ECONOMIC ANALYSIS OF LLRW DISPOSAL COMPACT PROGRESS

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ABSTRACT

Federal regulation has drastically altered the nature and economics of the disposal business for commercially generated low-level radioactive waste. The Federal LLRW Policy Act of 1980 allowed for individual states to enter into cooperative regional compacts for the disposal of LLRW. To encourage states to establish new disposal facilities or to participate in these interregional agreements, the LLRW Policy Amendments Act of 1985 established a system of financial incentives and defined conditions for continued access to the three existing disposal sites.

The immediate effect of this legislation has been the steady increase in disposal fees, principally through the addition of federally mandated surcharges at the three existing disposal sites. In 1980 the cost to dispose of one cubic foot of waste was about $15. In 1990 surcharges alone are $40 per cubic foot and in 1992 will increase to $80.

The long term effect of this legislation will be significantly higher disposal fees as the new facilities come on-line. Nationally, waste volumes have declined by nearly 50% in the last decade. This reduced waste volume has to support several (6 to 10) new facilities that require large investments of capital to develop, that will have higher operating costs, and that will have additional surcharges assessed to meet state and local regulations and closure funding requirements.

Projections of nominal disposal fees at the new facilities range from about $100 to over $500 per cubic foot. Several factors will determine at which end of this range a compact's disposal fee will actually be. The type of disposal technology used (enhanced shallow land burial, above or below-grade concrete vaults), operating practices (grout filled concrete overpacks, monitoring, mitigation measures), surcharges (for host community, state, and compact commission costs, liability, closure and post-closure funds), and financing (public or private, current or future) all have a bearing upon establishing a facilities' revenue requirement for coverage of these costs. Most LLRW facility development and operating expenses are fixed costs and will not fluctuate with changes in the volume of waste handled, thus the major factor in determining the unit disposal fee is the quantity of waste over which all the development, construction, operating and closure costs must be distributed.

FACILITY DEVELOPMENT COSTS

All LLRW disposal facility development projects have experienced significant increases in costs above those initially predicted. Early estimates, such as those that were prepared for competitively bid facilities, included basic costs for expected conditions of the major program elements that were identifiable. Capital costs were normally based upon a "reference" facility design that is compatible with assumed geologic and other specified site conditions, and also consistent with bidding criteria defined in the states request for proposal. Notable changes in developmental costs are attributable to:

- Expanded Public Involvement - More extensive Public Involvement Programs have been implemented in virtually every compact in response to the informational needs of the public and the affected agencies. Additional public meetings have been held, comment periods on public documents were extended, presentations have been made at numerous local civic group meetings, and project personnel have participated on radio call-in shows. Printed materials such as newsletters, fact sheets, and brochures have been prepared in response to public concerns and project milestones. The development and distribution, such as mass mailing or inserting in newspapers of affected communities, has generally been broader than anticipated.
- Regulatory Guidance - The Nuclear Regulatory Commission (NRC) issued several "guidance" documents, the contents of which are often interpreted as mandates that require either strict compliance or explicit justification for exceptions. NUREGs 1199 and 1200, issued in January 1987 and revised in January 1988, identify the recommended format and content, and the review plan for a license application. The detail presented in these documents resulted in additional unanticipated research, field studies, and documentation of methods, procedures and reports related to the characterization, operation and closure of a LLRW facility.

- Multiple Sites Pre-characterized and Characterized - As described in 10 CFR Part 61.7 (b)(5)(c)(1), the original rule anticipated that only one location would be fully characterized to demonstrate the suitability of the site. However, in response to requests from advisory committees and reviewing agencies, and in efforts to minimize potential schedule delays if a selected site was later determined to be unsuitable, all developmental projects either elected to or were required by state regulation to pre-characterize (i.e. search for fatal flaws) or fully characterize more than one site.
- Field Conditions - Actual field conditions encountered often differed and were more difficult and complex from those assumed for the "reference" facility design and cost estimates. For example, actual ground water depth at the Ward Valley site in California, more than double the 300 feet originally envisioned, greatly increased the geotechnical characterization and well drilling costs.
- Design Changes - Facility design and operating philosophy has been subject to both public and agency review and input. The Southeast Compact developer has submitted a proposed disposal technology to North Carolina for review and approval. New York is revamping their public involvement process to include the early selection of a proposed disposal technology method. In both the Southwestern and Central Interstate Compacts, modifications to design and operating requirements were incorporated into the facility design in response to public and agency concerns. For the California facility, a state contractor researched and prepared a detailed report on the potential benefits and costs for various disposal alternatives and enhancements to shallow land burial. This report was used by the state as the basis for directing the developer to include specific facility design and operational requirements.
- Local Advisory Programs - Committees composed of state and local citizens and knowledgeable experts often provided guidance and were a source of public input to the site selection process. Grants to these committees have provided for reimbursement of their meeting expenses and in some states, the hiring of independent consultants.
- Regulatory Programs - Funding for the regulatory, licensing and environmental activities of the state agency, including their support contractors, has been assisted by fees and assessments placed upon the license applicant.
- Environmental Studies & Mitigation - NEPA and state environmental regulations call for extensive assessments of environmental and socio-economic impacts, determination of mitigative measures and a subsequent monitoring plan for the proposed location. In the Southwestern Compact, an ad hoc working group was established to review concerns about the desert tortoise and to recommend methods of potentially acceptable mitigation.
- Litigation - Legal challenges have been faced in several states and have caused diversion of project resources and delays in the project schedule. These challenges have included questions of constitutionality of the Federal legislation, state sovereignty for taking title of waste, state regulations, compact re-ratifications, and alleged defects in the siting process.
- Property Access & Acquisition - Negotiations and obtainment of access rights and purchase options, including the exercise price, has often been more involved and costly than expected. Factors contributing to this include the designation of multiple candidate sites to be characterized, prices negotiated for contiguous properties, and valuation of the land based upon an added value that the characterization and pre-construction activities contributed towards its proposed use as a LLRW facility.

Schedule Impacts on Pre-operational Costs

Many of the factors that have contributed to increased pre-operational costs have also caused delays in the development schedule thus further increasing costs because of the inherent carrying costs. Schedule delay costs vary with the project staffing, current level and type of activities, and the method of financing the project. Estimates of the costs of delays range from $200,000 to over $500,000 per month plus interest expenses on privately financed projects that can easily add $250,000 to $450,000 per month. Listed below are a few of the reasons that schedule slippages have been experienced in LLRW facility development projects to date.

- Public Involvement Program - Expansions of public and agency involvement programs have required the scheduling of additional public meetings and the extension of comment periods.
- Regulatory Agency Approvals - Pre-licensing guidance, reviews and approval of project work plans, determination of facility disposal technology and design enhancements have generally required more intensive regulatory reviews then originally anticipated.

- Environmental Assessments - Environmental concerns have delayed site selection activities to allow for more extensive evaluations of the potential impacts.
- Characterization Scope - Multiple and more extensive site pre-characterization and characterization programs have required additional time to develop detailed work plans, to obtain agency reviews and approvals, for implementation in the field, and to analyze data results.
- Property Access - Negotiations for access to and acquisition of candidate and proposed site properties have caused unplanned for delays in project activities.

Pre-construction Costs

In 1982 the "Final Environmental Impact Statement for Land Disposal of Radioactive Waste", NUREG 0945, estimated the total direct capital costs for their reference 1.7 million cubic foot per year shallow land burial facility at $7,870,200 of which $500,000 was for site selection and characterization. DOE sponsored reports in 1987 estimated costs for six conceptual facilities to dispose of 235,000 cubic feet per year. Site selection and characterization costs for these facilities were estimated between $3.1 and $3.5 million with total pre-operating costs ranging from $21 to $35 million. (1)

Based upon the experiences and observations of the compacts that have made measurable progress, it appears that site selection and characterization related costs have typically been the most difficult to accurately estimate. This is in part due to the research-oriented nature of collecting and analyzing the type of data that is needed to understand and model a site. The evolving expectations and quest for a higher degree of confidence on the part of technical reviewers and members of the public has also required that the programs be state-of-the-art and leave no stone unturned in the efforts to fully characterize a proposed site.

Table I presents the predicted direct capital costs from contractor proposals and the current estimated figures for the site selection and characterization programs for the listed compacts. Texas has achieved the lowest reported cost of $4.4 million for site selection and characterization by relying heavily on the usage of public sector people from the universities and the state's Geological Survey. (2) At the other end of the spectrum, Illinois, through a contractor, characterized two sites for about $31.6 million. (3)

Table II presents the predicted and current estimates of the total direct capital pre-construction costs including the above site selection and characterization costs, and all other program management, environmental, and licensing costs. At this time only the Southwestern and Central Interstate Compacts have submitted license applications. (See Fig. 1) They and Texas and the Central Midwest Interstate Compact have completed the detailed site characterization, so the figures cited are actual.

TABLE I

Site Selection and Characterization Costs

Compact	Predicted	Current
Southwestern	$1,374,000	$7,037,000
Central Interstate	$3,408,000	$10,011,000
Southeast	$5,344,000	$20,848,000
Appalachian	$7,989,000	$11,833,000
Texas	(a)	$4,400,000
Central Midwest	(a)	$31,600,000

(a)Figures were not readily available to the author.

TABLE II

Pre-construction Development Costs

Compact	Predicted	Current
Southwestern	$4,020,000	$21,678,000
Central Interstate	$14,959,000	$31,760,000
Southeast	$15,878,000	$45,786,000
Appalachian	$19,800,000	$29,217,000
Texas	(a)	$20,000,000
Central Midwest	(a)	$54,600,000

(a)Figures were not readily available to the author.

Funding of Pre-operational Costs

The method of funding the pre-operational expenses for the siting and development of the LLRW disposal facilities will have an effect on the disposal fees that are paid during the operational phase of the facility. Early developmental projects have relied on the developer to provide the funding for all phases and elements of the facility siting, licensing and construction. The developer then recovers the investment and associated interest costs over a designated operational period from the disposal fee revenues. For the California facility of the Southwestern Compact about 25% of the pre-operational cost is interest expense. Texas is financing their project with funds from the state that must be repaid to the general fund with interest. In Nebraska, pre-construction costs are jointly paid for by the developer and the utilities of the compact. More recent

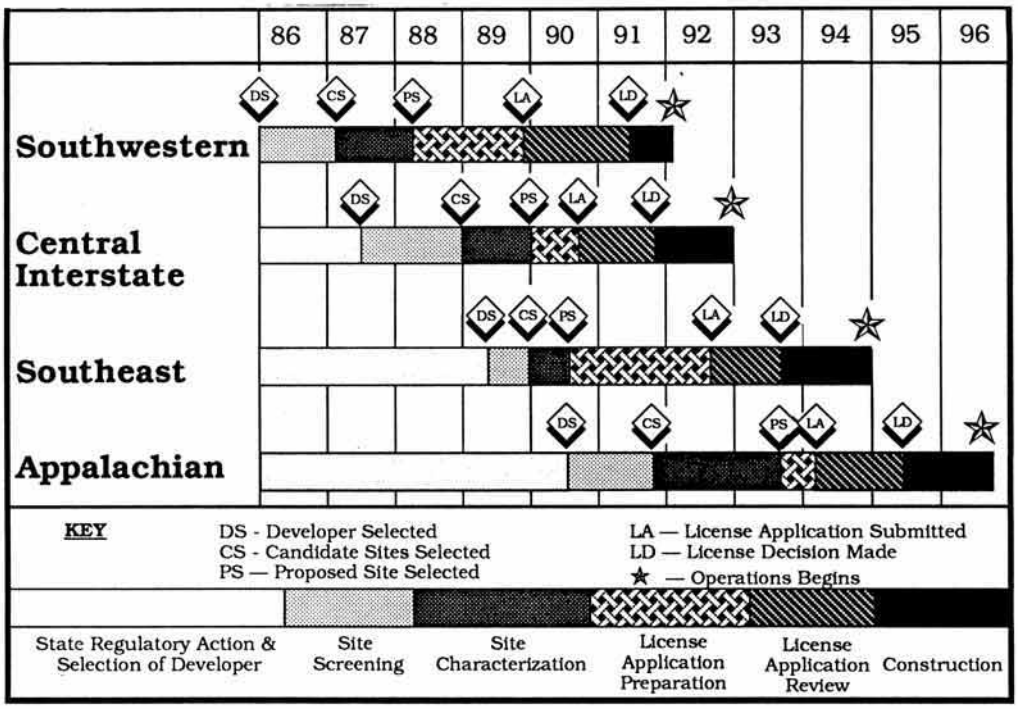

Fig. 1. Progress schedule of selected compacts.

pay-as-you-go approaches for funding facility pre-construction development activities have predominated. Temporary surcharges or fees have been placed on the compact's waste generators or assessments have been levied on nuclear power reactors. Illinois, Michigan, New York, North Carolina, and Pennsylvania are using various permutations of these methods. For the construction of most facilities, however, there is still a large reliance on external financing.

FACILITY REVENUE REQUIREMENTS

LLRW generators will bear the expenses for the development, operation and closure of the new LLRW disposal facilities by paying a fee for disposal of their waste. Although the exact method will vary among the different compacts, the fees will be set to provide sufficient funds to ensure the long term protection of public health and safety, safe operation of the facility, and a return to the developer for their investment and the business risk in undertaking the project. The components of the annual Facility Revenue Requirement are expected to include:

- Amortization of Development Expenses
- Depreciation of Construction and Capital Costs
- Interest and Financing Expenses
- Developer Return on Investment
- Facility Operating Expenses
- Operator Profit and Fees
- Closure & Institutional Care Funding
- Compact, State & Local Community Surcharges

Disposal Fee Considerations

Once the Facility Revenue Requirement (FRR) is determined, a nominal or base disposal fee per cubic foot can be calculated by dividing the FRR by the estimated annual volume of LLRW to be disposed of. Per state regulation, this simple and direct "dollars per cubic foot" method is to be used in California. Other compacts are considering further adjustments or factoring of this base fee to accommodate specific objectives of the compact, such as waste minimization and volume reduction. Computer modeling can be employed to correlate the disposal fee with cost related criteria and compact objectives by using historical data compiled for the projected waste stream. In developing a rate schedule that provides for financial incentives and penalties, consideration may be given to the following factors:

- Class of Waste - Traditionally Class A waste accounts for more that 90% of the waste volume, however, Class B and, particularly Class C, wastes have more stringent requirements per 10 CFR 61 that require additional design, construction, operational, and closure considerations. Most compacts are physically segregating all or some of the waste by class into separate disposal units for which some marginal costs may be assignable.
- Curie Content - Average specific activity and the radionuclide content are indicators of the radio-

logical hazard that potentially exists for the radiological workers and for the long-term performance of the site.

- Waste Treatment or Processing - Objectives such as implementation of volume reduction techniques or improved waste form may use the fee structure as an inducement to implement otherwise economically marginal technologies.
- Special Handling - Currently at the existing operating sites extra fees are levied for heavy and oversize packages that require the use of special cranes or equipment. Specially constructed shielding, waste placement or segregation may also be necessary for particular waste types and may be incrementally charged for.
- Source Inspection - As stated in the preamble to 10 CFR 61, "Inspection of waste generators for compliance with waste classification is more the responsibility of the Commission or the Agreement State regulating the generator." With the changes experienced in regulatory and disposal requirements, it is likely that inspections of waste and waste packaging by state inspectors will occur at the generator's location prior to shipment to the disposal facility. The cost for this service may be recovered through the facility disposal fee structure.
- Generator Classification - Price incentives may be given to research facilities, universities, medical institutions and other perceived desirable users of radioactive materials.

Waste Volume - The Major Factor

The factor that has the largest impact on determining the disposal fees at a new LLRW facility is the volume of waste that is to be disposed of. Most LLRW facility development and operating expenses, including surcharges for regulatory agencies, are fixed costs and will not fluctuate significantly with changes in volume of waste handled. For facilities with planned progressive or staged disposal unit expansions, the prre-operational construction is expected to provide disposal capacity for five to ten years, therefore future contruction costs will not have a direct impact on the initial disposal fees. Thus the major factor in determining a facility's unit disposal fee is the quantity of waste over which all the development, construction, operating and closure costs must be distributed.

Since the implementation of increasing disposal site user fee surcharges mandated by the 1985 amendments to the Federal Waste Policy Act, waste generators have been economically driven to minimize the generation of LLRW and to reduce the volume of waste that is generated. This is evident when examining the volumes of waste disposed in each of the years before and after 1985 as shown in Fig. 2. The average annual national volume of waste disposed in each of the years 1980 through 1985 was 2,933,597 cubic feet versus a 1,569,799 average for 1986 to 1990. (4)(5)(6) As can be seen in Fig. 3, the volumes for most compacts similarly declined by about 50% for the same periods. The trend is likely to continue as in the late 1980's there has been a growth in both on-site and off-site volume reduction and minimization technologies. In 1989, 38% of the disposed waste was processed by one of three commercial processing services. They processed 1,932,754 cubic feet that through volume reduction or decontamination resulted in only 600,884 cubic feet of waste that was actually sent to the commercial disposal sites. (7)

The true effects of changes in waste volume on the nominal disposal fee can be seen in Fig. 4. This curve is for a facility that has an annual revenue requirement of $20 million, the approximate amount that is estimated for both the Southwestern and Central Interstate Compact sites. At this revenue requirement, the nominal per cubic foot fee could range from $100 if 200,000 cubic feet of waste is disposed of to $500 for 40,000 cubic feet. Currently, Texas has the lowest projected revenue requirement of $11 million per year. At an annual waste volume of 60,000 cubic feet, this equates to a projected disposal fee of $180. (8)

Surcharges

Surcharges on the disposed waste will be collected to ensure funding for agency activities related to the protection of the public health and safety, and to provide for local compensation and incentives. Funding levels will often be set by the host state and levied by the compact on the waste producers in the compact. Surcharges can be imposed based on volume, waste class, percentage of revenues, or otherwise prorated to obtain a predetermined amount. Surcharges in several compacts are anticipated for the following categories:

- Closure & Post-closure Observation Fund - To comply with 10 CFR Part 61.62, a financial "surety that is at least sufficient at all times to cover the costs of closure of the disposal units that are expected to be used before the next license renewal" must be in place. By state regulation a closure surcharge of ten percent of the disposal charges is to be levied in California.
- Institutional Control Period Fund - 10 CFR Part 61.63 requires that a binding arrangement be executed "between the applicant and the site owner that ensures sufficient funds will be available to cover the costs of monitoring and any required maintenance during the institutional control period."

- Liability Insurance Fund - Regulations of some states require, and others allow, the establishment of a fund specifically for potential third party liability claims in the event of personal injury or property damage attributable to the operation of the LLRW disposal facility.
- Compact Commission - Funding for the compact's commission, including assigned staff, meeting and other required expenses would be provided for by this surcharge.
- Regulatory Agency - State agency expenses for regulatory oversite, licensing, and environmental monitoring would be paid for from this surcharge fund. State regulatory staffs are expected to include a program manager, health physicists, on-site inspectors, engineers, chemists, economists, and clerical support. They will be supplemented with consultants and contractors that can provide additional specific or unique expertise on an as needed basis. The projected California regulatory budget for the Southwestern Compact's facility in fiscal 1991/92 is approximately 1.1 million dollars.
- Repayment of State General Fund - Provision has been made in some states to finance pre-operational expenses from the general fund of the host state. This surcharge would repay those funds from the revenues of the facility. In Texas, imputed interest is also to be repaid.
- Local Community and Government - Generally this surcharge will provide direct payments to the host municipality to compensate for impacts and services or other costs incurred as a result of the new LLRW disposal facility. It can also be used to provide the local community with incentives and benefits that are required in some states by law. The extent of local government responsibilities, authority and resulting expenses varies from state to state. In some states, such as Pennsylvania, the local government can place their own inspectors at the facility site. Others can conduct their own independent environmental monitoring program. It is expected that most local governments will be provided funding for the training and equipage of emergency response units and for reimbursement of local citizen advisory committees. In the South-

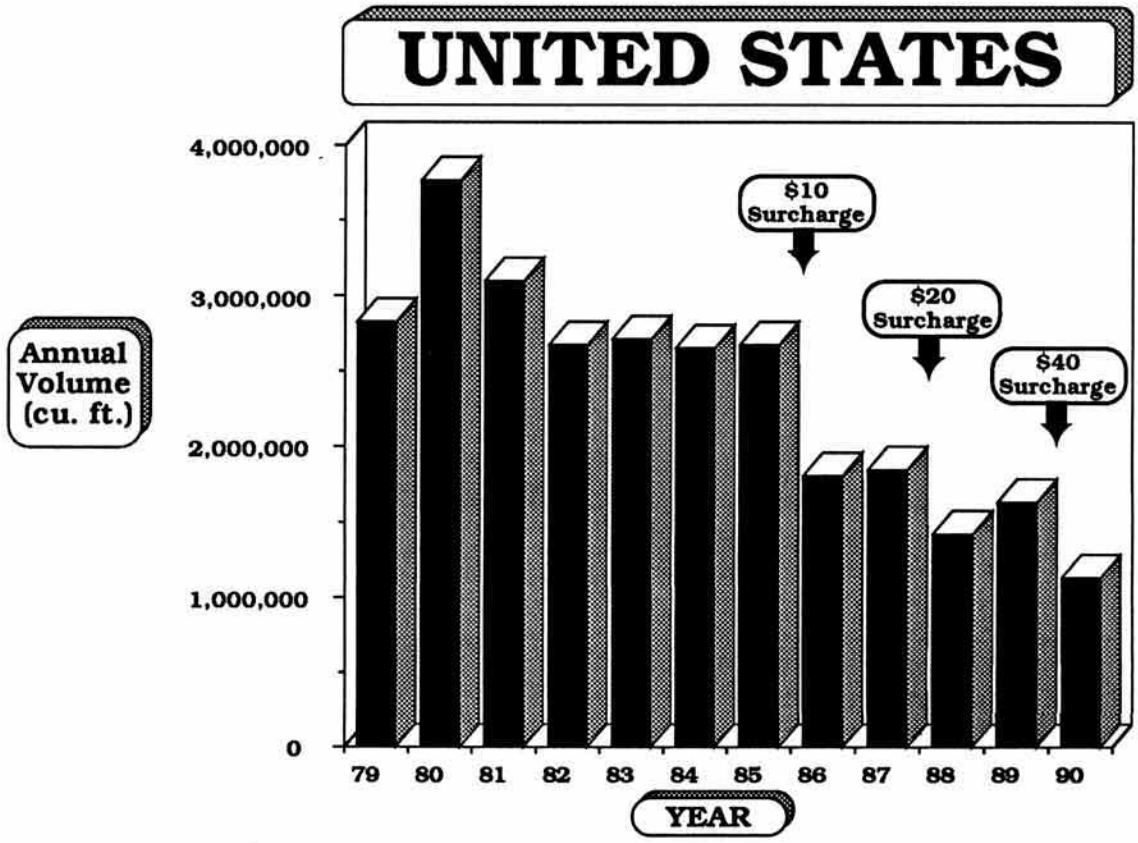

Fig. 2. Commercial LLRW disposed in the United States - 1979 to 1990.

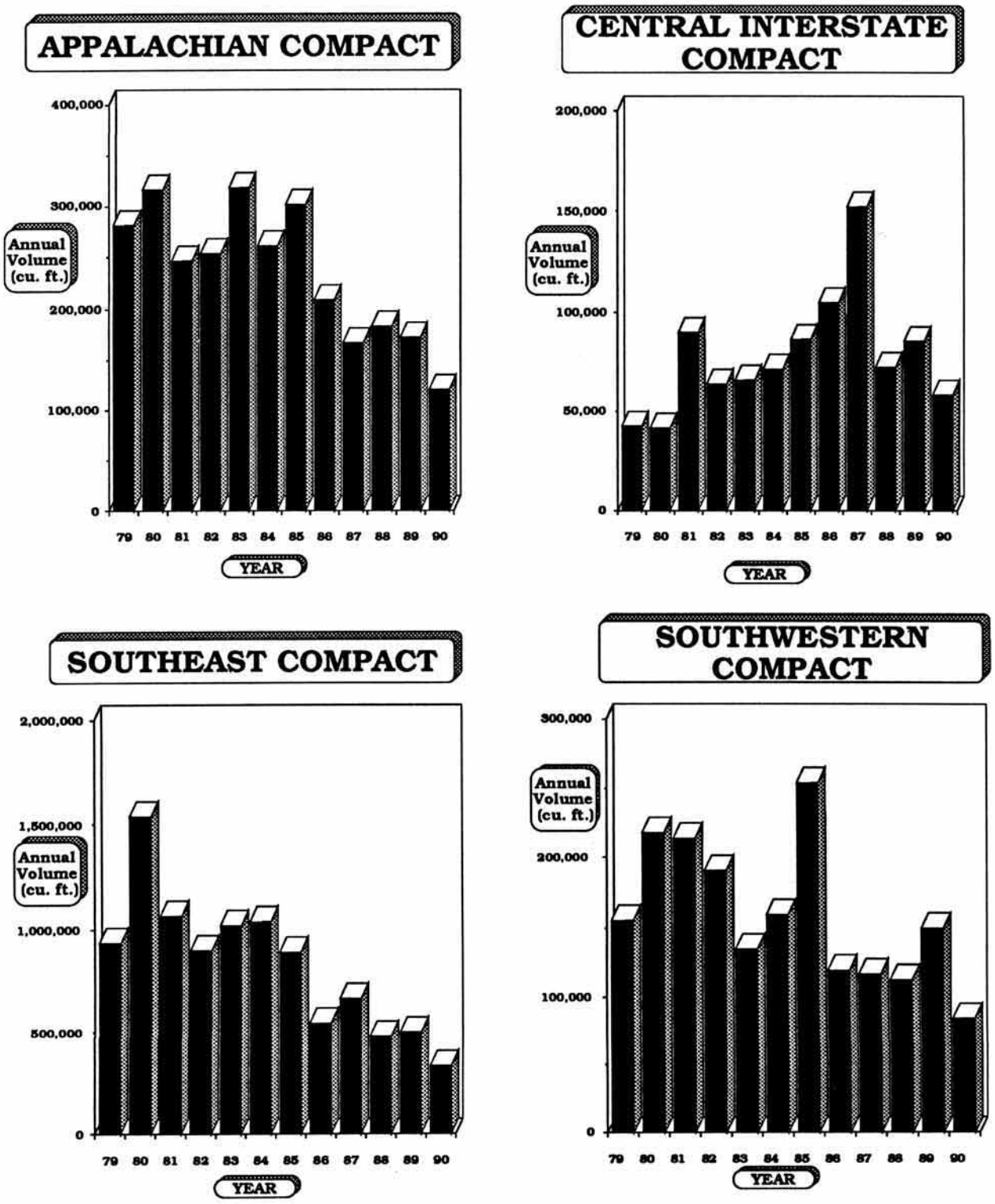

Fig. 3. LLRW disposal volumes of selected compacts.

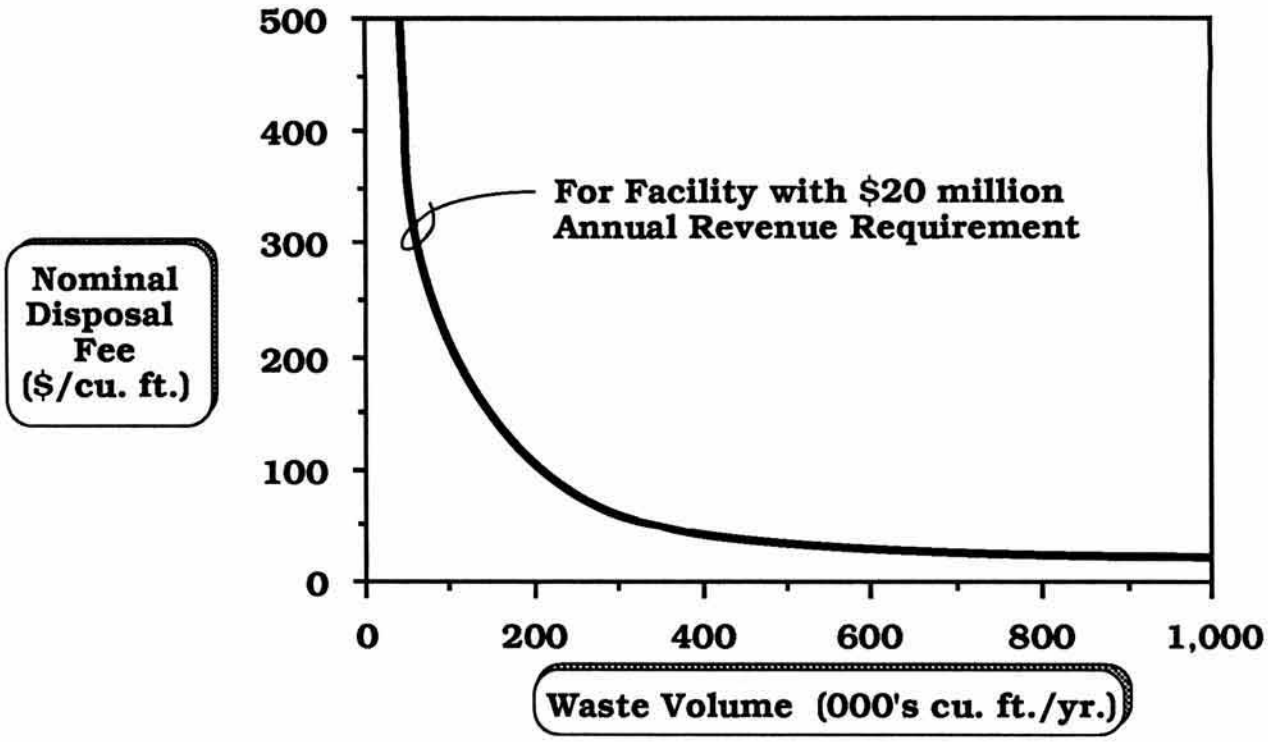

Fig. 4. Facility revenue requirement curve.

western Compact, which provides for the establishment of a specific fund to reimburse local government agencies, the California Department of Health Services will enter into a contract with the county and local agencies to define the funding criteria.

SUMMARY

Comparisons of early estimates with the costs that have been recorded in the most progressive compacts show that the efforts required to accomplish successful siting and development of a LLRW disposal facility are much more involved and complex than envisioned. There are many discrete reasons for the specific increases in costs that are being incurred, however, there is probably one major underlying reason, that being the increased awareness and concern of the American public towards environmentally related issues. This change is evident in the more thorough and exacting regulatory requirements and in the publicly open approaches being implemented for all phases of the life-cycle of a low-level radioactive waste disposal facility.

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