CHAPTER ELEVEN

GROUND WATER MONITORING

11.1 BACKGROUND AND OBJECTIVES

The hazardous waste management facility permit regulations were promulgated in July, 1982 (40 CFR 265). Subpart F of these regulations, Ground Water Protection, sets forth performance standards for ground water monitoring systems at permitted facilities. Performance standards were selected, rather than design and operating standards, because of the diversity of designs and practices appropriate in various site-specific situations. Performance standards provide more flexibility than design and operating standards because site-specific conditions can be accomodated case by case without variance procedures. However, implementation is less efficient because permit writers may need to consider a wider variety of designs and practices; furthermore, much of the variation in reported values is attributable to the variety of designs and practices currently in use.

The purpose of this Chapter is to identify certain designs and practices which meet the performance requirements in specified situations. One of the Agency's reasons for doing so is to encourage the use of more standard methods. The designs and practices which are identified as acceptable in this chapter are considered to be acceptable for the uses and conditions specified. Therefore, permit applicants need not justify their selection. Use of these designs and practices is not mandatory; owners and operators may submit applications based on other approaches. The only incentive to use the "acceptable" designs and practices is that they are already recognized by the Agency and so they need not be justified again. As this list matures, the Agency is hopeful that sources of variance due to the variety in methodology will decrease.

The provisions of this Chapter were developed recognizing that professional judgement will always be needed in designing effective monitoring systems. But, for efficiency of operation, repeated patterns of acceptance and rejection of designs and operations are identified so that the lengthy documentation need not be repeated each time. Readers will note that there are many arbitrary criteria for some "acceptable" methods and that there is little or no attempt to justify the cut-off values. This is intended. This Chapter is expected to be a living document, cautiously developed. As new criteria become identified further refinements of these values should be expected. The purposes of listing the acceptable designs and practices are to encourage use of standard techniques by making their use easier and to reduce the burden on the applicants by relieving their need to justify use of proven designs or practices. The listing establishes, in essence, blanket approvals for a limited number of techniques in those conditions for which they are known to be acceptable.

This Subsection establishes certain ground water sampling system designs and practices as being acceptable under certain conditions for use in meeting the requirements of Subpart F (264.90 et seq.). It also lists certain practices and designs which are not acceptable. The acceptable designs and practices are listed in Paragraph 11.4, below, with specified conditions for which each may be acceptable. The proscribed practices and designs are listed in Paragraph 11.5. These are not acceptable for use in satisfaction of the permit requirements; petitions for their use must follow normal channels.

11.2 RELATIONSHIP TO THE REGULATIONS AND TO OTHER DOCUMENTS.

The regulations in Subpart F will continue to be the sole location of the performance standards for ground water monitoring systems. The provisions of this Chapter only establish the acceptability of a limited number of designs or operations. The Chapter is not intended to replace the regulations or the guidance documents which explain application of the regulations in the particular, or site-specific, situation. It is related to the guidance documents in that it will promote use of the more established procedures found in general guidance.

The contents of this Chapter will be taken from general enforcement and permitting guidance documents, and it is intended that these be consistent with all RCRA ground water monitoring guidance. The specific conditions given for the acceptable designs and precedures may not be found in the several guidance documents from which those designs and procedures are taken. Many of these conditions are arbitrarily selected. They are based on the experience of permit writers and enforcement officials. Since the conditions only affect procedural issues (whether the selection is justified or not) the rigor of their development has not been as extensive as if they were requirements.

There is one preeminent RCRA guidance document for ground water monitoring at this time: The Technical Enforcement Guidance Document. (The TEGD, finalized September 1986, is available from the Office of Waste Programs Enforcement, (202)-475-9328). This document is written for enforcement officials' use in implementing the interim status provisions, 265.90 et seq., but most of the hydrogeologic principles apply directly to permitted facilities as well as to those in interim status. The TEGD is the major source of concepts for this chapter; it is and will be the major repository of RCRA ground water monitoring principles. It is intended that nothing in this chapter conflicts with the TEGD.

Other ground water monitoring guidance documents are in circulation. Several, such as "Ground Water Monitoring Guidance for Owners and Operators of Interim Status Facilities," have been superceded by the TEGD. Others, such as the draft "Permit Writers Guidance for Ground Water Monitoring," have never been finalized and do not fully reflect Agency policy.

Other documents which may be of interest are as follows:

1. Barcelona, Michael J., James P. Gibb and Robin A. Miller, A Guide to the Selection of Materials for Monitoring Well Construction and Ground Water Sampling, Illinois State Water Survey Contract Report (ISWS) #327, EPA Contract No. EPA CR-809966-01, August 1983.

2. Benson, R.C., R.A. Glaccum, and M. R. Noel, Geophysical Techniques for Sensing Buried Waste and Waste Migration, Technos, Inc., EPA Contract No. 68-03-3050; available from National Water Well Association, Worthington, OH.

3. Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EMSL, Cincinnati, EPA-600-4-79-019, March 1979 and subsequent revisions; available from EMSL, Cincinnati, OH.

4. Hazardous Waste Ground Water Task Force, Protocol for Ground Water Inspections at Hazardous Waste Treatment Storage and Disposal Facilities, April 1986.

5. Methods for the Storage and Retrieval of RCRA Ground Water Monitoring Data on STORET, Ref. Storet User Support (800-488-5985).

6. Methods of Chemical Analysis of Water and Wastes, EMSL, Cincinnati, EPA-600/4-79-020, Revised March 1983; available from EMSL, Cincinnati, OH.

7. Plumb, R.H., and C.K. Fitzsimmons, Performance Evaluation of RCRA Indicator Parameters for Ground Water Monitoring, Proceedings of the First Canadian-American Conference on Hydrogeology, National Water Well Association, Worthington, OH, pp. 129-137, June 1984.

8. A Practical Guide for Ground Water Sampling, ERL, ADA, OK, EPA/600/2-85/104, Sept. 1, 1985; available from Illinois State Water Survey, Champagne, IL.

11.3 REVISIONS AND ADDITIONS

This Chapter will be revised from time to time as new technological developments and experience dictate. Each revision will be proposed before being finalized, and there will be ample time before the effective date for the revisions to be incorporated into future designs.

Applicants desiring to add particular designs or practices to the "acceptable" list, either for their own unique situation or as general provisions, or to use designs or practices on the "proscribed" list may do so by petitions.

11.4 ACCEPTABLE DESIGNS AND PRACTICES

The following designs and practices are acceptable, in the conditions described and for the purposes listed, without need for justification. Permit writers may question the existence of the condition or the definition of

purpose, but not the use of the design or practice once conditions and purposes are established.

11.4.1 Site Characterisation

(a) Borehole location patterns, designed by qualified geologists, are acceptable for site characterization. Such characterizations are for general delineation of stratigraphy and flow paths and for establishing initial design of well placement, screen length, depth, etc.
Conditions: When unexpected discontinuities of major strata or pathways do not occur.

(b) Geophysical logging and other indirect measurement techniques may be used in site characterization for the limited purpose of augmenting direct observation of cuttings and corings by professional geologists.
Conditions: None.

(c) Quarterly measurements are generally satisfactory for establishing seasonal and temporal variations in flow velocity and direction for purposes of assuring that the elevations of screens are correct, of documenting the appropriateness of background well locations, and of assuring coverage of all possible downgradient pathways.
Conditions: None.

11.4.2 Well Location, Design, and Construction

(a) Downgradient well locations which result in placement in potential pathways of contaminant migration are acceptable for routine detection sampling programs. The density will vary based on the size of the pathway.
Conditions: When site characterization confirms simple homogenous hydrogeology, without discontinuities or faults in the vicinity of the wells, and when folds and fractures are not expected to channel flows past well intakes.

(b) Monitoring well screen lengths should generally not cut across several flow zones but rather furnish depth-discrete measurements. These conditions are acceptable for the purpose of obtaining samples which represent ground water quality at the point of compliance.
Conditions: When the strata of concern is $\geq$ 10' thick.

(c) Use of air rotary drilling methods is acceptable for installing monitoring wells.
Conditions: Except when drilling through contaminated upper horizons, unless precautions are taken.

(d) Fluorocarbon resins (PTFE, PFA, FEP, etc.) and stainless steel (304 or 316) are acceptable materials for sample-contact surfaces in new or replacement monitoring wells where potentially sorbing organics are of concern.
Conditions: Stainless steel may only be used in non-corrosive conditions. All new or replacement wells to be installed at a given time should be of the same material.

(e) Existing wells which do not meet the recommendations in guidance for materials or installation may be proposed for inclusion in the permit.

Conditions: When documented to be free of bias by pairing new PTFE OR stainless wells with, for instance, at least ten percent of the old, existing wells.

11.4.3 Sampling

(a) The field quality control procedures contained in Reference 4, Section 11.2 above, and those specified in Chapters 1 and 9 of this document are the only acceptable procedures.

(b) Well evacuation measured at three times the computed well casing volume is acceptable for assuring that the sample contains ground water representative of the formation.

Conditions: Evacuation measured to ±5% of the computed volume based on water surface elevation and well bottom measured immediately prior to evacuation.

(c) Samples containing less than 5 N.T.U. turbidity are acceptable for analysis when the analytic method is sensitive to turbidity (such as the analysis of metals). Samples containing greater than 5 N.T.U. are only acceptable when well development is certified by a qualified hydrogeologist as the best obtainable.

Conditions: Turbidity evaluation must accompany all potentially affected values.

(d) The sample preservation techniques presented in Table 11-1 are acceptable.

(e) The scheduled time interval between sample collections should not be greater than the computed time of travel either from the upgradient wells to the point of compliance or from the point of compliance to the property boundary.

(f) Evacuation of the well to dryness is an acceptable procedure to ensure that the sample contains representative ground water.

Conditions: When the recharge is so slow that the well will yield fewer than three well volumes before dryness but fast enough that the recharging water will not cascade down the inside of the casing.

11.4.4 Analysis and Reporting

The codes listed in Table 11-2 may be used for purposes and conditions listed.

11.5 UNACCEPTABLE DESIGNS AND PRACTICES

The following designs and practices are unacceptable in the conditions or for the purposes specified.

11.5.1 Site Characterization

Use of unsubstantiated data not meeting quality assurance criteria may not be used other than in support of general trends or to establish relationships between parameters.

Conditions: All conclusions and findings based on unconfirmed data and unsupported by quality controlled data are inadmissable as support for permit conditions or stipulations.

11.5.2 Well Location, Design, and Construction

Fabric filters should not be used as filter pack material.

11.5.3 Sampling

(a) The following devices are not generally acceptable for collecting samples for analysis:

1. Gas driven piston pump.

2. Suction lift pumps.

3. Submersible diaphragm.

4. Gas lift samplers.

5. Impeller pumps.

(b) Data obtained by unsubstantiated techniques and procedures not meeting quality assurance criteria or not conforming to quality control procedures may not be used except when attempting to describe pre-existing site conditions which are no longer observable.

11.5.4 Data Evaluation and Comparisons

Pooling upgradient or background values from diverse hydrogeologic strata in a manner which combines data from discrete or distinct sampling locations as though they were points along a continuous spectrum is not acceptable. All up-down comparisions must be between samples taken from common flow paths.

TABLE 11-1

SAMPLING AND PRESERVATION PROCEDURES FOR DETECTION MONITORING[a]

Parameter	Recommended Container[b]	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
		Indicators of Ground Water Contamination[c]		
pH	T, P, G	Field determined	None	25 mL
Specific conductance	T, P, G	Field determined	None	100 mL
TOC	G, Teflon-lined cap	Cool 4°C, HCl to pH <2	28 days	4 x 15 mL
TOX	G, amber, Teflon-lined cap	Cool 4°C, add 1 mL of 1.1M sodium sulfite	7 days	4 x 15 mL
		Ground Water Quality Characteristics		
Chloride	T, P, G	4°C	28 days	50 mL
Iron Manganese Sodium	T, P	Field acidified to pH <2 with HNO_3	6 months	200 mL
Phenols	G	4°C/H_2SO_4 to pH <2	28 days	500 mL
Sulfate	T, P, G	Cool, 4°C	28 days	50 mL
		EPA Interim Drinking Water characteristics		
Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver	T, P Dark Bottle	Total Metals Field acidified to pH <2 with HNO_3 Dissolved Metals 1. Field filtration (0.45 micron) 2. Acidify to pH <2 with HNO_3	6 months 6 months	1,000 mL 1,000 mL
Fluoride	T, P	Field acidified to pH <2 with HNO_3	28 days	300 mL
Nitrate	T, P, G	4°C/H_2SO_4 to pH <2	14 days	1,000 mL

(Continued)

TABLE 11-1 (Continued)

SAMPLING AND PRESERVATION PROCEDURES FOR DETECTION MONITORING[a]

Parameter	Recommended Container[b]	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
Endrin Lindane Methoxychlor Toxaphene 2,4 D 2,4,5 TP Silvex	T, G	Cool, 4°C	7 days	2,000 mL
Radium Gross Alpha Gross Beta	P, G	Field acidified to pH <2 with HNO_3	6 months	1 gallon
Coliform bacteria	PP, G (sterilized)	Cool, 4°C	6 hours	200 mL
	Other Ground Water Characteristics of Interest			
Cyanide	P, G	Cool, 4°C, NaOH to pH >12	14 days	500 mL
Oil and Grease	G only	Cool, 4°C H_2SO_4 to pH <2	28 days	100 mL
Semivolatile, volatile organics	T, G	Cool, 4°C	7 days	1,000 mL

[a]References: Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846 (3rd edition, 1986).
Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.
Standard Methods for the Examination of Water and Wastewater, 16th edition (1985).

[b]Container Types:
P = Plastic (polyethylene)
G = Glass
T = Teflon
PP = Polypropylene

[c]Based on the requirements for detection monitoring (265.93), the owner/operator must collect a sufficient volume of ground water to allow for the analysis of four separate replicates.

TABLE 11-2
A LISTING AND DESCRIPTION OF CODES USED TO INDICATE THAT POLLUTANT CONCENTRATIONS WERE BELOW A CONCENTRATION WHICH CAN BE MEASURED ACCURATELY OR THAT THE POLLUTANTS WERE NOT PRESENT

Codes	Definition of the Acronyms	Examples of Use	Used to Indicate That the Pollutant Was Less Than a Limit of Detection	Used to Indicate That the Pollutant Was not Present
LOD+	Limit of detection	LOD 0.421	Yes	No
LOQ+	Limit of quantification	LOQ 2.234	Yes	No
MDL++	Method detection limit	MDL 0.631	Yes	No
LT	Less than	LT, LT 0.01 LT 0.148	Yes	No
BDL	Below detection limit	BDL, BDL 0.01 BDL 0.148	Yes	No
<		<0.01, <0.148	Yes	No
Negative signs		-0.01, -0.148	Yes	No
Trace*		Trace, T	Yes	No
K		K0.01, K0.148	Yes	No
ND*	Not detected	ND	Yes	Yes
Dashes*		--	Yes	Yes
Large numbers*		999999	Yes	Yes
Zeros*		0	Yes	Yes
Blanks*			Yes	Yes

NOTES:
1. The codes marked with a + are the codes used when the American Chemical Society methodology is applied.
2. The code marked with a ++ is the code that is used when the 40 CFR 136 methodology is applied.
3. The Codes column lists examples of low concentration designations that may be included in data submissions.
4. Several codes, marked with a *, have potential for being ambiguous. Their meaning depends on laboratory reporting protocols and could either indicate that the value was LT a limit of detection or not present.