am. (6), cr. (20h) and (20m), Register, March, 1994, No. 459, eff. 4-1-94.

Subchapter II — Groundwater Quality Standards

NR 140.10 Public health related groundwater standards. The groundwater quality standards for substances of public health concern are listed in Table 1.

Note: For all substances that have carcinogenic, mutagenic or teratogenic properties or interactive effects, the preventive action limit is 10% of the enforcement standard. The preventive action limit is 20% of the enforcement standard for all other substances that are of public health concern. Enforcement standards and preventive action limits for additional substances will be added to Table I as recommendations are developed pursuant to ss. 160.07, 160.13 and 160.15, Stats.

Table 1
Public Health Groundwater Quality Standards

Substance	*Enforcement Standard (micrograms per liter - except as noted)*	*Preventive Action Limit (micrograms per liter - except as noted)*
Acetone	1000	200
Alachlor	2	0.2
Aldicarb	10	2
Arsenic	50	5
Asbestos	7 million fibers per liter (MFL)	0.7 MFL
Atrazine, total chlorinated residue	3′	.3′
Bacteria, Total Coliform	Less than one in 100 ml for membrane filter method or not present in any 10 ml portion by fermentation tube method for both preventive action limit and enforcement standard	
Barium	2 milligrams/liter (mg/l)	.4 mg/l
Benzene	5	0.5
Benzo (a) pyrene	0.003	0.0003
Bromodichloromethane	179	36
Bromoform	4.4	0.44
Butylate	67	6.7
Cadmium	5	0.5
Carbaryl	960	192
Carbofuran	40	8
Carbon Tetrachloride	5	.5
Chloramben	150	30
Chlordane	2	0.2
Chloroethane (Ethyl chloride)	400	80
Chloroform	6	.6
Chromium	100	10
Copper	1300	130
Cyanazine	12.5	1.25
Cyanide	200	40
Dibromochloromethane (Chlorodibromomethane)	215	43
1,2-Dibromoethane (EDB, ethylene dibromide, dibromoethane)	0.05	0.005
1,2-Dibromo-3-chloropropane (DBCP, dibromochloropropane)	0.2	0.02
Dicamba	300	60
Dichlorodifluoromethane (Freon 12)	1000	200
1,2-Dichlorobenzene (O-dichlorobenzene)	600	60
1,3-Dichlorobenzene (M-dichlorobenzene)	1250	125

1,4-Dichlorobenzene (p-Dichlorobenzene)	75	15
1,1-Dichloroethane	850	85
1,2-Dichloroethane	5	0.5
1,1-Dichloroethylene	7	0.7
1,2-Dichloroethylene (cis)	70	7
1,2-Dichloroethylene (trans)	100	20
2,4-Dichlorophenoxyacetic Acid (2,4-D)	70	7
1,2-Dichloropropane	5	0.5
Di (2-ethylhexyl) phthalate (Bis(2-ethylhexyl) phthalate)	3	0.3
Dimethoate	2	.4
2,4-Dinitrotoluene	0.05	0.005
2,6-Dinitrotoluene	0.05	0.005
Dinoseb	13	2.6
Dioxin (2, 3, 7, 8-TCDD)	.00000022	.000000022
Endrin	.2	.02
EPTC (Eptam)	250	50
Ethylbenzene	700	140
Ethylene glycol	7 mg/l	0.7 mg/l
Fluoride	4 mg/l	0.8 mg/l
Fluorotrichloromethane (Freon-11, trichlorofluoromethane)	3490	698
Formaldehyde	1000	100
Heptachlor	0.4	0.04
Heptachlor epoxide	0.2	0.02
Lead	15	1.5
Lindane	0.2	0.02
Mercury	2	0.2
Methoxychlor	40	4
Methylene Chloride (Dichloromethane)	150	15
Methyl ethyl ketone (MEK)	460	90
Methyl isobutyl ketone (MIBK, 4-methyl-2-pentanone, isopropylacetone)	500	50
Methyl tert-butyl ether (MTBE, 2-methoxy-2-methylpropane)	60	12
Metolachlor	15	1.5
Metribuzin	250	50
Monochlorobenzene (Chlorobenzene)	100	20
Naphthalene	40	8
Nitrate (as N)	10 mg/l	2 mg/l
Nitrate + Nitrite (as N)	10 mg/l	2 mg/l
Nitrite (as N)	1 mg/l	0.2 mg/l
Pentachlorophenol (PCP)	1	0.1
Polychlorinated biphenyls (PCBs)	0.03	0.003
Phenol	6 mg/l	1.2 mg/l
Selenium	50	10
Silver	50	10
Simazine	1.7	0.17
Styrene (Ethenylbenzene)	100	10
Tetrachloroethylene (Perchloroethylene)	5	0.5
Tetrahydrofuran	50	10
Toluene	343	68.6
Toxaphene	3	0.3
1,1,1-Trichloroethane	200	40
1,1,2-Trichloroethane	.6	.06
Trichloroethylene (TCE)	5	0.5
2,4,5-Trichlorophenoxypropionic Acid (2,4,5-TP, silvex)	50	5
Trifluralin	7.5	.75
Vinyl Chloride	.2	0.02
Xylene	620	124

[1] Total chlorinated atrazine residue includes parent compound and the following metabolites of health concern: deethylatrazine, deisopropylatrazine and diaminoatrazine.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. table 1, Register, October, 1988, No. 394, eff. 11-1-88; am. table 1, Register, September, 1990, No. 417, eff. 10-1-90; am. Register, January, 1992, No. 433, eff. 2-1-92; am. Table 1, Register, March, 1994, No. 459, eff. 4-1-94.

NR 140.12 Public welfare related groundwater standards. The groundwater quality standards for substances of public welfare concern are listed in Table 2.

Note: For each substance of public welfare concern, the preventive action limit is 50% of the established enforcement standard.

Table 2
Public Welfare Groundwater Quality Standards

Substance	*Enforcement Standard (milligrams per liter - except as noted)*	*Preventive Action Limit (milligrams per liter - except as noted)*
Chloride	250	125
Color	15 color units	7.5 color units
Foaming agents MBAS (Methylene-Blue Active Substances)	.5	.25
Iron	.3	.15
Manganese	.05	.025
Odor	3 (Threshold Odor No.)	1.5 (Threshold Odor No.)
Sulfate	250	125
Zinc	5	2.5

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. table 2, Register, October, 1990, No. 418, eff. 11-1-90; am. Table 2, Register, March, 1994, No. 459, eff. 4-1-94.

NR 140.14 Statistical procedures. (1) If a preventive action limit or an enforcement standard for a substance listed in Table 1 or 2, an alternative concentration limit issued in accordance with s. NR 140.28 or a preventive action limit for an indicator parameter established according to s. NR 140.20 (2) is attained or exceeded at a point of standards application:

(a) The owner or operator of the facility, practice or activity at which a standard is attained or exceeded shall notify the appropriate regulatory agency that a standard has been attained or exceeded; and

(b) The regulatory agency shall require a response in accordance with the rules promulgated under s. 160.21, Stats. No response shall be required if it is demonstrated to the satisfaction of the appropriate regulatory agency that a scientifically valid determination cannot be made that the preventive action limit or enforcement standard for a substance in Table 1 or 2 has been attained or exceeded based on consideration of sampling procedures or laboratory precision and accuracy, at a significance level of 0.05.

(2) The regulatory agency shall use one or more valid statistical procedures to determine if a change in the concentration of a substance has occurred. A significance level of 0.05 shall be used for all tests.

(3) In addition to sub. (2), the following applies when a preventive action limit or enforcement standard is below the limit of quantitation:

(a) If a substance is not detected in a sample and the limit of detection is higher than the preventive action limit or enforcement standard for that substance, the preventive action limit or enforcement standard shall be considered not to have been attained or exceeded.

(b) If a substance is reported to be present in a sample above the limit of detection but below the limit of quantitation, and if the preventive action limit or enforcement standard for that substance is below the limit of detection, the preventive action limit or enforcement standard shall be

considered to have been attained or exceeded only if the presence of that substance has been confirmed by the use of an appropriate statistical test at a significance level of 0.05.

(c) The owner or operator of the facility, practice or activity shall report the limit of detection and the limit of quantitation with the sample results when requested by the regulatory agency.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1) (intro.) and (b), r. and recr. (2), Register, October, 1988, No. 394, eff. 11-1-88; am. (1) (b), (2) and (3) (b), Register, September, 1990, No. 417, eff. 10-1-90; am. (1) (b), Register, March, 1994, No. 459, eff. 4-1-94.

NR 140.16 Monitoring and laboratory data requirements. (1) All water quality samples collected to determine compliance with ch. 160, Stats., except samples collected for total coliform bacteria analysis and field analyses for pH, specific conductance, and temperature, shall be analyzed by a laboratory certified or registered under ch. NR 149. Samples for total coliform bacteria analysis shall be analyzed by the state laboratory of hygiene or at a laboratory approved or certified by the department of health and social services. The results of the analysis shall be submitted to the department and the appropriate regulatory agency. Except as provided in s. NR 205.07 (3) (c) for wastewater permittees, this subsection does not require the submission of groundwater monitoring data which is collected voluntarily and which is not being collected to determine compliance with this chapter or other laws. The samples shall be collected in accordance with procedures specified by the department or, where no procedures are specified, in accordance with published sampling procedures. The specified sampling procedures may include requirements for field filtration.

Note: Published sampling procedures include those contained in the following sources. Other published sampling procedures are also acceptable.

1. "Groundwater Sampling Procedures Guidelines." Wisconsin Department of Natural Resources, PUBL-WR-153, February 1987.

2. "Groundwater Sampling Procedures Field Manual." Wisconsin Department of Natural Resources, PUBL-WR-168, September 1987.

3. "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Sites." EPA SW-611, Office of Water and Waste Management, U.S. Environmental Protection Agency, Dec. 1980, Washington, D.C.

4. "Techniques of Water Resources Investigations of the United States Geological Survey, Guidelines for Collection and Field Analysis of Ground Water Samples for Selected Unstable Constituents," Book I, Chapter D2, U.S. Geological Survey, Washington, D.C.

5. "Procedures for the Collection of Representative Water Quality Data from Monitoring Wells," Cooperative Groundwater Report 7, Illinois State Water Survey, 1981, Champaign, Illinois.

6. "Manual of Ground Water Sampling Procedures," NWWA/EPA Series, Robert S. Kerr, Environmental Research Laboratory, 1981, Ada, Oklahoma.

(2) The laboratory shall select the analytical methodology which:

(a) Is specified in rules or approved by the regulatory agency, and

(b) Is appropriate for the concentration of the sample, and

(c) Is one of the following:

1. Has a limit of detection and limit of quantitation below the preventive action limit, or

2. Produces the lowest available limit of detection and limit of quantitation if the limit of detection and limit of quantitation are above the preventive action limit.

(3) If the owner or operator of a facility, practice or activity believes that a sample result does not represent groundwater quality in the vicinity of the facility, practice or activity, the owner or operator shall resample the appropriate well or wells to obtain a representative sample at the earliest possible time. All sample results shall be submitted to the department and the appropriate regulatory agency with an explanation of why the owner or operator believes that all or some of the results are invalid.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1), Register, September, 1990, No. 417, eff. 10-1-90; am. (1), r. and recr. (2), Register, March, 1994, No. 459, eff. 4-1-94.

Subchapter III — Evaluation and Response Procedures

NR 140.20 Indicator parameter groundwater standards. (1) ESTABLISHING BACKGROUND WATER QUALITY. Background water quality at a facility, practice or activity at which monitoring is required shall be established by sampling one or more monitoring points at locations and depths sufficient to yield groundwater samples that are representative of background water quality at or near the facility, practice or activity. Background water quality shall be determined for indicator parameters specified by the department. Background water quality for indicator parameters shall be established by averaging a minimum of 8 sample results from each well. The department may exclude any sample result which is nonrepresentative of background water quality. In making the calculations required in this section, the department may use as many representative sample points as are available.

(2) ESTABLISHING PREVENTIVE ACTION LIMITS FOR INDICATOR PARAMETERS. For each indicator parameter for which groundwater monitoring is required by the department, the preventive action limit shall be established based upon a change of water quality with respect to background water quality according to the methodology specified in pars. (a) to (c) and in Table 3.

(a) For field pH, the preventive action limit shall be one pH unit above or below the pH of the background water quality.

(b) For field temperature, the preventive action limit shall be 3 standard deviations or 10°F (5.6°C), whichever is greater, above or below the temperature of the background water quality.

(c) For all other indicator parameters, the preventive action limit shall be the background water quality for that parameter plus 3 standard deviations or the background water quality plus the increase of that parameter listed in Table 3, whichever is greater.

Note: The standard deviation for a group of samples is equal to the square root of: the value of the sum of the squares of the difference between each sample in the sample group and the mean for that sample group divided by the number of samples in the sample group where the sample group has 30 or more samples and by one less than the number of samples in the sample group where the sample group has less than 30 samples.

Table 3
Methodology for Establishing Preventive Action Limit for Indicator Parameters

Parameter	*Minimum Increase (mg/l)*	
Alkalinity	100	
Biochemical oxygen demand (BOD_5)	25	
Boron	2	
Calcium	25	
Chemical oxygen demand (COD)	25	
Magnesium	25	
Nitrogen series		
—Ammonia nitrogen	2	
—Organic nitrogen	2	
—Total nitrogen	5	
Potassium	5	
Sodium	10	
Field specific conductance	200	micromhos/cm
Total dissolved solids (TDS)	200	
Total hardness	100	
Total organic carbon (TOC)	1	
Total organic halogen (TOX)	.25	

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. table 3, Register, October, 1990, No. 418, eff. 11-1-90.

NR 140.22 Point of standards application for design and compliance. (1) DESIGN. Facilities, practices or activities regulated by the department, including remedial actions, shall be designed to minimize the level of substances in groundwater and to comply with the preventive action limits to the extent technically and economically feasible at all the following locations:

(a) Any point of present groundwater use.

(b) Any point beyond the boundary of the property on which the facility, practice or activity is located.

(c) Any point within the property boundaries beyond the 3-dimensional design management zone if one is established by the department at each facility, practice or activity under sub. (3).

(d) Every point at which groundwater is monitored to determine if a preventive action limit or enforcement standard has been attained or exceeded for sites identified under s. NR 140.22 (2) (c).

(2) COMPLIANCE. (a) The point of standards application to determine if a preventive action limit has been attained or exceeded is any point at which groundwater is monitored.

(b) The point of standards application to determine whether an enforcement standard has been attained or exceeded shall be the following locations:

1. Any point of present groundwater use;

2. Any point beyond the boundary of the property on which the facility, practice or activity is located;

3. Any point within the property boundaries beyond the 3 dimensional design management zone if one is established by the department at each facility, practice or activity under sub. (3).

Note: The boundary beyond which the enforcement standards apply is the closer of the property boundary or the design management zone boundary to the waste boundary for the facility, practice or activity.

(c) For discharges, releases, sites or facilities regulated under s. 144.76, 144.442, 144.64(2m) or 144.735, Stats., or s. NR 600.07, for which a design management zone has not been established in sub. (3), Table 4, the point of standards application shall be every point at which goundwater is monitored to determine if a preventive action limit or enforcement standard has been attained or exceeded.

(3) DESIGN MANAGEMENT ZONE. (a) The design management zone for facilities, practices or activities subject to regulation by the department shall be an area enclosed by vertical boundaries which extend from the land surface downward through all saturated geological formations. The design management zone shall extend horizontally beyond the waste boundary to the distance indicated in Table 4 for the specific type of facility, practice or activity. The waste boundary shall be the outermost limit at which waste from a facility, practice or activity has been stored, applied or disposed of, or permitted or approved for storage, application or disposal. For hazardous waste facilities regulated under ss. 144.60 to 144.74, Stats., the waste boundary shall include the horizontal space taken up by any liner, dike or other barrier to contain waste.

(b) In issuing or reissuing a permit, license or approval, the department may consider an expansion or reduction of the design management zone at a regulated or proposed facility, practice or activity by a horizontal distance not to exceed 50% of the distance listed in Table 4.

(c) The department shall consider the following factors in determining whether to expand or reduce the design management zone:

1. Nature, thickness and permeability of unconsolidated materials, including topography;

2. Nature and permeability of bedrock;

3. Groundwater depth, flow direction and velocity;

4. Waste volume, waste type and characteristics, including waste loading;

5. Contaminant mobility;

6. Distances to property boundary and surface waters;

7. Engineeering design of the facility, practice or activity;

8. Life span of the facility, practice or activity;

9. Present and anticipated uses of land and groundwater; and

10. Potential abatement options if an enforcement standard is exceeded.

(d) The design management zone may not be expanded or reduced unless it has been demonstrated to the satisfaction of the department that the preventive action limits and enforcement standards will be met at the adjusted design management zone. The design management zone may not be expanded unless it has been demonstrated to the satisfaction of the department that the preventive action limits and enforcement standards cannot be met at the design management zone specified in Table 4.

Table 4

Type of Facility, Practice or Activity	*Horizontal Distances for the Design Management Zone*
Land disposal systems regulated under ch. 144 or 147, Stats.	250 feet
Wastewater and sludge storage or treatment lagoons regulated under ch. 144 or 147, Stats.	100 feet
Solid waste disposal facilities regulated under ss. 144.43 to 144.47, Stats., which have feasibility reports approved after October 1, 1985.	150 feet
All other solid waste disposal facilities regulated under ss. 144.43 to 144.47, Stats.	300 feet
Hazardous waste disposal facilities, waste piles, landfills and surface impoundments subject to regulation under s. NR 635.16	300 feet
Hazardous waste disposal facilities, waste piles, landfills and surface impoundments subject to regulation under ss. NR 635.05 to 635.15.	0 feet

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1) (b), Register, October, 1988, No. 394, eff. 11-1-88; am. (4) and table 4, Register, January, 1992, No. 433, eff. 2-1-92; am. (1), cr. (1) (d), renum. (2) to (5) to be (2) (a), (b), (c) and (3) and am. (2) (b) 3., Register, March, 1994, No. 459, eff. 4-1-94.

NR 140.24 Responses when a preventive action limit is attained or exceeded. (1) NOTIFICATION AND ASSESSMENT. If the concentration of a substance, including indicator parameters, in groundwater attains or exceeds a preventive action limit at a point of standards application as described in s. NR 140.22 (2):

(a) The owner or operator of the facility, practice or activity shall notify the department in writing when monitoring data is submitted that a preventive action limit has been attained or exceeded in accordance with any deadlines in applicable statutes, rules, permits or plan approvals. Where no deadlines are imposed, the owner or operator shall notify the department as soon as practical after the results are received. The notification shall provide a preliminary analysis of the cause and significance of the concentration.

Note: Section 144.76 (2) (a), Stats., requires that the department be notified immediately of hazardous substance discharges.

Note: See s. NR 140.27.

(b) Upon receipt of the notice under par. (a), the department shall evaluate the information and, if further information is required to make the assessment under par. (c), direct the owner or operator to prepare and submit a report by a specified deadline. The report shall assess the cause and significance of the increased concentration based on a consideration of the factors identified in par. (c) and shall propose a response to meet the objectives of sub. (2).

(c) The department shall assess the cause and significance of the concentration of the substance in determining the appropriate response to meet the objectives of sub. (2). In addition to all other relevant information, the department shall consider the information submitted under par. (b) and the following factors where applicable:

1. Background water quality. a. The department shall compare background water quality data and monitoring data from wells downgradient of the facility, practice or activity to determine if downgradient water

quality is adversely affected. If the background water quality at a facility, practice or activity is not known or is inadequately defined, the department may require additional sampling of existing wells, or installation and sampling of additional wells, or both.

b. Except for substances which are carcinogenic, teratogenic or mutagenic in humans, before requiring a response at a site where the background concentration of a substance is determined to be equal to or greater than the preventive action limit, the department shall determine that the proposed remedial action will protect or substantially improve groundwater quality notwithstanding the background concentrations of naturally occurring substances.

2. Reliability of sampling data. As part of its review of the quality of the sampling data, the department shall evaluate the sampling procedures, precision and accuracy of the analytical test, size of the data set, and the quality control and quality assurance procedures used. If there is insufficient information to evaluate the reliability of the sampling data, the department may require additional samples or other changes in the monitoring program at the facility, practice or activity.

3. Public health, welfare and environmental effects of the substance. The department shall consider the public health, welfare and environmental effects of the substance, including but not limited to its mobility in the subsurface, environmental fate, the risks considered when the standard was adopted and whether it is carcinogenic, mutagenic, teratogenic or has interactive effects with other substances.

4. Probability that a preventive action limit or an enforcement standard may be attained or exceeded outside the design management zone. In evaluating the probability that a preventive action limit or an enforcement standard may be attained or exceeded outside the design management zone, the department shall consider, at a minimum, geologic conditions, groundwater flow rate and direction, contaminant mobility in the subsurface and environmental fate.

5. Performance of the facility, practice or activity. The department shall consider whether the facility, practice or activity is performing as designed in accordance with the design requirements in s. NR 140.22 (1). The department shall consider the type, age and size of the facility, practice or activity; the type of design, if applicable; the operational history; and other factors related to performance of the facility, practice or activity as appropriate.

6. Location of the monitoring point. The department shall consider the location of the monitoring point in relation to the facility, practice or activity and the design management zone in assessing the appropriate response.

7. Other known or suspected sources of the substance in the area. If other known or suspected sources are present in the vicinity of a facility, practice or activity of concern, the department shall evaluate the probability of contributions from other sources of the substance. The department shall consider, at a minimum, the number, size, type and age of nearby sources; the groundwater flow patterns; and the substances involved.

8. Hydrogeologic conditions. The department shall consider the geologic and groundwater conditions, including but not limited to the na-

ture, thickness and permeability of the unconsolidated materials; the nature and permeability of bedrock; the depth to the water table; groundwater flow gradients, both vertical and horizontal; the position of the facility, practice or activity within the groundwater flow system; and the present and potential groundwater use in the vicinity of the facility, practice or activity at which an exceedance occurs. If there is insufficient hydrogeologic information, the department may require additional information.

9. Extent of groundwater contamination. The department shall consider the current and anticipated future extent of groundwater contamination in 3 dimensions. If water supplies are affected or threatened, the department shall evaluate the existing effects and potential risks of the substance on the potable water supplies. If the extent of contamination is not known, the department may require further documentation of the extent of contamination.

10. Alternate responses. The department shall evaluate alternate responses, including consideration of the technical and economic feasibility of alternate responses from Table 5 or 6 or both, the practicality of stopping the further release of the substance and the risks and benefits of continued operation of the facility, practice or activity and the ability of a response to meet other applicable environmental protection laws.

(2) RESPONSE OBJECTIVES. Based on its evaluation of the report required under sub. (1), and the assessment criteria of sub. (1) (c), the department shall specify the responses to be implemented by the owner or operator of the facility, practice or activity designed to the extent technically and economically feasible to prevent any new releases of the substance from traveling beyond the design management zone or other applicable points of standards application described in s. NR 140.22 and restore contaminated groundwater within a reasonable period of time. Both the source control and the groundwater restoration components of the response shall be designed to:

(a) Minimize the concentration of the substance in groundwater at the point of standards application where technically and economically feasible;

(b) Regain and maintain compliance with the preventive action limit. If the department determines that compliance with the preventive action limit is either not technically or economically feasible, the owner or operator shall achieve compliance with the lowest possible concentration which is technically and economically feasible; and

(c) Ensure that the enforcement standard is not attained or exceeded at the point of standards application.

(3) RANGE OF RESPONSES FOR INDICATOR PARAMETERS. Except as otherwise provided in this subsection, the range of responses which the department may take or may require if a preventive action limit for an indicator parameter identified in Table 3 has been attained or exceeded, is one or more of the responses in items 1 to 4 in Table 5. The range of responses is one or more of the responses in items 1 to 6 of Table 5 in the event the department determines that:

(a) There is a threat to public health or welfare as a result of a preventive action limit for an indicator parameter being attained or exceeded; or

(b) The results demonstrate a significant design flaw or failure of the facility to contain substances, such that the facility can be expected to emit one or more of the substances on Table 1 or 2 in excess of a preventive action limit at a point of standards application.

(4) RANGE OF RESPONSES FOR SUBSTANCES OF PUBLIC HEALTH OR WELFARE CONCERN. The range of responses which the department may take or may require if a preventive action limit for a substance of health or welfare concern has been attained or exceeded are listed in Table 5. More than one response may be required by the department.

Table 5

Range of Responses for Exceedance of a Preventive Action Limit for Indicator Parameters and Substances of Health or Welfare Concern

1. No action pursuant to s. NR 140.24 (5) and consistent with s. 160.23, Stats.
2. Sample wells or require sampling of wells.
3. Require a change in the monitoring program, including increased monitoring.
4. Require an investigation of the extent of groundwater contamination.
5. Require a revision of the operational procedures at the facility, practice or activity.
6. Require a change in the design or construction of the facility, practice or activity.
7. Require an alternate method of waste treatment or disposal.
8. Require prohibition or closure and abandonment of a facility, practice or activity in accordance with sub. (6).
9. Require remedial action to renovate or restore groundwater quality.
10. Require remedial action to prevent or minimize the further discharge or release of the substance to groundwater.
11. Revise rules or criteria on facility design, location or management practices.

(5) NO ACTION RESPONSE CRITERIA. The department may determine that no response is necessary and that an exemption under s. NR 140.28 is not required when either of the following conditions is met:

(a) The concentration of a substance within a design management zone is detected above the preventive action limit, the enforcement standard has not been attained or exceeded within the design management zone, and the department determines that there is no indication that the preventive action limit will be attained or exceeded at any point outside the design management zone, or

(b) The background concentration of a substance is greater than the preventive action limit, the anticipated or detected incremental increase in the concentration of a substance which results from a specific facility, practice or activity is not greater than the preventive action limit, and the anticipated or detected concentration is not greater than the enforcement standard either within or outside of the design management zone.

(6) PROHIBITION AND CLOSURE CRITERIA. The department may not impose a prohibition on a practice or activity or require closure of a facility which produces the substance unless the department:

(a) Bases its decision upon reliable test data;

(b) Determines, to a reasonable certainty, by the greater weight of the credible evidence, that no other remedial action would prevent the violation of the enforcement standard at the point of standards application;

(c) Establishes the basis for the boundary and duration of the prohibition; and

(d) Ensures that any prohibition imposed shall be reasonably related in time and scope to maintaining compliance with the enforcement standard at the point of standards application.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (5) (intro.) and (6) (intro.), Register, October, 1988, No. 394, eff. 11-1-88; am. (1) (intro.), (a), (b), (c) (intro.), 5. and 10., (2) (intro.), and (5) (intro.), renum. (7) to be NR 104.02 (4), Register, January, 1992, No. 433, eff. 2-1-92; am. (1) (intro.), (c) (intro.), (3) (intro.) and Table 5, Register, March, 1994, No. 459, eff. 4-1-94.

NR 140.26 Responses when an enforcement standard is attained or exceeded. (1) NOTIFICATION AND ASSESSMENT. If the concentration of a substance in groundwater attains or exceeds an enforcement standard at a point of standards application as described in s. NR 140.22 (2):

(a) The owner or operator of the facility, practice or activity shall notify the department in writing when monitoring data is submitted that an enforcement standard has been attained or exceeded in accordance with any deadlines in applicable statutes, rules, permits or plan approvals. Where no deadlines are imposed, the owner or operator shall notify the department as soon as practical after the results are received. The notification shall provide a preliminary analysis of the cause and significance of the concentration.

Note: Section 144.76 (2) (a), Stats., requires that the department be notified immediately of hazardous substance discharges.

Note: See s. NR 140.27.

(b) Upon receipt of the notice under par. (a), the department shall evaluate the information and, if further information is required to make the assessment under par. (c), direct the owner or operator to prepare and submit a report by a specified deadline. The report shall assess the cause and significance of the increased concentration based on a consideration of the factors identified in s. NR 140.24 (1) (c) and shall propose a response to achieve compliance with the enforcement standard at the point of standards application and to comply with sub. (5).

(c) The department shall assess the cause and significance of the concentration of the substance in determining the appropriate response measures to achieve compliance with the enforcement standard at the point of standards application and to comply with sub. (5). In addition to all other relevant information, the department shall consider the information submitted under sub. (1) and the factors listed in s. NR 140.24 (1) (c), where applicable.

(2) REGULATORY RESPONSES. (a) If a facility, activity or practice is regulated under subch. IV of ch. 144 or 147, Stats., the department shall require responses as necessary, based on the evaluation of the increased concentration as outlined in sub. (1), to prevent any new releases of the substance from traveling beyond the design management zone or other applicable point of standards application described in s. NR 140.22 and restore contaminated groundwater within a reasonable period of time. Both the source control and the groundwater restoration components of

the response shall be designed to achieve compliance with the enforcement standard at the point of standards application and to achieve compliance with the preventive action limit at the point of standards application unless compliance with the preventive action limit is not technically and economically feasible. The range of responses which the department may take or require if an enforcement standard for a substance of public health or welfare concern has been attained or exceeded at a point of standards application is listed in Table 6. More than one response may be required by the department. In addition, the department may require one or more responses from Table 5, except number one.

Table 6

Range of Responses for Exceedance of Enforcement Standards for Substances of Health or Welfare Concern

1. Require a revision of the operational procedures at a facility, practice or activity.
2. Require a change in the design or construction of the facility, practice or activity.
3. Require an alternate method of waste treatment or disposal.
4. Require prohibition or closure and abandonment of a facility, practice or activity.
5. Require remedial action to renovate or restore groundwater quality.
6. Require remedial action to prevent or minimize the further release of the substance to groundwater.
7. Revise rules or criteria on facility design, location or management practices.

(b) If an activity or practice is not subject to regulation under subch. IV of ch. 144 or 147, Stats., and if the concentration of a substance in groundwater attains or exceeds an enforcement standard at a point of standards application, the department shall take the following responses unless it can be shown to the department that, to a reasonable certainty, by the greater weight of the credible evidence, an alternative response will achieve compliance with the enforcement standard at the point of standards application:

1. Prohibit the activity or practice which uses or produces the substance; and

2. Require remedial actions with respect to the specific site in accordance with this chapter.

(3) RESPONSES FOR NITRATE AND SUBSTANCES OF PUBLIC WELFARE CONCERN. If nitrates or any substance of welfare concern only attains or exceeds an enforcement standard, the department is not required to impose a prohibition or close a facility if it determines that:

(a) The enforcement standard was attained or exceeded, in whole or in part, because of high background concentrations of the substance; and

(b) The additional concentration does not represent a public welfare concern.

(4) COMPLIANCE WITH PREVENTIVE ACTION LIMITS. When compliance with the enforcement standard is achieved at the point of standards application, s. NR 140.24 applies.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1) (intro.), (a), (b), (2), r. (6), Register, January, 1992, No. 433, eff. 2-1-92; am. (1) (intro.) and Table 6, renum. (2) to (5) to be (2) (a), (b), (3) and (4), Register, March, 1994, No. 459, eff. 4-1-94.

NR 140.27 Responses when an enforcement standard is attained or exceeded at a location other than a point of standards application. If the concentration of a substance in groundwater attains or exceeds an enforcement standard at a location other than a point of standards application for an enforcement standard, s. NR 140.24 shall apply.

History: Cr. Register, October, 1988, No. 394, eff. 11-1-88.

NR 140.28 Exemptions. (1) EXEMPTIONS REQUIRED. (a) The department may not approve a proposed facility, practice or activity at a location where a preventive action limit or enforcement standard adopted under s. NR 140.10 or 140.12 has been attained or exceeded unless an exemption has been granted under this section.

(b) For an existing facility, practice or activity, a response is required under s. NR 140.24 (2) or 140.26 (2) when a preventive action limit or an enforcement standard has been attained or exceeded at a point of standards application unless an exemption has been granted under this section or the criteria of s. NR 140.24 (5) (a) or (b) are met.

(2) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS BELOW THE PREVENTIVE ACTION LIMIT. The department may grant an exemption under this section when a preventive action limit is attained or exceeded if it determines that:

(a) The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically and economically feasible;

(b) Compliance with the preventive action limit is either not technically or economically feasible;

(c) The enforcement standard for that substance will not be attained or exceeded at the point of standards application; and

(d) Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

(3) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS ABOVE A PREVENTIVE ACTION LIMIT. (a) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of nitrate or a substance of public welfare concern attains or exceeds the preventive action limit if the facility, practice or activity is designed to achieve the lowest possible concentration for that substance which is technically and economically feasible and the existing or anticipated increase in the concentration of the substance does not present a threat to public health or welfare.

(b) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of a substance of public health concern, other than nitrate, attains or exceeds a preventive action limit for that substance:

1. If the facility, practice or activity has not caused and will not cause the further release of that substance into the environment; or

2. If the background concentration of the substance does not exceed the enforcement standard for that substance, the facility, practice or activity has not caused and will not cause the concentration of the substance to exceed the enforcement standard for that substance at a point of standards application and the facility, practice or activity is designed to achieve the lowest possible concentration of that substance which is technically and economically feasible.

(4) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS ABOVE AN ENFORCEMENT STANDARD. (a) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of nitrate or a substance of public welfare concern attains or exceeds an enforcement standard if the facility, practice or activity is designed to achieve the lowest possible concentration for that substance which is technically and economically feasible and the existing or anticipated increase in the concentration of the substance does not present a threat to public health or welfare.

(b) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of a substance of public health concern, other than nitrate, attains or exceeds the enforcement standard for that substance if:

1. The facility has not caused and will not cause the further release of that substance into the environment; or

2. a. The facility is designed to achieve the lowest possible concentration of that substance which is technically and economically feasible; and

b. The existing or anticipated increase in the concentration of the substance has not caused or will not cause an increased threat to public health or welfare; and

c. The existing or anticipated incremental increase in the concentration of the substance by itself, has not exceeded or will not exceed the preventive action limit.

(c) The department shall take action under s. NR 140.26 if it determines that the increase in the concentration of the substance causes an increased threat to public health or welfare or it determines that the incremental increase in the concentration of the substance, by itself, exceeds the preventive action limit.

(5) EXEMPTION PROCEDURES. If the department grants an exemption for a substance it shall specify:

(a) The substance to which the exemption applies;

(b) The terms and conditions of the exemption, which may include an alternative concentration limit, under which the department may seek a response under s. NR 140.24 or 140.26 relating to the substance; and

(c) Any other conditions relating to the exemption.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1) (a) and (b), (3) (a), (b) (intro.) and 2., (4) (a) and (b) 1. and (5) (b), Register, October, 1988, No. 394, eff. 11-1-88; am. (1) (b), Register, January, 1992, No. 433, eff. 2-1-92; correction in (4) (b) made under s. 13.93 (2m) (b) 1, Stats., Register, January, 1992, No. 433; am. (1) (b) and (5) (b), Register, March, 1994, No. 459, eff. 4-1-94.

APPENDIX B
WATER QUALITY STANDARDS AND HEALTH ADVISORIES

Onalaska Landfill Site
Onalaska, Wisconsin

Drinking Water Standards and Health Advisories

Chemical	Federal Drinking Water Standards			Health Advisories (d)				
	MCL (a) (mg/L)	MCLG (b) (mg/L)	SMCL (c) (mg/L)	1-day HA - Child (e) (mg/L)	10-day HA Child (f) (mg/L)	Long-term HA - Child (g) (mg/L)	Long-term HA - Adult (g) (mg/L)	Lifetime HA (h) (mg/L)
acenaphthylene	--	--	--	--	--	--	--	--
acetone	--	--	--	--	--	--	--	--
aluminum	--	--	--	--	--	--	--	--
arsenic	0.05	0.05	--	--	--	--	--	--
barium	2	2	--	--	--	--	--	--
benzene	0.005	0	--	0.235	0.235	--	--	--
benzoic acid	--	--	--	--	--	--	--	--
benzyl alcohol	--	--	--	--	--	--	--	--
bis(2-ethylhexyl)phthalate	0.006	0	--	--	--	--	--	--
cadmium (water)	0.005	0.005	--	--	--	--	--	--
chloroethane	--		--	--	--	--	--	--
chromium (hexavalent)	0.1	0.1	--	1.4	1.4	0.24	0.84	0.12
chromium (trivalent)	0.1	0.1	--	1.4	1.4	0.24	0.84	0.12
copper	1.3	1.3	1	--	--	--	--	--
ddd, 4,4'-	--	--	--	--	--	--	--	--
dde, 4,4'-	--	--	--	--	--	--	--	--
ddt, 4,4'-	--	--	--	--	--	--	--	--
di-n-butyl-phthalate	--	--	--	--	--	--	--	--
dichlorobenzene, 1,4-	0.075	0.075	--	--	--	--	--	--
dichloroethane, 1,1-	--		--	--	--	--	--	--
dichloroethene, 1,1-	0.007	0.007	--	--	--	--	--	--
dichloroethene, 1,2- (mixed isomers)	--		--	--	--	--	--	--
dichloroethene, cis-1,2-	0.07	0.07	--	--	--	--	--	--
dichloroethene, trans-1,2-	0.1	0.1	--	--	--	--	--	--
ethylbenzene	0.7	0.7	--	32	3.2	1	3.4	0.68
fluoranthene	--	--	--	--	--	--	--	--
fluorene	--	--	--	--	--	--	--	--
iron	--	--	--	--	--	--	--	--
isophorone	--	--	--	--	--	--	--	--
lead	0.015 (i)	0	--	--	--	--	--	--
lindane	0.0002	0.0002	--	1	1.2	0.033	0.12	0.0002
manganese (water)	--	--	--	--	--	--	--	--
methoxychlor	0.04	0.04	--	6	2	0.5	2	0.4
methylphenol, 2-	--	--	--	--	--	--	--	--
methylphenol, 4-	--	--	--	--	--	--	--	--

Onalaska Landfill Site
Onalaska, Wisconsin

Drinking Water Standards and Health Advisories

Chemical	Federal Drinking Water Standards			Health Advisories (d)				
	MCL (a) (mg/L)	MCLG (b) (mg/L)	SMCL (c) (mg/L)	1-day HA - Child (e) (mg/L)	10-day HA Child (f) (mg/L)	Long-term HA - Child (g) (mg/L)	Long-term HA - Adult (g) (mg/L)	Lifetime HA (h) (mg/L)
naphthalene	--	--	--	--	--	--	--	--
nickel, soluble salts	0.1	0.1	--	--	--	--	--	--
phenanthrene	--	--	--	--	--	--	--	--
phenol	--	--	--	--	--	--	--	--
pyrene	--	--	--	--	--	--	--	--
silver	--	--	0.1	--	--	--	--	--
toluene	1	1	--	20	3	3	10	1
trichloroethane, 1,1,1-	0.2	0.2	--	100	40	40	100	0.2
trichloroethene	0.005	0	--	--	--	--	--	--
vanadium	--	--	--	--	--	--	--	--
xylene, m-	10	10	--	--	--	--	--	--
xylene, mixture	10	10	--	--	--	--	--	--
xylene, o-	10	10	--	--	--	--	--	--
xylene, p-	10	10	--	--	--	--	--	--
zinc	--	--	5	--	--	--	--	--

a. Maximum Contaminant Levels (MCLs) are enforceable drinking water standards, developed under the Safe Drinking Water Act, that are set as close to MCLGs as feasible (with the use of the best technology, treatment techniques taking into consideration cost). MCLs are part of National Primary Drinking Water Regulations. MCLs are listed at 40 CFR.61 for organic contaminants and 40 CFR 141.62 for inorganic contaminants.

b. Maximum Contaminant Level Goal (MCLGs) are non-enforceable health goals, developed under the Safe Drinking Water for drinking water. They are set at levels at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety. MCLGs were previously named RMCLs. MCLGs are listed at 40 CFR 141.50 for organic chemicals and 40 CFR 141.51 for inorganic chemicals.

c. Secondary Maximum Contaminant Levels (SMCLs) are part of the National Secondary Drinking Water Regulations developed under the Safe Drinking Water Act. They are not federally enforceable but offer guidance to water systems and states on contaminant levels that protect public welfare. They are based on odor, aestheics, and appearence. They are listed at 40 CFR 143.

d. Drinking water health advisories are informal technical guidance issued by the U.S. EPA Office of Drinking Water (ODW).
They are not legally enforceable standards. They are subject to change as new information becomes available. They are based on data describing noncarcinogenic endpoints. Lifetime health advisories describe concentrations of drinking water contaminants at which health effects would not be anticipated to occur over a lifetime exposure, accounting for other sources of exposure. No lifetime health advisories are issued for carcinogens. A "NRC" is indicated where health advisories have been issued for the chemical for less than lifetime exposures.

e. Based on ingestion of 1 liter/day by a 10 kg child. One day exposure.

f. Based on ingestion of 1 liter/day by a 10 kg child. Ten day exposure.

g. Longer term advisories based on ingestion of 1 liter/day for a 10-kg child and 2 liters/day for a 70-kg adult. Assumes exposure for approx. 7 years, or 10% of an individual's lifetime.

h. Lifetime health adisories assumes that other sources besides water contribute to exposure. Where other source are not known, a 20% drinking water contribution is assumed.
Based on ingestion of 2 liters/day for a 70kg adult.

i. "Action level" measured in 90th percentile at consumers' taps.

APPENDIX C
GROUNDWATER MONITORING WELL REQUIREMENTS, WISCONSIN ADMINISTRATIVE CODE NR 141

Chapter NR 141

GROUNDWATER MONITORING WELL REQUIREMENTS

NR 141.01 Purpose. The purpose of this chapter is to establish minimum acceptable standards for the design, installation, construction, abandonment and documentation of groundwater monitoring wells. These rules are adopted under chs. 144, 160 and 227, Stats.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.03 Applicability. This chapter applies to all persons installing and abandoning groundwater monitoring wells and boreholes for purposes regulated by the department under ch. 144, 147 or 160, Stats., or in permits, plan approvals, licenses or orders issued under those chapters. In addition, this chapter applies to all persons installing groundwater monitoring wells and boreholes in fulfillment of terms of a contract with the department. All wells and boreholes installed for purposes regulated by the department under this chapter shall be abandoned according to s. NR 141.25. All other wells and boreholes shall be abandoned according to the provisions of ch. NR 112.

Note: Additional requirements concerning soil testing and groundwater sampling are located in other chapters regulating wastewater and solid and hazardous waste disposal, see chs. NR 110, 206, 213, 214, 508, 512, 550 and the 600 series.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.05 Definitions. In this chapter:

(1) "Air rotary drilling" means a drilling method whereby the borehole is advanced using a circular rotating action applied to a string of drilling rods which have a diffused discharge bit attached to the bottom of the rods. Pressurized air is forced through the drilling rods and cools the drilling tools and removes the cuttings from the borehole.

(2) "Annular space seal" means the following:

(a) For wells constructed with filter packs, it is the material placed above the top of the filter pack or the filter pack seal up to the surface seal and between the well casing and the adjacent formation; or

(b) For wells constructed into bedrock formations and without well screens, it is the material placed from the bottom of the enlarged borehole up to the surface seal, between the well casing and the adjacent formation.

(2m) "Aquifer test well" means a well installed to provide information on the hydraulic conductivity, transmissivity, storage coefficient, capture zone, specific capacity, radius of influence or other physical parameters of an aquifer, defined geologic unit, or water bearing formation through the imposition of a sustained stress on the aquifer by removal of water.

(3) "ASTM" means american society for testing and materials.

(5) "Bedrock" means the solid rock underlying any loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

(6) "Bentonite" means a clay consisting of at least 85% sodium montmorillonite. Bentonite is available in the following forms:

(a) "Bentonite powder" means 200 mesh pure bentonite, without additives.

(b) "Bentonite granules" means 8 mesh pure bentonite, without additives.

(c) "Bentonite pellets" means commercially manufactured tablets made by compressing pure bentonite, without additives, into forms greater than ¼" in size.

(d) "Bentonite chips" means commercially processed angular fragments of pure bentonite, without additives.

(7) "Bentonite - cement grout" means a mixture with the ratio of 5 pounds of bentonite with 94 pounds of Portland cement and 8.5 gallons of water from a known safe and uncontaminated source.

(8) "Bentonite - fine sand slurry" means a mixture with the minimum ratio of 50 pounds of bentonite with 100 gallons of water from a known safe and uncontaminated source and 10-25% sand by volume for a mud weight of 11 pounds per gallon.

(9) "Borehole" means a circular hole deeper than it is wide, constructed in earth material for the purpose of either installing a well or obtaining geologic or groundwater related data. Boreholes are also referred to as drillholes.

(10) "Clay" means an inorganic soil with low permeability characteristics and a plasticity index of 7 or more.

(11) "Coarse sand" means a well sorted sand with a predominant grain size between 4.76mm and 2.0mm as established by the unified soil classification system.

(12) "Concrete" means a slurry mixture with a ratio of 94 pounds of cement, equal volumes of dry sand and gravel and 5 to 6 gallons of water from a known safe and uncontaminated source. The ratio of sand and gravel to cement may not exceed 3 parts to one.

(13) "Department" means the department of natural resources.

(14) "Driven point well" means a well constructed by joining a drive point with lengths of pipe and driving the assembly into the ground with

percussion equipment or by hand, without first removing material below the 10 foot depth.

(15) "Filter pack" means the sand, gravel or both placed in direct contact with the well screen.

(16) "Filter pack seal" means the sealing material placed in the annular space above the filter pack and below the annular space seal to prevent the migration of annular space sealant into the filter pack.

(17) "Fine sand" means a well sorted sand with a predominant grain size between .42mm and .074mm, as established by the unified soil classification system.

(18) "Granular bentonite slurry" means a thoroughly blended mixture of up to 30 pounds of untreated bentonite powder added to 100 gallons of water from a known safe and uncontaminated source with a minimum of 100 pounds of untreated bentonite granules mixed together by a Venturi-hopper mud mixer or other equivalent high shear mixer.

(19) "Gravel" means an unconsolidated material with the predominant grain size being between 76.2mm and 4.76mm, as established by the unified soil classification system.

(20) "Groundwater" means any waters of the state, as defined in s. 144.01 (19), Stats., occurring in a saturated geologic formaton of rock or unconsolidated material.

(21) "Groundwater monitoring well" means any cased excavation or opening into the ground made by digging, boring, drilling, driving, jetting or other methods for the purpose of determining the physical, chemical, biological or radiological properties of groundwater. Groundwater monitoring wells may be piezometers, water table observation wells or both.

(21m) "High-solids grout" means a thoroughly blended mixture of water from a known safe and uncontaminated source with untreated bentonite, without additives, which has been approved by the department.

(22) "Hollow stem auger drilling" means a drilling method where continuous flighting is welded to a hollow stem pipe. The flighting carries drill cuttings to the surface as the flighting is rotated and pushed down into the earth.

(23) "Inside diameter" means the horizontal distance between the inner walls of a well casing, hollow stem auger or tremie pipe.

(24) "Medium sand" means a well sorted sand with a predominant grain size between 2.0mm and .42mm, as established by the unified soil classification system.

(25) "Montmorillonite" means a group of expanding lattice clay minerals of the general formula: $R.33Al_2Si_40_{10}(OH)_2 \cdot H_2O$, where R means one or more cations of sodium, potassium, magnesium or calcium and where Al means aluminum, Si means silicon, O means oxygen and H means hydrogen.

(26) "Mud rotary drilling" means a drilling method whereby a borehole is advanced by using a circular rotating action applied to a string of

drilling rods which have a diffused discharge bit attached to the bottom of the string. A bentonite and water mud slurry is used to provide borehole stability, to cool the bit and to carry cuttings to the ground surface.

(27) "Neat cement grout" means a slurry mixture with a ration of 94 pounds of Portland cement mixed with 5 to 6 gallons of water from a known safe and uncontaminated source.

(28) "Percussion drilling" means a drilling method using a cable tool drilling machine or a drilling method whereby the permanent or temporary well casing is driven, or is set into a borehole and then driven.

(29) "Permanent groundwater monitoring well" means any groundwater monitoring well in place for 60 days or longer.

(30) "Piezometer" means a groundwater monitoring well, sealed below the water table, installed for the specific purpose of determining either the elevation of the potentiometric surface or the physical, chemical, biological or radiological properties of groundwater at some point within the saturated zone or both.

(31) "Potentiometric surface" or "piezometric surface" means an imaginary surface representing the total head of groundwater and is the level to which water will rise in a well.

(32) "Psi" means pounds per square inch.

(33) "Purge" means an action that removes water from the well, commonly accomplished by using a pump or bailer.

(33m) "Recovery well" means a well intended and designed to capture and remove contaminated groundwater or non-aqueous phase liquids from the subsurface.

(34) "Rotary wash drilling" means a drilling method whereby metal temporary casing is advanced into the borehole by driving. At selected intervals, the temporary casing is cleaned out using rotary drilling tools by pumping clean water through the rod to flush out accumulated cuttings. This drilling method is also known as wash bore or wash down drilling.

(35) "Sand-cement grout" means a mixture of cement, sand and water in the proportion of 94 pounds of Portland cement, one cubic foot of dry sand and 5 to 6 gallons of water from a known safe and uncontaminated source.

(36) "Sediment" means any solid material dropping from suspension in water, including clay, silt, sand and gravel sized particles.

(37) "Solid stem auger drilling" means a drilling method where continuous flighting is welded onto a solid stem pipe. The flighting carries drill cuttings to the surface as the flighting is rotated and pushed down into the earth. The borehole is created by a cutting bit located at the tip of the lead auger.

(38) "Specific gravity" means the weight of a particular volume of substance compared to the weight of an equal volume of water at a reference temperature.

(39) "Surge" means an action causing water to move rapidly in and out of the well screen, thereby removing fine material from the surrounding aquifer.

(40) "Temporary groundwater monitoring well" means any groundwater monitoring well in place for less than 60 days.

(41) "Top of bedrock" or "top of firm rock" means at least 70% of the drill cuttings being either:

(a) Angular rock fragments, as in the case of crystalline rock; or

(b) Rock fragments composed of individual grains or rock particles that are cemented together to form an aggregate as opposed to a single sediment particle.

(42) "Tremie pipe" means a pipe or hose used to install well construction materials in an annular space or a borehole.

(43) "Unconsolidated material" means that material found above firm bedrock, composed of single sediment particles, individual grains or rock fragments. Unconsolidated material includes but is not limited to clay, silt, sand, gravel, loess, peat and organic soil.

(44) "Unified soil classification system" means the soil designation system based on the physical properties of the soil developed from the airfield classification system in 1952 and adopted by the American society for testing and materials in standard test method D2487-83.

Note: A copy of this publication is available for inspection at the offices of the department of natural resources, the secretary of state and the rivisor of statutes and may be obtained for personal use from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

(45) "Water table" means the surface of unconfined groundwater where the water pressure is equal to atmospheric pressure.

(46) "Water table observation well" means any groundwater monitoring well, in which the screen or open borehole intersects a water table, which is installed for the specific purpose of determining either the elevation of the water table or the physical, chemical, biological or radiological properties of groundwater at the water table or both.

Note: Construction of a typical water table observation well is depicted in Figure 1.

(47) "Well" means any borehole or other excavation or opening in the ground deeper than it is wide constructed for the purpose of obtaining or monitoring groundwater.

(48) "Well depth" means the distance from the ground surface to the bottom of the well screen or to the bottom of the open hole when a well screen is not used.

(49) "Well volume" means the volume of water contained in the well casing and the filter pack.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (7), (8) and (18), cr. (2m), (21m) and (33m), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.055 Borehole protection. If a borehole is left open, protective measures shall be taken to prevent the borehole from acting as a conduit for contamination or becoming a safety hazard.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.06 Soil testing. Specific soil sampling and testing procedures are specified in other chapters related to wastewater and solid and hazardous waste disposal facilities.

Note: See chs. NR 110, 181, 206, 214, 508, 512 and 550.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.065 Well location. (1) Monitoring wells installed where prior department approval is required shall be installed at the locations indicated on plans and specifications approved by the department prior to installation.

(2) Following installation of the wells, an as-built plan map shall be submitted specifying the exact vertical and horizontal location of the wells. All monitoring well locations shall be reported to the department on a plan map drawn to a specific scale. The map shall indicate structure boundaries, property boundaries, any nearby surface waters and a north arrow. The plan shall show the wells in relation to each other, to property and structure boundaries, and to a common reference point on a horizontal grid system. The origin of the grid system shall be located according to latitude and longitude or according to the state plane coordinate system. The exact vertical location of the top of the well casing shall be referenced to the nearest benchmark for the national geodetic survey datum to an accuracy of 0.01 feet. This plan map shall show the exact location of the installed well on a horizontal grid system which is accurate to within one foot. Direction of groundwater flow shall be indicated. In addition, an 8.5-inch by 11-inch site map drawn to scale according to the horizontal grid system shall be submitted showing the location of wells and structures on the site.

(3) The well casings for wells constructed in a floodplain or floodway shall terminate a minimum of 2 feet above the regional flood elevation for the well site.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (2), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.07 Well casing. (1) SPECIFICATIONS. All permanent groundwater monitoring wells shall be constructed of new polyvinyl chloride (PVC) well casing materials except in situations where the rock, soil or groundwater may react with PVC, in which case an approval under s. NR 141.31 for alternative materials shall be requested. All PVC casing materials shall meet national sanitation foundation standard 14 and ASTM D1785 specifications for any one of the following cell classifications: 12454-B, 12454-C, 11443-B, 14333-D, 13233 or 15223-B. All casing shall have a minimum inside diameter of 1.9 inches. In unconsolidated geologic formations, all wells less than or equal to 100 feet in depth shall be constructed of at least schedule 40 PVC casing and all wells greater than 100 feet in depth shall be constructed of at least schedule 80 PVC casing. Groundwater monitoring wells shall be installed with well casing no larger than a 4-inch inside diameter. Groundwater monitoring wells shall have a vented cap except as provided in s. NR 141.13 (4) (b).

(2) REFERENCE. The listed national sanitation foundation and ASTM references are available for inspection at the offices of the department of natural resources, the secretary of state and the revisor of statutes and may be obtained for personal use from the National Sanitation Foundation, 3475 Plymouth Road, P.O. Box 1468, Ann Arbor, Michigan 48106, and the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

(3) ASSEMBLY AND INSTALLATION. All casing couplings shall be constructed of flush threaded joints. Solvent welded joints may not be used without prior written approval by the department. The casing shall be centered in the borehole.

(4) INSPECTION. Prior to use, the casings and couplings shall be inspected for cuts, deformations, gouges, deep scratches, damaged ends and other imperfections. Any casing or coupling having such a defect may not be used.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1), Register, June, 1991, No. 426, eff. 7-1-91.

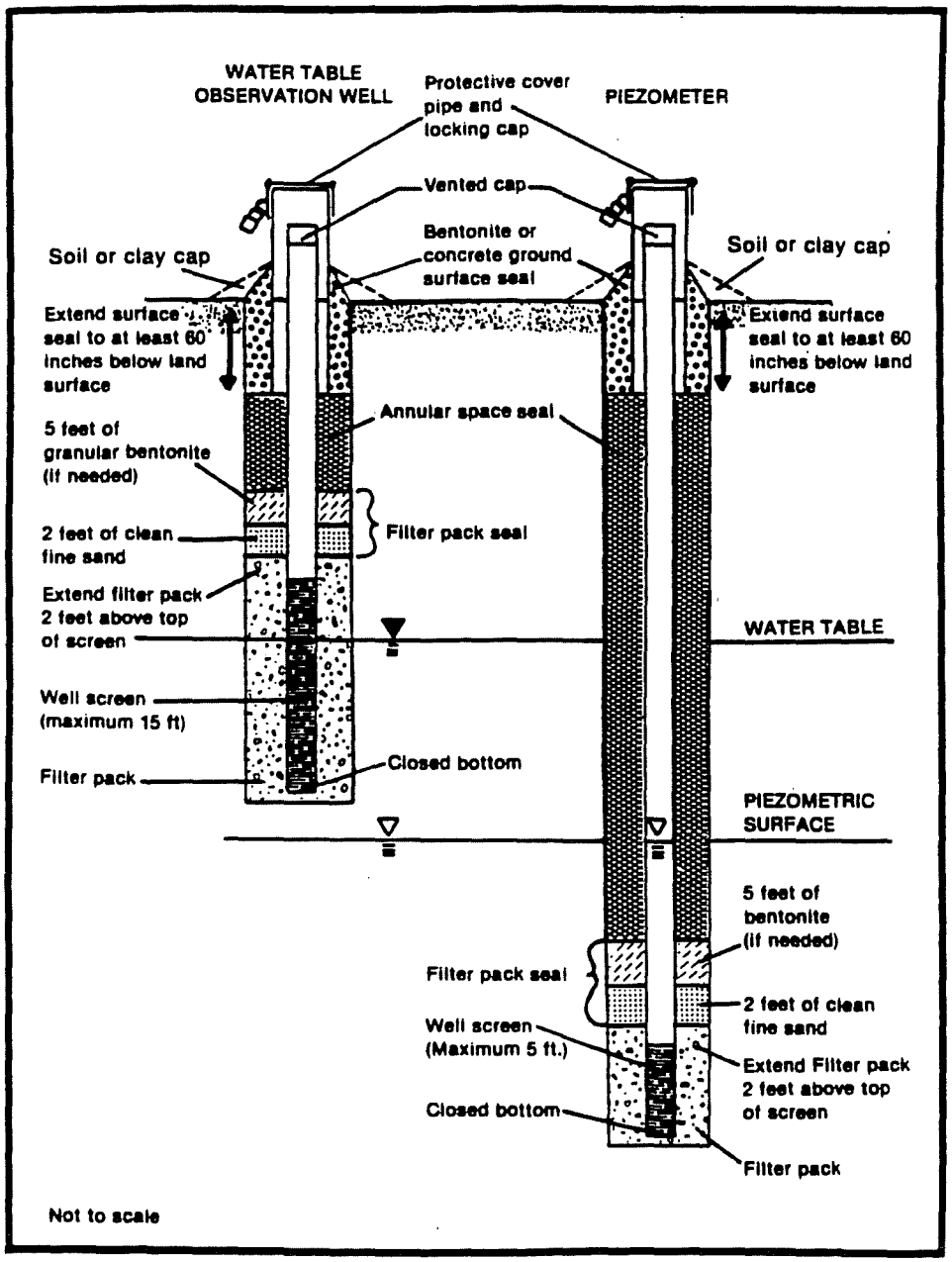
NR 141.09 Well screen. (1) SPECIFICATIONS. All permanent groundwater monitoring well screens shall be constructed of material which is nonreactive with the constituents in soils and groundwater at the monitoring location. The well screen may not be hand cut and may not be wrapped with filter cloth. The well screen slot size shall be sized to retain at least 90% of the grain size of the collapsed formation, based on a sieve analysis, when collapsed formation is used as filter pack material or at least 90% of the grain size of the filter pack, based on a sieve analysis, if material other than collapsed formation is used. Well screens on water table observation wells may not exceed 15 feet in length. Well screens on piezometers installed for the purpose of determining the elevation of the potentiometric surface may not exceed 5 feet in length.

Note: Well screens for wells other than the water table observation wells and piezometers identified above may vary in length.

(2) ASSEMBLY AND INSTALLATION. All well screens shall be permanently joined to the well casing by flush threaded joints. All joints shall be watertight. All well screens shall be centered in the borehole. Monitoring wells installed in bedrock using an open borehole may be constructed without a well screen.

Figure 1. . . .

Typical water table observation well and piezometer construction details.



History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.10 Tremie pipes and sealing procedures. (1) MATERIALS. The tremie pipe used for the placement of sealant materials shall be one of the following materials:

(a) Metal pipe,

(b) Rubber-covered hose reinforced with braided fiber or steel and rated for at least 300 psi, or

(c) Thermoplastic pipe rated for at least 100 psi including:

1. Polyvinyl chloride (PVC)

2. Chlorinated polyvinyl chloride (CPVC),

3. Polyethylene (PE),

4. Polybutylene (PB), and

5. Acrylonitrite butadiene styrene (ABS).

(2) PROCEDURES. This subsection describes department approved sealant placement methods when a tremie pipe is used.

(a) The estimated and actual volume of sealing material used shall be calculated and reported to the department.

(b) The sealant material shall be placed in one continuous operation in such a manner as to not disturb the integrity of the filter pack and seal.

(c) When a tremie pipe is used, the bottom end shall be kept submerged in the sealant material throughout the sealing process.

(d) The sealant material shall be brought up to the ground surface seal. The density of the sealant material in the annular space or borehole at the bottom of the ground surface seal shall be the same as the density of the sealant material being placed. Any settling of the sealant material shall be topped off.

(e) Tremie pipe - gravity. As depicted in Figure 2, sealing material may flow by gravity through a funnel or hopper connected to a tremie pipe. The tremie pipe shall be lowered to the bottom of the annular space or borehole to be sealed and the sealing material placed from the bottom up. The end of the tremie pipe shall be kept submerged in the grout or slurry at all times.

(f) Tremie pipe - pumped. As depicted in Figure 3, the sealing material shall be placed by a pump through a tremie pipe into the annular space or borehole. Tremie pipes used for the placing of pumped slurry or grout shall be fitted with a J-hook end or a closed end with side discharge ports.

Note: The J-hook end or closed end with side discharge ports of the tremie pipe will direct the flow of the materials to the side or upward.

Figure 2.

Conductor (tremie) pipe — gravity method

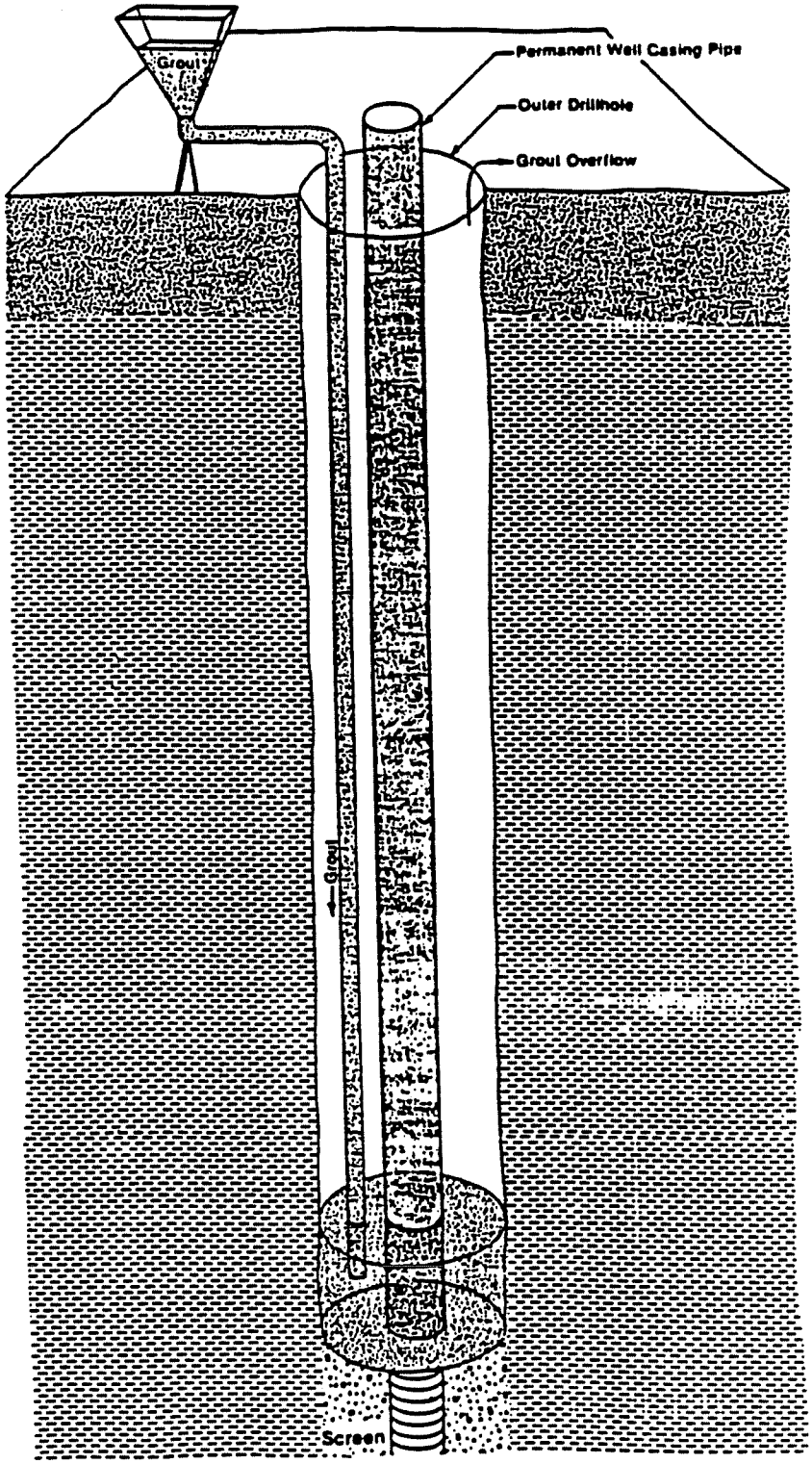
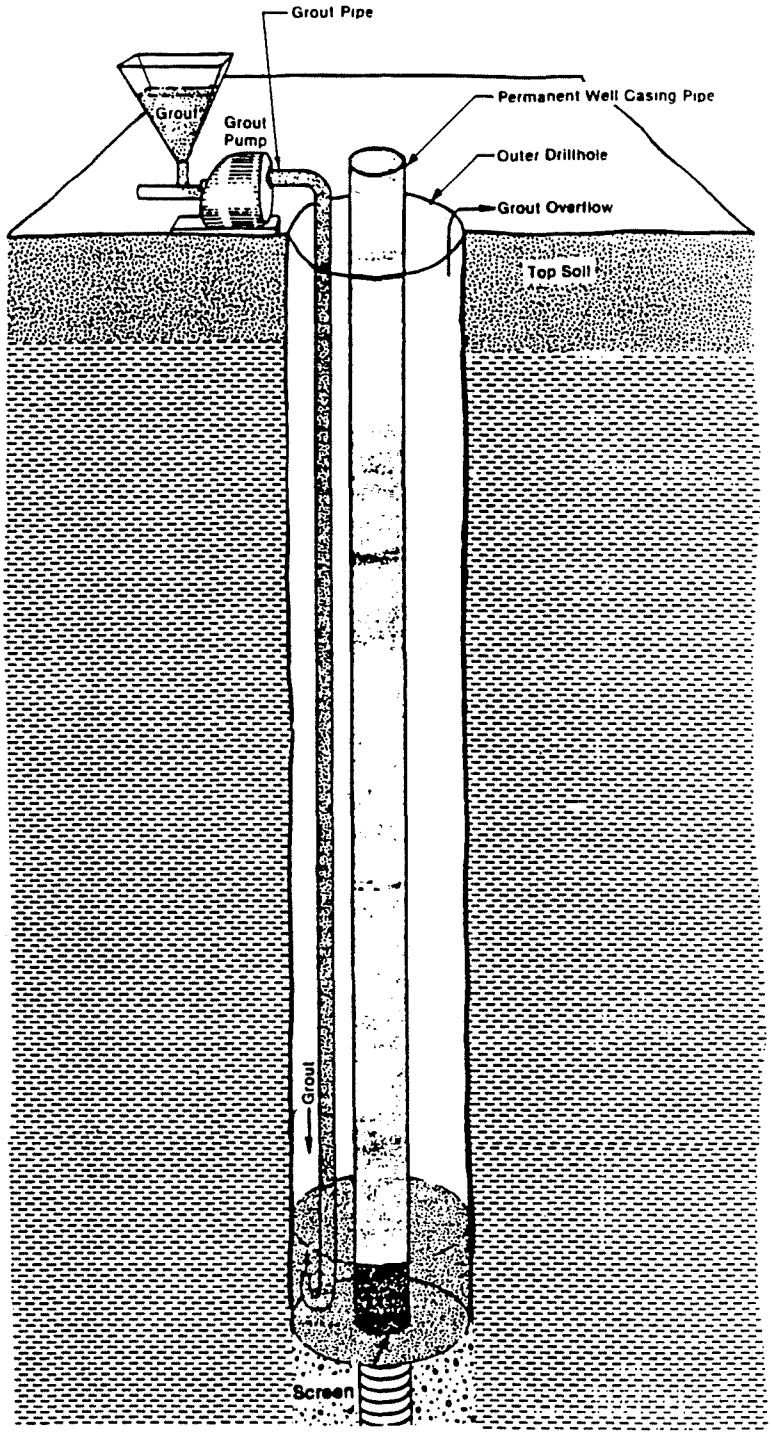


Figure 3.

Conductor (tremie) pipe — pumped method



History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (2) (d) and (f), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.11 Filter packs. All permanent groundwater monitoring wells installed in unconsolidated material and used for the collection of water quality samples shall be constructed with filter packs. Permanent groundwater monitoring wells installed in bedrock may be constructed with filter packs. When used, the filter pack shall be the only material in contact with the well screen. The estimated and actual volume of filter pack material used shall be calculated and reported to the department. All commercially prepared filter packs installed in permanent groundwater monitoring wells shall meet the requirements in sub. (1). All other filter packs shall meet the requirements in sub. (3).

(1) SPECIFICATIONS. The filter pack shall be a well sorted, silica based sand or gravel. The sand or gravel used for filter packs shall be hard and durable and shall have an average specific gravity of not less than 2.50. The sand and gravel shall be visibly free of clay, dust and micaceous and organic matter. Not more than 5% of the sand or gravel shall be soluble in a 10% hydrochloric acid solution. Thin, flat or elongated pieces of gravel, the maximum dimension of which exceeds 3 times the minimum dimension, may not constitute more than 2% of the material by weight. The filter pack for wells installed in unconsolidated material shall be sized to retain at least 50% of the surrounding formation based on a sieve analysis. In formations which are predominantly silt and clay, the filter pack shall be a fine sand. In bedrock, the filter pack shall be a medium or coarse sand or gravel. Crushed limestone, dolomite or any material containing clay or any other material that will adversely impact on the performance of the monitoring well may not be used as filter pack.

(2) INSTALLATION. The filter pack shall extend from 6 inches beneath the bottom of the well to 2 feet above the top of the well screen. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the required filter pack height above the top of the well screen may be reduced to 6 inches to allow for the required amount of annular space sealant to be placed. To ensure that the filter pack is installed evenly surrounding the well screen and casing over the proper depth interval, a tape measure, measurng rod or similar device shall be used to measure the height of the filter pack. The tape measure, measuring rod or similar device shall be carefully raised and lowered while the filter pack is being installed to identify bridging. If bridging occurs the filter pack material shall be tamped into place, surrounding the well screen and casing, using a measuring rod or similar device.

(3) COLLAPSED FORMATION. Collapsed formation may be used as filter pack material if the collapsed formation will limit the passage of formation fines into the well screen and either an artificial filter pack cannot be installed or the formation grain size is greater than or equal to fine sand sized grains. The grain size distribution of the collapsed formation shall be such that at least 90% of the formation will be retained by the well screen based on a sieve analysis. Analysis of the collapsed formation for specific gravity and particle size shall be performed and documentation shall be submitted to the department to support its use as an acceptable filter pack. Following review of the submitted information, the department may require new well construction if the collapsed formation analysis is not consistent with the filter pack specifications.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1) to (3), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.13 Sealing requirements. All materials and procedures used in the installation of seals for permanent groundwater monitoring wells shall meet the requirements of this section. The calculated and actual volume of sealant material used for the filter pack seal and annular space seal shall be reported to the department.

(1) FILTER PACK SEAL. (a) *Specifications.* All permanent groundwater monitoring wells installed with filter packs shall be constructed with a filter pack seal. For all water table observation wells and piezometers, the filter pack seal shall extend 2 feet upward from the top of the filter pack and shall consist of 2 feet of clean fine sand. When high-solids grout, granular bentonite slurry, bentonite-cement grout or neat cement grout is used as the annular space sealant, 5 feet of bentonite shall be placed on top of the clean fine sand seal. Bentonite chips no greater than ⅜ inch in diameter or bentonite pellets shall be used for seals placed below the water table. Bentonite granules may be used for seals when there is no standing water above the filter pack and the borehole is less than 25 feet or in areas where the depth to water table is less than 7 feet. For water table observation wells constructed in areas where the depth to water table is less than 16 feet, the filter pack seal shall be reduced to 2 feet of bentonite to allow for the required amount of annular space sealant to be placed. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the required fitler pack seal may be reduced to allow for the required amount of annular space sealant to be placed.

(b) *Installation.* A tape measure, measuring rod or similar device shall be used to ensure that the filter pack seal is installed over the proper depth interval. The tape measure, measuring rod or similar device shall be carefully raised and lowered while the filter pack seal material is being placed to identify bridging. If bridging occurs the filter pack seal material shall be tamped into place, surrounding the well casing, using a measuring rod or similar device. When a tremie pipe is used to place the filter pack seal the procedures of s. NR 141.10 (2) shall be followed. Bentonite pellets, bentonite chips or bentonite granules shall be hydrated in 2 foot lifts as placed in the borehole when placed above the water table.

(2) ANNULAR SPACE SEAL. (a) *Specifications.* All permanent groundwater monitoring wells shall be installed with an annular space seal designed to achieve a permeability of 1×10^{-7} centimeters per second or less. For permanent groundwater monitoring wells constructed with filter packs, the annular space seal shall extend from the filter pack seal to the ground surface seal and shall be at least 2 feet in length. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the annular space seal shall be bentonite granules. For monitoring wells constructed into bedrock formations and without well screens, the annular space seal shall extend from the bottom of the outer borehole to the ground surface seal and shall be at least 2 feet in length. Sealant materials may not contain additives. These requirements may be met by:

Note: The department does not recommend the use of neat cement grout or cement mixtures in fractured formations because they may impact water quality.

1. Bentonite granules slurry may be used as an annular space sealant in any type of monitoring well except where the depth to the water table is less than 7 feet.

2. Bentonite sand slurry may be used as an annular space sealant in any type of monitoring well except where the depth to the water table is less than 7 feet.

3. Bentonite pellets, bentonite chips or bentonite granules may be used to seal the annular space under the following conditions:

a. Bentonite granules may be used when there is no standing water in the well above the filter pack and the total well depth is less than 25 feet or the depth to water table is less than 7 feet.

b. Bentonite chips with diameter no larger than ⅜ inch or bentonite pellets may be used when the depth of standing water in the well is less than 30 feet and the total depth of the annular space seal is less than 50 feet except where the depth to the water table is less than 7 feet.

4. High-solids grout approved by the department, bentonite-cement grout or neat-cement grout may be used to seal the annular space in which a bentonite filter pack seal has been placed except where the depth to the water table is less than 7 feet.

(b) *Installation.* 1. When bentonite chips with diameter no larger than ⅜ inch, bentonite pellets or granules are used to seal the annular space, they may either be poured freely down the borehole or added through a tremie pipe, provided the specifications of par. (a) are met. When a tremie pipe is used to place the annular space sealant the procedures of s. NR 141.10 (2) (a) and (b) shall be followed.

2. When grouts or slurries are used to seal the annular space, the material may be poured freely down a tremie pipe or pumped down a borehole with the use of a tremie pipe, provided the specifications of par. (a) are met. For wells 100 feet in depth or greater the sealant material shall be pumped down the borehole with the use of a tremie pipe. When a tremie pipe is used to place the annular space sealant the procedures of s. NR 141.10 (2) shall be followed.

3. When any slurry or grout is used, there shall be a 12-hour period between the time the annular space seal is installed and the time the protective cover pipe is installed. Any settling in the annular space seal shall be topped off before the protective cover pipe is installed.

4. The top of the well casing shall be covered with a protective cap.

(3) GROUND SURFACE SEAL AND PROTECTIVE COVER PIPE. (a) *Ground surface seal.* All permanent groundwater monitoring wells shall be constructed with a bentonite or concrete ground surface seal. The ground surface seal shall extend to a minimum of 60 inches below the land surface, and the top shall be sloped away from the well casing. If bentonite is used, the top of the surface seal shall terminate 2 inches below the land surface and shall be covered with top soil or native soil to prevent drying out. The ground surface seal shall be installed around the protective cover and may not be placed between the protective cover pipe and the well casing. If the monitoring well depth is such that both a minimum 2 foot annular space seal and a minimum 5 foot ground surface seal cannot both be placed, the ground surface seal may be shortened.

Note: Certain soils are prone to frost heave and the department does not recommend use of concrete as a ground surface seal in these situations.

(b) *Protective cover pipe.* The protective cover pipe shall consist of a metal casing at least 2 inches larger in diameter than the well casing with a locking cap. The protective cover pipe shall extend from the bottom of the ground surface seal to a minimum of 24 inches above the ground surface except as provided in sub. (4). There may be no more than 4 inches between the top of the well casing and the top of the protective cover pipe. The protective cover pipe shall always extend above the top of the well casing. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the required length of protective cover shall be reduced and may not extend through the annular space seal or into the filter pack. If the monitoring well is located in a floodplain, the protective cover pipe shall be watertight. The department may require additional protective devices, such as rings of brightly colored posts around the well, as necessary. Weep holes or vents may be used in protective cover pipes.

(4) GROUND SURFACE SEAL AND FLUSH MOUNTED PROTECTIVE COVER PIPE. (a) *Ground surface seal.* All permanent groundwater monitoring wells with a flush mounted protective cover pipe shall be constructed with a concrete ground surface seal. The ground surface seal shall extend to, but not beyond, the total depth of the flush mounted protective cover pipe. The ground surface seal shall be installed around the flush mounted protective cover pipe and may not be placed between the flush mounted protective cover pipe and the well casing.

(b) *Flush mounted protective cover pipe.* The flush mounted protective cover pipe may be installed only in high vehicular traffic areas and may not be installed in areas subject to ponding or flooding. The flush mounted protective cover's lid shall have the wording "monitoring well" on its outer surface. Flush mounted protective cover pipes shall be installed through an impervious surface such as asphalt or concrete. If an impervious surface does not exist one shall be created which will support the weight of the traffic in the area. The flush mounted protective cover pipe shall consist of a watertight metal casing with an inside diameter at least 4 inches greater than the inside diameter of the monitoring well casing. The flush mounted protective cover pipe shall be one continuous metal piece or 2 metal pieces which are joined with a continuous weld. The flush mounted protective cover pipe shall be a minimum of 12 inches in length. There may be no more than 8 inches between the top of the monitoring well casing and the top of the flush mounted protective cover pipe after installation. The flush mounted protective cover pipe shall have an exterior flange or lugs. The flush mounted protective cover pipe may not extend beyond the annular space seal. The flush mounted protective cover pipe or the monitoring well shall have a locking mechanism. The monitoring well installed within any flush mounted protective cover pipe shall have a watertight cap.

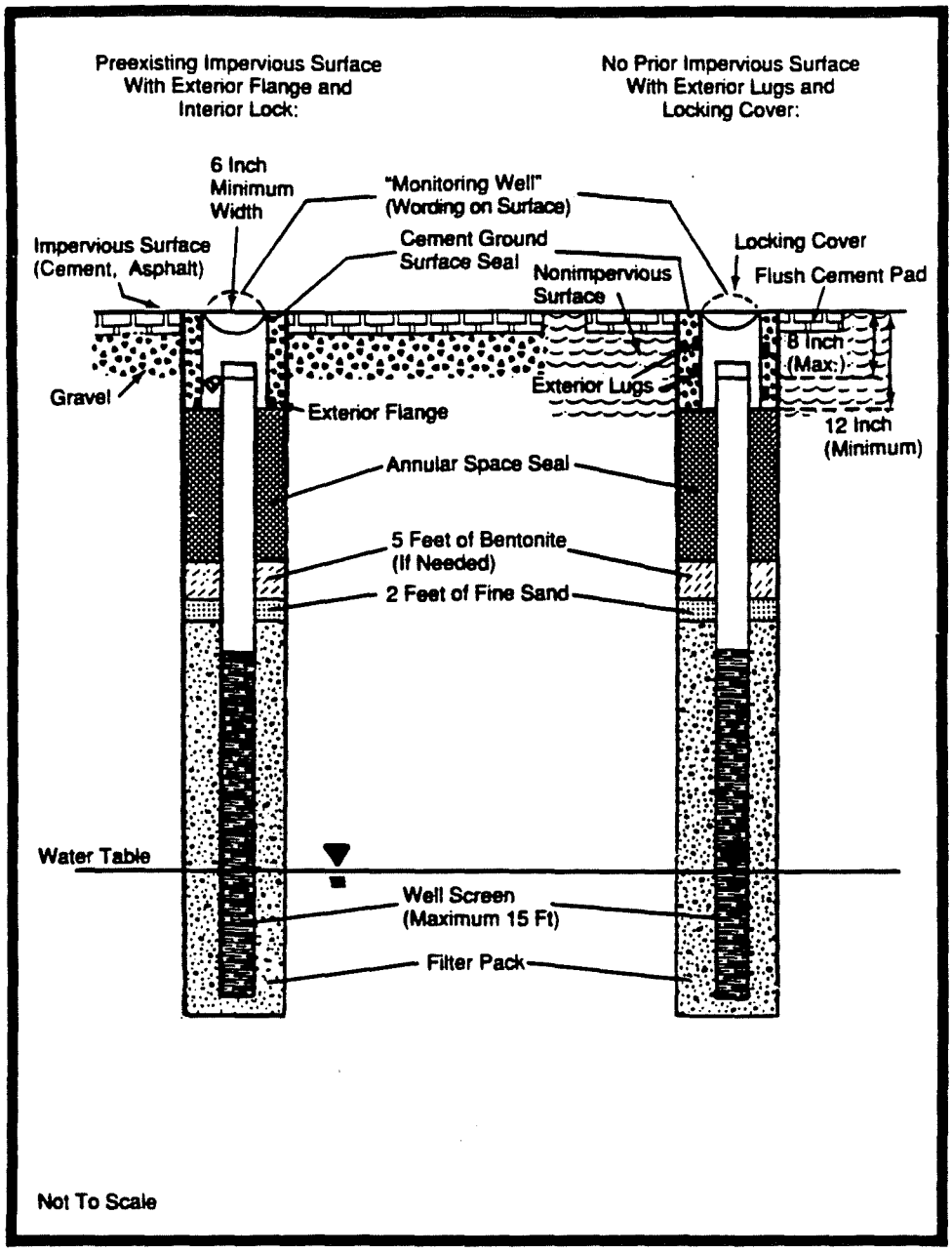
Note: Figure 4 depicts 2 typical flush mounted protective cover pipes after installation.

Note: An exterior flange or lugs will aid in the stabilization of the flush mounted protective cover pipe within the ground surface seal.

Note: After removing the watertight cap and prior to taking a pressure head measurment a waiting period is recommended to enable the water level to stabilize.

Figure 4.

Two typical flush mounted protective cover pipes after installation.



History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1), (2) (a) (intro.), 1., 2. and 3. and (b) 1. and 4. and (3), r. and recr. (2) (a) 4., r. (2) (a) 5. and 6., cr. (4), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.15 Drilling methods and fluids. The drilling method shall introduce the least possible amount of foreign material into the borehole, produce the least possible disturbance to the formation and permit the proper construction and development of the required diameter well. Only air, water from a known safe source free of bacterial and chemical contamination or bentonite drilling muds, mixed with water from a known safe and uncontaminated source, may be used as drilling fluids. The water used for drilling shall be stored in such a manner as to prevent contamination of the clean water. The department may require chemical analysis of the water used to produce drilling fluids. Hammer drill lubricants, used with air rotary drill rigs, may not be used for installing groundwater monitoring wells. If air is used as a drilling fluid, the air shall be filtered by a coalescing air filter. If water is used, the source of the water shall be reported. Drilling fluid additives may not be used without prior written department approval.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.16 Cross contamination. Precautions shall be taken to prevent cross contamination of aquifers or uncontaminated zones.

History: Cr. Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.17 Disposal and decontamination. (1) All drill cuttings and fluids and surge and wash waters from borehole and groundwater monitoring well construction and development shall be disposed of in a manner approved by the department.

(2) All borehole and groundwater monitoring well construction and development equipment shall be decontaminated by washing and triple rinsing or high pressure heat cleaning to prevent cross-contamination of boreholes or groundwater monitoring wells.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.19 Borehole diameter. (1) BOREHOLES IN UNCONSOLIDATED GEOLOGIC FORMATION. For all permanent groundwater monitoring wells in unconsolidated geologic formations, the borehole diameter shall meet the following requirements:

(a) If hollow stem augers are used, their inside working diameter shall be at least 2¼ inches greater than the inside diameter of the permanent well casing.

(b) If solid stem augers are used, their outside diameter shall be at least 4 inches greater than the inside diameter of the permanent well casing.

(c) If an air or mud rotary method is used, the borehole diameter shall be at least 4 inches greater than the inside diameter of the permanent well casing. If a temporary outer casing is used, the inside diameter of the temporary outer well casing shall be at least 4 inches greater than the inside diameter of the permanent well casing. The temporary outer casing shall be pulled as the annular space is being sealed.

Note: The dual-tube or triple-tube reverse rotary systems are rotary methods.

(d) If percussion methods, including the rotary wash, wash down and wash bore methods, with a temporary outer casing are used, in unconsolidated geologic formations, the inside diameter of the temporary outer casing shall be at least 4 inches greater than the inside diameter of the

permanent well casing. The temporary outer casing shall be removed during the sealing of the annular space.

(2) BOREHOLES IN BEDROCK GEOLOGIC FORMATIONS. For all permanent groundwater monitoring wells installed deeper than 2 feet past the top of the bedrock, the borehole diameter shall meet the following requirements:

(a) If an air or mud rotary method is used to construct the monitoring well, the requirements of sub. (1) (c) shall be followed.

(b) If percussion methods are used to construct the monitoring well, the requirements of sub. (1) (d) shall be followed.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.20 Aquifer test or recovery wells. The installation, location and construction of any aquifer test well or recovery well installed for a purpose regulated by the department under ch. 144, 147 or 160, Stats., shall be approved by the department program responsible for overseeing work at the site prior to installation. Unless another time period is specified by law, the department shall complete its review and make a determination on all applications for approval within 65 business days after receipt of the complete application for approval. Applications may be included with other submittals for work to be performed at the site. The start of the 65 day review period will not begin until a complete application is received by the department. All requests for approval shall be in writing, except that for situations that require immediate response, an approval may be requested verbally and an advanced verbal approval may be granted by the department and followed up with a written confirmation. Aquifer test wells or recovery wells may be used for pressure head monitoring or water quality monitoring only with the approval of the department. All aquifer test and recovery wells shall be abandoned according to s. NR 141.25 and documented according to s. NR 141.23.

Note: See ch. NR 112 for additional requirements that apply to aquifer test wells and recovery wells.

History: Cr. Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.21 Well development. All permanent groundwater monitoring wells shall be developed according to the requirements of section. Wells sealed with grout or slurry shall be developed after a minimum waiting period of 12 hours after installation is completed. The goal of well development is to produce water free of sediment and all drill cuttings and drilling fluids.

(1) WELLS THAT CANNOT BE PURGED DRY. All permanent groundwater monitoring wells that cannot be purged dry shall be developed by the following procedure:

(a) Alternately surge and purge the well for a minimum of 30 minutes. The surge and purge cycle shall consist of several minutes of surging followed by several minutes of purging to remove the material collecting in the bottom of the well. The surging shall move formation water in and out of the well screen. The surging shall be accomplished by using either a bailer or surge block or by pumping the well sufficiently to cause a drawdown and then allowing the well to recover and repeating the process.

Note: When a surge block is used, care should be taken to avoid drawing the annular space seal material into the filter pack or well screen.

(b) After the final surge and purge cycle is completed, the well shall be pumped or bailed until 10 well volumes of water are removed or until the well produces sediment free water. If sediment free water is not obtained any remaining sediment shall be removed from the bottom of the well. Well volume shall be calculated in the following manner:

$V_1 + V_2$ = well volume

V_1 = volume of water in well casing

$$V_1 = \Pi \left(\frac{D_1}{2}\right)^2 H_1$$

V_2 = volume of water in filter pack

$$V_2 = N \Pi H_2 \left[\left(\frac{D_3}{2}\right)^2 - \left(\frac{D_2}{2}\right)^2\right]$$

N = porosity of filter pack

D_1 = inside diameter of well casing

D_2 = outside diameter of well casing

D_3 = diameter of borehole

H_1 = height of water column

H_2 = length of sand used in filter pack and fine sand filter pack seal or the height of the water column in water table observation wells.

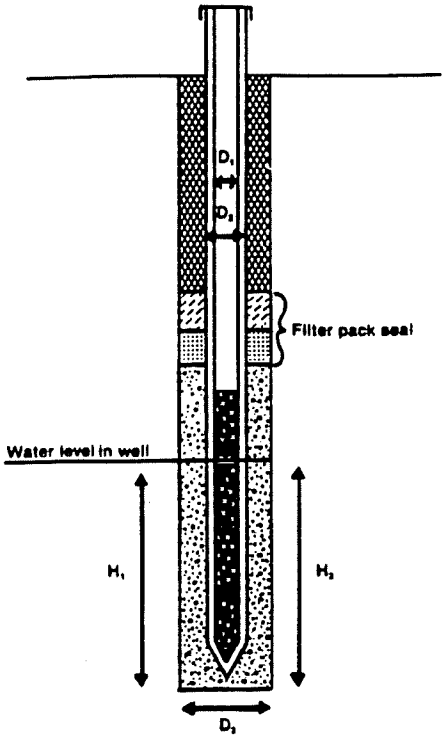
Note: There are 7.48 gallons per cubic foot.

H_1 = height of water column

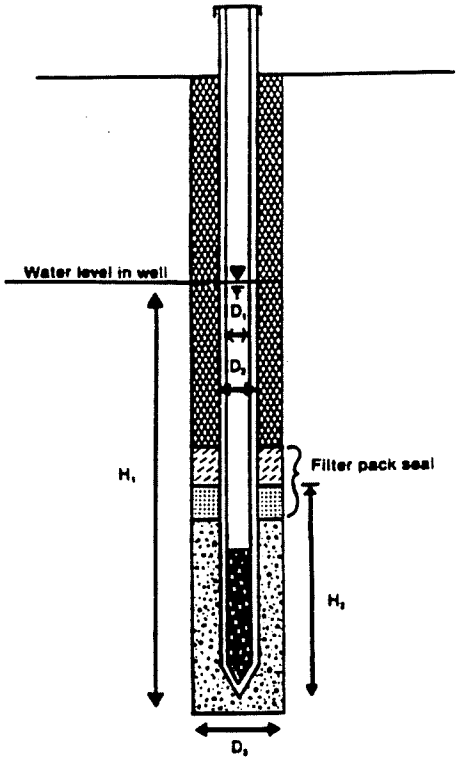
H_2 = length of filter pack or the height of the water column in water table observation wells.

CALCULATION OF WELL VOLUME

IN WATER TABLE OBSERVATION WELL



IN PIEZOMETER



(2) WELLS THAT CAN BE PURGED DRY. All permanent groundwater monitoring wells that can be purged dry shall be developed in a manner which limits agitation by slowly purging the well dry. Wells which can be purged dry may not be surged and no water may be added to the well.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (intro.), (1) (a) and (b) and (2), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.23 Well and borehole construction documentation. (1) All permanent groundwater monitoring well construction shall be reported to the department, using forms and instructions provided by the department, within 60 days after the well has been installed. The completed report shall include the following information:

(a) Well location,

(b) Well casing material and installation procedures,

(c) Well screen materials and installation procedures,

(d) Filter pack materials and installation procedures,

(e) Sealing materials and installation procedures,

(f) Drilling methods and fluids used for installation,

(g) Borehole diameter,

(h) Well development procedures,

(i) Sieve analysis, and

(j) Any other information deemed necessary by the department.

(2) All permanent groundwater monitoring wells installed after February 1, 1990 shall be labeled with labels supplied by the department.

(3) All borehole construction data shall be reported to the department using forms and instructions supplied by the department within 60 days after construction. The completed report shall include the following data: the results of any soil tests done and a description of the soil structure, soil color, mottling, moisture content, layering, jointing, lenses, fractures, organic matter and voids and any other information deemed necessary by the department. The constructor shall report any decontamination procedures used between borehole installations.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1) (h), renum. (1) (i) to (j), cr. (1) (i), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.25 Abandonment requirements. The following requirements apply to the abandonment of all boreholes greater than 10 feet deep or which intersect a water table and all groundwater monitoring wells. The department may require, by order or other appropriate means, that any borehole or monitoring well be abandoned. The department shall consider the following factors in determining whether a borehole or monitoring well should be abandoned: purpose, location, groundwater quality, age and condition of the well or borehole potential for groundwater contamination and well or borehole construction.

(1) TIMELINES FOR ABANDONMENT. (a) A borehole shall be abandoned within 3 working days after its use has been discontinued.

(b) Any permanent groundwater monitoring well no longer being used to gather information on geologic or groundwater properties shall be abandoned within 60 days after its use has been discontinued.

(c) Any groundwater monitoring well found by the department to be acting as a conduit for groundwater contamination shall be abandoned within 15 working days after written notification by the department.

(d) Any groundwater monitoring well constructed after February 1, 1990 not meeting the requirements of this chapter shall be abandoned and replaced with a monitoring well meeting the requirements of this chapter or any department approval granted under this chapter within 60 days after installation of the noncomplying well or 15 days after written notification by the department that the well is noncomplying.

(2) ABANDONMENT PROCEDURES. (a) *Boreholes.* Any borehole intersecting the water table or greater than 10 feet deep, whose use has been discontinued, shall be abandoned according to the requirements of par. (d).

(b) *Monitoring wells - impermeable annular space seals.* A permanent groundwater monitoring well known to be constructed with an impermeable annular space seal shall be abandoned according to the requirements of par. (d) after the protective cover pipe and ground surface seal have been removed and the well casing cut off at least 30 inches below the ground surface. The well casing may be completely removed during abandonment by pulling the well casing, overdrilling around the casing and then pulling the well casing out of the ground or by drilling out the well casing completely. If the well casing is to be removed, the well shall be sealed as the casing is removed.

(c) *Monitoring wells - permeable annular space seals and wells in waste areas.* A groundwater monitoring well not known to be constructed with an impermeable annular space seal or located in an existing or planned future waste disposal or treatment area shall be abandoned by removing the protective cover pipe and the ground surface seal and then completely removing the well casing. The well casing shall be pulled out of the ground as the well is filled according to the requirements of par. (d).

(d) *Sealing requirements.* Boreholes and groundwater monitoring wells shall be abandoned by complete filling with neat cement grout, bentonite-cement grout, sand-cement grout, concrete or bentonite-sand slurry. When a tremie pipe is used to place the sealing material, the procedures of s. NR 141.10 (2) shall be followed. A tremie pipe shall be used to abandon groundwater wells and boreholes greater than 30 feet in depth or with standing water. Groundwater monitoring wells and boreholes greater than 100 feet in depth shall be sealed with a tremie pipe-pumped method. Bentonite may be used as a sealing material without the use of a tremie pipe under the following conditions:

1. Bentonite granules may be used for abandonment of boreholes and groundwater monitoring wells less than 25 feet deep and when there is no standing water above the filter pack seal.

2. Bentonite chips no greater than ⅜ inch in diameter or bentonite pellets may be used for abandonment of boreholes and groundwater monitoring wells less than 50 feet deep and the depth of standing water is less than 30 feet.

3. Bentonite chips no greater than ⅜ inch in diameter or bentonite pellets may be used for abandonment of boreholes and groundwater monitoring wells which are greater than 4 inches in diameter and less than 250 feet deep and the depth of standing water is less than 150 feet.

(3) SEALANT SETTLEMENT. Any settling of the sealant material shall be topped off. Sealing material may be terminated 30 inches below the ground surface in agricultural areas to avoid interference with agricultural activities. A native soil plug shall be placed on top of the settled sealing material in such cases.

(4) ABANDONMENT DOCUMENTATION. All borehole and permanent groundwater monitoring well abandonments shall be reported to the department within 60 days of the abandonment on forms supplied by the department. In addition to the information required on the form, the person performing the abandonment shall report any decontamination procedures used between borehole and well abandonments.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (2) (b), (2) (d) 1 to 3 and (3), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.27 Driven point wells. Driven point wells with galvanized steel drive pipes and contaminant compatible well screens may be used as permanent groundwater monitoring wells if prior department approval is obtained. Written documentation shall be supplied to the department prior to installation indicating:

(1) That the well is to be used only for water table elevation measurements or to monitor for parameters for which the well casing and screen material will not interfere with the analytical results;

(2) That the well will not provide a conduit for contaminants to enter the groundwater; and

(3) That information on subsurface stratigraphy is not needed. In situations where subsurface geologic information is needed, a separate borehole shall be constructed to collect the required data.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.29 Temporary groundwater monitoring wells. Temporary groundwater monitoring wells may be installed according to less stringent standards than specified for permanent groundwater monitoring wells. Any temporary monitoring well construction shall be approved by the department prior to its installation. All temporary monitoring wells shall be abandoned in accordance with s. NR 141.25 within 120 days after their installation.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.31 Special circumstances and exceptions. (1) The department may require or approve more restrictive or alternative well material, assembly, installation, development or abandonment if the contaminant concentrations or geologic setting require alternative construction. Prior written approval is required before any alternative materials are used in monitoring well installation.

(2) Exceptions to the requirements of this chapter may be approved by the department prior to installation or abandonment. An exception request shall state the reasons why compliance with the rule requirements is infeasible. The department may conditionally approve an exception by

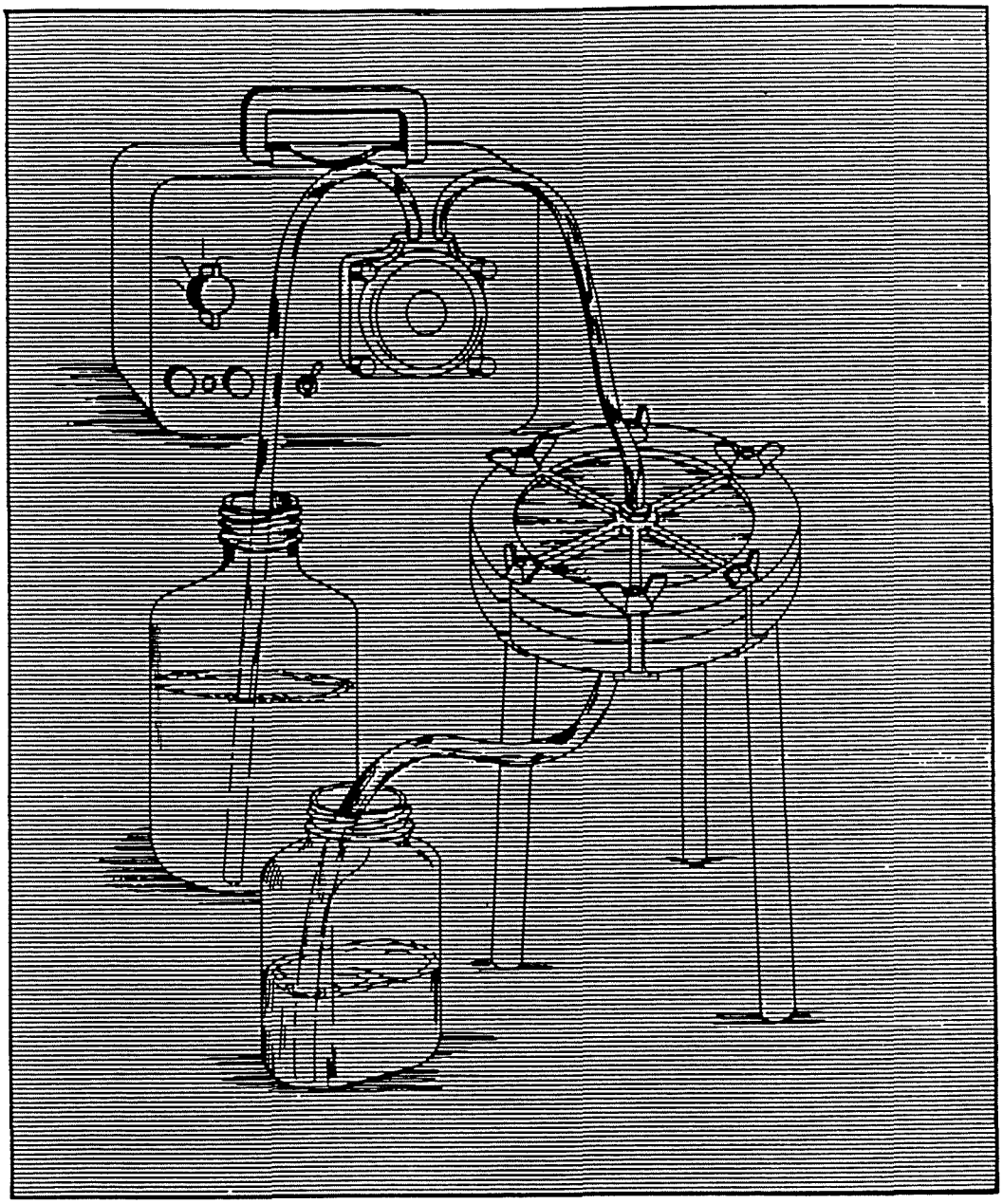
requiring materials or procedures which safeguard against contamination and result in groundwater monitoring well construction which is substantially equivalent to the requirements of this chapter. Failure to comply with the conditions of an exception voids the department's approval of the exception.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

APPENDIX D
GROUNDWATER SAMPLING PROCEDURES FIELD MANUAL

Wisconsin Department of Natural Resources

Groundwater Sampling Procedures



Field Manual

September 1987

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Wisconsin Natural Resources Board

Helen M. Jacobs, Milwaukee
John A. Lawton, Madison
Richard A. Hemp, Mosinee
Thomas D. Lawin, Bloomer
Will Lee, Wisconsin Rapids
Stanton Helland, Wisconsin Dells
Richard Lange, South Range

Department of Natural Resources

C. D. Besadny, Secretary
Bruce B. Braun, Deputy Secretary
Linda H. Bochert, Executive Assistant

Division of Environmental Standards

Lyman F. Wible, Administrator

Authors: David E. Lindorff
Bureau of Water Resources Management

Jodi Feld
Bureau of Solid Waste Management

Jack Connelly
Bureau of Solid Waste Management

Groundwater Sampling Procedures Workgroup:

Ron Arneson, Office of Technical Services
Greg Becker, Bureau of Water Supply
Jack Connelly, Bureau of Solid Waste Management
Jodi Feld, Bureau of Solid Waste Management
Tom Harpt, Southern District
Ed Kreul, North Central District
David Lindorff, Bureau of Water Resources Management
David Sauer, Bureau of Wastewater Management

Groundwater Sampling Procedures Field Manual

Principal Authors:
David E. Lindorff
Jodi Feld
Jack Connelly

Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

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SAMPLING PROCEDURES FOR MONITORING WELLS

A. PRE-SAMPLING CHECKLIST

Equipment (Not all of the following may be necessary each time you sample.):

1. A map of the site (preferably a 8-1/2" x 11" topographic map) that shows the access roads and the locations of the wells you will be sampling.
2. A field notebook and Well Specific Field Sheet (WSFS) forms for recording all observations.
3. Well Information Forms (WIF's), well construction reports or well logs for all wells being sampled.
4. Waterproof marking pens or pencils.
5. Calculator and necessary conversions (or tables) to calculate the volume of water you will need to purge from the well(s).
6. Keys for all locked well caps.
7. Camera and film.
8. Water level measuring device and a backup (make sure it will extend deep enough to reach water in the well). If using an electrical tape, bring extra batteries.
9. Sampling and purging device (make sure the diameter is compatible with the well diameters being sampled).
10. Plastic bags or plastic sheets to place on the ground around the well.
11. Calibrated bucket to measure the volume of water removed when purging the well.
12. Extra rope (if a bailer is being used).
13. Five feet of tubing for peristaltic pump.
14. Transfer containers.
15. Sample containers (should be provided by the lab); bring extra for field quality control (blanks, duplicates) and to allow for breakage.
16. Labels for sample containers and preservatives*. Bring extra.
17. Thermometer.
18. Conductivity meter, standards, and extra batteries.
19. pH meter, buffers, extra batteries, beakers for buffers and standards.
20. Filtering apparatus (make sure all of the parts are included), filter membranes (0.45 micron pore size) and pre-filters.
21. Preservatives (should be provided by the lab; bring extras)*.
22. pH paper*.
23. Lab sheets (if required by your lab).
24. Ice or frozen cold packs to cool the samples.
25. Cooler large enough to hold all the sample containers (including duplicates and blanks) and ice.
26. Lab packs for the samples that need to be mailed to the lab.
27. Tape and stamps for mailing.
28. At least two 250 ml bottles with squirter (for rinsing).
29. Scrub brush for cleaning sampling equipment.
30. Two five gallon jugs of reagent grade water from your lab. Note: Do not purchase this water from a supermarket.
31. Tools: wrenches, screwdrivers, hammers, scissors/utility knife.
32. Miscellaneous hardware: nails, screws, washers, etc.
33. Plastic gloves, face shields, respiratory equipment, if needed.
34. First aid kit.
35. Treble fish hook with sinker to retrieve bailer.

*Contained in State Lab of Hygiene Preservation Kit.

Procedures:

_____ 1. Contact the lab coordinator with sampling information (date, number of samples, analyses desired). DNR only.
_____ 2. Check equipment log book for previous problems with equipment.
_____ 3. Check equipment for good working order.

_____ test batteries
_____ test with a tap sample
_____ calibrate instruments

_____ 4. Follow the formalized procedures set up by your company/agency to check out equipment for use.
_____ 5. Check diameter of sampling equipment for compatibility with wells to be sampled.
_____ 6 Measure volume of water your bailer holds if not done previously.
_____ 7. Fill in as much of the data collection sheets as possible (i.e., lab sheets and well inventory forms).
_____ 8. Obtains keys to the wells.
_____ 9. Familiarize yourself with chain of custody procedures.
_____ 10. Review general site hydrogeology and past water quality information (i.e., Turn Around Documents). List wells from least to most contaminated.
_____ 11. Review well information:

_____ Well location
_____ Well depth
_____ Well diameter
_____ Well casing elevation (top of casing)
_____ Well screen elevation (and depth to top of well screen)
_____ Well screen length
_____ Well history (ex: recovery times)
_____ Water level depth

_____ 12. Assign a sample point ID for all wells without a sample point ID.

_____ 13. Locate the nearest post office or United Parcel Service office if you'll need to mail samples to the lab.

B. MEASURING WATER LEVEL

Use the following procedures to measure static water levels with a popper:

1. Rinse the popper and line with reagent grade water.

2. Lower the popper into the well.

3. Listen for the "pop." You may have to raise and lower the popper several times to make sure you have found the water level.

4. Read the tape measurement at the prescribed reference point (generally a specific point at the top of the inner casing) to the nearest .01 foot and add the length of popper to arrive at the depth to water.

5. Subtract the depth to water from the reference point elevation to yield the water level elevation. If the elevation at the top of the well is not known, survey the well to a benchmark or reference point with a known elevation.

6. Use the popper to determine the depth of the well.

Use the following procedures to measure static water levels using a coated tape:

1. Lower the tape into the well until you hear or feel the tape reach the water surface. Lower the tape a few inches into the water.

2. Read the tape measurement at the top of the casing to the nearest .01 feet.

3. Withdraw the tape from the well and record the measurement where the wetted and dry portions of the tape meet.

4. Subtract this value from the elevation of the top of the casing. This difference is the depth to the water surface.

5. Subtract the depth to water from the elevation at the top of the casing to yield water level elevation. If the elevation at the top of the well is not known, survey the well to a benchmark or reference point with a known elevation.

6. Use the tape to determine the depth of the well.

Use the following procedures to measure static water levels with an electric tape:

1. Lower the probe or electrode into the well by pulling cable from the hand held reel.

2. Continue lowering until the bulb lights up, the beeper beeps or the ammeter needle deflects, indicating that the water table has been reached.

3. Measure the length of cable in the well from the top of casing or other monitoring point to the probe (depth to the water table) and subtract from the measuring point elevation to determine the water level elevation.

C. PURGING

Wells Screened in Low Permeability Formations (Wells that can be purged dry):

1. Pump (or bail) the well dry.
2. Allow the well to recover after purging.
3. Purge the well a second time, if time permits.
4. Collect the sample as soon as there is a sufficient volume of water for the intended analyses (not necessarily when the well is fully recovered).

Wells Screened in High Permeability Formations:

1. Remove four well volumes (calculate as shown in equation (1) or refer to Table 1).
2. Purge wells by pumping or bailing from as near the water surface as possible to ensure that no stagnant water remains in the well above the screen after purging.
3. Introduce as little air and turbulence into the formation as possible to prevent alteration of the samples.

EQUATION (1)

$$V = \left[\pi \cdot \left(\frac{D}{2}\right)^2 \cdot H\right] \times 4 \times 7.48$$

Where:

V = Total volume of water needed to purge (gallons)
D = Inside diameter of well (ft)
H = Height of water column in well (ft)
(depth to bottom of well minus depth to water)

TABLE 1: Volume of Water Contained in One Foot Section of Well Casing

Inside Diameter (inches)	Volume of Water (Gallons)	Gallons to be Purged (4 x Vol. of Water)
1	0.041	.163
1 1/4	0.064	.255
1 1/2	0.092	.367
2	0.163	.652
3	0.367	1.469
4	0.653	2.610

D. WITHDRAWING SAMPLES

Before Sampling:

1. Choose a sampling device which minimizes the potential for altering the water quality of the sample.

2. Withdraw samples shortly after purging (as soon as a volume of water sufficient for the intended analyses reenters the well).

3. Sample the least contaminated wells first, the more contaminated wells last (i.e., sample in increasing order of contamination). If the degree of contamination is unknown, sample the upgradient wells first, the downgradient wells last.

4. Withdraw samples from within or just above the screened section of the well.

Sampling With A Bailer:

Note: The Department strongly recommends the use of bottom emptying devices when sampling with a bailer.

1. Rinse the bailer and line with reagent grade water.

2. Place a large clean plastic bag or cloth on the ground around the well to prevent the bailer rope from touching the ground.

3. Lower the bailer slowly and gently into contact with the water in the well. Do not simply let the bailer fall free into the well while holding the end of the rope. Do not allow the bailer to touch the bottom of the well.

4. Lower the bailer to the same depth in the well each time, preferably within or just above the screened interval.

5. Retrieve the bailer smoothly (do not allow the bailer rope to touch the ground). If the bailer is not retrofitted with an in-line filtering system, empty the water in a slow steady stream in the following order:

   a) Slowly pour an unfiltered portion into a sample container for the required in-field analyses (one person should perform the in-field analyses immediately while the other continues collecting samples for other analyses).

   b) Slowly pour an unfiltered portion into sample containers for volatile organics analyses (as necessary). Collect samples for VOC's from a bailer-full of water as soon as it is brought to the surface. Refer to the next page for special procedures to be followed when sampling for VOC's.