INFORMATION SHEET FOR OWNER/OPERATORS OF CLASS 1HW INJECTION WELLS WHO ARE SUBMITTTING SIMULTANEOUS APPLICATIONS FOR PERMITS AND PETITIONS FOR EXEMPTIONS FROM THE RCRA LAND BAN OR NEW DEMONSTRATIONS FOR EXISTING EXEMPTIONS

Permits Team

UIC Instruction Sheet No. 1
March, 2006
Revised, July 2006

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U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 5, WATER DIVISION
UNDERGROUND INJECTION CONTROL BRANCH

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1 INTRODUCTION

1.0 Scope and Applicability

This Information Sheet is for owners/operators of Class I injection wells subject to the land disposal restrictions (land ban), established by the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act and implemented through regulations at Title 40 of the Code of Federal Regulations part 148, 40 C.F.R. part 148.

This Information Sheet is meant to assist well operators and owners in preparing and submitting their applications for a Class 1 injection well permit and land ban exemption petition or new demonstration for an existing land ban exemption. In particular, it was created to provide some assistance in preparing the applications and petitions or new demonstrations at the same time, as there is some similarity in the required information for them and because Region 5 intends to simultaneously review these two types of submissions if submitted in the same time period. This Information Sheet does not constitute a rulemaking or create a policy, practice, or guidance that Region 5 is required to follow. The relevant statutes, regulations, rules, and/or guidance are controlling.

Submission of simultaneous permit applications and exemption petitions or new demonstrations following this Information Sheet will allow the Underground Injection Control Branch (UIC Branch) to simultaneously perform the decision processes for permitting and exemption. Conducting these two reviews at the same time is expected to result in elimination of redundant efforts on the part of both the UIC Branch and the owner/operators. This Information Sheet is not for operators of wells not subject to the land ban. In the event a state has primacy for Class 1HW well injection permits, the owner/operator also seeking an exemption should submit a petition to Region 5 at the same time it submits its permit application. It should also provide Region 5 with a copy of its permit application.

Guidance which has previously been prepared may also have particular value to Class 1HW permit applicants. These guidances are available by request and can be found on the Branch's web page at http://www.epa.gov/region5/water/uic/techdocs.htm#r5guid/ or go the Branch's home page at http://www.epa.gov/region5/water/uic/uic.htm and navigate to Underground Injection Control Topics to UIC Technical Documents including the UIC National Technical Workgroup to Region 5 Guidances where links to all of the UIC guidances can be found.

1.1 Basis of Information Sheet

The UIC regulations governing criteria and standards for injection wells which inject hazardous industrial wastes below the lowermost underground sources of drinking water (Class 1HW) are found at 40 C.F.R. § 146.61 to 146.73. These regulations require the consideration of geological and geohydrological factors which govern migration of fluids which are injected into deep geological reservoirs. Appropriate standards to measure these factors against are provided in the part 148 subpart C regulations. These regulations require a demonstration that there will be no migration of hazardous constituents from the injection zone for a period of 10,000 years after injection. Other requirements under the part 148 regulations refer to activities such as the performance of a search of an area of review for wells which are so constructed that they might serve as conduits for flow out of the injection zone and demonstrations of the injection wells' internal mechanical integrity and the seal at the top of the injection interval. These requirements are somewhat similar to the requirements for a Class 1HW UIC permit.

The most efficient way to implement the regulations is to identify and quantify the factors which make reservoirs suitable for the storage of waste as required by the part 146 regulations, then consider those factors among other things in the demonstration of no migration required by the part 148 regulations within the context of permit review.

UIC regulations at 40 C.F.R. 148.21(a)(4) require an approved quality assurance and quality control plan (QA/QC) which shall address all aspects of the demonstration of no migration. The QA/QC should be approved prior to submission of the separate permit application and land ban petition. If a QA/QC addressing the permit application and land ban petition is reviewed and approved by the UIC Branch before the assembly of the application, the application is more likely to meet the needs of the Branch and review time should be reduced.

1.2 Duration of Terms of the Permits and Exemptions or Demonstrations of No Migration

All of the Class 1HW wells in Region 5 have previously been both permitted and exempted from the land ban. Permits in the direct implementation (DI) states were originally issued for five years and second-round and later permits were issued for terms of ten years, the longest term allowed (§ 144.36). Exemptions have a 10,000 year period demonstration of no migration after injection, and in Region 5 the demonstrations typically include a 20 year injection period that is in addition to any injection that has already occurred. The validity of demonstrations is dependent on, among other factors, the volume of waste injected and that is dependent on both time and rate of injection. The conditions included in the notices of exemption consider time as the governing variable because rate was limited by permit conditions.

1.3.1 Governing Regulations

§ 148.23 Review of exemptions granted pursuant to a petition.
(a) When considering whether to reissue a permit for the operation of a Class I hazardous waste injection well, the Director shall review any petition filed pursuant to § 148.20 and require a new demonstration if information shows that the basis for granting the exemption may no longer be valid.
(b) Whenever the Director determines that the basis for approval of a petition may no longer be valid, the Director shall require a new demonstration in accordance with § 148.20.

1.3.2 Interpretation for Class 1HW applicants

Pursuant to the above regulation, anytime U.S. EPA is considering to reissue a permit for a Class 1HW injection well it shall review any exemption petition to determine if a new demonstration must be submitted. U.S. EPA can also require a new demonstration whenever it determines that the basis for approval of a petition may no longer be valid. U.S. EPA will make these determinations on a case by case basis, but is likely to request a new demonstration a year or two prior to the close of an existing injection period in a demonstration, so that there will be time to review the new demonstration prior to completion of the prior demonstration's injection period.

Those Class 1HW well operators that are preparing to submit a new permit application that also have an exemption with an injection period coming to a close in the next few years, may elect to submit a new demonstration simultaneously with the permit application so that both are considered by U.S. EPA at the same time. This would allow the Class 1HW operator to save resources by preparing the two items during the same time period. If an operator does not submit a new demonstration along with a new permit application, U.S. EPA intends to notify the operator whenever it determines that a new demonstration must be submitted pursuant to 40 C.F.R. § 148.23.

1.3 Organization

The organization of this Information Sheet follows that of EPA Federal Reporting Form 7520-6 (Permit Application) which provides basic guidance to permit applicants. This Information Sheet focuses on the completion of the attachments to the permit application because that is where the information crucial to the decision-making processes should be found. This information sheet primarily provides details and the relevant regulations for each of the attachments required for a permit application. However, because the applicant may also be simultaneously submitting a separate petition for the exemption or new demonstration, it also provides relevant citations to the regulations relating to exemption petitions where they are similar or have some overlap with the permit material.

The applicant/petitioner should submit separate summary texts for both the permit application and exemption petition or new demonstration. These summaries should also provide any additional information which will assist in processing the application and petition including:

(1) This statement, required by regulation at § 148.22(a)(4), signed by the petitioner or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this permit application and exemption petition and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(2) The name, title, address, phone number, and e-mail address of any person authorized to make the certifications required of permit applicants and petitioners. A certifier may be qualified because of their position as a responsible corporate officer (president, secretary, treasurer, or vice president of the corporation in charge of a principal business function) or the certifier may be the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. See 40 C.F.R. 144.32(a).

(3) The names, telephone and fax numbers and e-mail addresses of any alternate contacts within the organization or the consulting firm responsible for the technical aspects of the application and petition. Identification of such a contact implies that the Agency may contact this person freely and rely on any information provided by the contact.

2 COMPLETION OF ATTACHMENTS TO THE PERMIT APPLICATION

2.1 Attachment A - Area of Review Methods

2.1.1 Governing Regulations

§ 146.63 Area of review:
For the purposes of Class I hazardous waste wells, this section shall apply to the exclusion of § 146.6. The area of review for Class I hazardous waste injection wells shall be a 2-mile radius around the well bore. The Director may specify a larger area of review based on the calculated cone of influence of the well.

Applicable Part 148 Regulations:
§ 148.20 Petitions to allow injection of a waste prohibited under subpart B
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
. . .
(2) For each well the petition has:
(i) Demonstrated that the injection well's area of review complies with the substantive requirements of § 146.63;
. . .

2.1.2 Interpretation for Class 1HW Applicants

The regulations at § 146.63 require a minimum radius of two miles for the area of review (AOR). The Director may increase this distance to the radius of the zone of endangering influence (ZEI). The Director of Region 5's Water Division, who is responsible for the implementation of the part 148 regulations in Region 5, has opted, when it is larger than two miles, to use the ZEI as the AOR.

The regulations provide a method of determining the radius of the ZEI. This method is usually appropriate for Class 1HW wells because it returns a conservative result when either realistic or conservative values are provided as input. Region 5 has a spreadsheet program which can be used to calculate the radius of the ZEI using the method illustrated in § 146.6.

Other methods are also allowed. Any method should take the same factors into account as the provided method, but they may also take additional factors into account. For instance, the provided method does not consider vertical movement of fluid within the injection zone. This ensures the conservatism of the calculation. A more comprehensive model and simulation might account for vertical movement of fluid within the injection zone. Such movement of fluid out of more permeable strata into less permeable strata leads to decreased pressure transmission and a reduced ZEI. If the applicant uses a model which includes factors which decrease conservatism while making the simulation more realistic, additional efforts should be taken to demonstrate conservatism. The parameter values should be at worst realistic or at the conservative end of the spectrum of possibilities for the values under the circumstances existing (lithology, age, depth of burial, for example, when considering permeability or compressibility). The applicant should provide an exposition of all of the values used to determine the ZEI explaining why each value will result in a conservative result for the calculation.

2.2 Attachment B - Maps of Well/Area and Area of Review

2.2.1 Governing Regulations

§ 146.70 Information to be evaluated by the Director
(a) Prior to the issuance of a permit for an existing Class I hazardous waste injection well to operate or the construction or conversion of a new Class I hazardous waste injection well, the Director shall review the following to assure that the requirements of this part and part 144 are met:
. . .
(2) A map showing the injection well for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, mines (surface and subsurface), quarries, water wells and other pertinent surface features, including residences and roads. The map should also show faults and fractures, if known or suspected;

Applicable Part 148 Regulations:

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
. . .
(2) For each well the petition has:
. . .
(ii) Located, identified, and ascertained the condition of all wells within the injection well's area of review (as specified in §146.63) that penetrate the injection zone or the confining zone by use of a protocol acceptable to the Director that meets the substantive requirements of §146.64. . . .
(b) A demonstration under § 148.20(a)(1)(i) shall identify the strata within the injection zone which will confine fluid movement above the injection interval and include a showing that this strata is free of known transmissive faults of fractures and that there is a confining zone above the injection zone.
(c) A demonstration under §148.20(a)(1)(ii) shall identify the strata within the injection zone where waste transformation will be accomplished and include a showing that this strata is free of known transmissive faults or fractures and that there is a confining zone above the injection zone.

2.2.2 Guidance from Form 7520-6

MAPS OF WELL/AREA AND AREA OF REVIEW - Submit a topographic map, extending one mile beyond the property boundaries, showing the injection well(s) or project area for which a permit is sought and the applicable area of review. The map must show all intake and discharge structures and all hazardous waste treatment, storage, or disposal facilities. If the application is for an area permit, the map should show the distribution manifold (if applicable) applying injection fluid to all wells in the area, including all system monitoring points. Within the area of review, the map must show the following: The number, or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, mines (surface and subsurface), quarries, water wells, and other pertinent surface features, including residences and roads. The map should also show faults, if known or suspected. In addition, the map must identify those wells, springs, other surface water bodies, and drinking water wells located within one quarter mile of the facility property boundary.

2.2.3 Interpretation for Class 1HW applicants

This section is fairly straightforward, but the final sentence requires some amplification. The most critical elements which are required are geological features such as faults and fractures and artificial penetrations reaching the confining zone (§ 146.64).

The owner/operator is expected to conduct a thorough search through all reasonably accessible records in searching for potential vertical conduits which might facilitate migration within and from the injection interval. Public records include any record of wells permitted or drilled previous to any permitting authority which might be created or maintained by state agencies or any commercial well data repository or organization which makes the records available to the public, including newspapers. Geological studies published in journals or available through university libraries are public records. The regulations at § 146.70(a)(2) do not limit the sources to public records. Therefore, any records to which the owner/operator has access should be reviewed and, if evidence can be found in those records that any of the features listed exists, they should be indicated on the map**.**

2.3 Attachment C - Corrective Action Plan and Well Data

2.3.1 Governing Regulations

§ 146.64 Corrective action for wells in the area of review
For the purposes of Class I hazardous waste wells, this section shall apply to the exclusion of

§§ 144.55 and 146.07.
(a) The owner or operator of a Class I hazardous waste well shall as part of the permit application submit a plan to the Director outlining the protocol used to:
(1) Identify all wells penetrating the confining zone or injection zone within the area of review; and
(2) Determine whether wells are adequately completed or plugged.
(b) The owner or operator of a Class I hazardous waste well shall identify the location of all wells within the area of review that penetrate the injection zone or the confining zone and shall submit as required in § 146.70(a):
(1) A tabulation of all wells within the area of review that penetrate the injection zone or the confining zone; and
(2) A description of each well or type of well and any records of its plugging or completion.
(c) For wells that the Director determines are improperly plugged, completed, or abandoned, or for which plugging or completion information is unavailable, the applicant shall also submit a plan consisting of such steps or modification as are necessary to prevent movement of fluids into or between USDWs. Where the plan is adequate, the Director shall incorporate it into the permit as a condition. Where the Director's review of an application indicates that the permittee's plan is inadequate (based at a minimum on the factors in paragraph (e) of this section), the Director shall:
(1) Require the applicant to revise the plan;
(2) Prescribe a plan for corrective action as a condition of the permit; or
(3) Deny the application.
(d) Requirements:
(1) Existing injection wells. Any permit issued for an existing Class I hazardous waste injection well requiring corrective action other than pressure limitations shall include a compliance schedule requiring any corrective action accepted or prescribed under paragraph (c) of this section. Any such compliance schedule shall provide for compliance no later than 2 years following issuance of the permit and shall require observance of appropriate pressure limitations under paragraph (d)(3) until all other corrective action measures have been implemented.
(2) New injection wells. No owner or operator of a new Class I hazardous waste injection well may begin injection until all corrective actions required under this section have been taken.
(3) The Director may require pressure limitations in lieu of plugging. If pressure limitations are used in lieu of plugging, the Director shall require as a permit condition that injection pressure be so limited that pressure in the injection zone at the site of any improperly completed or abandoned well within the area of review would not be sufficient to drive fluids into or between USDWs. This pressure limitation shall satisfy the corrective action requirement. Alternatively, such injection pressure limitation may be made part of a compliance schedule and may be required to be maintained until all other required corrective actions have been implemented.
(e) In determining the adequacy of corrective action proposed by the applicant under paragraph (c) of this section and in determining the additional steps needed to prevent fluid movement into and between USDWs, the following criteria and factors shall be considered by the Director:
(1) Nature and volume of injected fluid;

(2) Nature of native fluids or byproducts of injection;
(3) Geology;
(4) Hydrology;
(5) History of the injection operation;
(6) Completion and plugging records;
(7) Closure procedures in effect at the time the well was closed;
(8) Hydraulic connections with USDWs;
(9) Reliability of the procedures used to identify abandoned wells; and
(10) Any other factors which might affect the movement of fluids into or between USDWs.

If a permitee for a post-HSWA well wants its UIC permit to serve as a permit by rule under RCRA, then they will also have to comply with the corrective action requirements of RCRA at 40 CFR Part 264.101**.**

Applicable Part 148 Regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
. . .
(2) For each well the petition has:
. . .
(ii) Located, identified, and ascertained the condition of all wells within the injection well's area of review (as specified in § 146.63) that penetrate the injection zone or the confining zone by use of a protocol acceptable to the Director that meets the substantive requirements of § 146.64;
(iii) Submitted a corrective action plan that meets the substantive requirements of § 146.64, the implementation of which shall become a condition of petition approval;

2.3.2 Guidance from Form 7520-6

CORRECTIVE ACTION PLAN AND WELL DATA - Submit a tabulation of data reasonably available from public records or otherwise known to the applicant on all wells within the area of review, including those on the map required in B, which penetrate the proposed injection zone. Such data shall include the following:
*A description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Director may require. In the case of new injection wells, include the corrective action proposed to be taken by the applicant under 40 CFR 144.55***.**

2.3.3 Interpretation for Class 1HW Applicants

An AOR has been determined in accordance with the requirements for Attachment A and the wells within the AOR have been plotted on the map submitted in accordance with the requirements of Attachment B. Note that, although the instructions for Attachment C require a listing of all of those wells which penetrate (reach, not necessarily completely penetrate) the proposed *injection* zone, for Class 1HW wells, this requirement is expanded to include all wells which penetrate the *confining* zone.

The regulations require the operator to submit a plan to identify all of the wells penetrating the confining zone and to determine whether the wells are adequately completed or plugged. This means that the procedures used to identify and evaluate the construction of the listed wells should be described in the application. If the Director believes that the measures undertaken are insufficient, the applicant may be required to make additional efforts. The descriptions of the wells should be supported by the inclusion of copies of well records for each well which penetrates the top of the confining zone**.**

If the construction or plugging of any well listed allows the escape of formation fluids or injection fluids from the injection interval, then corrective action which will prevent any such well from becoming a conduit for hazardous waste should be proposed. The UIC Branch will review the proposed corrective action and, if the corrective action is determined to be effective, include permit conditions to require implementation of the corrective action plan.

2.4 Attachment D - Maps and Cross Sections of USDWs

2.4.1 Governing Regulations

§ 146.70(a)(5) Information to be evaluated by the Director
Maps and cross-sections indicating the general vertical and lateral limits of all underground sources of drinking water within the area of review, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the proposed injection;
. . .

2.4.2 Guidance from Form 7520-6

MAPS AND CROSS SECTION OF USDWs -Submit maps and cross sections indicating the vertical limits of all underground sources of drinking water within the area of review (both vertical and lateral limits for Class I), their position relative to the injection formation and the

direction of water movement, where known, in every underground source of drinking water which may be affected by the proposed injection.

2.4.3 Interpretation for Class 1HW Applicants

This requirement is straightforward. Such maps and cross sections should be obtained and included. A most important feature is the depth to the base of the lowermost USDW. This should be confirmed by sampling which may be carried out by the owner/operator or by another credible entity. Results of the analysis of water from the lowermost USDW and uppermost non-USDW reservoir and analyses (possibly log analysis) which demonstrate that intervening strata are not capable of sustained production of water are required. Published results of studies of ground water geochemistry and hydrology which include tables of geochemical data from wells within or surrounding the area of review are acceptable substitutes for copies of analyses of water from individual wells.

All determinations based on log analysis should provide tabulations of all data, including log measurements, temperature, drilling fluid measurements, and complete calculations for all zones, including any charts, tables or nomographs used. If sample analyses are available for any aquifers within the zone of USDWs, the results should be compared to the results of log analysis.

2.5 Attachment E - Name and Depth of USDWs

2.5.1 Guidance from Form 7520-6

There is no guidance for Class 1HW owner/operators.

2.5.2 Interpretation for Class 1HW applicants

This Attachment is omitted from applications for permits for Class I wells because the more rigorous requirements of Attachment D make it unnecessary.

2.6 Attachment F - Maps and Cross Sections of Geologic Structure of Area

2.6.1 Governing Regulations

§ 146.70 Information to be evaluated by the Director:
. . .
(a) Prior to the issuance of a permit for an existing Class I hazardous waste injection well to operate or the construction or conversion of a new Class I hazardous waste injection well, the Director shall review the following to assure that the requirements of this part and part 144 are met:
. . .
(6) Maps and cross-sections detailing the geologic structure of the local area;
(7) Maps and cross-sections illustrating the regional geologic setting;

Applicable Part 148 Regulations:

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
. . .
(i) Fluid movement conditions are such that the injected fluids will not migrate within 10,000 years:
. . .
(B) Laterally within the injection zone to a point of discharge or interface with an Underground Source of Drinking Water (USDW) as defined in 40 CFR part 146;
. . .
(b) A demonstration under § 148.20(a)(1)(i) shall identify the strata within the injection zone which will confine fluid movement above the injection interval and include a showing that this strata is free of known transmissive faults of (sic) fractures and that there is a confining zone above the injection zone.

2.6.2 Guidance from Form 7520-6

MAPS AND CROSS SECTIONS OF GEOLOGIC STRUCTURE OF AREA - Submit maps and cross sections detailing the geologic structure of the local area (including the lithology of injection and confining intervals) and generalized maps and cross sections illustrating the regional geologic setting.

2.6.3 Interpretation for Class 1HW Applicants

The required maps focus on local and regional features which might affect the demonstration of no migration. The operator should either include maps of the injection zone large enough to illustrate the total extent of the formations or demonstrate that changes beyond the limits of mapping can have no influence on the pressurization or plume movement.

Features such as pinch outs of porosity zones and transitions from brine to fresh water (total dissolved solids are less than 10,000 mg/l) reservoirs should be illustrated and labeled. The cross sections should illustrate the 1) continuity of stratigraphic units to confirm the geologic model of the reservoir and 2) the absence of structural elements which might serve as conduits for waste movement. If such conduits exist, they are assumed to be at least locally transmissive if they are not shown to be filled with secondary mineralization.

The maps and cross sections should be accompanied by text to provide more interpretive detail than maps and cross sections alone can provide. This may be an appropriate place for all geological information. Alternatively, all geological information in addition to that needed for the calculation of the AOR may be placed in Attachment A with only enough text in Attachments D and F to ensure comprehension of the maps and cross sections.

2.7 Attachment G - Geological Data on Injection and Confining Zones

2.7.1 Governing Regulations:

§ 146.62 Minimum criteria for siting.
(a) All Class I hazardous waste injection wells shall be sited such that they inject into a formation that is beneath the lowermost formation containing within one quarter mile of the well bore an underground source of drinking water.
(b) The siting of Class I hazardous waste injection wells shall be limited to areas that are geologically suitable. The Director shall determine geologic suitability based upon:
(1) An analysis of the structural and stratigraphic geology, the hydrogeology, and the seismicity of the region;
(2) An analysis of the local geology and hydrogeology of the well site, including, at a minimum, detailed information regarding stratigraphy, structure and rock properties, aquifer hydrodynamics and mineral resources; and
(3) A determination that the geology of the area can be described confidently and that limits of waste fate and transport can be accurately predicted through the use of models.
(c) Class I hazardous waste injection wells shall be sited such that:
(1) The injection zone has sufficient permeability, porosity, thickness and areal extent to prevent

migration of fluids into USDWs.
(2) The confining zone:
(i) Is laterally continuous and free of transecting, transmissive faults or fractures over an area sufficient to prevent the movement of fluids into a USDW; and
(ii) Contains at least one formation of sufficient thickness and with lithologic and stress characteristics capable of preventing vertical propagation of fractures.
(d) The owner or operator shall demonstrate to the satisfaction of the Director that:
(1) The confining zone is separated from the base of the lowermost USDW by at least one sequence of permeable and less permeable strata that will provide an added layer of protection for the USDW in the event of fluid movement in an unlocated borehole or transmissive fault; or
(2) Within the area of review, the piezometric surface of the fluid in the injection zone is less than the piezometric surface of the lowermost USDW, considering density effects, injection pressures and any significant pumping in the overlying USDW; or
(3) There is no USDW present.
(4) The Director may approve a site which does not meet the requirements in paragraphs (d) (1), (2), or (3) of this section if the owner or operator can demonstrate to the Director that because of the geology, nature of the waste, or other considerations, abandoned boreholes or other conduits would not cause endangerment of USDWs.

The regulations at § 146.66 are directed at operators of wells which are not constructed at the time of permitting. However, they also indicate the sources of information which should be utilized to meet the requirements of the regulations at § 146.70. The 146.66 regulations can be found in Section 2.9 which provides guidance for Attachment I - Formation Testing Program.

§ 146.70 Information to be evaluated by the Director:
. . .
(b) Prior to the Director's granting approval for the operation of a Class I hazardous waste injection well, the owner or operator shall submit and the Director shall review the following information, which shall be included in the completion report:
. . .
(4) The results of the injection zone and confining zone testing program as required in § 146.70(a)(9);

Applicable Part 148 Regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
(1) The hydrogeological and geochemical conditions at the sites and the physiochemical nature of the waste stream(s) are such that reliable predictions can be made that:

(i) Fluid movement conditions are such that the injected fluids will not migrate within 10,000 years:
(A) Vertically upward out of the injection zone; or
(B) Laterally within the injection zone to a point of discharge or interface with an Underground Source of Drinking Water (USDW) as defined in 40 CFR part 146; or
(ii) Before the injected fluids migrate out of the injection zone or to a point of discharge or interface with USDW, the fluid will no longer be hazardous because of attenuation, transformation, or immobilization of hazardous constituents within the injection zone by hydrolysis, chemical interactions or other means;
. . .
(b) A demonstration under § 148.20(a)(1)(i) shall identify the strata within the injection zone which will confine fluid movement above the injection interval and include a showing that this strata is free of known transmissive faults of [sic] fractures and that there is a confining zone above the injection zone.
. . .
(2) Estimation techniques shall be appropriate, and EPA-certified test protocols shall be used where available and appropriate;
. . .

§ 148.21 Information to be submitted in support of petitions.
(a) Information submitted in support of §148.20 must meet the following criteria: . . .
(5) Reasonably conservative values shall be used whenever values taken from the literature or estimated on the basis of known information are used instead of site-specific measurements: . . .
(b) Any petitioner under § 148.20(a)(1)(i) shall provide sufficient site-specific information to support the demonstration, such as:
(1) Thickness, porosity, permeability and extent of the various strata in the injection zone;
. . .
(2) Thickness, porosity, permeability, extent, and continuity of the confining zone;
(3) Hydraulic gradient in the injection zone;
(4) Hydrostatic pressure in the injection zone; and
(5) Geochemical conditions of the site.
(c) In addition to the information in §148.21(b), any petitioner under §148.20(a)(1)(ii) shall provide sufficient waste-specific information to ensure reasonably reliant predictions about the waste transformation. The petitioner shall provide the information necessary to support the demonstration, such as:
(1) Description of the chemical processes or other means that will lead to waste transformation; and
(2) Results of laboratory experiments verifying the waste transformation.

2.7.2 Guidance from Form 7520-6

There is no guidance for Class 1HW owner/operators.

2.7.3 Interpretation for Class 1HW Applicants

The guidance for completing form 7520-6 was prepared before the promulgation of regulations specific to Class 1HW wells. This attachment is the logical place for the information required by the more recent regulations of §§ 146.62 through 146.73 and § 148.21**.**

Regulations at § 146.70 require the Director to consider a number of geological factors. Information which is necessary for consideration should be submitted by applicants for permits.

An injection zone and a confining zone should be defined in this attachment. We know from the regulations at § 148.20 that hazardous constituents should not migrate out of the injection zone within 10,000 years of the time during which they are injected. The injection zone must contain an arrestment interval above the top of the injection interval to prevent vertical migration out of the injection zone. The thickness of the arrestment interval must be in excess of the distance through which waste constituents will migrate, by any predictable means, in hazardous concentrations for a period of 10,000 years. The tops of the injection and confining zones need not be at the interface between two formations, but they should be at a traceable stratigraphic marker. The confining zone must immediately overlie the arrestment interval of the injection zone. It must meet the requirements and standards. It may include parts of one or more formations.

<u>Structure</u>
A description of the structure should be presented. It should discuss nearby structural elements depicted on the maps included in Attachment E. A qualitative discussion about the influence of the structure on the injection operation and plume movement should be included.

<u>Stratigraphy</u>
Applicable Part 148 Regulations

§ 148.20(b) Petitions to allow injection of a waste prohibited under subpart B
. . ..
(b) A demonstration under § 148.20(a)(1)(i) shall identify the strata within the injection zone which will confine fluid movement above the injection interval and include a showing that this strata is free of known transmissive faults of fractures and that there is a confining zone above the injection zone.
(c) A demonstration under § 148.20(a)(1)(ii) shall identify the strata within the injection zone where waste transformation will be accomplished and include a showing that this strata is free of known transmissive faults or fractures and that there is a confining zone above the injection zone.

Copies of all open-hole logs should be submitted. These copies may be paper or digital data accompanied by graphic representations on disks (CDs or DVDs). The limits of each geological formation within the injection interval, the containment/arrestment interval, the confining zone,

the zone of USDWs, and all bleed-off zones should be marked on the logs. Significant geological features such as joints and fractures and intervals tested or cored during well construction should be marked using generally accepted symbols. Regulations at 146.66(a) require submission of a descriptive report by a knowledgeable log analyst. The report should focus on the suitability of the formations to serve as injection reservoir, arrestment strata, or confining strata depending on their position. The report should identify potential bleed-off zones between the confining zone and the zone containing USDWs. To the extent possible, the reports should include calculations of the concentrations of dissolved solids in milligrams per liter. Where all of the material described above is included in a previously submitted completion report, the completion report may be referenced as an alternative to submission of new copies of logs.

The boundary conditions which control the results of the simulations using empirical or numerical simulators should consider those geological factors which have been established through the preceding steps. The goal of the no-migration demonstration is not to accurately determine where the limits of waste movement will be, it is to conservatively determine limits beyond which there can be reasonable certainty that waste will not migrate. Therefore, consistency and accuracy may be sacrificed if conservatism (calculated distance of movement) is increased. For instance, where a high value for some parameter might result in a more conservative result while in another calculation the opposite is true, different values may be used if the values result in more conservative results in each instance than would either a well-controlled or reasonably estimated value.

Geology

Geology is largely illustrated by the maps and cross-sections included in Attachments E and F. A description of the geological processes which have formed the geological characteristics of the injection and confining zones, referencing the maps and cross sections, is required.

Hydrogeology

The effects of any nearby wells even if only permitted but not yet constructed which inject into or extract fluid from the injection zone should be discussed. These effects should be addressed through simulations.

The measured hydrostatic pressures in each aquifer penetrated by wells within the AOR should be marked on the logs containing resistivity information for the facility wells. The points of measurement should be stratigraphically correlated, but the actual depths of measurement and subsea level equivalents should be noted on the logs.

Information necessary to determine the direction and velocity of regional fluid movement in the injection zone should be presented. Recharge and discharge areas should be identified and discussed. Published studies should be provided in their entirety. New information developed as a result of testing at the facility should be integrated into the results of existing studies if those studies did not originally include the information.

Seismicity
The generalized seismic risks map available through the U.S Geological Survey does not take the effects of injection wells into account. As a result, it, alone, cannot address the concern. Information regarding the regional stress field, rock strength, and natural and induced hydrostatic pressures should be presented and discussed. The discussions should include calculations of the hydrostatic pressure which would be required to initiate movement on a favorably aligned weak fracture, through competent rock of the type which exists in the injection and confining zones, or on fractures consistent with the regional stress field.

2.8 Attachment H - Operating Data

2.8.1 Governing Regulations

§ 146.67 Operating requirements
(a) Except during stimulation, the owner or operator shall assure that injection pressure at the wellhead does not exceed a maximum which shall be calculated so as to assure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone. The owner or operator shall assure that the injection pressure does not initiate fractures or propagate existing fractures in the confining zone, nor cause the movement of injection or formation fluids into a USDW.
(b) Injection between the outermost casing protecting USDWs and the well bore is prohibited.
(c) The owner or operator shall maintain an annulus pressure that exceeds the operating injection pressure, unless the Director determines that such a requirement might harm the integrity of the well. The fluid in the annulus shall be noncorrosive, or shall contain a corrosion inhibitor.

Applicable Part 148 Regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
. . .
(d) A demonstration may include a showing that:
(1) Treatment methods, the implementation of which shall become a condition of petition approval, will be utilized that reduce the toxicity or mobility of the wastes;

See also 40 C.F.R. §§148.20(a)(2)(iv) and 148.21.

2.8.2 Guidance from Form 7520-6

OPERATING DATA - Submit the following proposed operating data for each well (including all those to be covered by area permits): (1) average and maximum daily rate and volume of the fluids to be injected; (2) average and maximum injection pressure; (3) nature of annulus fluid; (4) for Class I wells, source and analysis of the chemical, physical, radiological and biological characteristics, including density and corrosiveness, of injection fluids; . . . If the information is proprietary, maximum concentrations only may be submitted, but all records must be retained.

2.8.3 Interpretation for Class 1HW Applicants

All of the issues raised by the regulations should be addressed in this attachment. Average and maximum daily rates and volumes are important in the calculation of the ZEI and waste plume radii. These values are normally measured in gallons per minute and measurements in gallons per minute should be provided along with the daily rates. The permit applicant should provide a tabulation of monthly injection volume and the cumulative injection volume as of the date projections of future injection begins and a projected average rate for the anticipated future life of the well.

Average and maximum injection pressures. Maximum allowable surface injection pressures (MASIPs) have been determined by one or more means of stress testing at most Class 1HW facilities in Region 5. Average injection pressures are not normally used in calculating the extent of pressure-driven, vertical migration. Normally, petitioners have assumed the MASIP to exist throughout the operating life of injection wells. This is a conservative assumption, and eliminates the potential for confusion and invalidation as a result of exceeding the projected average injection pressure. The MASIP is based on fracture closure pressure. The formula which Region 5 uses is:

$$P_m = d_i \times \left(FG - \left(\left(SG_w + SF \right) \times 0.433 \right) \right) - 14.7$$

Eq. 1

Where:
P_m = Maximum allowable surface injection pressure;
FG = Fracture gradient;
SG_w = Maximum specific gravity of waste;
d_i = Depth to the top of the active injection zone; and
SF = Safety factor for SG.

The nature of annulus fluid is important as a factor affecting the life of the well. The annuli of wells which inject hazardous liquid wastes should be filled with a fluid which is only slightly compressible, such as water with additives or organic liquids. Organic liquids such as diesel fuel

are often used to prevent freezing of the liquid in the annulus and for the prevention of internal corrosion.

The composition of the injectate is a factor in corrosion and in other physical characteristics. The density of injectate is a factor in calculation of MASIP and may be a factor in calculating the ZEI if the plume is large or the ZEI is small. The viscosity affects the near-wellbore pressurization in the reservoir. Temperature is an important factor affecting density, viscosity, and reactivity. Therefore, these characteristics should be measured and provided. Discussions based on actual testing of the effect of the injectate on well construction materials, the injection zone lithologies and confining zone lithologies should be provided. If there is no on-going corrosion monitoring program, the discussion should demonstrate that the well materials are designed to be unaffected by the waste constituents.

For conservatism, calculations are often done using high and low values. Rather than the average, the extreme value which results in the greatest distance of migration is assumed to predominate.

2.9 Attachment I - Formation Testing Program

2.9.1 Governing Regulations

§ 146.66 Logging, sampling, and testing prior to new well operation
(a) During the drilling and construction of a new Class I hazardous waste injection well, appropriate logs and tests shall be run to determine or verify the depth, thickness, porosity, permeability, and rock type of, and the salinity of any entrained fluids in, all relevant geologic units to assure conformance with performance standards in § 146.65, and to establish accurate baseline data against which future measurements may be compared. A descriptive report interpreting results of such logs and tests shall be prepared by a knowledgeable log analyst and submitted to the Director. At a minimum, such logs and tests shall include:
(1) Deviation checks during drilling on all holes constructed by drilling a pilot hole which are enlarged by reaming or another method. Such checks shall be at sufficiently frequent intervals to determine the location of the borehole and to assure that vertical avenues for fluid movement in the form of diverging holes are not created during drilling; and
(2) Such other logs and tests as may be needed after taking into account the availability of similar data in the area of the drilling site, the construction plan, and the need for additional information that may arise from time to time as the construction of the well progresses. At a minimum, the following logs shall be required in the following situations:
(i) Upon installation of the surface casing:
(A) Resistivity, spontaneous potential, and caliper logs before the casing is installed; and
(B) A cement bond and variable density log, and a temperature log after the casing is set and

cemented.
(ii) Upon installation of the long string casing:
(A) Resistivity, spontaneous potential, porosity, caliper, gamma ray, and fracture finder logs before the casing is installed; and
(B) A cement bond and variable density log, and a temperature log after the casing is set and cemented.
(iii) The Director may allow the use of an alternative to the above logs when an alternative will provide equivalent or better information;
. . .
(b) Whole cores or sidewall cores of the confining and injection zones and formation fluid samples from the injection zone shall be taken. The Director may accept cores from nearby wells if the owner or operator can demonstrate that core retrieval is not possible and that such cores are representative of conditions at the well. The Director may require the owner or operator to core other formations in the borehole .
(c) The fluid temperature, pH, conductivity, pressure and the static fluid level of the injection zone must be recorded.
(d) At a minimum, the following information concerning the injection and confining zones shall be determined or calculated for Class I hazardous waste injection wells:
(1) Fracture pressure;
(2) Other physical and chemical characteristics of the injection and confining zones; and
(3) Physical and chemical characteristics of the formation fluids in the injection zone.
(e) Upon completion, but prior to operation, the owner or operator shall conduct the following tests to verify hydrogeologic characteristics of the injection zone:
(1) A pump test; or
(2) Injectivity tests.

Applicable Part 148 Regulations:

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
. . .
(b) A demonstration under § 148.20(a)(1)(i) shall identify the strata within the injection zone which will confine fluid movement above the injection interval and include a showing that this strata is free of known transmissive faults of (sic) fractures and that there is a confining zone above the injection zone.
(c) A demonstration under § 148.20(a)(1)(ii) shall identify the strata within the injection zone where waste transformation will be accomplished and include a showing that this strata is free of known transmissive faults or fractures and that there is a confining zone above the injection zone.

See also § 148.20(a)(1).

2.9.2 Guidance from Form 7520-6

FORMATION TESTING PROGRAM - Describe the proposed formation testing program. For Class I wells the program must be designed to obtain data on fluid pressure, temperature, fracture pressure, other physical, chemical, and radiological characteristics of the injection matrix and physical and chemical characteristics of the formation fluids.

2.9.3 Interpretation for Class 1HW Applicants

This is for permit applications for proposed, rather than existing wells. The testing program must satisfy the requirements of § 146.66 which specifies characteristics which must be measured and § 146.12(b)(2) which specifies logging requirements applicable upon the installation of intermediate casing and provide information to support the no-migration demonstration required by the part 148 regulations. Guidance for this attachment will be forthcoming, probably as separate documents.

2.10 Attachment J - Stimulation Program

2.10.1 Governing Regulations

§ 146.70 Information to be evaluated by the Director
(a) Prior to the issuance of a permit for an existing Class I hazardous waste injection well to operate or the construction or conversion of a new Class I hazardous waste injection well, the Director shall review the following to assure that the requirements of this part and part 144 are met:
. . .
(10) Proposed stimulation program;

2.10.2 Guidance from Form 7520-6

STIMULATION PROGRAM - Outline any proposed stimulation program.

2.10.3 Interpretation for Class 1HW Applicants

Where no stimulations are planned, only a statement to that effect is required. However, this requirement should be recalled in the future if stimulation is planned. At that time, the permittee should inform the Director about the details of any proposed stimulation to allow consideration by the Director and be granted approval before the stimulation is carried out.

2.11 Attachment K - Injection Procedures

2.11.1 Governing Regulations

§ 146.67 Operating requirements
(a) Except during stimulation, the owner or operator shall assure that injection pressure at the wellhead does not exceed a maximum which shall be calculated so as to assure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone. The owner or operator shall assure that the injection pressure does not initiate fractures or propagate existing fractures in the confining zone, nor cause the movement of injection or formation fluids into a USDW.
(b) Injection between the outermost casing protecting USDWs and the well bore is prohibited.
(c) The owner or operator shall maintain an annulus pressure that exceeds the operating injection pressure, unless the Director determines that such a requirement might harm the integrity of the well. The fluid in the annulus shall be noncorrosive, or shall contain a corrosion inhibitor.
. . .
(e) Permit requirements for owners or operators of hazardous waste wells which inject wastes which have the potential to react with the injection formation to generate gases shall include:
(1) Conditions limiting the temperature, pH or acidity of the injected waste; and
(2) Procedures necessary to assure that pressure imbalances which might cause a backflow or blowout do not occur.

§ 146.70 Information to be evaluated by the Director.
(a) Prior to the issuance of a permit for an existing Class I hazardous waste injection well to operate or the construction or conversion of a new Class I hazardous waste injection well, the Director shall review the following to assure that the requirements of this part and part 144 are met:…
8) Proposed operating data;
(i) Average and maximum daily rate and volume of the fluid to be injected; and
(ii) Average and maximum injection pressure;
. . .
11) Proposed injection procedure;
(12) Schematic or other appropriate drawings of the surface and subsurface construction details of the well;
(13) Contingency plans to cope with all shut-ins or well failures so as to prevent migration of fluids into any USDW;

2.11.2 Guidance from Form 7520-6

INJECTION PROCEDURES - Describe the proposed injection procedures including pump, surge tank, etc.

2.11.3 Interpretation for Class 1HW Applicants

The parts of the industrial process which produce the wastes should be described along with the physical routing of the waste through pipelines and storage vessels. Diversions of any part of the waste stream for whatever purpose should be described and shown on a schematic diagram. The configuration of the injection system, including pumps, sample taps, pressure relief systems, etc upstream from the well head should be described and diagrammed.

2.12 Attachment L - Construction Procedures

2.12.1 Governing Regulations

§ 146.65 Construction Requirements
(a) General. All existing and new Class I hazardous waste injection wells shall be constructed and completed to:
(1) Prevent the movement of fluids into or between USDWs or into any unauthorized zones;
(2) Permit the use of appropriate testing devices and workover tools; and
(3) Permit continuous monitoring of injection tubing and long string casing as required pursuant to § 146.67(f).
(b) Compatibility. All well materials must be compatible with fluids with which the materials may be expected to come into contact. A well shall be deemed to have compatibility as long as the materials used in the construction of the well meet or exceed standards developed for such materials by the American Petroleum Institute, The American Society for Testing Materials, or comparable standards acceptable to the Director.
(c) Casing and Cementing of New Wells.
(1) Casing and cement used in the construction of each newly drilled well shall be designed for the life expectancy of the well, including the postclosure care period. The casing and cementing program shall be designed to prevent the movement of fluids into or between USDWs, and to prevent potential leaks of fluids from the well. In determining and specifying casing and cementing requirements, the Director shall consider the following information as required by § 146.70:
(i) Depth to the injection zone;
(ii) Injection pressure, external pressure, internal pressure and axial loading;
(iii) Hole size;

(iv) Size and grade of all casing strings (well thickness, diameter, nominal weight, length, joint specification and construction material);
(v) Corrosiveness of injected fluid, formation fluids and temperature;
(vi) Lithology of injection and confining zones;
(vii) Type or grade of cement; and
(viii) Quantity and chemical composition of the injected fluid.
(2) One surface casing string shall, at a minimum, extend into the confining bed below the lowest formation that contains a USDW and be cemented by circulating cement from the base of the casing to the surface, using a minimum of 120% of the calculated annular volume. The Director may require more than 120% when the geology or other circumstances warrant it.
(3) At least one long string casing, using a sufficient number of centralizers, shall extend to the injection zone and shall be cemented by circulating cement to the surface in one or more stages:
(i) Of sufficient quantity and quality to withstand the maximum operating pressure; and
(ii) In a quantity no less than 120% of the calculated volume necessary to fill the annular space. The Director may require more than 120% when the geology or other circumstances warrant it.
(4) Circulation of cement may be accomplished by staging. The Director may approve an alternative method of cementing in cases where the cement cannot be recirculated to the surface, provided the owner or operator can demonstrate by using logs that the cement is continuous and does not allow fluid movement behind the well bore.
(5) Casings, including any casing connections, must be rated to have sufficient structural strength to withstand, for the design life of the well:
(i) The maximum burst and collapse pressures which may be experienced during the construction, operation and closure of the well; and
(ii) The maximum tensile stress which may be experienced at any point along the length of the casing during the construction, operation, and closure of the well.
(6) At a minimum, cement and cement additives must be of sufficient quality and quantity to maintain integrity over the design life of the well.
(d) Tubing and packer.
(1) All Class I hazardous waste injection wells shall inject fluids through tubing with a packer set at a point specified by the Director.
(2) In determining and specifying requirements for tubing and packer, the following factors shall be considered:
(i) Depth of setting;
(ii) Characteristics of injection fluid (chemical content, corrosiveness, temperature and density);
(iii) Injection pressure;
(iv) Annular pressure;
(v) Rate (intermittent or continuous), temperature and volume of injected fluid;
(vi) Size of casing; and
(vii) Tubing tensile, burst, and collapse strengths.
(3) The Director may approve the use of a fluid seal if he determines that the following conditions are met:
(i) The operator demonstrates that the seal will provide a level of protection comparable to a packer;

(ii) The operator demonstrates that the staff is, and will remain, adequately trained to operate and maintain the well and to identify and interpret variations in parameters of concern;
(iii) The permit contains specific limitations on variations in annular pressure and loss of annular fluid;
(iv) The design and construction of the well allows continuous monitoring of the annular pressure and mass balance of annular fluid; and
(v) A secondary system is used to monitor the interface between the annulus fluid and the injection fluid and the permit contains requirements for testing the system every three months and recording the results.

See also § 148.20(a)(2)(iv)

Note that the well must be constructed and tested as required by 148.20(a)(2)(iv) before the petition can be considered.

2.12.2 Guidance from Form 7520-6

CONSTRUCTION PROCEDURES -Discuss the construction procedures (according to 40 C.F.R. § 146.65 . . .) to be utilized. This should include details of the casing and cementing program, logging procedures, deviation checks, and the drilling, testing and coring program, and proposed annulus fluid. (Request and submission of justifying data must be made to use an alternative to a packer for Class I.)

2.12.3 Interpretation for Class 1HW Applicants

Although this attachment may appear to apply only to the construction of proposed wells, this is also the place where descriptions of the actual construction along with records of drilling and each cementing stage should be submitted. The daily records of the wells' drilling and completion should be provided. A history of all changes to the wells' configurations should be presented. Details including the specifications for casings (with copies of data sheets for casing grades used) and the calculations of the stresses anticipated should be included. These records should describe the volume in sacks and in cubic feet and the composition of each batch of cement used with a complete list of additives and physical characteristics such as density, yield factor, time to reach maximum compressive strength, final compressive strength, and the volume of cement circulated to the surface, or left in the casing and later drilled out. All forms, required by any regulatory agency, detailing changes in the wells' construction should be submitted. Each of the issues addressed by the regulations should be discussed with an explanation of how construction complies with each regulatory requirement.

2.13 Attachment M - Construction Details

2.13.1 Guidance from Form 7520-6

CONSTRUCTION DETAILS - Submit schematic or other appropriate drawings of the surface and subsurface construction details of the well.

2.13.2 Interpretation for Class 1HW Applicants

The well schematic is the focus of this attachment. If the material included in Attachment L is complete, then only schematic diagrams of the well head, casing string, and bottom seal assembly for each well need be provided along with any brief notes needed to clarify the relationships of construction elements. The schematics should include each construction element required by the regulations.

2.14 Attachment N - Changes in Injected Fluid

2.14.1 Governing Regulations

None.

2.14.2 Interpretation for Class 1HW Applicants

This attachment need not be submitted. In applications for Class 1HW wells, the information requested will be submitted as a result of other requirements.

2.15 Attachment O - Plans for Well Failures

2.15.1 Governing Regulations

§ 146.67 Operating Requirements
. . .
(g) If an automatic alarm or shutdown is triggered, the owner or operator shall immediately investigate and identify as expeditiously as possible the cause of the alarm or shutoff. If, upon

such investigation, the well appears to be lacking mechanical integrity, or if monitoring required under paragraph (f) of this section otherwise indicates that the well may be lacking mechanical integrity, the owner or operator shall:
(1) Cease injection of waste fluids unless authorized by the Director to continue or resume injection.
(2) Take all necessary steps to determine the presence or absence of a leak; and
(3) Notify the Director within 24 hours after the alarm or shutdown.
(h) If a loss of mechanical integrity is discovered pursuant to paragraph (g) of this section or during periodic mechanical integrity testing, the owner or operator shall:
(1) Immediately cease injection of waste fluids;
(2) Take all steps reasonably necessary to determine whether there may have been a release of hazardous wastes or hazardous waste constituents into any unauthorized zone;
(3) Notify the Director within 24 hours after loss of mechanical integrity is discovered;
(4) Notify the Director when injection can be expected to resume; and
(5) Restore and demonstrate mechanical integrity to the satisfaction of the Director prior to resuming injection of waste fluids.
(i) Whenever the owner or operator obtains evidence that there may have been a release of injected wastes into an unauthorized zone:
(1) The owner or operator shall immediately [cease] injection of waste fluids, and:
(i) Notify the Director within 24 hours of obtaining such evidence;
(ii) Take all necessary steps to identify and characterize the extent of any release;
(iii) Comply with any remediation plan specified by the Director;
(iv) Implement any remediation plan approved by the Director; and
(v) Where such release is into a USDW currently serving as a water supply, place a notice in a newspaper of general circulation.
(2) The Director may allow the operator to resume injection prior to completing cleanup action if the owner or operator demonstrates that the injection operation will not endanger USDWs.
(j) The owner or operator shall notify the Director and obtain his approval prior to conducting any well workover.

See also §§ 148.20(a)(2)(iv) and 148.24(b)(2).

2.15.2 Guidance from Form 7520-6

PLANS FOR WELL FAILURES - Outline contingency plans . . . to cope with all shut-ins or wells failures, so as to prevent migration of fluids into any USDW.

2.15.3 Interpretation for Class 1HW applicants

The primary focus of this attachment is to show that the owner/operator has a plan to address well failures, especially well failures down hole. The plan should take well construction,

subsurface geology, and plant requirements for waste disposal into account.
This attachment should also describe alternatives to disposal of wastes through injection which can be used in the event that the wells are not available. It should provide information about storage capacity and provide an estimate of time during which the production processes can operate using on-site waste storage or removal of waste from the facility using an approved means.

2.16 Attachment P - Monitoring Program

2.16.1 Governing Regulations

§ 146.67 Operating Requirements
. . .
(e) Permit requirements for owners or operators of hazardous waste wells which inject wastes which have the potential to react with the injection formation to generate gases shall include:
(1) Conditions limiting the temperature, pH or acidity of the injected waste; and
(2) Procedures necessary to assure that pressure imbalances which might cause a backflow or blowout do not occur.
(f) The owner or operator shall install and use continuous recording devices to monitor: the injection pressure; the flow rate, volume, and temperature of injected fluids; and the pressure on the annulus between the tubing and the long string casing, and shall install and use:
(1) Automatic alarm and automatic shut-off systems, designed to sound and shut-in the well when pressures and flow rates or other parameters approved by the Director exceed a range and/or gradient specified in the permit; or
(2) Automatic alarms, designed to sound when the pressures and flow rates or other parameters approved by the Director exceed a rate and/or gradient specified in the permit, in cases where the owner or operator certifies that a trained operator will be on-site at all times when the well is operating.

See also 40 C.F.R. § 148.20(d)(2).

2.16.2 Guidance from Form 7520-6

MONITORING PROGRAM -Discuss the planned monitoring program. This should be thorough, including maps showing the number and location of monitoring wells as appropriate and discussion of monitoring devices, sampling frequency, and parameters measured. . . .

2.16.3 Interpretation

The regulations governing continuous monitoring of daily operations are specific. The one problem which occurs repeatedly is failure to record continuously.

The entire monitoring program should be described. Sections below include applicable regulations and some interpretation and guidance.

2.16.4 Waste Analysis Plan

2.16.4.1 Governing Regulations

§ 146.68 Testing and monitoring requirements.
Testing and monitoring requirements shall at a minimum include:
(a) Monitoring of the injected wastes.
(1) The owner or operator shall develop and follow an approved written waste analysis plan that describes the procedures to be carried out to obtain a detailed chemical and physical analysis of a representative sample of the waste, including the quality assurance procedures used. At a minimum, the plan shall specify:
(i) The parameters for which the waste will be analyzed and the rationale for the selection of these parameters;
(ii) The test methods that will be used to test for these parameters; and
(iii) The sampling method that will be used to obtain a representative sample of the waste to be analyzed.
(2) The owner or operator shall repeat the analysis of the injected wastes as described in the waste analysis plan at frequencies specified in the waste analysis plan and when process or operating changes occur that may significantly alter the characteristics of the waste stream.
(3) The owner or operator shall conduct continuous or periodic monitoring of selected parameters as required by the Director.
(4) The owner or operator shall assure that the plan remains accurate and the analyses remain representative.

Applicable Part 148 Regulations:

§ 148.21 Information to be submitted in support of petitions.
(a) Information submitted in support of § 148.20 must meet the following criteria:
(1) All waste analysis and any new testing performed by the petitioner shall be accurate and reproducible and performed in accordance with quality assurance standards;
. . .
(c) In addition to the information in § 148.21(b), any petitioner under § 148.20(a)(1)(ii) shall provide sufficient waste-specific information to ensure reasonably reliant predictions about the

waste transformation. The petitioner shall provide the information necessary to support the demonstration, such as:
(1) Description of the chemical processes or other means that will lead to waste transformation; and
(2) Results of laboratory experiments verifying the waste transformation.

§ 148.22 Requirements for petition submission, review and approval or denial.
(a) Any petition submitted to the Director pursuant to § 148.20(a) shall include the following components:
(1) An identification of the specific waste or wastes and the specific injection well or wells for which the demonstration will be made;
(2) A waste analysis to describe fully the chemical and physical characteristics of the subject wastes;
(3) Such additional information as is required by the Director to support the petition under §§148.20 and 148.21.

2.16.4.2 Interpretation for Class 1HW Applicants

A waste analysis plan must be included in this attachment. The plan should describe how the waste management process is monitored to ensure that the concentration of waste constituents is controlled, measured, and reported. Region 5's guidance for waste analysis plans is available on the UIC Branch web page. The waste analysis plan must meet the requirements of part 148 for exemption determinations.

Procedures for regular monitoring of injection processes and conditions should be included. The description should indicate the operator understands that monitoring of injection processes, including injection pressure, as described in the monitoring plan, is required at all times, whether or not injection is occurring. Although continuous monitoring is required, that does not mean that there must be an unbroken string of measurements and that digital recording - which is at discrete intervals - is not allowed. Measurements at intervals which must be short enough to provide representative measurements of any pressure change which typically occurs in the well may be approved. Occasionally there are power outages, and there may be no back-up power supply. In such cases there should be mechanical gauges in place. Readings of measurements at approved intervals are then required.

2.16.5 Hydrogeologic Compatibility Demonstration

2.16.5.1 Governing Regulations

146.68(b) Hydrogeologic compatibility determination.
The owner or operator shall submit information demonstrating to the satisfaction of the Director that the waste stream and its anticipated reaction products will not alter the permeability, thickness or other relevant characteristics of the confining or injection zones such that they

would no longer meet the requirements specified in § 146.62.

See also 40 C.F.R. §§ 148.20(a)(1) and 148.21(b).

2.16.5.2 Interpretation for Class 1HW Applicants

Applicants are required to demonstrate that injection will not alter reservoir characteristics to the extent that siting requirements in § 146.62 or the demonstration criteria in Part 148 are no longer met. The requirement may be violated if the confining properties of the injection zone may be compromised by the injection of corrosive wastes or the injection zone may become plugged with particulate matter entrained in the waste or precipitated from it in the injection zone.

The applicant should provide information which demonstrates that the waste will not compromise the confining zone. However, the precipitation of solids cannot always be assured. Fortunately, plugging of the injection zone, of itself, will not cause a violation of siting criteria. The effect of plugging is to force the use of increasing injection pressure. Before the injection pressure increases to the point at which fractures might occur, the limit of injection pressure will be reached.

The petitioner should demonstrate that the hydrogeological and geochemical conditions at the sites and the physicochemical nature of the waste streams are such that the Part 148 criteria are met.

2.16.6 Compatibility of Well Materials

2.16.6.1 Governing Regulations

§ 146.68(c) Compatibility of well materials.
(1) The owner or operator shall demonstrate that the waste stream will be compatible with the well materials with which the waste is expected to come into contact, and submit to the Director a description of the methodology used to make that determination. Compatibility for purposes of this requirement is established if contact with injected fluids will not cause the well materials to fail to satisfy any design requirement imposed under § 146.65(b).
(2) The Director shall require continuous corrosion monitoring of the construction materials used in the well for wells injecting corrosive waste, and may require such monitoring for other waste, by:
(i) Placing coupons of the well construction materials in contact with the waste stream; or
(ii) Routing the waste stream through a loop constructed with the material used in the well; or
(iii) Using an alternative method approved by the Director.
(3) If a corrosion monitoring program is required:
(i) The test shall use materials identical to those used in the construction of the well, and such materials must be continuously exposed to the operating pressures and temperatures (measured at the well head) and flow rates of the injection operation; and
(ii) The owner or operator shall monitor the materials for loss of mass, thickness, cracking,

pitting and other signs of corrosion on a quarterly basis to ensure that the well components meet the minimum standards for material strength and performance set forth in § 146.65(b).

See also 148.20(a)(2)(iv).

2.16.6.2 Interpretation for Class 1HW Applicants

The regulations require corrosion monitoring of well materials in all wells which inject corrosive wastes. Unless the specifications by the manufacturer of the materials which will come into contact with the injected waste used in the well state that the materials are compatible with the type and concentrations of wastes which are permitted, then corrosion monitoring as described in §§ 146.68(c)(i)(2) and (3) is also required for noncorrosive wastes. A permit cannot be drafted until the applicant has presented documentation that the well materials are compatible with the waste stream or a plan for corrosion monitoring has been developed and submitted.

2.16.7 Periodic Mechanical Integrity Testing

2.16.7.1 Governing Regulations

§ 146.68(d) Periodic mechanical integrity testing.
In fulfilling the requirements of § 146.8, the owner or operator of a Class I hazardous waste injection well shall conduct the mechanical integrity testing as follows:
(1) The long string casing, injection tube, and annular seal shall be tested by means of an approved pressure test with a liquid or gas annually and whenever there has been a well workover;
(2) The bottom-hole cement shall be tested by means of an approved radioactive tracer survey annually;
(3) An approved temperature, noise, or other approved log shall be run at least once every five years to test for movement of fluid along the borehole.
The Director may require such tests whenever the well is worked over;
(4) Casing inspection logs shall be run whenever the owner or operator conducts a workover in which the injection string is pulled, unless the Director waives this requirement due to well construction or other factors which limit the test's reliability, or based upon the satisfactory results of a casing inspection log run within the previous five years. The Director may require that a casing inspection log be run every five years, if he has reason to believe that the integrity of the long string casing of the well may be adversely affected by naturally-occurring or man-made events;
(5) Any other test approved by the Director in accordance with the procedures in § 146.8(d) may also be used.

Applicable Part 148 Regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the

injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:

. . .

(2) For each well the petition has:

. . .

(iv) Submitted the results of pressure and radioactive tracer tests performed within one year prior to submission of the petition demonstrating the mechanical integrity of the well's long string casing, injection tube, annular seal, and bottom hole cement. In cases where the petition has not been approved or denied within one year after the initial demonstration of mechanical integrity, the Director may require the owner or operator to perform the tests again and submit the results of the new tests.

2.16.7.2 Interpretation for Class 1HW Applicants

For new wells, the permit application should describe the tests which are planned including the placement of each test in the construction process. The standard annulus pressure test (SAPT) will almost certainly be used to demonstrate that there is no significant leak in the casing, tubing, or packer. The SAPT should be run as soon as the well is assembled with the tubing and packer. There are alternatives for demonstrating that there is no significant fluid movement into a USDW through vertical channels adjacent to the injection well bore. However, the regulations at § 146.66(c) require a determination of the fluid temperature in the injection zone, and the only practical method of making this determination is through the use of a temperature log made some time after there has been any fluid flow through the well bore. Thus, at least the first demonstration of external mechanical integrity (MI) should use the temperature log. The temperature log may be run before any work is begun after the casing has been set or any time when there has been no appreciable fluid movement through the well bore for several days.

For existing wells, demonstrations of mechanical integrity and integrity of the cement seal at the top of the injection interval should be up to date. The permit application should describe any losses of MI during the term of the current permit and the means used to restore MI.

For an exemption, pressure and radioactive tracer tests must be performed within one year prior to the submission of the petition. The well has to be constructed and tested before a petition can be granted. Exemptions cannot be issued for wells prior to construction and testing but conditional upon passage of tests. The reason is that all information about each factor considered must be available to the public to allow full public participation. The Eastern District Court of Texas affirmed this principle in Brent Kay et al. vs. EPA and Gibralter Chemical, Inc. in 1993.

2.16.8 Ambient Monitoring

2.16.8.1 Governing Regulations

§ 146.68(e) Ambient monitoring.
(1) Based on a site-specific assessment of the potential for fluid movement from the well or injection zone, and on the potential value of monitoring wells to detect such movement, the Director shall require the owner or operator to develop a monitoring program. At a minimum, the Director shall require monitoring of the pressure buildup in the injection zone annually, including at a minimum, a shut down of the well for a time sufficient to conduct a valid observation of the pressure fall-off curve.
(2) When prescribing a monitoring system the Director may also require:
(i) Continuous monitoring for pressure changes in the first aquifer overlying the confining zone. When such a well is installed, the owner or operator shall, on a quarterly basis, sample the aquifer and analyze for constituents specified by the Director;
(ii) The use of indirect, geophysical techniques to determine the position of the waste front, the water quality in a formation designated by the Director, or to provide other site specific data;
(iii) Periodic monitoring of the ground water quality in the first aquifer overlying the injection zone;
(iv) Periodic monitoring of the ground water quality in the lowermost USDW; and
(v) Any additional monitoring necessary to determine whether fluids are moving into or between USDWs.

2.16.8.2 Interpretation for Class 1HW Applicants

The program for periodic monitoring of the ambient reservoir pressure required at § 146.68(e) should be described. The plan should describe the specific operational requirements and analysis strategies which are used to ensure data quality and accurate results. Brief summaries of the results of monitoring with explanations of inconsistencies and trends of change should be provided. These results should be considered in the description of the reservoir model used in the no-migration demonstration.

To be meaningful, monitoring must use consistent units. This includes all boundary conditions involved in the analysis of annual ambient reservoir pressure monitoring. Therefore properties which should not change should be held constant. Results of ambient monitoring through the history of the well's operation should be discussed. It is imperative that a consistent reservoir model (e.g. infinite acting and unbounded, parallel boundaries, etc.) be used in the interpretation of data from different years. Factors which do change, such as formation damage around the well bore and the volume of waste previously injected and consequent pressurization are variables and should be addressed in the analysis of the pressure monitoring. Where differences occur which are outside the range of accuracy of the method, then explanations should be provided. Guidance for ambient reservoir pressure monitoring may be found on the Branch's web page at http//www.epa.gov.region5.water.uic.techdocs.htm#r5guid/.

2.16.9 Ground Water Monitoring

2.16.9.1 Governing Regulations

Applicable Part 146 Regulations:

§ 146.68(e) Ambient monitoring.
. . .
(2) When prescribing a monitoring system the Director may also require:
(i) Continuous monitoring for pressure changes in the first aquifer overlying the confining zone. When such a well is installed, the owner or operator shall, on a quarterly basis, sample the aquifer and analyze for constituents specified by the Director;

Applicable Part 148 Regulations:

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(d) A demonstration may include a showing that:
. . .
(2) A monitoring plan, the implementation of which shall become a condition of petition approval, will be utilized to enhance confidence in one or more aspects of the demonstration.

2.16.9.2 Interpretation for Class 1HW Applicants

Where monitoring of aquifers below the base of the USDWs is required or proposed under § 148.20(d)(2), the results of such monitoring should be described and those results should be analyzed with reference to the injection operations. Regional guidance for ground water monitoring may be found on the Branch's web page at http://epa.gov/region5/water/uic/r5guid/monitoring_well.htm and http://epa.gov/region5/water/uic/r5guid/supp_monitoring_well.htm.

2.16.10 Seismicity Monitoring

2.16.10.1 Governing Regulations

§ 146.68 Testing and monitoring requirements.
Testing and monitoring requirements shall at a minimum include:
(f) The Director may require seismicity monitoring when he has reason to believe that the injection activity may have the capacity to cause seismic disturbances.

Applicable Part 148 Regulations

§148.20(b) A demonstration under §148.20(a)(1)(i) shall identify the strata within the injection zone which will confine fluid movement above the injection interval and include a showing that this strata is free of known transmissive faults of [sic] fractures and that there is a confining zone above the injection zone.

2.16.10.2 Interpretation for Class 1HW Applicants

There are no areas currently identified as susceptible to seismicity resulting from injection in Region 5. Attempts have been made to link seismicity which has occurred near the eastern end of Lake Erie in Ohio to injection there, but this linkage appears very tenuous. Seismicity monitoring may be required before injection begins or at any time there appears to be evidence relating injection to seismicity.

Applicants/petitioners should review information about past seismicity and the presence of fracture systems which might be affected by the effects of injection. If earthquake epicenters or fractures affecting the injection zone have been located within or near the area of review, a plan for seismic monitoring should be considered.

2.17 Attachment Q - Plugging and Abandonment Plan

2.17.1 Governing Regulations

§ *146.71 Closure.*
(a) Closure Plan. The owner or operator of a Class I hazardous waste injection well shall prepare, maintain, and comply with a plan for closure of the well that meets the requirements of paragraph (d) of this section and is acceptable to the Director. The obligation to implement the closure plan survives the termination of a permit or the cessation of injection activities. The requirement to maintain and implement an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit.
(1) The owner or operator shall submit the plan as a part of the permit application and, upon approval by the Director, such plan shall be a condition of any permit issued.
(2) The owner or operator shall submit any proposed significant revision to the method of closure reflected in the plan for approval by the Director no later than the date on which notice of closure is required to be submitted to the Director under paragraph (b) of this section.
(3) The plan shall assure financial responsibility as required in § 144.52(a)(7).
(4) The plan shall include the following information:
(i) The type and number of plugs to be used;
(ii) The placement of each plug including the elevation of the top and bottom of each plug;
(iii) The type and grade and quantity of material to be used in plugging;
(iv) The method of placement of the plugs;
(v) Any proposed test or measure to be made;

(vi) The amount, size, and location (by depth) of casing and any other materials to be left in the well;
(vii) The method and location where casing is to be parted, if applicable;
(viii) The procedure to be used to meet the requirements of paragraph (d)(5) of this section;
(ix) The estimated cost of closure; and
(x) Any proposed test or measure to be made.
(5) The Director may modify a closure plan following the procedures of § 124.5.…
(c) Closure report. Within 60 days after closure or at the time of the next quarterly report (whichever is less) the owner or operator shall submit a closure report to the Director. If the quarterly report is due less than 15 days after completion of closure, then the report shall be submitted within 60 days after closure. The report shall be certified as accurate by the owner or operator and by the person who performed the closure operation (if other than the owner or operator). Such report shall consist of either:
(1) A statement that the well was closed in accordance with the closure plan previously submitted and approved by the Director; or
(2) Where actual closure differed from the plan previously submitted, a written statement specifying the differences between the previous plan and the actual closure.
(d) Standards for well closure. (1) Prior to closing the well, the owner or operator shall observe and record the pressure decay for a time specified by the Director. The Director shall analyze the pressure decay and the transient pressure observations conducted pursuant to § 146.68(e)(1)(i) and determine whether the injection activity has conformed with predicted values.
(2) Prior to well closure, appropriate mechanical integrity testing shall be conducted to ensure the integrity of that portion of the long string casing and cement that will be left in the ground after closure. Testing methods may include:
(i) Pressure tests with liquid or gas;
(ii) Radioactive tracer surveys;
(iii) Noise, temperature, pipe evaluation, or cement bond logs; and
(iv) Any other test required by the Director.
(3) Prior to well closure, the well shall be flushed with a buffer fluid.
(4) Upon closure, a Class I hazardous waste well shall be plugged with cement in a manner that will not allow the movement of fluids into or between USDWs.
(5) Placement of the cement plugs shall be accomplished by one of the following:
(i) The Balance Method;
(ii) The Dump Bailer Method;
(iii) The Two-Plug Method; or
(iv) An alternate method, approved by the Director, that will reliably provide a comparable level of protection.
(6) Each plug used shall be appropriately tagged and tested for seal and stability before closure is completed.
(7) The well to be closed shall be in a state of static equilibrium with the mud weight equalized top to bottom, either by circulating the mud in the well at least once or by a comparable method prescribed by the Director, prior to the placement of the cement plug(s).

§ 146.72 Post-closure care.
(a) The owner or operator of a Class I hazardous waste well shall prepare, maintain, and comply with a plan for post-closure care that meets the requirements of paragraph (b) of this section and is acceptable to the Director. The obligation to implement the post-closure plan survives the termination of a permit or the cessation of injection activities. The requirement to maintain an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit.
(1) The owner or operator shall submit the plan as a part of the permit application and, upon approval by the Director, such plan shall be a condition of any permit issued.
(2) The owner or operator shall submit any proposed significant revision to the plan as appropriate over the life of the well, but no later than the date of the closure report required under § 146.71(c).
(3) The plan shall assure financial responsibility as required in § 146.73.
(4) The plan shall include the following information:
(i) The pressure in the injection zone before injection began;
(ii) The anticipated pressure in the injection zone at the time of closure;
(iii) The predicted time until pressure in the injection zone decays to the point that the well's cone of influence no longer intersects the base of the lowermost USDW;
(iv) Predicted position of the waste front at closure;
(v) The status of any cleanups required under § 146.64; and
(vi) The estimated cost of proposed post-closure care.
(5) At the request of the owner or operator, or on his own initiative, the Director may modify the post-closure plan after submission of the closure report following the procedures in § 124.5.
(b) The owner or operator shall:
(1) Continue and complete any cleanup action required under § 146.64, if applicable;
(2) Continue to conduct any groundwater monitoring required under the permit until pressure in the injection zone decays to the point that the well's cone of influence no longer intersects the base of the lowermost USDW. The Director may extend the period of post-closure monitoring if he determines that the well may endanger a USDW.
(3) Submit a survey plat to the local zoning authority designated by the Director. The plat shall indicate the location of the well relative to permanently surveyed benchmarks. A copy of the plat shall be submitted to the Regional Administrator of the appropriate EPA Regional Office.
(4) Provide appropriate notification and information to such State and local authorities as have cognizance over drilling activities to enable such State and local authorities to impose appropriate conditions on subsequent drilling activities that may penetrate the well's confining or injection zone.
(5) Retain, for a period of three years following well closure, records reflecting the nature, composition and volume of all injected fluids. The Director shall require the owner or operator to deliver the records to the Director at the conclusion of the retention period, and the records shall thereafter be retained at a location designated by the Director for that purpose.
(c) Each owner of a Class I hazardous waste injection well, and the owner of the surface or subsurface property on or in which a Class I hazardous waste injection well is located, must

record a notation on the deed to the facility property or on some other instrument which is normally examined during title search that will in perpetuity provide any potential purchaser of the property the following information:
(1) The fact that land has been used to manage hazardous waste;
(2) The name of the State agency or local authority with which the plat was filed, as well as the address of the Regional Environmental Protection Agency Office to which it was submitted;
(3) The type and volume of waste injected, the injection interval or intervals into which it was injected, and the period over which injection occurred.

2.17.2 Guidance from Form 7520-6

PLUGGING AND ABANDONMENT PLAN -Submit a plan for plugging and abandonment of the well including: (1) describe the type, number, and placement (including the elevation of the top and bottom) of plugs to be used; (2) describe the type, grade, and quantity of cement to be used; and (3) describe the method to be used to place plugs, including the method used to place the well in a state of static equilibrium prior to placement of the plugs. . . .. Submit this information on EPA Form 7520-14, Plugging and Abandonment Plan.

2.17.3 Interpretation for Class 1HW applicants

The contents of this attachment are spelled out in sufficient detail that further elaboration is probably not needed. Additional guidance is available in Region 5's Guidance #4 which is available on the UIC Branch's web page as previously described.

2.18 Attachment R - Necessary Resources

2.18.1 Governing Regulations

144.52(a)(7) Financial responsibility.
(i) The permittee, including the transferor of a permit, is required to demonstrate and maintain financial responsibility and resources to close, plug, and abandon the underground injection operation in a manner prescribed by the Director until:
(A) The well has been plugged and abandoned in accordance with an approved plugging and abandonment plan pursuant to §§ 144.51(o) and 146.10 of this chapter, and submitted a plugging and abandonment report pursuant to § 144.51(p); or
(B) The well has been converted in compliance with the requirements of § 144.51(n); or
(C) The transferor of a permit has received notice from the Director that the owner or operator receiving transfer of the permit, the new permittee, has demonstrated financial responsibility for

the well.
(ii) The permittee shall show evidence of such financial responsibility to the Director by the submission of a surety bond, or other adequate assurance, such as a financial statement or other materials acceptable to the Director. For EPA administered programs, the Regional Administrator may on a periodic basis require the holder of a lifetime permit to submit an estimate of the resources needed to plug and abandon the well revised to reflect inflation of such costs, and a revised demonstration of financial responsibility, if necessary. The owner or operator of a well injecting hazardous waste must comply with the financial responsibility requirements of subpart F of this part.

§ 144.62 Cost estimate for plugging and abandonment.
. . .
(b) The owner or operator must adjust the plugging and abandonment cost estimate for inflation within 30 days after each anniversary of the date on which the first plugging and abandonment cost estimate was prepared. The adjustment must be made as specified in paragraphs (b) (1) and (2) of this section, using an inflation factor derived from the annual Oil and Gas Field Equipment Cost Index. The inflation factor is the result of dividing the latest published annual Index by the Index for the previous year.
(1) The first adjustment is made by multiplying the plugging and abandonment cost estimate by the inflation factor. The result is the adjusted plugging and abandonment cost estimate.
(2) Subsequent adjustments are made by multiplying the latest adjusted plugging and abandonment cost estimate by the latest inflation factor.

§ 144.63 Financial assurance for plugging and abandonment.
. . .
(f) Financial test and corporate guarantee for plugging and abandonment.
. . .
(5) After the initial submission of items specified in paragraph (f)(3) of this section, the owner or operator must send updated information to the Regional Administrator within 90 days after the close of each succeeding fiscal year. This information must consist of all three items specified in paragraph (f)(3) of this section.

See also 40 C.F.R. 144 Subpart F.

2.18.2 Guidance from Form 7520-6

NECESSARY RESOURCES - Submit evidence such as a surety bond or financial statement to verify that the resources necessary to close, plug or abandon the well are available.

2.18.3 Interpretation for Class 1HW applicants

This requirement is also fairly straightforward. All owner/operators must have such financial assurance mechanisms in place. The attachment should describe the procedures which will be used to ensure that the regulatory requirement to review the mechanism annually and revise it as necessary is met. The application should contain a plan and commitment to recalculate the cost of the implementation of the approved plugging and abandonment and post-closure care plans annually.

2.19 Attachment S - Aquifer Exemptions

2.19.1 Guidance from Form 7520-6

AQUIFER EXEMPTIONS -If an aquifer exemption is requested, submit data necessary to demonstrate that the aquifer meets the following criteria:(1) does not serve as a source of drinking water; (2) cannot now and will not in the future serve as a source of drinking water; and (3) the TDS content of the ground water is more than 3,000 and less than 10,000 mg/l and is not reasonably expected to supply a public water system. Data to demonstrate that the aquifer is expected to be mineral or hydrocarbon production (sic), such as general description of the mining zone, analysis of the amenability of the mining zone to the proposed method, and time table for proposed development must also be included. For additional information on aquifer exemptions, see 40 CFR §§ 144.7 and 146.04.

2.19.2 Interpretation for Class 1HW applicants

There are no aquifer exemptions issued in Region 5 in areas where Class 1HW wells operate and none is anticipated. A statement that no exempted aquifers overlie the area of review should be included as Attachment S.

2.20 Attachment T - Existing EPA Permits

2.20.1 Governing Regulations

§ 144.31 Application for a permit; authorization by permit.
. . .
(e) Information requirements. All applicants for permits shall provide the following information to the Director, using the application form provided by the Director.
(1) The activities conducted by the applicant which require it to obtain permits under RCRA,

UIC, the National Pollution Discharge Elimination System (NPDES) program under the Clean Water Act, or the Prevention of Significant Deterioration (PSD) program under the Clean Air Act.

. . .

(6) A listing of all permits or construction approvals received or applied for under any of the following programs:

(i) Hazardous Waste Management program under RCRA.

(ii) UIC program under SDWA.

(iii) NPDES program under CWA.

(iv) Prevention of Significant Deterioration (PSD) program under the Clean Air Act.

(v) Nonattainment program under the Clean Air Act.

(vi) National Emission Standards for Hazardous Pollutants (NESHAPS) preconstruction approval under the Clean Air Act.

(vii) Ocean dumping permits under the Marine Protection Research and Sanctuaries Act.

(viii) Dredge and fill permits under section 404 of CWA.

(ix) Other relevant environmental permits, including State permits.

2.20.2 Guidance from Form 7520-6

EXISTING EPA PERMITS - List program and permit number of any existing EPA permits, for example, NPDES, PSD, RCRA, etc.

2.20.3 Interpretation for Class 1HW applicants

The permits which must be listed include those from state agencies implementing federally approved primacy programs. This is true for all well classes.

2.21 Attachment U - Description of Business

2.21.1 Governing Regulations

§ 144.31 Application for a permit; authorization by permit.

. . .

(e) Information requirements. All applicants for permits shall provide the following information to the Director, using the application form provided by the Director.

. . .

(8) A brief description of the nature of the business.

2.21.2 Guidance from Form 7520-6

DESCRIPTION OF BUSINESS - Give a brief description of the nature of the business.

2.21.3 Interpretation for Class 1HW applicants

The operator should describe the nature of the business. The UIC Branch and operators of injection wells have found it helpful to include information about the processes through which waste is generated. This includes descriptions of the products and raw materials and any hazardous materials used or produced. The means of disposing of all hazardous materials received by the facility or generated as a result of manufacturing processes on site should be included.

2.22 SEPARATE SUBMISSION OF PETITION FOR EXEMPTION FROM THE RCRA LAND BAN OR NEW DEMONSTRATION

2.22.1 Governing Regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous.

2.22.2 Interpretation

In addition to meeting regulatory requirements and being issued a permit, operators of wells which inject hazardous industrial wastes must also be granted an exemption from the Hazardous and Solid Waste Amendments (HSWA) of the Resource Conservation and Recovery Act (RCRA). The requirements for submission of an acceptable petition are found at subpart C of the regulations at 40 CFR. 148. These regulations require compliance with particular sections of the part 146 subpart G regulations pertaining to Class I hazardous waste injection wells and submission of a demonstration that wastes will not migrate out of the injection zone for as long as the wastes remain hazardous. The demonstration is based, in part, on the geological information developed pursuant to the part 146 regulations. In addition, the part 148 regulations add certain requirements and standards some of which are described below. Some of these requirements and standards have effects which reach into compliance with the part 146

regulations.

The separate exemption petition or new demonstration should contain the demonstration of no migration and information about its development. The quality assurance and quality control plan (QA/QCP) required under the Part 148 regulations but not originally required under the part 146 regulations deserves special attention. Because this plan must be approved, it should be approved by the Director before the information required for the demonstration is gathered. Therefore, the QA/QCP is a standalone document, not directly a part of the permit or the petition. Instructions for the preparation of the QA/QCP are available on the EPA's Quality Group's web page. This and other QA/QC documents can be found at: http://www.epa.gov/QUALITY/qa_docs.html.

The separate exemption petition or new demonstration may be organized as desired by the petitioner. Following are several sections, each of which addresses a smaller section of the part 148 regulations.

2.22.3 Vertical Movement

2.22.3.1 Governing Regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
(1) The hydrogeological and geochemical conditions at the sites and the physiochemical nature of the waste stream(s) are such that reliable predictions can be made that:
(i) Fluid movement conditions are such that the injected fluids will not migrate within 10,000 years:
(A) Vertically upward out of the injection zone;
. . .

2.22.3.2 Interpretation for Class 1HW Applicants

The no-migration demonstration should at a minimum address vertical migration which will occur during the active life of the injection well as a result of pressure-driven movement and vertical migration which will occur after the well(s) has(ve) been plugged as a result of buoyancy and molecular diffusion of waste through the containment interval which overlies the injection interval.

The part of the demonstration addressing movement resulting from diffusion should use either the minimum tortuosity consistent with the most porous, non-shale lithology in the arrestment

interval, or include treatment of each stratum through which diffusion will occur. The pressure gradient should be realistic. It is not realistic to choose the pressure in an aquifer which will not realistically be reached by flow as one endpoint in calculating the pressure gradient. It is more accurate to assume a virtual aquifer near the anticipated limit of vertical movement with appropriate pressure. If the flow rate results in flow reaching the virtual aquifer within the 10,000 year period of interest, extend the separation until it does not.

2.22.4 Horizontal Movement

2.22.4.1 Governing regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
(1) The hydrogeological and geochemical conditions at the sites and the physiochemical nature of the waste stream(s) are such that reliable predictions can be made that:
(i) Fluid movement conditions are such that the injected fluids will not migrate within 10,000 years:
. . .
(B) Laterally within the injection zone to a point of discharge or interface with an Underground Source of Drinking Water (USDW) as defined in 40 CFR part 146;

2.22.4.2 Interpretation for Class 1HW Applicants

The no-migration demonstration should address horizontal movement resulting from among other things, forces arising from waste injection, injection and/or withdrawal from other wells, regional movement of fluids within the injection reservoir, and buoyancy, including the effects of dispersion and diffusion. The prediction of migration distance of liquids and molecules as required is a mature science. Empirical relationships between boundary conditions and migration have been established. Numerical simulators which can effectively predict the movement of fluids are also readily available.

Buoyancy may be an important factor controlling distance of migration through the 10,000 year post injection period. The value of specific gravity should be chosen to yield a conservative result. The limits of the range of expected values of specific gravity need not be used if another value can be justified as both conservative and likely to be more nearly realistic.

The results of modeling should be displayed in map form. The limits of horizontal movement after 10,000 years should be superimposed on a map showing the structure at the top of the injection zone or a nearly parallel horizon to demonstrate conformance to geological controls. The map should also show surface features to allow reviewers to grasp the scale of movement.

2.22.5 Chemical Transformation

2.22.5.1 Governing regulations

§ 148.20 Petitions to allow injection of a waste prohibited under subpart B.
(a) Any person seeking an exemption from a prohibition under subpart B of this part for the injection of a restricted hazardous waste into an injection well or wells shall submit a petition to the Director demonstrating that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. This demonstration requires a showing that:
(1) The hydrogeological and geochemical conditions at the sites and the physiochemical nature of the waste stream(s) are such that reliable predictions can be made that:
. . .
(ii) Before the injected fluids migrate out of the injection zone or to a point of discharge or interface with USDW, the fluid will no longer be hazardous because of attenuation, transformation, or immobilization of hazardous constituents within the injection zone by hydrolysis, chemical interactions or other means;

2.22.5.2 Interpretation for Class 1HW Applicants

Although a demonstration of attenuation, immobilization, or chemical transformation is allowable, no petitioners in Region 5 have attempted any such demonstration, nor do we anticipate that such a demonstration will be submitted. Therefore, no guidance is provided.

2.22.6 Validation

2.22.6.1 Governing regulations

§ 148.21 Information to be submitted in support of petitions:
(a) Information submitted in support of § 148.20 must meet the following criteria:
. . .
(3) Predictive models shall have been verified and validated, shall be appropriate for the specific site, waste streams, and injection conditions of the operation, and shall be calibrated for existing sites where sufficient data are available;
. . .

2.22.6.2 Interpretation for Class 1HW Applicants

Regulations at § 148.21(a)(3) require verification and validation of the geological model used. In this case, validation refers to the appropriateness of the geological scenario which is assumed to control pressurization and migration. Therefore, the model used to calculate migration distances must be consistent with all geological observations.

2.22.7 Verification

2.22.7.1 Governing regulations

§ 148.21 Information to be submitted in support of petitions:
(a) Information submitted in support of § 148.20 must meet the following criteria:
. . .
(3) Predictive models shall have been verified and validated, shall be appropriate for the specific site, waste streams, and injection conditions of the operation, and shall be calibrated for existing sites where sufficient data are available;
. . .

2.22.7.2 Interpretation for Class 1HW Applicants

Verification refers to a demonstration that the mathematical means used will produce results which are reproducible and essentially equivalent to other accepted methods of calculation. The normal means of verification is the benchmarking of one method in relation to another using published data and results. Other means may be acceptable. Demonstrations of no migration should include quantitative calculations using such methods.

2.22.8 Calibration

2.22.8.1 Governing regulations

§ 148.21 Information to be submitted in support of petitions:
(a) Information submitted in support of § 148.20 must meet the following criteria:
(1) All waste analysis and any new testing performed by the petitioner shall be accurate and reproducible and performed in accordance with quality assurance standards;
. . .
(3) Predictive models shall have been verified and validated, shall be appropriate for the specific site, waste streams, and injection conditions of the operation, and shall be calibrated for existing sites where sufficient data are available;
. . .

2.22.8.2 Interpretation for Class 1HW Applicants

Whichever method of geological simulation is used for predicting pressurization, it must be calibrated. Calibration is accomplished by matching the results of simulation to data measured in situ. The most common means of calibration is a match of simulated pressurization through the course of a long pressure transient test against actual measurements. The most efficacious scenario is through matching the results of an interference test which measures pressure change in one well while rates of injection through a different well are changed to create points of reference. Interference testing minimizes the effects of skin damage which annual fall-off tests show are increasing in many Class I injection wells in Region 5.

Because the real-world results of injection will be felt at considerable distances and times from

the point of injection, there is more uncertainty than might seem to be indicated by the calibration exercise. Data collected during the calibration exercise will react only to geological features at which there will be significant pressure changes after a few days of injection. However, the limits of the ZEI are affected by processes which have significant results when measured in terms of years although they may be negligible when measured in terms of days. Discuss the impacts of uncertainty on the conservatism of the simulation.

2.22.9 Quality Assurance and Quality Control Plan

2.22.9.1 Governing regulations

§ 148.21 Information to be submitted in support of petitions.
(a) Information submitted in support of § 148.20 must meet the following criteria:
(1) All waste analysis and any new testing performed by the petitioner shall be accurate and reproducible and performed in accordance with quality assurance standards;
. . .
(4) An approved quality assurance and quality control plan shall address all aspects of the demonstration;
. . .

2.22.9.2 Interpretation for Class 1HW Applicants

This regulation requires that each factor in the demonstration be investigated and prepared in accordance with an approved QA/QCP. At the time this regulation was promulgated, the no-migration demonstrations for most of the Class 1HW facilities were nearing completion. There was no time for preparation of guidance for the preparation of QA/QCPs by the Region or even for submission by petitioners and approval of QA/QCPs by the Region before preparation and submission of the petitions. Petitioners took many different approaches, typically including some descriptions of efforts taken to ensure the validity of only a few aspects of the no-migration demonstrations. We are now looking for a more formalized approach. Guidance for the preparation of QA/QC documents can be found at:
http://www.epa.gov/QUALITY/qa_docs.html.

2.22.10 Uncertainty Analysis

2.22.10.1 Governing regulations

§ 148.21 Information to be submitted in support of petitions.
(a) Information submitted in support of § 148.20 must meet the following criteria:
. . .
(6) An analysis shall be performed to identify and assess aspects of the demonstration that contribute significantly to uncertainty. The petitioner shall conduct a sensitivity analysis to determine the effect that significant uncertainty may contribute to the demonstration. The demonstration shall then be based on conservative assumptions identified in the analysis.

2.22.10.2 Interpretation for Class 1HW Applicants

Even a well-calibrated demonstration must be viewed with some skepticism. Regulations at § 148.21(a)(6) require analysis of factors that lead to uncertainty in the demonstration. The geological model utilized and the parameter values incorporated into the model must be such that there is no uncertainty in the totality of the result of the demonstration. To eliminate uncertainty, each choice required to complete the demonstration must tend to result in over estimation of migration distance. Reasonable error bars can be determined for processes which are estimated or for which measurements may be questionable. Then values lying between the best estimate of reality and the conservative end of the estimate bar may be used. Values chosen to represent parameters which are well constrained may be only very slightly toward the conservative end of the range of possible values. As effects of processes become more poorly constrained, values chosen should come from nearer the conservative end of the range.

Empirical simulations normally do not attempt to account for vertical movement within the injection zone. Numerical simulators are capable of taking vertical movement into account, but valid definitions of cell properties are difficult to ascertain, tedious to enter, and time-consuming to compute. Because neglecting these effects tends to deliver conservative results (higher pressurization than will occur) we consider the resulting uncertainty and inaccuracy acceptable.

2.22.11 Sensitivity Analysis

2.22.11.1 Governing regulations

§ 148.21 Information to be submitted in support of petitions.
(a) Information submitted in support of § 148.20 must meet the following criteria:
. . .
(6) An analysis shall be performed to identify and assess aspects of the demonstration that contribute significantly to uncertainty. The petitioner shall conduct a sensitivity analysis to determine the effect that significant uncertainty may contribute to the demonstration. The demonstration shall then be based on conservative assumptions identified in the analysis.

2.22.11.2 Interpretation for Class 1HW Applicants

Sensitivity analysis is a thoughtful analysis of the effects of parameter change on results. The calibration process and uncertainty and sensitivity analysis can be teamed to present an effective demonstration of the quality of some aspects of the geological model. One must remember that the calibration exercise is affected by geological factors which are within a relatively short distance of the injection well.

Sensitivity analysis tells us how we should react to uncertainty. Where results are relatively insensitive to variation, then uncertainty analysis and compensation for uncertainty can be reduced. When results can be changed significantly by variations within the range of the uncertainty, then compensation by added conservatism in the model is important.