CHAPTER 110
HYDROGEOLOGIC INVESTIGATION AND MONITORING REQUIREMENTS

567—110.1(455B) Applicability. This chapter pertains to the hydrologic monitoring system standards for solid waste disposal facilities.

567—110.2(455B) Hydrologic monitoring system planning requirements.

110.2(1) All plans, specifications and other documentation required herein must be developed by an engineer registered in Iowa.

110.2(2) All sanitary disposal projects shall conduct a soil and hydrogeologic investigation which conforms to the requirements of this chapter. The purpose of soil and hydrogeologic investigation is to obtain data which will enable a determination of potential routes of contaminant migration from a site via groundwater. The following items are minimum requirements for such investigations. Additional work and use of other methods (e.g., geophysical techniques) are encouraged.

567—110.3(455B) Soil investigation.

110.3(1) *Soil borings.*

a. Number of borings. A sufficient number of soil borings shall be made to accurately identify the hydrogeologic variations of the site. For new sites, the minimum number of borings required is 10 for sites of 10 acres or less, 20 for sites of 10 to 50 acres, and 20 plus an additional boring for every 10 acres above 50 acres for sites larger than 50 acres. Fewer borings may be needed for existing sites, depending on previous work done at the site. Also, no borings will be required in existing fill areas. The department may require additional borings based on the geological complexity of the site.

b. Depth of borings. All borings must extend a minimum of 25 feet deep and at least 10 feet deep below the water table. However, borings in proposed fill areas shall be terminated 10 feet above the uppermost aquifer or grouted to provide such separation. At least half the borings located outside the existing or proposed fill area shall extend 10 feet into the uppermost aquifer, 50 feet below the water table, or 10 feet into bedrock. At least one boring shall go 10 feet into bedrock, or 100 feet below the lowest ground surface elevation.

c. Boring method. Borings shall comply with the applicable portions of rule 567—110.11(455B). The preferred boring method is hollow stem auger, although it may be necessary to use other methods at greater depths and in bedrock. When wet drilling methods are used for boring in which monitoring wells or piezometers are installed, the drilling fluid and methods and development procedures shall be approved by and documented with the department.

d. An assurance that soil boring samples have been taken at the site. The soil boring samples must be kept by the permit applicant until the permit is issued and must be made available to the department if the department requests them.

110.3(2) *Soil samples.* Samples shall be collected at 5-foot intervals plus at every change in stratum. These samples should be obtained using a split spoon sampler and the procedures of the standard penetration test, conducted in accordance with American Society of Testing and Materials (ASTM) Standard D1586. This test simply counts the blows of a 140-pound hammer falling 30 inches on the sampler per foot penetration of the sampler. A minimum of one undisturbed shelby tube sample shall be obtained in the uppermost cohesive stratum at or below the lowest depth at which solid waste will be disposed. Shelby tube sampling shall be in accordance with ASTM Standard D1587. Samples should be clearly marked, preserved, and maintained for future inspection. Samples selected for laboratory analysis shall be preserved and transported to the laboratory in accordance with ASTM Standard D422.

110.3(3) *Laboratory test of discrete soil samples.* Laboratory tests of discrete soil samples shall be conducted to correlate strata between soil borings, obtain permeability data on each stratum, and design monitoring wells.

a. Permeability tests. Permeability tests using a constant-head or falling head permeameter shall be run on a minimum of one sample from each shelby tube sample. Each sample shall be from a different soil boring representing a different area of the site.

b. Grain size distribution. Grain size distribution tests should be conducted on a minimum of one sample from each distinct stratum. Analysis should be conducted in accordance with ASTM Standards D422 and D1140. Estimates of permeability shall be developed for each sample tested based on grain size distribution and standard penetration blow counts.

567—110.4(455B) Hydrogeologic investigation.

110.4(1) *Groundwater level measurements.* The elevation of the water table shall be determined at or near the location of each soil boring which penetrates the water table. The water table may be determined using a completed water table monitoring well, or piezometer. The bottom of a piezometer used to measure water table elevation shall be no more than 5 feet below the water table.

The apparent horizontal groundwater flow direction should be determined based on water table measurements. Vertical groundwater flow shall then be assessed in at least two profiles approximately parallel to the apparent horizontal flow direction. Vertical groundwater flow shall be assessed using at least two well clusters per profile. Each well cluster shall contain a water table monitoring well or piezometer and additional water level monitoring points based on site conditions as follows:

a. If the water table is in the uppermost aquifer, one additional water level monitoring point is to be located near the base of the aquifer or at least 20 feet below the base of the water table monitoring point. This additional monitoring point may not be required if the aquifer is less than 20 feet thick.

b. If the uppermost aquifer is less than 50 feet below the water table, an additional water level monitoring point shall be located at the top of the aquifer.

c. If the uppermost aquifer is more than 50 feet below the water table, additional water level monitoring points shall be placed at depths of 30 feet and 50 feet below the water table.

d. If required, the one deeper soil boring into bedrock shall be used as a site for one well cluster. Water table monitoring points in this cluster shall correspond to the other well cluster used for a profile. In addition, water level monitoring points shall be placed at the bottom of the boring and, if possible, at the top and bottom of the uppermost aquifer.

Groundwater level measurements should be made after the water levels have stabilized in the monitoring point; at least 24 hours after completion and bailing of the monitoring well, or installation of the piezometer. The water level in existing wells shall be observed and recorded prior to bailing. Each set of water level measurements shall be made in as short a time frame as possible within an eight-hour period maximum.

110.4(2) *In-situ permeability tests.* In-situ permeability tests shall be conducted on each monitoring well and piezometer in each well cluster.

a. Pumping test. If more than one monitoring point is located in the uppermost aquifer, a pumping test should be conducted at one or more upper aquifer monitoring point. A pumping test involves pumping at constant rate from one well while observing water levels in other wells. The pumping rate should be as high as possible without dewatering the well. Water level measurements in other uppermost aquifer wells should be measured at frequent intervals near the start of the test and then at progressively longer intervals (e.g., 1-minute intervals to 10 minutes, 5-minute intervals to an hour, 15-minute intervals to 2 hours, and half-hour intervals thereafter). Continuous water level recording is preferable. Water levels in wells not located in the uppermost aquifer should be recorded throughout the test at regular intervals (e.g., every half hour). Water levels in all wells should be measured 24 hours prior to the test and just before the test. The test duration should be at least 4 hours and continuing until a stabilized drawdown condition is observed. Longer tests may be necessary if other uppermost aquifer monitoring points are slow to respond. Water level readings should be recorded through the recovery phase of the water table.

b. Bail and slug tests. Monitoring wells and piezometers located in materials with low permeabilities should be tested using bail or slug tests. These tests involve rapidly removing or adding a known volume of water to a well and then recording water levels in the well as it recovers to its original level. Typically, the necessary frequency of measurements will be similar to that required of pumping tests. In materials of very low permeability, less frequent measurements are necessary; and in materials of higher permeability, more frequent measurements may be necessary.

567—110.5(455B) Hydrologic monitoring system planning report requirements. The hydrologic monitoring system planning report shall contain a description of field investigations and presentation of results including a description of the field and laboratory testing methods; a presentation of the test results and field measurements; a reasonable effort to inventory all active, unused, and abandoned wells within one mile of the facility shall be made; and the identification of all public water supply wells and wells with water withdrawal permits pursuant to 567—Chapters 50, 51 and 52 within three miles of the facility. Well logs, other available information on well construction, static water levels, and usage shall be obtained. The well inventory should be based on thorough reviews of state and local collections of well logs and, when possible, interviews or surveys of well owners.

Also to be included are maps showing the location of soil borings, other field tests/measurements, and existing wells.

567—110.6(455B) Evaluation of hydrogeologic conditions.

110.6(1) Based on soil boring and other available information, a description of the site geology shall be made. This shall include preparation of geologic cross sections of sufficient number and spacing (no fewer than four at every site) to adequately define all areas of the site and of sufficient detail to adequately depict major stratigraphic and structural trends and reflect geologic structural features in relation to groundwater flow. Each pair of cross sections must be as near to perpendicular as possible to adequately portray the site geology.

110.6(2) A description of the hydrogeologic unit(s) within the saturated zone shall be made including: thickness; depth, hydraulic properties, such as transmissivity and storage coefficient or specific yield; description of the role of each as confining bed, aquifer, or perched saturated zone, and their actual or potential use as water supply aquifers.

110.6(3) All groundwater flow paths from the site shall be identified, including both horizontal and vertical components of flow. A contour map of the water table shall be presented showing horizontal flow paths. A potentiometric surface map of the uppermost aquifer showing horizontal flow paths shall also be presented, if different than the water table. Vertical flow paths shall be shown in at least two profiles approximately parallel to the direction of horizontal flow. Vertical flow paths shall be determined by water level measurements from clustered wells at different depth, if possible. An evaluation of vertical groundwater flow based on the hydrologic properties of the various strata encountered at the site, estimated groundwater flow and recharge rates, and known information on hydraulic head shall also be made.

110.6(4) The seasonal, temporal and artificially induced variations in groundwater flow shall be evaluated. Temporal variations would occur due to natural events, such as rainfall. The addition of tile lines, removal of overburden, or deposition of wastes would constitute artificially induced variations.

110.6(5) Surface water flow paths from the site shall be identified on topographic contour maps.

567—110.7(455B) Monitoring system plan. A hydrologic monitoring system shall be designed to intercept the groundwater and surface water flow paths from the site. The plan shall include proposed locations and depths for monitoring wells in accordance with monitoring well siting criteria in 110.1(2). Monitoring wells shall be designed in accordance with 110.1(3).

The surface water monitoring plan shall include monitoring points on all standing and flowing bodies of water which will receive surface runoff or groundwater discharge from the site. For streams, sampling points upstream and downstream of areas of potential impact from the site should be selected.

567—110.8(455B) Sampling protocol. At a minimum, the sampling protocol must include procedures or descriptions of the:

Order in which monitoring points are to be sampled, all tests and procedures needed at each monitoring point and the order in which these procedures will be carried out, equipment and containers to be used, procedures and precautions for their use; precautions to avoid introducing contaminants from outside sources into monitoring wells or samples; and how equipment must be cleaned between uses,

Procedures for evacuating each monitoring well prior to each water quality sampling,

Procedures for handling field blanks and other quality assurance samples at the facility and in transit to and from the laboratory,

Procedures for field filtration of samples, if required,

Procedures for sample preservation,

Procedures for sample collection, labeling and handling at the facility and during transport to the laboratory,

Procedures for recording field observations and measurements,

Procedures for records maintenance and data analysis, and

Procedures for sampling surface water monitoring points including exact sampling locations and depths.

567—110.9(455B) Monitoring well maintenance performance reevaluation plan.

110.9(1) A monitoring well performance reevaluation plan shall be included as part of the hydrogeologic monitoring system plan. The plan shall ensure that all monitoring points remain reliable.

110.9(2) The plan shall include the following items:

a. Every two years an examination of high and low water levels accompanied by a discussion of the acceptability of well location (vertically and horizontally) and exposure of the screened interval to the atmosphere.

b. A biannual evaluation of water level conditions in the monitoring wells to ensure the effects of waste disposal or well operation have not resulted in changes in the hydrologic setting and resultant flow paths.

c. Annually conducting well depth measurements to ensure wells are physically intact and not filling with sediment.

d. Every five years conduct in-situ permeability tests on monitoring wells; comparing test data with those collected originally to determine if well deterioration is occurring.

567—110.10(455B) Monitoring well siting requirements.

110.10(1) *Downgradient monitoring wells.* Downgradient monitoring wells must be located to provide a high level of certainty that releases of contaminants from the site can be promptly detected. Downgradient monitoring wells should be placed along the site perimeter, within 50 feet of the planned liner or waste boundary unless site conditions dictate otherwise, downgradient of the facility with respect to the hydrologic unit being monitored. For those facilities which are long-term, multiphase operations, the department may establish temporary waste boundaries in order to define locations for monitoring wells. Downgradient monitoring well placement may consider the convergence of groundwater paths to minimize the overall length of the downgradient dimension.

110.10(2) *Water table wells.* At least three downgradient water table monitoring wells shall be installed at each facility. The maximum spacing between wells shall be 600 feet.

110.10(3) *Uppermost aquifer monitoring wells.* If different than water table monitoring wells, at least three uppermost aquifer monitoring wells shall be installed at each facility. Uppermost aquifer monitoring wells shall be spaced no more than 600 feet apart. If the uppermost aquifer is located more than 50 feet below the water table, this requirement may be relaxed, although at least one downgradient uppermost aquifer monitoring well will be required.

110.10(4) *Other downgradient monitoring wells.* Additional downgradient monitoring wells will be required if the water table and uppermost aquifer monitoring wells do not intercept most vertical flow paths from the site. In such situations, monitoring wells shall be placed at the appropriate depths to intercept the remaining flow paths and shall be spaced at no more than 600 feet apart.

110.10(5) *Upgradient monitoring wells.* Upgradient monitoring wells shall not be affected by the site. At least one upgradient monitoring well shall be installed into each stratum being monitored by downgradient monitoring wells. If it is not possible to actually locate a monitoring well upgradient of the site, the well should be placed as near the site as feasible without being affected by the site.

110.10(6) *Monitoring point identification system.* The various types of monitoring points should be identified as follows:

Monitoring Well	MW# _____
Surface Water Monitoring Point	SW# _____
Piezometer	PZ# _____

Each monitoring point must have a unique number, regardless of the type of monitoring point, and that number must never change.

567—110.11(455B) Monitoring well/soil boring construction standards.

110.11(1) *General considerations.*

a. Contractors involved in construction of monitoring wells and piezometers and soil boring activities shall be registered with the department as required in 567—Chapter 37.

b. To the extent possible, all monitoring well construction materials must not absorb, desorb, react or otherwise alter the screened soil stratum or the quality of the groundwater being sampled. Galvanized metal, glues, welding solvents, pipe thread lubricants and other foreign substances must not be used.

c. All monitoring well construction materials must be protected from contamination prior to installation.

d. A typical cross section of a property constructed monitoring well is shown in Figure 1 at the end of this chapter.

110.11(2) *Casings.*

a. As a minimum, the diameter of the inner casing (see Figure 1) of a monitoring well must be at least 2 inches.

b. Plastic cased wells must be constructed of materials with threaded, nonglued joints which do not allow water infiltration under natural subsurface pressure conditions or when the well is evacuated for sampling.

c. Well casings must provide structural stability to prevent casing collapse during installation as well as drill hole integrity when installed. Flush joint casing is required for small diameter wells installed through hollow stem augers.

d. Well casings must be constructed of inert materials such as polytetrafluorethylene, stainless steel or polyvinyl chloride. The department may approve other casing materials if the owner or operator can demonstrate the material has a low potential for biasing the water quality parameters of samples. The department may approve the construction of composite well casings (casings with less inert materials in the unsaturated zone).

110.11(3) *Well screens.*

a. Slot size will be based on sieve analysis of the sand and gravel stratum or filter pack. The slot size must hold out 35 percent to 60 percent of the formation material and not less than 90 percent of the filter pack.

b. Slot configuration and open area must permit effective development of the well.

c. Screen length. Maximum screen length shall be 10 feet except for water table wells in which the screen must be of sufficient length to accommodate expected seasonal fluctuations of the water table. The screen should be placed 5 feet above and below the observed water table, unless local conditions are known to produce greater fluctuations. Screen length for piezometers should be 2 feet or less.

Multiple screened single-cased wells are prohibited.

110.11(4) *Filter pack.*

a. To prevent other materials from coming in contact with the well screen, extend the filter pack 18 inches above and 12 inches below the well screen.

b. Size must be based on sieve analysis of sand and gravel stratum. The filter pack material must be 2.5 to 3 times larger than 50 percent grain size of the zone being monitored.

110.11(5) *Grouting.*

a. The annular space above the filter pack must be sealed with expanding cement or bentonite grout. The vertical dimension of this seal must be a minimum of 3 feet.

b. The annular space between the seal and to just below the frostline must be backfilled with an impervious material such as bentonite or expanding cement.

c. The remaining annular space must be sealed with bentonite grout to the ground surface.

d. Grouting materials must be installed from the top of the filter pack up in one continuous operation with a tremie tube.

110.11(6) *Well protection.*

a. Plastic cased wells. A protective metal casing must be installed around the well casing. The inside diameter of the protective metal casing should be at least 2 inches larger than the outside diameter of the well casing. Extend the protective metal casing from a minimum of 1 foot below the frostline to slightly above the well casing top. The protective casing should be shortened or omitted if it covers part of the well screen. Seal or immobilize the protective casing with a concrete plug around the outside. The bottom of the concrete plug must extend at least 1 foot below the frostline. The concrete plug should be shortened if it covers part of the well screen. Extend the top of the plug approximately 3 to 6 inches above the ground surface and slope it away from the well approximately 3 feet. Soil may be placed above the plug. Seal the inside of the protective casing with a bentonite grout. Place a vented cap on the well casing and a protective locking cap on the metal casing. The lockable cap must be kept locked when the well is not in use.

b. Metal cased wells. Extend the concrete plug from at least 1 foot below the frostline to approximately 3 to 6 inches above the ground surface and slope it away from the well approximately 3 feet. Soil may be placed on top of the concrete plug. Place a vented, locking cap on the casing. The lockable cap must be kept locked when the well is not in use. See Figure 1.

c. To protect against accidental damage, a ring of brightly colored posts or other protective devices must be installed around all wells.

110.11(7) *Well drilling.*

a. The owner or operator must ensure that in all phases of drilling, well installation and completion, the methods and materials used do not introduce substances that may alter the results of water quality analyses.

b. Well drilling equipment coming into contact with contaminants in the borehole or above ground must be thoroughly cleaned to avoid spreading contamination to other depths or locations. Contaminated materials or leachate from wells must not be discharged onto the ground surface or into ponds or streams so as to cause environmental harm in the processes of drilling or well development.

c. The owner or operator must ensure that, at a minimum, the following well design and construction log information be retained at the site and a copy of this information be sent to the department.

Date/time of construction;
Name and address of the driller;
Drilling method and drilling fluid used;
Soil sampling methods;
Surveyed location (±0.5 ft.);
Soil and rock classifications;
Field observations;
Well name/number;
Borehole diameter and well casing diameter;
Well depth (±0.1 ft.);
Water level measurements;
Drilling and lithologic logs;
Casing materials, inside diameter and weight or wall thickness;
Screen materials;
Casing and screen joint type;
Screen slot size/length;
Filter pack material/size; (depths from ____ to ____)
Filter pack volume;

Filter pack replacement method;
Sealant materials; (depths from ____ to ____)
Sealant volume;
Sealant placement method;
Grouting schedule and materials;
Surface seal design/construction; (depths from ____ to ____)
Type of protection well cap;
Ground surface elevation (±0.1 ft.);
Well cap elevation (±0.01 ft.);
Top of casing elevation (±0.01 ft.); and
Detailed drawing of well (include dimensions).

110.11(8) *Well development.* Prior to use of the monitoring well for water quality monitoring purposes, well development is required to ensure the collection of representative groundwater samples. Procedures used in well development involve using a surge block, bailing or surging by pumping of compressed inert gas to produce a movement of water at alternately high and low velocities into and out of the well screen and gravel pack in order to loosen and remove fine materials. Development of low hydraulic conductivity wells may require the circulation of water down the well casing, out through the screen and gravel pack, and up the open borehole prior to the placement of grout or seal in the annulus. Any additional water used must be of a quality so as not to interfere with future groundwater quality determinations. Following surging, the well is pumped until the water does not contain significant quantities of suspended solids.

567—110.12(455B) Sealing abandoned wells and boreholes. Boreholes, piezometers and observation wells not used for groundwater monitoring must be sealed. Document in writing the location of the abandoned well or borehole with reference to the landfill's coordinate system and method of sealing. The document must be retained at the landfill with a copy sent to the department.

110.12(1) *Sealing boreholes.* Fill the borehole by extending a tremie tube to the bottom of the hole. Apply bentonite or expanding cement grout through the tube to the bottom of the hole and raise the tremie tube as the hole is filled from the bottom upward. Keep the end of the tremie tube submerged in the grout while filling. Fill the borehole from the base of the boring all the way to the ground surface.

110.12(2) *Sealing abandoned monitoring wells.*

a. Well is known to be constructed properly with impermeable grout that was installed from the bottom up using a tremie tube. Remove any existing protective metal casing by vertically pulling it off the well. Using a tremie tube, fill the inner well casing with an impermeable grout slurry from the bottom to ground surface. After 24 hours, retop the grout if it has settled below the existing ground surface.

b. Well construction is improper or undocumented. Attempt to remove the well casing. If this fails, either drill around the well casing using a hollow stem auger of large inside diameter or drill out the well casing using a standard casing bit or solid stem auger with a boring diameter greater than the initial diameter of the hole. Drill to the maximum depth of the previously drilled boring. Clean the drilling debris from the interior of the auger or borehole. Seal the borehole with an impermeable grout using a tremie tube. If the soil conditions permit the sealing to be conducted in a continuous operation, keep the tremie tube submerged in the grout at all times. After 24 hours, retop the grout if it has settled below the ground surface.

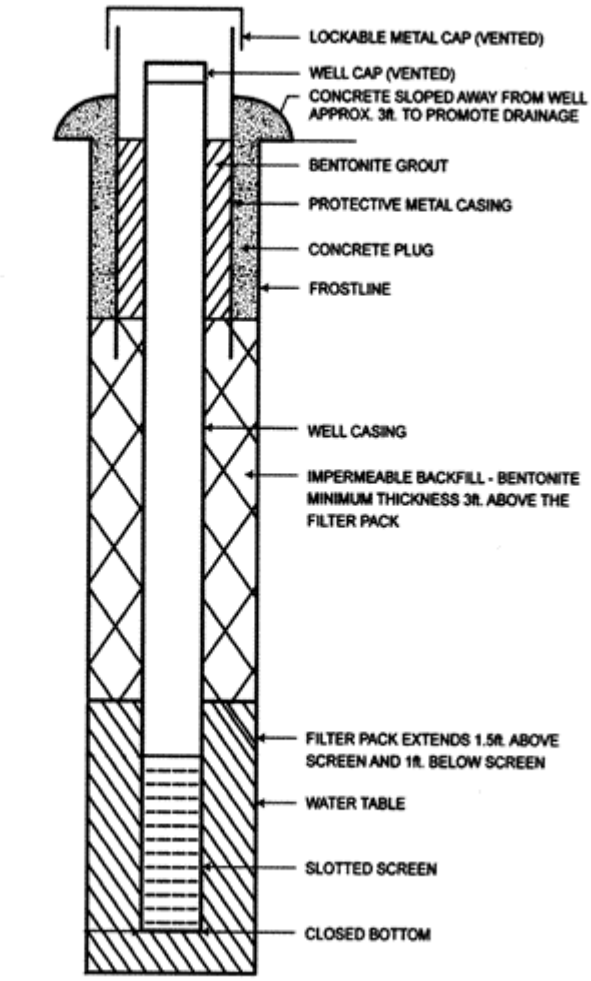
c. Monitoring wells in future fill areas. Remove well and seal as described in the procedures for sealing boreholes per 110.12(1).

567—110.13(455B) Variance from design, construction, and operation standards. Pursuant to the authority of Iowa Code section 455B.303, a variance from the specific requirements of Chapter 110 may be issued, modified, or denied by the director. The request should also include any supporting information to be considered by the director in the formulation of a decision.

These rules are intended to implement Iowa Code section 455B.304.

Figure 1

Typical Monitoring Well Cross Section



PLASTIC CASED WELL CONSTRUCTION DETAILS

-- NOT TO SCALE --

[Filed 4/28/89, Notice 1/11/89—published 5/17/89, effective 6/21/89]
[Filed 5/22/92, Notice 3/18/92—published 6/10/92, effective 7/15/92]
[Filed 11/21/02, Notice 9/18/02—published 12/11/02, effective 1/15/03]