SECTION 5
SUMMARY AND CONCLUSIONS

5.1 CURRENT INVENTORY

5.1.1 NATIONAL INVENTORY

The Class V Injection well inventory, based on State reports, is conservatively estimated to be 173,159 wells. Well types have been grouped into seven main categories for the purposes of the National inventory:

1. Drainage Wells;
2. Geothermal Reinjection Wells;
3. Domestic Wastewater Disposal Wells;
4. Mineral and Fossil Fuel Recovery Related Wells;
5. Industrial/Commercial/Utility Disposal Wells;
6. Recharge Wells; and
7. Miscellaneous Wells.

Based on the purpose of the well and the origin of the injection fluids, 30 well types have been identified and inventoried for this report. A summary of the numbers of Class V well types, shown in Table 5-1, indicates over 94 percent of the inventory is from four categories of wells: drainage wells, domestic wastewater disposal wells, geothermal wells (mostly heat pump/air conditioning return flow wells), and mineral and fossil fuel recovery related wells. These four categories are predominantly comprised of low-tech wells. Low-tech wells typically 1) have simple casing designs and well head equipment and 2) inject to shallow formations by gravity flow or low volume pumps. In contrast, high-tech wells typically 1) have multiple casing strings, 2) have sophisticated wellhead equipment to control and measure pressure and volume of injected fluid, and 3) inject high volumes into deep formations.

The Class V injection well inventory is characterized by extreme variations in database completeness and quality. In general, inventories for high-tech Class V wells are more accurate than those for low-tech wells.

Because high-tech Class V injection wells are typically associated with special industries or large scale remediation and disposal projects, they constitute a small proportion of all Class V wells. They also tend to be localized, and are easier for regulatory agencies to inventory and monitor. In addition, several agencies may be involved with these operations for

TABLE 5-1: CLASS V WELL NATIONAL INVENTORY
RANKED BY WELL CLASSIFICATION

WELL TYPE & CATEGORY	TOTAL #WELLS	% OF TOTAL
DRAINAGE	100744	58.2
DOMESTIC	43688	25.2
GEOTHERMAL	10163	5.9
MINERAL	8712	5.0
MISCELLANEO	3754	2.2
RECHARGE	3719	2.1
INDUSTRIAL	2379	1.4
TOTAL	173159	100

drilling and waste discharge permits at local, county, and state levels.

It has also been found that, in general, operators of high-tech wells are more informed about existing regulations and more responsible in reporting activities than are owner/operators of some types of low-tech wells. As a result, files maintained by high-tech well operators tend to be more complete, whereas no such files may exist for many low-tech wells.

A number of inspection programs have been conducted that target high-tech Class V injection wells. These inspections have provided valuable inventory data for facilities inspected, as well as other facilities owned by the same owner/operator. The result of all these factors has been a generally complete inventory database for high-tech wells and a generally poor to nonexistent one for low-tech wells.

The high-tech Class V database is relatively good; however it is certain that uninventoried facilities exist, and files for certain other high-tech facilities are lacking in technical data.

The data summarized in this section were submitted by 56 States, Territories, or Possessions of the United States. The inventory data reveal that Class V wells are not distributed evenly among the ten USEPA Regions. In fact, four Regions contain over 80 percent of the Class V wells inventoried. Region IX alone accounts for 37 percent of Class V wells. Table 5-2 summarizes the distribution of wells by USEPA Region.

Several well types have very incomplete inventories. In general, the well types which have been most difficult to inventory are those for which records are kept only at a local level or registration or permitting of the wells has not been required. The well types most seriously impacted by these limitations are:

1. All types of drainage wells (5F1, 5D2, 5D3, 5D4);
2. All types of domestic wastewater disposal wells (5W9, 5W10, 5W11, 5W12, 5W31, 5W32);
3. Industrial disposal wells (5W20);
4. Automobile service station disposal wells (5W28); and
5. Abandoned drinking water/waste wells (5X29).

TABLE 5-2: CLASS V NATIONAL WELL INVENTORY
RANKED BY USEPA REGION

EPA REGION	TOTAL #WELLS	% OF TOTAL
IX	64214	37.1
X	29826	17.2
IV	27911	16.1
V	17772	10.3
VIII	9015	5.2
II	8950	5.2
VII	6675	3.9
III	4589	2.7
VI	3843	2.2
I	364	0.2
TOTAL	173159	100

5.2 ASSESSMENT OF WELL TYPES

5.2.1. REVIEW OF RATING SCHEME

The available data were used in Section 4 to qualitatively assess the consequences of injection on current or potential beneficial uses of USDW. Four major criteria entered into the assessment of contamination potential:

1. The identification and potential usability of USDW (water quality parameters);

2. The typical well construction, operation, and maintenance as they relate to injection or migration of injectate into unintended zones;

3. The injection fluid characteristics with regard to the water quality parameters; and

4. The estimated degree and areal extent of contamination based on injection rates and volumes, and contaminant transport and fate in the USDW.

The rating system consists of a series of questions based on the four major criteria which produce "YES" or "NO" answers. Section 4.1 fully describes the methods used in assessing contamination potential.

5.3 SUMMARY OF WELL TYPE ASSESSMENTS

Application of the rating system resulted in each well type being rated as having a high, moderate, low, or unknown contamination potential. For some well types, one typical injection situation was difficult to establish. In these cases, a range of contamination potentials is indicated. The well types are listed below under all the appropriate contamination potential headings. In all following tables, the well type is listed under the highest contamination potential ascribed in a range. Stricter State regulation of some well types rated high or moderate may lower the assessment of their contamination potential. Table 5-3 lists the number of wells by contamination potential for each State. Table 5-4 summarizes by Region the numbers of wells reported. Figures 5-1 through 5-4 illustrate the distribution of wells by contamination potential and Region.

<u>High Contamination Potential</u>

- Agricultural drainage wells, 5F1;

- Improved sinkholes, 5D3 (high to moderate);

Table 3-1: REPORTED CLASS V INJECTION WELLS

REGION & STATES	TOTAL # WELLS	DRAINAGE					GEOTHERMAL				DOMESTIC WASTEWATER						MINERAL & FOSSIL FUEL				INDUSTRIAL			RECHARGE			MISCELLANEOUS			
		5F1	5D2	5D3	5D4	5D30	5E5	5E6	5E7	5E8	5I9	5I10	5I11	5I31	5I32	5I12	5I13	5I14	5I15	5I16	5I19	5I20	5I28	5R21	5R22	5R23	5X24	5X25	5X26	5X29
REG1	344	0	72	3	16	0	0	0	24	0	0	0	97	0	0	72	0	0	0	0	14	99	14	1	0	0	0	0	2	0
Connecticut	84	0	3	0	0	0	0	0	12	0	0	0	62	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0
Maine	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0
Massachusetts	132	0	19	0	0	0	0	0	10	0	0	0	27	0	0	72	0	0	0	0	3	1	0	0	0	0	0	0	0	0
New Hampshire	38	0	0	3	16	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	13	0	1	0	0	0	0	0	0
Rhode Island	80	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	59	3	0	0	0	0	0	2	0
Vermont	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	0	0	0	0	0	0	0
REG 2	8950	150	2504	10	1116	0	0	x	181	0	5	68	1260	65	63	72	0	48	0	x	6	401	21	3000	0	x	0	0	10	0
New Jersey	379	0	1	0	1	0	0	0	181	0	0	1	143	0	0	0	0	0	0	0	5	20	18	0	0	0	0	0	9	0
New York	7172	150	2500	0	1100	0	0	x	x	0	0	x	x	x	x	21	0	48	0	x	0	350	3	3000	0	x	0	0	0	0
Puerto Rico	1352	x	3	10	15	0	0	0	0	0	5	67	1073	65	63	1	0	0	0	0	1	28	0	0	0	0	0	0	1	0
Virgin Islands	47	0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
REG 3	4589	x	275	x	4	0	0	0	2791	0	x	0	8	905	0	5	1070	0	0	2	x	30	1	0	0	0	0	0	0	0
Delaware	164	0	0	0	0	0	0	0	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maryland	1271	0	0	0	3	0	0	0	368	0	0	0	0	890	0	0	1	0	0	0	0	9	0	0	0	0	0	0	0	0
Pennsylvania	1026	0	125	0	0	0	0	0	24	0	x	0	0	13	0	4	811	0	0	0	x	19	0	0	0	0	0	0	0	0
Virginia	1864	0	116	x	3	0	0	0	1735	0	0	0	6	0	0	1	0	0	0	0	x	2	1	0	0	0	0	0	0	0
West Virginia	264	x	2	x	x	0	0	0	0	0	0	0	2	0	0	0	258	0	0	2	0	0	0	0	0	0	0	0	0	0
REG 4	27911	43	2072	81	2	1385	0	0	2998	0	0	0	19001	756	200	586	61	0	0	0	75	318	x	349	2	0	1	18	13	0
Alabama	144	0	9	0	0	0	0	0	0	0	0	0	1	0	0	0	x	0	0	0	33	98	0	0	0	0	0	2	1	0
Florida	25857	x	1539	x	x	1385	0	0	2671	0	0	0	19000	0	0	353	0	0	0	0	35	20	x	349	2	0	0	3	0	x
Georgia	163	43	2	0	2	0	0	0	111	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
Kentucky	1360	x	484	76	x	0	0	0	x	0	0	0	0	736	0	3	61	0	0	0	0	0	0	0	0	0	0	0	0	0
Mississippi	12	0	0	0	0	0	0	0	7	0	0	0	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
North Carolina	99	0	0	0	0	0	0	0	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	12	0
South Carolina	493	0	31	0	0	0	0	0	60	0	0	0	0	0	200	0	0	0	0	0	2	200	0	0	0	0	0	0	0	0
Tennessee	83	0	7	0	0	0	0	0	70	0	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0	1	0	0	0
REG 5	17772	167	4987	135	191	0	0	0	1164	0	959	65	4537	2635	0	41	5	15	2	41	90	527	34	2	0	4	1	8	97	2095
Illinois	1764	6	697	0	47	0	0	0	57	0	916	0	0	0	0	1	5	0	0	0	10	16	5	1	0	0	1	2	0	0
Indiana	3816	72	2180	26	8	0	0	0	236	0	22	22	895	105	0	27	0	0	1	8	22	30	2	0	0	0	0	0	4	156
Michigan	7575	15	623	103	9	0	0	0	760	0	11	18	2693	2511	0	2	0	15	1	33	52	9	27	0	0	0	0	0	59	630
Minnesota	2106	54	30	6	8	0	0	0	34	0	10	25	588	16	0	11	0	0	0	0	4	1	0	1	0	0	0	2	7	1309
Ohio	2360	0	1341	x	118	0	0	0	73	0	0	0	361	0	0	x	0	0	0	0	x	467	0	0	0	0	0	0	0	x
Wisconsin	151	0	116	0	1	0	0	0	4	0	0	0	0	3	0	0	0	0	0	0	2	4	0	0	0	4	0	0	17	0
REG 6	3843	108	57	0	5	1	x	5	1146	0	10	30	66	0	0	0	76	1073	x	77	7	4	0	74	0	0	2	12	147	985
Arkansas	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	1	0	0	0	0	0	0	0	0	0
Louisiana	11	0	0	0	5	1	0	0	5	0	0	0	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New Mexico	1237	0	5	0	0	0	0	2	27	0	0	14	10	0	0	0	11	1073	0	0	6	2	0	30	0	0	1	6	50	0
Oklahoma	168	x	x	0	0	0	0	0	100	0	0	0	x	0	0	0	0	0	0	7	0	0	0	0	0	0	1	0	60	0
Texas	2356	108	52	0	0	0	x	1	1014	0	10	16	56	0	0	0	65	0	x	0	0	2	0	44	0	0	0	6	37	985
REG 7	6675	235	10	250	0	0	0	0	1802	0	0	x	5	0	0	0	4326	0	0	0	16	0	6	8	0	0	0	2	15	x
Iowa	262	230	6	0	0	0	0	0	17	0	0	0	3	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0
Kansas	419	0	3	0	0	0	0	0	394	0	0	0	0	0	0	0	0	0	0	0	3	0	0	4	0	0	0	0	15	0
Missouri	5324	x	0	250	0	0	0	0	741	0	0	0	2	0	0	0	4326	0	0	0	0	0	5	0	0	0	0	0	x	0
Nebraska	670	5	1	0	0	0	0	0	650	0	0	x	x	0	0	0	0	0	0	0	8	0	0	4	0	0	0	2	0	x
REG 8	9015	1	7250	0	321	35	0	5	219	0	0	3	422	0	0	x	366	14	64	1	6	36	2	7	0	0	0	137	81	7
Colorado	115	x	2	0	0	0	0	2	2	0	0	0	0	0	0	0	2	0	23	0	1	0	0	0	0	0	0	2	81	x
Montana	4587	0	4500	0	0	35	0	0	20	0	0	0	2	0	0	0	10	0	0	0	x	0	0	0	0	0	0	0	0	0
North Dakota	438	1	0	0	0	0	0	0	135	0	0	0	0	0	0	0	300	0	0	1	1	0	0	0	0	0	0	0	0	0
South Dakota	49	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Utah	3068	0	2743	0	321	0	0	1	7	0	0	0	x	0	0	0	0	0	0	0	3	4	2	0	0	0	0	0	0	7
Wyoming	738	0	5	0	0	0	0	0	7	0	0	3	420	0	0	x	74	14	41	0	0	32	0	7	0	0	0	135	0	0
REG 9	64214	0	59483	0	4	1	81	7	53	25	3	120	1313	75	1279	358	1	825	0	0	26	209	0	103	155	0	0	45	0	0
Arizona	51207	0	50000	0	x	0	0	0	x	0	0	17	143	18	3	1	0	870	0	0	0	72	0	51	0	0	0	32	0	0
California	12178	0	9175	0	x	0	65	1	53	0	0	46	1165	48	1276	22	0	5	0	0	20	93	0	52	155	0	0	2	0	0
Hawaii	617	0	129	0	4	1	0	0	0	25	3	57	0	7	0	335	0	0	0	0	6	44	0	0	0	0	0	6	0	0
Nevada	46	0	15	0	x	0	16	6	x	0	0	0	3	0	x	0	1	0	0	0	0	0	x	0	0	0	0	5	0	0
American Samoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Terr. of P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guam	164	0	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CNMI	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REG 10	79826	654	16910	0	2141	115	0	8	150	0	3	6336	60	3	2241	45	575	0	0	0	51	365	21	14	0	0	120	3	0	3
Alaska	2542	0	66	0	0	0	4	0	7	0	3	79	8	3	2133	4	0	0	0	0	2	230	0	0	0	0	0	0	0	3
Idaho	2533	572	1165	0	0	7	4	2	20	0	0	0	52	0	0	9	575	0	0	0	49	46	21	7	0	0	4	0	0	0
Oregon	7120	16	776	0	0	0	0	6	13	0	0	6257	0	0	0	32	0	0	0	0	0	20	0	0	0	0	0	0	0	0
Washington	17631	66	14903	0	2141	108	0	0	110	0	0	0	0	0	108	0	0	0	0	0	x	69	0	7	0	0	116	3	0	0
TOTAL	173159	1338	93569	479	3802	1537	89	21	10028	25	980	6622	26769	4435	3783	1099	6500	2025	66	121	291	1989	99	3558	157	4	124	225	335	3050

NOTE: Some numbers in this table are estimated. "X" indicates well type reported; no numbers available.

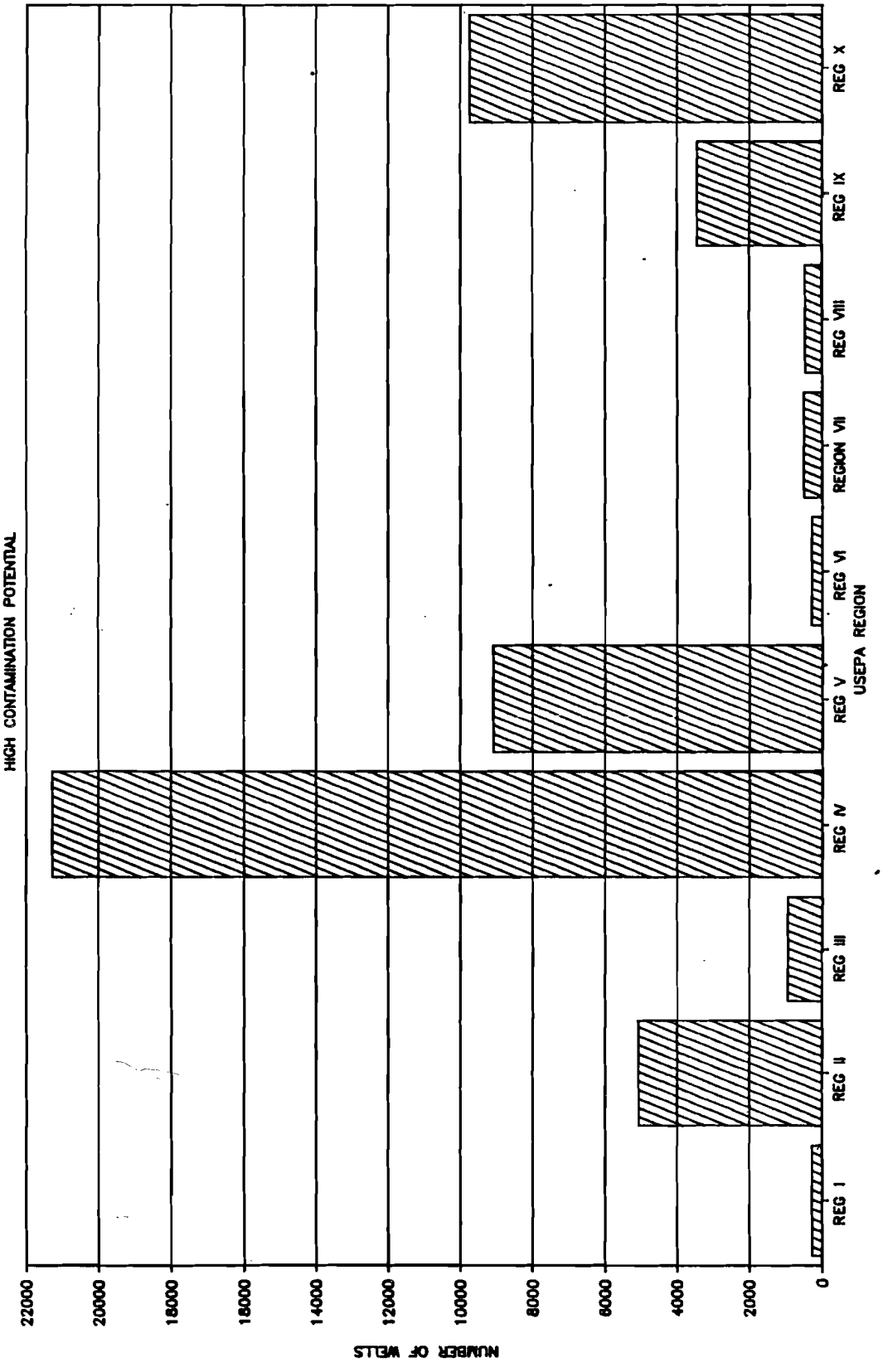
Table 5-3: DISTRIBUTION OF CLASS V WELLS BY CONTAMINATION POTENTIAL

REGION & STATES	TOTAL # WELLS	HIGH POTENTIAL											MODERATE POTENTIAL											LOW POTENTIAL					UNKNOWN POTENTIAL	
		5F1	5D3	5W9	5W10	5W11	5W31	5W32	5W12	5W20	5X28	5X21	5D2	5D4	5E30	5R5	5A6	5R8	5X13	5X15	5W19	5X25	5X27	.5W7	5X14	5X16	5W22	5X23	5W24	5X26
REG 1	544	0	3	0	0	97	0	0	72	99	14	1	22	16	0	0	0	0	0	0	14	0	0	24	0	0	0	0	0	2
Connecticut	84	0	0	0	0	62	0	0	0	6	1	0	3	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0
Maine	15	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Massachusetts	132	0	0	0	0	27	0	0	72	1	0	0	19	0	0	0	0	0	0	0	3	0	0	10	0	0	0	0	0	0
New Hampshire	38	0	3	0	0	0	0	0	0	13	0	1	0	16	0	0	0	0	0	0	3	0	0	2	0	0	0	0	0	0
Rhode Island	80	0	0	0	0	8	0	0	0	59	3	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	2
Vermont	15	0	0	0	0	0	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REG 2	8950	150	10	5	68	1260	85	63	72	401	21	3000	2504	1116	0	0	0	0	0	0	4	0	0	181	48	0	0	0	0	10
New Jersey	379	0	0	0	1	143	0	0	0	20	18	0	1	1	0	0	0	0	0	0	5	0	0	181	0	0	0	0	0	0
New York	7172	150	0	0	x	x	x	x	21	350	3	3000	2500	1100	0	0	x	0	0	0	0	0	0	x	48	x	0	x	0	0
Puerto Rico	1352	x	10	5	67	1073	85	63	1	28	0	0	3	15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Virgin Islands	47	0	0	0	0	44	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REG 3	4589	0	0	0	0	8	903	0	5	30	1	0	223	6	0	0	0	0	1070	0	0	0	0	2291	0	2	0	0	0	0
Delaware	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	164	0	0	0	0	0	0
Maryland	1271	0	0	0	0	0	890	0	0	9	0	0	0	3	0	0	0	0	1	0	0	0	0	368	0	0	0	0	0	0
Pennsylvania	1026	0	0	x	0	0	13	0	4	19	0	0	155	0	0	0	0	0	811	0	x	0	0	24	0	0	0	0	0	0
Virginia	1864	0	x	0	0	6	0	0	1	2	1	0	116	5	0	0	0	0	0	0	x	0	0	1735	0	0	0	0	0	0
West Virginia	264	x	x	0	0	2	0	0	0	0	0	0	2	x	0	0	0	0	258	0	0	0	0	0	0	2	0	0	0	0
REG 4	27911	43	81	0	0	19001	756	200	556	318	0	349	2072	2	1385	0	0	0	61	0	25	18	0	2998	0	0	2	0	1	13
Alabama	144	0	0	0	0	1	0	0	0	98	0	0	9	0	0	0	0	0	x	0	33	2	0	0	0	0	0	0	0	1
Florida	25557	x	x	0	0	19000	0	0	553	20	x	349	1539	x	1385	0	0	0	0	0	35	3	x	2671	0	0	2	0	0	0
Georgia	143	43	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	5	0	0	111	0	0	0	0	0	0
Kentucky	1360	x	76	0	0	0	736	0	3	0	0	0	484	x	0	0	0	0	61	0	0	0	0	x	0	0	0	0	0	0
Mississippi	12	0	0	0	0	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	7	0	0	0	0	0	0
North Carolina	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79	0	0	0	0	0	12
South Carolina	493	0	0	0	0	0	0	200	0	200	0	0	31	0	0	0	0	0	0	0	2	0	0	60	0	0	0	0	0	0
Tennessee	83	0	5	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	x	0	0	0	0	70	0	0	0	0	1	0
REG 5	17772	147	135	959	65	4537	2635	0	41	527	34	2	4987	191	0	0	0	0	5	2	90	8	2095	1164	15	41	0	4	1	87
Illinois	1764	6	0	916	0	0	0	0	1	16	5	1	697	47	0	0	0	0	5	0	10	2	0	57	0	0	0	0	1	0
Indiana	3816	72	26	22	22	895	105	0	27	30	2	0	2180	8	0	0	0	0	0	1	22	0	156	256	0	8	0	0	0	4
Michigan	7575	15	103	11	18	2693	2511	0	2	9	27	0	623	9	0	0	0	0	0	1	52	4	630	760	15	33	0	0	0	59
Minnesota	2106	54	6	10	25	588	16	0	11	1	0	1	30	8	0	0	0	0	0	0	4	2	1309	34	0	0	0	0	0	7
Ohio	2360	0	x	0	0	361	0	0	x	467	0	0	1341	118	0	0	0	0	0	0	x	0	x	73	0	0	0	0	0	0
Wisconsin	151	0	0	0	0	0	3	0	0	4	0	0	116	1	0	0	0	0	0	0	2	0	0	4	0	0	0	4	0	17
REG 6	3845	108	0	10	30	66	0	0	0	4	0	74	57	5	1	0	3	0	76	0	7	12	945	1146	1073	77	0	0	2	147
Arkansas	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	70	0	0	0	0
Louisiana	11	0	0	0	0	x	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
New Mexico	1237	0	0	0	14	10	0	0	0	2	0	30	5	0	0	0	0	2	0	0	11	0	6	27	1073	0	0	0	1	50
Oklahoma	168	x	0	0	0	x	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0	0	100	0	7	0	0	1	40
Texas	2356	108	0	10	16	56	0	0	0	2	0	44	52	0	0	x	1	0	65	x	0	6	945	1014	0	0	0	0	0	57
REG 7	6675	255	250	0	0	5	0	0	0	0	6	0	10	0	0	0	0	0	4328	0	16	2	0	1802	0	0	0	0	0	15
Iowa	262	230	0	0	0	3	0	0	0	0	0	0	6	0	0	0	0	0	0	0	5	0	0	17	0	0	0	0	0	0
Kansas	419	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0	3	0	0	394	0	0	0	0	0	15
Missouri	5324	x	250	0	0	2	0	0	0	0	5	0	0	0	0	0	0	0	4326	0	0	0	0	741	0	0	0	0	0	x
Nebraska	670	5	0	0	x	x	0	0	0	0	0	4	1	0	0	0	0	0	0	0	8	2	x	650	0	0	0	0	0	x
REG 8	9015	1	0	0	3	422	0	0	0	34	2	7	7250	321	55	0	3	0	386	66	4	137	7	219	14	1	0	0	0	81
Colorado	115	x	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	2	23	1	2	x	2	0	0	0	0	0	81
Montana	4587	0	0	0	0	2	0	0	0	0	0	0	4500	0	55	0	0	0	10	0	x	0	0	20	0	0	0	0	0	0
North Dakota	438	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300	0	1	0	0	135	0	1	0	0	0	0
South Dakota	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	48	0	0	0	0	0	0
Utah	3088	0	0	0	0	x	0	0	0	4	2	0	2743	321	0	0	1	0	0	0	3	0	7	7	0	0	0	0	0	0
Wyoming	738	0	0	0	3	420	0	0	x	32	0	7	5	0	0	0	0	0	74	41	0	135	0	7	14	0	0	0	0	0
REG 9	64214	0	0	3	120	1313	73	1779	358	209	0	103	59485	4	1	81	7	25	1	0	26	45	0	53	875	0	155	0	0	0
Arizona	51207	0	0	0	17	143	18	3	1	72	0	51	50000	x	0	0	0	0	0	0	0	32	0	x	870	0	0	0	0	0
California	12178	0	0	0	46	1165	48	1276	22	93	0	52	9175	x	0	65	1	0	0	0	20	2	0	53	5	0	155	0	0	0
Hawaii	617	0	0	3	57	0	7	0	335	44	0	0	129	4	1	0	0	25	0	0	6	6	0	0	0	0	0	0	0	0
Nevada	46	0	0	0	0	3	0	x	0	0	x	0	15	x	0	16	6	0	1	0	0	5	0	x	0	0	0	0	0	0
American Samoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Terr. of P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guam	164	0	0	0	0	0	0	0	0	0	0	0	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CNMI	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REG 10	29026	859	0	3	6358	80	3	2741	45	365	21	14	16910	2141	115	8	8	0	525	0	51	3	3	150	0	0	0	0	120	0
Alaska	2542	0	0	3	79	8	3	2133	4	230	0	0	66	0	0	4	0	0	0	0	2	0	3	7	0	0	0	0	0	0
Idaho	2533	572	0	0	0	52	0	0	9	46	21	7	1165	0	7	4	2	0	525	0	49	0	0	20	0	0	0	0	4	0
Oregon	7120	16	0	0	6257	0	0	0	32	20	0	0	776	0	0	0	4	0	0	0	0	0	0	13	0	0	0	0	0	0
Washington	17631	66	0	0	0	0	0	108	0	69	0	7	14903	2141	108	0	0	0	0	0	x	3	0	110	0	0	0	0	116	0
TOTAL	173159	1338	479	980	6422	26769	4435	3783	1099	1989	99	3558	93568	3802	1557	89	21	25	6500	66	291	225	3050	10028	2025	121	157	4	124	355

NOTE: Some numbers in this table are estimated. "X" indicates well type reported; no numbers are available.

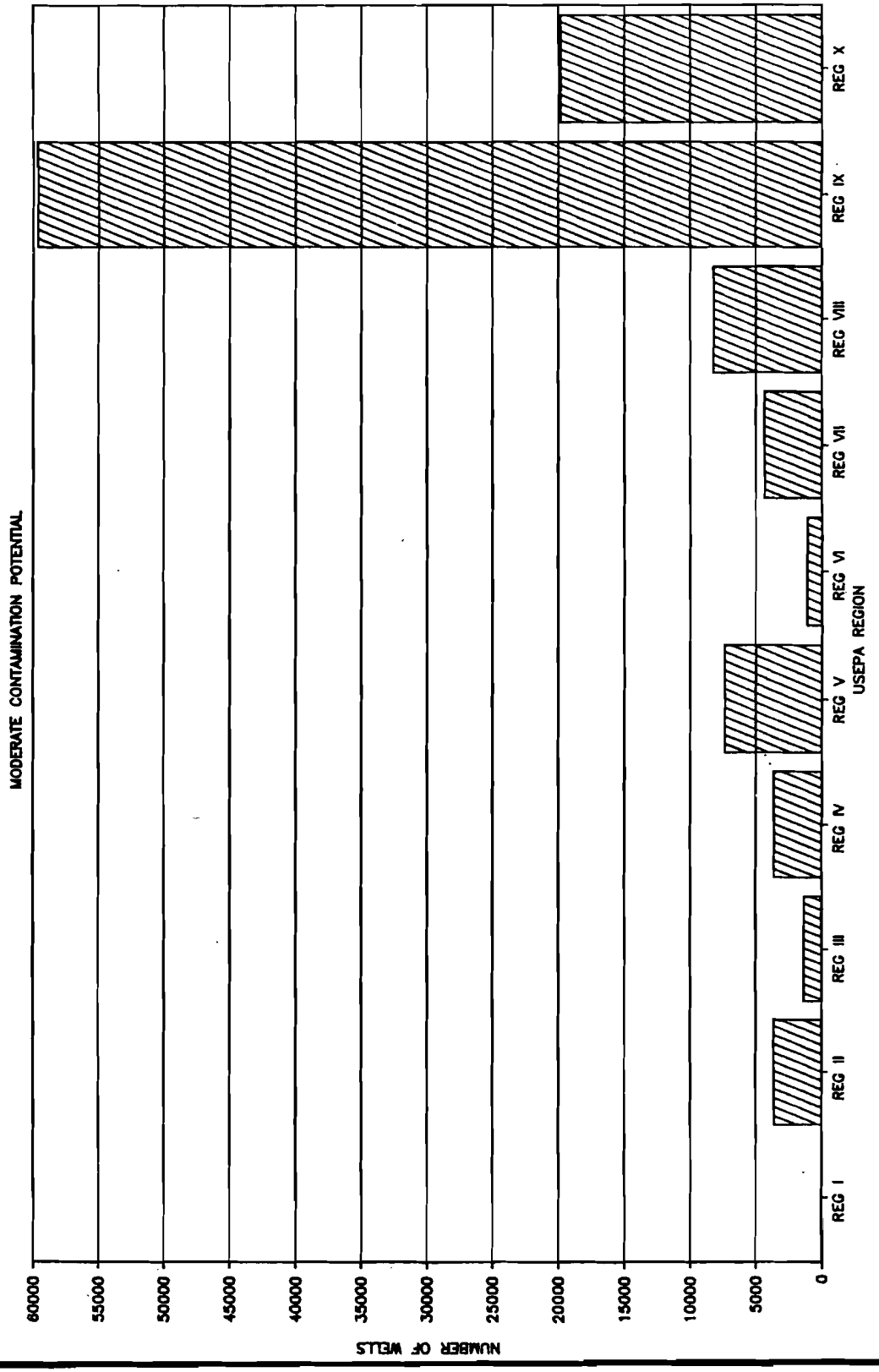
TABLE 5-4: CLASS V INJECTION WELL INVENTORY BY REGION

REGION	HIGH	MODERATE	LOW	UNKNOWN	TOTAL
I	286	52	24	2	364
II	5085	3626	229	10	8950
III	947	1349	2293	0	4589
IV	21284	3613	3000	14	27911
V	9082	7378	1224	88	17772
VI	292	1106	2296	149	3843
VII	504	4354	1802	15	6675
VIII	471	8229	234	81	9015
IX	3458	59673	1083	0	64214
X	9742	19814	150	120	29826
TOTAL	51151	109194	12335	479	173159



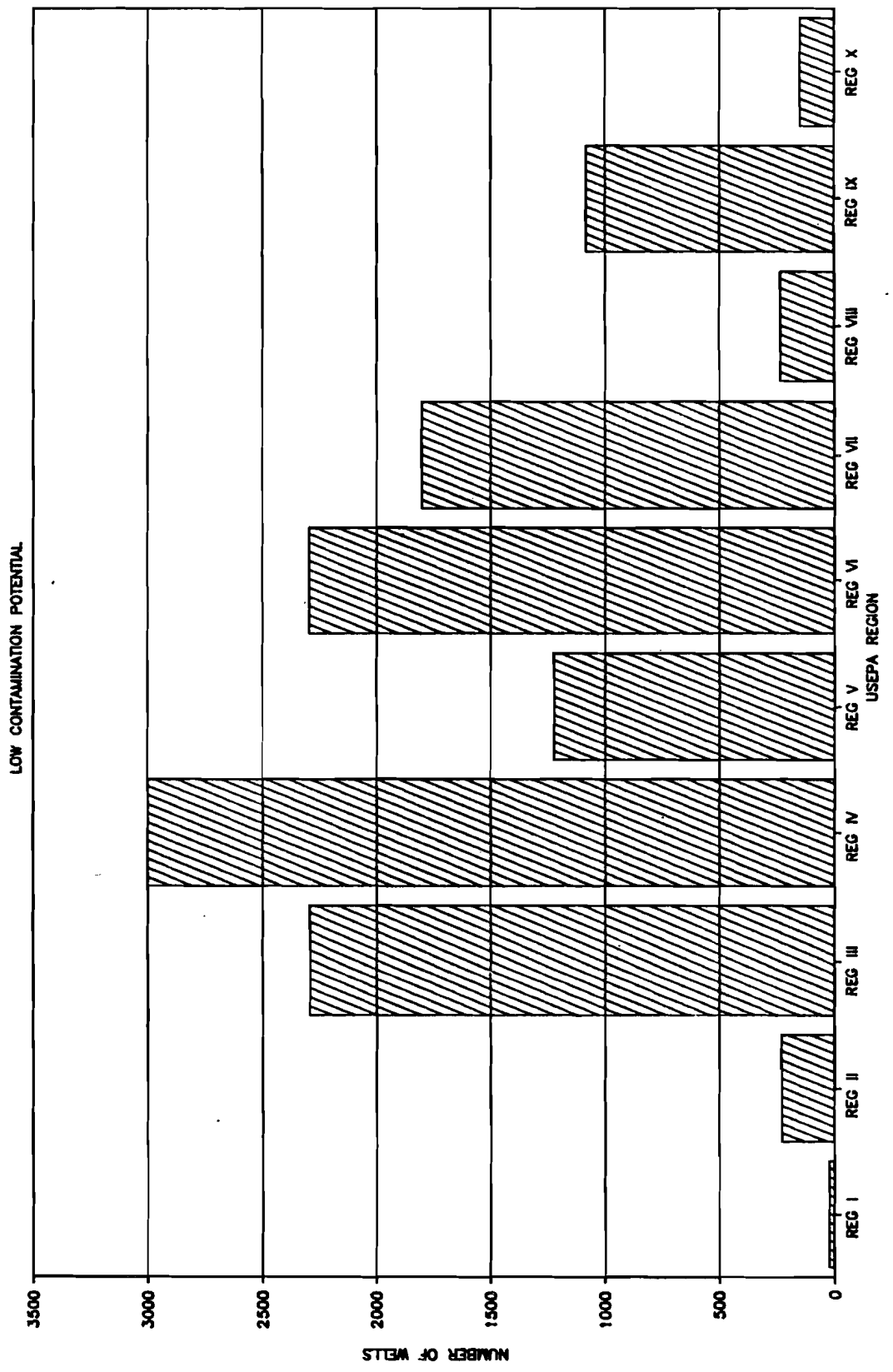
BAR GRAPH ILLUSTRATING
HIGH CONTAMINATION POTENTIAL
DISTRIBUTION BY USEPA REGION

Figure 5-1



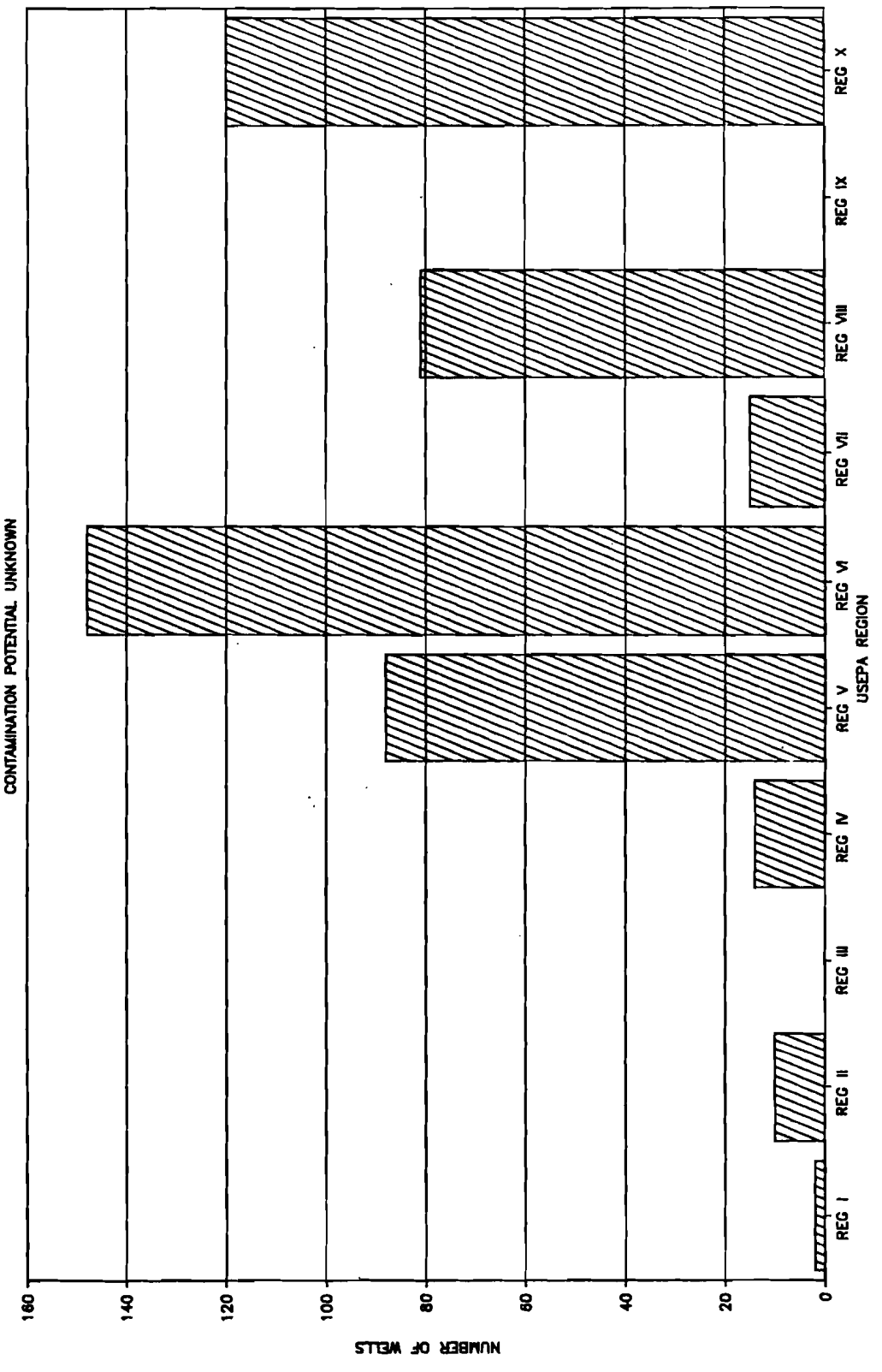
BAR GRAPH ILLUSTRATING
MODERATE CONTAMINATION POTENTIAL
DISTRIBUTION BY USEPA REGION

Figure 5-2



BAR GRAPH ILLUSTRATING
LOW CONTAMINATION POTENTIAL
DISTRIBUTION BY USEPA REGION

Figure 5-3



BAR GRAPH ILLUSTRATING
CONTAMINATION POTENTIAL UNKNOWN
DISTRIBUTION BY USEPA REGION

Figure 5-4

- Raw sewage waste disposal wells, 5W9, and cesspools, 5W10;
- Septic systems, 5W11, 5W31, 5W32;
- Domestic wastewater treatment plant disposal wells, 5W12 (high to low);
- Industrial process water and waste disposal wells, 5W20;
- Automobile service station disposal wells, 5X28; and
- Aquifer recharge wells, 5R21 (high to low).

Moderate Contamination Potential

- Storm Water drainage, 5D2, and industrial drainage wells, 5D4;
- Improved sinkholes, 5D3, (high to moderate);
- Special drainage wells, 5G30 (moderate to low);
- Electric power, 5A5, and direct heat reinjection wells, 5A6;
- Aquaculture return flow wells, 5A8;
- Domestic wastewater treatment plant disposal wells, 5W12 (high to low);
- Mining, sand, or other backfill wells, 5X13;
- In-situ fossil fuel recovery wells, 5X15;
- Cooling water return flow wells, 5A19, (moderate to low);
- Aquifer recharge wells, 5R21 (high to low);
- Experimental technology wells, 5X25 (moderate to low); and
- Abandoned drinking water/waste wells disposal wells, 5X29.

Low Contamination Potential

- Special drainage wells, 5G30 (moderate to low);
- Heat pump/air conditioning return flow wells, 5A7;
- Domestic wastewater treatment plant disposal wells, 5W12 (high to low);
- Solution mining wells, 5X14;
- Spent brine return flow wells, 5X16;
- Cooling water return flow wells, 5A19 (moderate to low);
- Aquifer recharge wells, 5R21 (high to low);
- Saline water intrusion barrier wells, 5B22;
- Subsidence control wells, 5S23; and
- Experimental technology wells, 5X25 (moderate to low).

Unknown Contamination Potential

- Radioactive Waste Disposal Wells, 5N24; and
- Aquifer remediation related wells, 5X26 (including hydrocarbon recovery related injection wells).

5.3.1 REGIONAL BREAKDOWN OF INVENTORY ACCORDING TO CONTAMINATION POTENTIAL

A series of tables have been compiled to indicate the breakdown of well types in each USEPA Region. The well types and numbers are listed in Tables 5-5 to 5-14 under headings which group well types by contamination potential. The tables are useful tools for prioritizing additional Class V inventory and assessment efforts in the various Regions.

5.3.2 SUMMARY OF REGULATORY SYSTEMS CURRENTLY KNOWN TO BE IN EFFECT

Class V injection wells are authorized by rule under the Federally-administered UIC programs (Section 1). Several States, however, implement their own methods of regulating Class V wells. Table 5-15 lists and Figure 5-5 illustrates the known regulatory systems in effect.

TABLE 5-5: WELL TYPES IN REGION I
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Improved Sinkholes (5D3)	3	0.8
Septic Undifferentiated(5W11)	97	26.6
Domestic WW Treatment Plant Effluent(5W12)	72	19.8
Industrial Process Water & WW(5W20)	99	27.2
Automobile Service Station(5X28)	14	3.8
Aquifer Recharge Wells(5R21)	1	0.3
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	22	6.0
Industrial Drainage(5D4)	16	4.4
Cooling Water Return Flow Wells(5A19)	14	3.8
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	24	6.6
CONTAMINATION POTENTIAL UNKNOWN		
Aquifer Remediation Related Wells(5X26)	2	0.5
TOTAL	364	100.0

TABLE 5-6: WELL TYPES IN REGION II
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Agricultural Drainage(5F1)	150	1.7
Improved Sinkholes (5D3)	10	0.1
Untreated Sewage Disp(5W9)	5	0.1
Cesspools(5W10)	68	0.8
Septic Undifferentiated(5W11)	1260	14.1
Septic with Well(5W31)	85	0.9
Septic with Drainfield(5W32)	63	0.7
Domestic WW Treatment Plant Effluent(5W12)	22	0.2
Industrial Process Water & WW(5W20)	401	4.5
Automobile Service Station(5X28)	21	0.2
Aquifer Recharge Wells(5R21)	3000	33.5
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	2504	28.0
Industrial Drainage(5D4)	1116	12.5
Cooling Water Return Flow Wells(5A19)	6	0.1
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	181	2.0
Solution Mining Wells(5X14)	48	0.5
CONTAMINATION POTENTIAL UNKNOWN		
Aquifer Remediation Related Wells(5X26)	10	0.1
TOTAL	8950	100.0

TABLE 5-7: WELL TYPES IN REGION III
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Septic Undifferentiated(5W11)	8	0.2
Septic with Well(5W31)	903	19.7
Domestic WW Treatment Plant Effluent(5W12)	5	0.1
Industrial Process Water & WW(5W20)	30	0.7
Automobile Service Station(5X28)	1	0.0
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	273	5.9
Industrial Drainage(5D4)	6	0.1
Mining Sand/Other Backfill Wells(5X13)	1070	23.3
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	2291	49.9
Spent-Brine Return Flow Wells(5X16)	2	0.0
CONTAMINATION POTENTIAL UNKNOWN		
None		
TOTAL	4589	100.0

TABLE 5-8: WELL TYPES IN REGION IV
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Agricultural Drainage(5F1)	43	0.2
Improved Sinkholes (5D3)	81	0.3
Septic Undifferentiated(5W11)	19001	68.1
Septic with Well(5W31)	736	2.6
Septic with Drainfield(5W32)	200	0.7
Domestic WW Treatment Plant Effluent(5W12)	556	2.0
Industrial Process Water & WW(5W20)	318	1.1
Aquifer Recharge Wells(5R21)	349	1.3
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	2072	7.4
Industrial Drainage(5D4)	2	0.0
Special Drainage Wells(5G30)	1385	5.0
Mining Sand/Other Backfill Wells(5X13)	61	0.2
Cooling Water Return Flow Wells(5A19)	75	0.3
Experimental Technology Wells(5X25)	18	0.1
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	2998	10.7
Saline Water Intrusion Barrier Wells(5B22)	2	0.0
CONTAMINATION POTENTIAL UNKNOWN		
Radioactive Waste Disposal Wells(5N24)	1	0.0
Aquifer Remediation Related Wells(5X26)	13	0.0
TOTAL	27911	100.0

TABLE 5-9: WELL TYPES IN REGION V
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Agricultural Drainage(5F1)	147	0.8
Improved Sinkholes (5D3)	135	0.8
Untreated Sewage Disp(5W9)	959	5.4
Cesspools(5W10)	65	0.4
Septic Undifferentiated(5W11)	4537	25.5
Septic with Well(5W31)	2635	14.8
Domestic WW Treatment Plant Effluent(5W12)	41	0.2
Industrial Process Water & WW(5W20)	527	3.0
Automobile Service Station(5X28)	34	0.2
Aquifer Recharge Wells(5R21)	2	0.0
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	4987	28.1
Industrial Drainage(5D4)	191	1.1
Mining Sand/Other Backfill Wells(5X13)	5	0.0
In-situ Fossil Fuel Recovery Wells(5X15)	2	0.0
Cooling Water Return Flow Wells(5A19)	90	0.5
Experimental Technology Wells(5X25)	8	0.0
Abandoned Drinking Water Wells(5X29)	2095	11.8
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	1164	6.5
Solution Mining Wells(5X14)	15	0.1
Spent-Brine Return Flow Wells(5X16)	41	0.2
Subsidence Control Wells(5S23)	4	0.0
CONTAMINATION POTENTIAL UNKNOWN		
Radioactive Waste Disposal Wells(5N24)	1	0.0
Aquifer Remediation Related Wells(5X26)	87	0.5
TOTAL	17772	100.0

TABLE 5-10: WELL TYPES IN REGION VI
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL # S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Agricultural Drainage(5F1)	108	2.8
Untreated Sewage Disp(5W9)	10	0.3
Cesspools(5W10)	30	0.8
Septic Undifferentiated(5W11)	66	1.7
Industrial Process Water & WW(5W20)	4	0.1
Aquifer Recharge Wells(5R21)	74	1.9
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	57	1.5
Industrial Drainage(5D4)	5	0.1
Special Drainage Wells(5G30)	1	0.0
Direct Heat Reinjection Well(5A6)	3	0.1
Mining Sand/Other Backfill Wells(5X13)	76	2.0
Cooling Water Return Flow Wells(5A19)	7	0.2
Experimental Technology Wells(5X25)	12	0.3
Abandoned Drinking Water Wells(5X29)	945	24.6
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	1146	29.8
Solution Mining Wells(5X14)	1073	27.9
Spent-Brine Return Flow Wells(5X16)	77	2.0
CONTAMINATION POTENTIAL UNKNOWN		
Radioactive Waste Disposal Wells(5N24)	2	0.1
Aquifer Remediation Related Wells(5X26)	147	3.8
TOTAL	3843	100.0

TABLE 5-11: WELL TYPES IN REGION VII
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Agricultural Drainage(5F1)	235	3.5
Improved Sinkholes (5D3)	250	3.7
Septic Undifferentiated(5W11)	5	0.1
Automobile Service Station(5X28)	6	0.1
Aquifer Recharge Wells(5R21)	8	0.1
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	10	0.1
Mining Sand/Other Backfill Wells(5X13)	4326	64.8
Cooling Water Return Flow Wells(5A19)	16	0.2
Experimental Technology Wells(5X25)	2	0.0
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	1802	27.0
CONTAMINATION POTENTIAL UNKNOWN		
Aquifer Remediation Related Wells(5X26)	15	0.2
TOTAL	6675	100.0

TABLE 5-12: WELL TYPES IN REGION VIII
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Agricultural Drainage(5F1)	1	0.0
Cesspools(5W10)	3	0.0
Septic Undifferentiated(5W11)	422	4.7
Industrial Process Water & WW(5W20)	36	0.4
Automobile Service Station(5X28)	2	0.0
Aquifer Recharge Wells(5R21)	7	0.1
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	7250	80.4
Industrial Drainage(5D4)	321	3.6
Special Drainage Wells(5G30)	55	0.6
Direct Heat Reinjection Well(5A6)	3	0.0
Mining Sand/Other Backfill Wells(5X13)	386	4.3
In-situ Fossil Fuel Recovery Wells(5X15)	64	0.7
Cooling Water Return Flow Wells(5A19)	6	0.1
Experimental Technology Wells(5X25)	137	1.5
Abandoned Drinking Water Wells(5X29)	7	0.1
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	219	2.4
Solution Mining Wells(5X14)	14	0.2
Spent-Brine Return Flow Wells(5X16)	1	0.0
CONTAMINATION POTENTIAL UNKNOWN		
Aquifer Remediation Related Wells(5X26)	81	0.9
TOTAL	9015	100.0

TABLE 5-13: WELL TYPES IN REGION IX
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Untreated Sewage Disp(5W9)	3	0.0
Cesspools(5W10)	120	0.2
Septic Undifferentiated(5W11)	1313	2.0
Septic with Well(5W31)	73	0.1
Septic with Drainfield(5W32)	1279	2.0
Domestic WW Treatment Plant Effluent(5W12)	358	0.6
Industrial Process Water & WW(5W20)	209	0.3
Aquifer Recharge Wells(5R21)	103	0.2
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	59483	92.6
Industrial Drainage(5D4)	4	0.0
Special Drainage Wells(5G30)	1	0.0
Electric Power Reinjection Well(5A5)	81	0.1
Direct Heat Reinjection Well(5A6)	7	0.0
GW Aquaculture Return Flow Well(5A8)	25	0.0
Mining Sand/Other Backfill Wells(5X13)	1	0.0
Cooling Water Return Flow Wells(5A19)	26	0.0
Experimental Technology Wells(5X25)	45	0.1
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	53	0.1
Solution Mining Wells(5X14)	875	1.4
Saline Water Intrusion Barrier Wells(5B22)	155	0.2
CONTAMINATION POTENTIAL UNKNOWN		
None		
TOTAL	64214	100.0

TABLE 5-14: WELL TYPES IN REGION X
CLASSIFIED BY CONTAMINATION POTENTIAL

WELL TYPE & CLASSIFICATION	WELL #'S	% OF TOTAL
HIGH CONTAMINATION POTENTIAL		
Agricultural Drainage(5F1)	654	2.2
Untreated Sewage Disp(5W9)	3	0.0
Cesspools(5W10)	6336	21.2
Septic Undifferentiated(5W11)	60	0.2
Septic with Well(5W31)	3	0.0
Septic with Drainfield(5W32)	2241	7.5
Domestic WW Treatment Plant Effluent(5W12)	45	0.2
Industrial Process Water & WW(5W20)	365	1.2
Automobile Service Station(5X28)	21	0.1
Aquifer Recharge Wells(5R21)	14	0.0
MODERATE CONTAMINATION POTENTIAL		
Storm Water Drainage(5D2)	16910	56.7
Industrial Drainage(5D4)	2141	7.2
Special Drainage Wells(5G30)	115	0.4
Electric Power Reinjection Well(5A5)	8	0.0
Direct Heat Reinjection Well(5A6)	8	0.0
Mining Sand/Other Backfill Wells(5X13)	575	1.9
Cooling Water Return Flow Wells(5A19)	51	0.2
Experimental Technology Wells(5X25)	3	0.0
Abandoned Drinking Water Wells(5X29)	3	0.0
LOW CONTAMINATION POTENTIAL		
Heat Pump/AC Return Flow Wells(5A7)	150	0.5
CONTAMINATION POTENTIAL UNKNOWN		
Radioactive Waste Disposal Wells(5N24)	120	0.4
TOTAL	29826	100.0

SUMMARY OF STATE'S REGULATORY SYSTEMS OF CLASS V WELLS (PART ONE)
AUGUST 1987

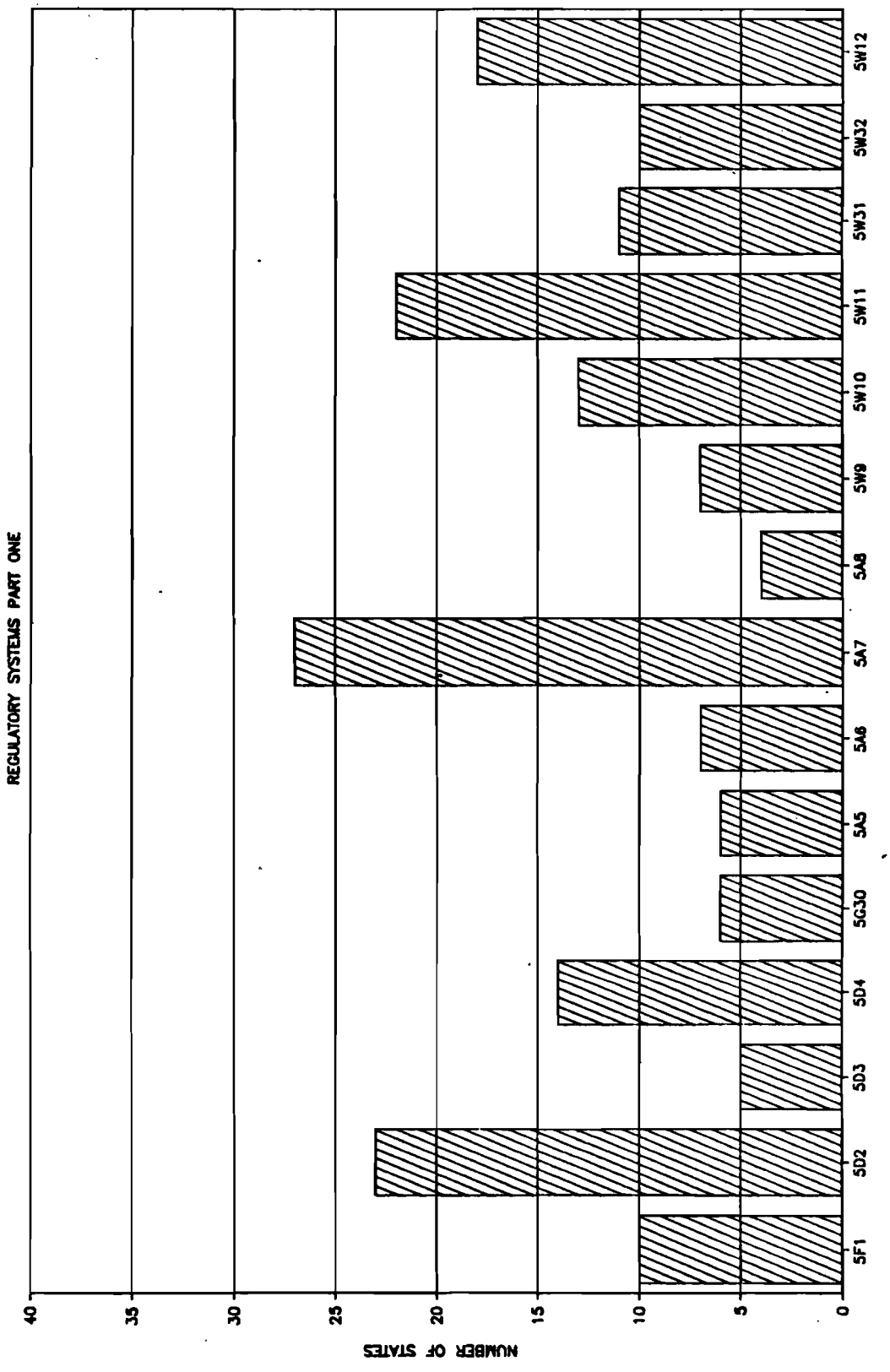
STATES BY REGION	EPA REGION	DRAINAGE					GEOTHERMAL				DOMESTIC WASTEWATER					
		5F1	5D2	5D3	5D4	5G30	5R5	5A6	5A7	5A8	5W9	5W10	5W11	5W31	5W32	5W12
Connecticut	I	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	PERMIT>5K GPD	N/A	N/A	N/A
Maine	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Massachusetts	I	N/A	EXEMPT	N/A	N/A	N/A	N/A	N/A	PERMIT>15K GPD	N/A	N/A	N/A	PERMIT>15K GPD	N/A	N/A	PERMIT>15K GPD
New Hampshire	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Rhode Island	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vermont	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
New Jersey	II	N/A	NJPDES PERMIT	N/A	NJPDES PERMIT	N/A	N/A	N/A	RULE/PERMIT	N/A	N/A	NJPDES PERMIT	NJPDES PERMIT	N/A	N/A	N/A
New York	II	SPDES PERMIT	PERMIT>1K GPD	N/A	PERMIT>1K GPD	N/A	N/A	N/A	PERMIT	N/A	N/A	PERMIT>1K GPD	PERMIT>1K GPD	PERMIT>1K GPD	PERMIT>1K GPD	PERMIT
Puerto Rico	II	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT
Virgin Islands	II	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Delaware	III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Maryland	III	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A
Pennsylvania	III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Virginia	III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
West Virginia	III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alabama	IV	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A
Florida	IV	PERMIT	PERMIT	PERMIT	PERMIT	PERMIT/RULE	N/A	N/A	PERMIT	N/A	N/A	N/A	PERMIT	N/A	N/A	PERMIT
Georgia	IV	BANNED	BANNED	BANNED	BANNED	N/A	N/A	N/A	BANNED	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kentucky	IV	N/A	LOCAL	LOCAL	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	RULE	N/A	ELIMINATE
Mississippi	IV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
North Carolina	IV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A
South Carolina	IV	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	RULE	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A
Tennessee	IV	N/A	PERMIT	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Illinois	V	RULE	RULE	N/A	RULE	N/A	N/A	N/A	RULE	N/A	BANNED	N/A	N/A	N/A	N/A	RULE
Indiana	V	N/A	N/A	NONE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT
Michigan	V	N/A	N/A	NONE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT
Minnesota	V	N/A	N/A	NONE	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	RULE	N/A	N/A	N/A
Ohio	V	N/A	N/A	NONE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wisconsin	V	N/A	NONE	N/A	RULE	N/A	N/A	N/A	RULE	N/A	N/A	N/A	N/A	RULE	N/A	N/A
Arkansas	VI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Louisiana	VI	N/A	N/A	N/A	CLASS II	CLASS II	N/A	N/A	PERMIT	N/A	N/A	N/A	RULE	N/A	N/A	N/A
New Mexico	VI	N/A	REGISTRATION	N/A	N/A	N/A	N/A	PERMIT	REGISTRATION	N/A	N/A	BANNED	REGISTRATION	N/A	N/A	N/A
Oklahoma	VI	RULE	RULE	N/A	N/A	N/A	N/A	N/A	RULE	N/A	N/A	N/A	RULE	N/A	N/A	N/A
Texas	VI	N/A	N/A	N/A	N/A	N/A	PERMIT	PERMIT	RULE	N/A	N/A	RULE	LOCAL	N/A	N/A	RULE/PERMIT
Iowa	VII	DIVERSION PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kansas	VII	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Missouri	VII	NONE	N/A	NONE	N/A	N/A	N/A	N/A	REGISTRATION	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A
Nebraska	VII	RULE	RULE	N/A	RULE	RULE	RULE	RULE/PERMIT	RULE	RULE	RULE	RULE	RULE	RULE	RULE	RULE
Colorado	VIII	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Montana	VIII	N/A	PERMIT	N/A	N/A	PERMIT	N/A	N/A	NONE	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A
North Dakota	VIII	N/A	N/A	N/A	N/A	N/A	N/A	N/A	RULE	N/A	N/A	N/A	RULE	N/A	N/A	N/A
South Dakota	VIII	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Utah	VIII	RULE	RULE	N/A	RULE	N/A	PERMIT	PERMIT	PERMIT	PERMIT	BANNED	BANNED	PERMIT	PERMIT	PERMIT	PERMIT
Wyoming	VIII	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	PERMIT	PERMIT	N/A	N/A	N/A
Arizona	IX	PERMIT	REGISTRATION	N/A	REGISTRATION	N/A	N/A	N/A	NONE	N/A	N/A	PERMIT	PERMIT	PERMIT	PERMIT	PERMIT
California	IX	N/A	RULE	N/A	RULE	N/A	PERMIT	PERMIT	PERMIT	N/A	N/A	BANNED	N/A	PERMIT	PERMIT	PERMIT
Hawaii	IX	N/A	PERMIT	N/A	PERMIT	PERMIT	N/A	N/A	N/A	PERMIT	PERMIT	PERMIT	N/A	PERMIT	N/A	PERMIT
Nevada	IX	N/A	N/A	N/A	N/A	N/A	PERMIT	PERMIT	N/A	N/A	BANNED	BANNED	PERMIT	BANNED	PERMIT	BANNED
American Samoa	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tr. Terr. of P	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Guam	IX	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CNMI	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NONE	N/A	N/A	N/A
Alaska	X	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	PERMIT OR RULE	PERMIT OR RULE	PERMIT OR RULE	PERMIT OR RULE	PERMIT OR RULE	PERMIT OR RULE
Idaho	X	PERMIT>10 ft	PERMIT>10 FT	N/A	N/A	PERMIT>10 FT	PERMIT	PERMIT	PERMIT	N/A	N/A	N/A	PERMIT>10 FT	N/A	N/A	RULE
Oregon	X	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT>5K GPD	PERMIT>5K GPD	PERMIT>5K GPD	RULE	RULE	N/A	N/A	PERMIT>5K GPD	N/A
Washington	X	UNDECIDED	NONE	N/A	NONE	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	PERMIT/RULE	N/A	PERMIT	RULE

TABLE 5-15A

SUMMARY OF STATE'S REGULATORY SYSTEMS OF CLASS V WELLS (PART TWO)
AUGUST 1987

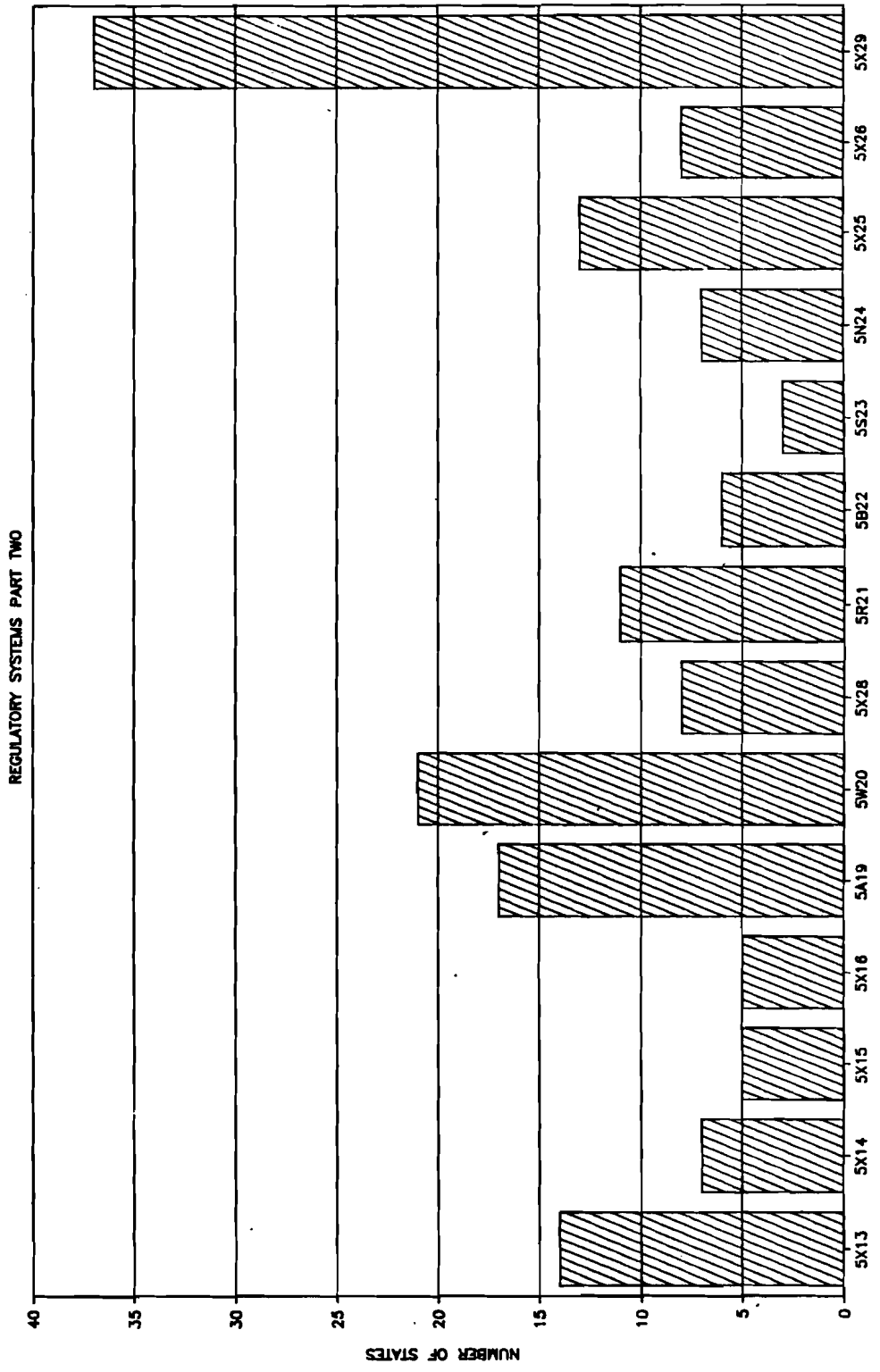
STATES BY REGION	EPA REGION	MINERAL & FOSSIL FUEL				INDUSTRIAL			RECHARGE			MISCELLANEOUS			
		5X13	5X14	5X15	5X16	5X19	5X20	5X28	5X21	5X22	5X23	5X24	5X25	5X26	5X29
Connecticut	I	N/A	N/A	N/A	N/A	N/A	PERMIT	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	NO
Maine	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Massachusetts	I	N/A	N/A	N/A	N/A	PERMIT>2K GPD	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
New Hampshire	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Rhode Island	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Vermont	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
New Jersey	II	N/A	N/A	N/A	N/A	NJPDES PERMIT	NJPDES PERMIT	NJPDES PERMIT	RULE/PERMIT	RULE/PERMIT	N/A	N/A	N/A	NJPDES PERMIT	PIA RULES
New York	II	N/A	PERMIT	N/A	PERMIT	N/A	PERMIT	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	NO
Puerto Rico	II	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Virgin Islands	II	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Delaware	III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Maryland	III	PERMIT	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Pennsylvania	III	MINE OPERATION	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Virginia	III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
West Virginia	III	MINE OPERATION	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Alabama	IV	PERMIT	N/A	N/A	N/A	PERMIT	PERMIT	N/A	N/A	N/A	N/A	N/A	PERMIT	PERMIT	PIA RULES
Florida	IV	N/A	N/A	N/A	N/A	PERMIT	PERMIT	PERMIT	PERMIT	PERMIT	N/A	N/A	PERMIT	N/A	PIA RULES
Georgia	IV	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Kentucky	IV	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Mississippi	IV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	RULE	N/A	NO
North Carolina	IV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT	PERMIT	PIA RULES
South Carolina	IV	N/A	N/A	N/A	N/A	RULE	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Tennessee	IV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Illinois	V	RULE	N/A	N/A	N/A	RULE	RULE	RULE	RULE	N/A	N/A	RULE	RULE	N/A	PIA RULES
Indiana	V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Michigan	V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Minnesota	V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Ohio	V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Wisconsin	V	N/A	N/A	N/A	N/A	RULE	PERMIT	N/A	N/A	N/A	PERMIT	N/A	N/A	RULE	PIA RULES
Arkansas	VI	N/A	N/A	N/A	PERMIT	NONE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Louisiana	VI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
New Mexico	VI	N/A	PERMIT	N/A	N/A	REGISTRATION	N/A	N/A	REGISTRATION	N/A	N/A	ILLEGAL	PERMIT	N/A	NO
Oklahoma	VI	N/A	N/A	N/A	RULE	N/A	N/A	N/A	N/A	N/A	N/A	RULE	N/A	RULE	PIA RULES
Texas	VI	RULE	N/A	PERMIT	N/A	N/A	CLASS I	N/A	PERMIT +	N/A	N/A	N/A	N/A	N/A	PIA RULES
Iowa	VII	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Kansas	VII	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Missouri	VII	NONE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Nebraska	VII	RULE	PERMIT	RULE	RULE	RULE	RULE	RULE	RULE	RULE	RULE	RULE	RULE	PERMIT	PIA RULES
Colorado	VIII	RULE	N/A	RULE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Montana	VIII	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
North Dakota	VIII	RULE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
South Dakota	VIII	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Utah	VIII	RULE	PERMIT	PERMIT	RULE	PERMIT	BANNED	BANNED	RULE/PERMIT	RULE/PERMIT	RULE/PERMIT	RULE/PERMIT	RULE/PERMIT	RULE/PERMIT	BANNED
Wyoming	VIII	PERMIT	PERMIT	PERMIT	N/A	N/A	PERMIT	N/A	PERMIT	N/A	N/A	N/A	PERMIT	N/A	PIA RULES
Arizona	IX	N/A	PERMIT	N/A	N/A	N/A	PERMIT	N/A	PERMIT	N/A	N/A	N/A	PERMIT	N/A	PIA RULES
California	IX	N/A	PERMIT	N/A	N/A	PERMIT	PERMIT	N/A	PERMIT	PERMIT	N/A	N/A	PERMIT	PERMIT	PIA RULES
Hawaii	IX	N/A	N/A	N/A	N/A	PERMIT	PERMIT	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	NO
Nevada	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PERMIT	N/A	PIA RULES
American Samoa	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Tr. Terr. of P	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Guam	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
CNMI	IX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO
Alaska	X	N/A	N/A	N/A	N/A	PERMIT	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Idaho	X	RULE	N/A	N/A	N/A	PERMIT	PERMIT>18 FT	RULE	PERMIT>18 FT	N/A	N/A	PERMIT>18 FT	N/A	N/A	PIA RULES
Oregon	X	N/A	N/A	N/A	N/A	PERMIT>5K GPD	PERMIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	PIA RULES
Washington	X	N/A	N/A	N/A	N/A	PERMIT	N/A	N/A	N/A	PERMIT	N/A	PERMIT	N/A	N/A	PIA RULES

TABLE 5-15B



NUMBER OF STATES WITH KNOWN IN-PLACE REGULATORY SYSTEMS FOR CLASS V WELLS (PART ONE) AUGUST 1987

Figure 5-5a



NUMBER OF STATES WITH KNOWN IN-PLACE REGULATORY SYSTEMS FOR CLASS V WELLS (PART TWO) AUGUST 1987

Figure 5-5b

Several items should be clearly understood when interpreting this information. First, these data are based on information reviewed to date (5-15-87) as provided by State Class V reports. Second, it is very likely that many additional regulatory systems are currently in effect, but the State reports have not completely addressed them, in many cases.

In describing States' regulatory systems, the intent was to use one of the following words: Permit, Rule, Banned, None, or Information Not Available (N/A). However, many States use these systems in conjunction with a multitude of qualifiers and/or exemptions. For example, Idaho regulates some well types by permit if the wells are deeper than 18 feet but regulates by rule if they are shallower than 18 feet. Several States regulate by permit only when the amount of injection fluid exceeds a set volume (i.e., Oregon 5A6-8 are permitted if injecting more than 5,000 (5K) gallons per day). In the case of abandoned drinking water wells (5X29), most States appear to have existing rules for proper plugging and abandonment (P & A) procedures. Utah specifically indicated that injection into abandoned drinking water wells is illegal. Kentucky could not identify State systems in effect for drainage wells (5D2, 5D3) because they are regulated locally.

In general, few States regulate all well types, since many well types are highly dependent on the geology of the area (5D3, 5A6-8). The fact that some States do not have a regulatory program for a particular well type does not mean that those wells are not adequately regulated. In actuality, many States have not regulated some well types because these well types are not located in their States.

In spite of some of the pitfalls, the effort to identify current regulatory systems will help simplify the task of identifying future actions necessary for an effective National Class V program.

5.3.3 SUMMARY OF CLASS V INJECTION WELL DATA

Table 5-16 presents a summary of available inventory data, types of fluids injected, contamination potentials, recommendations, and State regulatory systems for each well type.

TABLE 5-16

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Drainage Wells					
Agricultural Drainage Wells (5F1)	Nationwide: 1,338 wells New York: 150 wells Puerto Rico: no numbers West Virginia: no numbers Florida: no numbers Georgia: 43 wells Kentucky: no numbers Illinois: 6 wells Indiana: 72 wells Michigan: 15 wells Minnesota: 54 wells Oklahoma: no numbers Texas: 108 wells Iowa: 230 wells Missouri: no numbers Nebraska: 5 wells Colorado: no numbers North Dakota: 1 well Idaho: 572 wells Oregon: 16 wells Washington: 66 wells Potentially many times this figure in areas typified by irrigation.	Varies due to differing farming practices and soil types; potential agricultural contaminants include sediment, nutrients, pesticides, organics, salts, metals, and pathogens in some cases.	High	New York - SPDES Permit Florida - Permit Georgia - Banned Illinois - Rule Oklahoma - Rule Iowa - Diversion Permit Missouri - None Nebraska - Rule Utah - Rule Arizona - Permit Idaho - Permit if deeper than 18 feet Washington - Undecided	- Improvement of inventory efforts is essential. (PR, GA, IN, MI, MN, CO, OR) - Locate and properly plug all abandoned wells near Agricultural Drainage Wells. (IA) - Close surface inlets to allow infiltration through soil. (MO) - Raise the inlets above maximum ponding levels. (IA) - Require that injection fluids meet all or some drinking water standards. (NE, OR) - Require irrigation tailwater recovery and pumpback. (OR) - Use only necessary amounts of irrigation water and applied chemicals. (CA) - Require frequent monitoring of drinking water wells in surrounding areas. - Require detailed map with all well locations. (NE) - Require diagram of injection well construction. (NE) - Require siting of wells at least 2,000 ft. away from any stock, municipal, or domestic well. (NE) - Discourage use and encourage elimination of agricultural drainage wells by developing alternate methods. (IA)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Storm Water Drainage Wells (5D2)	Nationwide: 80,000-100,000 wells reported for 39 States	Herbicides, pesticides, fertilizers, deicing salts, asphaltic sediments, gasoline, grease oil, tar and residues from roofs and paving, rubber particulates, liquid wastes and industrial solvents, heavy metals and coliform bacteria.	Moderate	Information applies to both 5D2 and 5D4 unless otherwise specified. Connecticut-Permit (5D2) Massachusetts-Exempt (5D2) New Jersey-NJPDES Permit New York-Permit if injected volume exceeds 1,000 GPD Maryland-Permit (5D4) Alabama-Permit (5D2) Florida-Permit Georgia-Banned Kentucky-Local (5D2), Permit (5D4) South Carolina-Permit (5D2) Tennessee-Permit (5D2) Illinois-Rule Wisconsin-None (5D2) Rule (5D4) Louisiana-Class II Regulations (5D4), Registration of Class V wells not required New Mexico-Registration Oklahoma-Rule Nebraska-Rule Montana-Permit (5D2) Utah-Rule Wyoming-Permit (5D2) Arizona-Registration California-Rule Hawaii-Permit Guam-Permit (5D2) Alaska-Permit (5D2) Idaho-Permit if deeper than 18 feet (5D2) Washington-None	Apply to both storm water and industrial drainage wells: - New wells should be investigated and added to FURS. (KY, UT, WA) - Construction of new industrial drainage wells should be limited or discouraged; storm water sewers, detention ponds, or vegetative basins are preferred. (OR, IL, KY, TN, UT). - Sand and gravel filters should be added to wells. (KY, TN) - Stand pipes should be constructed at the openings of wells. (KY, TN) - Limit future construction to residential areas. (IL) - All spills should be diverted away from industrial drainage wells (OR, UT, WA) - New construction of wells in areas served by storm water sewers should be prohibited. (CA, AZ) - Drainage wells should not be constructed within 200 ft. of water supply wells which tap lower water-bearing aquifers. (CA) - Deep wells should be plugged or cemented to avoid mixing between aquifers. (KY, TN) - Depth to water data should be made available to well drillers. (AZ) - Additional studies including use of monitoring wells should be conducted to study possible pollution sources and prolonged effect of industrial drainage wells on ground water. (FL, WI, KS) - An assessment of the effects of storm drainage wells should be conducted prior to completing an inventory because the inventory would be time-consuming and costly. (MT, OR) - Sediments extracted from drainage wells, catch basins, or sediment traps should be disposed in an appropriate landfill. (AZ) - A public awareness program should be implemented. (AZ) - All drainage wells should be identified and plugged. (WV)
Industrial Drainage Wells (5D4)	Nationwide: 3,802 wells reported for 23 States.	Similar constituents to those found in Stormwater Drainage Wells, though generally present in higher concentrations. Heavy metals such as lead, iron, and manganese. Organic compounds.			

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Improved Sinkholes (5D3)	Nationwide: 479 wells New Hampshire: 3 wells Puerto Rico: 10 wells Kentucky: 76 wells Tennessee: 5 wells Indiana: 26 wells Michigan: 103 wells Minnesota: 6 wells Missouri: 250 wells Virginia, West Virginia, Florida, and Ohio: numbers not yet confirmed. Potentially in all areas with limestone and dolomite lithologies at relatively shallow depths.	Runoff, from paved areas, containing lead and petroleum products from automobiles, pesticides from horticulture and lawn care, nitrates from fertilizers, and fecal material from wild and domestic animals; normal fallout from air pollutants may also be present.	High to Moderate	Puerto Rico-Permit Florida-Permit Georgia-Banned Kentucky-Local Tennessee-Permit Indiana-None Michigan-None Minnesota-None Ohio-None Missouri-None	- Training should be required for engineers and drillers in the proper construction of wells with special emphasis on sanitary sealing and protection against corrosion. Training should be slanted toward construction in Karst or limestone formations. (PR) - Careful dye trace studies should be run on any existing or improved sinkhole drainage systems, and occasional monitoring of both entering and exiting fluids should be run after the system is in operation. (MO)
Special Drainage Wells (5G30)	Nationwide: 1,557 wells Florida: 1,385 wells Louisiana: 1 well Montana: 55 wells Hawaii: 1 well Idaho: 7 wells Washington: 108 wells. Potentially present in all Regions.	Highly variable, depending on system design; for landslide control, ground water is generally used; swimming pool drainage fluid may contain lithium hypochlorite, calcium hypochlorite, sodium bicarbonate, chlorine, bromine, iodine, cyanuric acid, aluminum sulfate, algaecides, fungicides, and muriatic acid.	Moderate to Low	Florida-Permit/Rule Louisiana-Class II Regulations, Registration of Class V wells not required Nebraska-Rule Montana-Permit Hawaii-Permit Idaho-Permit if deeper than 18 feet.	- Random sampling and analysis of swimming pool wastewater for possible contaminants should be required. (FL)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Geothermal Reinjection Wells					
Electric Power Reinjection Wells (5A5)	Nationwide: 89 wells Texas: numbers not confirmed California: 65 wells Nevada: 16 wells Idaho: 4 wells Alaska: 4 wells	Vapor-Dominated Resource heavy metals (arsenic, boron, selenium), sulfates, and dissolved solids. Hot Water-Dominated Resource heavy metals (arsenic, boron, selenium), chlorides, dissolved solids, and acidic pH.	Moderate	Texas-Permit Nebraska-Rule Utah-Permit California-Permit Nevada-Permit Idaho-Permit	Apply to both electric power and direct heat reinjection wells: - Detailed study on the types of MIT available for geothermal systems and the resolution of each method. (NV) - Initial analysis of injectate and injection zone water conducted prior to full-scale injection operations; parameters of concern are temperature, inorganic constituents of Primary and Secondary Drinking Water Regulations, alkalinity, hardness, silica, boron, and ammonia nitrogen. (CA, NV) - Injection into non-thermal reservoirs if the thermal injection fluids meet drinking water requirements or if the receiving fluids are of equal or lesser quality. (ID)
Direct Heat Reinjection Wells (5A6)	Nationwide: 21 wells New York: no numbers New Mexico: 2 wells Texas: 1 well Colorado: 2 wells California: 1 well Nevada: 6 wells Idaho: 2 wells Oregon: 6 wells Utah: 1 well	Arsenic, boron, fluoride, dissolved solids, sulfates, chloride.	Moderate	New Mexico-Permit Texas-Permit Nebraska-Rule/Permit Utah-Permit California-Permit Nevada-Permit Idaho-Permit Oregon-Permit if injected volume exceeds 5,000 GPD	

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Heat Pump/Air Conditioning Return Flow Wells (5A7)	Nationwide: 10,028 wells. Potentially present in all regions; more expected in areas characterized by climatic extremes. Reported in all States except the following: Maine, Rhode Island, Vermont, Puerto Rico, Virgin Islands, West Virginia, Alabama, Arkansas, Hawaii, American Samoa, TTPI, Guam, CNMI.	Primarily thermally altered ground water; additives designed to inhibit scaling, corrosion and incrustation when water high in metals and salts, or demonstrating high or low pH, is used.	Low	Connecticut-Permit Massachusetts-Permit if injected volume is greater than 15,000 GPD New Jersey-Rule/Permit New York-Permit Delaware-Permit Maryland-Permit Florida-Permit Georgia-Banned North Carolina-Permit South Carolina-Rule Illinois-Rule Minnesota-Permit Wisconsin-Rule Louisiana-Permit New Mexico-Registration Oklahoma-Rule Texas-Rule Missouri-Registration Nebraska-Rule Montana-None North Dakota-Rule Utah-Permit Wyoming-Permit Arizona-None California-Permit Alaska-Permit Idaho-Permit Oregon-Permit if injected volume is greater than 5,000 GPD Washington-Permit	- More research is needed on the theoretical environmental effects of heat pumps. (MO, AZ, SC) - Authorization by rule is appropriate for properly spaced and operated systems. (SC) - New regulatory programs should be directed at large-scale systems rather than at systems for single-family dwellings. (LA, OK, TX) - Records should be maintained by counties and periodically up-loaded to State databases in order to monitor well densities. (WA) - The State permitting agency should set construction standards and ensure that wells are constructed and operated properly. (FL, KS, MO, NE, SC, WA) - Permits for commercial developments should include requirements for water quality characterizations of both source and receiving water. (WA) - Return wells should be cased through top of injection zone. (IA) - Annular space should be cemented or grouted. (IA, KS, NE, TN) - Adequate spacing between production wells should be practiced. (KS, NE, SC) - Discharge should be into or above the supply aquifer. (LA, IA, KS, SC) - Closed loop systems should be required. (UT, TN) - Discharge should be to the surface rather than to an injection well. (LA) - The waste product should contain no additives or only approved additives (LA, KS, NE) - Volumes and temperatures of injection fluids should be monitored. (NC) - Analyses of receiving fluids should be conducted periodically. (KS, WA) - A licensed water well driller should be employed to install, rework, and/or plug and seal the well. (IA, IL) - New well installation in known or suspected contaminated aquifers should be prohibited. (WA)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Ground-water Aquaculture Return Flow Wells (5A8)	Hawaii: 7 active wells 3 standby wells 15 proposed wells Potentially found wherever marine or fresh water organisms are cultured in large quantities.	Large volumes of wastewater composed of essentially salt water with added nutrients, bacteriological growth, perished animals, and animal detritus. Effluent typically contains nitrates, nitrites, ammonia, high BOD, and orthophosphate.	Moderate	Nebraska-Rule Utah-Permit Hawaii-Permit Oregon-Permit if injected volume exceeds 5,000 GPD	- Regular sampling and analysis of injection fluid and injection zone fluid should be required (semi-annually). (HI) - Water to be disposed should be filtered and appropriately treated prior to injection. (HI) - Return waters should be carefully monitored at a point before and after treatment to ensure the measures being employed are sufficient to allow the water to be injected. (HI)
Domestic Wastewater Disposal Wells					
Raw Sewage Disposal Wells (5W9)	Nationwide: 980 wells Puerto Rico: 5 wells Pennsylvania: no numbers Illinois: 916 wells Indiana: 22 wells Michigan: 11 wells Minnesota: 10 wells Texas: 10 wells Hawaii: 3 wells Alaska: 3 wells	Generally poor quality, including high fixed volatiles, BOD, COD, TOC, nitrogen (organic, and free ammonia), chloride, alkalinity and grease.	High	Illinois-Banned Nebraska-Rule Utah-Banned Hawaii-Permit Nevada-Banned Alaska-Permit or Rule Oregon-Rule	No recommendations concerning raw sewage disposal wells and cesspools were provided in State reports. However, the use of such disposal methods has been banned in several States.
Cesspools (5W10)	Nationwide: 6,622 wells New Jersey: 1 well New York: no numbers Puerto Rico: 67 wells Indiana: 22 wells Michigan: 18 wells Minnesota: 25 wells New Mexico: 14 wells Texas: 16 wells Nebraska: no numbers Wyoming: 3 wells Arizona: 17 wells California: 46 wells Hawaii: 57 wells Alaska: > 79 wells Oregon: 6,257 wells	Same as for Raw Sewage Disposal Wells.	High	New Jersey-NJPDES Permit New York-Permit if injected volume exceeds 1,000 GPD New Mexico-Banned Texas-Rule Nebraska-Rule Utah-Banned Wyoming-Permit Arizona-Permit California-Banned Hawaii-Permit Nevada-Banned Alaska-Permit or Rule Oregon-Rule	

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Septic Systems (5W11, 5W31, 5W32)	5W11: 26,769 inventoried wells in 31 States 5W31: 4,435 wells in 13 States 5W32: 3,783 wells in 8 States	Varies with type of system; fluids typically 99.9% water (by weight) and .03 suspended solids; major constituents include nitrates, chlorides, sulfates, sodium, calcium, and fecal coliform.	High	Connecticut-Permit if volume injected exceeds 5,000 GPD Massachusetts-Permit if volume injected exceeds 15,000 GPD New Jersey-NJPDES Permit New York-Permit if volume injected exceeds 1,000 GPD Maryland-Permit (5W31) Alabama-Permit Florida-Permit Kentucky-Rule (5W31) South Carolina-Permit (5W32) Minnesota-Rule Wisconsin-Rule (5W31) Louisiana-Rule New Mexico-Registration Oklahoma-Rule Texas-Local Missouri-Permit Nebraska-Rule Montana-Permit North Dakota-Rule Utah-Permit Wyoming-Permit, Arizona-Permit California-Permit Hawaii-Permit (5W31) Nevada-Banned (5W31), Permit (5W32) CNMI-None Alaska-Permit or Rule Idaho-Permit if deeper than 18 feet Oregon-Permit if injected volume exceeds 5,000 GPD (5W32) Washington-Permit/Rule	- Further study is recommended. (FL, MT, OR) - Proper construction and installation guidelines should be developed. (MD) - Ongoing training programs for sanitarians is recommended; should include hydrogeology, ground-water flow, theory of septic system operation, and potential risks to human health. (PR, MD, MN) - Siting should be conducted so as not to endanger water wells. (KS, NE) - All systems should be sited and designed individually. (TX) - Local planning groups should be encouraged to establish septic tank density limits. (NE) - Sewage disposal wells for private facilities should be phased out and replaced by alternate methods of treatment and disposal. (TX) - Well constructions should be investigated. (KS) - Statewide monitoring systems should be established and should include inventory methodology and database updates. (WA)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Domestic Wastewater Treatment Plant Effluent Disposal Wells (5W12)	Potentially present in all Regions. 1,099 wells inventoried nationwide in 19 States.	Injected fluid, after secondary or tertiary waste treatment, believed to be generally compatible with receiving formation; may contain high nitrates and fecal coliform if improperly treated.	High to Low	Massachusetts-Permit if injected volume exceeds 15,000 GPD New York-Permit Puerto Rico-Permit Florida-Permit Kentucky-Eliminate Illinois-Rule Indiana-Permit Michigan-Permit Texas-Rule/Permit Nebraska-Rule Utah-Permit Arizona-Permit California-Permit Hawaii-Permit Nevada-Banned Alaska-Permit or Rule Idaho-Rule Washington-Rule	- Operation should ensure that injection is restricted to rates and pressures dictated by site-specific hydrogeologic conditions (should involve monitoring). (WY, AL, HI). - Alternative methods of disposal and feasibility of upgrading existing plants should be evaluated. (VA) - In some cases, wells should be plugged. (KY)
Mineral and Fossil Fuel Recovery Related Wells					
Mining, Sand or Other Backfill Wells (5X13)	Nationwide: 6,500 wells Maryland: 1 well Pennsylvania: 811 wells West Virginia: 258 wells Alabama: no numbers Kentucky: 61 wells Tennessee: no numbers Illinois: 5 wells New Mexico: 11 wells Texas: 65 wells Missouri: 4,326 wells Colorado: 2 wells Montana: 10 wells North Dakota: 300 wells Wyoming: 74 wells Nevada: 1 well Idaho: 575 wells	Hydraulic or pneumatic slurries - Solid portion of slurries may be sand, gravel, cement, mill tailings/refuse, or fly ash. - Slurry waters may be acid mine water or ore extraction process wastewater.	Moderate	Maryland-Permit Pennsylvania-Mine operation West Virginia-Mine operation Alabama-Permit Kentucky-Permit Illinois-Rule New Mexico-Unknown Texas-Rule Missouri-None Nebraska-Rule Colorado-Rule Montana-Permit North Dakota-Rule Utah-Rule Wyoming-Permit Idaho-Rule	- Siting, design, construction, and operation should be specified in permit requirements. (IL) - Slurry injection volumes should be monitored and compared to calculated mine volume to prevent catastrophic failure. (WV) - Ground-water monitoring in areas containing potable water. (MO) - Site-specific study is necessary to determine the nature and extent of degradation from mine backfill wells. (MT) - Authorization of mine backfill wells without permits should continue where tailings are injected into formations that are effectively isolated from USDW. (ID)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Solution Mining Wells (5X14)	Nationwide: 2,025 wells New York: 48 wells Michigan: 15 wells New Mexico: 1,073 wells Wyoming: 14 wells Arizona: 870 wells California: 5 wells Potentially in other mining districts.	Weak acid solutions (sulfuric and hydrochloric) Ammonium carbonate Sodium carbonate/bicarbonate Ferric cyanide	Low	New York-Permit New Mexico-Permit Nebraska-Permit Utah-Permit Wyoming-Permit Arizona-Permit California-Permit	- Network of injection wells should not extend beyond surface projection of ore body. (CA) - New types of mechanical integrity tests for implementation with this well type should be studied. (AZ) - Hydrologic monitoring should be conducted to determine a water budget. (AZ)
In Situ Fossil Fuel Recovery Wells (5X15)	Nationwide: 66 wells Colorado: 23 wells Indiana: 1 well Michigan: 1 well Wyoming: 41 wells Potentially in other areas wtih relatively shallow, organic rich sub strata.	Underground coal gasification: - air, oxygen, steam, water, igniting agents such as ammonium nitrate-fuel oil (ANFO) or propane. In situ oil shale retorting: - air, oxygen, steam, water, sand, explosives, igniting agents (generally propane) Purpose in both cases is to initiate and maintain combustion. Combustion products include polynuclear aromatics, cyanides, nitrites, phenols.	Moderate	Texas-Permit Nebraska-Rule Colorado-Rule Utah-Permit Wyoming-Permit	- Conduct complete geologic and hydrogeologic investigations prior to system implementation. (WY) - Remediate zone fluids to minimize future contamination. (WY)
Spent Brine Return Flow Wells (5X16)	Nationwide: 121 wells New York: no numbers West Virginia: 2 wells Indiana: 8 wells Michigan: 33 wells Arkansas: 70 wells Oklahoma: 7 wells North Dakota: 1 well Potentially in Regions having commercially recoverable halogen deposits.	Limited to brines from which halogens or salts have been extracted; Potential for addition of other undefined constituents into waste stream.	Low	New York-Permit Arkansas-Permit Oklahoma-Rule Nebraska-Rule Utah-Rule	- Technical requirements specified in permits should be similar to those for oilfield brine injection wells or solution mining wells. (WV, AR) - Construction requirements should be developed based upon well operating parameters. (AR) - Mechanical integrity tests should be required. (AR) - Semi-annual comprehensive sampling and analysis of fluid and comparison of produced vs. injected fluid should be required. (AR)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Industrial/Commercial Utility Disposal Wells (5A19)					
Cooling Water Return Flow Wells (5A19)	291 wells inventoried nationwide; potentially many times this number, and would be located in all Regions.	Dependent upon type of system, type of additives, and temperature of water; open pipe systems may expose ground water to accidental introduction of surface contaminants, industrial spills, or unauthorized disposal of wastes.	Moderate to Low	Massachusetts-Permit if injection volume exceeds 2,000 GPD New Jersey-NJPDES Permit Alabama-Permit Florida-Permit Georgia-Permit South Carolina-Rule Illinois-Rule Wisconsin-Rule Arkansas-None New Mexico-Registration Iowa-Permit Nebraska-Rule Utah-Permit California-Permit Hawaii-Permit Alaska-Permit Idaho-Permit Oregon-Permit if injected volumes exceed 5,000 GPD Washington-Permit	- Minimum locating requirements for the injection well relative to any nearby municipal supply wells should be established. (NE, SC) - Wells should be grouted from at least 20 feet below land surface to land surface or to the water table. (NE) - Wells should be cased from surface to the top of the uppermost supply and injection zone. (AR) - Cemented annulus from surface to supply/injection zone. (AR) - Require minimum of 2 wells: supply well and return well. (AR, SC) - Wells should be constructed such that spent fluids are injected into source aquifer. (AR) - Open loop return flow wells should be prohibited. (FL, AR, NE, UT) - Wells should be plugged with cement upon abandonment. (AR) - Permit specifications needed: Detailed map showing all area wells. Diagram of injection well design. Diagram of entire system. Type and volume of injectate. (AR, NE)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Industrial Process Water and Waste Disposal Wells (5W20)	1,989 inventoried wells in 33 States.	Potentially any fluid disposed by various industries; can have high dissolved solids, suspended solids, alkalinity, chloride, phosphate, sulfate, total volatiles.	High	Connecticut-Permit Massachusetts-Permit New Jersey-NJPDES Permit New York-Permit Maryland-Permit Pennsylvania-Permit Alabama-Permit Florida-Permit South Carolina-Permit Illinois-Rule Wisconsin-Permit Texas-Class I Regulations Nebraska-Rule Utah-Banned Wyoming-Permit Arizona-Permit California-Permit Hawaii-Permit Alaska-Permit Idaho-Permit if deeper than 18 feet Oregon-Permit	- Inventory efforts should continue with high priority on identifying industrial disposal facilities. (PR, IN, WI, AK, WY) - Assume all industrial waste disposal has a deleterious effect on USDW, warranting immediate action. (PA) - Extensive ground-water evaluation studies should be conducted to identify areas which would be vulnerable to contamination by industrial waste disposal. (PR, AL) - Drainage areas surrounding industrial facilities should be studied and all possible pollution sources noted. (KS) - Inspection of these facilities should be mandatory, and conducted by teams backed by chemical or industrial engineers. (PR) - Monitoring programs should be required and sampling specifications should be tightened. (PR, MD, FL, KS) - Ground-water monitoring should be conducted using a minimum of one upgradient and two downgradient wells. (AZ) - Practice of injecting industrial process water and waste should be discouraged, and wastes routed to on-site treatment facilities or municipal sanitary sewer systems. (FL) - Discharge of industrial process wastes to septic systems should be discouraged. (PR, NE) - These wells should be permitted only when injection is into ground water containing greater than ten-thousand mg/l TDS. (FL)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Automobile Service Station Waste Disposal Wells (5X28)	Nationwide: 99 wells Connecticut: 1 well Rhode Island: 3 wells Vermont: 10 wells New Jersey: 18 wells New York: 3 wells Virginia: 1 well Florida: no numbers Illinois: 5 wells Indiana: 2 wells Michigan: 27 wells New Mexico: no numbers Iowa: 1 well Missouri: 5 wells Utah: 2 wells Nevada: no numbers Idaho: 21 wells	Waste oil, antifreeze, floor washings (including detergents, organic, and inorganic sediment) and other petroleum products.	High	Connecticut-Permit New Jersey-NJPDES Permit New York-Permit Florida-Permit Illinois-Rule Nebraska-Rule Utah-Banned Idaho-Rule	- Inventory update is vital. Guidelines for construction, operation, and overall regulation of these wells need to be established. (NY, PR) - Permits should show construction features, a plan to utilize separators and holding tanks, and a plan to sample and analyze injected fluids. (IA) - Underground holding tanks should be required. (UT) - Local building code and sewer pretreatment inspection should identify areas where discharge to sewers is prohibited. (UT)
Recharge Wells					
Aquifer Recharge Wells (5R21)	Nationwide: 3,558 wells New Hampshire: 1 well New York: 3,000 wells Florida: 349 wells Illinois: 1 well Minnesota: 1 well New Mexico: 30 wells Texas: 44 wells Kansas: 4 wells Nebraska: 4 wells Wyoming: 32 wells Arizona: 51 wells California: 52 wells Idaho: 7 wells Washington: 7 wells Potentially found in areas characterized by large withdrawals for drinking water or irrigation far in excess of recharge.	Dependent upon source; water quality changes noted include adsorption, ion exchange, pre-precipitation and dissolution, chemical oxidation, biological nitrification and denitrification, aerobic or anaerobic degradation, mechanical dispersion, and filtration.	High to Low	New Jersey-Rule/Permit Florida-Permit Illinois-Rule New Mexico-Registration Texas-Permit Nebraska-Rule Utah-Rule/Permit Wyoming-Permit Arizona-Permit California-Permit Idaho-Permit if deeper than 18 feet	- Injection fluid should be of generally equivalent or better quality than injection zone fluid. (NE) - Standards for injectate quality must be on a case by case basis. (AZ) - Regular injectate sampling should be conducted. (NE) - Use of proper design, construction and operation is essential. (FL, NE)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Saline Water Intrusion Barrier Wells (5B22)	California: 155 wells Florida: 2 wells Potentially found in coastal areas typified by abundant fresh water withdrawals for irrigation and/or drinking water.	Varies with type of source; examples include advanced treated sewage, surface urban and agricultural runoff, and imported surface waters.	Low	New Jersey-Rule/Permit Florida-Permit Nebraska-Rule Utah-Rule/Permit California-Permit Washington-Permit	- Pilot studies to define lithologic and hydrogeologic parameters influencing salt water intrusion should be conducted on site-specific basis. (CA) - Characterization of interaction of injectate and formation fluids is necessary. (CA)
Subsidence Control Wells (5S23)	4 wells inventoried for Wisconsin from state reports; it is believed inventory is incomplete; potentially present in desert and coastal areas typified by large, long-term ground-water withdrawals; areas having carbonate aquifers are particularly susceptible to subsidence.	See 'Aquifer Recharge Wells'	Low	Wisconsin-Permit Nebraska-Rule Utah-Rule/Permit	- Injectate quality should be monitored. (CA) - Proper well design, operation, and construction practices should be implemented. (CA) - For additional recommendations, see 'Aquifer Recharge Wells'
Miscellaneous Wells					
Radioactive Waste Disposal wells (5W24)	Unknown number, but existence confirmed for Tennessee, New Mexico, Idaho, and Washington in State reports.	Variety of radioactive materials, including Beryllium 7, Tritium, Strontium 90, Cesium 137, Potassium 40, Cobalt 60, beta particles, Plutonium, Americium, Uranium, and radionuclides.	Unknown	Illinois-Rule New Mexico-Banned Oklahoma-Rule Nebraska-Rule Utah-Rule/Permit Idaho-Permit if deeper than 18 feet Washington-Permit	- Discharges should satisfy all known, available, reasonable treatment and control methods. (WA) - Discharge to cribs and french drains should be pretreated prior to disposal. (WA) - Permits, permit compliance, and enforcement actions should be negotiated annually with EPA through the State/EPA Agreement Program. (WA)
Experimental Technology Wells (5X25)	225 wells in State reports; Potentially located in every Region.	Wide variety of injected constituents: highly acidic or basic compounds for solution mining; domestic wastewater containing high total suspended solids, fecal coliform, ammonia, BOD, pH; air is used in certain water recovery projects.	Moderate to Low	Alabama-Permit Florida-Permit Mississippi-Rule North Carolina-Permit Illinois-Rule New Mexico-Permit Nebraska-Rule Utah-Rule/Permit Wyoming-Permit Arizona-Permit California-Permit Hawaii-Permit Nevada-Permit	- Wells should not be sited and operated so as to permit injection into Class IIB aquifers. (CA) - Detailed hydrogeological studies should be conducted prior to any proposed injection. (CA) - Chemical analysis of waste stream periodically. (CA) - Mechanical integrity tests should be developed and conducted regularly. (CA, FL)

TABLE 5-16, continued

SUMMARY OF CLASS V INJECTION WELL DATA AND RECOMMENDATIONS

TYPE OF INJECTION WELL	LOCATION & NUMBER OF WELLS OR POTENTIAL LOCATION	TYPES OF FLUIDS INJECTED	GROUND-WATER (USDW) CONTAMINATION POTENTIAL	STATE REGULATORY STRUCTURE	RECOMMENDATIONS
Aquifer Remediation Wells (Including Oil Recovery Injection Wells) (5X26)	Nationwide: 355 wells Rhode Island: 2 wells New Jersey: 9 wells Puerto Rico: 1 well Alabama: 1 well North Carolina: 12 wells Indiana: 4 wells Michigan: 59 wells Minnesota: 7 wells Wisconsin: 17 wells New Mexico: 50 wells Oklahoma: 60 wells Texas: 37 wells Kansas: 15 wells Missouri: no numbers Nebraska: no numbers Colorado: 81 wells	Dependent upon hydrogeologic regimen, parameters of the contamination plume, and design of the remediation program; for refinery projects, typical injectate constituents are oil/grease, phenols, toluene, benzene, lead, iron.	Unknown	New Jersey-NJPDES Permit Alabama-Permit North Carolina-Permit Wisconsin-Rule Oklahoma-Rule Nebraska-Permit Utah-Rule/Permit California-Permit	- Implementation of registering and monitoring programs. (KS) - Construction standards should be similar to those established for discharge wells. (OK) Cased from surface through the top of the injection zone. (OK) Screened intervals through sands and gravels. (OK) Annulus should be grouted. (OK) - Injected fluid quality should be better than that of the fluid in the contaminated aquifer but not necessarily of drinking water standards. (FL)
Abandoned Drinking Water/Waste Disposal Wells (5X29)	3,050 wells inventoried. Potentially present in all areas having shallow fresh water aquifers.	Potentially any kind of fluid, particularly brackish or saline water, hazardous chemicals and sewage; documentation of nitrate and coliform contamination documented in Nebraska (Exner and Spalding, 1985); Domestic sewage disposal via these wells documented for 75 homes in Minnesota; also documentation for disposal of pesticides within agricultural runoff (Jones, 1973; Exner and Spalding, 1985).	Moderate	Utah-Banned The following states have plugging and abandonment regulations for water wells: Rhode Island, New Jersey, Puerto Rico, Delaware, Maryland, Pennsylvania, Virginia, West Virginia, Alabama, Florida, Georgia, North Carolina, Tennessee, Illinois, Michigan, Minnesota, Ohio, Wisconsin, Arkansas, Louisiana, Oklahoma, Texas, Kansas, Missouri, Nebraska, Colorado, North Dakota, South Dakota, Wyoming, Arizona, California, Nevada, Alaska, Idaho, Oregon, and Washington	- Must establish a better inventory of wells. (PR, IN, MI, MN) - Wells should be properly plugged using cement. (MN)

SECTION 6
RECOMMENDATIONS

6.1 INVENTORY DATABASE

6.1.1. PRIORITIES

The inventory database is based on reports submitted by the State UIC programs. Inventory data on most of the low-tech well types has been described in this report as generally poor. Both the completeness (inventoried vs. existing) and the quality (level of detail) of the database are poor for the low-tech wells. The lack of inventory information is reflected in the extremely low number of detailed case studies of low-tech wells. Case studies of low-tech well types, including site investigations, will need to be conducted if appropriate policy is to be set concerning their siting, construction, and operation.

Several States recommended that, based on numbers and contamination potential, all types of drainage wells and domestic wastewater disposal wells are appropriate candidates for further study. States also recommended that the inventory and contamination potential of the two well types listed as unknown contamination potential be clarified by further study.

6.1.2 INVENTORY DATABASE UPDATE

Some States recommended that the inventory of newly constructed wells also be tracked along with status changes for inventoried wells. Successful inventory methods and a consistent approach to updating the Class V inventory are discussed below.

6.1.2.1. Inventory Methods

Lessons learned to date on effective inventory methods should be built upon. Some of the more successful techniques and sources of information are listed below.

1. Survey efforts involving questionnaires are an appropriate first step in building an inventory database. A minimum of actual facility information should be requested initially. This may improve inventory response since volunteering lengthy or technically sensitive data goes against human nature.

2. Personal, follow-up telephone calls to respondents for data verification and to explain the UIC program have been especially useful in obtaining cooperation when a more detailed questionnaire or report is needed later. Personal follow-up is also a very good technique for producing new inventory leads.

3. Federal, State, and local government agencies are storehouses of information on Class V injection wells. Much of the current inventory information was provided by these sources. Indications are that these sources have not been fully utilized. There are problems associated with information accessibility because it has not been filed according to Class V well types. Many agencies have indicated they do not have the manpower or finances to sort through files and determine which wells meet Class V criteria.

4. Visits to regulatory agencies and site inspections are invaluable for in-depth investigations and new inventory leads.

Details on compiling mailing lists and agencies which have information on specific well types and other inventory strategy can be found in Section 3, Class V Injection Well Inventory.

6.1.2.2. Mechanism for Updating the Class V Inventory Database

Presently, there is not a well defined, consistent approach among USEPA Regions or State and local governments to locate additional inventory and report it. This has seriously hampered inventory and assessment efforts to date. Consequently, a mechanism or system for passing along information needs to be developed. Ideally, one designated State agency would interface between the USEPA Region and other agencies in the same State. The interface would pass along new inventory information and be a directory for additional information requests. At least an annual update to the Class V injection well inventory database is needed in order to prioritize USEPA efforts. Some confusing inventory information could be eliminated if the database used the new well type codes (Table 1-1).

In order to enhance obtaining a more complete inventory database for all Class V wells, concerted effort on the part of agencies at all levels of government will be required. It will be necessary to redefine areas that may have Class V wells present and initiate a new questionnaire mailing. Historically, this has been best accomplished at the local or State levels by water resource and waste management agencies. These authorities seem to be most familiar with potential Class V injection facilities, and should be able to follow up questionnaire mailings with personal contact of possible owner/operators. It is essential

that replies be received for each questionnaire issued. It should not be assumed that no reply indicates there are no Class V wells at a given location.

Another essential element in building a more complete inventory database for Class V wells is the development of a more thorough public awareness about these wells and appropriate regulations. Many owners of private, small-scale domestic, or commercial facilities probably are not aware that they need to report their injection systems. A campaign must be conducted to promote public knowledge of potential contamination to major drinking water supplies as a result of unregulated Class V injection. The public must be made aware that valuable groundwater supplies are limited and susceptible to irreversible degradation.

6.2 CLASS V WELL TYPES

6.2.1 SITING, CONSTRUCTION, OPERATION, CORRECTIVE AND REMEDIAL ACTIONS

The following sections contain a discussion of recommendations for siting, construction, and operation of existing and future Class V injection wells. Recommendations are made for groups of well types established on the basis of contamination potential.

While certain recommendations are unique to specific Class V well types, many States made some general recommendations that apply to all well types, regardless of the rated contamination potential. These recommendations address the need for:

1. continued inventory efforts;
2. in-depth hydrogeologic studies for active and potential areas of Class V injection;
3. periodic comprehensive sampling and analysis of injected fluids and injection zone water;
4. protection of USDW by adequate construction and operational monitoring;
5. maintenance and verification of mechanical integrity; and
6. proper plugging and abandonment of wells upon termination of injection activities.

Certain well types are not characterized by a single contamination potential. Because of a wide disparity in State report assessments and case study data, some well types were found to

pose low or moderate contamination potential in certain areas and high potential in others. For the purpose of the subsequent recommendations summary, well types will be discussed under the highest contamination potential ascribed in a range. State reports containing applicable recommendations are indicated in parentheses.

6.2.1.1 High Contamination Potential Well Types

Well types assessed as having high contamination potential are:

- Agricultural drainage wells, 5F1;
- Improved sinkholes, 5D3 (high to moderate);
- Raw sewage waste disposal wells, 5W9, and cesspools, 5W10;
- Septic systems, 5W11, 5W31, 5W32;
- Domestic wastewater treatment plant disposal wells, 5W12 (high to low);
- Industrial process water and waste disposal wells, 5W20;
- Automobile service station waste disposal wells, 5X28; and
- Aquifer recharge wells, 5R21 (high to low).

Agricultural Return Flow Wells (5F1)

Locating and properly plugging all abandoned wells within the immediate area of agricultural drainage wells would significantly aid in protecting USDW (IA). Injected fluids should be required to meet all or some National Drinking Water Regulations (NE, OR). Recovery and pumpback of irrigation tailwater should be required (OR). Water from drinking water supply wells near agricultural drainage wells should be sampled and analyzed frequently to detect any contaminant mobility (NE).

A detailed map of the location of injection wells and all municipal, domestic, and stock wells within one mile of the injection wells should be required. A diagram showing construction features of injection wells should also be required, and all ADW should be sited at least 2,000 feet away from any stock, municipal, or domestic well (NE).

Closing surface inlets in order to allow infiltration through the soil would decrease the transport of bacteria, some pesticides, and sediment to the aquifer (MO). Iowa suggests that

inlets to the injection wells should be raised above ponding levels.

The volume of irrigation return flow would be reduced by applying only the quantity of water necessary and only the amounts of chemicals necessary to meet crop requirements and maintain correct soil balances (CA). Use of ADW should be discouraged and elimination should be encouraged: alternative drainage methods should be developed (IA).

Improved Sinkholes (5D3)

Little is currently understood about these wells, and few recommendations were provided in the State reports. The Puerto Rico report suggests that well construction training should be required for engineers and drillers, with special emphasis on sanitary sealing and protection against corrosion. Missouri suggests running careful, dye trace studies on improved sinkhole drainage systems.

Raw Sewage Disposal Wells and Cesspools (5W9, 5W10)

Assessments for these well types found within State reports indicate that the construction of any such wells should be strictly prohibited. Regional ground-water contamination resulting from cesspools and raw sewage disposal wells has been documented. Recommended on-site disposal systems for domestic wastewater would be septic systems with drainfields or septic tanks with absorption mounds.

Septic Systems (5W11, 5W31, 5W32)

Septic systems are a widely varied group of Class V facilities, and include undifferentiated systems, well disposal systems, and drainfield disposal systems. Because of the variabilites noted for disposal methodology, construction design, and operation, large variations in contamination potential are recognized.

Of extreme importance is that national continuing public education programs be implemented, with specific emphasis toward septic system owners. A key aspect to continued education about septic systems and their potential threat to USDW will be ongoing training programs for sanitarians at local and State levels. This training should include hydrogeology, ground-water flow, theory of septic system operation, and potential risks to human health (PR, MD, MN).

Kansas and Nebraska suggested that septic systems be sited in well-studied drainage areas to avoid endangering water wells. Present local regulations may ignore hydrogeology and allow

migration to the owner's and/or neighbor's wells. Septic systems which dispose without adequate treatment should be eliminated. Nebraska further recommended that the density of septic systems and total loading to ground water be studied.

Three States (Florida, Montana, and Oregon) recommended that further study is required. Missouri recommended that proper construction guidelines be developed, and Kansas suggested investigating facilities to ensure quality well construction.

Washington identified a critical need to establish a statewide monitoring system, inventory methodology, and database in order to evaluate design for existing systems, establish ambient water quality in vulnerable aquifer regions, and be able to quantify changes in critical parameters.

Texas recommended that systems be individually sited and designed and that sewage disposal wells for individual facilities be phased out.

Domestic Wastewater Treatment Plant Disposal Wells (5W12)

This is another well type that demonstrates much variability in design and operation, resulting in wide variations in assessed contamination potential. Operation should ensure that injection is restricted to rates and pressures dictated by site-specific hydrogeologic conditions. This will involve continuous monitoring of operations, assuring that injectate does not exceed standards set forth in waste disposal permits (WY, HI, AL). Alternative methods of disposal and feasibility of upgrading existing plants should be evaluated (VA). In some cases, wells should be plugged (KY).

Industrial Process Water and Waste Disposal Wells (5W20)

Inventory efforts must be continued with high priority placed upon identifying industrial disposal facilities (PR, IN, WI, AK, WY). It is believed that some industrial disposal into or above USDW will have a deleterious effect upon those aquifers, warranting immediate remedial or corrective action (PA). The practice of injecting these wastes in the future should be discouraged, and wastes should be routed to on-site treatment facilities or municipal sanitary sewer systems (FL). The discharge of these wastes to septic systems should be discouraged (PR, NE). Extensive ground-water evaluation studies should be conducted to identify areas potentially vulnerable to contamination by industrial disposal. This study would include an analysis of drainage areas surrounding industrial facilities, noting all possible sources of pollution (KS, PR, AS).

Periodic site inspections should be mandatory for these facilities, and inspections should be conducted by teams of chem-

ical and industrial engineers (PR). Monitoring programs should be specifically required and should include sampling and analysis of ground water. A minimum of one upgradient and two downgradient wells for monitoring ground water are recommended, and the well pattern should be sufficient to detect any migration of injected fluid into USDW (PR, MD, FL, KS, AZ).

The NPDES program could be more effective in helping the UIC program by requiring sewer improvement districts to inventory all industrial users of their systems and to review details of each user's waste stream(s) (NY). The issue of reluctance of operators to report their wells can be overcome by presenting a coordinated program (about waste streams that are allowed) through a multi-media approach (States in Region V).

All non-hazardous industrial process water and waste disposal wells shown to have a high contamination potential should be phased out. These wells should be required to inject below USDW as Class I wells in the future. Other 5W20 wells should be periodically checked for injection rate and fluid quality (States in Region VI).

The policy of prohibiting the installation of septic tank/drainfields for treating embalming fluids should be continued. (Current practice requires holding facilities and periodic removal and proper disposal.) (SC).

Until additional data are at hand to define the fate of industrial wastes in the saturated zone, it is prudent to take extraordinary precautions to minimize the potential for aquifer degradation via injection of highly toxic substances. Alternatives to land disposal such as recycling or resource recovery, reduction of wastes generated through process modification, and improved methods of hazardous waste neutralization should be actively pursued (WA).

Automobile Service Station Disposal Wells (5X28)

As with most Class V well types, continued inventory update is vital to continued monitoring and regulation of these wells. In general, guidelines for construction, operation, and overall regulation of these wells do not exist and must be established immediately (NY, PR). Iowa suggests requiring a permit tc operate which would include information on construction features, a plan to utilize separators and holding tanks, and a plan to sample and analyze the injected fluids.

Utah suggests that these wells can be corrected by providing underground holding tanks (total containment) for the waste oils/fluids. These tanks would require regular off-loading to waste oil reclaimers. In Utah, there is economic incentive for a service station to sell waste oil to a reclaimer. The management of these wells would best be accomplished at the local government

level because they already enforce their building and sewer ordinances. Any inspections by State or Federal staff would be a duplication of effort.

Utah continues that communities with a water reclamation system commonly prohibit oil and grease discharges to their sewer. Consequently, some operators opt to discharge to dry wells as a "loophole" to the environmental regulations. Local building code and sewer pretreatment inspection should be able to locate and manage these wells.

Finally, Utah states that the UIC program has not been effective in controlling this problem, but local government has. The UIC program can be more effective by educating those local government staff who conduct building and environmental inspections. This training will help locate these violators and hopefully solve the problem.

Aquifer Recharge Wells (5R21)

Design, construction and operation features will vary, depending upon the type of project, but it is essential that high standards be set and strictly enforced by regulatory agencies for these parameters. Again, because operations can vary so widely, standards for injectate quality must be determined on a case-specific basis (AZ). In general, injection fluids should be of equivalent or better quality than injection zone fluids, and periodic sampling and analysis of injectate and injection zone fluids should be required (NE). Certain wells of this type have been assessed as having high contamination potential (FL), whereas others have been rated moderate (TX). It is believed that properly designed, constructed, and operated wells may be assessed as low potential for contamination.

6.2.1.2 Moderate Contamination Potential Well Types

Well types assessed as having a moderate contamination potential include:

- Storm water drainage, 5D2, and industrial drainage wells, 5D4;
- Improved sinkholes, 5D3 (high to moderate);
- Special drainage wells, 5G30 (moderate to low);
- Electric power, 5A5, and direct heat reinjection wells, 5A6;
- Aquaculture return flow wells, 5A8;

- Domestic wastewater treatment plant disposal wells, 5W12 (high to low);
- Mining, sand, or other backfill wells, 5X13;
- In-situ fossil fuel recovery wells, 5X15;
- Cooling water return flow wells, 5A19 (moderate to low);
- Aquifer recharge wells, 5R21 (high to low);
- Experimental technology wells, 5X25 (moderate to low); and
- Abandoned drinking water/waste disposal wells, 5X29.

Stormwater and Industrial Drainage Wells (5D2, 5D4)

Inventory efforts should continue and newly located wells should be investigated and added to FURS (KY, UT, WA). The construction of new industrial drainage wells should be severely limited (OR, IL). Storm water sewers, detention ponds, or vegetative basins are the preferred alternatives (UT). If sewers are cost prohibitive, on-site vegetated basins with fine-grained sand beds should be constructed (Grass swales have been discovered in the NURP study to provide moderate improvements in runoff quality). Retention basins might be planned so runoff can be released slowly into the sanitary sewer or treated before entering the well (KY, TN). Sand and gravel filters should be added to wells (KY, TN). Stand pipes should be constructed, several feet in height, at the opening of wells (KY, TN).

Future construction should be limited to residential areas (IL). All spills should be diverted away from industrial drainage wells (PA, IA, OR, KY, UT, WA). The construction of new storm water and industrial drainage wells in areas served by storm water sewers should be prohibited (CA, AZ). Drainage wells should not be constructed within 200 feet of water supply wells which tap lower water-bearing aquifers (CA). Deep wells should be plugged or cemented to avoid mixing between aquifers (KY, TN).

Depth to ground water information should be made readily available to drainage well drillers and land planning engineers. Separation distances between the depths of storm water drainage wells and ground-water tables should be maximized. Proposed wells which would penetrate perched ground water or water tables should not be constructed (AZ).

Additional research should be conducted to study the prolonged effect of industrial drainage wells on ground-water quality. Additional research relating to the attenuation of

metals and organics under long term discharge conditions from industrial and storm water drainage wells should be conducted (States in Region VIII). Ground-water monitoring programs in industrial areas with many industrial drainage wells are advisable (FL, WI, KS). Sediments extraced from drainage wells catch basins, or sediment traps should be disposed in an appropriate landfill. Due to possible metal concentrations, these sediments may be considered as hazardous materials (AZ).

Assessment of the effects of drainage wells should be conducted prior to completing an inventory because the inventory would be time-consuming and costly (MT, OR). A public awareness program should be implemented (AZ).

Special Drainage Wells (5G30)

Certain wells that fall under this classification probably have been inventoried as other well types. Other inventoried well types should be cross-checked for special drainage wells.

In sensitive hydrogeological areas, continual monitoring of injection fluid volume and quality should be conducted. Florida recommended that random sampling and analysis of swimming pool waste fluids be conducted to define possible contaminants.

Electric Power and Direct Heat Reinjection Wells (5A5, 5A6)

Most recommendations for electric power and direct heat reinjection wells are derived from the California and Nevada reports. These wells are characterized by generally high volumes of disposed fluids. More work is necessary in the near future in determining what surveys will be the most reliable indicators of mechanical integrity.

It is essential that accurate characterization of injection fluids be conducted not only before operations begin but also periodically during the life of the facility. Parameters of concern in physical and chemical analyses of injection fluids include temperature, inorganic constituents of National Primary and Secondary Drinking Water Regulations, alkalinity, hardness, boron, silica, and ammonia nitrogen.

Geothermal fluids should not be injected into non-thermal reservoirs unless the receiving fluids are of equal or lesser quality or the thermal injection fluids meet drinking water standards (ID). Besides temperature pollution, concentrations of most other dissolved solids would be increased. Beneficial uses of most non-thermal waters with TDS <1,000 mg/l could be seriously altered if heat spent geothermal fluids from high temperature reservoirs were injected. Even heat spent geothermal fluids from low temperature resources should not be injected into non-thermal waters without carefully comparing water quality.

Most drinking water quality aquifers in the western United States would be negatively impacted by such a practice.

Aquacultural Return Flow Wells (5A8)

All recommendations for aquaculture return flow wells are derived from the Hawaii report. Wells of this type located in Hawaii should always be sited outside the UIC Line, as defined by the Hawaii Department of Health, and should be located as close to the coast as possible, where applicable. Injection well casing should be constructed of lightweight steel or Schedule 40 PVC. The annulus should be filled with rock packing across the injection zone and cement grout between the surface and the rock packing. An extremely important recommendation is that injection wellheads should not be open at the surface so as to allow disposal of unauthorized liquid wastes.

Regular comprehensive sampling and analysis of injectate and injection zone fluids should be required. Because injection volumes are typically high and waste streams are characteristically variable, semi-annual sampling is recommended.

Mining, Sand, or Other Backfill Wells (5X13)

Siting, design, construction, and operation of these wells should be specified in permit requirements (IL, KY, ID). Slurry injection volumes should be monitored continually and compared to calculated mine volumes to prevent catastrophic failure due to over-injection (WV). Regular analysis during injection operations should continue. It will be important to monitor ground water regularly in areas containing potable water (MO). Site-specific studies should be conducted to determine the nature and extent of degradation due to mine backfill wells (MT). Authorization without permits of mine backfill wells should be continued where tailings are injected into formations that are effectively isolated from USDW (ID).

In Situ Fossil Fuel Recovery Wells (5X15)

As part of any in situ fossil fuel recovery program utilizing injection wells, complete geologic and hydrogeologic investigations should be conducted prior to system implementation. All operations should have a well-defined remediation program for injection zone fluids to minimize future ground-water contamination after operations are terminated (WY).

Cooling Water Return Flow Wells (5A19)

Many States regulate cooling water return flow wells under a permit system. Permit specifications for these wells are not

consistent. It is recommended (IA, NE) that all permit applications include the following material:

1) detailed map showing all wells in the area;

2) a diagram of the injection well system;

3) a diagram of the entire operational system; and

4) detailed chemical and physical analysis of the injectate.

All injection wells of this type should be constructed such that injection of spent fluids is into the source aquifer. In addition, wells should be cased from the surface to the top of the uppermost supply and injection zone. Open loop return flow wells should be prohibited (FL, AR, NE).

Cooling water return flow systems should have a minimum of two wells: one supply well and one injection well. No additives should be used (AR). Upon abandonment, all wells should be plugged with cement (AR).

Experimental Technology Wells (5X25)

All recommendations for experimental technology wells are derived from the California and Arizona reports. Before operations for any experimental technology facility can commence, detailed hydrogeologic studies should be conducted for the area of interest. Of primary importance in such a study will be to determine the occurrence of USDW and, more importantly, the occurrence of aquifers of Class IIB or better quality. Injection into any Class IIB or better aquifer should be strictly prohibited.

Chemical analysis of the injection fluid should be conducted periodically, and the frequency should be dependent upon such factors as potential toxicity of the fluid and the consistency of the injected stream. Finally, a system of mechanical integrity testing applicable to these wells needs to be developed, and those tests should be conducted regularly. Annual mechanical integrity testing would be sufficient.

Abandoned Drinking Water/Waste Disposal Wells (5X29)

Because these wells are potentially located in all regions of the nation, it is critical that a better inventory database is established (PR, IN, MI, MN). This will require efforts at all regulatory levels. Wells of this type that are located should be properly plugged using high-quality cement (MN).

6.1.2.3 Low Contamination Potential Well Types

Wells rated in this assessment as having low potential for contamination are:

- Special drainage wells, 5G30 (moderate to low);
- Heat pump/air conditioning return flow wells, 5A7;
- Domestic wastewater treatment plant disposal wells, 5W12 (high to low);
- Solution mining wells, 5X14;
- Spent brine return flow wells, 5X16;
- Cooling water return flow wells, 5A19 (moderate to low);
- Aquifer recharge wells 5R21 (high to low);
- Saline water intrusion barrier wells, 5B22;
- Subsidence control wells, 5S23; and
- Experimental technology wells, 5X25 (moderate to low).

Heat Pump/Air Conditioning Return Flow Wells (5A7)

As with most Class V injection systems, it is essential that characteristics of the production/injection aquifer system be thoroughly understood. In addition, inventory updates must be continually conducted.

Adequate spacing between production and injection wells must be maintained (KS, NE). This will serve to enhance system efficiency and limit thermal interactions between injected fluids and fluids near the production wellbore. Return wells should be cased through the top of the injection zone, and the annular space should be grouted or cemented (IA, KS, NE).

It is important that the injection zone be the same as the production zone from water quality and availability standpoints. If injection must occur into a zone other than the production zone, the injectate should be of equal or better quality than water in the injection zone (LA, KS, IA). Volumes and temperatures of return fluids should be monitored continually, and comprehensive sampling and analysis of both injection and receiving fluids should be conducted periodically (KS, NC).

Solution Mining Wells (5X14)

The network of injection wells should not extend beyond the surface projection of the ore body (CA). It is also important that a study be conducted to determine what types of mechanical integrity tests should be implemented for testing these wells.

Spent Brine Return Flow Wells (5X16)

All recommendations for spent brine return flow wells are from the Arkansas State report. Technical requirements specified in permits for these wells should be similar to those for oil field brine injection wells. Construction and operation designs will vary with the scope of operations and should be developed based upon specific operation parameters of interest. Mechanical integrity tests should be required periodically. In addition, semi-annual comprehensive sampling and analysis of injection fluids, and comparison of produced and injected fluids, should be required. Injection of fluids other than spent brine (e.g. process water) should be prohibited.

Saline Water Intrusion Barrier Wells (5B22)

All recommendations for saline water intrusion barrier wells are derived from the California report. These wells are usually made necessary due to heavy ground-water withdrawals for irrigation and drinking water in coastal areas. Intrusion of saline water is into zones of high discharge by wells, thus injection to develop intrusion barriers must be into the same zone. Because this injection is typically into Class IIB or better aquifers, it is essential that studies precede any proposed injection of this type. These studies should address the definition of lithologic and hydrogeologic parameters influencing saline water intrusion and the impact of proposed injection fluids upon injection aquifers. Delineation of USDW within the area should also be a goal of such studies.

Subsidence Control Wells (5S23)

Recommendations for this well type are generally consistent with those presented previously for "Aquifer Recharge Wells." The reader is referred to that section for recommendations.

6.2.1.4 Unknown Contamination Potential Well Types

Two Class V well types have been assessed as having unknown contamination potential, based upon broad-scale lack of knowledge regarding their existence and operation. These well types are:

- Radioactive waste disposal wells, 5N24; and

- Aquifer remediation wells, 5X26 (including hydrocarbon recovery injection wells).

Radioactive Waste Disposal Wells (5N24)

Since the current inventory may constitute only a percentage of existing wells, it is recommended that investigations into radioactive waste disposal practices be conducted. The existence of facilities in Tennessee, New Mexico, Washington, Idaho, Oklahoma, and Illinois has been confirmed.

Washington provided the following recommendations. First, discharges should satisfy all known available, reasonable treatment and control methods. Second, discharge to cribs and french drains should be pretreated prior to disposal. Third, permits, permit compliance, and enforcement actions should be negotiated annually with EPA through the State/EPA Agreement Program.

Aquifer Remediation Wells (Including Hydrocarbon Recovery Injection Wells) (5X26)

Because projects of this type are believed to be operating in many, if not all, of the regions, the implementation of registering and monitoring programs must begin immediately. Construction standards for these wells should be similar to those established in permitting requirements for other discharge wells. Wells should be cased from the surface through the top of the injection zone. Screened intervals should be used when the injection zones are sands and gravels. Perforations should be used in less permeable injection lithologies. The annulus between wellbore and casing should be grouted, preferably with some type of cement (OK).