WATER RESOURCE PLANNING AND CONSERVATION IN DELAWARE

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Foreword

It is a pleasure to provide you with this report of the 1996 Science, Engineering & Technology (SET) Services Program.

The Center for Energy and Environmental Policy (CEEP) benefitted greatly from the assistance received from several state organizations including the Department of Natural Resources and Environmental Control (especially Mr. Stewart Lovell, Division of Water Resources); the Water Resources Agency of New Castle County; Artesian Water Company and the United Water Delaware (regulated water utilities in the state); and the Delaware Nature Society.

I hope that the report will be useful in your deliberations on how best to meet Delaware's water needs and to encourage sustainable development of this vital resource.

John Byrne
Director

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Water Resource Planning and Conservation in Delaware

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Executive Summary

As a companion to previous studies by the Center for Energy and Environmental Policy, this report examines the significance of integrated water resource planning, conservation and land use development. This study examines the ways in which Delaware might meet the water needs of its residents with minimal disturbance to existing open areas and environmentally sensitive regions through the implementation of comprehensive water resource policies.

A drought-induced water shortage in Northern Delaware in the summer of 1995 stimulated concern for the region's long-term water needs and supply. Several solutions under consideration focus on the development of additional surface storage capacity. This report focuses on demand-side strategies that can be of value in reducing pressures placed on existing water supplies and may even reduce the costs of more capital-intensive water supply options. Water conservation is increasingly being included in the practice of long-term water resources planning and management. The value of water conservation practices and the difficulties which exist in their implementation are considered. Policy options for Delaware are presented following reviews of nine, pioneering state water resource programs.

Approaches to Water Resource Management

The development of new water supply sources has become costly and expanded use of available sources can face problems of over-exploitation and contamination. For these reasons, water conservation is playing a greater role in water resources planning. In some case, conservation may be the most cost effective and environmentally sensitive option for making better use of existing sources.[1] For example, water conservation programs can provide alternatives to the development of capital-intensive water resource projects while attending to environmental concerns of wetland protection and wildlife needs.

Most states develop comprehensive water resource plans and implement water quality planning and management. These plans serve as guidelines for overall water resource management and set targets for local water utilities to provide adequate water supplies. Comprehensive plans are increasingly popular as a method of combining supply and conservation projects.

Water Resource Planning and Conservation

Water conservation can be a worthwhile component of water resource plans because small savings on the part of many individuals can add up to large volumes of reserve water. Benefits to the customer include reduced water bills and extended water supply which aids in increased economic development. Environmental benefits include ecosystem and habitat protection. Less water demand also has positive implications for recreational use of waterways and tourism. Water conservation can

[1] Vickers, 1991. "The Emerging Demand-Side Management Era in Water Management." *Journal of the American Water Works Association* 83. (October): 48-43.

be achieved through stricter plumbing codes, promotion of water conservation devices, pricing mechanisms and public education. All of these practices have shown positive results through the U. S.

Obstacles to water conservation are caused by certain characteristics of the water utility market. For example, a water utility often serves two distinct markets, one for water consumption and the other for wastewater removal and treatment. Unfortunately, a decrease in consumption may increase sewer rates as costs are spread across fewer units of water.[2] An additional problem is that water prices often do not accurately reflect the true cost of water resources. Administratively established prices and service subsidies frequently lead to wasteful water use and added pressure on existing supply sources.

To overcome these obstacles, many localities are experimenting with Integrated Resource Planning (IRP) efforts which combine supply-side investments with demand-side management (DSM) programs for a least-cost mix of promising options. These programs are often viewed as less risky and more effective than single-dimensional strategies.[3] In addition, some states have introduced new rate structures which encourage conservation while also addressing sewer revenue concerns.

Coordination of Land Use Planning and Water Resource Planning

Both California and Florida have begun to address the need for coordination between land use and water planning as part of a general growth management strategy. In California, the legislature has introduced several bills which require water agencies to determine whether existing supplies will meet future needs. One measure would allow water purveyors to reject a locality's proposed development plans if the water supply is inadequate to serve the development. Other measures would encourage voluntary coordination. Proponents of these bills wish to discourage sprawl by promoting development that makes best use of infrastructure that currently exists.

In contrast to California, Florida does not feel the need for new legislation since it has well established land use and water resource policies. Rather the state is trying to better coordinate the relationship between planning in the two areas. Florida has assigned a task force to research and formulate recommendations on how to integrate the planning process in a manner consistent with existing state comprehensive plans for land use, water, transportation and growth.

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[2] Wang et al, 1994. *Integrated Resource Planning Framework for Water Utilities: Applicability and Issues*. Newark, DE: Center for Energy and Environmental Policy, University of Delaware.

[3] Fiske and Dong, 1995. "IRP: A Case Study from Nevada." *Journal of the American Water Works Association* 87. (June): 72-83.; and Beecher, 1995. "Integrated Resource Planning Fundamentals." *Journal of the American Water Works Association* 87. (June): 34-48.

Innovative Water Conservation Programs

Seven states examined in the report offer innovative water conservation programs that are tailored to each state's particular situation. Several have strong DSM programs and others have adopted unique strategies which demonstrate the flexibility available in water conservation programs. The major themes in these programs include: the need to simplify and coordinate water resource planning efforts between all water players in the state; efforts to stretch limited supplies prior to initiating new source development projects; reduction of demand in residential, industrial and agricultural sectors; and improvements in the efficiency of aging water supply infrastructure. All states are concerned with adjusting their conservation programs to the particular needs and distinctive geographic, hydrologic and political characteristics of the state.

Meeting Delaware's Future Water Needs

Delaware's current water sources are limited. The recent drought of 1995 reaffirmed the need to address policies concerning water supply, especially in northern New Castle County. The hydrologic situation of the state is such that few water sources originate within state boundaries and this has resulted in the fact that over 50% of the water needs are serviced by surface water supplies.

In 1983, Delaware adopted a state water resource plan, which continues to serve as the guiding policy for comprehensive water management in the state. However, growth and development, coupled with the effects of the drought, have lead to several proposals for the development of additional supply sources in New Castle County. Growth projections indicate that the amount of water consumed is fast approaching the existing supply capacity and severe shortages are likely by 2040. Of the 19 viable options proposed in the state in 1995, nearly half are for new reservoir projects. The New Castle County Water Resources Agency has eliminated several DSM options such as new pricing and plumbing retrofit programs, as stand-alone options. The resulting reservoir storage options will be weighed with considerations for technical feasibility, environmental sensitivity, cost effectiveness, social and political acceptance, and the ability to implement the option within present legal and institutional constraints.

Water utilities within the state have varied needs including infrastructure upgrading, increased storage capacity and improved drought contingency plans. Local utilities have suggested that a wide range of options could be utilized to increase the reliability of long-term supply. Examples of initiatives include expanding the use of industrial grey water recycling, upgrading infrastructure to reduce water loss through leakage, inclining rate block structures to reduce consumer water waste, and other DSM and IRP techniques. Moreover, the Delaware Public Service Commission (PSC) has an active interest in encouraging sustainable resource planning by the utilities.

Water Resource Policy Options

The report summarizes available options for implementation of comprehensive water resource programs and provides policy options for consideration by the Delaware General Assembly. The options fall into two categories: Conservation Oriented Options and Planning Coordination Options.

- **Conservation Oriented Options**
  1. Legislation to encourage water utilities to develop long-term DSM programs.
  2. PSC promotion of an inclining block rate structure among water utilities.
  3. Consideration of less infrastructure-intensive supply-side solutions.
  4. PSC encouragement of IRP among water utilities.

- **Planning Coordination Options**
  1. Establish a stronger linkage between land use and water supply planning.
  2. Revise the Certificate of Public Convenience and Need process.
  3. Examine the existing state water resource plan to ensure that it conforms to current state land use planning strategies and is consistent with other relevant agency-level plans. Update and revise the water resource plan if necessary.
  4. Promote increased coordination and collaboration of activity among state water policy actors including state agencies, environmental organizations, and regional planning agencies.

Delaware has demonstrated leadership in water management in the past. The state could maintain this position by examining new strategies that might render cost effective and environmentally sensitive solutions to impending water supply shortages, especially in New Castle County. Conservation programs and integrated resource planning have contributed positively in several states to meeting water service needs in an economical and environmentally sensitive manner. It appears that Delaware may also benefit from these options.

I. INTRODUCTION

A. Purpose of the report

This year's report complements the Center's research on growth management summarized in the 1996 SET report by examining water resource planning and its significance for land use development patterns. Water resource planning must be a component of growth management legislation if sustainable land use development patterns are desired. This issue is particularly relevant to growth management policy, as increasing population and employment growth will require Delaware to address water service needs for areas where new residential and commercial development takes place. This report seeks to examine how Delaware might meet the water needs of its residents with minimal disturbance to existing open areas and environmentally sensitive regions through the implementation of comprehensive water resources policies.

In 1995, a drought-induced water shortage occurred in Northern Delaware. This event stimulated concern regarding the region's long-term water needs. Several options have been proposed to meet these needs. The primary options under consideration would increase Delaware's water supply. These include: 1) creating a reservoir in the Pike Creek Valley; 2) creating a reservoir at Churchmans Marsh; 3) desalinating water from the Delaware River; 4) forming underground reservoirs; 5) taking more water from the Susquehanna River; and 6) piping water purchased from Philadelphia. Options receiving less attention concern the development of long-term water conservation plans which emphasize demand-side management (DSM) strategies. These include wastewater reuse, drought demand management, water conservation pricing, and retrofit plumbing. Such demand-side strategies can be of some value in reducing pressures placed on existing water supplies and may even lower the costs of more capital-intensive water supply options.

This report examines the concept of water conservation and the practice of long-term water resources planning and management. The report begins with a discussion of the value of water conservation practices, and the difficulties which exist with regard to the implementation of conservation strategies. It then presents concise reviews of nine states which either have pioneering water conservation programs or which have begun to tackle the dilemma of coordinated land use and water supply planning. The report concludes with a discussion of policy issues relevant to Delaware and, more specifically, to the provision of water supply in northern New Castle County. Finally, a set of policy options are provided for consideration by the Delaware General Assembly.

The organization of the report is as follows. Section II addresses the concept of water conservation, considering its financial and ecological advantages and disadvantages. Section III investigates the water resource plans and water conservation policies undertaken to date by other states. Section IV describes the hydrologic and geographic characteristics and conditions in Delaware. Section V provides an overview of the water resources policies proposed for Delaware and the opinions of key policy actors in this field concerning these proposals. Finally, Section VI offers options for water resources management strategies for Delaware, examining the potential role for water conservation in the state.

B. Changing Approaches to Water Resource Management

Broadly, there are three ways to solve a water shortage problem: one is to find new sources to increase supply; a second is to decrease demand within the existing water supply system; and a third is to combine supply- and demand-side planning in what is referred to as integrated water resource planning (Beecher, 1995). Over time, water resource development projects have become difficult to gain approval and funding, while water conservation has come to play an increasingly important role in water resources planning.

For many years, high-quality water sources were relatively inexpensive to develop. However, the cost of developing new water supply sources has become expensive as affordable sources have been exploited and as some surface and groundwater sources have become so heavily contaminated by pollutants that they must be closed.[4] Consequently, with continued population growth and economic development, increased demand is placed on existing water supply systems.

Water conservation may be a viable, cost-effective and environmentally sound option to reduce demand. In some cases (discussed in later sections), it may be cheaper to make better use of current supply than to develop new sources. Water conservation can also delay or eliminate the development of capital-intensive water resource projects. In addition, water conservation may decrease negative impacts on the environment. It also helps defer or eliminate the use of inferior quality sources which otherwise might be necessary to meet increasing demand (Amy Vickers, 1991).

In recent years, water resource projects have been affected by increasing environmental concerns. More people are placing a high value on instream water uses for recreation, wildlife, wetland protection, and overall quality of life. These uses not only generate benefits for individuals but also can indirectly serve to protect valuable ecosystems.[5] Environmental concerns have also begun to shift the focus of water policy from the supply-oriented development of new sources to demand-oriented water conservation (Heilman et al, 1994).

Finally, there is evidence of a growing conservation ethic in the country. A 1983 survey by the

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[4]For example, in Tucson, because of trichloroethylene contamination, six municipal wells have been closed. In Deerfield Beach, Florida, an entire well field has been closed due to ethylene dibromide pollution. According to the U. S. Environmental Protection Agency, approximately 20% of all groundwater sources in the U. S. show trace levels of contamination (Fisher, 1987).

[5]For example, wetlands play a crucial role in wildlife management. They can provide habitats for freshwater and marine organisms. They can raise air temperatures in winter and cool them in summer.

U.S. Army Corps of Engineers showed that more than half of the states have implemented conservation programs in the form of public education and technical assistance. During the 1980s, particularly during periods of drought, technical retrofitting and pricing were used to encourage permanent and substantial water savings (Amy Vickers, 1991; Beecher and Laubach, 1989). Since 1990, more states have continued or joined in conservation practices. A discussion of specific state conservation programs is provided in Section III.

C. The Role of Federal and State Government in Water Resources Policy

Many actors are involved in water policy formation and implementation in the United States. These various actors form water policy networks on the basis of issues, geographic location and economic and political factors. For example, institutions or groups engaged in water-related issues such as groundwater protection, wetlands, wildlife conservation and non-point source pollution play a role in water policy. The result of these multiple and diverse actors is that water policy in the U.S. can sometimes be fragmented.

At the national level, there are at least 25 separate water programs, addressing hundreds of formal water policies (Roger, 1993: 16). Generally speaking, the federal government is more active in water policy formation than implementation and more involved in regulating water quality as opposed to water supply (quantity). In the case of water quality, the federal government directly affects local water supply by financing wastewater treatment facilities and setting safe drinking water standards. Federal agencies participate in water resource planning, development and management. The federal government also plays a role in drought management. It is responsible for providing drought relief money, monitoring drought conditions, and issuing drought warnings and drought emergency declarations. Most water resource problems such as drought and flood are regional in nature and therefore require solutions that are also regional in nature. Therefore, federal interstate water commissions play a prominent role in water resources policy. They coordinate action on water resource problems in the river basin regions shared by states and also perform water resource planning and management for the federal government (Heilman et al, 1994, Beecher and Laubach, 1989).

Traditionally, the federal government has also played an important role in the development of large water projects which increase supply, control flooding, produce hydroelectric power and transfer water. These projects have been subject to criticism recently for resulting in the unwise settlement human patterns and the development of water resources through subsidization of economically inefficient and environmentally destructive water-engineering projects. As a result, the federal government has made an effort to improve the management of current supplies (Heilman et al, 1994).

While the federal government plays an important role in water policy, the states have primacy in the formation and implementation of their own water laws. State policies can vary because water supply sources are heavily dependent on different geographical, historical and social conditions. Each state relies on a legal tradition that defines water rights and governs water issues. Thus, both surface and groundwater rights are determined by states.

In addition, most states develop comprehensive water supply plans, implement water quality

planning and management, and some perform both (Heilman et al, 1994, Beecher and Laubach, 1989). These plans serve as guidelines or benchmarks for overall management of state water resources and are intended to direct relevant state water actors toward the provision of adequate water supplies. Increasingly, states are accomplishing this through a combination of supply projects and water conservation programs.

II. WATER RESOURCE PLANNING

In the past, water resource planning entailed the development of traditional water supply projects such as reservoirs and new pipeline connections, as well as the retrofitting of water supply infrastructure with more efficient distribution technologies. However, because of diminishing water supplies in many regions of the country, water resource planning has broadened to include measures aimed at reducing water demand, improving supply efficiency, providing for long-term water supply reliability, and improving land use management in areas where supply projects are to be developed. This section begins with a discussion of broad water resource planning issues and then focuses on water conservation strategies, the concept of integrated resource planning and the obstacles which exist to the implementation of demand-side strategies.

Water resource planning is not an isolated activity but is related to political and social acceptability, technical feasibility, and environmental sensibility. Water resource plans, including river and stream regulation and the construction of artificial lakes or reservoirs, are examples of traditional water supply augmentation projects. The construction of reservoirs is particularly complex. Reservoirs can be harmful to wildlife protection, because they occupy a large expanse of open space, causing great changes in habitat structure. In addition, reservoir projects must pass political tests to determine if the community accepts not only the land use changes which accompany reservoir construction but also the costs of the reservoir—in part passed along to the consumer through increased state taxes and higher water bills. Therefore, water resource planning must be comprehensive and careful to integrate all possible supply solutions—both structural and nonstructural—in order to minimize environmental and economic impacts to the community.

Most, if not all, states include as part of their water management strategies a drought contingency plan. This plan provides for particular actions based on drought index readings. In Delaware, the drought index is based on the six-month antecedent precipitation and monthly stream flow in major streams in each county (DNREC, 7). Varying levels of drought severity can include water shortage warnings and drought emergency declarations.

However, short-term emergency water planning cannot guarantee protection to localities and regions against economic losses during droughts (Dziegielewski, Mee Jr., and Larson, 1992). Contingency plans such as providing for extra storage capacity and implementing water use restrictions to cope with water shortage often result in adverse economic effects either in the form of economic losses suffered directly by water consumers or as extraordinary water agency expenditures for emergency actions to increase supply. As the length and severity of a drought can never be known in advance, long-term planning, including future water use and climate condition projections, as well as economic assessments of consequences, is therefore necessary for water resource planning.

In an effort to minimize impacts to both consumers and purveyors, water utilities are increasingly incorporating water conservation into their management strategies as a way to enhance supply capacity and shift consumer demand toward sustainable use patterns (Vickers and Markus, 1992). The difficulty and cost of expanding supply capability and the threat of depletion of underground water resources has made water resource planning, including the use of water

conservation measures, a central concept in local and regional planning efforts.

A. Concept and Benefits of Water Conservation

Water conservation practices have been advocated since the 1960s. As early as 1965, the federal government made water conservation a goal of the Water Resources Planning Act (Beecher and Laubach, 1989). In 1980, the U. S. Water Resources Council defined conservation as "activities designed to reduce the demand for water, improve efficiency in use and reduce losses and waste of water, or improve land management practices to conserve water" (Beecher and Laubach quoted in Lee, 1994). Water conservation has been seen as a worthwhile component of a water resource plan because small savings on the part of many individuals can add up to large volumes of reserve water.

Water conservation programs help delay or eliminate large capital investment in new water projects (Mathias et al., 1994 : 405), thereby sustaining and protecting ecological areas and providing benefits such as wildlife protection, recreation, and tourism, while giving utilities time to develop long-term supply plans. Environmental benefits from water conservation can be substantial. Groundwater—vulnerable water resource facing depletion and salt water intrusion in coastal regions—also benefits from water conservation efforts.

In addition, water conservation has benefits for the consumer. It can lead to a reduction in water bills, and it can also extend the water supply of the area, providing conditions for further social and economic development. Decreased water use will, in turn, result in reduced amounts of wastewater, thereby requiring less expenditures on chemicals and electricity for wastewater treatment. Utilizing landscape plants that need little water also saves labor and fertilizer, the latter of which if overused can impart adverse ecological effects (Grisham and Fleming, 1989).

Means to reduce water demand include water use restrictions, plumbing codes, promotion of water conservation devices, pricing mechanisms and public education. Mandatory water use restrictions issued by authorities are often imposed during droughts to prohibit unnecessary water uses such as watering gardens and washing cars. Experience has shown that mandatory restrictions, especially of outdoor uses during water shortage periods, have been effective at reducing consumption.

Plumbing codes and conservation devices (toilets, urinals, lavatories, shower heads, and other low-flow fixtures) have also been promoted by many states. The incorporation of household water-conserving devices can result in a substantial reduction (up to 27%) in residential water use (Karpiscak, Foster, and Schmidt, 1990). In addition, a New York study showed that water-efficient plumbing fixtures (1.6-gal/flush toilets, 1.0-gal/flush urinals, and 2.0-gpm lavatories) implemented in 1989 demonstrate the potential to significantly reduce water consumption in office buildings by as much as 45% over the older 1980 plumbing standards (Behling and Batilucci, 1992).

Pricing policy has been suggested as another method to reduce water use. From an economic viewpoint, pricing is undoubtedly the most efficient mechanism for allocation of water between consumers and for rationing water during periods of limited supply. Following the law of supply and demand, as the price of a product or service increases, the demand will tend to decrease. Thus, when water rates rise, people tend to decrease water consumption by reducing unnecessary water use and

avoiding as much water waste as possible. Recent analysis suggests that pricing policies, when combined with utility programs to promote household adoption of conservation devices, can lead to sustained conservation (Wang et al, 1996 and 1994).

While the impact of public education is difficult to measure quantitatively, education is often viewed as key to water conservation. Many utilities have public outreach efforts that include targeting specific segments of the population, namely school-age children. By initiating lessons about wise water conservation practices at a young age, there is an increased possibility that those lessons will be carried forth into practice throughout life. Studies in northern Delaware indicate that education can have measurable, positive conservation impacts (Wang et al, 1996 and 1994).

Finally, water supply efficiency is viewed as a mechanism by which the utility can conserve water. Efficiencies can be increased through improved water utility management and upgrading of equipment. Management improvements refer to operation and maintenance of treatment, storage, and delivery and the improvement of water use in water treatment plants. Upgrade measures include meter testing and replacement, detection of main and service-line leaks, and proactive system upgrades. Detecting water leakages and improving supply system water use can significantly reduce a utility's unaccounted for water.

B. Obstacles to Water Conservation Efforts

Although there are many benefits to water conservation, there are also a host of obstacles to implementing successful water conservation efforts. These obstacles are caused by characteristics of the water utility market, the pricing system, economic, political and technological factors, as well as social convention.

There are usually two separate market systems in the water industry. One is the water consumption market, and the other is the wastewater removal and treatment market. Benefits for customers in one market may cause costs for customers in another market. A decrease in water demand which, in turn, reduces the cost of water supply services may cause an increase in sewer rates if cost recovery for water treatment must be spread across fewer units of water (Wang et al, 1994). Thus, there may be opposition from both the wastewater treatment industry and from consumers.

Compared with electric and gas utilities, water utilities are smaller and are relatively capital-intensive. Therefore, a utility's investment in conservation program costs may be difficult to recover through water bills (Wang et al, 1994). Furthermore, the utility will have to invest in DSM and marketing expertise in order to produce a successful program.

In addition, water conservation may impose short-term costs on utilities. The implementation of water conservation efforts may result in lost revenues when consumer demand drops and may also increase a utility's operating costs. Taken alone, these short-term costs may reduce the desire of utilities to implement conservation programs. However, when examined alongside long-term savings from delayed infrastructure development, water conservation may actually be profitable for utilities.

The fragmented way in which water policy is formed and implemented at the state level can be

another obstacle to water conservation efforts. While a government agency may devise a plan for the use of state water resources as a whole, private utilities individually create strategies for maintenance of their existing customer bases and expansion into new service territories. In addition, regional water authorities, often quasi-governmental in nature, serve a multiplicity of functions including the projection of future water supply needs within the region and suggestions as to the extent and type of viable supply solutions.

Moreover, the current water price system does not accurately reflect the true cost of water resources. The prices of many products in our society are determined by markets, but water is an exception. The rates for many water utility services have been established administratively. In most places in the United States, including Delaware, the water rate is based on cost of service. The scarcity of the resource is not considered. In addition, rates are regulated according to embedded costs which account for costs already incurred rather than marginal costs which reflect the cost of providing the next increment of service. The result is a deflated water bill which discourages water conservation (Lee, 1994: 40-41).

In some cases, the way bills are presented to customers discourages water conservation. Consumers' water fees are traditionally included in rent bills and so the rate charged per gallon is not directly evident. Because of the way in which water rates are established and because some consumers often do not see an actual water bill, it is difficult for them to realize the seasonal scarcity of water and the importance and need to conserve.

Another limitation to water conservation is the lack of use of water monitoring technology and equipment, such as meters, in certain jurisdictions. The electricity industry has established successful demand-side management programs in part because of the implementation of advanced metering technology and indicators which monitor electricity use. However, water meters are non-existent in some communities which, obviously, can hinder the practice of water conservation.

In spite of these obstacles, well-designed and implemented programs can succeed in extending the efficiency of existing supplies and decreasing expenses on additional supplies. Economic incentives that exist for suppliers to promote water conservation include reduced investment costs per gallon of increased capacity and reduced pumping and treatment costs (Vicker and Markus, 1992). Furthermore, when customers reduce water consumption, they save on their average cost per gallon of water while the utility saves marginal costs (i.e., the cost of supplying an additional gallon of water). Because more expensive water sources are explored only after cheaper resources have been developed, the implementation of conservation programs can save the utility significant expense related to new infrastructure supply development. In this way, water conservation measures can prove to be a cost-effective component of a long-term water resource plan.

In sum, water conservation has financial advantages for both customers and utilities. Water consumers benefit from their efforts at reducing water use through lower bills. For utilities, water conservation reduces the magnitude of and delays the need for costly infrastructure development projects. For society and the natural environment as a whole, water conservation efforts can minimize the alteration of the natural landscape, thereby benefiting recreational activities, the aesthetic quality of our surroundings, as well as the preservation of wildlife and wetlands habitats (Jordan, 1995).

C. Applicability of Integrated Resource Planning

Integrated resource planning (IRP), a concept developed in the electric utility sector in the 1980s, is a practice that may very well be beneficial to water resource planning. Traditional water planning emphasizes supply options and future risk avoidance. In contrast, IRP focuses on developing a least-cost mix of supply-side investments and demand-side management programs. IRP integrates demand-side management and supply options to identify practical long-term strategies to serve consumer needs which providing financial stability and reasonable returns to utilities. Because no single strategy will immediately solve any complex water problem, IRP applies various techniques to the problem.[6] The combination and coordination of multiple strategies can be more effective and less risky than single-dimension strategy (Fiske and Dong, 1995; Beecher, 1995). Where the goal is to balance supply and demand "in an efficient manner," IRP can be a valuable water planning strategy (Mathias et al, 1994: 405). Several states and cities have already implemented IRP. See, for examples, the discussions of Massachusetts and Washington in Section III of this report.

[6] IRP can include least-cost planning (which analyses and compares the costs of alternatives including conservation programs to meet the demand), an assessment of external costs and benefits (under which the external costs and benefits of different options such as the environmental impact of project construction are quantified), public input (where the purpose is to determine the conservation programs the public wants and will accept), and evaluation of the implications of uncertainty (which addresses uncertainty assessment in terms of such factors as population forecasts, weather, regulations and facility failures) (Mathias et al, 1994: 405).

III. OVERVIEW OF WATER CONSERVATION POLICIES IN THE U.S.

This section reviews pioneering water resource programs in nine U.S. states. First, California and Florida are examined for a planning innovation in which officials have begun to address the important—although often absent—need for coordination between local land use plans and water supply planning. Then, a review of planning and policy in seven other states is offered—Connecticut, Massachusetts, New Mexico, New York, Oregon, Texas and Washington—all of which currently have innovative water conservation programs in place.

A. Coordinating Land Use and Water Resource Planning

1. California

California officials estimate that the state's population will increase 53% by the year 2020 to 49 million people. In conjunction with population growth, water demands will increase from 6.8 million acre-feet (1990) to 10.5 million acre-feet in 2020. This increase includes projected offsets from existing demand-side management programs (McClurg 1995, p. 4).

In response to these imposing projections, several bills have been introduced in the California legislature over the past year which would establish a stronger link between land use and water supply.[7] The bills vary in the extent to which they require coordination between land use and water resource planning but the basic premise behind each is to establish an official policy and planning connection between water and growth issues—a connection which has often been ignored.

Assembly Bill (AB) 584 is the most modest of the four proposed pieces of legislation. It would require cities or counties to amend their general plans to consider and include information on local water supply provided by a water agency (McClurg 1995, 8). Proponents state that the legislation would encourage longer-range planning strategies and more effectively coordinate water and land use planning decisions. Opponents contend that AB 584 does not propose measures significantly different from already existing legislation; they contend that the bill should be amended to require localities to *act* upon—and not just include—a water agency's water supply findings in their general plans (California Legislative Information 1995a, 4). As of June 1996, AB 584 remained in committee.

[7] These are Assembly Bills 584, 1005 and 1332; and Senate Bill 901.

Senate Bill (SB) 901 goes a step further, requiring water agencies to determine whether existing water supplies are adequate to support proposed development.[8] If supplies are determined to be insufficient, the agency must prepare an Environmental Impact Report (EIR) for the proposed development, pursuant to provisions in the California Environmental Quality Act (CEQA) (McClurg 1995, 8). SB 901 is intended to compel local officials to recognize and react to water supply problems before a supply situation reaches a point of crisis. In so doing, localities allow themselves more flexibility in deciding on the options used to resolve the problem. SB 901 was passed in 1995 (California Legislative Information 1995b, 1).

AB 1332 is like SB 901 in that it utilizes the CEQA process to coordinate water supply and growth. However, it makes the use of that process voluntary (McClurg 1995, 8) and therefore is not as strong as SB 901. As of June 1996, this bill remained in committee (California Legislative Information 1996, 1).

The most contentious piece of legislation introduced over the last year was AB 1005, co-sponsored by the East Bay Municipal Utility District and the California Farm Bureau Federation. The issue debated in this bill was whether a water utility district or authority can veto a locality's proposed development project if water supplies are not presently available. This would require a locality that was planning a new development outside a water agency's service area to submit the plan to the water purveyor. The water purveyor would then be authorized to determine if the development was serviceable given the existing water supply and could determine whether the development proceeded (McClurg 1995, 7).

Proponents of the bill emphasized that AB 1005 would encourage infill development and discourage sprawl. In addition, the legislation would compel localities to expand their planning horizons, thereby reducing the necessity for short-term reaction to a crisis event such as drought. However, opponents objected to the long planning horizon imposed by the bill, which they viewed as unrealistic (California Legislative Information 1995c, 2). Localities traditionally plan capital improvement program needs on a five-year horizon. AB 1005 would have required these localities to devise a 20-year planning horizon. The bill was ultimately defeated in January 1996.

California is still grappling with questions facing most regions across the country that anticipate significant population growth: Where will growth occur? And what is the link between water resources and land use planning? However, it is evident from recent legislative activity that state officials recognize the importance of interrelating water supply and land use planning initiatives and have begun to take steps in that direction. By considering these interconnections now, the state can plan for "positive" growth and economic development which enhances quality of life as opposed to settling communities in areas where obvious water resource problems exist (Cohen 1992, 344).

[8] The law limits the required water supply analysis to large projects or new towns that are likely to create new water supply demand.

2. Florida

Like California, Florida is attempting to bring greater clarity to the interrelationships of land use and water resources policies in the state. In 1992, the state's Environmental Land Management Study (ELMS) Committee identified a lack of coordination between land use and water planning as a significant missing link in Florida's overall growth management process use (FLUWPTF 1994, 1). This lack of coordination is a result of the historical relationship between the institutional bodies which have respective authority over land use and water supply decisions. Specifically, planning administration is traditionally separated; localities are charged with land use planning while state agencies and regional water districts handle water resource planning. As a means of alleviating this disjuncture in policy making, the Land Use and Water Planning Task Force was established in 1993 to recommend the appropriate relationship among each planning entity.

Florida is rich in state-level planning and policies pertaining to water and land use. However, the 1993 Task Force found no clearly existing relationship between and among these powers and activities in the two areas (FLUWPTF 1994, 12). As a result, Florida's primary concern was not the establishment of new legislation, as in California's case. Rather Florida looked for a means to simplify existing water planning policies and provide greater coordination with land use planning and policy. In its focus on the state's water resource plan, the Task Force noted that two separate statute plans were called for by Florida statute: (1) the State Water Use Plan—an existing, yet rarely used planning document, and (2) the Florida Water Plan—which incorporates the State Water Use Plan, and state water quality standards and which authorizes the Department of Environmental Protection (DEP) to adopt the State Water Policy.

Included in the recommendations offered by the Task Force were the following:

(1) The State of Florida is divided into five water management districts. Together with the DEP, these districts manage, conserve, develop and provide for the use of the state's ground and surface waters (FLUWPTF 1994, 2). The Florida Water Plan should be implemented by the DEP and the management districts. The Plan should become the state's overall water policy, replacing other pre-existing documents such as the State Water Use Plan. It should be based on the best available data and information and should be updated every five years.

(2) The State Comprehensive Plan is the cornerstone of Florida's integrated planning system. An assessment of the Florida Water Plan revealed that it, along with other agency plans such as the Land Development Plan and the Florida Transportation Plan, had been ineffective in providing direction on interrelated growth management issues (FLUWPTF 1994, 4). The Task Force recommended that the agency-level plans be better integrated into the state's overall growth management planning framework in order to provide more detailed policy guidance. Essentially, this requires that the Florida Water Plan be consistent with the State Comprehensive Plan and compatible with both the State Land Development Plan and the Florida Transportation Plan.

In sum, Florida's situation was like that of many other states in the country. Water resource and land use plans had been developed but were rarely coordinated in a practical way. Florida's strategy was to reassess the existing agency plans, and simplify the goals, benchmarks and policies of each plan so as to eliminate unnecessary overlap in policy, identify areas within each plan where deficiencies in policy were seen to exist, and most importantly, promote interagency coordination in the development of these plans so that the plans work in conjunction with one another rather than in conflict.

Both California and Florida are taking steps to increase coordination between land use and water resources initiatives. By introducing legislation and reevaluating state agency planning processes, they are attempting to bridge the gap between two traditionally distinct resource planning areas.

B. Innovative Water Conservation Programs

This section focuses on several states that have implemented progressive water conservation programs in the country. Some were chosen solely because of their reputation for having strong demand-side management programs. However, others were chosen because they had a particular strategy that seemed unique to the given state, yet showed promise of applicability to other states. The section begins with Connecticut, where a strong retrofit program made this state a water conservation pioneer.

1. Connecticut

Connecticut is one of several states that has undertaken an extensive and innovative water conservation program. Its current water resources policy was established in 1989. Unlike many conservation policies, the 1989 law was not created because of a need for drought avoidance measures, rather it was created within a legislatively proactive atmosphere.

Connecticut's first water resources policy, the Long Range Water Supply Utility Plan, was implemented in 1985. This plan was motivated by a perceived short-term water shortage intensified by a drought situation in the state. Between 1985 and 1989, three changes in policy or conservation strategy occurred. First, the Plumbing Fixtures Efficiency Act (1989) was passed which made the 1.6 gallon/flush toilet and the 2.5 gallon/minute low-flow showerhead standard for new construction. Connecticut also adopted a unique "sale of fixtures technique" under which old plumbing fixtures were removed from suppliers' shelves and replaced by new, more water efficient fixtures. In this way, customer purchase of water-saving fixtures, and the process of implementing the state's overall retrofitting program, was accelerated. Connecticut was the first state to implement this type of mandatory retrofit program (Ruzicka 1995, personal interview).

Second, Connecticut implemented a mandatory residential retrofit program which required utilities to provide free water-saving retrofit kits to residential customers (Ruzicka 1993, 1). Two-thirds of Connecticut's residential customers received kits. One-half of those kits were installed completely or partially (Ruzicka 1995, personal interview). Other water conservation strategies undertaken included the implementation of an inclining block rate structure—a pricing mechanism in

which, as the customer uses additional units of water, the rate per unit of water increases—and an annual retrofit public education program. These strategies served to complement the mandatory retrofit program, as well as the implementation of the fixture standards set forth in the Plumbing Fixtures Efficiency Act.

Finally, the Water Resources Policy Act was passed in 1989. This legislation required the three water resource agencies in the state to coordinate reviews of water utilities. This legislation is viewed as significant because it reduced jurisdictional overlap and duplicative planning practices among agencies. It also created the opportunity for long-term water resource planning development and implementation (Ruzicka 1995, personal interview).

The state water agency in Connecticut has also emphasized water utility management. State water officials find that eliminating waste in the production and distribution of water within a system is a key factor in water conservation. In contrast, other than during periods of peak demand, the agency does not believe that behavioral changes with regard to water usage can be effective in reducing daily water usage (Ruzicka 1995, personal interview).

2. Massachusetts

During the 1980s, a series of water laws were passed and implemented in Massachusetts focusing on issues ranging from interbasin transfers to state permit registration for water withdrawals exceeding 100,000 million gallons per day (MGD). During this period, the state legislature established the Massachusetts Water Resources Authority (MWRA) in 1984. MWRA provides wholesale water and sewer services to 47 communities in the metropolitan Boston area. Prior to MWRA's creation, the development of safe water supply yields concentrated on a succession of larger and more distant diversions of water from tributary sources west of Boston (Platt 1995, 187). In the early 1970s, this type of strategy met with increasing opposition from local environmental activists who were opposed to structural alteration of the Connecticut River because of the water quality impacts such alteration would impose on the river's fisheries and biota (Platt 1995, 188). The desire for a more diversified water supply system led to a broad study of viable water supply options and their accompanying environmental impacts.

In addition to the concern expressed by environmentalists, population projections and long term water supply needs reported in a 1986 MWRA Summary Report painted a bleak picture with regard to the deficit expected between the demand for water and available supply. Deficits were projected to be approximately 120 MGD (Platt 192). As a result, rather than developing expensive and environmentally problematic new supply sources, the Authority chose to adopt a long range water supply program that incorporated demand management into supply planning—IRP (Lahage 1993, 451). The objectives of this program are to obtain best use of existing water resources, reduce water leakage and maintain MWRA and local water systems in good working order using modern technology and management practices (Platt 1995, 194). When the MWRA was initiated, average system usage was 330 MGD—10% above the system safe yield (Lahage 1993, 451). After a five year pilot run, the program went system-wide in 1990. As a result of this program, system usage now averages 250 MGD—or a 27% decrease since 1987 (Lahage 1995, personal interview).

There are several important components of the MWRA program. Leak detection and repair is a major one. The MWRA funded a $2.5 million survey of distribution pipes. Subsequently, communities are now required to conduct complete leak detection surveys every two years. Technical assistance is provided if needed.[9] Metering is a second focus. Rehabilitation of system supply meters is emphasized and technical assistance is available to test and repair large meters.[10] Installation of water efficient residential fixtures and a household leak detection survey is another key area.[11] The MWRA has also implemented a comprehensive water management assessment program for large industrial, commercial and institutional customers which enables them to evaluate a full range of supply- and demand-side management options. Installation of low flush toilets in public facilities has been made compulsory. Public information including various campaigns to increase awareness of water use efficiency and the benefits of specific conservation projects have also been launched (Lahage 1993, 452-453).

One of the primary lessons learned in Massachusetts is that demand management programs can achieve significant consumption reductions when administered by a water authority or district. Furthermore, diminishing surface water supplies have provided a reminder that water resources are finite (Platt 1995, 197). The passage of new water resource legislation in Massachusetts was critical to the change in local and regional water management approaches. Finally, it should be stressed that a commitment from the MWRA to provide $30 million in funding and staff support was important in aiding the success of demand management programs in the state.

3. New Mexico

New Mexico's statewide water conservation program was initiated in 1993. The state did not decide to develop the program because of the presence of drought or other water shortage. Instead, the program has been undertaken as a long-term effort to stretch limited water supplies to meet future demands (Darilek 1993, 59).

New Mexico is experiencing an influx of new residents, companies and tourists attracted to the state because of its climate and recreational attractions. As a result, both the residential and industrial water demand is increasing. Competition for water resources is increasing between urban and rural areas as well, and between the agricultural community and recreational users as well (Darilek 1993, 60).

As one of the primary state goals, New Mexico's water conservation program is making efforts to "increase water use efficiency and reduce water demand in the municipal, agricultural and

[9] Approximately 25 MGD of leaks were located during the first two years of the program.

[10] Installations were made in 44% of single-family homes and 90% of multi-family units. Municipal officials and civic leaders were active in the planning and promotion of the program.

[11] In the first 2½ years, 300,000 households were reached and savings between 6.5 and 8 MGD were estimated system-wide.

industrial sectors to help provide a water supply that will more readily meet current and future water needs" (Darilek 1993, 61). Conservation measures and programs are implemented at the local and regional levels while the state provides technical assistance, information, coordination, as well as exercising its regulatory authority.

In addition, New Mexico has a different perspective to offer on state water planning. In a sense, it has chosen to turn traditional planning on its head. A key feature of the New Mexico plan is public involvement in the development of the water conservation program. Public input takes the form of regional water planning groups, focus groups, an advisory committee and public meetings. Involvement is encouraged at each level of government: local, regional, and state and includes federal agency representatives, state agency representatives, water use interests, local and regional agency representatives, as well as public interest groups. The rationale behind making public involvement a crucial element of the plan development process is the belief that the success of any conservation program is strongly bound to the behavioral motivations of consumers. That is, if the consumer is not motivated by the program, it will fail. Therefore, if consumers (or a subset of consumers) are involved in the creation and direction of a conservation program in conjunction with water resource managers and planners, the overall motivation should naturally be to create a successful program—one that will be utilized and produce measurable results (Darilek 1993, 61-62).

Although New Mexico is notably different from eastern states in terms of its water sources, semiarid climate and the breakdown of sector demand on total water supply (agriculture accounts for about 79 percent of total water withdrawals), like Delaware, it is considered to be a small state (in terms of population) with limited finances, it is experiencing significant population growth, and is subject to interstate stream compacts which regulate the volume of water New Mexico's suppliers must deliver to downstream users. Lessons learned in this state can offer some benefit to states which desire to create a more comprehensive and participatory approach to water conservation.

4. New York

New York State has approximately 1,800 public water supply systems. Water supplies include the Great Lakes as well as the New York City (NYC) regional water supply system which serves half the population of the state. The NYC system tends to be drought prone and is therefore the focus of much of the state's water conservation programs.

Concern over recurring drought in the 1980s and the depletion of groundwater aquifers serving the two easternmost counties on Long Island has led to several legislative initiatives in New York State (Nechamen 1996, personal interview). The 1988 Environmental Conservation Law requires a local government or water utility applying for a supply system permit to establish a water conservation program in order for the permit to be granted (Nechamen 1993, 975). The law also requires the state's Department of Environmental Conservation to establish water conservation program standards. These standards provide localities with technical assistance and information on conservation strategies but leave the specific combination of adopted strategies to the local water supply operator (Nechamen 1993, 975).[12]

[12]Minimum standards cover the following areas: metering, water supply audit, leak detection and repair, pricing,

In addition, an earlier 1984 law required the state to conduct a comprehensive water management plan. However, this regulation is currently inactive and the state plan is used primarily as a reference document (Nechamen 1996, personal interview). Essentially, the plan reviews projections of supplies that utilities will need in order to meet future demand. The legislation could have been interpreted as a requirement that a more comprehensive assessment of the water system be conducted with consideration of demand-side management options integrated into overall water system management. However, a less active interpretation has been followed to this point.

New York City has two specific water conservation strategies: a toilet rebate program for the commercial and residential sectors and a building water audit program. Under these programs, water rates are held constant for two years as an incentive to participating consumers who would thus garner savings through implementation (Nechamen 1996, personal interview). The weakest link in New York's conservation strategies program are those efforts targeting the industrial sector. The city performs some industrial audits but, overall, the state has struggled in its conservation goals with this sector (Nechamen 1996, personal interview).

New York State has experienced some resistance to its programs from water suppliers outside the NYC area. However, there are two major strengths of New York State's conservation programs, as cited by one of the state's water program specialists. First, because of the demonstrated savings in the state, New York's low-flow plumbing standards have been adopted by the federal government.[13] Second, the state has been able to work effectively with many utilities (particularly around NYC) to convince them to think about conservation alternatives. As a result, New York has one of the most innovative water conservation programs in the country (Nechamen 1996, personal interview).

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plumbing fixtures, outdoor water use reductions, non-residential water conservation, and drought and emergency procedures and planning. See William S. Nechamen (1993) for details on each area.

[13]These standards include: 3 gallons per minute for sink faucets and showerheads, 2 gallons per minute for lavatory faucets, 1.6 gallons per flush for toilets, 1 gallon per flush for urinals, self-shut off drinking water fountains, and self-shut off faucets in public restrooms (Water Conservation in New York--Policies and Practices, n.d.).

5. Oregon

A statewide water resources policy was adopted by the Oregon Water Resources Commission (WRC) in 1994. This policy requires major users and suppliers to prepare water management plans with the goal of achieving more efficient water use and the prevention of waste (Oregon Water Resources Department 1994, 1).[14] Because this process is still in a pilot phase, the state is only just beginning to receive reports of community efforts at compliance with the established policy. State water resources officials observe that communities have struggled to manage the rules regarding the preparation of water management plans. As one official stated, communities have been asked to "deal with an issue [water supply] that they have not yet viewed as an issue" (Parrow 1996, personal interview).

Although Oregon is a pioneer in terms of growth management policy (with adoption of statewide goals in 1974 see our report—CEEP, 1995), statewide water management planning and land use planning and development are not well integrated.[15] Water supply and water availability are viewed as separate factors. Water supply needs do not influence whether development will occur. This is in part due to the fact that many communities in Oregon have not reached the point where a water crisis is evident. As a result, the limits seen with regard to water supply are typically technological in nature: capturing the water source (either through surface storage or by tapping into underground aquifers) and constructing the infrastructure necessary to transport the water for treatment and then on to the consumer.

In contrast, at the local level, under water management planning rules, municipal water suppliers are required to consult with planning department and other local government officials and coordinate their activities with comprehensive land use plans (Oregon Water Resources Department 1994, 5). In addition, water suppliers must make their water use plans available for public review and comment.

Water use plans must include the following elements: a description of the water system, water conservation strategies, estimated schedule for implementation of conservation measures, water curtailment procedures, and long-range water supply projections including an assessment of what source is expected to supply any increase in demand (Oregon Water Resources Department 1994, 5-8). Conservation elements required in the plan include an assessment of current measures' efficacy, as well as an evaluation of the future feasibility and suitability of water conservation measures not included in a community's plan. These measures are detailed in WRC's rules.

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[14]Municipal water suppliers are encouraged to prepare plans but are not required to do so unless the municipality is requesting a water use permit.

[15]The water supply element of a community's comprehensive land use plan may substitute for the preparation of a water management plan. However, the WRC's water management and conservation planning rules specifically state that "approval of a water management plan shall not substitute for compliance with Statewide Planning Goals nor any other comprehensive land use planning requirement ..." This suggests that the State of Oregon acknowledges the importance of integrating the two planning issues, but has not yet determined how that integration can best be accomplished.

A strong water conservation strategy promoted in the state's water management and conservation plan guidelines is the use of metering to measure water use. The state's goal is to have a community fully metered within five years of state approval of its plan (Oregon Water Resources Department 1994, 7). Basic accountability for water usage is seen as a key factor in effective conservation. Some water utilities in Oregon have taken the goal of accountability one step further through the utilization of an inclining block rate structure. Oregon officials are witnessing more utilities moving toward an inclining block rate structure as they observe the success of their predecessors and as these utilities are increasingly confronted with supply augmentation issues (Parrow 1996, personal interview).

Over the next two years, the WRC is scheduled to review the effectiveness of policy implementation and consider both rule modifications and extensions of the policy requirement to other water users and suppliers.

6. Washington

While the State of Washington has not pursued a statewide conservation strategy, the state's major city—Seattle—has introduced an innovation approach. The City of Seattle owns and operates the primary water supply system for a region of nearly 1.3 million people (Seattle Water Department 1995). Approximately half of the population lives within Seattle and is directly served by the Seattle Water Department (hereafter referred to as "Seattle Water"). The remaining population is served by 26 neighboring suburban cities and special water districts that are wholesale customers of Seattle Water.

Seattle is currently considering adoption of a long range regional conservation plan. The impetus behind creation of such a plan stems from continued population increases within the city's service area. Since 1980, the population served by Seattle Water and the 26 wholesale purveyors has grown by more than 20%, yet water consumption in 1995 was essentially the same as it was in 1980.[16] Seattle Water credits this to wise water use by customers and the department's conservation programs (Seattle Water Department 1995). The establishment of a long range regional conservation plan is Seattle's strategy for continuing to develop conservation as a reliable water resource for the entire service area. The belief of Seattle Water is that conservation aids in the environmentally sustainable management of the water system as a whole (Seattle Water Department, 1995).

Seattle has consistently pursued water conservation for several years. In the early 1980s, conservation was not considered a viable option for meeting Seattle's water demand. However, by the late 1980s, conservation strategies were receiving heightened attention as an option for keeping demand in line with supply. Seattle Water made the decision to invest in conservation because existing sources of water supply, primarily the Cedar and Tolt Rivers, were nearing their capacity to serve the region's growth. Seattle Water now views conservation as an economical and

[16]It is worthwhile to note that Seattle Water and the purveyors meter 100% of their customers (Seattle Water Department 1995, 9).

environmentally responsible way to meet the area's future water demands (Seattle Water Department 1995, 1).[17]

In 1989, with the passage of the Water Use Efficiency Act, water systems experiencing growth in demand were required to include a conservation option in their comprehensive plans. Then, in the early 1990s, Seattle Water revised its Comprehensive Water Supply Program. Revisions included the provision that conservation options be placed on "equal footing" with traditional supply augmentation options in the process of determining how best to meet projected water needs—in other words, the establishment of an integrated resource planning approach (Seattle Water Department 1995, 13).

The establishment of the Water Supply Plan in 1993 provided the current policy guidelines for Seattle Water's conservation principles, strategies and programs. So far, conservation initiatives taken by Seattle Water have resulted in a reduction in water usage of 14 MGD—or 8% between 1990 and 1995 (Seattle Water Department 1995, 16). The currently proposed long range regional conservation plan represents a continuation of policy direction established in the 1993 plan. The guidelines in the proposed plan are projected to provide additional savings of 21 million gallons per day by 2005, representing a total of 35 MGD and an overall 18% reduction in demand from what consumption would have been without conservation (Seattle Water Department 1995, 16).

If the draft long range regional conservation plan is adopted, specific strategies to be implemented in order to achieve water demand reduction by sector by the year 2005 will include:

(1) Domestic water use:[18] The city would implement an inclining block rate structure which charging customers higher rates as the number of gallons increases. This gives the customer an incentive to conserve. Between 1990 and 1995, 9 MGD were saved due to a change in the water rate structure. It is projected that an additional 13 MGD will be achieved by 2005 under the new plan. And the institution of plumbing code changes involving the installation of high efficiency plumbing fixtures will make more efficient, water conserving equipment the norm. Wholesale and retail suppliers will only sell these high efficiency appliances. This strategy is expected to result in improvements in domestic use efficiency of 19% over 1990 levels (Seattle Water Department 1995, 3).

(2) Landscaping: A greater reliance on water efficient landscaping and improved irrigation systems will be implemented leading to an expected improvement in landscape water use efficiency of 18% over 1990 levels (Seattle Water Department 1995, 4).

[17] Average annual total system yield in 1995 was 160 MGD.

[18] The breakdown of annual water use by sector is: Domestic - 58%; Landscaping - 8%; Commercial/Industrial - 26%; and Nonrevenue water - 9%.

(3) Commercial/Industrial: More efficient equipment and water use practices in cooling and manufacturing processes will be implemented leading to an expected 16% improvement in commercial, industrial and institutional water use efficiency from 1990 levels (Seattle Water Department 1995, 4).

(4) Nonrevenue water: Reservoir leak reductions and improved reservoir operations will be managed more effectively leading to an expected 13% improvement in nonrevenue water use efficiency from 1990 standards (Seattle Water Department 1995, 4).

7. Texas

Up until the 1970s, water policy and planning in Texas followed the traditional supply-side approach. During the 1970s, this orientation began to change and expanded to include the promotion of and, in some cases, the mandate for demand-side or conservation strategies. The impetus for such a change was brought about by the energy shocks in the early 1970s which created an incentive for water conservation particularly in the agricultural sector of the state (Personett 1993, 958).

In the industrial and municipal sectors, water usage leveled off over time and started to decline in the 1980s. Municipal water usage declined from a high of 180 MGD per person to 170 MGD per person in 1987 (Personett 1993, 958). This decrease is the result of a number of factors including the installation of more efficient plumbing fixtures, demographic changes, an increase in water service costs and the implementation of water conservation programs in various parts of the state.

A significant movement toward a more comprehensive approach to water resources management came after the defeat of Proposition Four in 1981. A proposed amendment to the state constitution, Proposition Four would have set aside half of the state's budget surplus for a water resources development trust fund. It was criticized as being too open-ended, and as having the potential to result in "unnecessary and environmentally damaging water projects" (Personett 1993, 959). Following Proposition Four's defeat, and, as a result of water policy and planning review by a Governor's task force, in 1984 the state set forth its water plan. This plan included water conservation as a key factor to be incorporated into long-range water demand projections.

Currently, water conservation in Texas can be grouped into four categories (Personett 1993, 960-965):

(1) Regulatory Requirements: These include an expanded statutory definition of water conservation, a Texas Water Commission requirement that a water conservation plan and the adoption of conservation measures be conditions for receiving a permit to use state water, establishment of plumbing efficiency standards, and provisions for the use of reclaimed water.

(2) Water Resources Planning: The current Texas Water Plan was adopted in 1990 and amended in 1992. The plan increases the emphasis on water conservation in demand planning and policy (Personett 1993, 962). Future municipal water use is projected to be 15 percent lower with conservation. The need for additional surface water

impoundments would have doubled over the next 50 years without the conservation component.

(3) Technical and Financial Assistance: This includes programs directed at promoting agricultural water conservation through technology transfer and grants to be used to purchase water efficiency equipment. This also includes municipal water conservation programs to assist utilities and local and regional water agencies in the development of water conservation plans. Finally, it includes low-interest loans for wastewater reclamation and reuse projects.

(4) Research: This involves conservation research funded through state universities and the state agricultural experiment station and extension service.

Overall, each of the states reviewed here offer ideas for innovative water conservation strategies and also suggest planning approaches that incorporate flexibility in order to adjust conservation programs to the changing needs and distinctive geographic, hydrologic and political characteristics of the given state. The report now turns to a discussion of Delaware's current water resource situation.

IV. THE CASE OF DELAWARE: HYDROLOGIC AND GEOGRAPHIC CHARACTERISTICS

Several natural factors contribute to the system of water supply that serves the State of Delaware, and northern New Castle County in particular. The northern part of Delaware is characterized by limited surface water reserves and is positioned at the base of the Delaware River watershed. Water is drawn from the White Clay, Red Clay and Brandywine Creeks and the Christina River—accounting for 69% of northern New Castle County's water supply. All four of these waterways originate outside the state—a factor which may influence the vulnerability of supply (Montgomery 1995, A9). The remainder of the water supply servicing New Castle County comes from the area's only long-term, in-state water storage facility, Hoopes Reservoir, located in Wilmington, and from drilled wells which tap underground aquifers.[19]

Aquifers are the source of approximately 26% of northern New Castle County's water supply.[20] These water pockets beneath the earth's surface are tapped by water suppliers. Under normal rainfall conditions, aquifers act like large underground reservoirs, assuring more than adequate groundwater supplies to meet the needs of the state's population.

In addition to the water drawn from surface waters, reservoirs and aquifers, New Castle County water suppliers purchase water from authorities in Pennsylvania—accounting for 4% of the county's water supply. A complete table of water supply sources for the state, New Castle County and northern New Castle County, specifically, are found in Table 1. The six main water suppliers serving northern New Castle County and their source(s) of supply are found in Table 2.

[19]Delaware is positioned between two physiographic formations—the Appalachian Piedmont and the Atlantic Coastal Plain. The Piedmont covers about 113 square miles or 26% of northern New Castle County. This region is characterized by hard igneous and metamorphic rock structures. Water is drawn through the Piedmont's crystalline rock structures, where it may be found situated between grains of weathered rock, fracture joints, openings, and other channels in the formation. One rock formation within the Piedmont, the Columbia, sustains shallow water-table wells within its surficial sands and gravels in an unconfined aquifer. Other water supplies in New Castle County are found in deep, confined aquifers including the Potomac, Manokin, Pocomoke and Cheswold. The "fall zone," which separates the Piedmont from the Coastal Plain, is a narrow area running from Newark to Wilmington parallel to Route 2. The Atlantic Coastal Plain region is below the "fall zone." The Coastal Plain consists of an area of low relief underlain by unconsolidated sands, gravels, silts and clays (Talley 1988, 4). The sand and gravel material are capable of storing large quantities of fresh and saline groundwater.

[20]Groundwater accounts for 43% of Delaware's water supply and 27% of New Castle County's supply.

Table 1
Delaware and New Castle County: Water Supply Sources

	Surface Water	Groundwater	Pennsylvania Imports	Total
Delaware	50.0 MGD (54%)	40.1 MGD (43%)	3 MGD (3%)	93.1 MGD
New Castle County	50.0 MGD (68%)	19.5 MGD (27%)	3 MGD (4%)	73.0 MGD
Northern New Castle County	50.0 MGD (69%)	18.8 MGD (26%)	3 MGD (4%)	71.8 MGD

Source: DNREC, Division of Water Resources, August 1996.

Table 2
Northern New Castle County Water Suppliers

Water Supplier	Water Source
City of Wilmington	Brandywine Creek Hoopes Reservoir
Artesian Water Co.	Chester (Pa.) Water Authority New Castle interconnections wells
United Water Delaware	White Clay Creek Christina River Chester (Pa.) Water Authority Artesian interconnections
City of Newark	Artesian and United interconnections wells
City of New Castle	wells
Delaware City	wells

Delaware's current water sources have limited capacity. In addition, recent periods of drought have placed significant constraints on existing reserves. As a result, over the past few years, several policy proposals have been suggested to address Delaware's future water needs. Section V reviews the events currently under way to address these needs.

V. MEETING DELAWARE'S WATER NEEDS

Although local, state, regional and federal interests shape the debate on Delaware's water policy, the focus of these discussions relates almost exclusively to northern New Castle County where the effects of limited water supply are felt most strongly. As such, policy and planning initiatives are primarily geared towards the characteristics of and future demand predictions for New Castle County in general and northern New Castle County (north of the C&D Canal) in particular. This section reviews previous state water policy initiatives and the proposed water supply policies aimed at meeting Delaware's future water needs to the year 2040. It then considers the perspectives of various policy actors regarding these policies. This latter section is based on interviews conducted with state agency officials, utility executives, the regional water planning agency and state environmental advocates. Interviews were aimed at assessing both perceptions of how best to meet future water demand in northern New Castle County and opinions as to how water resource management might connect with land use planning and growth management policy.

A. Past State Activity

In 1983, Delaware adopted its state water resource plan. Written by the State Department of Natural Resources & Environmental Control (DNREC), the document still serves as the guiding policy for comprehensive water management in the state. Delaware's plan is recognized for being one of the first of its kind among neighboring states.

With regard to specific conservation measures, Delaware revised its plumbing code in 1991 following a requirement from the Delaware River Basin Commission (DRBC). Delaware was the first state in the region to adopt the code changes. The plumbing code specifies 1.6 gallons per flush (gpf) for toilets and 2.5 gallons per minute (gpm) for fixtures in new housing construction. Projections to the year 2040 indicate that the revisions will result in a 15% reduction in water use over what would have occurred without the code changes. Daily savings by the year 2040 will be 18 MGD, reducing average daily demand from 120 MGD to 102 MGD. During this same time period, the projections assume that all businesses will be retrofitted with water saving fixtures.

B. Proposed Water Supply Policies

The drought of 1995 created a resurgence in the quest for a long-term solution to northern New Castle County's water needs. In September 1995, the Brandywine River, the largest single source of water for northern New Castle County, was at its lowest since 1946. In general, stream flows throughout the area were at their lowest since 1966; and the 2-billion gallon Hoopes Reservoir in Wilmington, the city's back-up water supply source, was drawn down so that the city could no longer provide excess water to other utilities (Caddell 1995, A1).

There are several arguments for the development of additional supply sources in New Castle County (NCC). The County has been managing the same sources of water supply since the 1940s. As described earlier, surface water reserves in the County are limited. Furthermore, current population and economic growth projections for the area indicate that the amount of water consumed is fast

approaching the existing level of supply. The probable increase in the number of households in the county and the construction of new developments in previously open areas are thus generating concern among water utilities and planning agencies. For these reasons, over 60 options to bolster water supply have come under consideration since the late 1980s. Of these 60, 19 viable projects were agreed upon in summer 1995. (See Figure 1 for a list of these projects).

Figure 1

19 Initial Water Supply Alternatives
New Castle County Water Supply Plan

1. Churchmans Marsh Reservoir Site
2. Artesian Marsh Reservoir Site (Churchmans, south of I-95)
3. Thompson Station Reservoir Site
4. Pike Creek Reservoir Site
5. Ashland Reservoir Site
6. Mill Creek Reservoir Site
7. Yorklyn Reservoir Site
8. Corner Ketch Reservoir Site
9. Susquehanna River via Chester Water Authority Pipeline
10. City of Philadelphia Water Pipeline
11. Susquehanna River via Cecil County Pipeline
12. Groundwater North of the C & D Canal
13. Groundwater South of the C & D Canal
14. Aquifer Storage and Recovery
15. Desalination of Brackish Surface Water
16. Wastewater Reuse: Wilmington Treatment Plant
17. Indirect Use of Treated Wastewater (discharged below a water supply intake to maintain minimum streamflow)
18. Pricing & Retrofit Plumbing
19. Drought Demand Management

One option that has received high priority consideration is the proposed 2-billion gallon reservoir in Churchmans Marsh—projected to cost up to $100 million. Because of its primacy as an option, and due to the existence of wetlands habitat on the proposed site, Churchmans Marsh is the subject of an environmental impact statement (EIS). A pre-EIS, begun in 1989, was conducted to establish water needs for New Castle County through the year 2040, and calculated existing supply sources, present water use, population and housing allocation, projected population and employment growth, future water demands and future water supply. Based on these calculations, the report concluded that a water supply deficit will occur in New Castle County throughout the planning period 1990-2040 with the City of Newark being able to meet only half of its total water demand and suffering the most serious water shortage. Upon completion, the pre-EIS report was submitted to and approved by the Army Corps of Engineers—the U.S. agency responsible for determining whether or

not a permit will be granted to construct the reservoir. The Churchmans Marsh pre-EIS estimated that northern New Castle County will experience a 20 MGD deficit by the year 2040 without provisions for increasing the amount or efficiency of water allocation. This scenario is based on the projected growth in population and consumption as predicted by Metcalf and Eddy.[21]

Water Supply Alternatives
New Castle County Water Supply Plan
(As of July 1996)

1. Artesian Marsh Reservoir Site
2. Churchmans Reservoir Site
3. Pike Creek Reservoir Site
4. Thompson Station Reservoir Site
5. City of Philadelphia Water Pipeline
6. Susquehanna River via Chester Water Authority Pipeline
7. Desalination of Brackish Surface Water
8. Indirect Reuse of Treated Wastewater (discharged above the water supply intake on the Brandywine Creek)

Under the second phase of the Churchmans EIS process, which began in spring 1996, the Water Resources Agency of New Castle County (WRA) and the Delaware Department of Natural Resources & Environmental Control's Division of Water is evaluating all 19 options. This formal screening has, so far, narrowed the number of options to a small group of eight. Each alternative will be studied in detail for the purpose of determining which option meets the water needs of northern New Castle County at the minimum social, economic and environmental cost. Most of the options chosen favor new infrastructure development, specifically reservoir impoundments or technological solutions to the problem. Options such as pricing and retrofit plumbing have been eliminated as stand-alone alternatives. In other words, although these options may provide beneficial outcomes, they are not considered options which can provide complete solutions to the county's water supply needs given projected demand (see Figure 2 for the options presently receiving greatest consideration). Factors to be considered in the evaluations of each of the eight policy proposals include technical feasibility, environmental sensitivity, cost effectiveness, social and political acceptance, and ability to implement the option within legal and institutional constraints. As of August 1996, preliminary evidence based on sediment and water quality sampling has raised some problems with the use of Churchmans Marsh as a reservoir with primary capacity as a drinking water source. Further studies are to be conducted in order to determine the extent of sediment and water quality contamination. A determination on Churchmans Marsh will be made later this year.

[21]Metcalf and Eddy is the consulting firm chosen to conduct the EIS by the Water Resources Agency for New Castle County.

C. Perspectives of Key Policy Actors

The individual water providers in New Castle County have different goals which drive their water planning processes. As a result, the methods employed by each utility to meet long term water needs varies according to its service territory. The City of Wilmington for example, as a result of ample storage capacity and relatively stable growth projections in its service territory, foresees essentially no supply problem in the mid- to long-term. As a result, the City of Wilmington is most concerned with improving and upgrading infrastructure and metering in its service territory. The regulated utilities (Artesian Water Company, Inc., United Water Delaware), on the other hand, are far more interested in augmenting storage capacity because their lack of surface storage facilities makes them more susceptible to water shortages during drought conditions. However, compared to United Water, Artesian is in a better position to meet long term growth because of its development of groundwater resources. Both Artesian and United anticipate relatively stable growth in the industrial sector with the majority of future increased demand resulting from growth in their residential customer base.[22] Currently, annual growth in residential water use is 3% and is expected to continue at that rate for the next 10 to 15 years.

With regard to the Churchmans EIS, some of those interviewed recalling a growth trend study from the 1960s, expressed concern over whether the current Metcalf and Eddy predictions might overestimate the long term growth trends for New Castle County. A variety of factors, from the management of land use development patterns to quality of life choices, might influence population growth rates and impact future water needs for New Castle County. If Delaware is to implement growth management legislation enacted in the 1995 General Assembly, one might expect that the level of increase in water demand will be less than what was predicted in the pre-EIS. Similarly, if New Castle County's population were to grow at the predicted rate, the quality of life might not remain static over time. As population increases, traffic congestion and its accompanying air pollution problems might increase, open space and farmland decrease, and crowded coastal areas grow. As a result, the state might, in fact, become a less desirable place to be. As is the case with any long term resource allocation projection, demand and growth projections extrapolated over a 50 year time continuum run the risk of producing unreliable results, particularly when such projections involve many variables.

Both public and private sector respondents interviewed for this study indicated that developing a matrix of water policy and planning options is an important component of water resources management for New Castle County. Reliability, cost, environmental sustainability, and safety should be some of the fundamental goals of any water policy initiative. Although the development of surface storage capacity options has received the most exposure in the media, all of those interviewed suggested a wide range of options which could be utilized to increase the reliability of potable water supply. Examples of the range of initiatives which could serve the interests of diversifying water

[22]Ninety percent of Artesian's customer base is residential, while 60% of United's is residential. However, United's commercial/industrial customers, representing 7% of the company's customer base, consume 40% of United's water supply.

policy options include: encouraging and expanding the use of greywater recycling (especially for industrial facilities), reducing water losses resulting from old and inefficient pipeline infrastructure, using inclining rate block structures to discourage the inefficient use of water by consumers, purchasing excess capacity from Philadelphia via pipeline and incorporating demand side management (DSM) and integrated resource planning (IRP) techniques through a revamped regulatory compact between the utilities and the Public Service Commission (PSC).

VI. POLICY OPTIONS

A. Conservation-Oriented Options

From a review of programs in other states, a wide range of options can be identified which regulators, publicly owned utilities, and state officials can utilize to provide both stability and diversity in the management of Delaware's water resources. Although much of the emphasis on long-term water management in Delaware has recently focused on issues relating to surface storage, there exists strong consensus that a diversified approach to water management is important. Supply considerations need to be balanced with initiatives aimed at reducing inefficient water usage in all end-use sectors. To this end, we offer several conservation-oriented policy options for consideration.

1. *Legislation to encourage water utilities to develop long-term DSM programs.*

DSM initiatives have the ability to displace water consumption in both residential and industrial sectors and assist in providing a more stable water future for New Castle County. United Water, for example, whose industrial customers purchase nearly 40% of the utility's total water supply, has seen a permanent 10-15% reduction by these industrial customers since the drought. This has largely occurred because many of the conservation-oriented initiatives implemented during the drought were cost-effective and viewed as a good investment by industry managers (United Water officials suggested this explanation in interviews with Center staff). Artesian Water is currently the only regulated utility which has received approval from PSC and initiated efficiency and conservation programs. In part due to these efforts, Artesian Water is predicting that per capita consumption by its residential customers will likely continue to decline at approximately 2% per year. Independent analyses conducted with the benefit of four years of household consumption and billing data have shown a high degree of persistence in water savings attributable to Artesian's conservation strategy (Wang et al 1995 and 1996). Despite declines in per capita consumption, Artesian has seen its marginal return per capita increase, although this may be primarily as a result of its development of groundwater wells.

The combination of conservation initiatives and an inclining block rate structure by Artesian is an example of the direction other utilities should consider in moving to stabilize and balance demand and supply. The Public Service Commission can encourage other water utilities to develop such long-term DSM programs and might consider examining in greater detail the programs undertaken in the states discussed in this report—including Connecticut, Massachusetts, New Mexico, New York, Washington, and Texas.

2. *PSC promotion of an inclining block rate structure among water utilities.*

In order to meet future demand increases, various water management strategies could be adopted to serve the interests of short-term, mid-term and long-term water planning. In the short-term, strategies such as conservation and efficiency programs and inclining block rate structures could be implemented to assist in maximizing the efficient use of water resources. As a policy initiative, these techniques require relatively short planning and implementation periods compared to surface storage options. Such initiatives are best initiated via the regulatory compact between utilities and the Public

Service Commission. Demand-side and regulatory options have relatively few institutional and organizational "layers" involved in their development. The time frame for implementing such initiatives ranges from one to five years.

Basing water rates on an inclining block rate structure in combination with the implementation of conservation initiatives, has had a positive effect in terms of reducing per capita consumption for Artesian Water customers. At present, United Water has not introduced inclining block rate structures. Extending this rate structure to industrial customers is somewhat problematic because a relatively large portion of water goes to a few industrial users. United Water does not want to drive these customers away by substantially increasing prices. However, it is likely that such initiatives will be considered in the future for residential customers.

The PSC could adopt a more pro-active role in encouraging privately owned utilities to institute inclining block rates. Other places outside Delaware that have begun to implement conservation-oriented rate structures include Oregon and Seattle, Washington. By allowing for regulated utilities to capture DSM program costs in their rate bases, regulated utilities can continue to earn a profit from their DSM program investment while still encouraging efficient use of water resources.

3. *Consideration of less infrastructure-intensive supply-side solutions such as the pipeline option.*

In the mid-term, a different range of options exist which can serve both the interests of providing additional water resources to New Castle County and the development of more efficient use of water by large industrial and commercial ventures. Such options include the construction of a pipeline from Philadelphia to supply water from areas which have excess capacity, and the development of greywater recycling and reuse from large industrial customers. The planning time frame for these water resource scenarios would likely range from five to 10 years. Unlike short term regulatory and demand side options, these projects require more technical regulatory review such as an environmental impact statement and permit issuance. Although this process would not likely be as involved as the review process for surface supply augmentation projects, it does require the participation of a wider range of institutional and organizational actors.

The long-term options consist primarily of increasing surface storage capacity through the construction of a reservoir. Such an initiative requires multiple levels of regulatory assessment and approval, large expenditures of public and private fiscal resources, and uncertainty with regard to incremental demand growth.

Massachusetts and Seattle, Washington have undertaken conscious efforts to examine less costly and more environmentally sustainable solutions to their water supply problems. With regard to Northern New Castle County’s current water supply situation, Delaware might consider the development of less infrastructure-intensive options.

4. *PSC encouragement of IRP among water utilities.*

By encouraging a long-term planning process such as Integrated Resource Planning, the PSC may be able to assist regulated utilities in adopting water resource solution which are based on the total aggregate costs of providing water to end-users. The legislature might consider examining in more detail the cases of Massachusetts and Seattle, Washington where IRP has been undertaken as a more environmentally sustainable approach to water resources management.

B. Planning Coordination Options

In addition to specific conservation program recommendations, we also encourage the state to investigate planning coordination options so that, like the states discussed in Section III.A., Delaware can begin to think about how, and to what extent, it might unite land use and water resource policies. We offer several options—some which call for legislative initiative and others which involve state agency action.

1. *Establish stronger linkage between land use and water supply planning.*

In 1995, Delaware passed the Shaping Delaware's Future Act which, in part, seeks to ensure conformity of county comprehensive plans with state planning goals. The Shaping Delaware's Future Act is a significant piece of legislation that offers positive, long-term implications for growth and development in the state. It is important that initiatives taken now to implement the Act keep at the forefront the objective of coordinating interagency decision-making among state level plans. Without this, Delaware will find itself confronted with the same issue faced by so many other states in the U.S.—a missing link between land use development decisions and water supply planning projections.

Delaware might consider legislation (similar to that which was recently debated in the California legislature) or other mechanisms to assure coordination in land use and water resource planning. Such an initiative should encourage local officials to recognize and react to water supply problems before a supply situation reaches a point of crisis. A clear policy and planning connection between water and growth issues is essential to avoiding crisis-prone conditions in the water resource sector.

2. *Revise the Certificate of Public Convenience & Need process.*

The state might consider revising its policy for the provision of Certificate of Public Convenience & Need (CPCN) permits. Water supply permits are issued to individual purveyors on a subdivision-by-subdivision basis which can quickly lead to undesirable, sprawling land use patterns—a situation which runs contrary to effective growth management planning. This type of development pattern is already evident in southern New Castle County around the Middletown/Odessa/Townsend area where a patchwork of water purveyor's territories and a duplication of facilities is evident.

In addition to the land use development consequences, the current CPCN process presents a situation in which an area of the county may suddenly find itself faced with a strain on water resources

because the cumulative impacts of land development on water supply are left unconsidered. In the end, this CPCN process will negatively impact consumers. It will cost more money to develop duplicative infrastructure and, in turn, that cost will be passed on to water customers. At a minimum, the state might consider establishing a set of guiding principles and standards for the CPCN process that consider cumulative impacts of different development patterns on water supply and demand.

3. *Examine the existing state water resource plan to ensure that it conforms to current state land use planning strategies and is consistent with other relevant agency-level plans. Update and revise the water resource plan if necessary.*

Delaware might consider updating its 1983 water resources management plan. The content of the plan demonstrates the vision taken by the state in the 1980s. Given current efforts to coordinate state land use goals with county comprehensive plans, amending the 1983 state water resources management plan will work to enhance the state's overall planning efforts. Toward this end, the state might consider a reevaluation of goals, benchmarks and policies—as in Florida's case. In fact, establishing a link between land use and water resource planning will have a better chance of success if DNREC produces a revised water resource plan.

Integral to the production of a revised plan, accurate and reliable data must be available. Whereas wastewater management data appears to be secure, there remains a need for a more complete water demand/consumption database. Working from a common base of information, the state, counties, municipalities and regional planning agencies may enhance and expedite the process of evaluating new supply- and demand-side projects.

4. *Promote increased communication and collaboration of activity among state water policy actors including, state agencies, environmental advocacy organizations, and regional planning agencies.*

Most, if not all, of the officials interviewed for this report agreed that state planning needs to involve all relevant water actors. Before this type of collaboration can yield positive results, however, a clarification of the roles of each actor needs to be established. With the state taking steps to revive state-level planning, the Department of Natural Resources & Environmental Control might consider taking the lead in bringing the different water actors together.

Each actor can bring valuable knowledge and expertise to the decision making process. For example, water purveyors have accurate knowledge of the size and location of major water sources. This type of knowledge should have direct relevance to land use planning initiatives. Yet, water purveyors indicate that they are seldom asked about water supply as it relates to local planning decisions.

The fragmentation of water resources policy in the U.S. has led to many inefficiencies in water resource plan development. However, recognizing the existence of fragmentation is the first step toward finding a solution and perhaps rethinking water resources policy from a new perspective based on increased communication and collaboration among actors.

VII. CONCLUSION

This report has addressed issues of water conservation and water resources management in Delaware. Its purpose has been to provide the Delaware General Assembly with an overview of this policy area for use in their deliberations.

That Delaware was one of the first to produce a comprehensive water management plan and adopt plumbing efficiency standards is an accomplishment that deserves praise. However, it is in the State's best interest to maintain its leadership position by examining new strategies that might render cost effective and environmentally sensitive solutions to the current water supply strain in northern New Castle County. Included in these strategies are specific water conservation measures such as an inclining block rate structure and the implementation of integrated resource planning. In addition, by examining existing water resource planning mechanisms and integrating those with overall statewide land use planning initiatives, Delaware will be well-positioned to provide effective resource management into the next century.

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