SECTION I

CONCLUSIONS

During the past decade, much effort has been expended in identifying and analyzing the wet-weather pollution control problem. The initial concern with combined sewer overflows expanded to consideration of stormwater runoff in general. This study assesses the costs of controlling wet-weather pollution to varying degrees. A key question is what is the relative importance of various sources of wet-weather pollution and how does wet-weather pollution control compare to dry-weather pollution control? Also, what is its impact on receiving water?

Control of wet-weather pollution is distinctly different than the traditional dry-weather problem. In wet-weather pollution control, one would normally use a mix of storage and treatment, not treatment alone. Thus, new techniques are needed to determine optimal mixes of storage and treatment. Numerous effectiveness criteria for wet-weather control have been used, e.g., number of overflows, percent runoff control, percent BOD control. For wet-weather control, the most critical impact on the receiving water does not necessarily occur under low flow conditions. How should the critical conditions be defined? Basic questions of this nature arose throughout the study because it is such a relatively new area of concern. Thus, the final estimate could vary widely if some of these assumptions are changed. However, the approach is a fairly general one and assumptions are stated explicitly. Thus, the interested reader can refine the estimates as better information becomes available. The remainder of this section presents conclusions. The following section on recommendations will focus on data gaps and related matters.

DEMOGRAPHIC CHARACTERISTICS OF THE URBANIZED AREAS

Urban areas in this study have been taken as the 248 urbanized areas defined by the Bureau of the Census of the US Department of Commerce in the 1970 census and other urban areas. The 248 urbanized areas defined in 1970 are generally characterized as having:

- a central city or urban core of 50,000 or more inhabitants;

- closely inhabited surroundings, consisting of incorporated places of 100 housing units or more; and small unincorporated parcels with population densities of 1,000 inhabitants per square mile or more (386 per square km); and

- other small unincorporated areas that may eliminate enclaves, square up the geometry of the urbanized area or provide a linkage to other enumeration districts fulfilling the overall criteria within 1 1/2 miles (2.5 km) of the main body of the urbanized area.

All 248 urbanized areas in the United States were analyzed in varying levels of detail. Population density distribution functions were developed for 50 urbanized areas. These results were extrapolated to the other 198 urbanized areas. Land use information was derived based on a statistical analysis of 106 cities. The results for all USEPA regions and the entire US are shown in Table I-1, Demographic Characteristics of the Urban Areas. A total of almost 150 million people live in urbanized areas in the United States at an overall average population density of 5.1 persons per acre (12.6 persons per ha). Urbanized areas, as defined, are about 46.2 percent undeveloped as estimated in Table I-2, Land Use Distribution for the Urban Areas in the US. The distribution of the developed land uses is approximately as follows:

Residential	58.4
Industrial	14.8
Commercial	8.6
Other	18.2
Total	100.0

Information on population and area served by combined sewerage systems were provided by APWA. The population and area served by storm sewers and in the unsewered area were estimated as residuals. All areas with a developed population density of less than five persons per acre were assumed to be unsewered. The results, shown in Table I-3, Land Use by Type of Sewerage System, indicate that about 14.4 percent of the urban area is served by combined sewers, 38.3 percent by storm sewers, and the balance of the developed area is unsewered. Table I-4, Population by Type of Sewerage System indicates that 25.2 percent of urban population is served by combined sewer systems, 52.1 percent by storm sewer systems, and the remaining 22.7 percent is unsewered. Table I-5, Population Density by Type of Sewerage System indicates nationwide average developed population densities of 16.73 (41.30), 13.00 (32.09), and 4.59 (11.33) persons per acre (persons per ha) in combined, storm and unsewered areas and an overall average developed population density of 9.56 persons per acre (23.6 persons per ha).

TABLE I-1 DEMOGRAPHIC CHARACTERISTICS OF THE URBAN AREAS

EPA REG	STATE ID	1000 ACRES	1970 POP 1000	POP AVE PD
1	CT	559.	2344.	4.19
1	ME	235.	507.	2.15
1	MA	966.	4813.	4.98
1	NH	125.	417.	3.34
1	RI	162.	826.	5.09
1	VT	35.	143.	4.14
TL REG 1		2082.	9050.	4.35
2	NJ	1479.	6372.	4.31
2	NY	830.	15611.	18.82
TL REG 2		2309.	21983.	9.52
3	DE	75.	395.	5.27
3	DC	39.	757.	19.26
3	MD	403.	3005.	7.46
3	PA	1350.	8433.	6.24
3	VA	569.	2933.	5.15
3	WV	162.	680.	4.21
TL REG 3		2598.	16203.	6.24
4	AL	683.	2011.	2.94
4	FL	1275.	5465.	4.29
4	GA	697.	2768.	3.97
4	KY	304.	1687.	5.54
4	MS	276.	987.	3.57
4	NC	651.	2287.	3.51
4	SC	344.	1233.	3.59
4	TN	719.	2307.	3.21
TL REG 4		4949.	18745.	3.79
5	IL	1189.	9221.	7.75
5	IN	778.	3371.	4.33
5	MI	1092.	6559.	6.01
5	MN	696.	2527.	3.63
5	OH	1714.	8021.	4.68
5	WI	688.	2911.	4.23
TL REG 5		6157.	32610.	5.30
6	AR	301.	962.	3.20
6	LA	328.	2406.	7.34
6	NM	175.	711.	4.07
6	OK	599.	1740.	2.91
6	TX	2546.	8934.	3.51
TL REG 6		3948.	14753.	3.74
7	IA	536.	1615.	3.01
7	KS	328.	1485.	4.53
7	MO	710.	3278.	4.61
7	NE	184.	913.	4.96
TL REG 7		1758.	7291.	4.15
8	CO	335.	1737.	5.18
8	MT	82.	372.	4.53
8	ND	50.	274.	5.51
8	SD	68.	297.	4.34
8	UT	231.	854.	3.69
8	WY	49.	201.	4.08
TL REG 8		816.	3735.	4.58
9	AK	49.	147.	2.99
9	AZ	384.	1408.	3.67
9	CA	2828.	18142.	6.41
9	HI	106.	638.	6.01
9	NV	120.	396.	3.31
TL REG 9		3487.	20731.	5.95
10	ID	85.	387.	4.58
10	OR	305.	1403.	4.60
10	WA	546.	2475.	4.54
TL REG 10		935.	4265.	4.56
TL U.S.		29037.	149366.	5.14

TABLE I-2 LAND USE DISTRIBUTION FOR THE URBAN AREAS IN THE U.S.

EPA REG	STATE ID	LAND USE AS % OF TOTAL AREA UNDV	RES	COMM	INDL	OTH	TOTAL
1	CT	50.0	29.2	4.3	7.4	9.1	100.0
1	ME	69.9	17.6	2.6	4.5	5.5	100.0
1	MA	44.2	32.6	4.8	8.3	10.2	100.0
1	NH	56.9	25.2	3.7	6.4	7.8	100.0
1	RI	42.1	33.8	5.0	8.6	10.5	100.0
1	VT	49.5	29.5	4.3	7.5	9.2	100.0
AV REG 1		49.3	29.6	4.4	7.5	9.2	100.0
2	NJ	48.5	30.1	4.4	7.6	9.4	100.0
2	NY	23.8	44.5	6.6	11.3	13.9	100.0
AV REG 2		39.6	35.3	5.2	8.9	11.0	100.0
3	DE	40.8	34.6	5.1	8.8	10.8	100.0
3	DC	3.8	56.2	8.3	14.2	17.5	100.0
3	MD	28.4	41.8	6.2	10.6	13.0	100.0
3	PA	36.3	37.2	5.5	9.4	11.6	100.0
3	VA	46.9	31.0	4.6	7.9	9.7	100.0
3	WV	47.5	30.7	4.5	7.8	9.6	100.0
AV REG 3		37.7	36.4	5.4	9.2	11.3	100.0
4	AL	61.3	22.6	3.3	5.7	7.0	100.0
4	FL	50.0	29.2	4.3	7.4	9.1	100.0
4	GA	50.5	28.9	4.3	7.3	9.0	100.0
4	KY	39.2	35.5	5.2	9.0	11.1	100.0
4	MS	54.7	26.4	3.9	6.7	8.2	100.0
4	NC	55.2	26.2	3.9	6.6	8.2	100.0
4	SC	54.3	26.7	3.9	6.8	8.3	100.0
4	TN	59.4	23.7	3.5	6.0	7.4	100.0
AV REG 4		53.6	27.1	4.0	6.9	8.4	100.0
5	IL	28.7	41.6	6.1	10.5	13.0	100.0
5	IN	47.1	30.9	4.6	7.8	9.6	100.0
5	MI	37.3	36.6	5.4	9.3	11.4	100.0
5	MN	54.1	26.8	3.9	6.8	8.3	100.0
5	OH	45.3	32.0	4.7	8.1	10.0	100.0
5	WI	49.7	29.4	4.3	7.4	9.2	100.0
AV REG 5		42.4	33.6	5.0	8.5	10.5	100.0

TABLE I-2 LAND USE DISTRIBUTION FOR THE URBAN AREAS IN THE U.S.

EPA REG	STATE ID	LAND USE AS % OF TOTAL AREA UNDV	RES	COMM	INDL	OTH	TOTAL
6	AR	58.8	24.1	3.5	6.1	7.5	100.0
6	LA	39.1	35.6	5.2	9.0	11.1	100.0
6	NM	50.1	29.2	4.3	7.4	9.1	100.0
6	OK	61.1	22.7	3.3	5.8	7.1	100.0
6	TX	56.0	25.7	3.8	6.5	8.0	100.0
AV REG 6		55.3	26.1	3.8	6.6	8.1	100.0
7	IA	60.4	23.1	3.4	5.9	7.2	100.0
7	KS	46.4	31.3	4.6	7.9	9.8	100.0
7	MO	46.7	31.1	4.6	7.9	9.7	100.0
7	NE	43.0	33.3	4.9	8.4	10.4	100.0
AV REG 7		50.4	28.9	4.3	7.3	9.0	100.0
8	CO	41.9	33.9	5.0	8.6	10.6	100.0
8	MT	46.5	31.3	4.6	7.9	9.7	100.0
8	ND	39.2	35.5	5.2	9.0	11.1	100.0
8	SD	47.8	30.5	4.5	7.7	9.5	100.0
8	UT	53.7	27.1	4.0	6.9	8.4	100.0
8	WY	50.0	29.2	4.3	7.4	9.1	100.0
AV REG 8		46.5	31.2	4.6	7.9	9.7	100.0
9	AK	60.1	23.3	3.4	5.9	7.3	100.0
9	AZ	53.7	27.0	4.0	6.9	8.4	100.0
9	CA	35.4	37.7	5.6	9.6	11.8	100.0
9	HI	36.0	37.4	5.5	9.5	11.6	100.0
9	NV	57.1	25.0	3.7	6.3	7.8	100.0
AV REG 9		38.6	35.9	5.3	9.1	11.2	100.0
10	ID	45.9	31.6	4.7	8.0	9.8	100.0
10	OR	45.8	31.6	4.7	8.0	9.9	100.0
10	WA	46.3	31.4	4.6	7.9	9.8	100.0
AV REG 10		46.1	31.5	4.6	8.0	9.8	100.0
AV U.S.		46.2	31.4	4.6	8.0	9.8	100.0

TABLE I-3 LAND USE BY TYPE OF SEWERAGE SYSTEM
AREA SERVED BY TYPE OF SYSTEM
1000 ACRES

EPA REG	STATE ID	UNDV	COMB	STORM	UNSEW	TOTAL
1	CT	279.4	51.4	82.7	145.4	558.8
1	ME	164.4	44.4	0.0	26.5	235.3
1	MA	426.9	101.8	160.5	276.8	966.0
1	NH	71.1	31.7	0.0	22.1	124.9
1	RI	68.3	21.8	23.9	48.2	162.2
1	VT	17.1	7.9	0.0	9.6	34.6
TL REG 1		1027.1	259.1	267.0	528.5	2081.8
2	NJ	717.6	26.5	301.5	433.4	1479.0
2	NY	197.1	245.6	241.1	145.9	829.7
TL REG 2		914.8	272.1	542.6	579.2	2308.7
3	DE	30.6	6.8	17.2	20.3	75.0
3	DC	1.5	12.7	25.1	0.0	39.3
3	MD	114.5	0.0	190.5	97.9	402.8
3	PA	489.5	89.3	432.0	339.5	1350.4
3	VA	266.8	28.0	154.3	120.0	569.2
3	WV	76.7	57.6	3.5	23.7	161.6
TL REG 3		979.6	194.5	822.6	601.4	2598.2
4	AL	418.8	0.0	105.1	159.1	683.0
4	FL	637.4	0.4	311.6	325.3	1274.7
4	GA	352.1	60.2	102.7	181.8	696.9
4	KY	119.4	9.6	88.1	87.4	304.4
4	MS	151.2	0.0	51.5	73.5	276.2
4	NC	359.1	0.0	113.7	178.1	650.9
4	SC	186.7	0.0	62.1	94.8	343.6
4	TN	427.0	25.7	98.8	167.5	718.9
TL REG 4		2651.8	95.9	933.6	1267.4	4948.6
5	IL	341.9	306.9	218.5	321.9	1189.1
5	IN	366.3	167.9	57.3	186.6	778.1
5	MI	406.8	233.8	156.0	295.4	1092.0
5	MN	376.6	47.9	98.1	172.9	695.5
5	OH	775.7	211.2	237.6	489.0	1713.6
5	WI	341.9	31.8	144.4	170.0	688.2
TL REG 5		2609.2	999.5	912.0	1635.8	6156.6

TABLE I-3 LAND USE BY TYPE OF SEWERAGE SYSTEM
AREA SERVED BY TYPE OF SYSTEM
1000 ACRES

EPA REG	STATE ID	UNDV.	COMB.	STORM	UNSEW	TOTAL
6	AR	177.0	11.6	30.1	82.4	301.0
6	LA	128.2	0.0	130.0	69.5	327.7
6	NM	87.4	0.0	38.3	48.9	174.7
6	OK	365.8	0.0	87.6	145.3	598.8
6	TX	1426.8	5.1	489.3	624.8	2546.0
TL REG 6		2185.2	16.7	775.3	970.9	3948.2
7	IA	323.8	8.9	76.5	126.7	535.9
7	KS	151.9	21.3	66.8	87.6	327.5
7	MO	331.6	163.6	29.8	185.4	710.4
7	NE	79.1	29.6	19.4	55.8	183.9
TL REG 7		886.4	223.3	192.6	455.5	1757.7
8	CO	140.5	1.8	98.1	94.5	334.9
8	MT	38.2	0.0	24.2	19.8	82.2
8	ND	19.5	1.0	18.5	10.6	49.7
8	SD	32.7	0.7	15.0	20.1	68.4
8	UT	124.1	0.0	46.3	60.8	231.2
8	WY	24.6	0.0	11.3	13.4	49.3
TL REG 8		379.5	3.4	213.3	219.3	815.6
9	AK	29.6	0.7	6.7	12.1	49.2
9	AZ	206.2	0.0	80.7	97.1	384.0
9	CA	1002.0	67.1	1050.4	708.7	2828.1
9	HI	38.3	0.0	36.9	31.1	106.2
9	NV	68.3	2.8	17.3	31.1	119.6
TL REG 9		1344.4	70.6	1191.9	880.1	3487.0
10	ID	38.8	0.0	21.9	23.8	84.5
10	OR	139.8	32.7	45.7	86.7	305.0
10	WA	252.6	79.9	68.8	144.3	545.6
TL REG 10		431.2	112.6	136.5	254.8	935.1
TL U.S.		13409.	2248.	5987.	7393.	29037.

TABLE I-4 POPULATION BY TYPE OF SEWERAGE SYSTEM

EPA REG	STATE ID	POPULATION SERVED (1000 PERSONS) COMB	STORM	UNSEW	TOTAL
1	CT	692.	979.	673.	2344.
1	ME	372.	0.	135.	507.
1	MA	1155.	2404.	1254.	4813.
1	NH	286.	0.	131.	417.
1	RI	346.	278.	202.	826.
1	VT	69.	0.	74.	143.
TL REG 1		2919.	3661.	2470.	9050.
2	NJ	405.	4473.	1495.	6372.
2	NY	9603.	5369.	639.	15611.
TL REG 2		10007.	9842.	2134.	21983.
3	DE	83.	210.	101.	395.
3	DC	400.	357.	0.	757.
3	MD	0.	2545.	460.	3005.
3	PA	1354.	5802.	1277.	8433.
3	VA	298.	2143.	492.	2933.
3	WV	515.	42.	122.	680.
TL REG 3		2651.	11100.	2451.	16203.
4	AL	0.	1238.	773.	2011.
4	FL	6.	4075.	1385.	5465.
4	GA	590.	1156.	1022.	2768.
4	KY	116.	1187.	384.	1687.
4	MS	0.	596.	391.	987.
4	NC	0.	1315.	972.	2287.
4	SC	0.	697.	536.	1233.
4	TN	312.	1249.	746.	2307.
TL REG 4		1024.	11512.	6209.	18745.
5	IL	6109.	1582.	1530.	9221.
5	IN	1845.	715.	811.	3371.
5	MI	3293.	1885.	1382.	6559.
5	MN	593.	1218.	716.	2527.
5	OH	2647.	3429.	1944.	8021.
5	WI	679.	1272.	960.	2911.
TL REG 5		15166.	10101.	7343.	32610.

TABLE I-4 POPULATION BY TYPE OF SEWERAGE SYSTEM

EPA REG	STATE ID	POPULATION SERVED (1000 PERSONS) COMB	STORM	UNSEW	TOTAL
6	AR	80.	345.	537.	962.
6	LA	0.	2012.	394.	2406.
6	NM	0.	485.	226.	711.
6	OK	0.	1150.	590.	1740.
6	TX	101.	6031.	2801.	8934.
TL REG 6		181.	10023.	4549.	14753.
7	IA	252.	754.	609.	1615.
7	KS	254.	768.	463.	1485.
7	MO	1635.	254.	1389.	3278.
7	NE	419.	260.	234.	913.
TL REG 7		2559.	2036.	2695.	7291.
8	CO	36.	1260.	441.	1737.
8	MT	0.	256.	116.	372.
8	ND	10.	197.	67.	274.
8	SD	8.	183.	106.	297.
8	UT	0.	589.	265.	854.
8	WY	0.	126.	75.	201.
TL REG 8		55.	2610.	1070.	3735.
9	AK	10.	93.	44.	147.
9	AZ	0.	989.	419.	1408.
9	CA	1663.	13493.	2986.	18142.
9	HI	0.	499.	139.	638.
9	NV	41.	217.	139.	396.
TL REG 9		1713.	15291.	3727.	20731.
10	ID	0.	232.	155.	387.
10	OR	427.	574.	402.	1403.
10	WA	903.	871.	701.	2475.
TL REG 10		1330.	1677.	1258.	4265.
TL U.S.		37606.	77853.	33906.	149366.

TABLE I-5 POPULATION DENSITY BY TYPE OF SEWERAGE SYSTEM

EPA REG	STATE ID	POPULATION DENSITY (PERSONS/ACRE) COMB	STORM	UNSEW	AVER
1	CT	13.47	11.84	4.63	8.39
1	ME	8.36	0.0	5.12	7.15
1	MA	11.34	14.98	4.53	8.03
1	NH	9.02	0.0	5.02	7.75
1	RI	15.85	11.60	4.20	8.79
1	VT	8.75	0.0	7.73	8.19
AV REG 1		11.27	13.71	4.67	8.58
2	NJ	15.27	14.83	3.45	8.37
2	NY	39.10	22.27	4.38	24.68
AV REG 2		36.78	18.14	3.68	15.77
3	DE	12.23	12.23	4.98	8.81
3	DC	31.40	14.24	0.0	20.02
3	MD	0.0	13.36	4.70	10.42
3	PA	15.17	13.43	3.76	9.80
3	VA	10.63	13.89	4.10	9.70
3	WV	8.94	12.04	5.16	8.01
AV REG 3		13.63	13.49	4.08	10.01
4	AL	0.0	11.78	4.86	7.61
4	FL	14.20	13.08	4.26	8.58
4	GA	9.81	11.25	5.62	8.03
4	KY	12.03	13.48	4.40	9.12
4	MS	0.0	11.57	5.32	7.90
4	NC	0.0	11.56	5.46	7.84
4	SC	0.0	11.22	5.66	7.86
4	TN	12.16	12.64	4.45	7.90
AV REG 4		10.68	12.33	4.90	8.16
5	IL	19.91	7.24	4.75	10.88
5	IN	10.99	12.48	4.34	8.19
5	MI	14.08	12.08	4.68	9.57
5	MN	12.37	12.41	4.14	7.92
5	OH	12.53	14.43	3.98	8.55
5	WI	21.32	8.81	5.65	8.41
AV REG 5		15.17	11.08	4.49	9.19
6	AR	6.93	11.47	6.52	7.76
6	LA	0.0	15.47	5.68	12.06
6	NM	0.0	12.66	4.62	8.15
6	OK	0.0	13.12	4.06	7.47
6	TX	19.78	12.33	4.48	7.98
AV REG 6		10.87	12.93	4.68	8.37
7	IA	28.38	9.85	4.81	7.61
7	KS	11.93	11.50	5.29	8.45
7	MO	10.00	8.52	7.49	8.65
7	NE	14.17	13.41	4.19	8.71
AV REG 7		11.46	10.57	5.92	8.37
8	CO	19.93	12.84	4.66	8.93
8	MT	0.0	10.57	5.86	8.46
8	ND	10.67	10.67	6.18	9.06
8	SD	12.23	12.23	5.28	8.32
8	UT	0.0	12.72	4.37	7.98
8	WY	0.0	11.16	5.62	8.16
AV REG 8		15.90	12.24	4.88	8.56
9	AK	13.75	13.75	3.66	7.50
9	AZ	0.0	12.26	4.32	7.92
9	CA	24.79	12.85	4.21	9.93
9	HI	0.0	13.55	4.46	9.39
9	NV	14.38	12.50	4.46	7.72
AV REG 9		24.26	12.83	4.23	9.68
10	ID	0.0	10.58	6.52	8.47
10	OR	13.04	12.57	4.64	8.50
10	WA	11.31	12.65	4.86	8.45
AV REG 10		11.82	12.29	4.94	8.46
AV U.S.		16.73	13.00	4.59	9.56

RUNOFF ANALYSIS

An examination of precipitation patterns led to the division of the country into five zones for purposes of analysis with the Corps of Engineers' STORM model: Pacific Coast, Rocky Mountain, Midwest and Texas, South and Southeast, and Northeast. STORM was run on a representative city for each of these regions: San Francisco, Denver, Minneapolis, Atlanta, and Washington, DC. Results from these runs were used in developing the nationwide assessment methodology and also used to calibrate the elementary technique used for runoff prediction for the 248 urbanized areas.

Annual wet-weather runoff was generated using a runoff coefficient that is a function of imperviousness which in turn is a function of population density. Table I-6, Annual Wet-Weather Runoff for Combined, Storm, and Unsewered Areas indicates average runoff of 16.5 inches (41.9 cm) per year, 14.8 inches (37.6 cm) per year, and 10.8 inches (27.4 cm) per year from an average precipitation of 33.4 inches (84.8 cm) per year in combined, storm and unsewered urban areas, respectively. Dry-weather flow is a function of population density on the basis of 100 gallons per person-day (379 liters per person-day). Table I-7, Annual Dry-Weather Flow for Combined, Storm, and Unsewered Areas illustrates runoff magnitudes by USEPA region and for the US as a whole.

Average annual dry-weather flow (DWF) is significantly greater than average wet-weather flow (WWF) only in the arid areas of USEPA regions 8 and 9. The heavily urbanized regions 2 and 3 produce the highest dry-weather flows (although above average precipitation partially offsets these values). However, in most parts of the country, dry-weather flows represent 30-50 percent of the total (wet plus dry) runoff from urban areas.

PREDICTION OF URBAN RUNOFF QUALITY

Analysis of available urban runoff quality data indicates a great number of disaggregated urban runoff studies from which it is highly difficult to draw meaningful conclusions as to pollutant loading rates. For instance, there are no known studies in which both surface and effluent data have been gathered simultaneously. In addition, there is a wide variation in the manner in which data are reported (e.g., "average" concentrations) and in the amount of related information provided about the catchment areas (e.g., population density).

On the basis of the available data, pollutant loading estimates were developed for wet weather for BOD_5, suspended solids, volatile solids, total phosphate (PO_4) and total nitrogen (N), and derived as functions of precipitation, land use and population density, the latter only for residential land use. Other land uses are commercial, industrial and open. These estimates indicate that, for the same population density, loads from combined sewered areas are approximately four times higher than those from separate sewered areas. Furthermore, higher population

TABLE I-6 ANNUAL WET-WEATHER RUNOFF

EPA REG	STATE ID	IN/YR ANNL. PRECP	WET-WEATHER FLOW (INCHES PER YEAR) COMB	STORM	UNSEW	AVER
1	CT	43.7	18.8	18.1	13.4	16.1
1	ME	43.5	16.0	0.0	13.6	15.2
1	MA	43.6	17.6	19.6	13.2	16.4
1	NH	41.0	15.4	0.0	13.5	14.7
1	RI	40.0	18.5	16.5	12.0	15.0
1	VT	35.0	13.1	0.0	12.6	12.8
AV REG 1		41.1	17.2	18.9	13.2	16.0
2	NJ	42.8	19.1	19.4	12.2	15.9
2	NY	38.1	25.8	21.4	11.0	21.1
AV REG 2		40.5	25.2	20.3	11.9	18.2
3	DE	45.0	19.0	19.0	14.2	17.0
3	DC	41.0	24.8	18.2	0.0	20.7
3	MD	42.0	0.0	18.5	13.1	16.9
3	PA	41.0	17.6	18.2	11.4	15.9
3	VA	42.9	16.9	18.7	13.2	16.6
3	WV	41.0	15.4	18.6	13.8	15.2
AV REG 3		42.1	17.4	18.4	12.2	16.3
4	AL	55.8	0.0	23.4	17.7	20.3
4	FL	56.5	22.7	24.9	17.1	21.3
4	GA	46.5	18.1	19.2	15.3	17.1
4	KY	42.3	17.9	18.1	12.5	15.8
4	MS	54.5	0.0	22.1	17.5	19.6
4	NC	46.0	0.0	18.6	14.6	16.4
4	SC	46.7	0.0	19.1	15.3	17.0
4	TN	48.3	19.4	20.5	14.6	17.3
AV REG 4		49.6	18.5	21.7	15.8	18.6
5	IL	35.0	16.6	11.6	10.3	13.4
5	IN	37.2	14.7	15.1	10.9	13.3
5	MI	31.0	13.6	12.9	9.5	11.9
5	MN	26.0	10.5	10.6	7.4	9.1
5	OH	37.2	14.6	15.6	10.2	12.9
5	WI	29.7	14.5	10.8	9.2	10.5
AV REG 5		32.7	14.8	12.9	9.8	12.3

TABLE I-6 ANNUAL WET-WEATHER RUNOFF

EPA REG	STATE ID	IN/YR ANNL. PRECP	WET-WEATHER FLOW (INCHES PER YEAR) COMB	STORM	UNSEW	AVER
6	AR	48.0	15.0	20.6	16.4	17.4
6	LA	56.0	0.0	27.5	17.4	24.1
6	NM	9.0	0.0	3.6	2.5	3.1
6	OK	32.7	0.0	14.2	9.7	11.7
6	TX	31.0	24.7	14.2	10.1	12.3
AV REG 6		35.3	17.9	16.2	10.7	13.4
7	IA	31.3	18.0	12.1	9.7	11.1
7	KS	33.0	14.1	13.2	10.4	12.1
7	MO	36.8	14.2	13.3	12.7	13.5
7	NE	26.5	11.4	11.5	7.7	9.7
AV REG 7		31.9	14.0	12.6	10.8	12.2
8	CO	14.5	6.1	5.8	4.0	5.1
8	MT	14.0	0.0	5.4	4.3	5.0
8	ND	21.0	8.3	8.3	6.9	7.8
8	SD	25.0	10.4	10.4	7.9	9.1
8	UT	15.0	0.0	6.3	4.4	5.3
8	WY	15.0	0.0	5.9	4.7	5.3
AV REG 8		17.4	7.5	6.4	4.7	5.6
9	AK	30.0	13.1	13.1	8.6	10.6
9	AZ	9.0	0.0	3.1	2.2	2.7
9	CA	17.2	11.3	5.9	4.6	5.7
9	HI	23.0	0.0	9.9	6.9	8.7
9	NV	5.5	2.9	1.6	1.2	1.5
AV REG 9		16.9	10.9	5.8	4.3	5.5
10	ID	11.0	0.0	4.2	3.5	3.9
10	OR	39.3	17.2	16.8	12.2	14.7
10	WA	30.3	12.0	15.5	10.6	12.3
AV REG 10		26.9	13.5	14.1	10.5	12.4
AV U.S.		33.4	16.5	14.8	10.8	13.4

TABLE I-7 ANNUAL DRY-WEATHER FLOW

EPA REG	STATE ID	IN/YR ANNL. PRECP	DRY-WEATHER FLOW (INCHES PER YEAR) COMB	STORM	UNSEW	AVER
1	CT	43.7	18.1	15.9	6.2	11.3
1	ME	43.5	11.2	0.0	6.9	9.6
1	MA	43.6	15.2	20.1	6.1	12.0
1	NH	41.0	12.1	0.0	8.0	10.4
1	RI	40.0	21.3	15.6	5.6	11.8
1	VT	35.0	11.8	0.0	10.4	11.0
AV REG 1		41.1	15.1	18.4	6.3	11.5
2	NJ	42.8	20.5	19.9	4.6	11.2
2	NY	38.1	52.5	29.9	5.9	33.2
AV REG 2		40.5	49.4	24.4	5.0	21.2
3	DE	45.0	16.4	16.4	6.7	12.0
3	DC	41.0	42.2	19.1	0.0	26.9
3	MD	42.0	0.0	18.0	6.3	14.0
3	PA	41.0	20.4	18.0	5.1	13.2
3	VA	42.9	14.3	18.7	5.5	13.0
3	WV	41.0	12.0	16.2	6.9	10.8
AV REG 3		42.1	18.3	18.1	5.5	13.5
4	AL	55.8	0.0	15.8	6.5	10.2
4	FL	56.5	19.1	17.6	5.7	11.5
4	GA	46.5	13.2	15.1	7.6	10.8
4	KY	42.3	16.2	18.1	5.9	12.3
4	MS	54.5	0.0	15.6	7.1	10.6
4	NC	46.0	0.0	15.5	7.3	10.5
4	SC	46.7	0.0	15.1	7.6	10.6
4	TN	48.3	16.3	17.0	6.0	10.6
AV REG 4		49.6	14.4	16.6	6.6	11.0
5	IL	35.0	26.8	9.7	6.4	14.6
5	IN	37.2	14.8	16.8	5.8	11.0
5	MI	31.0	18.9	16.2	6.3	12.9
5	MN	26.0	16.6	16.7	5.6	10.6
5	OH	37.2	16.8	19.4	5.3	11.5
5	WI	29.7	28.7	11.8	7.6	11.3
AV REG 5		32.7	20.4	14.9	6.0	12.4

TABLE I-7 ANNUAL DRY-WEATHER FLOW

EPA REG	STATE ID	IN/YR ANNL. PRECP	DRY-WEATHER FLOW (INCHES PER YEAR) COMB	STORM	UNSEW	AVER.
6	AR	48.0	9.3	15.4	8.8	10.4
6	LA	56.0	0.0	20.8	7.6	16.2
6	NM	9.0	0.0	17.0	6.2	11.0
6	OK	32.7	0.0	17.6	5.5	10.0
6	TX	31.0	26.6	16.6	6.0	10.7
AV REG 6		35.3	14.6	17.4	6.3	11.2
7	IA	31.3	38.1	13.2	6.5	10.2
7	KS	33.0	16.0	15.5	7.1	11.4
7	MO	36.8	13.4	11.4	10.1	11.6
7	NE	26.5	19.0	18.0	5.6	11.7
AV REG 7		31.9	15.4	14.2	8.0	11.2
8	CO	14.5	26.8	17.3	6.3	12.0
8	MT	14.0	0.0	14.2	7.9	11.4
8	ND	21.0	14.3	14.3	8.3	12.2
8	SD	25.0	16.4	16.4	7.1	11.2
8	UT	15.0	0.0	17.1	5.9	10.7
8	WY	15.0	0.0	15.0	7.6	11.0
AV REG 8		17.4	21.4	16.4	6.6	11.5
9	AK	30.0	18.5	18.5	4.9	10.1
9	AZ	9.0	0.0	16.5	5.8	10.6
9	CA	17.2	33.3	17.3	5.7	13.4
9	HI	23.0	0.0	18.2	6.0	12.6
9	NV	5.5	19.3	16.8	6.0	10.4
AV REG 9		16.9	32.6	17.2	5.7	13.0
10	ID	11.0	0.0	14.2	8.8	11.4
10	OR	39.3	17.5	16.9	6.2	11.4
10	WA	30.3	15.2	17.0	6.5	11.4
AV REG 10		26.9	15.9	16.5	6.6	11.4
AV U.S.		33.4	22.5	17.5	6.2	12.8

densities in combined sewered areas will increase the ratio even more because loadings are assumed to be an increasing function of population density.

NATIONWIDE QUALITY ASSESSMENT

Annual BOD_5 loads were calculated for the 248 urbanized areas for both wet and dry-weather conditions, the latter under the assumption of 0.17 pounds per person-day (0.08 kg per person-day). Annual loads for other parameters may be easily calculated for any urbanized area from information provided in Section V.

The national summary is shown in Table I-8, Dry-Weather BOD Loadings and Table I-9, Wet-Weather BOD Loadings. Loading rates for untreated dry-weather flow are higher than for wet-weather flow. However, if 85 percent secondary treatment is assumed for dry-weather BOD generation, wet-weather loads are seen to be one third of the total residual loadings in urban areas. Moreover, BOD loadings from combined sewered areas are comparable to loads due to secondary effluent.

COST ASSESSMENT METHODOLOGY

A generalized method for evaluating the optimal mix of storage and treatment for any desired level of pollutant control was presented. This method can be used for any city in the United States to obtain a first approximation of control costs. Five cities (Atlanta, Denver, Minneapolis, San Francisco, and Washington, DC) were used in the more detailed analysis. The effects of treatment plant efficiency and first flush are included.

An evaluation was made of the relative desirability of using a mix of storage with either primary treatment or secondary treatment. The basic tradeoff to be evaluated is whether primary treatment is sufficiently less expensive than secondary treatment to offset its lower removal efficiency which necessitates treating a much larger amount of flow to effect an equivalent BOD removal. The results indicate that a primary type of facility is preferable up to BOD removals of about ten percent. A secondary facility is preferable for higher levels of control.

The annual average percent runoff control and the annual number of overflow events were correlated to permit the reader to use either criterion as an effectiveness metric. A precipitation event was assumed to terminate following 12 hours of no precipitation.

The final assessment results (annual costs per acre) are shown in Table I-10, Annual Control Costs - Combined Areas, Table I-11, Annual Control Costs - Storm Areas, and Table I-12, Annual Control Costs - Unsewered Areas.

TABLE I-8 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	IN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
1	CT	43.7	836.	736.	288.	521.
1	ME	43.5	519.	0.	318.	444.
1	MA	43.6	704.	931.	281.	554.
1	NH	41.0	560.	0.	368.	481.
1	RI	40.0	984.	721.	261.	546.
1	VT	35.0	544.	0.	480.	509.
AV REG 1		41.1	700.	851.	290.	533.
2	NJ	42.8	948.	921.	214.	520.
2	NY	38.1	2428.	1383.	272.	1533.
AV REG 2		40.5	2284.	1126.	229.	979.
3	DE	45.0	760.	760.	309.	553.
3	DC	41.0	1950.	884.	0.	1243.
3	MD	42.0	0.	830.	292.	647.
3	PA	41.0	942.	834.	234.	608.
3	VA	42.9	660.	862.	254.	602.
3	WV	41.0	555.	748.	320.	498.
AV REG 3		42.1	846.	838.	253.	622.
4	AL	55.8	0.	732.	302.	473.
4	FL	56.5	882.	812.	264.	533.
4	GA	46.5	609.	699.	349.	499.
4	KY	42.3	747.	837.	273.	566.
4	MS	54.5	0.	719.	330.	490.
4	NC	46.0	0.	718.	339.	487.
4	SC	46.7	0.	697.	351.	488.
4	TN	48.3	755.	785.	277.	491.
AV REG 4		49.6	663.	766.	304.	507.
5	IL	35.0	1236.	450.	295.	676.
5	IN	37.2	683.	775.	270.	508.
5	MI	31.0	875.	750.	290.	594.
5	MN	26.0	768.	771.	257.	492.
5	OH	37.2	778.	896.	247.	531.
5	WI	29.7	1324.	547.	351.	522.
AV REG 5		32.7	942.	688.	279.	571.

TABLE I-8 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	IN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
6	AR	48.0	430.	712.	405.	482.
6	LA	56.0	0.	961.	352.	749.
6	NM	9.0	0.	786.	287.	506.
6	OK	32.7	0.	815.	252.	464.
6	TX	31.0	1228.	766.	278.	496.
AV REG 6		35.3	675.	803.	291.	520.
7	IA	31.3	1763.	612.	299.	473.
7	KS	33.0	741.	714.	328.	525.
7	MO	36.8	621.	529.	465.	537.
7	NE	26.5	880.	833.	260.	541.
AV REG 7		31.9	712.	657.	367.	520.
8	CO	14.5	1238.	798.	290.	555.
8	MT	14.0	0.	657.	364.	525.
8	ND	21.0	662.	662.	384.	563.
8	SD	25.0	759.	759.	328.	516.
8	UT	15.0	0.	790.	271.	495.
8	WY	15.0	0.	693.	349.	506.
AV REG 8		17.4	988.	760.	303.	532.
9	AK	30.0	854.	854.	227.	466.
9	AZ	9.0	0.	761.	268.	492.
9	CA	17.2	1539.	798.	262.	617.
9	HI	23.0	0.	841.	277.	583.
9	NV	5.5	893.	777.	277.	480.
AV REG 9		16.9	1507.	797.	263.	601.
10	ID	11.0	0.	657.	405.	526.
10	OR	39.3	810.	780.	288.	528.
10	WA	30.3	703.	785.	302.	525.
AV REG 10		26.9	734.	763.	307.	526.
AV. U.S.		33.4	1039.	807.	285.	594.

TABLE I-9 WET-WEATHER BOD LOADINGS

EPA REG	STATE ID	IN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
1	CT	43.7	158.6	37.8	31.8	56.9
1	ME	43.5	144.3	0.0	32.1	102.4
1	MA	43.6	152.9	39.7	31.6	56.9
1	NH	41.0	137.8	0.0	31.0	94.0
1	RI	40.0	152.9	34.6	28.8	59.1
1	VT	35.0	117.7	0.0	27.9	68.5
AV REG 1		41.1	149.6	38.7	31.3	62.2
2	NJ	42.8	160.1	39.2	30.1	38.2
2	NY	38.1	190.8	41.1	26.5	95.9
AV REG 2		40.5	187.8	40.1	29.2	64.4
3	DE	45.0	162.2	39.4	33.3	55.5
3	DC	41.0	187.4	37.1	0.0	87.8
3	MD	42.0	0.0	38.0	31.0	35.6
3	PA	41.0	147.0	37.4	28.0	45.1
3	VA	42.9	147.8	38.3	31.8	45.8
3	WV	41.0	137.6	38.6	32.3	104.1
AV REG 3		42.1	147.5	37.8	29.6	47.9
4	AL	55.8	0.0	48.7	41.6	44.4
4	FL	56.5	190.0	51.0	40.8	45.9
4	GA	46.5	159.7	40.4	35.3	58.6
4	KY	42.3	153.2	37.2	30.0	39.8
4	MS	54.5	0.0	46.2	40.5	42.9
4	NC	46.0	0.0	39.0	34.0	36.0
4	SC	46.7	0.0	40.2	35.3	37.2
4	TN	48.3	166.2	42.3	34.7	48.8
AV REG 4		49.6	161.0	44.9	37.2	45.5
5	IL	35.0	133.8	26.3	24.6	64.6
5	IN	37.2	128.6	31.5	26.3	68.8
5	MI	31.0	114.5	27.1	22.7	55.0
5	MN	26.0	90.5	22.3	18.2	30.3
5	OH	37.2	125.3	31.9	24.8	49.3
5	WI	29.7	116.2	23.7	21.5	31.1
AV REG 5		32.7	124.0	27.4	23.5	52.8

TABLE I-9 WET-WEATHER BOD LOADINGS

EPA REG	STATE ID	IN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
6	AR	48.0	138.4	43.2	37.2	48.1
6	LA	56.0	0.0	55.1	40.0	49.9
6	NM	9.0	0.0	7.9	6.6	7.2
6	OK	32.7	0.0	29.4	23.6	25.8
6	TX	31.0	200.1	29.7	24.3	27.5
AV REG 6		35.3	157.3	33.4	25.5	30.2
7	IA	31.3	138.1	26.2	23.0	29.0
7	KS	33.0	121.9	27.9	24.4	37.5
7	MO	36.8	125.2	29.2	28.5	70.3
7	NE	26.5	96.8	23.8	18.9	41.8
AV REG 7		31.9	121.7	27.0	25.0	50.2
8	CO	14.5	50.2	12.4	10.1	11.6
8	MT	14.0	0.0	12.0	10.5	11.3
8	ND	21.0	73.5	17.9	16.1	19.0
8	SD	25.0	90.1	21.9	18.7	21.3
8	UT	15.0	0.0	13.4	10.9	12.0
8	WY	15.0	0.0	12.9	11.3	12.0
AV REG 8		17.4	64.2	13.7	11.5	13.0
9	AK	30.0	111.0	27.0	21.2	26.5
9	AZ	9.0	0.0	7.0	5.8	6.3
9	CA	17.2	88.7	12.5	11.5	14.9
9	HI	23.0	0.0	20.6	16.7	18.8
9	NV	5.5	26.2	4.0	3.5	4.9
AV REG 9		16.9	86.4	12.4	10.9	14.2
10	ID	11.0	0.0	9.3	8.5	8.9
10	OR	39.3	146.0	34.9	29.0	53.8
10	WA	30.3	103.9	32.1	25.3	48.3
AV REG 10		26.9	116.1	29.4	25.0	46.5
AV U.S.		33.4	136.6	30.5	25.9	43.6

TABLE I-10 ANNUAL CONTROL COSTS - COMBINED AREAS

EPA REG	STATE ID	CONTROL COST ($/ACRE) 25%	50%	75%	85%
1	CT	33.	102.	321.	510.
1	ME	16.	44.	124.	187.
1	MA	27.	79.	231.	356.
1	NH	16.	46.	130.	196.
1	RI	43.	130.	394.	614.
1	VT	13.	37.	104.	157.
AV REG 1		26.	77.	228.	354.
2	NJ	45.	165.	624.	1068.
2	NY	103.	404.	1606.	2797.
AV REG 2		97.	381.	1510.	2629.
3	DE	29.	84.	244.	374.
3	DC	119.	490.	2014.	3546.
3	MD	0.	0.	0.	0.
3	PA	44.	141.	447.	711.
3	VA	24.	69.	199.	305.
3	WV	17.	48.	136.	206.
AV REG 3		38.	124.	415.	676.
4	AL	0.	0.	0.	0.
4	FL	53.	146.	406.	610.
4	GA	28.	77.	208.	310.
4	KY	27.	79.	228.	350.
4	MS	0.	0.	0.	0.
4	NC	0.	0.	0.	0.
4	SC	0.	0.	0.	0.
4	TN	35.	95.	259.	387.
AV REG 4		30.	82.	225.	336.
5	IL	76.	242.	771.	1225.
5	IN	27.	75.	204.	305.
5	MI	34.	94.	262.	396.
5	MN	21.	56.	153.	229.
5	OH	31.	87.	242.	365.
5	WI	69.	235.	799.	1305.
AV REG 5		46.	137.	416.	650.

EPA REG	STATE ID	CONTROL COST ($/ACRE) 25%	50%	75%	85%
6	AR	14.	37.	96.	141.
6	LA	0.	0.	0.	0.
6	NM	0.	0.	0.	0.
6	OK	0.	0.	0.	0.
6	TX	80.	277.	992.	1665.
AV REG 6		35.	111.	371.	608.
7	IA	96.	385.	1542.	2688.
7	KS	26.	71.	193.	287.
7	MO	22.	59.	158.	235.
7	NE	28.	77.	214.	322.
AV REG 7		26.	75.	224.	349.
8	CO	46.	141.	434.	684.
8	MT	0.	0.	0.	0.
8	ND	13.	35.	94.	140.
8	SD	20.	54.	148.	221.
8	UT	0.	0.	0.	0.
8	WY	0.	0.	0.	0.
AV REG 8		32.	95.	286.	445.
9	AK	40.	107.	287.	426.
9	AZ	0.	0.	0.	0.
9	CA	80.	247.	764.	1201.
9	HI	0.	0.	0.	0.
9	NV	14.	36.	96.	142.
AV REG 9		77.	237.	732.	1150.
10	ID	0.	0.	0.	0.
10	OR	48.	128.	343.	509.
10	WA	30.	80.	212.	314.
AV REG 10		35.	94.	250.	370.
AV U.S.		47.	151.	501.	815.

TABLE I-11 ANNUAL CONTROL COSTS - STORM AREAS

EPA REG	STATE ID	CONTROL COST ($/ACRE) 25%	50%	75%	85%
1	CT	27.	79.	230.	352.
1	ME	0.	0.	0.	0.
1	MA	42.	127.	381.	592.
1	NH	0.	0.	0.	0.
1	RI	23.	67.	195.	297.
1	VT	0.	0.	0.	0.
AV REG 1		36.	107.	318.	491.
2	NJ	41.	122.	364.	565.
2	NY	86.	335.	1313.	2271.
AV REG 2		61.	216.	736.	1323.
3	DE	29.	88.	244.	374.
3	DC	35.	105.	311.	481.
3	MD	32.	95.	279.	430.
3	PA	34.	101.	305.	474.
3	VA	35.	103.	306.	473.
3	WV	28.	81.	235.	360.
AV REG 3		33.	100.	298.	461.
4	AL	40.	110.	298.	445.
4	FL	50.	138.	380.	570.
4	GA	31.	84.	228.	340.
4	KY	32.	96.	282.	435.
4	MS	37.	100.	271.	403.
4	NC	32.	86.	233.	348.
4	SC	31.	83.	223.	332.
4	TN	40.	111.	305.	458.
AV REG 4		40.	110.	303.	450.
5	IL	15.	41.	110.	164.
5	IN	32.	88.	243.	364.
5	MI	25.	67.	181.	270.
5	MN	21.	57.	155.	232.
5	OH	40.	112.	315.	477.
5	WI	15.	41.	110.	162.
AV REG 5		25.	69.	189.	283.

EPA REG	STATE ID	CONTROL COST ($/ACRE) 25%	50%	75%	85%
6	AR	34.	92.	250.	372.
6	LA	86.	249.	717.	1096.
6	NM	14.	37.	85.	139.
6	OK	31.	84.	232.	347.
6	TX	28.	76.	208.	310.
AV REG 6		38.	105.	292.	440.
7	IA	19.	50.	134.	198.
7	KS	23.	63.	170.	254.
7	MO	18.	49.	130.	193.
7	NE	25.	70.	194.	290.
AV REG 7		21.	56.	152.	226.
8	CO	24.	62.	161.	236.
8	MT	16.	42.	106.	154.
8	ND	13.	35.	94.	140.
8	SD	20.	54.	148.	221.
8	UT	25.	64.	166.	243.
8	WY	19.	49.	126.	183.
AV REG 8		22.	56.	147.	216.
9	AK	40.	107.	287.	426.
9	AZ	11.	30.	77.	112.
9	CA	16.	43.	115.	170.
9	HI	29.	79.	212.	314.
9	NV	6.	16.	41.	60.
AV REG 9		16.	43.	115.	171.
10	ID	13.	32.	82.	119.
10	OR	44.	119.	317.	469.
10	WA	41.	109.	292.	432.
AV REG 10		38.	100.	266.	394.
AV U.S.		32.	94.	279.	434.

TABLE I-12 ANNUAL CONTROL COSTS - UNSEWERED AREAS

EPA REG	STATE ID	CONTROL COST ($/ACRE) 25%	50%	75%	85%
1	CT	9.	23.	62.	92.
1	ME	10.	27.	72.	107.
1	MA	9.	24.	63.	93.
1	NH	10.	28.	76.	113.
1	RI	8.	20.	52.	77.
1	VT	11.	31.	87.	130.
AV REG 1		9.	24.	63.	94.
2	NJ	7.	19.	49.	72.
2	NY	7.	19.	50.	74.
AV REG 2		7.	19.	49.	72.
3	DE	10.	26.	68.	101.
3	DC	0.	0.	0.	0.
3	MD	9.	23.	61.	90.
3	PA	7.	19.	50.	73.
3	VA	8.	22.	57.	85.
3	WV	10.	26.	68.	101.
AV REG 3		8.	21.	55.	81.
4	AL	14.	34.	87.	127.
4	FL	12.	31.	78.	113.
4	GA	13.	32.	83.	121.
4	KY	8.	21.	57.	84.
4	MS	14.	36.	91.	133.
4	NC	12.	31.	78.	114.
4	SC	13.	32.	83.	121.
4	TN	11.	27.	68.	99.
AV REG 4		12.	31.	78.	114.
5	IL	8.	21.	54.	78.
5	IN	9.	22.	55.	79.
5	MI	8.	19.	49.	70.
5	MN	6.	14.	35.	51.
5	OH	8.	19.	48.	70.
5	WI	8.	21.	53.	77.
AV REG 5		8.	20.	49.	71.
6	AR	15.	39.	100.	146.
6	LA	14.	37.	95.	138.
6	NM	4.	9.	21.	30.
6	OK	7.	18.	46.	66.
6	TX	8.	20.	52.	75.
AV REG 6		9.	22.	56.	82.
7	IA	8.	20.	50.	73.
7	KS	9.	22.	57.	82.
7	MO	15.	38.	100.	147.
7	NE	6.	15.	37.	53.
AV REG 7		11.	27.	70.	103.
8	CO	6.	14.	34.	48.
8	MT	7.	18.	43.	62.
8	ND	6.	17.	42.	62.
8	SD	7.	17.	43.	62.
8	UT	6.	14.	35.	50.
8	WY	7.	18.	45.	64.
AV REG 8		6.	15.	37.	53.
9	AK	8.	19.	48.	69.
9	AZ	3.	7.	18.	25.
9	CA	4.	11.	27.	40.
9	HI	7.	17.	42.	61.
9	NV	2.	4.	10.	14.
AV REG 9		4.	11.	27.	38.
10	ID	6.	16.	38.	55.
10	OR	12.	30.	77.	112.
10	WA	11.	27.	68.	99.
AV REG 10		11.	27.	69.	100.
AV U.S.		8.	22.	56.	81.

In order to obtain an overall wet-weather pollutant control of, say, 50 percent in a given urbanized area, the optimal strategy is to use a blend of control in the combined, storm, and unsewered portions of the urbanized areas such that the marginal cost of control in each of these three areas is equal. The results are shown in Table I-13, Optimal Percent Control for Specified Overall Percent Control. Knowing this result and the control cost equations for each type of sewerage system in each urbanized area, the optimal cost per acre can be determined as shown in Table I-14, Optimal Annual Cost per Acre for Specified Percent Control. Lastly, the costs per acre are multiplied by the acreage in the combined, storm, and unsewered categories to obtain the final assessment results which are shown in Table I-15, Optimal Annual and Capital Control Costs. The results indicate that, for the entire US, the total annual costs for 25, 50, 75 and 85 percent BOD control are $297, $886, $2,725, and $5,029 millions of dollars per year. Similarly, the initial capital investment for 25, 50, 75 and 85 percent BOD control is $2,476, $7,391, $22,744, and $41,968 millions of dollars based on 85 percent of the present worth of the total annual cost at an assumed interest rate of 8 percent over 20 years. Note that the incremental costs for wet-weather control increase significantly. This is due to the disproportionately larger control units needed to capture the less frequent, larger storms.

An analysis was made of the possibility of cost allocation among wet-weather quality control and dry-weather quality control (with flow equalization) and wet-weather quantity control (with storage required to reduce runoff rates and volumes). The results suggest that significant savings might be realized as shown in Figure I-1, Single Purpose and Multiple Purpose Stormwater Pollution Control Costs for US, which indicates reductions ranging from 70 percent at low control levels to 30 percent at high levels.

In addition to using storage-treatment devices to control wet-weather pollution, other options, popularly called best management practices (BMP's), are available. A related study suggests that significant savings in control costs could be realized if BMP's are used in conjunction with storage-treatment. The estimated costs of control incorporating BMP's are shown in Figure I-1. The savings range from about 50 percent at low levels of control to about 38 percent at higher control levels. Further savings could be realized by allocating some of the cost to other purposes, e.g., street sweeping for aesthetics.

The relationship between tertiary treatment and wet-weather control was examined by finding the percent wet-weather control to initiate prior to using tertiary treatment. Results indicate that about 4 percent of the wet-weather flow problem should be controlled before initiating tertiary treatment control. BOD removal was used as the effectiveness metric. Different results would be obtained using nutrient control as the criterion.

The results of this assessment indicate significantly lower control costs than reported in earlier studies, i.e., the USEPA Needs survey (initial capital cost = $\$266.1 \times 10^9$), and the National Commission on Water Quality (NCWQ) study (initial capital cost of $\$288.6 \times 10^9$). The NCWQ study

TABLE I-13 OPTIMAL PERCENT CONTROL FOR SPECIFIED OVERALL PERCENT CONTROL

EPA REG	STATE ID	OPTIMAL PERCENT CONTROL 25% COMB	25% STORM	25% UNSEW	50% COMB	50% STORM	50% UNSEW	75% COMB	75% STORM	75% UNSEW	85% COMB	85% STORM	85% UNSEW
1	CT	31.0	3.9	28.6	54.6	29.1	56.1	78.1	54.2	83.5	85.0	85.0	85.0
1	ME	27.9	0.0	3.0	52.8	0.0	28.7	77.7	0.0	54.5	85.0	0.0	85.0
1	MA	34.6	0.0	26.1	60.5	18.4	54.4	84.9	42.2	81.2	85.0	85.0	85.0
1	NH	28.3	0.0	3.7	53.2	0.0	29.5	78.1	0.0	55.3	85.0	0.0	85.0
1	RI	26.5	7.0	32.1	50.5	32.1	59.4	75.1	57.8	85.0	85.0	85.0	85.0
1	VT	32.0	0.0	0.8	56.9	0.0	26.0	81.8	0.0	51.2	85.0	0.0	85.0
2	NJ	29.0	4.0	42.7	48.9	28.1	70.2	77.9	63.0	85.0	85.0	85.0	85.0
2	NY	27.3	2.6	54.8	51.9	27.4	85.0	78.5	54.3	85.0	85.0	85.0	85.0
3	DE	36.7	3.5	27.5	61.1	27.9	54.0	85.0	52.7	81.0	85.0	85.0	85.0
3	DC	25.8	22.9	0.0	48.9	52.8	0.0	72.0	82.8	0.0	85.0	85.0	0.0
3	MD	0.0	16.1	46.2	0.0	40.4	73.0	0.0	70.8	85.0	0.0	85.0	85.0
3	PA	32.2	8.9	42.4	55.7	33.5	70.3	83.3	62.4	85.0	85.0	85.0	85.0
3	VA	44.6	3.8	36.5	69.2	27.8	63.5	85.0	61.5	85.0	85.0	85.0	85.0
3	WV	27.2	0.0	6.5	52.3	9.6	33.1	77.2	33.9	59.3	85.0	85.0	85.0
4	AL	0.0	10.4	36.3	0.0	34.4	62.1	0.0	62.1	85.0	0.0	85.0	85.0
4	FL	40.9	9.9	43.0	64.7	33.9	69.2	85.0	66.6	85.0	85.0	85.0	85.0
4	GA	37.8	0.9	21.4	62.3	25.4	47.4	85.0	51.6	75.1	85.0	85.0	85.0
4	KY	44.0	6.6	37.3	68.4	30.6	64.0	85.0	62.5	85.0	85.0	85.0	85.0
4	MS	0.0	12.1	35.3	0.0	36.2	61.0	0.0	62.5	85.0	0.0	85.0	85.0
4	NC	0.0	11.7	34.7	0.0	35.8	60.4	0.0	61.3	85.0	0.0	85.0	85.0
4	SC	0.0	13.1	33.9	0.0	37.3	59.5	0.0	61.6	85.0	0.0	85.0	85.0
4	TN	39.0	1.2	31.9	63.3	25.2	58.1	85.0	50.9	85.0	85.0	85.0	85.0
5	IL	22.0	24.7	40.8	45.7	52.6	70.4	71.9	83.5	85.0	85.0	85.0	85.0
5	IN	28.4	0.0	19.3	53.7	14.6	46.8	78.3	39.1	73.6	85.0	85.0	85.0
5	MI	28.2	0.8	27.7	52.6	25.9	54.8	77.0	51.0	82.0	85.0	85.0	85.0
5	MN	34.4	0.0	29.5	58.8	23.6	56.2	83.1	47.8	82.7	85.0	85.0	85.0
5	OH	30.6	0.0	28.3	56.3	16.8	56.9	80.7	40.9	84.0	85.0	85.0	85.0
5	WI	18.6	20.4	35.8	39.7	46.7	63.5	63.7	76.6	85.0	85.0	85.0	85.0

TABLE I-13 OPTIMAL PERCENT CONTROL FOR SPECIFIED OVERALL PERCENT CONTROL

EPA REG	STATE ID	OPTIMAL PERCENT CONTROL 25% COMB	25% STORM	25% UNSEW	50% COMB	50% STORM	50% UNSEW	75% COMB	75% STORM	75% UNSEW	85% COMB	85% STORM	85% UNSEW
6	AR	55.0	1.4	19.3	80.1	25.5	44.6	85.0	56.8	77.5	85.0	85.0	85.0
6	LA	0.0	13.6	54.3	0.0	37.7	81.6	0.0	71.1	85.0	0.0	85.0	85.0
6	NM	0.0	7.4	41.6	0.0	31.5	67.5	0.0	64.4	85.0	0.0	85.0	85.0
6	OK	0.0	5.8	39.5	0.0	29.4	65.5	0.0	61.7	85.0	0.0	85.0	85.0
6	TX	25.7	10.2	39.1	44.9	34.3	65.3	69.2	64.9	85.0	85.0	85.0	85.0
7	IA	12.7	15.7	36.5	30.9	41.4	63.9	53.7	73.5	85.0	85.0	85.0	85.0
7	KS	38.2	4.2	27.1	62.6	28.7	53.3	85.0	54.4	80.8	85.0	85.0	85.0
7	MO	31.4	0.0	4.2	56.3	24.1	29.8	81.2	49.2	55.4	85.0	85.0	85.0
7	NE	27.7	0.0	28.7	52.5	20.3	56.3	76.8	44.8	83.4	85.0	85.0	85.0
8	CO	24.6	9.6	44.7	45.4	34.0	70.9	73.8	67.3	85.0	85.0	85.0	85.0
8	MT	0.0	16.7	36.7	0.0	41.3	62.3	0.0	67.9	85.0	0.0	85.0	85.0
8	ND	51.4	15.5	32.4	76.1	40.1	58.3	85.0	67.6	85.0	85.0	85.0	85.0
8	SD	44.8	9.5	35.5	68.9	33.6	61.4	85.0	61.8	85.0	85.0	85.0	85.0
8	UT	0.0	6.9	41.9	0.0	30.9	67.8	0.0	64.3	85.0	0.0	85.0	85.0
8	WY	0.0	13.0	36.5	0.0	37.4	62.1	0.0	64.6	85.0	0.0	85.0	85.0
9	AK	36.1	0.3	39.0	60.2	24.4	64.9	85.0	56.4	85.0	85.0	85.0	85.0
9	AZ	0.0	8.6	41.6	0.0	32.8	67.4	0.0	65.1	85.0	0.0	85.0	85.0
9	CA	19.7	13.4	47.6	41.7	38.6	74.4	69.9	71.1	85.0	85.0	85.0	85.0
9	HI	0.0	10.6	46.0	0.0	35.0	71.9	0.0	68.2	85.0	0.0	85.0	85.0
9	NV	30.2	2.5	35.6	54.1	27.0	61.7	80.1	53.5	85.0	85.0	85.0	85.0
10	ID	0.0	16.4	33.7	0.0	41.0	59.1	0.0	65.6	84.5	0.0	85.0	85.0
10	OR	31.9	0.0	27.7	57.0	22.6	54.1	81.6	47.2	80.1	85.0	85.0	85.0
10	WA	32.2	0.0	23.8	57.8	19.7	50.7	82.5	44.3	76.6	85.0	85.0	85.0

TABLE I-14 OPTIMAL ANNUAL COST PER ACRE FOR SPECIFIED PERCENT CONTROL

EPA REG	STATE ID	OPTIMAL ANNUAL COST PER ACRE 25% COMB	25% STORM	25% UNSEW	50% COMB	50% STORM	50% UNSEW	75% COMB	75% STORM	75% UNSEW	85% COMB	85% STORM	85% UNSEW
1	CT	43.	11.	10.	127.	32.	30.	371.	95.	87.	510.	352.	92.
1	ME	18.	0.	4.	50.	0.	11.	139.	0.	32.	187.	0.	107.
1	MA	41.	0.	9.	124.	31.	28.	355.	90.	80.	356.	592.	93.
1	NH	19.	0.	4.	53.	0.	12.	147.	0.	34.	196.	0.	113.
1	RI	46.	11.	10.	133.	32.	29.	396.	94.	77.	614.	297.	77.
1	VT	18.	0.	4.	49.	0.	12.	137.	0.	33.	157.	0.	130.
2	NJ	55.	16.	14.	157.	46.	41.	727.	215.	72.	1068.	565.	72.
2	NY	116.	25.	23.	450.	98.	74.	1955.	425.	74.	2797.	2271.	74.
3	DE	48.	12.	11.	135.	33.	30.	374.	94.	87.	374.	374.	101.
3	DC	125.	32.	0.	460.	118.	0.	1696.	436.	0.	3546.	481.	0.
3	MD	0.	22.	20.	0.	63.	56.	0.	233.	90.	0.	430.	90.
3	PA	62.	17.	14.	183.	49.	41.	656.	175.	73.	711.	474.	73.
3	VA	55.	14.	13.	156.	39.	37.	305.	171.	85.	305.	473.	85.
3	WV	19.	0.	5.	53.	14.	13.	149.	41.	37.	206.	360.	101.
4	AL	0.	23.	21.	0.	59.	54.	0.	178.	127.	0.	445.	127.
4	FL	101.	27.	24.	266.	72.	63.	610.	271.	113.	610.	570.	113.
4	GA	47.	12.	11.	125.	32.	29.	310.	90.	83.	310.	340.	121.
4	KY	61.	15.	13.	172.	41.	37.	350.	164.	84.	350.	435.	84.
4	MS	0.	22.	21.	0.	58.	54.	0.	164.	133.	0.	403.	133.
4	NC	0.	19.	17.	0.	49.	45.	0.	135.	114.	0.	348.	114.
4	SC	0.	19.	18.	0.	50.	46.	0.	131.	121.	0.	332.	121.
4	TN	61.	15.	14.	162.	41.	36.	387.	115.	99.	387.	458.	99.
5	IL	66.	15.	15.	198.	46.	46.	667.	154.	78.	1225.	164.	78.
5	IN	31.	0.	7.	87.	21.	19.	233.	57.	52.	305.	364.	79.
5	MI	38.	9.	8.	105.	25.	23.	285.	69.	63.	396.	270.	70.
5	MN	30.	0.	7.	80.	20.	18.	212.	52.	47.	229.	232.	51.
5	OH	39.	0.	9.	113.	29.	25.	306.	77.	67.	365.	477.	70.
5	WI	50.	13.	12.	142.	36.	34.	459.	117.	77.	1305.	162.	77.

TABLE I-14 OPTIMAL ANNUAL COST PER ACRE FOR SPECIFIED PERCENT CONTROL

EPA REG	STATE ID	OPTIMAL ANNUAL COST PER ACRE 25% COMB	25% STORM	25% UNSEW	50% COMB	50% STORM	50% UNSEW	75% COMB	75% STORM	75% UNSEW	85% COMB	85% STORM	85% UNSEW
6	AR	45.	13.	12.	117.	35.	31.	141.	121.	110.	141.	372.	146.
6	LA	0.	53.	44.	0.	148.	121.	0.	609.	138.	0.	1096.	138.
6	NM	0.	7.	6.	0.	18.	16.	0.	63.	30.	0.	139.	30.
6	OK	0.	14.	12.	0.	37.	32.	0.	136.	66.	0.	347.	66.
6	TX	82.	15.	14.	217.	41.	36.	743.	139.	75.	1665.	310.	75.
7	IA	49.	13.	12.	134.	36.	33.	472.	126.	73.	2688.	198.	73.
7	KS	44.	10.	10.	118.	27.	25.	287.	75.	70.	287.	254.	82.
7	MO	28.	0.	7.	76.	18.	18.	202.	47.	47.	235.	193.	147.
7	NE	31.	0.	7.	85.	21.	18.	230.	57.	50.	322.	290.	53.
8	CO	45.	13.	11.	115.	33.	29.	412.	119.	48.	684.	236.	48.
8	MT	0.	12.	11.	0.	30.	27.	0.	81.	62.	0.	154.	62.
8	ND	37.	9.	9.	98.	24.	23.	140.	70.	62.	140.	140.	62.
8	SD	44.	11.	10.	116.	28.	26.	221.	87.	62.	221.	221.	62.
8	UT	0.	12.	11.	0.	31.	27.	0.	110.	50.	0.	243.	50.
8	WY	0.	12.	11.	0.	31.	28.	0.	85.	64.	0.	183.	64.
9	AK	62.	15.	13.	160.	39.	33.	426.	138.	69.	426.	426.	69.
9	AZ	0.	6.	5.	0.	15.	14.	0.	53.	25.	0.	112.	25.
9	CA	63.	10.	10.	169.	27.	27.	607.	99.	40.	1201.	170.	40.
9	HI	0.	17.	14.	0.	44.	38.	0.	162.	61.	0.	314.	61.
9	NV	17.	3.	2.	43.	7.	6.	118.	18.	14.	142.	60.	14.
10	ID	0.	9.	9.	0.	23.	22.	0.	57.	54.	0.	119.	55.
10	OR	63.	0.	13.	169.	40.	35.	445.	106.	93.	509.	469.	112.
10	WA	40.	0.	10.	108.	33.	28.	284.	88.	73.	314.	432.	99.

TABLE I-15 OPTIMAL ANNUAL AND CAPITAL CONTROL COSTS

EPA REG	STATE ID	OPTIMAL ANNUAL CONTROL COST (MILLIONS OF DOLLARS) 25%	50%	75%	85%	OPTIMAL CAPITAL COST (BILLIONS OF DOLLARS) 25%	50%	75%	85%
1	CT	4.6	13.5	39.5	68.0	0.039	0.113	0.330	0.573
1	ME	0.9	2.5	7.0	11.1	0.008	0.021	0.058	0.093
1	MA	6.7	25.4	72.8	157.1	0.056	0.212	0.608	1.311
1	NH	0.7	1.9	5.4	8.7	0.006	0.016	0.045	0.073
1	RI	1.7	5.0	14.6	24.2	0.015	0.042	0.122	0.202
1	VT	0.2	0.5	1.4	2.5	0.002	0.004	0.012	0.021
TL REG 1		14.9	49.0	140.8	272.3	0.124	0.409	1.175	2.273
2	NJ	12.5	35.8	115.2	229.8	0.104	0.299	0.961	1.918
2	NY	37.9	144.9	593.3	1245.2	0.316	1.209	4.951	10.392
TL REG 2		50.4	180.7	708.4	1475.1	0.420	1.508	5.912	12.310
3	DE	0.7	2.1	5.9	11.0	0.006	0.017	0.049	0.092
3	DC	2.4	8.8	32.6	57.2	0.020	0.074	0.272	0.478
3	MD	6.1	17.4	53.2	90.7	0.051	0.146	0.444	0.757
3	PA	17.4	51.5	159.1	293.2	0.146	0.430	1.327	2.447
3	VA	5.2	14.9	45.0	91.8	0.044	0.124	0.376	0.766
3	WV	1.2	3.4	9.6	15.5	0.010	0.028	0.080	0.130
TL REG 3		33.1	98.2	305.4	559.4	0.276	0.819	2.549	4.669
4	AL	5.7	14.8	38.9	66.9	0.047	0.123	0.324	0.558
4	FL	16.3	43.1	121.5	214.6	0.136	0.360	1.014	1.791
4	GA	6.1	16.2	43.1	75.6	0.051	0.135	0.360	0.631
4	KY	3.0	8.5	25.2	49.0	0.025	0.071	0.210	0.409
4	MS	2.7	6.9	18.2	30.5	0.022	0.058	0.152	0.255
4	NC	5.2	13.6	35.7	59.9	0.043	0.114	0.298	0.500
4	SC	2.9	7.5	19.6	32.1	0.024	0.063	0.164	0.268
4	TN	5.4	14.3	37.9	71.7	0.045	0.119	0.316	0.599
TL REG 4		47.2	124.9	340.0	600.3	0.394	1.043	2.838	5.010
5	IL	28.5	85.5	263.6	437.0	0.238	0.714	2.200	3.647
5	IN	6.6	19.4	52.1	86.9	0.055	0.162	0.435	0.725
5	MI	12.9	35.2	96.1	155.4	0.108	0.294	0.802	1.297
5	MN	2.6	8.8	23.3	42.4	0.022	0.074	0.195	0.354
5	OH	12.6	42.8	115.8	224.7	0.105	0.357	0.967	1.875
5	WI	5.5	15.6	44.5	78.1	0.046	0.130	0.371	0.652
TL REG 5		68.7	207.3	595.5	1024.4	0.573	1.730	4.970	8.549

TABLE I-15 OPTIMAL ANNUAL AND CAPITAL CONTROL COSTS

EPA REG	STATE ID	OPTIMAL ANNUAL CONTROL COST (MILLIONS OF DOLLARS) 25%	50%	75%	85%	OPTIMAL CAPITAL COST (BILLIONS OF DOLLARS) 25%	50%	75%	85%
6	AR	1.9	5.0	14.3	24.8	0.016	0.042	0.119	0.207
6	LA	9.9	27.7	88.7	152.2	0.083	0.231	0.740	1.270
6	NM	0.6	1.5	3.9	6.8	0.005	0.012	0.032	0.057
6	OK	3.0	7.9	21.5	40.1	0.025	0.066	0.179	0.334
6	TX	16.5	43.5	118.3	206.9	0.138	0.363	0.987	1.727
TL REG 6		32.0	85.5	244.7	430.7	0.267	0.714	2.058	3.595
7	IA	3.0	8.1	23.1	48.3	0.025	0.068	0.193	0.403
7	KS	2.5	6.5	17.3	30.2	0.021	0.054	0.144	0.252
7	MO	5.9	16.2	43.2	71.5	0.049	0.135	0.360	0.596
7	NE	1.3	4.0	10.7	18.1	0.011	0.033	0.089	0.151
TL REG 7		12.6	34.8	94.2	168.1	0.105	0.291	0.786	1.403
8	CO	2.5	6.2	17.0	28.9	0.020	0.052	0.142	0.241
8	MT	0.5	1.3	3.2	5.0	0.004	0.011	0.027	0.041
8	ND	0.3	0.8	2.1	3.4	0.002	0.006	0.018	0.028
8	SD	0.4	1.0	2.7	4.7	0.003	0.008	0.023	0.039
8	UT	1.2	3.1	8.1	14.3	0.010	0.026	0.068	0.119
8	WY	0.3	0.7	1.8	2.9	0.002	0.006	0.015	0.024
TL REG 8		5.2	13.1	35.0	59.2	0.043	0.109	0.292	0.494
9	AK	0.3	0.8	2.1	4.0	0.002	0.006	0.017	0.034
9	AZ	1.0	2.6	6.7	11.5	0.009	0.021	0.056	0.096
9	CA	21.9	59.2	172.4	287.6	0.183	0.494	1.439	2.400
9	HI	1.1	2.8	7.9	13.5	0.009	0.023	0.066	0.113
9	NV	0.2	0.4	1.1	1.9	0.001	0.004	0.009	0.016
TL REG 9		24.5	65.8	190.1	318.5	0.204	0.549	1.587	2.658
10	ID	0.4	1.0	2.5	3.9	0.003	0.008	0.021	0.033
10	OR	3.2	10.4	27.5	47.8	0.027	0.087	0.230	0.399
10	WA	4.6	14.9	39.2	69.2	0.039	0.124	0.327	0.577
TL REG 10		8.2	26.4	69.2	120.9	0.069	0.220	0.578	1.009
TL U.S.		296.7	885.7	2725.4	5029.0	2.476	7.391	22.744	41.968

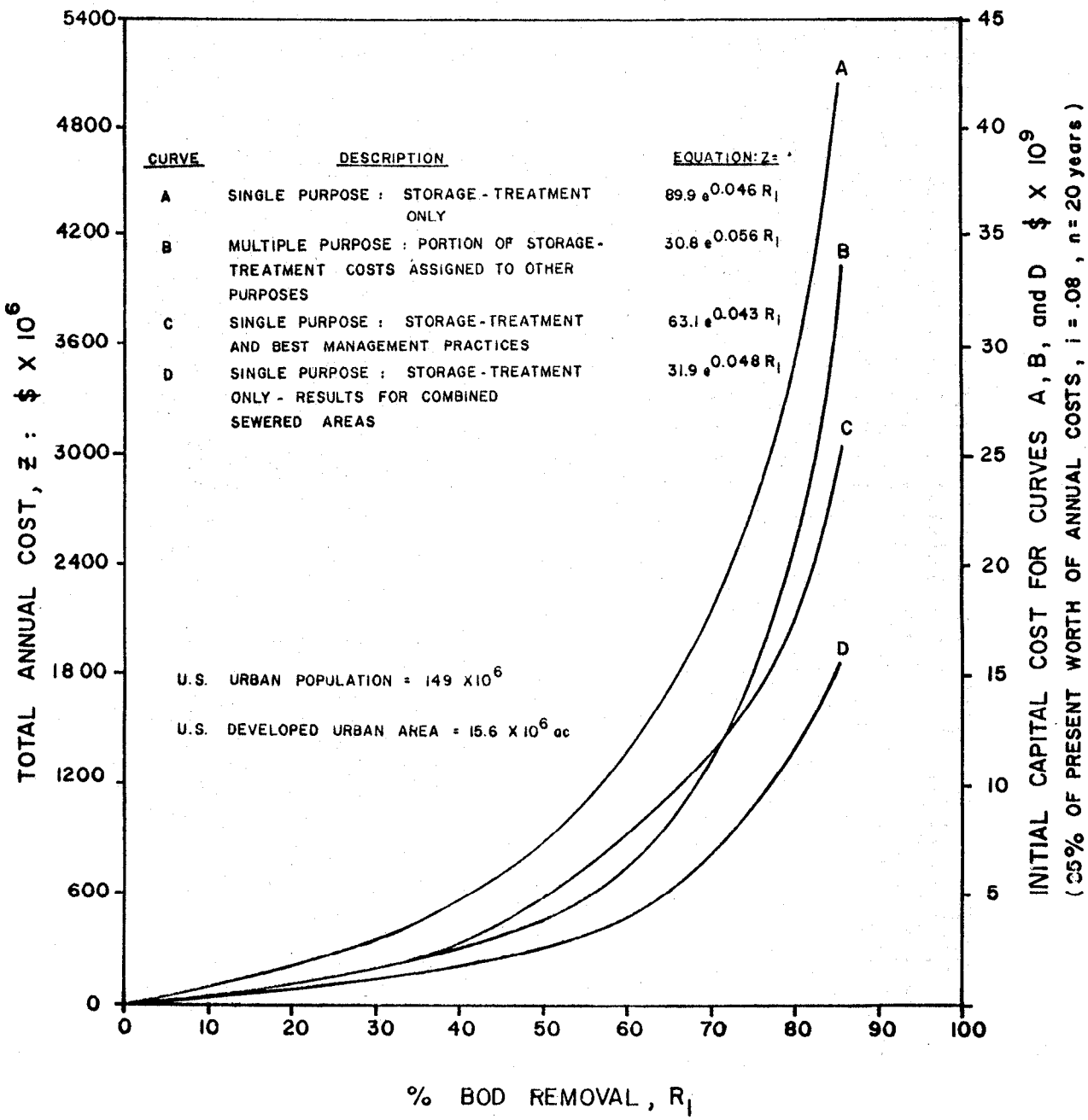

Figure I-1. Single Purpose and Multiple Purpose Stormwater Pollution Control Costs for US

was the only other one which explains its methodology and assumptions. Thus, a comparison with that study has been made. Major differences in results are attributable to the following:

1. Collection System Costs - The NCWQ estimate includes $\$84.0 \times 10^9$ for constructing storm sewers. This study does not view storm sewers as chargeable to pollution control.

2. Choice of a Design Storm - The NCWQ studies used control of the two year, one hour storm as the basis for their mean estimate of control costs. The concept of a design storm was not used in this study because it was felt that a continuous characterization in terms of percent of the runoff which could be treated was more appropriate since no accepted design event condition exists which also specifies a design antecedent dry-weather period. Figure I-2, Overall Percent Precipitation Control vs. Rainfall Intensity, Atlanta, GA (1948-1972) shows that using a frequency of one month would permit capture of 90 percent of the precipitation volume. Sizing for the two year, one hour storm yields relatively little incremented control and requires a much higher control volume.

Only the future will tell which, if any, of the above cost estimating procedures provides the most accurate estimate of national control costs. Within the severe data gathering limitations imposed by a national estimate, this study has attempted to make the results as site specific as possible. Improved estimates can be obtained using local data. In particular, topographic information and knowledge of the numbers of outfalls permits inclusion of pumping costs and analysis of the optimal combination of control units and interceptor sewers.

RELATIVE IMPACT OF WET- AND DRY-WEATHER FLOWS ON RECEIVING WATER

The relative importance of separate storm water, combined and dry-weather flow runoff as waste sources generated by the urban environment may be assessed more effectively through the use of models that simulate continuously in time. Based on an annual simulation of waste inputs to the Des Moines River from the Des Moines metropolitan area, various treatment alternatives are investigated. Minimum dissolved oxygen (DO) cumulative frequency curves indicate that:

1. During periods of wet weather, the urban runoff contribution of BOD is the most significant among all of the urban BOD sources.

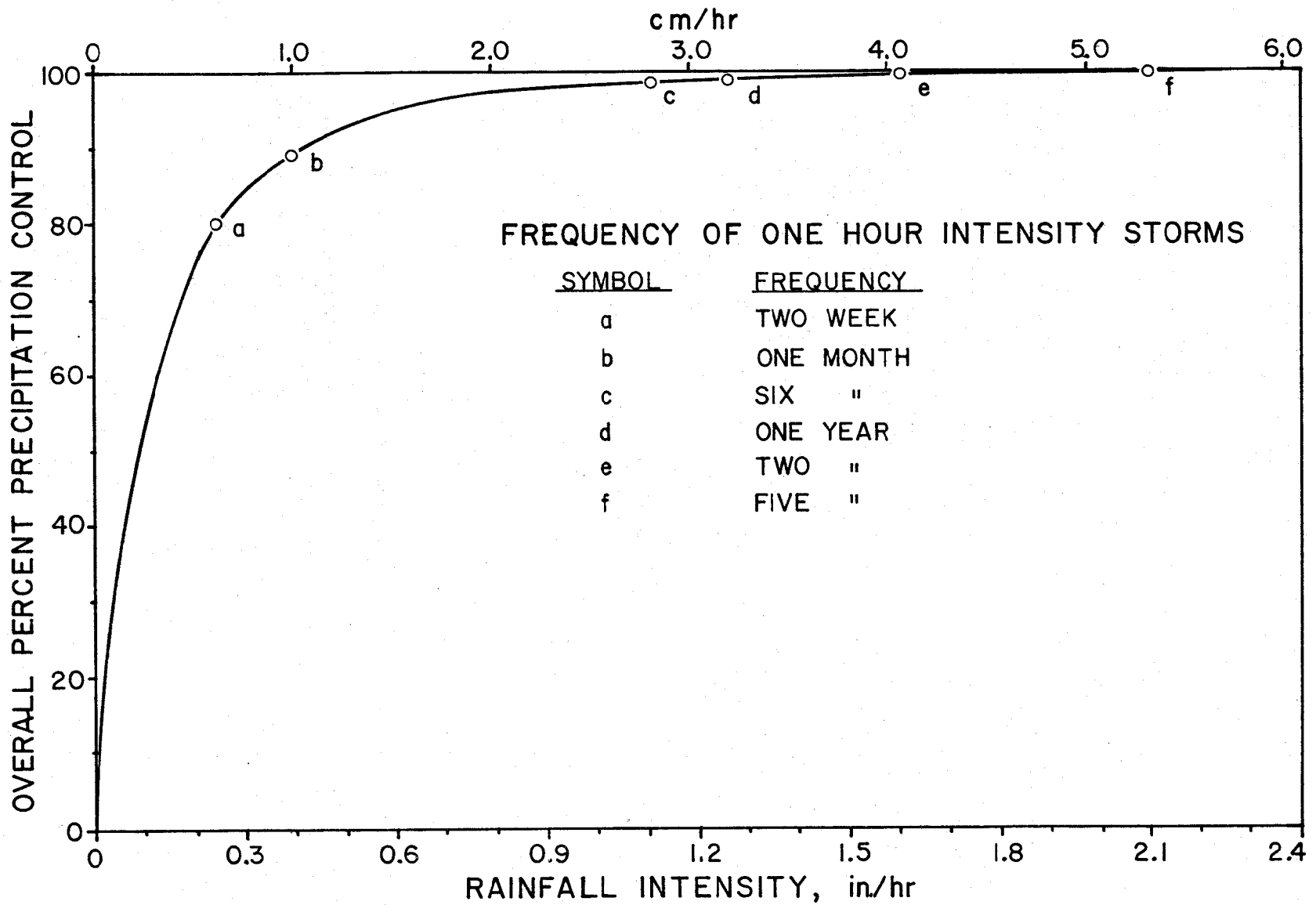

Figure I-2. Overall Percent Precipitation Control vs Rainfall Intensity - Atlanta, GA (1948-1972)

2. For existing treatment facilities in Des Moines, Iowa, 42 percent of the wet-weather events were predicted by the mathematical models to violate a 4.0 mg/l minimum DO standard. During these periods of wet weather, the sewage treatment facility provided secondary treatment to municipal wastewater.

3. During periods of dry weather, effluent from the secondary treatment facilities violated the same stream DO standard two percent of all the dry-weather days in 1968.

4. Combining the effects of wet weather and dry weather, the models predicted that DO standard violations would occur 33 total days out of the year.

5. An evaluation of costs incurred indicates that 25 percent BOD control of wet-weather flow, while providing secondary treatment of dry-weather sanitary flow, is an effective treatment strategy. Violations are reduced to 26 days out of the year at an incremental cost of approximately $800,000/yr.

6. The benefits received from a reduction of shock loads from urban runoff are not readily quantifiable but should be considered when compared to strategies that involve high levels of municipal wastewater control.