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The Class V Underground Injection Control Study

Volume 23

Subsidence Control Wells

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SUBSIDENCE CONTROL WELLS

The U.S. Environmental Protection Agency (USEPA) conducted a study of Class V underground injection wells to develop background information the Agency can use to evaluate the risk that these wells pose to underground sources of drinking water (USDWs) and to determine whether additional federal regulation is warranted. The final report for this study, which is called the Class V Underground Injection Control (UIC) Study, consists of 23 volumes and five supporting appendices. Volume 1 provides an overview of the study methods, the USEPA UIC Program, and general findings. Volumes 2 through 23 present information summaries for each of the 23 categories of wells that were studied (Volume 21 covers 2 well categories). This volume, which is Volume 23, covers Class V subsidence control wells.

1. SUMMARY

Subsidence control wells are injection wells whose primary objective is to reduce or eliminate the loss of land surface elevation due to removal of ground water providing subsurface support. These wells also may be used to control land subsidence caused by man-induced activities other than ground water withdrawal (e.g., construction). Land subsidence control is achieved by injecting water into an underground formation to maintain fluid pressure and avoid compaction.

Sources of injectate in subsidence control wells include untreated surface water, untreated ground water, saline water, and surface water treated to drinking water standards. No data on injectate constituents or concentrations associated with subsidence control wells were identified during preparation of this report. However, it is reasonable to assume that injectate in some subsidence control wells exceeds drinking water standards for some parameters.

None of the known, active subsidence control wells inject into USDWs. Some wells are being used to inject beneath construction zones to minimize damage from settlement caused by construction, and other wells inject into a salt dome cavity that is used for the storage of oil at the Strategic Petroleum Reserve Weeks Island site in Louisiana.

No contamination incidents associated with the operation of subsidence control wells have been reported.

Details on the design, construction, and operation of subsidence control wells are not available. Thus, it is not possible to determine if subsidence control wells are vulnerable to receiving spills or illicit discharges.

According to the state and USEPA Regional survey conducted for this study, there are 28 subsidence control wells documented in the United States. All documented subsidence control wells are located in Louisiana (8), Oregon (14), and Wisconsin (6). The estimated number of subsidence control wells in the nation is approximately 158. Of these, as many as 50 wells may be located in New York. The documented and estimated numbers of subsidence control wells in

the United States do not include any wells in Alaska. However, officials responsible for the UIC Program in that state did not rule out the possibility that some exist.

The statutory and regulatory requirements differ significantly among the four states where subsidence control wells are believed to exist. Louisiana, a UIC Primacy state for Class V wells, authorizes subsidence control wells by rule. In New York, USEPA Region 2 directly implements the UIC program for Class V injection wells. However, New York has additional jurisdiction over Class V wells through state pollutant discharge elimination system permits. Oregon, a UIC Primacy state for Class V wells, authorizes subsidence control wells by rule. The six wells in Wisconsin were individually permitted by the Department of Natural Resources. All six of these wells have either been abandoned or are in the process of being abandoned. New subsidence control wells in Wisconsin are now prohibited.

2. INTRODUCTION

Ground water withdrawn from an aquifer (for public, private, or industrial water supply) is often replaced through natural recharge of the aquifer. When the amount of ground water withdrawn exceeds the available recharge for an extended period of time, water levels decline. As sand and gravel aquifers that were once fully saturated with ground water are dewatered, they eventually adjust to the loss of water by compacting. Where significant declines in water levels have occurred, and favorable subsurface conditions exist, aquifer compaction and land subsidence (i.e., loss of surface elevation due to removal of subsurface support) will occur.

Problems associated with land subsidence include: (1) differential changes in elevation and gradient of stream channels, drainage, and water transport structures, (2) failure of water well casings due to compressive stresses generated by compaction of the aquifer system(s), (3) tidal encroachment in lowland coastal areas, and (4) damage to engineering structures (Poland et al., 1984).

One method used to control land subsidence is the use of subsidence control wells. These wells are used to inject water into an aquifer from which ground water has been withdrawn in order to maintain fluid pressure and avoid compaction. By keeping the pressure up, subsidence control wells stop or reduce the gradual settling or sudden sinking of the earth’s surface.

According to the existing UIC regulations in 40 CFR 146.5(e)(10), “subsidence control wells (not used for the purpose of oil or natural gas production) used to inject fluids into a non-oil or gas producing zone to reduce or eliminate subsidence associated with the overdraft of fresh water” are considered Class V injection wells. For the purpose of this study, the definition of subsidence control wells has been broadened to include those wells used to control land subsidence caused by man-induced activities other than ground water withdrawal (e.g., construction). Injection wells used to control subsidence caused by oil or gas production activities are not considered in this volume because they qualify as Class II injection wells. In addition, geothermal electric power and geothermal direct heat wells (covered separately in Volumes 17 and 18 of the Class V UIC Study, respectively), which return water to the formation for the purpose of subsidence control, are not considered subsidence control wells. Aquifer recharge and aquifer storage and recovery (ASR) wells, whose primary objective is to replenish the water in an aquifer but may have subsidence control as a secondary objective, are addressed separately in Volume 21 of the Class V UIC Study.

3. PREVALENCE OF WELLS

For this study, data on the number of Class V subsidence control wells were collected through a survey of state and USEPA Regional UIC Programs. The survey methods are summarized in Section 4 of Volume 1 of the Class V UIC Study. Table 1 lists the numbers of Class V subsidence control wells in each state, as determined from this survey. The table includes the documented number and estimated number of wells in each state, along with the source and basis for any estimate, when noted by the survey respondents. If a state is not listed in Table 1, it means that the UIC Program responsible for that state indicated in its survey response that it did not have any Class V subsidence control wells.

As shown in Table 1, there are currently 28 subsidence control wells known to exist in the United States (i.e., documented wells). The actual number of subsidence control wells in the United States, however, is estimated to be 158. These estimates do not include any wells in Alaska, which indicated in its survey response that it has subsidence control wells but did not provide any numbers.

It should be noted that none of the documented subsidence control wells are known to have been constructed to reduce or eliminate subsidence caused by excessive ground water withdrawal. In Wisconsin, six wells were temporary and constructed to restore ground water levels and minimize damage from settlement during the construction of the Milwaukee Tunnel Project. Construction activities were completed, and four of the six wells have been abandoned (removed and sealed). The remaining two wells are in the process of being abandoned. Construction of new subsidence control wells is now prohibited in Wisconsin (Jonas, 1999). In Louisiana, eight wells were constructed to slow down the influx of fresh ground water into a salt dome being used by the Strategic Petroleum Reserve (SPR) and to control the formation of sinkholes. This SPR site (Weeks Island site) is being decommissioned. In Oregon, fourteen wells were constructed to restore ground water levels and minimize damage from settlement caused by the construction of tunnels and highways, and to prevent landsliding (Priest, 1999). The purpose for the wells in New York and Alaska is unknown.

Although California and Texas did not report the presence of active subsidence control wells, the use of these wells may be important in the future. These two states contain the largest areas of the United States that have experienced land subsidence due to ground water withdrawal: the San Joaquin Valley in California and Houston-Galveston area in Texas. Approximately 13,500 km^2 and 12,000 km^2 of land have subsided in San Joaquin and Houston-Galveston, respectively (NRC, 1991). Maximum subsidence in the United States caused by ground water withdrawal has been nine meters, from 1925 to 1977, in the San Joaquin Valley (NRC, 1991).

Table 1. Inventory of Subsidence Control Wells in the United States

State	Documented Number of Wells	Estimated Number of Wells	
		Number	Source of Estimate and Methodology[1]
USEPA Region 1 -- None			
USEPA Region 2			
NY	0	< 50	Best professional judgement.
USEPA Region 3 -- None			
USEPA Region 4 -- None			
USEPA Region 5			
WI	4 abandoned wells 2 wells in the process of being abandoned	4 abandoned wells 2 wells in the process of being abandoned	State records.
USEPA Region 6			
LA	8	8	State records.
USEPA Region 7 -- None			
USEPA Region 8 -- None			
USEPA Region 9 -- None			
USEPA Region 10			
AK	NR	NR	N/A
OR	14	50 to 100	Best professional judgement (Priest, 1999).
All USEPA Regions			
All states	28	158	Estimated total does not include 6 wells in WI that have been abandoned or are in the process of being abandoned.

[1] Unless otherwise noted, the best professional judgement is that of the state or USEPA Regional staff completing the survey questionnaire.

N/A Not available.

NR Although USEPA Regional, state and/or territorial officials reported the presence of the well type, the number of wells was not reported.

Other areas that may be suitable for subsidence control wells include parts of southern Arizona, Freemont County and the Santa Clara Valley in California, and Las Vegas Valley in Nevada (NRC, 1991). Several Arizona cities are investigating recharge options, and Las Vegas Valley, Nevada began an aquifer recharge program in 1990 (Aqua Resources Inc. and Earth Technology Corp., 1991; Brothers and Katzer, 1990). While these projects are primarily aimed at aquifer recharge, there may also be a need for subsidence control. Many coastal areas of southern California have recharge and ASR projects that provide secondary subsidence control (Bouwer, 1990; Crook et al., 1991; Miller, 1991; Mills, 1993; Pyne, 1989). For further information on aquifer recharge and ASR wells, refer to Volume 21 of the Class V UIC Study.

4. INJECTATE CHARACTERISTICS AND INJECTION PRACTICES

4.1 Injectate Constituents

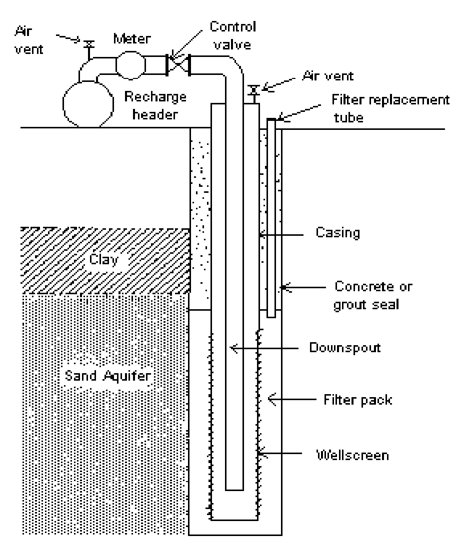
Sources of injectate for the documented subsidence control wells include untreated ground water (Oregon), untreated surface water (New York), surface water treated to drinking water standards (Wisconsin), and saline water (Louisiana). However, no injectate sampling data for subsidence control wells were submitted in response to the survey or found in the literature.

4.2 Well Characteristics

Details on the design, construction, and operation of subsidence control wells are not available. However, according to the 1987 Report to Congress on Class V injection wells, the construction and siting characteristics of subsidence control wells are similar to those of aquifer recharge wells (USEPA, 1987).

Although the design and construction of recharge wells depend on site-specific conditions, the components of most recharge wells are very similar. These include: (1) the well casing; (2) the well screen (except in rock and other open hole wells); (3) sand/gravel (filter) pack around the screen (except in rock and other open hole wells); (4) grout/cement around the casing; and (5) a pump. Figure 1 illustrates a typical recharge well.

Figure 1. Typical Recharge Well



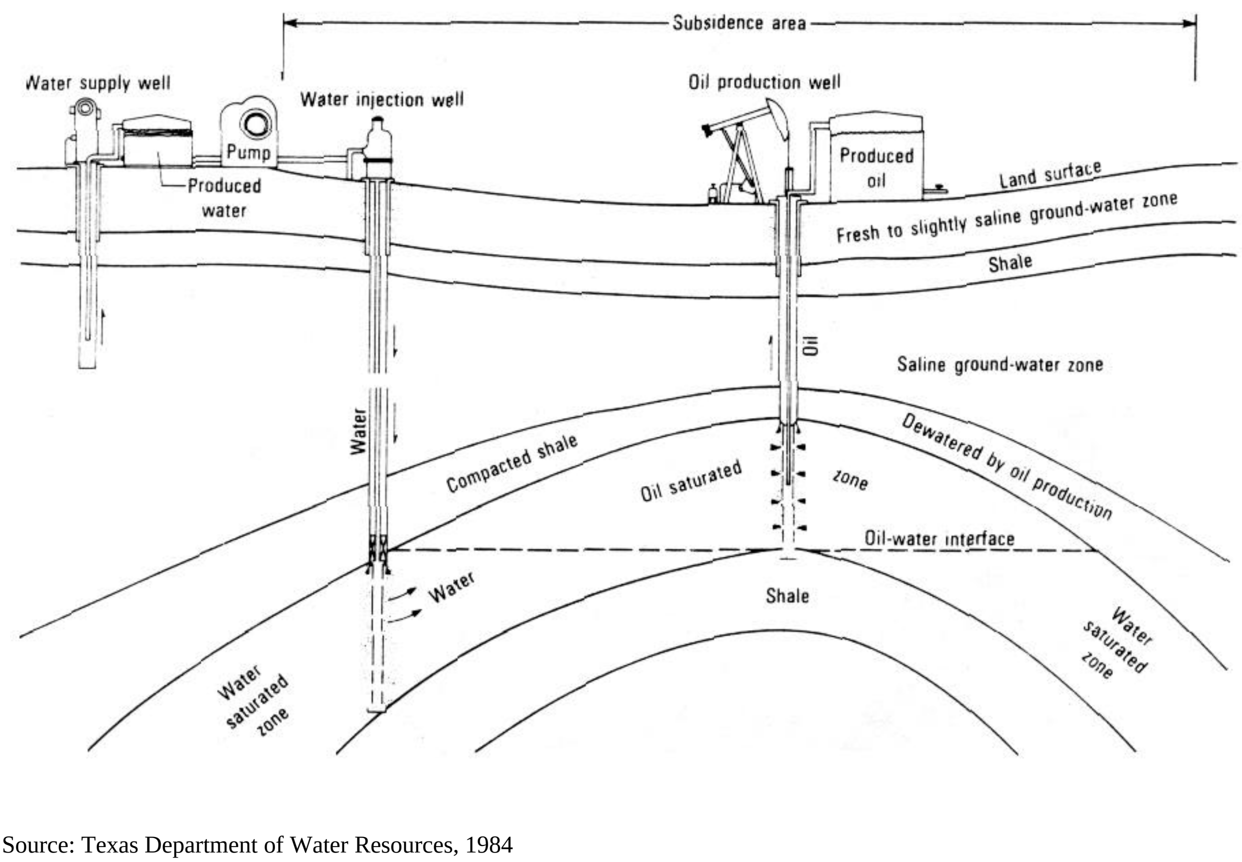
Source: Powers, 1992

Subsidence control well design and operation could also be compared to that of injection wells used to control land subsidence due to oil and gas production operations (i.e., Class II UIC wells). A well-documented example of Class II subsidence control wells is the operation of the Wilmington Oil Field in Long Beach, California.

The Wilmington Oil Field is one of the largest oil fields in the United States (Colazas et al., 1987). Since the early 1940s, this field has experienced a total of 29 feet of subsidence, caused primarily by the withdrawal of hydrocarbons (Colazas et al., 1987). Subsidence in the Wilmington Oil Field caused extensive damage to Long Beach port industrial and naval facilities. In order to combat subsidence, the City of Long Beach began one of the largest water injection "waterflood" programs in the world (Colazas et al., 1987).

Figure 2 presents a schematic diagram showing the relationship of the injection well used to control land subsidence to oil wells in the Wilmington Oil Field. As shown in this figure, the water injection well at the Wilmington Oil Field was sited in such a manner that it injects water into the water saturated zone of the reservoir rock, but below the oil saturated zone. Because oil is less dense, injected water acts to push the oil upward through the producing well, and also to increase reservoir pressures. Increasing reservoir pressures in this case resulted in abatement of shale dewatering and compaction, which were causing the land subsidence. This project resulted in reduction of the subsiding area and a local land surface rebound of as much as one foot (Mayuga and Allen, 1969).

Figure 2. Relationship of Injection Well Used to Control Land Subsidence to Oil Wells in the Wilmington Oil Field, Long Beach, California



Source: Texas Department of Water Resources, 1984

4.3 Operational Practices

This section briefly discusses standard operational and maintenance practices that are recommended to obtain optimum performance of recharge wells. Operating requirements for subsidence control wells established by state and USEPA Regional UIC programs are discussed in Attachment A of this volume.

In order to obtain optimum performance of recharge wells without excessive maintenance cost, the following operational practices are recommended:

- Use of "good" quality recharge water. If the recharge water is not low in suspended solids, air, and microorganisms, and is not chemically compatible with natural ground water and the aquifer material, clogging can cause a recharge operation to be infeasible (Lichtler et al., 1980).

- Periodic redevelopment of the well to restore its efficiency and specific capacity. Artificial recharge of ground water through a well usually results in increasing resistance to flow, which is referred to as "plugging." To mitigate the effects of plugging, wells are periodically redeveloped. Redevelopment of a well involves the removal of finer material from the natural formations surrounding the perforated sections of the casing.

- Calibration of flow meters and other equipment associated with the recharge well system to accurately keep track of flow rates. This, in turn, allows the operator to determine whether clogging is occurring and redevelopment is necessary.

- Monitoring of ground water to ascertain the direction and rate of water movement and the extent of water quality changes occurring during movement of the recharged water through the aquifer.

5. POTENTIAL AND DOCUMENTED DAMAGE TO USDWs

5.1 Injectate Constituent Properties

As mentioned in Section 4.1, injectate in the documented subsidence control wells consists of untreated ground water, untreated surface water, surface water treated to drinking water standards, and saline water. No data on injectate constituents and concentrations associated with subsidence control wells were obtained from state and USEPA Regional offices or found in literature. However, it is reasonable to assume that injectate in some subsidence control wells exceeds drinking water standards for some parameters.

5.2 Observed Impacts

The information on subsidence control wells obtained from the survey of state and USEPA Regional offices and found in the literature did not reveal any contamination incidents or impacts on USDWs associated with the use of subsidence control wells.

6. BEST MANAGEMENT PRACTICES

While many areas in the United States have experienced land subsidence, the cause of subsidence differs greatly from site to site. Some of the approaches being used to mitigate land subsidence include: voluntary and educational measures, such as public information and mapping programs, to raise public consciousness; regulatory schemes that require subsidence prevention or control; land-use management and building codes to reduce damage; market-based methods to transfer the costs of subsidence to the parties causing it; and insurance programs to distribute cost more equitably (NRC, 1991).

There are two basic alternatives available to control land subsidence caused by excessive ground water withdrawal. Prevention or control measures include repressuring the withdrawal zone by injection or enhanced recharge, which are discussed in this summary, and reducing the amount of ground water withdrawn.

7. CURRENT REGULATORY REQUIREMENTS

Several federal, state, and local programs exist that either directly manage or regulate Class V subsidence control wells. On the federal level, management and regulation of these wells falls primarily under the UIC program authorized by the Safe Drinking Water Act (SDWA). Some states and localities have used these authorities, as well as their own authorities, to extend the controls in their areas to address concerns associated with subsidence control wells.

7.1 Federal Programs

Class V wells are regulated under the authority of Part C of SDWA. Congress enacted the SDWA to ensure protection of the quality of drinking water in the United States, and Part C specifically mandates the regulation of underground injection of fluids through wells. USEPA has promulgated a series of UIC regulations under this authority. USEPA directly implements these regulations for Class V wells in 19 states or territories (Alaska, American Samoa, Arizona, California, Colorado, Hawaii, Indiana, Iowa, Kentucky, Michigan, Minnesota, Montana, New York, Pennsylvania, South Dakota, Tennessee, Virginia, Virgin Islands, and Washington, DC). USEPA also directly implements all Class V UIC programs on Tribal lands. In all other states, which are called Primacy States, state agencies implement the Class V UIC program, with primary enforcement responsibility.

Subsidence control wells currently are not subject to any specific regulations tailored just for them, but rather are subject to the UIC regulations that exist for all Class V wells. Under 40

CFR 144.12(a), owners or operators of all injection wells, including subsidence control wells, are prohibited from engaging in any injection activity that allows the movement of fluids containing any contaminant into USDWs, "if the presence of that contaminant may cause a violation of any primary drinking water regulation . . . or may otherwise adversely affect the health of persons."

Owners or operators of Class V wells are required to submit basic inventory information under 40 CFR 144.26. When the owner or operator submits inventory information and is operating the well such that a USDW is not endangered, the operation of the Class V well is authorized by rule. Moreover, under section 144.27, USEPA may require owners or operators of any Class V well, in USEPA-administered programs, to submit additional information deemed necessary to protect USDWs. Owners or operators who fail to submit the information required under sections 144.26 and 144.27 are prohibited from using their wells.

Sections 144.12(c) and (d) prescribe mandatory and discretionary actions to be taken by the UIC Program Director if a Class V well is not in compliance with section 144.12(a). Specifically, the Director must choose between requiring the injector to apply for an individual permit, ordering such action as closure of the well to prevent endangerment, or taking an enforcement action. Because subsidence control wells (like other kinds of Class V wells) are authorized by rule, they do not have to obtain a permit unless required to do so by the UIC Program Director under 40 CFR 144.25. Authorization by rule terminates upon the effective date of a permit issued or upon proper closure of the well.

Separate from the UIC program, the SDWA Amendments of 1996 establish a requirement for source water assessments. USEPA published guidance describing how the states should carry out a source water assessment program within the state's boundaries. The final guidance, entitled *Source Water Assessment and Programs Guidance* (USEPA 816-R-97-009), was released in August 1997.

State staff must conduct source water assessments that are comprised of three steps. First, state staff must delineate the boundaries of the assessment areas in the state from which one or more public drinking water systems receive supplies of drinking water. In delineating these areas, state staff must use "all reasonably available hydrogeologic information on the sources of the supply of drinking water in the state and the water flow, recharge, and discharge and any other reliable information as the state deems necessary to adequately determine such areas." Second, the state staff must identify contaminants of concern, and for those contaminants, they must inventory significant potential sources of contamination in delineated source water protection areas. Class V wells, including subsidence control wells, should be considered as part of this source inventory, if present in a given area. Third, the state staff must "determine the susceptibility of the public water systems in the delineated area to such contaminants." State staff should complete all of these steps by May 2003 according to the final guidance.[1]

[1] May 2003 is the deadline including an 18-month extension.

7.2 State and Local Programs

As discussed in Section 3, the four states for which documented or estimated numbers of subsidence control wells were provided by the states or USEPA Regional offices are: Louisiana, New York, Oregon, and Wisconsin. The program requirements differ significantly among these states. Attachment A of this volume describes how each of these states currently regulates subsidence control wells. In brief:

- Louisiana is a UIC Primacy state for Class V wells. Subsidence control wells located in this state are authorized by rule.

- In New York, USEPA Region 2 directly implements the UIC program for Class V injection wells. However, New York has additional jurisdiction over Class V wells through state pollutant discharge elimination system permits.

- Oregon is a UIC Primacy state for Class V wells. In this state, subsidence control wells located are authorized by rule.

- Wisconsin is a UIC Primacy state for Class V wells. Although, formerly, subsidence control wells were individually permitted by the Department of Natural Resources, construction of new subsidence control wells is now prohibited in the state.

Although no subsidence control wells currently exist in Texas, the measures used in the past to control land subsidence in the Houston-Galveston area provide an example of how states can address this problem. In 1975, the Texas State Legislature authorized the formation of the Houston-Galveston Coastal Subsidence District and gave it the mandate to control land subsidence in those areas where subsidence contributes to or precipitates flooding. To accomplish this mandate, the district was given authority to regulate water pumpage from major production wells. Armed with this regulatory authority, the district was able to reduce pumpage near the coastal area and allow the water level to recover partially in that area (Strause, 1984).

ATTACHMENT A
STATE AND LOCAL PROGRAM DESCRIPTIONS

The four states for which documented or estimated numbers of subsidence control wells were provided by the states or USEPA Regional offices—Louisiana, New York, Oregon, and Wisconsin—have substantially different regulatory structures. A discussion of each state's permitting, siting and construction, operating, mechanical integrity testing, plugging and abandonment, and financial assurance requirements follows.

Louisiana

Louisiana is a UIC Primacy State for Class V wells. The Department of Natural Resources (DNR), Office of Conservation, has promulgated rules on injection wells in Title 43, Part XVII, Subpart 1, Chapter 1 of the Louisiana Administrative Code (LAC). Subsidence control wells used to inject fluids into a non-oil or gas producing zone to reduce or eliminate subsidence associated with the overdraft of a USDW are classified as Class V wells (§103.C.5.j LAC).

Permitting

Injection into Class V wells may be authorized by rule (§103.E.1.c. LAC). Statewide Order No. 29-N-1 (LAC 43: XVII, Subpart 1) has authorized subsidence control wells. If at any time the DNR learns that a Class V well may cause a violation of the Louisiana Drinking Water Regulations, Chapter XII of the State Sanitary Code, or may be otherwise affecting the health of persons, the operator may be required to obtain an individual permit and may be ordered to take other actions, including closure of the injection well, as may be necessary to prevent the violation or adverse effect (§103.D.3 LAC). Currently, no individual permits have been issued for subsidence control wells.

Siting and Construction Requirements

Currently, there are no specific siting and construction requirements for Class V wells in Louisiana. Form UIC-25, used to obtain inventory information, states "the injection well must be constructed according to guidelines established by the Louisiana Department of Transportation and Development (DOTD) for a similar type water well by a licensed water well contractor." DOTD has established siting and construction requirements in Title 70, Part XIII, Chapter 3, "Water Well Construction."

Operating Requirements

Form UIC-25 also states that within 30 days after commencement of operation of a non-waste injection well, a sample of the injected water collected immediately prior to entering the injection well must be analyzed for chloride and total dissolved solids. A copy of the analysis must be sent to the Injection and Mining Division.

Plugging and Abandonment

Form UIC-25 states that upon abandonment the well must be plugged in accordance with Office of Conservation guidelines in effect at the time of abandonment. However, as of October 1994, which was the last revision date of Form UIC-25, the Office of Conservation had not issued any specific guidelines for the plugging and abandonment of Class V wells. Instead, the Office of Conservation has adopted DOTD's plugging and abandonment guidelines as interim guidelines. DOTD's plugging and abandonment guidelines may be found in Title 70, Part XIII, Chapter 5, "Methods for Plugging and Sealing of Abandoned Water Wells."

New York

USEPA Region 2 directly implements the UIC program for Class V injection wells in New York. However, under New York's Environmental Conservation Law, the Department of Environmental Conservation, Division of Water Resources (DWR) has promulgated regulations in the State Code Rules and Regulations, Title 6, Chapter X, Parts 703, 750, 754, and 756. These regulations establish water quality standards and effluent limitations, create a state pollutant discharge elimination system requiring permits for discharges into the waters of the state, including ground water, specify that such discharges must comply with the standards in Part 703, and provide for monitoring in Part 756.

Permitting

Applications for a State Pollution Discharge Elimination System (SPDES) permit must be submitted on a required form, describe the proposed discharge, supply such other information as the DWR requests, and are subject to public notice. SPDES permits must ensure compliance with effluent limitations and standards, and will include schedules of compliance, monitoring requirements, and records and reports of activities (Parts 751 - 756).

Siting and Construction Requirements

Not specified by statute or regulations.

Operating Requirements

Effluent limits (Part 703) in the SPDES permit must be met. Monitoring and reporting requirements in the SPDES permit also must be met.

Plugging and Abandonment

Not specified by statute or regulations.

Oregon

Oregon is a UIC Primacy State for Class V wells. The UIC program is administered by the Department of Environmental Quality (DEQ). Under the State's Administrative Rules (OAR) pertaining to underground injection, "underground injection activity" means any activity involving underground injection of fluids, including subsidence control wells (340-44-0005 (20) OAR).

Permitting

Construction or use of a "waste disposal well,"defined as any bored, drilled, driven or dug hole, whose depth is greater than its largest surface dimension, which is used or is intended to be used for disposal of sewage, industrial, agricultural, or other wastes, including drain holes, drywells, cesspools and seepage pits," along with other underground injection wells" (340-44-0005 (22) OAR), is restricted without a water pollution control facility (WPCF) permit (340-044-0015 OAR). However, subsidence control wells are permitted by rule under 340-44 OAR because the injection activities are not considered to allow the movement of fluids into USDWs.

Siting and Construction Requirements

Not specified by statute or regulations.

Operating Requirements

Not specified by statute or regulations.

Plugging and Abandonment

The state UIC requirements provide that upon discontinuance of use or abandonment a waste disposal well is required to be rendered completely inoperable by plugging and sealing the hole. All portions of the well which are surrounded by "solid wall" formation must be plugged and filled with cement grout or concrete. The top portion of the well must be effectively sealed with cement grout or concrete to a depth of at least 18 feet below the surface of the ground, or if this method of sealing is not effective by a manner approved by the DEQ.

Wisconsin

Wisconsin is a UIC Primacy State for Class V wells. The Department of Natural Resources (DNR) has promulgated regulations in Chapter 812 of the Natural Resources Administrative Code pertaining to well construction. They prohibit injection except in limited cases:

> "The use of any well, drillhole, or water system for the underground placement of any waste, surface or subsurface water or any substance . . . is prohibited unless the

placement is a department-approved activity necessary for remediation of contaminated soil, ground water, or an aquifer." (NR 812.05.)

Permitting

DNR regulations establish the requirements for permits to discharge from a point source, including a well, to the waters of the state, including ground waters (NR Chapter 200). Formerly, subsidence control wells approved under NR 812.05 were required to obtain a permit under NR Chapter 200. Construction of new subsidence control wells is now prohibited in the state.

The existing six subsidence control wells in the state were temporary and used during the construction of the Milwaukee Tunnel Project. Construction activities were completed, and four of the six wells have been abandoned (removed and sealed). The remaining two wells are in the process of being abandoned. Thus, there are no active subsidence control wells in Wisconsin.

Siting and Construction Requirements

Subsidence control wells approved by DNR were required to have casing meeting ASTM standards. The well had to terminate at least 24 inches above grade, the annular spacing surrounding the screen had to be filled with gravel pack, a bentonite seal had to be installed above the well screen, neat cement grout to the surface was required, and the wells had to be protected against vandalism.

Operating Requirements

DNR allowed only clear water from the Milwaukee Public Water System to be injected into subsidence control wells, based on NR 812.05. Recharge rates had to be recorded monthly and reported to DNR quarterly. Piezometers were required within 100 feet of the wells.

Ambient ground water standards are established in Chapter NR 140 of the Natural Resources Administrative Code. Chapter NR 140 supplements the regulatory authority elsewhere in the statutes and administrative rules and provides guidelines and procedures for the exercise of that authority. The ground water standards apply to all facilities or activities regulated by a state agency. NR 140.10 establishes public health related ground water standards for over 90 substances. These standards include both enforcement standards (ES) and preventive action limits (PALs). PALs are set at 10, 20, or 50 percent of the enforcement standard and are intended to provide site design safety factors and early warning factors. Under NR 140.14, if an ES or PAL is attained or exceeded, the owner or operator of the facility must notify the appropriate regulatory agency. That agency will undertake evaluation and may require response actions to be taken (NR 140.20 to 140.27).

Plugging and Abandonment

Not specified by statute or regulations.

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