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WATER RESOURCE ALLOCATION: AN IMPACT ANALYSIS OF THE CONNECTICUT WATER POLICY DIVERSION ACT

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WATER RESOURCE ALLOCATION:
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CONNECTICUT WATER POLICY DIVERSION ACT

BY

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CHAPTER ONE: INTRODUCTION

Allocation planning is the process by which decisions are made as to who will get how much of what resource. It also implies that the resource is scarce and in need of management. The primary goal of allocative water resource planning, therefore, is to create a process by which water is managed so that its use is maximized by all consumers.

Historically, water resource allocation in the United States has been through adjudication rather than by legislation. Prior appropriation, riparian right, or some combination of the two have formed the basis of water law in court decisions. Both allocation systems hinge on the concept that water rights are usufructuary--the water itself is used but never owned in substance (Goldfarb 1988:11). Instead, rights to use of the water are obtained. Riparian rights, more fully described in Chapter Two, are water rights given to abutters of watercourses. Prior appropriation is described as "qui prior est in tempore, potoir est in jure" or, more simply, first in time, first in right (Meyers and Tarlock 1971:77). Both systems are primarily concerned with stream flow as opposed to groundwater or diffused overland flow.

Prescriptive water rights apply to both prior appropriation and riparian law and are acquired over time, similar to adverse possession of land. After water is used without legal challenge for a period of time, the user has obtained a prescriptive right to that use (Meyers and Tarlock 1971:-67).

In New England, water diversions were historically created as a reduction of instream flow for hydropower, canals, or withdrawals for mill processes (Kaynor 1976:Ch.1-3). In most cases, the water was consumed and returned within the basin of origin. By 1900, water supply reservoirs in both the Eastern and Western states were developed that transferred water from natural drainage basins by aqueduct systems to other drainage areas and even other states (National Water Commission 1973:317). These transfers, or interbasin diversions, became such a common source for expansion of water facilities nationwide, that by 1970 there were no fewer than 11 *interregional* river basin transfers proposed, encompassing approximately 176.8 million acre-feet per year of water, crisscrossing both state and national boundaries, and traversing hundreds of miles (Geraghty et al. 1973). Subsurface diversions also became a viable source of obtaining water as large groundwater reservoirs were tapped for use as public water supplies (Water Symposium IV. Contemporary Developments in Water Law 1970: Ch.1).

Although water companies viewed diversions as the most efficient and cost effective method of meeting demand, the environmental and equity issues were not always addressed. As Figure 1 demonstrates, different uses require different flow rates in order to function (NERBC 1981:91). In the case of subsurface flows, well withdrawals lower water tables significantly. Occasionally saltwater or other contaminants are drawn into the freshwater source or the withdrawal depletes the availability of water to nearby wells (Fetter 1980:295) as shown in Figure 2.

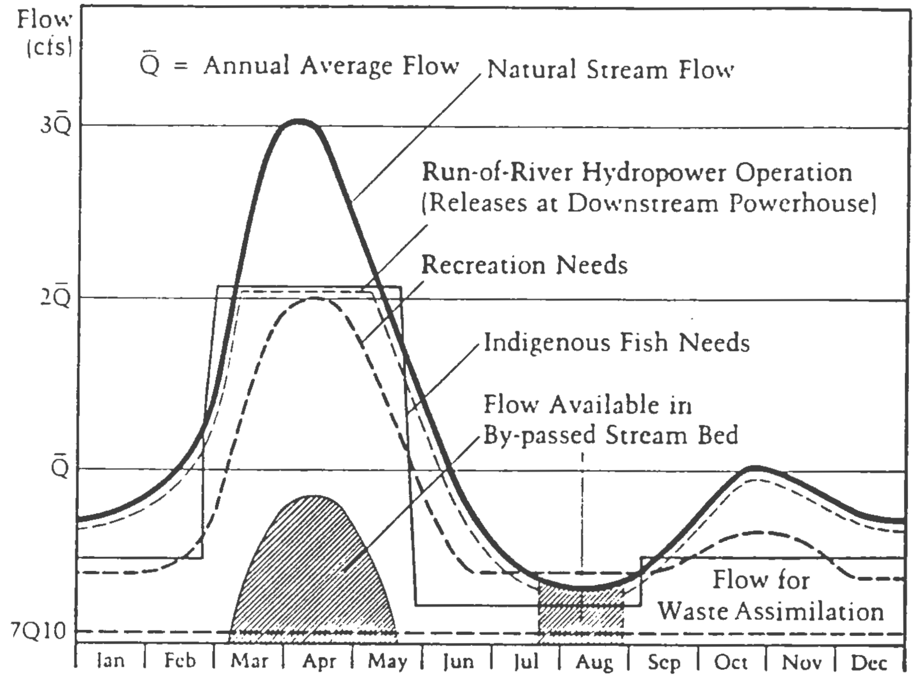

Figure 1. Hydrograph showing conflicts between a run-of-river hydropower diversion project and other stream uses. Source: NERBC. 1981:91.

As competition for water resources increased, so too did public awareness of the significance of commitment of these same resources. In practice, this resulted in diverse groups seeking legal remedy outside of riparian or prior use laws to reverse the loss of water rights. For example, a 1983 California Supreme Court decision reversed traditional prior appropriation rulings on the basis of the public trust doctrine. The Court found in favor of the Audubon Society in a suit challenging the claims to unrestricted transfer of water by the City of Los Angeles from Mono Lake for public water supply (National Audubon Society v. Superior Court of Alpine County, 33 Cal. 3d 419, 658 P.2d 709, 189 Cal. Rptr. 346. 1983 cited by Casey 1984:809-825). In the past decade, however, both the courts and the states have given water rights allocation a new perspective. But, allocation by adjudication fails on several counts when measured against the need for a comprehensive, equitable distribution of water resources. The primary inadequacies in court determined water resource allocations are as follows:

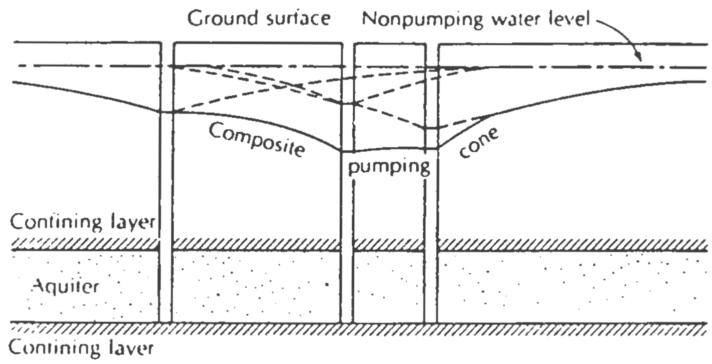

Figure 2. Water table depression from composite pumping cone for three wells within the same aquifer. Source: Fetter, C.W. 1980:-293.

(1) The courts can only look at the issues before them. For example, if the case before the court only concerns

competing municipal water supply needs, other issues -- such as minimum low stream flow for anadromous fish passage--cannot be addressed (Koch 1980:17).

(2) Decisions are made on a case-by-case basis without a comprehensive, regional view (Goldfarb 1984:10);

(3) Court remedy only allows for adversarial resolution; alternative solutions are not required to be exhausted.

(4) Lawsuits are time consuming and costly. As a result, some parties may be deterred from bringing suit even if there is a valid claim (Kaynor 1976:86).

(5) Public participation is very limited (Goldfarb 1988:-25).

(6) It is difficult to reverse committment of resources once they have been allocated through the judicial system.

Because of the increasing conflicts between competing uses and the failure of the courts, the National Water Commission's 1973 Final Report recommended that permit systems be instituted in riparian states to better manage water resources (National Water Commission 1973: 280-294).

Subsequently, Connecticut legislature passed the Water Diversion Policy Act in 1982 which enabled the Department of Environmental Protection (DEP) to regulate all diversions by a permit process.

Connecticut´s statutory permit system evolved as a result of the proposal of two major interbasin watercourse transfers--both involving the Connecticut River basin. One, the proposed diversion of approximately 375 million gallons per day (mgd) from tributaries of the Connecticut River to the Quabbin Reservoir for use by the City of Boston (Kaynor 1976:89), would not have been regulated by this statute had the proposal come to fruition. However, the statute would have given credence to Connecticut´s claims in any lawsuit stemming from that transfer (Thomas 1991).

The second was a proposal by the Hartford Metropolitan District Commission to divert a portion of the Farmington River. In the Farmington River controversy, the need for augmenting public water supply came into direct conflict with the need for instream recreational uses of the river. This was the seminal diversion for the Act, but the end result encompassed much larger issues than outlined in that controversy (Altobello et al. 1983:23). For example, the Act as it was approved in June 1982 affected the state rather than one watershed. More importantly, it made the connection between aquifers and surface water reservoirs by including groundwater withdrawals in the definition of diversions (Thomas 1991).

The purpose of the research presented here is to evaluate the effectiveness of the adopted permit process in balancing the needs of competing uses while incorporating the broader policy goals of conservation, public participation and long-range commitment of resources. To perform this evaluation, Chapter Two reviews federal, regional, and state water law and policies. The history of Connecticut water policy leading to the Connecticut Water Diversion Policy Act is discussed in Chapter Three, as well as its regulations and permit processes. Chapter Four contains the method of analysis, its limits and validity. The analysis and results can be found in Chapter Five. Lastly, findings and conclusions are presented in Chapter Six.

CHAPTER TWO: WATER LAW AND POLICIES

Uses of Water

Water uses are categorized by type and kind. The National Water Commission (1973:6) defined instream uses (also called flow uses) as navigational, hydropower, waste dilution, recreation, and fisheries. Intake uses are those removed from the source. These include agriculture, irrigation, public water supply, and industrial uses. Uses are also classified as consumptive, which do not return water to its course, or withdrawals, which return water to the same basin. The terms diversions and withdrawals are interchangeable.

Goldfarb (1988:11) questions the usefulness of such definitions in evaluating water resources since they lead to comparing uses with grossly dissimilar impacts. He cites the grouping of hydroelectric plants and scenic vistas as instream uses as a prime example. He suggests the terms "transformational" and "non-transformational" to delineate uses. Transformational uses represent changes to the water-body, while non-transformational uses leave it intact. This view, however progressive, has not yet been widely adopted.

While the riparian doctrine accommodates withdrawal or intake uses that remove water from a stream and instream uses that rely on stream flowage, on-site water uses as defined by the National Water Commission (Goldfarb 1988:11) are not accounted for. These uses, also described as "low-flow" uses, represent water consumed by wildlife, wetlands, and other natural processes (National Water Commission 1973:6). In fact, the greatest change in riparian water law that has occurred in the past twenty years is the shift from the heavily weighted economic priority of reasonable use to an attempt to recognize and place equal value on environmental or so-called natural uses.

Water Law

Every discipline has its own jargon which captures the essence of the field. Central to water law is the concept that water rights are usufructuary (Meyers and Tarlock 1971:52; Goldfarb 1988:2). Water of itself cannot be owned under the law. Riparian rights, which stem from English law, confine those rights to property owners whose property touches the watercourse (Meyers and Tarlock 1971:52; Goldfarb 1988:21; Altobello et al. 1983:21). However, riparian rights only apply to streams and natural waterbodies and do not extend to artificial lakes or groundwater (Goldfarb 1988:21) nor are the rights transferrable to non-riparians (Meyers and Tarlock 1971:118.)

Unlike the original English rule which entirely prohibits any right to be transferred to non-riparian uses, the American version of riparian rights allows transferral of water rights if the water will be put to "reasonable use"

(Meyers and Tarlock 1971:54). The benchmark case in this issue is Red River Roller Mills v. Wright (1883) which defined "reasonable use" and still sets the standard for statutory criteria one hundred years later. In that case, the Court decided water may be used off-site if the type of use, the necessity and duration of the use, the nature and size of the stream, and the proposed economic use of the water were balanced against the importance and necessity of the existing stream uses, the extent of injury to other riparian users, and consideration of other possible uses (eg: hydropower). The Court also stated that individual cases should be reviewed based on "all the other and ever-varying circumstances of each particular case, bearing upon the question of the fitness and propriety of the use of the water under consideration" (Red River Roller Mills v. Wright, 30 Minn 29, 15 N.W. 167, 169 (1883) cited in Meyers and Tarlock 1971:54). In this way, the court could take into account public need for water, power and economic development while requiring compensation for harm.

Because each user's allocation is tied to the type of use and the needs of other users, the actual quantity per riparian is not specified (Meyers and Tarlock 1970:52). This "correlative" right has often been the central legal issue, especially in time of drought (Mason, et al. v. Hoyle, 56 Conn 255, 14 Atl. 786 (1888), Dimmock v. City of New London, 157 Conn 9, 245 A.2d 569 (1968) as cited in

Meyers and Tarlock 1971:56-67). During drought, each user gives up an equal share of the water. To the water company providing potable water for domestic use, to the industrial plant requiring a minimum quantity for processing, or to the sewage treatment plant attempting to meet minimum dilution standards for waste treatment, the riparian systems places a greater burden on high water demand users during drought.

From an economic stance, the riparian doctrine falls short on several counts(1). Riparian rights pose development instability because the access to water has no relationship to the land´s capacity for development. In addition, downstream riparian right to an undiminished flow is held in reserve regardless of whether or not it is currently being used by the downstream riparian. Consequently there is no pressure to develop property to hold onto the water right.

The land´s investment potential is reduced due to the uncertainty on the part of the potential industrial user since there is no way of knowing in advance if a non-riparian use will be considered reasonable. If the courts decide a strict adherence to riparian law is required, the rights may not be transferrable at all. And as mentioned earlier, prorationing during a drought affects some water users more than others.

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1. The shortcomings of riparianism may be found in most water law texts. The economic issues described here were taken from Gaffney´s "Economic Aspects of Water Resource Policy"(1969: 137-141) as cited in Meyer and Tarlock (1971:-117-118).

Further, the individual nature of riparian rights does little to promote economic optimization or a coordinated management of water resources. Although the courts can override the individual rights for the greater public good for public water supply (Dimmock v. City of New London (1968)), there is still the ability for individuals to prevent other beneficial uses such as agriculture and mining.

In addition to the economic failings of the riparian system, the unprotected water needs of fish and wildlife and the lack of legal representation for those needs are also cited as one of the major failings of riparianism (Goldfarb 1988:7).

Water Policy

> The complex web of federal, state and local governments, private interests, varying social and political views and the physical differences among regions make unity of goals and control of resources difficult to achieve much less understand.
>
> M.M. Holland and J.J. Balco
> 1985:2222

The interplay of government agencies through the years exemplifies the web described by Holland and Balco, and has given rise to the claim that, at least at the federal level, water resource planning has been fragmented and uncoordinated (Goldfarb 1984:70-71). What follows is a brief history of water resource planning and policy during the past century on the federal, regional, and state levels.

Federal Water Resource Policy

For the first twenty years of this century, water policy evolved as a series of acts governing navigation of surface waters. The 1899 Rivers and Harbors Act (Holland and Balco 1985:2221), the creation of the Inland Waterways Commission in 1908, and the National Waterways Commission in 1912 (Foster 1984:3) primarily concerned maintenance of navigable waters.

Once federal intervention had been granted to navigation, the obvious conflict with the damming effects of hydropower had to be resolved. Since energy production was considered in the nation's best interest, Congress passed the Federal Power Act in 1920 which created the Federal Power Commission to regulate both navigation and hydropower (Foster 1984:3). By then the federal government also began to recognize the need for river basin planning and the Rivers and Harbors Act passed in 1927 included navigation, flood control and irrigation in its domain (Foster 1984:3). With this act, the Federal Power Commission shared responsibilities with the US Army Corps of Engineers for flood control structures.

Although funding for water resource projects in the next decade was influenced greatly by the Depression, the

1930´s began a fifty year era of regional planning for water resources (Foster 1984:4-5). Starting in 1933, with enactment of the Tennessee Valley Authority Act, federal funding was used for hydropower planning and construction (Holland 1985:2221). The Federal Interagency River Basin Committee (FIARBC) was formed in 1934 as an extension of the interagency coordination initiated with the 1927 Harbors Act but also included the Department of Interior and the Department of Agriculture (Foster 1984:4-5).

In the next thirty years, periodic presidential reviews occurred in response to criticisms of federal projects (Gregg 1989:11-19). In 1961, a Senate Select Committee was formed to revaluate federal water policy (Gregg 1989:11-19; Goldfarb 1984:70-73). Its report was the basis of the 1965 Water Resource Planning Act (WRPA) which, even now, demonstrates the viability of coordinated water resource planning (Goldfarb 1984:71).

The WRPA´s administrative agency was the Water Resource Council (WRC). The Council was given specific tasks to implement the Select Committee´s goals of comprehensive river basin planning, enhancement of fish and wildlife habitat, and greater participation by regional entities (Gregg 1989:11-19). To this end, the Council was to perform a nationwide water needs assessment for 18 water resource regions, create criteria and standards for determining water resource project eligibility, work with the seven newly formed river basin commissions in preparing water basin plans, and allocate funding for state water resource planning (Goldfarb 1984:71-73, Gregg 1989:11-19). For seventeen years, the Council and River Basin Commissions (RBCs) worked toward coordinating the efforts and needs of the diverse public and private sector water resource users. Although both the WRC and the RBCs lost political and financial support in 1982, the Water Resource Institutes, funded under the Water Research and Development Act, remained intact (Goldfarb 1984:73). These institutes, although federally funded, still reside in the state land grant universities and provide the bulk of research and documentation of local water resource issues and interests.

New England Water Resource Planning

The loss of the River Basin Commission was not the first time that the New England region lost regional coordination. An alphabet soup of agencies have consecutively attempted to coordinate water usage since mid-century. From 1950 to 1956, the New England-New York Interagency Committee (NENYIAC) attempted to represent the area´s concerns. As a federal agency without strong funding, its effect was extremely limited. When it disbanded in 1957, it was replaced with the Northeastern Resources Committee (NRC). This committee acted as the go-between for the Interagency Committee on Water Resources (IACWR) and the New England Board of Governors. It, in turn, was replaced in 1967 by the New England River Basin Commission (NERBC), another federal-state commission with greater representation by the states but lacking funding (Foster 1984). The last attempt in regional water resource planning was the formation of the New England New York Water Council (NENYWC) in 1981. Foster (1984:150) notes:

> ...None [of these institutions]...worked satisfactorily...The simple truth appears to be that a fixed institution, without the capability to change, is destined for obsolescence.

State Policies

The lack of federal policy in the 1980's was perhaps an opportunity for state government to focus on water resource policies and management (1981 Council of Governments as cited by Born 1989:2). In the absence of federal guidelines for allocation, and faced with droughts and increased water demands, many states began programs to manage existing resources and regulate new withdrawals. States that had begun a permit system earlier (ie: Florida, New Jersey, and Iowa) were often used as models for management permit systems (National Water Commission 1973:294-298). But the 1980's versions frequently superseded common law, rather than augmenting it, as with the older systems. Most states tailored management systems to suit individual needs.

Texas, with over 182 surface reservoirs, focused on surface water management. Since Texas relies also on groundwater recharge to surface waters as a supply source, the coordination of the two systems was essential (Wurbs 1987:-130-148). Although Texas did not abandon the appropriative system of water law, its reservoir management system has all the key elements of the permitting system.

Wisconsin´s permit process focused on groundwater protection, water quality management, and non-point source pollution abatement (Born 1989). Nebraska created substate regional units which regulate groundwater sources by permit (Born 1989). Georgia and Massachusetts both have integrated surface and groundwater water management permit systems similar to Connecticut´s.

Georgia regulates water quality, quantity, and withdrawals in excess of 100,000 gpd within its single-permit process. The permit process also incorporates requirements for drought management as well as conservation planning (Kundell 1989:19-35).

Massachusetts´ permitting system also regulates withdrawals exceeding 100,000 gpd, requires minimum flow requirements and conservation planning (Dyballa 1989:24-25). Where Massachusetts differs from Georgia is in the requirement for twenty-year water demand projections and interbasin diversion restrictions. Both systems analyze applications on a watershed basis.

The foregoing provides a sense of the interconnections between the political, economic, and social environments in which water policy planning has been formed. From planning programs which are underfunded or lack political clout, to competing issues and regions, the direction of water planning policy and management in Connecticut has been influenced by federal policies and those of surrounding states. This framework of prior and existing water law established the basis for the Water Diversion Policy Act.

CHAPTER THREE: CONNECTICUT WATER DIVERSION POLICY ACT

CT Water Resource Policy History

Connecticut's historical development is inseparable from its water resources. The earliest permanent European settlement, in 1620, occurred on the banks of the Connecticut River in Windsor, as was the second settlement in Wethersfield in 1637 (Bell 1985:14). Waterways provided economical trade and transportation routes for the colonies (Healy 1987:193) as well as a source of food. Anadromous fish such as shad and atlantic salmon made their way to spawning grounds in Vermont and Canada (Kaynor 1976:64-67). In fact, fishermen reported catching 400-500 shad per haul of the net as far north as Agawam, Massachusetts and could "salt a year's supply" at Lancaster, New Hampshire as recently as the 1820's (Kaynor 1976:65).

In fact, some of the earliest documented water right disputes derive from fishermen opposing flow reductions from the South Hadley canal (1792) and hydropower operations at Turners Falls Dam (1799) (Burnham 1900:144 as cited in Kaynor 1976:54). Beginning in the mid-nineteenth century, public water supply development further reduced the available volume for other instream uses (Healy 1987:194). In the case of the Connecticut River, uses prior to 1840 determined future allocations (Kaynor 1976: 2, 69).

In general, the first three centuries of Connecticut water resource law, policy, and management favored economic uses such as navigation and power supply over environmental concerns. The policies reflected the societal attitude of the European settlers who viewed water as a resource to be stilled, tamed and put to human use.

During the first two decades of the twentieth century, water supply by surface reservoirs increased 1100% (Healy 1987:194). Still, non-riparian rights were only permitted to public water supply diversions by special act of the legislature (Leonard 1970:2). Water quality, as well as quantity, had become the concern with the discovery that water-borne diseases could be carried in public water systems (Holland 1981:18). Consequently, the Connecticut State Water Commission was formed to administer both water supply and water quality standards (Foster 1984:9).

As with the federal policy changes during the twenties and thirties, Connecticut water policy became oriented toward comprehensive river basin planning which included other water system functions. Hard hit by the 1936 and 1938 hurricanes, and again in 1955, Connecticut formed the Water Resource Council in 1957 to replace the State Water Commission. The Council took on the additional responsibilities of flood management (Foster 1984:10). By 1970, no less than 25 different state agencies and nine federal agencies were involved in some phase of water resource management (IWR

1970:Appendix). With the creation of DEP in 1970, many of the water resource functions merged into this department. The Department of Health Services (DOHS) retained specific duties regulating, for example, public water supply quality, plans, and some waste discharge permits (Healy 1987:193). Prior to 1982, DOHS was the sole permitting authority for diversions and then only for those diversions that were intended for public water supply (Okrongly 1991).

Two highly controversial diversion proposals brought stream allocation to the forefront of water resource policy. The outcome, however, was an integrated water resource management policy document that far exceeded the original controversies (Altobello et al. 1983:23).

Beginning in 1965, the Army Corps of Engineers (COE) offered the Boston Metropolitan District Commission the use of flood waters from a proposed flood structure at Northfield, Massachusetts for storage at the Quabbin Reservoir. Since federal funding policy required that dams be multipurpose, flood control, water supply, and recreation were often linked in COE projects (Kaynor 1976:87). What this represented, however, was a diversion of approximately 375 mgd from the Connecticut River.

Connecticut had lost an earlier court case regarding the MDC's right to use the Connecticut for public water supply in 1922. But because the MDC delayed making a decision until after 1969, the initiation of the National Environmental Protection Act (NEPA) allowed Connecticut greater leverage for opposing the diversion. That, and the opposition from within Massachusetts, were leading reasons for abandonment of the project (Kaynor 1976:83-101).

One of the products of the fifteen-year-plus controversy was an enlightened public. The level of awareness of both the participants and the general public provided a well-equipped opposition to the second major diversion. When the Hartford Metropolitan District Commission proposed to increase the diversion of the Farmington River for water supply purposes in early 1982, a highly organized, highly politicized group awaited (Altobello, et al. 1983:23).

To allow adjudication for non-riparian uses such as water-based recreation and fisheries, the Farmington citizen's group endorsed legislation drafted by the DEP regarding diversions. The final version, however, represented a comprehensive policy document which integrated surface and groundwater withdrawals, allocation and conservation, and long range water planning (Thomas 1991; Altobello, et al. 1983:23).

The Water Diversion Policy Act

The Water Diversion Policy Act contained in the Connecticut General Statutes (CGS) Sections 22a-365 et seq includes legislative intent, stated goals, underlying policy, and regulatory process.

CGS Section 22a-366 frames the goals and policies by which water will be allocated within Connecticut. Specifically, it states that diversions will only be allowed when "...necessary, ...compatible with long-range water resource planning, proper management and use of the water resources" and "consistent ...with the state plan of conservation and development...". It further states that "the necessity and public interest for [this act] and the protection of the water resources of the state is declared a matter of legislative determination". In so doing, this removed water allocation from the judiciary branch of government and placed it within the DEP´s regulatory powers.

The regulatory process is equally clear. The statute is structured as a three-tiered hierarchy. The permit process is different for diversions occurring prior to 1982, new within-basin diversions, and new interbasin diversions. Each tier requires increasing regulatory review and more detailed information. This highlights one of several underpinning policies framing the law: that existing diversions have special, protected status, that within basin diversions are considered less significant than out-of-basin transfers, and that interbasin (out-of-basin) diversions represent a separate set of concerns requiring the highest level of public participation--a mandatory public hearing.

CGS 22a-369 (1)-(9) outline the minimum information necessary to be submitted with an application for all new diversions. These include the demonstration of need, conservation measures, environmental impacts, alternatives to the diversion, and descriptions of the type, quantity and duration of the diversion. Further, Subsection (10) requires that applications for interbasin diversions be accompanied by a report discussing the impact on present and future water use in the donor basin and a twenty-five year plan for meeting water supply needs and demands in the donor basin.

The decision criteria to be used by the Commissioner of the Department of Environmental Protection are outlined in 22a-373. Again, the primary concern is allocating water resources with respect to need, conservation, environmental impact, long-range planning, economic development, and commitment of resources both economic and environmental.

Lastly, Section 22a-377 permits certain uses to be exempt from regulation as a matter of right. Withdrawals less than 50,000 gpd, certain discharges, and stormwater detention systems in which the drainage area equals less than 100 acres are examples of exemptions in the original act.

1990 Revisions to the WDPA

As a result of review beginning in 1988, the DEP initiated changes to the Act in response to difficulties in interpretation and procedures. The revisions, approved by the Connecticut General Assembly in April 1990, cover four areas of the diversion process: exemptions, registrations, decision consistencies, and long range plans.

Exemptions

Several new groups were included in exempted diversions. Some are functions of water companies such as well replacements, pump tests for feasibility of new well sites, and diversions as part of distribution extensions for existing registered public water systems. Other exemptions include diversions for federal or state projects except multi-purpose structures. This would appear to exempt all but the Army Corps of Engineer flood control structures. The third group of exemptions are those temporary diversions necessary for inspection of dams, water quality, weed control on lakes or ponds, and development and construction sites.

Registrations

As with most new regulations, an enforcement date was set that applied to all registrations of pre-existing diversions. This represents a veritable tidal wave of documentation, as hundreds of water companies attempted to comply with the filing requirements. Additionally, there was nothing in the statutes to permit review and corrections of the registrations as submitted. The 1990 revision allows

DEP staff to review and request corrections of the original registrations as necessary.

Decision Criteria

This set of revisions was primarily statutory housekeeping. The revisions spell out the need for consistency with Coastal Area Management goals, flood hazard regulations, and the State Plan of Conservation and Development. The last item was included in the original goal statement of the WDPA but was placed in this section as clarification. The changes to this section also limit the duration of the permit in all cases to twenty five years and refer to prior allocation and the need for conservation as influencing factors in determining the permit duration.

Long Range Planning

Two types of long range plans are clarified in the 1990 revisions. The first specifies the requirements under 22a-369(10) for water supply and demand projections for donor basins and potential conflicts of uses.

The second clarification concerns the long range conservation plans required of water companies for public water supply diversions. Conservation plans must now focus on water loss reduction and leak detection. This section is linked to the DOHS and CT Department of Public Utilities (DPUC) water supply plan requirements by PA 89-327, "An Act

Establishing a Water Resources Policy", that required the three governmental units to agree on emergency and conservation measures required of public water suppliers. The agreement, signed in December, 1990, coordinates water conservation plan requirements. Rather than divert new sources, the water companies are required to maximize existing sources and plan for demand management whenever possible.

CHAPTER FOUR: METHODS OF ANALYSES

The purpose of this research project is to measure the effectiveness of the adopted permit process in balancing the needs of competing uses while incorporating the policy goals of conservation, public participation, and long range committment of resources. Specifically, the criteria outlined in 22a-373 have been used to identify how the Commissioner decides, and what relative values are placed on the criteria when the decision is made. Last, diversion registrations are compared to permit diversions to determine if the pattern of use allocation is significantly different since the WDPA was adopted. In short, has the permit process changed the way in which water is allocated? Are the criteria being utilized and if so, are there special values given to some criteria over others?

To address these questions, two interrelationships were tested. The first, a comparison of the types and locations of uses registered as withdrawals in existence prior to 1982 with those allocated by permit after 1982, is used to identify significant variations in use allocation and potential prioritization.

In the second test, values attached to decision-making criteria were measured. To do so, the correlation between the occurrence frequency disaggregated by use and the decision to approve is estimated. If each criterion had the same value, then frequency would also be equal. In other words, for a particular use, each criteria would be as likely to occur in the decision process. If the criteria is represented more frequently, then they are more likely to have influenced the decision.

Data Sources

All data were obtained from the Department of Environmental Protection Water Resource Unit (WRU) files on registered and new diversions. The data were limited in that they only reflect legally registered diversions.

Other agencies such as the U.S. Geological Survey and DEP Natural Resources Center maintain water supply data on a town and county wide basis, by regional planning area, as well as by principal drainage basin. Unfortunately the data do not match the basin coding used by the WRU and could not be disaggregated for this study.

Data Description and Sample Size

Data used for the temporal comparison were supplied in two forms. Non-public water supply data were given by subbasin, registration name, diversion name, type of structure, source, and use. Quantities of withdrawal were reported as registered capacity, withdrawal capacity, annual withdrawal, and maximum daily withdrawal. Withdrawal capacity was selected as the estimated quantity of water per use because of the consistency in reporting of that item.

Public water supply data were reported by utilities citing the subbasin, reservoir/groundwater source, and statistics on quantities for the base year. The statistic used for estimating quantities was the registered capacity. The public water supply data were the most complete of the registrations.

Of a total 680 registrations, 434 were registered non-public water supply withdrawals by individuals and companies. Two hundred and sixteen were reported public water supply withdrawals by water companies. A reduced sample of 386 observations was selected by combining like uses within subbasin designations since only the use and not the ownership of the withdrawal was relevant to the test. Zero withdrawal uses such as recreational ponds were retained as separate observations.

Permit data after 1982 were less uniformly reported. The single largest difference in reporting was in the ability to fix quantities to specific flow uses. Additionally, two new use groups were reported: flood structures and mining diversions. These discrepancies are detailed in the discussion below on the validity of variables.

Of the 418 total post-1982 diversion permits, 52 applications received public hearings. Forty-seven were available for review at the time of sampling. These 47 represent the sample group for the tabular analysis between statutory criteria and decisions.

Variables

The selected method of analysis largely depends on the level of measurement, the scale, and the type of variables chosen. Most variables are descriptive nominal variables with discrete values. Appendix 1.2 identifies the variable, its level of measurement, scale and type.

Temporal Comparison Variables

Three variables were reviewed for use in the temporal comparison: use, location, and quantity. These are described as follows.

Quantity data were reviewed for possible use as an allocative variable but discounted due to problems with comparing intake and instream values. Many of the instream uses were not reported prior to 1982 and therefore the difficulty in determining flow quantities for those uses was not encountered. Flood control structures built prior to 1982, for example, were not registered. When the post-1982 data were reviewed, the issue of quantifying inflow uses became apparent. Hydropower and flood control structures reduce flow on a periodic basis--they cause instream flow reductions at varying rates depending in the first case on power demands and in the second on storm events. Flow reduction measurements for such structures are provided but cannot be used in direct comparison with consumptive withdrawals which occur on a continuous basis.

Similarly, volumes of retention by new dams are a one-time interruption of flow measured in millions of gallons. Although such impoundments have significant impacts on downstream uses, the type of reduction is not directly comparable to either sporadic power and flood retention interruptions or continuous consumption.

The location of the use allocated was reported consistently in all cases. Subregional watershed basins (subbasins) were identified by a four digit coding system for each registration and new diversion permit using the 1982 Department of Environmental Protection Drainage Map (Figure 3).

Uses were classified as one of fourteen number coded groups shown in Appendix 1.1. These groups were established by the Water Resource Unit as part of the regulatory process.

Policy Variables

Eight independent variables (decision variables) and two dependent variables were used to describe the criteria used in the decision making process. The use group, coded as in the previous analysis, and the decision to approve or deny, were categorized as dependent variables.

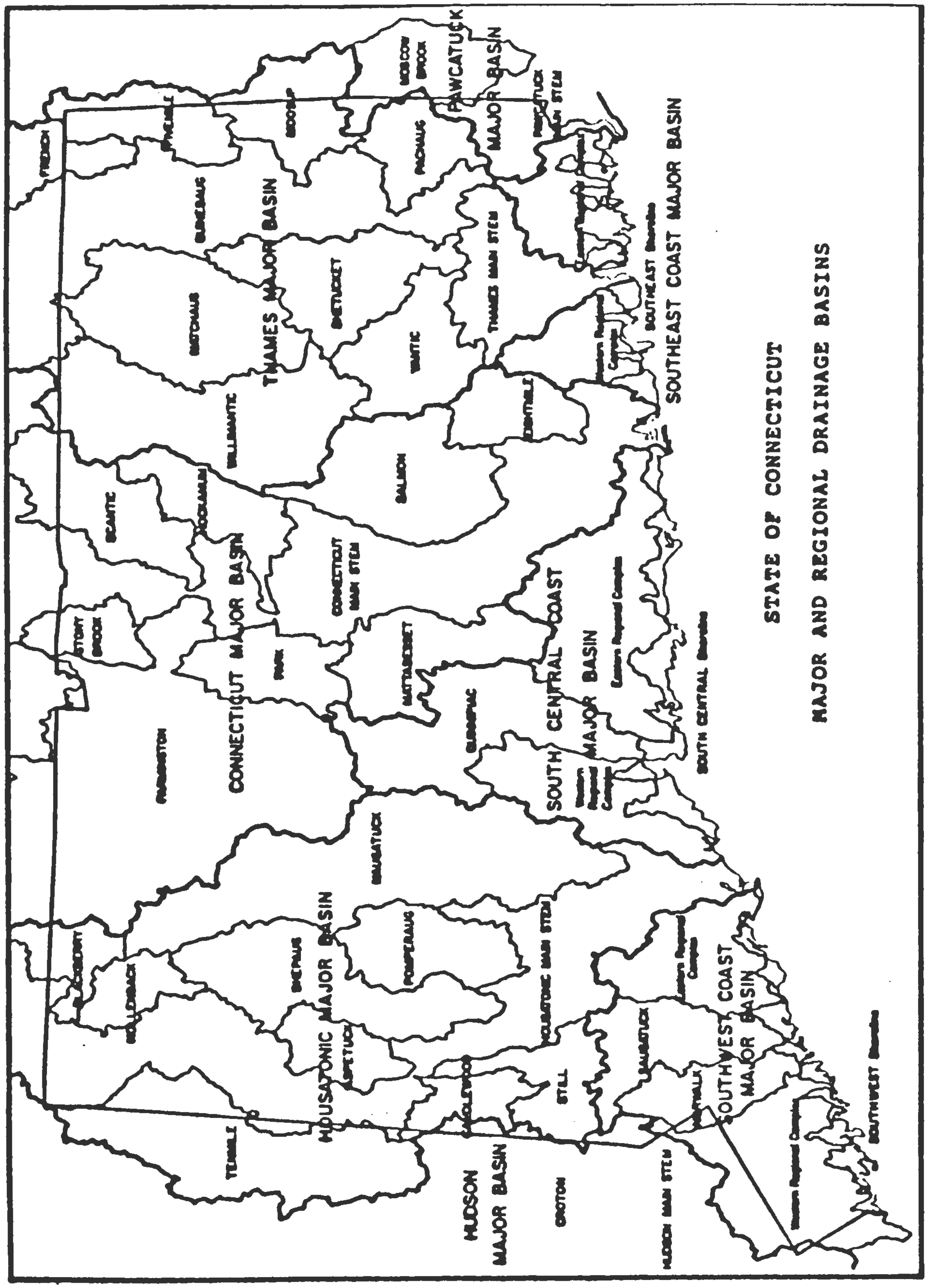

Figure 3. Drainage map of subbasins. Source: State of Connecticut 1981 Public Water Supply Water Production. CT DEP Natural Resources Center.

The decision variables consisted of the elements described in Section 22a-369(1)-(10) and the specific environmental considerations required by the DEP as part of its authority to establish procedures for enforcement of the Act.

Public participation was defined as the number of non-mandated parties to the proceedings. Mandated parties include the DEP subunits, the State´s Attorney General, the applicant, and the chief executive officer of the municipality. Non-mandated parties intervene or participate by filing for status under the Uniform Administrative Procedure Act. Intervenors are thosewho can show they will directly be harmed by a proposal but whose participation is limited to testimony during hearings. Intervenors cannot cross-examine other witnesses. Party status is granted to those individuals/groups who can show potential harm and who wish to take a greater position in the proceedings. Parties to a proceeding may be enjoined in appeals to decisions. Alternatives to a proposal were defined as the number of options the applicant considered in addition to the proposal. The "no-action" alternative was considered as an option. If no alternatives were considered, this variable was given a zero value.

Although the extent of economic analysis varied from application to application, the variable was defined as the applicant´s attempt to justify the diversion based on prior capital outlay, marginal analysis of the project, cost-benefit analysis (as in the case of most flood control structures), or cost in terms of expected regional economic benefits.

Conservation planning refers to applications for consumptive out-of-stream withdrawals that included discussion of water conservation. Long range plans are a statutory requirement for interbasin diversions that remove water from one subregion to another.

The DEP identified twelve areas of environmental concern that applicants must address in their submittal. Many of the early environmental assessments were performed by the DEP subunit staff. For example, DEP fisheries unit gave input to the record on issues concerning fish and wildlife. Over time, most applicants were required to perform an environmental analysis which the DEP then reviewed.

For this study, the categories were clustered around three attributes: quantity, quality, and instream use. The following twelve categories represent the DEP check list of potential impacts:

Instream use (WFR)	**Quantity** (QUANT)	**Quality** (QUAL)
wetland habitat	groundwater supply	water quality
fish and wildlife	public water supply	adjacent wells
water recreation	low flow use	waste treatment
	agriculture	waste assimilation
	flooding	

Economic analysis, conservation planning, long range plans and the three environmental concerns were given a dichotomous coding : 0 = none submitted, 1 = submitted. Public participation and alternatives were converted to dichotomous nominal variables for direct comparison by using the code: 0 = not present, 1 = present.

Validity

Before proceeding with the description of the methods of analysis, the limitations of the variables selected should be discussed. This research is intended as a specialized study and external validity is not claimed. The allocation schema in Connecticut cannot be generalized to other states because the administration of the law may be greatly different. However, there are eight tests for internal validity generally acknowledged as indicative of the variables´ accuracy for measurement (Grosof and Sardy 1985:93-94). Because there are actually two separate sets of variables associated with two hypotheses, Appendix 1.3 summarizes the tests and sets of variables.

The allocation variables appear to meet the standards with only one exception. Mortality, the differential loss of subjects between test groups, will have some impact on the results if the data are not adjusted to compensate. Specifically, certain use groups such as flood control structures were not registered in 1982. Similarly, the municipal improvement group disappears. Because the size of the post-1982 variable would compromise the ability to compare the results, the flood control diversions are not included in this part of the analysis.

Although possible history effects on the policy variables were reviewed because of the 1990 revisions to the statutes, this does not pose a serious problem. No public hearings have been held since the change in regulations. Consequently, the sample group is consistent over time. Similarly, the use groupings have not changed over time, nor have the report requirements changed for each use.

However, selection of the sample was not random but consisted of default reduction from the universe of permits which went to public hearing. This is not a threat to validity but changes the mathematical methods available for testing these variables.

Method of Analysis

The selection of a statistical model to describe and test the hypotheses was largely determined by the type and scale of variables and the questions being posed by the hypotheses. Since the goal is to determine correlations · between groups of variables, models which measures the expected frequencies and the patterns of occurrence were best suited for this project. Several models exist, each with assumptions and limitations. To perform the mathematics, the Number Cruncher Statistical System (NCSS) Version 5.2 (Hintze 1991) and Lotus 1-2-3 were used.

Once the type of model was selected, the level of variables determined whether to use parametric or non-parametric approaches. Specifically, a chi-square analysis is valid for nominal data, as are the test statistics phi, the contingency coefficient and the lambdas (Grosof and Sardy 1985:264). Chi-square tests enumerate the frequency of occurrence, the expected cell frequency, and then test the strength of the relationships. Although not as powerful as some of the more sophisticated nonparametric multiple correlation analyses, these test statistics are more than adequate for general trend analysis.

The data for the temporal comparison were nominally coded and could not meet the assumptions of parametric statistical treatments. For example, a median of the use group would be meaningless, as would an analysis of variance between that median and another. Instead, the data were summarized by use group and the frequency of occurrence analyzed in tabular form for the pre-and post-1982 data. Using chi-square testing, actual occurrences were compared against the null hypothesis that each cell had an equal probability of occurring. In addition, expected frequencies were generated, and the probability or significance level was established. The frequencies by use and subbasin were also used to rank and map changes in the location of types of withdrawal before and after 1982.

Chi-square analysis is extremely useful in analyzing all levels of variables in multivariate analysis. However, it cannot be used for extremely small samples--particularly when the expected cell frequency drops to zero. Therefore, this method was unsuitable for the policy analysis.

The small sample size and the large number of independent variables in the policy analysis disallows the use of many statistical methods. However, contingency tables can be derived which identify patterns in the frequencies of occurrence. The weighted average of the criteria variables´ frequency disaggregated by use was tabulated for permits which received approval after public hearing. Row (use) and column (criteria) percentages were calculated from the averages to establish the contingency table. The the relative frequency of occurrence and ranking was based on these percentages.

Finally, the validity of the method used was tested by comparing policy implementation data against the results of the policy analysis. Written record of the hearing decisions for those permits which were denied were reviewed to determine whether the results of the analyses corresponded to DEP´s decisions. And the findings of a landmark approval by DEP concerning four public water supply applications was reviewed as well.

The analyses presented here attempt to measure the changes in water allocation relative to the WDPA. It should be clear from this discussion of methods that the analyses and results which follow are intended as a "first cut" analysis of a relatively new permit process for which few quantitative measurements exist.

CHAPTER FIVE: ANALYSES AND RESULTS

This chapter is comprised of three sections: the temporal comparison, the policy analysis, and a comparison to existing policy implementation. The first set of results describe changes in use allocation resulting from the Act. The second and third sections describe correlations between policy goals and implementations.

Temporal Comparison

Because the quantities of water withdrawn could not be used, it is important to emphasize that the numbers in this comparison represent the frequency of reporting and not the relative volume of use. The proportion of uses reported is used as an indicator of changes in the types of uses over time.

Data for pre-1982 (registrations) and post-1982 (applications for new permits) were summarized by use and summary tables created. Contingency tables were created from the summary tables and chi-square statistics generated. The tables and statistics can be found in Appendix 2.1.

A cursory examination of the four most frequently occurring uses denotes the economic shift that Connecticut experienced in the 1980's. Prior to 1982, agricultural withdrawals accounted for 17.4% of total registrations, and public water supply was the principal reported use. In the eight years following the Act, development permits were most frequently sought and public water supply dropped to the third highest use. Agricultural permits sank to less than 3.0% of all permits requested.

The contingency tables which compare pre-1982 to post-1982 uses indicate the increases in industrial, hydro/electric, and instream/fisheries use diversion permits. Public and private water supplies, recreational, and municipal uses declined (Table 1.0).

Use Group (Col %)	**Pre-1982**	**Post-1982**	**%Total**	**%Change**
Public Water	34.0	22.0	28.0	-12.0
Industrial	9.7	11.4	21.0	+ 1.7
Recreation	22.5	17.1	20.0	- 5.4
Hydro/Elect	4.7	6.1	5.3	+ 1.4
Agriculture	17.4	2.4	10.5	-15.0
Private Supply	1.6	0.0	.8	- 1.6
Instream/Fish	.3	2.1	1.1	+ 1.8
Municipal	.5	.0	.3	- .5
Unknown	.3	.3	.3	0.0
Development	.3	25.1	11.6	+24.8

<u>Test Statistics:</u>

Chi-Square with 9 degrees of freedom	160.6249
Probability	.0000
Phi	.4746
Cramer´s V	.4746
Pearson´s Contingency Coefficient	.4288
Lambda B (Columns dependent)	**.3089**

Table 1.0 Temporal Comparison of Uses

The lambda b test statistic indicates that there is a very low correlation (.3089) between the two sample groups, which indicates that the groups are independent. This is further substantiated by the middle range of the phi, Cramer´s V, and Pearsons contingency coefficient statistics. Each of those statistics have a range from 0 = no correlation to 1 = perfect correlation.

Therefore, it would appear that there **has** been a change in allocation types since the 1982 WDPA took effect. From the test statistics, it would seem that only part of the change occurred as a result of change in policy. Had there been no statistical relationship, one could postulate that the WDPA had radically changed the allocation of water resources. Apparently, there are consistent demands requiring allocation which are unaffected by the Act. Other factors such as climatological effects on water supply and economic shifts with different water usage demands may also have had some effect on the post-1982 results. These effects are highly cyclical and would have been balanced by representation in the pre-1982 data. Overall, the analysis points to a distinct effect on water use allocation as a result of the Act (Figure 4).

Prior to summarizing the data, a contingency table was created which calculated the frequency of reported uses by subbasin. This was used to identify which basins were experiencing the greatest demand. Basin 4000, the Connecticut

River basin, has continued to support the greatest munber of uses. Since the Connecticut is the largest river with the most densely populated area, the results are compatible with expected use patterns.

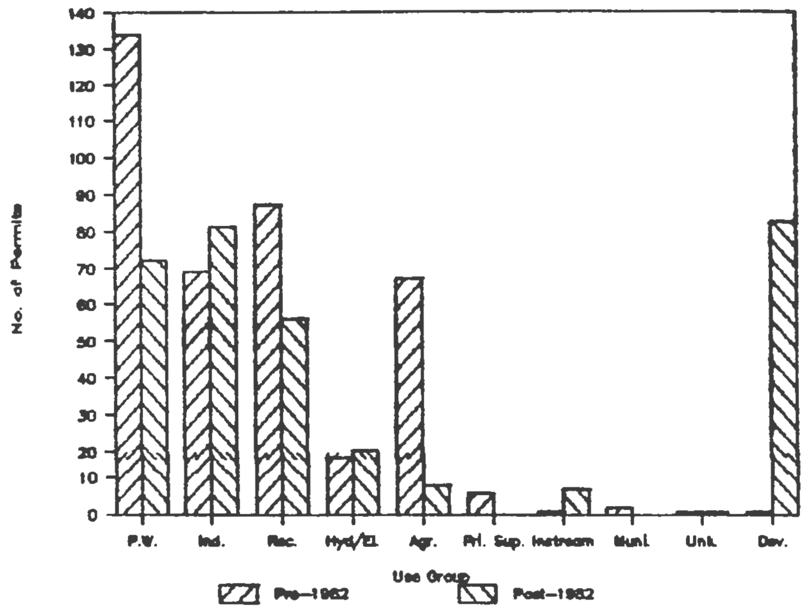

Figure 4.
Changes in use over time.

Before 1982, the second highest usage area was Basin 6000, containing the Housatonic River, followed by the Thames River in Basin 3000. While the number of use demands did not change after 1982, it is important to note that the type of use did shift. Both basins experienced increased development demands, and additionally Basin 3000 witnessed greater industrial and hydro/electric usage.

Figure 5 represents the DEP Bureau of Water Management´s "Drainage Basins of Concern" (Mauger 1990). These are basins that DEP has classified as being over-allocated, water quality impaired, or experiencing water quality problems during the summer when flows are lowest. The key to the listing of basins associated with the drainage map states that it "reflects the thinking of the Water Compliance Unit with regard to existing water use conflicts and the availability of waters in these basins for allocation of future uses" (Mauger 1990). Since diversion permit data were used in part to generate this map, it stands to reason that the locational analysis presented here should and does correspond to the map.

The change in use by subbasin has not significantly changed over time. Apparently the WDPA has not had an impact on the location of allocated uses. Since the Water Compliance Unit has only recently identified those basins that are over-allocated, the Act may have greater impact in this area in the future.

Policy Analysis

As described in the methodology section, the contingency table compared the permit data of seven use groups with eight decision variables for all applications which were approved after receiving a public hearing (2). The comparisons may be analyzed two ways: by within group differences which rank the criteria with use groups, and between group differences which would denote underlying use prioritization.

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2. Although public hearings are mandated for interbasin transfers, the Commissioner, at her discretion, may require a hearing for other diversion applications. A petition signed by 25 persons also mandates a hearing.

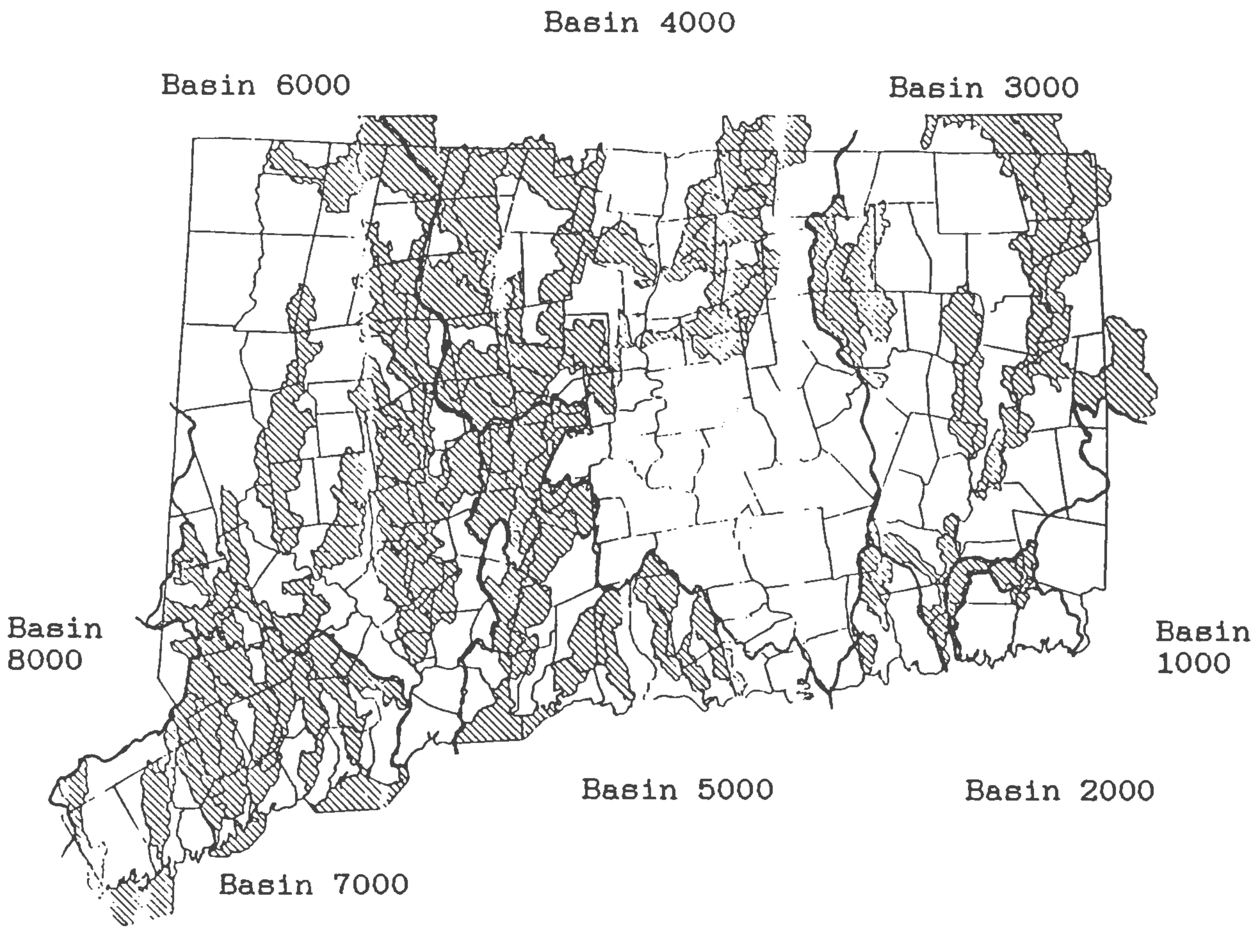

Figure 5. Drainage Basins of Concern.
Source: Waterbodies or Watersheds with Existing or Potential Water Resource Concerns From a Water Quality/Quantity Perspective. DEP Bureau of Water Management.

The within group analysis (Table 2.0) shows a clear nexus between the stated goals of the Act and the implemented policy. Each use group has a distinct criteria pattern consistent with expected impacts. For example, public water supply diversions most frequently require submission of long range plans and consideration of alternative sources, and then conservation plans, economic analysis, and quantity impacts.

Use	Variable Ranking
Public Water	Long-range plans and Alternative Conservation plans Economic analysis and Quantity impacts
Industrial Uses	Economic analysis and Quantity impacts Instream Uses Alternatives
Recreation	Instream Uses and Quantity impacts Economic analysis Quality impacts and Alternatives
Hydro/Electric	Quantity impacts Quality impacts, Public participation and Alternatives
Development	Economic analysis, Instream uses, and Quantity impacts Alternatives Public participation and Quality impacts
Flood Control	Instream uses Quantity impacts Public participation and Alternatives
Mining	Public participation Alternatives, Instream uses, and Quantity impacts

Table 2.0 Within group ranking of decision variables by use groups.

Table 3.0 is a matrix ranking decision variables by use generated from the row percentages of the contingency table. A cursory glance reveals quantity impacts most frequently reviewed with instream (WFR) uses second. Again, quantities are defined as low flow uses, water supply, flooding, and agriculture.

	Variables							
Use	Pub	Alt	Long	Cons	Econ	WFR	Qual	Quant
PW	-	1	1	2	3	-	-	3
Ind	-	3	-	-	1	2	-	1
Rec	-	3	-	-	2	1	3	1
Hydro	2	2	-	-	-	-	2	1
Devel	3	2	-	-	1	1	3	1
Flood	3	3	-	-	-	1	-	2
Mining	1	2	-	-	-	2	-	2
Sum Rank	5	3	8	7	4	2	6	1

Table 3.0 Relative ranking within groups.

Both from the total row percentages and from the relative rankings, it would appear that water supply (QUANT), instream uses (WFR), and consideration of alternatives are the criteria that have the greatest influence on the decision to approve. If the sample size were larger (ie: after a greater passage of time), further analysis could be performed to determine which instream uses or quantity groups have the greatest influence.

Again, noting that these results are relative, the areas of lesser concern seem to be the presence of economic analyses, public participation, and water quality issues. While it may seem incongruous that water quality is a lesser concern, the explanation lies in the composition of that variable. Waste treatment and assimilation are regulated by DEP in other permits as well as in the diversion permit process which might account for the apparent low ranking here. The low ranking of conservation plans and long range plans is due to the interpretation of the statute. These plans are only required of public water supply withdrawal applications.

In comparing the between group rankings, the results are consistent with the temporal comparison results. Industrial and public water supply uses rank highest with flood control structures second. This use hierarchy suggests that those uses are more frequently occurring and permitted.

One way to verify results is by comparison with the reasons for the decisions as stated in the records. The decisions to deny give clearly stated reasons for denial. Unfortunately, most approval decisions did not state reasons for approval but instead were of a standard form. One recent exception to this is the decision rendered for four combined applications in which the diversions were in close proximity of each other on the Quinnipiac River basin.

Issued in 1988, it is cited by DEP in a later decision to deny an application, and was the impetus to the 1990 revisions.

Comparison of Policy Implementation to Analysis Results

Of the five denied permits, one permit application was not available during the review period. Three permits were denied in 1985 and one in 1988. The reasons cited are as follows:

Peat mining permit (#85-26)

- o Conflict with public policy
- o Lack of need in comparison to environmental impacts
- o Lack of alternatives
- o Insufficient information

Relocation of portion of river for flood control (#85-34)

- o Lack of alternatives
- o Environmental impacts

Relocation of river for creation of land for housing (#85-36)

- o Lack of need in comparison to environmental impacts
- o Inconsistent with the State Conservation Plan

Increased reservoir impoundment for public water supply (#88-38)

- o Lack of conservation plan
- o Lack of long range plan

Overall, the criteria used appear to validate what the analysis indicated. Environmental impacts are cited most frequently, with use (lack of need) second, and lack of alternatives third. Though the sample size is too small to be of more than general use, the pattern is consistent with the ranking in the results.

Other indicators of policy implementation give strength to the interpretation of the results. First, the 1990 revision which reiterates requirements for the conservation and long range plans lends credence to the results since those variables were not represented in all but the public water supply applications.

Second, the decision for the diversion on the Quinnipiac River is perhaps the summary decision concerning policy implementation on allocation of resources as pertains to the WDPA. In it are the elements of the location analysis, all eight statutory criteria, and an extensive discussion of the purpose of the Act.

Relevant to the discussion at hand is the weight the Commissioner gave the different elements in making the decision. She states:

> The major substantive issues raised by these applications relate to their environmental impacts: first, on water quality in the Quinnipiac River, and second, on water quality and habitats of the River's tributaries and wetlands
> (Carrothers 1988:26).

The approval went on to include requirements for establishment of a river flow management plan, streamflow baseline data, monitoring of groundwater levels, and monitoring of flora and fauna surrounding groundwater withdrawal wells. Further, the decision to approve despite the lack of existing data was based on consideration of the proposed use and the need for public water supply.

The water quality impacts cited were not the ability to assimilate or treat waste but the effect of the reduction of flow on instream uses. However, the Commissioner did review existing waste load allocations in making her decision.

Therefore, the results of the policy analysis tend to reflect the consistency of the Commissioner's decisions between enactment of the WDPA to the present. Further, the ranking which emerges from the contingency tables appears to be relevant in face of the written record. Where the Quinnipiac River decision varied from the results was in the depth of field--the Commissioner required that a more detailed analysis be performed than previously required of applicants.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

The Water Diversion Policy Act was created to legislate the equitable apportionment of the state's water resources. Its roots lie in riparian water law. Early on, it was recognized that there was a need for balancing a "reasonableness of use" against the stream's natural capacity and its value as a shared resource. As in many states previously governed by riparian water law, the permit system was an attempt to regulate and administer the water resources for the benefit of all.

The permit system addresses the failings of riparianism, rather than leave these issues to the vagaries of the courts. By allowing greater public participation in the decision making process, by requiring consideration of instream uses, by evaluating both groundwater and surface waters as one unit, and by recognizing economic and conservation needs, the Act establishes policy for water allocation and planning.

The policy created by the WDPA is a reasonable attempt to fill the gap created by a lack of federal water policy. Absent federal planning, state allocation can resolve minor local conflicts while retaining a long-term perspective of the State's water needs. As such, the policy can address those concerns peculiar to the State's needs. In Connecticut, this meant making the connection between groundwater and surface water resources, addressing the needs of the donor basin in interbasin transfers, and implementation of conservation planning techniques to maximize the use of dwindling capacities.

Is the policy workable? Has it been effective or were the statutory guidelines overly broad? To answer these questions, an analysis was necessary which would investigate several levels of the permit record. General use patterns before and after the implementation of the Act, as well as detailed information on public hearing records, were evaluated for trends and correlative effects to determine if there were noticeable differences in use allocation. From the results of the analysis, the goals and policies in the Act have been consistently implemented.

In part, this has established a set of prioritized considerations. Foremost is the proposed diversions's impact on existing uses such as supplies, agriculture, and low flow uses. This is similar to the "reasonableness of use" criteria in riparian law. Second is the diversion's impact on instream uses such as fisheries and recreation. The consideration of alternatives is the next criterion.

The DEP has recognized the trends of limited quantity, over-allocation and the need for conservation in view of ever increasing demands on water. The identification of "over-utilized" basins, amendments to the WDPA requiring greater conservation measures such as demand management, and the Memorandum of Understanding between lead water resource regulatory agencies are several ways that DEP has reiterated the goals of the Act.

The DEP has attempted to balance environmental concerns against the need for the water for the use proposed. However, its ability to do so is restricted by the lack of quantification of streamflow data and the consequent inability to assess those impacts. Given the lack of comparative base between flow diversions (eg: flood control structures) and withdrawals, it is inappropriate to imply that it has merely been overlooked. But the River Management Plan detailed in the Quinnipiac decision asserts that the methods exist for such analysis.

The Quinnipiac decision also identified the problem of incremental planning. Although in that case the applications were recognized as having a cumulative impact, no mechanism exists to ensure such coordination in all cases. Now that over-allocated basins have been identified, the next step is to proactively plan to assure that the cumulative impact of withdrawals is addressed.

To do so, the DEP needs to make the linkage between past water usage, current applications for permits, and projected future needs. Just as riparian law allowed for setting aside future rights to water, DEP needs to estimate how much is available, how much is being used, and then allocate the balance. These three estimates are necessary for planning future water allocation.

Measurement of the existing volumes available, though difficult, is not impossible. Each major basin has been inventoried and flow regimes established. The National Weather Service and the USGS both record river and precipation data on major basins which can be included to assist in establishing drought conditions.

Current use estimates are available from the USGS and the Natural Resource Center of DEP. This data needs to be disaggregated by the four digit code that the Water Resource Unit uses. Unreported diversions, hydro/electric and flood control structures should be inventoried, also on a subbasin basis. The storage capacities of flood control, hydro/electric and other reservoirs should be calculated to estimate the impact on low flows of the affected streams.

DEP should work with the private sector, DOHS and DPUC to estimate future water demands within each subbasin. These demands should be used to identify potential problems and solutions. Impacts from future uses can be estimated from a combination of methods. For example, computer models exist which incorporate subsurface and surface drainage features and simulate demands. These models can be used for application requests, as well as creating scenarios of future demands. The USGS Finite Difference Model for Aquifer Simulation is one such model that is currently being used by water companies at the behest of DEP to delineate aquifer recharge areas.

Drainage areas of special concern as highlighted in the Mauger report should be studied for planning purposes. DEP should establish guidelines for future permitted use allocations and reductions in those areas. Minimum flow rates should be established for all major rivers, and for drainage areas of special concern.

All of these recommendations require additional cost and staffing to the diversion program. However, the costs can be offset by use of diversion permit fees or by phasing the work over several years.

Connecticut is to be commended for its attempt at long range water resource planning. Although it originated as a reaction to an unwanted diversion, the Water Diversion Policy Act became instead a measure to plan for the protection and allocation of Connecticut's water resources.

APPENDIX 1.0 VARIABLES

1.1 LIST OF VARIABLES

Use Groups	Decision Variables	
# Use	Pubpar	Public participation
	Alt	Alternatives
1 Public Water	Econ	Economic analysis
2 Industrial	Cons	Conservation plan
3 Recreation	Long	Long range plan
4 Hydro/Electric	WFR	Wetlands,fisheries, recreation
5 Agriculture		
6 Private Supply	Quan	Low flow, agriculture, flooding, supply
7 Instream/lfisheries		
8 Municipal	Qual	Waste treatment, assimilation, quality, adjacent wells, groundwater
9 Unknown		
10Development		
11 Flood Control		
12Mining	Dec	Decision
13Temporary		

Major Drainage Basins

Pawcatuck Basin	1000
Southeast Coastal Basin	2000
Thames Basin	3000
Connecticut Basin	4000
South Central Coast Basin	5000
Housatonic Basin	6000
Southwest Coast Basin	7000
Hudson Basin	8000

1.2 VARIABLE DESCRIPTION

Variable	Level of measurement	Scale	Type
Use	nominal	discrete	dependent
PP	interval	discrete	independent
Alt	interval	discrete	"
Cons	nominal	"	"
Econ	"	"	"
Long	"	"	"
Environ.	"	"	"
Decision	nominal	discrete	dependent

1.3 VALIDITY

Validity Criteria	Allocation Variable	Statutory Variable	Comments
History	-	-	
Instability/ Maturation	-	-	
Testing	-	-	
Selection	-	x	Non-random sample
Instrumentation	-	-	
Mortality	x	x	Members dropped out
Spuriousness	x/-	x	Potential
Regression	-	-	

Source: Grosof and Sardy. 1985:93-95.

APPENDIX 2.0 STATISTICS

CROSS TABS
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Description Data base created at 20:33:16 on 04-26-1991

Contingency Table Results

Page 1 /Numeric Count/Row Pct/Column Pct/Table Pct/Exp. Value/Chi-Square/

	[illegible]	[illegible]	Total
Public [illegible]	[illegible]	[illegible]	206
	[illegible]	[illegible]	100.0
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	206
	[illegible]	[illegible]	[illegible]
Industrial	[illegible]	[illegible]	150
	46.0	54.0	100.0
	17.9	24.8	21.0
	9.7	[illegible]	21.0
	81	69	150
	1.8	2.2	4.0
Recreation	87	56	143
	60.8	39.2	100.0
	22.5	17.1	20.1
	12.2	7.9	20.1
	77	66	143
	1.2	1.4	2.6
Hydro/Elec	18	20	38
	47.4	52.6	100.0
	4.7	6.1	5.3
	2.5	2.8	5.3
	21	17	38
	0.3	0.4	0.7
Agricultur	67	8	75
	89.3	10.7	100.0
	17.4	2.4	10.5
	9.4	1.1	10.5
	41	34	75
	17.2	20.3	37.4
Private Su	6	0	6
	100.0	0.0	100.0
	1.6	0.0	0.8
	0.8	0.0	0.8
	3	3	6
	2.3	2.8	5.1
Total	386	327	713
	54.1	45.9	100.0
	100.0	100.0	100.0
	54.1	45.9	100.0
	386	327	713
	73.7	87.0	160.6

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Date/Time 04-26-1991 20:40:50
Data base Name [illegible]
Description Data base created at 20:33:16 on 04-26-1991

Contingency Table Results

Page 1 /Number/Count/Row Pct/Column Pct/Table Pct/Exp. Value/Chi-Square/

	PRE-1980	POST-1980	Total
[illegible]	[illegible]	7	8
	[illegible]	[illegible]	100.0
	[illegible]	2.1	1.1
	[illegible]	1.0	1.1
	4	4	8
	[illegible]	3.0	5.6
Municipal	2	0	2
	100.0	0.0	100.0
	0.5	0.0	0.3
	0.3	0.0	0.3
	1	1	2
	0.8	0.9	1.7
Unknown	1	1	2
	50.0	50.0	100.0
	0.3	0.3	0.3
	0.1	0.1	0.3
	1	1	2
	0.0	0.0	0.0
Developmen	1	82	83
	1.2	98.8	100.0
	0.3	25.1	11.6
	0.1	11.5	11.6
	45	38	83
	43.0	50.7	93.7
Total	386	327	713
	54.1	45.9	100.0
	100.0	100.0	100.0
	54.1	45.9	100.0
	386	327	713
	73.7	87.0	160.6

Date/Time 04-26-1991 [illegible]
Data Base Name [illegible]
Description Data base created at 20:33:16 on 04-26-1991

Chi-Square Statistics

PRE-USE Versus POST-USE

Chi-Square with 9 degrees of freedom	160.6249
Probability Level	0.0000
Phi	0.4746
Cramer's V	0.4746
Pearson's Contingency Coefficient	0.4288
Tschuprow's T	0.2740
Lambda A .. Rows dependent	0.0197
Lambda B .. Columns dependent	0.3089
Symmetric Lambda	0.1331
Kendall's tau-A	0.0988
Kendall's tau-B (with correction for ties)	0.1562
Kendall's tau-C	0.1097
Gamma	0.2386

--CROSS TABS--

Date/Time 04-20-1991 20:52:54

Data Base Name C:\joyce2

Description Copy of data in spreadsheet file: B:\premod.wk1

Cross Tabulation Results

Page 1 /Numeric/Counts/

PRE-USE	PRE-BAS <=1999	<=2999	<=3999	<=4999	<=5999	<=6999	<=7999	Total
<=1	1	9	17	39	23	29	16	134
<=2	1	1	15	19	7	21	4	69
<=3	0	4	9	37	7	19	11	87
<=4	0	1	5	6	1	4	1	18
<=5	0	1	13	33	13	7	0	67
<=6	0	0	1	2	1	2	0	6
<=7	0	0	1	0	0	0	0	1
<=8	0	0	0	2	0	0	0	2
<=9	0	0	0	1	0	0	0	1
<=10	0	0	0	0	0	1	0	1
Total	2	16	61	139	52	83	32	386

CROSS TABS

Date/Time 04-20-1991 20:53:31
Data Base Name C:\joyce2
Description Copy of data in spreadsheet file: B:\premod.wk1

Cross Tabulation Results

Page 2 /Numeric/Counts/

PRE-USE	PRE-BAS <=8999	Total
<=1	0	134
<=2	1	69
<=3	0	87
<=4	0	18
<=5	0	67
<=6	0	6
<=7	0	1
<=8	0	2
<=9	0	1
<=10	0	1
Total	1	386

--CROSS TABS--

Date/Time   04-20-1991   20:55:56
Data Base Name C:\joyce2
Description   Copy of data in spreadsheet file: B:\premod.wk1

Cross Tabulation Results

Page 1   /Numeric/Counts/

POST-USE	POST-RAS <=.1	<=1999	<=2999	<=3999	<=4999	<=5999	<=6999	Total
<=1	0	1	4	9	22	10	21	72
<=2	1	0	2	17	27	9	19	80
<=3	1	0	0	8	17	6	17	55
<=4	0	0	0	13	2	1	4	20
<=5	0	0	0	0	6	0	2	8
<=7	4	0	0	1	1	0	1	3
<=9	0	0	0	1	0	0	0	1
<=10	1	0	0	4	26	16	27	81
<=11	0	0	3	2	23	15	17	68
<=13	0	0	0	0	0	1	1	3
Total	7	1	9	55	124	58	109	391

CROSS TABS

Date/Time 04-20-1991 20:56:33
Data Base Name D:\joyce7
Description Copy of data in spreadsheet file: B:\premod.wk1

Cross Tabulation Results

Page 2 /Numeric/Counts/

POST-USE	POST-BAS <=7999	<=8105	Total
<=1	3	2	72
<=2	6	0	80
<=3	7	0	55
<=4	0	0	20
<=5	0	0	8
<=7	0	0	3
<=9	0	0	1
<=10	8	0	81
<=11	8	0	68
<=13	1	0	3
Total	33	2	391

-- CROSS TABS --

Date/Time 08-27-1991 10:08:49

Data Base Name B:\time4

Description Copy of data in spreadsheet file: A:\comfort.wk1

Cross Tabulation Results

Page 1

USE	Count	Row %|Histogram
<=1	[illegible]	[illegible]
<=2	10	21.3|FFFFF
<=3	3	6.4|F
<=4	3	6.4|F
<=5	1	2.1|F
<=10	4	8.5|FF
<=11	12	25.5|FFFFFFF
<=12	1	2.1|F
Total	47	100.0

#Ferm/Total	USE	PUBPART	ALT	CONS	LONG	ECON	WFR	QUANT	QUAL
0.27	Public Water	0.54	1.88	1.34	1.88	1.07	0.80	1.07	0.54
		21.36	44.51	84.62	100.00	29.33	20.00	24.31	23.66
		5.88	20.59	14.71	20.59	11.76	8.82	11.76	5.88
0.24	Industrial	0.73	0.98	0.24	0.00	1.46	1.22	1.46	0.73
		29.13	23.12	15.38	0.00	40.00	0.00	33.15	32.26
		10.71	14.29	3.57	0.00	21.43	17.86	21.43	10.71
0.05	Recreation	0.00	0.05	0.00	0.00	0.10	0.15	0.15	0.05
		0.00	1.16	0.00	0.00	2.67	3.64	3.31	2.15
		0.00	10.00	0.00	0.00	20.00	30.00	30.00	10.00
0.07	Hydro/Elect	0.07	0.07	0.00	0.00	0.00	0.00	0.15	0.07
		2.91	1.73	0.00	0.00	0.00	0.00	3.31	3.23
		20.00	20.00	0.00	0.00	0.00	0.00	40.00	20.00
0.07	Development	0.07	0.15	0.00	0.00	0.22	0.22	0.22	0.07
		2.91	3.47	0.00	0.00	6.00	5.45	4.97	3.23
		7.69	15.38	0.00	0.00	23.08	23.08	23.08	7.69
0.27	Flood Control	1.07	1.07	0.00	0.00	0.80	1.61	1.34	0.80
		42.72	25.43	0.00	0.00	22.00	40.00	30.39	35.48
		16.00	16.00	0.00	0.00	12.00	24.00	20.00	12.00
0.02	Mining	0.02	0.02	0.00	0.00	0.00	0.02	0.02	0.00
		0.97	0.58	0.00	0.00	0.00	0.61	0.55	0.00
		25.00	25.00	0.00	0.00	0.00	25.00	25.00	0.00
1.00	Col. Total	2.51	4.22	1.59	1.88	3.66	4.02	4.41	2.27
	Row % Total	85.29	121.26	18.28	20.59	88.27	128.76	171.27	66.29
	Rank	5	3	8	7	4	2	1	6

APPENDIX 3.0 BIBLIOGRAPHY

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