Illinois
Environmental
Protection Agency

Bureau of Land
1021 North Grand Avenue East
Box 19276
Springfield, IL 62794-9276

INSTRUCTIONS FOR A SIGNIFICANT MODIFICATION DEMONSTRATING COMPLIANCE WITH 35 IAC, Subtitle G, Part 814, Subpart C (i.e., Standards for existing units accepting chemical and putrescible wastes, but not household waste, that may remain open for more than seven (7) years after September 18, 1990)

(LPC-PA19)

(Sec. V rev. 11/9/2010)

I. Introduction

The purpose of these instructions is to explain how to prepare a Significant Modification for an existing unit accepting chemical and putrescible wastes that may remain open for more than seven (7) years after September 18, 1990. LPC-PA2 and its appendices were designed to be used in permitting new units. However, the LPC-PA2 form, the instructions to it, and the instructions to its appendices should also be used in preparing this type of Significant Modification. These instructions are intended to provide information on how to apply for the first significant modification and explain how the provisions of 35 IAC 814 apply with regard to the exemptions from parts of 35 IAC 811. Also included are general information discussions related to interpreting portions of the rules.

II. Exemptions (35 IAC 814.302(a))

The following standards do not need to be demonstrated in the Significant Modification:

A. The Location Standards required by 35 IAC 811.302(a), (d) and (e). These are reiterated below.

1. No part of a unit shall be located within a setback zone established pursuant to Section 14.2 or 14.3 of the Act -- 811.302(a)

2. No part of a unit shall be located closer than 500 feet from an occupied dwelling, school, or hospital -- 811.302(d)

3. The facility shall not be located within 5,000 feet of any runway used by piston type aircraft or within 10,000 feet of any runway used by turbojet aircraft -- 811.302(e)

B. The Foundation and Mass Stability Analysis Standards required by 35 IAC 811.304 and 811.305.

C. The Final Cover Requirements described in 35 IAC 811.314. Note: This exemption only applies to those units and parts of unit to which final cover was applied before September 18, 1990. The Significant Modifications for facilities seeking to use this exemption should include:

1. A map identifying the areas in which Part 807 final cover has been applied and those areas in which Part 811 final cover will be applied.

2. Documentation for all areas relying upon Part 807 final cover, that the final cover was applied before September 18, 1990.

3. Cross sectional drawings and a contour map showing the transition between Part 807 final cover and Part 811 final cover and any drainage control structures necessitated or impacted by the transition.

D. The Liner and Leachate Drainage and Collection Requirements described in 35 IAC 811.306, 811.307 and 811.308.

E. The hydrogeological site investigation requirements of 35 IAC 811.315, except that information shall be collected to implement a groundwater monitoring program in accordance with 35 IAC 811.318 and 811.319 and establish background concentrations for the purpose of establishing water quality standards pursuant to 35 IAC 811.320. Item V in these instructions explains the requirements for establishing the proper groundwater monitoring program.

III. Specific Information required by 35 IAC 814.302(b) which must be included in the first significant modification.

The Significant Modification must include the following information:

A. A description of a system which will effectively drain and collect leachate from the unit and transport it to a leachate management system. Note: In cases where the drainage and collection system has not yet been constructed (or completed), a construction quality assurance program consistent with 35 IAC, Part 811, Subpart E and a construction schedule must also be provided.

Examples of effective removal may include maintaining an inward gradient, limiting the leachate head, etc.

B. Calculations demonstrating that the final slopes of the completed unit shall have a long-term static safety factor of at least 1.5 with respect to slope failure.

C. Calculation of the design period to be used in making the post-closure cost estimates. The design period shall be determined using the following guidance:

1. The design period shall be no less than the operating life of the landfill plus fifteen years of post-closure care for permitted facilities in accordance with 35 IAC 814.302(b)(3)(A) and Section 22.17(b) of the Act. For unpermitted on-site facilities, the minimum post-closure care period is three years pursuant to 35 IAC 807.318.

2. For each year the unit is expected to be in operation past 1990, three years of post-closure care are required (up to the applicable design period required by 35 IAC 811). Take for example, three existing units with expected operating lives of three, seven and 12 years (after September 18, 1990). Each would be required to provide financial assurance during operation for its closure and its post-closure care period. The minimum post-closure care periods for each of these units, respectively, would be: <u>15 years</u> since 3 x 3 = 9 years is less than the 15 year minimum specified in subsection 35 IAC 814.302(b)(3)(A); <u>21 years</u> since 3 x 7 = 21 years; and <u>30 years</u> since 3 x 13 = 39 years is greater than the 30 years specified in 35 IAC 811.303(a).

3. Finally, the design period may not be reduced as allowed by 811.303(b) and (c) (i.e., reductions for waste shredding and leachate recycling).

IV. <u>General Information Discussions</u>

1. Facilities that had permits prior to adoption of the 35 IAC 810-814 rules and timely filed information in accordance with Part 814 may continue to operate under their Part 807 permits until the final action is taken on their initial significant modification (which is required to be filed no later than September 18, 1994). Facilities which request increased permitted capacity or will expand the placement of waste laterally, after the new rules are applicable to them, are included in the definitions as new units. These units become new units at existing facilities. As such, they are treated differently under Part 814. The area of landfill footprint constructed after the issuance of the significant modification must be designed to make the transition to the new liner and leachate collection system standards. That is, the unfilled areas will be required to meet the Part 811 design standards while the filled areas will be allowed the exemptions allowed by Part 814 Subpart C. This transition will be

reviewed on a case-by-case basis. In designing this transition, you should consider the waste placement requirements of Part 811.321, integrating the old and new leachate collection systems, future operating permits and all other relevant aspects to allow for an effective design and construction transition. Previously permitted units which have not received waste prior to the modification will be required to meet all the new design standards, except for location requirements.

2. The vertical expansion resulting from new waste areas on top of permitted existing waste is not a separate and distinct "unit." As such, they are considered new units in existing facilities, and because the waste boundary is not expanding laterally all exemptions of Subpart C apply.

3. Despite the definition of borrow area in 35 IAC 810.103 and the requirements in 35 IAC 812.107(c), a borrow area is not necessarily part of the facility. Borrow areas which are not contiguous to the facility are not part of the facility. Also, a borrow area adjacent to a disposal unit might be part of the facility or not part of it depending on who controls and operates the borrow area. If a separate entity operates it, it will not be part of the facility.

V. Groundwater Instructions

This Section explains the minimum information that is necessary to establish a groundwater monitoring program and groundwater quality standards in accordance with 35 Ill. Adm Code 814.402(a), 811.318, 811.319, 811.320, and the appropriate portions of 811.315 for existing units. If the application for significant modification includes an expansion to the permitted unit all of the requirements in Part 811 apply to the expansion area. Refer to LPC-PA2 Appendix C for the discussion on minimum requirements for groundwater site investigations for new areas.

A. HYDROGEOLOGIC SITE INVESTIGATIONS

Pursuant to 35 Ill. Adm. Code 814.302(a)(5), the applicant is exempt from Sections of 35 Ill. Adm. Code 811.315 except for that information necessary to develop and implement a groundwater monitoring program in accordance with 35 Ill. Adm. Code 811.318, 811.319, and 811.320.

Portions of Section 811.315, the hydrogeologic site investigation, provide the foundation of data on which the monitoring system groundwater impact assessment, and groundwater quality standards are developed. The study area shall include the entire area occupied by the unit being monitored and any adjacent areas, if necessary.

All borings should be continuously sampled. However, where a sufficient number of continuously sampled borings are drilled to document the continuity of a unit or formation, additional borings which are not continuously sampled are acceptable pursuant to 811.315(b)(3).

A literature survey should be performed to establish the regional geologic and hydrogeologic characteristics. A minimum of one continuously sampled boring is required to confirm the literature evaluation. The borings must extend at least 50 feet (15.2 meters) below the bottom of the uppermost aquifer or through the confining layer below the bottom of the uppermost aquifer, or to bedrock, if the bedrock is below the uppermost aquifer, whichever elevation is higher.

The Illinois EPA realizes that in parts of the State, this may require boring 300 to 500 feet below ground surface to fulfill this requirement when the uppermost aquifer is of considerable thickness. Considering the purpose of the hydrogeologic investigation (i.e., to provide information to perform a groundwater impact assessment and establish a groundwater monitoring system), boring to excessive depths on site would yield data of limited use at extraordinary expense. For these extreme field conditions, the Illinois EPA recommends the following:

> If the bedrock is part of or below the uppermost aquifer, borings through the entire thickness of the bedrock will not be required if supporting documentation from the literature search can be correlated with the site data. However the borings must characterize the permeable portion of the bedrock, (usually described as being weathered, vuggy, desiccated or fractured, etc.) and include coring a minimum of 15 to 20 feet of the bedrock. Similar logic can be applied to characterizing the uppermost aquifer and confining layer when the former is a considerable thickness of unconsolidated material. The borings must extend at least 100' into the uppermost aquifer and correlate with supporting documentation.

A complete search of the published documents and a request for preliminary site information from the Illinois State Geologic Survey and/or State Water Survey at a minimum is also required. This should be followed by a sufficient number of preliminary borings to evaluate the proposed site and define the study area.

Exploratory borings are required to establish the stratigraphy and general groundwater characteristics. Exploratory borings and soil sampling techniques must comply with the procedures from the American Society for Testing and Materials (ASTM) standards D1586 (split-barrel), D1587 (thin walled tube), and D2113 (diamond core drilling) or an equivalent procedure. The information required includes the structural, chemical, physical properties and classification of the subsurface materials in accordance with the United Soil Classification System (USCS).

As far as practicable, an investigation of the subsurface conditions over the entire site should be conducted to determine the structural and lithologic characteristics of the site. Use of a site grid pattern to initially determine the boring locations is strongly recommended. The number of borings should be adequate to represent the variability in subsurface characteristics at the site. No less than 20 borings per site will be acceptable when in a simple geologic setting. Additional borings will be required in areas of complex or transitional stratigraphy. Not all of the borings are required to penetrate the entire depth of the uppermost aquifer, but a sufficient number of the borings should be conducted to demonstrate the continuity or discontinuity of the uppermost aquifer and confining layer beneath the site. Wells should be located near each corner of the study area. Additional wells may be located at intermediate points within the study area to determine the hydrogeologic characteristics of the study area [Section 811.315(b)(2)].

For existing units, previous borings documenting the liner and geology beneath the unit must be correlated with the new information. Information from site development such as test pits and aerial photographs may provide additional information on existing units.

All borings must be properly plugged upon abandonment of the borehole and the procedures used should be carefully documented. In addition to the requirements of Section 811.316, all borings (i.e. drill holes) and wells shall be plugged and abandoned in accordance with current Illinois EPA procedures and applicable sections of the Department of Public Health (DPH) requirements given at 35 IAC Part 920 Illinois Water Well construction code (1/92). See Part D of these instructions for well/piezometer construction and abandonment requirements.

Field tests and insitu methods shall be used to confirm the initial information and to identify and characterize all known hydrogeologic units. Site-specific geologic and hydrogeologic information include hydraulic conductivities, extent of aquifers and the direction and velocities of groundwater movement as determined by field methods. Identification of potential pathways for contaminant migration, identification of any variations in groundwater quality and flow patterns, and any unusual features which may affect hydrogeologic systems. Piezometers should be installed in each hydrogeologic unit to allow testing by the use of rising or falling head techniques and pump tests. Monitoring wells in each hydrogeologic unit should be sampled to establish the applicable groundwater quality standards for the site. For areas with existing contamination, groundwater from test wells must be collected and disposed of properly.

A narrative description of the site geology should be prepared which includes a detailed description of each geologic unit found within the study area, including physical and geochemical properties and a description of all water bearing strata within the study area including potentiometric maps, groundwater flow velocities, gradients, and directions.

The narrative should be supported by geologic cross sections of the permit area illustrating all water bearing strata, water elevations, uppermost aquifer, confining units, all discernable geologic formations and test results.

Documentation of all activities and supporting references should be contained in the permit application. Data should be presented in summary form such as tables and graphs with the row data organized and presented in appendices.

Gathered information and data for the application should include, but is not limited to:

* Climatic Conditions such as annual precipitation (required for GIA input)
* Regional Geology
* Regional Groundwater
* Structural Characteristics
* Chemical and Physical Properties of Strata
* Soil Characteristics
* Hydraulic Conductivities
* Vertical Extent of Aquifers
* Direction and Rate of Groundwater Flow
* Characterization of Potential Pathways
* Hydrodynamic Dispersion
* Correlation of Stratigraphic Units
* Petrographic Features
* Identification of Zones with High Hydraulic Conductivity
* Concentrations of Chemical Constituents In the Groundwater Below the Unit
* Characterization of Variations in the Groundwater Quality and Flow
* Identification of Unusual Features

B. <u>GROUNDWATER QUALITY</u>

The applicant is required to determine groundwater quality spatially throughout the "uppermost aquifer" and other potential pathways for contaminant migration which are saturated within the study area; characterize the seasonal and temporal, naturally and artificially induced variations in groundwater quality; include in the application an evaluation of the background concentrations; and identify each constituent monitored. Proper identification of the "Uppermost Aquifer" is therefore essential before proceeding with the installation of a groundwater quality monitoring system for determining background. Groundwater quality must also be determined at potential sources of discharge to groundwater from existing units to determine compliance with the applicable groundwater quality standard to establish the appropriate groundwater program (detection, assessment, remedial action) and validate the GIA results.

1. Uppermost Aquifer

   "Aquifers" as defined in Part 810 means saturated (with groundwater) soils and geologic materials which are sufficiently permeable to readily yield economically useful quantities of water to wells, springs, or streams under ordinary hydraulic gradients and whose boundaries can be identified and mapped from hydrogeologic data. [Section 3(b) of the Illinois Groundwater Protection Act (Ill. Rev. Stat. 1989, ch. 111 1/2, par. 7453).]

   The "Uppermost Aquifer" means the first geologic formation above or below the bottom elevation of a constructed liner, or waste where no liner is present, which is an aquifer, and includes any lower aquifer that is hydraulically connected with this aquifer within the facility's permit area.

   Groundwater outside the uppermost aquifer must be classified as Class I, II, III or IV by the owner or operator in accordance with the criteria of 35 IAC Part 620.

   The identification of the hydrogeologic conditions within the study area are essential to the definition of uppermost aquifer. Distinctions between the hydraulic properties of the units shall be supported by insitu testing.

2. Establishment of the Applicable Groundwater Quality Standards

   The applicable groundwater quality standards for the facility are the background concentrations determined for each parameter pursuant to 811.320(d).

   The background concentrations shall be based on the chemical analysis of groundwater samples from an appropriate number of wells within the study area at least quarterly for one year, resulting in a <u>minimum</u> of 4 samples (taken quarterly) per parameter per well. Additional samples can be taken to expand the data base, however an equal number of samples must be taken from each well on a routine schedule (e.g. monthly, semi-monthly, etc.). The main objective of gathering background is to determine the existing groundwater quality unaffected by discharges of contaminants by the unit for the purpose of establishing the applicable groundwater quality standards. It is not required that <u>all</u> test wells be utilized to achieve this goal, however a multi-level monitoring system is usually necessary. Variations in background groundwater quality shall be determined within the three dimensional limits of the study area. The background groundwater parameter list is included as Attachment 1 to these instructions. The parameters were selected from the following:

a. The parameter is a constituent found in leachate; or,

b. The parameter must be monitored in accordance with Section 811.319(a); or,

c. The parameter is expected to be a constituent of the leachate and the Illinois Pollution Control Board has established a standard for the constituent [see Sections 811.315(e)(1)(G)(i) & (ii); or

d. The parameter is included on the list of 51 organic chemicals in drinking water described at 40 CFR 141.40 and any other organic chemical for which a groundwater quality standard or criterion has been adopted pursuant to Section 14.4 of the Act or Section 8 of the Groundwater Protection Act (i.e. Part 620); or

e. Any other constituent which is expected to be in the leachate, that may cause or contribute to groundwater contamination [see Sections 811.315(e)(1)(G)(ii) and 811.319(a)(2)(A)(ii)].

Those parameters listed in a - d above shall always be included in background determinations. However, those parameters represented in point e above may be excluded if a justification of why it is not expected to be present in the leachate is provided. The justification should include the information from leachate testing as described in Part C.1.f. of these instructions and testing of groundwater monitoring wells downgradient of the existing unit(s).

Facilities which cannot justify reducing the parameter list for establishing background due to incomplete leachate testing results must use the list of parameters from the "Expected in Leachate" column in the revised Attachment 1. Parameters which are not detected at the appropriate detection limit for two consecutive quarters and are not listed in 40 CFR 141.40 or Part 620.410(a) and (b) may be dropped from future background sampling events.

3. Development of (AGQS) Applicable Groundwater Quality Standards

Statistical tests and procedures shall be employed to establish the AGQS using background concentrations. Specific requirements for choosing the statistical tests are included in Section 811.320(e). The data needs for the statistical methods considered must be determined and incorporated into the sampling schedule before sampling begins. For statistical purposes, the recommended minimum of data for naturally occurring constituents is twenty (20) values from pooled upgradient wells. An equal number of samples must be taken from each well to ensure equal weighting. The minimum data for organic constituents is one (1) value assuming they are not detected during the background monitoring period. However for any detected organic, additional analyses are necessary to establish the background concentration for that constituent.

The operator must submit a list of the background concentrations and the AGQSs for the site with the permit application as required by Section 812.317 (1).

For existing units, wells downgradient must also be sampled for the applicable groundwater quality standards to determine compliance prior to issuance of the permit and to demonstrate that the groundwater impact assessment (GIA) is valid. This information is required pursuant to Section 812.316(h).

If the statistically derived background concentration for a groundwater constituent exceeds a "Board established standard" as defined in 811.320(a)(3)(B) an adjusted groundwater quality standard is not required. The background concentration will be the applicable standard. However, if the owner or operator determines an adjusted groundwater quality standard is appropriate for a constituent, for example in lieu of the established background, the adjusted standard shall be included in the permit application with documentation of the Board decision.

4. Groundwater Monitoring Wells for the Establishment of Background

Monitoring wells should only be installed with proper design, materials, quality control, and sufficient understanding of the geologic and hydrogeologic conditions present on site. See Part D (pages 21-26) of these instructions for well construction and abandonment requirements for new and existing wells.

Specific requirements include piezometers and groundwater monitoring wells installed in all strata and extending down to the bottom of the uppermost aquifer. Wells should be located near each corner of the study area and near the site boundary in the area of upgradient groundwater flow. The number of sampling points required for establishing background is dependent on the geologic and geochemical complexity of the study area.

5. Sample Collection

Monitoring groundwater quality is a difficult task because of the complex interaction of many factors including site hydrogeology, well construction, sampling materials and methods. Monitoring programs must be designed in such a manner that sources of error or bias are minimized or controlled. A monitoring program must include a carefully designed plan, appropriate sampling protocol, applicable chemical parameters and data evaluation techniques.

The sampling protocol includes methods of development and purging. Because the response of a well is controlled by transmissivity of the geologic materials near the well and by the design of the well, each well must be analyzed individually to obtain representative samples.

Samples should be analyzed for both the dissolved and total concentrations of inorganic parameters during the initial background sampling period. The dissolved concentrations would continue through routine monitoring for statistical analysis. General practice for dissolved concentrations is field filtering prior to preservation through a 0.45 micron membrane filter. The difference between total and dissolved concentrations may vary due to well construction, sampling procedures or natural physical or geochemical processes occurring in the aquifer. If the difference between total and dissolved concentrations is greater than one magnitude, then both analyses may be required individually for routine monitoring after the establishment of background concentrations at non-MSWLF sites.

C. GROUNDWATER IMPACT ASSESSMENT

The purpose of the groundwater impact assessment is to provide an integrated evaluation of the acceptability of the physical setting and design of the landfill units through contaminant transport modeling. The impacts of leachate seepage from the unit must be addressed (i.e., modeled) in a systematic fashion using the techniques described in 35 IAC 811.317 and 812.316.

A written evaluation and analysis of the results of the groundwater impact assessment must be submitted with the permit application. Every application requiring a groundwater impact assessment should include a report addressing the following issues:

1. Groundwater Impact Assessment

This portion of the instructions provides a systematic method to assess the impacts of leachate seepage from the unit, as referenced under 35 IAC 811.317. This is essentially an outline of the modeling process presented as an organized sequence of events, along with a brief description of what the Illinois EPA is looking for under each outline topic. Applications that follow this format will facilitate Illinois EPA review of the application.

a. Conceptual Model

The conceptual model used to simulate contaminant transport at the facility should be described in the groundwater impact assessment portion of the

Groundwater Protection Evaluation report. This should include both a diagrammatic representation of the hydrogeologic setting being modeled, and a narrative description of the concepts or processes of contaminant transport used to assess the impacts of leakage from the unit accounted for in the model.

The diagrammatic representation of the facility should present the hydrogeologic setting in a simplified form, as it will be viewed by the model, versus the more complex features of the site that may have been discovered during the hydrogeologic site investigations, but are not individually represented in the model.

The diagrammatic representation should reflect the entirety of the facility including any existing regulated areas along the length of the flow direction.

The narrative description of the conceptual model should elaborate on the simplifications inherent in modeling the site (e.g., how the hydrogeologic setting can be represented in this simplified manner and still adequately assess the impacts of leakage from the unit).

The narrative description should also discuss and describe the transport processes that are considered as leachate constituents move through each of the hydrogeologic units considered in the model.

This section of the report should allow the Illinois EPA reviewer an understanding of exactly which transport processes and site conditions were considered in the model and how these were modeled. It should be readily apparent to the Illinois EPA reviewer that the facility is adequately represented in the model and that releases from unit(s) will be adequately simulated.

b. Translation to Mathematical Model

The conceptual model should be translated into a mathematical model, expressed in the same terms as those presented in the transport model user's guide and/or associated model documentation. This should include equations for each transport process under consideration.

These equations should then be coupled into the full mathematical model that will be used to simulate contaminant transport at the facility.

From this point, the Illinois EPA reviewer should be able to use the documentation provided with the model to assess the theoretical basis of those equations (see instructions regarding model documentation below). Any modifications or deviations from the generic expression(s) of these equations, as presented in the model documentation, that may be needed for site-specific application of the model should be fully explained and theoretically justified.

c. Model Input Values

The report should provide a narrative description of how model input values (e.g., dispersivities, leachate concentrations, hydraulic conductivities, etc.) were obtained, their applicability to conditions at the proposed site, and an assessment of any uncertainty in the selection of those values. If confidence in the selection of a parameter value is low, particularly for those parameters to which the model is sensitive, conservative values must be used for model input.

d. Seepage from the Unit

The procedures for performing the groundwater impact assessment require the operator to estimate the amount of seepage from the unit using the minimum design standards for slope configuration, cover, liner, leachate drainage and leachate collection, and assuming that the actual design standards planned for the unit apply. For example, if the actual design of the landfill includes leachate withdrawal during the active life and during the entire 100 year period following closure, this can be accounted for in estimates of seepage from the unit.

[Note: Additional financial assurance for leachate collection beyond the minimum design period would be required under the example given above.]

e. Site-Specific Values

Site-specific data must be used for model input whenever possible. Hydrogeologic site investigations should provide most of the input data required for contaminant transport modeling. Sampling strategies should be designed to obtain estimates of both the magnitude and variability of site hydrogeologic characteristics and landfill data. Sensitivity analyses must be performed on these parameters and represent the extremes in the range of data.

If it is not practical to obtain site-specific data, the Illinois EPA will consider use of other data for model input provided that the applicant selects reasonably conservative values for model input (i.e., conservative in the sense that the values used generate the greatest predicted contaminant concentrations at or beyond the limit of the zone of attenuation). The validity of any model input that is not based on site-specific data must be well documented and the conservative nature of the selected value must be demonstrated by the sensitivity analysis. If the applicant does not wish to use a reasonably conservative value in the baseline model, then the selected value for that parameter must be based on site-specific data.

f. Leachate Constituents and Concentrations

The chosen concentrations of chemical constituents representing leachate in model inputs for the groundwater impact assessment must reflect relatively conservative estimates over the design period at the facility. These may be developed in any of the following three ways:

i. Testing leachate from an existing landfill;

1. The samples should be from the subject landfill or from a landfill which would be analogous with regard to expected leachate generation.

2. The landfill must be sampled to accurately reflect the expected leachate quality, accounting for both spatial and temporal variability (i.e., location in the landfill, the types of waste placed there, and the age of the leachate).

   Conservative leachate quality estimates for model input values may be chosen as the maximum value from of the leachate sampling results for a given constituent; or, the same statistical approach used for calculating the background groundwater concentrations should be used to calculate the leachate input values. For instance an upper confidence limit is acceptable if justified.

3. Testing of actual leachate or synthetic leachate in (ii) below must include at a minimum all of those parameters listed in Attachment 1 as expected to be in leachate. Again, the concentrations to be used as inputs shall be calculated with the goal of evaluating the greatest concentrations expected during the life of the landfill. Landfills which do not receive municipal waste must consider actual types of waste received and the expected resultant leachate.

ii. Testing a "Synthetic Leachate" (i.e., laboratory derived extract of a representative sample of the waste expected to be disposed in the proposed unit). Once again the overall estimate should consider the greatest expected concentration of each parameter during the design period; or

iii. Using the values shown in Attachment 1 (Note: in instances where the proposed unit is not analogues to the landfills from which the values were derived (municipal waste landfills), the Illinois EPA may require adjustments to the concentrations and the parameter list.

g. Surrogate Modeling

Every chemical constituent expected to be present in leachate must be modeled in the groundwater impact assessment. However, a surrogate compound representing groups of leachate constituents may be used in lieu of modeling each leachate constituent individually. The following procedure should be used if the applicant wishes to conduct surrogate modeling for a given group of leachate constituents:

i. Make a list of the group of leachate constituents to be represented as the surrogate(s) in the model.

ii. Tabulate all of the chemical data required for model input for each of those leachate constituents (e.g., leachate concentrations, partitioning coefficients, etc). This table should also include the AGQS for each of the leachate constituents to be represented by the surrogate.

iii. Select the most conservative value for each input parameter, from the entire table of values, for use as the surrogate in the model. The conservative nature of that value must be supported by sensitivity analysis.

iv. Using the chosen surrogate input(s), run the model and compare the results to the lowest AGQS in the table.

v. The groundwater impact assessment is considered acceptable for those leachate constituents represented by the surrogate(s) only if the lowest groundwater standard is not exceeded at or beyond the zone of attenuation at any time during the modeling period.

While the surrogate modeling approach can optimize the use of resources, the conservative nature of surrogate modeling can also make it more difficult for the applicant to demonstrate an acceptable groundwater impact assessment. Any combination of surrogate groups and/or individual leachate constituents may be used for groundwater impact assessments, depending on the needs of the applicant, as long as all leachate constituents are modeled.

h. Dispersivity

Model input parameters related to the processes of dispersion are particularly problematic in conducting groundwater impact assessments. Site-specific dispersivity tests are not routinely conducted during the hydrogeologic site investigations. Longitudinal dispersivity values used for model input may be based on site-specific dispersivity tests or on published literature values.

Acceptable sources for evaluating dispersivity include: Gelhar, et.al, 1992 for all distances; Xu and Eckstein, 1995 for distances greater than 100 m; and Schulze-Makuch, Dirk, 2005 for distances less than 100 m. For the purposes of the groundwater impact assessment, the scale used to determine the determine dispersivity may conservatively be assumed to be ½ the landfill length, in the direction of flow, plus 50 ft to the MAPC well locations. If the property boundary is less than 50ft, then the smaller value must be used.

Transverse dispersivities may be estimated as 1 to 10% of the longitudinal dispersivity value (Gelhar, 1992). Obviously, no single "rule-of-thumb" for selection of dispersivity values from the literature is universally applicable for all models, and, without site-specific data, the Illinois EPA has no way of estimating what the appropriate values for model input might be. Therefore, if literature values are used to estimate dispersivity, reasonably conservative values must be selected for model input. This must be based on sensitivity analysis conducted by the applicant. The more sensitive the model, the greater the degree of conservatism required for model input.

i. Retardation

The process of retardation of leachate constituents may be considered in the groundwater impact assessment. Most contaminant transport models account for this process through the use of distribution or partitioning coefficients (K_d). For inorganic leachate constituents, the applicant may use K_d values from literature sources as input to the model. For organic leachate constituents, K_d values must be calculated according to the formula:

$$K_d = K_{oc} \times f_{oc}$$

where, K_{oc} = the organic carbon partitioning coefficient

f_{oc} = the organic carbon fraction of the medium

Literature values for K_{oc} may be used in these calculations, but the organic carbon fraction of the medium must be based on site-specific sampling results that account for spatial variability. The horizontal and vertical variability of organic carbon content should be determined for each of the hydrogeologic units in which retardation is simulated, with equal weighting for each sampling depth. The lower 95% confidence limit of the organic carbon fraction should then be used to calculate the K_d value for each organic leachate constituent using the formula given above.

j. Table of Values

Summary table(s) of all input parameter values used in the model should be provided in the Groundwater Impact Assessment Report.

k. Flow Model Calibration

The model should be calibrated to observed site-specific field conditions. Generally, it will only be practical to calibrate the model to groundwater flow conditions, particularly at new landfills, since releases to groundwater in the vicinity will not have occurred, or due to lack of knowledge of the nature of previous releases that may have occurred.

l. Sensitivity Analysis

Sensitivity analyses must be conducted to measure the response of the model to change in the values assigned to major model input parameters, boundary conditions, specified error tolerances, and numerically assigned space and time discretions. The results of the sensitivity analyses must be presented in the groundwater impact assessment report.

Sensitivity analysis should be conducted separately for each model input parameter, boundary condition, etc., using baseline model results (i.e., results of models used to demonstrate an acceptable groundwater impact assessment) as the standard for comparison. Each sensitivity analysis should include the full range of reasonable values or model options potentially considered for use in the model. The range of values investigated should include values both greater than and less than those used in baseline models.

m. Model Reliability

This section of the application should present a narrative discussion of the reliability of the modeling results. How reliable are the results? Discussion of model reliability should include an assessment of model uncertainty, particularly with regard to selection of model input parameter values and the results of the sensitivity analyses conducted. This section should also assess the effects of any deviations from the assumptions inherent in the model (see section on model documentation below).

n. Groundwater Standards

The groundwater standards (AGQS) used to determine the acceptability of the groundwater impact assessment are background concentrations as determined in accordance with 35 IAC 811.320(d). Board established standards are not directly applicable unless they have been adjusted by the IPCB in accordance with requirements of 35 IAC 811.320(b).

o. Concentration vs. Time Profiles

Concentration vs. time profiles should be presented graphically for at least three points within the zone of attenuation for each leachate constituent. Surrogate modeling results may be used to represent corresponding groups of leachate constituents. The selected locations should include points of greatest predicted concentrations at the limit of the zone of attenuation, and 1/3 and 2/3 of the distance between the waste management boundary and the limit of the zone of attenuation.

p. Concentration vs. Distance Profiles

Concentration vs. distance profiles should be presented graphically for each leachate constituent modeled at five year increments covering the entire modeling period. These should be presented along a line parallel to the direction of groundwater flow that intersects the points of greatest predicted concentrations over time. The distance covered should be from the limit of the waste management boundary, to the zone of attenuation or to the point at which the predicted concentration is lower than the detection limit for that leachate constituent, whichever is greater. Surrogate modeling results may be used to represent corresponding groups of leachate constituents.

2. Groundwater Impact Assessment Report

The results of the groundwater impact assessment should be summarized and presented in a report in the application to show that it is acceptable. This should include summary tables and graphs, and well as a narrative discussion of the results. An acceptable groundwater impact assessment must demonstrate that the concentrations of leachate constituents in groundwater will be less than the applicable groundwater quality standards of Section 811.320 at any point at or beyond the limit of the zone of attenuation at any time during operation and within 100 years following closure of the unit.

Raw data must also be submitted to verify the accuracy of the data summaries. Raw data must be submitted as a hard copy: an original and 3 to 4 copies, although if the program outputs are extremely large, a hard copy original w/ the remaining copies on electronic storage may be considered. The applicant must contact the Illinois EPA to discuss this option on a case-by-case basis.

The application should include a clear explanation identifying what each of the raw data points represent and the units in which they are presented. Templates may be presented as an identification guide for highly repetitive data.

3. Model Selection

The selected model must be able to adequately represent and simulate groundwater flow and contaminant transport in the specific hydrogeologic setting at the proposed site, considering such features as water table vs. confined aquifer conditions, porous media vs. fracture flow, homogeneous vs. heterogeneous conditions, dispersivity characteristics, and multi-dimensional components of groundwater flow and contaminant transport.

[Note: Additional guidance on model selection can be found in USEPA's "Selection Criteria for Mathematical Models used in Exposure Assessments: Groundwater Models." EPA/600/8-88/075. Office of Health and Environmental Assessment. Washington, D.C. May 1988.]

4. Model Documentation

A contaminant transport model must be utilized in the groundwater impact assessment, in accordance with the requirements of Sections 811.317 and 812.316. The Illinois EPA review of model acceptability will be gauged on a site-specific basis. Documentation must be provided to show that the selected model is capable of simulating groundwater flow and contaminant transport under the conditions identified in the hydrogeologic site investigations.

a. Software and User Support

If a commercially available model is utilized, a copy of that model along with full documentation and user support must be provided to the Illinois EPA (unless one has been previously provided) directly from the vendor as part of the application.

b. Groundwater Flow & Contaminant Transport

The applicant must submit documentation that establishes the ability of the model to represent groundwater flow and contaminant transport. This documentation should include validation and verification studies, and any history of it's previous applications. Studies published in professional journals are preferable and should be used for model documentation when possible. When using a model without a great deal of supporting documentation, a greater burden is placed on the applicant in terms of site-specific validation and/or verification of the model.

c. Equations and Numerical Solution Techniques

The applicant must provide documentation to support the validity of the equations used to simulate groundwater flow and contaminant transport, and the numerical solution techniques. Usually this type of information will be detailed in model documentation supplied from the commercial vendor, along with a copy of the software. If this is not the case, the applicant must supply this documentation with the groundwater impact assessment report. Any modifications or deviations from the generic expression(s) of these equations and solution techniques that may be needed for site-specific application of the model should be fully explained and theoretically justified.

d. Model Assumptions

The applicant should summarize the set of assumptions that are inherent in the selected model. This should also include an assessment of the applicability of these assumptions to the setting at the facility. Any deviations from these assumptions should be addressed in terms of model reliability.

5. Maximum Allowable Predicted Concentrations

Maximum allowable predicted concentrations (MAPCs) are projected concentrations of leachate constituents in the uppermost aquifer that, when exceeded within the zone of attenuation, indicate potential for exceedence of a groundwater quality standard at the limit of the zone of attenuation. The applicant must use the same calculation methods, data and assumptions used in the groundwater impact assessment to predict the concentration over time and space of all constituents chosen to be monitored in accordance with Section 811.319 at all monitoring points. The predicted values must be used to establish MAPCs for each monitoring point within the zone of attenuation. MAPCs must be developed for all constituents monitored in accordance with Section 811.319.

This assumes that the applicant has demonstrated an acceptable groundwater impact assessment. In order to obtain predicted concentrations that, when exceeded within the zone of attenuation, would indicate future exceedence of the groundwater standard at zone of attenuation, the applicant must adjust the baseline model until the predicted concentration at the limit of the zone of attenuation just equals the groundwater standard. The manner by which this can be accomplished may vary depending on the contaminant transport model being utilized. There is no single correct method. The most generally accepted method of accomplishing this task is by altering model input to affect an increase in leakage rate. Once a model scenario that accomplishes this task has been developed, this same model should be used to establish predicted concentrations for each monitoring well located within the zone of attenuation. These will be the MAPCs for those monitoring points.

If modeling for the groundwater impact assessment fails to predict significant attenuation to occur within the zone of attenuation, then the applicant may use the established background concentrations (AGQS) described in Part B.2 and B.3 of these instructions as MAPCs for monitoring points within the zone of attenuation. For leachate constituents which were not detected during the background sampling period, an Illinois EPA approved method detection limit (MDL) or practical quantitation limit (PQL) will be accepted as the MAPC.

6. Updated Groundwater Impact Assessments

The applicant must conduct a new groundwater impact assessment as described above if any of the following changes in the facility or its operation will result in an increase in the probability of exceeding a groundwater standard beyond the zone of attenuation:

1. New or changed operating conditions;

2. Changes in the design and operation of the liner and leachate collection system;

3. Changes due to more accurate geological data;

4. Changes due to modified groundwater conditions due to off-site activity;

5. Changes due to leachate characteristics.

D. <u>GROUNDWATER MONITORING SYSTEMS</u>

The purpose of the groundwater monitoring system is to assess the success of the design of the facility, to confirm the results of the groundwater impact assessment over time, and to detect any discharge of contaminants from any part of a potential source over the design period. The design period includes the active phase of the operation of the unit and the post closure care period.

The groundwater monitoring system is the network of groundwater monitoring wells established within and at the edge of the zone of attenuation in accordance with Sections 811.318 and 811.319. Assuming a zone of attenuation of 100 ft. from the edge of the waste, the majority of the wells (MAPC wells) must be located at 50 ft or less from the edge of the waste. A minimum of one (1) well (AGQS or Compliance Boundary well) must be located 100 ft from the edge of the waste, or at the property boundary, if closer.

The monitoring system will monitor all potential sources of discharges within the facility, including all waste disposal units and leachate collection and storage systems. The wells must be located in zones identified during the investigation phase that could serve as contaminant migration pathways. The groundwater monitoring wells must be capable of yielding samples of a sufficient quantity for the completion of the required analysis.

Wells must be installed hydraulically upgradient and downgradient from the facility. All wells must be screened to access groundwater from a specific interval. The number and location of the monitoring wells is determined on a site specific basis. Spacing between the wells must be technically justified. The Illinois EPA recommends using a hypothetical liner failure combined with the advective-dispersive calculation to determine plume dimensions to justify spacing between wells.

1. Modeling for Well Spacing

   The applicant may use contaminant transport modeling to design a groundwater monitoring program, or to demonstrate the adequacy of an existing program.

   a. Criterion for Acceptability

      The groundwater monitoring well system (MAPC wells) should be capable of detecting a contaminant plume that would exceed an AGQS at the zone of attenuation. Contaminant transport modeling must demonstrate that the proposed monitoring system has a reasonable chance of meeting this goal.

   b. Modeling Procedures

      The modeling inputs used to assess well spacing are similar to those described above for the groundwater impact assessment, except as follows:

i. Attenuation within the aquifer should not be considered in the model.

ii. A small areal source (e.g., 1 sq. meter), located near the downgradient boundary of the potential leachate source area, should be used to simulate the effect of a tear in a synthetic liner, or a crack or fissure in a clay liner.

iii. Other reasonable failure scenarios may be used as needed to affect a significant release from the unit.

iv. If a plume is modeled, a contaminant plume is defined as a specific concentration contour with a downgradient boundary near, but not at, the zone of attenuation. The specific concentration used to define the plume is not consequential, as long as the plume width is defined by the same concentration. Maximum allowable well spacing is then determined by the predicted width of the plume at 50 ft from the waste boundary.

v. If efficiency is modeled, a 99% efficiency is the goal.

2. Monitor Well Construction

The application must provide detailed documentation of the monitoring well and piezometer construction. Casing and screen material must be inert to avoid contributing contamination or causing interference with the analysis of the water sample. Teflon, Stainless Steel 316, and Stainless Steel 304 are recommended as durable, corrosion-resistant materials. Since plastic (PVC) may have a significant effect on the ability to obtain a "representative" sample, the Illinois EPA only allows the use of plastic casing for piezometers or through the unsaturated zone for wells.

a. Existing Wells

The Illinois EPA is not requesting replacement of existing PVC or stainless steel wells provided that:

i. The wells are appropriately located as discussed in Part D above; and

ii. The boring logs and well construction diagrams are submitted to demonstrate that the specific or equivalent construction specifications discussed below have been met.

b. Well Construction Criteria

The well casing must have a minimum inside diameter of not less than two inches. The joints must be flush threaded and water-tight. The well casing must be straight and free of any obstructions. The wells must be screened at appropriate intervals to monitor the permeable zones encountered. The well screens must be not less than 2 feet or more than 10 feet in length. The slot size must be compatible with the grain size of the annular filter pack to prevent silting in by the surrounding formation. Screens must be continuous slot wire wound or machine cut.

Annular space along the screened section must be packed with silica sand or gravel 2 1/2 - 3 times larger than the 50% grain size of the zone being monitored. The top of the sand pack shall not extend past 2 feet above the well screen. A clean, well rounded and uniform (mainly one grain size) filter pack is preferred; however, in sand and gravel deposits where cave-ins occur, the natural sand and gravel is acceptable.

To insure that the sealing material does not interfere with the screen, the filter pack shall extend two feet above the top of the well screen. The sealing material above the filter pack must prevent the migration of fluids from the surface and between subsurface sediments. A pure bentonite seal must be installed above the filter pack and extend no less than 2 feet above the filter pack extension. Pure bentonite should be hydrated at the surface and installed from the bottom of the annular opening upward in one continuous operation using a "tremie tube" or "tremie pipe". A sealing material of expanding cement grout with 1% bentonite, by weight, added to the appropriate amount of water before being added to the cement or 5% bentonite, by volume, added to the cement before mixing with water should be used above the bentonite seal. This also should be installed using the tremie method as formerly described. No quick setting cements that contain additives will be allowed. Any bentonite used must also be free of additives.

At the surface, a concrete cap shall be installed around the protective casing. The cap shall extend below the frost zone and slope away from the well casing on the surface so that rain water will be diverted away from the well casing and bore hole. The portion of the well casing above the ground surface must be protected to minimize damage or tampering. These precautions should include a locking cap. Wells must be identified by a monitor point number, using an Illinois EPA approved designation. The location of the wells in relation to the waste management area must be located on a topographic map (scale 1"=200' or larger). This map must include county, site name, township, range, and section.

The Illinois Department of Public Health Water Well Construction Code, 77 IAC Part 920 (effective 1/1/92) contains minimum standards for groundwater monitoring wells and piezometers. The code also includes reporting well construction and decommissioning to the IDPH within specified timeframes. Alternate designs may be submitted for Illinois EPA approval in writing, prior to installation.

3. Sampling Frequency

The monitoring programs consist of routine quarterly and semi-annual lists of parameters. The quarterly and semi-annual parameter lists are found in Section 811.319(a)(2) and (3).

4. Monitor Well Development

After the monitor well has been constructed and allowed to sit for 24 hours, the well must be adequately developed to minimize turbidity within the well and increase flow into the well. To be effective, development procedures require reversal or surges in flow to avoid bridging by particles, which is common when flow is continuous in one direction. This action can be created by using surge blocks, bailers, or pumps. An insitu test must be conducted for each monitor well to determine hydraulic conductivity near the well. The test method (i.e., slug tests, pumping tests) used, calculations and interpretations must be submitted to the Illinois EPA. The tests shall be conducted after the well is properly developed.

5. Monitor Well Plugging and Abandonment

Monitoring wells and borings, which are no longer being used, must be properly plugged/sealed and abandoned so that groundwater is protected from surface contamination and potential degradation between stratigraphic units. Procedures which have been developed for guidance in the plugging of monitoring wells are based upon geologic materials and well construction.

All open drill holes must be marked and covered until properly abandoned. Soil borings and test wells are to be plugged upon abandonment of the borehole using the procedures for monitoring wells if they penetrate a water bearing sediment. Those that do not contain water can be filled from the surface, as long as methods are used which ensure that pure cement slurry will reach the bottom of the hole. There may also be abandoned drinking water wells onsite that should be plugged because they can serve as routes for contamination.

When a well has been damaged, such as when the casing has been broken off at or below the surface, it should be bailed to remove any material that entered it before plugging is initiated. The depth of the well should be checked to detect the presence of any obstructions that may interfere with sealing. Any obstructions in the well must be retrieved and the well casing and screen removed prior to plugging. The operator is to restore the areas around the drill holes to their original condition.

Accurate records of plugging and abandonment procedures should be maintained for future reference and documentation for closure. See D.2.b, Monitor Well Construction.

6. Monitoring Well Construction Reports

Boring logs must be completed for all test borings and monitor wells. Also, all test borings should be continuously sampled and have the elevations surveyed and reported in relation to Mean Sea Level (MSL) to the nearest 0.01 ft. Well completion ("as-built") diagrams which have been surveyed by a registered surveyor must be submitted to the Illinois EPA on Illinois EPA forms, as in Attachments.

A scale drawing showing monitor well and test boring locations must be submitted to the Illinois EPA. The drawing should also show buildings, roads, the site's property boundary, the Zone of Attenuation, the permitted waste boundary and currently filled area. In addition, a Cartesian coordinate grid for the site should be established, shown on the map, and all test borings and monitor wells should have coordinates surveyed and reported.

All necessary permits, licenses, and reporting regarding well construction, operation and plugging must be in accordance with the requirements of the Illinois Department of Public Health and the Illinois Department of Mines and Minerals if applicable.

E. <u>GROUNDWATER MONITORING PROGRAM</u>

A groundwater monitoring program must be included in the application. The program must include a sampling and analysis plan (SAP) describing the procedures for collecting and analyzing data in accordance with Section 811.318(e). The program must also describe the parameters and frequency of sampling for each location and the evaluation method(s) of data in accordance with Section 811.319.

1. Parameters

To establish background in accordance with Section 811.320(d), groundwater samples must be collected and analyzed for the parameter list given in Attachment 1 at a minimum frequency of quarterly for one year, plus any additional parameters which may be unique to the waste handled by the facility or site conditions. See Parts B.2 and B.3 of these instructions for specific information.

Parameters for routine and semi-annual monitoring will be proposed by the applicant in accordance with Section 811.319(a)(2) and (3).

2. Sampling Frequency

Routine parameters, listed under Section 811.319(a)(2) will be sampled and analyzed quarterly. The parameters listed under Section 811.319(a)(3) will be sampled and analyzed semi-annually.

3. Quality Assurance/Quality Control (QA/QC)

A sufficient number of QA/QC samples will be prepared for evaluating field, transport and laboratory procedures. The samples such as equipment, trip and lab blanks must be fully described in the facility sampling and analysis plan. The Illinois EPA recommends QA/QC for groundwater sampling and analysis as described in SW846.

4. Statistics

All groundwater sample results will be evaluated to determine if an increase in a constituent has occurred in accordance with Section 811.319(a)(4). Statistical methods must meet the minimum standards of Section 811.320(e).

5. Groundwater Quality Reporting

Groundwater data will be reported in a format prescribed by the Illinois EPA within the following time periods (QA/QC sample data must be reported for each sampling event):

Sampling Quarter	Report Due Date
January-February (1st)	April 15
April-May (2nd)	July 15
July-August (3rd)	October 15
October-November (4th)	January 15

A statistical increase is any exceedence of the established AGQS (see B.2, B.3 and E.4). Any statistical increase is subject to the confirmation procedures described in Section 811.319(a)(4). A confirmation of a statistical increase must be addressed through the application process to the Illinois EPA. The application must either establish an alternate source or propose groundwater assessment.

F. ELECTRONIC REPORTING OF DATA

The Illinois EPA requires groundwater and leachate data be submitted in electronic format in accordance with http://www.epa.state.il.us/land/waste-mgmt/groundwater-monitoring.html.

References

1. Scientific/Technical Section, 1990, Response to Additional Comments on proposed Part 807, and 810 through 815, Illinois Pollution Control Board.

2. ASTM, 1990, Design and Installation of Ground Water Monitoring Wells in Aquifers, Designation: D 5092-90.

3. USEPA, 1991, "Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells", EPA/600/4-89/034, Office of Research and Development, Washington DC.

4. IEPA, 1991, Groundwater Quality Standards, 35 Ill. Adm. Code 620, R89-14 (Rulemaking), Proposed Rule, Second Notice, Illinois Pollution Control Board.

5. USEPA, 1986, "RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD)", OSWER-9950.1.

6. USEPA, 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", EPA Publication SW846 (Third Edition and updates), Document number PB89-148076.

7. Gelhar, L.W, C. Welty and K.R. Rehfeldt, 1992, “A Critical Review of Data on Field-Scale Dispersion in Aquifers”, Water Resources Research, Vol. 28, No. 7, pp 1955-1974.

8. Xu, M. and Y. Eckstein, 1995, “Use of Weighted Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Field Scale”, Ground Water, Vol. 33, No. 6, pp 905 – 908.

9. Schulze-Makuch, Dirk, 2005, “Longitudinal Dispersivity Data and Implications for Scaling Behaviour”, Ground Water, Vol.43, No. 3, pp 443-456.

<u>Attachment 1</u>
<u>Chemical Parameters Associated with Putrescible and Chemical Landfills</u>
(rev 3/94)

Parameters	Generally Predicted Values for Municipal Solid Waste Landfills* ug/l	Basis for Inclusion on List: Expected in Leachate	35 IAC Part 620	35 IAC Part 302	40 CFR 141.40	Sub-Title D MWSLF
1,1,1,2-tetrachloroethane					X	X
1,1,1-trichloroethane	2,000	X	X			X
1,1,2,2-tetrachloroethane	400	X	X		X	X
1,1,2-trichloroethane	630	X			X	X
1,1-dichloroethane	3,000	X			X	X
1,1-dichloroethene (or ethylene)			X			X
1,1-dichloropropene					X	
1,2,3-trichlorobenzene					X	
1,2,3-trichloropropane	500	X			X	X
1,2,4-trichlorobenzene					X	
1,2,4-trimethylbenzene					X	
1,2-dibromo-3-chloropropane					X	X
cis-1,2-dichloroethylene	500	X	X		X	X
trans-1,2-dichloroethylene	1,000	X	X		X	X
1,2-dichloroethane	4,000	X	X			X
1,2-dichloropropane	200	X	X		X	X
1,3,5-trimethylbenzene					X	
1,3-dichloropropane					X	
1,3-dichloropropene		X			X	
cis-1,3-dichloropropene						X
trans-1,3-dichloropropene						X
trans-1,4-dichloro-2-butene						X
2,2-dichloropropane					X	
2,4,5-tp (silvex)			X	X		
2,4-dichlorophenoxyacetic acid (2,4-D)			X	X		
2-butanone (methyl ethyl ketone)	8,000	X				X
2-hexanone (methyl butyl ketone)	500	X				X
4-methyl-2-pentanone	700	X				X
acetone	5,000	X				X
acrolein	400	X				
acrylonitrile						X
alachor			X			
aldicarb			X			
aldrin				X		
aluminum	6,000	X				
ammonia (as N)	600,000	X				
antimony	9,000	X				X
arsenic	100	X	X	X		X
atrazine			X			
barium	10	X	X	X		X
benzene	500	X	X			X
beryllium			X			X
bicarbonate						
BOD	5,000,000	X				
boron	4,410	X	X			
bromobenzene					X	
bromochloromethane					X	X
bromodichloromethane					X	X
bromoform					X	X
bromomethane	400	X			X	X
n-butylbenzene					X	
sec-butylbenzene					X	
cadmium (total)	100	X	X	X		X
calcium	1,200,000	X				

Parameters	Generally Predicted Values for Municipal Solid Waste Landfills* ug/l	Basis for Inclusion on List				
		Expected in Leachate	35 IAC Part 620	35 IAC Part 302	40 CFR 141.40	Sub-Title D MWSLF
carbofuran			X			
carbon disulfide	6	X				X
carbon tetrachloride	400	X	X			X
chemical oxygen demand	10,000,000	X				
chlordane			X	X		
chloride	3,000,000	X	X	X		
chlorobenzene	400	X	X		X	X
chloroethane	400	X			X	X
chloroform	400	X			X	X
chloromethane	400	X			X	X
bis(chloromethyl)ether (or dichloromethylether)	400	X				
o-chlorotoluene					X	
p-chlorotoluene					X	
chromium (total)	50	X	X	X		X
chlorodibromomethane					X	X
cobalt	130	X	X			X
copper	1,000	X	X			X
p-cresol	239	X				
cyanide	300	X	X			
DDT		X		X		
dibromomethane	10	X			X	X
m-dichlorobenzene					X	
o-dichlorobenzene	25	X	X		X	X
p-dichlorobenzene	25	X	X			X
dichlorodifluoromethane	450	X			X	
dichloromethane (or methylene chloride)	10,000	X			X	X
dieldrin				X		
diethyl phthalate	200	X				
dimethyl phthalate	60	X				
di-n-butyl phthalate	150	X				
endrin		X	X	X		
bis(2-ethylhexyl)phthalate	400	X				
ethylbenzene	500	X	X		X	X
ethylene dibromide (EDB)					X	X
fluoride			X			
heptachlor			X	X		
heptachlor epoxide			X	X		
hexachlorobutadiene					X	
iodomethane						X
iron	500,000	X	X	X		
isophorone	2,500	X				
isopropylbenzene					X	
p-isopropyltoluene					X	
lead	500	X	X	X		X
lindane	.025	X	X	X		
magnesium	500,000	X				
manganese	20,000	X	X	X		
mercury	10	X	X			
methoxychlor			X	X		
naphthalene	75	X			X	
nickel	1,000	X	X			X
nitrate			X	X		
oil (hexane-soluable or equivalent)				X		
parathion				X		
pentachlorophenol	400	X	X			
pH	5-9		X			
phenols	5,000	X	X	X		
polychlorinated biphenyls			X			
potassium	500,000	X				

Parameters	Generally Predicted Values for Municipal Solid Waste Landfills* ug/l	Basis for Inclusion on List: Expected in Leachate	35 IAC Part 620	35 IAC Part 302	40 CFR 141.40	Sub-Title D MWSLF
n-propylbenzene					X	
selenium	50	X	X	X		X
silver	50	X	X			X
sodium	1,500,000	X				
styrene			X		X	X
sulfate	1,000,000	X	X	X		
TDS	10,000,000	X	X	X		
TOC	6,000,000	X				
tert-butylbenzene					X	
tetrachloroethylene	300	X	X		X	X
tetrahydrofuran	1000	X				
thallium	500	X				X
toluene	2,000	X	X		X	X
toxaphene	2	X	X	X		
trichloroethylene(or ethene)	400	X	X			X
trichlorofluoromethane (or fluorotrichloromethane)	150	X			X	X
vanadium	30	X				X
vinyl chloride	60	X	X			X
vinyl acetate						X
xylenes (total)	300	X	X			X
m-xylene	200	X			X	
o-xylene					X	
p-xylene					X	
zinc	20,000	X	X			X

* References

1. Gasper, James A. and Jeff M. Harris, Management of Leachate from Sanitary Landfills (for Browning Ferris Industries).

2. Dolan, David, Helen Keougl, R.L. O'Hara and Kevin O'Leary, 1991, A Comparison of Chemical Constituents in Industrial Hazardous Waste Municipal Waste Landfill Leachates (for Waste Management of North America, Inc.).

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