AID TO THE GATEKEEPERS: DESIGN PRINCIPLES FOR TECHNICAL ASSISTANCE UNDER COASTAL NONPOINT SOURCE WATERSHED MANAGEMENT

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ABSTRACT

This thesis explores the political dimensions of technical assistance programs, and the information that these programs generate in the context of watershed-based nonpoint source (NPS) pollution management. The backdrop to this study is provided in §6217 of the federal Coastal Zone Amendment and Reauthorization Act (CZARA), which mandates NPS watershed management, as well as the provision of technical assistance to municipal governments in implementing the program at the local level. The geographic focus of the thesis is on implementing §6217 within the Commonwealth of Massachusetts.

A theoretical framework is offered, based on recent literature in successful management of common property resources. In this framework, the role of common interests shared by all members of the watershed community, which is likely to include multiple political jurisdictions, is emphasized. A case study of successful watershed-based management at Buttermilk Bay in southeastern Massachusetts is then presented, highlighting the role of technical assistance, information, interests, and local officials in implementing changes in management practices to protect a coastal embayment from excess nitrogen loading.

The technical tasks, as well as the political factors involved in watershed management are then discussed more generally following the case study. These discussions are supported by analysis of data concerning local technical capacity and dependence on water resources within the Commonwealth's §6217 program area.

The thesis concludes by deriving a set of "design principles" which should be incorporated by policy-makers in formulating a technical assistance program in support of NPS watershed management, regardless of the specific form which this program will take. These principles are based on the recognition that many aspects of NPS management is highly politicized. Information, and the means to generate it, therefore becomes a key positive force if technical assistance is designed around these political realities.

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I dedicate this thesis to my grandmother Helen, and to her daughter, Jillerie.

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CHAPTER 1

INTRODUCTION

In 1990 the U.S. Congress passed the Coastal Zone Amendments and Reauthorization Act, also known as CZARA. CZARA §6217 mandated the most aggressive national effort to date to combat nonpoint source pollution (NPS), going much further in requiring implementation by the states than in previous attempts under the Clean Water Act.

The U.S. Congress charged two federal environmental agencies with administering CZARA. The National Oceanographic and Atmospheric Administration (NOAA) within the Department of Commerce played the lead role in developing program guidance for state submittals, pointing out minimum requirements to be met by each coastal state to have the program accepted (U.S. NOAA 1993). The program guidance was reviewed by the Environmental Protection Agency (EPA) prior to being published jointly by NOAA and EPA. The coastal NPS program developed by each coastal state must be reviewed and accepted by both the Secretary of Commerce and the EPA Administrator.

Within the §6217 legislation, Congress required the EPA Administrator to develop a set of management measures, representing "Best Management Practices" (BMPs) for controlling NPS pollution. EPA was charged with promulgating these specific management measures, which were released in January 1993 (U.S. EPA 1993). These BMPs represent the implementation component of the legislation as interpreted by EPA.

In interpreting the intent of Congress under the legislation, EPA has mandated a watershed-based approach to NPS management. This action by EPA represents a new era in federally mandated water quality management. The focus of my thesis, the §6217 Watershed Management Measure, is a major foundation of the CZARA program envisioned by EPA. The inclusion of this management measure represents a departure from the federal government's past reluctance to get involved in local land-use regulation, which is the foundation of watershed-based NPS management.

The recent Senate testimony of a U.S. Government Accounting Office official underscores the approach historically taken by the federal authorities in attacking NPS pollution (U.S. GAO 1992: 2):

> "The way individuals use land can substantially affect the amount of nonpoint source pollution runoff...As a result of political sensitivity over land-use issues, coupled with the decentralized nature of the problem, the Congress has historically been reluctant to allow the federal government to deal directly with nonpoint source pollution."

Within the text of the legislation, Congress required coastal states to develop adequate "enforceable policies and mechanisms" in support of each management measure. The 29 federally recognized Coastal Zone Management (CZM) programs face possible withholding of federal CZM program funding if they fail to develop such policies and mechanisms according to congressionally set deadlines.[1]

The program guidance developed by NOAA, and the watershed management measure promulgated by EPA indicate a new willingness on the part of the federal government to promote land-use regulation at the local level through the authority of the state. It charges coastal states with developing a centralized approach to tackling the sensitive issue of local land-use regulation. The full text of EPA's watershed management measure are presented in Appendix A.

PURPOSE AND SCOPE: A FOCUS ON TECHNICAL ASSISTANCE

> "NOAA and EPA expect states to identify those portions of the coastal nonpoint programs that are to be implemented by local governments and to include a program to provide technical assistance to local governments and the public in their coastal nonpoint source program." (U.S. NOAA 1993)

This passage from the NOAA program guidance points to the focus of this study. The

[1] The CZARA legislation does not impact non-CZM states. This does not, however, preclude Congress or EPA from requiring similar measures in the future, such as when the Clean Water Act, which currently contains less stringent NPS requirements.

purpose of my thesis is to show that a technical assistance program in support of watershed-based management of NPS pollution must be designed around a set of basic principles. These must recognize the *political* nature of technical information in the context of managing common property resources (CPRs) such as watersheds, especially the dynamics of local politics.

Successful watershed-based NPS management, hinged upon coordinating land-use regulation among distinct municipal jurisdictions, is reliant upon local political processes and cooperative action. Technical assistance is a means of facilitating political decision-making in favor of effective NPS management. It is a critical component in fostering political changes, specifically in coordinating changes in land-use management practices among communities. Technical assistance does this by subsidizing information flows. It can generate vital information on common interests and direct it to those sharing the watershed. Similarly, it identifies common threats to those interests; as well as ways in which cooperation can mitigate or prevent harm to those connected to watersheds by the environmental benefits they provide.

Thus, targeting technical assistance is a dual process. First, a technical assistance program must identify and fill gaps in technical capacity in affected communities. Second, it must fill these gaps while providing implementation strategies appropriate to the political context in which it is working to promote more effective management.

ORGANIZATION OF THE STUDY

Following the introduction, Chapter 2 offers a general theoretical framework developed to unite the two elements of watershed-based decision-making: technical information, and the political context in which that information is generated and used in decision-making. This framework is drawn from recent literature dealing with effective management of common property resources. A conceptual model which merges the technical and political components of the watershed management process is offered to guide the remainder of the study.

Following the model presented in Chapter 2, important concepts in the thesis are illustrated through a case study of watershed-based NPS management at Buttermilk Bay, a small coastal embayment in southeastern Massachusetts. This case study is presented in Chapter 3, and highlights the role of technical assistance and information in identifying common interests, common threats, and politically appropriate solutions to NPS pollution within a coastal watershed.

Chapters 4 and 5 build upon the conceptual model in the second chapter, and the Buttermilk Bay case study for a more general discussion of the technical and political components of NPS watershed management. Chapter 4 is devoted to the technical considerations which will have to be incorporated into technical assistance design as CZARA is implemented in Massachusetts, the geographic focus for this study.

Similarly, Chapter 5 summarizes the myriad political factors which should be considered in watershed management in Massachusetts. The discussions in Chapters 4 and 5 are supported by empirical data concerning the technical capacity and political context of local land-use regulation within the state's CZARA program area. These results are from survey data gathered in Massachusetts specifically for this study.

My thesis concludes in Chapter 6 with a summary of design principles which policy-makers in Massachusetts and elsewhere can adopt in developing effective technical assistance programs in support of the CZARA watershed management measure.

NONPOINT SOURCE POLLUTION: THE PROBLEM AND THE LOGIC BEHIND THE WATERSHED SOLUTION

To understand the importance of watershed-based management of NPS pollution, some fundamental questions must first be addressed:

- What is the extent of the nonpoint source pollution problem (nationally and in Massachusetts), and what do we know about the nature of the problem which will impede efforts at managing it?

- What is the watershed approach to managing NPS pollution, and why is the watershed the most appropriate management unit?

THE PROBLEM OF NPS POLLUTION

Gross pollution of our rivers, streams, lakes, and estuaries in the post World War II era was a major catalyst for the environmental movement during the 1960's and 1970's. In reporting about NPS pollution in 1991, EPA Administrator William K. Reilly was quick to point out the progress made in regulating point sources through the National Pollutant Discharge Elimination Permit System (NPDES) and massive federal construction grants for municipal sewage treatment plants. Reilly was equally quick to point out the fundamental problem behind managing NPS: "Nonpoint source pollution fails to inflame or incite action" (Reilly 1991: 21).

Yet NPS pollution is becoming recognized as America's number one water quality problem, so much so that the federal government has been criticized for taking the path of least resistance, errantly focusing almost exclusively on point source regulation (U.S. GAO 1992).

It has been estimated that NPS pollution is responsible for 99% of sediment,[2] 88% of nitrates, and 84% of phosphates entering the nation's lakes and streams. (Clark, et. al 1985: 8). As early as 1976, it was estimated that nonpoint sources were responsible for over 10 million tons of average daily sediment load to surface waters of the U.S.; almost 58,000 tons/day of excess BOD; and 28,000 tons/day of excess nutrient loading, including nitrogen and phosphorous (Barton 1978: 15).

In Massachusetts, NPS pollution affects almost 70% of all rivers and coastal waters. Nearly half of this pollution finds its way into coastal waters via runoff from urban areas (MCZM 1992: 3). Estimates for Cape Cod indicated a 25% increase in nitrate loading in 1988 over 1980 levels (Herr and Associates 1989). This increase of almost 500,000 lbs/yr was due primarily to onsite septic systems associated with increased residential development. The islands of Martha's Vineyard and Nantucket showed a comparable increase of 38% (Herr and Associates 1989).

[2] Excess sediment is a potentially serious pollution problem. In can severely impair water and habitat quality by decreasing water clarity, smothering aquatic habitats, and transporting chemical contaminants, such as pesticides, adsorbed to particles.

The economic impact of NPS pollution is substantial. A study conducted in 1985 estimated that *erosion alone* costs the U.S. economy between $3.2 and 13.0 billion annually (Clark, et. al 1985: 8). Locally, the effects of NPS pollution are severe. In early 1989 approximately one-half of the commercially exploitable shellfish beds in southeastern Massachusetts were closed due to contamination by pathogens; largely a result of NPS pollution (MEOEA 1991: 3). A 1989 study of the shellfish industry in the North Shore region of the Commonwealth indicated 24,000 acres of shellfish beds were closed due to high bacterial counts resulting from surface runoff (Brady and Buchsbaum 1989). On Cape Cod, shellfishery closures have doubled since 1982 (MEOEA 1991: 3). Groundwater supplies in both coastal and inland communities are particularly threatened by the diffuse nature of NPS pollution and subsurface transport of contaminants. Groundwater supplies are crucial within the CZARA program area in Massachusetts. Approximately 55% of the §6217 communities in the Commonwealth have at least half of their households fully dependent on groundwater supplies (MCZM Survey 1993).

Two key aspects of the NPS pollution problem distinguish it from other (point) sources of water pollution, making it a much more difficult problem to solve. The first is that, unlike wastewater generated from controlled application in internal industrial or municipal sewage disposal processes, NPS pollution is generated through the action of an external, uncontrolled, and unpredictable force: the weather. Stormwater which does not infiltrate the ground washes over land surfaces. In the process, it picks up a wide-range of contaminants from roads, parking lots, rooftops, construction sites, open farmlands, and lawns. Hydrocarbons left behind by car exhaust or leaking engines; chemical pesticides, fertilizers, and animal wastes from lawns; excess sediment and salts from paved and bare surfaces; and human wastes generated in septic tanks are conveyed to surface and groundwater.

The second key characteristic of NPS pollution derives from the first, namely that it is diffuse in nature. Exact sources, along with the quantity and quality of contaminant loads from those sources are extremely difficult to identify and to control. Unlike point sources, the regulation of NPS does not lend itself to "end of pipe" abatement measures.

PRINCIPLES OF NPS MANAGEMENT AND THE LOGIC OF THE WATERSHED PROTECTION APPROACH

Managing NPS pollution is difficult, but the problem is far from intractable. In its CZARA "Management Measures Guidance," U.S. EPA classifies NPS pollution prevention into two categories (U.S. EPA 1993). "Delivery reduction" aims at preventing pollution already picked up by precipitation from entering surface water. Typically structural in nature, an appropriately designed catchment traps contaminated runoff, removing pollutants through settling or filtration prior to discharge to surface or groundwater.

In contrast, source controls *prevent* the introduction of contaminants to land surfaces before they come in contact with precipitation. Some source control measures aim to limit the interaction of precipitation and pollutants already introduced. Limiting the actual amount of runoff generated by cutting down on impervious surface areas is another source control strategy, as is directing runoff away from potentially contaminated surfaces through proper site planning. Protection of sensitive areas is another important source control strategy. This calls for protection of those areas susceptible to erosion and those with significant potential for guarding water quality against NPS effects. Such areas include wetlands and riparian zones with well developed natural capacities to process or absorb NPS pollutants.

In considering implementation of the NPS management programs, it is important to contrast these two prevention approaches. Unlike delivery reduction efforts, the key feature of source control efforts is that they are by and large non-structural solutions. The emphasis is on preservation of sensitive lands, on proper siting of development, and on guiding what land owners do to the land. Residential development can be guided away from sensitive areas, or planned with proper densities in mind to avoid excess contaminant loading. Levels of fertilizers and pesticides applied can be managed. Agricultural lands can be worked to reduce erosion and offsite transport of farm chemicals. Logging practices can be directed to minimize erosion and maintain critical water storage capacity to prevent flooding and subsequent sediment transport.

Thus, NPS management practices often deal directly with land-use. As a brief example, the categories of NPS management practices listed by U.S. EPA in its CZARA guidance documents include (U.S. EPA 1993):

- Infrastructure planning;
- Local ordinances (including zoning);
- Limits on impervious surfaces, encouragement of open space, and promotion of cluster development;
- Setback standards (including buffer zones);
- Slope restrictions;
- Site plan restrictions and approvals;
- Environmental impact assessment statements.

EPA envisions the application of such management measures on a watershed basis. A watershed, or drainage basin, channels ground and surface water, along with contaminants to a common outlet. This outlet, or design point, can be placed to isolate land areas of various sizes draining in its direction. A watershed comprises a number of subwatersheds (also known as subbasins).

All watersheds are defined on the basis of hydrologic science, the basic idea being that water flows downhill. Surface water flows within the watershed begin at the highest topographic point relative to the design point. Groundwater flows are a bit trickier to characterize. They are influenced by subsurface obstructions and pressure gradients. Groundwater contours do not necessarily coincide with surface topography.

Eugene Odum, an ecologist who greatly influenced current thinking on watersheds referred to drainage basins as "the minimum ecosystem unit...[including] terrestrial and aquatic systems together with humans and their artifacts all functioning as a system" (Odum 1971: 20). Waterways, wetlands, forests, lakes, various animal species, and human settlements all cohabitate these hydrologic units. Each of these components interact at some level within the basin. Problems arise when humans overload the watershed with wastes generated by their activity; whether it is primarily agricultural or commercial (e.g., forestry) or simply a byproduct of inhabiting the land, such as inappropriate siting of onsite septic systems.

OBSTACLES TO WATERSHED-BASED NPS MANAGEMENT

Obstacles to effective watershed-based NPS management can be seen at two levels. First, regulating land-use in this country is usually contentious. Deeply rooted in liberal western traditions of limited government, owners of private property frequently stand opposed to intervention by public authority, protective of their investments and the profit generating potential of their real estate.

Basing NPS management on watersheds, however, poses political difficulties on a second level. Not only do individual land-owners resist regulation, but political jurisdictions operate independently of one another, superimposed on the natural system. In states like Massachusetts the lack of coordination has in the past been severe, driven by an "ancient and strong history of home rule; the state's 351 cities and towns are typically more concerned about what goes on inside their borders than outside" (MA Audubon Society 1990: 74).

Given that NPS pollution emanates from potentially large tracts of land, and from many types of sources, improvements made in one region are easily muted by increased pollutant loads elsewhere. Watershed protection is driven by this problem, and represents a more effective unit for both analyzing and managing the NPS problem.[3]

Opposing private property owners and municipal home rule together create the potential for two-tiered resistance in the Commonwealth. First, policy-makers are faced with opposition from individual land-owners who resist regulation of their land, who may be able to influence the local political process in their favor. Second, the citizenry at large, and/or local government may resist out-of-town influences.

The major thrust of this thesis is that technical assistance can work towards

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[3] For further elaboration on the case for watershed based pollution control, see Massachusetts Audubon Society, *Watershed Decisions...* (1990).

overcoming the political obstacles presented by such private interests, and by the home rule mentality. While this topic is further developed below, for now we should recognize that a technical assistance program supporting implementation of watershed-based NPS management, at a minimum, must (1) highlight a compelling public interest in seeking cooperative solutions to the regional NPS problem, and (2) generate information sufficient to balance potential (private) interests opposing needed change against the wider public interest.

SOME PRINCIPLES AND DEFINITIONS GUIDING THE STUDY

In structuring this thesis, the following guiding principles and/or definitions are adopted:

(1) Voluntary cooperation of cities and towns on a regional basis is key to the success of the CZARA. There is currently no state legislation mandating regional planning, with the exception of the Cape Cod Commission. While there is currently a movement towards requiring regional planning in the state (discussed in Chapter 5), I assume an absence of such legislation. If legislation was in place, the lack of enforcement capability deriving from budget shortfalls could stand in the way of implementation unless it was supported voluntarily.

(2) I occasionally refer to "rule making" and "rules of use" in the study. By this I mean the process of adopting, through legislation at the local level, watershed management practices similar to those listed above (U.S. EPA 1993).

(3) Perhaps most importantly, I have purposefully avoided the issue of funding of the technical assistance program. While I do not mean to simply assume the problem away, the funding issue is extremely complex and requires a separate comprehensive study. Instead, I simply state from the outset that the CZARA Watershed Management Measure cannot be implemented in any form unless some effective funding mechanism is found.

CHAPTER 2

WATERSHED MANAGEMENT, INFORMATION, AND THE THEORY OF COMMON PROPERTY RESOURCES: AN ANALYTICAL FRAMEWORK

A fundamental issue in making and implementing effective environmental policy is the struggle between two systems: (1) the requirements of resource systems which are set in natural laws, and (2) those systems governing how we use these resources; nested within political, economic, and cultural realities of policies imposed by humans. Resource protection ultimately depends upon uniting these "separate worlds."

In this chapter I set out an analytical framework built around this notion of union, while taking into account the special properties of watershed-based NPS management. I focus on the role of technical information and systems for delivering technical assistance in overcoming the political obstacles to implementing the §6217 watershed management measure. The framework presented here is meant as a diagnostic and prescriptive tool to guide the remainder of this thesis, and to aid state policy-makers in designing an effective technical assistance program for watershed-based NPS management.

The theoretical basis for this framework is found in the research associated with common property resources (CPRs). The latest research suggests that sustainable CPR management can be achieved and maintained through decision-making based on common interests of interdependent users. This outcome relies on how the political tensions are played out between public interests and private uses, and the conflict between long-term maintenance and short-term gain. Information plays a key role in this process by helping to define the divergence between these interests, and by helping to spawn cooperative action in support of the public interests derived from the resource system.

The challenge is to link conceptually many parts of the same puzzle; how to modify politically driven resource management practices to ensure sustainability. To do this, I have organized the chapter as follows:

- o A review of the commons problem, and the conceptual basis for viewing watershed-based NPS management within this framework;

- o A discussion highlighting the features of sustainable management of common property resources which are suggested in the latest research on CPRs;

- o A view of the role of information in political decision-making, with an emphasis on environmental issues;

- o And finally, a discussion of the management problem, including the development of a conceptual model of the NPS watershed management process, and an overview of how information flows within this framework affect the political process of modifying management practices.

WATERSHEDS AS A COMMON PROPERTY RESOURCE

Although Garett Hardin was not its originator with the 1968 publication of "Tragedy of the Commons," he popularized the conceptual foundation of our current thinking about most environmental issues.[4]

The cornerstone of Hardin's piece is the metaphor highlighting "the divergence between individual and collective rationality" (Feeny et al. 1990: 2). The classic scenario concerns the grazing of animals on commonly held property. Each individual makes a rational decision to add extra animals. In economic terms this appears as rational since this only adds to profits. A lack of clearly assigned property rights over the pasture means that he or she does not bear the marginal environmental costs resulting from grazing one additional animal. "Freedom in a commons brings ruin to all" (Hardin, 1968: 20) as each herdsman makes the same choice without regard for the cumulative impacts on the pasture. The resource is degraded beyond recognition.

Scholars have devoted entire careers to critiques and refinement of the "commons" concept since Hardin published the "Tragedy" twenty-five years ago. An

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[4] In his original "Tragedy" essay, Hardin himself mentions the work of William Foster Lloyd, an amateur mathematician who, as early as 1833, wrote and lectured on the commons problem as it relates to population (Feeny et al., 1990: 2; Hardin 1968: 19).

important refinement has been the clear delineation between "public goods" and "common property resources."

A coastal lighthouse is the classic example of the public good dilemma. An individual ship owner refuses to pay for the lighthouse, wary that potential competitors may reap its benefits as well, yet pay nothing. It is a problem of *exclusion* which makes private parties reluctant to pay.

The lighthouse benefits all ships who need to spot the coastline, and do so without depleting the supply of lightwaves available to the additional ships which may pass by. Theoretically, an infinite number of ships can be supported during each instance that the lighthouse is operating. This points to another feature of pure public goods; the benefits from the good are not depleted by the marginal user. This idea is often referred to as *subtractability*, and this too leads to difficulties in billing private parties for such goods.

Hardin's formulation of the commons problem is rooted in these features of public goods: excludability and subtractability. The commons problem is one of excludability, or lack of it. The benefits of the commons are subtractible, however, although those appropriating the benefits of the resource (the herders on the commons) may not be aware of this fact until collapse. Hardin's remedy is to limit access to the commons, by (1) either privatizing the commons in hopes that granting individual property rights will lead to effective stewardship over the resource, or (2) state-ownership, with some government authority granting rights of use to the resource, limiting access to avoid degradation (Hardin 1968; Feeny et al. 1990).

The concept of the CPR as developed more recently expands on Hardin's formulation. CPR management theory is based on the idea that you can limit access to the resource system from the outside, but internally those appropriating the benefits of the resource system can crowd each other. This crowding effect is a critical defining feature of CPRs (Ostrom 1990), with "each [CPR] user capable of subtracting from the welfare of other users" (Feeny et al. 1990: 3). Successful CPR management relies on voluntary institutional arrangements to prevent crowding.

In CPRs user groups are clearly defined, and geographic boundaries can be drawn to separate those who would benefit from the resource from those who would not. In other words, excludability is possible. In the context of watershed management, there are ready-made resource-system boundaries provided by nature. Yet, there are no physical barriers *within* the watershed system to exclude those sharing it from using it to the detriment of fellow appropriators.[5]

In its role as a sink for NPS pollution, the watershed is clearly held in common by those living within its natural boundaries.[6] Water moves wastes deposited throughout the watershed, making exclusion difficult. Yet the physical, chemical, and biological processes responsible for processing these wastes are increasingly stressed as human settlement progresses within the watershed. The subtractability inherent in overuse of the resource system is real.

There are a number of fundamental concepts drawn from the resource economics and CPR literature that also must be understood in the analysis of CPR management systems (Ostrom 1990: 30-57).

The resource system represent the *stock* variables in an analysis of CPRs. These are the resource components from which environmental benefits flow. In complex environmental systems stocks comprise a number of components and subsystems. A forest is reliant on stocks of nutrients and other components of the soil matrix, surface and subsurface water flows, or specific levels of plant and animal populations and diversity to ensure the forest's long-term survival. Similarly, in the context of watersheds and NPS pollution, the renewable stock variables must be viewed holistically. In complex combination with one another, land, water, and associated biological, physical, and chemical processes make up the waste elimination

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5 "Appropriators" is a CPR management term which stands for users of the resource system, those which are extracting benefits from it.

6 I have simplified the boundary issue for purposes of this discussion, recognizing that it could be much more complex. For example, wastes could be transferred from one drainage basin to another, such as with the disposal of septic sludge at facilities located outside of the immediate watershed. Also, as discussed in Chapter 1, the geographic scope of the drainage basin is somewhat subjectively defined, in that it can extent to the level of major river basin, or be considered at the scale of small, localized subbasins.

system which, in turn, affects water quality.

In the theory of CPR management, and of resource economics in general, resource units represent the *flow* variables in an analysis of CPRs. These are the units of benefit derived from the resource system stocks. Within the context of NPS watershed management, resource units are somewhat abstract, representing some quantifiable measurement of the "units of contaminant assimilative capacity" generated by the action of the resource system stocks.

The physical, chemical, and biological processes associated with the land-water interface within the watershed are capable of assimilating a certain level of waste before harming the resource system stocks. Exceeding this capacity results in the impairment of the system as a waste sink (Pearce and Turner 1990:39).

For example, nutrients can be assimilated by land and water-based components of the watershed resource system, such as wetlands or eelgrass beds. Working in concert within the watershed, these components (or subsystems) are capable of generating a finite number of resource units (units of assimilative capacity). This capacity for the watershed to assimilate nutrients is not unlimited. Excess nutrient loading can result in anaerobic conditions within the receiving waters, killing terrestrial and aquatic plants, and increasing turbidity. The life essential for processing wastes in the first place is harmed, and the waste processing benefits of the watershed are impaired. Put another way, the management practices invoked are not suitable to sustaining the waste processing capacity of the watershed.

Within the scope of this thesis, these management practices are adapted as a function of local municipal government. City and town governments are the "gatekeepers" of the local watershed waste sink. They largely determine which management practices (if any) are allowed within their jurisdictions. For example, zoning and other local regulations influence both the quality and quantity of waste entering the system. Sustainable management means that management practices consistent with the watershed's assimilative capacity are adopted by these governments; recognizing that they are granted the power to adopt such practices within the legal and institutional constraints found in state law, and, ultimately, the judicial interpretation of U.S. Constitutional protection of property rights and municipal police power.

SUSTAINABLE MANAGEMENT OF COMMON PROPERTY RESOURCES

Garett Hardin's model of the "tragedy" is characterized by some as "insightful but incomplete"..."a heuristic fable" requiring amendment (Feeny et al. 1990: 12). Hardin's (1968) prescription for preventing the tragedy was to eliminate the commons completely through enclosure.

A rich and diverse body of empirical evidence compiled and analyzed since clearly shows that the "tragedy of the commons" is not inevitable--things are not as simple as Hardin suggests (see Feeny et al 1990; Ostrom 1990; 1992). A number of present day examples exist of groups collectively developing resource use rules for communal property resources. From managing coastal fisheries in Turkey (Berkes 1986) and New Jersey (McCay 1980), to water resource management in Botswana (Fortmann and Roe 1986) and India (Wade 1986), a number of examples can be found of successful, sustainable CPR management. The "tragedy" is *not* inevitable.

The ground breaking work of Elinor Ostrom (1990; 1992) represents the state of the art in thinking about CPR management. This has focused primarily, but not exclusively, on managing watershed extraction for irrigation purposes.

Scholars concerned with CPR management are quick to point out that a fully generalizable set of features of successful CPR management regimes is yet to come. Much work needs to be done and more empirical data must be gathered before such a "checklist" of features can be developed, one which will allow policy makers and communities to design effective management systems around them. In *Governing the Commons* Ostrom posits a list of "design principles" for long enduring, self-organized, self-governing CPR management systems, the core of which, in her view, will stand the rigor of future empirical verification (Ostrom 1990:91). These are summarized in Table 2-1.

TABLE 2-1
DESIGN PRINCIPLES ILLUSTRATED BY LONG ENDURING CPR INSTITUTIONS

Clearly defined boundaries
Individuals or households with rights to draw benefits from the resource system are clearly defined along with the boundaries of the resource system are clearly defined and recognized;

Development of local rules of use for the resource
Rules governing when, where, how, and how many resource units are appropriated are developed in conformance with local conditions;

Collective choice arrangements
Most if not all individuals affected by the rules of appropriation are given voice in modifying these operational rules;

Monitoring
Individuals are charged with monitoring the behavior of those using the resource units, as well as conditions within the resource system itself;

Graduated sanctions
Violation of the local use rules is likely to result in sanctions which are set at levels fitting the severity of the violation--these are imposed by other appropriators or by those officials accountable to the users;

Conflict resolution mechanisms
Appropriators of resource units and their representatives have ready access to low-cost measures for resolving disputes with other appropriators or officials;

Right to organize is not impeded by external government authorities
External government authority does not challenge the right of appropriators to devise their own institutions in response to the needs of governance;

Nested enterprises for CPRs which are components of larger systems
The above governance activities are clustered in multiple, nested layers.

Source: After Ostrom (1990:90)

For purposes of this paper, I want to highlight the role of interests in evolving sustainable management practices ("use rules" in Ostrom's terms). Developing sustainable management practices based on local conditions (including natural system constraints) is the key to sustainable CPR management. These practices are adopted through a political process working among resource users; through a mutually agreed upon system of "gatekeeping" to protect resource stocks. Governance is driven primarily by the recognition of common interest amongst users in sustaining resource flows, and the benefits which flow from cooperation. From the observations of Ostrom and others, Bromley (1992) summarizes the foundations of sustainable CPR management as:

> "a common understanding of the management problem, a common understanding of the alternatives for cooperation, a common perception of mutual trust and reciprocity, and a shared perception that decision-making costs are less than the benefits of joint action"

This paper will utilize the concepts summarized in this passage to develop a framework for thinking about watershed-based NPS management in Massachusetts.

INFORMATION AND DECISION-MAKING IN CPR MANAGEMENT

Gatekeepers must recognize when current management practices are leading to degradation of the resource. But this is not enough. Sustainable management of CPRs is a process, and it requires more than identifying inconsistencies between practices in use and resource capacity. The management process must generate political will sufficient to cause needed changes in those insufficient management practices. Herein lies the problem. Proper gatekeeping is an exercise in finding sufficient common political ground among individual constituencies. These constituencies must work to enact and enforce rules to protect the resource.

The issue of concern in this paper is how programs designed to facilitate the generation and transfer of information can influence this political decision-making process. Some brief reminders about the power of information are useful before proceeding.

Information can empower us to meet our environmental needs. In terms of management, this means that we can use information to describe resource systems that we *understand* to be vital to our own health and welfare. From there we can begin to apply more knowledge to predict impacts, to identify threats, and to prevent potential harm. Depending on a number of factors, many of which are political, it is possible to use information to respond to existing visible threats through mitigation or we can respond to threats that we predict somewhere in the future through preemption.

Information allows us to compare, protect ourselves from threats, and to threaten others. We can interpret before and after. It helps us determine if a strategy worked, or if we should try something else. It allows us to compare the condition of our community with those of another, whether or not we are better off than "them." It allows us to assign blame. It allows us not only to protect ourselves from threats, but also to threaten others that we perceive as outsiders by identifying weaknesses while capitalizing on our own strengths.

Information can limit, or eliminate uncertainty, allowing us to go about our daily lives secure in the knowledge that things will be alright. We know for example, that water from the tap is, in general, safe to drink. It is a source of stability but it can also have the opposite effect. What we know, or what we *think* we know, can elicit the worst of human responses. The depleting ozone layer or rising sea levels due to global warming can act as catalysts for international cooperation, or they can generate a tension, with blame, deceit, economic and political threats as its outfall.

The ability to use information to manipulate the environment around us allows us the option of multiple approaches to a single problem. Put another way, flexibility is the offspring of information. This in turn allows us to fit the solution within the wider context of the problem. Some otherwise "viable" solutions may be too costly, either in economic or political terms. By generating more than one option, we can find the least costly solution, while at the same time allowing us more flexibility in cooperating with others in joint ventures to protect resources.

Most importantly perhaps, information brings us together. By unearthing our interdependencies, communities are defined, and redefined again as new information emerges.

Technical assistance provides pre-packaged information directly, generates fresh information specific to a situation, or facilitates the generation of information through delivery of appropriate tools. Access to these technical resources is key.

Power can be concentrated in individuals or groups. Those who have the capacity to assess or predict environmental impacts possess power in the political schemes surrounding environmental regulation. Large U.S. corporations, for example, have a long history of protecting their interests by contesting regulation. In many cases this is done through litigation on the technical basis of a specific regulatory approach (see for example *Ethyl Corp. v. EPA*, 541 F.2d 1 (D.C. Cir. 1976); *International Harvester v. Ruckelshaus*, 478 F.2d 615 (D.C. Cir. 1973); *Lead Industries Association, Inc. v. EPA*, 647 F.2d 1130 (D.C. Cir. 1980)).

The term "disaggregated interests" refers to those groups or individuals which have been unable to consolidate their political interests into a unified voice. Anderson and Leal (1992: 300) point to two factors which can limit the use of information by disaggregated interests in environmental decision-making through the democratic process.

First is what they term "rational ignorance." In regulation, the political power of the "Exxons" of the world derives from the fact that information is not a public good. Disaggregated interests (e.g., average voters) face extremely high information costs when deciding on a technical policy issue at the polls. Anderson and Leal point out that the rare exception to this occurs when the issue directly affects the voter. The typical voter on Cape Cod is more likely to know about groundwater contamination if he or she relies on a private drinking well, set in a community completely reliant on onsite septic systems.

Related to this is that so-called "special interests" may feel threatened by a change in the rules due to concentrated <u>costs</u> they must bear as a result of the new policy. Since the environmental <u>benefits</u> of the new policy may be diffused throughout the community at large, these special interests are more likely to "spend time and money influencing decision-making in the political arena" (Anderson and Leal 1992: 300). In cases of environmental regulation, this often includes recruitment of a cadre of technical experts to protect their interests.

Against the backdrop described by Anderson and Leal, technical assistance can lend *political* support to resource protection by increasing access to information to the informationally disadvantaged. By lowering information costs to these groups, and targeting the information to the right actors in a form accessible to the larger polis, technical assistance can inform of threats, interests, and options to solve the problem. It can generate a sense of urgency and instability where there was none--all of which feeds into the ballot box, and into the decision-making process.

Technical assistance can also be viewed as a teaching process. Given the power of knowledge in the environmental arena, the ability to analyze or generate one's own information is an obvious asset, particularly where there is strong resistance to outsiders bringing advice. So technical assistance can be viewed as a system of increasing *local* capacity to deal with both current and future political problems associated with resource protection.

This paper is focused on the role of technical assistance in proper gatekeeping, changing the rules governing resource use. The key political dimensions of such modifications are highlighted in the following passages:

> "The only purpose for which power can be rightfully exercised over any member of a civilized community, against his [or her] will, is to prevent harm to others." (John Stuart Mill 1858)

> and...

> "At the most general level, the problem facing CPR appropriators is one of organizing: how to change the situation from one in which appropriators act independently to one in which they adopt coordinated strategies to obtain higher joint benefits or reduce their joint harm." (Ostrom 1990).

Despite the fact that these passages were first published more than 140 years apart, a common thread binds them, one which is at the core of affecting change in CPR management practices. Harm, and the common interest of securing ourselves against it, is a potent political force.

Within CPR management, the process of getting individuals to pursue their joint welfare, often in direct opposition of private interests, can be termed "collective action." Preventing joint harm represents the organizing principles for collective action to protect the resource (Ostrom 1990).

Put in political terms, the potential harm associated with liberty in the atomized, unconsidered use of the commons is an "area of public policy where the tension between individual purpose and collective result is most pronounced" (Stone 1988: 87). How this tension plays out in the political process will support changes in management practices, or act as barriers to change.

Information, and systems designed to facilitate delivery of it, must play a role in defining the community within the resource boundaries, and identifying common interests in preserving the system. Communities X, Y, and Z must *know* that they share a watershed in the first place. They must know why the watershed is important to each of them. They must be made to understand how current management practices may result in harm to the system and to themselves. This knowledge, in turn, must be fed into the political process.

Behind this is a complex chain of political events (Stone 1988). The perceived effects of harm create political interest groups out of those affected. These interests must then be translated into "needs" within the political process, a prerequisite for collective political action (Stone 1988:80). Elected representatives, in theory, will respond to those needs in their decision-making. Decision-making is, in turn, largely influenced by conceptions of causality (Stone 1988:198).

Within this political arena the key role of information is clear. Identifying potential harm, predicting the effects of that harm on the public interest (derived from the private actions of individuals), and assigning causality are all technical tasks.

In the CPR context gatekeeping is a multi-level task of governance. The multiple levels of analysis required complicates both the technical and political processes supporting rule changes. To achieve the sustainable management practices within the CPR, the process must be played out *within* and among individual political units occupying the watershed. The "public" in "public interest" must be effectively redefined to include the watershed community.

Generating options can be important also, and information can be used to generate those options. By introducing more options into the political fray, the chances of achieving agreement on changing management practices may be increased, both within and among political units. If players feel boxed in by having just one avenue to cooperate, there exists only one appropriate management practice which must be adopted or else, they may choose not to play. The lone option offered may not be perceived as politically, economically, or culturally desirable. This may occur particularly where the costs of non-cooperation are perceived as minimal. For example, the need to re-site a development project for groundwater protection purposes may fall on deaf ears in a community with only limited reliance on the local aquifer.

Multiple options could also complicate matters. Groups or individuals may want one particular solution. Others may identify more readily with another alternative, equally effective in solving the pollution problem, but the one that harms their own specific interests the least. In this way, political pressure for change can be diffused, flowing in a many directions at once, with political splintering and paralysis resulting.

Policy-making can be viewed as a process of minimizing political and economic costs after having considered and compared a number of options. The public and policy-makers, however, incur costs to gain information (Anderson and Leal 1992: 302). To the extent that citizens and policy-makers must join forces through the political process of rule changing, these two sets of actors have a shared need for lowering information costs, especially concerning alternatives. If only one change in the rules can be devised that will be effective, and that proposed change is politically infeasible, it will not be made.

The statement by Bromely cited earlier highlights this: that successful CPR management is in large part based on "the shared perception that the costs are less than the benefits of joint action" (1992: 11). By lowering information costs, technical assistance can work to facilitate collective action. Policy-makers and the public can share information which identifies the least costly alternatives which will still result in sustainable use of the resource.

A MODEL OF INFORMATION FLOWS AND POSITIVE POLITICAL OUTCOMES IN NPS WATERSHED MANAGEMENT

This thesis explores the political role of technical assistance programs, and the information that these programs help to generate. The underlying theme in this study is that these two components must be viewed holistically. Technical assistance is linked to the political processes of watershed management.

To illustrate this union, and to guide the remainder of my thesis, I have developed a model of NPS watershed management which considers simultaneously its technical features and political aspects.

This model represents a distillation of many versions of watershed management presented in the literature. It is a kind of "generic" step-by-step approach which focuses on "problem identification," "evaluation of alternatives," and, "implementation."[7]

The model is illustrated in Figure 1. In the chapters which follow, I discuss each of the model components in greater detail. By way of introduction, however, information is generated throughout this management process, with technical assistance as an external input. It complements any existing technical capacity within the relevant watershed communities. Information is generated through a series of technical steps, which in turn is fed into the politics of modifying management practices. The technical steps in the management process can be broken out as

[7] The basis for this framework can be found in the full text of §6217 Watershed Management Measure in Appendix A, and others state and federal agency guidance (U.S. EPA 1993; EPA 1992; 1992a; MDEP 1993).

follows:

(1) ***Defining the Resource System***
Delineating watershed boundaries, and inventory of the resource (including hydrology, soils, biota and their habitats, and human settlement, etc.)

(2) ***Identifying Harm***
The key to effective rule-making, accomplished by combining information about the resource obtained in step 1 with water quality data and or predictive models to identify existing or potential threats to the resource and to all those dependent upon it. To the extent possible, a firm relationship between cause and effect is established.

(3) ***Choosing How to Address Harm to the Resource System***
Once a choice to seek solutions is made, evaluating the tools/approaches available to secure the resource system and the watershed community from potential harm identified in the first two steps. Here is where flexibility is key.

(4) ***Acting to Address Joint Harm to the Resource System***
Actually "installing" measures chosen to prevent harm which are selected from the options presented in step 4.

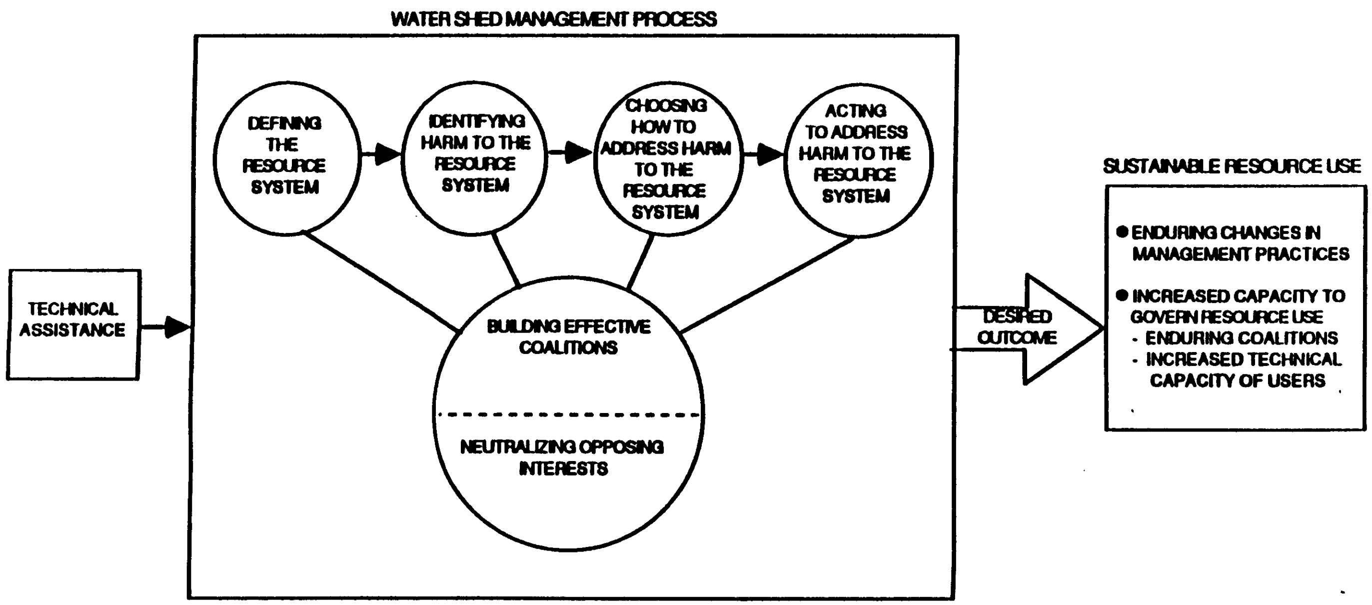
MODELING THE POLITICAL WORLD

The graphical representation of the NPS watershed management model places these technical steps in the same "box" with the key political outcomes needed to modify management practices. I have labeled these "Building Effective Coalitions," and "Neutralizing Opposing Interests."

The arrows pointing between the management steps indicate information flows throughout the process. Solid lines are drawn to represent the linkage between the information generated in each step and the political world.

FIGURE 1

MODEL OF INFORMATION FLOWS WITHIN WATERSHED MANAGEMENT



MODELING THE DESIRED OUTCOMES: SUSTAINABILITY AND INCREASED LOCAL CAPACITY

Simply put the management process, the technical and political processes and information flows within and between them, should result in management practices which are consistent with the capacity of the watershed to assimilate waste, and maintain the flow of multiple benefits. This can be seen as a *first order* goal of the management process. In other words, rules should reflect the concept of sustainable yield.

In Figure 1, I have also pointed to increased capacity to govern the resource by users. I view this as a *second order* outcome, but potentially important in the long-run. Due to the existence of multiple contaminants it is unlikely that all potential problems can be addressed in a single iteration of the management process. The value of enduring coalitions and increased technical capacity within the user groups is therefore obvious. The potential for resistance of externally generated information can be diminished to the extent that information can be generated within the watershed community. Local knowledge of the resource is at its peak in those communities sharing it. Technicians based at the local level can take advantage of this familiarity with the resource, and generate new information more effectively.

All of the components within the model are driven by the notion of shared interests in preserving the benefits derived from the resource system, and the values placed on these benefits. The technical steps 1 through 4 help to illuminate these shared interests, and show how to go about protecting them. The information generated in each technical step is fed into the political process, hopefully generating positive political outcomes; the adoption of appropriate management practices within the watershed community.

TWO HIDDEN PLAYERS: ON COMMUNITY VALUES AND MEMORY IN WATERSHED MANAGEMENT

Harm and how it is perceived is largely a function of the values that we place on the resource system, and the benefits which we draw from it. Given this, community values are a critical component in the watershed management model.[8]

While I have chosen not to depict community values in Figure 1, they are, in fact, instrumental throughout the watershed management process. They are, in fact, everywhere in the model, likened to the canvass on which the paint is applied.

Shellfishermen may be concerned with water quality on purely economic grounds, and are likely to be very receptive to issues of harm in terms of their livelihood. A cost-benefit analysis of a proposed change in management practices could target these interests in terms of the revenue lost from shellfishery closures. Others may be concerned about waterfront real estate values which could decline as water quality is impaired. These are simple examples, and do not stray from what we have established through our review of CPR management and its reliance on joint interests.

Conceptually more elusive, there are other "values" which can propel collective, cooperative action on a watershed basis. One of the towns participating in the case study which follows seems to have cooperated simply because it was "the right thing to do." Altruism <u>can</u> drive policies toward collective action, and this component of the value system is difficult, if not impossible to quantify.

I choose to acknowledge the existence of these complex value systems, reminding the reader that they are constantly at work in the watershed management process.[9]

Community memory is another key factor relating to perceptions in watershed management. Memory of past environmental episodes is the most obvious example. People are cognizant of the notion that if it happened before it could happen again.

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8 I broadly define community values as the economic, aesthetic, cultural, and ethical value that members of the watershed community place on the resource system.

9 Mark Sagoff (1988) offers an excellent analysis of environmental value systems and policy-making in his work, *The Economy of the Earth*, particularly as they pertain to issues of economic valuation in environmental policy. The reader is also referred to the volume edited by Engel and Engel (1990), *Ethics of Environment and Development*, which offers a global, cross-cultural perspective on various value systems and sustainable development.

Memory influences our value system. The two are linked. Memory can therefore promote an aversion to risk which can drive policy-making. In the Buttermilk Bay case study which follows, the communities' memory of shellfishery closures was an important factor which translated into modified management practices, voted on in open town meeting.

CHAPTER 3

WATERSHED-BASED MANAGEMENT OF NONPOINT NITROGEN SOURCES: THE CASE OF BUTTERMILK BAY

This chapter offers a glimpse of watershed-based NPS management in action. It highlights the role of technical assistance and information in this process, and the role of interests in propelling changes in management practices to protect a coastal watershed from the effects of NPS pollution. Value systems come into play, and the importance of targeting information to the appropriate political actors is underscored. The local political process is shown to be unpredictable at times, a point which I hope to drive home in this thesis.

The case study is limited in many ways, and it is best to point out these limits before presenting the case. First, the case involves only a single NPS contaminant. Accordingly it represents a simplification of an ideal where all sources, and potential sources of harm are dealt with at once, limiting the case's technical complexity.

The nature of the single problem, and fiscal considerations limited the solutions considered in the case. This single choice focus also limited the intensity of political fallout in considering the choice at all three town meetings which voted on the changes.

The primary technical assistance program involved to a rather ad hoc approach. There was limited formal involvement between officials of the three towns. The staff of the Buzzards Bay Project was instrumental as both technical experts and advocates of change, working as the primary conduits for information flowing to and among the towns involved.

Finally, the changes were primarily preventative rather than mitigative. The impact of the changes in management practices were spread widely among a number of land-owners, and in many cases did not represent a significant intrusion upon their interests.

INTRODUCING THE CASE OF BUTTERMILK BAY

On April 24, 1992, three southeastern Massachusetts towns were notified that EPA Administrator William K. Reilly had given them an award. They were one of 35 recipients, out of a total of 840 applications, given the national EPA Administrator's award for pollution prevention. The EPA Regional Administrator at that time, Julie Belaga, stated that "we [at EPA] are proud of our New England winners who are on the cutting edge in excelling in innovative pollution prevention initiatives" (U.S. EPA 1992d).

This "innovative pollution prevention initiative" was the nation's first zoning overlay district established for the expressed purpose of managing nitrogen inputs to a coastal embayment. It is a good example of how communities can coordinate management practices on a watershed basis, and it highlights the important political role of technical assistance in such cases.

As one of 28 embayments of Buzzards Bay, in southeastern Massachusetts, Buttermilk Bay falls under the aegis of the "Buzzards Bay Project" (BBP) a joint effort of the Massachusetts Office of Coastal Zone Management and U.S. EPA under the National Estuary Program. The Buttermilk Bay project described here is an outgrowth of the wider management effort lead by the BBP. It represents a demonstration project aimed at nutrient management through appropriate land-use planning.

This discussion follows the same four-step framework used above, first focusing briefly on the technical work performed by the BBP, outside consultants, and town staff. I then analyze key political factors contributing to the outcome: coordinated changes in land-use regulation to protect Buttermilk Bay from excess nutrient loading from nonpoint sources.

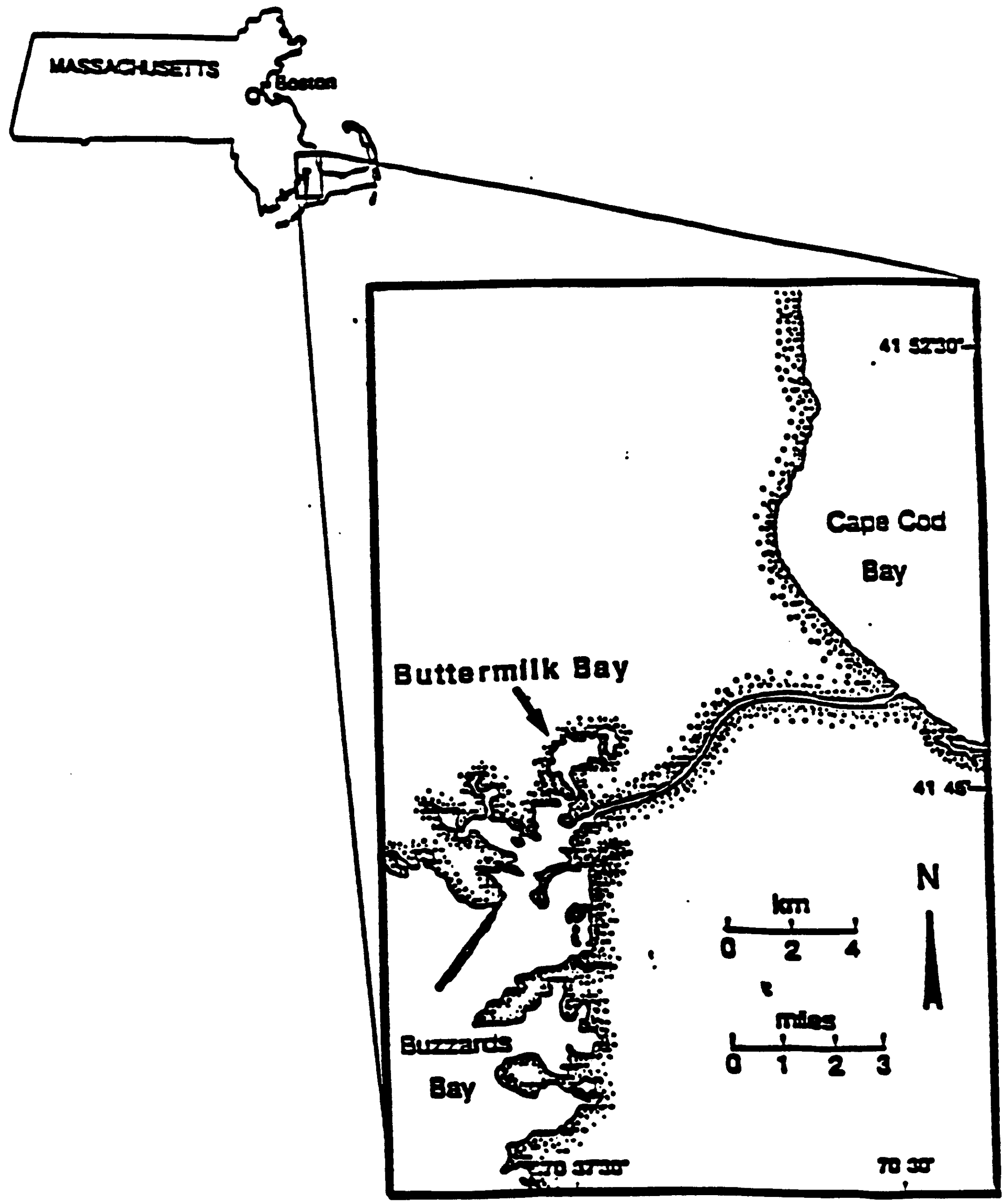
DEFINING THE RESOURCE

Buttermilk Bay is a small, shallow embayment, with a surface area of approximately 530 acres (HWH 1991:1). Figure 2 shows the location of the embayment.

With a grant from U.S. EPA, Horsley Witten and Hegemann, Inc. (HWH), a

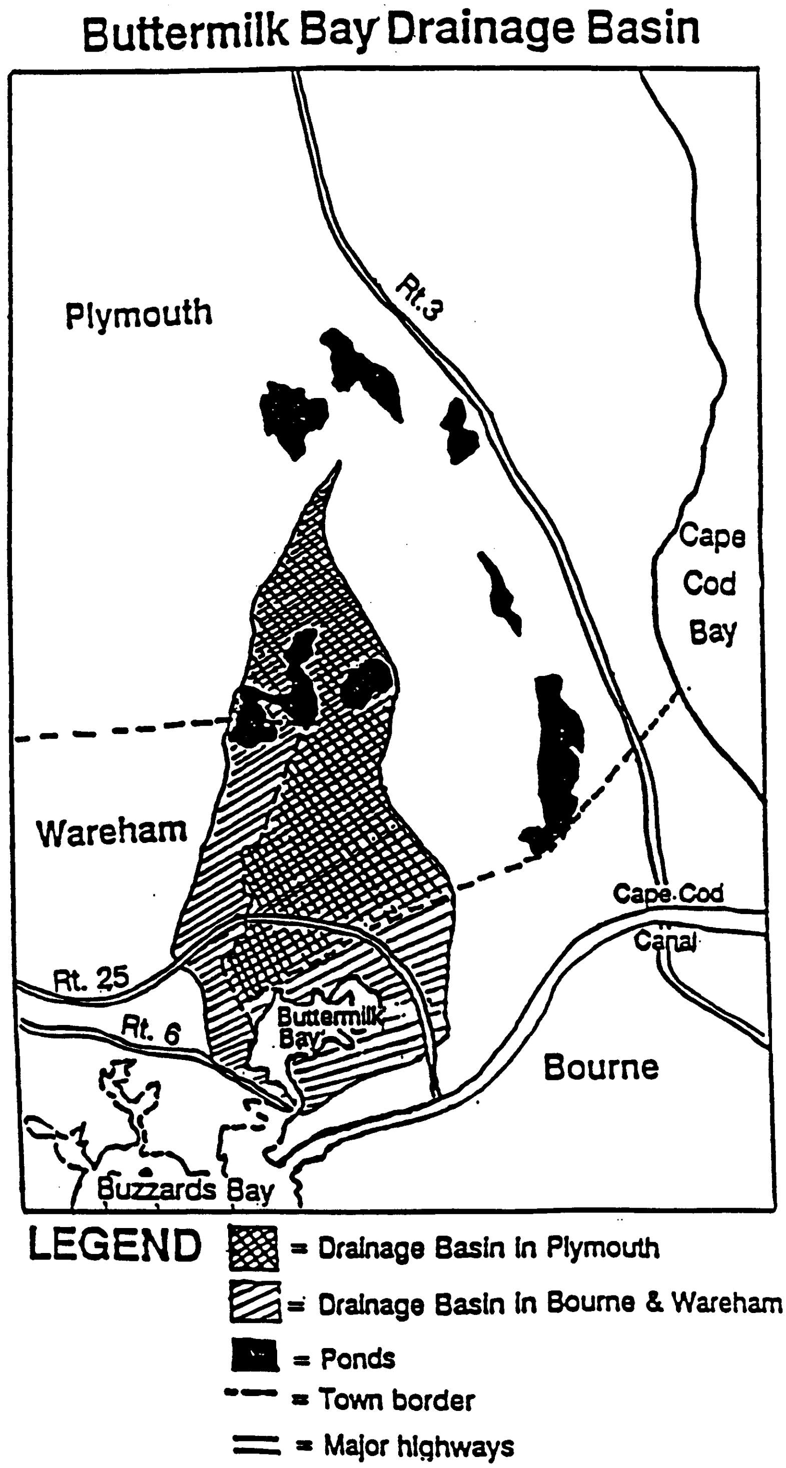
FIGURE 2

BUTTERMILK BAY
LOCUS MAP



Source: Horsley Witten Hegemann, Inc. (1991); after Heufelder

FIGURE 3



Source: Buzzards Bay Project (1991)

water resources and planning consultancy based in Barnstable, were contracted by BBP to conduct the hydrological study, buildout analysis, and nitrogen loading study for the embayment.

HWH delineated a watershed of approximately 6,953 acres (approximately 11 mi^2) draining into Buttermilk Bay, extending approximately 8 miles inland from the coast (HWH 1991: 6). Three towns share portions of the watershed (see Table 3-1). Their location with respect to the embayment, and the area draining into the embayment are shown in Figure 3.

TABLE 3-1
SUMMARY OF LAND AREA
WITHIN THE BUTTERMILK BAY WATERSHED

TOWN	TOTAL AREA OF TOWN (acres)	AREA WITHIN WATERSHED (acres)	% TOTAL AREA OF TOWN WITHIN WATERSHED	% OF TOTAL BUTTERMILK BAY WATERSHED
BOURNE	26,464	1,398	5.2%	20%
PLYMOUTH	65,682	4,160	6.3%	60%
WAREHAM	23,968	1,395	5.8%	20%

Source: Horsley Witten Hegemann (1991), and MCZM

In all three cases, the watershed comprises approximately 5% to 6% of the total area of each town. Plymouth has by far the lion's share of the land area draining into Buttermilk Bay, with Bourne and Wareham splitting the balance of the watershed. The dominant zoning within the watershed is residential, with approximately two-thirds of both Bourne and Wareham's portion already fully developed. In contrast, less than half of the drainage area located within Plymouth had been developed at the time of the nitrogen loading study (HWH 1991).

In mapping the watershed, previous water table measurements made by the U.S. Geological Survey were input to a groundwater flow net model to interpolate groundwater contours between the 21 data points measured by USGS in December 1984 (HWH 1991), 6 years prior to the Buttermilk Bay project. The hydrological study determined that freshwater input into Buttermilk Bay via surface streamflow was minimal. The focus instead was on nitrogen inputs via groundwater.

BUILDOUT ANALYSIS

HWH also conducted a land-use and buildout analysis of the Buttermilk Bay watershed under existing zoning. Zoning within the watershed areas of Bourne, Plymouth, and Wareham varied widely. It ranged from required minimum lot sizes of 20,000 ft^2 to 130,000 ft^2 as follows (HWH 1991:10):

BOURNE: The majority of the land within the Buttermilk Bay drainage basin was zoned residential and commercial with minimum lot sizes of 20,000 and 40,000 ft^2 (with **40,000 ft^2** lots dominant by far).

PLYMOUTH: Minimum lot sizes ranged from 25,000 to 60,000 ft^2, with 75% of the area of concern zoned as residential with minimum lot size of **60,000 ft^2**.

WAREHAM: Dominant minimum lot size within the drainage basin was set at **130,000 ft^2**, with the exception of the densely developed section of southern portion of Wareham which was being sewered at the time of the study.

The results of the buildout analysis are summarized in Table 3-2. The analysis indicated that, after compensating for so-called "grandfathered" and "Approval Not Required" lots, a full potential for development of 5,355 units was estimated, with the vast majority as residential. This represents an addition of approximately 2,300 housing units above the current levels throughout the watershed.

TABLE 3-2
SUMMARY OF RESULTS OF
BUILDOUT ANALYSIS
WITHIN THE BUTTERMILK BAY WATERSHED

	BOURNE	PLYMOUTH	WAREHAM	WATERSHED AGGREGATE TOTALS
AREA IN WATERSHED (acres)	1,398	4,160	1,395	6,953
PORTION ALREADY DEVELOPED	67%	44%	71%	57%
NUMBER OF EXISTING UNITS [DENSITY] (units/acre)	1,219 [0.9 units/acre]	1,075 [0.3 units/acre]	755 [0.6 units/acre]	3,049 [0.4 units/acre]
POTENTIAL ADDITIONS THROUGH SUBDIVISION AT BUILDOUT	468 units	998 units	99 units	1,565 units

Source: Adapted from Horsley Witten Hegemann (1991)

IDENTIFYING HARM AT BUTTERMILK BAY

The Buttermilk Bay overlay district was aimed exclusively at excess nitrogen loading to the embayment. No other contaminants, or there impacts were considered.

The nitrogen cycle is a complex process whereby atmospheric nitrogen (N_2) is transformed into nitrites and nitrates, which are much more readily available for use by plants in photosynthesis. Nitrogen sources include precipitation, decomposing plants, mineral fertilizers (applied to lawns and crops), and sewage/septic effluent where wastes are transformed to ammonia, then to nitrates.

Nitrate (NO_3) is typically the form of nitrogen which enters groundwater. It is highly mobile and persistent. It does not attenuate readily in soils, allowing it to travel great distances prior to discharging to surface waters (HWH 1991). Nitrogen as nitrate is highly available for use by marine plankton, which leads to a series of environmental effects collectively termed "eutrophication."

The first primary effect is on the amount of sunlight reaching below surface. Eelgrass is an important habitat and nursery for a number of estuarine species. Bay scallops for example cling to the stems of eelgrass during their first month of life (BBP 1991). Increased growth of free-floating algae from elevated levels of nitrogen leads to increased turbidity, blocking out solar radiation needed by eelgrass.

As algae stimulated by excess nitrogen die off, they decompose. This process takes up dissolved oxygen within the water column. Decomposing algae may also sink, where it similarly increases oxygen demand in sediments. The combined effects of increased oxygen demand in both the water column and bottom sediments may result in deficient oxygen levels in water, known as hypoxia. Hypoxia occurs at dissolved oxygen levels less than 3 ppm, and may cause extreme physical stress on marine life, forced migration, or death (U.S. EPA 1990a: 29).

VISIBLE HARM AT BUTTERMILK BAY

The Buttermilk Bay project was innovative in that it took a *proactive approach.* Water quality within the embayment is still relatively good, aided by the high flushing rate, estimated at 5 days (HWH 1991: 31). The severe effects of nitrogen loading are not wide-spread as yet. Water quality in Buttermilk Bay, however, has degraded to the point where some designated uses and other environmental benefits are sometimes impaired.

One Bourne Selectman (also a former member of the Town Board of Health) pointed to the deterioration of bay water during the twenty year period that he lived on the shores of Buttermilk Bay. Deterioration was visible through decreased clarity, occasional algal blooms, and closures of shellfish beds (H. Coggeshall 1993). Areas around Wareham had experienced limited eutrophication according to the former Conservation Agent (L. Van Hine 1992).

Shellfish beds in Buttermilk Bay were closed to shellfishing for the first time in 1984 (Costa 1993; Heufelder 1988). During a conversation in April 1992 one

Wareham official pointed out that all of the shellfish beds within the jurisdiction of the town were then closed due to pathogen contamination linked to stormwater (L. Van Hine 1992). The link between pathogen contamination and nitrogen is indirect, and not well understood.[10] I discuss in later sections, however, how these closures still worked to the advantage of the BBP and local advocates in establishing the N-loading overlay district.

PREDICTING HARM AT BUTTERMILK BAY

HWH conducted a N-loading study in conjunction with the buildout, using the projected density under current zoning to predict future N-loading. They performed a review of the literature in adopting "conservative yet defensible" parameters to combine with the results of the buildout (HWH 1991: 20). These modeling assumptions included the concentration of nitrogen in septic system effluent, leaching rates of fertilizers applied to lawn areas, and nitrogen concentrations in road runoff and precipitation (HWH 1991: 20-23).

N-loading from existing sources were estimated through this modeling exercise, and combined with N-loading projections assuming full buildout to estimate the total potential N-loading from the watershed discharging into the bay under current zoning. Septic systems were estimated to account for 72% of the following totals (HWH 1991: 27; BBP 1991a):

[10] Studies suggest an indirect link between nutrient loading and the survival of bacteria in marine waters for two reasons: (1) increased algal growth may block UV radiation, resulting in increased rates of survival for bacteria, and (2) algae may release substances (sugars, nutrients) on which certain bacteria can thrive (BBP 1991: 167).

TABLE 3-3
SUMMARY OF PREDICTED N-LOADING ESTIMATES
AT BUTTERMILK BAY

	BOURNE	PLYMOUTH	WAREHAM	TOTAL
TOTAL N-LOADING (lbs/yr)	43, 405	66, 407	15, 526	126, 664

The next step was in defining the "critical" N-loading limit of Buttermilk Bay, the assimilative capacity of its receiving water. The BBP staff and HWH collaborated in this task.[11] Accounting for volume of the bay, flushing time, surface area, depth, and other factors a critical N-loading limit of 115,617 lbs/yr was estimated (HWH 1991: 32; BBP 1991a).

Note that the projected total N-loading rate in Table 3-3 exceeds the estimated limits of the bay by over 11,000 lbs/yr. With this figure the BBP predicted harm to the embayment unless changes were made in the allowable land-use among the three towns.

CHOOSING HOW TO ADDRESS HARM AT BUTTERMILK BAY

In the course of my research, one of the key BBP staff members involved in the Buttermilk Bay overlay district confided that their initial feeling was that they little chance of succeeding in getting the towns to coordinate zoning (B. Rosinoff 1993). He thought, at best, the project would provide the opportunity for the three towns to consider various alternatives. They thought perhaps one town might re-zone, others might start thinking about extending sewerage to protect the bay.

About mid-way in the process, the BBP staff began to think that they had a shot at the needed zoning changes, and abandoned other potential tools that could be used to manage nitrogen inputs based on the following rationale:

[11] The director of the BBP had done graduate research at Buttermilk Bay, and was familiar with many of its physical and chemical features.

NONREGULATORY ALTERNATIVES:
These might include purchasing open space (setbacks) of some kind, but as noted above, buffer strips are not effective against nitrogen transport.

SUBDIVISION AND PERFORMANCE STANDARDS:
For example, a town can impose performance standards on subdivisions or individual households forcing them to meet certain criteria for N-loading. This could be done by adopting appropriate technologies of their choice to prevent overloading of the resource. Advanced onsite septic systems in the words of one BBP staff member, would have been a "hard sell." Telling home owners that they had to spend upwards of $15,000 per septic unit. This was twice that of current systems meeting Massachusetts Title 5 requirements, and would have been difficult to sell (D. Janik 1992, 1993). Intermunicipal coordination of this approach would have been problematic.

EXPANSION OF SEWERAGE:
Limited sewering had already taken place in Bourne and Wareham. The staff of BBP pointed out in interviews that both of these options were neither technically, politically, or financially feasible for widespread use (D. Janik 1992, 1993). Sewering is obviously capital intensive. The permitting, design, and construction process is arduous; all of which translates into high cost. It is something the towns were unlikely to take on.

Given the nature of the problem, and the apparent window of opportunity perceived by the BBP, they chose to focus their energies on getting the towns to establish an intermunicipal overlay district within the drainage area of Buttermilk Bay. HWH, as part of their N-loading study, estimated that a minimum lot size of 70,000 ft^2 within the watershed would keep future N-loading within the assimilative limits of the embayment. This figure translated into the following required actions by each of the three towns (BBP 1991a):

BOURNE:
Would have to "downzone" (increase minimum lot size) to 70,000 ft^2 from the existing 40,000 ft^2. This would result in a lost development potential of 220 residential units (from 468 down to 248);

PLYMOUTH:
Would have to downzone from the existing 25,000-60,000 ft^2 zoning to 70,000 ft^2. This translates to a loss of 217 potential housing units upon subdivision at full buildout (from 998 units down to 781);

WAREHAM:
Wareham already had 130,000 ft^2 zoning in place (a long established agricultural watershed district). Changes to their zoning bylaws were to be limited to modification of language only. This language would discourage variances and granting of special permits which could result in excess N-loading from their portion of the watershed.

With these recommendations in hand, the BBP staff began an intensive outreach program with each of the three towns.

ACTING TO ADDRESS HARM AT BUTTERMILK BAY

Once zoning was selected by the BBP, they began working with the towns to get them to agree to the needed changes. A number of presentations were given by BBP staff and their consultants to various town boards, including selectmen, health, and planning boards, along with conservation commissions. They spelled out in clear, simple, and effective terms the methodology used, the cause of the potential problem, and the merits of the zoning approach (B. Rosinoff 1993; B. Parady 1993; M. MacGregor 1993; D. Ellis 1993; Wareham PB 1993). The interface between the technical staff of BBP and the political structures of each town is discussed in greater detail below.

Apart from these presentations, the BBP staff's role in the towns taking action was limited primarily to providing sample bylaws for the towns to consider, and reviewing town meeting articles from each town to ensure that they met the overall goals of the program.[12]

ANALYZING KEY POLITICAL FACTORS IN ESTABLISHING THE NITROGEN OVERLAY DISTRICT AT BUTTERMILK BAY

All towns are unique. Each of the three towns participating in establishing the overlay district at Buttermilk Bay have their own agenda. A different set of factors came into play within each community. They cooperated for different reasons.

As I noted earlier, this project did not feature a high level of formal coordination, as in the watershed management committee structure outlined later in this paper. The BBP was clearly instrumental in getting the plan considered by the towns, and in getting the changes passed at the local level through "shuttle diplomacy" between the towns. They served as the only consistent link between Bourne, Plymouth, and Wareham in the process.

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[12] "Articles" are proposed legislation to be brought before town meeting.

POLITICAL FACTORS IN DEFINING THE RESOURCE AT BUTTERMILK BAY

The resource definition task performed for establishing the N-loading overlay fell short of a full blown assessment as discussed in the chapters which follow. In this particular case, the "watershed assessment" simply included the delineation of the drainage area, defining land-use within this area, and conducting the buildout analysis.

The BBP staff obviously felt, none the less, that this information was critical to the political process. A series of pamphlets and fact sheets were developed by BBP staff as part of their public outreach program in support of the overlay district proposal. Examples of these are presented in Appendix B, and the reader should note the prominent placement of a diagram showing the drainage area in these examples.[13]

It was not clear to what extent the delineation influenced the political outcome. Overall, the project went through without a massive public outreach program. BBP staff instead focused their attention on the various town boards. At the town board level, the extent of the watershed into Plymouth surprised many of the local officials (H. Coggeshall 1993; L. Hartmann 1993). As one selectman from Bourne noted (H. Coggeshall 1993):

> "Its like when you get into a plane and you can't recognize your own house from the air. You live in a place and you think you know it, but it takes a study to really show what is impacting that place."

For their part, policy-makers in Plymouth were generally aware of the impacts they may have outside of their borders. This was key to the overall success of the project, since, in theory, Plymouth should have been the most difficult place to "sell" the project. They have no frontage property on Buttermilk Bay.

As a testament to Plymouth's cross-boundary awareness, however, a large part of the southern Plymouth (including a substantial portion of the Buttermilk Bay drainage area) was zoned as an aquifer protection district in the early 1980's, primarily

[13] The pamphlet, "What Does Article 28...Mean to Plymouth" was produced by BBP staff to be handed out at town meeting the night the overlay district was to be voted on.

for the protection of groundwater wells in neighboring Bourne.[14]

Plymouth's Planning Director was serving as Secretary for the Old Colony Planning Council at the time of the N-loading project (L. Hartmann 1992, 1993). He is now the President of OCPC, which is a regional planning agency promoting the idea that the choices made in one community could have regional impacts, and that these should be evaluated.

POLITICAL FACTORS IN IDENTIFYING HARM

Politically, the key question is what interests were at stake in each town which persuaded the communities to modify their land-use regulations. In some cases these interests were obvious, in the case of Plymouth, they were more subtle, and reflect values extending beyond its own boundaries.

Two communities have a direct interest in the health and well-being of Buttermilk Bay. Bourne and Wareham have significant frontage property on the bay, and the shellfishing industry is important in both towns. Generally speaking, water-based tourism is a factor in these two communities as well, but more important in Bourne than in Wareham. Selectmen in Bourne note that recreational boating is limited on the bay due to the presence of a low bridge (B. Parady 1993). Recreational shellfishing is an important factor in both communities, as one former official in Bourne put it, "we are all shellfishermen on the weekends" (D. Ellis 1993).

Groundwater represents the sole source of potable water in Bourne and Wareham. Household septic systems are key in both communities, with a higher percentage of households reliant on onsite systems in Bourne. Survey results indicated between 10% and 50% of households in Wareham rely on onsite systems, whereas more than half of Bourne households use onsite disposal (MCZM 1993 Survey). The recommendations of the BBP staff and their consultants were therefore consistent with the existing efforts to protect groundwater quality in these two towns.

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[14] There are no public wells belonging to Plymouth in this region of town, however, a number of private wells are used by residents of the area (L. Hartmann 1992, 1993).

The case of Plymouth is curious. As I noted above, there is no Buttermilk Bay frontage property within Plymouth town boundaries. One BBP staff member commented that "most people in Plymouth couldn't even find Buttermilk Bay" (B. Rosinoff 1993).

The Chairman of Plymouth's Conservation Commission (also the Vice-chairman of the Planning Board), described one reason for Plymouth's near unanimous vote in favor of the overlay district (M. MacGregor 1993). As noted earlier, Plymouth has its own aggressive ground water protection bylaw affecting this area, in spite of the fact that no public wells exist in the area (L. Hartmann 1993). The proposed changes merely strengthened the protection already granted the area. However, the Conservation Commission Chairman has, for a long time, advocated the formation of a town water company. The idea is not to develop Plymouth's groundwater resources for Plymouth's use, but rather to someday sell the water to towns on Cape Cod (M. MacGregor 1993).

Anti-growth sentiment fed into the political process as well. All three communities experienced fairly rapid growth over the past two decades. The former Conservation Agent for Wareham characterized her community as "conservatively pro-growth" (L. Van Hine 1992). A member of the Bourne Board of Selectmen at the time the overlay district was passed noted a "general sentiment to limit growth in the community" (M. Oliva 1992), while the town planner in Plymouth said, simply, that "any proposal at the time to limit growth would have been favored" (L. Hartmann 1992, 1993). The level of anti-growth sentiment varied in each community, but in each case, it was present to some degree when it came time to vote.

THE ROLE OF MEMORY IN IDENTIFYING HARM AT BUTTERMILK BAY

Memory played an important role in many ways in establishing the N-loading overlay district, playing off the interests in watershed protection identified above.

The most obvious example is seen in both Bourne and Wareham. The public's dependence on Buttermilk Bay as an economic and recreational resource was intuitive to those considering the regulatory changes (B. Parady 1993; H. Coggeshall 1993; D.

Ellis 1993; Wareham PB 1993; L. Van Hine 1992). The widespread closure of shellfish beds in the mid-late 1980's due to bacterial contamination left an impression on these coastal communities, sparking support for stormwater remediation efforts and expanded sewerage in some high density areas.

The memory of these episodes, according to the BBP director, worked to the advantage of the N-loading project (J. Costa 1993). As he put it, "there is a great deal of confusion between fecal coliform contamination and excess nitrogen loading; they are distinctly different problems with different solutions." He was convinced, however, that this "confusion" in fact helped generate support for the N-loading district, simply by raising awareness of self-interest in resource protection.

In Plymouth, memory played a completely different role; tied to its fervent anti-growth sentiment. A town meeting representative from one of the districts affected by the N-loading project notes that Plymouth, as one of the fastest growing communities in the Commonwealth over the past two decades (he estimates the population has doubled since 1970), is full of people from "the city." As he put it, "they remember what they left, and realize what they have here in Plymouth to protect" (B. Abbott 1993).

The Chairman of the Conservation Commission points to the community's experience with the Pilgrim nuclear power plant, sited in Plymouth since 1970. He sees this as one possible factor influencing Plymouth's generally proactive, pro-environmental approach to land-use regulation. His sense is that the plant was sited in Plymouth before its citizens fully understood the implications. He suggested that this possibly contributes to a heightened sense of environmental awareness (M. MacGregor 1993).[15]

[15] An alternative view of the "Pilgrim Issue" was offered by Bill Abbott, a town meeting representative who discounts the importance of the siting on the current pro-environment character of the community. He points out that he had to fight for ten years to keep "Pilgrim II" from being sited in Plymouth.

OTHER POLITICAL FACTORS INFLUENCING THE IDENTIFICATION OF HARM

A former member of the Plymouth Board of Selectmen stated simply that the overlay district "seemed like the right thing to do. These problems need to be addressed on a regional basis." (A. Thompson 1993). Plymouth's previous regulatory efforts to protect Bourne's aquifer, at little or no benefit to its own community is a testament to this idea and to Plymouth's regional perspective on resource protection.

Bourne and Wareham have a history (albeit limited) of working together on certain problems. The areas of Bourne which are sewered pump their waste to a treatment plant in Wareham. This has allowed Wareham greater economies of scale, while preventing the need for Bourne to develop a separate facility.

The interests at stake, and the degree of threat to those interests varied in each community, and in fact, are perceived differently among individuals involved. The important point is that the three communities responded in concert to the N-loading study, and the potential threat to interests tied to the watershed was bolstered by a pre-existing pro-environmental ethos among many of those participating.

POLITICAL FACTORS IN CHOOSING HOW TO ADDRESS HARM AT BUTTERMILK BAY

BBP took on the job of choosing the appropriate solution the problem. By the time the various Boards in each community were approached, the proposal was solidly built around changes in zoning. If zoning changes were perceived by BBP staff to be more contentious, it is likely that other alternatives would have been presented to the towns. This was not the case.

A political problem arose, however, in the mind of Bourne's Planning Board Chairman (D. Ellis 1993). Charged with review and formal development of all zoning changes proposed at town meeting, the PB Chairman was instrumental in the passage of Bourne's portion of the N-loading plan. A local landowner (who is also an attorney) was slated to be affected by the proposed changes. His land falling within the watershed which was already subdivided.[16] This particular landowner had opposed land-use regulation in the past, and the PB Chairman sensed that he would cause problems at town meeting.

The Chairman approached the town's land-use planning consultant, and out of this came a proposal to redefine Bourne's portion of the overlay district to end at the western edge of Rte. 25 in Bourne. In addition, instead of the increase in minimum lot size of 70,000 ft^2 recommended by BBP, the zoning would be increased to 80,000 ft^2 (D. Ellis 1993; P. Herr 1993).

This served two purposes. First, it avoided the subdivision owned by the attorney, and potentially powerful opposition at town meeting (this attorney was a former Selectman and State Representative). Second, it changed the zoning in conformance with other zoning within Bourne (which was already at 80,000 ft^2)increasing the "clarity" of the zoning proposal.[17]

The idea was presented to BBP, which quantitatively evaluated the modified proposal. Bourne would have a smaller portion of the watershed protected under the modified district. BBP examined the new proposal, and determined that since the allowable lot density was being decreased at the same time, it result in a wash (D. Janik 1993).

POLITICAL FACTORS IN TAKING ACTION AT BUTTERMILK BAY

There was no "Buttermilk Bay Watershed Management Committee" established to pass the overlay district. The project was limited in scope to one contaminant, the viable solutions were narrowed down early in the process by BBP staff, and the level of

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[16] This meant that the land was immune to the changes through the grandfather clause of MGL Chapter 40A §6, but only if he began construction within eight years.

[17] Phil Herr, the consultant under contract with Bourne recalled that his proposal was based on technical grounds, not political. He questioned the delineation of the watershed, and thought that it made no sense to extend the overlay past the highway (on hydrological grounds). He characterized the episode as a "good marriage" between his technical concerns, and the political concerns of the PB Chairman.

sacrifice for any one party was not drastic.

An ad hoc approach evolved, apparently not as a result of choices made by BBP. There was no indication that any formal management structure was considered for Buttermilk Bay by BBP staff.[18]

The BBP and its consultants were active in providing and reviewing articles for submission to each of the town meetings. This was to ensure that what was voted on was both legally defensible and environmentally sound.

By the time the towns voted in April and May 1991, the BBP staff, and local advocates placed primarily in town government had put in months of work in preparing presentations and publications, drafting and redrafting articles, lobbying key individuals, and allaying the fears of certain large landowners.[19] (D. Janik 1992, 1993; B. Parady 1993).

A number of officials pointed to the clarity of the presentations given by the BBP staff. One former official from Plymouth emphasized the importance of these presentations: "when you make the right presentation, people recognize that there is a need" (D. Daniels 1993).

In the end those that voted at town meeting granted a great deal of deference to their respective Boards of Selectman, Finance Committees, Planning Boards, Boards of Health, and Conservation Commissions, all of which supported the articles put forth; with one illustrative exception.

At the "eleventh hour," the Wareham Planning Board pulled its support from the article that they themselves had submitted to town meeting (D. Janik 1992, 1993). Keep in mind that Wareham had the least at stake, all that was requested of them were certain changes in the zoning language which they had already agreed upon.

At town meeting, the PB stated that they could not support the article. In

[18] Wareham and Bourne are both members of the wider Buzzards Bay Advisory Committee, which includes 12 other towns in southeastern Massachusetts, as well as representatives from MCZM, U.S. EPA, MA DEP, and Regional Planning Agencies.

[19] The BBP staff, along with Bourne town officials made a presentation to a representative of the area's largest land owner specifically for that purpose.

interviews, no one seems to remember exactly what the problem was, but it could have been disastrous. The coordination that BBP thought they had achieved was crumbling. A selectman, who apparently was aware of the project, but by no means intimately involved with it up to that point stood up, giving an impassioned speech before the meeting prior to vote. He spoke about the vital need to protect Buttermilk Bay (D. Janik 1992, 1993). The article passed easily.

SUMMARIZING OUTCOMES

Looking back to chapter 2 and outcomes posited in the management model, we can see that the first order outcomes were clearly achieved at Buttermilk Bay. The three towns voted on and passed changes in management practices, adopting a nonstructural measure for the control of NPS nitrogen inputs. This was achieved throughout the watershed contributing to the embayment. The process was driven by shared interest in protecting the shellfish beds and ground water resources within the region, along with a pre-existing regional ethic on the part of Plymouth. At each step in the process, the technical assistance provided by the BBP staff and their consultants was key in highlighting those interests, identifying future threats, and proposing (and promoting) a viable alternative.

Turning to the second order outcome in the model, that of increasing local capacity to govern the resource, the results were mixed. In part, this is because these towns have worked together in the past on other issues. Big improvements in already good relations were not to be expected, although a new awareness of Plymouth's role in the watershed was certainly raised.

In terms of building local technical capacity, the project was accomplished almost entirely on the efforts of the Buzzards Bay Project and their consultants. Funding from EPA was obtained for the needed studies early on. The relatively straightforward methods used, and the available funding meant that BBP could pretty much do it on their own. The modification of the original overlay district in Bourne was the only clear instance where technical work was contributed by any of the towns.

What did happen is that the BBP was able to develop partnerships with these town governments, an important end in itself if you consider that more work will need to be done in the future. One BBP staff member, citing the lack of funds and technical expertise common to many communities in Massachusetts, noted that the building of effective networks is really all one should expect. Most towns will always need technical guidance in their decision-making (D. Janik 1993).

CHAPTER 4

THE TECHNICAL ASPECTS OF NPS WATERSHED MANAGEMENT IN MASSACHUSETTS

Using the same framework established in the previous chapters I now begin to anticipate watershed-based NPS management in Massachusetts under CZARA §6217. The task requires addressing two interrelated questions within the theoretical framework presented above:

> What information is relevant to the NPS watershed management process? How is it generated?

This chapter answers these questions on a *conceptual* level. The watershed management process is a dynamic, situation-specific process. The key technical tasks as well as key players will vary with the location, character of each community, the specific NPS pollution problems being addressed, the availability of viable options to solve these problems, and the relationships among the communities seeking common solutions within their watershed.

ORGANIZATION OF THE CHAPTER

Using the questions outlined above, I present an overview of the NPS watershed management process in terms of key information which needs to be generated and/or utilized to achieve its purpose: sustainable use of the watershed resource. Using the four-step management framework presented in the previous chapter, I highlight the technical complexities of the management process. I move on to the political dimensions of NPS watershed management in the next chapter.

An offshoot of this discussion is the identification of gaps in local capacity to meet the technical requirements of watershed management in Massachusetts. This will serve to better define the scope and scale of technical assistance needed for successful implementation of CZARA in the Commonwealth.

My observations throughout this chapter are supported with empirical data wherever possible. These data were derived from results of a survey administered to local governments within the program area.

The "Survey of Local Resources for Implementation of Coastal Nonpoint Source Pollution Control Program" is included in Appendix C along with a summary of results. This data-gathering effort was initiated by the author and the MCZM §6217 NPS Program Coordinator in October of 1992. At that time, a questionnaire, along with basic information about the §6217 program, was mailed to all 213 communities within the §6217 program area. Planning departments or planning boards in each community were targeted wherever possible. Followup mailings in December 1992, and February 1993 resulted in an overall response rate of approximately 75% (with 163 of 213 communities responding).

The survey asked a wide range of questions to each program community to ascertain:

(1) Efforts in place already to protect environmental resources;
(2) Environmental "vulnerability": dependence on in situ groundwater supplies, septic tanks, etc.;
(3) Economic vulnerability such as: dependence on tourism, commercial fishing, general economic indicators;
(4) Current technical capacity: e.g., professional technical staff available to contribute to future NPS management in each community.

TECHNICAL TASKS: DEFINING THE RESOURCE SYSTEM

To begin mapping out a management strategy, the first step is obviously defining the resource system itself. Conceptually, the resource definition step in the watershed management process can be broken into a set of discreet tasks which are summarized below.[20]

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[20] The specific tasks included in the four-step management process are the product of integrating a number of sources. Actual watershed assessment reports from the Puget Sound region in Washington State have been used for this purpose (Clallam County WQO 1992; Puget Sound RBT 1990; Piper's Creek WMC 1990); Guidance published

TABLE 4-1

SUMMARY OF RESOURCE DEFINITION TASKS IN WATERSHED-BASED NPS MANAGEMENT

- **IDENTIFY WATERSHED PHYSICAL CHARACTERISTICS**
  - o General setting (name, size, administrative boundaries)
  - o Current Land-use within the watershed
  - o Land-cover, including vegetation
  - o Geology, soils
  - o Topography
  - o Hydrology/delineation of watershed boundaries

- **CONDUCT A BUILDOUT ANALYSIS UNDER CURRENT LAND-USE REGULATIONS**

- **IDENTIFY AREAS OF CRITICAL ENVIRONMENTAL CONCERN**
  - o Surface Waters
    - Habitats: endangered/threatened species
    - Outstanding resource waters
    - Critical riparian habitats (wetlands)
  - o Groundwater
    - Water supplies
    - Groundwater recharge areas

- **IDENTIFY BENEFICIAL USES OF THE RESOURCE SYSTEM**
  - o Economic
    - Fisheries
    - Irrigation
    - Tourism
    - Domestic water supplies
    - Industrial water supplies
    - Influence of water quality on real estate values

    Other Benefits
    - Local recreation
    - Wildlife habitats
    - Hydroelectric power
    - Navigation

- **IDENTIFY KEY SOCIO-ECONOMIC CONDITIONS**
  - o Current demographics
  - o Employment conditions by sector
  - o Sources of local government revenue

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by U.S. EPA (1992a; 1992b), USDA Soil Conservation Services (1986), and Massachusetts DEP (1993). It is apparent that significant "gray areas" exist, for example, between defining the resource and proving harm. The reader should note that the tasks involved in the management process could easily be rearranged to suit specific conditions.

IDENTIFY WATERSHED PHYSICAL CHARACTERISTICS

Proper management practices require the clear delineation of the watershed (or subwatershed) to be managed. Watersheds have boundaries. Pollutant inputs to the system begin and end at some point which can be hydrologically determined. The process of characterizing the hydrological properties of a watershed system is often referred to as comprehensive watershed mapping.

Surface and subsurface geology and soil types are important to consider due to extreme differences in the infiltration capacity of different soil types. The generation of runoff, for example, is in part a function of the infiltration capacity of the soil type and intensity of rainfall.[21]

Similarly, subsurface topography, or contours, should be mapped to determine the direction of groundwater flows, which may or may not match surface flow direction. Areas of recharge for public wells should be included in the comprehensive map. These can act as entry points for contamination in groundwater which eventually discharges at the surface.

Mapping current land-use is critical. Areas of impervious surface can radically alter the hydrology of a region. For example, parking lots increase surface runoff while simultaneously diverting natural groundwater infiltration. Significant levels of contaminants from automobiles can accumulate on these surfaces, so paved and other impervious surfaces also act as potential source areas for NPS pollution. Likewise, vegetation can intercept rainfall, and removing vegetation can result in higher levels of runoff. Wetlands and ponds can act as natural storage areas for runoff and remove pollutants at the same time. Altering these can influence NPS contaminant loads.

The comprehensive mapping exercise places on the page critical components of the hydrologic system, both natural and man-made, while at the same time delineating

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[21] Infiltration capacity refers to the amount of water which can be absorbed by soils per unit of time.

the system for management purposes. In a sense it assigns responsibility for the care of the watershed by identifying those who use it. Maps are the first step in predicting potential impacts of future development and identifying existing potential sources of pollution which eventually are discharged to surface water.

Comprehensive watershed mapping is typically beyond the reach of staff working in municipal government, particularly in the numerous small towns within the CZARA program area. Particularly with regard to groundwater flows, significant expertise is needed to complete the mapping exercise. While it is possible to obtain much of the information needed from existing sources, getting this information in a useable form is difficult, however, and would require a great deal of commitment and time from those involved.[22]

Forty-one percent of the program communities who responded to the CZARA survey administered in Massachusetts indicated that they had completed the process of mapping their watersheds. It should be noted that the survey could not specify each component of a "comprehensive watershed map" when asking the question. It is likely therefore that this figure is somewhat overstated. Many of the communities which responded "yes" to this question probably have some level of mapping completed, but it is likely that the maps do not contain all of the information outlined above.

Further, there is limited usefulness of a watershed map which essentially ends at the municipal boundary. To the extent that the maps which have been completed depict only surface and subsurface features within the town boundaries, these will have to be pieced together with those of neighboring towns in order to take a true watershed approach to NPS management.

Such a cut and paste exercise would be made much simpler, and would likely be more accurate if the process could be automated through the use of a computer-based Geographic Information System (GIS). GIS allows for digital storage of maps,

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22 The "Mega-manual" currently being developed by the Massachusetts Department of Environmental Protection (MA DEP 1993) contains a section which describes how communities can obtain some of the information included in a comprehensive watershed map (from existing sources, such as USGS topographic maps, Water Atlases, etc.).

along with data referenced spatially. Fewer than 20% of the survey respondents have any kind of GIS running in their town. An additional 4% are in the process of developing a GIS. Linking adjacent watershed maps of towns or cities for purposes of a complete watershed assessment would be very tedious given this lack of computing resources.

CONDUCT A BUILDOUT ANALYSIS UNDER CURRENT LAND-USE REGULATIONS

The level of pollution is often a function of the number of people within the watershed and/or how these people use the land. Population density is as important as the land-use mix, and the ability to forecast populations with adequate certainty is critical in anticipating pollution problems.

As we saw in the preceding case study, the buildout analysis is an important and powerful tool in evaluating future NPS problems. It involves identifying potential housing and population densities under current zoning. It assumes that each parcel of land will be developed to its fullest density allowable under current land-use regulation. The buildout analysis can be a tedious process and requires a great deal of information to do properly. Tax assessor's maps are often used as the base, overlaid by current zoning. The buildout analysis rests upon a detailed and accurate inventory of what land is already developed and which parcels are vacant and developable. The process can be hampered to the extent that this information does not pre-exist in useable form.

The result of the buildout analysis is an estimate of future expected population densities within the study area. I discuss below how this can be an important input variable in various modeling exercises in predicting harm from NPS pollution. The general steps in a buildout analysis are described in Appendix D.

Respondents of the program area survey indicated that only 55% of the program communities had completed a buildout analysis, in whole or in part. The absence of professional staff and computer-based geographic information systems in these communities will hamper future efforts at internally generating these studies.

AREAS OF CRITICAL ENVIRONMENTAL CONCERN

A watershed assessment must include identification of critical ecological sub-regions. These shelter the living resources whose health and welfare largely influence the survival of the watershed system as a whole.

An explanation of how this takes place would fill volumes of text in the fields of general and aquatic chemistry, ecology, biology, botany, hydrology, soil science, and innumerable subspecializations. It is enough to point out here that certain geographic areas within a watershed contribute more to the waste-processing capacity than others. Riparian habitats, the edges of rivers and streams, may include freshwater wetlands. Coastal wetlands, eelgrass beds, and saltmarshes are home to a number of plant species which are capable of "uptake" of a number of contaminants, including excess nutrients, and in some cases heavy metals such as lead. Eel grass meadows, for example, serve multiple purposes. They serve as nurseries for juvenile fish, habitats for adult shellfish (including the bay scallop), beneficial sediment traps, and filters against pollution, taking up nutrients and other contaminants (Mass. Audubon Society 1992: 15). Yet when nitrogen levels exceed the capacity of the receiving areas to process them, eelgrass meadows are lost, along with these multiple benefits.

The survey administered to the §6217 towns asked if they had completed mapping of local wetlands within their jurisdiction. Approximately 52% said that they had completed wetlands mapping. Another 10% had completed wetlands mapping in part.

BENEFICIAL USES OF THE RESOURCE SYSTEM

This study presumes that the more people whose livelihoods are dependent upon the watershed's waste processing capacity, the greater the concern over its health and welfare. Survey data concerning these factors are highlighted in my discussion of political factors in Chapter 5.

This part of defining the resource system gets directly to the issue of interests shared by those using the watershed. It asks about the important human activities which are dependent upon the health of the watershed and the quality of the waters within the system. Activities ranging from fishing and tourism to recreation by locals can propel political action on pollution issues at the local level. Threats to water supplies are likely to be even more compelling. The potential effects of water quality on real estate values is an area of concern in many communities, but one which does not receive as much attention as it should.[23]

Local officials and citizens probably have a good intuitive sense of the beneficial uses of a watershed. Ordering and quantifying these issues is another matter however.

SOCIO-ECONOMIC CONDITIONS

In part, this step in the resource definition process serves to quantify the benefits of watershed protection. Identifying important economic activities within the watershed will, as a by-product, produce data on direct economic dependence on resource system.

Demographic forecasting can be a valuable asset in environmental land-use management. Just as a buildout analysis can predict future densities, population forecasting can work to estimate future needs with regards to housing, employment, and can shed light on the expected value of the revenue base. All of these factors can be used in environmental decision-making at the local level, particularly by highlighting direct *future* economic dependence on the resource system.

IDENTIFYING HARM TO THE RESOURCE SYSTEM

This section discusses the second step in the NPS watershed management process presented in the previous chapter: the underlying concepts behind identifying harm due to NPS pollution.

Table 4-2 summarizes key characteristics of the wide variety of pollutants

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[23] Mass Audubon (1990) included a brief discussion of this issue in their *Watersheds Decisions* publication, offering figures on the impact of degrading ground water quality on real estate values in Minnesota.

which are common to nonpoint sources. These include: sedimentation, excess nutrients, organic and inorganic toxic chemicals, salts, as well as disease carrying pathogens.

The variety of pollutants potentially generated by nonpoint sources is important to consider here for two reasons. First is that each contaminant class is associated with specific types of environmental harm. Benefits shared by users of the watershed resource may or may not be threatened by NPS pollution, depending on which specific interest is being considered, and which contaminant group is indicated as a problem.

Second, the type of contaminant will have to be considered when it comes to taking cooperative action to either restore the watershed resource or prevent harm from occurring. Certain management options are only effective for specific contaminants and ineffective for others. A setback may work against bacteria transported via groundwater, but viruses may be capable of traveling with groundwater flow much further in the subsurface due to their smaller size (Heufelder 1988).

TABLE 4-2
SUMMARY OF PRIMARY NPS CONTAMINANTS
AND THEIR POTENTIAL ENVIRONMENTAL EFFECTS

CONTAMINANT CATEGORIES/EXAMPLE	NONPOINT SOURCE	TYPE OF POTENTIAL HARM
Sediment	Agriculture; Construction; earth removal; mining; highway maintenance	Increased turbidity which can reduce primary productivity in waters; habitat destruction; interference with navigation; increased flood potential
Nutrients o Phosphorous o Nitrogen	Fertilization of lawns, crops; livestock/pets; septic systems; waterfowl	Excess algal growth (blooms) leading to oxygen depletion; increased turbidity; destruction or alteration of habitats; water supply contamination
Toxics o Oil and other petroleum products o Household chemicals o Pesticides o Heavy Metals (e.g., lead, mercury)	Landfills; junkyards; underground storage tanks; agriculture; lawn maintenance; runoff from pavement; household septic disposal; boats; marinas	Potential accumulation in sediments with risk to bottom feeders; potential for bioaccumulation; contamination of water supplies including potential carcinogenic effects
Chlorides (Salts)	Ice and snow removal operations from roads and other paved surfaces and sidewalks	Toxic to aquatic organisms at high levels (especially in fresh water)
Pathogens o Bacteria o Viruses	Septic systems; livestock; pet waste	Swimming restrictions; shellfish closures; water supply restrictions due to introduction of disease-carrying organisms

Source: Adapted from MA DEP (1991) and Schueler (1987)

Evaluating *existing* harm from these contaminants within the watershed management model is different from *predicting* future harm. These differences are highlighted in the discussion below.

IDENTIFYING EXISTING HARM

The simplest means of evaluating harm is through visual inspection. By "walking the watershed" it is possible to identify water quality problems without the aid of measurement or modeling tools. The effects are apparent, and indicators such as water clarity, algal or aquatic weed growth, and various suspended debris can be used. Odor can also serve as a direct indicator of water quality problems. Episodes such as fish kills are more dramatic visible indicators of contamination.

An absence of visible indicators does not indicate an absence of harm. The impacts of many chemical constituents can be subtle, and can occur at concentrations which are not necessarily detectable by visible indicators. Water must be sampled and analyzed in these cases to detect the presence of contaminants and to determine their concentration in water to evaluate the magnitude of threat they pose.

If watershed-based decisions are to be based on harm, or potential harm, the water quality data must be made available to local decision-makers and other interested parties. The expense and level of technical expertise involved in collecting and analyzing such data make it impractical for these efforts to be conducted at the local level.[24]

Water quality assessment is therefore done through a centralized effort at the state level. Under the Federal Clean Water Act §305(b) the Massachusetts Department of Environmental Protection (DEP) Division of Water Pollution Control is charged with collecting such data for inland rivers/streams, lakes, and marine coastal waters. This latest state-wide water quality assessment indicates that NPS pollution is causing significant harm to assessed rivers, lakes, and coastal waters. Urban and "non-urban" runoff accounted for over 40% of the river miles which did not attain water quality goals (broadly termed "fishable and swimmable" conditions). More than half of marine waters in "non-attainment" were classified as such due to NPS urban runoff/storm sewers (MA DEP 1993a).[25]

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[24] That is not to say that "citizen monitoring" programs are not potentially valuable, given that clear protocols are developed for sample collection, storage, and transport to suitable analytical facilities.

[25] The latest 305(b) report (MA DEP 1993a) indicated that only 20% of the Commonwealth's river miles had been assessed, but these included all principal mainstream rivers (p. 1). Virtually all of the marine waters had been evaluated for some

MCZM §6217 program staff are currently working with DEP to improve geographic referencing of water quality data, and provide communities and regional CZM program coordinators with detailed assessments of their areas (J. Smith 1993). Also, Massachusetts DEP recognizes the fundamental need for expanding water quality monitoring throughout the Commonwealth (MA DEP 1993a).

The concentration of many contaminants is not the only factor which needs to be considered when evaluating harm (or potential harm). The amount of time the contaminant remains in the water body (residence time) or suspended in the water column, whether or not it is deposited in sediments, and various factors concerning the receiving waters such as pH, flushing time[26], and the uncertain effects that chemicals may have on one another all are relevant to the task.

The evaluation of harm, both existing and future, is of course subject to the constraints of scientific knowledge. There are many areas, particularly toxics, where we simply don't know about potential effects. Often these chemicals are introduce in combinations. Their possible effects on each other and on the environment is not well understood.

In summary, evaluating existing harm is a highly technical exercise. The watershed community will be heavily reliant on technical assistance to do it properly.

PREDICTION: IDENTIFYING FUTURE HARM

Predicting harm is the goal of the environmental modeling. For our purposes, a "model" can be described as the integration of certain concepts assumed to be relevant to the outcome being studied, and arranging them in such a way as to emulate reality. They can range in complexity from a simple picture or a flow chart, to complex mathematical models integrating hundreds, even thousands of variables.

Modeling for the sake of prediction requires a certain level of familiarity with

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category of pollutant.

[26] Flushing time is the amount of time it takes for a water body such as an embayment to fully exchange its capacity through tidal action or other flows.

what is being studied. This is where a thorough watershed assessment can be extremely useful. Information on surface and groundwater flows, soil types, population densities, economic and demographic trends can all be used as inputs into a model designed to evaluate future impacts of pollution generated within the watershed. All of these inputs are provided in the core evidence of researchers on the causes of harm.

The complexity of the task becomes clear when we recognize that many of these model inputs are themselves the result of modeling exercises (e.g., groundwater flows, or demographic projections). In the absence of "hard" input values, certain assumptions must be made to make the model work. The assumptions in the Buttermilk Bay methodology included assumptions for the amount of effluent generated by a typical onsite septic system, based on the number of rooms in the home that it serves. The next step was to assume a certain level of nitrates in each unit of effluent from the septic system. Adopting such parameters becomes extremely complicated when dealing with toxins such as volatile organics, so much so that risk assessments performed at hazardous waste sites often ignore the possibility of chemical transformation or degradation over time, assuming constant chemical concentrations for the entire modeled exposure period (U.S. EPA 1989).

This is not to say that simple models cannot be developed or used by non-specialists working from within the watershed community. USDA Soil Conservation Service, for example, has developed a model, useable with any PC spreadsheet application, known as "Technical Release (TR) 55" which can provide rough estimates of storm water volume in small urban watersheds (USDA SCS 1986). The Washington Metropolitan Area Council of Governments has published the "Rational Method"a simple model which can predict the levels of some contaminants generated by certain types of development (Schueler 1987).

These models generally require, at a minimum, professional training in engineering and/or planning in order to be run properly, to interpret their results, and to translate those results to others. On that note, only 52% of the towns within the §6217 program area indicated that they had a professional engineer available for NPS management. Similarly only 45% had a professional planner, indicating another gap which needs to be filled somehow by technical assistance.[27]

ON CHOOSING HOW TO ADDRESS HARM

By now it is clear that watershed communities will be facing a complicated task. Each watershed community may face a variety of NPS problems, each requiring a specific approach to prevent harm, or restore water quality where it is already degraded.

A variety of options exist within the watershed communities' "tool-box." Appendix E presents two sample matrices (one each for structural and non-structural BMPs) used in evaluating the effectiveness of BMPs.

BMPs are classified as either structural or nonstructural. The selection approach is driven by a number of factors, including (Schueler 1987):

- The specific NPS problem to be addressed;
- The type and availability of funding (e.g., capital funding vs. operation budgets);
- Cost-effectiveness;
- Physical conditions in the area being served, including existing development;
- System maintenance requirements;
- Aesthetics.

Structural BMPs are primarily aimed at reducing stormwater volume as well as reducing contaminant concentrations in runoff and/or groundwater prior to discharge to receiving waters. They often require building concrete ponds to detain water, to enable sediment or other contaminants to settle out to the bottom. Runoff can be channeled so that contaminants are filtered out in soil prior to discharge to surface water. Structural BMPs can be installed with new development, or they can be

[27] Municipal planning budgets are decreasing, making enhancement of planning capacity in the near future unlikely. In the MCZM survey, 57% of the program communities stated that their planning budgets had been cut or cut drastically since 1990 (17% responded with "drastically").

retrofitted within the existing stormwater management network.

The selection and design of most structural BMPs requires basic skills in civil engineering. At the level of the individual municipality, to the extent that local Department of Public Works is available to design, or review design options generated by outside consultants in terms of published specifications, extensive input from a §6217 technical assistance program will not be required. With just over half of the communities with engineers available, this will still be an obstacle.

At the watershed level, structural BMPs must be coordinated in with efforts of other municipalities. This is an important role of technical assistance under the watershed management measure.

The science of selecting nonstructural BMPs is far less exact relative to structural solutions. These are measures "minimize the accumulation of pollutants on land surface when rainstorms are not occurring (reduction before transport in storm water)" (RI LMP 1990). A variety of land-use practices are possible NPS management measures, including such regulatory measures as zoning, subdivision control, site-plan review, and slope restrictions. Setbacks and other types of open-space reservation can also be used.

The same complexities surrounding characteristics of targeted pollutants plague the selection of nonstructural BMPs. Vegetated buffer zones between potentially affected water bodies and contaminant sources may work for phosphorous, but will not be effective against excess nitrogen loading. The effectiveness of public education, itself a nonstructural approach, is difficult to predict. While it is possible to address many of these issues through technical publications, the physical and political idiosyncrasies involved within specific watershed communities may necessitate substantial onsite technical assistance to make nonstructural measures effective. The problem of coordinating measures adopted among individual communities within the watershed is again highly technical.[28]

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[28] The potential for "takings claims" points to another important role of technical assistance in support of nonstructural measures. When land-use restrictions are utilized

The potential for a technological fix to some NPS problems looms large in Massachusetts and elsewhere, and communities will need technical guidance on deciding whether these solutions fit the problem. The most notable example is the proliferation of denitrifying onsite septic systems, which are currently being field tested at the Waquoit Bay Marine Reserve at Cape Cod. Where low-density zoning would have been used in the past to control excess nitrogen loading, these systems could allow for greater development densities as they remove nitrogen from septic effluent prior to subsurface discharge.

THE IMPORTANCE OF TECHNICAL ASSISTANCE IN GENERATING OPTIONS: AN ILLUSTRATION

Figure 4 highlights the spatial dimension of NPS pollution within the watershed. Sources are dispersed, and impacts on water quality are *cumulative*. In this simplified model, three towns are shown, each affecting multiple tributaries within a network of streams. These eventually converge draining into a small coastal embayment.

Assume that nitrogen loading is becoming a problem within this embayment. It is symptomized by isolated areas of eutrophication along its edges. ATown contributes to the problem due to extremely dense residential development served by septic systems. Groundwater discharging into tributaries 1 and 2 carry nitrates from ATown to the coast. Groundwater and overland flows transport nitrogen-based fertilizers from golf courses and residential lawns in BTown to streams 2 and 3. Agricultural activities in CTown also deposit fertilizers (and pesticides) into streams 2 and 3. As these tributaries converge and discharge to the embayment, so do the

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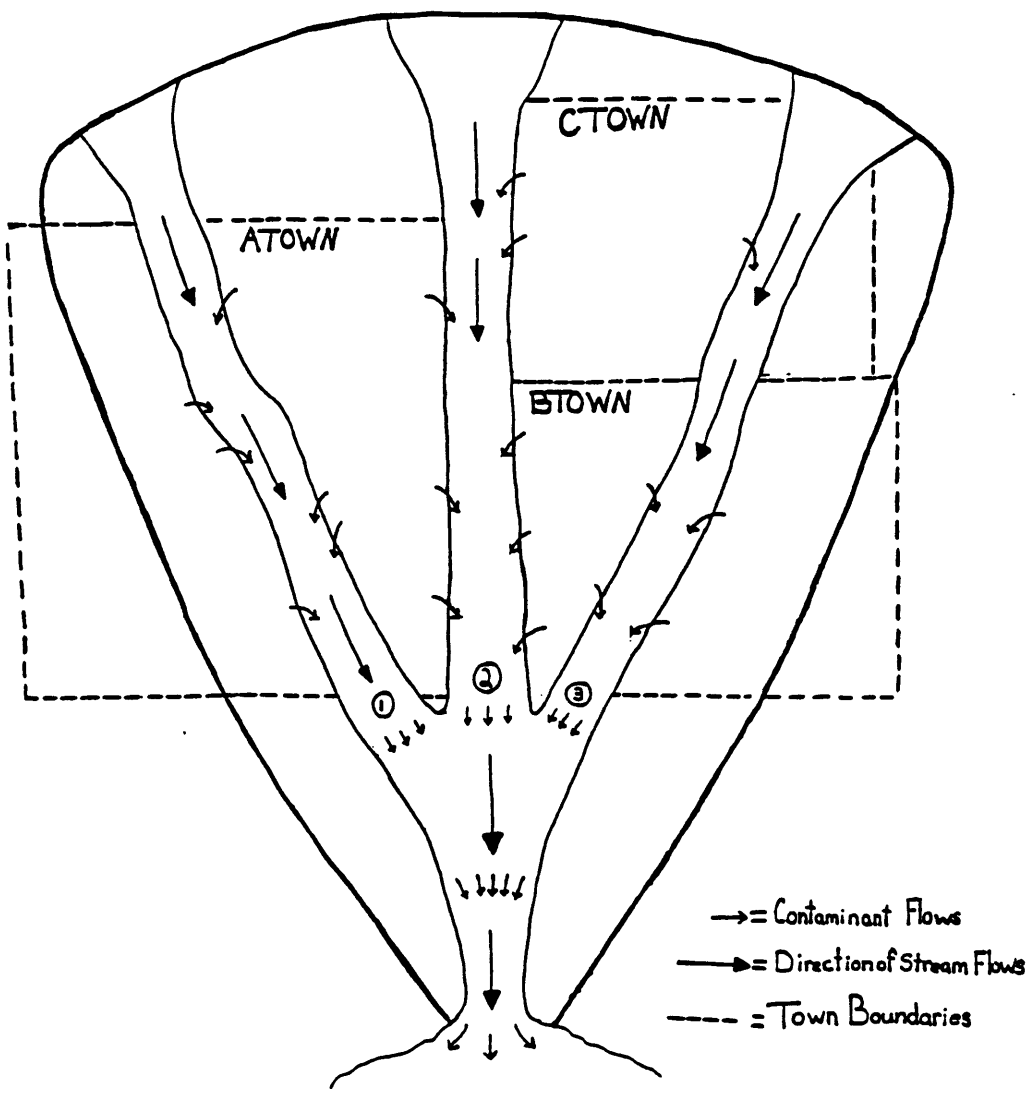
to manage NPS pollution, property owners may have grounds to claim a "regulatory taking" has occurred by the local government under the Fifth Amendment of the U.S. Constitution. The land-owner may argue in court that the change in regulation has left her without any economically viable use of her property. An excellent summary of the takings issue as it related to environmental land-use regulation is presented in U.S. EPA's (1992c) *Protecting Coastal and Wetlands Resources: A Guide to Local Governments* (Appendix D).

FIGURE 4

A HYPOTHETICAL WATERSHED



contaminants carried by them.

This simplified model leaves out a number of complex physical, chemical, and biological processes at work prior to discharge to embayment (e.g., uptake of nitrogen by aquatic plant life within each tributary). It serves, however, to illustrate the main point. The three towns potentially contribute to, and suffer from, a single problem.

To illustrate the advantage of these three communities working together to solve the problem, let us assume that a detailed modeling exercise has been conducted of current conditions within the watershed. Like at Buttermilk Bay, the study determines that a maximum of 1,000 additional residential units can be built within the watershed before nitrogen loading exceeds the embayment's assimilative capacity for the contaminant. Under current zoning however ATown will allow up to 750 units, BTown 500 units, and CTown is closer to full buildout. Undeveloped land will only support an additional 250 units under current zoned densities. The total buildout potential of all three (1,500) exceeds the watershed's capacity by 500 units.

In this simplified example, a number of choices are available to solve the problem. One choice is for ATown to bear the full burden, downzoning undeveloped land (decreasing potential density) to 250 units. BTown on the other hand could allow for no additional development. This would similarly eliminate 500 future units, also solving the problem completely. CTown is unable to take this approach as it only has a maximum of 250 units to work with. It *must* work in concert with one of the other communities to contribute effectively to the solution.

It is neither just nor logical for any one of the three towns to bear the full burden. Modifying local zoning is politically contentious. Each community must also pursue its own agenda concerning local economic development.

If both the problem and the solution are viewed as a *system* however, the burden can be shared by all. This would serve to lower economic and political costs borne by each community while meeting the goal of preserving water quality in the embayment. Under this approach all three towns could agree to decrease potential density by 175 units, eliminating a total of 525 units.

Since this option eliminates 70% of CTown's remaining development potential they may not favor this approach. Instead it could adopt other means of contributing to the effort. It could adopt performance standards which would force future developers to install new technology for dealing with septic disposal (e.g., denitrifying septic systems, or small package treatment plants), an option which in fact may be available to all three communities.

There is a mixed bag of tools to solve the problem. Technical assistance plays a key role in such a coordinated effort by appropriately identifying and siting options within the watershed. If the right type of assistance is provided, such coordination can help share the burden of NPS management among the watershed community, minimizing both economic and political costs. The political importance of technical assistance in coordinating options will be discussed in detail in the chapter which follows.

THE TECHNICAL ASPECTS OF TAKING ACTION

Once a path is chosen by a community in coordination with the other resource users, getting the solution installed on the ground is the next step. All of the information generated and decisions made are brought to bear on the installation process. From a technical standpoint, there are distinct differences in how structural (engineered) solutions are implemented versus nonstructural practices.

Technical assistance is likely to be needed in selecting the appropriate structural BMP. Once a structural BMP is selected, however, there are 4 key factors in ensuring that it is effective at managing NPS pollution. These include:

- Proper siting
- Proper Design
- Proper Construction
- Adequate Maintenance Practices

In the absence of local engineering expertise, a state or regional technical assistance program or a consulting engineer will have to fill the gap. Ensuring proper maintenance following construction is particularly important. In Maryland, for example, a recent study of infiltration facilities noted that half the facilities were not functioning as designed, and two-thirds were in need of maintenance (Lindsey, et al. 1992). Establishing training programs for local stewards of structural BMPs should therefore be part of the §6217 technical assistance program.

Selection of nonstructural BMPs is a highly technical ask. Many watershed communities will need assistance in selecting and coordinating their efforts on this front.

Implementing nonstructural controls, such as changes in land-use regulation, requires technical assistance of a different sort to help in some of the technico-legal aspects of proposed changes. Further, legal issues surround bylaws and ordinances passed at the local level.

The specific language used in these local laws is key to proper implementation. Regulations should be clearly written, void of loopholes, and considerate of due process (U.S. EPA 1992c). Equally important is that standards set in these regulations must be scientifically reviewed to protect the health and welfare of the watershed, and the public. *Does the proposed regulation do what it is supposed to do?* We saw how the BBP program played this role at Buttermilk Bay in the previous chapter. Publishing model bylaws can be a very effective way of ensuring the legal integrity of proposed regulations, although the technical merits of the law should still be reviewed in terms of local environmental conditions.[29]

Public outreach and education, another key set of nonstructural management measures, is a specialized field. The §6217 program should be prepared to either, (1) conduct extensive public outreach within each affected watershed community, or (2) provide significant guidance to those communities in doing it on their own. This task is key to generating political support for watershed management.

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[29] See for example, *Sample Bylaws and Regulations*, a collection of model bylaws published jointly by U.S. EPA/MCZM Buzzards Bay Project and the Southeastern Regional Planning and Economic Development District (BBP 1989).

CHAPTER 5

POLITICAL FACTORS IN WATERSHED-BASED NPS MANAGEMENT IN MASSACHUSETTS

In many ways the Commonwealth of Massachusetts is an anomaly. It has been at cutting edge of some areas of environmental policy. The Jones Act, also known as the Wetlands Protection Act (MGL Chapter 131 §40; originally passed in 1963), was one of the first regulations of its kind in the country. The Toxics Use Reduction Act (MGL Chapter 21I) is a vanguard of state regulations to prevent pollution. Very recent amendments to the Massachusetts Superfund law (MGL Chapter 21E) point to a new direction in management of hazardous waste sites, with an emphasis on streamlining through privatizing the oversight of remedial activities.

Yet when it comes to regionalism and resource protection, Massachusetts is still in the dark ages. A long history of home rule in Massachusetts and weak county governments, particularly in the coastal regions, has made regional coordination of resource protection difficult. The role of the Regional Planning Agencies (RPAs) is purely advisory to its member communities.[30] With the exception of the legislature's creation of the Cape Cod Commission there is no state-level legislative impetus for regional coordination.

A NEW REGIONALISM IN MASSACHUSETTS

That is not to say that things are not changing. Increasingly towns in Massachusetts are looking for "partners with which to plan, purchase, and develop" (1000 Friends of MA 1992).

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[30] This is true with the exception of the Cape Cod Commission, which was granted more extensive power through special state legislation in 1990. These include approval power and incentives over the comprehensive planning process among its 15 member communities, and the ability to designate Districts of Critical Planning Concern in order to direct development.

Two state legislative committees are currently at work exploring ways to rearrange the "middle level" of government, setting boundaries and governing all aspects of land-use according to those boundaries. The legislation is due to be introduced in the Fall of 1993, and 5 different models are being considered, one which includes watersheds as the regional unit of governance (K. Preston 1993).

In addition to this movement to legislate regional growth management (referred to as "Growing Smart" by its promoters), there are a number of examples of voluntary regional coordination for environmental protection. The case of Buttermilk Bay presented above is an example of this. Others include the 32 watershed associations active in the state (Bickford and Dymon 1990), and an umbrella organization called the Massachusetts Watershed Coalition has also been formed to represent there collective interests (K. Preston 1993). On the North Shore, the Massachusetts Audubon Society has sparked the formation of the Essex County Regional Coalition to "strengthen the regional approach to environmental management" (MA Audubon Society 1992a).

The Executive Director of 1000 Friends of Massachusetts, a major player in promoting regionalism in land-use decision-making, attributes this emerging movement to an "expansion of the concept of home...the planet is getting smaller, and people are realizing that our actions have impacts beyond our boundaries" (K. Preston 1993). This growing sentiment complements the fiscal advantages in greater economy through sharing services.

One senior representative of the Metropolitan Area Planning Council, the RPA with close to 50% of the §6217 program communities, has characterized the Commonwealth's planning history as that of "351 fiefdoms surrounded by moats." Yet, there is hope and some evidence that home-rule is breaking down. A window of opportunity for regional approaches like watershed management appears to be opening. This is a key political factor to bear in mind.

THE DYNAMICS OF THE LOCAL POLITICAL PROCESS

Generalizing about relevant political forces and how to manage these in public policy can be difficult and dangerous. Coalitions are formed of seemingly disparate groups and often formed on the basis of fundamental differences in perceptions between groups. Town attitudes can change over time, as can administrations, creating an unstable political climate to work programs at the local level (M. Pillsbury 1993; L. Rafferty 1993). Relations among neighboring towns can suddenly worsen, and, over time improve again (L. Rafferty 1993). The interplay of these factors is difficult to see or to understand, much less predict.

The following discussion attempts to outline some of the political factors which will interface with technical assistance in the watershed management process, while recognizing that *each situation will be different.* This discussion is general, and aims at simply identifying some of the questions about these political factors when planning for and implementing NPS watershed management: without presuming definite answers.

POLITICAL FACTORS IN DEFINING THE RESOURCE SYSTEM

Defining the resource system includes delineation of the watershed boundary. It is a scientifically derived description of where we live, capable of redefining our sense of place. The awareness of where we live, the natural system(s), and the other human communities with which we cohabitate can be a powerful political tool.

There are 28 major watersheds within Massachusetts, and 1,800 small "subbasins." The Merrimack and Shawsheen river basin comprises almost 1,300 mi^2 in Massachusetts, the South Coastal basin comprises only 127 mi^2 (Bickford and Dymon 1990). The first important question to ask is what size to choose as the management unit. The bigger the watershed, the more individual communities, the greater the potential for divergence.

On one hand, one could argue that the number of communities is the key consideration, and dealing with a large number of communities at once would be problematic because of the wide range of interests reflected in such a multitude.[31] It is possible, however, to tailor the management scale downward to the level of subbasin which would limit the number of communities which must be coordinated.

On the other hand, a large number of communities may be better. The power of a small group which opposes change is relatively diminished; diluted in a way when involved with a larger group.

Defining the resource system is the step in the management process which identifies the benefits of water quality to the watershed community. It is the step which raises the awareness of common interests in protecting the resource system, and the benefits of protection which would be shared by the watershed communities.

Table 5-1 summarizes data gathered in the CZM §6217 program survey pertaining to dependence on the watershed and water quality.

TABLE 5-1
SUMMARY OF SURVEY DATA
BENEFICIAL USE/DEPENDENCE ON WATERSHED RESOURCE

BENEFICIAL USES	% §6217 COMMUNITIES DEPENDENT
Groundwater Supplies (1)	55%
Onsite Septic Disposal (1)	58%
Water-based Tourism (2)	34%
Commercial Fishing (2)	31%

(1)Figures represent the percentage of communities which indicated more than half of their households relied exclusively on this benefit.

(2)These figures indicate the fraction of communities which responded simply "yes" when asked if this was important in their community.

[31] I recognize that this, too is subject to variation. Effective watershed protection is not necessarily precluded when a large number of communities are brought together. For example, past experience at coordinating on other issues could influence outcomes.

In addition, streams and rivers are used for recreational purposes in 60% and 65% of the CZARA communities, respectively; lakes by 70% of the towns; and 36% of the communities have coastal waters within their jurisdiction which are used for recreation.

This is obviously just a sample of the potential benefits derived from the watershed resource. There is a whole range of public health, economic, and aesthetic benefits which may form the core of common interests within any given watershed community.

The possibility of multiple interests (benefits) is obvious. The potential for one community to identify more strongly with one component of the watershed benefits package is also likely. For example, a town nearer to the coast may be more concerned with protecting its tourism base, whereas a town within the same watershed, but slightly inland may be primarily concerned with its groundwater quality.

POLITICAL FACTORS IN ADDRESSING HARM

Although the Commonwealth is making strides towards regionalism, home rule still dominates the thinking in many communities throughout the state (M. Pillsbury 1993). With the wide variety of interests at stake within any given watershed community, it may prove difficult to identify solid, common ground. Recalling the example cited in the previous section, the most effective strategy may be to focus on that harm which affects those interests locally (M. Pillsbury 1993). In the coastal community, any technical assistance should be geared towards proving harm to near-coastal waters and the subsequent effects on the tourist industry. When working with the inland community, the best approach may be to focus on groundwater quality and potential public health impacts.

The ability of a watershed community to deal with multiple contaminants at once is another factor that must be gauged. Some towns may simply become overwhelmed by the process of dealing with a number of water quality issues at once (L. Rafferty 1993). The ideal second order outcome suggested in our watershed management model looks at this. Technical assistance, and other public outreach-type programs should work to increase both local technical and political capacity. In evaluating the outcome of the Buttermilk Bay case, we saw that the technical side of this improvement is hard coming for a variety of reasons.

Also, each town within the watershed community may simply be more or less risk averse than its neighbors. Here memory can play an important role. A community that has suffered from environmental effects in the past may be more receptive to preventing future harm.

The distinction between *restorative* measures, and those aimed at *preventing* future harm are important. Restorative management practices are often preceded by visible episodes. A direct threat to vital interests in the community may drive its efforts more readily. At the same time the costs to those responsible, if that can be determined at all, is often more direct when dealing with remediation. The direct nature of the costs associated with remedial action can generate resistance from those forced to pay (D. Janik 1993; J. Smith 1993).

Preventative measures do not offer the advantage of visibility, and communities may respond more slowly, if at all, to consequences which may be somewhere in the future.

Finally, the balancing of interests themselves may impact the perception of harm, or risk of harm. A developer resisting a new land-use regulation may find public sympathy at town meeting simply by pointing to the number of jobs that might be lost to the community (D. Ellis 1993).

POLITICAL FACTORS IN CHOOSING HOW TO ADDRESS HARM

As we saw in the previous chapter, there is a wide variety of potential impacts from NPS pollution. Depending on the contaminant in question, there is potential for choice in how the harm identified in the second step can be addressed. The restorative v. preventative dichotomy discussed above is also relevant here.

But perhaps the most important political factor in choosing the solution is the level of flexibility provided. This gets back to the three town example offered in the previous chapter. In some cases one proposed solution may not be politically feasible.

Funding may not be available, a common occurrence in an age where towns are barely able to keep their schools opened, and overrides of Proposition 2 1/2 are next to impossible to pass. Vested private interests may simply be too powerful to overcome, even in the face of strong coalitions formed around a seemingly wider public interest.

Wherever possible, a technical assistance program aimed at maximizing the prospects of implementation should maximize each community's options to cooperate with one another. If possible, non-structural solutions should be included in the tool box where there is no funding for capital intensive management practices. The potential for performance standards should be evaluated. If set properly, these standards could protect the resource from harm, while still allowing the flexibility that property owners need to keep costs down. Enforcing such standards at the local level is labor-intensive and may require unavailable experise. This would likely to be a major obstacle to using this approach under CZARA.

POLITICAL FACTORS IN ACTING TO ADDRESS HARM

A vote at town meeting is often required to change the management practices within the watershed community. By the time the vote is taken, all of the technical information has been generated, public meetings and presentations on the pollution issue have been held, members of various town boards, citizens' groups, and individuals have landed on one side of the issue, and it is voted upon.

Most of the towns within the §6217 program area (67%) have an "open town meeting" form of local government. The vote therefore hinges upon whoever happens to show up that night, which could be as little as only 5% of the town's registered voters (B. Parady 1993).

It is common (though not guaranteed) for citizens to grant deference to their town government, particularly in cases where the voters' interest is not directly affected by the proposed change (D. Janik 1993; H. Coggeshall 1993). In the words of one selectman on the Cape, "many people haven't even seen the warrant when they come to vote...If the Board of Selectmen, Planning Board, Finance Committee, and Board of Health all endorse an article, it is then likely to pass."

This illustrates an important point about targeting technical information. It is popular to focus on "public outreach" and "grass-roots" support in passing political change. In some cases, however, the general public may not care that much. This was the case at Buttermilk Bay. Once citizens realize that they will not be directly affected by proposed changes, they leave the processing of information to the elected officials.[32]

In cases where the impacts of a proposed rule change are not wide-spread (e.g., the number of stakeholders is limited), it may be better to focus technical assistance almost exclusively on town officials, convincing them of the problem, the merits of action, and the costs of inaction. In cases where the number of stakeholders is large, technical assistance (and public outreach) may have to extend down to the grass-roots level in order to prevent the town boards from bending to political pressure from those adversely affected by the change.

There is a difference also in identifying *stakeholders*, and identifying those individual communities which have *influence* (L. Rafferty 1993). For example, an individual, or a specific group (such as a particular board, or a private citizen) may be highly respected and capable of swaying votes simply by speaking in favor of a change at town meeting. We saw a lone selectman counter the opposition of the Planning Board in Wareham in the presentation of the Buttermilk Bay case.

One of the most important things to remember about taking action in watershed management is that things change in local politics, sometimes very quickly. One election can alter the path of a project for good. Recalling two characters from Buttermilk Bay, the Wareham selectman who gave the speech in support of the overlay district is now deceased. In Bourne, the Planning Board Chairman no longer holds his position. BBP staff and a former member of one Planning Board were convinced that the overlay district may not pass today. They cite the poor economy

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[32] A member of the Buzzards Bay Project staff pointed out that it is advisable to bring to town meeting a map with adequate detail to show individual voters whether or not proposed land-use changes impact their property (B. Rossinoff 1993).

and the aversion to any kind of regulation. The speed of the project is important given this unstable climate.

Finally, an arena is needed to coordinate NPS management efforts among multiple jurisdictions. There are two fundamentally different approaches, and the demands placed on technical assistance differ in each.

For simplicity I term the first one the "ad hoc" approach. We are familiar with form of technical assistance. It was exemplified by what we saw in the previous case study. Ties are less formal, and towns sharing the watershed may never sit down at the table together to discuss trade-offs and shared interests. In this model, technical assistance helps to generate information, but the technical assistance team may act as messengers as well. The coordination of management practices is likely to be done behind the scenes by the technical assistance team, approaching local government with ideas that it knows will work environmentally.

The second approach is to establish a "Watershed Management Committee" (WMC) to deal with pollution issues affecting a particular basin. In the Puget Sound region of Washington State, this approach has been mandated through rule-making by the Puget Sound Water Quality Authority (WSL Chapter 400-12 WAC; PSWQA 1989). Agencies and communities in Massachusetts are heavily involved in the Merrimack River Initiative, a U.S. EPA sponsored multi-state effort to deal with pollution affecting millions, based on the management committee approach (and a number of subcommittees).

The underlying premise is to provide a decision-making forum where all stakeholders, including local officials, agency representatives, technical experts, and citizens can work together in forming a consensus about management actions to address pollution issues. Studies are generated by the committee. Options are generated, and selected. The political obligations of the members are presumably reflected in a process resembling negotiation. Technical assistance is provided throughout the process of resource definition, assessing impacts, and selecting management alternatives.

CHAPTER 6

DESIGN PRINCIPLES FOR WATERSHED-BASED NPS MANAGEMENT

A number of decisions still need to be made concerning how the CZARA §6217 program will be implemented in Massachusetts. This paper has shown how crucial some decisions will be to the success of watershed-based NPS management, namely those concerning the §6217 technical assistance program. Implementing EPA's watershed management practices will require both expertise and local political support. The goal of this chapter is to present a series of ideas central to the success of technical assistance.

The ideas offered here are both design principles for technical assistance, and a call for further research. They point out what should be done to help guarantee the success of technical assistance under the watershed management measure. I do not presume to say exactly how each is to be accomplished. The question of "how" is one that should be taken up in further comprehensive studies. I hope to at least steer those interested in this topic in the right general direction.

Before concentrating on my recommendations for program design, I would like to highlight the potential for data gathering efforts like the one that MCZM and myself undertook. In spite of some format problems, and initial responses which were less than spectacular, it has proven to be a valuable tool in both outreach and program design. Such data can be used to characterize the technical assistance problem both statewide, within watersheds, and even at the subbasin level.

DESIGN PRINCIPLES FOR TECHNICAL ASSISTANCE UNDER WATERSHED-BASED NPS MANAGEMENT

DESIGN PRINCIPLE 1: ***Assume nothing about the subject watershed community.***

This appears obvious at first glance. It is however, the root principle; the one which carries the most weight in the big scheme of things. All communities are different, and the interactions between individual towns and cities are equally difficult to anticipate.

Politically, both allies and enemies come from unexpected places. As we saw in the Buttermilk Bay case study, it is not possible to fully anticipate events in local politics. What worked in watershed Z may not work in watershed Y; quite possibly because two political players within watershed Y resent each other, whether they be individuals or entire towns.

Things could go in the opposite (positive) direction of course. I pointed out the initial skepticism of the BBP staff when embarking on the project at Buttermilk Bay. Yet the Town of Plymouth cooperated fully, with very little to gain from the whole affair.

One reason why this design principle is so important is that there has been considerable discussion about adopting a River Basin Team (RBT) concept for the Commonwealth (M. McQueen 1993).[33] A team of experts centrally located in the Commonwealth would provide technical assistance to watershed communities, one after the other (M. McQueen 1993). While the RBT idea should be applauded, and supported in full, there may be a tendency to approach things in packaged fashion because of heavy workloads, and pre-conceived ideas based on passed experiences. An RBT would enhance its effectiveness if it was fully armed with knowledge of

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[33] The RBT concept originates from Washington State's Puget Sound Region. A multi-disciplinary team of technical experts is assembled, anchored by the USDA Soil Conservation Service. One state RBT assists a number of local and county governments (and watershed management committees) in assessing watersheds and NPS problems.

individual local political dynamics and idiosyncracies.

DESIGN PRINCIPLE 2: ***Technical assistance should provide information which is adequate in both quantity and quality.***

The amount and quality of information required to modify management practices will vary with the political context. A rule of thumb is that where private interests are lined up in opposition, a more comprehensive technical assistance effort will improve the prospects for change.

At Buttermilk Bay we saw that the overlay district, with a few minor exceptions was not a "hard sell." Memory of previous environmental episodes, legitimate economic interests in preserving the bay, and a regional ethic on the part of Plymouth made BBP's job much easier. Informants involved in local government, however, continually applauded the outreach and assistance efforts of the BBP staff. They presented their evidence in clear, concise language before town boards, and were prepared to support the initiative at town meeting with similar efforts if needed.

DESIGN PRINCIPLE 3: ***Technical assistance should be streamlined as much as possible to expedite rapid political action***

Political support and political momentum are two key assets in watershed management. Study, design, funding, and implementation of watershed-based NPS programs should be done as quickly as possible to capitalize on existing political support. A keen eye should be kept on the local political calendars, e.g., the next election for town boards, town meeting dates, etc.

DESIGN PRINCIPLE 4: ***Focus on the right interests***

The first step in the technical assistance effort should be the identification of environmental issues that the watershed community cares about. An attempt should also be made to determine how deep this concern runs within the community at large, and in individual towns. Protection of groundwater may be the most effective entry point in one town, or watershed. Shellfishing, or tourism may be perceived as more important in others.

Interests which may be threatened by NPS pollution should be identified at the most local level possible. These localized interests can then be coordinated at the regional level, translated into protection for the watershed as a whole.

DESIGN PRINCIPLE 5: *Find the right audience*

Political influence can be subtle, a latent force that is none the less important to consider. Stakeholders, those with a direct interest (either pro or con) in changing management practices can have influence. But influence is not always limited to those affected by the change. An individual can wield political power simply because he or she is respected in the community, regardless of whether the person is directly affected.

Also, the sway of various town boards should be considered. We saw at Buttermilk Bay that in all three towns, the citizens voted with the Boards of Selectmen. The BBP staff was successful in getting the zoning amendments without an extensive *public* outreach effort. Instead they focused on the selectmen, planning, and other boards; leaving it up to them to sway the vote at town meeting. By effectively targeting the information, the BBP staff saved time and its own resources.

DESIGN PRINCIPLE 6: *Find the right arena*

Relationships between neighboring towns can be good or bad, and even that can change over time. The decision to approach watershed management through a formal committee structure, or as an ad hoc process, is dependent upon a number of factors. First to consider are these relations. Is there a legacy of cooperation, or have relations been strained?

If the prospects for getting towns to work together are very bleak, that does not preclude effective coordination. It could be effectively coordinated by the technical assistance team, as we saw at Buttermilk Bay. Such efforts take more time, in that individual towns must be met with one at a time. This approach also precludes positive outcomes associated with emerging consensus-decision making techniques.[34]

DESIGN PRINCIPLE 7: ***Technical assistance should provide choice for addressing harm wherever possible***

This issue has been thoroughly covered throughout this thesis (see for example the hypothetical case provided in Chapter 4). In summary, increasing options tends to increase the prospects for cooperation. Technical assistants should be wary, however, of generating too many options. This could result in splintering and eventual political paralysis due to the wide range of choice, and divergent interests associated with one solution over another.

As I state at the beginning of the chapter, the CZARA technical assistance program has not yet been designed by MCZM policy-makers. I offer these design principles in hopes of informing any watershed management technical assistance program, whatever its final form.

If we are to come to grips with the divergence between natural systems and human governance, we must somehow make policy-making more rational. This notion may be dismissed by some as an ideal; completely ignorant of the primacy of politics.

I would argue instead that we must learn to effectively work the political system with the information we gain through technical expertise. As we improve our knowledge of both natural and political systems, we get that much closer to uniting them, if we can learn how to better translate between the two.

[34] See L. Susskind (1987) *Breaking the Impasse* for a thorough discussion of how CDM can be used effectively in public dispute resolution.

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APPENDIX A

U.S. EPA GUIDANCE SPECIFYING THE WATERSHED MANAGEMENT MEASURE

(Source: U.S. EPA 1993)

CHAPTER 1: Introduction

I. BACKGROUND

This guidance specifying management measures for sources of nonpoint pollution in coastal waters is required under section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). It provides guidance to States and Territories on the types of management measures that should be included in State and Territorial Coastal Nonpoint Pollution Control Programs. This chapter explains in detail the requirements of section 6217 and the approach used by the U.S. Environmental Protection Agency (EPA) to develop the management measures.

A. Nonpoint Source Pollution

1. What Is Nonpoint Source Pollution?

Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification. Technically, the term "nonpoint source" is defined to mean any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act. That definition states:

> The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

Although diffuse runoff is generally treated as nonpoint source pollution, runoff that enters and is discharged from conveyances such as those described above is treated as a point source discharge and hence is subject to the permit requirements of the Clean Water Act. In contrast, nonpoint sources are not subject to Federal permit requirements. The distinction between nonpoint sources and diffuse point sources is sometimes unclear. Therefore, at several points in this document, EPA provides detailed discussions to help the reader discern whether a particular source is a point source or a nonpoint source. Refer to Chapter 2, Section II.B.1 (discussing applicability of management measures to confined animal facility management); Chapter 4, Section I.E (discussing overlaps between this program and the storm water permit program for point sources); and Chapter 5, Section I.G (discussing overlaps between this program and several other programs, including the point source permit program).

Nonpoint pollution is the pollution of our nation's waters caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural pollutants and pollutants resulting from human activity, finally depositing them into lakes, rivers, wetlands, coastal waters, and ground waters. In addition, hydrologic modification is a form of nonpoint source pollution that often adversely affects the biological and physical integrity of surface waters. A more detailed discussion of the range of nonpoint sources and their effects on water quality and riparian habitats is provided in subsequent chapters of this guidance.

2. National Efforts to Control Nonpoint Pollution

a. Nonpoint Source Program

During the first 15 years of the national program to abate and control water pollution, EPA and the States have focused most of their water pollution control activities on traditional "point sources," such as discharges through pipes from sewage treatment plants and industrial facilities. These point sources have been regulated by EPA and the States through the National Pollutant Discharge Elimination System (NPDES) permit program established by section 402 of the Clean Water Act. Discharges of dredged and fill materials into wetlands have also been regulated by the U.S. Army Corps of Engineers and EPA under section 404 of the Clean Water Act.

As a result of the above activities, the Nation has greatly reduced pollutant loads from point source discharges and has made considerable progress in restoring and maintaining water quality. However, the gains in controlling point sources have not solved all of the Nation's water quality problems. Recent studies and surveys by EPA and by State water quality agencies indicate that the majority of the remaining water quality impairments in our nation's rivers, streams, lakes, estuaries, coastal waters, and wetlands result from nonpoint source pollution and other nontraditional sources, such as urban storm water discharges and combined sewer overflows.

In 1987, in view of the progress achieved in controlling point sources and the growing national awareness of the increasingly dominant influence of nonpoint source pollution on water quality, Congress amended the Clean Water Act to focus greater national efforts on nonpoint sources. In the Water Quality Act of 1987, Congress amended section 101, "Declaration of Goals and Policy," to add the following fundamental principle:

> It is the national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint sources of pollution.

More importantly, Congress enacted section 319 of the Clean Water Act, which established a national program to control nonpoint sources of water pollution. Under section 319, States address nonpoint pollution by assessing nonpoint source pollution problems and causes within the State, adopting management programs to control the nonpoint source pollution, and implementing the management programs. Section 319 authorizes EPA to issue grants to States to assist them in implementing those management programs or portions of management programs which have been approved by EPA.

b. National Estuary Program

EPA also administers the National Estuary Program under section 320 of the Clean Water Act. This program focuses on point and nonpoint pollution in geographically targeted, high-priority estuarine waters. In this program, EPA assists State, regional, and local governments in developing comprehensive conservation and management plans that recommend priority corrective actions to restore estuarine water quality, fish populations, and other designated uses of the waters.

c. Pesticides Program

Another program administered by EPA that controls some forms of nonpoint pollution is the pesticides program under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Among other provisions, this program authorizes EPA to control pesticides that may threaten ground water and surface water. FIFRA provides for the registration of pesticides and enforceable label requirements, which may include maximum rates of application, restrictions on use practices, and classification of pesticides as "restricted use" pesticides (which restricts use to certified applicators trained to handle toxic chemicals). The requirements of FIFRA, and their relationship to this guidance, are discussed more fully in Chapter 2, Section II.D, of this guidance.

B. Coastal Zone Management

The Coastal Zone Management Act of 1972 (CZMA) established a program for States and Territories to voluntarily develop comprehensive programs to protect and manage coastal resources (including the Great Lakes). To receive Federal approval and implementation funding, States and Territories had to demonstrate that they had programs, including enforceable policies, that were sufficiently comprehensive and specific both to regulate land uses, water uses, and coastal development and to resolve conflicts between competing uses. In addition, they had to have the authorities to implement the enforceable policies.

There are 29 federally approved State and Territorial programs. Despite institutional differences, each program must protect and manage important coastal resources, including wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitats. Resource management and protection are accomplished in a number of ways through State laws, regulations, permits, and local plans and zoning ordinances.

While water quality protection is integral to the management of many of these coastal resources, it was not specifically cited as a purpose or policy of the original statute. The Coastal Zone Act Reauthorization Amendments of 1990, described below, specifically charged State coastal programs, as well as State nonpoint source programs, with addressing nonpoint source pollution affecting coastal water quality.

C. Coastal Zone Act Reauthorization Amendments of 1990

1. Background and Purpose of the Amendments

On November 5, 1990, Congress enacted the Coastal Zone Act Reauthorization Amendments of 1990. These Amendments were intended to address several concerns, a major one of which is the impact of nonpoint source pollution on coastal waters. In section 6202(a) of the Amendments, Congress made a set of findings, which are quoted below in pertinent part.

> "1. Our oceans, coastal waters, and estuaries constitute a unique resource. The condition of the water quality in and around the coastal areas is significantly declining. Growing human pressures on the coastal ecosystem will continue to degrade this resource until adequate actions and policies are implemented.
>
> "2. Almost one-half of our total population now lives in coastal areas. By 2010, the coastal population will have grown from 80,000,000 in 1960 to 127,000,000 people, an increase of approximately 60 percent, and population density in coastal counties will be among the highest in the Nation.
>
> "3. Marine resources contribute to the Nation's economic stability. Commercial and recreational fishery activities support an industry with an estimated value of $12,000,000,000 a year.
>
> "4. Wetlands play a vital role in sustaining the coastal economy and environment. Wetlands support and nourish fishery and marine resources. They also protect the Nation's shores from storm and wave damage. Coastal wetlands contribute an estimated $5,000,000,000 to the production of fish and shellfish in the United States coastal waters. Yet, 50 percent of the Nation's coastal wetlands have been destroyed, and more are likely to decline in the near future.
>
> "5. Nonpoint source pollution is increasingly recognized as a significant factor in coastal water degradation. In urban areas, storm water and combined sewer overflow are linked to major coastal problems, and in rural areas, runoff from agricultural activities may add to coastal pollution.
>
> "6. Coastal planning and development control measures are essential to protect coastal water quality, which is subject to continued ongoing stresses. Currently, not enough is being done to manage and protect coastal resources.
>
> . . . .
>
> "8. There is a clear link between coastal water quality and land use activities along the shore. State management programs under the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.) are among the best tools for protecting coastal resources and must play a larger role, particularly in improving coastal zone water quality."

Based upon these findings, Congress declared that:

> "It is the purpose of Congress in this subtitle [the Coastal Zone Act Reauthorization Amendments of 1990] to enhance the effectiveness of the Coastal Zone Management Act of 1972 by increasing our understanding of the coastal environment and expanding the ability of State coastal zone management programs to address coastal environmental problems." (Section 6202(b))

2. State Coastal Nonpoint Pollution Control Programs

To address more specifically the impacts of nonpoint source pollution on coastal water quality, Congress enacted section 6217, "Protecting Coastal Waters," which was codified as 16 U.S.C. §1455b. This section provides that each State with an approved coastal zone management program must develop and submit to EPA and the National Oceanic and Atmospheric Administration (NOAA) for approval a Coastal Nonpoint Pollution Control Program. The purpose of the program "shall be to develop and implement management measures for nonpoint source pollution to restore and protect coastal waters, working in close conjunction with other State and local authorities."

Coastal Nonpoint Pollution Control Programs are not intended to supplant existing coastal zone management programs and nonpoint source management programs. Rather, they are to serve as an update and expansion of existing nonpoint source management programs and are to be coordinated closely with the existing coastal zone management programs. The legislative history indicates that the central purpose of section 6217 is to strengthen the links between Federal and State coastal zone management and water quality programs and to enhance State and local efforts to manage land use activities that degrade coastal waters and coastal habitats. The legislative history further indicates that State coastal zone and water quality agencies are to have coequal roles, analogous to the sharing of responsibility between NOAA and EPA at the Federal level.

Section 6217(b) states that each State program must "provide for the implementation, at a minimum, of management measures in conformity with the guidance published under subsection (g) to protect coastal waters generally," and also to:

(1) Identify land uses which, individually or cumulatively, may cause or contribute significantly to a degradation of (a) coastal waters where there is a failure to attain or maintain applicable water quality standards or protect designated uses, or (b) coastal waters that are threatened by reasonably foreseeable increases in pollution loadings from new or expanding sources;

(2) Identify critical coastal areas adjacent to coastal waters identified under the preceding paragraph;

(3) Implement additional management measures applicable to land uses and areas identified under paragraphs (1) and (2) above that are necessary to achieve and maintain applicable water quality standards and protect designated uses;

(4) Provide technical assistance to local governments and the public to implement the additional management measures;

(5) Provide opportunities for public participation in all aspects of the program;

(6) Establish mechanisms to improve coordination among State and local agencies and officials responsible for land use programs and permitting, water quality permitting and enforcement, habitat protection, and public health and safety; and

(7) Propose to modify State coastal zone boundaries as necessary to implement NOAA's recommendations under section 6217(e), which are based on NOAA's findings that inland boundaries must be modified to more effectively manage land and water uses to protect coastal waters.

Congress required that, within 30 months of EPA's publication of final guidance, States must develop and obtain EPA and NOAA approval of their Coastal Nonpoint Pollution Control Programs. Failure to submit an approvable program (i.e., one that meets the requirements of section 6217(b)) will result in a reduction of Federal grant dollars under the nonpoint source and coastal zone management programs. The reductions will begin in Fiscal Year 1996 (FY 1996) as a 10 percent cut, increasing to 15 percent in FY 1997, 20 percent in FY 1998, and 30 percent in FY 1999 and thereafter.

3. Management Measures Guidance

Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990 requires EPA to publish (and periodically revise thereafter), in consultation with NOAA, the U.S. Fish and Wildlife Service, and other Federal agencies, "guidance for specifying management measures for sources of nonpoint pollution in coastal waters." "Management measures" are defined in section 6217(g)(5) as:

> economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives.

The management measures guidance is to include at a minimum six elements set forth in section 6217(g)(2):

> "(A) a description of a range of methods, measures, or practices, including structural and nonstructural controls and operation and maintenance procedures, that constitute each measure;
>
> "(B) a description of the categories and subcategories of activities and locations for which each measure may be suitable;
>
> "(C) an identification of the individual pollutants or categories or classes of pollutants that may be controlled by the measures and the water quality effects of the measures;
>
> "(D) quantitative estimates of the pollution reduction effects and costs of the measures;
>
> "(E) a description of the factors which should be taken into account in adapting the measures to specific sites or locations; and
>
> "(F) any necessary monitoring techniques to accompany the measures to assess over time the success of the measures in reducing pollution loads and improving water quality."

State Coastal Nonpoint Pollution Control programs must provide for the implementation of management measures that are in conformity with this management measures guidance.

The legislative history (floor statement of Rep. Gerry Studds, House sponsor of section 6217, as part of debate on Omnibus Reconciliation Bill, October 26, 1990) confirms that, as indicated by the statutory language, the "management measures" approach is technology-based rather than water-quality-based. That is, the management measures are to be based on technical and economic achievability, rather than on cause-and-effect linkages between particular land use activities and particular water quality problems. As the legislative history makes clear, implementation of these technology-based management measures will allow States to concentrate their resources initially on developing and implementing measures that experts agree will reduce pollution significantly. As explained more fully in a separate document, *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, States will follow up the implementation of management measures with additional management measures to address any remaining coastal water quality problems.

The legislative history indicates that the range of management measures anticipated by Congress is broad and may include, among other measures, use of buffer strips, setbacks, techniques for identifying and protecting critical coastal areas and habitats, soil erosion and sedimentation controls, and siting and design criteria for water-related uses such as marinas. However, Congress has cautioned that the management measures should not unduly intrude upon the more intimate land use authorities properly exercised at the local level.

The legislative history also indicates that the management measures guidance, while patterned to a degree after the point source effluent guidelines' technology-based approach (see 40 CFR Parts 400-471 for examples of this approach), is not expected to have the same level of specificity as effluent guidelines. Congress has recognized that the effectiveness of a particular management measure at a particular site is subject to a variety of factors too complex to address in a single set of simple, mechanical prescriptions developed at the Federal level. Thus, the legislative history indicates that EPA's guidance should offer State officials a number of options and permit them considerable flexibility in selecting management measures that are appropriate for their State. Thus, the management measures in this document are written to allow such flexibility in implementation.

An additional major distinction drawn in the legislative history between effluent guidelines for point sources and this management measures guidance is that the management measures will not be directly or automatically applied to categories of nonpoint sources as a matter of Federal law. Instead, it is the State coastal nonpoint program, backed by the authority of State law, that must provide for the implementation of management measures in conformity with the management measures guidance. Under section 306(d)(16) of the CZMA, coastal zone programs must provide for enforceable policies and mechanisms to implement the applicable requirements of the State Coastal Nonpoint Pollution Control Program, including the management measures developed by the State "in conformity" with this guidance.

D. Program Implementation Guidance

In addition to this "management measures" guidance, EPA and NOAA have also jointly published *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*. That document provides guidance to States in interpreting and applying the various provisions of section 6217 of CZARA. It addresses issues such as the following: the basis and process for EPA/NOAA approval of State Coastal Nonpoint Pollution Control Programs; how EPA and NOAA expect State programs to implement management measures "in conformity" with this management measures guidance; how States may target sources in implementing their programs; changes in State coastal boundaries to implement their programs; and other aspects of State implementation of their programs.

II. DEVELOPMENT OF THE MANAGEMENT MEASURES GUIDANCE

A. Process Used to Develop This Guidance

Congress established a 6-month deadline (May 5, 1991) for publication of the proposed management measures guidance and an 18-month deadline (May 5, 1992) for publication of the final guidance.

EPA published the proposed guidance on June 14, 1991, and, in the interest of promoting the broadest possible consideration of the proposal by a wide variety of interested Federal and State agencies, affected industries, and citizens groups, provided a 6-month comment period. EPA received 477 public comments on the proposed guidance. In addition, EPA maintained an open process of consultation and discussion with many of the commenters and other experts. EPA's response to those comments, both written and oral, is reflected in the final guidance and is summarized in a separate document available from EPA entitled *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters: Response to Public Comments.*

In developing the final guidance, EPA continued to draw upon a diversity of knowledgeable sources of technical nonpoint source expertise by using a work group approach. Since the guidance addresses all nationally significant categories of nonpoint sources that impact or could impact coastal waters, EPA drew upon expertise covering the very wide range of subject areas addressed in this guidance.
Because experts in the field of nonpoint source pollution tend to specialize in particular source categories, EPA decided to form work groups on a category basis. Thus, in consultation with NOAA, the U.S. Fish and Wildlife Service, and other Federal and State agencies, EPA established five work groups to develop this guidance:

(1) Urban, Construction, Highways, Airports/Bridges, and Septic Systems;
(2) Agriculture;
(3) Forestry;
(4) Marinas and Recreational Boating; and
(5) Hydromodification and Wetlands.

Each of these work groups held many 1- or 2-day meetings to discuss the technical issues related to the guidance. These meetings, which included State and Federal non-EPA participation, were very helpful to EPA in formulating the final guidance. EPA, however, made all decisions on the final contents of the guidance.

B. Scope and Contents of This Guidance

1. Categories of Nonpoint Sources Addressed

Many categories and subcategories of nonpoint sources could affect coastal waters and thus could potentially be addressed in this management measures guidance. Including all such sources in this guidance would have required more time than the tight statutory deadline allowed. For this reason, Congressman Studds stated in his floor statement, "The Conferees expect that EPA, in developing its guidance, will concentrate on the large nonpoint sources that are widely recognized as major contributors of water pollution."

This guidance thus focuses on five major categories of nonpoint sources that impair or threaten coastal waters nationally: (1) agricultural runoff; (2) urban runoff (including developing and developed areas); (3) silvicultural (forestry) runoff; (4) marinas and recreational boating; and (5) channelization and channel modification, dams, and streambank and shoreline erosion. EPA has also included management measures for wetlands, riparian areas, and vegetated treatment systems that apply generally to various categories of sources of nonpoint pollution.

2. Relationship Between This Management Measures Guidance for Coastal Nonpoint Sources and NPDES Permit Requirements for Point Sources

a. Urban Runoff

Historically, there have always been ambiguities in and overlaps between programs designed to control urban runoff nonpoint sources and those designed to control urban storm water point sources. For example, runoff may often originate from a nonpoint source but ultimately may be channelized and discharged through a point source. Potential confusion between these two programs has been heightened by Congressional enactment of two important pieces of legislation: section 402(p) of the Clean Water Act, which establishes permit requirements for certain municipal and industrial storm water discharges, and section 6217 of CZARA, which requires EPA to promulgate and States to provide for the implementation of management measures to control nonpoint pollution in coastal waters. The discussion below is intended to clarify the relationship between these two programs and describe the scope of the coastal nonpoint program and its applicability to urban runoff in coastal areas.

b. The Storm Water Permit Program

The storm water permit program is a two-phase program enacted by Congress in 1987 under section 402(p) of the Clean Water Act. Under Phase I, National Pollutant Discharge Elimination System (NPDES) permits are required to be issued for municipal separate storm sewers serving large or medium-sized populations (greater than 250,000 or 100,000 people, respectively) and for storm water discharges associated with industrial activity. Permits are also to be issued, on a case-by-case basis, if EPA or a State determines that a storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States. EPA published a rule implementing Phase I on November 16, 1990.

Under Phase II, EPA is to prepare two reports to Congress that assess the remaining storm water discharges; determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges; and establish procedures and methods to control storm water discharges to the extent necessary to mitigate impacts on water quality. Then, EPA is to issue regulations that designate storm water discharges, in addition to those addressed in Phase I, to be regulated to protect water quality, and EPA is to establish a comprehensive program to regulate those designated sources. The program is required to establish (1) priorities, (2) requirements for State storm water management programs, and (3) expeditious deadlines.

These regulations were to have been issued by EPA not later than October 1, 1992. Because of EPA's emphasis on Phase I, however, the Agency has not yet been able to complete the studies and issue appropriate regulations as required under section 402(p).

c. Coastal Nonpoint Pollution Control Programs

As discussed above, Congress enacted section 6217 of CZARA in late 1990 to require that States develop Coastal Nonpoint Pollution Control Programs that are in conformity with this management measures guidance published by EPA.

d. Scope and Coverage of This Guidance with Respect to Storm Water

EPA is excluding from coverage under this section 6217(g) guidance all storm water discharges that are covered by Phase I of the NPDES storm water permit program. Thus EPA is excluding any discharge from a municipal separate storm sewer system serving a population of 100,000 or more; any discharge of storm water associated with industrial activity; any discharge that has already been permitted; and any discharge for which EPA or the State makes a determination that the storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States. All of these activities are clearly addressed by the storm water permit program and therefore are excluded from the coastal nonpoint pollution control program.

EPA is adopting a different approach with respect to other (non-Phase I) storm water discharges. At present, EPA has not yet promulgated regulations that would designate additional storm water discharges, beyond those regulated in Phase I, that will be required to be regulated in Phase II. It is thus not possible to determine at this point which additional storm water discharges will be regulated by the NPDES program and which will not. Furthermore, because of the great number of such discharges, it is likely that it would take many years to permit all of these discharges, even if EPA allows for relatively expeditious State permitting approaches such as the use of general permits.

Therefore, to give effect to the Congressional intent that coastal waters receive special and expeditious attention from EPA, NOAA, and the States, storm water runoff that potentially may be ultimately covered by Phase II of the storm water permit program is subject to this management measures guidance and will be addressed by the States' Coastal Nonpoint Pollution Control Programs. Any storm water runoff that ultimately is regulated under an NPDES permit will no longer be subject to this guidance once the permit is issued.

In addition, it should be noted that some other activities are not presently covered by NPDES permit application requirements and thus would be subject to a State's Coastal Nonpoint Pollution Control Program. Most importantly, construction activities on sites that result in the disturbance of less than 5 acres, which are not currently covered by Phase I storm water application requirements[1], are covered by the Coastal Nonpoint Pollution Control Program. Similarly, runoff from wholesale, retail, service, or commercial activities, including gas stations, which are not covered by Phase I of the NPDES storm water program, would be subject instead to a State's Coastal Nonpoint Pollution Control Program. Further, onsite disposal systems, which are generally not covered by the storm water permit program, would be subject to a State's Coastal Nonpoint Pollution Control Program.

Finally, EPA emphasizes that while different legal authorities may apply to different situations, the goals of the NPDES and CZARA programs are complementary. Many of the techniques and practices used to control urban runoff are equally applicable to both programs. Yet, the programs do not work identically. In the interest of consistency and comprehensiveness, States have the option to implement management measures in conformity with this guidance throughout the State's 6217 management area, as long as NPDES storm water requirements continue to be met by Phase I sources in that area. States are encouraged to develop consistent approaches to addressing urban runoff throughout their 6217 management areas.

e. Marinas

Another specific overlap between the storm water program and the coastal nonpoint source programs under CZARA occurs in the case of marinas (addressed in Chapter 5 of this guidance). In this guidance, EPA has attempted to avoid addressing marina activities that are clearly regulated point source discharges. Any storm water runoff at a marina that is ultimately regulated under an NPDES permit will no longer be subject to this guidance once the permit is issued. The introduction to Chapter 5 contains a detailed discussion of the scope of the NPDES program with respect to marinas and of the corresponding coverage of marinas by the CZARA program.

f. Other Point Sources

Overlapping areas between the point source and nonpoint source programs also occur with respect to concentrated animal feeding operations. Operations that meet particular size or other criteria are defined and regulated as point sources under the section 402 permit program, while other confined animal feeding operations are not currently regulated as point sources. Other overlaps may occur with respect to aspects of mining operations, oil and gas extraction, land disposal, and other activities.

[1] On May 27, 1992, the United States Court of Appeals for the Ninth Circuit invalidated EPA's exemption of construction sites smaller than 5 acres from the storm water permit program in *Natural Resources Defense Council* v. *EPA*, 965 F.2d 759 (9th Cir. 1992). EPA is conducting further rulemaking proceedings on this issue and will not require permit applications for construction activities under 5 acres until further rulemaking has been completed.

EPA intends that the Coastal Nonpoint Pollution Control Programs to be developed by the States, and the management measures they contain, apply only to sources that are not required under EPA's current regulations to obtain an NPDES permit. For any discharge ultimately covered by Phase II of the storm water permitting program, the management measures will continue to apply until an NPDES permit is issued for that discharge. In this guidance, EPA has attempted to avoid addressing activities that are regulated point source discharges.

3. Contents of This Guidance

a. General

Each category of sources (agriculture, forestry, etc.) is addressed in a separate chapter of this guidance. Each chapter is divided into sections, each of which contains (1) the management measure; (2) an applicability statement that describes, when appropriate, specific activities and locations for which the measure is suitable; (3) a description of the management measure's purpose; (4) the basis for the management measure's selection; (5) information on management practices that are suitable, either alone or in combination with other practices, to achieve the management measure; (6) information on the effectiveness of the management measure and/or of practices to achieve the measure; and (7) information on costs of the measure and/or practices to achieve the measure.

b. What "Management Measures" Are

Each section of this guidance begins with a succinct statement, set off in bold typeface in a box, that specifies a "management measure." As explained earlier, "management measures" are defined in CZARA as economically achievable measures to control the addition of pollutants to our coastal waters, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives.

These management measures will be incorporated by States into their coastal nonpoint programs, which under CZARA are to provide for the implementation of management measures that are "in conformity" with this guidance. Under CZARA, States are subject to a number of requirements as they develop and implement their Coastal Nonpoint Pollution Control Programs in conformity with this guidance and will have some flexibility in doing so. The application of these management measures by States to activities causing nonpoint pollution is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by EPA and NOAA.

c. What "Management Practices" Are

In addition to specifying management measures, this guidance also lists and describes management practices for illustrative purposes only. While State programs are required to specify management measures in conformity with this guidance, State programs need not specify or require the implementation of the particular management practices described in this document. As a practical matter, however, EPA anticipates that the management measures typically will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices listed in this document have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measures. EPA has also used some of these practices, or appropriate combinations of these practices, as a basis for estimating the effectiveness, costs, and economic impacts of achieving the management measures. (Economic impacts of the management measures are addressed in a separate document entitled *Economic Impacts of EPA Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*.)

EPA recognizes that there is often site-specific, regional, and national variability in the selection of appropriate practices, as well as in the design constraints and pollution control effectiveness of practices. The list of practices for each management measure is not all-inclusive and does not preclude States or local agencies from using other technically sound practices. In all cases, however, the practice or set of practices chosen by a State needs to achieve the management measure.

EPA recognizes as well that many sources may already achieve the management measures, or that only one or two practices may need to be added to achieve the measures. Existing NPS progress should be recognized and appropriate credit given to those who have already made progress toward accomplishing our common goal to control NPS pollution. There is no need to spend additional resources for a practice that is already in existence and operational. Existing practices, plans, and systems should be viewed as building blocks for these management measures and may need no additional improvement.

III. TECHNICAL APPROACH TAKEN IN DEVELOPING THIS GUIDANCE

A. The Nonpoint Source Pollution Process

Nonpoint source pollutants are transported to surface water by a variety of means, including runoff, snowmelt, and ground-water infiltration. Ground water and surface water are both considered part of the same hydrologic cycle when designing management measures. Ground-water contributions of pollutant loadings to surface waters in coastal areas are often very significant. Hydrologic modification is another form of nonpoint source pollution that often adversely affects the biological and physical integrity of surface waters.

1. Source Control

Source control is the first opportunity in any nonpoint source control effort. Source control methods vary for different types of nonpoint source problems. Examples of source control include:

(1) Reducing or eliminating the introduction of pollutants to a land area. Examples include reduced nutrient and pesticide application.

(2) Preventing pollutants from leaving the site during land-disturbing activities. Examples include using conservation tillage, planning forest road construction to minimize erosion, siting marinas adjacent to deep waters to eliminate or minimize the need for dredging, and managing grazing to protect against overgrazing and the resulting increased soil erosion.

(3) Preventing interaction between precipitation and introduced pollutants. Examples include installing gutters and diversions to keep clean rainfall away from barnyards, diverting rainfall runoff from areas of land disturbance at construction sites, and timing chemical applications or logging activities based on weather forecasts or seasonal weather patterns.

(4) Protecting riparian habitat and other sensitive areas. Examples include protection and preservation of riparian zones, shorelines, wetlands, and highly erosive slopes.

(5) Protecting natural hydrology. Examples include the maintenance of pervious surfaces in developing areas (conditioned based on ground-water considerations), riparian zone protection, and water management.

2. Delivery Reduction

Pollution prevention often involves delivery reduction in addition to appropriate source control measures. Delivery reduction practices intercept pollutants leaving the source prior to their delivery to the receiving water by capturing the runoff or infiltrate, followed either by treating and releasing the effluent or by permanently keeping the effluent from reaching a surface water or ground-water resource. Management measures in this guidance incorporate delivery reduction practices as appropriate to achieve the greatest degree of pollutant reduction economically achievable, as required by the statute.

By their nature, delivery reduction practices often bring with them side effects that must be accounted for. For example, management practices that intercept pollutants leaving the source may reduce runoff, but also may increase infiltration to ground water. For instance, infiltration basins trap runoff and allow for its percolation. These devices, although highly successful at controlling suspended solids, may not, because of their infiltration properties, be suitable for use in areas with high ground-water tables and nitrate or pesticide residue problems. Thus, the reader should select management practices with some care for the total water quality impact of the practices.

The performance of delivery reduction practices is to a large extent dependent on suitable designs, operational conditions, and proper maintenance. For example, filter strips may be effective for controlling particulate and soluble pollutants where sedimentation is not excessive, but may be overwhelmed by high sediment input. Thus, in many cases, filter strips are used as pretreatment or supplemental treatment for other practices within a management system, rather than as an entire solution to a sedimentation problem.

These examples illustrate that the combination of source control and delivery reduction practices, as well as the application of those practices as components of management measures, is dependent on site-specific conditions. Technical factors that may affect the suitability of management measures include, but are not limited to, land use, climate, size of drainage area, soil permeability, slopes, depth to water table, space requirements, type and condition of the water resource to be protected, depth to bedrock, and pollutants to be addressed. In this management measures guidance, many of these factors are discussed as they affect the suitability of particular measures.

B. Management Measures as Systems

Technical experts who design and implement effective nonpoint source control measures do so from a management systems approach as opposed to an approach that focuses on individual practices. That is, the pollutant control achievable from any given management system is viewed as the sum of the parts, taking into account the range of effectiveness associated with each single practice, the costs of each practice, and the resulting overall cost and effectiveness. Some individual practices may not be very effective alone but, in combination with others, may provide a key function in highly effective systems. This management measures guidance attempts to adopt an approach that encourages such system-building by stating the measures in general terms, followed by discussion of specific management practices, which combined encourage the use of appropriate situation-specific sets of practices that will achieve the management measure.

C. Economic Achievability of the Proposed Management Measures

EPA has determined that all of the management measures in this guidance are economically achievable, including, where limited data were available, cost-effective. Congress defined "management measures" to mean "*economically achievable* measures ... which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives."

B. Watershed Protection Management Measure

Develop a watershed protection program to:

(1) Avoid conversion, to the extent practicable, of areas that are particularly susceptible to erosion and sediment loss;

(2) Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian and aquatic biota; and

(3) Site development, including roads, highways, and bridges, to protect to the extent practicable the natural integrity of waterbodies and natural drainage systems.

1. Applicability

This management measure is intended to be applied by States to new development or redevelopment including construction of new and relocated roads, highways, and bridges that generate nonpoint source pollutants. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal nonpoint source programs in conformity with this management measure and will have flexibility in doing so. The application of management measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

The purpose of this management measure is to reduce the generation of nonpoint source pollutants and to mitigate the impacts of urban runoff and associated pollutants that result from new development or redevelopment, including the construction of new and relocated roads, highways, and bridges. The measure is intended to provide general goals for States and local governments to use in developing comprehensive programs for guiding future development and land use activities in a manner that will prevent and mitigate the effects of nonpoint source pollution.

A watershed is a geographic region where water drains into a particular receiving waterbody. As discussed in the introduction, comprehensive planning is an effective nonstructural tool available to control nonpoint source pollution. Where possible, growth should be directed toward areas where it can be sustained with a minimal impact on the natural environment (Meeks, 1990). Poorly planned growth and development have the potential to degrade and destroy entire natural drainage systems and surface waters (Mantel et al., 1990). Defined land use designations and zoning direct development away from areas where land disturbance activities or pollutant loadings from subsequent development would severely impact surface waters. Defined land use designations and zoning also protect environmentally sensitive areas such as riparian areas, wetlands, and vegetative buffers that serve as filters and trap sediments, nutrients, and chemical pollutants. Refer to Chapter 7 for a thorough description of the benefits of wetlands and vegetative buffers.

■ *n. Educate the public about the importance of runoff management facilities.*

"... the value of a comprehensive public information and education program cannot be overemphasized. Such a program must explain the basis, purpose, and details of the proposal and must convince the public and their elected officials that it is both necessary to implement and beneficial to their interests. It must also explain the fundamentals of storm water management facilities, the vital role they play in our lives, and their need for regular maintenance. This information can be presented through flyers, brochures, posters, and other educational aids. Work sessions and field trips can also be conducted. Signs at facility sites can also be erected. Finally, presentations to planning boards, municipal councils and committees, and county freeholders by storm water management experts can also be of great assistance" (New Jersey, undated).

5. Effectiveness and Cost Information

The box and whisker plot in Figure 4-3 summarizes efficiencies for selected structural TSS removal practices, as reported by Schueler et al., 1992. The whiskers of each box represent the range of reported TSS removal efficiencies. The box ends delimit the 25th and 75th percentiles. The horizontal line represents the median, or 50th percentile. Circles represent outliers. Figure 4-3 and Table 4-7 illustrate the range of removal efficiencies, based on monitoring and modeling studies, for total suspended solids for several of the structural practices. The reviewed literature reported a median TSS removal efficiency above 80 percent for three practices—constructed wetlands, wet ponds, and filtration basins. However, it has been reported that the other practices are capable of achieving 80 percent TSS removal efficiency when properly designed, sited, operated, and maintained. More detailed information on the removal efficiencies of the practices and factors influencing the removal efficiencies is presented in Table 4-7. Costs of the practices are shown in Table 4-8.

In many cases, a systems approach to best management practice (BMP) design and implementation may be more effective. By applying multiple practices, enhanced runoff attenuation, conveyance, pretreatment, and treatment may be attained (Schueler et al., 1992). In addition, regionalization of systems (installing and maintaining a BMP or BMPs for more than one development site) may prove more efficient and cost-effective due to the economies of scale of operating one large system versus several smaller systems.

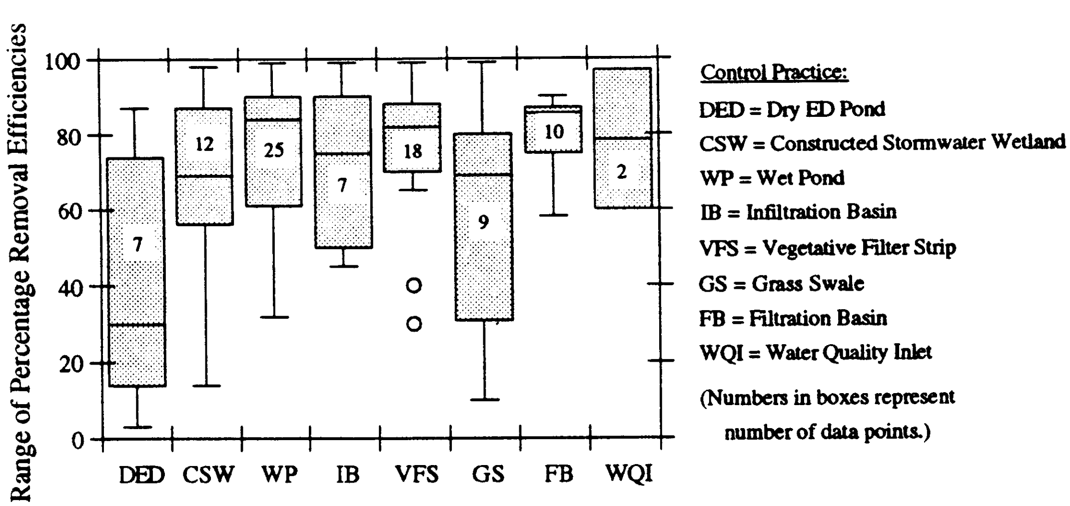


Figure 4-3. Removal efficiencies of selected urban runoff controls for TSS (adapted from Schueler et al., 1992).

Areas such as streamside buffers and wetlands may also have the added benefit of providing long-term pollutant removal capabilities without the comparatively high costs usually associated with structural controls. Conservation or preservation of these areas is important to water quality protection. Land acquisition programs help to preserve areas critical to maintaining surface water quality. Buffer strips along streambanks provide protection for stream ecosystems and help to stabilize the stream and prevent streambank erosion (Holler, 1989). Buffer strips protect and maintain near-stream vegetation that attenuates the release of sediment into stream channels and prevent excessive loadings. Levels of suspended solids increase at a slower rate in stream channel sections with well-developed riparian vegetation (Holler, 1989).

The availability of infrastructure specifically sewage treatment facilities, is also a factor in watershed planning. If centralized sewage treatment is not available, onsite disposal systems (OSDS) most likely will be used for sewage treatment. Because of potential ground-water and surface water contamination from OSDS, density restrictions may be needed in areas where OSDS will be used for sewage treatment. Section VI of this chapter contains a more detailed discussion of siting densities for OSDS.

3. Management Measure Selection and Effectiveness Information

This measure was selected for the following reasons:

(1) Watershed protection is a technique to provide long-term water quality benefits, and many States and local communities already use this practice. Numerous State and local governments have already legislated and implemented detailed watershed planning controls that are consistent with this management measure. For example, Oregon, New Jersey, Delaware, and Florida have passed legislation that requires county and municipal governments to adopt comprehensive plans, including requirements to direct future development away from sensitive areas. Several municipalities and regions, in addition to those in these States, have adopted land use and growth controls, including Amherst, Massachusetts, the Cape Cod region, Norwood, Massachusetts, and Narragansett, Rhode Island.

(2) Setting general water quality objectives oriented toward protection of environmentally sensitive areas and areas that provide water quality benefits allows States flexibility in the pursuit of widely differing water quality priorities and reduces potential conflicts that may arise due to existing State or local program goals and requirements. Although public comments on the May 1991 draft guidance suggested that much more specific criteria should be required, such as minimum setbacks from waterbodies, prohibitions on development on slopes in excess of 45 degrees, and bans on development in floodplains, such prescriptive measures are deemed unreasonable given the need for State and local determination of priorities and program direction.

(3) This measure is effective in producing long-term water quality benefits and lacks the high operation and maintenance costs associated with structural controls.

By protecting those areas necessary for maintaining surface water quality in a natural or near natural state, adverse impacts can be reduced. To illustrate the effectiveness of this management measure, two case studies are presented.

CASE STUDY 1 - RHODE RIVER ESTUARY, CHESAPEAKE BAY, MARYLAND

An evaluation of the impact of the Maryland Critical Area Act on nonpoint source pollution (nutrients and sediment) in surface runoff was completed by modeling three land use scenarios and determining the relative change in nonpoint loadings from the Rhode River Critical Area. Research findings suggest that the implementation of the Act will reduce nonpoint source nutrient and sediment loading by mandating agricultural and urban best management practices (BMPs) and limiting development in forested lands. Figure 4-4 illustrates the predicted nitrogen and phosphorus loadings from various land uses within the watershed under various development scenarios. These predictions are based on the assumption that no structural BMPs are in place.

New development allowed by the Critical Area Act is required to minimize impervious surfaces and reduce nonpoint source pollution through urban BMPs. Results from this study indicate that by limiting the impervious portion of a building site to 15 percent in the Rhode River Estuary, nutrient loadings could be reduced by one-third when compared to similar development without this practice (Houlihan, 1990).

CASE STUDY 2 - ALAMEDA COUNTY, CALIFORNIA

Pollutant loading estimates can be used to evaluate the effectiveness of land planning on controlling nonpoint source pollution. For example, Alameda County, California, has estimated seven pollutant loadings for seven parameters by type of land use, as shown in Table 4-9. By leaving larger areas in open space—through easements, buffers, clustering, or preserves—the potential pollutant loading to San Francisco Bay can be reduced. For example, it is estimated that if 50 percent of a 100-acre parcel designated for residential development is preserved in open space, pollutant loadings for zinc and total suspended solids can be reduced by 50.24 percent and 49.76 percent, respectively, when compared to residential development of the entire 100-acre parcel.

Table 4-9. Load Estimates for Six Land Uses in Alameda County, California (based on average wet weather load, lb/acre; adapted from Woodward-Clyde, 1991)

Land Use	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Total Suspended Solids
Open	N/A	N/A	N/A	N/A	N/A	0.002	0.75
Residential	0.002	0.026	0.058	0.134	0.037	0.424	52.16
Commercial	0.002	0.038	0.084	0.094	0.053	0.655	511.76
Transportation	0.003	0.050	0.112	0.259	0.071	0.274	683.23
Industrial	0.003	0.044	0.097	0.171	0.028		251.43
Industrial Park	0.002	0.026	0.057	0.101	0.017	0.479	148.88

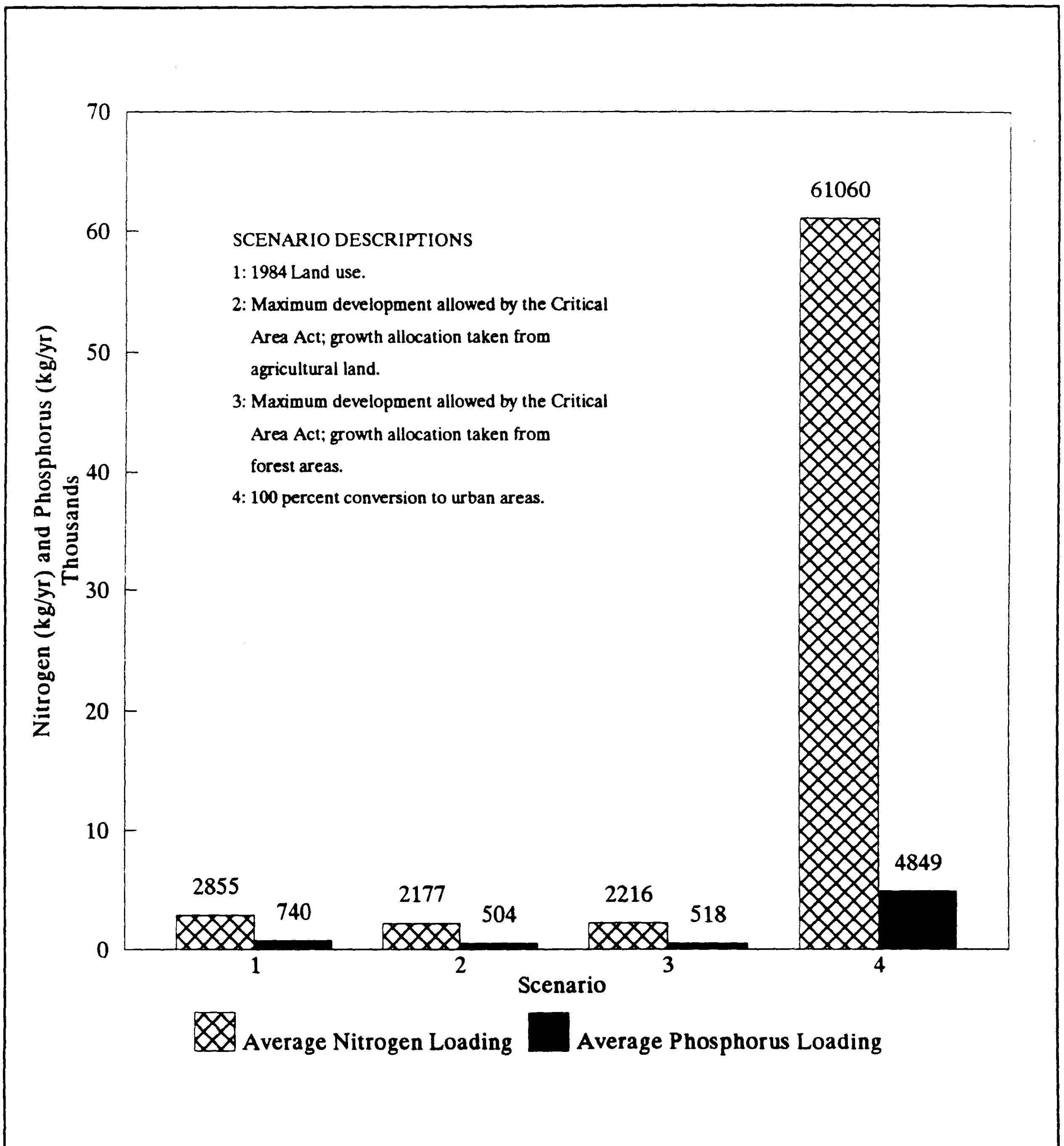


Figure 4-4. Predicted total nitrogen and phosphorus loadings in surface water after runoff from the Rhode River Critical Area under different land use scenarios (Houlihan, 1990).

Considerable uncertainty is associated with the ability to quantify load reductions from various nonstructural practices for controlling nonpoint source pollution (USEPA, 1990). Table 4-10 illustrates the general effectiveness of various planning and site design practices. Many are described in the practices section of this management measure and the Site Development Management Measure.

Table 4-10. General Effectiveness of Various Nonstructural Control Practices (Metropolitan Washington Council of Governments, 1991)

	Nutrient Control	Shellfish	Estuarine Habitat Protection	Sedimentation	Sediment Toxics	Stormwater Control	Feasibility in Coastal Areas	Maintenance Burdens	Longevity	Community Acceptance	Secondary Environmental Impacts	Cost to Developers	Cost to Local Governments	Difficulty in Local Implementation	Site Data Required	Water Dependent Use
I. COASTAL DENSITY ZONES																
Intense Zones	○	○	○	○	○	○	●	■	■	○	○	○	◍	○	◍	
Rural Zones	○	◍	◍	◍	◍	◍	●	■	■	○	◍	◍	◍	○	◍	
Protection Zones	●	●	●	●	●	●	●	■	■	○	●	●	◍	◍	◍	
Overlay Zones	●	●	●	●	◍	◍	●	■	■	○	◍	◍	◍	◍	○	
Performance Zoning	●	●	●	◍	◍	●	●	■	■	○	◍	◍	◍	◍	○	
II. ENVIRONMENTAL RESERVES																
Stream Buffers	●	◍	●	◍	○	○	●	●	●	●	●	◍	●	◍	●	○
Wetland Buffers	●	○	●	◍	○	○	●	●	●	●	●	○	●	●	●	●
Coastal Buffers	●	●	●	◍	○	○	●	●	●	●	●	○	◍	○	●	●
Expanded Buffers	●	●	●	●	○	○	●	●	●	◍	●	◍	●	○	○	●
Floodplain Limits	●	○	●	○	○	◍	●	●	●	◍	●	◍	●	◍	◍	○
Steep Soils Limits	○	○	◍	●	○	◍	●	●	●	◍	●	◍	●	●	●	◍
Septic Limits	●	●	○	○	○	■	●	●	●	◍	●	○	◍	○	◍	◍
Wetland Protection	●	●	●	●	○	◍	●	●	●	●	●	◍	●	●	○	●
Forest Protection	○	●	●	●	○	○	●	●	●	●	●	○	●	◍	◍	●
Habitat Protection	○	○	●	○	○	○	●	●	●	●	●	◍	●	◍	○	●
Open Space Protection	○	○	◍	○	○	○	●	●	●	●	●	○	●	◍	◍	●
	● 8 - 40% High Level of Control; ◍ 30 - 40% Moderate Level of Control; ○ 0 - 29% Low Level of Control; ■ Ineffective	● Highly Effective; ◍ Moderately Effective; ○ Low Effectiveness; ■ Ineffective	● Directly Protects; ◍ Indirectly Protects; ○ No Protection; ■ Not Related	● 80% + High; ◍ 30 - 80% Mod; ○ 0 - 30% Low; ■ Ineffective	● Highly Effective; ◍ Moderately Effective; ○ Low Effectiveness; ■ Ineffective	● Highly Effective; ◍ Moderately Effective; ○ Low Effectiveness; ■ Ineffective	● Widely Applicable; ◍ Applicable Depending on Site; ○ Seldom Applicable; ■ Not Applicable	● Low Burden; ◍ Moderate Burden; ○ High Burden; ■ Not Applicable	● Long Lived; ◍ Long Lived w/Maintenance; ○ Shortlived; ■ Not Applicable	● Positive; ◍ Neutral; ○ Negative; ■ Mixed	● None or Positive; ◍ Slight Negative Impacts; ○ Strong Negative Impacts at Some Sites; ■ Prohibited	● Low; ◍ Moderate; ○ High; ■ Very High	● Low; ◍ Moderate; ○ High; ■ Very High	● Easy; ◍ Moderate; ○ Tough; ■ Very Tough	● Simple; ◍ Moderate; ○ Complex; ■ None	● Can be Used Moderately in These Areas; ◍ Sometimes Can Be Used; ○ Seldom Used; ■ Not Used

Table 4-10 (continued)

	Nutrient Control	Shellfish	Estuarine Habitat Protection	Sedimentation	Sediment Toxics	Stormwater Control	Feasibility in Coastal Areas	Maintenance Burdens	Longevity	Community Acceptance	Secondary Environmental Impacts	Cost to Developers	Cost to Local Governments	Difficulty in Local Implementation	Site Data Required	Water Dependent Use
III. SITE PLANNING																
Cluster	○	◍	○	○	○	○	●	●	●	◍	●	●	●	○	◍	●
Performance Criteria	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●
Minimize Imperviousness	○		○	○	○	●	●									
EROSION & SEDIMENT CONTROL		○														
Time/Area Disturbance	◍	○	●	◍	■	○	●	●	●	●	●	●	◍	●	◍	●
V. POST DEVELOPMENT																
Urban Housekeeping	○	◍	○	◍	◍	■	●	◍	○	◍	◍		●	●	●	●
Fertilizer Control	◍	○	■	■	■	■	◍	○	○	◍	●		◍	◍	◍	◍
Septic Maintenance	◍	●	○	■	■	■	●	○	◍	◍	◍		◍	◍	○	◍
Household Hazardous Waste	○	■	○	■	●	■	◍	○	○	◍	◍		◍	◍	○	◍
	● 0 - 40% High Level of Control ◍ 30 - 40% Moderate Level of Control ○ 0 - 20% Low Level of Control ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Directly Protects ◍ Indirectly Protects ○ No Protection ■ Not Related	● 60% + High ◍ 30 - 60% Mod ○ 0 - 30% Low ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Widely Applicable ◍ Applicable Depending on Site ○ Seldom Applicable ■ Not Applicable	● Low Burden ◍ Moderate Burden ○ High Burden ■ Not Applicable	● Long Lived ◍ Long Lived w/Maintenance ○ Shortlived ■ Not Applicable	● Positive ◍ Neutral ○ Negative ■ Mixed	● None or Positive ◍ Slight Negative Impacts ○ Strong Negative Impacts at Some Sites ■ Prohibited	● Low ◍ Moderate ○ High ■ Very High	● Low ◍ Moderate ○ High ■ Very High	● Easy ◍ Moderate ○ Tough ■ Very Tough	● Simple ◍ Moderate ○ Complex ■ None	● Can be Used Moderately in These Areas ◍ Sometimes Can Be Used ○ Seldom Used ■ Not Used

4. Watershed Protection Practices and Cost Information

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

The most effective way to achieve this management measure is to develop a comprehensive program that incorporates protection of surface waters with programs and plans for guiding growth and development. Planning is an orderly process, and each step builds upon preceding steps. The following practices are part of the process and can be modified to meet the needs of the community. Many of the practices can be incorporated into existing activities being carried out by a local government, such as land planning, zoning, and site plan review. Other activities, such as land acquisition programs, may have to be developed. Where cost and effectiveness information was available, it was included in the discussion of the examples. The general cost and effectiveness of planning programs are described after the practices.

■ a. *Resource Inventory and Information Analysis*

Before a comprehensive program can be developed, define the watershed boundaries, target areas, and pollutants of concern, and conduct resource inventory and information analysis. These activities can be done by using best available information or collecting primary data, depending on funding availability and the quality of available data. Activities pursued under this process include: assessment of ground-water and surface water hydrology; evaluation of soil type and ground cover; identification of areas with water quality impairments; and identification of environmentally sensitive areas, such as steep or erodible uplands, wetlands, riparian areas, floodplains, aquifer recharge areas, drainage ways, and unique geologic formations. Once environmentally sensitive areas are identified, areas that are integral to the protection of surface waters and the prevention of nonpoint source pollution can be protected.

The following are examples of resource inventory and information analysis programs:

LOCATION	PROGRAM	COST
City of Virginia Beach, Virginia	Three-phase natural areas inventory to help planners and public officials develop practices for resource protection	Phase I (data collection) $13,867; Phase II (field inventory) $54,624; and Phase III (final report) $15,225 (Jenkins, 1991).
Richmond County, Virginia	The Richmond County Resource Information System (RIS) was developed to provide a basis for responsible planning and development of shoreline areas. The compilation and mapping of resource information are part of the county's planning and zoning program.	In 1990, the program was supported by a $39,000 Federal Coastal Zone Management Grant, $45,000 from the Chesapeake Bay Foundation through a Virginia Environmental Endowment Grant, and $96,000 from the county's comprehensive plan budget (Jenkins, 1991).

■ b. *Development of Watershed Management Plan*

The resource inventory and information analysis component provides the basis for a watershed management plan. A watershed management plan is a comprehensive approach to addressing the needs of a watershed, including land use, urban runoff control practices, pollutant reduction strategies, and pollution prevention techniques.

For a watershed management plan to be effective, it should have measurable goals describing desired outcomes and methods for achieving the goals. Goals, such as reducing pollutant loads to surface water by 25 percent, can be articulated in a watershed management plan. Development and implementation of urban runoff practices, both structural and nonstructural, can be incorporated as methods for achieving the goal. Table 4-11 describes the general steps for developing a watershed management plan.

Table 4-11. Watershed Management: A Step-by-Step Guide (Livingston and McCarron, 1992)

1. **Delineate and map watershed boundary and sub-basins within the watershed.**

2. **Inventory and map natural storm water conveyance and storage systems.**

3. **Inventory and map man-made storm water conveyance and storage system.**
   This includes all ditches, swales, storm sewers, detention ponds, and retention areas and includes information such as size, storage capacity, and age.

4. **Inventory and map land use by sub-basin.**

5. **Inventory and map detailed soils by sub-basin.**

6. **Establish a clear understanding of water resources in the watershed.**
   Analyze water quality, sediment, and biological data. Analyze subjective information on problems (such as citizen complaints). Evaluate waterbody use impairment–frequency, timing, seasonality of problem. Conduct water quantity assessment–low flows, seasonality.

7. **Inventory pollution sources in the watershed.**
   Point sources—location, pollutants, loadings, flow, capacity, etc. Nonpoint sources—type, location, pollutants, loading, etc.
   - land use/loading rate analysis for storm water;
   - sanitary survey for septic tanks;
   - dry flow monitoring to locate illicit discharges

8. **Identify and map future land use by sub-basin.**
   Conduct land use loading rate analyses to assess potential effects of various land use scenarios.

9. **Identify planned infrastructure improvements—5-year, 20-year.**
   Stormwater management deficiencies should be coordinated and scheduled with other infrastructure or development projects.

10. **Analysis.**
    Determine infrastructure and natural resources management needs within each watershed.

11. **Set resource management goals and objectives.**
    Before corrective actions can be taken, a resource management target must be set. The target can be defined in terms of water quality standards; attainment and preservation of beneficial uses; or other local resource management objectives.

12. **Determine pollutant reduction (for existing and future land uses) needed to achieve water quality goals.**

13. **Select appropriate management practices (point source, nonpoint source) that can be used to achieve the goal.**
    Evaluate pollutant removal effectiveness, land owner acceptance, financial incentives and costs, availability of land operation and maintenance needs, feasibility, and availability of technical assistance.

14. **Develop watershed management Plan.**
    Since the problems in each watershed will be unique, each watershed management plan will be specific. However, all watershed plans will include elements such as:
    - existing and future land use plan;
    - master storm water management plan that addresses existing and future needs;
    - wastewater management plan including septic tank maintenance programs;
    - infrastructure and capital improvements plan

Development of a watershed management plan may involve establishing general land use designations that define allowable activities on a parcel of land. For example, land designated for low-density residential use would be limited to a density of two houses per acre, provided that all other regulations and requirements are met. All development activities allowed in a use category should be defined. By guiding uses within the planning areas, impacts to surface waters from urban runoff can be controlled. Those areas identified in the resource inventory and information analysis phase as environmentally sensitive and important to maintaining water quality can be preserved through various measures supported by State or local goals, objectives, and policies.

The following are examples of plan development:

LOCATION	PROGRAM	COST
Florida	• Local governments (counties and incorporated municipalities) were required to develop comprehensive plans based on existing information to guide growth and development in the short term (5 years) and long term (20 to 25 years). • Local plans must be consistent with the State plan and the State Growth Management law. • Each plan must identify environmentally sensitive areas and areas with water quality problems.	Cost information specific to those parts of the plans relating to NPS pollution was not available.
Fairfax County, Virginia	• The Environmental Quality Corridor (EQC) System was established to preserve floodplains, wetlands, shoreline areas, and steep valley slopes. • EQCs are defined in the county's comprehensive plan and identified on the county land use map. • If a parcel of land subject to a zoning or land use designation change contains an EQC, it is set aside by the developer as part of development approval. Since its initiation, tens of thousands of acres have been set aside through the EQC program.	The cost of implementing the program is part of the operating budget of the County Planning Department (Fairfax County Planning Department, personal communication, 1991).
Howard County, Maryland	• A Land Preservation and Recreation Plan was developed as part of the county comprehensive plan. • Open space resources are purchased for preservation and recreation.	The annual cost to update the plan, $25,000, is funded by the State. In FY 1990, the county received $1.14 million in State funds to update the plan and to acquire land (Jenkins, 1991).

c. *Plan Implementation*

Once critical areas have been identified, land use designations have been defined, and goals have been established to guide activities in the watershed, implementation strategies can be developed. At this point, the requirements of future development are defined. These requirements include, but are not limited to, permitted uses, construction techniques, and protective maintenance measures. Land development regulations may also prescribe natural performance standards; for example, "rates of runoff or soil loss should be no greater than predevelopment conditions" (USEPA, 1977). Listed below are examples of the types of development regulations and other implementation tools that have been successful at controlling nonpoint source pollution.

- *Development of ordinances or regulations requiring NPS pollution controls for new development and redevelopment.*

  These ordinances or regulations should address, at a minimum:

  (1) Control of off-site urban runoff discharges (to control potential impacts of flooding);

  (2) The use of source control BMPs and treatment BMPs;

  (3) The performance expectations of BMPs, specifying design storm size, frequency, and minimum removal effectiveness, as specified by the State or local government;

  (4) The protection of stream channels, natural drainage ways, and wetlands;

  (5) Erosion and sediment control requirements for new construction and redevelopment; and

  (6) Treatment BMP operation and maintenance requirements and designation of responsible parties.

- *Infrastructure planning*

  Infrastructure planning is the multiyear scheduling and implementation of public physical improvements (infrastructure), such as roads, sewers, potable water delivery, landfills, public transportation, and urban runoff management facilities. Infrastructure planning can be an effective practice to help guide development patterns away from areas that provide water quality benefits, are susceptible to erosion, or are sensitive to disturbance or pollutant loadings. Where possible, long-term comprehensive plans to prevent the conversion of these areas to more intensive land uses should be drafted and adopted. Infrastructure should be planned for and sited in areas that have the capacity to sustain environmentally sound development. Development tends to occur in response to infrastructure availability, both existing and planned. New development should be targeted for areas that have adequate infrastructure to support growth in order to promote infill development, prevent urban sprawl, and discourage the use of septic tanks where they are inappropriate (International City Management Association, 1979). Infill development may have the added advantage of municipal cost savings.

  To discourage development in the environmentally sensitive East Everglades area, Dade County, Florida, has developed an urban services boundary (USB). In areas outside the USB, the county will not provide infrastructure and has kept land use densities very low. This strategy was selected to prevent urban sprawl, protect the Everglades wetlands (outside of Everglades National Park), and minimize the costs of providing services countywide. The area is defined in the county comprehensive plan, and restrictions have been implemented through the land development regulations (Metro-Dade Comprehensive Development Master Plan, 1988).

  Congress has enacted similar legislation for the protection of coastal barrier islands. In 1981, the availability of Federal flood insurance for new construction on barrier islands was discontinued. In 1982, Congress passed the Coastal Barriers Resources Act, establishing the Coastal Barrier Resource System (CBRS), and terminated a variety of Federal assistance programs for designated coastal barriers, including grants for new water, sewage, and transportation systems. In 1988, similar legislation was passed for the Great Lakes area, adding 112 Great Lakes barrier islands. Additions to the CBRS in 1990 included parts of the Florida Keys, the U.S. Virgin Islands, Puerto Rico, and the Great Lakes (Simmons, 1991).

The result of the legislation and subsequent additions to the CBRS has been the establishment of 1,394,059 acres of barriers that are ineligible for Federal assistance for infrastructure and flood insurance (Simmons, 1991). This Act has helped to guide development away from these sensitive coastal areas to more suitable locations.

- *Local ordinances*

Zoning is the division of a municipality or county into districts for the purpose of regulating land use. Usually defined on a map, the allowable uses within each zone are described in an official document, such as a zoning ordinance. Zoning is enacted for a variety of reasons, including preservation of environmentally sensitive areas and areas necessary to maintain the environmental integrity of an area (International City Management Association, 1979).

Within zoning ordinances, subdivision regulations govern the process by which individual lots of land are created out of larger tracts. Subdivision regulations are intended to ensure that subdivisions are appropriately related to their surroundings. General site design standards, such as preservation of environmentally sensitive areas, are one example of subdivision regulations (International City Management Association, 1979).

Farmland preservation ordinances are another measure that can be implemented to provide open space retention, habitat protection, and watershed protection. Farmland protection may be a less costly means of controlling pollutant loadings than the implementation of urban runoff structural control practices. Much of the farmland currently being converted has soils that are stable and not highly erodible. Conversion of these farmlands often displaces farming activities to less productive, more erodible areas that may require increased nutrient and pesticide applications.

- *Limits on impervious surfaces, encouragement of open space, and promotion of cluster development*

As described earlier, urban runoff contains high concentrations of pollutants washed off impervious surfaces (roadways, parking lots, loading docks, etc.). By retaining the greatest area of pervious surface and maximizing open space, nonpoint source pollution due to runoff from impervious surfaces can be kept to a minimum.

The following are examples of open space requirements and cluster development:

LOCATION	PROGRAM	COST
Brunswick, Maine	• Recently adopted an allowable impervious area threshold of 5 percent of the site to be developed in the defined Coastal Protection Zone. • The remaining 95 percent must be left natural or landscaped.	Accomplished with a $28,000 grant (Brunswick Planning Department, personal communication, 1991).
Commonwealth of Virginia	• Provides general guidance with regard to minimum open space/maximum impervious areas to local governments within the Chesapeake Bay watershed. • While specific requirements are not associated with the guidance, local government plans must contain criteria and must be approved by the Chesapeake Bay Local Assistance Board.	Cost information specific to those parts of the guidance relating to NPS pollution was not available.

LOCATION	PROGRAM	COST
Carroll County, Maryland	• Amended its zoning ordinance to encourage cluster development and preserve open space. • This requirement has been applied to three subdivisions in the county and has resulted in the protection of more than 200 acres of wetlands (Carroll County Planning Department, personal communication, 1991).	Developed using existing county staff and funding.
State of Maryland	• Adopted the Forest Conservation Act of 1991. • Requires all public agency and private landowner submitting a subdivision plan or application for a sediment control permit for an area greater than 40,000 square feet to develop a forest conservation plan for retention of existing forest cover on the site. • Clearing essential to site development is allowed. • The Act also established a forest conservation fund for reforestation projects.	Not available.
Broward County, Florida	• Implements an open space program and encourages cluster development to reduce the amount of impervious surface, to protect water quality, and to enhance aquifer recharge (Broward County, Florida, Land Development Code, 1990).	Developed using existing county staff and funding.
New Hampshire	• Model shoreland protection ordinance. • Encourages grouping of residential units provided a minimum of 50 percent of the total parcel remains as open space.	Not available.

One way to increase open space while allowing reasonable development of land is to encourage cluster development. Clustering entails decreasing the allowable lot size while maintaining the number of allowable units on a site. Such policies provide planners the flexibility to site buildings on more suitable areas of the property and leave environmentally sensitive areas undeveloped. Criteria can be varied.

- *Setback (buffer zone) standards*

In coastal areas, setbacks or buffer zones adjacent to surface waterbodies, such as rivers, estuaries, or wetlands, provide a transition between upland development and waterbodies. The use of setbacks or buffer zones may prevent direct flow of urban runoff from impervious areas into adjoining surface waters and provide pollutant removal, sediment attenuation, and infiltration. Riparian forest buffers function as filters to remove sediment and attached pollutants, as transformers that alter the chemical composition of compounds, as sinks that store nutrients for an extended period of time, and as a source of energy for aquatic life (USEPA, 1992). Setbacks or buffer zones are commonly used to protect coastal vegetation and wildlife corridors, reduce exposure to flood hazards, and protect surface waters by reducing and cleansing urban runoff (Mantell et al., 1990). The types of development allowed in these areas are usually limited to nonhabitable structures and those necessary to allow reasonable use of the property (docks, nonenclosed gazebos, etc.).

Factors for delineating setbacks and buffer zones vary with location and environment and include seasonal water levels, the nature and extent of wetlands and floodplains, the steepness of adjacent topography, the type of riparian vegetation, and wildlife values.

EPA recommends that no habitat-disturbing activities should occur within tidal or nontidal wetlands. In addition, a buffer area should be established that is adequate to protect the identified wetland values. Minimum widths for buffers should be 50 feet for low-order headwater streams with expansion to as much as 200 feet or more for larger streams. In coastal areas, a 100-foot minimum buffer of natural vegetation landward from the mean high tide line helps to remove or reduce sediment, nutrients, and toxic substances entering surface waters (MWCOG, 1991).

Examples of setback or buffer requirements include the following:

LOCATION	PROGRAM	COST
Monroe County, Florida	• Requires a setback of 20 feet from high water on man-made or lawfully altered shorelines for all enclosed structures and 50 feet from the landward extent of mangroves or mean high tide line for natural waterbodies with unaltered shorelines (Monroe County, Florida, Code, Section 9.5-286).	Developed using existing county staff and funding.
Town of Brunswick, Maine	• Requires a buffer of 125 to 300 feet from mean high water within the Coastal Protection Zone (Section 315 of the Brunswick Zoning Ordinance), depending on the slope of the buffer, as designated on the land use map.	Developed using a $28,000 grant (Brunswick Planning Department, personal communication, 1991).
Queen Annes County, Maryland	• Established a standard shore buffer of 300 feet from the edge of tidal water or wetland, 50 percent of which must be forested.	Developed using existing county staff and funding; a bond of surety to cover the cost of implementation is required prior to development (Jenkins, 1991).
Maryland Critical Areas Regulations	• Requires a 25-foot buffer around nontidal wetlands and 100 feet landward of mean high water in tidal areas. • Allowable uses within the setback area are defined in the regulations (Chesapeake Bay Critical Areas Commission, 1988).	Developed as part of the Chesapeake Bay Critical Areas program.
City of Alexandria, Virginia	• Buffers are required as part of the city's Chesapeake Bay Preservation Ordinance. • Applies to all designated Resource Protection Areas (RPAs). • The buffer must achieve 75 percent reduction of sediments and 40 percent reduction of nutrients (100-foot-wide buffer is considered adequate to achieve this standard; smaller widths may be allowed if they are proven to meet the sediment and nutrient removal requirements). • Indigenous vegetation removal is limited to that necessary to provide reasonable sight lines, access paths, general woodlot management, and BMP implementation.	Not available.

LOCATION	PROGRAM	COST
Northeastern Illinois Planning Commission	• Model ordinance • Suggests 75-foot setback from the ordinary high watermark of streams, lakes, ponds, and edge of wetlands or the boundary of the 100-year floodplain (as defined by FEMA), whichever is greater. • Suggests a minimum 25-foot-wide natural vegetation strip from the ordinary highwater mark of perennial and intermittent streams, lakes, ponds, and the edge of wetlands.	Not available

- *Slope restrictions*

  Slope restrictions can be effective tools to control erosion and sediment transport. Erosion rates depend on several site-specific factors including soil type, vegetative cover, and rainfall intensity. In general, as slope increases, there is a corresponding increase in runoff water velocity, which may result in increased erosion and sediment transport to surface waters (Schwab et al., 1981; Dunn and Leopold, 1978). The Maryland Chesapeake Bay Critical Areas Program prohibits clearing on slopes greater than 25 percent (Chesapeake Bay Critical Areas Commission, 1988).

- *Site plan reviews and approval*

  A site plan review involves review of specific development proposals for consistency with the laws and regulations of the local government of jurisdiction. To ensure that natural resources necessary for protecting surface water quality are preserved, inspection of a potential development site should occur. Inspection ensures that the information presented in any application for development approval is accurate and that sensitive areas are noted for preservation. Inspections should also be conducted during and after development to ensure compliance with development conditions. Depending on the size of the local government and the amount of new development occurring, this inspection could be incorporated into the duties of existing staff at minimal additional cost to the local government or could require the addition of staff to conduct onsite inspections and monitoring. The effectiveness of such a program depends on the ability of the inspectors to evaluate property for its natural resource value and the practices used to protect areas necessary for the preservation of water quality.

  Development approvals should contain conditions requiring steps to be taken to maintain the environmental integrity of the area and prevent degradation due to nonpoint source pollution, consistent with the goals, objectives, and policies of the comprehensive program and the requirements of the land development regulations. The criteria for new development are outlined as part of a development permit. Examples include the following:

  - Areas for preservation or mitigation may be identified, similar to the Fairfax County Environmental Quality Corridor System (page 44).

  - The use of nonstructural and structural best management practices described in this chapter for controlling nonpoint source pollution may be a condition of development approval.

  - Setbacks and limits on impervious areas may be clearly defined in a condition for development approval, as is being done in the programs discussed earlier such as Monroe County, Florida, Queen Annes County, Maryland, State of Maryland Critical Areas Program, Town of Brunswick, Maine, and the Northeastern Illinois Planning Commission (pages 48 and 49).

- Reduce the use of pesticides and fertilizers on landscaped areas by encouraging the use of vegetation that is adaptable to the environment and requires minimal maintenance. (Xeriscaping is described later in this chapter.)

- *Designation of an entity or individual who is responsible for maintaining the infrastructure, including the urban runoff management systems*

  The responsible party should be trained in the maintenance and management of urban runoff management systems. If desired, the local government could be designated to maintain urban runoff systems, with financial compensation from the developer. Because they are not usually trained in infrastructure maintenance, homeowners groups are not the best entity for monitoring infrastructure for adequacy, especially urban runoff management systems. This responsibility should belong to a responsible party who understands the complexity of urban runoff management systems, can determine when such systems are not functioning properly, and has the resources to correct the problem. Again, this is a duty that the local government can assume, with either existing staff or additional staff, depending on the size of the local government and the amount of new development occurring. The amount of funding needed depends on the size of the local government.

- *Official mapping*

  Official maps can be used to designate and/or protect environmentally sensitive areas, zoning districts, identified land uses, or other areas that provide water quality benefits. When approved by the local governing body, these maps can be used as legal instruments to make land use decisions related to nonpoint source pollution.

- *Environmental impact assessment statements*

  To evaluate the impact that proposed development may have on the natural resources of an area, some counties and municipalities require an environmental assessment as part of the development approval processes. These assessments can be incorporated into the land development regulation process. Areas to be covered include geology, slopes, vegetation, historical features, wildlife, and infrastructure needs (International City Management Association, 1979).

d. *Cost of Planning Programs*

Cost information was provided for several of the practices discussed in this section. The cost of planning programs depends on a variety of factors, including the level of effort needed to complete and implement a program. As discussed earlier, many of the practices described in this section can be incorporated into ongoing activities of a State or local government.

The Florida legislature funded the development of comprehensive programs and land development regulations required by the Local Government Comprehensive Planning and Land Development Regulation Act (1985). Distribution of funds was based on population according to formulas used for determining funding for the plan and land development regulations. A base amount was given to all counties that requested it. The balance of the monies was allocated to each county in an amount proportionate to its share of the total unincorporated population of all the counties. A similar distribution process was used for local governments. A total of $2.1 million was allocated for plan development; however, not all components of the plans address NPS issues.

The effect of planning programs depends on many variables, including implementation of programs and monitoring of conformance with conditions of development approval.

5. Land or Development Rights Acquisition Practices and Cost Information

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

An effective way to preserve land necessary for protecting the environmental integrity of an area is to acquire it outright or to limit development rights. The following practices can be used to protect beneficial uses.

a. Fee Simple Acquisition/Conservation Easements

The most direct way to protect land for preservation purposes and associated nonpoint source control functions is fee simple acquisition, through either purchase or donation. Once a suitable area is identified for preservation, the area may be acquired along with the development rights. The more development rights that are associated with a piece of property, the more expensive the property. Many State and local governments and private organizations have programs for purchasing land.

Conservation easements are restrictions put on property that legally restrict the present and future use of the land. For preservation purposes, the easement holder is usually not the owner of the property and is able to control property rights that a landowner could use that might cause adverse impacts to resources on the property. In effect, the property owner gives up development rights within the easement while retaining fee ownership of the property (Mantell et al., 1990; Barrett and Livermore, 1983).

b. Transfer of Development Rights

The principle of transfer of development rights (TDR) is based on the concept that ownership of real property includes the ownership of a bundle of rights that goes with it. These rights may include densities granted by a certain use designation, environmental permits, zoning approvals, and others. Certain properties have a bigger bundle of rights than others, depending on what approvals have been received by the owner. The TDR system takes all or some of the rights on one piece of property and moves them to another parcel. The purpose of TDRs is to shift future development potential from an area that is determined to be unsuitable for development (sending site) to an area deemed more suitable (receiving site). The development potential can be measured in a variety of ways, including number of dwelling units, square footage, acres, or number of parking spaces. Most TDR systems require a legal restriction for future development on the sending site. TDR programs can be either fixed so that there are only a certain number of sending and receiving sites in an area or flexible so that a sender and receiver can be matched as the situation allows (Mantell et al., 1990; Barrett and Livermore, 1983).

This system is useful for the preservation of those areas thought necessary for maintaining the quality of surface waters in that development rights associated with the environmentally sensitive areas can be transferred to less sensitive areas. There are several examples in the United States where TDRs have been used. Some of the more successful projects involve preservation of the New Jersey Pine Barrens and the Santa Monica Mountains in California. For the TDR concept to work, receiving and sending sites should be identified and evaluated, a program that is simple and flexible should be developed, and the use of the program should be promoted and facilitated (Mantell et al., 1990).

c. Purchase of Development Rights

In this process, the rights of development are purchased while the remaining rights remain with the fee title holder. Restrictions in the deed make it clear that the land cannot be developed based on the rights that have been purchased (Mantell et al., 1990).

Howard County, Maryland, has the goal of preserving 20,000 acres of farmland. Development rights are acquired in perpetuity with one-fourth of one percent of the local land transfer tax used as funding. There is no cap on the percent of assessed value that may be considered development value, and payment for development rights may be spread over 30 years to ease the capital gains tax burden on the landowner (Jenkins, 1991).

d. Land Trusts

Land trusts may be established as publicly or privately sponsored nonprofit organizations with the goal of holding lands or conservation easements for the protection of habitat, water quality, recreation, or scenic value or for agricultural preservation. A land trust may also preacquire properties that are conservation priorities if the land trust enters the development market when government funds are not immediately available by acquiring bank funding with the government as guarantor (Jenkins, 1991).

e. Agricultural and Forest Districts

Agricultural or forest districting is an alternative to acquisition of land or development rights. Jurisdictions may choose to allow landowners to apply for designation of land as an Agricultural or Forest District. Tax benefits are received in exchange for a commitment to maintain the land in agriculture, forest, or open space.

Fairfax County, Virginia, taxes land designated as Agricultural or Forest District based on the present use valuation rather than the usual potential use valuation. A commitment to agricultural or forestry activities must be shown, and sound land management practices must be used. The districts are established and renewed for 8-year periods (Jenkins, 1991).

f. Cost and Effectiveness of Land Acquisition Programs

The cost associated with land acquisition programs varies, depending on the desired outcome. If land is to be purchased, the cost will vary depending on the value of the land. An additional cost to be considered is the maintenance of the property once it is in public ownership. Easements and development rights are less expensive, and maintenance of the property is retained by the owner. Depending on the size of the local government, implementation of these programs is usually part of the operating budget of the appropriate agency (planning department or parks and recreation department, for example) and additional operational funding for implementation is dependent on the size of the local government.

The effectiveness of a land acquisition program is determined by the size of the parcel and the difference between predevelopment and potential postdevelopment pollutant loading rates. In addition, wetlands and riparian areas have been shown to reduce pollutant loadings. The acquisition and preservation of these areas can be extremely important to water quality protection and decrease the cost of implementing structural BMPs. However, the use of wetlands for urban runoff treatment, in general, should be discouraged. Where no other alternative exists, States and local governments can target upland areas for acquisition to minimize the impacts to wetlands and preserve the function of wetlands. One option for acquiring land is a public/private partnership. Several examples of such partnerships exist throughout the country. Harford County, Maryland, has targeted areas for purchase of conservation easements. The county staff is working jointly with a local land trust to acquire conservation easements and to educate people in environmentally sound land use practices. The estimated cost for the program is $60,000 per year (Jenkins, 1991). To aid in the establishment of two local land trusts, Anne Arundel County, Maryland, provided $350,000 in seed money for capital expenditures such as land and easement procurement. The county also gives staff assistance to volunteers; additional support comes from contributions of money or land, grants, and fundraisers (Jenkins 1991).

APPENDIX B

SAMPLE OUTREACH MATERIAL FOR 1991 BUTTERMILK BAY PROJECT

(Source: Buzzards Bay Project)

BUZZARDS BAY PROJECT

FACT SHEET, Draft 2/91

BUTTERMILK BAY NITROGEN MANAGEMENT STRATEGY

Around each bay and estuary in Buzzards Bay is an area of land called a watershed or drainage basin which contributes freshwater to the sea through streams and groundwater. This movement of freshwater to the Bay also transports pollutants associated with certain types of land uses. One important pollutant transported in this way is nitrogen from septic systems and fertilizer applications.

There is ample evidence that coastal embayments are overwhelmed by excessive man-made nitrogen additions. Recognizing this fact, the Buzzards Bay Project has developed a comprehensive strategy for managing human nitrogen inputs around sensitive embayments with important economic and ecological resources to prevent eutrophication. Because Buttermilk Bay is an important shellfishing and swimming area, and habitat for many animals the Buzzards Bay Project is recommending that the three towns that share the Buttermilk Bay drainage basin - Plymouth, Bourne, and Wareham - take steps to manage future nitrogen inputs. Our proposed strategy establishes nitrogen loading limits for embayments to minimize the risk of eutrophic conditions. For embayments like Buttermilk Bay this loading limit is 240 milligrams per cubic meter per flushing time. This translates to an acceptable yearly load of 115,617 pounds of nitrogen. The major steps of the Buttermilk Bay Nitrogen Management Strategy are outlined below.

- *Delineation of the drainage area.*
- *Calculation of the nitrogen contribution from existing development including "grandfathered" lots, within the drainage area.*
- *Calculation of the potential additional nitrogen contributions under existing zoning(This is a "Build-out Analysis") within the drainage area.*
- *Comparison of the total nitrogen contribution from steps 2 and 3 with the acceptable contribution limit of 115,617 pounds per year.*

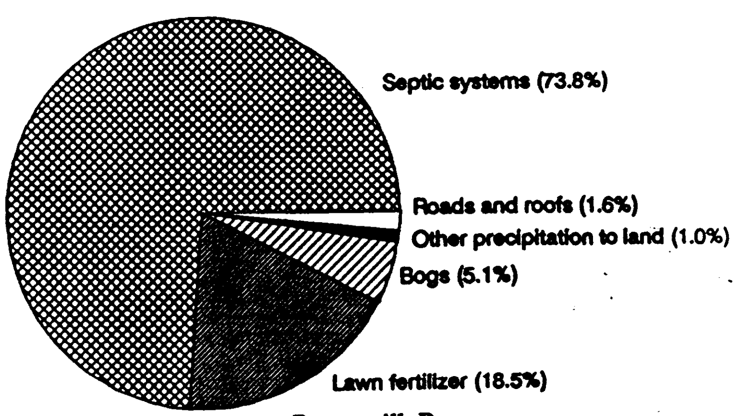
At build-out the drainage basin will contribute 126,664 pounds per year, approximately a 11,047 pound per year excess which the towns must prevent from occurring. This potential excess can be eliminated by increasing the minimum lot size to 70,000 sq.ft. for all areas currently zoned less than this.

The Buzzards Bay Project recommends that all three towns adopt a nitrogen managemnt overlay district for the drainage basin surrounding Buttermilk Bay as follows.

PLYMOUTH - Adopt the nitrogen management overlay district to increase the existing minimum lot size (25,000 sq. ft. and 60,000 sq.ft.) to 70,000 sq.ft. This would reduce the expected number of new lots through subdivision of the remaining unsubdivided parcels from 998 to 781. Thus, at build-out conditions, the number of units in the overlay district within Plymouth will be reduced from 2423 to 2206. We also recommend the adoption of subdivision regulations, to be applied within the overlay district to limit the additional nitrogen from development to 15.5 pounds per acre.

BOURNE - Adopt the nitrogen management overlay district to increase the minimum lot size for unsubdivided parcels from the existing 40,000 sq.ft. to 70,000 sq.ft. This willreduce the expected number of lots through new subdivision of the remaining parcels from 468 to 248. At build-out conditions, the number of units in the overlay district within the town of Bourne will be reduced from 1826 to 1620. We also recommend the adoption of subdivision regulations, to be applied within the overlay district to limit the additional nitrogen from development to 15.5 pounds per acre.

WAREHAM - Adopt the nitrogen management overlay district to discourage the reduction of existing zoning, (now set at 130,000 sq.ft.), and to discourage the granting of special permits to projects within the district that may contribute adverse loads of nitrogen. Adoption of the district will also demonstrate that Wareham recognizes the need for nitrogen management within this area and the need for the long-term protection of Buttermilk Bay.



Sources of nitrogen to Buttermilk Bay

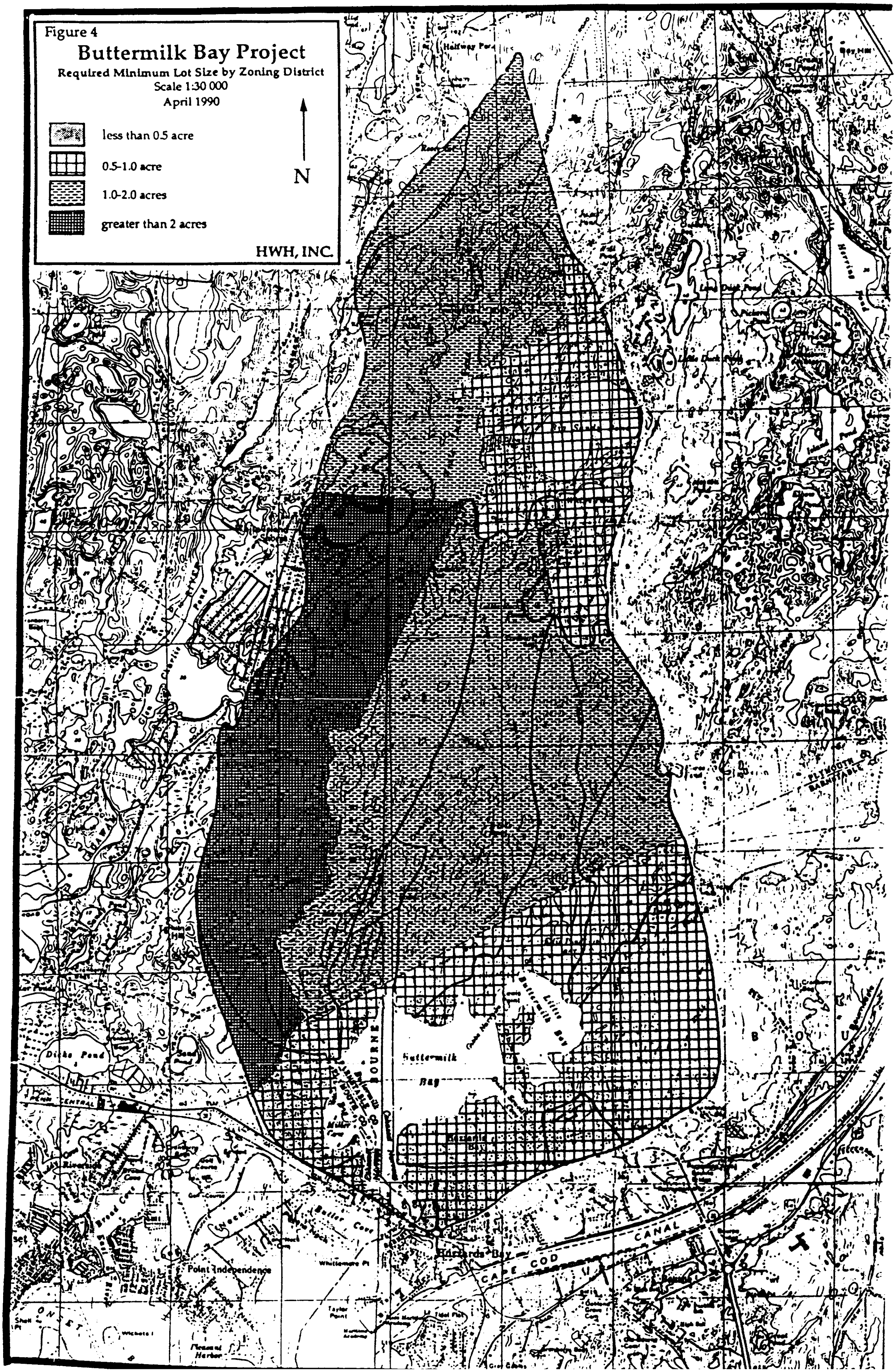
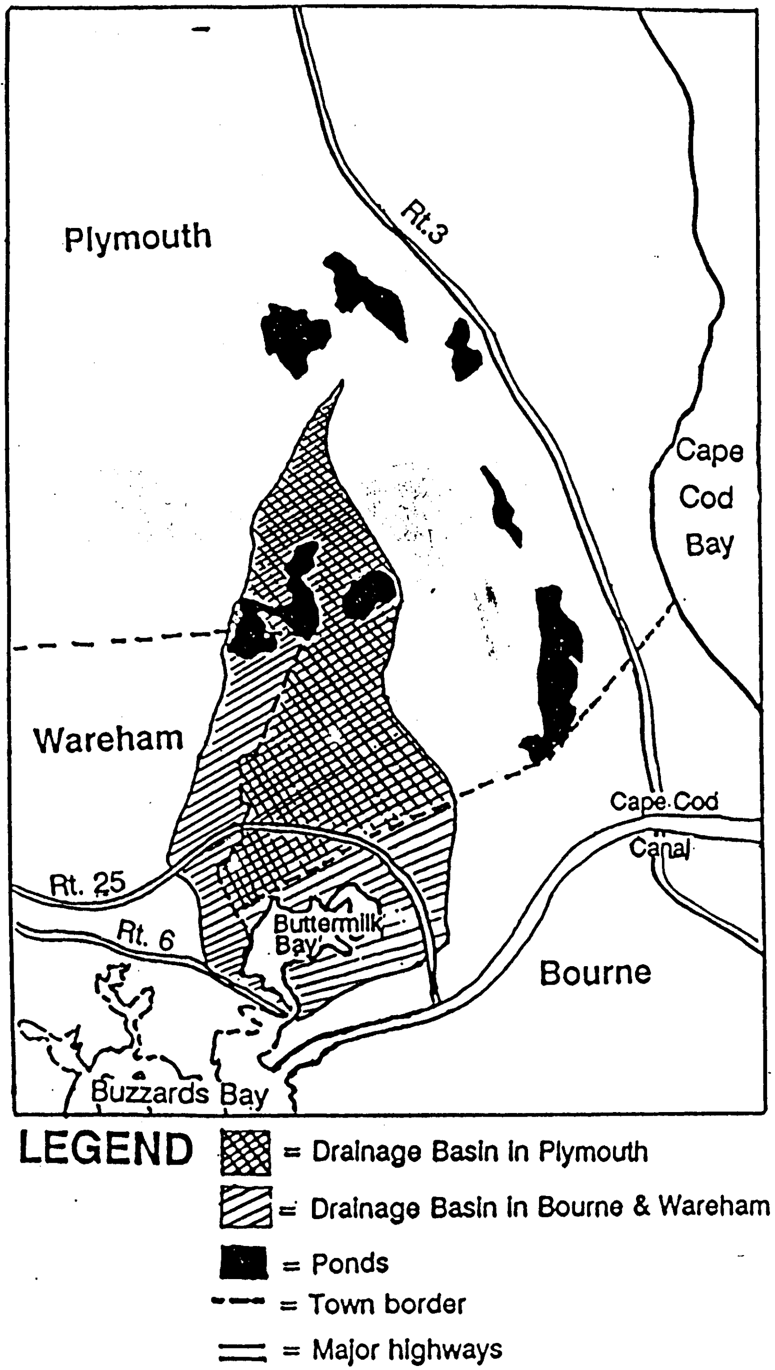


Figure 4
Buttermilk Bay Project
Required Minimum Lot Size by Zoning District
Scale 1:30 000
April 1990
less than 0.5 acre
0.5-1.0 acre
1.0-2.0 acres
greater than 2 acres
N
HWH, INC.
Buttermilk
Bay
BOURNE
CAPE COD CANAL
Point Independence
Buzzards Bay
Dicks Pond

Buttermilk Bay Drainage Basin



Q. What does Article 28, Buttermilk Bay District mean to Plymouth?

A. A change in local zoning that will help safeguard Plymouth's groundwater supplies and protect Buttermilk Bay, an ecologically sensitive Buzzards Bay embayment, from the dangerous effects of nitrogen pollution.

Q. What is nitrogen pollution and why is it dangerous?

A. Nitrogen pollution occurs when large amounts of nitrogen, particularly from septic systems and fertilizers, enter coastal waters via streams and groundwater. If we do not limit the amount of nitrogen allowed into Buttermik Bay it can:

- **lead to fish and shellfish death,**
- **destroy vital habitat areas, and**
- **aesthetically damage swimming beaches by causing excessive algae growth.**

Q. Why should Plymouth adopt Article 28?

A. In addition to protecting the natural resources of the Bay, the proposed Buttermilk Bay District is consistent with Plymouth's growth policy because it will limit development to manageable levels in specific rural areas. Within the District, the minimum lot size for unsubdivided parcels would be increased to 70,000 square feet or just over 1-1/2 acres.

Article 28 is part of a tri-town effort to protect the natural resources of Buttermilk Bay. The Buzzards Bay Project has worked closely with the Plymouth Planning Board to develop this strategy and similar articles will be voted on in Bourne and Wareham.

This information was jointly prepared by the Plymouth Planning Board and the Buzzards Bay Project.

WHAT DOES ARTICLE 28:

BUTTERMILK BAY

DISTRICT

MEAN TO PLYMOUTH?

APPENDIX C

"SURVEY OF LOCAL RESOURCES FOR IMPLEMENTATION OF COASTAL NONPOINT SOURCE CONTROL PROGRAM"

and

SUMMARY OF ANALYTICAL RESULTS

(Source: MCZM 1993 and the Author)

SURVEY OF LOCAL RESOURCES FOR IMPLEMENTATION OF COASTAL NONPOINT SOURCE POLLUTION CONTROL PROGRAM

Section 6217 of the 1990 Federal Coastal Zone Management Act Reauthorization Amendments requires that all coastal states establish a program for managing Nonpoint Source Pollution (NPS) affecting coastal waters. Local government agencies will play a key role in implementing this program, and your community is among the many in Massachusetts which will be affected. The Massachusetts Coastal Zone Management Office (MCZM) needs your input in designing and implementing an effective coastal NPS program. we are asking you to provide the following information needed to build a program around constraints identified at the local level.

PLANNING & GROWTH MANAGEMENT IN YOUR COMMUNITY

Please check appropriate boxes and fill in the blanks.

1. Does your community have an updated Comprehensive Master Plan?

   ☐ A. Yes — Date of last update ______________
   ☐ B. No

2. Has your community implemented any efforts towards growth management?

   ☐ A. Yes
   ☐ B. No

3. If the answer for question number two is yes, please specify:

   ____
   ____
   ____

4. Has there been an effort to acquire open space and recreation areas resulting in recent acquisitions within your community?

   ☐ A. Yes
   ☐ B. No

5. Please provide the following information on residential development projects underway (currently planned or under construction) within your community (if there are none, please indicated "0" in the space provided):

   A. Total number of residential units underway

   ____

   B. Total acres comprising all residential projects underway______________________________

   ____

6. Please provide the following information on commercial/industrial development projects underway (currently planned or under construction) within your community (if there are none, please indicated "0" in the space given):

   A. Total square footage of all commercial/ industrial buildings underway ______________

   B. Total acres comprising all commercial/industrial projects underway ______________

7. Does your community experience significant population increases during the summer (greater than 10% over the normal year-round population)?

   ☐ A. Yes
   ☐ B. No

8. Year-round population estimate ______________

9. Summer season population estimate ______________

10. Are there currently any major public works projects (such construction or improvements of roads and bridges) underway within your community?

    ☐ A. Yes
    ☐ B. No

11. In deciding on changes to your local zoning ordinance, what type of municipal voting structure is used in your community?

    ☐ A. Open town meeting
    ☐ B. Representative town meeting
    ☐ C. City Council
    ☐ D.Other (please specify) ______________

    ____
    ____

USE OF LAND AND MARINE RESOURCES WITHIN YOUR COMMUNITY

12. Please mark any and all agricultural land use occurring within your community.

- ❑ A. Orchards/tree crops
- ❑ B. Ground crops (such as corn)
- ❑ C. Cranberry cultivation
- ❑ D. Dairy farming/grazing
- ❑ E. Poultry farming
- ❑ F. Other (please specify) ____________________

____

____

13. Is there any timber cutting taking place in your community?

- ❑ A. Yes
- ❑ B. No

14. Please mark any and all types of surface water within your community used by the public for recreational purposes:

- ❑ A. Streams
- ❑ B. Rivers
- ❑ C. Lakes
- ❑ D. Coastal waters

15. Do you consider commercial fishing (lobster, shellfish, or finfish) to be an important source of employment in your community?

- ❑ A. Yes
- ❑ B. No

16. Please indicate if any of the following marine/boat facilities are located within your community:

- ❑ A. Public marinas
- ❑ B. Boat yards
- ❑ C. Private marinas/yacht clubs
- ❑ D. Other (please specify) ____________________

____

____

- ❑ E. Not applicable

17. Do you consider "water dependent" tourism to be an important factor in your community's economy?

- ❑ A. Yes
- ❑ B. No

18. If yes, please mark any and all types of water dependent tourism which are common to your community:

- ❑ A. Motorized boating
- ❑ B. Sail boating
- ❑ C. Whale watching
- ❑ D. Sail boarding (wind surfing)
- ❑ E. Swimming/beach going
- ❑ F. Rafting/canoeing (rivers or lakes)
- ❑ G. Other (please specify) ____________________

____

____

____

____

____

19. What is the current boat population within your community?

20. Are there any marine pumpout facilities located in your community?

- ❑ A. Yes
- ❑ B. No

21. If the answer to question twenty is yes, indicate how many:

____

WATER AND SEWER SYSTEMS

22. Please give us your best estimate of the percentage of households which rely on ground water (as opposed to reservoirs) for their drinking water supply:

- ❑ A. None rely on ground water
- ❑ B. Some rely on ground water, but less than 10%
- ❑ C. Between 10% and 50%
- ❑ D. More than 50%, but not all
- ❑ E. All rely on ground water

23. Are your ground water sources located within your community?

- ❑ A. Yes
- ❑ B. No

24. Please give us your best estimate of the percentage of households in your community which utilize onsite septic systems:

- ❑ A. None rely on onsite septic tanks
- ❑ B. Some rely on septic tanks, but less than 10%
- ❑ C. Between 10% and 50%
- ❑ D. More than 50%, but not all
- ❑ E. All rely on septic tanks

25. Does your Board of Health currently have septic system regulations stricter than Title 5 requirements?

- ❑ A. Yes
- ❑ B. No

26. Does your community currently require regular inspection of onsite septic systems to ensure that they are functioning properly?

- ❑ A. Yes
- ❑ B. No

27. Does your community dispose of storm water runoff through a combined sewer system?

- ❑ A. Yes
- ❑ B. No

LOCAL EFFORTS IN IDENTIFYING AND PROTECTING NATURAL RESOURCES

28. Are there currently any zoning overlay districts established within your community with the specific purpose to protect environmental resources?

- ❑ A. Yes
- ❑ B. No

29. If the answer to question twenty-eight is yes, please specify:

____
____
____
____
____
____

30. Have you conducted comprehensive mapping of your local watershed(s), including surface drainage and ground water contours?

- ❑ A. Yes
- ❑ B. No
- ❑ C. In progress

31. Have you mapped wetlands within your community?

- ❑ A. Yes
- ❑ B. No
- ❑ C. In progress

32. Does your community have a local wetlands protection bylaw?

- ❑ A. Yes
- ❑ B. No

33. Has your community ever done an analysis of potential densities under current zoning ("buildout analysis")?

- ❑ A. Yes
- ❑ B. No

34. If yes, has these results been used to predict environmental impacts of development?

- ❑ A. Yes
- ❑ B. No

FINANCIAL RESOURCES AVAILABLE WITHIN YOUR COMMUNITY

35. What is your community's current annual budget for the planning department?

$ ____________________________________

36. What is the current budget for stormwater drainage maintenance programs in your community?

$ ____________________________________

37. Since 1990, has the budget for your planning activities within your community:

- ❑ A. Increased
- ❑ B. Increased drastically
- ❑ C. Remained constant
- ❑ D. Decreased
- ❑ E. Decreased drastically

38. Please provide estimates of your community's total revenue derived from the following sources:

A. Industrial property tax _______ %
B. Commercial property tax _______ %
C. Residential property tax _______ %
D. Agriculture/open space property tax ______ %

39. Since 1988, has your percentage of property tax revenue derived from residential property:

- ❑ A. Increased
- ❑ B. Increased drastically
- ❑ C. Remained constant
- ❑ D. Decreased
- ❑ E. Decreased drastically

TECHNICAL RESOURCES AVAILABLE WITHIN YOUR COMMUNITY

40. Does your community have an officially designated "planning department"?

- ❑ A. Yes
- ❑ B. No

41. If no, please specify who performs the primary planning function (consultants, Town Engineer, Conservation Agent)

____

____

____

____

42. Based on current budgets, professional staffing, and technical expertise, please mark any and all of the local staff(s) working in your community available to contribute to local non-point source pollution reduction efforts in the future:

- ❑ A. Professional town or city planner
- ❑ B. Professional staff to members of the Board of Health
- ❑ C. Professional staff to members of the Conservation Commission
- ❑ D. Professional staff with town or city engineering/public works
- ❑ E. Harbor Master
- ❑ F. Technical advisors to local volunteer groups (please specify) ______________________

____

____

43. Do your planning staff or other agencies within your jurisdiction currently utilize a computerized Geographic Information System (GIS)?

- ❑ A. Yes
- ❑ B. No

44. Please mark any and all of the following computer resources that are available to you which could be used to support future environmental planning efforts:

- ❑ A IBM PC with a hard drive (please circle: 286, 386, or 486)
- ❑ B. Apple MacIntosh
- ❑ C. Unix Workstations
- ❑ D. Either a "Mini" or "Mainframe" computer system

45. We need your help in targeting technical assistance for your community in managing non-point source pollution. After carefully considering your needs, please mark the FIVE workshops which you feel would be most important in managing NPS pollution generated in your community.

- ❑ A. Managing NPS pollution from storm water and erosion
- ❑ B. Managing NPS pollution from onsite septic systems
- ❑ C. Managing NPS pollution from agriculture practices
- ❑ D. Managing NPS pollution from boats and marinas
- ❑ E. The environmental effects of NPS pollution
- ❑ F. The role of wetlands in controlling NPS pollution
- ❑ G. Local lawn care and NPS pollution
- ❑ H. Household chemicals and NPS pollution
- ❑ I. Educating the public about their role in managing NPS
- ❑ J. Local financing of NPS pollution managemen
- ❑ K. Other ______________________

____

____

____

Please take the time to offer any comments you may ha regarding the implementation of NPS pollution manageme measures in your community. Please focus on potential obs cles that you see to local implementation of effective NPS co trol. Please try be as constructive as possible. Your suggestio for overcoming these obstacles are vital to the success of t program.

____

____

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____

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____

____

Please provide the correct name, title, address, phone, and fa number of the person your community wishes to designate a the primary contact for the Coastal Non-point Source Pollutio Management Program:

NAME

____

____

TITLE

____

____

ADDRESS

____

____

____

PHONE *(including area code)*

____

FAX *(including area code)*

____

APPENDIX C
SURVEY RESULTS SUMMARY

This appendix presents an analytical summary of data gathered under the "Survey of Local Resources for Implementation of Coastal Nonpoint Source Pollution Control Program." All responses represent only those communities within the §6217 program area. A total of 163 of 213 program communities responded (approximately 75%). The number and valid percent is given in each case (valid percent represents only the fraction of communities which responded to the question). The number of valid responses is given as (n). For example, in question 1 n=160, meaning that 160 communities included responses to this question, and 3 did not. The percentages given are rounded to the nearest whole fraction.

The reader should bear in mind that these figures are not weighted by land area or population of individual communities. Program area communities vary widely in terms of size, so caution is urged in interpreting the data.

A number of questions and responses from the survey are not included here. For additional information contact the author or Jan Peter Smith at the Massachusetts Office of Coastal Zone Management, Boston, MA.

QUESTION 1

Number of §6217 communities with updated masterplan:

61 communities (38%) indicated that they had an updated masterplan, with an additional 17 communities (11%) indicating that they had one in progress (n=160).

QUESTION 2

Number of §6217 communities that have implemented efforts towards growth management:

109 communities (70%) have implemented some growth management effort. Among these are zoning restrictions, ground water protection bylaws, building permit caps, etc. (n=156).

QUESTION 11

Breakdown of municipal voting structure:

Open Town Meeting:	109 communities (67%)
Representative Town Meeting:	27 communities (17%)
City Council:	25 communities (15%)

(n=162)

QUESTION 12

Major agricultural activities present within the program area:

Tree Crops:	71 communities (44%)
Ground Crops:	99 communities (61%)
Cranberry Bogs:	40 communities (25%)
Dairy/grazing:	73 communities (45%)
Poultry:	32 communities (20%)

(n=162)

QUESTION 14

Number of communities where the public uses the following types of water resources for recreational purposes:

Streams:	98 communities (61%)
Rivers:	105 communities (65%)
Lakes:	114 communities (70%)
Coastal Waters:	58 communities (36%)

(n=162)

QUESTION 15

Number of communities which indicated that commercial finfishing or shellfishing was an important economic activity within their community:

A total of 50 communities (31%) stated that commercial fishing these were important to the local economy (n=163).

QUESTION 17

Number of communities which indicated that water-based tourism was an important economic activity within their community:

A total of 56 communities (34%) stated that water-based tourism was an important commercial activity locally (n=163).

QUESTION 22

Number of communities where at least half of all households are reliant on ground water:

A total of 89 communities (55%) stated that at least half of their households relied on ground water supplies for drinking (n=163).

QUESTION 24

Number of communities where at least half of all households reliant on onsite septic systems:

A total of 94 communities (58%) indicated that at least half of all households used onsite septic disposal systems (n=163).

QUESTION 28

Number of communities that currently use zoning overlay districts to protect environmental resources:

137 communities (85%) currently have such zoning overlay districts in place. Of these 66 communities have aquifer protection in place; 28 have wetlands protection districts (n=161).

QUESTION 30

Number of communities that have conducted comprehensive local watershed mapping:

A total of 65 communities (41%) stated that they had mapped their local watershed(s). An additional 19 (12%) indicated that they had partially mapped these, or were in the process of doing so (n=158).

QUESTION 31

Number of communities that have mapped local wetlands:

82 have mapped wetlands within their boundaries (52%). An additional 16 (10% of the total) said that they had done some wetlands mapping, or were in the process of doing so (n=159).

QUESTION 32

Number of communities with a local wetlands protection bylaw:

106 have such a law, comprising 66% of the total program area communities (n=160).

QUESTION 33

Communities that have conducted a buildout analysis under existing zoning:

76 communities have a current buildout analysis completed (49%), with an additional 7 (5%) having done at least a partial buildout (e.g., a specific portion of the town or city) or is in the process of finishing a complete analysis (n=156).

QUESTION 34

Number of communities that have used their buildout analysis for predicting environmental impacts of development:

35 have done so, comprising 44% of those communities with a buildout completed in whole or in part (n=80).

QUESTION 37

Number of communities where the municipal planning budget has decreased since 1990:

90 communities have experienced a decrease in the planning budget (57%). 27 of these (17% of the total program area communities) have experienced "drastic" cuts (n=157).

QUESTION 42

A breakdown of communities where the following local professional staff is available to help in implementing §6217 (based on current staffing and budgets):

Professional Planner:	72 communities (45%)
Professinal Health Brd Staff:	100 communities (62%)
Professional Conservation Agent:	79 communities (49%)
Professional Engineer:	83 communities (52%)
Professional Harbormaster:	46 communities (29%)

(n=161)

QUESTION 43

Number of communities using a computerized geographic information system (GIS):

Only 27 communities (17%) indicated that a GIS was in use at any local agency within their boundaries. An additional 7 communities (4%) indicated that they were in the process of developing a GIS (n=159).

APPENDIX D

SUMMARY OF STEPS IN A TYPICAL BUILDOUT ANALYSIS

(Source: Horsley Witten Hegemann, Inc.)

GENERAL GUIDELINES FOR DEVELOPABLE LOT/"BUILDOUT" ANALYSIS

1. Delineate watershed or other area of interest.

2. Obtain assessor maps for all land within study area.

3. Obtain current zoning map, zoning bylaws, wetlands bylaws, and subdivision regulations for study area. Review zoning regulations for minimum lot size and frontage requirements, as well as for other sizing requirements which may be incorporated into the analysis. Depending on the level of detail desired, wetlands and subdivision considerations may be incorporated, although this tends to become too time consuming. Typically, a set of assumptions is made and the level of detail decreased for efficiency. (See attached sample assumptions.)

4. Transfer study area boundaries and zoning district boundaries to assessor maps.

5. Obtain tax records/land use records for all parcels within study area. This data may be computerized, and obtainable in magnetic form. More frequently, it must be copied manually from tax cards in the Assessor's office. Field investigation may be required to ascertain certain land uses, particularly commercial properties. Standardized land use codes are used in many towns which have updated their records. If available, these codes can greatly simplify the buildout analysis. A copy of the codes is attached.

6. Identify all parcels with existing land uses. Record uses, differentiating between single family dwellings and duplexes or apartment buildings, since total occupancy will vary.

7. Identify all parcels which are protected open space and therefore non-developable. Town, state, and federal land, as well as parcels owned by conservation organizations generally fall in this category.

8. Quantify potential land use based on existing zoning regulations:

   - Vacant lots which are smaller than the minimum lot size, but larger than 5000 square feet are counted as grandfathered lots;

   - Lots larger than the minimum lot size are considered developable, potentially through either the "approval not required" (ANR) process, or through subdivision filing. If sufficient frontage is available, based on frontage requirements for the zoning district, the number of possible new lots

     = (lot area/minimum lot size) - existing number of houses.

If frontage is not available, 15% of the acreage is subtracted to account for internal subdivision roads as well as for wetlands, steep slopes and other constraints to development. In this case, the number of possible new lots

= {(lot area*0.85)/minimum lot size} - existing number of houses.

Calculate potential commercial development in terms of the maximum square footage that could be created according to the zoning regulations of the commercial district in question.

Consider farms, golf courses, recreational clubs and other open space as subdividable unless protected via deed restrictions or other means (land use code 900).

9. Compile results manually or with a computer spreadsheet. Such a spreadsheet can be set up to calculate the number of potential lots using the calculations above, after zoning, acreage, and frontage are entered for each parcel. Sample spreadsheets are attached, showing both formulas and results. Paper calculation can be much quicker for small areas, but is less easily updated than the spreadsheet method. For large areas, the apreadsheet method may be more efficient, although the computer files may also become cumbersome.

SAMPLE ASSUMPTIONS FOR BUILDOUT STUDY

a) Lots falling partially into the study area boundaries are counted if at least half the lot is within the bounds, or if, due to shape and/or location of lot, septic systems are expected to be located in the study area.

b) The land-use map is more up to date than individual assessor sheets. However, if the land-use map does not indicate that a parcel is residentially developed but a house is shown on the assessor sheet, the house is counted.

c) Parcels designated "group" are checked to determine their number of units; if their land-use code is"1090" (mixed single and multiple housing), 4 houses are assumed.

d) Subdivision of land is based on acreage and frontage requirements, and in a general sense, setback requirements. On lots requiring an access road, 15% of the acreage is subtracted for the road.

e) All land uses are assumed to be year-round.

SAMPLE LAND USE CODES

CODE	CLASSIFICATION
0	Multiple-Use
1	Residential
2	Open Space
3	Commercial
4	Industrial
5	Personal Property
6	Forest Property - Chapter 61
7	Agricultural/Horticultural - Chapter 61A
8	Recreational Property - Chapter 61B
9	Exempt Property

APPENDIX E

SAMPLE OF MATRICES FOR USE IN SELECTION OF
NPS BEST MANAGEMENT PRACTICES (BMPs)

(Sources: Schuler 1987; U.S. EPA 1993)

Figure 2.4: Comparative Pollutant Removal Of Urban BMP Designs

BMP/design	SUSPENDED SEDIMENT	TOTAL PHOSPHORUS	TOTAL NITROGEN	OXYGEN DEMAND	TRACE METALS	BACTERIA	OVERALL REMOVAL CAPABILITY
EXTENDED DETENTION POND							
DESIGN 1	◕	◔	◔	◔	◑	⊗	MODERATE
DESIGN 2	●	◑	◔	◑	◕	⊗	MODERATE
DESIGN 3	●	◕	◑	◑	◕	⊗	HIGH
WET POND							
DESIGN 4	◕	◑	◔	◔	◔	⊗	MODERATE
DESIGN 5	◕	◑	◔	◔	◕	⊗	MODERATE
DESIGN 6	●	◕	◑	◑	◕	⊗	HIGH
INFILTRATION TRENCH							
DESIGN 7	◕	◑	◑	◕	◕	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
INFILTRATION BASIN							
DESIGN 7	◕	◑	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
POROUS PAVEMENT							
DESIGN 7	◑	◕	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◕	◕	◕	●	●	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
WATER QUALITY INLET							
DESIGN 10	○	⊗	⊗	⊗	⊗	⊗	LOW
FILTER STRIP							
DESIGN 11	◔	○	○	○	◔	⊗	LOW
DESIGN 12	●	◑	◑	◕	●	⊗	MODERATE
GRASSED SWALE							
DESIGN 13	○	○	○	○	○	⊗	LOW
DESIGN 14	◔	◔	◔	◔	○	⊗	LOW

KEY:

- ○ 0 TO 20% REMOVAL
- ◔ 20 TO 40% REMOVAL
- ◑ 40 TO 60% REMOVAL
- ◕ 60 TO 80% REMOVAL
- ● 80 TO 100% REMOVAL
- ⊗ INSUFFICIENT KNOWLEDGE

Design 1: First-flush runoff volume detained for 6-12 hours.
Design 2: Runoff volume produced by 1.0 inch, detained 24 hours.
Design 3: As in Design 2, but with shallow marsh in bottom stage.
Design 4: Permanent pool equal to 0.5 inch storage per impervious acre.
Design 5: Permanent pool equal to 2.5 (Vr); where Vr=mean storm runoff.
Design 6: Permanent pool equal to 4.0 (Vr); approx. 2 weeks retention.
Design 7: Facility exfiltrates first-flush; 0.5 inch runoff/imper. acre.
Design 8: Facility exfiltrates one inch runoff volume per imper. acre.
Design 9: Facility exfiltrates all runoff, up to the 2 year design storm.
Design 10: 400 cubic feet wet storage per impervious acre.
Design 11: 20 foot wide turf strip.
Design 12: 100 foot wide forested strip, with level spreader.
Design 13: High slope swales, with no check dams.
Design 14: Low gradient swales with check dams.

Table 4-10 (continued)

	Nutrient Control	Shellfish	Estuarine Habitat Protection	Sedimentation	Sediment Toxics	Stormwater Control	Feasibility In Coastal Areas	Maintenance Burdens	Longevity	Community Acceptance	Secondary Environmental Impacts	Cost to Developers	Cost to Local Governments	Difficulty in Local Implementation	Site Data Required	Water Dependent Use
III. SITE PLANNING																
Cluster	○	◍	○	○	○	○	●	●	●	◍	●	●	●	○	◍	●
Performance Criteria	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	●
Minimize Imperviousness	○		○	○	○	◍	●									
EROSION & SEDIMENT CONTROL		○														
Time/Area Disturbance	◍	○	●	◍	■	○	●	●	●	●	●	●	◍	●	○	●
V. POST DEVELOPMENT																
Urban Housekeeping	○	◍	○	◍	◍	■	●	◍	○	◍	◍		●	●	●	●
Fertilizer Control	◍	○	■	■	■	■	◍	○	○	◍	●		◍	◍	◍	◍
Septic Maintenance	◍	●	○	■	■	■	●	○	◍	◍	◍		◍	◍	○	◍
Household Hazardous Waste	○	■	○	■	●	■	◍	○	○	◍	◍		◍	◍	○	◍
	● 0 - 40% High Level of Control ◍ 30 - 40% Moderate Level of Control ○ 0 - 20% Low Level of Control ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Directly Protects ◍ Indirectly Protects ○ No Protection ■ Not Rated	● 60% + High ◍ 30 - 60% Mod ○ 0 - 30% Low ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Widely Applicable ◍ Applicable Depending on Site ○ Seldom Applicable ■ Not Applicable	● Low Burden ◍ Moderate Burden ○ High Burden ■ Not Applicable	● Long Lived ◍ Long Lived w/Maintenance ○ Shortlived ■ Not Applicable	● Positive ◍ Neutral ○ Negative ■ Mixed	● None or Positive ◍ Slight Negative Impacts ○ Strong Negative Impacts at Some Sites ■ Prohibited	● Low ◍ Moderate ○ High ■ Very High	● Low ◍ Moderate ○ High ■ Very High	● Easy ◍ Moderate ○ Tough ■ Very Tough	● Simple ◍ Moderate ○ Complex ■ None	● Can be Used Moderately in These Areas ◍ Sometimes Can Be Used ○ Seldom Used ■ Not Used

Table 4-10. General Effectiveness of Various Nonstructural Control Practices (Metropolitan Washington Council of Governments, 1991)

	Nutrient Control	Shellfish	Estuarine Habitat Protection	Sedimentation	Sediment Toxics	Stormwater Control	Feasibility in Coastal Areas	Maintenance Burdens	Longevity	Community Acceptance	Secondary Environmental Impacts	Cost to Developers	Cost to Local Governments	Difficulty in Local Implementation	Site Data Required	Water Dependent Use
I. COASTAL DENSITY ZONES																
Intense Zones	○	○	○	○	○	○	●	■	■	○	○	○	◍	○	◍	
Rural Zones	○	◍	◍	◍	◍	◍	●	■	■	○	◍	◍	◍	○	◍	
Protection Zones	◍	●	●	●	●	●	●	■	■	○	●	●	◍	◍	◍	
Overlay Zones	◍	●	●	◍	◍	◍	●	■	■	○	◍	◍	◍	◍	○	
Performance Zoning	◍	◍	◍	◍	◍	●	●	■	■	○	◍	◍	◍	◍	○	
II. ENVIRONMENTAL RESERVES																
Stream Buffers	◍	◍	●	◍	○	○	●	●	●	●	●	◍	●	◍	●	○
Wetland Buffers	◍	○	●	◍	○	○	●	●	●	●	●	○	●	●	●	●
Coastal Buffers	◍	●	●	◍	○	○	●	●	●	●	●	○	◍	○	●	●
Expanded Buffers	●	●	●	●	○	○	●	●	●	◍	●	◍	●	○	○	●
Floodplain Limits	●	○	●	○	○	◍	●	●	●	◍	●	◍	●	◍	◍	○
Steep Soils Limits	○	○	◍	●	○	◍	●	●	●	◍	●	◍	●	●	●	◍
Septic Limits	◍	●	○	○	○	■	●	●	●	◍	●	○	◍	○	◍	◍
Wetland Protection	●	◍	●	●	○	◍	●	●	●	●	●	◍	●	●	○	●
Forest Protection	○	◍	◍	◍	○	○	●	●	●	●	●	○	●	◍	◍	●
Habitat Protection	○	○	●	○	○	○	●	●	●	●	●	◍	●	◍	○	●
Open Space Protection	○	○	◍	○	○	○	●	●	●	●	●	○	●	◍	◍	●
	● 0 - 40% High Level of Control ◍ 30 - 40% Moderate Level of Control ○ 0 - 30% Low Level of Control ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Directly Protects ◍ Indirectly Protects ○ No Protection ■ Not Related	● 80% + High ◍ 30 - 80% Mod ○ 0 - 30% Low ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Highly Effective ◍ Moderately Effective ○ Low Effectiveness ■ Ineffective	● Widely Applicable ◍ Applicable Depending on Site ○ Seldom Applicable ■ Not Applicable	● Low Burden ◍ Moderate Burden ○ High Burden ■ Not Applicable	● Long Lived ◍ Long Lived w/Maintenance ○ Shortlived ■ Not Applicable	● Positive ◍ Neutral ○ Negative ■ Mixed	● None or Positive ◍ Slight Negative Impacts ○ Strong Negative Impacts at Some Sites ■ Precluded	● Low ◍ Moderate ○ High ■ Very High	● Low ◍ Moderate ○ High ■ Very High	● Easy ◍ Moderate ○ Tough ■ Very Tough	● Simple ◍ Moderate ○ Complex ■ None	● Can be Used Moderately in These Areas ◍ Sometimes Can Be Used ○ Seldom Used ■ Not Used