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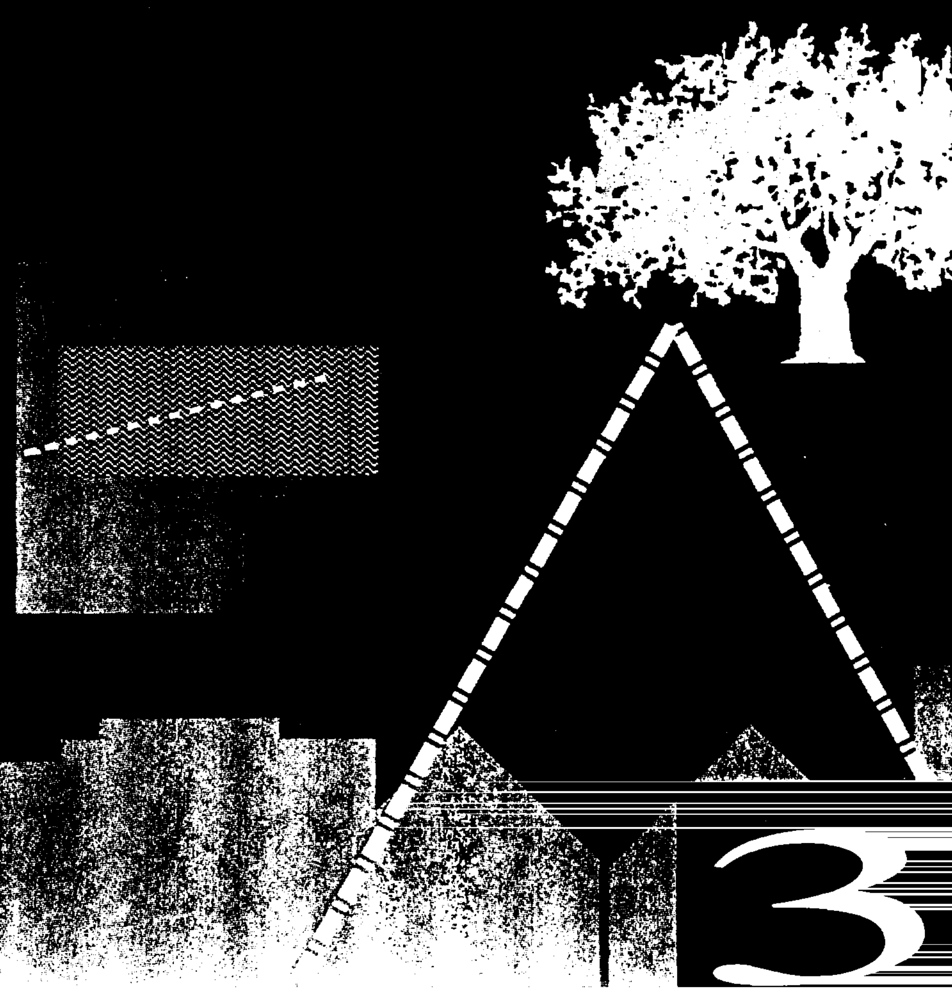
Alternative Approaches to Pollution Control and Waste Management

Regulatory and Economic Instruments

Janis D. Bernstein



URBAN MANAGEMENT PROGRAMME DISCUSSION PAPER

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Alternative Approaches to Pollution Control and Waste Management

Regulatory and Economic Instruments

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The Urban Management Programme (UMP) represents a major approach by the United Nations family of organizations, together with external support agencies (ESAs), to strengthen the contribution that cities and towns in developing countries make toward economic growth, social development, and the alleviation of poverty. The program seeks to develop and promote appropriate policies and tools for municipal finance and administration, land management, infrastructure management, environmental management, and poverty alleviation. Through a capacity building component, the UMP plans to establish an effective partnership with national, regional, and global networks and ESAs in applied research, dissemination of information, and experiences of best practices and promising options.

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FOREWORD

This paper has been prepared for the Urban Management and Environment component of the joint UNDP/UNCHS/World Bank–Urban Management Programme (UMP). The UMP represents a major coordinated approach by the United Nations family of organizations, together with external support agencies (ESAs), to strengthen the contribution of cities and towns in developing countries toward economic growth, social development, and the alleviation of poverty. The program develops and promotes appropriate policies and tools for environmental management, land management, infrastructure management, and municipal finance and administration. Through a capacity building component, the UMP plans to establish an effective partnership with national, regional, and global networks and ESAs in applied research and in the dissemination of information about successful practices and promising alternatives.

This background study is part of a series of working papers that, in combination with case studies and research, will be used to develop an overall report on strategic options for urban environmental management. Other papers in the series will cover priorities for urban waste management and pollution control, energy/environmental linkages in the urban sector, local management of wastes from small-scale and cottage industries, land degradation, and the urban environmental planning and management process. Each paper will provide background information on key urban development and environmental linkages and/or suggest elements of an environmental management strategy for cities in the developing world. In addition, research reports are being prepared on the following topics: health impacts of urban environmental problems, economic ramifications of urban environmental problems, urban environmental data collection, and the application of remote sensing and geographic information systems to urban environmental planning. Finally, case studies on important urban environmental problems are being prepared for São Paulo, Katowice, Tunis, Accra, Jakarta, Chittagong, and the Singrauli region of India.

EXECUTIVE SUMMARY

1. The purpose of this paper is to present an overview of the most common strategies and policy instruments (that is, regulatory and economic) used in developed and developing countries to achieve pollution control and waste management objectives. Although this topic has been at the center of theoretical controversy both within and outside the World Bank, this paper is not intended to contribute to this debate. Rather, its purpose is to explore how regulatory and economic instruments are used to control air and water pollution, protect ground water, and manage solid and hazardous wastes. The paper is directed to policy makers at the national, state, and local levels of government, as well as to other parties responsible for pollution control and waste management programs. Given the lack of consensus in this area, the paper does not intend to provide normative guidelines.

2. Since the inception of environmental policy in most developed countries, the command-and-control approach has been the predominant strategy. This involves direct regulation, along with monitoring and enforcement systems and relies primarily on applications of regulatory instruments, such as standards, permits and licenses, as well as land and water use controls. The command-and-control approach affords the regulator a reasonable degree of predictability about how much pollution levels will be reduced. Although this approach has been criticized for being economically inefficient and difficult to enforce, command-and-control strategies have made significant progress in meeting the objectives of environmental legislation and policies.

3. In recent years, many countries, primarily industrialized ones, have adopted economic instruments to introduce more flexibility, efficiency, and cost-effectiveness into pollution control measures. These instruments act as incentives to polluters to choose their own means of pollution control. When properly implemented, economic instruments have several advantages because they can:

- promote cost-effective means for achieving acceptable levels of pollution;
- stimulate the development of pollution control technology and expertise in the private sector;
- provide government with a source of revenue to support pollution control programs;
- provide flexibility in pollution control technology; and
- eliminate a government's requirement for large amounts of detailed information to determine the most feasible and appropriate level of control for each plant or product.

4. In theory, economic instruments have the capacity to regulate pollution according to market mechanisms and thus facilitate deregulation and a reduction in government involvement. In practice, however, they have not eliminated the need for standards, environmental monitoring,

enforcement, and other forms of government participation. Moreover, in developed countries, there are no known examples of instances where economic instruments have completely replaced direct regulation of polluting activities. Generally, economic instruments supplement direct regulation. Economic instruments alone have not produced impressive improvements in environmental quality, primarily because they are difficult to implement and have only been partially applied.

5. The regulatory and economic instruments selected to achieve pollution control and waste management objectives will have broad implications for institutions at the national, state or provincial, and local levels of government, as well as for nongovernmental organizations (NGOs). The choice of instruments will determine in large part the responsible level of government and the type of institution as well as the mechanisms for enforcement. In general, the activities requiring the greatest degree of political consensus and highest level of complexity (for example, setting standards) and risk are assigned to the national government level. The state and provincial levels tend to be responsible for policies that affect natural resources shared by several municipalities; local government generally is responsible for policy instruments associated with solid waste management, wastewater collection and disposal, air pollution from automobiles or local industries, and ground-water contamination. In some situations, pollution control responsibilities are assigned to watershed or airshed authorities. In addition, NGOs play a significant role in the development and enforcement of pollution control regulations.

6. The agency given responsibility for implementing pollution control or waste management policies must have clearly delineated authority and adequate expertise, staff, equipment, and funds to carry out its enforcement functions. In developing countries especially, institutions at all levels will require substantial strengthening in human and financial resources as well as in organizational structure to carry out waste management, pollution control, and enforcement responsibilities. In some cases, the development of new environmental agencies or environmental units within existing agencies will be necessary.

7. Based on a review of literature addressing pollution control and waste management, there are few in depth evaluations of the application of regulatory and economic instruments in developing countries. Most reports provide information on the existence of standards or other regulatory or economic instruments and highlight the inadequacy of existing institutions and personnel to carry out effective monitoring and enforcement activities. Very few developing countries (among them, China, Turkey, and Brazil) have been cited as having successfully applied regulatory and economic instruments to environmental management. Nonetheless, experience in developed countries points to the following considerations that should be taken into account when planning environmental strategies and selecting policy instruments for developing countries:

- economic instruments cannot be successfully implemented without pre-existing appropriate standards and effective capacities in monitoring and enforcement;

- economic instruments are not likely to replace traditional regulatory instruments, even if effective monitoring and enforcement capacities are established;

- in designing new environmental programs, the fundamental challenge will be to determine the most appropriate mix of instruments by taking into account such factors as desire for economic efficiency; compatibility with existing administrative, political, and judicial frameworks, economic conditions, and tax structure; political acceptability of instruments; complexity of application; ease of monitoring and enforcement; consistency with overall environmental policy; and compliance with relevant international agreements or principles; and

- among the various economic instruments, charges appear to have the most potential for contributing to the achievement of pollution control and waste management objectives in developing countries, given adequate enforcement mechanisms.

8. Further research on environmental management strategies is needed. The research should include in-depth studies on: evaluating the effectiveness of various regulatory and economic instruments in developing countries, the practical aspects of implementing and operating economic instruments and the circumstances under which they can be successfully applied, the combinations of instruments that are most appropriate for developing countries, approaches that take into account cross-media pollution effects, and appropriate standards for developing countries. Further research also is needed to identify means for building appropriate monitoring and enforcement capabilities in developing countries.

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I. OVERVIEW OF THE INSTRUMENTS

Introduction

1.1 Environmental managers can achieve their pollution control and waste management objectives through a variety of policy instruments. The purpose of this paper is to present an overview of the most widely used strategies and policy instruments (that is, regulatory and economic) that address urban environmental problems. Although this topic has been at the center of theoretical controversy both within and outside the World Bank, this paper is not intended to contribute to this debate. Rather, its purpose is to explore how regulatory and economic instruments are used in developed and developing countries to control air and water pollution, protect ground water, and manage solid and hazardous wastes. The paper also is intended to highlight general considerations for officials in developing countries in the process of establishing and implementing environmental policies and programs.

1.2 The paper is presented in two chapters. Chapter I presents a discussion of the two main approaches to pollution control and waste management as well as the principal regulatory and economic instruments to meet environmental objectives. It also addresses institutional implications of regulatory and economic instruments and draws conclusions on environmental strategies in developing countries and needs for further research. Chapter II discusses regulatory and economic instruments as they apply to surface water pollution control, ground-water protection, air pollution control, solid waste management, and hazardous waste management. This chapter presents examples of how individual countries, both developed and developing, have used these instruments to achieve environmental objectives. Information on the results of applying the selected instruments is provided.

Command-and-Control Versus Economic Strategies

1.3 The two principal approaches to pollution control and waste management are the command-and-control and economic strategies. Since the inception of environmental policy in most industrialized countries, governments have tended to use command-and-control (that is, direct regulation along with monitoring and enforcement systems) as the predominant strategy in pollution control and waste management. This approach generally requires a government to set health- or ecology-based ambient environmental objectives and specify the standards or amount of pollutants that can be discharged or the technology by which polluters should meet those objectives. In most cases, the command-and-control approach also specifies schedules for meeting the standards, permitting and enforcement procedures for facilities, liability assignment, and penalties for non-compliance. The responsibility for defining and enforcing the standards and other requirements is shared in legislatively specified ways between the national, state, and local governments.

1.4 The command-and-control approach gives the regulator maximum authority to control where and how resources will be spent to achieve environmental objectives. The major advantage of this approach is that it provides the regulator a reasonable degree of predictability about how much pollution levels will be reduced. Moreover, based on experience in the United States, this approach also protects competition among facilities. In the case of air pollution control, for example, all new facilities must adopt uniform abatement technology. In the case of water pollution control, uniform pollution control technology applies to an industrial class, regardless of facility age (Moore et al. 1989).

1.5 Although command-and-control strategies have made substantial progress in reducing pollution, this approach has been criticized for not achieving various legislative mandates and deadlines and for being economically inefficient and difficult to enforce. These strategies are inefficient for the regulatory agency, which must have detailed information concerning production processes and the suitability of various pollution control devices. With diverse industries, it is extremely expensive and time-consuming to obtain the necessary information and expertise on each industry. Other problems with this approach are the high costs for pollution control that leave little opportunity to take advantage of economies of scale. Although standards may be applied differently depending on the age or type of facility, most polluters using the same production process are required to meet the same standards. Polluters that could reduce pollution at a lower cost are not given the opportunity. Further, there is little flexibility for polluters who already have invested in some type of pollution control system. Consequently, the command-and-control approach provides little incentive for innovation in pollution control technology once the standards are achieved. Moreover, this approach is insufficient or ineffective in addressing many of the more recent pollution control and waste management problems confronting environmental managers, such as nonpoint source pollution (that is, urban and agricultural runoff), solid waste disposal, and global environmental problems (for example, stratospheric ozone depletion and climate changes).

1.6 In recent years, many countries have adopted various economic instruments (that is, pollution charges, marketable permits, subsidies, deposit and return systems, and enforcement incentives) to introduce more flexibility, efficiency, and cost-effectiveness into pollution control measures. Most of these instruments operate as incentives to polluters who can determine the most efficient and cost-effective means for achieving environmental targets. To various degrees, they incorporate the polluter-pays and user-pays principles. According to the polluter-pays principle, the polluter pays a financial penalty for higher levels of pollution and pays a smaller penalty or receives a financial reward for lower levels of pollution. According to the user-pays principle, the user of a resource pays the full social cost of supplying the resource, such as for water and related services including treatment costs (OECD 1990). While some economic instruments apply direct costs (for example, charges based on the volume and toxicity of discharges, pay-per-bag systems for solid waste disposal, permit fees for air emissions where the fee varies with the volume emitted, refundable deposits on containers), other instruments involve indirect costs such as pollution taxes on inputs (for example, fuel taxes).

1.7 Overall, the economic approach has several advantages. When properly implemented, it can:

- promote cost-effective means for achieving acceptable levels of pollution;

- stimulate development of pollution control technology and expertise in the private sector;

- provide government with a source of revenue to support pollution control programs;

- provide flexibility in pollution control technologies; and

- eliminate a government's requirement for large amounts of detailed information needed to determine the feasible and appropriate level of control for each plant or product (OECD 1989).

1.8 Despite these strengths, economic instruments have certain disadvantages. One significant problem is that the effects of economic instruments on environmental quality are not as predictable as those under the traditional regulatory approach, since polluters may choose their own solutions. Moreover, in the case of charges, some polluters may choose to pollute if the charge is not set at an appropriate level. From the perspective of developing countries, another major weakness of economic instruments (particularly marketable permits and effluent or emission charges) is that they require sophisticated institutions to implement and enforce them. Other disadvantages associated with specific instruments are discussed in Section C of this chapter.

1.9 As mentioned above, economic instruments often incorporate the polluter-pays principle. The aim of this principle is to integrate, at minimum social cost, expenditures on environmental protection in conjunction with standards or charges. According to Coase, however, there is no efficiency reason for a government to be involved in the regulation of pollution damage, except to enforce property rights. Depending on who possesses property rights, either the polluter will pay the victim to tolerate the damage or the victim will pay the polluter not to pollute (Pearce and Turner 1990). As long as the negotiations are not costly, the socially optimal amount of pollution will result in either situation. When there are few polluters and victims, and the number of beneficiaries from an agreement is given, negotiations may allow the internalization of environmental externalities. The validity of this approach, however, is based on two assumptions: the transaction costs are negligible (specifically, where the number of victims and polluters is not large) and the bargaining is successful with agreements enforced. In the absence of either condition, however, public intervention may be the only effective solution according to an internal World Bank report.

1.10 Theoretically, economic instruments have the capability to control pollution according to market mechanisms and thus facilitate deregulation and a reduction in government involvement. In practice, however, they have not eliminated the need for regulations, enforcement, and other forms of government participation. In industrialized countries, there are no known examples of instances where economic instruments have fully replaced direct regulation of polluting activities. In almost all cases, economic instruments supplement direct regulations, thereby contributing to the achievement of policy objectives. In mixed water effluent control systems, for example, charges have not eliminated the need to regulate discharges through licensing. With emissions trading, approval by authorities of environmental discharges have been replaced by approval of trading transactions (OECD 1989). In the case of marketable permits and effluent and emissions trading transactions (OECD 1989). In the case of marketable permits and effluent and emissions charges, which allow greater latitude in how and where reductions occur, the systems of monitoring and enforcement required are likely to be more complex and expensive than those needed for regulatory instruments (Moore et al. 1989). Nonetheless, not all economic instruments require expensive monitoring and enforcement. For example, beverage container deposit schemes (see Chapter II) do not require expensive monitoring and enforcement. In addition, sewer effluent charges generally are based on water consumption, which already is monitored in most jurisdictions (Anderson et al. 1989).

1.11 In their effect on environmental quality, economic incentives have not produced impressive results. The direct effect of both charges and marketable permits on environmental quality appears to be neutral or slightly positive. The direct effect of charges as an incentive has been modest, although the indirect environmental effect of earmarking the revenue raised by charges for pollution control actions has been positive (Hahn 1989).

1.12 Notwithstanding the potential benefits of economic instruments—raising public revenues, promoting innovation in pollution control technology, and lowering pollution control costs—government authorities, polluters, and environmentalists have not always supported the economic incentive approach. Regulatory agencies have objected to these instruments largely because they afford government less stringent control over polluters and provide less predictability about the amount of pollution emitted into the environment. In developed countries, industry and other polluters have resisted economic instruments such as effluent and emissions charges because they contend that they have greater negotiating power over the design and implementation of regulations than they do over economic instruments. Economic instruments act as an additional constraint on industry when they supplement existing regulations; some economic instruments (especially charges) impose a financial burden beyond the cost of complying with regulations (OECD 1989). When existing firms are protected from new competition by new source restrictions, they likely would object to lowering barriers to entry (Anderson et al. 1989). Further, if high charges are introduced in one country, more favorable market conditions will result in those countries with less stringent environmental controls. Lastly, not all types of pollution are appropriate for an incentive-based approach. For example, toxic substances, which can cause serious acute and chronic health problems, are better suited to some form of direct regulation. Further, some environmentalists historically object to any principle that implies a right to pollute, even though the existing regulatory system operates under permits to release stated quantities of pollutants at little or no cost to the polluter (Anderson et al. 1989).

Regulatory and Economic Instruments to Control Pollution and Manage Waste

1.13 The command-and-control approach to pollution control and waste management relies primarily on regulatory instruments (for example, standards, permits, licenses, land use controls); the economic approach usually incorporates regulatory instruments as well as economic instruments such as charges, marketable permits, and subsidies. Following is a brief description of the principal regulatory and economic instruments used to control pollution and manage waste in both developed and developing countries. The instruments described in this section, however, do not constitute a complete inventory. Some instruments, for example, have limited applications (for in Chapter II of this paper. Pricing policies, which are not directly concerned with environmental protection but indirectly affect the environment through their effects on production technologies and decisions, lie beyond the scope of this paper. Other potentially important pollution control instruments such as environmental impact assessments, technical assistance, negotiation, land acquisition, and public pressure (such as, boycotts, demonstrations, lobbying) also are not addressed in this paper.

Regulatory instruments

Standards

1.14 Standards are the predominant means for direct regulation of environmental quality throughout most of the developed world. They define environmental targets and establish the permissible amount or concentration of particular substances or discharges into air, water, land, or consumer products. Types of standards include: ambient environmental quality standards, effluent or emission standards, technology-based standards, performance standards, product standards, and process standards (see Box 1). Standards also may include technological specifications for the performance or design of equipment or facilities and the standardization of sampling or analytical methods. In some cases, a regulator takes into account the transfer of pollutants from one medium to another as well as total environmental exposure to specific pollutants in determining ambient standards or discharge limits. Each of the various types of standards are used to provide a reference for evaluation or target for legislative action and control. Generally, standards are established by central governments; in some instances, however, central governments set out framework regulations to be carried out by local, state, or regional authorities. Sub-national standards can be more stringent than those of the central government. In general, they are not less stringent, unless there are exceptional circumstances.

1.15 Standard setting presupposes the existence of a monitoring agency that oversees polluters' activities and has the power to impose a penalty for noncompliance. If the agency has no enforcement powers, the only incentive the polluter has to stay within the standard is social conscience. Thus, standards typically are associated with penalties (such as, noncompliance fees, loss of license); polluters also can be prosecuted or at least threatened with prosecution (Pearce and Turner 1990).

1.16 **Ambient Environmental Quality Standards.** Ambient environmental quality standards are used principally for protecting water and air quality. Ambient water quality standards, for example, specify the minimum conditions that must be met for specific parameters at specific locations in a water body. They are set on the basis of scientific criteria that assess the risk to a given victim and the amount of damage caused by a known dose of exposure to a pollutant. They also may be based on the possible uses of a specific body of water. The advantage of ambient water quality standards is that they establish the constraints that water quality objectives may impose on economic development, particularly for industrial and urban development. To achieve a certain standard requires establishing a threshold limit that a residual amount of pollution discharged must not exceed. Thus, setting a quality objective restricts development of an area to a certain level. The only way to expand, while ensuring the fixed level of environmental quality, is through technological innovation that increases the effectiveness of water treatment (OECD 1988). Another advantage of ambient water quality standards is that they provide a basis for the evaluation of the effectiveness of controls on discharges. They also establish priorities and targets to be achieved by such controls.

1.17 Two problems are associated with relying on ambient water quality standards alone to control pollution. First, when the combined effect of several discharges exceeds the assimilative capacity of the receiving waters and the standards are not achieved, responsibility cannot be

Box 1. Definitions

Criterion–Scientific information (for example, concentration-effect or dose-effect data) used as a basis for setting environmental quality objectives. It assesses the risk to a given victim and the amount of damage caused by a known amount of pollution or dose of exposure.

Objective–A designated concentration of a pollutant in an environmental medium or a narrative statement (for example, adequate to support aquatic life, zero pollutant discharge). The objective is based on scientific criteria, local natural conditions, and socioeconomic and environmental factors.

Standard–A legally defined regulatory instrument for limiting pollution. Several types of standards are commonly employed:

a. **Ambient Environmental Quality Standard**–Establishes the highest allowable concentration of specified pollutants in the ambient air or water. For example, an ambient standard for a specific river may require that dissolved oxygen, averaged over a 24-hour period at a selected river mile point, must not fall below 4 parts per million on more than one day per year.

b. **Effluent or Emission Standard**–Establishes the legal ceiling on the total quantity or concentration of a pollutant discharged from a pollution source (for example, mg/liter, grams/24 hours, kg/ton)). Effluent standards may include maximum effluent limitations for specified time periods (for example, maximum for any one day, maximum averages of daily values for 30 consecutive days, or for one year) and monitoring requirements.

c. **Technology-Based Standard**–A type of effluent standard that specifies a specific technology a firm must use to comply with environmental laws and regulations. For example, a utility may be required to use a scrubber to control sulphur oxide emissions.

d. **Performance Standard**–A type of effluent standard that defines a performance measure (for example, volume or concentration of a pollutant in a discharge, percent pollutant removal to be achieved) and allows dischargers the flexibility to select the best means to meet this standard. For example, automobile companies may be required to develop a technology for new automobiles that limit tailpipe emissions to no more than .41 grams of hydrocarbons, 3.4 grams of carbon monoxide, and 1.0 grams of nitrogen oxides per mile.

e. **Product Standard**–Establishes a legal ceiling on the total quantity or concentration of pollutants that can be discharged into the environment per unit of product output (kg per 1000 kg of product). Product standards also prohibit the addition of certain substances to products, for example, to eliminate lead discharges from the burning of gasoline, authorities prohibit the addition of lead to gasoline.

f. **Process Standard**–Limits the emission of pollutants associated with specific manufacturing processes (for example, the mandatory replacement of mercury cells by diaphragm cells to prevent mercury emissions from chlor-alkali manufacture).

assigned to a specific source. Moreover, it is also possible for the source farthest upstream to consume more than its share of the receiving water's self purification capacity, leaving little or no capacity for the downstream dischargers (Pallange and Zavala 1987). Second, the problem of determining acceptable concentrations of various pollutants is complicated by inadequate knowledge of the pollutants' effects, particularly in small concentrations, on human health and animal and plant life. These uncertain hazards must be weighed against other, often-competing economic and social interests (WHO 1983).

1.18 Ambient air quality standards are limits established for air pollutants inambient (outdoor) air. The standards are to be met through the application of control technology that reduces emissions continuously and results in improved air quality. These standards provide the targets for most command-and-control approaches as well as economic strategies for air pollution control (See Chapter II).

1.19 **Effluent and Emission Standards.** Effluent or emission standards are mean or maximum values for allowable concentrations or quantities of pollutants that may be discharged into a water body or emitted into the atmosphere; they must be achieved by an individual source at the point of discharge. Limitations may be applied to the entire plant or to each pipe discharging from the plant. Special effluent standards may be set for particular industries. In some cases, a distinction is made between standards applicable to all industries and standards specific to particular industries. Different standards also may apply to new and existing plants. Standards also may define the means for achieving specific environmental targets. Generally, ambient and effluent standards are complementary components of a regulatory scheme to control water or air pollution.

1.20 A technology-based standard is a type of effluent or emission standard that specifies particular technologies that firms must use to comply with environmental laws and standards. They afford no flexibility to firms in determining what control technology to use in order to meet such requirements. By contrast, performance standards specify the amount of pollutants that can be discharged, the allowable discharge concentration, or the amount of pollutants that must be removed prior to discharge, but allows firms to select the best way to meet the standard. The implementation of performance standards requires only that the pollution control agency define permit conditions in terms of performance rather than in terms of equipment or processes that will be adopted. The advantage of performance standards is that they allow polluters the flexibility to meet environmental requirements using the least-cost technique.[1] Performance standards are considered to be a low cost approach to pollution control than technology-based standards. Lastly,

1. In the enforcement of performance standards, an important prerequisite is the clarity of the standard and its measurement. In some cases, it has been difficult to determine whether the agency is issuing performance standards or technology-based standards. For example, an agency may set the standard on the basis of what the best available technology will achieve. This can be expressed as a technology-based standard, in which the agency requires the discharger to install the best available technology, or as a performance standard, by which the agency requires the discharger to meet the standard that can be achieved with the best available technology without specifying a particular technology. In the latter case, however, the performance standard may be equivalent to a technical standard because there is only one demonstrated technique that achieves the performance standard (OECD 1987).

performance standards may be best suited to large, complex enterprises that can choose the most efficient pollution control techniques. For small, relatively simple operations, it might be preferable to impose technical specifications or general rules which are easier to apply by activity and easier to enforce by the regulatory agency (OECD 1987).

1.21 Effluent standards generally provide a direct and manageable means for controlling pollution with a reasonable degree of predictability regarding the quality of surface water. Thus, establishing appropriate effluent standards is probably the best approach to controlling water pollution for developing countries. Nonetheless, there are several weaknesses associated with this instrument. First, uniform effluent standards do not take into account the water quality requirements of local water bodies. They can provide for overprotection in some river stretches and insufficient protection in others (Helmer 1987). Where there are numerous waste dischargers, however, achieving an ambient water quality standard through independent regulation of various discharges will be impossible. Instead, the government must coordinate the various effluent standards so as to achieve the desired goals in the receiving water body. Moreover, enforcement is usually carried out by spot-checks by government inspectors with penalties imposed on violators. The violators in turn may prefer to delay compliance with standards and to engage the government in lengthy legal battles. Another disadvantage of this approach is that it requires enormous administrative and enforcement costs (Fano et al. 1986).

1.22 **Product and Process Standards.** Product and process standards establish a legal ceiling on the amount of polluting products that can be discharged into surface water, ground water, and the atmosphere. For example, product standards prohibit the addition of lead to gasoline to eliminate lead discharges from automobiles. Similarly, the problem of aquatic blooms caused by detergents has been addressed by the removal of phosphates from detergents. An example of a process standard is the prevention of mercury emissions from chlor-alkali manufacture in Japan through the mandatory replacement of mercury cells by diaphragm cells. Outright bans on the use or production of a product that has no close substitute may be the strictest form of regulation. Nonetheless, close substitutes are often available at little extra costs (Bohm and Russell 1985). Bans on products or processes, therefore, may be an efficient policy instrument when there are close alternatives at low additional costs.

Permits and licenses

1.23 The granting or withholding of permits, licenses, or other authorizations is another important tool for controlling pollution. The permits or licenses are generally tied to an air or water quality standard and may be subject to the fulfillment of specific conditions such as compliance with a code of practice, selection of the location that minimizes environmental and economic impacts, installation of a treatment plant or pollution control equipment within a certain time period, or adoption of other environmentally protective measures. One major advantage of permits and licenses is that they facilitate the enforcement of environmental programs by including in one document all of a facility's pollution control obligations. Other advantages are that they may be withdrawn or suspended according to the needs of the national economy or other social interests and often require a fee that can be used to cover the costs of the pollution control program. Nonetheless, the use of permits and licenses normally involves regular monitoring and facility reporting.

Land and water use controls

1.24 Land use controls (such as, zoning, subdivision regulations) are principally local government tools that can be applied to environmental protection. Zoning may be defined as the division of a municipality or other jurisdiction into districts and the regulation within those districts of the allowable uses of land, height, and bulk (for example, maximum usable floor area as a percentage of lot area) of buildings and other structures; minimum allowable lot sizes; and population density. Thus, zoning can prevent the location of polluting industries in inappropriate areas or control the density of development in specific districts. In Brazil, for example, under Decreto-Lei 1413, an urban zoning program must be adopted in officially designated critical areas of pollution, which covers all major metropolitan areas and most industrial areas of that country. The objectives of this program include relocation of some existing facilities and installation of pollution control equipment at others (Findley 1988).

1.25 Performance zoning allows flexibility in design as long as certain standards are achieved. For example, performance zoning has been applied to industrial zones where any industry is permitted as long as its discharges do not exceed certain limits. Generally, performance standards are expressed as ratios of open space, density, and floor area. As long as standards are achieved, development can be clustered in one or more parts of the tract, leaving other areas in natural cover (U.S. Department of the Interior 1982).

1.26 Subdivision regulations are locally adopted laws governing the process of converting raw land into building sites. They control the physical layout of new development by establishing standards such as lot size, width and length of streets, and sites for public facilities. They also include provisions for adequate space for traffic, utilities, recreation, installation of water and sewer services, and the avoidance of population congestion. Subdivision regulations are accomplished through plat approval procedures; a developer is not permitted to make improvements or divide and sell his land until the plat (map) of the proposed subdivision is approved by the planning authority. Although these regulations, as well as zoning, can be used to promote a balanced pattern of urban development, land use controls can have negative effects on local populations in search of affordable housing (see Chapter II). Moreover, land use controls often are vulnerable to economic and political pressures that may override environmental objectives.

1.27 Controls on special uses of water can be used to limit or ban energy development, exploitation of natural resources in river banks and beds or seabeds, recreational activities (fishing, swimming, boating) and other potentially polluting uses in designated waters. In many cases, these regulations form part of regional or special planning measures for purposes of managing coastal zones, national parks, seashores and recreational areas, and/or marine sanctuaries.

Economic instruments

Pollution charges

1.28 Pollution charges establish the expenditure that will be made to control incremental units of pollution, but leave uncertain the resulting level of environmental quality. Their application is particularly appropriate when the damage from incremental units of pollution can be estimated reliably and least appropriate when regulators require certainty in the level of environmental quality achieved (Anderson et al. 1989). They encompass several types of instruments used for the purpose of controlling environmental degradation. They include effluent or emission charges, user charges, product charges, administrative charges, and tax differentiation.

1.29 **Effluent and Emission Charges.** Effluent or emission charges are fees levied by a government authority based on the quantity and/or quality of pollutants discharged into the environment by an industrial facility. Under an effluent or emission charge system, a discharger is required to pay a certain amount for every unit of pollution discharged into surface water or emitted into the atmosphere. Generally, effluent and emission charges are used in conjunction with standards and permits and allow ambient air and water quality standards to be achieved at the least possible cost.

1.30 An effluent or emission charge is based on some measure of the pollution dispensed in the environment. To control water pollution, for example, the charge can be based on: water quality objectives, the costs for financing a pollution abatement scheme, or effluent standards. Under the first scheme, individual sources are induced to take internal measures to reduce the quantities of pollutants in their discharges and thereby reduce their payments for pollutants that affect preexisting water quality standards. If the goal of the program is to meet a given ambient water quality, the most efficient charge would probably vary from location to location and from time to time. For example, the charge for discharging pollutants that do not degrade in the environment would be higher if they occurred upstream rather than downstream or if they occurred during low flow rather than high flow periods. The more sophisticated the pollution charge system, the more difficult it will be to implement and enforce (Palange and Zavala 1987).

1.31 Under the second scheme, the charges are used for financing a basin or regional control program to be shared by all users so that charges are allocated among dischargers in terms of a given pollution indicator (expressed as a unit measure) or presence of a toxic substance. Another form of this method is to levy ad valorem taxes to recover municipal cost charges based on volumes discharged or a combination of volumes with excessive pollutant concentrations over preestablished values. The third scheme involves charges imposed on all discharges in excess of established standards (Palange and Zavala 1987).

1.32 The most commonly proposed effluent charge schemes encompass whole regions. To ensure effective implementation of such a system, however, a number of institutional, political, and technical conditions must exist or be created. First, the responsible institution (often a regional authority) should encompass natural boundaries such as watersheds and airsheds and have the legal authority to impose and enforce charges on polluters. This authority would require:

analytical methods and data to establish the monetary value of damages caused by various pollutants or a method for estimating the level of the fee necessary to meet environmental quality standards, adequate resources to monitor emissions for each source of pollution, self-monitoring with periodic verification and enforcement, and legal power over the disposition of revenues (Moore et al. 1989). When pollution charges and permits are used together, it is important to ensure close coordination between the two instruments. Accordingly, specifications for polluting discharges must be identical in the permits and in the computation of charges. If these specifications differ, it increases enforcement difficulties since both types of requirements must be checked and monitored unless permits regulate one category of substances and charges another, which generally is not the case.

1.33 In theory, effluent and emission charges have several advantages: they induce firms to reduce pollution at lower costs than those under a command-and-control approach; they provide incentives to firms to invest in new pollution control technology; and they generate revenue, which can be used to finance and enhance enforcement activities. Lastly, effluent and emission charges can compensate, at least partially, for the unpaid costs of industrial activity usually borne by society at large. These include government expenditures associated with the development and enforcement of environmental regulations as well as the costs arising from discharges that are legal but still cause damage to natural resources (Hamrin 1990).

1.34 The principal disadvantages of effluent charges relate to practical and political considerations. First, industry always prefers control through standards over a system of fees with the same abatement costs because payment of the fee on remaining discharges will cost more in total. Another weakness is that there is no scientific or politically accepted way to assign monetary values to pollution damage. Charge setting is further complicated because the location of individual pollution sources will determine the extent of damage to ambient quality, thus requiring firm-specific rates. This results in areas competing for economic development by reducing charges, thus penalizing areas trying to improve environmental quality. Due to the complexity of pollution sources, developing and administering fees for numerous pollutants from single or multipoint sources would probably not be feasible with available resources for monitoring and enforcement in developing countries or even developed countries. Further, local authorities in most areas would not be strong enough to handle the complex planning, analysis, monitoring, enforcement, litigation, and interjurisdictional negotiation that would be required under an effluent or emission charge system. In addition, defining regional boundaries to apply the fee presents major difficulties. In the case of water, for example, watersheds are relatively easy to define, but the extent of an authority's jurisdiction throughout the tributaries is often unclear. The problem is significantly more complex in the case of airsheds given the variability of pollution dispersion (Moore et al. 1989).

1.35 In practice, charges are used primarily to control water pollution rather than air pollution. The charges generally are designed to raise revenue for the purpose of funding activities that promote environmental quality. Thus, the revenue from the charges is typically earmarked for specific environmental purposes rather than contributed to the general revenue. For more detailed discussions of effluent and emission charges as they apply to water and air pollution control, see Chapter II.

1.36 **User Charges.** User charges are direct payments for the costs of collective or public treatment of pollution. They are used most often in the collection and treatment of municipal solid waste and for the discharge of wastewater into sewers (see Chapter II). With respect to water pollution control, for example, user charges are fees paid to water authorities to allow discharges of industrial wastes into public sewers. Through these charges, which are related to the quality and characteristics of the effluent, the public authority receiving the waste discharge is compensated for the effort involved in its disposal. At the same time, the scale of the charges ensures that the plant has an economic incentive to improve the quality of the effluent. This approach, however, is not appropriate when disposing of certain toxic pollutants (for example, mercury) that never should be permitted to enter watercourses. Another application of user charges is in the area of vehicle-related taxes and charges.

1.37 **Product Charges.** Product charges are fees added to the price of products or product inputs that cause pollution in either the manufacturing or consumption phase or for which a special disposal system has been established. They function like effluent and emission charges in that they allow users to determine their own cost-effective means for reducing pollution. For example, all members of the European Community (EC), except Denmark, have levied a product charge on lubricating oils as a result of a 1975 EC directive to adopt measures to recycle waste oil. The system involves a tax on lubricating oil and subsidies provided for recycling oil. In Germany, this program was highly successful until the country encountered problems with illegal PCB contamination. In France and Italy, where the systems have less of an incentive effect, oil collections have at least doubled since the beginning of the programs. In Norway and Sweden, other product charges connected to environmental goals include charges on non-returnable containers, batteries, lubricating oil, fertilizer, and pesticides (Anderson et al. 1989).

1.38 The effectiveness of a charge on polluting products or product inputs will depend on the availability of substitutes. For example, where input costs are a small fraction of total costs, doubling or tripling the price through an input tax is unlikely to have a significant effect on consumption unless there are suitably priced substitutes. If less polluting substitutes are available, small increases in input prices may induce substitution and innovation over the longer term (Moore et al. 1989). Revenues from product charges can be used to treat pollution from the product directly, to provide for recycling of the used product, or for other budgetary purposes.

1.39 **Administrative Charges.** Administrative charges are fees paid to authorities for such services as chemical registration or the implementation and enforcement of environmental regulations. They usually are a component of direct regulation and are intended primarily to finance the licensing and control activities of pollution authorities. In Norway, for example, these charges are levied to finance the registration and control activity for fish farming and agricultural pollution, control of emissions from industrial sources, and for the licensing of chemical products. In some cases, administrative charges can have an incentive purpose as well. For example, a registration charge based on the relative hazards of pesticides or other chemicals may be imposed to encourage the use of less harmful products. In practice, administrative charges are similar to product charges in that the levels of such fees are usually low and do not provide significant incentives for changes in purchasing patterns. Revenues from administrative charges usually are added to the general budget rather than the budget of the pollution authority involved. In Belgium, for example, the mandatory registration fee for imported and exported waste is not earmarked for environmental purposes (OECD 1989).

1.40 **Tax Differentiation.** Tax differentiation is used to promote consumption of products that are environmentally safe. This instrument involves a combination of two surcharges added to other product charges: a positive charge levied on a polluting product and a negative charge on a cleaner alternative. It is used primarily in the context of transport to discourage consumer purchases of polluting vehicles or fuels (OECD 1989). Differential taxation of leaded and unleaded gasoline is a common practice throughout Europe. In the Netherlands, for example, unleaded gasoline is taxed at 0.1 ECU per 100 liters (about US$.004 per gallon) and leaded gasoline at 1.74 ECU per 100 liters (about US$.08 per gallon). Other taxes are levied on diesel and other fuel oils. The fuel taxes are designed to have some incentive effects. Generally, the levels of the charge are calculated so as to keep the total financial effects budget neutral. Differential taxation of new automobiles based on pollution is practiced in the Netherlands, Norway, Sweden, Finland, and Germany (Anderson et al. 1989).

Market creation

1.41 Under this approach, markets can be created in which actors can buy "rights" for actual or potential pollution or where they can sell these "rights" to other actors. Market creation generally takes one of two forms: marketable permits or liability insurance.

1.42 **Marketable Permits.** Under a marketable or tradeable permit system, the responsible authority determines a target level of environmental quality defined as an allowable level of emissions or an ambient environmental quality standard. This level of environmental quality is then translated into a total number of allowable emission that can be discharged and then allots discharge rights to firms in the form of permits.[2] Permits are then distributed to firms with each permit allowing the owner to discharge a specified amount of pollution. This permit to discharge may be transferred from one source to another. The demand for the permits is derived from the discharger's marginal costs of treatment; the discharger will treat waste as long as the marginal cost of treatment is less than or equal to the cost of buying a permit.

1.43 There are two basic approaches to implementing a marketable discharge permit system: government auction of permits or free distribution of permits to dischargers followed by trading among dischargers to establish a market price. Under the first approach, permits are sold for a

2. Marketable permits also can be used to reduce stress on an overly exploited renewable resource. In New Zealand, for example, a particular fish species was being depleted. To reduce the amount of fish being taken, regulators imposed catch quotas on which fishermen had to pay an annual fee. The revenues from this fee were used to buy out fishermen who were willing to forgo future fishing for the endangered species. Each fisherman stated the lowest price that he or she would accept for leaving the industry; the regulators selected those who could be induced to leave at the lowest price, paid the stipulated amount from the tax revenues, and retired the licenses that had enabled the fishermen to fish for the endangered species. In a relatively short time, a sufficient number of licenses had been retired and the fish species was protected (Tietenberg 1990).

single market-clearing price, which might be the lowest accepted bid, the highest rejected bid, or some value in between. Alternatively, the permits are allocated to the highest bidders. Under the second approach, permits might be distributed initially to duplicate the effect of uniform removal regulations or to allocate permits to communities on a basis such as population or to firms based on value added. After the initial distribution, the method for exchange of the permits could be centralized market or bilateral exchanges (Lyon 1989).

1.44 Marketable discharge permits that are transferable across jurisdictional boundaries have the potential for strengthening long-range pollution control. If applied, each source would be allowed to transfer all or part of its permitted emissions to another agency for monetary compensation. Sources that would incur high abatement costs could compensate sources in other jurisdictions for cutting back further than otherwise required. Differences among jurisdictions in marginal pollution-control costs would thus tend to narrow. Moreover, should some jurisdictions experience exceptionally high damages from pollution originating elsewhere, they could compensate sources in the offending region for cutting back more than the minimum prescribed amount. To achieve these benefits, however, cooperation is essential (Repetto 1990).

1.45 The most important advantages of marketable discharge permit programs are that they tend to be cost-effective and that they generate revenues. Marketable permit systems also have an advantage over pollution charge systems in that they ensure a given level of environmental quality. The potential savings under marketable discharge permit programs generally depend on the cost structure of the particular management program. Cost savings tend to be greater where there are several types of discharges, where there are opportunities to exploit economies of scale, and where standards are not so stringent as to require nearly all dischargers to remove 100 percent of their wastes. The system also affords great flexibility in terms of time; polluters would have increased incentives to invest in emission-reducing technologies during periods of regional growth (Hamrin 1990).

1.46 According to numerous reports, emissions trading can achieve substantial cost savings. In the United States, for example, emissions trading activities have resulted in aggregate cost savings in the billions of dollars (Hahn 1989). There is more evidence of cost savings associated with marketable permits than with charges. With respect to developing countries, where initial environmental quality standards often are fairly modest, there may be opportunities for substantial cost savings through trades. Another important advantage of this system is that it facilitates continuous economic growth in polluted areas without further increases in pollution levels. Nonetheless, the effect of marketable permit systems on environmental quality has not been impressive; the direct effect of these instruments has been reported to be neutral or slightly positive.

1.47 In planning marketable discharge permit systems, several potential implementation problems should be considered. First, the issue of defining exactly what "emission right" is being traded, and making adjustments in the value of the right depending upon where and when it is used, is one of the more complicated problems. For the program to work efficiently, the regulatory agency must be able to define these rights quickly, be able to compute any changes in the value of the rights easily, and have an efficient system for keeping track of who owns what rights. For example, the discharge of a thousand kilograms of a pollutant will have a different impact on ambient air quality depending on where it is discharged and the conditions of discharge (such as stack height, flow rate, temperature). Thus, trades that involve significant changes in the location of the discharge may require the establishment of a location-based "exchange rate." Successful implementation also requires the development of a robust market for permits. Without such a market, one firm may hoard permits and thus delay attainment of environmental standards and development of new pollution control technology. Another potential difficulty lies in determining a basis for the initial allocation of the permits. Where there is no existing regulatory framework, the initial distribution without charge may be problematic. Ensuring compliance may also be more complicated than with some forms of technology-based standards. For decision makers in developing countries that have limited technical resources, all of these potential difficulties may take on greater significance. Even in the world's most technologically advanced countries, the movement to introduce systems of permits that are fully transferable has been slow (Lyon 1989).

1.48 **Liability Insurance**. Liability insurance is another market creation mechanism in which risks for damage penalties are transferred from individual companies or public agencies to insurance companies. Insurance premiums reflect the probable magnitude of the damage and the likelihood it will occur. An incentive is created by the possibility of lower premiums when industrial processes are more secure or, in the case of accidents, result in less damage (OECD 1989).

Subsidies

1.49 Subsidies include grants, low interest loans, and tax incentives that act as incentives to polluters to change their behavior or reduce the costs of pollution abatement to be borne by polluters, both private and public. For example, central governments provide grants to industry primarily to help finance pollution abatement equipment purchases or to subsidize personnel training. In some countries, they make available grants to state and local governments for technological research and development programs or for assisting in the adoption of new techniques required by legislation or regulations. They apply to pollution control, recycling, and resource recovery.

1.50 Tax incentives involve tax credits or accelerated depreciation for industrial investments in equipment to abate or control pollution. This incentive also may take the form of special tax reliefs for firms that adopt management practices and production technologies that minimize the release of environmental pollutants. In the United States, for example, a tax rule enacted in December 1990 in Louisiana links the amount of business property taxes a company pays to its environmental record (Schneider 1991). In some cases, governments offer tax incentives to industries to site their facilities away from urban concentrations. The extent to which tax incentives can be used for environmental purposes depends on the particular taxation system and political structure of the country. In general, however, tax incentives should be used only where it can be clearly demonstrated that the costs of pollution abatement investments or relocating impose severe financial burdens on firms. In the case of relocation, which involves considerably higher transaction costs and freeing up of land for more productive uses, tax incentives appear to be more justifiable (Kosmo 1989).

1.51 Subsidies can provide a genuine incentive to industry to reduce its discharges. Nonetheless, they do not discourage the continuation of highly polluting industries, nor do they encourage alterations in polluting production processes or inputs of raw materials. Moreover, the taxpayer, rather than industry, bears the costs of these pollution control subsidies.

Deposit-refund systems

1.52 Under this approach, consumers must pay a surcharge when purchasing potentially polluting products. When the consumers or users of the product return it to an approved center for recycling or proper disposal, their deposit will be refunded. This instrument is applied to products that are either durable and reusable or are not consumed or dissipated during consumption such as beverage containers, automobile batteries, and pesticide containers (see Chapter II). They also can be applied to substances that have significant potential for damaging the environment (for example, CFCs).

1.53 To establish most deposit-refund systems, new organizational arrangements would be needed for handling the collection and recycling of products and substances as well as for managing the financial arrangements. National or state statutory authority also would be required for establishing the system. The advantages of deposit-refund systems are that most of the management remains with the private sector and incentives are built in for third parties to establish return services when users do not participate. One disadvantage of these systems, however, is that the costs of managing deposit-refund programs--which involve administration, collection facilities, recycling, and disposal expenditures--fall to the private sector; the only compensation is raising prices. Another weakness is that a refund for the return of polluting substances has the potential to create an incentive for counterfeiting (Moore et al. 1989).

Enforcement incentives

1.54 Enforcement incentives are economic instruments tied to direct regulation. They are designed to encourage dischargers to comply with environmental standards and regulations. As described below, enforcement incentives include noncompliance fees or fines, performance bonds, and liability assignment. They also include denial of public subsidies and financing and partial or total suspension of plant operations.

1.55 **Noncompliance Fees.** Noncompliance fees are charged to polluters when they emit or discharge pollution that exceeds levels imposed by regulations. When regulatory rather than economic instruments are the prime method of pollution prevention, enforcement generally is weak in that fines for violations are so low that it pays polluters substantially to break the law. To avoid time-consuming litigation, it is better to use noncompliance fees rather than criminal prosecution, provided that these fees are set so that firms have a strong incentive to abide by the regulations. Noncompliance penalties should be related to the extent and duration of the violation and exceed the source's estimated costs of compliance (Repetto 1990).

1.56 Performance Bonds. Performance bonds are payments to regulatory authorities before a potentially polluting activity is undertaken. The payments are returned when the environmental performance of the activity is acceptable. Like deposit-refund systems, performance bonds are charges for potential pollution; they are refunded when adequate measures are taken to prevent pollution. For example, restoration of production sites after shut-down may be required to avoid accident risks or environmental damage. The producer would be required to pay a deposit, determined by a court estimate of the likely maximum restoration costs or the maximum damages, to be refunded once certain conditions are met. In this way, society is protected against incomplete restoration due to intentional or unintentional bankruptcies. In the case of potential risks of innovation, performance bonds allow the introduction of new products or processes without having to await the results of government administered or supervised tests. If the government does not trust a firm to meet its obligations without a financial commitment, the firm may convince a bank or insurance company that its product is safe. If convinced, the bank or insurance company may assume the financial liability at a price (Bohm and Russell 1985).

1.57 Liability Assignment. Assignment of liability provides incentives to actual or potential polluters to protect the environment by making them liable for the damage they cause. This ensures that victims of environmental damage are compensated and serves as a preventive measure. If the polluter knew with certainty that he would be required to pay the cost of the damage, he would be encouraged to take action that would minimize risks. In contrast to pollution standards or charges, liability rules are administered by the courts after a problem has occurred and payment goes to the victims (Moore et al. 1989).

1.58 In common-law countries, polluters have been responsible for their damages before as well as after the enactment of pollution control legislation. This liability is based on the common law of private and public nuisance and is enforceable through the courts, by damaged parties and by the government. Its apparent independence of government regulatory activity has made it attractive to those who favor minimal government interference with the functioning of the market system (Bohm and Russell 1985). Nonetheless, making polluters clearly liable for any damages they cause, with the burden of proof on the polluter to establish harmlessness unless the emission level falls within established safety standards, has proven effective in obtaining industry's cooperation in standard setting. When the burden of proof is on the victim to establish that emissions above a standard have caused harm, industries have frequently resisted standard setting (Repetto 1990).

1.59 A liability system can be an effective way to deal with environmental problems when information is scarce and expensive. In the case where the potential damages of a proposed action (for example, construction and operation of a hazardous waste dump site) cannot be estimated, the designation of strict liability can be desirable. The liability payment might be guaranteed by a performance bond. It can provide incentives for the project proponent to gather information and take preventive actions, particularly those where the costs are small and the information or prevention effects are likely to be substantial (Bohm and Russell 1985). Where environmental injury is long-term in its effects, however, litigation and liability assignment may be prohibitively expensive and thus impractical (Moore et al. 1989).

Mixed systems

1.60 In practice, economic instruments are rarely used alone to achieve environmental protection objectives. Generally, they supplement direct environmental regulations to raise revenues for financing pollution control activities or other environmental measures, provide incentives to better implement regulations, and stimulate technical innovation. Figure 1 illustrates the various locations for imposing regulatory and economic instruments within the life cycle of pollutants. As indicated, they are applied at the point of input to production through final discharge into the ambient environment. Table 1 presents an overview of the regulatory and economic instruments indicating the environmental application and the main advantages and disadvantages of each instrument.

Institutional implications

1.61 The regulatory and economic instruments selected to achieve environmental objectives will have broad implications for the institutions responsible for implementing and enforcing them. Generally, the institutions that would be responsible for pollution control and waste management include: national sector agencies (for example, ministry of health, ministry of public works, national environmental protection agency); state and provincial agencies such as pollution control boards, watershed or airshed authorities (for example, river basin authority and air quality management districts), and county or municipal agencies (for example, departments of public works, planning, sanitary district). The courts and nongovernmental organizations (NGOs) also play roles in the development and enforcement of environmental regulations. The choice of instrument will determine in large part the responsible level of government and type of institution as well as the mechanisms for enforcement. The following sections outline some of the institutional requirements for implementing the various regulatory and economic instruments described in this paper and identifies the types of activities generally associated with each level of government.

Institutional Requirements

1.62 The legal framework (that is, laws, ordinances, regulations, sanctions for noncompliance) covering pollution control and waste management should define the responsibilities of each organization in implementing relevant laws and the procedures by which the responsible agencies should carry out their functions. In some countries, it may be necessary to pass new legislation intended to protect the environment, assign institutional responsibilities, and encourage public cooperation with pollution control and waste management objectives. In many instances, however, existing laws provide sufficient authority for carrying out environmental policies through various regulatory and economic instruments.

1.63 The effective implementation and enforcement of regulatory instruments will require responsible institutions to carry out a range of activities that will induce compliance and achieve improved environmental quality, whatever the resource. For example, regulatory institutions may need to:

- develop and issue ambient environmental quality and effluent/emission standards for air and water quality parameters and specify and carry out monitoring programs and facility inspections;

- prohibit certain polluting activities (for example, ban open dumps, prohibit installation of septic tanks in certain areas, prohibit addition of lead to gasoline) and monitor compliance;

- require environmentally protective practices and procedures (for xample, require pretreatment of industrial wastewater before discharge into municipal treatment plants, limit disposal of solid waste to approved sanitary landfills, require "cradle to grave " tracking of hazardous wastes);

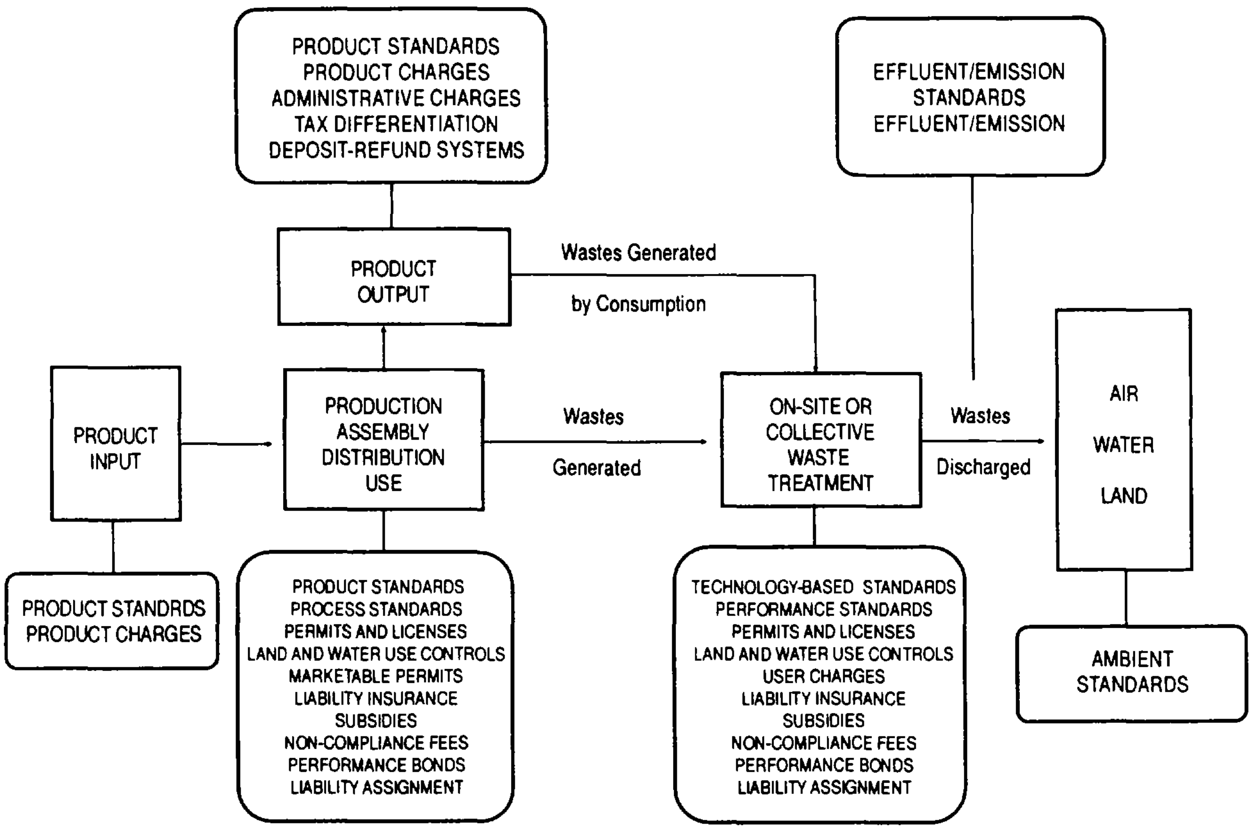
- establish design, fabrication, installation, process, and operation specifications applicable to industrial and municipal sources of pollution (for example, wastewater treatment plants, sanitary landfill) and develop and carry out procedures for inspection and issuing licenses and permits; and

- establish and impose fines and other sanctions (for example, plant closures, permit suspension, court actions) for noncompliance.

1.64 If economic instruments are used in conjunction with regulatory instruments, the responsible institution will need adequate capacity to carry out an additional set of highly sophisticated activities. In the case of effluent charges, for example, the regulatory agency will need to determine a basis for the charge and carry out other complex activities such as monitoring discharges to determine charge levels, enforcing the charge through litigation or other means, and coordinating the charge system with other jurisdictions. The agency also will need to establish an effective accounting system to ensure that the charges are collected and channeled to the appropriate agency. In addition, if charges will be used in conjunction with permits or other regulatory instruments, the responsible agency will need to ensure coordination among the instruments. If marketable permits will be introduced, the responsible agency will need to determine: the total number of allowable emissions based on an ambient environmental quality standard or target level of environmental quality, the method of permit distribution, and the procedural and recordkeeping requirements for trades.

1.65 Effective enforcement mechanisms and institutions are crucial to the success of any command-and-control as well as economic strategy to improve environmental quality and management of wastes. Accordingly, the selection and implementation of each regulatory and economic instrument or mix of instruments must incorporate a strategy for enforcement. Such a strategy would include: specification of major objectives and courses of action; provision of enforcement mechanisms and procedures in laws and regulations; mechanisms for defining requirements; means for identifying those subject to requirements and the methods of educating the affected parties about what is expected of them; compliance monitoring; enforcement tools (for example, fines, warning letters, administrative orders, permit suspension or revocation, permit

Figure 1. Alternative locations for regulatory and economic instruments



Source: Adaptad from Bower et al. (1977)

modification, adverse publicity, blacklisting, civil injunctions and penalties, criminal penalties, incarceration); means of evaluating compliance with standards and other requirements; and allocation of enforcement tasks among responsible agencies at each level of government. The nature of each enforcement strategy will depend on the activity being regulated as well as the severity and complexity of the pollution problem (OECD 1987).

1.66 Regardless of what agency is given responsibility for implementing pollution control or waste management policies, the agency must have clearly delineated authority and adequate expertise, staff, equipment, and funds to carry out its enforcement functions. In addition, the courts must have the capacity for carrying out enforcement responsibilities. For example, they will require the necessary expertise to determine: whether discharges are in compliance, whether standards are "reasonable," and whether the regulatory agency has adequately performed its designated function. In some cases, the courts will have an active role in issuing permits (OECD 1987).

Table 1. Regulatory and economic instruments

Instruments	Existing Applications					Advantages	Disadvantages
Regulatory	Surface Water Pollution Control	Ground-Water Protection	Air Pollution Control	Solid Waste Management	Hazardous Waste Management		
Ambient environmental quality standards*	X	X	X			Provide basis for evaluating effectiveness of existing controls	Require highly technical knowledge of pollutants' effects
Effluent and emission standards	X		X			Provide maximum government control	Involve high monitoring and enforcement costs
Technology-based effluent/emission standards	X	X	X			Provide maximum government control	Allow no flexibility in control technology Involve high monitoring and enforcement costs
Performance-based effluent/emission standards	X	X	X			Promote cost savings Allow flexibility in control technology	Involve high monitoring and enforcement costs
Product/process standards	X	X	X			Eliminate or limit emission of pollutants prior to production	Require close substitutes for banned products
Permits and licenses		X	X	X	X	Require compliance with standards prior to facility operation Facilitate enforcement of effluent and emission standards Allow government to withdraw or suspend according to national needs	Involve high monitoring and enforcement costs
Land and Water use controls	X	X	X	X	X	Prevent inappropriate siting of polluting activities	Allow government to withdraw or suspend according to national needs Vulnerable to local political and economic pressures

*Although ambient standards are not applied to individual sources of pollution, they establish the targets for other types of standards and economic instruments.

Table 1. Regulatory and economic instruments (*continued*)

Instruments	Existing Applications					Advantages	Disadvantages
Economic	Surface Water Pollution Control	Ground-Water Protection	Air Pollution Control	Solid Waste Management	Hazardous Waste Management		
Effluent and emission standards	X		X	X	X	Raise revenue Encourage polluters to reduce discharges Encourage innovation in control technology Promotes cost savings	Involve complex implementation and high monitoring costs
User charges	X	X	X	X	X	Raise revenue	Encourage illegal disposal without effective enforcement Involve high enforcement costs
Product charges	X	X	X	X		Raise revenue Promote use of safe products	Require close substitutes for affected products or inputs
Administrative charges		X	X		X	Raise revenue Facilities control measures Encourage use of safe products	Have limited applications
Tax differentiation			X			Promotes use of safe products Involves low administrative costs	Has limited applications
Marketable permits	X			X		Promote cost-savings Raise revenue Promote reduction in discharges beyond requirements Encourage innovation in control technology	Involve high transcation costs for firms Involves complex implementation and high monitoring and enforcement costs Require well-organised markets

Table 1. Regulatory and economic instruments (*continued*)

Instruments	Existing Applications					Advantages	Disadvantages
Economic	Surface Water Pollution Control	Ground-Water Protection	Air Pollution Control	Solid Waste Management	Hazardous Waste Management		
Liability Insurance	X	X			X	Provide incentive to control and/or clean-up pollution	Involve complex implementation and high monitoring costs
Subsidies	X	X	X	X	X	Provide incentive to control pollution and manage waste Require low monitoring costs Promote innovation in control technology	Perpetuate polluting industries Impose costs on tax payer rather than polluter
Deposit-refund systems		X	X		X	Encourage recycling Require little or know government involvement	Impose management costs on private sector May create incentive for counterfeiting
Noncompliance fees		X			X	Encourage compliance Involve high administration costs	Requires penalty to be set at appropriate level
Performance bonds	X	X		X	X	Ensure environmental restoration	Have limited applications and experience
Liability assignment	X	X			X	Encourage polluters to minimize risks	May involve costly litigation

Responsibilities by level of government

1.67 There are no set rules regarding the allocation of pollution control and waste management responsibilities at each level of government. In general, however, the activities requiring the greatest degree of political consensus and highest level of complexity (for example, setting standards) and risk are assigned to the national level of government. The state and provincial levels assume responsibility for implementing policies that affect natural resources shared by several municipalities; the local level of government generally is responsible for implementing policy instruments associated with solid waste management, wastewater collection and disposal, air pollution from automobiles or local industries, and ground water contamination. In some situations, pollution control responsibilities are assigned to watershed or airshed authorities. In addition, NGOs play a significant role in the enforcement of pollution control regulations. The following highlights the activities that would be assigned to relevant institutions at each level of government and to NGOs.

1.68 **National Government.** At the national level, sector agencies (for example, ministry of health) are responsible for pollution control policy making. Typical functions include: establishing or adopting and enforcing standards; establishing and carrying out nationwide monitoring programs; establishing, implementing, and enforcing permit programs (including marketable permit programs); carrying out research; establishing and administering programs of technical and financial assistance to pollution control and waste management agencies at lower levels of government; and establishing mechanisms for public participation in standard setting and in resolving major policy issues. In addition to the agencies responsible for various aspects of pollution control and waste management, other institutions at the national level with related functions play a role in implementing environmental policy. For example, a ministry of education may establish and implement training programs in environmental management for government personnel at all levels of government. In addition, a finance ministry would be involved in making national funds available for pollution control and waste management enforcement activities at subnational levels.

1.69 **State and Provincial Government.** In large countries, the national government may delegate various degrees of pollution control authority to state or provincial agencies. For example, the state may be required to adopt national ambient environmental quality standards or establish its own standards that are at least as stringent as those of the national government. The state or provincial government also may have the authority to establish and maintain technical design standards for waste disposal facilities; establish and implement statewide water quality monitoring; develop and implement statewide public education programs on pollution control; establish and/or administer financial assistance for pollution control investments as well as training in pollution control technology; conduct inspections to monitor compliance by public and private actors with standards, policies, regulations, permits, licenses; and carry out enforcement actions.

1.70 **Watershed and Airshed Authorities.** In developed countries, authorities have been established to manage water or air quality within jurisdictions based on naturally occurring air or water boundaries. With respect to the latter, a national government or group of states through mutual agreement can establish a river basin authority that will be responsible for implementing water quality policies within a river basin or watershed. In Germany, for example, the Ruhrverband, established in 1904, has restored recreational water use within one of the most highly industrialized basins in the world (Pallange and Zavala 1987). Similarly, metropolitan authorities for airshed management or solid waste management would be responsible for coordinating pollution control and waste management activities among involved jurisdictions.

1.71 **Local Government.** The local or municipal level of government is largely responsible for establishing, operating, and maintaining waste management services. Municipal agencies (for example, public works, engineering, water or sewer authority, sanitation district) must comply with national and state regulations; establish local standards, requirements, and enforcement strategies related to wastewater collection and disposal systems, stormwater drainage, solid and hazardous waste collection, transfer, and disposal, and in some cases, local air quality management; and establish and implement user charges or other cost recovery systems. Local planning boards would be responsible for zoning and subdivision regulations and reviewing and approving development applications.

1.72 **NGOs.** In addition to public agencies, private organizations can play a significant role in establishing and enforcing regulatory and economic instruments. For example, public interest groups will participate in developing standards and monitoring procedures, reviewing facility permits, monitoring the performance of public institutions in meeting their legislatively defined responsibilities, and taking court action against private industries or public agencies found to be out of compliance with environmental requirements. In addition, insurance companies may establish operational standards for obtaining liability insurance; professional trade associations may be required to present testimony in the standard-setting process or carry out subsidized research and technology development. Private companies or other entities also may be involved in the development of standards, selfmonitoring, introduction of deposit-refund systems, and meeting environmental standards and requirements associated with the provision of urban services.

Need for institutional strengthening in developing countries

1.73 In most developing countries, institutions at all levels of government have not established effective pollution control and waste management programs that take into account country-specific problems, nor have they had the capacity to adequately develop and implement standards, regulations, and charge systems, where they exist. The implementation and enforcement of regulatory and economic instruments has been constrained by: inadequate expertise, funds, and equipment; lack of political will; limited public support and participation; unclear or overlapping and uncoordinated institutional responsibilities; and lack of effective financial management for collecting charges. To design and implement pollution control and waste management strategies, therefore, national, state, and local institutions in developing countries will require substantial strengthening in terms of human resources, organizational structure, and financial resources. In some cases, the development of new environmental agencies or environmental units within existing agencies will be necessary.

Conclusions

Environmental strategies in developing countries

1.74 Based on a review of literature addressing pollution control and waste management, there are few reports providing in-depth evaluations of the application of regulatory and economic instruments in developing countries. Most reports provide information on the existence of standards or other regulatory or economic instruments and highlight the inadequacy of existing institutions and personnel to carry out effective monitoring and enforcement activities. Very few countries (among them, China, Turkey, and Brazil) have been cited as having successfully applied regulatory and economic instruments to pollution control. Nonetheless, experience in developed countries points to a number of considerations that should be taken into account when planning environmental strategies and selecting policy instruments for developing countries.

1.75 First, economic instruments cannot be successfully implemented without preexisting appropriate standards and effective monitoring and enforcement capacities. Although economic incentives have been viewed by some as alternatives to the traditional command-and-control approach—which requires in most developing countries the development of laws, institutions, and monitoring and enforcement capabilities—they cannot be considered a shortcut to pollution control. According to World Bank data, there is little difference, if any, in the monitoring and enforcement capability required of government for regulatory and economic instruments. For example, if monitoring is uncertain and enforcement doubtful, there is little or no reason for a firm to report its emissions and pay a tax. Similarly, if discharges are normally made without a permit, firms will not be motivated to purchase permits or to engage in emissions trading. Without an existing regulatory framework that has established baseline treatment standards for different kinds of discharges, it will be difficult to determine initial allocations of marketable permits. Moreover, subsidies for less than the total cost of pollution abatement activities will not influence firms that have no other reason to change their practices. The use of charges for nonhazardous and hazardous waste disposal and for discharges of industrial wastewater into municipal sewer systems also will be limited.

1.76 Another consideration in designing environmental control strategies in developing countries is that economic instruments are not likely to replace the traditional regulatory instruments, even if effective monitoring and enforcement capacities could be established. Given the experience in developed countries, efficient environmental management calls for the use of more than one policy instrument. In designing new environmental programs in developing countries, therefore, the fundamental problem will be to determine the most appropriate mix of instruments, taking into account practical, economic, and political realities. Factors that will determine the mix of regulatory and economic instruments include: desire for economic efficiency, need for greater efficiency with respect to environmental projects (speedier attainment of goals, more stringent requirements); compatibility with the existing administrative, political, and judicial frameworks, economic conditions, and tax structure; political acceptability of policy instruments; complexity of application (for example, method of computing charges); ease of monitoring and enforcement; consistency with overall environmental policy; and compliance with relevant international agreements or principles (OECD 1989).

1.77 Lastly, among the various economic instruments, charges have the most potential for contributing to the achievement of pollution control and waste management objectives in developing countries, given adequate enforcement mechanisms. Since most charges have not been high enough to have a dramatic impact on the behavior of polluters, the main function of the charges (that is, emissions fees, effluent fees, user charges, product charges) would be to finance the costs of constructing and operating sewage treatment facilities and carrying out other government activities that improve environmental quality. Presumably, starting out with a relatively low charge is a way to test the political waters as well as to determine whether the instrument will have the desired effect (Hahn 1989). In addition, the initial introduction of the charge system should incorporate dates for specified rate increases and take into account the effects of inflation.

Needs for further research

1.78 Further research on environmental management strategies is needed to provide sound guidance to developing country officials in the process of establishing new policies and programs and selecting policy instruments aimed at pollution control and waste management. The research should include in-depth studies on: the effectiveness of various regulatory and economic instruments in developing countries, the practical aspects of implementing and operating economic instruments and the circumstances under which they can be successfully applied, the combinations of regulatory and economic instruments that are most appropriate for developing countries, approaches that take into account cross-media pollution effects, and appropriate standards for developing countries. Further research also is needed to identify means for building appropriate monitoring and enforcement capabilities in developing countries.

II. REGULATORY AND ECONOMIC INSTRUMENTS: APPLICATION TO POLLUTION CONTROL AND WASTE MANAGEMENT

Surface Water Pollution

Regulatory instruments

Standards

2.1 Most countries have used ambient water quality standards and effluent standards as the principal means for controlling surface water pollution. They often are used together to achieve pollution control objectives. Product standards also are used to control water pollution.

2.2 **Ambient Water Quality Standards.** In the United States, the states are responsible for establishing ambient water quality standards. The standards set are for designated use for the water and identify the maximum concentration of various pollutants that would not interfere with that use. In Belgium, general norms define water quality objectives for surface waters with special uses. These objectives apply to surface water used for drinking and fresh waters in need of protection or improvement to be suitable for bathing, ensuring fish survival, and breeding shellfish.

2.3 In Brazil, ambient water quality standards cover basically the same broad range of pollutants and characteristics as do standards in the United States. The range includes oil, solids, fecal coliform, dissolved oxygen, and various toxic substances. Agencies of the state governments, which have jurisdiction over state waters, designate the principal uses of specific segments of streams and water bodies. This process of designating uses and establishing applicable ambient standards sometimes is referred to as "zoning" the stream or water body. Brazil's water quality standards, however, do not include a general nondegradation clause as is the case in the United States. In some Brazilian states, supplemental ambient standards exceed the federal minimums. In Rio de Janeiro, for example, Class 2 waters, which are used for public water supply after conventional treatment, are subject not only to standards previously set by the Ministry of the Interior but to restrictions on pollutants not covered by the federal standards (for example, herbicides and pesticides). As is the case elsewhere, in Brazil enforcement of the ambient water quality standards, in contrast to the enforcement of emission limitations and equipment standards applicable to individual sources, is very difficult where there are multiple polluters. Often no one source emits enough pollutants to cause a violation. The imposition of sanctions, therefore, may be particularly vulnerable to legal challenges (Findley 1988).

2.4 In India, a use-based classification of river stretches provides the prerequisites for setting water quality goals. Any river stretch may be subjected to one or more uses, including irrigation, drinking, industry, power generation, fisheries and wildlife propagation, navigation, recreation and aesthetics, and receptacle for treated wastes. The designated best use, requiring the highest quality of water, is then marked on an official water use map with the degree of treatment required for all discharges (Helmer 1987).

2.5 **Effluent Standards**. Effluent standards have been introduced in a number of developed and developing countries, either alone or in conjunction with ambient water quality standards or other control mechanisms. The standards vary according to the historical, legal, and administrative traditions of each country. In the United States, for example, all municipal and industrial point sources of pollution are subject to effluent limitations as required by the Clean Water Act. The best practicable technology (BPT) limitations focus on conventional pollutants (that is, biochemical oxygen demand (BOD), dissolved oxygen, suspended solids, metals). They take into account such factors as age of equipment, facilities involved, process employed, process changes, engineering aspects of control techniques, environmental impact, and the balance between total cost and effluent reduction benefits. The more stringent best available technology (BAT) limitations apply to toxic pollutants. In addition to these limitations, which cover different categories of industries, EPA has issued water quality criteria for more than 115 pollutants. The criteria recommend ambient or overall concentration levels for the pollutants and provide guidance to the states for establishing water quality standards. The Clean Water Act also requires municipal discharges to comply with secondary treatment requirements. Industrial dischargers must comply with pretreatment standards for discharging into municipal treatment plants.

2.6 In Mexico, recent changes in federal environmental laws provide for the establishment of minimum industrial effluent discharge standards by major industrial groups for the main pollutants associated with each industry; additional discharge standards where the instream water quality criteria for prevailing uses would still not be achieved; specific industrial effluent standards for discharges into municipal sewers; and a discharge permit system which requires all individual dischargers to meet the applicable standards or present a plan for coming into compliance, and all new industrial plants to meet these standards upon starting operations (Bartone 1990).

2.7 In Brazil, effluent limitations and equipment requirements are negotiated largely on a case-by-case basis between state environmental agencies and polluters. These emissions limitations and equipment requirements subsequently become part of construction and operating licenses and may differ substantially for similar facilities according to local or regional differences in ambient environmental quality and on the financial resources and political influence available to particular facility owners. In heavily polluted areas, licenses for new facilities may not be issued and public assistance may be provided for relocation of existing plants to other areas (Findley 1988).

2.8 The State of Rio de Janeiro, for example, established effluent standards to speed up the development of waste treatment systems for polluting industries. These standards include federal norms, which set out minimum discharge requirements and take into account the various pollutants found in wastewater, and general guidelines that establish maximum permissible concentrations for toxic pollutants. The state established limitations on the concentrations of heavy metals, pesticides, and other toxic substances in liquid effluent discharged into bodies of water or sanitary sewers as well as maximum allowable concentrations of BOD, which varies with the activity generating the waste and the dissolved oxygen content of the receiving waters (Findley

1988). This approach to standard setting differs from that of most countries in that it takes into account the assimilative capacity of the bodies of water, thus requiring water quality monitoring and the development of mathematical models to simulate the impact of future discharges and proposed control measures (WHO 1983).

2.9 According to Findley (1988), the process of setting applicable ambient water quality standards by zoning water bodies as well as setting effluent limitations for individual industrial plants through issuance of construction and operating licenses often fails to attain ambient standards in Brazil. Licenses often are required only for new plants; enforcement is lax, and nonindustrial water pollution sources (that is, commercial and residential buildings, construction sites, agricultural activities, and public waste treatment plants) are not covered by the licensing system or any other regulation.

2.10 The Water Pollution Prevention and Control Law in China provides for the implementation of ambient water quality standards and pollutant discharge standards. The ambient water quality standard is the maximum allowable limit for the existence of pollutants in waters, set to protect human health, ecological equilibrium, and the living environment. The pollutant discharge standard is a regulation aimed at controlling the discharge of pollutants to meet the ambient quality standard. The law clearly provides for the power of the state and the localities to determine ambient quality and discharge standards, their legal effect, and their revision (Ross and Silk 1987).

2.11 In Izmir, Turkey, the Izmir Water and Sewerage Authority (IZSU) monitors and controls industrial effluent from about 450 industries which have been analyzed and placed into categories according to their respective levels of pollutant discharges. The discharges must conform to standards covering such parameters as BOD, chemical oxygen demand (COD), pH, temperature, and heavy metals. The standards have been established by the General Directorate for the Environment, amended in light of local conditions, and set out in a municipal ordinance. Once violations are detected, IZSU provides the information to the municipality, which can take legal action to fine or close the plant. A grace period is allowed if the company can provide evidence of an investment in pretreatment. The threat of closure, usually brought about under a parallel public health ordinance, most often brings results. Thus far, companies have been subject to fines ranging from US$400 to US$20,000, and a number of leather tanneries have been closed for six months. About eighteen industrial enterprises have recently built pretreatment plants and other industries are relocating. Based on experience to date, this program is off to a propitious start; it demonstrates the importance of supplementing national environmental legislation with local regulatory initiatives and ensuring the full collaboration of the local political administration. Nonetheless, the program has encountered problems associated with the lengthy judicial process, industry inertia, and manpower and equipment shortages (World Bank 1990).

2.12 **Product Standards**. Product standards limit the amount of toxic substances and polluting products that can be discharged into surface water. They apply mainly to detergents, fertilizers, insecticides, and pesticides. In Canada, cleaning agents and water softeners that contain phosphorous are controlled by regulations under the Canada Water Act. In the EC countries, non-biodegradable detergents are prohibited or not used by agreement with the makers of the detergent. In Belgium, for example, the biodegradability of certain agents in detergents must be equal or superior to 90 percent (Docter International and Institute for Environmental Studies 1987).

Permits and licenses

2.13 In the United States, industrial and municipal dischargers must obtain National Pollution Discharge Elimination System (NPDES) permits in order to discharge into the nation's waters. An NPDES permit requires the discharger to obtain technology-based effluent limitations (BPT or BAT for industry, secondary treatment for municipalities, or more stringent water quality protection). Permits are issued for five-year periods and must be renewed thereafter to allow continued discharge. Dischargers also are required to maintain records and to carry out effluent monitoring activities.

2.14 When licenses to discharge wastewater are subject to effluent standards, one of the most serious problems is compliance. Generally, checking for compliance is done either at the regional or national level. In the United States, discharge permits granted by state authorities are screened at the federal level by the EPA, which has the right of veto. Since the NPDES permit system is central to the country's water quality program, its reporting and reviewing requirements may make it easier to monitor discharges. In Japan, the Water Pollution Control Act, the Sewerage Act, and the Rivers Act establish the regulations for reporting discharges. In the United Kingdom, discharges subject to license must have prior consent and any license granted may be reviewed or cancelled after two years. Any industry in the Netherlands that fails to comply with the licensing terms at any time, whatever the reason, must inform the relevant authority (OECD 1977).

Controls on special uses of water

2.15 In many countries, there are special requirements covering specific uses of surface water bodies. For example, there are many regulations addressing the exploration, development, production, and transport of oil and gas. Regulations also cover the exploiting of natural and cultural resources in marine environments as well as the dumping of solid and hazardous wastes. Mining codes in different countries lay down conditions for exploiting natural resources in river banks and beds. In addition, various regulations cover the use of surface water for tourism and recreation (for example, sport fishing, swimming, and boating), commercial fishing, and fish breeding.

Economic instruments

Pollution charges

2.16 As alternatives or supplements to direct controls on water pollution, a number of countries use charges to induce polluters to reduce the quantity of their discharges. The two principal types of charges used to control water pollution are effluent charges and user charges.

2.17 **Effluent Charges**. Effluent charges for water pollution are used successfully in many countries. In China, for example, those enterprises or activities that discharge pollutants into bodies of water pay effluent fees according to state regulation. In cases where the pollutants discharged exceed state or local standards, those enterprises or activities are required to pay additional effluent fees according to state regulations and are responsible for control and treatment. The effluent fee is based on the amount and concentration of pollutants. Research conducted in China demonstrates that effluent fees have exerted a useful enforcement role in the cases studied. Essentially, the environmental protection bureau and the enterprise with excess emissions have engaged in a "conspiracy" to extract from the enterprise's parent bureaucracy an increase in its allotment of funds to pay the fees. The enterprise benefits because an average of 70 to 80 percent of the fees are rebated back to the enterprise for environmental protection improvements. The regulator retains a portion of the fees and influences the enterprise's spending of the rebate, all with fewer political restrictions than the assessments of fines would have involved. The study concluded that the advantages to the regulator of assessing fees rather than fines are greater flexibility and less stringent requirements for approval by the local People's Congress of the fees assessment (World Bank 1988).

2.18 Since 1969, France has had a system of charges on water pollutants. The charge is levied on all actors that pollute seawater or fresh water. It applies to various pollutants including suspended solids, BOD, COD, soluble salts, organic/ammonia nitrogen, and total phosphorus. Household charges are calculated on a yearly basis by municipalities. Other sources are charged a flat rate based on an estimate or an actual measurement. The effluent charge rates, determined at the national level, vary from agency to agency (OECD 1989). The system is designed primarily to raise revenues which are used to maintain or improve water quality. Although the application of charges is widespread, they are generally set at low levels. The basic mechanism by which these charges improve environmental quality is through judicious earmarking of revenues for pollution abatement activities. Charges now appear to be accepted in France and provide a significant source of revenue for water quality control. One of the keys to their initial success appears to have been the gradual introduction and then increase of charges. Moreover, the number of pollutants covered has expanded considerably since the inception of the charge program (Hahn 1989).

2.19 The purpose of the charge system in the Netherlands is to finance projects that will improve water quality. As in France, the approach to managing water quality relies on both permits and effluent charges for meeting ambient standards. Permits tend to be uniform for similar discharges. The system is designed to ensure that water quality will remain the same or improve. Charges are based on both volume and concentration of pollutants. Actual levels of the discharge are monitored for large polluters; small polluters often pay fixed fees unrelated to the actual discharge (Hahn 1989).

2.20 The water pollution charge system in the Netherlands is considered to be effective and has provided strong incentive on certain industries to improve their pollution abatement practices (particularly the chemical, food, beverages, and tobacco industries). Pollution decreased by 50 percent between 1969 and 1975 and another 20 percent by 1980. For organic matter, the charge system made the largest contribution toward pollution abatement by industry. For heavy metals, regulation emerged as the most effective incentive, but not significantly greater than charges and negotiations between authorities and firms on setting standards. Moreover, an analysis of the period from 1969 to 1980 showed that 50 to 70 percent of the improved abatement among fourteen industrial sectors was attributable to effluent charges. Enforcement, however, has been problematic. Disagreements have arisen over correction factors and the coefficient table for medium-sized firms. The charge for heavy metals has been difficult to enforce because sources are diffuse and discharges cannot easily be traced to polluters. Lastly, differences in charge rates have posed questions of equity (OECD 1989).

2.21 In contrast to the more successful experiences in France and the Netherlands, the use of effluent charges in Yugoslavia illustrates problems with this regulatory approach. Because the charges in Yugoslavia have been set well below the costs of pollution abatement and are not adjusted frequently for inflation, they have been ineffective. In addition, pollution charges are not always collected since many public enterprises face severe financial problems. Finally, effluent charges are based on concentration levels rather than pollutant loads, encouraging firms to dilute their effluents particularly when water consumption is subsidized (Kosmo 1989).

2.22 **User Charges**. Sewage charges may be variable, fixed, or some combination thereof. In Canada, for example, the sewage charge levied on domestic users may be based on residential property values or calculated according to a formula that includes consumption in cubic measures. A flat rate residential sewage tax also is used. Swedish municipalities levy a charge for treatment of sewage water which consists of two elements: a fixed charge and a variable charge related to consumption. The charge appears to be effective since there are growing numbers of households and smaller industries attached to the sewer system and extended water treatment facilities. It has some incentive effect in that industries try to reduce water use when extending or renewing their plants. Nonetheless, this could give rise to a higher pollution concentration. In some municipalities, a redistribution occurs because firms pay a relatively high charge, implying a subsidy to households (OECD 1989).

2.23 In Izmir and Istanbul, Turkey, sewer charges (wastewater charges) are assessed for industrial discharges into the sewer systems. These charges are significant because they motivate factories to treat industrial effluents. Enterprises face two costs: treatment costs and disposal costs (sewer charges). Generally, high sewer charges encourage full treatment of industrial wastewaters so that they are suitable for discharge to surface waters, thereby eliminating sewer charges. Low sewer charges, by contrast, encourage only enough pretreatment of wastewaters so that they are suitable for discharge to the municipal sewer system. In this way, the enterprise minimizes its treatment costs. Since the firm will seek to minimize costs, its decision concerning pretreatment or full treatment will be in direct response to the level of the sewer charge (Kosmo 1989).

2.24 The problem of illegal discharges complicates the application of an optimal tariff in Izmir and Istanbul. If the sewer charge is too high, firms may seek to avoid it by illegally discharging wastewater. Thus, the ability to monitor industrial polluters and enforce pollution standards is critical. Assuming that monitoring and enforcement are adequate in Turkey, however, and that industry has the technical capacity to operate full treatment plants, sewer charges appear to be too low. They encourage excessive pretreatment and not enough full treatment of industrial wastewaters. (In Izmir and Istanbul, sewer charges are TL 100/m3 and TL 540/m3, respectively, while the marginal cost of municipal wastewater treatment is closer to TL 1000/m3.) A realistic average for full treatment of industrial waste in Izmir is approximately 700 TL/m3, while the cost for pretreatment is 70 TL/m3. For those factories with full treatment plants already in operation, a sewer charge that exceeds the present operating costs of their plants will cause the factories to continue discharging into surface water after full treatment to save on sewer charges. New factories and factories presently operating without full treatment, however, will have to consider the sewer charge in relation to the cost of full treatment including capital and depreciation costs (about 700 TL/m3). As long as the sewer charge is below 630 TL/m3, these companies will continue to opt for pretreatment since the combined costs will be lower. Charges that reflect treatment costs are essential so that industries will have adequate incentive to invest in additional effluent treatment as a means of reducing total pollution abatement expenditures, both to the firm and the municipality (Kosmo 1989).

2.25 Experience in the eastern part (Suzano) of São Paulo, Brazil, also demonstrates the importance of establishing sewage charges at the appropriate level before public investment in a sewage treatment. In this case, a sewage treatment plant was being constructed largely to treat the wastes of a local paper mill. About 90 percent of the facility's capacity was expected to be consumed by this company. Due to an unacceptably high tariff level set by the state sanitation company (Basic Sanitation Company of the State of São Paulo, or SABESP), the paper company chose not to connect to the new sewage treatment plant and constructed its own treatment facility at a lower cost. Consequently, the Suzano treatment plant operated at only 10 percent of its full capacity for several years (World Bank 1989).

Market creation (marketable discharge permits)

2.26 Marketable discharge permits have not produced impressive results in water pollution control. In the United States, for example, the state of Wisconsin implemented a program to control BOD into the Fox River. The flexibility of the program allowed limited trading of marketable discharge permits. Firms were issued five-year permits that defined their wasteload allocation, which in turn defined the initial distribution of permits for each firm. Although early studies indicated several potentially profitable trades involving large cost savings (on the order of US$7 million), since the program began in 1981 there has been only one trade and actual cost savings have been minimal (Hahn 1989). Stringent restrictions on trades have significantly inhibited trading under this program (Oates 1988). Numerous administrative requirements also add to the cost of trading and lower the incentive for facilities to participate. Some costs are attributable to the small number of firms involved and others to the absence of brokering or banking functions (Anderson et al. 1989).

Subsidies

2.27 Under this approach, countries make available grants, low interest loans, or tax incentives to mitigate the water pollution abatement or prevention costs to be borne by polluters. In the United States, the Clean Water Act authorizes grants for planning, design, and construction of publicly owned municipal sewage treatment facilities. Grants are allocated among the states according to a complex statutory formula that combines two factors: state population and an estimate of municipal sewage treatment funding needs derived from a biennial survey conducted by EPA and the states.

2.28 In the Philippines, the Environmental Code enacted in 1977 allowed half of the tariff and compensating tax on imported pollution control equipment to be waived for a period of years from the date of enactment. The code also made available rebates for domestically produced equipment and a deduction for certain pollution control research.

2.29 In Yugoslavia, the government exempts pollution control equipment from custom duties. It also provides subsidies, often in the form of reduced interest rates, to new technologies that reduce pollution. These policies, however, have not had a significant effect on industrial pollution abatement (Kosmo 1989).

2.30 Subsidized credit for relocation is an effective incentive used in Turkey. For example, leather tanneries relocating to the Maltepe Industrial Zone north of Izmir are entitled to subsidized interest rates of 35 percent for general loans and 22 percent for construction and infrastructure investment, implying negative real interest rates at an 80 percent annual rate of inflation. This is a clear incentive as interest costs in 1988 and 1989 account for 20 percent of total investment expenditures. Finally, the federal government offers a 40 percent tax deduction on investment for the tanneries relocating to another industrial zone during the first two years of estate construction (1988 and 1989) and a 7 percent reimbursement on investment for small and medium-scale tanneries (Kosmo 1989).

Enforcement incentives

2.31 Penalties for failure to meet environmental standards are commonly used instruments to encourage dischargers to comply with environmental standards and regulations. In Izmir and Istanbul, however, the use of this instrument has been ineffective. In these two cities, penalties for noncompliance with environmental standards have been assessed on several industrial polluters (for example, tanneries, cement, oil and soap, licorice, detergent, vegetable oil factories) by the municipality. When compared with sales for all large companies in the tens of billions of Turkish lira, however, charges act as a significant deterrent only to smaller companies, which account for relatively little industrial pollution. Moreover, all companies have an incentive to litigate to delay payment. At an inflation rate of 80 percent, the financial burden of such fines is greatly reduced the longer the delay in the courts. If a company continues to pollute, the municipality can double the fine for the second offense. Nonetheless, the real incentive for constructing treatment plants is the threat of closure by the municipality. By closing down several firms for continued failure to meet effluent standards, Izmir and Istanbul have shown that they are serious about dealing with the pollution problem and this has acted as a strong incentive for other companies to comply with pollution control standards (Kosmo 1989).

2.32 In Mexico, fines are set according to the severity of pollution adjusted for inflation; repeated offenses lead to closure. Combined with public pressure, these measures have been effective in controlling surface water pollution (Bartone 1990).

Mixed systems

2.33 As indicated in the above sections, economic instruments are generally used in combination with regulatory instruments to achieve water pollution control objectives. According to Bower (1981), these mixed systems appear to be more effective in water quality management than a system composed of only one instrument. Experience in the United States and France illustrate how the instruments work together to produce positive results.

2.34 In the United States, many cities have instituted mixed systems involving pretreatment standards (that is, limits on discharges into the sewer system); effluent charges (that is, charges on quantity and quality of discharges into the sewer system); tax credits for capital investment; and rapid depreciation allowances on investments in pollution control facilities. The pretreatment standards typically cover: fats, oil, and grease; pH; temperature; explosives; radioactive materials; metals and toxics; sulfides; phenols; and garbage and other solids that may obstruct sewers and treatment facilities. For some pollutants, discharges are prohibited; for others, limits on pollutant concentration and/or total discharge are specified. The various charge systems were not designed to induce reductions in discharges from individual activities. Instead, the purpose of the charges is to raise revenues to cover the costs of sewage treatment—including amortization of capital investment, operation and maintenance, and administration—and to distribute these costs equitably among the users of the system (Bower 1981).

2.35 According to a study of 101 individual plants in five U.S. cities, there are many factors influencing the response of an individual plant to the mixed systems, including: prices of inputs other than water (for example, energy and water); capital availability; available technical knowledge; regulations on discharges or gaseous and solid residuals; regulations concerning food safety; and regulations concerning worker safety. Although the study was unable to isolate the effects of specific measures, some conclusions could be drawn. First, despite the fact that the sewer charges were low in relation both to the total costs of production and to the costs of reducing discharges of liquid residuals, the charges triggered responses such as improved housekeeping and changes in production processes. In a few cases, the charges induced significant innovation in production systems. Second, the sewer charges induced more continuous adherence to the pretreatment standards. The regulatory system requires that a sanction be imposed each time the pretreatment standards are exceeded, resulting in a relatively weak inducement for continuing compliance. By contrast, receiving monthly bills reflecting actual behavior is a readily observable signal to plant management. Third, reductions in effluents are a function of the level of charges; as the charge increases in proportion to total production costs, there are greater reductions in discharges. Moreover, physical measures to reduce water intake, wastewater discharge, and energy use often reinforce one another. Lastly, stringent regulations imposed on the discharge of toxic substances have in most cases produced reductions in other pollutants as well (Bower 1981).

2.36 Investigations of mixed systems in France revealed similar conclusions. First, the levels of effluent charges are low, relative to total production costs and to the average annual costs of treatment by the individual activity. Even with the relatively low charges, however, where it is cost-effective to undertake some discharge reduction, enterprises have found it profitable to do so. Second, those industrial sectors where it is more cost-effective to reduce discharges have been pushed, by regulatory and economic incentives imposed at the national level, to undertake reductions. Third, the regulatory and economic components of water quality management turned out to be complementary. The regulatory system establishes the framework in which the basin agencies operate to offer or impose economic incentives and continues to be important for several reasons: some kind of licensing procedure is necessary, if only to check on illegal discharges; experience has demonstrated that industrialists are extremely reluctant to modify, even marginally, their production technology, even if the investment is paid back in one year; and the inducement for action appears to be at a maximum when there is a stick, such as penalties and sanctions for disregarding standards, as well as a carrot, such as technical advice, loans, and grants (Bower 1981).

2.37 For French municipalities and private enterprises, the regulatory system produces divergent effects. At the municipal level, for example, the incentive effect of the regulatory system is fairly low because it is difficult, if not politically infeasible, to impose sanctions, such as sending a mayor to jail. Thus, the economic incentive is crucial; the system of grants that reduces capital costs of treatment plants to the municipalities provides a major incentive. Further, the premium paid to municipalities is linked to efficiency levels in discharge, which increases the economic incentive for reducing discharges. Thus, the system is set so that little regulatory incentive is needed to induce municipalities to take action. (Bower 1981).

2.38 For the private sector, by contrast, the regulatory incentive carries significant weight, inspections are made, fines are levied, and litigation occurs. Nonetheless, these incentives have not produced the desired effects on environmental quality. For example, the ambient quality of French water rapidly worsened in the 1960s. According to Bower (1981), some economic incentives were used, but more importantly, an independent interlocutor (partner) was needed, who could give technical advice on how to achieve the discharge standards. (The fact that this interlocutor, the basin agency, also makes grants to cover 30 percent of the capital costs is a positive factor.) Thus, the combined effect of regulations and economic incentives is to induce private activities to reduce discharges.

Ground-Water Protection

Regulatory instruments

Standards

2.39 Ground-water standards apply to the resource itself as well as to the many sources (facilities, activities, products) of ground-water contamination. These standards include ambient ground-water quality standards, effluent standards, technical standards, product standards, and best management practices.

2.40 **Ambient Ground-Water Quality Standards.** Ambient ground-water quality standards limit the permissible concentrations of a substance in ground water. The standard may be a single concentration limit for all ground-water resources or various concentration limits based on the water use (for example, drinking, agricultural, industrial). Most ambient standards are expressed numerically (in parts per million or billion) or qualitatively (for example, adequate to support aquatic life).

2.41 In the United States, there is no federal law authorizing the establishment of national ground-water quality standards. Under the Safe Drinking Water Act, however, the EPA established standards for public drinking water supplies that have become a surrogate for ground-water standards. There are primary standards and secondary standards. For each regulated pollutant, primary standards—also known as Maximum Contaminant Levels (MCLs)—establish the maximum concentration allowed in tap water provided by public water supply systems. They are based on ideal health goals, called Maximum Contaminant Level Goals (MCLGs), which are set at levels that present no known or anticipated health effect, with a margin for safety. MCLGs establish targets for existing and new MCLs. MCLs are supposed to be as close as "feasible" to MCLGs. Factors affecting feasibility include the availability and cost of treatment technology. MCLs include monitoring requirements and are enforceable. Secondary standards protect the public welfare by providing guidelines on taste, odor, color, and other nonáesthetic characteristics. In addition to primary and secondary standards, EPA issues health advisories, which identify potentially hazardous contaminants and contain information on the health effects of those contaminants as well as analytical measurement techniques and control technologies (U.S. EPA 1987).

2.42 At the state level, standard-setting has taken four forms: establishing narrative ground-water standards, adapting state surface water quality criteria and/standards to ground water, adopting federal drinking water standards, and adopting drinking water standards for contaminants not yet covered by federal regulation. In establishing standards, some states (for example, Connecticut) have adopted variable standards based on the use classification of ground water. Other states uniformly protect all ground waters or allow limited degradation. The state of Wisconsin takes enforcement action against sources when ambient monitoring detects contamination at a specified fraction (called a preventive action level) of the health-based ground-water standard. The intent is to prevent contaminant concentrations from reaching the point at which public health or the environment is threatened (Conservation Foundation 1987).

2.43 **Effluent Standards.** Effluent standards limit the permissible amount or concentration of a substance to be discharged from a particular source of ground-water contamination. Although many source control authorities were originally adopted for reasons other than ground-water protection, they are being used for this purpose. In the United States, for example, most of the existing standards relevant to ground water are surface water standards limiting the contaminants in effluent from waste management facilities and commercial and production sources. In addition, some states and localities limit discharges from large residential or industrial septic systems. In China, strict limitations are placed on the use of seepage wells, seepage pits, and fissures and limestone caves to discharge poisonous industrial wastewater and water containing pathogenic agents.

2.44 **Technical Standards.** Technical standards govern the siting, design, construction, installation, operation, and closure of major sources of ground-water contamination. These include underground injection wells, underground storage tanks, landfills, surface impoundments, septic tanks, mining, and waste piles. They are the most commonly used approach for controlling major sources of ground-water contamination. Effective monitoring and enforcement of technical standards, however, is difficult. A facility leaching contaminants into ground water may be out of compliance for many years before a problem is identified through monitoring.

2.45 **Best Management Practices.** In the United States, best management practices (BMPs) specify how a source of ground-water contamination is to be managed, operated, and maintained. For example, BMPs for agricultural operations address tillage practices; crop rotation practices; terrace, grassed waterway, and debris basin installations; and fertilizer, water, and pesticide application. BMPs for forest operations relate to location, design, and construction specifications for roads; harvesting methods; methods of slash disposal; revegetation; and fire prevention. BMPs for surface mining operations relate to location, design, and construction of haul roads; type of mining; handling of overburden; proportion of site uncovered at a time; runoff reduction measures; and revegetation and reclamation of mined land. A general problem with the imposition and enforcement of BMPs relates to the effect of their application on production costs and thus net income of the operation. The problem is exacerbated when the operation is the major employer in a given local area. Moreover, BMPs are the most difficult types of standards to enforce due to the extensive monitoring required (OECD 1987).

2.46 **Product Standards.** Using this approach, states and local governments have banned or limited the sale and use of septic system cleaning solvents because they are harmful to ground water. Controls on pesticides require the incorporation of ground-water considerations into decision making on registering chemical and pesticide products. Other pesticide-related controls limit use to certified applicators and require improved product labeling to provide directions on how to protect ground water.

Permits and project review

2.47 Another approach to protecting ground water is through the project review and permitting process. In the United States, some states have modified their general permitting and project review authorities to ensure that potential polluters take appropriate measures to prevent ground-water contamination. New Jersey, for example, has broadened its entire program of surface water pollution discharge permits to cover discharges to ground water. New Mexico regulates all discharges to ground water, except those from agricultural practices and energy production, through rigorous reviews of required discharge plans. The discharge plans must include extensive provisions for control, monitoring, and reporting. At the national level, the Resource Conservation and Recovery Program for licensing waste disposal facilities includes design and operating requirements and a monitoring system to detect contamination from the facility. To obtain a permit, the disposal site must use certain landfill liners to prevent leachate from percolating into ground water, have collection systems to gather any leachate that does percolate for subsequent safe disposal, monitor ground-water quality, and be prepared to take remedial action if certain ground-water protection standards are exceeded. As part of the Underground Injection Control Program, the EPA sets minimum national standards for waste disposal. The states are delegated authority for permit programs to regulate injection wells. Many states have responded by adopting strict construction codes or prohibitions. For example, the state of Florida prohibits the granting of new permits to wells that inject hazardous wastes. The state requires permits for any wells that pose a threat to drinking water sources and public health (U.S. EPA 1987).

2.48 In Eastern Europe, the disposal of municipal sewage and industrial wastewater into ground water requires a special permit. The sewage and waste fee is defined in terms of the sewage type, the concentration of pollutants, and the purity of the body of water that will receive the sewage. The fees are defined according to specific chemical pollution coefficients (Wilczynski 1990).

Land use controls

2.49 Land use controls promote ground-water protection by restricting activities within sensitive areas. In the United States, for example, some local governments have begun to use planning and/or zoning regulations to protect ground water from contamination. Specific zoning instruments include minimum lot size requirements, rezoning industrial land to less intense residential use, restrictions on density of septic systems, zoning overlay districts which encompass zones of contribution to existing and future supply wells, and protective zones around aquifer recharge or wellhead areas where ground water is most vulnerable to contaminants. For example, in Austin, Texas, separate ordinances created three zones: the critical water quality zone, the buffer zone, and the upland zone to protect the watersheds in the Edwards Aquifer recharge area (U.S. EPA 1987). In the United States and Europe, regulatory authorities have designated wellhead protection zones, which are surface and subsurface areas surrounding a drinking water well or wellfield supplying a public water system. To ensure that contaminants do not enter these sensitive zones, authorities impose a mix of control mechanisms (see Box 2).

2.50 In many cases, certain vulnerable aquifers (for example, those overlain by shallow or porous soils) in need of special protection are located outside the jurisdiction of local zoning authorities. Since many critical decisions about land use occur outside city boundaries, a few states have granted municipalities extraterritorial zoning authority up to five miles beyond city limits. Recognizing that local controls alone are not always sufficient, some states have enacted measures authorizing regional and state participation in land use controls. For example, the state of Connecticut requires local zoning authorities to consider ground-water impacts in making zoning decisions. The state of Florida, which passed two laws to develop goals to guide social, economic, and physical growth through orderly land development, included provisions to protect the state's ground-water quality and supply. These laws mandate local governments to develop regulations jointly with the state to control land use in critical environmental areas (U.S. EPA 1987).

2.51 Although zoning and other land use controls can be used to protect ground water, these instruments may have negative impacts on other local concerns. In the areas surrounding Jakarta, Indonesia, for example, land use controls designed to protect underground sources of drinking water have profound effects on housing affordability (See Box 3). Moreover, the design, adoption, and enforcement of land use controls and other measures to protect ground water can strain already scarce municipal budgets because most local officials are ill-equipped to adopt land use

Box 2. Wellhead Protection

In the United States, a number of states have adopted protective zones around wellheads. The various methods used to delineate these protective zones largely reflect each area's unique combination of hydrogeological characteristics, potential sources of contamination, and the available institutional capabilities to manage those sources. In Florida, for example, Dade County delineates recharge areas around wellfields using computer modeling and imposes various restrictions within designated wellfield protection zones (for example, no new activities involving hazardous materials, annual permitting and inspection of all non-residential uses, density restrictions within protection zones, expedited sewering of unsewered protection areas, and expedited clean-up of known contamination). Other features of the program include: public information on the importance and methods of protecting drinking water, drinking water treatment programs, ground-water monitoring, extensive permitting and inspection of all nonrestricted activities in wellfield areas, and land use controls that prohibit or limit certain uses in proximity to wellfields.

West German authorities have delineated four zones of protection around wellheads. The first zone lies immediately around the wellhead extending out at least 10 meters. In this zone, pedestrian and vehicular traffic and agricultural activities are prohibited as are the activities restricted in the other two zones. In Zone II (defined by the distance that ground water will travel in 50 days), gravel pits, mining, oil storage, new cemeteries, and the transport of radioactive substances are prohibited. In the third zone, various restrictions are imposed on a number of activities, including liquid and solid waste disposal, the transport and storage or hazardous chemicals, and the application of leachable pesticides.

In Belgium, ground water is controlled by defining zones for the abstraction of waters and zones for their protection. Similarly, French law authorizes the creation of protection zones around the points from which water for human consumption is to be taken. As part of a two-tier protection system, a "close protection perimeter" is established in the immediate vicinity of the abstraction point, and no activity, deposit, or installation is permitted within its borders if it might directly or indirectly compromise the quality of the water. An "extended protection perimeter" is then drawn; activities within that perimeter are subject to control (U.S. EPA 1987).

controls for this purpose. Municipalities will need to develop or strengthen local land use capabilities, requiring financial support for training and technical assistance.

Controls on ground-water extraction

2.52 To control the quantity of ground water, a number of countries have established controls on ground-water extraction. In the United States, for example, some coastal states (for example, Florida and California) and localities have undertaken efforts to prevent saltwater intrusion by limiting the location and amount of water than can be pumped from wells near the coast. In Finland, a permit is required for extracting underground water. Similarly, in Prince Edward Island, Canada, permits are required for developing new wells.

Economic instruments

Subsidies

2.53 National laws authorize grants to states to assist them in developing ground-water protection strategies. In the United States, for example, the Clean Water Act authorizes grants to states to assist them in devising ground-water protection strategies to guide all future ground-water protection efforts. This Act also authorizes grants for states to design programs to prevent ground-water contamination from nonpoint sources. The Safe Drinking Water Act

Box 3. Secondary Effects Of Land Use Controls To Protect Ground Water

In Jabotabek (Jakarta Metropolitan Area), the Urban Planning Department established a residential zoning plan to protect ground water. The plan contains regulations that impose maximum densities of 50 persons per hectare in the most sensitive areas and 150 persons per hectare in less fragile areas. These densities were established on the assumption that households in new residential areas will obtain water from shallow wells and will dispose of wastewater through seepage pits. In a residential area, a density of 50 persons per hectare implies that about 1000 square meters of land has to be developed for each household. A density of 150 persons per hectare corresponds to about 330 square meters of land per household. Based on a survey conducted in the area, however, these land development standards are unaffordable. Only the most luxurious residential housing was found to be at the two maximum densities. Middle income formal development (financed through mortgages) and informal development were found to be at densities from two to three times the maximum officially permitted.

The zoning regulations would have been more effective if the planning authority established performance standards rather than fixed density standards. These standards could have controlled the quantity of the water drawn by shallow and deep wells as well as the volume and quality of the effluent discharged by hectare of land. Thus, developers would have been able to make a trade-off between quantity of land and type of infrastructure required. Although this approach would result in higher densities, the housing would be more affordable and easier to serve with infrastructure and public transport (Bertaud 1990).

established two grant programs. One of these programs provides grants to states for developing and implementing programs to delineate and manage wellhead protection areas. The other program is intended to fund demonstration projects to protect ground-water resources within Critical Aquifer Protection Areas (CAPAs) in approved Sole Source Aquifers. At the state level, grants have been used to finance land acquisition to protect ground water. Under the Aquifer Land Acquisition Program in Massachusetts, for example, the state established a fund to assist localities in the purchase of land to protect aquifers. In Belgium, another approach to subsidies involves the establishment of a loan fund for the reparation of damages due to tapping and pumping underground waters. In the United States, Wisconsin provides financial aid to replace septic tanks for homeowners in counties that have enacted septic tank pollution controls.

Enforcement incentives

2.54 Noncompliance fees also encourage compliance with standards and other regulatory instruments that relate to ground-water protection. They can be civil or criminal penalties. Under the Resource Conservation and Recovery Act, for example, an administrative compliance order may set a civil penalty of US$25,000 per violation, per day; failure to comply with the terms of the order can result in an additional US$25,000 fine. By contrast, criminal penalties can be US$50,000 per day for knowingly violating the law and US$250,000 for knowingly endangering public health and the environment (U.S. EPA 1987).

Air Pollution Control

Regulatory instruments

Standards

2.55 Like standards developed to control water pollution, air quality standards are the principal means for direct regulation of air pollution. They are the targets for most command-and-control approaches as well as economic strategies for air pollution control. The two principal types of standards that apply to air pollution control are ambient air quality standards and emissions standards, which are applied to both stationary and mobile sources.

2.56 **Ambient Air Quality Standards.** In the United States, EPA has established two levels of National Ambient Air Quality Standards (NAAQS): primary standards, set at levels necessary to protect human health; and secondary standards, set to protect welfare. The latter encompasses air pollution effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility and climate; damage to and deterioration of property; hazards to transportation; as well as effects on economic values, personal comfort, and well being. As of 1989, EPA had promulgated NAAQS for six air pollutants: sulphur dioxide, particulate matter, nitrogen dioxide, carbon monoxide, ozone, and lead. The states are responsible for establishing the procedures by which the federal air quality standards will be met and adopting plans, known as State Implementation Plans (SIP). The SIP are developed by assessing emissions in air quality regions and computer modeling to determine whether those emissions will result in air quality in violation of applicable standards. To the extent standards will be exceeded, the state imposes controls on sources to reduce the excess emissions (Congressional Research Service 1989).

2.57 **Emissions Standards for Stationary Sources.** Emissions standards are limits set for the discharge of pollutants from individual sources. In the United States, the most important controls over stationary sources of air pollution (for example, factories, power plants, refineries, other industrial facilities) are known as new source performance standards (NSPSs). NSPSs set maximum emissions for new or extensively modified facilities, which are major polluters, with the emission levels determined by the "best technological system of continuous emission reduction," taking into account affordability to affected parties. Initially, the NSPSs were intended to apply uniformly throughout the United States. Over time, however, these standards incorporated variation based on local conditions (Portney 1990).

2.58 The Clean Air Act Amendments of 1990 offer a plan for substantially reducing emissions of hazardous air pollutants from major sources. The amendments targeted 189 toxic air pollutants for which emissions must be reduced. The law requires EPA to publish a list of source categories that emit specified levels of these pollutants within one year of the enactment of the new law. The list of source categories must include: major sources emitting 10 tons per year of any one, or 25 tons per year of any combination, of those pollutants; and area sources (smaller sources, such as dry cleaners, gas stations, and wood stoves). EPA subsequently must issue Maximum Achievable Control Technology (MACT) standards for each listed source category according to a prescribed schedule. These standards will be based on the best demonstrated control technology or practices within the regulated industry; EPA must issue the standards for 40 source categories within two years of enactment. Standards for the remaining source categories will be established within ten years of enactment. Companies that voluntarily reduce emissions according to certain conditions may obtain a six-year extension for meeting the MACT requirements. Eight years after MACT is installed on a source, EPA must examine the risk levels remaining at the regulated facilities and determine whether additional controls are necessary to reduce unacceptable residual risks (U.S. EPA 1990).

2.59 China's emissions standards are generally uniform for a given pollutant across industries. In the case of sulphur dioxide, however, differential removal requirements apply to new power plants depending on whether they burn high or low sulphur coal. Emissions standards also are tighter for low stacks, providing incentive for building tall stacks, thereby reducing local emissions but contributing to acid rain and other long-range pollutant transport problems (Krupnick and Sebastian 1990).

2.60 **Emissions Standards for Mobile Sources.** With regard to emissions standards for mobile sources, the U.S. Clean Air Act establishes standards that apply to automobiles, light trucks, buses, and motorcycles. In 1963, the Clean Air Act authorized federal emissions standards for automobiles and light trucks. These standards took effect with the 1968 model year and preempted state auto emissions standards, except for California which was permitted to request a waiver annually to allow stricter standards. EPA enforces these standards by conducting a testing and certification program to ensure that new model vehicles, including imports, meet these standards (Congressional Research Service 1989). The 1970 Amendments to the Clean Air Act require average emissions of carbon monoxide and hydrocarbons to be reduced by 90 percent by 1975 (measured from the already controlled levels existing at the time) and average emissions of nitrogen oxides to be reduced by 82 percent (measured from the then-uncontrolled levels) by the same time. The EPA, however, was empowered to waive the deadlines for meeting these standards under certain conditions (Portney 1990). In 1990, amendments to the Clean Air Act imposed more stringent tailpipe emissions on cars and light trucks to reduce tailpipe emissions of hydrocarbons by 35 percent and nitrogen oxides by 60 percent from existing standards. These standards were scheduled to take effect beginning in 1994 and to be completely phased in by 1996. In 2003, a second round of tightened emissions may be imposed, depending on the results of a study on the availability of technology and on the need for and cost effectiveness of additional controls. The 1990 amendments also require automobile manufacturers to install onboard controls to reduce vehicle emissions resulting from the evaporation of gasoline during refueling (Blodgett 1991).

2.61 In Brazil, the Vehicle Air Pollution Control Program defines phased and increasingly rigorous emission limits and standardized emission testing procedures for all new gasoline-, alcohol-, and diesel-powered engines used in automobiles, trucks, and buses. Under this program, the required reduction of automobile exhaust emissions, including carbon monoxide, hydrocarbons and nitrogen oxides, would occur in three progressively stringent stages. As part of the Vehicle Air Pollution Control Program, state and local governments are authorized to implement inspection and maintenance programs to verify the effectiveness of the vehicle emission control devices. According to Estache (1991), however, general emissions testing has not been implemented. Except for random testing of trucks or buses in large cities (for example, São

Paulo, Rio de Janeiro, Forteleza, Curitiba), any attempts at implementing general automobile emissions testing have been unsuccessful.

2.62 **Product Standards for Stationary Sources.** Another approach to air pollution control involves the regulation of products that contain polluting substances. To control indoor air pollution, various product controls govern the use of fuels for heating. In Italy, for example, only those fuels whose viscosity and sulphur and volatile substance contents fall within certain limits may be used for domestic heating. In Belgium, the sulphur content of fuels must not exceed 1 percent; exhaust ducts for domestic heating systems must be contracted to prevent dangerous or at least harmful pollution. In addition, users of heating appliances must comply with a number of obligations. For example, they must use only the type of fuel for which the appliance has been designed and calibrated. Users also must maintain the appliance in correct working order and arrange for annual servicing. New heating appliances are inspected by a body authorized for this purpose (OECD 1989).

2.63 **Product Standards for Mobile Sources.** Products standards applicable to mobile sources of air pollution involve prohibitions on the sale of gasoline with specific ingredients. For example, the Clean Air Act requires the EPA to control fuels and fuel additives used in mobile sources. Under this authority, the agency has been phasing out the use of lead as an octane-booster because of its health hazards. The Clean Air Act Amendments of 1990 require scheduled reductions in gasoline volatility and sulphur content of diesel fuel. Moreover, new programs requiring cleaner fuel (the so-called reformulated gasoline) are to be initiated in 1995 for the nine cities with the worst ozone problems; other cities can choose to take part in the reformulated gasoline program. According to the 1990 amendments, reformulated gasoline shall contain at least 2.0 percent oxygen (by adding alcohol), no more than 25 percent aromatics, no lead, no more than 1.0 percent benzene and detergents, plus a performance specification requiring a reduction of 15 percent in the mass of emissions of ozone-forming organics and of specified toxic air pollutants. In addition, fuels with levels of alcohol-based oxygen above 2.7 percent fuels will be produced and sold during the winter months in areas exceeding the federal standard for carbon monoxide (U.S. EPA 1990).

2.64 As part of Brazil's Vehicle Air Pollution Control Program, the National Petroleum Council was requested to establish a program for reducing the sulphur content in diesel fuel and to define and oversee the elimination of lead in the ethanol-gasoline mixture (World Bank 1990). In Hong Kong, the use of heavy fuel oil has been banned altogether as of July 1, 1990. Consequently, sulphur dioxide emissions have been reduced by 80 percent. Easily enforced, the ban requires only that an inspector check a factory's fuel tank. Violation carries a threat of a six-month prison term (The Economist 1990).

2.65 **Emission Standards and Product Standards for Mobile Sources.** Both emission standards and product standards can be complementary tools for reducing pollution from mobile sources. In the United States, for example, the 1990 amendments to the Clean Air Act established a clean fuel car pilot program in California, which requires the gradual tightening of emission limits for 150,000 vehicles in model year 1996 and 300,000 vehicles by the model year 1999. These standards can be met with any combination of vehicle technology and fuels. The standards become even more stringent in 2001. Although designed for California, other states can participate voluntarily through incentives, rather than through sales or production mandates (U.S. EPA 1990).

Permits and licenses

2.66 Permits allow stationary air pollution sources to discharge pollutants into the atmosphere as long as they comply with all applicable requirements. In the United States, for example, the Clean Air Act Amendments of 1990 introduced a permit program to ensure that all pollution control obligations pertaining to one source will be contained in one document (issued for a fixed term of up to five years) and that the source will file periodic reports identifying the extent to which it has complied with those obligations. Sources subject to the new requirements include major sources that emit or have the potential to emit 100 tons per year of any regulated pollutant, plus stationary and area sources that emit or have the potential to emit lesser specified amounts of hazardous air pollutants. In nonattainment areas, the permit requirements include sources that emit as little as 10 tons per year of volatile organic compounds (VOCs), depending on the severity of the region's nonattainment status. Air pollution sources subject to the program must obtain an operating permit; states must develop and implement the program; and EPA must issue permit regulations, review each state's proposed program, and oversee the state efforts to implement any approved program. The permitted facility also must pay a fee to cover reasonable direct and indirect program costs. The fee is not less than US$25 per ton of regulated pollutants, excluding carbon monoxide (Blodgett 1991 and U.S. EPA 1990).

Land Use Controls

2.67 Land use planning and controls constitute another approach to managing pollution from stationary sources. In the United Kingdom, for example, local authorities can designate all or parts of their areas as Smoke Control Areas, in which it is an offense to emit smoke. In these areas, only authorized fuels may be burned in exempted appliances capable of burning without smoke. Local authorities also can determine heights of new chimneys or chimneys for extension to existing furnace capacities. Moreover, permission for development of all kinds must be obtained from local planning authorities.

2.68 In Germany, land use planning authorities are responsible for supervising and preventing the installation of polluting plants close to protected areas. For over 200 categories of firms, there are minimum distances of new developments of between 50 and 1,500 meters according to their effect on adjacent residential areas.

Economic instruments

Pollution charges

2.69 Various pollution charges are applied to both stationary and mobile sources of air pollution. Emissions charges are applied primarily to stationary sources. By contrast, user charges, product charges, administrative charges, and tax differentiation are applied primarily to mobile sources.

2.70 **Emission Charges for Stationary Sources**. Emissions charges do not play an important role in air pollution control. One explanation is that there is no collective treatment to which the revenues can be allocated. Any charge system also would be very complex unless restricted only to a few pollutants. Monitoring air emissions is more complex than monitoring water pollutants and would lead to high administrative costs. Another significant obstacle is the strong opposition from powerful political interests. Nonetheless, this instrument has been applied to air pollution from stationary sources in a number of countries.

2.71 Since 1985, emission fees have been used in France. Their purpose is to raise revenues to finance air pollution control equipment as well as technological research by the Air Quality Agency. Covered under the program are industrial firms that either have a power generation capacity of 50 mW or more or discharge over 2,500 tons of sulphur oxides or nitrogen oxides per year. The charge is calculated for the actual sulphur oxide emissions at a rate of ECU 19 (approximately US $21) per ton. Based on an OECD evaluation, this system has not produced an incentive effect for several reasons: the fees are too low, 90 percent of the charge fund is recovered by charge payers as subsidy for control equipment, and only 10 percent is used for new technological developments. Moreover, only a few major plants are affected. Thus, only some polluters pay for only one pollutant and payments are too low to cover full costs. The charge is expected to operate until 1990 (OECD 1989).

2.72 China's emission fee system has given the local Environmental Protection Bureaus (EPBs) revenue to allocate to environmental matters and to raise capital for pollution control investment. Eighty percent of collections are placed in banks for borrowing by enterprises making pollution control investments. Although these funds cover only about 20 to 25 percent of pollution investment needs, this investment pool represents an important source of earmarked pollution control funding (Krupnick and Sebastian 1990).

2.73 China's fee system has potential incentive effects, but the charges are not considered high enough to induce industry to reduce pollution. A standard practice is for an enterprise to pay the fee in the beginning of the year on the basis of the previous year's emissions and then ignore the system for the rest of the year. Moreover, the amount of the fine is negotiable; firms that cannot afford the fee do not pay (Krupnick and Sebastian 1990).

2.74 In Poland, emission fees are the principal instruments of air pollution control from stationary sources. Polluters are required to obtain a point source emission permit; fees are computed on the basis of kinds and quantities of air pollutants (the list in Poland contains fifty-four substances). The fee rates apply only to emissions not exceeding the permissible point source emission norm. The fees paid by the polluters to the government buy the right to use the environment as a receptor of pollutants, but the polluter is not relieved of his liability for any damages and losses that may occur. In practice, the level of fees can be higher or lower than the costs for abatement, according to the industry affected. In general, however, it appears that the fee rates provide no real economic incentive for reducing environmental pollution. In addition, the level of fees does not reflect the economic losses caused by pollution. In 1979, for example, it had been estimated that in order to compensate the losses caused by air pollution in Katowice voivodship (governate), the fee rate should have been increased by sixty-four to eighty-four times (Wilczynski 1990).

2.75 **User Charges.** User charges are fees directly applied to motorized vehicles to reduce congestion and thus air pollution. A restricted zone tax, or area road licensing, is a user charge that can be applied to the use of designated sections of roads during specified times of the day. The vehicle charge reflects the cost of congestion attributed to that type of vehicle. This cost is measured by traffic speed, which is then applied to a congestion index (Ford 1990). In Singapore, for example, the Area Licensing Scheme (ALS), introduced in 1975, incorporates a license fee to individual automobiles (cars and taxis) as part of a larger package of transport measures aimed at arresting the growth of car ownership and use and at improving public transport and the environment. Under this system, motorists are required to buy special licenses to enable them to enter a restricted zone encompassing 620 hectares (roughly corresponding to the central business district, CBD) during morning rush hours. Other features of the transport policy package are: free passage into the restricted zone for car pools, increased parking charges in the CBD, provision of park and ride services, strict enforcement at twenty-eight points of entry to the restricted zone, and progressively more onerous taxes on the import, purchase, and registration of cars (Behbehani et al. 1984).

2.76 Initially, the number of private cars entering the restricted zone fell by 71 percent; taxis entering the restricted zone fell from 11,100 to 3,900. Although car traffic rose steadily after 1977, private car traffic was still 64 percent below pre-ALS flows by 1982, despite growth in income and employment. Moreover, during the afternoon peak, private car traffic volume was about 100 percent higher than during the morning peak; taxi traffic increased to 6,100. It was estimated that at least twice as many taxi trips were made in the afternoon as in the morning peak due to the delay of business appointments until after the restricted period and to some car pool passengers returning home by taxi. The impact of these changes on air quality in the central area of Singapore was positive. Although the concentration of carbon monoxide increased after 1976, reflecting increased vehicular traffic, there was a substantial decline in total acidity, smoke levels, nitric oxide, and nitrogen dioxide. According to Behbehani et al. (1984), however, these favorable effects on air quality cannot be attributed solely to the ALS. A large part of the improvement was due to better control and monitoring of industrial pollutants, improved automobile inspection and repair requirements, and the introduction of tax incentives to replace old cars, which had fewer pollution control devices, with new cars.

2.77 As illustrated in the Singapore example, area road licensing schemes can contribute to reductions in automotive air pollution. Nonetheless, according to OECD (1990), they also can lead to rapid and excessive development in areas adjacent to the road pricing area, as evidenced to some extent in Singapore. To mitigate these effects, an area road licensing scheme would need to cover an entire urban area, as proposed in Stockholm, Sweden. This approach involves a cordon toll pricing scheme encompassing the entire urban area of Stockholm, and was expected to reduce nitrogen oxide emissions by 30 percent from the 1980 level by 1995.

2.78 An annual inspection charge and surtax is another user charge that discourages air pollution from mobile sources. An annual inspection of pollution emissions and operating noise level is required before a vehicle can be registered. Polluting vehicles would have a surtax applied to their annual vehicle registration cost based on the level of pollution discovered and the cost of pollution previously determined (Ford 1990).

2.79 **Product Charges**. Differential taxation systems involve surcharges imposed over existing taxes: a fee is levied on a polluting product and a subsidy is offered on a cleaner alternative. The main application of tax differentiation is for automobiles. Several countries have applied tax differentiation to car price taxes, encouraging clean car sales, and to leaded and leadfree gasoline. In the Netherlands, for example, revenues from the taxes on leaded fuel finance the environmental program of the Ministry of the Environment. In Sweden, a special tax is applied to cars sold without catalytic converters; a subsidy is applied to new cars equipped with them. According to Tietenberg (1990), this policy succeeded in introducing low polluting vehicles into the country at a rate much faster than normal. The effect of this program on revenues, however, was not neutral; the subsidy payments greatly exceeded the tax revenue. In Norway, taxes applied to the sulphur content of oil provides an incentive for fuel switching and lowers demand for the input. This method also raises revenues to subsidize installation of pollution control equipment. According to OECD (1989), however, the effects of lowering the price of unleaded petrol on fuel consumption are probably slight.

2.80 **Administrative Charges**. OECD (1989) cites two examples of how administrative charges can be applied to air pollution control; both relate to mobile sources. In Denmark, authorities proposed to implement a high registration fee on imported private cars that do not comply with Danish regulations. A charge on the sale of new cars in Sweden finances the costs of implementing car exhaust regulations and transfers expenditures for exhaust control from general tax payers to car buyers. In addition, the administrative efficiency of this charge is expected to be high because it is combined with other taxes on new cars.

Market creation (emissions trading)

2.81 In the United States, EPA's Emissions Trading Program allows stationary air pollution sources to undertake internal and external trades to introduce more flexibility into the manner in which the objectives of the Clean Air Act are achieved. Under this program, any source that reduces emissions more than is required by the standard can apply to the control authority for an emission reduction credit (ERC). The ERC, defined in terms of a specific amount of a particular pollutant, can be used to satisfy emission standards at other discharge points controlled by the same source or can be sold to other sources. The ERC is the currency used in emissions trading (Tietenberg 1990). The ERCs may be applied internally through netting, bubbling, or offsetting. They also may be banked for future use or sale.

2.82 Under the bubble provision, a plant with many sources of emissions is subject to an overall emissions limitation. The managers of the plant have the flexibility to select a set of controls to achieve the limit, rather than having to conform to specified treatment procedures for each source of discharge within the plant. In theory, a bubble can be used for more than one plant or firm, thus involving external trading. In practice, however, bubbles have consisted only of internal trading. Under the "netting" provision, firms can avoid stringent emissions limitations on new sources of discharges by reducing emissions from other sources of the pollutant within the plant. Thus, the net emissions would not increase significantly. A firm using netting is allowed to obtain the necessary ERCs only from its own sources, thus involving internal trading. "Offsets" involve internal or external trades in "nonattainment areas" (that is, areas that fail to meet National Ambient Air Quality Standards). Under this provision, new sources can be installed in nonattainment areas as long as they offset their new emissions with larger reductions by acquiring ERCs from existing sources. Lastly, the "banking" provision allows firms to store ERCs when they exert greater control over emissions than is required by the existing technology standards.

2.83 According to Oates (1988), the results of the Emissions Trading Program have been mixed. Although the program has substantially increased the flexibility with which sources can meet their discharge limitations, most of the trades has been internal. A real and active market in emissions rights involving different firms has not developed. This is due largely to the extensive and complicated procedures required for external trades, and their related high costs, along with uncertainties about the nature of the property rights being acquired. Nonetheless, the costs of complying with Clean Air Act requirements under the Emissions Trading Program have been substantially reduced. Most estimates place the accumulated capital savings at over US$12 billion. Although the cost savings have been substantial (see Box 4), the program has led to little or no net change in the level of emissions (Hahn 1989).

2.84 One program in the United States that has produced an active trading market is the "Inter-refinery averaging" program for lead rights. Under this program, refineries have actively traded the right to add specified quantities of lead to gasoline. During the first half of 1987, for example, around 50 percent of all lead added to gasoline was obtained through trades of lead rights with large cost savings reported. The reason for the program's success may be that the market in lead rights has relatively few restrictions and administrative requirements to inhibit trading (Oates 1988). Other reasons given for its success are that the amount of lead in gasoline is easily monitored and that the program was implemented after a consensus had been reached that lead was to be phased out of gasoline (Hahn 1989). Due to these reasons, the success of the lead trading program may not be repeated in other applications where monitoring is problematic or where environmental goals are poorly defined (Hamrin 1990).

2.85 Since 1990, two additional applications of emissions trading have been introduced. With

Box 4. Emissions Trading Program

Under EPA's Emissions Trading Program, the cost savings afforded by the netting and bubble provisions have been the most significant. Netting is estimated to have resulted in the most cost saving with a total of between US$525 million to over US$12 billion from both permitting and emissions control cost savings. By allowing new or modified sources to locate in areas that are heavily polluted, offsets provide a major economic benefit on the order of hundreds of millions of dollars. Federally approved bubbles have resulted in savings of an estimated US$300 million, while state bubbles have produced savings of an estimated US$135 million. Average savings from bubbles are higher than those from netting, reflecting the fact that bubble savings may be derived from several emissions sources in a single transaction and netting generally involves cost savings at a single source. Although the cost savings from the application of banking has not been estimated, it is small given the small number of banking transactions that have occurred (Hahn 1989).

respect to sulphur dioxide emissions from utility plants, which contribute to acid rain, the Clean Air Act Amendments of 1990 established a comprehensive permit and emission allowance system for U.S. facilities. An allowance authorizes the emission of a ton of sulphur dioxide during a specific year. Facilities receive allowances based on specific formulas contained in the law. These allowances may be traded or banked for future use or sale. If an affected unit does not have sufficient allowances to cover its emissions, it is subject to an excess emission penalty of US$2,000 per ton and required to reduce an additional ton of pollutant the next year for each ton of excess pollutant emitted (Parker 1991). In an effort to reduce the use of (CFCs), the Singapore government auctions permission to companies to use given quantities of CFCs. The high cost of successful bidding has already convinced many electronics companies to switch to substitutes (The Economist, 1990).

Subsidies

2.86 Government subsidies provide another incentive-based approach to controlling air pollution from stationary and mobile sources. They include grants for developing innovative technologies with low air pollution emissions as well as tax benefits for environmentally favorable energy systems, both industrial and residential, and low-polluting vehicles and fuels. In Sweden, for example, the fuel environment fund provides financial assistance for flue gas cleaning (primarily desulphurization) and other measures for controlling emissions from fuel combustion and waste incineration. By supporting the innovation of clean technologies, this fund serves as an incentive for the development of new environmental control techniques.

Enforcement incentives

2.87 Noncompliance fees are imposed on polluters who violate applicable air pollution regulations. In the United States, for example, noncompliance fees apply to facilities that fail to install or properly operate air pollution equipment required by the Clean Air Act. Detection of violations results in a two-part penalty. The first part of the penalty is a mandatory administrative fine computed to equal the firm's economic gains after the notification of non-compliance. The second part is a fine of up to US$25,000 per day, based on judicial discretion, for the period of violation before detection (Moore et al., 1989).

Solid Waste Management

Regulatory instruments

Standards

2.88 Standards apply to all aspects of solid waste management including waste storage, collection, transfer, resource recovery, and final disposal. They include technical and operational standards, which apply to solid waste storage, collection, transfer, and disposal as well as the management, operation, and maintenance of a solid waste facility. They also include regulations on waste reduction and recycling.

2.89 Technical and operational standards relating to solid waste collection specify types of storage bins, locations for pick-ups, and the amount or types of wastes to be collected. They also specify the frequency of collection (for example, once or twice a week in residential areas) as well as requirements for the collection vehicles themselves. Standards have included noise emission requirements for the truck chassis and refuse body compaction mechanism as well as requirements for computerized braking systems for air-braked trucks. Some jurisdictions require the collection vehicle to be covered at all times except while loading and unloading. Other jurisdictions require the vehicle to be maintained in good repair and emptied every night.

2.90 In numerous countries, measures are taken to reduce the amount of waste products generated as well as to promote reuse of materials. In the United States, for example, a few states have mandatory statewide laws requiring residents to have recyclables picked up at the curb like regular refuse. Some states require household waste to be sorted into various categories before collection. The French government regulates the use of certain materials, elements, or energy sources to facilitate the recovery of constituent materials. Accordingly, the regulations prohibit certain treatments, mixtures, or combinations of constituents or certain production methods. The government also may require manufacturers and importers to use salvaged materials to protect the environment or alleviate shortages of a given material; it must, however, consult and negotiate agreements with trade associations before imposing these requirements. In Korea, the Waste Plastics Recovery Law requires recycling of waste plastics by the appropriate corporations.

2.91 Technical and operational standards also govern the siting, design, construction, and closure of solid waste facilities. In the United States, for example, the Resource Conservation and Recovery Act (RCRA) bans open dumps and requires such facilities to be closed or upgraded to sanitary landfills by a designated date. Recent amendments to RCRA authorized the development of standards for sanitary landfills; they cover leak detection systems (for certain land disposal units), ground-water monitoring, location restrictions, and corrective actions. These amendments also authorize regulations banning certain management practices and types of facilities from being located in sensitive environments. In France, technical standards relate to site layout, landscaping, control and management of water, management of fermentation gases, control of incoming water to avoid ingress of special industrial waste, and post-operational landscaping and control.

Permits and licenses

2.92 Licenses and permits are issued to approved solid waste facilities to ensure safe waste disposal practices. In England, the Control of Pollution Act of 1974 authorizes a comprehensive licensing system for the disposal of wastes over and above existing planning controls. The act makes it an offense to deposit household, commercial, or industrial waste on land or to use waste disposal plants unless the land in question is licensed by the waste disposal authority (or explicitly exempted from licensing). Site licenses can be issued only if the required planning permission for the site is in force. They can be made subject to conditions as determined by the waste disposal authority and may cover such items as: duration of the license; supervision by the license holder; the kinds and quantities of waste, the methods of dealing with them, and the recording of information; precautions to be taken; hours when the waste may be dealt with; and the works to be completed before licensed activities begin or while they continue (Royal Commission on Environmental Pollution 1985).

Solid waste plans

2.93 In this approach, solid waste authorities are required to prepare plans for the disposal of all household, commercial, and industrial waste likely to arise in their areas and to review and modify the plans where appropriate. In the Netherlands, for example, every province has to draw up a refuse management plan that shows how, where, and by whom waste may be deposited, treated, or reused. As required in England, the plan may include information on: the kinds and quantities of waste that will arise or be brought into the area during the plan period; what waste the authority will dispose of; what waste others are expected to dispose of; the methods of disposal; the sites and equipment being provided; and the cost. Other plans may include measures for waste reduction, reuse, and recycling.

Economic instruments

Charges

2.94 Three types of charges apply to the collection and disposal of solid wastes: user charges, disposal charges, and product charges.

2.95 **User Charges.** User charges are commonly applied to the collection and treatment of municipal solid waste. They are considered normal payments for such services and rarely act as incentives. In most cases, the charge is calculated to cover total expenditures and does not reflect the marginal social costs of environmental effects. In some instances, municipalities have instituted solid waste pricing systems that provide continuous incentives for households to reduce waste generation. For example, variable garbage can rates (for example, in Seattle, Washington) as well as pay-per-bag systems (as in New Jersey, Pennsylvania, Illinois) have reduced solid waste collections substantially (See Box 5). Based on experience in the United States, the effectiveness of marginal pricing in reducing the volume of solid waste is enhanced when communities also implement recycling programs for newspaper, glass, plastic, and metals (Anderson et al. 1989). Charges are based on the volume of waste collected, however, problems associated with the high costs of monitoring, disagreements over the charge base, and billing have arisen.

2.96 **Disposal Charges.** Some countries apply charges ("tipping fees") on waste disposal. In Belgium, a charge is levied on dumping of industrial and municipal waste. The rate depends on the type of waste and the method of treatment before dumping. Incinerated and composted waste faces a lower rate than landfilled waste. In Denmark, a charge is levied on solid waste from households and industrial firms. The charge is intended to encourage waste recycling. In the United States, some states (for example, Maryland) require disposal charges for troublesome wastes such as tires and used oil. In addition, some states are charging landfill surcharges or closure taxes to fund pollution monitoring and control as well as resource recovery activities (Bartone 1990).

2.97 **Product Charges**. Most product charges on waste have applied to nonreturnable containers, lubricant oils, plastic bags, fertilizers, pesticides, feedstock, tires, and car fuels. In Finland, for example, charges on non-returnable beverage containers are relatively high. They have been introduced to support the successful deposit-refund system for bottles. Reportedly, however, the market share of nonreturnable plastic bottles tends to increase despite the high charges. The French product charge on lubricants, which accompanies regulations on collection, storage, and disposal of used oil, is too low to have incentive impacts. With few exceptions, most product charges that have a stated regulatory function lack actual incentive impact. In practice, product charges finance parts of the policy measure developed to deal with the negative environmental effects of the products on which the charges are imposed. Their lack of incentive impact implies that these charges generally do not contribute to a transition from curative to preventive policies. The consumption of products will continue unless charge levels are raised considerably or direct regulations become more stringent (OECD 1989).

Subsidies

2.98 Subsidies are provided to waste authorities and the private sector for various aspects of solid waste management. In the United States, for example, federal grants have been made available to states for developing and implementing their own comprehensive plans for solid waste management, resource conservation, and resource recovery. They also are available for training, research and demonstration projects for energy and materials recovery, as well as for planning for solid waste disposal. In Denmark, an amendment to the Act on the Re-use and the Reduction of Waste (1974) authorizes subsidies for the development or installation of technology that produces less waste or reuses waste. Similarly, Japan's Waste Disposal and Treatment Law stipulates that the state should subsidize various categories of local expenditures in accordance with policy provisions, necessary expenditures for maintenance and repair of refuse disposal facilities, and expenditures for the disposal of wastes caused by natural hazards or other factors. In Finland, the Ministry of Environment provides a subsidy for reducing interest on loans financing waste recycling investments.

2.99 Another approach to subsidization is to afford preferential tax treatment to bond issues of state and local governments for the construction of solid waste treatment plants or development of plants capable of burning municipal solid waste for the generation of heat or power. In the United States, earnings on such municipal bonds are exempt from payment of federal and state income tax. Similarly, governments can afford preferential tax treatment to private industry for resource recovery. In Poland, for example, a 20 percent income tax cut is granted if a byproduct production is started that will use wastes, scrap, or low quality materials. Turnover tax relief is given to those enterprises that sell products made from wastes instead of high quality raw materials (Wilczynski 1990). Other incentives include tax credits to industries that use recycled materials as part of their feedstock; stabilization of markets for recyclables through price supports for the establishment of materials banks; guaranteed income (tipping fees or quantity guarantees) to recycling plants; and investment grants, accelerated depreciation, and soft loans that encourage private enterprises to implement resource recovery activities (Bartone 1990).

Box 5. Incentives For Reducing Municipal Solid Waste

In the United States, a few communities have instituted solid waste pricing systems that provide ongoing incentives for households to reduce waste generation. In Seattle, Washington, for example, the "variable garbage rate structure" gives residents, who must pay for the amount of garbage cans they fill, an economic incentive to reduce the amount of garbage cans they fill. When they reduce the number of garbage cans, they are rewarded with a lower solid waste collection bill. The rate structure includes several components: multifamily rates; basic rate structure (one 30-gallon can collected each week costs US$13.75 per month; each addition 30-gallon can costs US$9); compacted waste rate; low-income, elderly, and handicapped customers rate; backyard versus curbside pickup rates (backyard pickup rates are 40 percent more than curbside to encourage lower collection costs); extra waste rate (a prepaid trash tag for extra waste is available for US$5); yard waste rate; minican rate (a 19 gallon minican service is available for US$10.70 per month to those who produce little waste and/or recycle and compost most of their waste); and bulky item pickup. In January 1989, Seattle's program was fully implemented; monthly waste collections in that year fell about 30 percent in comparison to 1988 levels.

Solid waste collection systems in New Jersey and Pennsylvania further illustrate the effectiveness of pay-per-bag systems. In High Bridge, New Jersey, each 30 gallon can or bag placed at the curb for weekly pickup must have a town sticker (In 1988, households purchased 52 stickers for US$140 with additional stickers available in strips of ten for US$12.50). Since the introduction of this system in 1988, the residential trash volume fell by 25 percent; the amount of trash collected dropped from 8.5 tons per day to 6.3 tons per day. In Perkasie, Pennsylvania, the introduction of per-bag fees in 1988 led to reductions in the volume of solid waste by more than half; the cost of solid waste disposal fell by 30 to 40 percent. Most of the reduction can be attributed to the separation and recycling of glass, paper, and aluminum cans. As another result of this program, however, some local businesses have had to chain and padlock their dumpsters. In addition, some local residents have illegally burned trash in their fireplaces (Anderson et al. 1989).

Deposit-refund systems

2.100 Deposit-refund systems—which impose special taxes, charges, or fees on consumers—are designed to encourage recycling and prevent pollution. They are applied most often to beverage bottles. In the United States, ten states have implemented mandatory deposits on soft drinks and beer containers. According to Moore et al. (1989), the states with these deposit-refund systems (also known as bottle bills) report that 80 to 95 percent of deposit containers are returned voluntarily for recycling. The economic incentive (five or ten cent refund per container) is sufficient to produce the desired behavior. In Denmark, the Minister for the Environment issued a statutory order declaring that soft drinks and beers may be sold only in reusable bottles for which the consumer must pay a deposit. In Finland, deposit-refund systems for beverage containers have been very successful; the percentage of containers returned is about 90 percent. In Sweden, doubling the deposit charge for aluminum beer cans increased the percentage of cans returned from 70 percent to more than 80 percent (OECD 1989).

2.101 In addition to deposit-refund systems applied to beverage containers, deposit-refund systems have proven effective in the recycling of automobiles and automobile batteries. In Norway, for example, a deposit-refund on hulks of passenger cars and vans was introduced in 1978. Under this system, new car buyers pay a deposit; when the car is no longer wanted and returned to an official recovery site, a larger amount is refunded. The objective of this program is to reduce the number of abandoned vehicles outdoors and to promote the reuse of materials. The percentage of cars returned is between 90 and 99 percent. The revenues are used for refunds and financial assistance for collection, transportation, and scrapping facilities.

2.102 In the United States, Rhode Island's General Laws provide for a mandatory deposit system for automobile batteries. Every battery sold or offered for sale must have a US$5 deposit paid at the time of sale. Payment of the deposit is waived if a used automotive battery is returned to the dealer at the time of purchase; the deposit is refunded if a used battery is returned within seven days of purchase. The deposits are held by dealers in a special account. In July, dealers are required to return 80 percent of the deposit funds they hold to the state. This system has been considered a success (Anderson et al. 1989).

2.103 With respect to pesticide containers, the state of Maine enacted a law requiring a deposit system for limited and restricted use pesticide containers. This law requires triple rinsing or the equivalent in accord with the Maine Board of Pesticides Control and provides an incentive through the deposit system for the return of the rinsed containers. All limited and restricted use pesticide containers must be affixed with a sticker obtained from the board. Deposit fees of US$5 for containers of less than 30 gallon capacity and US$10 for containers of 30 gallon capacity and larger have been established. This rule applies to all limited and restricted use pesticide containers that are sold, bartered, or traded within the state as well as those purchased out-of-state and used within Maine. Pesticide dealers collect the deposit fee at the time of purchase; the board collects deposits on out-of-state containers. Deposits are returned to the owner when the triple rinsed container is returned. Since the passage of this legislation, approximately 13,000 containers have been returned (Anderson et al. 1989).

2.104 On average, deposit-refund systems function well. Although a ban on certain products is more effective, it is less acceptable to the parties concerned. In practice, deposit-refund systems appear to be more effective than voluntary return systems, perhaps because they reward good behavior. From an administrative perspective, these systems are efficient. They require no monitoring or other involvement by authorities, except for the system involving car hulks. Under this system, the deposit is paid to dealers who transfer the money to registration authorities who then refund the money to the car owner when the scrapping certificate is produced. In terms of the efficiency of deposit-refund systems,there have been no assessments comparing the costs of deposit-refund systems to the costs of alternatives with equal environmental results. Nonetheless, it can be assumed that, in some cases, the costs of household waste collection, transport, and incineration or dumping exceed the costs of the deposit-refund system (OECD 1989).

Hazardous Waste Management

Regulatory instruments

Standards

2.105 To manage hazardous wastes, a number of countries have implemented a "cradle to grave" approach. This requires a comprehensive set of standards, regulations, and requirements applied to hazardous waste management from the point of generation to the final disposal site. The various types of standards—technical, operational, product, clean-up, and other requirements—apply to hazardous waste generators and transporters as well as the facilities that store, treat, and dispose of the wastes.

2.106 **Technical and Operational Standards**. Standards and operational requirements covering hazardous waste generators and transporters include steps to register with a regulatory agency, analyze waste, and keep records so that wastes can be tracked from the point of generation to the point of final disposal. For example, generators must determine whether substances are hazardous, based on certain qualities (for example, ignitability, corrosivity, reactivity, toxicity). They also may be responsible for obtaining a firm identification number and permit for the waste generating facility, using appropriate shipping containers, and preparing a manifest (shipping form) for tracking the waste once it leaves the site of generation. In some countries, waste reduction, recycling, and treatment regulations require hazardous waste generators to reduce the volume of hazardous waste they produce. Methods of waste reduction include source separation, recycling, substitution of raw materials, manufacturing process changes, and substitution of products. Requirements for hazardous waste transporters cover labeling, packaging, placarding, and actual transport of the waste. They also cover tracking, reporting of any discharges or spills that occur in transit, and clean-up.

2.107 With regard to hazardous waste storage, treatment, and disposal facilities, technical and operational standards specify design, construction, and maintenance techniques as well as pollution control technologies. They also establish requirements for emergencies, manifest handling, recordkeeping, waste treatment and storage, containers and tanks that store wastes, monitoring, closure of a facility, and financial liability during operation and after a facility is closed. These standards apply to landfills, surface impoundments, and land treatment units. They address the burning and blending of wastes used as fuels and treatment of banned wastes. They also specify a level or method of treatment that substantially reduces the toxicity or mobility of the hazardous constituents so as to minimize long-term threats to human health and the environment. In addition, standards establish limits on air emissions from hazardous waste incinerators as well as other treatment, storage, and disposal facilities. Standards also may include outright bans on land disposal. For example, bulk or noncontainerized hazardous liquid wastes may be prohibited from disposal in any landfill, and severe restrictions may be placed on the disposal of containerized hazardous liquids as well as on the disposal of nonhazardous liquids in hazardous waste landfills. In several countries, land disposal of certain highly toxic wastes is banned or phased out over a certain period of time. In the United States, for example, the use of waste or used oil containing dioxin or other listed wastes as dust-control agents on roads is banned.

2.108 **Product Standards.** A number of countries control the disposal of hazardous substances through product standards and controls. For example, technical documents attached to the declaration of a chemical being offered for sale must include information concerning the possibilities of disposal or recovery at various stages of its use. The manufacture, sale, import, export, or disposal of a toxic substance or pesticide may be banned, controlled, or restricted to prevent serious pollution or negative health effects. In addition, authorities may establish safety standards for pesticide products and remove from the market, restrict the use of, or refuse registration of products that do not meet those standards. They also may control the methods by which chemicals are disposed of or take immediate emergency action against a chemical substance or mixture that presents any unreasonable risk of serious widespread injury to health or the environment.

2.109 **Cleanup Standards.** Cleanup standards specify the level that any releases of hazardous wastes into the environment must attain. Generally, this level coincides with that established under existing ambient environmental quality standards. In the United States, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund) establishes a system for identifying and cleaning up chemical and hazardous substance releases into the environment, whether intentional, accidental, one-time (from a spill), or continuing (from an old waste disposal site).

Permits and licenses

2.110 The treatment, storage, and disposal facilities that receive hazardous waste may be subject to a permitting system to ensure their safe operation. The permit system ensures that facilities meet the established standards, many of which are designed to protect ground water. In the United States, for example, RCRA requires anyone involved in the generation, storage, transportation, treatment, or disposal of such waste to be licensed by the EPA or an authorized state. Licensed treatment, storage, and disposal facilities must comply with all standards and technical requirements under the act. Permit applications must specify: contingency plans for emergencies; waste analysis procedures; inspection schedules; operating procedures to prevent contamination at the site; facility design and layout; engineering; ground-water protection measures; closure and post-closure plans; and containers, tanks, and incinerators used at the site. The act also authorizes EPA inspectors to enter sites for compliance inspections, sampling of wastes, and examining and copying records. In Finland, a facility that wishes to receive hazardous waste generated elsewhere for pretreatment or disposal needs a permit granted by the provincial government. The generator of the hazardous waste or other waste in a quantity or quality not comparable to wastes usually generated domestically, must draft a waste management plan to be reviewed and approved by the provincial authority.

Land use controls

2.111 Under this approach, the consent of planning authorities is necessary before land can be used for hazardous waste disposal purposes. Zoning has been used to control the location of waste disposal sites and potentially dangerous industrial installations.

Economic instruments

Pollution charges

2.112 **Disposal Charges.** Disposal charges (also known as waste-end taxes) are direct taxes or fees on hazardous wastes either at the point of generation or disposal. A principal objective of these taxes is to provide industry with an economic incentive to employ waste management practices such as waste reduction, recycling, and incineration, which are more environmentally desirable than land disposal, with its high potential for contaminating ground water.

2.113 In practice, charges play a small role in the field of waste management. In the United States, for example, a federal hazardous waste charge is levied on waste site operators. The charge feeds the Post-Closure Liability Trust Fund aimed at financing restoration of permitted chemical waste sites after closure. Nonetheless, the charge is low and unlikely to influence behavior significantly. In the Netherlands, firms that treat, store, or dump chemical waste collected from primary sources are charged according to waste volume. The economic significance of this charge is low; funds used for disposal, reduction, and prevention have not met the targeted amounts. The most important problems with this charge are the high administrative costs and the unintended incentive for waste export and unregistered disposal. The charge has been replaced by the new fuel charge that came into effect in 1988.

2.114 **Product Charges**. In France, a product charge on lubricants is levied on lubricant manufacturers and importers. The charge accompanies regulations on collection, storage, and disposal of used oil. The revenues are used by the National Waste Recovery and Disposal Agency to provide assistance in developing the infrastructure necessary for proper collection, storage, and disposal of used oil. The charge, however, has been too low to have incentive impacts.

Subsidies

2.115 In this approach, federal funds are authorized to respond to spills and other actual or threatened releases of hazardous substances and leaking hazardous waste dumps. To finance these funds, federal programs may use special taxes. In the United States, for example, sources of funds to finance the Superfund program include a petroleum tax, chemical feedstocks tax, corporate environmental tax, and a tax on imported chemical derivatives. Additional sources of funds are congressional appropriations, interest (rolled back into the fund, not the general treasury), and the federal government's recovery of cleanup costs from private responsible parties. Funds also are made available for cleaning up leaking underground storage tanks through a tax on motor fuels.

Enforcement incentives

2.116 Assignment of legal liability for pollution damages has been used in the area of hazardous waste management. In the United States, CERCLA requires all "potentially responsible parties" (that is, waste site operators, waste generators, and anyone involved in the transportation, treatment, or disposal of hazardous wastes) to be held liable for the damage due to releases of hazardous wastes into the environment from inactive waste sites. The fee levied will be equal to the damage that has occurred; the level of the fee can be determined by settlements or by court judgment. According to the law, EPA can hold one party whose wastes were disposed of at a particular site responsible for all the costs associated with cleaning up the site, regardless of the share of total waste disposed of at the site by the identified party or the level of care given by the firm to the disposal activity. EPA's Superfund program also establishes a liability strategy for dealing with damages to the environment before and after a site is discovered and cleaned up.

Under these rules, local, state, or federal governments may seek dollar compensation from responsible parties for natural resources injured or destroyed by spills and hazardous waste releases. Under the liability provisions of Superfund, EPA or the states need only identify the most significant or obvious contributors and then build a legal case as if those contributors were responsible for the entire problem. The responsible party need not have owned or used the site to be held responsible for its cleanup. Institutions that lend money to firms that may have operated or used a hazardous waste site also can be held responsible (Dower 1990). Assignment of legal liability for pollution damages is considered to be effective. Since actual cases have achieved large damage awards, this instrument can be expected to induce appropriate waste management practices.

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