APPENDIX A - SUMMARY OF DISINFECTANT USAGE IN THE UNITED STATES

Two sources of information were consulted regarding disinfectant usage in the United States:

- The Community Water Systems Survey (USEPA, 1997); and
- The Information Collection Rule (ICR) database on water utilities (presently under development).

A.1 Community Water Systems Survey

Most water treatment plants disinfect water prior to distribution. The 1995 Community Water Systems Survey (USEPA 1997a) reports that 81 percent of all community water systems provide some form of treatment on all or a portion of their water sources (Table A-1). The survey found that 99 percent of the surface water systems provide some treatment of their water. Of those systems reporting no treatment, 80 percent rely on ground water as their only water source.

Table A-1. Disinfection Practices of Water Systems with Treatment

Treatment	Service Population								
	<100	101-500	501-1,000	1,001-3,300	3,301-10,000	10,001-50,000	50,001-100,000	Over 100,001	Total
Surface Water Systems									
Pre-Disinfection, Oxidation/Softening									
Chlorine	59.0%	73.9%	67.3%	66.3%	68.8%	58.6%	47.5%	57.1%	63.8%
Chlorine Dioxide	0.0%	0.0%	0.0%	5.0%	4.7%	13.2%	14.2%	7.8%	6.3%
Chloramines	4.6%	0.0%	1.1%	2.1%	0.0%	2.2%	15.5%	10.8%	3.1%
Ozone	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	5.4%	5.8%	0.9%
KMnO4	0.0%	4.9%	9.6%	9.9%	15.2%	28.3%	25.9%	28.5%	16.0%
Predisinfection/oxidation	0.0%	0.0%	2.0%	2.9%	0.6%	9.2%	5.1%	4.3%	3.5%
Lime/Soda ash softening	6.8%	9.8%	20.9%	16.2%	14.3%	11.7%	3.5%	5.9%	12.5%
Recarbonation	0.0%	0.0%	0.0%	0.0%	2.1%	4.7%	0.6 %	6.3%	1.9%
Post-Disinfection									
Chlorine	49.7%	51.6%	80.6%	62.8%	77.9%	71.1%	73.8%	63.6%	67.5%
Chlorine Dioxide	0.0%	0.0%	0.0%	0.0%	0.3%	4.9%	5.9%	11.2%	1.6%
Chloramines	0.0%	0.0%	0.0%	2.9%	2.1%	15.6%	29.4%	24.2%	8.1%
Postdisinfection combine	0.0%	0.0%	0.0%	2.1%	4.0%	3.9%	1.9%	1.6%	3.0%
Fluoridation	0.0%	4.9%	13.9%	32.4%	42.6%	48.8%	49.9%	63.6%	35.5%
Ground Water Systems									
Pre-Disinfection, Oxidation/Softening									
Chlorine	64.2%	69.9%	56.7%	73.2%	60.6%	57.4%	36.2%	38.1%	63.9%
Chlorine Dioxide	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.3%
Chloramines	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	1.4%	0.7%	0.1%
Ozone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%
KMnO4	0.0%	0.9%	2.2%	0.6%	5.8%	3.2%	7.0%	0.0%	1.8%
Predisinfection/oxidation	0.3%	0.5%	0.0%	0.7%	1.0%	2.6%	0.0%	0.0%	0.7%
Lime/Soda ash softening	2.9%	2.9%	2.2%	3.6%	3.5%	3.8%	5.0%	9.1%	3.2%
Recarbonation	0.0%	0.5%	0.0%	0.6%	1.4%	1.5%	2.8%	1.1%	0.6%
Post-Disinfection									
Chlorine	23.0%	23.4%	32.5%	28.3%	42.5%	41.9%	54.5%	65.8%	31.0%
Chlorine Dioxide	0.0%	1.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.4%
Chloramines	0.0%	0.0%	0.0%	0.0%	0.1%	1.1%	3.9%	4.3%	0.3%
Postdisinfection combine	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
Fluoridation	2.4%	6.3%	13.2%	12.4%	45.3%	31.2%	34.3%	52.5%	16.0%

Source: 1995 Community Water Systems survey (USEPA, 1997a)

A.2 Information Collection Rule Database

The ICR database contains information from 527 community water systems. Some of these systems are owned by the same utility, representing different treatment plants within the same organization. The following tables summarize the ICR data regarding disinfectant database entries. Note that the information about disinfectant includes usage of the disinfectant at the given utility. In some cases, the utility may use more than one disinfectant. Therefore, the 527 systems reported use of 740 different disinfectants. Three systems reported using 3 different chemical disinfectants - for different purposes or during different times of the year. The tables show a breakdown of the disinfectant usage at these facilities. Capacities are shown in terms of flow. Population served data are not recorded.

The tables are as follows:

- Table A-2 shows the breakdown of systems based on water source (i.e., surface or ground water).
- Table A-3 to Table A-5 shows the disinfectant usage at water plants by flow categories for all water sources, surface water sources, and ground water sources, respectively. The tables show the percentage of facilities that are using the particular disinfectant. Because some facilities use more than one disinfectant, the total usage exceeds 100 percent. For example, for facilities in the range 51-100 mgd, the total disinfectant usage is 155 percent. This means that 155 types of disinfection systems are used at 100 plants.
- Table A-6 through Table A-8 shows the disinfectant usage in number of applications in water plants by flow categories for all water sources, surface water sources, and ground water sources, respectively. These tables show the actual numbers used in calculating the percentages in Table A-3 to Table A-5.
- Table A-9 through Table A-11 show the number of systems using two or more disinfectants for all water sources, surface water sources, and ground water sources, respectively. The database does not separate usage as primary or secondary disinfectant.

Table A-2. Breakdown of systems in Survey based on Water Source

Systems	GW	SW	GW/SW	Unknown	Total
Number	135	390	2	2	529
Percentage	26%	74%	0%	0%	100%

GW = Ground Water; SW = Surface Water; GW/SW = Choice of Ground or Surface Water Source.

Table A-3. Disinfectant usage as a function of flow for all Water Sources. Numbers show the percentage of systems using a particular disinfectant

Flow, mgd	Cl_2	NaOCl	NH_2Cl_2	O_3	ClO_2	Total use
0-5	69%	19%	19%	0%	0%	106%
6-10	90%	10%	10%	0%	0%	110%
11-50	93%	6%	30%	5%	9%	143%
51-100	95%	5%	41%	5%	9%	155%
>100	98%	5%	43%	5%	3%	154%
Unknown	77%	13%	8%	0%	0%	98%
Percentage*	92%	7%	31%	4%	6%	140%

Percentage calculated as a fraction of 527 - the total number of systems. 740 different disinfectants are used by the 527 systems.

Table A-4. Disinfectant usage as a function of flow for Surface Water Sources. Numbers show the percentage of systems using a particular disinfectant

Flow, mgd	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2	Total use
0-5	89%	11%	0%	0%	0%	100%
6-10	85%	8%	8%	0%	0%	100%
11-50	93%	5%	32%	5%	12%	148%
51-100	96%	4%	42%	6%	11%	158%
>100	96%	6%	46%	6%	4%	158%
Unknown	88%	13%	50%	0%	0%	150%
Percentage*	94%	5%	37%	5%	9%	150%

Percentage calculated as a fraction of 527 - the total number of systems. 576 different disinfectants are used by the 383 systems.

Table A-5. Disinfectant usage as a function of flow for Ground Water Sources. Numbers show the percentage of systems using a particular disinfectant

Flow, mgd	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2	Total use
0-5	43%	29%	43%	0%	0%	114%
6-10	94%	13%	13%	0%	0%	119%
11-50	92%	6%	24%	2%	2%	125%
51-100	88%	13%	38%	0%	0%	138%
>100	108%	0%	25%	0%	0%	133%
Unknown	79%	14%	0%	0%	0%	93%
Percentage*	87%	10%	18%	1%	1%	117%

Percentage calculated as a fraction of 527 - the total number of systems. 168 different disinfectants are used by the 144 systems.

Table A-6. Disinfectant usage as a function of flow for all Water Sources

Flow, mgd	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2	Total use	Total plants
0-5	11	3	3	0	0	17	16
6-10	26	3	3	0	0	32	29
11-50	200	12	65	10	20	307	215
51-100	113	6	49	6	11	185	119
>100	94	5	41	5	3	148	96
Unknown	40	7	4	0	0	51	52
Total	484	36	165	21	34	740	527
Percentage*	92%	7%	31%	4%	6%	140%	

* Percentage calculated as a fraction of 527 - the total number of systems. 740 different disinfectants are used by the 527 systems.

Table A-7. Disinfectant usage as a function of flow for Surface Water Sources

Flow, mgd	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2	Total use	Total plants
0-5	8	1	0	0	0	9	9
6-10	11	1	1	0	0	13	13
11-50	154	9	53	9	20	245	165
51-100	99	4	43	6	11	163	103
>100	82	5	39	5	3	134	85
Unknown	7	1	4	0	0	12	8
Total	361	21	140	20	34	576	383
Percentage*	94%	5%	37%	5%	9%	150	

* Percentage calculated as a fraction of 383 - the total number of plants. 576 different disinfectants are used by the 383 systems.

Table A-8. Disinfectant usage as a function of flow for Ground Water Sources

Flow, mgd	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2	Total use	Total plants
0-5	3	2	3	0	0	8	7
6-10	15	2	2	0	0	19	16
11-50	47	3	12	1	1	64	51
51-100	14	2	6	0	0	22	16
>100	13	0	3	0	0	16	12
Unknown	33	6	0	0	0	39	42
Total	125	15	26	1	1	168	144
Percentage*	87%	10%	18%	1%	1%	117%	

* Percentage calculated as a fraction of 144 - the total number of systems. 168 different disinfectants are used by the 144 systems.

Table A-9. Number Water Systems (Ground and Surface Water Sources) using Two Different Disinfectants

	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2
Cl_2	---	8	150	17	32
NaOCl	---	---	8	3	0
NH2Cl	---	---	---	12	18
O_3	---	---	---	---	1
ClO_2	---	---	---	---	---

Table A-10. Number Surface Water Systems using Two Different Disinfectants

	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2
Cl_2	---	7	129	16	31
NaOCl	---	---	7	7	3
NH2Cl	---	---	---	11	18
O_3	---	---	---	---	1
ClO_2	---	---	---	---	---

Table A-11. Number Ground Water Systems using Two Different Disinfectants

	Cl_2	NaOCl	NH_2Cl	O_3	ClO_2
Cl_2	---	1	21	1	0
NaOCl	---	---	1	0	0
NH_2Cl	---	---	---	1	0
O_3	---	---	---	---	0
ClO_2	---	---	---	---	---

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