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Groundwater Protection at the Local Level: Towards a Comprehensive Strategy for the Town of South Kingstown, Rhode Island

Philip M. Masters
University of Rhode Island

GROUNDWATER PROTECTION AT THE LOCAL LEVEL: TOWARDS A COMPREHENSIVE STRATEGY FOR THE TOWN OF SOUTH KINGSTOWN, RHODE ISLAND

BY

PHILIP M. MASTERS

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OF

PHILIP M. MASTERS

Approved:

Major Professor: ______________________
Dr. John J. Kupa

Acknowledged:

Director: ______________________
Dr. Howard H. Foster, Jr.

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CHAPTER ONE

GROUNDWATER PROTECTION: THE NATURE OF THE PROBLEM

INTRODUCTION

Few environmental issues have received as much attention in the last few years as the problem of groundwater contamination and how to eliminate it. All too often, we are alerted by the mass media to chemical spills, pesticide contamination, leaking underground storage tanks or landfill leachate **after** a contamination problem has been detected.

As will be shown later in this chapter, the best solution to groundwater contamination is prevention through protection measures. While this may seem intuitively obvious to even the most casual observer, governmental efforts to protect groundwater have primarily focused on remedial measures, such as toxic waste site cleanups. Of 16 federal environmental statutes which deal with groundwater in some manner (Phillips, 1987), only the Safe Drinking Water Act (SDWA) deals exclusively with protecting groundwater aquifers. State efforts to protect groundwater vary widely, and to some extent rely on federal programs and grant money administered by the U.S. Environmental Protection Agency (EPA).

It is not the intent of this report to criticize the numerous state and federal programs dealing with groundwater. Many of these programs are improving, especially since the June 1986 amendments to the SDWA were enacted. While such efforts are becoming increasingly oriented towards protection, rather than mitigation, it is ironic to note that many federal statutes designed to clean up the nation's waterways inadvertently led to an increase in groundwater pollution. This took place as the result of such statutes shifting emphasis on disposal methods, from surface water discharges to burial on land (Anderson, et al., 1984). Land uses such as hazardous waste dumps and chemical discharge pits have had a devastating effect on groundwater in this country.

Since local governments in most states have sovereignty over land use regulation, the question of how to effectively protect groundwater resources becomes one of local significance. Consequently, the purpose of this research project is to synthesize a comprehensive plan for groundwater protection which can be used by local governments. Although this study concentrates on the Town of South Kingstown, Rhode Island, following the methodology used here will enable other communities to tailor a protection strategy suited to their own needs.

METHODOLOGY

The primary goal of this study is to determine what the best comprehensive approach to groundwater protection in South Kingstown is. To accomplish this, a four-step analysis has been conducted.

The first step in the analysis was a review of all the currently available techniques for groundwater protection, including regulatory and non-regulatory methods. For this overview, protection schemes from across the country were examined, so that any methods not currently used in New England could be applied to South Kingstown if they proved to be effective. A matrix was established to evaluate techniques in terms of variables such as existing hydrologic conditions, political climate necessary for implementation, and costs to the municipality.

The second phase of the analysis examines three case studies of municipalities that have implemented groundwater protection programs. The case studies are limited to New England due to the similar nature of the aquifers in this region. Before discussion of the case studies, criteria for choosing them are established and explained. This insures that any conclusions drawn from the case studies can be reviewed objectively by the reader.

The third step is a comparison of both the case studies and survey of available techniques with the specific nature of the problem in South Kingstown. After looking closely at this town, the study shows, by reference to the first two phases of the analysis, what should be done to protect South Kingstown's aquifers. The fourth and final part of the study presents a set of recommendations for groundwater protection in South Kingstown.

In order to make it clear as to why groundwater protection is primarily a land use issue, it is necessary to briefly discuss the basics of groundwater hydrology. This will enable the reader to better understand the analyses of various protection strategies which will follow in later chapters.

THE GROUNDWATER RESOURCE: OCCURRENCE AND CHARACTERISTICS

Definition Of An Aquifer

The term groundwater refers to water which is found below the earth's surface, either in bedrock or unconsolidated materials such as deposits of sand and gravel. While some quantity of groundwater can be found almost anywhere, significant quantities are stored in underground reservoirs known as aquifers. An aquifer can be defined as a "saturated bed, formation, or group of formations which yields water in sufficient quantity to be economically useful" (Driscoll, 1986, p.61). To be an aquifer, in addition to containing an economically useful quantity of water the formation must also be able to act as a water "pipeline" to supply wells.

Aquifer Porosity and Permeability

Storage capacity and the ability to transmit water are controlled by porosity and permeability. Porosity refers to the open spaces within the water-bearing material which have the potential of becoming filled with water. Pore spaces occur in many forms which vary according to the geologic nature of the aquifer. Depending upon the type of bedrock, pore spaces may occur as intergranular openings, fractures or solution cavities. Intergranular pores are typical of sandstones, while fracture porosity often occurs in granites and shales. Solution porosity is most common in limestones and other carbonate rocks, often causing large sinkholes to open in the land surface, such as is common in the southeastern U.S.

In unconsolidated sediments, such as stratified drift, pore space takes the form of intergranular cavities. The term stratified means the sediments are deposited in layers containing well sorted material. Each layer contains sediment of one basic grain size, such as silt, sand or gravel. It is important to note that the better sorted the material, that is, the more uniform the grain size is within any one section of the formation, the higher the porosity will be. This phenomenon is due to the fact that in poorly sorted material, small grains fit into the openings between larger grains, thus clogging up potential pore space. Figure 1.1 is an excellent representation of this characteristic, as well as showing the different types of porosity. Porosity is the most important determinant of the storage capacity of an aquifer.

Permeability, on the other hand, refers to the degree to which pore spaces are interconnected, thereby allowing water to flow readily through the aquifer. It is this

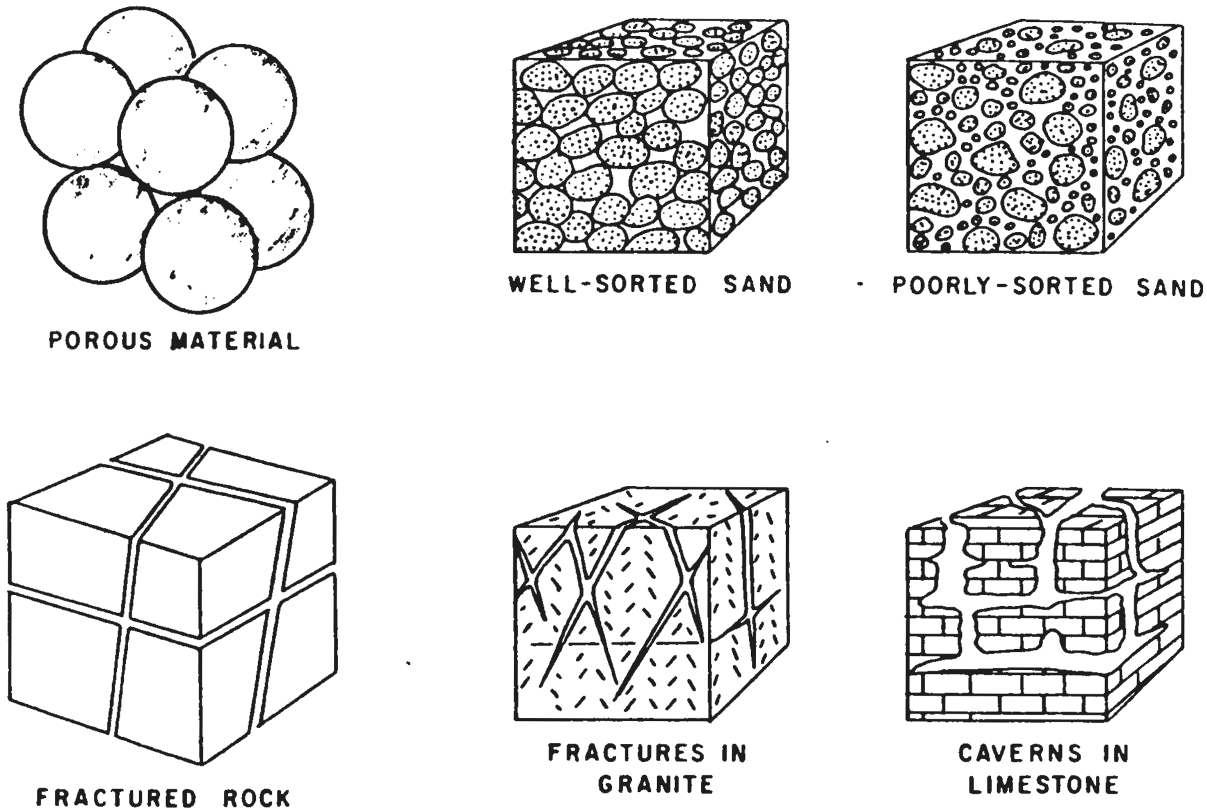

Figure 1.1 Different Types Of Porosity

Source: Newton, 1984

characteristic which, to a large extent, determines whether or not the aquifer will readily yield water to wells. For instance, clay formations often have very high porosity, but the pores are poorly connected. Consequently, even though clay formations often contain large quantities of water, they are rarely classified as aquifers since they don't yield water to wells (Driscoll, 1986). In stratified drift, since the grains have not been lithified (turned to bedrock through compression and cementation), there is a high porosity and permeability, conditions making excellent aquifers. Fractured bedrock formations may also make excellent aquifers because water can flow through the cracks unobstructed.

This study will focus on stratified drift aquifers because they provide the largest quantities of groundwater in the New England region. Unlike many western U.S. aquifers which have areas extending under several states, stratified drift aquifers are much more localized, often occurring entirely within the boundaries of one city or town. The variability in specific conditions at such a small scale lends itself to local protection measures.

Groundwater Flow

Within an aquifer, groundwater flow is controlled by differences in energy potentials, or gradients. The total energy in the aquifer is the sum of pressure, velocity and elevation components (Driscoll, 1986). Since groundwater flow velocity is very slow (200 feet/day for coarse sandstone, down to .0001 feet/day for limestone, according to Newton, 1984), the velocity component of energy is usually neglected in the energy equation (Driscoll, 1986). The energy potential at a given point in an aquifer is known as head. Change in head per unit of distance is referred to as the hydraulic gradient (Newton, 1984). Groundwater flow is normally from areas of high head to areas of lower head, or down gradient. This is a very important concept because if a potential groundwater contamination source exists, it must be determined if it is up- or down gradient of any wells which may be in the area. A groundwater supply well down gradient of a contamination source has a high risk of becoming polluted.

Aquifers fall into two general categories, confined and unconfined. An unconfined aquifer is one in which the upper level of the aquifer is subject to atmospheric pressure. In a confined aquifer, water is sandwiched in-between two confining layers, typically bedrock with little or no permeability.

Stratified drift aquifers, which will be focused on in this study, are unconfined. In such an aquifer, when water is pumped from a well a head difference is formed, causing water in the surrounding aquifer to flow towards the well (Driscoll, 1986). The water level in the well is now theoretically at a lower elevation than the surrounding water table, causing water to rush into the well to equalize the head difference. This causes what is known as a cone of depression (see Figure 1.2). The area surrounding a given well, from which water flows to that well during pumping, is referred to as the well's area of influence. The shape and extent of the area of influence is determined by pumping rate, pumping duration and the geologic nature of the aquifer itself. Protection of areas of influence should be a top priority because it is from these areas that water is drawn directly into supply wells for use.

Recharge And Discharge

The supply of groundwater is controlled through the hydrologic cycle, and the level of groundwater (the water table) in an aquifer is a delicate balance between recharge and discharge. Figure 1.3 is a representation of the hydrologic cycle. This cycle is continually taking place as one integrated system, there is no specific end or beginning point. Recharge takes place primarily through precipitation, which infiltrates the land surface to be stored in the aquifer. In this regard, the aquifer acts like a sponge. Discharge, on the other hand, includes any groundwater flowing out of the aquifer; into the ocean, wetlands, streams, or lakes. The amount of water pumped out of wells can be viewed as discharge, since it will affect the height of the water table. Figure 1.4 schematically shows the

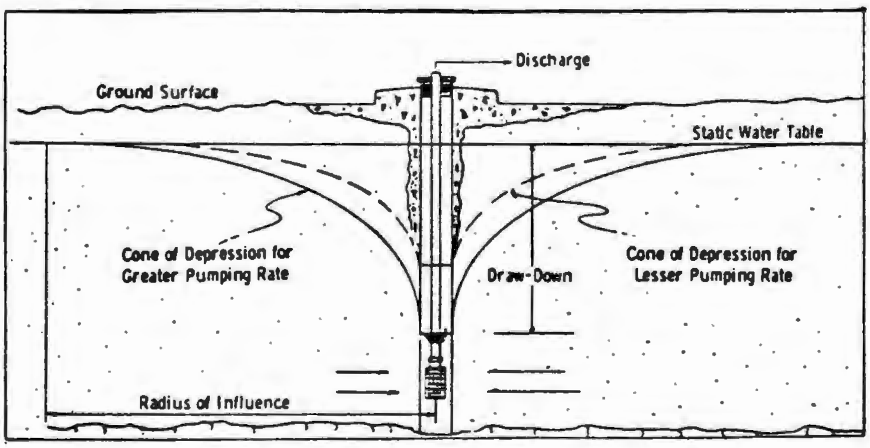

Figure 1.2

Relationship Between A Pumping Well, Its Cone Of Depression And Radius Of Influence

Source: Newton, 1984

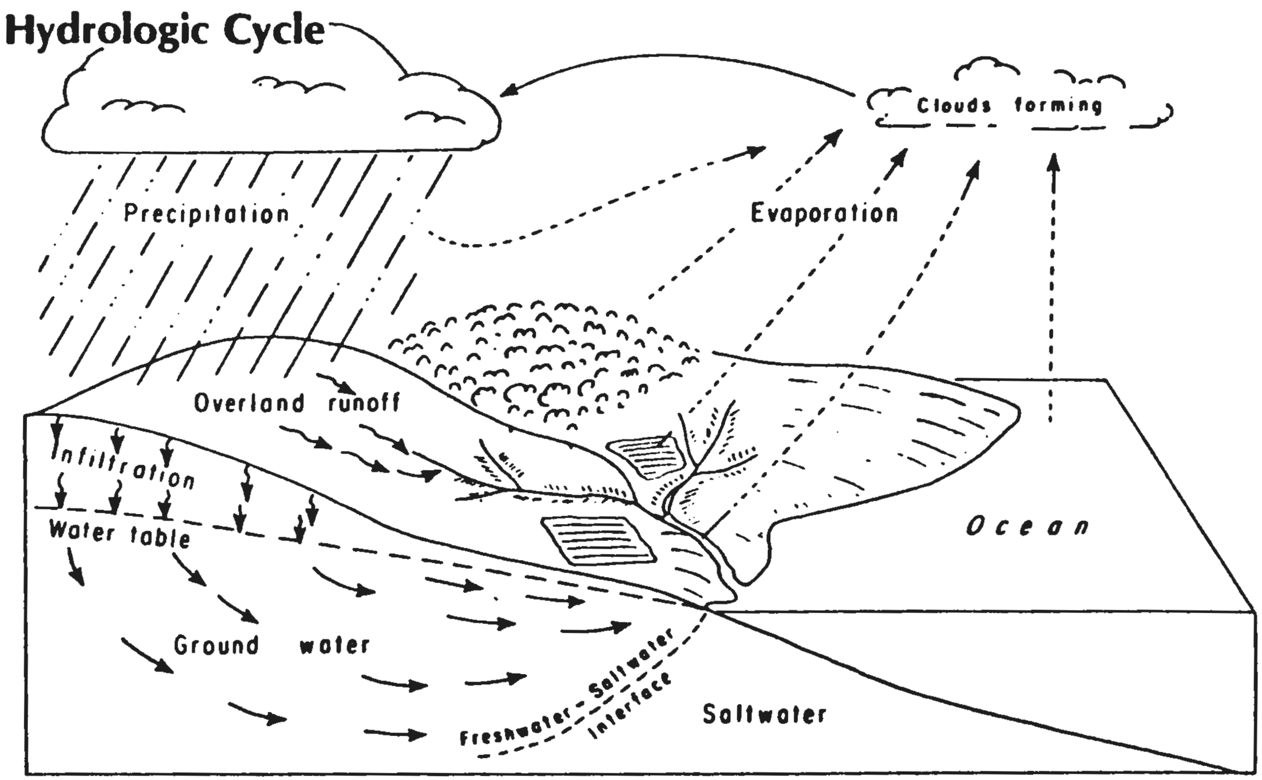

Figure 1.3 The Hydrologic Cycle

Source: Newton, 1984

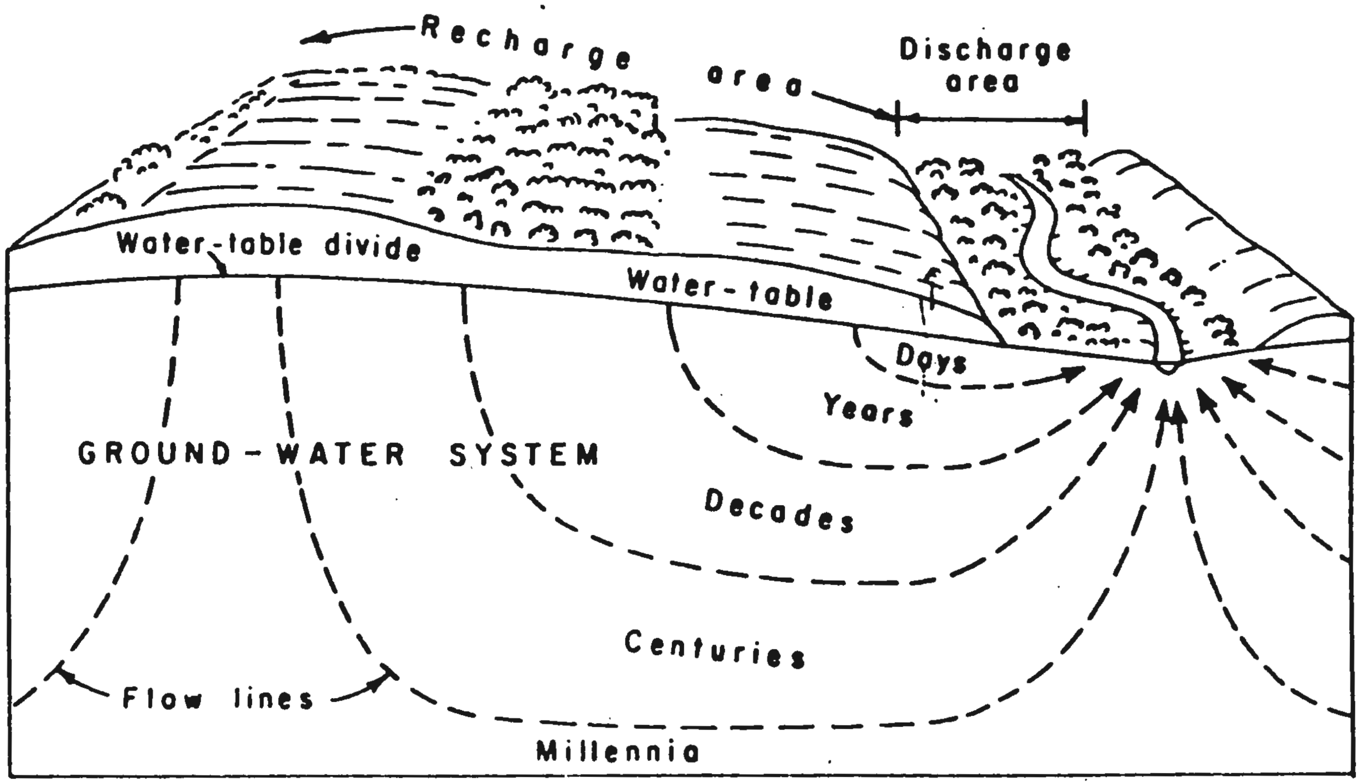

Figure 1.4

Relationship Between Recharge Area, Aquifer And Discharge Area

Source: Newton, 1984

relationship between recharge, groundwater storage and discharge.

The fundamental element in understanding any approach to groundwater protection is the concept that aquifers are recharged by water passing through (infiltrating) the land surface. Thus **any land use** can potentially affect the quality of water recharging an aquifer. For example, if precipitation falls in an area contaminated by toxic chemicals, these compounds can be dissolved and then infiltrate the aquifer. Consequently, in order to protect groundwater, it is necessary to protect the aquifer itself **and** the recharge zones, those areas in which water to replenish the subsurface supply is collected.

THE IMPORTANCE OF GROUNDWATER PROTECTION

Pure water is a fundamental building block of life as we know it. Consequently, its supply is of the utmost importance for the survival of the human race. From a community planning perspective, the ability of a municipality to provide drinking water is often a deciding factor in determining the limits and/or density of new residential developments. Municipal water supplies must come either from surface water reservoirs, such as the Scituate Reservoir in Rhode Island, or groundwater aquifers.

In recent years, an increase in the use of groundwater resources has been necessitated by population increase, rapid land development and the resultant decrease in surface water supplies. Today, more than fifty percent of the total U.S.population as well as ninety-seven percent of the nation's rural residents depend upon groundwater for drinking water (The Conservation Foundation, 1987).

Besides supplying drinking water, groundwater is extensively used for farming and industry. Groundwater provides 40 percent of all water used for irrigation and roughly one-quarter of all water used in industrial applications, excluding use in steam-electric power generating plants (The Conservation Foundation, 1987). Groundwater is crucial in providing pure water to wetlands, streams, estuaries and lakes; all valued for their fisheries, wildlife habitat and recreational opportunities. During periods of low precipitation, such as droughts, streams and wetland areas rely heavily on groundwater discharge as a source of water. Thus groundwater is vital for the maintenance of such fragile ecosystems.

Because groundwater aquifers were often ignored in the past due to plentiful surface water supplies, land uses above and adjacent to aquifers were usually not chosen in accordance with protecting the valuable resource below. After decades of such misuse, an ever increasing number of private and public groundwater wells are beginning to show contamination of one type or another. Due to the subsurface nature of groundwater resources, it can be very difficult and extremely expensive to correct groundwater contamination.

This is partially due to the fact that groundwater flows very slowly (as previously noted), and thus an aquifer does not have the capacity to "flush itself out" the way a rapidly moving river or stream might. Furthermore, many pollutants such as organic waste or volatile organic compounds (VOC's), which ordinarily would begin to undergo decomposition in an oxygenated environment (such as some surface waters), are not readily broken down in subsurface aquifers where there is little or no oxygen. Consequently, the lifespan of such pollutants can be very long, and they may travel in plumes of contaminated groundwater until they encounter drinking water wells or surface waters.

THE CONSEQUENCES OF A LACK OF GROUNDWATER PROTECTION

Health Impacts

There are over 200 substances known to occur in groundwater in the United States. Of these, about 175 are organic chemicals, approximately 50 are inorganic chemicals (metals, non-metals and acids), and the remainder are biological organisms and radionuclides (Office of Technology Assessment, 1984). Many of the chemicals which have been found in groundwater can have adverse impacts on human health. According to the U.S. Congress, Office of Technology Assessment (1984, p.32), "central nervous system (CNS) damage, liver and kidney damage, and cancers may be the most commonly expected serious forms of adverse health impacts associated with known groundwater chemical contaminants." It should be noted that whether or not such ill effects actually occur depends upon several variables, such as the nature and properties of the contaminant, a person's exposure to the substance, and the physical characteristics of the particular person.

In addition to the variety of chemical contaminants found in groundwater, pathogenic biological organisms such as bacteria, viruses and parasites are also found. The most commonly found pathogens are bacteria associated with the gastrointestinal tract of humans and animals, such as fecal coliform (Office of Technology Assessment, 1984). The sources of such contaminants are failing septic systems and cesspool leaks or overflows, events which are common in poorly designed housing developments.

Non-Health Impacts

In addition to health impacts, there are other adverse impacts of contaminated groundwater, namely social, environmental and economic. The social impacts usually take the form of psychological stress caused by not knowing whether exposure to contamination has occurred, or by anxiety over long-term exposure to low-levels of contaminants. This problem is compounded by the fact that many groundwater contaminants are colorless, odorless and tasteless (Office of Technology Assessment, 1984). Consequently it is not uncommon to become exposed to such compounds unknowingly. Additional social impacts are shown in Table 1.1.

Environmental impacts are usually expressed as loss of critical wildlife and fish habitat, water unfit for human recreational activities (fishing, swimming) and drinking, and damage to vegetation.

Economic impacts can be measured most directly by the costs incurred during groundwater clean-up activities and establishment of alternate water supply systems. These costs often range from hundreds of thousands to tens of millions of dollars. Often there is a direct, one-time cost, such as replacing a supply well. There is also the possibility of annual costs or losses of revenue, such as the loss of income to farmers when soil or irrigation wells become unfit for use (Office of Technology Assessment, 1984). Table 1.2 summarizes several examples, from around the U.S., of the economic costs resulting from contaminated groundwater.

Although only one of the examples described in Table 1.2 occurred in New England (Canton, Connecticut), This geographic region is by no means without its share of groundwater contamination incidents. Perhaps one of the most highly publicized of such occurrences was the recent (1986-87) Woburn, Massachusetts lawsuit against W.R. Grace and Company over polluted groundwater wells. Citizens in Woburn alleged that Cryovac, a subsidiary of W.R. Grace,

Table 1.1

Examples of Economic, Environmental, and Social Impacts Resulting from Groundwater Contamination

Economic impacts	
Industry	Higher operation/maintenance or capital costs (e.g., for accelerated repair or replacement of damaged equipment or materials)
	Lost output from downtime during repairs, during the search for alternative water supplies, and during relocation
	Relocation costs
	Decreases in property value
	Decreases in revenue if quantity of products sold or their prices fall as a result of lower product quality
	Secondary costs (e.g., incurred by suppliers to inputs to the industry or by receivers of the output such as by processors or marketing agents)
	Legal and administrative costs
	Costs of detection, correction, and prevention activities
Agriculture	Higher operation/maintenance or capital costs (e.g., for accelerated repair or replacement of damaged equipment or materials)
	Loss of output due to damage to productivity of land (also reflected in decreases in property value)
	Lost revenue from discarding of food products unsuitable for consumption
	Loss of output due to injury or death to perennial plants and trees
	Decreases in livestock productivity, including illness and death
	Secondary costs (e.g., incurred by suppliers of inputs to agriculture or by receivers of output)
	Legal and administrative costs
	Costs of detection, correction, and prevention activities
Households	Higher operation/maintenance or capital costs (e.g., for cleaning, replacement, and/or rehabilitation of damaged pipes, plumbing, appliances)
	Decreased value of residential property
	Relocation expenses, including search costs, higher purchase prices, higher interest rates and fees, and moving costs
	Secondary costs (e.g., contraction or expansion of commercial activities)
	Loss of income due to sickness
	Legal costs
	Costs of detection, correction, and prevention activities (e.g., pre-treatment and purchase of bottled water)
Municipalities	Lost receipts from property, sales, or income taxes
	Re-allocation of additional resources to provide emergency services
	Costs of procuring alternative supplies
	Legal and administrative costs
	Detection, correction, and prevention activities
Environmental impacts	
Aesthetics	Odor
	Taste
	Appearance
Surface water contamination by groundwater	
Biota	Damage to vegetation, waterfowl, and aquatic life
	Contamination of fish
Air pollution	
Soil contamination	
Social impacts	
Psychological stress	
Inconvenience	
Social disruption	

SOURCE: Office of Technology Assessment.

Table 1.2 —Examples of Economic Costs Resulting From Contaminated Groundwater[a]

Location	Contaminants	Nature of costs	Direct costs incurred	Documentation
Canton, CT	Carbon tetrachloride, methylethylketone, trichloroethythene, chloroform	Well closings; extension of water lines to affected areas	$145,000–379,000	CRS, 1980a
Oscoda, MI	Trichloroethylene	Well closings; provision of new source of water	$140,000	CRS, 1980a
South Brunswick, NJ	Chloroform, toluene, xylene, trichloroethane, trichloroethylene	Well closings; extension of municipal water lines to affected area	$300,000	CRS, 1980a
Cohansey Aquifer, NJ	Wastes from manufacture of organic chemicals, plastics, resin	Well closings (148); removal of drums; interim emergency water supply (via tanker trucks); drilling of new wells; extension of public water supply (60% of total monetary costs)	$417,000 (Residential cost of water increased from an average of $45/year to $75/year)	U.S. EPA, 1976 CRS, 1980b
Miller County, AR	Brine contamination from oil and gas activities	Loss of irrigation well	$4,000	Fryberger, 1972
		Partial rice crop loss	$38,000	
		Estimated loss in profits for changing from irrigated to nonirrigated crops	$150/acre/year for rice $35/acre/year for cotton $20/acre/year for soybeans	
38 communities in 11 Midwestern States[c]	Mineral content	Reduced service lives of household plumbing and appliances	Increased annual capital cost per household of 40% as total dissolved solids increase from 250 ppm to 1,750 ppm	Patterson, et al., 1968
Atlantic City, NJ	Chemical wastes (Price's Landfill)	Estimated cost of new well field to replace contaminated wells	$2 million	As reported in Sharefkin, et al., 1983
		Cost of alternative water supply to 35 private residences	$250,000	
Orange County, CA[d]	Mineral content	Estimated cost of reduced service lives of household plumbing and appliances	$6.5 million total annual capital cost	Orange County Water District, 1982
		Estimated average annual cost of water softeners or increased cost of cleaning products	$12.3 million	
		Estimated average costs of using bottled water	$2.2 million	
Montana	Salinity	Loss of farm income	$5 million per year	Miller, 1980
San Joaquin Valley, CA	Salinity	Loss of farm income	$31.2 million per year	Sheridan, 1981
Auburn, MA	Unspecified chemicals	Alternative water supply for affected area	$180,000	U.S. House of Representatives, 1980
Lathrop, CA	Pesticides	Purchase of water by residents	$3–5 per 5 gallons	CRS, 1980b
		Connection to district water supply	$150 per connection, monthly operating costs of $4–10	
Jackson Township, NJ	Chloroform, methyl chloride, benzene, toluene, trichloroethylene, ethylbenzene, acetone	Costs of planned water system to replace closing of 100 wells	$1.2 million	CRS, 1980a

[a]Based on University of Oklahoma, 1983.
[b]Costs shown are not comparable because they are not measured in constant dollars.
[c]Almost all these communities obtain their primary water supply from groundwater.
[d]Costs are those associated with using higher salinity (surface) water from the Colorado River as opposed to water from the State Water Project.

SOURCE: Office of Technology Assessment.

discharged toxic chemicals into the groundwater which led to six leukemia deaths. While much scientific controversy still lingers over whether or not leukemia can be caused by contaminated groundwater, W.R. Grace settled the suit outside the courtroom for a sum of $8 million (Phillips, 1987). The obvious issue raised is whether or not 6 lives, plus immeasurable amounts of social stress on the victims families and their neighbors, can be compensated for by money, however large a sum it may be.

SUMMARY

It has been shown through the course of this chapter that groundwater contamination is 1) a land use issue and, 2) a serious threat to the health, safety and welfare of communities throughout the nation. Since groundwater aquifers in the New England region are usually of local extent, and local governments are granted state enabling legislation to protect the health safety and welfare of the community, groundwater protection measures must start in "our own backyards". Traditionally, zoning ordinances regulating land use by district have been used by cities and towns to carry out this function.

Today, many towns in New England and the rest of the U.S. are implementing zoning ordinances specifically designed to protect groundwater aquifers. Other non-zoning measures such as public land acquisition, transfer of development rights and ordinances designed to regulate underground fuel storage, hazardous chemicals and road salting, can all be important elements of a comprehensive groundwater protection plan.

The next chapter in this study will review the advantages and disadvantages of several groundwater protection methods available to local governments.

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CHAPTER TWO

AN OVERVIEW OF LOCAL GROUNDWATER PROTECTION TECHNIQUES

TYPES OF TECHNIQUES

There are several techniques available to municipalities for the protection of groundwater, all of which deal with the control of land use in one way or another. Groundwater protection methods fall into two general categories, regulatory and non-regulatory. Regulatory techniques involve the adoption or amendment of zoning ordinances, by-laws and subdivision regulations. Non-regulatory techniques include all other methods of protection which do not include the passing of laws, such as land acquisition or transfer of development rights (TDR). Often, non-regulatory methods rely on voluntary actions by citizens, land developers and public interest groups.

While regulatory techniques may appear to be more effective because they have the power of law as backing, this is not always true. A major difficulty with regulatory techniques is the lack of enforcement often associated with the regulations, usually because municipalities are understaffed or their staffs simply do not have the necessary expertise for proper enforcement. Since regulatory techniques are adopted as law, they need to be approved by various town boards, such as the Town Council or Board of Selectmen (depending upon local and state variations). This process can complicate or even prevent implementation of regulatory strategies for groundwater protection.

THE IMPORTANCE OF PUBLIC SUPPORT

While most non-regulatory techniques are not implemented through actions of elected officials, this doesn't necessarily mean that implementation of these techniques is any simpler. Contrary to this notion, there is a binding thread between regulatory and non-regulatory techniques and the effective implementation and enforcement of all of these strategies. That thread is public support. Public support is extremely important regardless of which technique or combination of techniques a municipality chooses to use. Unless the public understands why such groundwater protection work is needed and how it will work, there is a likelihood that any proposal put forth by a town agency or board will be rejected. A properly educated public will act as a solid constituency for legal proposals and will support those proposals once they become law (Rural New England, 1986-87).

Furthermore, once the public believes in what the town is doing, citizens will be more apt to help in the enforcement of the new rules and regulations. Once educated, if a person sees dangerous chemicals haphazardly being dumped along the side of a road, he or she might be very concerned and report the incident to the proper authorities. However, if the eyewitness to such an event was not aware of the potential harm of the activity, then the incident might be more likely to go unnoticed. After all, groundwater protection is intended to benefit the citizens of the municipality; it is the quality of their drinking water and the health of their families which is at stake. A little public education goes a long way towards achieving the goals of a groundwater protection strategy. Voters would probably never approve expenditures of tax money for public acquisition of land without understanding the significance of its purchase. Similarly, non-regulatory techniques such as the transfer of development rights (TDR) and conservation restrictions rely on the willingness of landowners to bargain with developers and/or the local municipality itself. This concept will be reinforced when these techniques are discussed in greater detail later in this chapter.

VARIABLES AFFECTING SUCCESS OF THE TECHNIQUES

Public education, although a major consideration in determining the effectiveness of groundwater protection methods, is only one variable which affects the success or failure of the overall program within a municipality. There are several other variables which affect choice, implementation and enforcement of both regulatory and non-regulatory groundwater protection techniques. These include cost to the municipality, difficulty of enforcement, whether or not special enabling legislation is necessary, the effects on affordable housing and economic development, existing hydrologic conditions and other legal questions which may arise, such as inverse condemnation of property (the taking issue). The degree to which each of these variables may affect groundwater protection will vary from community to community. Each city or town is slightly different, with a different political infrastructure and economic base which causes people to react differently to new laws which affect them. A farming community in Vermont cannot be expected to protect their groundwater resources the way an industrial town or city might, although there will be some similarities.

In order to simplify and summarize how the variables mentioned above affect each protection technique, a data matrix has been constructed. This matrix, displayed as Table 2.1, assigns a letter or group of letters to each variable for each technique listed. The letters correspond to the degree to which each variable may affect a certain technique and whether or not that variable may cause use of a particular technique to be prohibitive. (The letter designations used are described at the bottom of the matrix.) It will be useful for the reader to refer to Table 2.1 as the discussion of groundwater protection techniques proceeds.

REGULATORY TECHNIQUES

Zoning

Zoning has often been described as the tool by which

Table 2.1 Matrix Of Variables Affecting Groundwater Protection Methods

VARIABLES:

Techniques:	Municipal Costs (Capital)	Need for Public Education	Need for Favorable Political Climate	Affect On: Economic Growth	Affect On: Affordable Housing	Need for Enabling Legislation	Difficulty of Enforcement	Existing Hydrologic Conditions
Overlay Zoning	LN	M	M	S	S	LN	S	M
Concentric Ring Method	LN	M	M	S	S	LN	M	M
Large Lot Zoning	LN	M	M	S	M	LN	NA	M
Cluster Zoning	LN	M	M	S	M	S	NA	M
Hazardous Materials Ordinance	LN	S	M	M	NA	LN	M	S
LUST Ordinance	LN	S	M	S	NA	LN	M	M
Road Salt Ordinance	S	NA	M	LN	NA	LN	M	S
Subdivision Regulations	LN	M	M	S	M	LN	M	M
Public Land Acquisition	M,P	S	M	S	S	LN	NA	M
Land Trust	LN	M	S	LN	LN	NA	NA	M
TDR	LN	S	M	S	S	S	NA	M
PDR	M,P	S	M	S	S	LN	NA	M
Conservation Restrictions	S	S	M	LN	S	LN	S	M
Septic Tank Management	S	M	M	LN	NA	S	S	M

KEY

NA=Not Applicable
LN=Little or No Affect
S=Some Affect
M=Major Affect
P=Makes Technique Prohibitive
LUST=Leaking Underground Storage Tank

planners regulate land use. As previously discussed, the power to zone comes from state enabling legislation granted to municipalities in order to protect the health, welfare and safety of the general public. It is no surprise then that zoning is one of the most widely used methods to protect groundwater resources. Traditional zoning (often termed Euclidean zoning after Euclid, Ohio, where zoning was first upheld by the U.S. Supreme Court in 1926) regulates land use by establishing separate districts for different uses of land. It also establishes different density requirements for residential land use.

Overlay Zoning

The most common method of using zoning to protect groundwater aquifers is by overlaying additional regulations on a previously existing zoning ordinance. Typically, the use of such overlay districts will first define the areas to be included in the overlay district, and then spell out the additional regulations pertaining to individual land uses within that district. Overlay zones may be established for any number of environmental constraints, including soils, groundwater aquifers and/or recharge zones, entire watersheds or wetlands. An extremely useful technique is to combine different overlay districts within one zoning ordinance, or section of the ordinance. For instance, the capability of different soils to properly treat septic wastewater in leach fields varies greatly. If septic systems are placed in soils with little or no capacity to treat such waste, groundwater contamination may result. Consequently, combining a soil overlay district with a groundwater protection overlay district will help insure that no septic systems are built in soils with poor septic capabilities.

Such an overlay ordinance works in the following manner. A soil overlay district will typically list soil types in the town which have very severe or severe limitations for the construction of septic waste systems. This list essentially defines those areas overlain by the district (the local Soil Survey contains maps showing the extent and distribution of each soil type). The ordinance will then spell out the permitted uses in the soil overlay district, such as "any use permitted in the primary zoning district which does not require a basement or a subsoil sewage disposal system" (Town of North Kingstown, 1974). It should be noted that any use permitted under the primary zoning district is still permitted, unless otherwise specified in the overlay district regulations. When regulations within the overlay district conflict with primary zoning regulations, the overlay regulations take precedence.

Groundwater protection or conservation districts typically are defined by reference to U.S. Geological Survey (USGS) maps and/or reports describing in some detail aquifer resources, such as stratified drift deposits. In addition to the establishment of permitted, non-permitted and special exception uses within the defined area of a groundwater overlay zone, an existing soil overlay zone as described above would also apply to the groundwater zone. Thus, if a soil listed as having severe limitations for septic fields was found on land within the groundwater overlay zone, no septic systems could be built there. Such a non-permitted use could be spelled out exclusively within a groundwater overlay district. However, regulations in two separate overlay districts would prevent loopholes from occurring and would thus better protect the aquifer. Where surface water or wetlands are hydrologically connected to important aquifer areas, overlay zones protecting these areas can also be included in the zoning ordinance.

A variation of the overlay district is the establishment of critical areas, such as a public supply well's area of influence, aquifers and aquifer recharge areas (Town of Dartmouth, Massachusetts, 1981). Once again, regulations within each of these areas overlay existing regulations. However, this type of aquifer protection ordinance focuses on protecting the most important areas with the most stringent regulations. For example, a municipal well's area of influence may have as permitted uses conservation of natural features, outdoor recreation such as nature study or fishing (where applicable), and certain agricultural uses. Regulations in the next zone outward from the area of influence, which may be defined as primary recharge areas to existing wells, might be less stringent. Here the ordinance might allow more land uses to take place, such as all of the above uses plus residential development at a low density (Town of Dartmouth, 1981). Thus as the radial distance from a supply well increases, the permitted uses also increase. This may be termed the "concentric ring method" for purposes of this study and will be referred to as such from here on.

A major drawback to this method is the complexity of defining all of the critical areas, such as the areas of influence of supply wells. Unless detailed hydrologic data already exist, a municipality would have to pay a consultant to collect such information so boundaries could be drawn on an official map. The hierarchy of regulations can also become quite confusing to the public, hindering implementation and enforcement of such an ordinance. In general, one advantage that overlay zones provide is that they are implemented as floating zones. This means their regulations are applicable to all areas which have characteristics matching those spelled out in the section defining the district, such as all glacial outwash areas on a particular USGS map. Consequently, the floating zone concept enables municipalities to uniformly regulate land uses on a town-wide basis with the implementation of one ordinance.

Large Lot Zoning

Another common zoning choice for groundwater protection is the use of large lot zoning to keep residential development at a lower density and thus minimize the impact upon the land. Such zoning may be included within overlay districts so that the minimum permitted lot size is raised, regardless of what it is within the primary zoning ordinance in the same area.

Although the size of lots considered to be large varies from one acre to more than five acres, five acre zoning often is used for purposes of groundwater protection. It should be noted that as the lot size increases, so does the likelihood of legal challenges attempting to stike down the ordinance for being confiscatory of private property. When private property is condemned under eminent domain, without just compensation being paid to the landowner, this is known as a taking. When a municipality regulates land to the point where the owner can no longer use that property for what it is best suited for, this form of a taking is known as inverse condemnation. The Fifth and Fourteenth Amendments to the U.S. Constitution guarantee that landowners shall be compensated for such takings, under due process of law. There is a fine line between condemnation of land under the principle of eminent domain, and regulation of that land to the point where it deprives the owner of beneficial use.

The whole taking issue revolves around the fact that the "fine line" mentioned above is not well defined. Consequently, municipalities must be able to justify the use of large lot zoning. For groundwater protection, the basis behind the use of large lot zoning is the carrying capacity of the land. The carrying capacity concept holds that "there are limits to the amount of growth and development the natural environment can absorb without threatening public health, welfare and safety through environmental degradation..." (Schneider, et al., 1978, p.1). For example, where there are no public sewer lines, low-density residential development might be used to insure septic wastes are dispersed over a larger area. This in turn is based on the theory that if soils are not ideally suited to treating such wastes, less effluent will be discharged per square foot. Thus marginal soils will still be able to "carry" the pollution load, denitrifying the wastewater to the point where it is clean enough to enter an aquifer as recharge. Additionally, impermeable construction surfaces are dispersed over a larger area, minimizing any increase in surface water runoff.

The carrying capacity is dynamic and changes from area to area based on soils, climate, geology, vegetation and hydrology. Local carrying capacities should be determined only after detailed study of the area in question. This should be done as a prerequisite to determining the minimum lot size in groundwater sensitive areas.

As previously mentioned, five acre zoning is often used as a standard large-lot size for groundwater protection. However, in municipalities where economic development and affordable housing are prominent issues, the city or town may wish to lower the size of the lots as a compromise between groundwater protection and growth (Rural New England, 1986-87). Large lot zoning has often been synonymous with exclusionary zoning because larger lots traditionally have meant larger, more expensive homes. Consequently, lowering the minimum lot size from five down to three or less acres, might decrease the housing costs somewhat. This would also allow for an increase in population in a municipality, since the housing density would increase. This is a definite consideration for communities experiencing economic growth and attempting to house a labor force. However, it should never be done where the carrying capacity of the land will be exceeded.

Residential Cluster Zoning

An excellent way to balance economic growth concerns with groundwater protection while maintaining a stock of affordable housing (a term which is of course very relative to income levels) is through residential cluster zoning. Unlike large lot zoning, this technique is a non-traditional type of zoning because it allows for reductions in the minimum lot sizes specified under normal zoning codes. As a result, cluster zoning has met varying degrees of acceptance, especially in New England where private land ownership has been a strong tradition since colonial times.

There are several distinct advantages to cluster zoning which apply directly to groundwater protection. Cluster zoning can be defined as a land development concept in which housing units are densely spaced (either single or multi-family), allowing for an increase in open space and economies of scale for construction costs (Builder Magazine, 1978). By clustering development, the same amount of units which would have been allowed under the standard zoning are built but on only half the acreage. Thus, that portion of land at a given site which is most suited for development can be used, while critical resource areas such as aquifer recharge zones or wetlands can be left unscathed. The remainder of a given parcel can be left as open space, aiding in the preservation of vegetation, topsoil and natural drainage systems.

By using cluster development it is theoretically possible to build relatively affordable housing, in or near aquifer areas, without greatly altering the natural balance of the groundwater system. Cluster developments, because they will concentrate human waste, should only be constructed on soils with good capabilities for septic leach fields. If there are public sewer lines in the area, this need not be considered.

In addition to residential land use, there are dozens of commercial, industrial and even agricultural uses which are potential threats to groundwater quality. Table 2.2 lists many of these uses. Table 2.3 lists some of the contaminants associated with common household products which may find their way into groundwater from residential land use.

Table 2.2 —Sources of Groundwater Contamination

Category I—Sources designed to discharge substances

Subsurface percolation (e.g., septic tanks and cesspools)
Injection wells
- Hazardous waste
- Non-hazardous waste (e.g., brine disposal and drainage)
- Non-waste (e.g., enhanced recovery, artificial recharge, solution mining, and in-situ mining)

Land application
- Wastewater (e.g., spray irrigation)
- Wastewater byproducts (e.g., sludge)
- Hazardous waste
- Non-hazardous waste

Category II—Sources designed to store, treat, and/or dispose of substances; discharge through unplanned release

Landfills
- Industrial hazardous waste
- Industrial non-hazardous waste
- Municipal sanitary

Open dumps, including illegal dumping (waste)
Residential (or local) disposal (waste)
Surface impoundments
- Hazardous waste
- Non-hazardous waste

Waste tailings
Waste piles
- Hazardous waste
- Non-hazardous waste

Materials stockpiles (non-waste)
Graveyards
Animal burial
Aboveground storage tanks
- Hazardous waste
- Non-hazardous waste
- Non-waste

Underground storage tanks
- Hazardous waste
- Non-hazardous waste
- Non-waste

Containers
- Hazardous waste
- Non-hazardous waste
- Non-waste

Open burning and detonation sites
Radioactive disposal sites

Category III—Sources designed to retain substances during transport or transmission

Pipelines
- Hazardous waste
- Non-hazardous waste
- Non-waste

Materials transport and transfer operations
- Hazardous waste
- Non-hazardous waste
- Non-waste

Category IV—Sources discharging substances as consequence of other planned activities

Irrigation practices (e.g., return flow)
Pesticide applications
Fertilizer applications
Animal feeding operations
De-icing salts applications
Urban runoff
Percolation of atmospheric pollutants
Mining and mine drainage
- Surface mine-related
- Underground mine-related

Category V—Sources providing conduit or inducing discharge through altered flow patterns

Production wells
- Oil (and gas) wells
- Geothermal and heat recovery wells
- Water supply wells

Other wells (non-waste)
- Monitoring wells
- Exploration wells

Construction excavation

Category VI—Naturally occurring sources whose discharge is created and/or exacerbated by human activity

Groundwater—surface water interactions
Natural leaching
Salt-water intrusion/brackish water upconing (or intrusion of other poor-quality natural water)

SOURCE: Office of Technology Assessment.

Table 2.3

COMMON HOUSEHOLD PRODUCTS AND THEIR TYPICAL INGREDIENTS*
(from NE Mich. COG, 1982)

PRODUCTS	TYPICAL INGREDIENTS
Organic Solvent Cesspool Cleaners and Drain Aids	1,1,1 trichloroethane Methylene chloride Ortho dichlorobenzene Para dichlorobenzene
Paint and Varnish Removers	Methylene chloride Benzene Toluene Acetone Methanol
Household Cleaners, Disinfectants, and Oven Cleaners	Methylene chloride Petroleum distillates O-phenylphesol
Laundry Degreasers	Perchloroethylene
Paint Thinners and Solvents	Toluene Acetone Trichloroethylene Methylene chloride Methyl ethyl ketone Butyl acetate 1,1,1 trichloroethane Xylene Dichloroethane
Engine and Metal Degreasers	Petroleum distillates Perchloroethylene Toluene Methylene chloride
Toilet Bowl Deodorizers	Paradichlorobenzene
Gasoline, Kerosene, and Fuel Oil	Benzene Toluene Xylene Ethyl benzene N-propyl benzene Trimethyl benzene
Antifreeze	Ethylene glycol
Pesticides	(Numerous)

* Ingredients listed are not common to all products within each category.

Source: Potter, 1984

ADDITIONAL ZONING BY-LAWS

Of the non-residential uses contributing to groundwater contamination today, the use, storage and discharge of hazardous substances; leaking underground fuel-storage tanks and road salting practices are three of the most pervasive sources of groundwater pollution. Consequently, many communities across the country have implemented zoning ordinances or by-laws specifically designed to regulate these pollution sources.

Hazardous Materials

Many common commercial businesses, which are found in virtually every community in the United States, use, store, process or discharge chemical substances which can be hazardous to human health. Such compounds frequently find their way into groundwater aquifers, either by accident, negligence or illegal "midnight" dumping incidents. Businesses such as dry cleaning, hair dressing, printing, photo processing, electroplating/metal finishing and motor vehicle servicing/repair all use potentially harmful chemical substances (Metropolitan Area Planning Council, 1982). In many instances, community officials are unaware that these and other businesses can produce hazardous wastes and how, or if, the businesses in their town dispose of such wastes properly.

According to Potter (1984, p. 6) while "large generators of hazardous wastes are regulated by the state and federal governments, small generators are exempt from many of these regulations."

Ordinances designed to regulate the use, storage, transport and discharge of such hazardous materials generally require that owners or operators of establishments using or storing such materials in a certain quantity register with the town or local board of health. The ordinances usually spell out specific procedures for reporting accidental discharges, and for the maintenance of inventories detailing the purchase, use, sale and disposal of hazardous materials (Metropolitan Area Planning Council, 1982). Appendix A contains a generic example of such an ordinance which was written by the Conservation Law Foundation of New England. This ordinance, like many others, includes the regulation of underground fuel storage tanks.

Underground Fuel Storage Tanks

Whether ordinances regulating underground fuel storage tanks are contained in a hazardous materials ordinance or if they are separate, all of them are set up in a similar manner. Potter (1984, p.6) provides an excellent summary of these ordinances:

> ...Existing underground storage tanks are required to to be registered...All of the regulations require monitoring of tank volume and periodic comparison of the volume against metered fillings and withdrawals...Periodic inspection and testing is also provided for in the ordinances. Older tanks and those made of materials susceptible to corrosion may be required to undergo more frequent testing...All of the ordinances require that older non-conforming tanks be brought into conformance within 15 to 20 years...

The EPA estimates there are at least 1.5 million underground fuel tanks in this country, with anywhere from 5 to 30 percent of them presently leaking (Wilhelm, 1987). Many more steel tanks will start to leak over the next few years as their 15-20 year life expectancy is reached. Regulation of such tanks is thus a priority for groundwater protection.

Road Salt

One of the contributing factors to the rusting out of steel, underground fuel storage tanks is excess road salt leaching through the soil and quickening the pace at which such tanks rust. Excess road salt is a major concern in many New England states due to the long, snow-filled winters the region is known for. As of 1979, in Massachusetts alone there were 90 communities with high salt levels in their water supplies (Metropolitan Area Planning Council, 1982). High sodium levels (resulting from ionization of the salt elements sodium and chloride) are dangerous to human health, contributing to high blood pressure and heart disease.

Although less communities have implemented ordinances for road salting/storage practices than for leaking underground storage tanks, regulation of these practices should be a priority for communities concerned with protecting groundwater.

Ordinances designed to control salt runoff and excess application on roads should all contain certain provisions. First and foremost, salt storage piles should be covered with a permanent shed. This should be built on an impervious surface on flat land to avoid overland runoff from carrying salt away (Metropolitan Area Planning Council, 1982). A closed drainage system around the storage shed should be constructed, so any salt which is dissolved stays on-site and can even be recycled through evaporation. There are several best-management practices (BMP's) for application of road salts. These include calibration of salt spreaders, special application rates for sensitive areas adjacent to surface water and groundwater, varying mixtures of salt, calcium chloride and sand (to minimize the amount of salt used) and experimentation with new deicers which are being developed continuously (Metropolitan Area Planning Council, 1982).

Another important aspect of any road-salt ordinance is a set of regulations against the dumping of snow, which has been removed from salted areas, on sensitive aquifer areas. Many communities dump such snow into rivers or streams, a practice which may be harmful to downstream aquifers if they are hydrologically connected. A snow-disposal site should be carefully chosen with surface and groundwater protection in mind. Appendix B contains a more detailed description of the BMP's for use and storage of road salt.

Enforcement of By-Laws

One problem in all of the by-laws mentioned in this section is the use of performance standards requiring owners of businesses, or users of certain materials, to perform certain duties laid out in the ordinances. While the regulations may be reasonable, enforcement by a municipality is very difficult because there is often a lack of trained, professional staff to carry out this function. Very often, elements of hazardous materials, underground fuel storage and road salting by-laws are incorporated into one groundwater protection ordinance. While this is admirable, it does not simplify enforcement. In fact, this may make enforcement more difficult by placing the burden of the task on one governmental department, board or official. If enforcement duties are spread throughout the local government infrastructure, there is a better chance that the regulations will be effective because more than one person is responsible, and no one official is swamped with the whole enforcement task. One manner in which the duties of enforcement may be made less burdensome is through the use of subdivision regulations.

Subdivision Regulations

As part of their police powers, municipalities are required to control the division of land into two or more lots for sale or development. To control this subdivision, cities and towns adopt a set of regulations dictating small scale details of development such as road widths, curb style, landscaping, vegetation removal, soil conservation, drainage provisions and open space dedication. By forcing developers or landowners to meet such performance standards as a stipulation for subdivision approval, planning and other review boards can more readily enforce provisions for groundwater protection. Since subdivision approval is contingent upon conformance to the regulations, the subdivider at least knows, from the initial hearing process, what is required of him.

There are several provisions which can be placed within subdivision regulations to protect groundwater. Among these are limiting the amount of impervious surface (usually 10% of the lot size is a maximum), design standards requiring on-site surface water detention basins including oil and grease traps, the sealing of sewer pipe joints, provisions for permeable pavement (where applicable), the planting of nursery stock trees, and the preservation of open space.

In some instances, municipalities require the developer to submit a detailed environmental analysis of the project's impact on the site and surrounding area.

This is especially important in aquifer and recharge areas. Since the burden of compiling such information is placed on the developer, less technical expertise is needed on the part of local officials (Potter, 1984).

Municipalities may want to limit use of this scheme to critical areas, especially if they are developing communities and are attempting to balance resource protection with growth. Over-regulation by a municipality will only backfire in the long run, making it even more difficult to pass additional regulations even when they are desperately needed. Ideally, an environmental impact analysis requirement for subdivisions could be tied into overlay districts, as defined in a soil and/or groundwater protection ordinance if one exists.

NON-REGULATORY TECHNIQUES

Public Land Acquisition

Although the discussion in this chapter has thus far concentrated only on regulatory techniques, there are several non-regulatory techniques for groundwater protection which can be quite successful. By far the best of these, and perhaps the best overall technique, is public acquisition of sensitive land areas, such as the areas surrounding public supply wells and their associated recharge zones. Once a municipality owns the land it can do whatever it chooses with it. Leaving the land in its natural state is the best option, although turning the area into a park for passive recreation, with no facilities, will have little if any detrimental effects on the groundwater system. The phrase "no facilities" should be stressed because if the land is developed into a more active type of park, such as with ballfields, parking lots and restroom facilities, the potential for groundwater contamination is greatly increased.

The obvious drawback to public land acquisition is that it is often cost prohibitive. Land can be very expensive, especially when aquifer areas are relatively flat and fertile, as is the case in New England. These characteristics make the land over the aquifers ideal for agriculture or development. Consequently, as many farmers sell out to developers in the land rush that New England has been experiencing in the last few years, municipalities are forced to compete with developers for purchase of sensitive land areas. In most instances, cities and towns cannot compete with the capital finances of large real estate development corporations. Fortunately, municipalities can receive some grant money for purchase of sensitive lands from state programs. In Massachusetts, Chapter 723 of the Acts of 1984 allocated $4.25 million for continuation of the Aquifer Land Acquisition Program. This program was initially established in 1982 with a fund of $10 million for financial assistance to communities attempting to purchase sensitive land. The program is currently administered by the

Massachusetts Department of Environmental Quality Engineering Division of Water Supply (Pisanelli & Bridge, 1986). Similar funding will soon become available in Rhode Island under the State Open Space Act.

Land Trusts

Land may also be donated to local Land Trusts. A Land Trust is operated as a private, non-profit organization, the sole purpose of which is to preserve land for open space, recreation and environmental protection. A Trust is operated by citizens who volunteer their time, thereby allowing municipalities to benefit from their efforts without expending any money. Although land donated to or purchased by a Land Trust becomes tax exempt, it is not much of a burden on a municipality's tax base because it rarely places demands on community services. State environmental agencies have begun to recognize the importance of local Land Trusts and are beginning to aid communities in establishing them.

Purchase of Development Rights

Rather than purchasing property outright, a city or town may purchase the development rights of that property from the landowner. This allows the owner to retain the land but not develop it. This procedure may also be cost prohibitive but somewhat less so than purchase of the land outright.

Purchase of development rights (PDR) is often used by communities to maintain agricultural land and open space. Since the best groundwater protection method is to leave land in its natural state, this method can be very effective for aquifer protection.

Transfer of Development Rights

A similar method but one which is less costly to the municipality is the transfer of development rights (TDR). Under this concept, land ownership is viewed as having a bundle of rights associated with it (Metropolitan Area Planning Council, 1982) such as development rights, air rights, water and/or mineral rights. TDR works under the premise that landowners who have property in highly regulated areas, such as over an aquifer, can sell off their development rights at a profit. This enables them to receive economic gains from their property, which might not be developable due to the regulations imposed upon it. Developers can purchase the rights from such property and apply them to less sensitive land in other areas of the community. In order to establish incentive for this to take place, the community allows the developer who purchases the rights of the sensitive lands, to develop his land at a higher density than would normally be allowed under the zoning ordinance.

Although setting up and implementing a TDR system can be difficult, all parties involved benefit. The original owner benefits by sale of his development rights. The municipality benefits by steering development away from aquifer and/or recharge areas, and the developer is allowed to build an increased number of units on his land.

Conservation Restrictions

Where a full TDR scheme cannot be established, a municipality may work out a conservation restriction with the landowner directly. Under such an agreement, the landowner agrees not to develop his or her land for a certain period of time, usually 5 years to perpetuity (Metropolitan Area Planning Council, 1982). In return, the landowner would receive a property tax abatement since the land is no longer developable and therefore worth less. The restrictions may be written into a deed as a restrictive covenant which "runs with land" (Wright & Wright, 1985). This means the restrictions are handed down from owner to owner if the land is sold. Once again, both the landowner and the community benefit from this voluntary protection scheme.

Septic System Management

Tax abatements can also be used to encourage homeowners to have their septic tanks routinely pumped out. Where residential development has taken place prior to groundwater protection methods being instituted, and the soils are poor, this can be an important groundwater protection device. In some states, such as Ohio, California and Michigan, septic system maintenance districts have been set up. These districts are intended to regulate septic system design, as well as encourage routine pumping of septic tanks (Potter, 1984). However, an additional administrative burden is placed on local governments by establishment of such districts.

SUMMARY

While each groundwater protection method discussed here has its advantages and disadvantages, a combination of two or more techniques is recommended for a comprehensive protection strategy. Which techniques are most applicable depends upon many variables within each community. These variables have been summarized in Table 2.1.

The following chapter will focus on the protection strategies chosen by a few New England Communities.

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CHAPTER THREE

CASE STUDIES OF GROUNDWATER PROTECTION

Up until now, this study has focused on broad overviews of the nature of groundwater contamination and mechanisms available to avoid it. Since the primary goal of this project is to develop a groundwater protection strategy for the Town of South Kingstown, Rhode Island, the previous two chapters are intended to serve only as a body of reference from which ideas and concepts may be drawn. With this in mind, the study now turns towards a more narrow discussion of what some towns in New England have done to protect their groundwater resources. Consequently, this chapter is transitional in that it begins to focus on protection schemes which may be applicable to South Kingstown.

CRITERIA FOR CHOOSING CASE STUDIES

In choosing communities in which to examine existing groundwater protection ordinances, several criteria were used to narrow down the number of choices available. Without these simple criteria, the choice of case studies would have been totally arbitrary. The choices were based on whether or not the community is in Rhode Island, the complexity of the existing ordinance and whether the ordinance could be considered good or bad. The last criterion is based upon the author's educated opinion. This opinion is partially based on Chapter Two, which discusses many of the advantages and disadvantages of various groundwater protection techniques. This enables the reader to view the author's opinions in reference to a basic framework, one which does not make value judgements arbitrarily.

It is acknowledged here that while Chapter Two discussed many groundwater protection techniques, the case studies focus only on zoning ordinances. This was done because zoning ordinances are the most common technique presently used for groundwater protection. As a result, information regarding their application and effectiveness is more available than for some of the less commonly used techniques. Additionally, the concepts of other techniques are often incorporated in some of the better, more comprehensive ordinances.

The choice of a community based upon whether or not it is in Rhode Island is important because the target community (South Kingstown) is in this state. Thus it became imperative to examine at least one other ordinance from **another** state. Different states have different enabling legislation, a fact which allows for great variation in what communities may do to protect groundwater under their police powers. Similarly, it is just as important to look at the protection schemes of other municipalities within Rhode Island to see how they use the existing enabling legislation.

This chapter will examine the ordinances of three communities. These are the Towns of Dartmouth, Massachusetts; and East Greenwich and North Smithfield, Rhode Island. The case studies will briefly trace the history leading up to implementation of the ordinances. The particular type of ordinance adopted will be discussed, as well as the positive and negative features of each one. The examinations will pay particularly close attention to positive features which are applicable to groundwater protection in the Town of South Kingstown.

Two additional ordinances will be discussed briefly in Chapter Four. While the techniques used in these communities are not innovative or comprehensive enough to warrant detailed case studies of them, particular sections of each ordinance are extremely applicable to South Kingstown. For this reason, they are included in the next chapter where their contents are most relevant. The two ordinances are from the Towns of Exeter and Richmond, Rhode Island.

IMPORTANT FEATURES OF A GROUNDWATER PROTECTION ORDINANCE

Regardless of the type of ordinance used and its specific regulations, there are a few key elements which every ordinance should contain. A brief review of these components will further prepare the reader for the case studies which follow.

The first important feature is a statement of purpose. This should be a clearly written, easily understood declaration of why the town is adopting the given regulations, and how they will protect the health, safety and welfare of the community. A brief explanation about the nature of groundwater resources within the town may be included, but should only be done if it will further clarify the regulations.

A second very important feature of any groundwater protection ordinance is the definition of terms used within the regulations. "Defining terms is crucial in eliminating ambiguity and aids in the consistent interpretation of the zoning ordinance" (Lanzarone, et al. 1984, p.3). Terms defined in this section of an ordinance will naturally vary according to the type of ordinance and exactly what it regulates. However, all ordinances should at least define the following terms: groundwater aquifer, groundwater, aquifer zoning district, groundwater recharge area and impervious surfaces. Most ordinances should define: area of influence, cone of depression, hazardous material, hazardous waste, solid waste, slowly and excessively permeable soils, sanitary waste, saturated thickness, stratified drift, till, bedrock, and building structure. These are examples of terms which are commonly used. Obviously if an ordinance doesn't regulate something, say hazardous waste, it need not be defined.

Definition of the aquifer zoning district may be done in a separate, more detailed section of the ordinance, since this definition controls which areas of the community fall under its regulations. Disputes as to the actual boundaries of protection districts may arise. Consequently, a paragraph stating that such disputes are to be settled by a licensed professional engineer, hydrologist or geologist is usually included in groundwater protection ordinances. Such a paragraph will place the burden of proof on the owner of the land in question, and also allow the town to hire the professional at the expense of the landowner.

This type of disclaimer is extremely important because geologic/hydrologic boundaries are often inferred on maps. Such boundaries are not "carved in stone". Consequently, the ability of a private citizen to exempt his property from regulation may reduce or eliminate litigation over the constitutional taking issue. On the other hand, the way a community initially defines aquifer protection districts may mean the difference between an effective ordinance and one which makes politicians look good simply by its existence. If the definition is so loose that everybody can exempt their property from the regulations, than the ordinance is useless.

Zoning ordinances that use overlay districts should contain a clear statement concerning conflicts with the primary zoning regulations. Since the overlay zone is designed to work as an additional measure of strictness, overlay regulations should take precedence over those in the primary zoning district.

Finally, regulations requiring site plan review for certain types of development in certain districts should be carefully written. Site plan review insures identification of potentially adverse effects on groundwater caused by development. More importantly, it shifts the burden of reporting these effects onto the developer (Lanzarone, et al., 1984). A municipality can then make site plan approval contingent upon a developer's promise to take necessary avoidance or mitigation actions in order to protect groundwater.

CASE STUDIES

Town of Dartmouth, Massachusetts

Background

The Town of Dartmouth lies in southeastern Massachusetts. Approximately fifty percent of its drinking water supply comes from stratified drift aquifers (Golledge, 1987). Due to rapid growth in the area, the Town is investigating the potential of expanding its current water supply from groundwater. This is very important because the rights to nearby surface water reservoirs are controlled by other towns. Consequently, protecting Dartmouth's groundwater supply is a main concern of the local government.

In 1981 the Town adopted an Aquifer Protection District, in the form of an overlay zoning ordinance. The ordinance follows the basic structure of the "concentric ring method" discussed in Chapter Two of this study. Thus the strictest regulations apply to the municipal wells' areas of influence (Area 1 in the ordinance), while more uses are allowed in

Areas 2A and 2B (primary recharge areas to existing wells and potential groundwater development areas, respectively). A copy of the ordinance can be found in Appendix C.

According to Mr. Robert Golledge, Conservation Officer for the Town of Dartmouth, a few events caused the implementation of the ordinance (personal communication, 1987). First, one groundwater supply well became contaminated. Shortly thereafter, a hazardous waste site in the northern part of the town was placed high on EPA's list of Superfund sites. Although the aquifers are in the south-central portion of the town, the Superfund site is near streams and a wetland in which the water flows from north to south (Golledge, 1987). Thus contamination could reach surface water and be carried south into the aquifers. Since the aquifers are composed primarily of stratified drift, they are very susceptible to rapid movement of contamination plumes. Consequently, the Town felt the need to adopt a groundwater protection ordinance.

Positive Features of the Dartmouth Ordinance

Dartmouth's Aquifer Protection District is comprehensive and well-written. Section I of the ordinance defines terms used in the regulations, while Section II spells out the purpose of the district. This includes "to preserve and protect present and potential sources of water supply for the public health and safety". Section III clearly establishes the precedence of the overlay district if there are conflicts with the primary zoning regulations. Having these three sections in the beginning of the ordinance prevents confusion over interpretation and enforcement of the law.

There are several other features of Dartmouth's Aquifer Protection District which make it an excellent ordinance. The first of these is Section IV, entitled "Establishment and Delineation of Aquifer Protection District". While most groundwater protection ordinances rely on USGS maps and/or reports for delineation of district boundaries, Dartmouth's ordinance defines its own standards for definition of these districts. The ordinance states that zones are defined on the basis of

> standard geologic and hydrologic investigations which may include drilling observation wells, utilizing existing boring data and stratigraphic profiles, conducting seismic surveys or other geophysical techniques, performing pumping tests, water sampling and geologic mapping. (Section IV)

This statement may be looked upon as an attempt by the Town of Dartmouth to legitimize its delineation of districts through scientific fact-finding, rather than arbitrary choices. It is important to note the above statement does not preclude the use of USGS information, which in many instances is the best available source of hydrologic information. Rather, it hints at the complexity of defining district boundaries based on geologic/hydrologic data. Mr. Golledge (personal communication, 1987) noted it is very difficult to write a good ordinance due to the geologic assumptions which typically need to be made. For instance, as a town's population increases, supply well pumping rates must increase in order to keep up with demand (unless additional wells are drilled). An increase in pumping rate causes enlargement of a well's area of influence. The net effect is that a larger land area needs to benefit from the strictest regulations of a groundwater protection ordinance. Section IV of the Dartmouth ordinance takes into account the complexities of a stratified drift aquifer system, thereby strengthening the regulations with sound scientific principles.

Another important feature of Section IV is the recognition of wetlands or streams which contribute surface water to primary recharge areas (Section IV, B.4). Unlike many other ordinances, these regulations take into account the importance of the relationship between surface and groundwater.

Section V of the Dartmouth ordinance, entitled "Use Regulations", also contains several positive features. For Area 1, the ordinance allows "the maintenance and repair of any existing structure provided there is no increase in impermeable area". While this is very strict, it is the kind of regulation that more towns need to implement to insure protection of the most sensitive groundwater areas. Mr. Golledge has stated (personal communication, 1987) that several variances from this particular regulation have been granted. Although this is sometimes necessary, communities must be cautioned not to adopt too many overly strict regulations, under which variances might be granted on a regular basis. Granting of variances on a routine basis is risky because it may set a precedent for the development of an area in which groundwater needs to be protected.

Although Section VA permits non-intensive agricultural land use in Area 1, it does require the installation of groundwater monitoring wells where "fertilizers, herbicides, pesticides or other potential contaminants" are used. Furthermore, it requires that an agent of the Board of Health conduct water quality sampling from these wells. This feature of the ordinance is one that is directly applicable to the Town of South Kingstown because extensive turf farming takes place in the immediate vicinity of supply wells there.

Section VB of the Dartmouth ordinance details prohibited uses. In spelling out prohibited uses for Area 2, the regulations are quite comprehensive. For instance, provisions governing the maximum percent impervious area of a lot, industrial uses discharging process wastewater on-site, storage of road-salt and deicing chemicals, and the storage or disposal of hazardous wastes and materials are all covered in this section of the ordinance.

Section VC.3 of the ordinance lists standards for site plan review of commercial or industrial uses. There are several innovative regulations in this section. Among them is the requirement that "no stormwater shall be permitted to be recharged to the groundwater before passage through oil and grease traps...". Additionally, wastewater from commercial and industrial uses which is to be recharged to groundwater must meet or exceed certain standards. The standards are given for five water quality parameters, including total nitrogen and phosphorous.

Negative Features of the Dartmouth Ordinance

One flaw in this ordinance is the lack of specific provisions detailing the **monitoring** of performance standards once special permits have been granted. Similarly, no schedule for sampling of monitoring wells (for uses in Area 1, as discussed above) is given. Without such regular checks on land uses in sensitive areas, the ordinance will not be as effective.

Despite this lack of monitoring schedules, the Town Conservation Officer feels the ordinance has been effective thus far. Currently, there are two engineering firms reviewing the protection district boundaries in an effort to improve the ordinance (Golledge, 1987).

Town of East Greenwich, Rhode Island

Background

The Town of East Greenwich is located in central Rhode Island. The Town is presently in the process of adopting an Aquifer and Watershed Protection District. Several drafts of the proposed ordinance have been written and adoption is imminent (Youngken, 1987). The latest draft as of this writing can be found in Appendix D. It must be noted that this draft is subject to change before adoption. All discussion herein is based solely on the current draft and a personal meeting with Mr. Richard C. Youngken, the Town Planner.

Mr. Youngken initiated the process of implementing a groundwater protection ordinance a few years ago. At that time, a zone change request had been filed for a parcel close to the Hunt River. The Town gets its public drinking water through the Kent County Water Authority, which uses the Hunt River Aquifer as one source. This aquifer is composed of stratified drift. At approximately the same time as the zone change request, several proposals for condominium and subdivision projects were filed. All of these were within the aquifer area, some within one-quarter mile of public wells. During this time, the western portion of the town was experiencing rapid growth. Since three-fourths of the town lies within the Hunt River watershed, Mr. Youngken became concerned about the potential impacts on groundwater (personal communication, 1987).

After consulting with the Kent County Water Authority and an Environmental Review Team (consisting of experts from the University of Rhode Island and the Department of Environmental Management), a consultant was hired by the Town to write the initial draft of the ordinance. Like the Dartmouth, Massachusetts ordinance, the regulations overlay and supersede the primary zoning regulations. However, the East Greenwich ordinance is not based on the "concentric ring method" as is Dartmouth's.

Positive Features of the East Greenwich Ordinance

The ordinance contains two subdistricts, designated as Zone A and Zone UD. Zone A contains the Hunt River Aquifer and adjacent recharge areas. Zone UD is the upstream drainage area, which contributes surface water runoff to the Hunt River Aquifer. Land areas that fall within these zones are defined by reference to a 1987 USGS study (see page 2 of the ordinance). Limiting the protection districts to two primary areas is an advantage because it makes the ordinance simpler than if three or more zones were defined.

Like the Dartmouth ordinance, the purpose of this law and the definition of zones and areas is clearly stated in the beginning of the regulations. Although definitions of terms are included, these are placed towards the end of the lengthy document. This section should be in the front of the ordinance to avoid confusion when it is read. The final section of the ordinance is background information about groundwater in the town. This material is excerpted from a recent USGS report and is quite useful as an explanation of the local aquifer system. Including this section supports the purpose of the ordinance, and it may be an aid towards gaining citizen support for implementation and enforcement of the regulations.

Prohibited uses in both the A and UD zones are very comprehensive. In Zone A, these include regulations pertaining to road salt and deicing chemicals, hazardous waste and landfill sites, septage disposal, and underground storage of petroleum products. Of particular relevance to this study are regulations, in both Zones, prohibiting the "use or storage of hazardous substances designated under 40 CFR Part 116 pursuant to Section 311 of the federal Clean Water Act and subsequent amendments thereto." This approach to the regulation of hazardous substances in sensitive groundwater areas is directly applicable to South Kingstown. Similarly, in Zone A, "all uses which discharge process wastewater on-site, including wastewater containing contaminants other than normal organic waste" are prohibited. As will be discussed in more detail in Chapter Four, such uses currently exist over aquifer areas in South Kingstown.

Additional positive features of the East Greenwich ordinance are the detailed and stringent site plan review requirements for special exceptions in Zone A (see pages. 5-7 of the ordinance). Applications for special exceptions and variances must contain an Environmental Report. The Report must contain, at a minimum, a list of all potentially toxic or hazardous materials to be used or stored in quantities greater than for normal household use. In addition, the Report must have soil survey data and percolation test results, as well as a water quality analysis of the property. The water quality analysis must contain ambient measures of ground and surface water (if applicable). The ordinance goes even further and lists 20 quality parameters which must be tested for. These include lead, copper, sodium, nitrogen, phosphorous, zinc and chloride.
The Environmental Report must also have

> a detailed narrative report by a hydrologist, geologist...regarding present water quality conditions and the potential impact...of the proposed use...including the cumulative impacts of the discharge of pollutants over an extended period of time." (page 6 of the ordinance)

The cumulative impacts of development upon water quality are often overlooked by many regulatory schemes. The East Greenwich ordinance is excellent because it does take this into account. It also requires a large amount of scientific data in the Environmental Report. This should insure that decisions concerning special exceptions and variances are made rationally.

Section 5 of the proposed ordinance lists site design standards required for all permitted uses within Zones A and UD. The standards are primarily concerned with mitigating development impacts on surface water runoff. The standards suggest vegetation be used for filtering of runoff, and that runoff be directed away from the more restrictive district if a parcel is within two districts. Finally, a series of standards to be used for calculating nutrient loading associated with development projects is given. These constants are essentially used to determine the carrying capacity of the land, as discussed in Chapter Two of this study.

Negative Features of the East Greenwich Ordinance

Although the proposed ordinance is innovative because it lists carrying capacity standards, nowhere does it state what the minimum lot size requirements are. Only after discussing the ordinance with Mr. Youngken did it become apparent that a two acre minimum lot size, for residential development, is necessary to conform to the regulations. The proposed ordinance could be reduced in length (it is currently 13 pages long) by simply stating what the minimum lot size requirements are. Although Mr. Youngken suggested (personal communication, 1987) inclusion of the standards would help avoid potential litigation over unconstitutional takings, such litigation seems unlikely since two acre lots are not excessively large. As previously discussed, most groundwater protection ordinances use a minimum residential lot size of five acres. The Town of Sanbornton, New Hampshire requires six acres as the minimum lot size in its Aquifer Conservation District.

One poorly designed feature of the ordinance can be found in Section 5, under "Site Design Standards." Subpart B here requires the use of "natural or man-made liners" in all retention/detention basins. The purpose of a retention basin is to hold runoff until it can infiltrate as groundwater recharge. Placement of a man-made liner in such a basin will not allow percolation of the water into the ground. While ponding of the water will cause the settling of suspended materials, this serves no purpose other than to fill the retention basin with "clear" water. Liners may be used in detention basins, where the function is to detain runoff until it can be fed back into natural drainage systems without contributing to increased erosion or flood conditions.

In general, the proposed East Greenwich ordinance is well-written and comprehensive. The above criticisms are minor in relation to the overall quality of the ordinance. Once implemented, this ordinance may become a model upon which other towns base their groundwater protection ordinances.

Town of North Smithfield, Rhode Island

Background

The Town of North Smithfield is located in north-central Rhode Island, where it borders Massachusetts. There are two stratified drift aquifers in the town. These are the Slatersville and Lower Branch of the Blackstone River. In 1979, the Town adopted groundwater protection regulations "in response to a landfill crisis" (Lanzarone, et al., 1984, p. 11). Like other ordinances examined in this study, the North Smithfield ordinance is designed as an overlay zone "which shall take precedence over any other conflicting laws, ordinances or codes..." (6.19.1). A copy of the ordinance can be found in Appendix E.

Positive Features of the North Smithfield Ordinance

The ordinance contains a well-written section on the purpose behind the regulations (6.19.1). It also has a very extensive definition section (6.19.2). There is a brief section entitled "Characteristics" (6.19.3) which explains the function of the local aquifer systems.

Negative Features of the North Smithfield Ordinance

Unfortunately, the ordinance is not a broad, comprehensive attempt to protect the town's groundwater resources, "but rather a response intended to forbid any kind of waste-generating facility or waste disposal facility within the town" (Lanzarone, et al., 1984, p. 11). This is evident when looking at Section 6.19.5-"Prohibited Uses". The only uses listed are hazardous waste generation, management and disposal facilities; septic waste management facilities and solid waste management facilities.

The ordinance is a classic example of one which looks good "on the books" but lacks effectiveness. For instance, the definition of "hazardous material" (6.19.2) includes septic wastes. However, section 6.19.6 entitled "Exemptions" lists individual sewage disposal systems as exempt from the regulations. This makes no sense, especially since septic system waste is a leading cause of groundwater contamination. Section 6.19.6 also exempts agricultural uses from the provisions of the ordinance. Agricultural uses are another important potential contamination source. Recall that the Dartmouth ordinance requires groundwater monitoring wells for such land uses.

Although the ordinance functions as an overlay zone, the areas covered by the regulations are defined in a separate section (5.1) of the Town Zoning Ordinances. Consequently, it seems as though the Town does not feel groundwater protection is a priority. If it did, the areas covered by the regulations would be defined within "Regulation of groundwater aquifer zones", which is Section 6.19.1 of the Town Zoning Ordinances. Furthermore, there is no mention of any Town department, board or commission being charged with any responsibility towards enforcing the regulations.

SUMMARY

This chapter has examined in detail the groundwater protection ordinances of three towns, from two different states. While the basic approach used is similar in all three cases (overlay zoning), there is a great deal of variety within the specific regulations.

Throughout this discussion, whenever components of a particular ordinance appeared to be applicable to South Kingstown, this was noted. In a few instances, the specific characteristics of the groundwater protection problem in South Kingstown were briefly mentioned. Having examined what other communities have done to protect groundwater, it is now time to examine the specific nature of the problem in this town. Chapter Four does this, as well as analyzing an aquifer protection ordinance which has been proposed for certain areas of the town.

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CHAPTER FOUR

GROUNDWATER PROTECTION IN SOUTH KINGSTOWN, RHODE ISLAND: ANALYSIS OF A PROPOSED ZONING ORDINANCE

THE NATURE OF THE PROBLEM IN SOUTH KINGSTOWN

The Town of South Kingstown, Rhode Island, contains outstanding groundwater resources which supply area residents with drinking water. There are four stratified drift aquifers. Three of the aquifers, the Chipuxet River, the Usquepaug-Queen River and the Mink Brook have been mapped by the United States Geological Survey (Allen, et al., 1966).

Since the stratified drift is composed of unconsolidated silt, sand and gravel, contamination can move readily, spreading throughout those portions of the aquifer which are down gradient of the pollution source. The quality of the Chipuxet River Aquifer has already been decreased due to a leachate plume from an abandoned landfill in West Kingston (Kelly, 1975).

Recent Well Contamination

During the summer of 1987, the Rhode Island Health Department conducted random water tests for pesticide contamination. A resident whose water had never been tested requested further tests be run on samples from his well. Test results on this water showed levels of trichlorethylene "substantially higher" than the federal safety guideline of 5 parts per million (Mooney, 1987). One account says results showed levels were 20 times higher than federal standards (Woodcock, 1987a). Further testing showed that contamination was present in at least three homes, all located along Plains Road in Kingston.

Trichlorethylene is a volatile organic compound (VOC) which is used as a degreaser. Tetrachlorethylene, another grease remover, has also been found in well water at the homes. Such chemicals can be hazardous to human health and trichlorethylene is a suspected carcinogen. Blood tests conducted on one family showed all members had slightly elevated levels of the enzyme dehydrogenase, possibly due to drinking contaminated water. This enzyme is often used to indicate liver or muscle damage (Mooney, 1987). Although the State of Rhode Island began providing residents with bottled water, one person who continued to use his well water suffered anaphylactic shock and needed to be hospitalized (Mooney, 1987). He no longer uses his well water and claims "his home is virtually worthless" (Woodcock, 1987a).

The homes are located approximately a quarter mile north of an abandoned municipal landfill. Another closed landfill, on University of Rhode Island (URI) property, is just across Plains Road from the homes. This location is less than a mile north, or up gradient of, URI water supply wells (Mooney, 1987). These wells pump approximately 1 million gallons per day (Narragansett Times, 1987) from the Chipuxet River Aquifer.

Although both landfills are technically abandoned, material dumped at them was not carefully monitored for hazardous materials (Woodcock, 1987b). Furthermore, illegal dumping of materials, such as construction debris and fertilizer bags from turf farming, has been reported by one South Kingstown Town Council member (Woodcock, 1987c). Although one or both landfills are assumed to be the source of the contaminated groundwater, this has not been verified by scientific proof. However, a 1975 Rhode Island Water Resources Board study found a mineralized plume of groundwater, in the form of leachate, flowing from the former town dump towards the Chipuxet River Aquifer (Kelly, 1975). (Both dumps are, or are close to being, over the aquifer itself. At the very least, they are well within the recharge area of the aquifer.) Although the report made recommendations towards eliminating landfill leachate from reaching the groundwater, these recommendations were never followed.

The Town of South Kingstown has put out construction bids for extending public water lines to four affected houses along Plains Road. The lack of groundwater protection has now burdened town finances, as well as emotionally and physically harming town residents. There has never been a more opportune time for the Town of South Kingstown to adopt some form of groundwater protection program.

Other Potential Contamination Sources

Much of the area directly above the Chipuxet and Usquepaug-Queen River Aquifers is used for turf farming, since these areas are flat and the soils are relatively fertile. However, this farming involves the use of many fungicides, herbicides and fertilizers, which can potentially contaminate groundwater in the aquifer if applied too heavily or otherwise misused.

Because of the nature of land uses in the vicinity of the Chipuxet River Aquifer, it is the most susceptible of the four aquifers to contamination. The University of Rhode Island (URI) lies within the recharge zone of the Aquifer. Many local roads and streets bisect the aquifer and its recharge zone, including Route 138. This is significant because during winter months, these roadways are heavily salted to melt ice and snow. Urban runoff from URI, as well as salt runoff from adjacent roadways, are both potential contamination sources which may find their way into the Chipuxet Aquifer. Additionally, rapid residential development is currently taking place within the recharge zones of this aquifer. Such development decreases the amount of permeable surface area for groundwater recharge as well as increasing surface water runoff. An increase in surface water runoff can decrease the quality of the water entering an aquifer.

The Town of South Kingstown has implemented 5 acre residential zoning (RLD200) over portions of the three mapped aquifers. The maintenance of low density residential zones should insure that the carrying capacity of the land is not exceeded, preventing contamination from pollutants such as septic waste. While the RLD200 zones are an excellent first step towards protecting the Town's aquifers, additional regulatory and non-regulatory strategies must be adopted to further protect the aquifers from hazardous substances, agricultural and urban runoff, and road salt.

Perhaps the most important of all the potential contamination sources in the vicinity of the Chipuxet River Aquifer is the manufacturing zone (M1 on South Kingstown's official zoning map) located in West Kingston. This zone lies directly above part of the reservoir area of the aquifer. The reservoir portion of the aquifer has the highest potential yield of groundwater. There are several small manufacturing firms in this zone which may use, store or discharge hazardous materials.

SCOPE OF ANALYSIS

The purpose of this chapter is to examine a proposed groundwater protection ordinance designed to regulate manufacturing uses in the M1 Zone. More specifically, it must be determined whether or not the ordinance contains regulations which are outside the specific powers granted the town under the Rhode Island Zoning Enabling Act. This is one of the first tests a new zoning ordinance is often put under, because it is one aspect of any ordinance which is likely to be challenged in court by private concerns. This chapter will then examine whether or not the proposed ordinance conflicts with the Rhode Island Hazardous Waste Management Act. This is necessary because the ordinance was designed to regulate the use of substances which may be classified as hazardous or toxic by state and federal agencies, such as the Environmental Protection Agency. The chapter briefly looks at groundwater protection ordinances adopted by towns surrounding South Kingstown.

The proposed ordinance in its present form can be found in Appendix F. It should be noted that on October 1, 1986, the South Kingstown Conservation Commission sent a letter to the Town Council suggesting that the council move favorably towards adopting the ordinance "as a preliminary step towards protecting the quality of our groundwater supply" (Stone, 1986). The Town Council has not taken any action in this direction to date.

The proposed ordinance as it presently stands would do two things. First, it would prohibit any new manufacturers that would use hazardous or toxic substances from locating over the Chipuxet River Aquifer in West Kingston. This prohibition is necessary because approximately half of the acreage zoned as M1 (manufacturing) is currently vacant. Consequently, it is necessary to minimize the potential for future groundwater contamination by restricting land uses which might someday provide a source of such contamination. Secondly, the proposed ordinance would permit existing uses of this type to continue as non-conforming uses, providing they report to the Town the type and quantity of any hazardous substances used, stored or discharged. The allowance of non-conforming uses is intended to minimize legal challenges of a "taking" nature, while the disclosure mechanism (in the form of a semi-annual report to the Town) should allow the Town to keep track of the amount and composition of hazardous substances in case of possible contamination incidents. Knowing as much as possible about the nature of any groundwater contamination will speed up remedial clean-up actions, as well as possibly decreasing their cost.

CONFORMANCE WITH RHODE ISLAND ZONING ENABLING ACT

General Scope

The General Laws of Rhode Island of 1956 (reenacted 1980) state:

> For the purpose of promoting the public health, safety, morals or general welfare...the town council of any town...shall have the power in accordance with the provisions of this chapter...by ordinance to regulate and restrict...the location and use of buildings, structures and land for trade, industry, residence and other purposes... (45-RI, Ch. 24-1).

It is quite obvious that the proposed ordinance is designed to protect the public health by preventing contamination of groundwater which supplies the Town of South Kingston with drinking water. Thus, the ordinance is within the proper scope of the state zoning enabling legislation.

Uniformity of Zoning Districts

Under the same legislation entitled "Division into districts-Uniformity within districts" (45-RI, Ch. 24-2), the town council is permitted to divide the town into zoning districts and "All such regulations shall be uniform ... throughout each district but the regulations in one district may differ from those in other districts". This essentially means that regulations in all districts zoned the same must be identical, but a district zoned commercial will have different regulations than one zoned as residential. This raises the question of whether or not the proposed ordinance has arbitrarily singled out one manufacturing zone for regulation. Although it is true that the M1 Zone in West Kingston was chosen because it overlies an important groundwater aquifer, there are three other such aquifers in South Kingstown (the Mink Brook, Usquepaug-Queen and Factory Pond). The Factory Pond Aquifer has not been mapped by the United States Geological Survey (USGS), while the others have. Consequently, the proposed ordinance might be challenged on the basis that it does not establish uniform regulations on a town-wide basis. Landowners in West Kingston, where the ordinance is focused, might claim they are being unfairly and arbitrarily regulated, since no landowners over other aquifers are regulated in a similar manner.

In order to conform with State enabling provisions for uniformity within districts (45-RI, Ch. 24-2), Section 2 of the proposed ordinance provided for the changing of the West Kingston M1 Zone to an M1-A Zone. Consequently, it would be a different district than other manufacturing (M1) zones, and could therefore regulate use differently.

From a comprehensive land use planning perspective, the proposed zone change in West Kingston would only protect the Chipuxet River Aquifer and would do nothing to protect the other aquifers in South Kingstown. A better approach would be to rewrite the proposed ordinance so that it "floats" over all aquifer areas worthy of protection. Floating zones are legal in Rhode Island and are often used in the form of cluster housing and residential compound ordinances. South Kingstown, as well as several other Rhode Island towns presently use such ordinances to preserve open space and protect natural features such as wetlands. It would be necessary to define "aquifer" in the floating ordinance so boundaries within which regulations should apply could be determined. Once this was done, the question of uniformity within zoning districts would be solved once and for all, thus eliminating any possibility of legal challenges claiming the proposed ordinance is arbitrary. The South Kingstown Town Planner feels that rewriting the proposed ordinance so it floats over all aquifer areas is very feasible and would make the ordinance stronger (Prager, 1986).

Accordance with the Comprehensive Plan

One other measure of whether or not the proposed ordinance is within the realm of the Rhode Island Zoning Enabling Act is its conformance to the South Kingstown Comprehensive Plan. Under "General purposes of ordinances" (45-RI, Ch. 24-3) it is stated that:

> Such regulations shall be made in accordance with a comprehensive plan...Such regulations shall be made with reasonable consideration, among other things, to the character of the district and its suitability for particular uses....

The purpose of this statutory requirement is to avoid haphazard or spot zoning, as well as arbitrary and capricious misuse of the power to zone (Cianciarulo v. Tarro, 92 RI. 352, 168 A. 2d 719, 1961). The Town of South Kingstown adopted a new comprehensive plan on September 8, 1986. The document is very sensitive to the importance of protecting groundwater as it specifically recognizes aquifers, states groundwater protection is a Town priority and even acknowledges that certain manufacturing uses can be detrimental to aquifers. The following excerpts are taken from various elements of the comprehensive plan:

> Water supplies in South Kingstown come from groundwater reservoirs. The four large groundwater aquifers (Usquepaug-Queen River, Mink Brook, Chipuxet River and Factory Pond) have significant quantities of groundwater. (p. 2-5, Community Facilities)

> The highest groundwater yields for South Kingstown are located in West Kingston. This represents a significant resource which must be protected from abuse or over-exploitation. (p. 1-9, Land Use)

> The Town recognizes that water supply is <u>not</u> inexhaustible, and that maintaining the quality of the drinking water is very important. The Town considers groundwater protection to be a priority concern. (p. 5-11, Environmental Goals and Policies)

> Industries should be required not to discharge toxic wastes into streams or recharge areas; performance standards should guide these uses. (p. 1-10, Land Use)

> <u>West Kingston</u> - Along the railroad line near Route 138, a large site has been zoned for manufacturing activity for many years. Primarily intended for light industry due to environmental constraints, the development of this site should be carefully controlled with appropriate performance standards. Particular attention should be paid to potential contamination of the underlying aquifer. (p. 1-22, Land Use)

Clearly the proposed ordinance is intended to implement the goals and policies defined in the comprehensive plan.

SPECIAL ZONING ENABLING LEGISLATION FOR SOUTH KINGSTOWN

In addition to the general zoning enabling legislation discussed above (45-RI, Ch. 24, sections 1-3), the Rhode

Island General Assembly in 1973 passed "An Act Relating to Zoning Ordinances for South Kingstown" (73-H-6430, approved May 15, 1973). Under Section 3 entitled "Contents of Zoning Ordinance," South Kingstown is granted the power of:

> Designating areas and restricting development in such areas which are deemed to be irreplaceable natural resources or areas of outstanding ecological value to the town.
>
> Restricting and limiting development and land use in areas where such development will create a hazard to the public health.

This removes any final doubt (and thus any potential "ultra vires" challenges) concerning the proposed groundwater protection ordinance being within the zoning authority granted to South Kingstown by the State.

CONFORMANCE WITH RHODE ISLAND HAZARDOUS WASTE MANAGEMENT ACT

Since the proposed ordinance is essentially a set of performance standards for the use, storage and discharge of chemicals or compounds which could be classified as hazardous, the question of whether or not the ordinance conflicts with the 1978 Rhode Island Hazardous Waste Management Act (23-RI, Ch. 19.1-1) arises.

An examination of this Act finds no mention of local authority being excluded from regulating hazardous waste. This act deals specifically with hazardous **waste**, whereas the proposed ordinance does not consider the chemicals or compounds being used, stored or discharged (see Section 3 of the ordinance) as hazardous **waste**. Consequently, the ordinance does not conflict with this Act in any fashion.

Furthermore, the section of the Act entitled "Groundwater resources" (23-RI, Ch. 19.1-11.1) states:

> No hazardous waste, including any septic waste, shall be disposed of in an area overlying an actual, planned, or potential underground drinking water source as described on the ground water maps of the U.S. Geological Survey and the Rhode Island water resources board providing such underground drinking water source has been designated, on the basis of hydrogeologic data, as a future or potential municipal water source by the city or town in which the underground water source is located and, furthermore, providing there is a local ordinance relating to groundwater aquifer zones.

This section of the Rhode Island Hazardous Waste Management Act is referred to as the Hagan Act (RI Statewide Planning, 1981, p. 54). Since it specifically makes reference to "hazardous waste, including septic waste," the Hagan Act does not overlap with what the proposed ordinance attempts to regulate, namely chemicals or compounds which may be hazardous or toxic. It does require that a local ordinance pertaining to aquifer zones exist as a stipulation for prohibiting the discharge of hazardous and septic waste. Consequently, the Hagan Act could advantageously be used by South Kingstown as a basis for rewriting the proposed ordinance so it floats over all aquifers in the Town.

If "aquifer" is defined for the purpose of creating a floating zone, "toxic or hazardous wastes" could also be defined in the same section of the rewritten ordinance. This would invoke the Hagan Act as further protection for the Town's aquifers, since the floating zone would qualify as "a local ordinance relating to groundwater aquifer zones". Furthermore, using one comprehensive definition of hazardous waste would simplify the present form of the proposed ordinance by eliminating the group of chemical lists published by state and federal agencies (see Section 3 of the proposed ordinance in Appendix F). Simplifying the ordinance would increase compliance by making regulations less confusing, and thus more effective at protecting the public health.

OTHER GROUNDWATER PROTECTION ORDINANCES

Town of Richmond, Rhode Island

The Town of Richmond, Rhode Island, which borders South Kingstown on the west, has adopted an aquifer protection ordinance with defines "Toxic or Hazardous Wastes" (18.08.331 of the ordinance, see Appendix G). Use of such a definition in the South Kingstown ordinance is highly recommended for reasons already mentioned. It should be noted that the Richmond definition includes "any substance deemed a hazardous waste or material under applicable federal or state law..." (18.08.331).

This definition is very important because it includes substances referenced on the proposed South Kingstown ordinance without naming specific substances. This vagueness is important as it allows more substances to come under the regulation of the ordinance, thus further protecting the aquifers from potential contamination.

Within the Aquifer Protection District of the Richmond ordinance, industrial or commercial uses are required to be subject to Planning Board site plan review (18.37.50 of the ordinance). Additionally, the ordinance requires submission of a report detailing the "amount and composition of industrial or commercial wastes...and proposed methods for disposal of such wastes outside of the Aquifer Protection District" (18.37.50). The ordinance also prohibits "All commercial or industrial uses which involve the use or storage of hazardous materials" (18.37.50).

The Richmond ordinance is thus very similar to the proposed South Kingstown ordinance in that it requires site plan review by the Planning Board, and a report on the use and storage of hazardous materials to be submitted to the Town. Most importantly, it regulates not only the discharge, but also the handling (use), transport and storage of these materials. Consequently, the Richmond ordinance seems to "pave the way" for the institution of a similar ordinance in

South Kingstown, especially since it has not been legally challenged since its adoption in August, 1984.

Town of Exeter, Rhode Island

The Town of Exeter, which borders South Kingstown to the north, defines a Ground Water Overlay District based on glacial outwash deposits mapped by the U.S. Geological Survey. Prohibited within this district are:

> ...industrial uses which discharge process wastewater on-site, including any commercial and service uses discharging wastewater containing contaminants other than normal organic waste (Pt. II, Section b-7).

The outright prohibition of industrial uses is stricter than what has been proposed for the West Kingston M1 Zone where allowances would be made for non-conforming uses. The overlay district applies to all existing zoning districts and adds additional restrictions of land use to those areas which are mapped as outwash. Consequently, the overlay district is a floating zone which protects all aquifers within the Town of Exeter. The ordinance was adopted in February of 1985 and has not yet been challenged in court.

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CHAPTER FIVE

THE SAFE DRINKING WATER ACT: ITS APPLICABILITY TO LOCAL GROUNDWATER PROTECTION

THE ROLE OF FEDERAL STATUTES IN GROUNDWATER PROTECTION

As already discussed, many towns in New England and the rest of the Northeast are currently instituting zoning ordinances specifically designed to protect groundwater aquifers. However, aquifers rarely adhere to political map boundaries; but rather, they occur over (or under) local, county and even state lines. This makes protection of an aquifer occurring within two or more jurisdictions complicated, especially if full cooperation is not given by one of the jurisdictions. It is not uncommon for part or all of a recharge zone to lie in one town, and the primary reservoir area of the same aquifer to lie in another. Protecting only the aquifer itself is useless in the long run, since the water coming from the recharge zone eventually flows into the aquifer. Unfortunately, many local protection schemes, while of good intention, are shortsighted and ignore recharge zones.

Another problem arises in situations involving federal preemption of state or local laws. Under this scenario, the Federal government may decide to build, for example, a military installation at a given location which may be over an aquifer. Although the National Environmental Policy Act (NEPA) of 1969 requires an environmental impact statement (EIS), the project may still be built even if a better location is found (Stryckers Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223, 1980).

To avoid such jurisdictional problems in environmental protection, the U.S. Congress has enacted a series of statutes which outline comprehensive, nationwide regulatory schemes for water pollution control. The federal Water Pollution Control Act Amendments of 1972 (Clean Water Act) and the Safe Drinking Water Act of 1974 (SDWA) provide the main body of these regulations. As will be discussed in more detail in the next section of this chapter, the Clean Water Act (CWA) does not provide substantive regulations for groundwater protection. However, the SDWA **was designed** primarily as a preventive measure against groundwater pollution.

Since the SDWA provides groundwater protection regulations which can be **initiated by municipalities**, it is the intent of this chapter to focus on this Act (42 U.S.C. 300f, et seq., Pub. L. 93-523, as Amended). More specifically, Section 1424(e) provides a mechanism whereby an aquifer or regional group of aquifers can be designated as sole-source drinking water supplies, entitling them to further protection from contamination. After briefly discussing the background behind enactment of the SDWA, the specifics of the sole-source aquifer provisions will be outlined. Applications to date of Section 1424(e) of SDWA will be discussed, leading to a proposal for sole-source aquifer designation for the Upper Pawcatuck River basin in southern Rhode Island (see Figure 5.1).

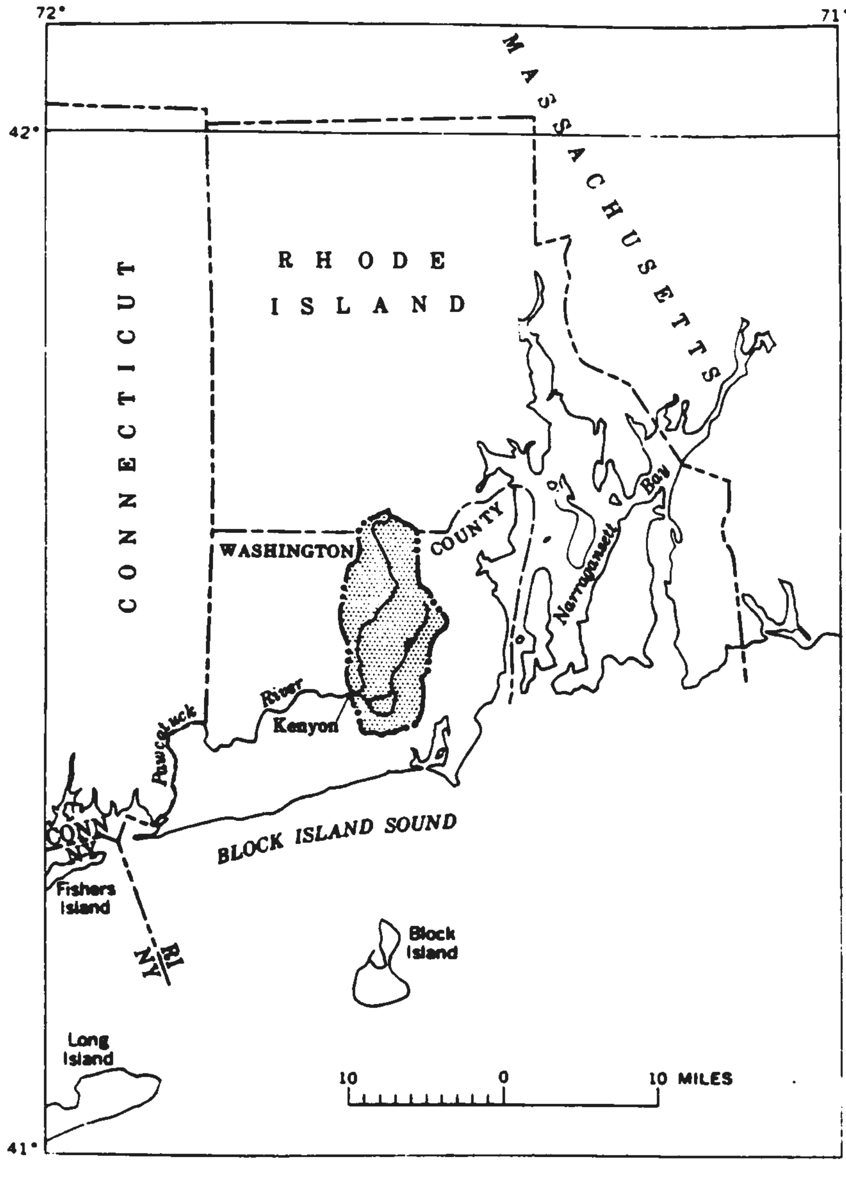

Figure 5.1 Location of upper Pawcatuck River basin.

Source: Allen et al., 1966

EVENTS LEADING TO ENACTMENT OF SDWA OF 1974

Increased Land Disposal of Wastes

The increase in awareness of pollution threats to the natural environment, which occurred during the late 1960's and into the mid 1970's, prompted the enactment of many federal statutes. Among these were the Clean Air and Clean Water Acts, which focused primarily on industrial pollutant discharges into the air and water, as well as from Publicly Owned Treatment Works (POTW's). One of the effects of these two acts was to increase the dependence upon **land** disposal of wastes which were formerly discharged into the air and water. Consequently, there was an increase in the number of landfills specifically built for accepting such wastes. It is ironic to realize that the increased land disposal of wastes has led to an increase in groundwater pollution, since in most cases special precautions were not taken to prevent such contamination. So while the CWA focuses primarily on surface water, it largely ignores another component of the hydrologic cycle, which is groundwater.

Lack of Applicability of CWA to Groundwater Protection

Although Congress intended the CWA to deal with groundwater pollution through various planning provisions of the Act (Tripp & Jaffe, 1979), it has not been effective in doing so. The planning provisions rely on the statutory language "navigable waters" for applicability, and the CWA defines "navigable waters" as "waters of the United States" (33 U.S.C.A. Section 1362(7), 1978). While this is a very broad view of navigable waters, common sense dictates that groundwater is not navigable. Under the interstate commerce clause of the U. S. Constitution, Congress has jurisdiction over groundwater.

While it can be argued that "waters of the United States" must include groundwater, this has not been upheld in the courts. In United States v. GAF Corp. (389 F. Supp. 1379, 1975), the court refused to enjoin the drilling of wells for subsurface disposal of organic chemical wastes by injection without EPA approval. The court dismissed the suit brought by the U.S. for lack of jurisdiction under the CWA. The court reasoned there was no discharge of a pollutant since "discharge of a pollutant" is defined as "any addition of any pollutant to navigable waters ..." by 33 U.S.C.A. Section 1362(12). The court held on the basis of legislative history that unless underground waters (groundwater) have been alleged to flow into or otherwise affect surface waters, they **were not** included within the term "navigable waters" (Hemphill, 1976). Although this case was litigated after the initial passing of the SDWA (1974), it clearly shows how the CWA does not apply to groundwater.

NEPA Inadequate to Protect Groundwater

Although by the early 1970's the need for a federal statute specifically protecting groundwater may have been recognized by Congress, the situation which arose in Sierra Club v. Lynn (502 F. 2d 43, 1974) served as the catalyst for enactment of the Safe Drinking Water Act (Hemphill, 1976). In this case, the federal Department of Housing and Urban Development (HUD) backed up loan guarantees (for $18 million) for a "new town" development. Part of the "new town" was to be located over the Edwards Aquifer recharge zone, in the vicinity of San Antonio, Texas. Under NEPA, HUD was required to file an EIS, which it did. The plaintiffs (local citizen groups and their members) sued to enjoin HUD's approval of the loan guarantees by alleging: 1) that HUD's EIS insufficiently addressed the no-action alternative, which would be non-approval of the loan guarantees, and 2) that the loan guarantees violated the Federal Water Pollution Control Act Amendments of 1972 (the Clean Water Act). The appellate court held that the plaintiffs failed to state a claim under the CWA, since there were no water quality standards for the aquifer set by EPA. Furthermore, the court held the EIS filed by HUD was sufficient. The court concluded this based on HUD's argument that the no-action alternative would not be in the best interests of protecting the aquifer, since it would allow uncontrolled development to take place over the recharge zone (Hemphill, 1976). The "new town" development concept, on the other hand, called for a comprehensively planned town to be built as a single entity with no urban sprawl.

The fact that the court upheld the sufficiency of an EIS allowing **any** development to take place over the recharge zone of the Edwards Aquifer obviously concerned Congress enough to speed up the enactment of the SDWA in 1974.

INTENTIONS OF THE SDWA OF 1974

Main Provisions

The SDWA is basically a federal regulatory scheme to insure the quality of publicly supplied drinking water (Tripp & Jaffe, 1979). There are three provisions of the SDWA which affect groundwater management, two of which are specifically designed to protect groundwater recharge zones (Tripp & Jaffe, 1979).

The main thrust of the Act is to give EPA authority to establish drinking water standards and treatment technologies for public water supply systems (42 U.S.C. Section 300f(4), 1976). A second major provision of the Act is the Underground Injection Control Program (42 U.S.C. Section 300f, 300h-1 to 3, 1976). Finally, the most important provision, for the purpose of this paper, is the Gonzales Amendment, which is more commonly known as the sole-source aquifer provision (42 U.S.C. Section 300f, 300h - 3(e), Section 1424(e), 1976).

The national primary drinking water standards specify maximum contaminant levels (MCL's) or treatment techniques for all pollutants having any adverse health effect. The states have been granted primary enforcement responsibility provided their enforcement programs can meet EPA approval (Hemphill, 1976).

The Underground Injection Control (UIC) provision of the Act allows EPA to establish minimum requirements for state programs, before states may assume authority to regulate discharges from deep wells into groundwater. The UIC program is designed to prevent "endangerment" of an Underground Drinking Water Source (UDWS). The problems which arise due to the vagueness of "endangerment" and "UDWS" as defined in the Act are beyond the scope of this chapter.

Specific Provisions of Section 1424(e) of SDWA

As previously mentioned, Section 1424(e) of the Act is known as the Gonzales Amendment or sole-source aquifer provision. The Amendment was first introduced by Congressman Gonzales in response to the lack of protection received by the Edwards Aquifer (San Antonio, Texas), which was in his district. The reader should recall this was the same aquifer over which Sierra Club v. Lynn (503 F. 2d 43, 1974) was litigated.

Section 1424(e), which was adopted in 1976, reads as follows:

> (e) If the Administrator determines, on his own initiative or upon petition, that an area has an aquifer which is the sole or principal drinking water source for the area and which, if contaminated, would create a significant hazard to public health, he shall publish notice of that determination in the Federal Register. After the publication of any such notice, no commitment for Federal financial assistance (through a grant, contract, loan guarantee, or otherwise) may be entered into for any project which the Administrator determines may contaminate such aquifer through a recharge zone so as to create a significant hazard to public health, but a commitment for Federal financial assistance may, if authorized under another provision of law, be entered into to plan or design the project to assure that it will not so contaminate the aquifer. (42 U.S.C. Section 300(h) - 3(e), 1976)

As with other federal environmental statutes, it is often necessary to define certain words or phrases in the language of the statute so that enforcement of the regulations is possible. There are three key phrases in Section 1424(e) of the SDWA. These are "an aquifer which is the sole or principal drinking water source", "a significant hazard to the public health" and "Federal financial assistance."

EPA regulations define a sole or principal source aquifer as one which supplies 50 percent or more of the drinking water of an area (42 Fed. Reg., 51620, 1977). While this requirement does not seem too restrictive, it does leave a large loophole in the regulation. For example, an aquifer which supplies up to 45 percent of the potable water for a certain geographic area is still a very important drinking water source and therefore requires protection. However, using the 50 percent cut-off for designation would not invoke protection of that aquifer under Section 1424(e) (Hemphill, 1976).

Even if an aquifer meets the criterion of supplying 50 percent or more of the drinking water of an area, it does not automatically mean it will be designated as a sole-source aquifer. The proposed EPA regulations (42 Fed. Reg., 51623, 1977) list six additional factors which the Administrator (of EPA) is to consider in making the decision on whether or not the aquifer deserves sole-source status. The six factors are: 1) the availability of alternative sources of drinking water; 2) the size of the area and population served by the aquifer; 3) the susceptibility of the aquifer to contamination through the recharge zone; 4) the location of the aquifer; 5) the number of public water systems using water from the aquifer, the number of people served by the systems, and the treatment provided by the systems; and 6) such other factors as deemed relevant (Office of Technology Assessment, 1984; 42 Fed. Reg., 51623, 1977). Thus, if a community or other organization submits a petition to EPA for designation of an aquifer as a sole-source, they must be able to supply scientific data to warrant such designation.

Another important phrase within Section 1424(e) which warrants further definition is "a significant hazard to public health." The EPA regulations give two criteria for creating such a hazard. These are: 1) any level of a contaminant which causes or may cause any MCL to be exceeded where the water may be used for drinking purposes, and 2) or which may require a public water system to install additional treatment to prevent such adverse affect (Office of Technology Assessment, 1984, p. 225). Note that specific contaminants or their potential sources are not listed, so "a contaminant" can be broadly interpreted. The two criteria are **not** dependent upon one another, so that if a public water system is forced to upgrade its water treatment without a source of contamination being found, a significant hazard to public health exists.

The third key term in the language of Section 1424(e) is "Federal financial assistance." The statutory language notes "through a grant, contract, loan guarantee, or otherwise," but this is still ambiguous. EPA regulations define the term to "include any financial benefits provided directly as aid to a project by a department, agency, or instrumentality of the Federal government in any form ..." (Office of Technology Assessment, 1984, p. 225). However, actions or programs carried out by the Federal government itself (e.g., by the Army Corps of Engineers) or by contractors for the government (construction of roads on federal lands) are not included (Office of Technology Assessment, 1984, p. 225).

Since federally funded projects require an EIS under NEPA, the EPA has stated that "the process of project review pursuant to Section 1424(e) will be integrated as fully as possible with the review of Federal actions subject to NEPA" (42 Fed. Reg., 51621, 1977). One potential weakness of Section 1424(e) of SDWA is that even if a sole-source aquifer is designated, it is protected from contamination only from federally funded projects. It should be noted, however, that such projects are often quite large and may act as a stimulus for private development in an area. Consequently, the prevention of the stimulus for private ventures should curtail such projects and indirectly protect the aquifer from potential contamination (Hemphill, 1976).

An additional loophole in Section 1424(e) is the absence of language specifying a time frame within which EPA is to make a designation decision for a particular aquifer. Consequently, there is often quite a time lag (up to three years) between the time a petition for sole-source designation is received by EPA and the date upon which a final decision is rendered (Office of Technology Assessment, 1984). This is a weakness in the Act since an aquifer is unprotected until publication of the final decision. Within this time frame, additional federal funding commitments could be made for projects within areas potentially affected by petition decisions (Hemphill, 1976). An increase in federal funding commitments might put political pressure on the EPA Administrator, causing denial of a petition for sole-source designation.

Application of Section 1424(e) to Date

As of October 1986, 21 sole-source aquifers have been designated by EPA (EPA, 1987). The Edwards Aquifer in Texas was the first to be designated, in 1975. Other significant designations include the Maryland Piedmont, Nassau/Suffolk and Kings/Queens Counties, New York, and Block Island, Rhode Island (Office of Technology Assessment, 1984).

Designation of the Maryland Piedmont aquifer was challenged in Montgomery County v. U.S. Environmental Protection Agency (662 F. 2d 1040, 1981). In this case, Montgomery County (the plaintiff) alleged that EPA's inclusion of seven drainage basins in one sole-source aquifer was "unreasonable, arbitrary and capricious because each basin acts independently as a separate and distinct hydrogeologic unit" (662 F. 2d at 1042, 1981). However, EPA's decision was upheld by the appellate court, giving more strength to a proposal for designation of three separate aquifers in southern Rhode Island. The following section of this chapter sets forth the basis for that proposal.

PROPOSED APPLICATION OF SECTION 1424(E) IN THE UPPER PAWCATUCK RIVER BASIN, RHODE ISLAND

Scientific Background

The following provides a basis for a petition to EPA for sole-source designation of aquifers in the basin:

The upper Pawcatuck River basin is a 70-square mile area in south-central Rhode Island. It is drained by the Pawcatuck River and two major tributaries, the Usquepaug-Queen River and the Chipuxet River (see Figure 5.1). The basin is approximately 15 miles long and 7 miles wide, and most of it lies within the Town of South Kingstown. Portions of the basin extend north into the Towns of North Kingstown and Exeter, while a small portion of the basin lies in the Town of Charlestown, just west of South Kingstown (Allen, et al., 1966).

All of the water in the upper Pawcatuck River basin is derived from precipitation (Allen, et al., 1966). This water is stored in three stratified drift aquifers within the basin. They are the Chipuxet River Aquifer, the Usquepaug-Queen River Aquifer and the Mink Brook Aquifer. All three aquifers consist of unconsolidated, glacial silt, sand and gravel deposits. These were deposited by retreating ice sheets of the Pleistocene age (the last great ice age, ending approximately 10,000 years ago). The unconsolidated deposits in these three aquifers lie within pre-glacial river valleys flanked by bedrock-supported topographic highlands. The recharge zones of the aquifers occur on the flanks of and between these hills, where urban runoff, road salt, leaking underground fuel tanks and sewage discharge threaten the quality of the groundwater.

Since the aquifer material is unconsolidated, contamination can move easily and quickly, spreading throughout the entire portion of the aquifer which lies down gradient of the pollution source. Already, the quality of the Chipuxet River Aquifer has been decreased due to a leachate plume from an abandoned landfill in the Village of Kingston (see Chapter 4). Much of the area directly above the Chipuxet and Usquepaug-Queen River Aquifers is used for turf farming, since these areas are flat and the soils are relatively fertile. However, this land use involves the use of many fungicides, herbicides and pesticides which also threaten the quality of the groundwater.

The Usquepaug-Queen River Aquifer and the Chipuxet River Aquifer are both capable of very high water yields (17 and 8.6 million gallons per day (mgd), respectively). Of the approximately 25 mgd of groundwater potentially available from these two aquifers, only about 1.5mgd was being used as of 1966 (Allen, et al.). Additional yields are taken out of the Mink Brook Aquifer, from which the Wakefield Water Company pumps its water, supplying the residents of Wakefield with drinking water. The Kingston Fire District and the University of Rhode Island (at Kingston) both extract potable water from the Chipuxet River Aquifer. There are no public water supply systems which use the Usquepaug-Queen River Aquifer at the present time. All of the publicly-supplied drinking water within the Town of South Kingstown is pumped from either the Mink Brook or Chipuxet River Aquifers, with the exception of the South Shore Water System.

The South Shore System is operated by the Town of south Kingstown at Factory Pond, near Green Hill. The Factory Pond Aquifer has not been mapped by the USGS, and it lies outside the watershed boundary of the upper Pawcatuck River basin. It is a groundwater based system, however, and supplies approximately 3,000 people with drinking water (Town of South Kingstown, 1987).

Consequently, the vast majority of South Kingstown's 20,414 residents (U.S. Bureau of the Census, 1980) receive their drinking water from two of the three aquifers within the upper Pawcatuck River basin (Chipuxet River or Mink Brook Aquifers). There are no surface water reservoirs capable of supplying drinking water to basin area residents. Furthermore, there are no emergency tie-ins between the public water supply systems of adjacent towns in the basin (R.I. League of Women Voters, 1983). Thus, other than groundwater in the aquifers and that pumped from scattered private wells, there are no other supplies of drinking water within the basin.

Direct Applicability of Section 1424(e)

The information supplied above is sufficient to show that over 50 percent of the drinking water in the South Kingstown area is supplied by two aquifers lying within one major river basin. It is also apparent that the availability of alternative sources of drinking water is non-existent, a large population is served by the aquifers and the unconsolidated nature of the aquifer material lends itself to contamination. These are the primary factors which EPA would weigh in making a designation decision for this region under Section 1424(e) of the SDWA (42 Fed. Reg., 51620, 1977). Indeed, the petition sent to EPA for Block Island contained significantly less information than is supplied above (48 Fed. Reg., 27146, 1983). EPA did review a report entitled Ground-Water Resources of Block Island, Rhode Island, which was prepared by the U.S. Geological Survey in 1964 (49 Fed. Reg., 2952, 1984). The report done by Allen, et al. (1966) provides the same type of detailed scientific data as the Block Island report. Also, there are several other USGS reports that furnish detailed geohydrologic data for the aquifers in the upper Pawcatuck River basin, which EPA could use in making a designation decision under Section 1424(e). Petitioners for sole-source aquifer designation will find this information invaluable in completing EPA's petition forms (EPA, 1987).

The question of whether or not a "significant hazard to public health" can be demonstrated in this area may be answered by the fact that contamination from an abandoned sanitary landfill has already decreased groundwater quality in the Chipuxet River Aquifer. In designating the Edwards Aquifer in Texas, EPA took the position that "once vulnerability of a sole-source aquifer to contamination through a recharge zone is demonstrated, there is a presumption that such contamination would create a significant health hazard" (Hemphill, 1976). It should be noted that the University of Rhode Island and Kingston Fire District wells are down gradient of this pollution source.

Whether or not the three aquifers within the upper Pawcatuck River basin could be defined as one aquifer under Section 1424(e) is another question which would have to be addressed by EPA. Although the USGS has extensively mapped the stratified drift deposits comprising the aquifers, recharge zones have not been delineated. Delineation of recharge zones is extremely complicated (Trench, 1986). However, if the upper Pawcatuck River basin watershed boundaries are used as aquifer boundaries, then by definition all recharge occurs within the basin. This is true because any precipitation falling outside the basin does not recharge any of the three aquifers within it. All precipitation within the basin recharges at least one of the three aquifers. This reasoning is supported by the decision of the appellate court in Montgomery County v. U.S. Environmental Protection Agency (662 F. 2d 1040, 1981). In this case, seven drainage basins were incorporated as one sole-source aquifer in Maryland. The court's reasoning was:

> ...Contamination in any of these seven drainage basins could contaminate this area's groundwater, even though pollution in one of the basins would not contaminate groundwater in the other six basins. Moreover, the designated aquifer incorporates the minimum number of drainage basins

necessary to encompass the area. Because its boundary is the outer perimeter of the basins, it can be readily identified and mapped.

Each of the three aquifers within the upper Pawcatuck River basin stores water derived from one or more drainage sub-basins. Consequently, the decision in Montgomery County v. U.S. Environmental Protection Agency seems to set a precedent for designation of the upper Pawcatuck River basin as a sole-source aquifer.

SUMMARY

Section 1424(e) of the SDWA, by itself, is not a comprehensive groundwater protection measure. The provisions of this section regulate only federal projects, while the majority of development occurring over recharge zones in the upper Pawcatuck River basin is initiated by the private sector. However, due to the importance of groundwater in this region, **all protective measures** which may protect the resource should be implemented as soon as possible. Only by protecting the aquifers in the basin with a comprehensive system of techniques will a safe drinking water supply be insured.

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CHAPTER SIX

RECOMMENDATIONS TO THE TOWN OF SOUTH KINGSTOWN

The latter half of this study details the need for a groundwater protection program in the Town of South Kingstown. Very recently, private drinking water wells in West Kingston have shown contamination by hazardous chemicals. Over the last few years, a groundwater contamination problem has also occurred in the Tower Hill section of the town. Private wells there have tested positively for petroleum products, causing monitoring wells to be installed in a nearby gasoline station. These incidents, although isolated, should be heeded as warning signs by the Town of South Kingstown. Prompt action now will insure more severe and widespread problems don't occur in the future.

THE CHIPUXET RIVER AQUIFER: A PROTECTION PRIORITY

Protection of the Chipuxet River Aquifer should be the top priority of the Town. Contamination of the Aquifer has already begun, and land uses over and adjacent to this Aquifer make it very vulnerable to additional pollution. Such land uses include turf farming and the M1 manufacturing zone in West Kingston. This zone is roughly half undeveloped. Thus, this is an opportune time for regulations to be put in place which can severely restrict the nature of new industry locating within the zone. Without such regulations, contamination of the Aquifer in this area is an "accident waiting to happen".

Amendments to the Proposed Ordinance

The fact that no litigation has yet taken place over existing groundwater protection ordinances in Rhode Island can be accredited to certain provisions of the Rhode Island Zoning Enabling Act (45-RI, Ch. 24, sections 1-3). Those provisions, which have been discussed in detail in Chapter Four, allow municipalities in Rhode Island to zone in such a manner as to protect groundwater resources. Several towns, including North Smithfield, Exeter, Richmond and East Greenwich have implemented, or are presently implementing, such ordinances.

The Town of South Kingstown should follow the lead of these towns in instituting a groundwater protection ordinance. The proposed industrial performance standards are a good start. In order to improve this set of regulations, the aquifers in the town should be defined. For definition of aquifers and other hydrologic zones, the Town should consult maps that have been prepared by the DEM in conjunction with the Environmental Data Center at the University of Rhode Island. These maps are based on USGS and other hydrologic information, making them a composite of the best available data. The Factory Pond Aquifer, the only one of four aquifers within the town which hasn't been mapped by USGS, must be studied in more detail before its boundaries can be defined. Protection of this Aquifer is important because it currently supplies drinking water to the south shore area of the town through two municipally operated wells. Once the aquifers are defined, the proposed ordinance can be re-written to float over all groundwater resource areas as a town-wide, uniform protection district. It would therefore function as an overlay zoning ordinance.

In the continued interest of improving the proposed ordinance, a definition of hazardous substance/waste should be adopted along the lines of the definition used by the Town of Richmond, Rhode Island. The definition would replace the current lists of substances in the proposed ordinance (Section 3), as well as allowing the Hagan Act (23-RI, Ch. 19.1-11.1) to be invoked to further protect the defined aquifer areas.

In addition to defining the aquifer areas and hazardous substances/wastes, several other definitions should be contained within the ordinance. Depending upon the approach used by the Town, these may include recharge zones, upstream areas contributing recharge and areas of influence of municipal wells.

An important component of a good ordinance that needs to be improved upon in the proposed ordinance is the statement of purpose. A statement explaining that all of South Kingstown's drinking water is derived from groundwater is necessary. This should also state that any land use can potentially impact groundwater adversely, and maintenance of high quality drinking water resources is necessary to maintain the high quality of life in South Kingstown. The statement of purpose could quote appropriate language from the Comprehensive Plan. Such excerpts have been discussed in Chapter Four. The statement of purpose should clearly show the ordinance is designed to protect the health, safety and welfare of the community.

These proposed changes to the ordinance will simplify it, make it protect the aquifers throughout the entire town, and make compliance with its regulations easier and less confusing. If these changes are made, the end result will be an ordinance which truly is in the best interests of the public health and safety, and is not susceptible to court challenges. Such an ordinance will insure South Kingstown of a drinking water supply which is free of industrial contaminants for years to come.

Remedial Action at the West Kingston Landfill

Since the top priority of the Town should be protection of the Chipuxet River Aquifer, remedial measures must be taken to limit the amount of leachate being produced at the abandoned West Kingston landfill. If the amount of precipitation reaching the surface of the landfill can be reduced, then less water will percolate through the landfill. During the percolation process, water becomes contaminated by chemicals, metals and other substances within the landfill. It is this water, or leachate, which ultimately flows into the Chipuxet Aquifer.

There are several ways of minimizing leachate volume. An impermeable or semi-impermeable barrier can be placed over the landfill as a cap. This would increase surface water runoff, which could then be retained in a basin off of the landfill site. Suspended sediments would settle out in the basin and then the water could be recharged to the aquifer. If the slope of the cap material were to be increased, even less infiltration and more runoff would occur (Brickell, 1982).

Landfill caps can be constructed of several materials including clays, fly ash, soils and membrane liners (Brickell, 1982). Use of a soil cover is probably the best method, since this will allow vegetation to be planted. Vegetation will utilize some of the water which does infiltrate the ground surface, helping to minimize leachate production. Furthermore, a well designed vegetative cover will be aesthetically pleasing.

Totally impermeable caps promote methane production through anaerobic decomposition of refuse within the landfill. Methane buildup can be explosive and therefore very dangerous, especially since the gas can migrate through unconsolidated sediments. A totally impermeable landfill cap is therefore not feasible.

The Town of South Kingstown should urge the University of Rhode Island to follow similar remedial actions at its abandoned landfill, adjacent to the Town's.

GENERAL RECOMMENDATIONS

Land Acquisition

The Town of South Kingstown should use funds from the Rhode Island Open Space Act to purchase groundwater sensitive lands. In November of 1987, a state bond referendum was passed allowing the State to borrow $65,200,000 to provide funds for the preservation of open spaces and recreational areas. Up to $22.5 million may be allocated to cities and towns in the state for purchase or preservation of open space lands. The money will be administered through state grants in which municipalities will share 25 percent of the cost, with the State paying the remaining 75 percent of the cost.

The Town should buy land in areas adjacent to municipal wells and their areas of influence (or land adjacent to these lands if they are privately held by the owners of the wells, such as by Wakefield Water Co.). Essentially, the Town should use the "concentric ring method" for prioritizing parcels for purchase. Consequently, land closer to aquifer reservoirs and supply wells should be bought before land in recharge areas.

Amendment of RLD200 Zones

Although the existing RLD200 zones are an excellent step towards protecting groundwater aquifers, the boundaries of these zones need to be amended. The South Kingstown Planning Department has a map which shows the relationship between the RLD200 Zones and the boundaries of the three aquifers mapped by USGS (the Chipuxet River, Mink Brook and Usquepaug-Queen River Aquifers). This map reveals several aquifer areas which are not zoned as RLD200. Additionally, an area adjacent to supply wells in the Mink Brook Aquifer lies outside the RLD200 zone. Consequently, the existing RLD200 zones surrounding primary aquifers should be reviewed for future conformance to boundaries defined in an overlay ordinance. Amendment of RLD200 zones should be done only after definition of the zones warranting overlay protection is complete. This will prevent a duplication of efforts by the Town.

Petition for Sole Source Aquifer Designation

As discussed in Chapter Five, certain aquifers may be designated by the EPA as sole-source aquifers, under Section 1424(e) of the Safe Drinking Water Act. Several graduate students at the University of Rhode Island are currently preparing a petition for sole source designation of the entire Pawcatuck River Basin. The South Kingstown Aquifers, exclusive of Factory Pond, are included in this petition. Whenever feasible, the Town of South Kingstown should cooperate in the petition process and supply available data. Federal designation of the region's aquifers as the sole source of drinking water is a necessary component of a comprehensive protection strategy.

Additional Regulatory Techniques

The proposed aquifer protection ordinance only addresses groundwater contamination caused by hazardous materials. As discussed throughout this study, there are several other sources of contamination, all of which warrant regulations for protection of groundwater. Foremost among these pollution sources are septic wastes, road salting/storage, underground fuel storage tanks and certain agricultural applications. The RLD200 zones are designed to prevent contamination of groundwater from septic wastes. The Town should seriously consider implementing by-laws for the use/storage of road salt and underground storage tanks. The East Greenwich, Rhode Island and Dartmouth, Massachusetts ordinances both contain regulations pertaining to such uses. Model ordinances for both uses can also be found in the appendices of this study. Best Management Practices for agricultural uses should also be included in a set of regulations.

The current Subdivision Regulations should also be reviewed in reference to specific measures that could help protect groundwater resources. For instance, in critical aquifer areas developers could be required to dedicate open space, rather than having a choice of dedication or paying fees-in-lieu of dedication. This option should be eliminated in aquifer areas, and the Planning Board should urge developers to do the same for development projects in recharge areas. The more open space maintained in such areas, the better the water quality in the aquifers will be.

A FINAL NOTE: IMPLEMENTATION

Although recent groundwater contamination incidents have once again put the groundwater protection issue in the spotlight, the issue is not a new one in South Kingstown. As early as 1975, a contamination plume was traced from the West Kingston landfill towards the Chipuxet River Aquifer (Kelly, 1975). In 1982, a University of Rhode Island graduate student designed a groundwater protection ordinance for the Town (Mckeag, 1982). This ordinance is very similar to the "concentric ring method" employed by Dartmouth, Massachusetts. No action has been taken towards its adoption. Furthermore, ever since the proposed industrial performance standards ordinance was written during the summer of 1986, no positive action has been taken towards its improvement or adoption. It is apparent that there has been some political resistance and apathy towards adopting groundwater protection measures in South Kingstown. The adoption of the RLD200 zones is a notable exception.

With this history in mind, the Town may wish to implement a comprehensive groundwater protection strategy in an incremental fashion. If the Town attempts to regulate too many potential sources of groundwater protection all at once, many interest groups may concurrently oppose adoption of such an ordinance. However, an ordinance which focuses on two or three of the most pressing protection issues will stand a better chance of being adopted. Once this is done, additional by-laws can be implemented in the future. For example, regulation of underground fuel storage tanks might be included in the currently proposed ordinance, especially since these tanks are often associated with manufacturing uses. On the other hand, it may be wise to regulate road salting/storage or agricultural practices in a separate ordinance. This should reduce resistance from citizens concerned about over-regulation by the Town.

Resistance to change is often very high in southern Rhode Island, especially where the use of land is in question. The Town of South Kingstown must consider this in implementing a comprehensive groundwater protection plan. If the Town can incrementally ease its citizens into supporting components of such a plan, it will be on its way towards insuring the quality of its drinking water for generations to come.

REFERENCES FOR CHAPTER SIX

Brickell, Mark. Assessment Of Groundwater Contamination From A Municipal Landfill And Evaluation Of Remedial Measures. University of Rhode Island Masters Thesis. Kingston: 1982.

Kelly, William E. West Kingston Landfill, South Kingstown, Rhode Island: An evaluation of its effect on groundwater quality. Rhode Island Water Resources Board, Water Information Series Report 1, 1975.

Mckeag, Thomas A. An Aquifer Protection Ordinance For The Town of South Kingstown. University of Rhode Island Masters Research Project. Kingston: 1982.

APPENDICES

APPENDIX A

GENERAL BY-LAW FOR HAZARDOUS MATERIALS

APPENDIX A

GENERAL BYLAW - HAZARDOUS MATERIALS

SECTION 1: AUTHORITY

This Bylaw is adopted by the town under its home rule powers, its police powers to protect the public health and welfare, and its authorization under Mass. Gen. Laws, ch. 40, §21.

SECTION 2: PURPOSE

The purpose of this Bylaw is to protect, preserve, and maintain the existing and potential groundwater supply, groundwater recharge areas, and surface water within the town from contamination with hazardous materials.

SECTION 3: DEFINITIONS

The following definitions shall apply in the interpretation and implementation of this Bylaw.

SECTION 3.1

"Hazardous material" means a product or waste, or combination of substances which because of quantity, concentration, or physical, or chemical, or infectious characteristics, poses in the Board of Health's judgment a substantial present or potential hazard to the human health, safety, or welfare, or the environment when improperly treated, stored, transported, used or disposed of, or otherwise managed. Any substance deemed a hazardous waste in Mass. Gen. Laws, ch. 21C, shall also be deemed a hazardous material for the purpose of this Bylaw.

Source: Metropolitan Area Planning Council, 1982

SECTION 3:2

"Discharge" means the disposal, deposit, injection, dumping, spilling, leaking, incineration, or placing of any hazardous material into or on any land or water so that such hazardous material or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.

SECTION 4: REGISTRATION

SECTION 4:1

Every owner or operator of a commerical or industrial establishment (including home occupations) storing hazardous materials in quantities totaling more than fifty gallons liquid volume or twenty-five pounds dry weight shall register with the Board of Health the types, quantities, location, and method of storage of said hazardous materials. Registration required by this provision shall be initially submitted by [initial date] and annually thereafter within thirty days of [month, day] each year.

SECTION 4:2

Owners or operators of commercial or industrial establishments who have not previously registered in accordance with Subsection 4:1 shall, if they meet registration requirement, register initially within thirty days of meeting such requirements and thereafter within thirty days of [month, day] each year.

SECTION 4:3

In addition to registration, owners or operators of commercial or industrial establishments registered in accordance with Subsections 4:1 and 4:2 shall maintain on the premises an inventory, reconciled on a monthly basis, of purchase, use, sale, and disposal of hazardous materials. The purpose of this account is to detect any product loss and to provide an ongoing record of all quantities of hazardous materials within the town over the registration threshold.

SECTION 4:4

Upon the request of the Board of Health, owners or operators shall produce within twenty four hours the latest reconciled inventory.

SECTION 4:5: HAZARDOUS WASTES GENERALLY

Wastes containing hazardous materials shall be held on the premises in product-tight containers for removal by a licensed carrier and for disposal in accordance with the Massachusetts Hazardous Waste Management Act, Mass. Gen. Laws, ch. 21C.

SECTION 4:6: ABOVEGROUND STORAGE OF HAZARDOUS WASTES

Aboveground containers of wastes containing hazardous materials shall be stored on a surface impervious to the material being stored. The storage area shall be enclosed by a permanent dike of impermeable construction. The volume of the area enclosed by the dike shall be equal to or greater than the capacity of the containers within the dike.

SECTION 5: UNDERGROUND STORAGE

The following provisions shall apply to all underground liquid hazardous material storage systems with capacities of 55 gallons or greater.

SECTION 5:1

Owners shall file with the Board of Health the size, type, age, and location of each tank, and the type of hazardous material stored in each, on or before [initial date]. Evidence of date of purchase and installation, including Fire Department permit, if any, shall be included along with a sketch map showing the location of such tanks on the property.

SECTION 5:2

Owners of tanks for which evidence of installation date is not available shall, at the order of the Board of Health, have such tank systems tested. If either the Board of Health or the Head of the Fire Department determines that the tank is not product tight, it shall be disposed of under the direction of the Board of Health or the Head of the Fire Department.

SECTION 5:3

All steel tanks shall be subject to one of the following tests 15 years after installation and annually after 20 years or if evidence of installation date is not available: a five-pounds per square inch air pressure test performed on an empty tank, or a Kent-Moore Pressure test, or any other testing system approved in advance by the Board of Health or the Head of the

Fire Department. Certification of testing shall be submitted to the Board of Health and the Head of the Fire Department. Any tanks failing the test shall be disposed of under the direction of the Board of Health or the Head of the Fire Department.

SECTION 5:4

Newly installed tanks shall be protected from internal and external corrosion and shall be of a design approved by the Board of Health and the Head of the Fire Department. The following tank construction systems are considered to provide adequate corrosion protection: all fiberglass construction steel with bonded fiberglass and internal lining; the Steel Tank Institute 3-Way Protection System; and such other tank construction systems as the Board of Health and the Head of the Fire Department shall approve.

SECTION 6

The following provisions apply to all underground hazardous material storage systems of any capacity.

SECTION 6:1

All leaking tanks must be emptied by the owner or operator within twelve hours of leak detection and removed by the owner or operator in a time period to be determined by the Board of Health.

SECTION 6:2

Tank installations on lots not having a permit prior to adoption of this Bylaw are not permitted within four feet of maximum high water table or within one hundred feet of a surface water body.

SECTION 7: VARIANCES

The Board of Health may vary the application of any provision of this Bylaw, unless otherwise required by law, in any case when, in its opinion, the applicant has demonstrated that an equivalent degree of environmental protection required under this Bylaw will still be achieved. The applicant at his own expense must notify all abutters by certified mail at least ten days before the Board of Health meeting at which the variance request will be considered. The notification shall state the variance sought and the reasons therefore. Any variance granted by the Board of Health shall be in writing. Any denial of a variance shall also be in writing and shall contain a brief statement of the reasons for the denial.

SECTION 8: ENFORCEMENT

SECTION 8:1: PROTECTION

All discharges of hazardous material within the town are prohibited.

SECTION 8:2: REPORTING OF DISCHARGE

Any person having knowledge of a discharge of hazardous material shall immediately report the discharge to the Board of Health, and if involving flammable or explosive materials, to the Head of the Fire Department.

SECTION 8:3: RIGHT OF ENTRY

The Board of Health and its agents may enter upon privately owned property for the purpose of performing their duties under this Bylaw.

SECTION 8:4: PENALTY

Any person who violates any provision of this Bylaw shall be punished by a fine of not more than [$___]. Each day or portion thereof during which a violation continues shall constitute a separate offense; if more than one, each condition violated shall constitute a separate offense. This Bylaw may be enforced pursuant to Mass. Gen. Laws ch. 40, §21D by a Town police officer or other officer having police powers. Upon request of the Board of Health or the Fire Department, the Board of Selectmen and Town Counsel shall take such legal action as may be necessary to enforce this Bylaw.

SECTION 9: FEES

Any person registering storage of hazardous materials pursuant to Section 4 shall pay to the [town] [Board of Health] an annual Registration Fee of [ ] dollars for every [ ] gallons or fraction thereof of storage capacity. Such fee shall be due on the same date as the annual registration. Failure to pay shall constitute a violation and shall subject the violator to the penalties of Section 8 of the Bylaw.

The Board of Health may charge for expenses incurred in the enforcement of this bylaw.

APPENDIX B

BEST MANAGEMENT PRACTICES FOR ROAD SALT USE

APPENDIX B

BEST MANAGEMENT PRACTICES FOR ROAD SALT USE

Recommended Best Management Practices (BMPs)*

The following is a list of control measures that should be used to reduce the impacts of road salt on water supplies and the environment without seriously affecting public safety.

SALT STORAGE AND HANDLING

In general, salt storage and mixing facilities should be located on flat sites and on impervious surfaces that are easily protected from overland runoff. The salt should be stored under cover to prevent runoff.

Drainage should be designed and installed to divert any surface runoff in the area and to collect any brine that may develop. Handling practices should also be considered when designing a salt-storage facility. The most important aspect of proper salt storage is the siting of the facility itself. Salt-storage facilities should not be located within public water-supply watersheds.

- Cover Salt Piles - Kelly (1980) provides a very convincing argument that salt storage sheds can save up to $19.00 per ton of salt as compared to uncovered piles and a price of $35 per ton of NaCl. Some of the savings cited are: reduced handling; less salt loss; reduction in spreader damage due to fewer lumps; material savings and environmental impact. Rainfall on an exposed salt pile can cause a loss of up to 10 percent of the pile's volume. This becomes a direct financial loss of salt and also results in additional indirect costs (corrosion, surface and groundwater pollution). Communities should build salt storage sheds to contain their salt piles. For interim protection, all storage piles should be covered with a waterproof covering, and placed on an impermeable pad. Practical information on salt storage and handling can be obtained from the Salt Institute (1980) and Richardson et al. (1974).

- Provide for Drainage - The buildup of salt brine in storage sheds, around storage piles, and in the vicinity of storage areas should be avoided to protect water quality. Brine buildup and environmental problems can be avoided by:

  1) proper design of storage shed and impervious pads,
  2) covering and sloping storage piles to provide for drainage,
  3) collection of any saline water that may develop in a tight drainage system. The brine   be dried and reapplied to the stockpile during dry seasons or applied directly to the trucks when they are salting.

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* From "Road Salts and Water Supplies: Best Management Practices," DEQE Office of Planning and Program Management, August, 1981.

Source: Metropolitan Area Planning Council, 1982

- Provide for Drainage (cont.) - Prevention of brine buildup through proper storage and good housekeeping practices are the most cost-effective methods to prevent damage from salt storage.

- Handling of Road Salts - There are four basic procedures to ensure easy handling, proper application, and to reduce waste of road salts:

  1) keep the chemicals dry through proper storage,
  2) keep handling area unobstructed and clean of spilled chemicals,
  3) reduce unnecessary handling through proper planning of shipments, and
  4) shield truck-loading and unloading operations from wind and weather.

APPLICATION OF ROAD SALTS

- The "Snowfighter's Handbook," produced by the Salt Institute, provides a very good guide for proper salting procedures, techniques, and equipment. Richardson et al. (1974) also provides a review of road salt application practices.

- Areas around public water supplies should be designated as sensitive areas where control over salt storage and application should be practiced.

- Ground-speed controllers should be used for all spreaders.

- Spreaders should be calibrated before the winter season, using the materials to be used (salt, mixtures of sand and salt, etc.).

- Levels of service depending on road type, weather conditions traffic volumes should be determined prior to the winter season. These levels of service can range from no salt use, to mainly plowing and using sand, to straight salt appplication on heavily traveled road sections and critical intersections.

- Application rates should be determined for the service area. Reduced salting rates should be developed for "sensitive areas" (roads adjacent to surface and groundwater supplies).

- Various mixtures of salt, calcium chloride, and sand should be used in identified sensitive areas. The State of Connecticut recommends that a 7:2 sand- to-oremix should be used in sensitive areas. Premix is three parts sodium chloride and 1 part calcium chloride by weight.

- Maintain equipment to ensure that the necessary plows and spreading equipment are in proper order.

- Appropriate accounting should be conducted after the storm to determine the amount of materials used, the area covered, and the results. This could be done using a standardized reporting form.

- Towns should keep aware of new and approved techniques on the application of road salts.

- Explore alternatives. Experiments should be conducted as new chemical alternatives are introduced. A new chemical which shows promise is calcium magnesium acetate (CMA). The U.S. Department of Transportation currently is conducting field tests on the use of CMA.

APPLICATION OF ROAD SALTS (cont.)

- Another alternative that is currently being field tested is an asphalt additive called Verglimit (American City and County, 1980). Verglimit is a multi-component defroster composed of partially crystallized calcium chloride (80 percent) and sodium hydroxide (five percent), which is added to the top-course mix of the roadway. A thin layer of calcium-chloride solution develops on the road surface and prevents ice formation.

SNOW DUMPING

As explained previously, sodium and chloride ions move readily through soils and eventually end up in surface or groundwater supplies. The dumping of snow plowed from highways, parking lots,and areas which have been treated with salt have the potential to contaminate water supplies because of the movement of the sodium and chloride ions through the soil. This can be particularly serious when snow is disposed of over aquifers. To reduce the environmental impact from disposing of salt-laden snow, the following is recommended:

- Carefully choose snow-disposal sites in areas that will not threaten water supplies.

- Avoid direct dumping into rivers or water sources. Consider downstream uses of the river and the impacts due to direct disposal into rivers.

- Try to choose a site near a large river with suitable soils where the melted snow can filter through the soil.

- Snow should not be deposited at a sanitary landfill since the added moisture from the melting snow will contribute to leachate generation.

TOWN OF DARTMOUTH

AQUIFER PROTECTION DISTRICT

SECTION I

Definitions

Animal Feedlot	A plot of land on which 25 livestock or more per acre are kept for the purposes of feeding.
Aquifer	Geologic formation composed of rock or sand and gravel that contains significant amounts of potentially producible potable water.
Area of Influence	The area which experiences drawdown by a pumping well as plotted on a 2 dimensional (map) surface, usually illipsoidal in shape.
Cone-of-depression	A three dimensional conical concavity produced in a water table by a pumping well.
Groundwater	All the water found beneath the surface of the ground. In this bylaw the term refers to the slowly moving subsurface water present in aquifers and recharge areas.
Impervious Surface	Material on the ground that does not allow surface water to penetrate into.the soil.
Leachable Wastes	Waste materials including solid wastes, sludge, and agricultural wastes that are capable of releasing water borne contaminants to the surrounding environment.
Mining of Land	The removal of geologic materials such as topsoil, sand and gravel, metallic ores, or bedrock to be crushed or used as building stone.
Overburden	Those unconsolidated geologic deposits lying above the bedrock surface
Recharge Areas	Areas composed of permeable, porous materials that collect precipitation or surface water and transmit it to aquifers.

Sanitary Waste	Waste waters arising from ordinary domestic water use as from toilets, sinks and bathing facilities, etc. and containing such concentrations and types of pollutants as to be considered normal wastes.
Saturated Thickness	The depth of permeable soil actually saturated with water to the capacity of the soil to contain water under normal conditions of temperature and pressure.
Sludge	Residual materials produced by water and sewage treatment processes and domestic septic tanks.
Structure	Anything constructed or erected, except a boundary wall or fence, the use of which requires location on the ground or attachment to something on the ground. For the purposes of this ordinance, buildings are structures.
Solid Wastes	Any discarded solid material, putrescible or nonputrescible, consisting of all combustible and noncombustible solid material including, but not limited to, garbage and rubbish.

SECTION II

Purpose of District

The purpose of this Aquifer Protection District is:

(a) to promote the health, safety, and general welfare of the community;

(b) to protect, preserve and maintain the existing and potential groundwater supply and groundwater recharge areas within the known aquifers of the town;

(c) to preserve and protect present and potential sources of water supply for the public health and safety;

(d) to conserve the natural resources of the town;

(e) to protect the groundwater and groundwater recharge areas of the town from adverse development or land use practices, and;

(f) to prevent blight and the pollution of the environment.

SECTION III

Scope and Authority

The Aquifer Protection District shall be considered as overlaying other zoning districts. Any uses permitted in the portions of the districts so overlaid shall be permitted subject to all the provisions of this district.

SECTION IV

Establishment and Delineation of Aquifer Protection District

For the purposes of this district, there are hereby established within the town, certain aquifer protection areas, consisting of aquifers and/or aquifer recharge areas. Aquifers and aquifer recharge areas are defined by standard geologic and hydrologic investigations which may include drilling observation wells, utilizing existing boring data and stratigraphic profiles, conducting seismic surveys or other geophysical techniques, performing pumping tests, water sampling and geologic mapping. The Aquifer Protection District includes the aquifer itself, the land above the aquifer and the aquifer's most significant recharge areas consisting of:

A. Area 1, municipal wells area of influence (cone-of-depression):

1. The cones of depression generated by the municipal wells after seven (7) days of continuous pumping at their respective rated capacities,

and,

B. Area 2A, primary recharge areas to existing wells:

1. The area contiguous to the wells in which groundwater flow is in the direction of the wells at any time and which exhibit greater than thrity (30) feet of saturated thickness of overburden at seasonally high water level, regardless of the geologic type of the overburden materials, and;

2. All land contiguous to A.1, and B.1 underlain by glaciofluvial or glaciofluvial lacustrine deposits and in which the prevailing direction of groundwater flow is toward any of areas A.1 and B.1 through 2 above, and;

3. All other areas completely surrounded by one or more of areas A.1 and B.1 through 2 above, and;

4. Contiguous wetlands as defined by Massachusetts General Laws Chapter 131, section 40, or streams which contribute surface water flow to areas A.1, B.1, and B.2.

C. Area 2B, potential groundwater development areas of moderate or high favorability and associated recharge areas:

1. Areas which are not included within area 1 or 2A, defined as having a saturated thickness of 10 or more feet, a transmissivity of 10,000 gpd per foot or greater, and which have been shown to be suitable for production of a municipal water supply well, and;

2. Areas contiguous to 1 above where such areas consist of permeable glaciofluvial or glaciofluvial lacustrine deposits in which: (a) the prevailing direction of groundwater flow is towards 1 above, or (b) the area is within 2000 feet of area 1, above, and;

3. All other areas completely surrounded by areas C.1 or C.2 above.

The boundaries of this district exclusive of B.4, are delineated on a map at a scale of 1 inch to 1000 feet entitled "Aquifer Protection Districts, Town of Dartmouth" on file in the office of the Town Clerk. These boundaries reflect the best hydrogeologic information available as of the date of the map. In the event of a discrepancy between the map and the criteria of areas A and B above, the criteria shall control.

Where the bounds as delineated are in doubt or in dispute, the burden of proof shall be upon the owner(s) of the land in question to show where they should properly be located. At the request of the owner(s) the town may engage a professional geologist, hydrogeologist or engineer trained and experienced in hydrogeology to determine more accurately the location and extent of an aquifer or recharge area, and may charge the owner(s) for all or part of the cost of the investigation.

SECTION V

Use Regulations

Within the Aquifer Protection District, these regulations shall apply:

A. The following uses are permitted within the Aquifer Protection District subject to s.8, provided that all necessary permits, orders, or approvals required by local, state, or federal law shall have been obtained;

1. Area 1:

a. conservation of soil, water, plants and wildlife;

b. outdoor recreation, nature study, boating, fishing and hunting where otherwise legally permitted.

c. duckwalks, landings, foot bicycle and/or horse paths and bridges;

d. proper operation and maintenance of existing dams, splash boards, and other water control, supply and conservation devices;

e. maintenance and repair of any existing structure provided there is no increase in impermeable area;

f. nonintensive agricultural uses (pasture, light grazing, hay), gardening, nursery, conservation, forestry and harvesting provided that fertilizers, herbicides, pesticides and other leachable materials are not stored outdoors nor used in excessive amounts. Where the application is being made of fertilizers, pesticides, herbicides or other potential contaminants, groundwater quality monitor test wells will be installed and periodically sampled and tested at the owner's expense. Test wells shall be located by a professional geologist, hydrologist or engineer trained and experienced in hydrogeology. Sampling will be conducted by an agent of the Board of Health;

g. necessary public utilities/facilities designed so as to prevent contamination of groundwater.

2. Area 2:

a. all uses permitted to Area 1, above, and;

b. residential development of single family dwellings on lots of at least 40,000 square feet, such that no more than 10 percent of building lot is rendered impervious if permitted in the underlying district;

B. The following uses are prohibited:

1. Area 1:

a. all uses not expressly permitted in Section A.1.

2. Area 2:

a. disposal of solid wastes, other than brush and stumps;

b. storage and/or transmission of petroleum or other refined petroleum products except within buildings which it will heat;

c. the disposal of liquid or leachable wastes, except one family residential subsurface waste disposal system or as provided in Sec. V C. 4 below;

d. the use of septic system cleaners which contain toxic organic chemicals;

e. the rendering impervious of more than 10% of any lot except as provided in Sec. V C. 4 below;

f. industrial uses which discharge process wastewater on-site; including any commercial and service uses discharging wastewater containing contaminants other than normal organic waste;

g. storage of road salt or deicing chemicals;

h. the use of sodium chloride for ice control;

i. dumping of snow brought in from outside the Aquifer Protection District;

j. animal feedlots;

k. the storage of manure;

l. the mining of land except as incidental to a permitted use;

m. the storage or disposal of hazardous wastes, as defined by the Hazardous Waste Regulations promulgated by the Division of Hazardous Waste under the provisions of Chapter 21(c) of the General Laws;

n. the storage or extended use of hazardous materials as defined by the Hazardous Waste regulations promulgated by the Division of Hazardous Waste under the provisions of Chapter 21(c) of the General Laws except as incidental to a permitted use;

o. automotive service and repair shops, junk and salvage yards.

p. the alteration of any natural site features or topography including but not limited to the cutting or removal of trees or other natural vegetation, or the dumping, filling, excavating, grading, transferring or removing of any gravel, sand, loam or other soft material, rock or ledge prior to obtaining all permits and approvals for final development plans required under this bylaw. Where such alteration is incidental to a permitted use and performed in the normal course of maintenance or operation of such permitted use, this paragraph shall not apply.

C. The following uses are permitted in Area 2 only, by Special Permit that is subject to the approval of the special permit granting authority with such conditions as they may attach to their approval and subject to s.B:

1. The application of pesticides for any uses provided that all necessary precautions shall be made to prevent hazardous concentrations of pesticides in the water and on the land within the Aquifer Protection District as a result of such application. Such precautions include, but are not limited to, erosion control

techniques, the control of runoff water (or the use of pesticides having low solubility in water), the prevention of volatilization and redeposition of pesticides and the lateral displacement (i.e., wind drift) of pesticides;

2. The application of fertilizers for any uses provided that such application shall be made in such a manner as to minimize adverse impacts on surface and groundwater due to nutrient transport and deposition and sedimentation;

3. Those commercial and industrial activities as permitted in the underlying district with a site plan review which meets the following requirements:

   (A) those commercial or industrial uses may be constructed and operated in such a manner as to:

      (1) discharge no wastewater except normal sanitary waste to subsurface disposal systems in quantities not to exceed 150 gallons per day per acre and;

      (2) render impervious not more than 10% of the lot and develop the remainder such that there is no increase in the state of runoff, over that experienced prior to development for rainfall intensity less than or equal to the one hundred year storm;

or,

   (B) those commercial or industrial uses may be constructed and operated in such a manner as to:

      (1) wastewater shall all be recharged through such means as may be required to the groundwater and shall meet or exceed the following standards:

         (a) biochemical oxygen demand less than or equal to 10 mg/l
         (b) suspended solids less than or equal to 10 mg/l
         (c) total phosphorous less than or equal to 1 mg/l
         (d) total nitrogen less than or equal to 5 mg/l

      (2) parking facilities and drainage structures shall permit no increase in the rainfall received on the site as runoff, over that experienced prior to development for rainfall intensity less than or equal to the one hundred year storm;

(3) no stormwater shall be permitted to be recharged to the groundwater before passage through oil and grease traps and sediment traps, constructed, operated and maintained in a manner acceptable to the Dartmouth Department of Public Works and Board of Health.

4. Expansion of existing or nonconforming uses, to the maximum allowed by the underlying district. The Board of Appeals shall not grant such approval unless it shall find that such expansion shall not be substantially more detrimental to the water supply than the existing use. In no case shall such permit be issued for a prohibited use under Section V.B.

5. Intensive agricultural uses of land that will require the continuing (annual, biannual or triannual) application of fertilizers, pesticides or herbicides; or grazing activites that result in conditions such as excessive soil compaction, defoliation or erosion.

D. Procedures for Issuance of Special Permit

1. Each application for a special permit shall be filed with the special permit granting authority and shall be accompanied by 5 copies of the plan.

2. Said application and plan shall be prepared in accordance with the data requirements of the proposed development, (e.g., site plan review, erosion and sedimentation control plan, etc.).

3. The special permit granting authority shall refer copies of the application to the Board of Health, Planning Board, the Conservation Commission and Town Engineer/Department of Public Works, which shall review, either jointly or separately, the application and shall submit their recommendations to the special permit granting authority. Failure to make recommendations within 35 days of the referral of the application shall be deemed lack of opposition.

4. The special permit granting authority shall hold a hearing, in conformity with the provisions of G.L. Ch.40A, s.9 within 65 days after the filing of the application with the special permit granting authority and after the review of the aforementioned town boards/departments.

   Notice of the public hearing shall be given by publication and posting and by first-class mailings to "parties in interest" as defined in G.L. Ch.40A, S.11. The decision of the special granting authority and any extension, modification or renewal thereof, shall be filed with the special permit granting authority and Town Clerk within 90 days following the closing of the public hearing. Failure of the special permit granting authority to act within 90 days shall be deemed as a granting of the permit. However, no work shall commence until a certification is recorded as required by said s.11.

5. After notice and public hearing, and after due consideration of the reports and recommendations of the Planning Board, the Board of Health, the Conservation Commission and the Department of Public Works/Town Engineer, the special permit granting authority may grant such a special permit provided that it finds that the proposed use:

   a. is in harmony with the purpose and intent of this bylaw and will promote the purposes of the Aquifer Protection District;

   b. is appropriate to the natural topography, soils, and other characteristics of the site to be developed;

   c. will not, during construction or thereafter, have an adverse environmental impact on any aquifer or recharge area in the town;

   d. will not adversely affect an existing or potential water supply, and

   e. is consistent with existing and probable future development of surrounding areas.

APPENDIX D

TOWN OF EAST GREENWICH, RHODE ISLAND

PROPOSED AQUIFER AND WATERSHED PROTECTION DISTRICT

TOWN OF EAST GREENWICH
PLANNING DEPARTMENT
111 PIERCE STREET
EAST GREENWICH, RI 02818

Article XXX D R A F T N O T F O R R E L E A S E 10/15/87

F O R D I S C U S S I O N O N L Y

AQUIFER AND WATERSHED PROTECTION DISTRICT

Section 1. Purpose

The purpose of the Aquifer and Watershed Protection District is:

A. To protect, preserve and maintain the quality and supply of groundwater reservoirs upon which the residents of the Town of East Greenwich and others depend for present and future water supply;

B. To protect the quality and supply of water by regulating the use and development of land adjoining wetlands and water courses which replenish ground water reservoirs, to protect primary ground water recharge areas to ground water reservoirs, and to prevent the uses of land detrimental thereto; and

C. To protect the health, safety and general welfare of the public

Section 2. Definition of District

The Aquifer and Watershed Protection District is superimposed over any other zoning district established by this Ordinance. It is an overlay district. The regulations imposed by the Aquifer and Watershed Protection District shall be considered to supersede the regulations of the underlying district. The Aquifer and Watershed Protection District is subdivided into two (2) sub-districts, designated as Zone A and Zone UD

Zone A is a geographic area composed of the Hunt River Aquifer and adjacent recharge areas which is critical to the protection of the Hunt River Aquifer which supplies through its ground water reservoir a source of public drinking water supply. This area requires a high level of protection from incompatible land uses.

Zone UD is the upstream drainage area, a second geographic area, which is contributory to surface water runoff to the Hunt River Aquifer (a geographic area contained in Zone A). Zone UD is contibutory to other areas likely to produce ground water and drains into Zone A either through surface water runoff via water courses and associated wetlands or groundwater movement.

Section 3. Areas within Zone A

A. Definition of Areas

Areas within Zone A of the Aquifer and Watershed Protection District are as follows:

1. Areas shown on the Town of East Greenwich Official Zoning Map as that area within two hundred (200) feet of the boundaries of the Hunt River Aquifer as mapped by the United States Geological Survey in Trench, Elaine C., Classification and Delineation of Recharge Areas to the Hunt River Aquifer Ground Water Reservoir in Central Rhode Island, Providence, RI, 1987.

2. Areas shown on the official Zoning Map as adjacent recharge areas as delineated by the United States Geological Survey in Trench, Elaine C., Classification and Delineation of Recharge Areas to the Hunt River Aquifer Ground Water Reservoir in Central Rhode Island, Providence, RI, 1987.

B. Regulation of Development

Within the boundaries of Zone A of the Aquifer and Watershed Protection District no structure or land shall be used, and no structure shall be erected, enlarged or relocated except in compliance with the following provisions:

1. PERMITTED USES: The proposed use shall be a permitted use (X); a use permitted by special exception (S); or an accessory use (A) permitted under the provisions of Article II and other applicable provisions of the Zoning Ordinance in the underlying zoning district in which said proposed use is located. All other uses are prohibited.

2. PROHIBITED USES: In addition to prohibited uses specified in Article II, the following uses are prohibited in Zone A of the Aquifer and Watershed Protection District:

a. Storage and/or loading of road salt or de-icing chemicals;

b. Incinerators, sanitary landfill sites, hazardous waste treatment facilities, solid waste transfer stations and waste water treatment plants, except publically-owned sewage treatment facilities;

c. Septage disposal;

d. All uses which involve the use or storage of hazardous substances designated under 40 CFR Part 116 pursuant to Section 311 of the federal Clean Water Act and subsequent amendments thereto. Provided, however, that minor or insignificant quantities of such substances for office use may be used or stored on the premises if, in the opinion of the Zoning Officer and Building Official, the presence of such substance does not constitute a potential for degradation of surface water or ground water resources in the area and such substance is contained in a suitable storage area. Insignificant quantities of hazardous substances may be construed as that which is necessary for the operation of an office including the operation of equipment,vehicles or other mechanical systems necessary for the operation of a permitted use.

e. Gravel banks, gravel mining, mineral deposit removal;

f. Storage of petroleum or refined petroleum products except within buildings in which said petroleum products will provide heat when burned. Above ground storage of liquid fuel for said heating purpose in excess of Three Hundred (300) gallons is prohibited except for storage of said liquid fuel for heating purposes which conforms with the regulations of the Department of Environmental Management (DEM). Provided however, that the Department of Environmental Management has promulgated regulations for said storage. Under ground storage of petroleum for heating purposes in any quantity is prohibited except for said storage which conforms with the regulations of the Department of Environmental Management. Provided, however, that the Department of Environmental Management has promulgated regulations for said storage.

g. The alteration of any natural site features or topography including but not limited to the cutting or removal of trees or other vegetation, or dumping, filling, excavation, grading, transferring or removal of any gravel, sand, loam or other soft material, rock or ledge, prior to obtaining all permits and approvals for final development plans, excepting where the use of land is for the primary purpose of agriculture. Where such alteration is minor in nature and is incidental to a permitted use and performed in the normal course of maintenance or operation of such permitted use, this paragraph shall not apply.

h. All uses which discharge process wastewater on-site, including wastewater containing contaminants other than normal organic waste.

3. Disposal of sewage

Where public sewers are not available, individual sewage disposal systems (ISDS) may be permitted, provided that wastewater generation shall not exceed an average daily rate of 225 gallons per day per acre of land. Calculations of the rate of wastewater discharge shall be based upon standards provided in the Rhode Island Department of Environmental Management (DEM) "Rules and Regulations Establishing Minimum Standards relating to location, design, construction and maintenance of Individual Sewage Disposal Systems (ISDS), December 1, 1980, and subsequent amendments thereto on an average daily rate of 75 gals per person per day for residential uses and 15 gals per person per day for office and commercial use.

** Any legal substandard residential lots of record will be exempt from the previous stipulation of ISDS requirements. Any commercial, industrial or waterfront legal substandard lots of record may be exempted from the ISDS requirements by the Zoning Board of Review by special exception as provided in this ordinance.

4. Proximity to wetlands:

No Individual Sewage Disposal System (ISDS) shall be located:

a. Within two hundred (200) horizontal feet of a "fresh water wetland" as defined in Title 2, Chapter 1 of the General Laws of Rhode Island, 1956, as amended.

b. Within two hundred (200) horizontal feet of a "river" as defined in said Title 2, Chapter 1 of the General Laws of Rhode Island, 1956, as amended.

5. Impervious surfaces

a. Impervious surfaces shall be limited to ten (10) percent of the minimum lot size of any developed lot.

C. Procedure for Approval

1. Applicability

The following procedure shall be required for all uses located within Zone A of the Aquifer and Watershed Protection District prior to the granting of a building permit; except uses which satisfy all three of the following conditions:

- The use is permitted in the underlining zoning district by right (X) or is a permitted accessory use (A); and,
- The use is not otherwise prohibited by Section 3.B.2 of this Article, and,
- The use is serviced by (1) the public sewer system or (2) an ISDS within the average daily generation rates herein cited.

A. Site Plan Review

The Zoning Board of Review shall not act upon the granting of a special exception, deviation or variance for any use within Zone A of the Aquifer and Watershed Protection District until the petition for said special exception, deviation or variance has been referred to and an advisory report has been received from, the Conservation Commission and the Planning Board. Said advisory report shall be submitted by the Conservation Commission and the Planning Board to the Zoning Board of Review within forty five (45) days of receipt of the petition. The Zoning Board of Review may then act upon granting the special exception, deviation or variance. Where the decision of the Zoning Board differs from the recommendations of the Conservation Commission and the Planning Board, the reasons therefor shall be clearly stated in writing.

Applications for special exceptions as required by this sub-section shall meet all requirements of Article VII, Section 5, plus the requirements below:

Applications for deviations and variances shall meet all requirements of Article IX, plus the requirements below:

1. Applications for special exceptions, deviations and variances shall contain an Environmental Report which includes the following information:

a. A complete list of all chemicals, fuels and other potentially toxic or hazardous materials to be used or stored on the premises in quantities greater than those associated with normal household use;

b. Soil survey data with water table and soil percolation tests prepared and certified by a registered professional engineer or a registered land surveyer;

c. A topographical survey of the property with two (2) foot contour intervals by a registered land surveyer;

d. Water quality analysis of the property, to include ambient (existing) water quality measurements of both ground water and surface water (if applicable) in the vicinity of the proposed project or construction. A report outlining detailed sampling and testing methods and procedures as required by this section shall be submitted by a qualified firm, individual or laboratory performing said sampling or testing. Analysis shall be based upon sampling and testing performed within one (1) year of the submission of the application.

Surface water and ground water samples shall be tested, if applicable, for the presence of the following components or other such components as may be recommended by the Conservation Commission or otherwise required by Zoning Board of Review.

Arsenic	pH
Lead	total volatile organics
Chrominum	Nitrogen (nitrate)
Mercury	Nitrogen (nitrite)
Zinc	Chloride
Copper	Sodium
Temperature	Ammonia
Phosphorus	Fecal coliform
Dissolved Oxygen	Total coliform
Total dissolved solids	Total solids

e. Primary data on the rate and direction of ground water movement on the property, or in the vicinity of the proposed construction or use, with detailed description of the methods and procedures used;

f. A detailed narrative report by a hydrologist, geologist, agronomist, or related soil/hydrology scientist regarding present water quality conditions and the potential impact to ground water and surface water supplies as a result of the proposed use, including the cumulative impacts of the discharge of pollutants over an extended period of time. Such report shall address mitigation measures to alleviate any potential sources of pollution, and shall also address alternatives to the proposed construction or use.

g. Any other pertinent data recommended by the Conservation Commission or otherwise requested by the Zoning Board of Review which it may deem necessary to properly assess impacts upon water quality and to insure compatibility of the use with the purposes and the intent of the Aquifer and Watershed Protection District.

Section 4. Areas within Zone UD

A. Definition of Areas

Areas within Zone UD of the Aquifer and Watershed Protection District are areas shown on the official Zoning Map as the geographic upstream drainage areas of the Hunt River Aquifer including the drainage basins of the Maskerchugg, Mawney, Fry, Frenchtown, and Scrabbletown watercourses and associated wetlands as mapped by the United States Geological Survey in Trench, Elaine C., Classification and Delineation of Recharge Areas to the Hunt River Aquifer Ground Water Reservoir in Central Rhode Island, Providence, RI, 1986.

B. Standards for Development:

Within the boundaries of Zone UD no structure shall be erected and no land shall be used except in compliance with the following provisions;

1. PERMITTED USES: The proposed use shall be a permitted use (X); a use permitted by special exception (S); or an accessory use (A) permitted under the provisions of Article II and other applicable provisions of the Zoning Ordinance in the underlying zoning district in which said proposed use is located. All other uses are prohibited.

2. PROHIBITED USES: In addition to prohibited uses specified in Article II, the following uses are prohibited in Zone UD of the Aquifer and Watershed Protection District:

a. All uses which involve the use or storage of hazardous substances designated under 40 CFR Part 116 pursuant to Section 311 of the federal Clean Water Act and subsequent amendments thereto. Provided, however, that minor or insignificant quantities of such substances for office or business use may be used or stored on the premises if, in the opinion of the Zoning Officer and Building official , the presence of such substance does not constitute a potential for degradation of surface water or ground water resources in the area and such substance is contained in a suitable storage area.

b. Incinerators, sanitary landfill sites, hazardous waste treatment facilities, solid waste transfer stations and wastewater treatment plants, except for publically-owned sewage treatment facilities.

c. Individual Sewage Disposal Systems (ISDS) located within one hundred (100) horizontal feet of the Fry, Mawney, Frenchtown, Scrabbletown watercourses or wetland systems which contribute to the surface and subsurface water supply of the Hunt River Aquifer.

d. Individual Sewage Disposal Systems (ISDS) which discharge wastewater in excess of 450 gallons per acre per day.

** Any legal substandard residential lots of record will be exempt from the previous stipulation of ISDS requirements. Any commercial, industrial or waterfront legal substandard lots of record may be exempted from the ISDS requirements by the Zoning Board of Review by special exception as provided in this ordinance.

e. All uses which discharge process wastewater on-site, including wastewater containing contaminants other than normal organic waste.

f. Storage of road salt or de-icing chemicals unless stored in a publicly maintained and roofed structure with an impervious floor and contained drainage system.

g. The alteration of any natural site features or topography, including but not limited to the cutting or removal of trees or other vegetation, or dumping, filling, excavation, grading, transferring or removal of any gravel, sand, loam or other soft material, rock or ledge, prior to obtaining all permits and approvals for final development plans, including where the use of land is for the primary purpose of agriculture. Where such minor alteration is incidental to a permitted use and performed in the normal course of maintenance or operation of such permitted use, this paragraph shall not apply.

Section 5. Site Design Standards

The following site design standards shall be required for all permitted uses, by special exception or otherwise, within the Aquifer and Watershed Protection District.

A. Surface water runoff shall, to the degree feasible, be directed toward areas covered with vegetation for surface infiltration and subsequent purification or to man-made filters for purification; and

B. All retention/detention basins for water drainage control shall be designed with natural or man-made liners for water infiltration and subsequent purification; and

C. Where the premises are partially outside of the Aquifer and Watershed Protection District, site design shall, to the degree feasible, locate pollution sources such as Individual Sewage Disposal Sysytems (ISDS) outside of the district; and

D. Surface water runoff shall be directed, to the degree feasible, to ward the lesser restricted district where the premises is located within two or more districts.

E. Impervious surfaces shall not exceed ten (10) percent of the minimum area of any developed lot.

F. The following standards shall be used when calculating the impacts of nutrient loading or potential pollution of a proposed project:

1. Loading per person: 5 lbs Nitrogen per person per year; .25 lbs Phosphorous per person per year for sewage disposal systems within 300 feet of a shoreline or boundary of river, stream, pond, lake or wetland.

2. Loading from lawn fertilizers: 3 lbs Nitrogen per 1,000 square feet per year.

3. Loading from runoff: .19 lbs Nitrogen per curb mile per day; .15 lbs Phosporous per curb mile per day.

4. Critical eutrophic levels: Fresh water concentration, total Phosphorous = .02 mg/liter; salt water concentration, total Nitrogen = .75 mg/liter.

5. Advisory Nitrate level for drinking water = 10 mg/liter

6. Advisory Sodium level for drinking water = 20 mg/liter

7. Advisory Chloride level for drinking water = 250 mg/liter

8. Persons per dwelling unit = 3 minimum

9. Average daily residential water usage per person per day = 75 gals/person/day.

10. Average daily commercial office water usage per person per day = 15 gals/person/day.

DEFINITIONS Chapter x entitled "Definitions is hereby amended by adding the following definitions:

Aquifer: A geologic formation composed of rock or sand and gravel capable of yielding usable amounts of water.

Aquifer and Watershed Protection District: The aquifer and watershed protection district as designated on the official zoning maps of the Town.

Designated aquifer: A geologic unit capable of yielding usable amounts of water and designated as such by the official zoning map of the Town.

Groundwater: Water in the subsurface zone beneath the water table in which pore spaces are filled with water.

Impervious Surface: Material on the ground that does not allow surface water to penetrate into the soil.

Induced infiltration: The process by which water in a stream or lake moves into an aquifer because of an hydraulic gradient from the surface water body toward a pumping well or wells.

Recharge Area: That area from which water is added to the saturated zone by natural processes.

Saturated Thickness: The depth of permeable soil actually saturate with water to the capacity of the soil to contain water under natural conditions of temperature and pressure.

Septage: Sludge produced by domestic waste that is pumped from septic tanks.

Solid Waste: Any discarded solid material, putrescible or non-putrescible, including, but not limited to, solid liquid, or contained gaseous materials.

Stratified-Drift Aquifers: Stratified drift deposits that are capable of yielding usable aqueous materials.

Stratified Drift: Unconsolidated, sorted sediment composed of layers of sand, gravel, silt or clay, deposited by meltwaters from glaciers.

Toxic or Hazardous Substances: Any substance deemed a toxic or hazardous under applicable federal and state law shall also be deemed a hazardous substance for the purpose of this Chapter. Toxic and hazardous substances include, without limitation, organic chemicals, petroleum products, heavy metals, radioactive or infectious wastes, acids and alkalies, and include products such as pesticides, herbicides, solvents and thinners. Substances generated by the following activities, without limitation, are presumed to be toxic or hazardous, unless and except to the extent that anyone engaging in such activity can demonstrate the contrary to the Rhode Island Department of Environmental Management (DEM) or the federal Environmental Protection Agency (EPA).

- Airplane, boat and motor vehicle repair and service
- Chemical and bacteriological laboratory operation
- Cabinet making
- Dry cleaning
- Electronic circuit assembly
- Metal plating, finishing and polishing
- Motor and machinery service and assembly
- Painting, wood preserving and furniture stripping
- Pesticide and herbicide manufacturing and commercial storage
- Photographic processing
- Printing
- Other industrial wastes

<u>Background (from Trench and Morrissey, 1987)</u>

The Aquifer and Watershed Protection District seeks to regulate land use that may have an adverse effect on the integrity of the Hunt River Aquifer and ground water reservoir through pollution of sources of recharge. The three major sources of recharge to the ground water reservoir are:

1) Precipitation over the aquifer area

2) Ground water inflow from adjacent upland areas

3) Surface water that infiltrates the aquifer area via the 5 water courses and wetlands of the watershed.

Following a classification system, these three primary sources of recharge are classified as:

1) aquifer areas

2) adjacent areas

3) upsteam drainage areas

The relative importance of each recharge source area, in terms of water supply for a particular well field in the ground water reservoir, differs depending on the hydrology of the specific site. This classification system is not a ranking of the relative importance of the recharge sources.

Aquifer Areas

Precipitation that falls directly on the stratified drift aquifer and infiltrates to the water table is one source of recharge to a ground water aquifer. An aquifer area is defined as the area of a stratified drift aquifer from which ground water flow reaches a designated ground water reservoir.

The boundary of the aquifer area is, in large part, the contact between stratified drift and till. In some areas, stratified drift which is contiguous with but not part of a designated ground water reservoir extends along stream valleys. Ground water levels are used to determine whether these areas are included in the aquifer area or classified as upstream drainage areas. Where no water table contours are available, the aquifer area boundary is approximated.

In some areas, the stratified drift aquifer extends across a drainage divide. Where surface water drainage divides coincide with ground water drainage divides, the surface water divides can be used to represent the aquifer area boundary. However, where hydrologic information indicates that the ground water drainage divide and the surface water drainage divide are not coincident, the ground water drainage divide must be used. The ground water drainage divide of the Hunt River Aquifer extends roughly on a line northeast from southwest in the Town of North Kingstown east of the East Greenwich town line.

Adjacent areas

Ground water inflow from adjacent till and bedrock uplands constitutes a second source of recharge. Where an upland area is drained by a surface stream,, ground water generally discharges to the surface stream before reaching the ground water reservoir. If an upland area is not drained by a perennial stream, ground water flows through the subsurface to the ground water reservoir. An adjacent area is defined as any area of till, bedrock,, or possibly mixed deposits, from which water that percolates to the water table flows through the subsurface to the ground water reservoir, without first discharging to a perennial stream.

The contact between till and stratified drift forms part of the adjacent area boundary. The remaining boundaries are subbasin drainage divides in till uplands, between areas without perennial streams and areas with perennial streams. Topographic maps are used to determine the subbasin boundaries, based on the assumption that water table contours in till are similar in configuration to land surface contours.

<u>Upstream Drainage Areas</u>

Infiltration from surface water bodies, such as streams and ponds, constitutes a third source of recharge. An upstream drainage area of a ground water reservoir is defined as the drainage area of any surface water system upstream from the aquifer area boundary. Upstream drainage areas, in practice, turn out to be all other areas within the drainage area or watershed of a ground water reservoir which are either aquifer areas or adjacent areas. Recharge to a ground water reservoir from surface water is by either natural or induce infiltration.

Natural infiltration can occur where a stream flows across an aquifer and the stream water elevation is higher than the water table. Water within the stream percolates downward through the permeable streambed to the water table.

Recharge from a surface water body to underlying deposits may be artificially induced if pumping wells lower the water table below the elevation of the surface water. Under these conditions, surface water may percolate downward to recharge the ground water, and eventually become part of the drinking water supply pumped from the well. This process is called induced infiltration of surface water. Induced infiltration is common in Rhode Island because of the proximity of many supply wells to surface waters in stratified drift aquifers.

Recharge from a surface water body can consist of runoff derived from the entire upstream drainage area of the stream. If stream water infiltrates to the aquifer, land uses throughout the entire upstream drainage area of stream may influence ground water quality. If a ground water reservoir is located at the downstream end of a large river basin, then its upstream drainage area may cover hundreds of square miles.

APPENDIX E

TOWN OF NORTH SMITHFIELD, RHODE ISLAND

GROUNDWATER PROTECTION REGULATIONS

Sec. 6.19. Regulation of groundwater aquifer zones.

6.19.1. Purpose. The regulations herein governing the development and use of lands lying above groundwater aquifers shall take precedence over any other conflicting laws, ordinances, or codes, and are established for the following purposes:

(1) To protect the public health and safety, and the environment, from the effects and potential effects of the improper or unsound use and management of pollutants and hazardous materials;

(2) To protect public drinking water supplies by minimizing the infiltration of leachate into surface and groundwaters;

(3) To permit only those uses and improvements of the groundwater aquifer zones that are beneficial and not hazardous and are in keeping with the town's comprehensive community plan;

(4) To protect the integrity of natural systems;

(5) To complement and enhance an overall conservation program.

6.19.2. Definitions. For the purpose of this subsection and this ordinance generally, the following terms shall have these meanings:

(1) *Groundwater.* Water beneath the surface of the ground, whether or not flowing through known and definite channels.

(2) *Aquifer.* Porous underground rock or unconsolidated sand or gravel deposits sufficiently permeable that water can move through them by gravity.

(3) *Recharge area of aquifer.* Any area in which precipitation percolates to the water table and flows through subsurface materials to the aquifer.

(4) *Pollutant.* A man-made or man-induced substance which causes or could cause the alteration of the chemical, physical, biological, or radiological integrity of groundwater.

(5) *Hazardous material.* Any material or combination of materials of a solid, liquid, contained gaseous, or

semisolid form which because of its quantity, concentration, or physical, chemical, or infectious characteristics may:

(a) Cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or

(b) Pose a substantial present or potential or potential hazard to human health or the environment.

Such materials include, but are not limited to, those which are toxic, corrosive, flammable, irritants, strong sensitizers, substances which are assimilated or concentrated in and are detrimental to tissue, or which generate pressure through decomposition or chemical reaction and includes septic wastes. In addition, such materials include "industrial waste" as such term is used in the Rhode Island General Laws, as amended, unless the context shall clearly indicate otherwise.

Hazardous materials shall also include all "hazardous wastes" and "hazardous waste types" as defined in the rules and regulations adopted in accordance with Title 23, Chapter 46.2 of the General Laws of the State of Rhode Island and Providence Plantations, as amended.

(6) *Hazardous material management facility.* A facility, excluding vehicles, for collection, source separation, storage, processing, treatment, recovery, or disposal of hazardous materials, or a transfer station for hazardous materials, and may include a facility at which such activities occur and hazardous materials have been generated.

(7) *Individual sewage disposal system.* One installed to provide sanitary sewage disposal by leaching into the ground where no public sewer system is available or accessible.

6.19.3. Characteristics. Water generally enters an aquifer by downward percolation from the land surface recharge area and moves laterally underground toward areas of natural and man-induced discharge. The soils and subsoil conditions of the lands in the groundwater aquifer zone are such that any use introducing pollutants or hazardous materials into the natural drainage system could adversely affect the quality of drinking water sources, including the waters of the Slatersville reservoirs.

6.19.4. Permitted uses. All uses otherwise permitted in the various zones established by this ordinance that do not cause the introduction of pollutants or hazardous materials into the ground or waters of the town shall be permitted within the groundwater aquifer zone.

6.19.5. Prohibited uses. Those uses which are prohibited include, but are not limited to, the following:

(1) Hazardous material management facilities;

(2) Septic waste management facilities;

(3) Hazardous waste disposal facilities;

(4) Hazardous waste generation facilities;

(5) Solid waste management facilities/landfill.

6.19.6. Exemptions. The following uses shall be exempt from the provisions of this subsection:

(1) Agricultural uses, as defined by subsection 5.4.1 of this ordinance;

(2) Individual sewage disposal systems associated with otherwise permitted uses.

(Ord. of 6-18-79; Ord. of 6-2-82)

APPENDIX F

TOWN OF SOUTH KINGSTOWN, RHODE ISLAND

PROPOSED INDUSTRIAL PERFORMANCE STANDARDS FOR GROUNDWATER PROTECTION

PROPOSED ORDINANCE ARTICLE _____

Section: 1 Purpose

The purpose of this ordinance is to regulate industrial uses which may be detrimental to the environment over the Chipuxet Aquifer in West Kingston. The Chipuxet Aquifer currently supplies drinking water to residents of South Kingstown, including the University of Rhode Island. Thus it is in the best interests of the Town to insure that no chemical contaminants from industrial land uses reach the Aquifer.

Section: 2 Redefinition of Manufacturing (M1) Zone

It is hereby proposed that in order to protect the Chipuxet Aquifer from contamination, the M1 Zone in West Kingston be changed to an M1-A Zone.

Section: 3 Industrial Performance Standards in the M1-A Zone

The following performance standards will apply to the M1-A Zone upon the date this ordinance goes into effect:

A. All use, storage and discharge of any chemical(s) or chemical compound(s) found on a minimum of one of the following lists and directly resulting from a manufacturing process is prohibited.

1. U. S. Environmental Protection Agency's list of Priority Pollutants.

2. All organic chemicals in Table C.3 entitled Substances With State Standards Or Federal Standards Or Guidelines For Water Quality That May Be Applied To Groundwater, published in Protecting the Nations Groundwater from Contamination: Volume II (Washington, DC: U.S. Congress, Office of Technology Assessment, OTA-0-276, October 1984).

3. All chemicals in Table II of Appendix E., entitled RI DEM Minimum Data Base Guidelines, published in Water Quality Regulations For Water Pollution Control, Rhode Island Department of Environmental Management, Division of Water Resources.

4. Any chemical for which the US Environmental Protection Agency has promulgated a health advisory or short-term risk assessment. Federal Register, Vol. 50, No. 219, November 13, 1985, pp. 46946-46947.

5. All chemicals in Table 14 entitled VOCs Proposed in Monitoring Regulations for Unregulated VOCs, in Federal Register, Vol. 50, No. 219, November 13, 1985, pp. 46923-46924.

6. All chemicals or compounds listed as "Hazardous Constituents" in the Federal Resource Conservation and Recovery Act. (RCRA).

B. If any of the lists cited above is updated or amended by the agency which publishes that list, the most recent version of that list shall apply to this ordinance.

C. All manufacturers in the M1-A Zone must submit to the South Kingstown Building Inspector, on a semi-annual basis, a report detailing the quantity and composition of all chemicals or chemical compounds used, stored or discharged as the result of a manufacturing process.

The form for this report may be picked up in the Building Inspector's office and is entitled Status of Chemical Substance Use Report Form, M1-A Zone.

Section: 4 Non-Conforming Uses

All uses which exist on the effective date of this ordinance and are in violation of Section 3 of this ordinance shall be considered non-conforming uses. All non-conforming uses will be subject to the regulations of Article 4 of the South Kingstown Zoning Ordinance, entitled Non-Conforming Uses.

Section: 5 Stipulations for Continuation of a Non-Conforming Use

In order to remain in operation, all non-conforming uses must comply with the following regulation within one (1) year of the effective date of this ordinance:

A. All process or cooling water, or any fluid which is to be discharged into a septic system as waste-water effluent directly resulting from a manufacturing process, must meet Rhode Island Department of Health drinking water standards for inorganic and organic chemicals. These standards must be met before the effluent leaves the confines of any structure discharging such effluent, including any pre-treatment facility.

Section: 6 **Expansion of Non-Conforming Uses**

All changes in manufacturing operations including any change in the quantity or composition of chemicals or chemical compounds used, manufactured, stored or discharged, shall be viewed by the Town as an expansion of a manufacturing structure. Such an expansion will be subject to Article 3, Section 333 of the South Kingstown Zoning Ordinance, entitled Site Plan Review-Commercial and Manufacturing Uses.

Section: 7 **Proof of Compliance**

The burden of proof in showing compliance with this ordinance lies with the manufacturer. The manufacturer may, at own cost, engage the services of a licensed professional consultant in order to prove compliance. The consultant must be approved by the Town of South Kingstown as being professionally competent.

STATUS OF CHEMICAL SUBSTANCE USE REPORT FORM M1-A ZONE

Name of Manufacturer: ______________________________

Address of Business Establishment: ______________________________

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Telephone No.: ______________

Product(s) Manufactured: ______________________________

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1. **List all chemicals or chemical compounds and their quantities which are currently used, manufactured, stored or discharged on your (the manufacturer's) premises.**

2. **Briefly describe the method(s) used for storage of any chemical or compound listed in question #1. Include information on whether the storage is indoors, outdoors, underground or above ground.**

3. **After use or storage, how is/are the chemical(s) listed in question #1 removed from the premises of your operation?**

4. **Do you (the manufacturer) currently operate with a RIPDES Permit granted by DEM? If so, please write the date the permit was granted and when it expires.**

APPENDIX G

TOWN OF RICHMOND, RHODE ISLAND

GROUNDWATER PROTECTION ORDINANCE

TOWN OF RICHMOND

TITLE 18 OF THE TOWN ORDINANCES OF THE TOWN OF RICHMOND ENTITLED "ZONING" IS HEREBY AMENDED AS FOLLOWS:

1. Chapter 18.08 entitled "Definitions" is hereby amended by adding the following definitions:

18.08.031 Adquifer: A geologic formation composed of rock or sand and gravel capable of yielding usable amounts of water.

18.08.032 Aquifer Protection Zone: The acquifer protection zone as designated on that certain plan entitled Map of Richmond, Rhode Island, showing area underlained by Dr. Melih M. Ozbilgin as overlain on the U.S. Geological Survey Maps quadrangle entitled Hope Valley, Slocum, Carolina and Kingston.

18.08.081 Designated Aquifer: A geologic unit capable of yielding usable amounts of water and designated as such on a map entitled Map of Richmond, Rhode Island, showing area underlain by stratified drift deposits by Dr. Melih M. Ozbilgin.

18.08.131 Groundwater: Water in the subsurface zone beneath the water table in which all pore spaces are filled with water.

18.08.032 Impervious Surface: Material on the ground that does not allow surface water to penetrate into the soil.

18.08.133 Induced Infiltration: The process by which water in a stream or lake moves into an aquifer because of a hydraulic gradient from the surface water body toward a pumping well or wells.

18.08.251 Recharge Area: That area from which water is added to the saturated zone by natural processes, such as induced infiltration.

18.08.252 Saturated Thickness: The depth of permeable soil actually saturated with water to the capacity of the soil to contain water under normal conditions of temperature and pressure.

18.08.253 Septage: Sludge produced by domestic waste that is pumped from septic tanks.

18.08.291 Solid Waste: Any discarded solid material, putrescible or non-putrescible, including, but not limited to, solid, liquid, or contained gaseous materials.

18.08.292 Stratified-Drift Aquifers: Stratified drift deposits that are capable of yielding usable amounts of water.

18.08.293 Stratified Drift: Unconsolidated, sorted sediment composed of layers of sand, gravel, silt or clay, deposited by meltwaters from glaciers.

18.08.331 Toxic or Hazardous Wastes: "Hazardous Material" means a product, or waste, or combination of substances which because of quantity, concentration, or physical, or chemical or infectious characteristics, poses in the Planning Board's judgment a substantial present or potential hazard to human health, safety, or welfare, or the environment, when improperly treated, stored, transported, used, or disposed of, or otherwise managed. Any substance deemed a hazardous waste or material under applicable federal or state law shall also be deemed a hazardous material for the purpose of this Chapter. Toxic or hazardous materials include, without limitation, organic chemicals, petroleum products, heavy metals, radioactive or infectious wastes, acids and alkalies, and include products such as pesticides, herbicides, solvents and thinners. Wastes generated by the following activities, without limitation, are presumed to be toxic or hazardous, unless and except to the extent that anyone engaging in such activity can demonstrate the contrary to the Department of Environmental Management.

- Airplane, boat and motor vehicle repair and service
- Chemical and bacteriological laboratory operation
- Cabinet making
- Dry Cleaning
- Electronic circuit assembly
- Metal plating, finishing and polishing
- Motor and machinery service and assembly
- Painting, wood preserving and furniture stripping
- Pesticide and herbicide application
- Photographic processing
- Printing
- Other industrial wastes

2. Chapter 18.37 entitled "Aquifer Protection Districts" is hereby added after Chapter 18.36 as follows:

Chapter 18.37
Aquifer Protection District

Sections:

18.37.10 Purpose
18.37.20 Aquifer protection districts
18.37.30 Lands to which regulations apply
18.37.40 Compliance
18.37.50 Regulations

18.37.10 Purpose: The purpose of Aquifer Protection Districts is to protect the public health by preventing contamination of the ground and surface water resources providing water supply for the Town.

18.37.20 Aquifer Protection Districts: Aquifer Protection Districts are delineated on a map entitled Richmond Rhode Island, Showing Area Underlain by Stratified Drift Deposits. Drawn as an overlay map on the U.S. Geological Survey Quadrangle Maps for Hope Valley, Slocum, Carolina and Kingston dated 1953, photorevised 1970, said map is adopted by reference and made part of the Richmond Zoning Map.

18.37.30 Lands to Which Regulations Apply. The provisions of this Chapter shall apply to all land within Aquifer Protection Districts.

18.37.40 Compliance: Within the boundaries of Aquifer Protection Districts, no structure shall be erected and no land shall be used except in compliance with the provisions of this Chapter. Aquifer Protection Districts shall be super-imposed as an overlay on existing zoning districts. The Building Inspector shall determine when the overlay map of Aquifer Protection Districts and its requirements regulate the granting of a building permit within said district(s). The location of the principal structure or use shall determine the application of overlay requirements.

18.37.50 Regulations: The special requirements of this Chapter shall be in addition to all the other applicable provisions of the Richmond Zoning Ordinance within Aquifer Protection Districts.

A. <u>Subsurface Disposal of Domestic Sewage</u> - Sanitary wastewater discharge into on-site septic systems (ISDS) shall not average more than 350 gallons per acre per day.

B. <u>Industrial or Commercial Uses</u> - Industrial or commercial uses shall be subject to a site plan review by the Planning Board and any restrictions or requirements imposed by the Planning Board upon approval of the site plan shall be prepared in accordance with the provisions of 18.40.030 of this chapter.

1. In addition to the site plan requirements of 18.40.030 the site plan shall be accompanied by a report which includes the following information:

a. Amount and composition of industrial or commercial wastes including fly-ash, and proposed methods for disposal of such wastes outside of the Aquifer Protection District.

b. Amount and composition of any hazardous materials, including, but not limited to, hazardous materials identified by Section 3001 of the Resource Conservation and Recovery Act, that are handled, transported, stored or discharged to the ground or air at the site.

C. <u>Prohibited uses</u>

1) Road Salt Storage and Loading
2) Solid Waste Disposal
3) Septage Disposal
4) All commercial or industrial uses which involve the use or storage of hazardous materials.

3. Chapter 18.60 entitled "Enforcement" is hereby amended as follows:

Chapter 18.60

<u>Enforcement</u>

<u>Sections</u>:

18.60.010 Building inspector enforcement authority.
18.60.011 Enforcement and compliance within aquifer protection districts.

18.60.020 Building permit -- required when.
18.60.030 Building permit -- issuance conditions.
18.60.040 Building permit -- copies to be kept.
18.60.050 Violation -- penalty.

4. Chapter 18.60 entitled "Enforcement" is hereby amended by adding the following:

<u>18.60.011 Enforcement and Compliance Within Aquifer Protection Districts</u>: Written notice of any violation of Chapter 18.37 within an Aquifer Protection District shall be provided by the Building Inspector by registered or certified mail to the owner of the premises, specifying the nature of the violations and a schedule of compliance, including cleanup of spilled materials. This compliance schedule shall be reasonable in relation to the public health hazard involved and the difficulty of compliance. In no event shall more than thirty (30) days be allowed for either compliance or finalization of a plan for longer term compliance.

THIS ORDINANCE SHALL TAKE EFFECT UPON ITS PASSAGE.

Adopted by the Richmond Town Councilthis twentieth day of August, 1984.

Attest: [signature]
Town Clerk