HAZARDOUS WASTE GENERATION, MANAGEMENT, AND EXPECTED WASTE-END TAX REVENUES FOR WASTE QUANTITIES REGULATED UNDER THE RESOURCE CONSERVATION AND RECOVERY ACT

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This paper concerns waste generation, management, industrial compliance costs, and expected waste-end tax revenues of hazardous wastes regulated under the Resources Conservation and Recovery Act. It was requested jointly by Congressman John J. Duncan, Ranking Minority Member of the House Committee on Ways and Means; Congressman Norman F. Lent, Ranking Minority Member of the Subcommittee on Commerce, Transportation, and Tourism of the House Committee on Energy and Commerce; and Representative Claudine Schneider, Ranking Minority Member of the Subcommittee on Natural Resources, Agriculture Research and Environment of the House Committee on Science and Technology.

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In its May 1985 study, *Hazardous Waste Management: Recent Changes and Policy Alternatives,* the Congressional Budget Office (CBO) examined various Superfund financing mechanisms and estimated their effects on future waste generation rates and industrial compliance costs. Because CBO's waste generation model employs a broader definition of hazardous waste than does the Environmental Protection Agency (EPA), CBO's and EPA's estimates of waste generation and waste-end tax revenues differ. To allow comparison with other studies, this paper examines U.S. hazardous waste generation, use of waste management technologies, industrial compliance costs, and potential waste-end tax revenues using EPA's current definition of hazardous waste.

Under the EPA definition, U.S. manufacturing industries could be expected to generate between 180 million metric tons (MMT) and 236 MMT of hazarous waste in 1986. Depending on the tax systems imposed, first year (1986) tax revenues could range from $900 million to $1.6 billion, falling to about $440 million to $1.0 billion by year five (1990). In comparison, CBO's May 1985 study--employing a broader definition of hazardous waste, but the same tax systems--reported year one tax revenues ranging from $1.4 billion to $2.7 billion, and decreasing by year five to between $1.1 billion and $1.4 billion. This paper describes these results in greater detail.

USING THE CBO WASTE GENERATION MODEL TO ESTIMATE EPA-REGULATED WASTES IN 1986

CBO's May 1985 study outlined hazardous waste generation and management practices for U.S. industries for a broad array of hazardous wastes, using a base year of 1983. The CBO waste coverage included wastes regulated by the EPA that year plus others under study by the agency for eventual regulation, some of which are now regulated. For this paper, three types of

adjustments were made to the earlier estimates: industrial output was updated from 1983 to 1986, the CBO model's waste coverage was limited solely to those wastes now considered hazardous and currently regulated by EPA under the Resources Conservation and Recovery Act (RCRA), and progress toward ultimate waste reduction targets was assumed. To account for uncertainties in this process, high and low cases were constructed for EPA-regulated waste for 1986. (The base year in this paper is 1986.)

Industrial output, which is used to estimate waste generation, was updated to 1986 levels from the 1983 levels used in the earlier CBO study. This adjustment was made using projections in employment growth at the four digit SIC code level, supplied by the Bureau of Labor Statistics. 1/ Output in 1986 is the same in both the high and low cases.

A range of EPA-regulated waste in 1986 was then calculated by excluding those hazardous wastes unlikely to fall under EPA control by that year. (Certain of these wastes were included in CBO's broader waste classification system.) To form the low estimate, CBO assumed that the EPA would begin to regulate some 2.4 MMT of waste oils that the agency estimates to be the annual amount burned in industrial boilers. 2/ In addition, the low estimate included only those air pollution control residues (dusts and sludges) and contaminated clays, sands, and soils reported by industry as hazardous under current RCRA regulations. The high estimate, on the other hand, assumed that EPA would begin to regulate all waste oils estimated by the CBO model (14.2 MMT). It was further assumed for the high estimate that those industries reporting air pollution control residues or contaminated soils regulated by EPA would generate them at rates equivalent to the higher CBO model generation rates for these combinations of industries and waste types.

The low estimate assumed that, by 1986, all industries would have achieved half of the waste reduction targets estimated in the May 1985 CBO study. 3/ In the high estimate, no waste reduction would occur between

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1. The assumptions underlying this methodology are discussed in more detail in Congressional Budget Office, *Hazardous Waste Management*, pp. 11-13. Also see Bureau of Labor Statistics, *Handbook of Methods*, Bulletin 2134-1 (1982).

2. See Westat, Inc. *Survey of Burners of Used Waste Oil and Waste-Derived Fuel Material* (October 1984 Draft); and Franklin Associated, Ltd., *Composition and Management of Used Oil Generated in the United States* (September 1984), cited in Federal Register, Vol. 50, No. 8, January 11, 1985, p. 1686.

3. See in particular, Table 11 on page 45 and accompanying text in Congressional Budget Office, *Hazardous Waste Management*.

1983 and 1986. Waste generated by small-quantity generators, though covered by CBO but not regulated in 1983, was included in both the high and low estimates for 1986.

Under these assumptions, CBO estimates that U.S. manufacturing industries would generate between 180 MMT and 236 MMT of EPA-regulated wastes in 1986 (see Table 1). This is roughly 13 percent to 34 percent lower than the 271 MMT that would be generated in 1986, under the CBO waste coverage. Together, nonmetallic inorganic liquids and sludges account for 57 percent of the low estimate and 47 percent of the high estimate of EPA-regulated wastes. Metal-containing liquids and sludges account for another 16 percent of both high and low estimates.

On an industry-by-industry ranking, the chemical and allied products industries would generate about 113 MMT, or about half of all the EPA-regulated wastes in 1986 (see Table 2). The primary metals industries would generate an average of about 35 MMT (16 percent), while the petroleum and coal products industries would produce about 23 MMT (11 percent). Although the estimated amounts by industry differ from the corresponding amounts found under the CBO waste definition, the relative contributions by each industry to the aggregate U.S. total remain about the same.

ESTIMATING MANAGEMENT TECHNOLOGIES USED TO COMPLY WITH RCRA AND THEIR COSTS TO INDUSTRY IN 1986

CBO's earlier study presented two pictures of waste treatment and disposal technology over a seven-year period, starting in 1983 and ending in 1990 (before and after the 1984 amendments to RCRA). These waste management changes are discussed fully in Chapter III of that report. For this analysis, it was assumed that, over the 1983-1986 period, industries would begin to shift their waste management practices toward those required by the 1984 RCRA amendments. (See Table 14 on page 49 of the May 1985 CBO paper for a description of the nature of these management shifts.)

Under this assumption, CBO estimates that industry would spend between $4.3 billion and $6.2 billion to manage EPA-regulated wastes in 1986 (based on the low- and high-generation cases described above). This is roughly 23 percent to 47 percent less than waste management expenditures of $8.1 billion in 1986 expected under the broader CBO waste definition (see Table 3). Under the high case, these expenditures would

TABLE 1. ESTIMATED NATIONAL GENERATION OF HAZARDOUS WASTE IN 1986, RANKED BY WASTE QUANTITY a/ (In thousands of metric tons)

Waste Type	EPA-Regulated				CBO Definition d/	
	Low Case b/		High Case c/			
	Generation	Percent of Total	Generation	Percent of Total	Generation	Percent of Total
Nonmetallic Inorganic Liquids	74,621	42	82,417	35	85,288	31
Nonmetallic Inorganic Sludge	27,251	15	27,950	12	28,119	10
Miscellaneous Wastes	14,808	8	15,522	7	15,878	6
Metal-Containing Sludge	13,695	8	14,353	6	14,778	5
Nonhalogenated Solvents	11,114	6	11,696	5	11,927	4
Metal-Containing Liquids	11,067	6	19,389	8	19,887	7
Cyanide and Metal Liquids	4,127	2	5,426	2	7,341	3
Resins, Latex, and Monomer	4,013	2	4,212	2	4,249	2
Dye and Paint Sludge	3,583	2	4,099	2	4,147	2
Oily Sludge	3,534	2	3,622	2	3,629	1
Halogenated Solvents	2,796	2	2,949	1	3,603	1
Other Organic Liquids	2,659	2	3,033	1	3,525	1
Nonhalogenated Organic Sludge	2,316	1	2,316	1	2,336	1
Waste Oils	2,123	1	12,916	5	13,901	5
Halogenated Organic Sludge	692	e	692	e	692	e
Explosives	650	e	666	e	762	e
Cyanide and Metal Sludge	545	e	575	e	576	e
Non-Metallic Inorganic Dusts	40	e	14,354	6	21,631	8
Pesticides, Herbicides	25	e	26	e	27	e
Halogenated Organic Solids	0	0	1,057	e	10,510	4
Metallic Dusts and Shavings	0	0	5,777	2	7,945	3
Contaminated Clay, Soil, and Sand	0	0	1,330	1	5,565	2
Nonhalogenated Organic Solids	0	0	1,816	1	4,835	2
Total	179,659		236,193		271,424	

SOURCE: Congressional Budget Office.

a. Waste quantities presented for all cases are mean estimates only. Statistical confidence limits at the 5 percent level could yield estimates about 15 percent higher or lower than the mean quantity.

b. Low case assumes that all industries move half way towards the long-term waste reduction targets outlined in the May 1985 CBO study and that only 2.5 million metric tons of waste oils will fall under RCRA regulation.

c. High case assumes that industies do not undertake waste reduction efforts, and that greater amounts of waste oils, air pollution control residues, and contaminated soils will fall under RCRA regulation.

d. CBO's broader waste coverage is described in the CBO Report, *Hazardous Waste Management: Recent Changes and Policy Alternatives* (May 1985). The updated (to 1986) waste generation quantities presented here assume no waste reduction efforts by industry in the 1983-1986 period.

e. Less than one percent.

TABLE 2. ESTIMATED NATIONAL GENERATION OF HAZARDOUS WASTE IN 1986, RANKED BY MAJOR INDUSTRY GROUP a/ (In thousands of metric tons)

Industrial Group	EPA-Regulated				CBO Definition d/	
	Low Case b/		High Case c/			
	Generation	Percent of Total	Generation	Percent of Total	Generation	Percent of Total
Chemicals and Allied Products	108,826	60	118,906	50	131,075	48
Primary Metals	22,692	13	46,594	20	48,835	18
Petroleum and Coal Products	19,059	11	27,151	11	30,132	11
Fabricated Metal Products	14,324	8	21,070	9	25,411	9
Rubber and Plastic Products	4,965	3	8,841	4	15,905	6
Miscellaneous Manufacturing	4,349	2	4,232	2	5,727	2
Transportation Equipment	2,252	1	2,589	1	3,089	1
Nonelectrical Machinery	1,296	1	1,681	1	2,092	1
Electrical and Electronic Machinery	946	1	1,186	1	5,213	2
Wood Preserving	584	e	1,739	1	1,739	1
Motor Freight Transportation	338	e	2,160	1	2,160	1
Drum Reconditioners	28	e	45	e	45	e
Total	179,659	100	236,193	100	271,424	100

SOURCE: Congressional Budget Office.

a. Table 1 of the CBO Staff Working Paper, *Empirical Analysis of U.S. Hazardous Waste Generation, Management, and Regulatory Costs* (1985) contains the master list of specific industry types that are aggregated into the major industry groups presented in this table.

b. Based on low case described in Table 1.

c. Based on high case described in Table 1.

d. Based on CBO case described in Table 1.

e. Less than one percent.

account for an average of 1.4 percent of sales in 1986. While the chemicals industry would spend the most in terms of dollar outlays (about $1.6 billion), it would be near average as a percent of sales. On the other hand, the wood preserving industry would spend a relatively small amount to comply with RCRA in 1986--about $53 million--but this would account for almost four times the weighted average percent of sales across all manufacturers.

TABLE 3. RANGE OF ANNUAL INDUSTRIAL EXPENDITURES FOR HAZARDOUS WASTE MANAGEMENT IN 1986 (In millions of 1983 dollars)

Industry	EPA-Regulated Low Case [a]	EPA-Regulated High Case [b]	CBO Definition [c]	Percent of Sales [d]
Chemicals and Allied Products	1,583	1,665	2,203	1.9
Primary Metals	716	1,637	1,727	1.4
Fabricated Metal Products	700	836	1,034	2.1
Rubber and Plastic Products	341	732	1,294	1.2
Transportation Equipment	193	224	266	0.1
Miscellaneous Manufacturing	192	194	302	0.6
Petroleum and Coal Products	149	335	502	0.2
Nonelectrical Machinery	130	157	191	0.3
Electrical and Electronic Machinery	98	123	283	0.1
Motor Freight Transportation	39	246	246	f
Wood Preserving	39	66	66	4.5
Drum Reconditioners	4	6	6	f
Total [e]	4,259	6,219	8,120	1.4 [g]

SOURCE: Congressional Budget Office.

a. Based on low case described in Table 1.

b. Based on high case described in Table 1.

c. Based on CBO case described in Table 1.

d. Percents based on EPA-regulated, high-case expenditures.

e. Numbers may not add to totals because of rounding.

f. Sales data not available.

g. Weighted average.

Considering the partial waste management shifts outlined above, CBO estimates that about 27 percent, or about 57 MMT, of dilute aqueous EPA-regulated wastes would be discharged to sewers and waterways in 1986--somewhat less than the 66 MMT expected under CBO's broader waste coverage (see Table 4). Another 51 MMT to 56 MMT would be disposed of in underground injection wells. This is below the 59 MMT estimated for well disposal in 1986 under the broader waste coverage. Surface impoundments would account for between 30 MMT and 33 MMT, while hazardous waste landfills would receive another 23 MMT to 45 MMT (including stabilized material). As much as 5.1 MMT of wastes could be incinerated in RCRA-approved waste incinerators and another 8.6 MMT could be burned in industrial boilers.

TABLE 4. ESTIMATED WASTE FLOWS BY MANAGEMENT TECHNOLOGY, IN 1986 (In millions of metric tons)

Technology	EPA-Regulated		CBO
	Low Case [a]	High Case [b]	Definition [c]
Sewers and Direct Discharge [d]	50.9	63.4	66.3
Injection Well	50.8	56.2	58.6
Surface Impoundment	30.4	33.0	33.9
Hazardous Waste Landfills			
No pretreatment	6.7	20.1	29.1
With stabilization	16.2	22.5	31.5
Distillation	9.7	10.3	10.9
Incineration	4.5	5.1	6.5
Oxidation	2.9	3.7	5.0
Industrial Boilers	1.9	8.6	9.2
Land Treatment	1.6	3.5	3.6
Oil Rerefining	0.5	1.9	2.1
Ion Exchange	0.5	0.7	0.7
Sanitary Landfill	e	7.2	13.6
Total	179.7	236.2	271.2

SOURCE: Congressional Budget Office.

a. Based on low case in Table 1.
b. Based on high case in Table 1.
c. Based on CBO case in Table 1.
d. Wastes entering this category include dilute aqueous streams and treated residuals from other treatment and disposal processes disposed in compliance with Clean Water Act regulations, which ordinarily pose little threat to the environment.
e. Less than 0.5 million metric tons.

WASTE-END TAX REVENUES

Using the 1986 baseline range of EPA-regulated waste, together with the 1986 estimates of waste management practices, CBO reestimated year one to year five tax revenues for two of the tax systems presented in the May 1985 CBO report. 4/ Tax Systems 1 and 4, analyzed in this paper, are identical to those presented on pages 64-70 of the earlier CBO report. Differences between the estimates for waste-end tax revenue in this paper and those presented in the earlier study stem solely from the effects of changed conditions in the tax base--that is, the base now includes only EPA-regulated waste and reflects recent waste management changes that industry has or is expected to make by 1986 in order to comply with the requirements of the 1984 RCRA amendments.

Tax System 1, with tax rates ranging from $5 to $25 per metric ton treated or disposed, would raise between $1.0 billion and $1.6 billion if instituted in 1986 (see Table 5). Revenues would decline to between $440 million and $1.0 billion by 1990. The drop in tax revenues over time would occur as industries switched to treatment or disposal technologies that were taxed at lower rates and as they incorporated waste reduction measures. Given the smaller EPA-regulated base for taxation and assuming no waste reduction (the high case), revenues estimated here are between 33 percent and 41 percent less than revenues that might be expected using the broader waste coverage as a tax base. Tax System 4, a $5 per metric ton flat tax, would raise from $900 million to $1.2 billion a year in 1986, with out-year revenues affected only slightly, depending on the levels of waste reduction achieved by U.S. industries. In the low case, all waste reduction targets would be met by 1990, while in the high case, no waste reduction would occur. With the smaller base for taxation, these new estimates are between 13 percent (no waste reduction) and 26 percent (full waste reduction) lower than comparable revenue estimates using the broader base.

FACTORS THAT AFFECT WASTE-END TAX REVENUE ESTIMATES

Two types of factors can affect estimates of tax revenues: changes in tax rates and changes in the tax base. Although both kinds of factors can be

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4. Although the results are not presented in detail in this paper, the Administration's proposed waste-end tax system (Tax system 3 in the May 1985 CBO study) was also analyzed since it would be imposed only on EPA-regulated wastes in 1986. Under these conditions, waste-end tax revenues would range from about $670 million (in the low case) to nearly $950 million (in the high case) in the first year.

discussed qualitatively, a quantitative analysis would be difficult. A doubling of tax rates in Tax System 1, for example, could be expected to approximately double tax revenues--at least in the first year, before industries made significant adjustments. All other things being equal, increasing tax rates should induce relatively faster and more dramatic waste reduction measures and shifts into management technologies that would result in lower tax burdens. If these improvements were realized, these and other factors related to reduction in industrial output would tend to reduce out-year tax revenues. Alternatively, as tax rates increase, industries might have a greater incentive to avoid payment through misreporting or improper handling of residuals.

A separate set of factors, which affects the size of the tax base, could in turn, influence net tax revenues actually collected. These include: waste reduction efforts, which, unless taken into account, could produce lower-than-expected revenues; shifts in waste management practices, which could reduce out-year revenues as industries switch from highly taxed technologies to lower taxed management categories; and illegal tax evasion, which

TABLE 5. ANNUAL REVENUES FROM ALTERNATIVE TAX SYSTEMS FOR EPA-REGULATED WASTE (In millions of 1983 dollars)

Year	Tax System 1 a/		Tax System 4 b/	
	Low Case	High Case	Low Case	High Case
1986	1,032	1,622	898	1,181
1987	869	1,467	887	1,190
1988	698	1,247	876	1,199
1989	530	1,056	864	1,208
1990	441	956	853	1,216

SOURCE: Congressional Budget Office.

a. Based on rates of Tax System 1 of the CBO Report, *Hazardous Waste Management: Recent Changes and Policy Alternatives* (May 1985).

b. Based on rates of Tax System 4 of the CBO Report, *Hazardous Waste Management*.

would result in revenue shortfalls unless the waste-end tax system is rigorously enforced. These factors are discussed below.

Waste Reduction

Waste reduction efforts are the logical first response of industrial managers when faced with increased costs of waste management, such as waste-end taxes. Unless taken into account, waste reduction would reduce the expected tax base, lowering out-year tax revenues. Waste reduction would be an equally, or perhaps more likely, response under a tax imposed on EPA-regulated wastes compared with one imposed on the broader CBO waste universe. This is because those wastes excluded by EPA under RCRA but included by the CBO coverage typically have less potential for either water reduction or materials recovery. For example, there is less opportunity to reduce waste volume or recover marketable residuals from the air pollution control dusts and sludges, most of which are not regulated by EPA under RCRA, than there is for the liquid waste streams, all of which are EPA-regulated. 5/ If full waste reduction targets (outlined in the May 1985 CBO study) were met, year five tax revenues for Tax System 1 would fall from $441 million to $421 million. Revenues for Tax System 4 would fall from about $1.2 billion to $850 million.

In addition to water or materials recovery and reuse, which were taken into account in the above estimates, there are several other types of waste reduction measures that are more difficult to quantify and are not considered: substituting nonhazardous compounds for hazardous components in waste-producing processes (for example, the use of water instead of petroleum-based solvents in paint production); making production lines more efficient, resulting in more product and less waste; and paying more attention to "general housekeeping" measures that reduce the flow of materials or result in fewer materials spills requiring cleanup. These adjustments also would tend to reduce tax revenues.

Shifts in Waste Management Technologies

If waste-end taxes were assessed on the basis of management technology, then uncertainty about the use of these technologies could result in unexpectedly low or high revenues. A comparison of CBO estimates of waste

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5. See, for example, Table 11 and the accompanying text (pages 43-47) of Congressional Budget Office. *Hazardous Waste Management.*

quantities treated, stored, and disposed with comparable EPA estimates shows considerable differences. 6/ For example, CBO estimated that 67 MMT of aqueous wastes were disposed of in underground injection wells in 1983 compared with EPA's estimate of only 32 MMT disposed of this way in 1981. Since the 1981 estimate, however, a more recent (1983) EPA survey revealed that some 44 MMT was pumped into the ground using injection wells. 7/ Such contrasting estimates can lead to differences of millions of dollars in tax revenue potential, depending on the chosen tax rates.

Perhaps the greatest uncertainty in estimating use of waste management technologies, however, is the extent to which industries have already begun to shift to better methods in response to new requirements of the 1984 RCRA amendments. Particularly important in this respect is the anticipated shift from land-based disposal into advanced treatment and incineration. CBO's reestimate of waste-end tax revenues has tried to account for these shifts by adjusting the national waste management baseline (see p. 4). Nonetheless, CBO's estimate of EPA-regulated wastes entering landfills in 1986 (25 MMT) remains higher than EPA's most recent projections of 3 MMT in 1981. In general, the greater the shifts that industry makes toward the goals of the 1984 RCRA amendments and away from land disposal, the more stable, but perhaps lower, the waste-end tax revenues are likely to be.

Enforcement and Tax Collection

It has become almost an axiom that waste-end tax systems, no matter how simply designed, will contain loopholes that could allow waste generators to avoid paying taxes. This would reduce the tax base, consequently lowering

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6. Some of the discrepancy between these two estimates--perhaps 25 percent or so--derives from the differences between the RCRA-regulated waste universe and the CBO waste coverage. But other sources of error and uncertainty, particularly those embedded in the estimating techniques of EPA and, indeed, of CBO, probably account for the majority of the difference. See CBO Staff Working Paper, *Empirical Analysis of U.S. Hazardous Waste Generation, Management, and Regulatory Costs* (1985); and Environmental Protection Agency, *National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Regulated Under RCRA in 1981* (1984).

7. See Environmental Protection Agency, Office of Drinking Water, *Report to Congress on Injection of Hazardous Waste* (May 1985).

revenues estimated here or elsewhere. 8/ More important, critics contend that waste-end taxes, by raising the overall costs to industry of waste management, might provide incentives for improper waste disposal as a means of tax evasion. These incentives for noncompliance might be strongest for high-hazard, hard-to-treat wastes.

Critics believe that these problems are significant enough to override the benefits of waste-end taxes--that is, incentives for reducing overall hazardous waste generation, increasing recycling and reuse, discouraging land disposal, raising revenues for Superfund, and discouraging the creation of future Superfund sites. Yet the concern that taxes, by increasing industrial compliance costs, would provide incentives for improper disposal ignores the effects of the 1984 RCRA amendments, which also raise industry's compliance costs--in some cases, dramatically (see Table 15 of the May 1985 CBO Study). The administration of this new law carries with it its own enforcement problems. For example, the new act's land disposal bans, which effectively act as an infinite tax, will ultimately require tough enforcement at the individual generator level to assure compliance. This is the identical form of oversight required to assure that waste-end taxpayers would not evade tax payments (under-report waste quantities) or mishandle residuals. A waste-end tax could, therefore, impose no greater regulatory burden on the government than already exists under the RCRA regulatory system over the 1986-1990 period. In fact, an effective waste-end tax system would almost certainly require industry to better monitor and report waste constituents and flows, thus creating an information base that would be useful for state and federal enforcement efforts.

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8. As a source of estimating error, waste underreporting appears to be much less significant than errors in tax system formulation or estimates of waste generation or management. See, for example, General Accounting Office, *State Experience with Taxes on Generators or Disposers of Hazardous Waste* (May 1984); and Environmental Protection Agency, "Special Analysis of the Implications of a Waste-End Tax and Limited Land Disposal Bans for Illegal Disposal," letter sent by William D. Ruckelshaus to Congressman James J. Florio (March 15, 1983).