PROCEEDINGS

of the

Conference on Water Quality on Long Island

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and the

Long Island Regional Planning Board

held at the

State University of New York
at Stony Brook

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Introduction

Dr. John Marburger, President - State University of New York at Stony Brook
Robert J. Gaffney, County Executive - Suffolk County, New York

Dr. John Marburger

Good morning, I am John Marburger, President of the State University of New York at Stony Brook, and your host for this morning's conference. The State University is, of course, the center of research and advanced education here on Long Island, and we are very pleased to sponsor a conference such as this to try to shed light on issues that are important to our region. The issue of water quality and water availability for Long Islanders is one that is very prominent in the thinking of planners, developers, and residents of Long Island, and has been for many, many years. It is a truism that all of our water comes from beneath our feet. We have no reservoirs, no sources of water from large flowing rivers from upstate or from other parts, and what we have here is what we have to live with far into the future. Planning on Long Island has been influenced by this acute awareness of our responsibility for the water that God has placed beneath our feet and the pattern of development on Long Island and development practices have been shaped for decades with this awareness. But the understanding of where the water comes from that we drink, how it got there, what affects its quality is still somewhat elusive. Stony Brook is a participant in a national consortium to simulate groundwater flows. It is sponsored by the Department of Energy, which has responsibility for water quality in the proximity of some of the most sensitive and highly polluting installations in the country. Consequently the Department of Energy has been very concerned about just how to model the groundwater flow in the vicinity of its plants. In connection with that effort I have learned, along with many, many others, that the problem of figuring out what happens to water from rainfall after it hits the ground is just not simple. The most advanced and complex computational facilities, highly trained, creative, and imaginative scientists and mathematicians are today lavishing their energies and their efforts on making mathematical models to simulate this flow. The models are different for each different part of the country and for each different local situation. I just mention this as one of the many different avenues of complexity in current research that affect our understanding of our water. So there are still scientific questions to be answered. There are still facts to be gained and learned and it is up to us, as responsible Long Islanders, to be aware of what science is learning now, and of the best information we have available to us to understand our situation. This is the kind of thing that universities are for. It is our responsibility to help bring out the current state of thinking, the current state of science on these things, and today we have many guests planned to come and talk to us about what is known, and about what still remains to be discovered about our groundwater situation here on Long Island. We are proud, of course, here at Stony Brook to have programs and people who work on these problems. Many of our programs are centered at the Marine Sciences Research Center, under Jerry Schubel, and the Center for Regional Policy Studies, headed by Lee Koppelman, both of which serve as centers for information and continuing elucidation of these ideas. So I am very pleased to be able to welcome you to Stony Brook. I hope that you find enlightenment in these sessions and I know you will have an interesting and stimulating experience. So thanks very much and it is a great pleasure to introduce County Executive Bob Gaffney to you.
County Executive Robert J. Gaffney

Thank you very much Dr. Marburger. I would like to thank all of you for coming here today, to this, the first of the Long Island water summits. As I am sure you will all agree, there is no environmental subject that is more important to Long Islanders than the protection and preservation of the groundwater system of Suffolk and Nassau Counties.

Long Island’s sole source aquifer has been scientifically studied, perhaps more than any other, for more than a century. I know of no other area where groundwater and groundwater systems have come under the same degree of extensive scientific scrutiny. Nevertheless there is a need to do more. We need to deal with these issues in a more definitive and scientific way. Long Island is widely viewed as a leader in hydrogeological modeling from a quality and quantity research standpoint. Long Island has been a pioneer in research and in creating regulatory programs. We have been so successful that other counties and states have followed our leads in land use planning and groundwater protection and enhancement. To emphasize that point, I would like to just briefly mention some of the progressive and innovative actions taken here in Suffolk County. In 1970, Suffolk County passed a law prohibiting the sale of laundry detergents containing foaming agents. This led the major detergent manufacturers to reformulate their products, making them more biodegradable. In 1980, we passed legislation banning the sale of organic cesspool cleaners. Legislation was enacted to ban single wall underground petroleum tanks, replacing them with double wall systems. You may have noticed we have placed in the foyer copies of scientific studies that have been conducted on groundwater systems and I would ask that you take a moment to take a look at them later. I know that they will reinforce some of the comments I am making this morning and comments that you might hear.

On the research and planning fronts, we have been both diligent and active. We have produced the acclaimed 208 Study, the Nationwide Urban Runoff Plan, and the Non-Point Source Management Handbook and the Special Groundwater Protection Plan. Additionally, Suffolk County contributed to the State Groundwater Management Plan. Research and legislation go hand in hand. One without the other can be ineffective at best, counterproductive at worst.

The last point that I would like to stress is that the people of Suffolk and Nassau Counties are receiving water from community systems that are of the absolutely highest quality. It is all well and good that I say these things, but for the rest of the day you will be hearing the facts in detail from the experts. What is true about our water systems? What are our misconceptions? What beliefs may be true or untrue? It is my hope that all of this will contribute to the body of knowledge that is available. I am an attorney, not a scientist. My background is in law, not in science. Many of us don’t have backgrounds in science, but the one thing I know from my background in law is that there is a search for the truth that comes with the legal process. It is a search not for scientific knowledge but for justice, and that tends to be an absolute just as science tends to be an absolute. The way we approach that is, I think, extremely important. What we are hoping to do today, what we’re hoping is the beginning of, is a process in which we can create or expand upon the body of knowledge that exists in that continuous search for the truth. Why is that important? Because people like me and other elected and public officials are going to have to make decisions concerning what this island will look like or not look like, what we will protect or what we will not protect, what we will drink or not drink, based upon the best information we have. We need to have that information in a body that’s able to be digested and considered. Public policy decisions will be made based upon information that has been developed over the years and will continue to be developed. It is very, very important to me and all other elected and public officials of Long Island that this be the best information available. We are going to be making policy decisions in the dark unless we have that kind of information available. So this morning’s program will contribute to that, and the program that will follow this afternoon will contribute as well. I can’t emphasize enough how important it is for those of us who are elected to make those decisions to have the kinds of information necessary so they can be made wisely and responsibly.
Conference on Water Quality on Long Island

Robert Gaffney (Cont'd.)

This morning’s program will consist of four segments addressing the hydrogeological system, the quantity and quality issues and many of the regulatory programs designed to insure the strictest control over the use of our groundwater. Our first speaker will be Mr. Herbert Buxton of the United States Geological Survey. I should note that the Federal Government recognizes the importance and the unique character of Long Island’s aquifer system, and because of this, the federal government established the Long Island Office of the United States Geological Survey over 60 years ago. The second presentation will be given by Mr. Jim Mulligan of the Nassau County Department of Public Works. Mr. Mulligan will be addressing quantity and quality issues as they relate to Nassau County. Next will be Mr. Joseph Baier of the Environmental Quality Office of the Suffolk County Department of Health Services. He will be speaking about the quantity and quality situation here in Suffolk County. Our fourth speaker will be Dr. Aldo Andreoli. Dr. Andreoli is a professional engineer who had 30 years of service with the Suffolk County Department of Health Services. He was responsible for a variety of our environmental programs including water supply, waste disposal, industrial discharge, solid waste and the protection of water resources. He will be speaking about the many and various laws, regulations and guidelines in effect relating to groundwater.

Finally, I would like to let you know that lunch will be served, following Dr. Andreoli’s address, in the Student Union, which is adjacent to this building. The afternoon session will begin one hour after lunch starts. Once again, I want to thank you for attending. I think you will find today’s program both interesting and informative. I would ask you to consider the information that will be presented. This is part of a sum total of information that should and will be made available to all of us as time progresses. We anticipate that the information that comes from this summit will be subject to review; will be subject, I am sure, to some criticism; will be subject to a scientific inquiry. I think that is the proper forum in which this whole discourse should take place. Again, I want to thank you for attending today and I look forward, as I am sure you do, to the remarks made by the speakers.

Our first speaker is Mr. Herbert Buxton. Herb has a BS degree in geology from Rensselaer Polytechnical Institute, an MS degree in geology from the State University at Fredonia, fifteen years experience in groundwater hydrology and model simulation. He is currently Assistant District Chief of the United States Geological Survey of the New Jersey District; formerly he was the modeling specialist of the Survey’s Long Island office. Let me introduce Herbert T. Buxton.

Herbert T. Buxton

Thank you Bob. I would like to start by briefly introducing the Geological Survey to any of you who are not familiar with the agency. The USGS is a scientific, fact finding, non-regulatory agency. Our mission is to collect pertinent hydrogeologic data; to analyze and interpret that data; and to develop the best possible scientific understanding of the way our water resources function. We then make every effort to make that understanding of water resources available to local governments and the public, so that they can best manage their water resources. So, with that objective in mind, I would like to thank the coordinators of this program for giving us the opportunity to communicate some of these ideas. I will be speaking about the hydrogeology of the Long Island groundwater system. My objectives will be, first, to provide an overview of the structure and the operation of that groundwater system under natural conditions — how that system operates, what comprises it; and second, to describe how we affect that system by development. I should also say that all the information that I am conveying to you is really an analysis and interpretation, an evaluation of hydrogeologic data that has been collected over a very long period of time. The analyses include quite a bit of technical analysis, including a lot of modeling - groundwater flow simulation type modeling. This is intended to provide the best interpretation from the data that has been collected; but again, it is firmly rooted in hydrogeologic data which is critical to any analysis.

Everybody knows Long Island, but let’s refresh our memory about some critical aspects of it. It is an island, and it is completely surrounded by salt water (Figure 1). This has a large ef-
Figure 1. Location Map - Long Island, New York
ffect on where it derives its source of fresh water. It is a separate island, surrounded by saltwater. The groundwater system on Long Island sits in a very large wedge of unconsolidated sediments. This means sands, gravels, and silts and clays. The wedge of unconsolidated deposits starts as a feather edge along the border of the north coast of Brooklyn and Queens and thickens to a maximum of about 2000 feet at Fire Island (Figure 2). It is important to understand the geometry of this wedge of sediments, so one can understand how the groundwater moves through it and evaluate how we develop that resource. It comprises three major aquifer units - the Upper Glacial Aquifer across the top, an intermediate aquifer called the Magothy, and a deep aquifer called the Lloyd (Figure 3). There are two confining units that separate these aquifers where they are present. One is the Gardiners Clay, which is primarily present along the south shore and shows some restriction of flow between the Upper Glacial and the Magothy where it is present. The other confining unit is the Raritan Confining Unit, which is a very large and thick confining unit that does much to separate the flow between the Magothy and the underlying Lloyd Aquifer. This is a general framework for the groundwater flow system. There are other units that affect things locally but for the purposes here, I think this is the best basis for understanding how the system generally operates.

Now let us talk about how the system operates. The groundwater flow system operates because water is continually flowing through it. Water enters the system, flows through and discharges. This is what we mean by operates, because when we develop it, we take a piece, we divert a piece that is going through on a continuous basis. I think of it many times as a conveyer belt where water comes in, in jugs, along a conveyer belt, and moves along to where it is taken off at different discharges. When we develop it, we take jugs off and they don't go to some of those discharges. Again, operation is a key factor. It is a key concept. The way the system operates - there is a water table across the top. This is where all the fresh water in the Long Island groundwater system enters. It enters as a fraction of precipitation that lands on the land surface and infiltrates down to the water table. That water then moves laterally and seeps to some streams and discharges to the shorelines. Some of it flows with depth and enters the Magothy aquifer, where it circulates and flows back up to the shallow aquifer and discharges at the shore, or it discharges at what you will hear me refer to as sub-sea boundaries. Sub-sea boundaries are those areas where fresh water seeps across a confining unit and is lost; where the groundwater above it is salty. Again, a smaller fraction flows to the Lloyd Aquifer, and a small amount is lost where it discharges to these sub-sea boundaries. There are two important boundaries that are going to be critical to the way we understand development. They are the water table and the fresh/saltwater interfaces. These boundaries are what scientists call free surfaces because they move. They move when changes, both natural and man-induced, affect the system. If we take some water out of the system, or if there is less recharge during some period like a drought, the system shrinks, and it shrinks by these moving boundaries. The water table declines, and the saltwater interface moves in. These are two critical factors that affect the cause and effect relationship between development and the operation of the system.

Streams are connected in this groundwater flow system. Under normal or high water table conditions, the water levels rise around the stream channel and intercept it (Figure 4). Groundwater seeps to the stream, causing it to flow even when there is no runoff because there is seepage going to the stream. When we put little wells in stream channels, we see the water actually pop up into the casing above the stream channel because groundwater is seeping to the stream. Since the water table is one of the boundaries that changes, that shrinks the groundwater system when we stress that system, it becomes obvious that streams are a feature that get affected. When water levels decline, streams actually can shorten and the amount of groundwater seepage that flows to the stream can decrease. This is an important result of what water table reductions or drawdowns do to affect our system in general.

I will talk more about the natural groundwater flow system on Long Island now and I will do that in three facets. The first will be to look at groundwater levels - the level that we measure that water rises to in wells, because this is the way we monitor the health of the groundwater system in an important way. The next thing will be to look at the groundwater budget because the groundwater budget is critical to quantity issues - the quantity of water in the groundwater
Figure 2  Thickness of Unconsolidated Deposits
Figure 3 Cross-section A-A from Figure 1
flow system, how much we can derive, and the effects of deriving that water from the system. The third issue will be groundwater flow patterns - and how drops of water actually move through the system. This is critical to water quality issues; because, when we contaminate a droplet of water, how that water moves through the system, and where it goes are critical for understanding how we manage quality issues.

Water levels are at a high in the center of an island, and water discharges laterally to the shores (Figure 5). It flows to the streams. The upper water table aquifer is bounded by the shoreline, and water discharges at the shoreline. The Magothy, or intermediary aquifer, is bounded by either a contact with salt water or where the aquifer pinches out. The groundwater system is a separate bubble, disconnected with the mainland, truly an island system. The Magothy is separated from the Lloyd Aquifer by a very thick confining unit - there is a big decrease in water levels as energy is dissipated by driving water through that Raritan confining unit and flowing laterally and discharging to sub-sea boundaries. The extent of the saltwater interface is considerably farther off shore but, again, not connected with any other water system.

This slide (Table 1) shows a generalized budget of the groundwater system under natural conditions. Remember, I said a groundwater system budget refers to the amount of water that is, on a dynamic basis, entering and leaving and flowing through that system. Under unstressed conditions, over 1.1 billion gallons of water enter the Long Island groundwater system every day. That is a lot of water. Under natural conditions, 460 million gallons of water discharge each day to the streams, 585 million discharge to the shore, and 81 million discharge to sub-sea boundaries. This next slide (Table 2) is intended to give us a feeling for how much water flows with depth in the groundwater system. What is the distribution of flow with depth? The vast majority of water discharges to the streams and shoreline. Of the total amount that recharges at the water table under natural conditions, only about 235 million gallons a day goes down to the base of the Magothy aquifer and only about 36 million gallons a day goes down to the Lloyd. In a practical sense, what that means is that water is entering the groundwater system and discharging to streams and the shoreline. That is the dominating flow system under unstressed conditions. Very little water flows down past those confining units, particularly the Raritan. It is critical to understand how the natural flow system behaves so you can understand how development affects it.

The pattern of flow, as it relates to quality issues, refers to the paths that water takes through the system. Four-tenths of the water that flows above the flow line discharges to south shore streams and shoreline (Figure 6). This is again consistent with our concept of distribution of flow. As water enters the Magothy, the lower permeability of the Magothy makes water flow more slowly with depth. The areas between flow lines on Figure 5 are called flow

<table>
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<tr>
<th>TABLE 1</th>
<th>Predevelopment Groundwater Budget (MGD)</th>
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<tr>
<td>Recharge From Precipitation</td>
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<td>Streams</td>
<td>Shore</td>
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<td>460</td>
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<tr>
<th>TABLE 2</th>
<th>Predevelopment Distribution of Flow (MGD)</th>
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<tr>
<td>Recharge at Water Table</td>
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<tr>
<td>Basal Magothy</td>
<td>235</td>
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<tr>
<td>Lloyd</td>
<td>36</td>
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Figure 4 Cross-sections of stream
**EXPLANATION**

- **EXTENT OF FRESH GROUND WATER**
- **-20-** LINE OF EQUAL SIMULATED WATER LEVEL -- Contour interval equals 10 and 20 feet. Datum is sea level

**Figure 5** Water discharges to the shores
Figure 6: Flownet showing streamlines and equipotential lines through modeled section.
tubes - and the same amount of water flows through a flow tube along its whole path. You can see that as the area of flow tubes gets bigger water moves more slowly and remains there longer. That means it is older (Figure 7). You can see that where water flows across confining units, the flow lines get vertical, and water moves very, very slowly through the confining units. This helps us understand how such a small amount of water can be flowing down here when all that water is entering the system; only a small amount moves here because it moves so much more slowly with depth.

The next slide (Figure 8) indicates a few selected flow paths to demonstrate the concept of aquifer recharge areas. Water that enters in the thin little strip under natural conditions near the center of the Island is the only water in the flow system that goes through and enters the Lloyd Aquifer. So the Lloyd's recharge area is the thin little strip by the divide. Now when we develop that, we affect it; but, we will talk about that later. Under natural conditions, this is the recharge area. The broader area is the recharge area of the Magothy aquifer. So before we stressed it, all water that entered this part of the water table flowed through the Magothy, and the water on either side stayed shallow and flowed to streams and shoreline.

Now let's see how that gets more complicated when we look at the three-dimensional nature of the system. The black area on Figure 9 is the recharge area of the Lloyd aquifer, and this area is the area where, under natural conditions, water entered that flowed in the Lloyd aquifer. The gray area is the recharge area of the Magothy. The unshaded area along the edges is where water that enters as recharge discharges to streams and shoreline, and you can see how shapes of these areas are affected by streams.

One more point about water quality considerations. It is not only the path of the water, but also the age. Remember water moves slower with depth, which means it is much older with depth. The age of the water generally increases with depth. It is taking a couple of hundred years to get to the Raritan, but it takes 600-700 years to flow through this confining unit, meaning water in the Lloyd is thousands of years old (see Figure 7). Now, when we start to develop water supplies, we start to accelerate some of the movements and change the groundwater flow system. Probably we haven't developed long enough to drastically alter these ages. Maybe water is a little bit younger down in the basal Magothy, but we have not moved very young water into the Lloyd yet. Lloyd water is still much older, and I think that is very consistent with water quality measurements that we have taken from the Lloyd, where we do not see the effects of human activities, except in a few spots where there may be a hole in the confining unit or something like that which is a pathway where water moves down quicker.

Let's go back and review what we consider to be stresses on the system (Table 3). What constitutes a stress on the groundwater system is something that affects its operation - something that affects the quantity or the pathways of water that is moving through the system. This is really what we consider a stress. There are also quality stresses, but these have to be considered as what contaminants get attached to different droplets of water as they move through the system, but really, as far as the flow system operation, a stress to the system is something that affects its operation. What affects the pattern and the quantity of water moving through the system?

1) Paving of recharge areas; what this does is let less water infiltrate to the groundwater system as recharge. Recharge never gets in the system; it is diverted. In Suffolk County, there is an extensive network of basins that keeps this water recharged and have maintained natural recharge. In New York City, that is not the case.

2) Groundwater withdrawals for different purposes, i.e., pumping. Pumping is taking water out and diverting from where it would have gone to a different discharge point.

We take water out through withdrawals for public supply, irrigation, commercial, and industrial uses. Then we redeposit some of it by leakage through septic tanks. A large percentage of the water used gets back into the flow system in areas where there are domestic disposal sites. Where there are sewers, a much smaller fraction seeps back in. With irrigation, the vast majority of the water evaporates or is transpired by plants. You can see we are diverting an amount of water, and we are recycling some of it back at the land surface; we are changing the quantity of water flowing and its pathway. Under stress conditions - recent stress condi-
Figure 7: Distribution of groundwater traveltime within modeled section.
Figure 8. Cross section showing recharge areas to the Lloyd and Magothy aquifers bounded by streamlines.

A NORTH FEET

A SOUTH FEET

SEA LEVEL

EXPLANATION

- AREA OF SALTY GROUND WATER
- MAGOTHY AQUIFER RECHARGE AREA
- LLOYD AQUIFER RECHARGE AREA
- STREAM LINE (LINE OF EQUAL STREAM FUNCTION VALUE) -- Arrow indicates direction of flow

NORTH FEET

SOUTH FEET

SEA LEVEL

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- AREA OF SALTY GROUND WATER
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- STREAM LINE (LINE OF EQUAL STREAM FUNCTION VALUE) -- Arrow indicates direction of flow
Figure 9  Recharge areas for the Lloyd and Magothy aquifers under predevelopment conditions
tions representative of the early 80s - we pumped 366 million gallons of water a day for public supply, and about 41 for industrial, commercial and agricultural uses (Table 4). Of that total withdrawal, about 249 million gallons per day actually get back into groundwater system. That is not all from that withdrawal. We import 700 million gallons a day from upstate into New York City, the vast majority of which gets put in the ground from leaky water supply lines and that kind of thing in New York City - artificial recharge. The other important factor is increased runoff, which diverts recharge. Again, this is in New York City, because Nassau and Suffolk handle this by recharge basins; but in New York City, because of combined sewers, a lot of runoff gets discharged into the ocean, so we reduce groundwater recharge by a considerable amount.

The net stress is important to consider, because it is the net stress or net reduction of water flowing through the system. This is the amount by which we will reduce the flow to the natural discharge points in the groundwater flow system. This is the amount by which we have reduced the natural flow to streams, to the shorelines, and to sub-sea boundaries. Let's review the groundwater levels, groundwater budgets, and groundwater flow paths for the recent stress conditions to understand better how development affects this flow system operation. Figure 10 is a map of the water table estimated for the recent developed conditions; there have been significant drawdowns of water levels - reductions of water table altitudes due to development - the most intense being over in Jamaica, where we have had water table altitudes of 30 ft. above sea level (see Figure 5), we now have cones of depression below sea level. In Nassau, where under predevelopment conditions the water table altitudes almost reached 100 feet, we are now just a little over 80 feet. In Suffolk, where there is not as much development, it has only decreased a few feet.

In the Magothy, we again see there is a mimicked response, very similar to the shape of the water table in the Upper Glacial. A large cone of depression exists where the Jamaica Water Supply Company is pumping a lot. I have to say, also, that this end of the system responds more severely, because its size is smaller. The initial diagram showed the wedge of unconsolidated deposits. It pinched out in this area, and is much thinner and smaller here. Even under natural conditions, the salt water interface is much closer here because the system is smaller. When I talk about the response of the system to stresses, and the system shrinking at its two free surface boundaries - the water table shrinking and the saltwater interface moving in - that

| TABLE 3 |
| Stresses |
| Paving Recharge Areas |
| Withdrawals with On-site Disposal |
| Withdrawals with Sewer Systems |
| Irrigation |

<p>| TABLE 4 |</p>
<table>
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<th>Stresses Under Recent Conditions (MGD)</th>
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<tr>
<td>Public Supply</td>
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<td>Returned Water Use</td>
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<td>Increased Runoff</td>
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<td>Net Stress</td>
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Figure 10 Map of the water table estimated for the recent developed conditions
is an important response of the system to development. There are concerns, and there is daily monitoring of the migration of saltwater intrusion in this area in western Long Island. Again, we see in the Lloyd a significant cone of depression below sea level; a small cone in Long Beach; and some pumping in the Lloyd, but not much further east, basically nothing; but we still have seen a significant decline in water levels down here. Actually, there is not that much pumped from the Lloyd, but the Lloyd aquifer responds much more to withdrawals because, if you think of that thick confining unit that overlies it, it takes a lot of drawdown to divert extra water down to that aquifer. Water naturally does not want to flow there; only a small fraction flows down there under unstressed conditions, so we need a lot of drawdown to divert the water down. It is a natural concern in confined aquifers in coastal areas. They are more sensitive to drawdown, which is what causes saltwater intrusion. It is an important cause and effect relationship to keep in mind in managing those aquifers.

Now let us see how we have affected the budget. At present, we have 407 million gallons a day combined withdrawals (Table 5). Some of this water gets back in the ground and actually increases what comes in at the water table, and the rest of it is diverted from discharging to these discharge boundaries. Let’s see how we have decreased natural discharge. We have decreased flow to streams, we have decreased flow to the shoreline, and decreased flow to deep sub-sea boundaries. This is an effect of water table declines; it causes some landward migration of seawater. We have affected the distribution of flow; again, flow entering at the water table, flow going to the basal Magothy, and flow going to the Lloyd Aquifer (Table 6). We have increased water at the water table, but we are actually recirculating some water that is pumped. A lot of our pumping comes from the basal Magothy and you can see how we have diverted a lot more water to flow deeper down to these wells, changing flow patterns; not much of an increase to the Lloyd, but this really changes east to west across the Island. Where there are a lot of wells in western Long Island, there has actually been an increase of the amount of water that goes down to the Lloyd; further east, where we develop water from the Magothy, we actually reduce what is going down to the Lloyd, because we get it before it goes down there; it stays about the same, but is very different east to west across the island. I would like in general terms to talk about how development affects flow pathways because this is an important consideration for water quality issues. This is the same slide I showed earlier of the system under unstressed predevelopment conditions (Figure 11). See how most of the water flows shallow; a small fraction flows with depth. Figure 12 shows what happens when we put a well in. It is very hard to talk about the system in general, because there are over

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<td>Total Recharge</td>
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Figure 11

Predevelopment Flow Patterns

Figure 12

Flow Pattern with a Pumping Well
1000 wells, and there are sewer districts with very irregular shapes, and the patterns of groundwater flow are drastically disturbed, so I can at best communicate the conceptual ideas of how this disturbance affects flow patterns.

We put a well in the Lloyd; the first thing this well does is have a drawdown that propagates out and diverts water to this well (Figure 12). It increases the amount of water flowing to the Lloyd aquifer, so that where before there was a small recharge area to the Lloyd aquifer, now the recharge area of the well alone and the recharge area of the whole aquifer is a wider band. You can see we have disturbed flow patterns; and now, the recharge area of the Lloyd is expanded, because more water flows down there in this area. What does that do to other areas? It means that the recharge area of all the shallower flow systems actually decreases too because we have decreased flow to the streams a little bit, we have decreased the amount of flow to the shoreline a little bit, and these flow paths actually flow a little deeper because less is flowing shallow and general flow lines move a little more deeply.

Another thing to note here, and this exaggerates this consideration, you will notice that the contributing area to this well (Figure 12) doesn’t even line up with where the well is. When you are developing wells in the deep aquifers like the basal Magothy or the Lloyd, it is important to keep in mind that where you are getting water from may not coincide with the well. I can also say that conceptually, in a general sense, the discrepancies probably occur more in a north-south direction across the island than in an east-west direction because, if you look at flow paths under natural conditions, you will see that when we put a well here, we are actually catching water that came from over there. So we would expect that the well’s recharge area would come from back here. The patterns of flow east west into and out of this area are of smaller scale and you would not be likely to see as much of this shift in an east-west direction. However, I think you can, in a sense, get a qualitative feeling of how, even in an east-west direction, the source of water from a well could come from a little bit away from where the well is.

Let us, in a generic sense, consider the effects of putting a well in a location and what this does to the flow system (Figure 13). If we put a well here (central Nassau), the first effect would be the drawdown that propagates away from that well. It diverts, or decreases, the amount of water discharging to some of the local streams. It decreases the flow most to the streams that are closest, and the boundaries that are closest. In effect, by locating our wells farther away from any individual streams, we spread out the effects over many streams; disperse the effects; and, many times, the effect is negligible or unmeasurable. The next effect is that we decrease the recharge area of these streams so, actually, the recharge area of these streams and the shoreline shrinks. If the well is screened in the Magothy, then we increase this area of the recharge area of the Magothy. In effect, we probably decrease the amount going to the Lloyd; in effect, we have disturbed the flow system by forcing more water to move to where the well is. We decrease the amount that is going to natural discharge boundaries, and force it to go to the well, and there is a corresponding rearrangement in the flow patterns in the system.

That is really all I wanted to say about the groundwater flow system operation, and hope this provides a basis for understanding what we at the USGS think is critical to water resource management planning. I would like to make one point - this information is an interpretation of data. It is critical to develop a relationship between monitoring, which is the continuing collection of data to observe how our system operates, and how it responds to development, and analysis, - the continual upgrading of our understanding of how the system works - and to use that improved understanding to devise better monitoring programs that really test model predictions and model understanding and interpretations of how the system works. I think that is a critical feature in water resource management - monitoring, data collection, interpretation and analysis and redesign of monitoring; because, basically, water resource management planning has to take advantage of our best understanding of the system at any given time. If we continually improve that understanding, and use it to the best of our ability, we can continually make water resource management decisions with the best understanding that is available. Thank you.
Figure 13  Recharge areas for the Lloyd and Magothy aquifers under present conditions
Robert J. Gaffney

Thank you Herb, that was terrific. The next topic we want to address is Nassau County water - quality and quantity, and the speaker will be James Mulligan of the Nassau County Department of Public Works. Just a little information about Mr. Mulligan. He has a BS degree in civil engineering from Northeastern University, and an MS degree in sanitary engineering from Manhattan College. He has been employed by Nassau County for 24 years, both in the Health Department and the Public Works Department. He has directed the County's water programs, including the development of a county-wide monitoring well network of over 500 wells. He is involved in the investigation of aquifer contamination, institution of county-wide water conservation efforts, federally mandated remedial efforts on streamflow augmentation and wetlands preservation, and the development of a county-wide computerized groundwater model that is being utilized to assess water quality and quantity issues. He participated in Long Island’s 208 Plan, the Nationwide Urban Runoff Study, the Long Island Groundwater Management Plan for NYSDEC, the Nassau County Water Plan, and the Special Groundwater Protection Area Plan. With that I give you James F. Mulligan of Nassau County.

James F. Mulligan

Thank you. Good morning, everyone. I would like to just make a few introductory remarks and then go on with a slide show of 40 slides. Given the fact that each speaker is supposed to be talking on the order of 45 minutes, I will have to run through the slide show very quickly. The initial remarks that I wish to make concern some of the historical events that have occurred in Nassau County which may give us some perspective as to why the confusion exists in various groups concerning the quality and quantity of Nassau County water. Depending on whom one talks to today, you may get a situation where one person will say we have an adequate supply of water, while another person will be arguing we are running out of water. Some of the historical events that occurred in Nassau County help to explain why we have these differing views. The first event was a series of studies that have been taking place in Nassau County. Nassau County has performed comprehensive water supply studies over many years, dating back to the 1950s, 1960s and through the 1980s. Many of our earlier reports projected a County population as high as 2.3 million people. We are presently at about half that population, at 1.28 million people. But with that projection of population going up to 2.3 million people, the reports talked in terms of Nassau County at some point in time, in the 1990s or thereabouts, as starting to mine its groundwater supply—meaning we would be withdrawing more water than we would be recharging; and that, hence, we would “be running out of water”. Now this projection existed in a number of reports, as late as the 1970s. What I will do when I go through the slides with you, I will show you the present day conditions, and how different they are from those that were projected earlier. Today we have our recharging exceeding what we are withdrawing. We are nowhere near running out of water. Looking back only 10, 20, 30 years ago, many of the reports that the County itself had issued projected that at some point in time we might begin to run out of water. That is one of the reasons why Nassau County began to study wastewater renovation—taking the sewage wastewater and treating it to a level where it could be recharged back into the aquifer system. We did such a pilot study in 1980, taking wastewater from Cedar Creek facility, pumping it up to East Meadow and recharging that through recharge basins and diffusion wells. We pumped 10 million gallons of water into the ground and successfully proved that that could be done, albeit at a very high cost. Those studies were done in anticipation that the County might start to run out of water. That is not the case today.

Another event that occurred in the past was the series of studies done by USGS regarding saltwater intrusion. Back in the 1960s, the USGS performed studies in southwestern Nassau and Queens that basically pointed out that saltwater intrusion had already occurred and was continuing to occur in the Magoghy aquifer and, at that point in time, was already landward and would be continuing to move inland. At that point in time, the computer models we now have did not exist and could not predict where it would stop, how far inland it would go, at what rate saltwater was intruding. Today we have very definitive information. Again, it does continue to move inland in certain areas, but it does stop. It does not impact a great number of public water supply wells. We have an adequate supply of water so in the case of those
wells that are impacted, we will be able to supply fresh water to them. Another event that occurred in 1976 was a discovery in reference to the Grumman situation, where employees in Hicksville were complaining about taste and odors in their water. With the assistance of federal, state and county governments, what are now called organic chemicals were found in that water. Existence of these chemicals were producing taste and odors. Nassau County made a comprehensive effort over the next two years to sample every public well in Nassau County, of which there are over 400. We determined that 16 out of those 400 wells contained these organic chemicals at such levels that the State Health Department recommended closing the wells. This gave advent to the concern, real concern, over organic chemical contamination which we are dealing with yet today. It has, in fact, been in the papers and has led to concern over breast cancer and many other illnesses, which people may attribute to those chemicals. They have been called toxics, hazardous chemicals, and some other names, but they boil down to organic chemicals which basically do have a health risk associated with them and are still, to this day, causing us concern. The last historical event that occurred was back in 1986 when NYSDEC, on the basis of previous studies and information existing at that time, saw fit to limit the Nassau County water purveyors on how much water they could pump each year. You may have heard the term "cap" used regarding to that limitation that was imposed on those water suppliers. Again, in some of the media, the placement of these caps was misinterpreted as evidence that we were running out of water in Nassau County. Far be it from that case. We are not running out of water. The caps were intended, as NYSDEC will clearly point out to you, to prevent certain environmental situations from becoming worse - such as saltwater intrusion, such as the drying up of our streams and lakes, which has occurred and is still occurring. DEC took a very responsible action but, again, this was misinterpreted to mean that Nassau County was running out of water, and this is not the case. I think it is important for us to understand some of the historical events that have taken place, so we can appreciate why the controversy exists. What I would like to do now is do the slide show, giving you the factual information that I believe exists in Nassau County based upon hard data that the County, USGS, DEC, and water suppliers have collected for many, many years and are in a position to take that data and evaluate it with such tools as computer models. USGS has computer models, Nassau County has computer models and we can evaluate that data very comprehensively and predict what will happen in the future if we do certain things. With that, I would like to start the slide show. (Figures 14 an 15).

I don't want to reiterate too much of what Mr. Buxton has gone through, but it is important in Nassau County's case, a very basic point which we all should understand — Nassau County receives 100% of its water supply from the rain that falls on its land surface. This water has a number of routes that it can take. Roughly half of the water finds its way down into the aquifer system. The remaining half of that water either flows overland to the surrounding saltwater bodies or is returned to the atmosphere through evapotranspiration. Once it gets into the groundwater system we either pump it out and serve it to homes along the south shore, which is served by sewage treatment plants, or we may pump it in the case of north shore to homes that are served by cesspools. Where cesspools exist, much of that water — about 80% of it — is returned to the groundwater system; only 20% of that water is lost. On the other hand, when we pump water to a home that is connected to sanitary sewer, almost 100% is lost. Only the water that is used outdoors may find its way back into the ground, but that is a very small percentage. So in Nassau County's case, it is very important to distinguish whether is the home connected to a sanitary sewer or not. Presently over 90% of our population is served by sewer plants. We have a number of districts. Nassau County itself operates three disposal districts, mainly along the south shore. 140 million gallons per day of wastewater is discharged to the surrounding saltwater bodies. Out of the 180 million gallons per day that we are pumping from the aquifer system, most of the water pumped out of the ground in Nassau County never finds its way back into the aquifer system. This is one of the stresses that Herb was referring to. I would like to go through a series of factors that we must understand to arrive at the total water picture in the County. I will be going through the whole water quantity scenario with you.

Another major factor is the annual precipitation. We have a number of weather stations in Nassau County recording the number of inches of rain that have occurred in the years 1935 to present. Nassau County averages about 44.7 inches of rain per year. However in any given
Figure 14 Water Cycle Schematic
**WATER BALANCE IN NASSAU COUNTY 1990**

**EVAPORATION**
315 MGD

**DIRECT RUNOFF**
15 MGD

**PRECIPITATION**
660 MGD

**GROUND WATER RESERVOIR**

**CONSUMPTIVE USE**
- SEwers
  140 MGD
- OUTDOOR USE
  34 MGD
- COMMERCIAL - INDUSTRIAL USE
  6 MGD

**TOTAL**
180 MGD

**RECHARGE**
330 MGD

**STREAMFLOW**
40 MGD

**UNDERFLOW**
110 MGD

**TOTAL DISCHARGES**
330 MGD

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Figure 15: Water Balance in Nassau County, 1990
In the 1960s, we see that we went through a number of successive years of below average rainfall and we call that a drought. Later we will discuss what that drought did to our groundwater table. In recent years we have recorded some abnormally high rainfall years, and we will also see what that does to the water table. What is important to note here is the fact that we must look at a long term picture. The water table will respond to these drops and rises in precipitation, with about half of that precipitation getting into the ground, so you would expect the groundwater table to fluctuate in direct response to the precipitation, which it does. But, whether the water table continues to go up or down will depend on what the average conditions are over a long period of time and how much water we are pumping with time. We have to look at a very long long-term picture when we look at the groundwater system. (Figures 16 and 17).

Another very important part of the County's groundwater system are the recharge basins. In Nassau County we have over 800 of these recharge basins. These basins, also referred to as sumps, serve to capture the stormwater. Storm drainage is routed to these basins where it finds its way into the groundwater system. We do not have the number of basins along the south shore and the north shore that we have near the middle of the island, and the reason for that is that we have higher groundwater conditions near the shoreline and therefore do not construct these basins. Along the shoreline we route much of stormwater to the streams, with the streams falling out to the surrounding bays. As we have developed Nassau County, we have changed the pattern of how we recharge the stormwater that falls in Nassau County. Along much of the shoreline that stormwater is routed to the surrounding surface water bodies and is not recharged, whereas in the center two-thirds of the island we are recharging more water today than we would have under natural conditions. These recharge basins basically recharge more water than in an undeveloped type condition mainly because we do not lose that water through evapotranspiration through the growing season. (Figure 18).

Another important concept that Herb had talked about when we looked at how much water is getting into the ground is the concept of capture, once we put a public water supply well in. When you drill a well into the aquifer system, what we are doing is changing the flow paths of the recharge water that might otherwise flow shallow to the surrounding bays and oceans. We pull it down vertically because of the decreased pressure that we are creating at the point where the water enters the well, since we are now capturing a lot of shallow groundwater or water above the screen level at whatever depth that may be. We are capturing that water which would otherwise naturally flow out of the groundwater system. Given the fact that we have over 400 public wells in Nassau County we are capturing an awful lot of groundwater that otherwise would not have been captured. A very important point. (Figure 19).

Another major factor obviously is population, as was mentioned earlier. Nassau County's population presently is about 1.28 million people, but the County grew very rapidly between the 1940s and 1970s. The projection was for this population to eventually go up to as high as 2.3 million people. This has not occurred. In fact, the population not only has stabilized, but seems to be falling. Population projections to the year 2010 indicate a population very similar to what we have today, about 1.3 million people. This is extremely important - the more people we have in the County the more water will be used. (Figure 20).

If we take a look at the County as a whole, we have 58 public water systems. These 58 public water systems have a total of 422 wells. In addition to those wells, we have over 400 monitoring wells, so that we have an over 800 well database from which to collect quantity and quality information. The locations of these public supply wells are scattered throughout the County. The amount of water that we pump in the County, again, basically reflects the population growth. Back in the 1940s we were pumping less than 40 million gallons per day. Presently that has risen to approximately 180 million gallons per day. With water conservation efforts since 1987, we are beginning to see a little tailing off of that pumpage, and we note that approximately six percent less water is being pumped today than was just five years ago. The water conservation efforts that the County is undertaking, along with the water suppliers and New York State, are working in Nassau County and we see the pumpage stabilizing and dropping slowly. The distribution of that pumping in Nassau County, by far the vast majority of
GROUNDWATER AQUIFER SYSTEM

LONG ISLAND SOUND

LAND SURFACE

WATER TABLE

GARDINER CLAY JAMESPORT AQUIFER

BARRIER ISLAND

ATLANTIC OCEAN

UPPER GLACIAL AQUIFER

FRANKLIN AQUIFER

MAGOthy AQUIFER

FRESH GROUNDWATER

FRESH GROUNDWATER

LLOYD AQUIFER

SALT WATER

BEDROCK

NORTH

SOUTH

NGD PW
Annual Precipitation at Mineola Weather Station (1937 - 1991)

- 50 Yr. Avg.
  44.7 Inches

DROUGHT

Precipitation (Inches)

Year


NCDPW
Figure 18 Location of Nassau County Recharge Basins
Figure 19 Water Capture
that water — 89 percent, is pumped from that middle Magothy aquifer. The remaining 5 percent is taken from the Upper Glacial and 6 percent from the Lloyd. (Figures 21, 22, 23, and 24).

As far as water conservation is concerned, the monthly pumpage in Nassau County, applying the amount of water we pump daily, by month, indicates that from 1987 to the present we have dropped monthly pumpage, especially in the summer months. There has been a 10 percent drop in summer, whereas winter months have seen a 4 percent drop. So our conservation program is working and we will see what the effects of that conservation program are in the long run. (Figure 25).

At present the water demand in Nassau County is 178 million gallons per day, 90% of which is residential, 10% commercial/industrial. What is it going to go to in the future? What level of demand are we going to be looking at? We have a flow projection that says if we don’t develop, basically we will stay at present day levels because our population is going to stay essentially the same. If we do not have any more development than this in Nassau County, we will stay at the same 178 million gallons per day level. On the other hand if we have more development in Nassau County, we will be looking at an increase of the water demand of up to 192 millions gallons per day. That is based upon development at the zoning presently established in the various undeveloped areas in the County. So we are looking at potentially a 14 million gallon per day increase if further development occurs in Nassau County. That increased water demand might be reduced even further if we were to practice additional water conservation. (Figure 26).

Looking at all of these factors, we want to take a look at the water table and say, well, with the water that we’re pumping, with the recharge that is occurring, how does this affect our water table? What does the water table do over time as a result of these various fluxes and stresses that are placed on our system. During the 1945 to 1955 period, the water table fluctuated up and down around the 45 point level. This is an average level. If you look at a given well in the County you basically have the same—it averages about 45 feet above mean sea level. We installed sanitary sewers in the western portion of Nassau County - Sewer District 2, and you can see that simultaneous with the installation of the sewers we went through a drought period in the 1960s, and the water table dropped dramatically, down to average of about 38 feet above sea level. After the whole effect of the sewering program, after the drought was over, we went back up to above normal precipitation, and the water table began to rebound. We then sewerred the eastern part of Nassau County. We are now pumping more and what we are pumping is going out to the surrounding bays and oceans as wastewater. The present day water table elevation will hover at a level that, on average, is about 5’ below what it once was 30-40 years ago. Again, looking at that average 5’ drop, depending on where you are in the County, that drop may actually be up to 15’ or down to nothing near the shoreline; if you look at it as an average 5’ drop and look at the total aquifer system which averages about 800 feet thick in Nassau County, that drop constitutes a loss in volume in Nassau’s groundwater system of less than 1%. From volumetric point of view, given the vastness of a ten trillion gallon storage system that exists in Nassau County, it is insignificant. However, as Herb Buxton previously pointed out, the streams, lakes and ponds and surface water bodies are fed from the groundwater system so that even a small decline in the water table can have a disastrous impact on streams. If we take a look, for example at Valley Stream, which is in the western portion of Nassau County, we can see that the flow in cubic feet per second over time, beginning in the 1900s to the present day period, the flow has dropped to where the stream is now dry. If we work our way eastward in the County, the next stream would be Pinesbrook, and again the flow is dropping off dramatically. East Meadowbrook is dropping off dramatically. Bellmore has gone down, Massapequa will go down severely. The point that I want to make on the streamflow - this is a separate and distinct issue from the ability to supply water. While the streams are drying up, and the water table has dropped, we are expecting that the water table will stabilize very close to its present day level. The reason we are expecting to stay at that level is the population is not increasing, the sewering programs are completed. The water table has already achieved most of the drop that will occur and the effects that we are seeing is a drying up of streams, lakes and ponds, but this is

34
WELLS IN NASSAU COUNTY

58 PUBLIC WATER SUPPLY SYSTEMS

PUBLIC SUPPLY WELLS:

- 40 GLACIAL WELLS
- 338 MAGOTHY WELLS
- 40 LLOYD WELLS
- 4 OTHER WELLS

422 TOTAL PUBLIC WATER SUPPLY WELLS

MONITORING WELLS:

- 273 GLACIAL WELLS
- 144 MAGOTHY WELLS
- 11 LLOYD WELLS
- 5 OTHER WELLS

433 TOTAL MONITORING WELLS

Figure 21 Wells in Nassau County
Figure 22: Location of Public Supply Wells in Nassau County

Legend:
- Lower Aquifer
- Upper Aquifer
- Water Supply Wells

Location of Public Supply Wells

Nassau County Groundwater System
Figure 23 Public Water Supply Pumpage in Nassau County
DISTRIBUTION OF PUMPAGE BY AQUIFER IN NASSAU COUNTY 1991

MAGOTHY 89%

UPPER GLACIAL AND JAMECO 5%

LLOYD 6%
Figure 25: Average Monthly Pumpage Rates Before & After Conservation in Nassau County

NASSAU COUNTY GROUNDWATER SYSTEM

AVERAGE MONTHLY PUMPAGE RATES
BEFORE & AFTER CONSERVATION
IN NASSAU COUNTY

PUMPAGE (MGD)

MONTH

JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC

■ PRE-CONSERVATION 1983–1987

□ POST-CONSERVATION 1988–1992

NCDPW
NASSAU COUNTY GROUNDWATER SYSTEM

WATER DEMAND IN NASSAU COUNTY

PRESENT DAY
178 MGD

HIGH PROJECTION

10%
90%

LOW PROJECTION

10%
90%

YEAR 2010
192 MGD

YEAR 2010
178 MGD

RESIDENTIAL
NON-RESIDENTIAL

HIGH PROJECTION = MORE DEVELOPMENT
LOW PROJECTION = NO FURTHER DEVELOPMENT

NCDPW
tota}ly and separately distinct from our ability to supply water. We have an adequate supply of drinking water. (Figures 27, 28, 29, 30, 31, 32, and 33).

Let's take a look at the complete picture now and put some numbers on some of the items we have been talking about. If we consider the groundwater system as a leaking tank and we take a precipitation of 45" of rain per year that occurs in Nassau County, that is equivalent to 660 million gallons per day when spread over a land area of about 300 square miles, the land surface area of Nassau County. Approximately half of that rainfall is lost as either evapotranspiration, a much larger component, or as direct runoff to our surrounding saltwater bodies. The remaining half of that 660 mgd, 330 mgd, gets into our leaking groundwater tank. When I say it is leaking, it has outflows from the tank. One of the outflows is the water that we pump from all of our wells. When we add those 422 public wells along with some of our commercial and industrial wells, we have a consumptive use, water that is pumped out of the ground that is not returned to the ground. We have a total consumptive use category of about 180 million gallons per day. We measure the streams in Nassau County; we know that the stream flow is about 40 mgd. The underflow, the water that flows under the ground, is approximately 140 mgd along the shorelines. That will, by necessity, add up to 330 mgd because the system must be in equilibrium, and it is an equilibrium so long as our consumptive use stays lower than the amount of water that we are recharging. We are looking at 330 mgd water going into the system. Man is using just a little more than half of it. The remaining is naturally discharged on its own via streamflow, or underflow. This is why I say we will not be running out of water. The water table will hover at its new equilibrium level that has been established as a result of us pumping this amount of water and having completed the sewering program in Nassau County and basically receiving fairly constant levels of recharge. This is the water quantity picture in Nassau County. (Figure 15).

Let's talk for a few minutes about the water quality situation in Nassau County. There are five basic problems that we see in water quality. One is the fact that the water that we pump from these wells is very acidic. The reason for it is that the rainfall itself has a very low pH. The number of wells exceeding this standard - there is no standard per se for acid water or low pH water. However, we do add chemicals, at a very low cost, to try and neutralize this acidity such that the water, when it flows through the pipes to our homes, is not leaching out any of the metals, such as lead, iron, copper, etc., from the pipes it flows through. If we did not neutralize that acidity we would have problems with some of the heavy metals in our waters. Virtually all of the wells in Nassau County have chemical additions to neutralize the acidity. That is not a major problem in terms of health problems, with the possible exception of lead. We do have a very low cost method of treating that water by adding either lime or caustic soda. (Figure 34).

Another problem is with nitrates. Nitrates are a pollutant that is a component of human waste, animal waste, fertilizers, natural organic decomposition. We have a groundwater standard for drinking water of 10 mg per liter. Nitrates are a health problem especially for infants because of the nitrates converting the hemoglobin to methemoglobin and voiding the ability of the blood to carry oxygen. This is the health concern that exists with nitrates in the water and we have to be very careful that we do not exceed the 10 mg per liter, especially as it concerns infants that may be drinking this water. To what extent is it a problem in Nassau County? Six percent of our public wells exceed that standard. You can deal with the problem by either blending the water, taking water from the very good quality well and blending it with the problem well. There is very low cost associated with providing good quality water as a result of blending technique. If we were to try and physically remove the nitrates from the water by installing a treatment facility at that well, we would be looking at some processes such as ion exchange, biological denitrification, both of which have an extremely high cost. In Nassau County we have one well in the Garden City Park water district that is treated by the ion exchange process for removal of nitrates and the reason we only have that one well is because of the high cost associated with it. Most of our wells are either abandoned - the well water is not used, or we blend the water from that high nitrate well with water from a good quality nitrate well. (Figure 35).
SEWERED AREA IN NASSAU COUNTY

90% OF THE POPULATION IS SEWERED

Figure 27 Sewered Area in Nassau County
NASSAU COUNTY WATER TABLE ELEVATION

Year


Nassau County Water Table Elevation

Drought

Western Nassau County Sewering

Eastern Nassau County Sewering
Bellmore Creek

- base flow
- runoff

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Projection (USGS)

Figure 32

Massapequa Creek

- base flow
- runoff

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Projection (USGS)

Figure 33
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<th>TREATMENT</th>
<th>COST</th>
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<td>* CHEMICAL ADDITIVE</td>
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<td>* BLENDING</td>
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<td>* ION EXCHANGE</td>
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<tr>
<td></td>
<td>* CESSPOOL CLEANERS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHLORIDES (&gt;250 PPM)</td>
<td>* SALTWATER INTRUSION</td>
<td>&lt;1</td>
<td>* REVERSE OSMOSIS</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>* ROAD SALT</td>
<td></td>
<td>* ION EXCHANGE</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>* DISTILLATION</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>* ELECTRODIALYSIS</td>
<td></td>
</tr>
<tr>
<td>IRON (&gt;0.3 PPM)</td>
<td>* NATURALLY OCCURS IN SOIL</td>
<td>28</td>
<td>* FILTRATION</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>* CHEMICAL SEQUESTERING</td>
<td>LOW</td>
</tr>
</tbody>
</table>
PUBLIC SUPPLY WELLS EXCEEDING STANDARD (>10 PPM) FOR NITRATES 1991

WELLS NOT USED
▲ WELLS IN USE (BLENDED OR TREATED)

Figure 35 Public Supply Wells Exceeding Standard (>10 ppm) for Nitrates, 1991
Synthetic organics - cleaning solvents, cesspool cleaners, etc.—the crux of our problem. How many wells in the County are affected? Approximately 17%. That’s a pretty good number of wells. That equates to about 60 or 70 public wells. There are two methods of treating for that particular problem. We either air-strip it out or we take it out through activated carbon. It has a medium cost associated with treatment. With the number of wells that we are looking at with that problem, it is important to understand what that cost is to the consumer.

Chlorides are in the water as a result of saltwater intrusion or the use of road salts. Less than 1% of the public wells have high chloride concentrations greater than 250 parts per million. How do we remove chlorides from the water? Distillation, electrodialysis - all of which have an extremely high cost. This is one of the reasons that saltwater intrusion is of great concern, not only from the point of view of how it is going to shrink the groundwater system, but the potential cost to the consumer as a result of having to treat that water.

The last problem that we have with the Nassau County wells regarding quality is the iron content that comes from natural iron in the soils within the aquifer system. Twenty-eight percent of the wells in Nassau County exceed the drinking water standard of 0.3 milligrams per liter of iron. How do we treat for that? We can either filter it, actually physically remove the iron, or we can add a sequestering chemical, a polyphosphate for example, which will chemically combine with the iron and render it innocuous in terms of color formation that occurs in the water.

What is very important for everybody to understand is that while we may have some of this contaminated groundwater, when we pump that well we send the water through a treatment process, either physically removing the contaminant or by blending it or adding chemical additives, etc., so that the treated water delivered to the consumer does not have these contaminants, or at least, is treated to the level that it meets every drinking water standard. When we talk about contaminated well water we must make every effort to make it clear to the consumer that this is not the water that he is drinking. He is drinking the water after it is treated. The 51 major public water systems that we have in Nassau County, they do an excellent job of treatment. They are very responsible people that provide all of the testing and meet every health standard that is imposed on them. They are assuring the public that they are drinking the highest quality water. (Figure 36).

Let’s take a look at the treatment cost for volatile organic chemicals. The assumptions we are making is that a well contains volatile organic chemicals and we are putting an air stripper down into the well. It has an operating cost of power for blowers and repumping that has to be done at a well after treatment. The operating cost may be about $8,000 per year, mainly for power. Also, we have a tapper cost of about $500,000 initially to install that equipment. If you annualized that over a 20 year period—almost all of the treatment facilities in Nassau County are funded through bonds, serial or municipal bonds, with a general life of approximately 20 years—at an interest rate of 8%, and an average pumping rate of 4 million gallons for that particular water system, the cost of the treatment amounts to four cents per thousand gallons. The cost of water before that treatment is approximately $1.85 per thousand gallons. We are looking at an increased cost of four cents due to that treatment, approximately a 2% increase in somebody’s water bill. I think the average consumers, when you tell them we have contamination of the well and that it will cost us $500,000 to put that treatment in at the well, think their water bill may double or triple. Generally, the impact to the consumer is about one nickel per thousand gallons. These are average numbers that will vary depending upon the specifics of the well, or the initial capital cost above $500,000, etc. (Figure 37).

Let me talk for one minute about saltwater intrusion. Where is it occurring in Nassau County? Basically on the south shore, but also on the Great Neck peninsula. It has been getting worse in those two areas over a very long time period, especially on the south shore. In Great Neck it is occurring at a little more rapid rate. Along the south shore we are basically looking at the Magothy formation as having saltwater intrusion existing at the barrier islands, Long Beach, Atlantic Beach; and already inland past those barrier islands. On the mainland, it is in the western part of Nassau County into Queens. Where will it go? It will eventually come further north. The driving force for saltwater intrusion on the south shore is two fold. It is a
Figure 36  Schematic of Water Treatment Testing
TREATMENT COSTS FOR VOLATILE ORGANIC CHEMICALS

ASSUMPTIONS:
OPERATING COST = $8,000/YR
CAPITAL COST = $500,000 (AIR STRIPPING)
ANNUALIZED PERIOD = 20 YRS
INTEREST RATE = 8%
ANNUAL PUMPAGE = 4 MGD

RESULTS:
COST OF TREATMENT = $0.04 PER THOUSAND GALLONS
COST OF WATER BEFORE TREATMENT = $1.85 PER THOUSAND GALLONS
COST INCREASE DUE TO TREATMENT = 2%
combination of the pumping effects, which will bring it further inland, than it would have naturally occurred otherwise. The second driving force is the rising sea level that has occurred: over a 300’ rise in sea levels over the last 18,000 years. It is a very, very long term phenomenon to see saltwater move from way out at the ocean point, inland to its new equilibrium line. It takes thousands of years before it can reach that equilibrium. We are still seeing that movement today. When we pump, we will be bringing that saltwater even further. Some public wells have been impacted in the Magothy aquifer by that saltwater intrusion. If we look at the Lloyd aquifer situation on the south shore, we are looking at the saltwater/freshwater front being some unknown location offshore. It is one of the mysteries that still exists regarding saltwater intrusion. We know it to be offshore, because we have public wells on the barrier island which are not impacted. They are in the Lloyd aquifer and they are drawing fresh water. We do expect that over hundreds of years it will eventually get to this level, without pumping, and it will be brought in even a little further because of the pumping that we are doing further north. It will take hundreds of years. It is moving at a rate of approximately 100 feet per year. What we have done is to install a number of monitoring wells, non-drinking wells, along the barrier islands so that if and when saltwater intrusion occurs, we will know about it before it hits the public wells, which are further north. The time-frame between it first hitting the monitoring wells and reaching the public wells is approximately ten years. We would have the time to make whatever corrections or engineering solutions necessary to take care of the water supply on the barrier islands. In Great Neck we are looking at a situation of saltwater intrusion from 1900 to 1990. Saltwater in 1900 was basically out in the bays. As we started pumping water, saltwater kept moving inland on this peninsula. Presently there are two public wells that have already been impacted by saltwater intrusion. These are Lloyd aquifer wells. As time goes on, the saltwater intrusion will come in further, with another four wells being impacted. Six of the eleven wells will be overrun by saltwater intrusion. We are looking at solutions to this today. We are working with the Great Neck Water Authority, and their consultant, to try and utilize the County’s groundwater wells to look at solutions to the problem. What are some of the options we do have? I mentioned the well-head treatment for chlorides is very expensive. An alternate solution to treating at the well itself might be to physically move the well, either vertically if the saltwater intrusion is coming down deep, or inland if the saltwater wedge is up higher. These are solutions we would look at first because of the expense to remove the chlorides at the well itself. The well screen locations could be raised in many of the wells because the saltwater intrusion does come down deep within the Magothy formation. (Figure 38).

Organic chemical contamination - areas in the County where we have significant organic chemical contaminations - there are sites where we have measured over 1000 ppb of total organic chemicals - Glen Cove, Grumman, New Castle, Roosevelt Field, Garden City Park - areas we know to have heaviest chemical contamination. As far as the public water supply wells, about 17% of our public wells do not meet the drinking water standards of 5 ppb because of contamination. The good news is that 83% of them do without any treatment. To say that the groundwater system of Nassau County is grossly contaminated is incorrect. Yes, we do have our problems, but 83% of the wells naturally, without any treatment, meet drinking water standards for organic chemicals. Impacted wells are located in a central band, east-west, across the county. Not certain about the reason for this. With the western part of Nassau County having been seweried for the past 40 years and with this number of public wells having been impacted - there does not seem to be any clear cause and effect as far as sanitary sewer system is concerned. Being tied into the sanitary sewer system is no guarantee that contamination has not occurred. Wells are being treated or abandoned, if there is sufficient capacity. In 1976, when we first started testing for organic chemicals, the standard was 50 ppb. The number of wells has remained very constant over time. In 1989 the standard changed from 50 to 5 ppb; therefore, an additional number of wells were impacted by this lowered standard. Over time, things do not seem to be getting worse, but are remaining constant. This suggests that much of the contamination in the groundwater occurred before the 1976 period. We don’t have the ability to determine when the contamination went into the ground that reached a particular well. The data does show that much of the contamination did occur many years ago. (Figures 39, 40, 41, 42 and 43).
Figure 38 Salt Water Position Lloyd/Port Washington Aquifer
Figure 39 Areas with Significant Volatile Organic Chemical Contamination
Figure 40 Public Supply Wells Exceeding Standard for Volatile Organic Chemicals

NASSAU COUNTY GROUNDWATER SYSTEM

PUBLIC SUPPLY WELLS EXCEEDING STANDARD FOR VOLATILE ORGANIC CHEMICALS

STD. = 5 PPB

STD. = 50 PPB

YEAR


NUMBER OF WELLS EXCEEDING STANDARD FOR VOC'S
Figure 41 Public Supply Wells Exceeding Standard (> ppb) for Volatile Organic Chemicals 1989-1991
PUBLIC SUPPLY WELLS IMPACTED BY VOLATILE ORGANIC CHEMICALS 1989-1991

17%
(70 WELLS)

83%
(352 WELLS)

ALL AQUIFERS
(422 WELLS)
Figure 43 Public Supply Wells Impacted by Volatile Organic Chemicals 1989-1991

NASSAU COUNTY GROUNDWATER SYSTEM

PUBLIC SUPPLY WELLS IMPACTED BY VOLATILE ORGANIC CHEMICALS 1989-1991

- Upper Glacial Aquifer (40 Wells)
  - 18% < 5 PPB
  - 82% > 5 PPB

- Magothy Aquifer (338 Wells)
  - 18% < 5 PPB
  - 82% > 5 PPB

- Lloyd Aquifer (40 Wells)
  - 3% < 5 PPB
  - 97% > 5 PPB

[Diagram showing percentages and well numbers for each aquifer type]
Public wells exceeding the standard for nitrate - there are 35 wells that exceed the standard - again, occur mainly in center of the island. Water from some wells is blended; other wells are abandoned. What is happening to nitrates in our groundwater system as result of having put in sanitary sewers? In the western part of the county, where sewers have been in for 40 years, the nitrate/nitrogen level had been up around 7 or 8 milligrams per liter on average, with some wells exceeding the standard. But as time has gone on, from 1960 to today, the nitrate trend in western Nassau County has been going down very dramatically, to the present level in the Upper Glacial of about 3 million parts per liter. In the eastern part of the County, sanitary sewers were installed from 1975 to 1985, and the rate is also starting to go down. This is the reason we spent billions of dollars to put in sanitary sewers. Everyone always talks about how the water table has gone down as a result of having put those sewers in, and it has, and it has impacted our streams, but we are trying to protect the water quality, and in fact we are. The nitrate level in the Upper Magothy is also remaining pretty constant at 3 or 4 mg/l; Lower Magothy in the 1 to 2 mg/l range and also remaining relatively constant. (Figures 44,45 and 46).

Special Groundwater Protection Areas - there are two in Nassau County—North Hills SGPA and Oyster Bay SGPA. When we look at water quality in SGPAs, North Hills has nitrates of only 3.8 parts per million. This is very good nitrate water quality. Oyster Bay has 2.5 ppm - excellent water quality. Volatile organic chemicals - North Hills has problems with public wells containing organic chemicals. In Oyster Bay every public well meets the standard. On a county-wide average, about 17% do not meet the standard. (Figures 47,48 and 49).

What have we done in Nassau County to protect public water supply? We installed sanitary sewers. The program began back in 1947 and has done a very good job. Ninety percent of County’s population is served by sanitary sewers. If we look at all the other programs that have come into play, it is interesting to note the relative time frame they have been instituted - 1970s and '80s, which is a relatively short time period; some of the newer programs have only been in since the late 1980s. We might ask ourselves - where are we headed? I think we have seen some positive results from the sanitary sewer program and I think we have yet to see the benefits of all these protection programs that have been implemented relatively recently. I would expect volatile organic chemicals in particular will have been dealt with successfully with these programs and that the future bodes well for us between the available treatment we have at the wellhead and the fact that we have protection programs that are minimizing present day input of these chemicals. (Figure 50).

In summary, if the Nassau County aquifer system could speak today, and if asked the state of its health, it would probably say, “I am feeling fine and getting stronger day by day.” This is, in fact, the actual situation based on water quantity and quality data collected by various agencies which oversee this vital resource that supplies 100 percent of the drinking water for its 1.28 million residents.

This is not to say that the groundwater system in the County is without problems. Solely from a water supply point of view, two major concerns stare us in the face; namely, 1) preservation and restoration of the chemical quality of our groundwater; and 2) saltwater intrusion in the southern and northwestern parts of the County. Diligent monitoring, planning and engineering, however, should give us comfort knowing that these concerns can and will be successfully managed without too much financial pain. From an environmental point of view, the loss in streamflow and associated freshwater wetlands, especially on the south shore, is of concern to many people and remedial action by Nassau County is mandated by the U.S. Environmental Protection Agency. It should be clear to all of us that the stream and wetlands problem is in no way related to water supply availability and, therefore, this problem should be viewed from an environmental perspective. Given the vastness of our groundwater system, which has a ten trillion gallon capacity, a relatively small, 5 to 6 foot average, decline in the water table that has caused depletion of south shore streams and lakes, is insignificant from a water supply perspective.

To help explain the overall good health of our aquifer system, many positive facts can be cited:

- the rate at which our aquifer system is recharged far exceeds the rate that we are consuming water from the system. Direct field measurements combined with a computerized groundwa-
Figure 44: Nitrates in the Upper Glacial Aquifer

NITRATES IN THE
UPPER GLACIAL AQUIFER

NASSAU COUNTY GROUNDWATER SYSTEM

YEAR


EASTERN
NASSAU COUNTY

WESTERN
NASSAU COUNTY

NITRATES (mg/L)
Figure 45 Nitrates in the Upper Magothy Aquifer
Figure 46: Nitrates in the Lower Magothy Aquifer
Figure 47 Special Groundwater Protection Areas in Nassau County
NITRATES IN
SPECIAL GROUNDWATER PROTECTION AREAS

NORTH HILLS SGPA
19 PUBLIC SUPPLY WELLS – AVERAGE NITRATES = 3.8 PPM

OYSTER BAY SGPA
34 PUBLIC SUPPLY WELLS – AVERAGE NITRATES = 2.5 PPM

Nassau County Groundwater System

North Hills SGPA

19 Wells

21%

Oyster Bay SGPA

34 Wells

Nassau County

422 Wells

\(< 5\) PPB

\(\geq 5\) PPB
<table>
<thead>
<tr>
<th>Protection Program</th>
<th>Year Started</th>
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<tbody>
<tr>
<td>* Sanitary Sewers</td>
<td>1947</td>
</tr>
<tr>
<td>* SPDES Permits/Inspections</td>
<td>1972</td>
</tr>
<tr>
<td>* Bulk Chemical Storage Permits/Inspections</td>
<td>1982</td>
</tr>
<tr>
<td>* Landfill Control</td>
<td>1982</td>
</tr>
<tr>
<td>* SGPA Ordinance</td>
<td>1985</td>
</tr>
<tr>
<td>* S.T.O.P. Programs</td>
<td>1986</td>
</tr>
<tr>
<td>* Underground Tank Testing/Replacement</td>
<td>1986</td>
</tr>
<tr>
<td>* Salt Storage Protection</td>
<td>1987</td>
</tr>
<tr>
<td>* Underground Injection Control</td>
<td>1989</td>
</tr>
</tbody>
</table>

Figure 50: Groundwater Quality Protection Programs in Nassau County
ter model analysis indicate that, on average, over 330 MGD (million gallons per day) of water recharge into the system while the consumptive withdrawal is only 180 MGD.

- water conservation efforts by the water suppliers, the County and the State have resulted in a six percent reduction in water use on a county-wide basis over the last five years, when compared to the five year period previous to that.

- the County's population has stabilized and actually declined slightly since 1980 and further development is projected to be slight in the years to come. This translates into a projected water demand very close to the present day water demand of about 178 MGD supplying some 1.28 million residents and businesses.

- groundwater quality is good to excellent in the vast majority of public supply and monitoring wells in the County. Only six percent of our 422 public wells exceed the 10 mg/l standard for nitrates, and 17 percent exceed the organic chemical standard (5 ppb for most organic chemicals). Furthermore, the level of nitrates in the shallow groundwater has decreased in the western portion of the County and is expected to decrease in the eastern portion as a result of protection afforded by sanitary sewers. As for organic chemical contamination, the number of public wells impacted has remained almost constant since testing began in 1977.

- given the last two decades of environmental awareness, public education, enactment of regulatory controls, and institution of groundwater protection programs at all levels of government, there is reason to believe that our groundwater quality will, in general, improve with time. The data indicates that this improvement has already begun.

- the cost to the consumer for wellhead treatment should remain relatively constant in the next several decades given the prospect that groundwater quality is expected to gradually improve if any change does occur. Of the 70 public wells impacted by organic chemicals, the public water suppliers have already installed air strippers or activated carbon treatment at half of these wells. Many of the water suppliers have adequate well capacity such that they can afford to shut down an impacted well rather than install treatment. It is estimated that the cost to the consumer of installing and operating organic chemical treatment facilities is about four cents per thousand gallons out of a county-wide average cost of $1.85 per thousand gallons. Therefore this type of treatment is very cost-effective, if and when it becomes necessary.

Allow me now to address the previously cited water supply concerns regarding preservation and restoration of groundwater quality and that of saltwater intrusion. Groundwater quality protection is a policy which the Federal, State and local governments have all embraced for many years. Given the County's medium to high density land development and its total reliance on groundwater for the supply of drinking water, government decisions to construct sanitary sewer systems in Nassau County at a cost in the billions of dollars have been, in my estimation, the best decisions made to protect the quality of our aquifers. Today, over 90 percent of the County residents are connected to a publicly owned sanitary sewer system. Such contaminants as nitrates, chlorides, heavy metals, volatile and nonvolatile organic chemicals, bacteria, viruses and other health, taste and odor substances are discharged at a rate of over 140 MGD into these systems in lieu of on site disposal systems. This is, by far, the largest and most effective protection program instituted in the County as evidenced by material improvement of groundwater nitrate quality.

While removal of some of the contaminants, such as volatile organic chemicals, is very cost-effective at the public well, removal of most of the contaminants is not. The cost to remove nitrates from water, for example, is very expensive and explains why so few treatment facilities exist for nitrate removal at public wells on Long Island and elsewhere. As drinking water standards have become much more stringent in recent years, so too has the protection provided by these sanitary sewer systems become more valued. Since not all areas of the County are sewered, nor is the only mechanism for groundwater contamination via sanitary waste disposal, it became apparent to regulatory agencies that other protection regulations and programs were needed. These regulations and programs address such concerns as on-site wastewater discharge to the ground (IUC and SPDES permits), underground fuel and chemical storage tanks, collection and disposal of household hazardous waste, road salt storage, bulk chemical storage, and sanitary landfills. In combination and, if enforced rigorously, these programs afford a high degree of protection for our groundwater that was not available a short while ago. However, we must endeavor to fund and conduct these programs at a optimum level if they are to be successful.
It should be noted also, that restoring already contaminated groundwater is in progress or planned at various locations in the County. Federal and State superfund sites, oil and gasoline spill sites and other site specific groundwater clean-up efforts serve to capture gross contamination due to accidental spills and/or poorly operated commercial and industrial facilities. Such cleanups tend to be extremely expensive and take many years to bring up to standards. Generally, these costs are paid by the responsible parties rather than the taxpayers. However, given the regulations and public awareness that now exists, the rate at which these site contamination incidents occur appears to be diminishing and cleanup efforts begun years ago are now restoring degraded groundwater in these limited areas of the County.

Saltwater intrusion, as mentioned previously, is the second water supply concern in Nassau County. Primarily as a result of newly completed computer model analyses by the County, in combination with past field studies by the U.S. Geological Survey, we now have for the first time, highly reliable information on where and when saltwater intrusion will occur. The south shore of Nassau and the Great Neck area in the northwest portion of the County are the two areas prone to saltwater intrusion. This phenomenon in the southern part of the County is due to a combination of the historical rise in sea level as well as groundwater withdrawals for water supply purposes. The problem on the north shore is due solely to excessive pumping from wells which exceeds the rate of aquifer recharge.

Nassau County Department of Public Works has studied this problem closely. No public supply wells in the southwest are in any immediate danger of being impacted by chlorides. However, in the coming decades it may be necessary to consider relocating pumping wells or perhaps raising the screen depth on some wells in order to avoid drawing in saltwater. In Great Neck, saltwater intrusion is a more immediate concern since 4 of 11 supply wells have already been impacted with an additional four wells predicted to be impacted over the next few decades. Alternatives are now being investigated, including the installation of new wells away from the shoreline. Importing water from outside the district is another alternative being investigated as well as dramatic water conservation measures. (Figure 51).

Overall, the assessment of the Nassau County aquifer system is very positive. From a water quantity point of view, we are in no danger of depleting the groundwater supply. Recharge continues to exceed consumptive use by a comfortable margin and conservation efforts have been successful in helping to reduce water demand even further. From a water quality point of view, the aquifer is protected from contamination by sanitary sewers serving 90 percent of the population and by virtue of an extensive array of regulations and programs geared toward pollution prevention at industrial sites, commercial establishments, and residences. Mechanisms are in place to identify and remediate any localized quality problems that are found before they become a danger to the public wells. It should also be remembered that a vital component in this effort is the protection provided to the consumer by the water suppliers who closely monitor the quality of the public water to ensure compliance with the strict drinking water health standards. Their diligence in reacting swiftly to water quality problems at the wellhead by providing any necessary treatment is of great comfort. The people of Nassau County will continue to be served the highest water quality at a very affordable cost for many years to come. Those of us in the water industry have the data to support this optimistic forecast. I think the future looks great. Thank you for your attention.

Robert J. Gaffney

Next topic for discussion is Suffolk County water, quality and quantity. Our speaker is Joseph Baier, a professional engineer, with Suffolk County Health Services Department. He has a BS in engineering from New York University, an MS in civil engineering from City College of New York, over 25 years of experience in environmental health, including water and wastewater treatment; water resources studies, hazardous and toxic waste investigations. Currently he is the Director of Environmental Health in the Suffolk County Department of Health Services.
Figure 51  Predicted Salt Water Position Lloyd/Port Washington Aquifer Pumping at Existing Wells Only
The discussion of Suffolk County's groundwater can be broken down into two major divisions:
• water resources and
• water supply.

The water resource is, of course, the groundwater beneath the ground's surface (the entire area of the County) and its total depth. The water supply is what you drink — whether it is from a public water supply or an individual home well.

One major point to keep in mind this morning is that of size. You just heard a discussion of Nassau County's water resources, and the point of size is the fact that Nassau County will easily fit into Brookhaven township, with space to spare. If the two county populations are the same, obviously, by comparing water amounts, Suffolk County must have much more groundwater.

When talking about the resources and the supply, the first thing is to bring everyone up-to-date on the current status of each and then to discuss the future. When discussing the water resources, I will talk about different parts of that resource, the size of it, its quality, and deal with two special portions — SGPA's and Pine Barrens — and their relationship to the total resource. For water supply, I will discuss the different types of water supply in Suffolk County, present some data on each, touch on the regulations, and discuss the quality of the supply, water treatment and water transmission.

A majority of the information presented comes from the Suffolk County Comprehensive Water Resources Management Plan, which was completed in 1987, as well as other reports regarding contamination, and public water supply data on file with the Suffolk County Department of Health Services.

Suffolk County has ten townships and eight Groundwater Management Zones. In addition, there are special water management areas or insular areas such as Montauk, Shelter Island, Fire Island, Fishers Island. Every one of these has unique water problems and must be looked at differently than the main water resource. This main resource is bounded by Long Island Sound on the north, Great South Bay on the south, Nassau border on the west, and on the east by an area extending from Shinnecock Canal across to Mattituck Inlet.

As a result of the Long Island Regional Planning Board 208 Waste Water Management Study, a series of Groundwater Management Zones were established. The eight zones were based on the concept of recharge and discharge of groundwater. Zones I, II, III and V are considered recharge zones where the major groundwater flow component is vertically downward. Zones IV, VI, VII and VIII are discharge zones where the major groundwater flow component is upward towards the surface. The SCDHS has adopted the recharge and discharge zones into its sanitary code, and various regulations (Articles 6, 7 and 12) were approved, recognizing these zones. Certain restrictions have been placed on recharge areas to limit groundwater pollution and industrial activities.

Some information about Suffolk County. Our population is approximately 1.4 million, and the land mass is 884 square miles. The USGS established a recharge rate for Suffolk County of 1.12 mgd per square mile, which computes to recharge of 990 million gallons of water entering the aquifer each day. Keep this number in mind for comparison to pumpage.

The two major aquifers, upper glacial and Magothy, provide all of the water supply for Suffolk residents. The pumpage from each aquifer is about evenly divided, with 100 million gallons per day coming from the glacial and 100 million gallons from the Magothy. The majority of the Magothy pumpage (80% or greater) comes from areas west of Nichols Road, which is a major north/south transportation artery in Suffolk County. This road is also a boundary between Groundwater Management Zones I and III and represents a separation between urban and rural portions of the county.

Suffolk County's estimated pumpage is anywhere from 200-220 mgd. The consumptive loss, that is the amount of water not returned to the aquifer, is estimated to be 95 mgd. The loss...
due to consumptive use consists of effluent discharge from sewage treatment plants with marine discharges, and the loss of recharge due to evapotranspiration, lawn sprinkling, and irrigation.

Looking at these numbers and at the previous recharge rate, you can see that Suffolk County recharges four times more than is actually pumped (990 recharged vs. 220 pumped). In addition, we also recharge almost 10 times the amount of water that is lost consumptively (990 recharge vs. 95 consumptive use). Where does the excess water go?

It goes into three distinct areas. The first is storage. This manifests itself as water table fluctuations. In years of heavy rainfall, storage increases and so does the height of the water table. Conversely, during drought or low rainfall years, less water goes into storage and the water table elevation will decrease. The excess recharge is also lost to streamflow. Suffolk County has many surface water streams. There are several major streams, including the Nissequogue, Peconic, Carmans, Connetquot and Carlls Rivers, plus many other smaller streams. A certain base flow can be associated with each of these streams to account for a major portion of this excess recharge. Finally, the remaining excess recharge flows out to the marine waters on the north and south shores as underflow.

To conclude the discussion of water quantity, Suffolk County has had, does have, and will continue to have an abundant quantity of water for many generations to come. There may be some difficulties in the special water management areas, such as Montauk and portions of the North Fork where the amount of water available is limited by saltwater underlying the freshwater.

**Water Quality**

Given the vast size of Suffolk County’s groundwater resource and the fact that some 70 trillion gallons are retained in storage, it is no easy task attempting to describe the water quality. In order to do this, one must begin with the obvious conclusion that land use impacts water quality. Whatever we do on the surface of the ground, whether it be farming, building, etc., some impact occurs on the groundwater beneath that land.

Next, there are two major sources of pollution

- point sources and
- non-point sources.

**Point sources** are occurrences such as spills from leaking gasoline tanks, illegal industrial discharges, or wastewater from sewage treatment plants. The important thing to recognize is that these point sources represent individual, definable and, sometimes, only potential sources of groundwater contamination. Most point sources or groundwater discharges are regulated by state discharge permits (SPDES). Major non-point sources are farming, housing developments in unsewered areas, and highway runoff.

When talking of impacts to the groundwater from pollution sources, we really need to become more specific about contaminants. To review groundwater contamination in Suffolk County, I thought it best to present data by decade. In the 1960s detergents and nitrates were our greatest concern. Detergents primarily made engineers and planners aware that our groundwater aquifer was indeed vulnerable to pollutants discharged into homeowners' cesspools. The '60s were also the time when sewering became a great issue and the Southwest Sewer District was formed. Nitrates were a problem to the east end farming communities. Contamination in the 1970's began with nitrates and iron. Some nitrates were discovered in shallow public water supply wells, and iron was found to be a problem as newer Magothy wells were installed. In the late '70s, pesticides, most notably aldicarb, were found extensively in the farming community. As a result of the pesticides' toxicity, a great many individual homeowner wells were contaminated. Aldicarb is still being found in groundwater, but explaining the aldicarb findings over the past 15 years is a subject of future presentations.

In the '80s, advances in technology allowed scientists to begin to look at contaminants in the parts per billion range. The use of mass spectrometer and gas chromatography began to show the presence of organics in our groundwater. When the laboratory could analyze for a new, specific group of contaminants, samples were taken and something was usually found.
Presently, 57 organic and pesticide compounds have been identified in Suffolk County groundwater. What can we expect in the 90's? Probably more of the '80s, with additional emphasis on bacteriological concerns from giardia, cryptosporidium and viruses.

Saltwater intrusion has always been a concern in Nassau County, but it is not a problem in Suffolk County. There are localized shoreline problems in communities on the North Fork where private wells are installed near shorelines, and also in the Montauk area where heavy summer population does cause saltwater problems. However, the phenomena of saltwater intrusion is something that should be considered in more detail at a future conference to allow for a more complete understanding of intrusion and upconing.

Now that the potential groundwater contaminants have been mentioned, where in vast aquifer system can they be found? The upper glacial aquifer becomes the initial recipient of all chemicals or contaminants introduced into the groundwater. Whether it be from farming (non-point) or a spill (point source), the upper glacial aquifer receives the pollutant first. Then as the groundwater hydrogeology takes over, the pollutant can move into the Magothy. Vertical movement can also be dramatically accelerated through pumpage of deep wells. Years ago, if a supply well was found to be contaminated, a deeper well was generally installed. When the deeper wells were then found to be affected, it became apparent that this was not the best solution and wellhead treatment was considered. (See later discussions in water supply.) In general, where land is used or developed, you will find groundwater quality changes and sometimes quality violations ensue.

Another discussion topic is the seven Suffolk County Special Groundwater Protection Areas (SGPA's). The boundaries of these areas were established primarily to include major undeveloped lands. As part of the SGPA Study, SCDHS performed water quality and quantity investigations in each area. With the exception of the Hither Hills SGPA (which has no development at all), each of the remaining SGPA's were shown to have areas of contamination; that is, they have a sewage treatment plant discharge, or spills have been identified, or leaking gasoline tanks have been found to have polluted the groundwater. Moreover, some public supply wells have also shown to be impacted in these SGPA's. Conversely, there are parts of the SGPA's where no contamination was shown, both in the glacial and Magothy. Yet, the presence of good and poor water is no different than what is found in other portions of the aquifer outside the SGPA.

As an example, the Central Suffolk SGPA, which is 195 square miles (almost as large as Nassau County) has Superfund sites, spill locations, landfills, monitoring wells, and SGPA's. As you might expect, there are areas of contamination and water quality violations within this SGPA. Yet, probably 75% of the water in this area is still of excellent quality.

The Pine Barrens is a land mass of approximately 110,000 acres or 172 square miles, and it is situated within the Central Suffolk SGPA. Again, there are areas of known contamination within the Pine Barrens. Areas such as Grumman, Brookhaven National Laboratory, and Westhampton Airport have groundwater contamination identified and cleanups occurring.

Both the SGPA's and the Pine Barrens are important parts of the total groundwater resource, but they are a no more important water resource than those areas outside their boundaries. The preservation of these areas is important, but not from groundwater perspective, rather from open space and quality of life perspective. Maintaining the rural character of central and eastern Suffolk is important to the economy of the county. The central portion is important for providing the open space buffer between the rural sections of eastern Suffolk and urban areas of western Suffolk. The east provides the tourist activity needed for the economy. Both need to be maintained.

The current status of our water resources is that the quantity is abundant enough to meet all needs except for some specific areas. The quality can be summarized using the chart below. The chart shows glacial and Magothy water quality by dividing the county up as: west of Nichols Road (L.I. Expressway, Exit 62); east of Nichols Road; the North Fork; South Fork; and Shelter Island.
Water Quality Status

<table>
<thead>
<tr>
<th></th>
<th>West of Exit 62</th>
<th>East of Exit 62</th>
<th>North Fork</th>
<th>South Fork</th>
<th>Shelter Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial Water</td>
<td>Poor to Average</td>
<td>Poor to Marginal</td>
<td>Good to Excellent</td>
<td>Average to Good</td>
<td></td>
</tr>
<tr>
<td>Magothy Water</td>
<td>Good to Excellent</td>
<td>Excellent</td>
<td>Salted</td>
<td>Excellent</td>
<td>Salted</td>
</tr>
</tbody>
</table>

SCALE

<table>
<thead>
<tr>
<th>Poor</th>
<th>Marginal</th>
<th>Average</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

Water Supply

There are three major water supply groups in Suffolk County:

- community,
- non-community (including non-community nontransient [NCNT]), and
- private wells.

The community water supplies serve customers where there are five or more service connections. Community water reaches 1.2 million people and consists of 63 supplies (reduced from 80 in 1987). Over 600 wells of varying capacity provide the drinking water. The Suffolk County Water Authority is the largest supplier, with 400 wells serving over one million people.

Most public water supply wells are located in the western portion of Suffolk County, and most of the water each customer receives travels distances no further than three miles.

An NCNT system is defined as a noncommunity system where a regular, definite population is served. An example is a school or office building where the same people frequent the building each day, and the building is served by an individual well. There are 114 NCNT’s, and an additional 631 non-community systems. The total of these, 745, is not all together different from the 724 reported in 1984. While community water supplies have been extended to eliminate some noncommunity systems, new ones are created to replace them.

There are an estimated 60,000 private wells serving individual year-round and seasonal homes. These wells serve a population of about 200,000 people. In 1980, there was an estimated 78,000 private wells, so the extension of community water systems has had a definite impact in reducing private wells.

The public water supply systems (community and noncommunity) are under the close scrutiny pursuant to many regulations. The Safe Drinking Water Act and the New York State and Suffolk County Sanitary Codes provide regulations for the operation of water systems as well as public water quality regulations. Standards for quality and monitoring are established and sampling is carried out by the water suppliers as well as by the County. For example, SCDHS analyzed 3,100 organic samples in 1991. In comparison, the SCWA analyzed 37,000 samples for organics, inorganics, and bacteriological quality. Suffice to say that your public water supplies are well monitored to ensure that proper quality water is supplied.

How good or how bad is the quality of the public water supplies? This can be summarized by looking at quality, using specific parameters, organics, pesticides and nitrates.

When a public supply exceeds any quality regulations, the well is automatically restricted; that is, it must be taken off line and cannot be returned to service until either treatment is provided or the contamination has dissipated. In Suffolk County, a total of 48 wells have been re-
stricted because of organic concentrations. Of this number, 26 have been returned to service with granular activated carbon treatment, 8 returned to service with air strippers, 4 are presently not used, and 10 have been returned to service without treatment because their contamination has disappeared.

In Suffolk County, 16 wells have been restricted because of pesticide contamination (primarily aldicarb). Of these wells, 11 are operating with granular activated carbon treatment, 2 have been returned to service because the pesticide contamination disappeared, and 3 are not in use. Finally, 23 wells have been restricted because of nitrates since 1960. Of these, 10 wells have been abandoned, one presently has treatment (two additional are in design), eight use blending, and four wells are not in use.

A summary of the community water supply wells is listed below:

<table>
<thead>
<tr>
<th>Well Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL COMMUNITY WELLS</td>
<td>600</td>
</tr>
<tr>
<td>TOTAL RESTRICTED WELLS</td>
<td>87</td>
</tr>
<tr>
<td>TOTAL WELLS WITH TREATMENT</td>
<td>55</td>
</tr>
<tr>
<td>TOTAL WELLS WITH BLENDING</td>
<td>8</td>
</tr>
<tr>
<td>WELLS NOT USED</td>
<td>14</td>
</tr>
<tr>
<td>WELLS ABANDONED</td>
<td>10</td>
</tr>
</tbody>
</table>

To summarize, the quality of public water supplies is well regulated, and no disease or other problems have been diagnosed as a result of poor water quality. Water supply to individuals meets all drinking water standards, and programs are in place to assure that this continues.

An alternative to providing treatment of a contaminated well would be to transmit water from an uncontaminated area over what might become a substantial distance. This subject was looked at in depth by the Suffolk County Comprehensive Water Resources Management Plan, with several graphs, charts, and tables developed to provide comparison. The tables permit evaluation of the feasibility of providing water from flows ranging from 0.5 mgd to 30 mgd over distances ranging from one half mile to 40 miles. For the purpose of clarification, two examples are presented. The first considers the replacement of a typical wellfield with a capacity of 2-4 mgd. In order to transmit water to this community rather than treat the contaminated wells with GAC, water could only be brought in from a maximum distance of 3-4 miles. Beyond this distance, the GAC treatment is more cost effective.

A second example considers regional pumpage using 10 mgd and considers bringing water from the central Pine Barrens. The development of a 10 mgd wellfield located in the vicinity of William Floyd Parkway and Route 25 (just N/O BNL) and bringing it a distance of 10 miles makes it equivalent to treating 10 mgd with GAC. Ten miles will take you from William Floyd Parkway to Nichols Road which is nowhere near populated areas such as Huntington or Smithtown where the water might be required. The conclusion finally reached by the Suffolk County Comprehensive Water Resources Management Plan was that transmission of water is not economically viable or a necessary part of Suffolk County's water management.

The current problems facing Suffolk County's groundwater resources start with a need for continual protection and vigilance to prevent groundwater contamination. The Suffolk County Comprehensive Water Resources Management Plan listed 14 recommendations to achieve this objective. Primary recommendations dealt with enforcement actions against those who are contaminating the groundwater and education, in general, for the majority of the population. The Plan did not consider land purchases for groundwater protection. However, for protection of open space areas, ecology, and maintaining quality of life, certain land purchases can be very beneficial to Suffolk County.

Future water concerns for Suffolk County are broken up into two areas—water resources and water supply. Future water resources concerns include continuation of enforcement programs and improvement of inspection and monitoring activities. Suffolk County must continue to be vigilant and keep doing what it is doing to prevent groundwater contamination. Conser-
vation programs and consumer education must also continue, for an informed public will be a responsible public, and indiscriminate groundwater contamination can be controlled.

Future water supply concerns involve continuing many of the activities which occur today:

- keep acquiring small water supplies;
- keep extending water mains;
- keep treating wells whenever needed;
- continue to comply with current, new regulations.

Perhaps, new water supply regulations will be of greatest concern to water suppliers. As an example, beginning January 1, 1993, 62 new organic and pesticide standards became effective. In the months and years to come, a series of regulations will be promulgated on radiological contamination, most notably, radon; disinfection byproducts (DBP) regulations addressing those organics formed as a product of disinfection; more stringent requirements for THM's; and additional individual standards.

Robert Gaffney

Our next speaker is Dr. Aldo Andreoli. Dr. Andreoli is a professional engineer who for 30 years was with the Department of Environmental Health Services for Suffolk County. He was responsible for a great number of the environmental programs undertaken by the County, including water supply, waste disposal, industrial discharge, solid waste and the protection of water resources. He will be speaking about the many and various laws, regulations and guidelines in effect relating to groundwater.

Dr. Aldo Andreoli

At present, groundwater management on Long Island is affected by a variety of federal, state, county, and local statutes, regulations, and agency programs. These activities and mandated requirements address an array of considerations, including management of the quality and quantity of the groundwater resource, control of pollution sources, utilization of groundwater for water supply and other purposes, and assurance of an adequate and potable water supply.

This morning I will identify and describe the legislation, regulations and agencies that relate to groundwater and water supply management. I will present pertinent aspects of the numerous laws that authorize and define the responsibilities of the regulatory agencies, including the salient features of regulations, codes, standards, and classifications promulgated by agencies to transform legislative directives into functional rules for groundwater and water supply protection. Finally, I will discuss the activities performed by the agencies in attempting to fulfill their respective mandates.

Statutory authority is necessary to empower agencies at all levels of government to promulgate regulations, codes, standards and rules. Most often, environmental legislation describes programs and the means for addressing an identified concern, and either directs or enables a designated agency to carry out the program. Funds, or the funding sources, for the programs may also be specified in the law.

Federal legislation that directs the USEPA to prepare and administer regulations and programs related to groundwater protection includes the Water Pollution Control Act (WPCA) and the Clean Water Act (CWA); the Safe Drinking Water Act (SDWA); the Resource Conservation and Recovery Act (RCRA); the Toxic Substances Control Act (TOSCA); the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also known as "Superfund"); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and the National Environmental Policy Act (NEPA).

Water Pollution Control Act of 1972 - at the time of its enactment in 1972, the WPCA (PL 92-500) represented a major change in federal water pollution control law. It set a national goal of eliminating pollutant discharges by 1985. Although groundwater pollution was not given major emphasis, several Suffolk County programs that received federal funding under
this and subsequent laws stressed groundwater resource protection. The 1972 WPCA included the following provisions:

- Section 208 provided funding for areawide waste treatment management planning.
- Section 201 provided funding for wastewater treatment facilities in three phases: Step 1 - Planning; Step 2 - Design; and, Step 3 - Construction.
- Established a federal permit system (NPDES) and effluent discharge limitations for all point sources.
- Effluent limitations were placed on three categories of discharges: municipal, industrial, and toxic.
- Created a formal rulemaking process under which the USEPA identifies toxic pollutants and issues effluent standards.
- Section 311 declared a national policy of seeking to prevent discharge of oil or hazardous substances into U.S. waters.
- Directed the USEPA to create national industrial pretreatment standards for discharges to municipal sewage systems.

The 1977 Clean Water Act (PL 95-217) amended the 1972 PWCA and included the following provisions:

- Created a three category classification system for industrial pollution—conventional, toxic, and nonconventional.
- Revised the toxic pollutant portion of the WPCA to empower the USEPA to add or subtract from a previous court imposed list of 65 chemicals. (This led to the initial list of 129 priority pollutants.)
- Strengthened Section 311 by increasing liability limits and gave the USEPA power to establish a special fund for emergency assistance in cases of contaminant discharges.
- Set a major policy of promoting innovative and alternative (I/A) waste management techniques. Sewer construction was specifically excluded from I/A financial incentives.
- Extended the planning period for initial “208 Plans” and directed that plans identify open space opportunities that would result in improved water quality.
- Increased funding to encourage the beneficial use of sludge.
- Made it policy for the states to manage the construction grants program and NPDES, and supported the states by allocating funding for administration.

The Municipal Wastewater Treatment Construction Grant Amendments of 1981 (PL 97-117) further amended the 1972 WPCA to include the following provisions:

- Eliminated construction grants funding for Steps 1 and 2 (these could possibly later qualify for reimbursement as part of a Step 3 grant).
- Directed the states to incorporate the concept of “priority water quality areas” in preparing priority projects lists.
- Replaced 208 Areawide Planning with Section 205 Water Quality Management Planning. Emphasis was placed on identifying non-point measures to meet and maintain quality standards.
- Expanded and added funding to the I/A program.

The Safe Drinking Water Act of 1974 (PL 93-523) was considered the first major federal legislative attempt to assure that the public is provided with an adequate quantity of safe drinking water. It replaced Title XIV of the Public Health Service Act, and included the following provisions:

- Required the USEPA to set Maximum Contaminant Levels (MCLs) monitoring frequencies, and record keeping requirements for “public water systems”, which included community and non-community supplies in municipal and private ownership.
- Allowed the USEPA to grant "primacy" to states with regulations at least as stringent as those established by the USEPA under the act, and laboratory facilities meeting USEPA criteria.

- Required water suppliers to make public notifications if their systems are in violation of any SDWA requirement (particularly an MCL), and to outline precautionary measures.

- Created two procedures—variances and exemptions—that can be used to allow a water supplier to operate while in violation of an MCL (or a minimum treatment requirement, if ever established), but only if it is documented by the supplier that such actions would not result in an unreasonable risk to public health.

- Authorized the USEPA to designate areas that have an aquifer that is the sole or principal drinking water source and to require review of federal projects so that no federal funds are expended on actions that might contaminate that aquifer.

- Allowed the USEPA to allocate funds for research and demonstration grants related to water supply.

The Safe Drinking Water Act Amendments of 1986 (PL 99-339) strengthened the original act in a number of ways that require expanded state and local monitoring and administrative programs.

- It required the USEPA to set additional drinking water standards for organic and inorganic chemicals and for microbiological parameters. A time table was established for setting MCLs and MCLGs (Maximum Contaminant Level Goals, previously called Recommended Maximum Contaminant Levels or RMCls).

- It directed the USEPA to promulgate regulations (within three years) that will require disinfection for all public water systems, and that will identify criteria for granting variances.

- Strengthened USEPA's role in enforcement actions against water suppliers that do not conform to regulations.

- Established the use of granular activated carbon (GAC) as the baseline for treatment of synthetic organic chemicals; i.e., all "best available" technology must be as effective as GAC.

- Prohibits, with minor exceptions, the use of lead solder, flux, and pipe in public water systems, or in any residential or non-residential facility connected to a public water system.

- Requires states to submit programs within three years that will protect groundwater sources by determining wellhead protection areas, identifying sources of contamination within these areas, specifying contingency plans, and identifying the duties of state agencies, local government, and public water systems.

- Requires additional monitoring for a list of unregulated contaminants (those with no MCL or MCLG) at least once every five years.

The Resources Conservation and Recovery Act of 1976 (PL 94-580) was the first comprehensive federal regulation of solid wastes. It amended the Solid Waste Disposal Act of 1965, which was essentially limited to research and development programs for waste disposal and resource recovery. The 1976 Act included the following:

- Provided for three major programs: a hazardous wastes control program; a land disposal regulatory program, in each state; and the initiation and support of state and local resource conservation programs.

- Subtitle C provided for an identification and listing of hazardous wastes; standards for storage, treatment, or disposal; permits for storage, treatment, and disposal facilities; and, a manifest system to ensure that hazardous wastes are transported from the waste generator only to a "permitted" disposal facility.

- Subtitle D, which deals with non-hazardous wastes, imposed federal constraints on upgrading or phasing out open dumps; and mandated establishment of criteria for sanitary landfills.

Toxic Substances Control Act of 1976 (PL 94-469) was intended to fill the gaps in other legislation concerning toxic substances control. It provided for broad regulatory powers regarding toxic chemical manufacturing, use, storage, labeling and disposal.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (PL 96-510). CERCLA or "Superfund" was enacted to provide the USEPA with the financial resources needed for emergency response to spills and environmental accidents. The Act included the following provisions:

- It created a trust fund of up to $1.6 billion during a five-year period starting in 1981 to provide emergency cleanup of hazardous materials spills and in-place hazardous wastes dumps that threaten the environment (where no responsible party can be identified). The fund is derived primarily from taxes on oil and on 42 specific chemicals; an additional 12.5% comes from general tax revenues.

- It directed the USEPA to establish a national priority list of hazardous waste sites.

- It specified that state authorities must be consulted before the Federal Government cleans up a site.

Federal Insecticide, Fungicide, and Rodenticide Act of 1975 (PL 94-140), provided the USEPA with broad premarket clearance powers over all pesticides used in the U.S. to ensure that they do not pose "unreasonable risks" to human health and the environment. The act requires establishments that produce pesticides to register with the USEPA, and directs the USEPA to classify each registered pesticide for general or restricted use.

National Environmental Policy Act of 1969 (PL 91-190) was the first major law to require the preparation of an environmental impact statement. The act included the following provisions: Established a national policy for the environment. Created the Council on Environmental Quality; Required federal agencies to determine if their proposed actions would have a significant impact on the environment. If a significant impact is likely, the act directed that an environmental impact statement be written.

Hazardous Materials Transportation Act of 1974 (PL 93-633) authorized the U.S. Department of Transportation to regulate interstate commerce of hazardous materials. The act was primarily intended to control immediate transportation hazards such as radioactive, disease causing, corrosive, explosive, flammable, or toxic materials and compressed gases, but pollution control was specified as a factor to be considered in the development of regulations. The Act directs the USDOT to prepare regulations for manufacturers of hazardous materials requiring transport manufacturers of hazardous materials containers and transporters of such materials in commerce.

New York State has a substantial amount of environmental legislation pertaining to groundwater resource management, source controls, water supply, and environmental review. The New York State Department of Environmental Conservation, and the New York State Department of Health are the two primary state agencies responsible for administering the regulations and programs under state law. I will briefly summarize selected groundwater legislation, including portions of the State Environmental Conservation Law (ECL) and Public Health Law (PHL).

ECL Article 8, "State Environmental Quality Review Act" - the intent of the 1974 SEQRA legislation was to ensure that protection and enhancement of the environment is given appropriate weight with social and economic considerations in public policy decisions. Article 8 includes the following provisions:

- Mandates that an environmental impact statement (EIS) be prepared for any action that may have a significant effect on the environment before an agency approves that action.

- It provides a brief summary of what information should be included in an environmental impact statement. It stipulates that, if necessary, a draft EIS be prepared as early as possible in the formulation of a proposed action. It defines "lead agency", calls for coordination of review among agencies and directs the NYSDEC to develop rules and regulations for carrying out SEQRA provisions, including criteria for determining whether or not a proposed action may have a significant effect on the environment.

ECL Article 15 "Water Resources" decrees that the power to regulate the water resources of the state is vested with New York State.

It directs that reasonable standards of purity and quality be maintained; provides for the preservation of wild, scenic and recreational river systems, and it calls for the preparation of comprehensive public water supply studies.
Title 15 “Water Supply” directs that the NYSDEC approve all applications for water supply development and extensions; that Long Island well drillers be certified by the NYSDEC, and that all wells on Long Island with capacities greater than 45 gpm be approved by the NYSDEC.

A 1983 amendment to Article 15 added a new subsection covering the prohibition of certain incompatible uses (i.e., uses involving any hazardous waste) over federally designated sole source aquifers, and directed the NYSDEC to promulgate rules and regulations.

A further amendment in 1986 added or modified the following requirements: placed a moratorium on withdrawals from the Lloyd aquifer except in certain coastal areas; limited new and renewal permits to a term of ten years; required public water suppliers to submit watershed rules and regulations for new wells pursuant to PHL 1100; and required permit reviews to consider aquifer stress, consumptive use, water conservation, leak detection, and consistency with regional plans. It also removed the permit exemption for new agricultural wells.

ECL Article 17 “Water Pollution Control” - replaces PHL Article 12, and contains the following titles:

- Title 3 “Jurisdiction of the Department” directs the NYSDEC to develop a classification system for state waters in accordance with considerations for best usage, and requires the preparation of standards of quality and purity for each classification. It also gives the NYSDEC administrative jurisdiction to abate and prevent water pollution, and the authority to issue and revoke permits. The NYSDEC is directed to conduct comprehensive studies of water pollution control, and is given authority to issue standards for testing waste discharges, and to enforcing regulations.

- Title 5 “Prohibitions” provides a general prohibition against water pollution in contravention of standards adopted by the NYSDEC as authorized by Article 17. It includes restrictions on the discharge of sewage, industrial wastes, and other wastes.

- Title 7 “Permits” empowers the NYSDEC to issue permits for new discharges of wastes.

- Title 8 “State Pollutant Discharge Elimination System” institutes a permit system (SPDES) which is designed to cover all liquid discharges greater than 1,000 gpd.

- Title 15 “Realty Subdivisions: Sewage Service” defines subdivisions as a division of a tract of land into five or more parcels. It empowers any city or county health department to adopt regulations for the control of sewage facilities, and requires plans to be submitted indicating methods for providing adequate sewage facilities. It also calls for coordination between the NYSDEC and NYSDOH for realty subdivisions.

- Title 17 “Discharge of Sewage into Waters” details NYSDEC powers to prohibit or order discontinuance of discharges. It also provides some details on permit requirements, and empowers local health departments to make inspections.

- Title 19 “State Aid: Collection, Treatment and Disposal of Sewage” details provisions on how municipalities may obtain state financial aid for comprehensive studies and construction of sewage facilities.

ECL Article 27 “Collection, Treatment and Disposal of Refuse and Other Solid Waste” replaces PHL Article 13, Title X, and contains the following:

- Title 1 “State Aid” describes how state financial aid shall be provided to municipalities to conduct comprehensive plans for the collection, treatment, and disposal of refuse.

- Title 3 “Private Waste Disposal” calls for all those engaged in cleaning septic tanks (cesspools), scavenging, or disposing of industrial wastes to be registered with the NYSDEC. Registrants are required to make an annual report indicating the number and type of installations cleaned, volume and types of wastes removed, and place and manner of disposal.

- Contains provisions of the State Industrial Hazardous Wastes Management Act of 1979, which directs the Environmental Facilities Corporation to construct, operate, and finance hazardous wastes management facilities, and to study hazardous wastes technology. The act also mandates the EFC to develop a program for the alternate disposal of hazardous wastes, including siting, marketing, and financing.
A recent amendment to Article 27 added a subsection (27-0704) which bans new landfills or expansions of existing landfills in deep recharge areas, but includes a provision for allowing limited expansion for solid wastes prior to implementation of a resource recovery system.

ECL Article 33 “Pesticides”

Title 3 “General Provisions” gives the NYSDEC jurisdiction over the distribution, sale, use and transport of pesticides. The NYSDEC is empowered to declare what constitutes a pest; determine whether pesticides are toxic to humans and prepare a list of those pesticides; prepare a list of restricted use pesticides, and the permitted usage and conditions; and, promulgate rules and regulations.

PHL Article 11 “Public Water Supplies; Sewerage and Sewage Control” includes the following provisions:

- Title I “Potable Waters” gives the NYSDOH power to make rules and regulations for protecting public water supplies from contamination. It empowers local health agencies to inspect public water supply facilities, and gives the NYSDOH authority to enforce regulations and fine violators. Under this title, local health agencies can require sewage treatment, if deemed necessary to protect public water supplies.

- Title II “Realty Subdivisions: Water and Sewerage Service” defines a subdivision as the division of any tract of land into five or more parcels. It requires maps or plans to be filed with appropriate local agencies indicating the methods to be employed for obtaining an adequate and satisfactory water supply for subdivisions; communal, rather than individual, water systems can be required.

Transportation Law Article 2, Section 14f authorizes the NYSDOT to promote safety in the transport of hazardous materials by all modes. Article 7, Section 161 provides additional authority for the NYSDOT to control carriers transporting hazardous materials.

Navigation Law Article 12, Section 191 “Oil Spill Prevention and Control” authorizes the NYSDEC to control the transfer and storage of petroleum; assigns liability for damage sustained within the state as a result of the discharge of petroleum by requiring prompt cleanup; and, provides a fund for swift and adequate compensation.

General Municipal Law Article 5C “Water Supply”, Section 118, empowers counties, towns and villages to provide for the development of a supply of water in excess of its own needs, for the purpose of sale to a public corporation or improvement district.

County Law Article 5-A “County Water, Sewers, Drainage and Water Treatment and Refuse Districts”, Section 250 et seq., empowers each county to establish or extend county water, sewer, drainage, water treatment, or refuse districts. It details procedures for establishing a district, applying to the State Comptroller, and setting up a rate schedule. Authority to create county Water Quality Treatment Districts was added in 1984 (L. 1984, c. 622). Sewer district formation in Suffolk County is specifically described in Section 279-a.

Town Law Article 12 “District and Special Improvements”, Section 190 et seq., empowers town boards to establish or extend water storage and distribution districts to acquire or develop supplies of water for sale to water and water supply districts. Authority to create town Water Quality Treatment Districts was added in 1984 (L. 1984, c. 622).

Town Law Article 16 “Zoning and Planning”, Section 261 et seq., includes a town board’s power to regulate the density of population and the location and use of buildings, structures, and land for trade, industry, residence, or other purpose for any areas outside the limits of an incorporated village or city. Section 269 describes conflicts with other laws; it states that if zoning ordinances are more stringent than other statutes, zoning shall govern. If, however, zoning ordinances are less stringent than other regulations, then those other regulations shall govern. The article also describes procedures for amending zoning ordinances, and authorizes a town planning board to prepare and change a comprehensive master plan for the development of an entire area of the town.
Village Law Article 7 “Building Zones” and Article 11 “Water” provide villages similar authority to that provided to towns by Town Law.

Although most of Suffolk County’s authority for groundwater resource management and enforcement is derived from the Suffolk Sanitary Code, the following are examples of relevant county legislation.

Local Law 23-1977 “Local Law Implementing the State Environmental Quality Review Act”, as amended by LL 28-1977 and LL 29-1980, formally adopts SEQRA in accordance with Article 8 of the ECL. It prescribes rules, regulations, and procedures for county agencies to comply with SEQRA, and includes lists identifying Type I and Type II actions.

Local Law 12-1980, “Local Law Prohibiting the Sale of Certain Cesspool Additive Products in the County of Suffolk” - prohibits the sale of any organic chemical(s) or compound(s) for the purpose of cleaning or unclogging sewer lines and/or individual sewage disposal systems unless approval is granted by SCDHS. It also directs that in order to obtain approval, scientific data, satisfactory to the SCDHS, must be submitted demonstrating that the organic chemical will not adversely affect the groundwater.

Local Law 8-1983 “Local Law Providing for Seizure and Forfeiture of Vehicles, Vessels and Other Conveyances Used to Illegally Transport or Dispose of Hazardous Wastes” empowers the Suffolk County District Attorney to seize vehicles, vessels, and other conveyances used to illegally transport or dispose of hazardous waste. After a hearing before a civil court judge, seized vehicles may be forfeited and sold at auction.

Local Law 1-1984 “Local Law Regulating the Use of Public Water Fire Hydrants for Pest Control and Other Commercial Purposes” requires fire hydrant users, such as tree sprayers and plumbers, to register with the local water purveyor; display user identification emblems; and have adequate cross connection (back flow) control devices installed on their trucks. The purpose of the law is to prevent pesticides and other materials from being accidentally introduced into water supplies.

Federal Regulations, Codes and Standards

National Primary and Secondary Drinking Water Standards - statutory authority for these standards comes from the Safe Drinking Water Act of 1974. Primary Standards are based on the protection of public health, and prescribe maximum contaminant levels for a number of inorganic and organic chemicals. Secondary standards are based on the protection of public welfare, and include recommended limits for taste, color, odor, and appearance.

New York State Regulations, Codes and Standards

NYCRR Title 10 “Health” includes the following:

- Part 5, “Drinking Water Supplies”, contained in Chapter I “State Sanitary Code”, imposes the same MCLs called for in the National Primary Drinking Water Standards, plus MCLs for an additional seven inorganic chemicals. It also prescribes requirements for sampling, reporting, operation, well construction, cross connection control, emergency planning, and water treatment operator training.

- Part 5 includes, as an appendix, the publication “Recommended Standards for Water Works: 1982”, NYSDOH Bulletin 42, which outlines specific requirements for engineering reports, plans, and specifications; design criteria; materials requirements; and other considerations for water treatment, storage, and distribution. Part 5 also includes, as an appendix, the NYSDOH publication "Rural Water Supply" that contains recommended design criteria for small water supplies.


- Part 75, “Standards for Individual Water Supply and Individual Sewage Disposal Systems”, contains standards promulgated to protect the health and safety of persons who must rely on individual water supply systems, individual sewage disposal systems, or both. It references

- Part 170, "Sources of Water Supply", is designed to protect surface and groundwater supplies from contamination from human and animal wastes. It contains a list of allowable limits for selected inorganic and organic chemicals, and coliform bacteria for raw water sources used for water supply.

NYCRR Title 6 "Conservation" includes the following:

- Part 326, "Restricted Pesticides", is authorized by ECL Article 15. It provides regulations for permits (sale and distribution) and purchase permits (purchase, possession, and use) for restricted pesticides, and lists all chemicals that have been declared restricted pesticides and their concentrations.

- Part 360, "Solid Waste Management Facilities", is authorized by ECL Article 27. It prescribes rules and regulations governing the transfer, processing, and disposal of all solid wastes, sludges, and regulated medical wastes. It also details permit administration procedures for constructing, modifying, and operating any solid waste management facility, and delineates special requirements for design, construction, maintenance, and operation of specific solid waste facilities - sanitary landfills, non-hazardous industrial wastes landfills, and incinerators. These design requirements include cover and liner materials for leachate prevention; separation distances from groundwater; and monitoring needs.

- Part 364, "Collection and Transport of Industrial-Commercial and Certain Other Wastes" includes regulations governing collection and transport of hazardous and non-hazardous industrial wastes, and septic tank materials.

- Part 371, "Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities" (formerly Part 365) establishes a system for tracking hazardous wastes from point of generation to point of ultimate disposal.

- Part 373 establishes permitting requirements for hazardous waste treatment, storage, and disposal facilities; and establishes interim and final status standards for owners and operators of hazardous waste facilities.

- Part 374 provides standards for the management of specific hazardous wastes and specific types of hazardous waste management facilities.

- Part 617, "State Environmental Quality Review" is authorized by ECL Article 8. It details the obligations of agencies and the procedures to implement SEQRA. It also contains the lists of Type I actions which are likely to require an EIS, and Type II actions which do not require an EIS.

- Part 703, "Groundwater Classifications, Quality Standards and Effluent Standards and/or Limitations (9/1/78)" is authorized by ECL Article 17. It classifies groundwaters of the state according to best use, and provides standards of quality (MCLs) for 83 pollutants, including selected metals, nitrate-N, pesticides, and a few organic solvents. All groundwater in the bi-county area is classified GA — best use as potable water supply. Effluent limitations, which are applicable to all point sources, are given for a similar list of substances. Part 703 also contains requirements for sample collection.

- Parts 750 through 757, "State Pollutant Discharge Elimination System (SPDES)" are authorized by ECL Article 17, Title 8, and prohibit any discharge of pollutants without the issuance of a SPDES permit. Exempted are new or modified disposal systems that discharge less than 1,000 gallons per day of sewage effluent (without admixture of industrial wastes or other wastes) from a private dwelling designed for less than three families, or premises having an occupancy of the equivalent of ten people per day. No discharge that violates the water quality standards of the state is allowed.

- Parts 750 through 757 specify that the duration of permits not exceed five years and outline specific information requirements for engineering reports, plans, and specifications; design criteria for sewers, pump stations, and sewage treatment plants; and, requirements for each process of sewage treatment.

Recent additions to ECL Article 17 relative to SPDES permits in sole source aquifer areas require identification of all public water purveyors with service areas within three miles of a proposed discharge (ECL Section 17-0828; L.1983, c. 663). They also require notification of these purveyors if permit violations occur that could have a significant impact on the water resources of the area.
Suffolk County Regulations, Codes and Standards - the Suffolk County Sanitary Code is the main source of County groundwater and water supply regulations. Following is a brief description of the three most relevant articles of the Sanitary Code, and the applicable standards of the Suffolk County Department of Health Services.

- Article 4 "Water Supply" states its intent, which is the protection of water supplies from actual or potential sources of contamination. It includes, among the powers of the Commissioner of the SCDHS, the authority to inspect public and private water systems, prepare comprehensive water supply plans, administer enforcement activities (including fines) and promulgate standards. It requires that plans and specifications be approved, and a permit to construct obtained, before the installation or modification of a water supply system. It also requires post construction system approval prior to operation. It states that water quality must comply with the standards of Part 5 of the State Sanitary Code and with other requirements, as may be imposed by the SCDHS. It provides requirements for the operation and maintenance of public water supply systems, water treatment, disinfection, corrosion control, cross connection control, and water treatment personnel. It prohibits the use of lead solder in public water supply systems. It includes "Standards for Subdivision Test Wells and New Construction to be Served by a Private Well", that impose sampling and well testing procedures; stipulate minimum analytical requirements; identify communities, such as agricultural areas, where aldicarb analysis must be performed; list acceptable treatment devices for various water quality problems; and direct that, if natural water quality necessitates installation of a water treatment device, then a covenant must be filed with the County Clerk indicating that the remedial measure was required.

- Article 6 "Realty Subdivisions and Developments" prescribes requirements for sewage facilities and water supply facilities necessary to obtain SCDHS approval of applications for subdivisions or developments. It defines subdivisions as in PHL Article 11 and ECL Article 17; i.e., subdivision of one property into five or more parcels. It includes a definition of a "development" as a division of one property into two, three, or four contiguous parcels. It requires a communal sewage system when a subdivision or development is located within Groundwater Management Zones III or VI and any parcel comprises less than 40,000 square feet, or outside of Zones III and VI and any parcel comprises less than 20,000 square feet. It requires sewage facilities for clustered residential realty subdivisions and developments and for developments of other than conventional single-family residences, based on population density equivalents. It requires public water supply for realty subdivisions or developments where any parcel is less than 40,000 square feet. It includes "Standards for Sewage and Waste Disposal Systems - Design of Residential Subsurface Sewage Disposal Facilities" which prescribe the minimum size of septic tanks (900 gallons) and leaching pools (300 square feet). These standards also provide details of construction criteria; materials; and separation distances from structures, facilities, etc. It includes "Standards for Sub-Surface Sewage Disposal Facilities for Other Than Single-Family Residences", which provide that, if the population density equivalent of an establishment does not exceed that allowed in the respective Groundwater Management Zone, conventional sub-surface sewage disposal is acceptable — assuming soil conditions and other factors are conducive to proper operation. If the population density exceeds the allowable density, and design flow is less than 15,000 gallons per day, then a sub-surface system with denitrification treatment is acceptable; if flow is greater than 15,000 gallons per day, then consideration must be given to conventional sewage collection and treatment facilities with denitrification.

- Article 12, "Toxic and Hazardous Materials Storage and Handling Controls", specifies requirements for storage and handling of toxic and hazardous materials, including tank testing; prohibited discharges; tanks, piping, and fittings materials and installation procedures; abandonment and removal procedures; construction and modification permits; and, permits to operate. It covers new and existing installations of above ground, indoor and underground facilities; transfer facilities and operations; and, portable containers. It provides time schedules for testing underground tanks and for full compliance for all facilities. It exempts storage facilities of less than 250 gallons in five gallon containers or dry storage of less than 2,000 pounds. It includes "Standards for the Design of Underground Gasoline and Oil Storage Facilities (10/1/83)", which mandates procedures for approval to construct; approval of field installations; and, final approval of completed installations. It also provides minimum specifications for underground tanks, piping, fittings, connections, and leak detection, as well as additional requirements for high groundwater areas; and for separation distances from water supply facilities, stormwater basins, and sanitary leaching pools.

- Article 7 "Water Pollution Control" is primarily intended to provide additional protection to deep recharge areas and water supply sensitive areas from possible spills and discharges of certain toxic and hazardous materials. It restricts the storage and discharge of toxic and hazardous materials in such areas. It exempts facilities and activities such as retail stores,
agriculture, and highway construction and repair, and specifies possible variances for gasoline service stations and industrial establishments served by sewage collection and treatment, with effluent disposal outside of deep recharge areas. It includes requirements for permits to construct sanitary facilities and to discharge wastes, and to control the commingling of wastes and stormwater discharges. It stipulates requirements for monitoring and reporting; connection to public sewer systems; and, abandonment of sanitary disposal systems.

**Town and Village Regulations, Codes and Standards.** Zoning ordinances are the principal means of land use control. They therefore have a very significant effect on groundwater. Among the regulations included in zoning ordinances are the control of the size of parcels; the percentage of the lots that may be occupied; and, the use of buildings, structures, and land. Recently some municipalities have implemented or are evaluating major zoning revisions on the basis of groundwater quality protection.

In 1983, the Town of East Hampton upzoned a large portion of its residentially-zoned property, and added a new section to the town zoning code entitled “Water Recharge Overlay District”. This amendment includes provisions intended to minimize impacts on groundwater resources and natural vegetation by limiting land clearing, landscaping, the use of fertilizers, and the disposal of waste materials. The Town of Southampton, as part of its recently revised master plan, upzoned large areas of residential land to two, three, and five acre lots. It also rezoned several thousand acres west of the Westhampton Airport, from industrial to five acre residential lots. The revised master plan also contains provisions amending the zoning code for “Recharge Area Overlay Districts”. In 1978, the Town of Brookhaven upzoned 13,000 acres of residential land in 208 Hydrogeologic Zone III to 2-acre. In 1984, about 1,000 acres of industrial zoned property in Zone III was rezoned to 2-acre residential use. The town also amended its zoning code for the “L Industrial 1” zoning category in Zone III. The code now requires financial assurances from any new establishments that are involved in the storage and handling of toxic or hazardous materials, or that have an industrial discharge, in order to pay for any cleanup of spills or illegal discharges. The Town of Riverhead is also presently revising its master plan. A major concern indicated by town officials is the preservation of water quality in Zone III.

There are agencies at all levels of government with groundwater and water supply management programs and activities. In many cases, these agencies have multiple responsibilities. For the purposes of organizing and presenting the material on the roles of different agencies, the numerous programs addressing specific concerns and causes of problems may be classified according to general categories. I want to discuss these program areas in order to aid in understanding the overall structure of groundwater management activities.

The United States Environmental Protection Agency (USEPA) and the United States Geological Survey (USGS) are the two principal federal agencies involved in groundwater management.

The USEPA is the major federal environmental agency administering several important groundwater protection programs. National Primary and Secondary Drinking Water Standards, promulgated by the USEPA to cover all public water systems, list maximum contaminant levels for specific constituents as measured at the consumer’s tap. There are no national ambient water quality standards for either ground or surface waters. Discharges to groundwater are not covered under the Federal Clean Water Act of 1977. USEPA has not adopted most of the treatment standards for toxic materials and various industrial categories as directed by the Clean Water Act.

During the 1970s and early 1980s the USEPA supported several long-range water quality planning efforts via grants to states, regional agencies, and local municipalities. On Long Island, these included the LIRPB’s 208 Study and 208 Plan Implementation Project; the NYS-DEC’s Long Island Groundwater Management Plan, and several other projects addressing specific concerns like the Nationwide Urban Runoff Program, Consumer Products Study, and Non-Point Source Project. In 1984, subsequent to the termination of Section 208 funding, the LIRPB received a small grant of USEPA Section 205(j) funds, provided under the 1982 amendments, to conduct a Special Groundwater Protection Area Pilot study.

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The USEPA maintains a water quality data base management system known as STORET. The system is nationwide in coverage and receives its data by batch duplication from many local agencies, as well as direct data entry by the USEPA itself and some agencies which have no data processing systems of their own. There has not been much use of the system by Long Island agencies.

Under Section 311 of the Federal Clean Water Act, the USEPA must ensure the preparation and maintenance of Spill Prevention and Countermeasure Control Plans for facilities storing petroleum products that would, if spilled, enter the navigable waters of the United States. The regulations apply to storage facilities with 42,000 gallons underground capacity and/or 1,320 gallons total above ground capacity, and/or 660 gallons above ground as any individual tank. Proposed revisions to federal regulations would extend coverage to spills of hazardous wastes, but at the present time, spill prevention of hazardous wastes is achieved through regulations under the Resource Conservation and Recovery Act.

The USEPA's authority to control hazardous waste related to sludges and residuals is also derived from the Resource Conservation and Recovery Act, which allows it to regulate the generation, transportation, treatment, storage, and disposal of hazardous wastes.

Although the Resource Conservation and Recovery Act applies to municipal solid wastes as well as hazardous wastes, the USEPA has essentially directed almost all its efforts to hazardous waste problems.

The USEPA administers the National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act. This regulatory program is limited to discharges to surface water.

The USEPA has been very active in evaluating water quality problems associated with the use of on-lot disposal systems, as well as investigating alternative design and operation measures. Several publications are available from the USEPA. Moreover, the USEPA has made the development of on-lot sewage disposal maintenance procedures a condition for localities to receive construction grants for scavenger waste treatment facilities.

Since 1972, when the Federal Environmental Pesticide Control Act was passed, the USEPA has been required to address the issue of "unreasonable adverse effects on the environment" in its evaluation of pesticides proposed for registration. Registrants are required to submit, on a continuing basis, information obtained concerning unreasonable adverse effects. USEPA staff is required to frequently review the available literature and conduct research on registered products. The USEPA has authority to cancel a registration if a pesticide has unreasonably adverse effects.

As part of the requirements of the Federal Superfund legislation, the USEPA has developed a priority system and has a national priority list of approximately 400 hazardous waste sites that will be response targets. In most cases, actual site cleanups under Superfund are done under delegated Superfund authority by private firms under contract to USEPA or to states. The USEPA also has a hazardous spill response capability, and can respond if requested by a state or local government. Such authority has existed for several years under Section 311 of the Clean Water Act, but both the scope of the authority and the available funds have been limited. The establishment of the Superfund in 1980 has provided increased capability.

The USEPA administers the Construction Grants Program under Section 201 of the Clean Water Act, which, in the past, provided federal reimbursement for a portion of the cost of municipal wastewater facilities. The program now provides for low interest rate loans.

Several of the federally funded programs that the USEPA administers, like 208 and 201, require extensive public participation programs as a grant condition. The USEPA is also responsible for numerous pamphlets, manuals, and handbooks distributed by the Federal Government regarding USEPA programs, wastewater treatment, hazardous materials, etc.

The USEPA not only conducts research but also provides grants for research related to a range of environmental issues, including water and wastewater treatment technology.
The second federal agency with a major role in groundwater management is the United States Geological Survey. The USGS maintains a sub-district office in Syosset, Long Island, and conducts resource evaluation activities through cooperative agreements with several local agencies in the area, as well as with state agencies.

The USGS has been a key participant in several recent planning projects, including the Long Island 208 Study, FANS, NURP, LIGWMP, and the Suffolk County Comprehensive Water Resources Management Plan. The Survey's efforts generally involve regional and sub-regional groundwater quantity modelling, data evaluation, sampling, and report preparation and review.

The USGS collects and maintains extensive geologic, hydrologic, and water quality databases through its sub-district office. These include general historical data, dealing with streamflow, groundwater levels, public and observation well water quality, and the stratigraphy and hydraulic properties of the major aquifer units. Site-specific studies are also conducted.

The USGS supplies technical assistance to the NYSDEC's Region I office for the administration of the Long Island Well Permit Program. This includes hydrogeologic review of permit applications, modelling to predict future impacts, and participation in permit application reviews, meetings, and hearings.

The published reports of the numerous studies conducted by the USGS provide a substantive body of information available to the public.

Over the last several years, the USGS Long Island Office has been involved in extensive regional and sub-regional groundwater quantity modelling efforts.

New York State has sought and received delegation of several federal programs. Of particular importance for the state's groundwater program are the delegated programs under the Clean Water Act and Resource Conservation and Recovery Act, which are administered by the NYSDEC. The powers and responsibilities provided under these federal statutes are reiterated in comparable state legislation. The delegated programs provide essential funding support to assist state programs in water pollution control, and solid and hazardous waste management.

The Department of Environmental Conservation (NYSDEC) has the responsibility for administering a full array of environmental quality and natural resource programs, several of which have direct relationships to groundwater. Principal among these are the Department's water quality and water resource programs currently administered by the Division of Water. However, they also include programs in areas such as solid waste and hazardous wastes management, pesticide regulation, mineral resources, oil and gas regulation, and others.

The NYSDEC is specifically charged with the "coordinated management of water resources", the control of water pollution, and the maintenance of reasonable standards of purity of the State's waters, both ground and surface.

Major elements of the department's water program are integral to Suffolk County groundwater management. They include water resources planning; water quality standards and classifications; water quality monitoring and surveillance; municipal and industrial wastewater discharge permits (SPDES); and programs which provide for the development, operation, and maintenance of municipal wastewater facilities. Also, the NYSDEC's Long Island Well Permit Program constitutes the only currently existing statutory authority and program for quantity management on Long Island.

The NYSDEC is the state agency given direct statutory responsibility for ambient groundwater standards and effluent discharge standards for point sources of pollution. In 1978, the NYSDEC revised the "Groundwater Classifications, Quality Standards and Effluent Standards and/or Limitations".

NYSDEC has been designated by the USEPA as the agency responsible for Statewide 208 and 201 Water Quality Planning. Under the Environmental Conservation Law, the NYSDEC is the designated planning agency for the management of quality and quantity of the state's water resources, including groundwater, and prevention of water pollution.
The NYSDEC maintains, either in Albany or its regional offices a variety of data files relating mainly to regulated activities. These include municipal and industrial wastewater discharges, solid waste landfills, hazardous waste treatment facilities, storage and disposal facilities, major oil storage terminals, petroleum and hazardous materials spills and leaks, and Long Island Well Permits.

Although SEQRA is part of the ECL, the NYSDEC does not administer the formal review process for projects. SEQRA relies heavily on local agencies being designated as "lead agency" to coordinate review and evaluate the significance of environmental impacts and identify mitigating measures. The NYSDEC's primary role, as administrator, is to assign lead agency status when there is a conflict among local agencies and to provide guidance, such as the SEQRA handbook. The NYSDEC is also considered an involved agency for all SEQRA reviews.

Through specific formal interagency relationships, the NYSDEC delegates major elements of its programs for Suffolk County to the SCDHS. This is usually accomplished under Local Assistance Programs administered by the NYSDEC, which partially reimburses the SCDHS for costs incurred.

The 1983 Petroleum Bulk Storage Act empowered the NYSDEC to regulate storage facilities of more than 1,100 gallons. The act also provided for an advisory council to work with the NYSDEC in developing regulations covering the registration of storage facilities, methods for preventing leaks and spills, and minimum construction standards for new or substantially modified storage facilities.

Several programs and state regulations administered by the NYSDEC are intended to fulfill responsibilities incurred by delegation of Federal Resource Conservation Recovery Act programs to the state. These responsibilities include control of the collection and transport of industrial wastes, administration of the hazardous wastes manifest system, and the identification and listing of hazardous wastes.

Non-hazardous solid wastes are regulated by the NYSDEC under the requirements of 6 NYCRR Part 360. As a result of a 1983 state law, now reflected in NYSDEC policy, there is a general prohibition on new landfills, and a mandated phasing out of existing landfills in deep recharge areas.

Utilizing funds provided by the 1972 State Environmental Quality Bond Act, the NYSDEC has made available 175 million dollars, statewide, for grants to local governments to build resource recovery, source separation, and waste management projects. EQBA funds have been set aside for projects in a number of Nassau and Suffolk municipalities.

The Federal NPDES program has been delegated to the NYSDEC through the New York State Pollutant Discharge Elimination System (SPDES). SPDES is a program for regulatory control and permitting of discharges of sanitary, industrial, or commercial wastes, with appropriate treatment into the surface or groundwaters of the state. It is intended to be a comprehensive program for protecting water quality and goes beyond NPDES in that it includes the regulation of discharges to groundwater.

The NYSDEC also administers several program activities designed to promote proper operation and maintenance of municipal sewage treatment facilities. Activities include periodic facilities inspections; treatment plant operator training and certification; and a program of operation and maintenance grants, which partially offset the costs of treatment plant operation and maintenance.

NYSDEC regulates the registration, commercial use, and application of pesticides through the Pesticide Control Program, administered in accordance with the Federal Insecticide, Fungicide and Rodenticide Act. Under the state program, pesticides must be registered. A commercial permit is required for the distribution, sale, or offer-for-sale of "restricted use" pesticides as defined by the NYSDEC. A purchase permit is also required for the purchase, possession, or use of these products. All commercial applicators must be certified. The primary emphasis of the program on Long Island is on the certification of pesticide users and on the issuance of permits to distributors of "restricted use" products.
Control over the use of pesticides for turf or home use is also provided through several mechanisms. First, all pesticides must be registered by the NYSDEC. Second, retail outlets selling these chemicals must keep records of all “restricted use” pesticides sold. Third, all applicators of restricted use pesticides must be registered, and two of the various categories of applicators are those that apply pesticides to home lawns. Another method of control over pesticide use is through labeling and the inclusion of instructions for all products sold, in accordance with NYSDEC regulations.

Basic statutory authority relating to the regulation of groundwater withdrawals on Long Island is contained in Article 15 of the ECL. The Long Island Well Permit Program is currently administered by the NYSDEC Region 1 office in Stony Brook. Where applications are for public water supplies, separate Water Supply Permits are required and are reviewed jointly with the New York State Department of Health. NYSDEC approval is required for all wells where the installed pumping capacity of such wells, singly or in the aggregate, or the total installed pumping capacity of old and new wells on one property, is in excess of 45 gallons per minute. Fire wells to which no pumping equipment is permanently attached are exempted; the exemption for new agricultural wells was eliminated in 1986.

All well drillers must be registered with the NYSDEC. Before drilling, a driller must file a preliminary report with the NYSDEC and, on completion of drilling, a report giving the well log and other pertinent information on the size and capacity of the well must be filed. The Department must also approve new or additional sources of public water supply and service extensions.

The State Superfund Program is administered by the NYSDEC and is intended to provide funding to investigate and remediate hazardous waste sites that cannot be addressed by the responsible parties or the Federal Superfund.

The NYSDEC is the lead state agency for coordinating the response to hazardous materials emergencies, which are defined as sudden and unexpected releases of non-petroleum, non-radioactive toxic chemicals. There is no established fund or administrative mechanism to routinely undertake immediate cleanup. NYSDEC policy currently is to place cleanup responsibility on the spiller, with legal action if necessary.

The NYSDEC has regulatory enforcement responsibilities associated with several of its major programs. Enforcement can include a range of actions, including notification of violations, conferences to secure voluntary compliance, administrative orders, and court proceedings.

The New York State Department of Health (NYSDOH), under the Public Health Law, is responsible for the protection of public health and, more particularly, for the assurance of a safe potable supply of drinking water for the state’s citizens. The NYSDOH is also responsible for the assurance of proper disposal of sanitary wastes via on-site disposal systems.

The NYSDOH prepares and administers standards and regulations for public water systems under Part 5 and Part 170 of the State Sanitary Code. These requirements cover planning, design, operation, and surveillance of public drinking water systems. A major concern in recent years is that standards have been developed for only a limited number of chlorinated hydrocarbon pesticides and total trihalomethanes. Since 1979, control of all other organic chemicals in water supplies has been based on guidelines issued by the NYSDOH. The guidelines generally used are 5 ug/l for one constituent and 50 ug/l aggregate. Guidelines have also been established for some pesticides like aldicarb which have been detected in Suffolk groundwater.

The NYSDOH participates in long-range planning programs related to water resources. In the past, funds were provided by the NYSDOH to Nassau and Suffolk Counties to prepare comprehensive water supply plans.

The NYSDOH maintains data files on all public water supply systems in New York State at its central office in Albany. Furthermore, the NYSDOH through its field laboratory in Stony Brook has provided analytical capability to local health departments for volatile organic analysis of samples taken from public water supplies. Since 1978, this laboratory has performed volatile organic analyses on 800 to 1,200 samples per year.
Through delegation to the SCDHS, the NYSDOH provides funding for monitoring and surveillance of public water supplies and review and approval of individual on-site sewage disposal systems.

In Part 75 of the State Sanitary Code, the NYSDOH identifies its handbook "Individual Household Systems" as the basis for standards of design, construction, and maintenance of on-site sewage disposal systems for individual residences.

Under the Public Health Law and Part 5 of the State Sanitary Code, the NYSDOH administers a major program to assure that all public water supply systems in the state are properly operated and maintained, and that all consumers are assured delivery of a safe and adequate supply of water. This program includes a variety of activities relating to regulation of public water supply facility design and construction; periodic inspection and evaluation of all public water systems, emergency response to water supply systems experiencing critical water quality and quantity problems; laboratory certification; training and certification of water supply operators; watershed protection rules and regulations; and, establishment and enforcement of State Drinking Water Standards. As mentioned previously, much of the program for Suffolk County has been delegated to the SCDHS.

In its 1980 publication, "Organic Chemicals and Drinking Water", the NYSDOH outlined potential wellhead treatment policies. Of the four options discussed, "Treatment of Contaminated Systems Only" is the one actually taking place.

The NYSDOH has prepared and distributed handbooks on water supply and waste disposal for homeowners and land developers.

Research is being conducted by the NYSDOH to evaluate alternative water treatment processes for the removal of organic chemicals. It has also provided funding to Nassau and Suffolk Counties to study water treatment.

As part of the administration of Sanitary Code provisions, the NYSDOH has broad enforcement powers to assure the adequacy of public water supplies.

The Legislative Commission on Water Resource Needs of Long Island was established in 1979 by the NYS Legislature to recommend legislative or administrative actions that may be required to preserve and protect groundwater resources for future use. Major accomplishments include passage of laws pertaining to the prohibition of landfills in deep flow recharge areas; regulation of hazardous materials in primary groundwater recharge areas; SPDES water supplier notification requirements; and municipal establishment of water quality treatment districts.

The Long Island Regional Planning Board has no direct regulatory, surveillance, enforcement, or administrative responsibilities with respect to groundwater management. It has, however, maintained an important role since directing the preparation of the 208 Study.

As the designated areawide agency for Nassau and Suffolk Counties, the LIRPB directed the preparation of the Long Island 208 Study. The LIRPB also managed two subsequent projects funded by federal Section 208 grants - the 208 Study Implementation Project and the Long Island portion of the Nationwide Urban Runoff Study. In 1984, it initiated the Special Groundwater Protection Area Pilot Study, which was supported by federal Section 205(j) funds. The LIRPB is responsible for updating the Comprehensive Development Plan (1970) by incorporating relevant aspects of other programs, including 208 Studies, Coastal Zone Management Planning, Census, and other population, land use, and environmental studies. Examples of LIRPB studies with groundwater implications are the "Industrial Location Analysis" and the Special Groundwater Protection Area Management Plan.

The LIRPB has had vigorous public participation and education efforts for some time. The numerous publications prepared by the LIRPB provide useful public education materials.

The Suffolk County Planning Department, upon request of a municipality, conducts special land use and development planning studies that take potential groundwater impacts into consideration. The Council on Environmental Quality (CEQ), which shares staff with the SCPD,
conducted the SEQRA review for county actions, and assesses environmental impacts of proposed county policies and projects. On occasion, the SCPD has prepared generic environmental impact statements, as requested by towns for portions of their local municipalities. The SCPD also provides other technical assistance for EIS preparation and review.

The Suffolk County Department of Health Services (SCDHS) is the principal local regulatory agency addressing groundwater in Suffolk County. As provided by local or delegated authority, the SCDHS performs the major portion of the activities required to administer regulatory programs for groundwater management and protection.

The SCDHS has been responsible for several county-wide and local groundwater planning projects. These include, among others, the North Fork Water Supply Plan, FANS, and South Fork Water Resources Study. Planning functions of the SCDHS entail considerable involvement in important regional projects, such as the LIGWMP, 208 Study, NURP, etc. As one of the activities delegated by the NYSDEC, the SCDHS reviews any Section 201 Construction Grants Studies conducted by local municipalities.

The SCDHS has carried out research associated with groundwater programs for many years. A number of these studies have been unique in the fields of water pollution control, water treatment, and groundwater resource management.

The SCDHS has a very comprehensive groundwater resources monitoring program. Information gathered includes water quality, water levels, streamflow, geologic and meteorological data. Several hundred wells have been installed by the SCDHS in recent years, mainly with its own well drilling equipment and staff. Monitoring is done for several purposes: to assess changes in overall groundwater ambient conditions; for surveillance of known or suspected contamination sources; plume delineation; for special studies such as FANS, Aldicarb, Consumer Products, etc. and for potential groundwater reclamation projects. Additional resource management information is provided by public supply well monitoring and the extensive private well sampling programs of the SCDHS. Groundwater and water supply data bases, as well as information on municipal and industrial discharges and underground fuel storage tanks, are maintained as part of the SCDHS's computer data processing services.

The SCDHS is actively involved in the SEQRA review activities, especially for Type I proposed projects directly affected by SCDHS code regulations for residential and industrial subdivisions and developments. Through formal Local Assistance Programs with the NYSDEC and NYSDOH, its own statutory authority, and informal contacts with other county and local agencies, the SCDHS conducts groundwater management activities.

By authority of Article 12, the SCDHS requires permits to construct and operate storage and handling facilities for toxic and hazardous materials as well as wastes. The SCDHS routinely maintains its own tank testing equipment, and performs the tests for county-owned facilities. Article 7 empowers the SCDHS to restrict or prohibit storage of certain toxic or hazardous materials in deep recharge areas.

The SCDHS assists the NYSDEC with portions of the solid wastes program under Part 360. This participation includes review of facility permits and plans, and site inspection and monitoring.

Acting as an agent for the NYSDEC, the SCDHS is responsible for a major portion of the regulatory activities under the SPDES program. These responsibilities include review of permit applications, assistance in drafting permits, inspecting facilities, conducting surveys to identify possible wastes sources, effluent and groundwater monitoring, and preparing background material for enforcement cases.

The delegation agreement with NYSDOH provides the SCDHS with the authority to approve all new individual on-lot sewage disposal systems. Standards for the approvals are set by the New York State Sanitary Code and by more detailed standards adopted by the county. Any individual who wishes to construct an on-lot system must file plans with the SCDHS, and these plans are reviewed and approved in accordance with state and local standards. Municipalities cannot issue a building permit until approval for the proposed sewage system for the dwelling has been given by the County Health agency.
The SCDHS, as stipulated in Article 6 of the Suffolk County Sanitary Code, regulates the maximum allowable density of on-site systems according to 208 Hydrogeologic Zones. New housing cannot be constructed in Zones III or VI at densities greater than one dwelling unit per acre without centralized collection and treatment of sewage. At lower housing densities, individual on-site systems may be used. For other zones, two dwelling units per acre is the maximum allowable density for on-site systems.

Suffolk County has also enacted a local law by which the SCDHS controls the sale and use of all cesspool additives. This law, which is somewhat more stringent than a similar state law, effectively bans all cesspool additives containing organic chemical solvents.

SCDHS does not have any formal regulatory control of pesticides. Nevertheless, results of private well sampling by the SCDHS in agricultural communities led the manufacturer of three pesticides (aldicarb, carbofuran and oxamyl) to voluntarily remove these products from the Suffolk market.

Articles 4 and 6 of the Suffolk County Sanitary Code assign authority to the SCDHS for approving public water supplies before any construction takes place within a subdivision or development. Under Article 4 and through delegation from the NYSDOH, the SCDHS is empowered to review water supply applications, inspect construction, inspect public supply systems, certify water treatment plant operators, sample public water supplies, prescribe treatment requirements, and require monitoring by purveyors. Because of the heavy reliance on private wells in parts of Suffolk, the SCDHS provides sampling of these wells, at a nominal cost and, when water quality problems are discovered, the SCDHS provides the homeowner with advice on how to rectify the situation.

Through the enactment of Article 12 and the delegation of responsibilities by the NYSDOH and NYSDEC, the SCDHS is one of the agencies that responds to local environmental emergencies such as fires, accidents, spills, etc., involving toxic and hazardous materials.

The SCDHS has been involved in a number of activities concerning contaminated aquifer segment management, including the delineation of plumes, participation in the selection and implementation of response measures, and water reclamation. Several contaminated groundwater segments have been investigated by the SCDHS through sampling private wells and the installation of monitoring wells. These affected segments have been associated with landfills, hazardous materials spills, industrial discharges, and agricultural areas.

Included in the SCDHS's "Standards for Subdivision Test Wells and New Construction to be Served by a Private Well" are specified treatment systems for various water quality problems encountered in Suffolk County. All systems must be approved by the SCDHS, which routinely evaluates submissions regarding alternative treatment systems.

All reports and plans for privately owned and public sewage collection and treatment facilities must be approved by the SCDHS. Article 6 of the County Sanitary Code stipulates when a centralized treatment system is necessary for residential, commercial, and industrial developments and subdivisions.

Public education is a daily responsibility of the SCDHS. Examples of these education activities include responding to citizen questions and complaints regarding private well water quality problems, general water resource concerns such as lakes, streams, flooding, etc., suspected sources of pollution, and water resource management and planning considerations. The SCDHS also issues pamphlets and maps upon request. Formal public participation has become integral to all the major projects the SCDHS has conducted in recent years.

Enforcement activities performed by the SCDHS are required for responsibilities delegated by the NYSDEC and NYSDOH, and for ensuring compliance with Suffolk County Sanitary Code provisions. Following the detection of a violation, the SCDHS regulatory enforcement procedure consists of notification of the violation, informal hearings to encourage voluntary compliance, and formal hearings to issue an administrative consent order. In the event that additional action is necessary, the SCDHS refers cases that are in violation of state regulations to the NYSDEC regional attorney. For violations of the County Sanitary Code, cases are
referred to the County Attorney. In both instances, the SCDHS is called upon for the preparation of background case material.

The Sanitation Division of the Suffolk County Department of Public Works (SCDPW) has very important functions related to sewage collection, treatment and disposal. As the operator of several sewage treatment facilities, the SCDPW collects and analyzes samples as required by SPDES, as well as to gain insight into the efficiency of various processes.

The SCDPW is directly responsible for assuring adequate treatment at the fifteen wastewater facilities it operates. Because industrial/commercial establishments are included in some of the county districts, especially in Southwest Sewer District and Port Jefferson, the SCDPW has conducted an industrial pretreatment program in order to determine necessary pretreatment operations for firms discharging to the municipal sewers. Part of the responsibilities of the SCDPW is to enforce the pretreatment requirements. In addition to county sewer district responsibilities, the SCDPW under an inter-departmental agreement with the SCDHS, also inspects the construction of privately owned sewage facilities.

The towns and villages of Suffolk County have important groundwater management responsibilities for overall land use regulations due to the authority bestowed upon them by New York State law. Moreover, as owners and operators of water supply facilities, landfills, and sewage treatment plants, and by their active involvement in SEQRA, towns and villages fulfill other major functions related to groundwater management. Towns and villages may prepare and periodically update master plans for land use development. Local planning boards review all subdivision plans to assure conformance with zoning regulations, including provisions for stormwater disposal. For almost all SEQRA actions concerning land development, or proposed projects of a local municipality, the town or village assumes lead agency status.

The Towns of Huntington and Riverhead, and the Villages of Greenport, Northport, and Patchogue operate sewage collection and treatment facilities. These municipalities have also been involved in Section 201 Wastewater Facilities Plans that include provisions for upgrading those facilities.

Some towns have made zoning changes in major areas that will have long-term positive impacts on groundwater quality by minimizing the density of on-lot sewage systems.

East Hampton and Southampton have instituted regulations for "Aquifer Recharge Overlay Areas" that include restrictions on fertilizer and pesticide use for other than agricultural purposes. Brookhaven, as part of the zoning regulation changes for industrial uses, has established size limits on landscaping and turf areas, and restricted the types of shrubbery, grasses, etc. so as to minimize the demand for fertilizers and pesticides.

New York State law gives towns, villages, and cities exclusive authority to designate zoning within their respective jurisdictions. Zoning is the fundamental means by which towns and villages prescribe the actual use of land, and regulate the density and intensity of use. In Suffolk County, there remain large areas where land use control is considered the primary means for protecting groundwater quality, and as discussed previously, several of the towns have enacted important zoning changes.

Some of the towns and villages of Suffolk operate water supply district facilities. Regardless of whether or not they have their own facilities, all local municipalities in the County have become increasingly involved in water supply decision making.

The only town or village facility that has any extraordinary treatment is the Greenport Water District, which has installed granular activated carbon filters at the wellhead in order to remove aldicarb.

Water supply issues in general have been receiving much attention from towns and villages. Water distribution and importation from abundant areas to water deficient areas are specific subjects of much concern to local municipalities. In recent years, some town governments have been actively involved in promoting public water extensions to residents in areas of poor water quality. Extending water to proposed development, however, has met with opposition in some cases. The opinion has been expressed during town SEQRA review actions that provid-
ing public water, especially in water deficient areas, may stimulate undesirable growth in environmentally sensitive areas.

Public information meetings and hearings have long been a primary public education and participation mechanism employed by town and village governments to obtain citizen input regarding proposed actions. In recent years, SEQRA review activities administered by towns and villages as “lead agency” have become an important means of encouraging public participation.

Robert J. Gaffney

Ladies and gentlemen, I would like to take a moment and welcome you back to the afternoon session. Before we begin with the panel discussion, I would like to introduce Mr. Russell Slayback. He has been involved with Long Island water supply for more than 32 years, initially as a field hydrologist and eventually as president of Leggette, Brashears & Graham. LBG has been the groundwater consultant for the Suffolk County Water Authority for more than 40 years. He will be commenting on water supply and land use perspectives. This afternoon there will be a panel of distinguished professionals who will be answering questions posed by the audience. A written transcript will be prepared for distribution.

Russell G. Slayback

There is not much that can be added to the four excellent presentations from this morning, so this will serve in the form of a review session for trying to put what we heard this morning into the context of water supplies in other areas of the country and the land use decisions which will face Nassau and especially Suffolk County as they seek to assure that the public continues to enjoy a bountiful supply of healthful drinking water into the future.

Long Island and its aquifers are indeed unique — an immense mass of fresh water captured in an island fully surrounded by saltwater — unique in our country not only by that fact, but by the sheer size, volume and recharge characteristics, favorable quality of the aquifer water, and the ease with which large quantities of drinkable water can be withdrawn from the aquifer with little or no adverse effect. The Suffolk County Water Authority has built single wells that produce 3.5 million gallons per day — enough to serve the daily needs of more than 40,000 people — with 50 feet or less of water-level drawdown. The size of the freshwater reservoir is indicated by Figure 52, an average thickness of fresh water 1,000 feet in Nassau and approaching 1800 feet — a third of a mile — in southern Suffolk. The aquifer water is derived solely from precipitation on the surface of Long Island. As Figure 53 indicates, the average precipitation on Long Island varies from place to place, but averages about 45 inches.

Figure 54 illustrates the disposition of that precipitation, with an average of 23 inches recharging the aquifer system under natural conditions, an average of about 1.1 million gallons per day per square mile.

There are other places where groundwater can be produced in like quantities but not with so little adverse effect or with such abundant replenishment, or with such excellent natural quality — all combined. I compare the aquifers of Long Island with the rest of the Atlantic and Gulf coast plains, and they fall short on productive capacity, on drawdown impact, on natural quality, on pumpage induced subsidence, or on sustained yield because of less favorable recharge. The carbonate Floridan aquifer system and the Edwards aquifer in Texas are highly prolific and support large populations, but the water is hard and the aquifers provide little natural filtration. Some of the great alluvial aquifers of the west are highly productive but recharge is generally deficient and the large suppliers have been literally mining water. Along the major rivers of the country such as the Ohio, very high yields are produced, deliberately inducing river water to enter the ground and support the wells, but they are vulnerable to whatever contaminants may be flowing by. And in the Northeast, and the rest of the glaciated north, there are terrific valley-fill sand and gravel aquifers but they are of limited extent and total yield capacity. With few exceptions, most already noted, large centers of population in our country are served by surface waters. Small cities, towns and rural areas are served by wells. Surface water has always been more expensive to develop and more expensive to treat, but where prolific aquifers are not present, surface water is the only available choice. Now EPA has mandated that most surface water systems must be filtered — a new treatment expense.
SIZE OF THE FRESH GROUND-WATER RESERVOIR
OF LONG ISLAND, NEW YORK, IN 1965

EXPLANATION

Line of equal thickness of materials saturated with fresh water.
Interval 200 feet

Water-budget area.

Source: NYWRC Bull. 62
Figure 53 Average Annual Precipitation on Long Island, New York, Water Years 1951-65

Source: NTWRC Bull 62
Hydrologic Cycle and Water Balance for Suffolk County, New York
Last week New York City got a reprieve from filtering its huge supply, a project that is estimated to cost $5 billion or more; and which, many water professionals believe, the City will eventually have to do. Of course, groundwater on Long Island flows through a variety of sandy materials to reach the water table and then flows slowly through that material — a perfect natural filtration medium.

When I first began learning about the hydrogeology of Long Island in 1960, Max Leggette, the founder of our firm and until 1944, the District Chief of the USGS office in Mineola, and Homer Gardner, the first Chief Engineer of the Suffolk County Water Authority, spent a lot of time reviewing and discussing the history of the Long Island water supply, to make sure the fledgling Water Authority avoided the mistakes of the past. I would like to review that history with you.

Early Brooklyn was served by the Flatbush Water Company, supplied by high capacity wells. The community grew from single family residences to apartment houses; lawns and farms were replaced by pavement and roofs. Stormwater was piped to the ocean, and recharge rates decreased. Population densities that grew to 25,000 to 50,000 people per square mile required sanitary sewers that discharged to the ocean, a consumptive water use that further depleted aquifer replenishment. Consumptive use means water that is removed from the ground — from the aquifer system — and used up or consumed by evapotranspiration - by lawn watering or crop irrigation - or wasted by discharge to the ocean or other tidal waters. In Brooklyn, water mining ensued; eventually ocean water encroached into the aquifer, and faulty sanitary sewers compounded the water quality problems. The aquifer was ruined and Brooklyn joined New York City’s upstate water system.

A similar but less disastrous story occurred in Queens. Urbanization moved into Queens, with some areas resembling Brooklyn land use, but with many areas staying residential with single-family and duplex houses to this day. However, population densities ranged from 10,000 to 25,000 people per square mile. Sanitary sewers were necessary at this density, and they discharged to the sea. Most stormwater was also sent to the ocean. A widespread cone of groundwater depression with its deepest parts more than 50 feet below sea level encompassed all of south-central Queens. Saltwater encroachment occurred in southern Queens, and one small water system after another shut down and joined the New York City system. Only the Jamaica Water Supply Company remains. It is of interest to note that New York City is now receiving proposals for an extensive evaluation of the Brooklyn-Queens aquifer to determine if treated groundwater from this area has a place in its long-term water supply plans.

Moving east into Nassau, our story is a good deal more pleasant. Stormwater management as an engineering practice came in time for Nassau, as evidenced by its 800 stormwater recharge basins. They are not perfect, but they do provide substantial quantities of recharge. The NURP Study, the Long Island segment of the Nationwide Urban Runoff Program, concluded that any adverse water quality impacts were minimal. Nevertheless, population densities of up to 10,000 persons per square mile, and averaging almost 5,000, necessitated that most of Nassau be served by sanitary sewers, with effluent discharge to the tidal waters. When this sewering was initiated, Max Leggette added a graph, Figure 6, to his annual report to the Water Authority, comparing the average water levels of Nassau and Suffolk and predicting that Nassau’s water levels would begin to fall as the result of increased consumptive use. The graph made the front page of the New York Times on January 23, 1972, at a time when Nassau was concerned about meeting the projected demands of continued growth to a projected population of 2.3 million people. I should note, however, that the graph ends in 1970 as the result of a changing data base so that the modest recovery of groundwater levels that Mr. Mulligan reported, is not shown. Large-scale consumptive use of groundwater by discharging sewage out of the aquifer system has a substantial quantitative impact that should be avoided wherever possible.

As was pointed out, one of the adverse effects of increased consumptive use of groundwater on Long Island is reduced streamflow, because streams on the island are supported far more than elsewhere by natural groundwater discharge. When the water table drops, streamflow decreases. That is an issue that is not directly related to the quantity and quality of water
# WATER-SUPPLY HISTORY
LONG ISLAND, NEW YORK

<table>
<thead>
<tr>
<th>County</th>
<th>Area (sq.mi.)</th>
<th>Population (millions)</th>
<th>Population density (persons)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kings</td>
<td>78</td>
<td>2.6</td>
<td>25,000 to 50,000</td>
<td>High density. Sewers to ocean. Stormwater to ocean. Salt-water encroachment. Sewer leakage. Connect to NYC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average: 33,000</td>
<td></td>
</tr>
<tr>
<td>Queens</td>
<td>115</td>
<td>1.9</td>
<td>10,000 to 25,000</td>
<td>Local high density. Sewers to ocean. Most stormwater to ocean. Salt-water encroachment in south. Most connect to NYC, except JWSC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average: 16,500</td>
<td></td>
</tr>
<tr>
<td>Nassau</td>
<td>291</td>
<td>1.4</td>
<td>1,000 to 10,000</td>
<td>Moderate density. Stormwater management. Sewers to ocean. Salt-water encroachment concerns.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average: 4,800</td>
<td></td>
</tr>
<tr>
<td>Suffolk</td>
<td>922</td>
<td>1.3</td>
<td>&lt;1,000 to 5,000</td>
<td>Moderate to low density. Stormwater management. Cesspools/septic systems and STP leaching fields. SWSD. No salt-water concerns. Farming impacts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average: 1,450</td>
<td></td>
</tr>
</tbody>
</table>
Figure 56 Water Table, 1984

WATER TABLE, 1984

(Courtesy U.S. Geological Survey)
Discharge of sewage effluent into tidewater began in January 1952 in Nassau County.

Average Yearly Groundwater Level on Long Island

Average ground water levels remained about the same until Nassau in 1952 dumped sewage wastes into bays.

LEGGETTE, BRASHEARS & GRAHAM
supply, our main topic of today, but it is an important environmental issue. Nassau is embarking on its first program to augment that stream flow with highly treated sewage effluent which would otherwise be wasted to the sea—a positive step in my view.

In Suffolk County, future land use and engineering decisions have substantial potential to affect future water supplies for good or for harm. Suffolk County started to grow when stormwater management was already well established. Recharge basins are common. The only significant sewage outfall to tidal water is from the Southwest Sewer District, serving an area of generally high density development and a high water table. Elsewhere in Suffolk County, sewage is returned to the ground by cesspools and septic systems and, for larger residential and commercial developments, after sewage treatment, to leaching facilities. Suffolk has grown to more than 1.3 million people, but the average population density is still less than 1,500 people per square mile, with the greatest density in the southwest.

Total groundwater storage is on the order of 70 trillion gallons. (See Figure 58) We have little concept of what trillions of gallons means. Seventy trillion gallons is equivalent to 380 feet of water standing on the surface area of Suffolk County. It is also equivalent to all the water on the U.S. side of Lake Erie. The freshwater storage has limited meaning except to demonstrate that the aquifer is a huge system that responds very slowly to change and can withstand drought without damaging impacts.

Far more important is the recharge rate — the average natural recharge rate is on the order of 1.1 million gallons per square mile as shown in Figure 59. The effective recharge area for the main body of the county is 885 square miles, so the average recharge rate approximates 990 million gallons per day. Incidentally, Long Island is one of the few places I know in this country where well planned and constructed developments can result in less total runoff and more total recharge by efficient capture and recharge of stormwater.

The current groundwater withdrawals for all uses are estimated at about 210 million gallons per day in Suffolk County. Of that withdrawal, the consumptive use is only about 100 million gallons per day. Thirty to thirty-five million gallons a day is from the Southwest Sewer District discharge to tidal water, and the balance is from household and farm irrigation losses through evapotranspiration.

The average consumptive water use is about one-tenth of the average recharge. If farms continue to give way to housing, and if no enlargement of treated sewage to tidal waters occurs, this ratio will likely improve in the future.

Mr. Mulligan referred to the lowering of the water table in Nassau County and its recent trend towards stability in response to reduced pumpage. Because of the small amount of consumptive groundwater use in Suffolk County, there has been no discernible lowering of the water table in the past 34 years. Figure 60 is a contour map of the water-table elevation in Suffolk in 1957. The two darkened contours are 60 and 80 feet above sea level. Figure 61 is for 1991, with the heavier contours being the 60 and 80 foot contours in the same general positions. For ease of comparison, Figure 62 shows the 1957 map overlain by the 1991 map, and black and red contours overlap closely, indicating no significant water level change over the past 34 years.

Figure 63 is a hydrograph of water table observation Well S4271. It demonstrates natural fluctuations in the water table in response to wet and dry periods. The most sustained trend was the water level decline during the mid-1960s drought, the worst drought on record; but other wet and dry cycles, as in the 1980s, are also evident. However, the total range of annual mean water table elevation is about 4 feet; from a high of 13 feet above sea level in 1984 to a low of about 9 feet in 1966, with no long-term trend. Natural water quality on Long Island is excellent. The water is soft and has low mineral content. Locally, mostly in the southern part of the island, iron content is high and may require treatment. SCWA has pioneered pre-testing of iron content of its well water and uses that pre-testing to determine screen elevations that will produce the lowest iron content. Generally, water is acidic and requires lime treatment to avoid corrosion in the system. And, as noted, salt content can be a problem in coastal areas.
SUFFOLK COUNTY, NEW YORK

- Total Ground-Water Storage ~ 70 trillion gallons
- Equivalent to 380 feet of fresh water over the land area of the County
- Equivalent to the amount of water in the American side of Lake Erie
SUFFOLK COUNTY, NEW YORK

- Recharge Rate $\sim 1.1$ million gallons/day/mi$^2$
- Area of Suffolk County $\sim 885$ mi$^2$
- Total Recharge $\sim 990$ million gallons/day
- Current Water Withdrawals = 210 million gallons/day
- Consumptive Water Use $\sim 100$ million gallons/day
SUFFOLK COUNTY WATER AUTHORITY

WATER-TABLE ELEVATION
MARCH 1991

LONG ISLAND SOUND

ATLANTIC OCEAN
Figure 63  Water Resources Data for New York, 1990
In both Nassau and Suffolk, water served to the public has excellent quality and meets all applicable federal and state regulations.

I have referred to the average annual recharge rate of 1.1 million gallons per day per square mile. The 208 report refers to one to two dwelling units per acre as appropriate for continued use of subsurface sewage disposal in deep recharge areas. At an average population of 3.5 persons per residence, this implies water use of 225,000 to 450,000 gallons per day per square mile, less than half the average annual recharge rate. With a consumptive water use of only about 15 percent; the maximum consumptive use at two dwelling units per acre is about 70,000 gallons per day per square mile, or about six percent of the average recharge rate. It is fair to conclude that there will be no shortage of water in Suffolk County if the County avoids high average density development with sewage effluent discharges to tidal waters.

The 208 report reached those conclusions based mainly on the projected increases in nitrate-nitrogen. Nitrate-nitrogen is a contaminant regulated under federal and state drinking water standards at 10 parts per million. Natural Long Island groundwater has a nitrate-nitrogen content of 1/10 of a part per million or less. Groundwater on Long Island has been impacted by nitrate-nitrogen, initially from agricultural practices and then from sewage disposal.

When sewage is discharged to a cesspool or septic system, some nitrogen is lost to the atmosphere as ammonia or nitrogen gases and about half is oxidized to nitrate-nitrogen and thereafter is only attenuated by dilution or molecular dispersion. Studies on Long Island and elsewhere have shown that with housing densities of one to two dwelling units per acre, the drinking water standard for nitrate-nitrogen will not be violated with continued use of septic systems. Obviously the nitrate-nitrogen impact of subsurface sewage disposal increases with increased density.

Other contaminant constituents in sewage are renovated well by subsurface disposal systems. Pathogenic organisms, bacteria and viruses die off after travel through the unsaturated zone and in the groundwater. More study is clearly needed on the mobility of viruses. Phosphates are readily absorbed in the fine particles of the soil and eventually break down into soluble salts.

There is, of course, some potential for on-site sewage disposal systems to misused and become sources of organic chemical contamination. Everyone recognizes the potential for paint thinners, grease cutters and other household chemicals to be dumped in the sink or toilet. Connecticut has found about 50 organic species in septic tanks, but generally only at trace levels. Overall the record so far is encouraging. I know of no documented case of a public supply well being contaminated by a normal household septic system. There have been several cases that come close, from what I call cottage or garage industries—the persons servicing motorcycles, lawn mowers or reconditioning oil burner motors at their homes and dumping the solvents on their lawns or down the sink. Public education and health and zoning code enforcement are the keys to minimizing this potential.

As noted, where development densities greater than the equivalent of two dwelling units per acre are proposed, sewage treatment plants with subsurface effluent disposal are generally also proposed. This minimizes consumptive water use. Modern sewage treatment technology has advanced considerably, and treatment plants can be designed to meet drinking water standards or better in their effluent. The effectiveness of treatment is only limited by incremental cost. However, and it is a big however, it is one thing to design and build a state-of-the-art sewage treatment plant and quite another to assure that it will continue to meet its discharge requirement, its SPDES permit requirements, throughout its operating life. (SPDES, of course, is the acronym for the permit that is issued under the State Pollutant Discharge Elimination System). Dollars for operation and maintenance are the key to longer-term treatment effectiveness.

The Water Authority has long been concerned about the many old sewage treatment plants with bad records of compliance with the SPDES permits. Plants are built by developers and commonly turned over to homeowners associations that have many demands on their limited
funding such that sewage treatment plant operation and management (O&M) get a low priority or no attention at all. Without proper O&M, the SPDES permit violations are inevitable.

This problem is now being addressed by the Department of Health Services by assuring that proposed new sewage treatment plants have funding irrevocably set aside for O&M as part of the requirements for SPDES permits. It is also planned that such requirements will be applied to SPDES permit renewals for older plants, a much more difficult situation. Here public funding will likely have to be tapped to avoid having existing plants being abandoned by their owners who cannot afford the improvements.

From a water quality standpoint, you have heard from both Jim Mulligan and Joe Baier about the occurrences of water quality problems in the two counties. It is vital to recognize that the public water supply is monitored frequently for water quality; and that once a public water quality problem is recognized, by a violation of the drinking standard or even approaching the standard, the well in question is taken out of service. Again, I am more familiar with Suffolk than Nassau. Forty-eight wells have been taken out of service because of contamination with organic chemicals, 48 out of more than 600.

The SCWA made the choice to treat the water from these wells with granular activated carbon. This is the more expensive treatment alternative, but it is highly effective and reliable and continued use of the wells is removing the contaminants from the aquifer system, just as a pump-and-treat remediation would for a contamination source site. The data are inconclusive as yet, but it appears that the organic content of raw water from some of the wells where treatment has been in place for a year or more is gradually improving.

I think it is important to note that the present organic chemical problems in Nassau and Suffolk are largely the result of past industrial chemical practices. In their general order of importance, the known cases of organic chemical contamination have been caused by industrial disposal practices; gasoline and fuel storage areas, including leaking underground storage tanks; commercial sites, especially dry cleaners; transportation spills; and abandoned farms accepting hazardous waste as a cash crop. Several Superfund sites across the country have involved abandoned farms where the owners accepted hazardous waste for a fee, or just were not around to prevent dumping.

To the extent that anyone can know, most of these practices have ended. The health codes have been a tremendous force to change waste disposal practices and improve the security of toxic and hazardous materials storage as discussed by Dr. Andreoli. Industries can no longer afford to improperly dispose of their wastes. Accidental spills on industrial sites and on highways will continue to occur, but rapid response and cleanup will minimize the impact. Nevertheless, I am confident that additional wells in both counties will eventually require treatment for the organics that have been regulated and, perhaps, for the Phase II and Phase V organics that Joe Baier referred to, which are coming under regulation this year. With time, I would also expect some wells that are presently being treated to clean up and no longer require carbon treatment.

Many people concerned about water supply in Suffolk County are concerned about the future of Pine Barrens, and properly so. The Pine Barrens are within the deep recharge zone and the Central Suffolk Special Groundwater Protection Area. The water quality has had much less impact from human activity because of the minimal development, but there has been some local contamination. Little water is presently drawn from this area; the available data suggest that natural iron content is a likely problem that would require treatment, especially in the southern sections.

I don't pretend to have the answers to the future of the Pine Barrens. I can simply offer a few water supply observations. From a water supply perspective, the least likely impact would result from public ownership and controlled parkland use. But if it is uneconomical to transport the water from the Pine Barrens to a place with population, as Joe Baier referred to, is there sufficient public benefit for that usage? There may be for other reasons than water supply.

Continued non-development of the Pine Barrens in their present state should not be regarded as an assurance of freedom from contamination. With few people around, they are too
accessible to midnight dumpers, and I need only remind you of the celebrated case in the Carolinas of tank trucks reaching deserted country roads, opening their valves and dumping toxic waste as they drove along. If access is not controlled, water quality security is not assured. In my view, well planned, low average density developments with subsurface sewage disposal would not cause significant groundwater quality degradation in this area. By significant I mean a significant incidence of water quality that does not exceed or approach any applicable drinking water standard. Just by having people in residence, my concern about illicit dumping impacts would be eliminated without fencing off the entire area. If well planned development occurs under the current laws and regulations, the incidence of water quality contamination will be much less than in the remainder of the county.

In this brief overview it is also worth noting that the public water supply in both Nassau and Suffolk Counties is inexpensive — generally under $2.00 per thousand gallons in Nassau and the current rate for the SCWA is $1.21. A gallon jug of safe drinking water for about 1/10 of a penny. Many water supply systems in the country charge double, triple or even quadruple that for their water supplies.

In conclusion, I would note that most of the significant aquifers in the United States have had considerable study in the past two decades, but I reiterate what others have said. I know of no place in this country that can match the volume and high quality of the studies done in Nassau and Suffolk, and which I am sure will continue. We understand, far better than most, the dynamics of the aquifer systems and of the water quality problems we have to deal with.

Both counties have strengthened their health codes. I consider the Suffolk County Health Code to be one of the best and toughest around. I know firsthand that parts of it have been used as models for other areas that are seeking to protect groundwater quality. Furthermore, the people involved in water quality and supply issues in Suffolk County get together and share information and share problems and talk about solutions on a regular basis.

Some degradation of groundwater quality is unfortunately inevitable wherever human beings live. The quality of groundwater served to the public in Nassau and Suffolk is excellent. Vigilance and enforcement will always be necessary to minimize future water quality impacts. Water treatment may become more important, but the technology is available. Although one would prefer that water pumped straight from the ground meet drinking water standards, we should not be afraid of water treatment, especially to remove trace level of organics at the parts per billion range. The treatment methods are reliable and much less involved than the chemical treatment that is routinely applied to most surface water sources. Finally, without comment on the diverse control of water supplies in Nassau, I believe that the dominance of future water supply planning, protection and development by the SCWA along with Suffolk County agencies is tangible proof of the wisdom of the County Legislature in establishing this water purveyor more than 40 years ago. The Water Authority has the resources and talent to thoroughly investigate and effectively deal with water problems throughout its service area and beyond. As examples, I would cite its rapid response to provide expensive granular activated carbon units for the wells that have been shut down by organic chemical contamination and its current program to develop a public water supply system for the North Fork, the western part of the Town of Southold, where iron content and agricultural fertilizer and pesticide problems have plagued private wells for years. This new venture will require treatment of the native groundwater, but will result in more healthful drinking water for the residents. The Water Authority will continue to work with the USGS and the State and County regulatory agencies to assure that the people of Suffolk County have a safe water supply. Thank you.
Robert Gaffney

That concludes the first part of our program - the program which involves presentations by speakers with regard to various aspects of Nassau and Suffolk County's groundwater systems. The second part of the program involves a round-table discussion. The people who will be participating in that will be sitting up here. When they are all seated I will ask them to introduce themselves and give their affiliation and some statement of their credentials, who they are. Many of you know who most of them are already, and at that point we can take some questions. I've gotten some questions from the box at the registration table, which we will address to them, and at that point, perhaps, we can get some dialogue. If the gentlemen who are part of the panel would now come up and take their appointed seats, it would move things along. I appreciate it.

You wouldn't believe the number of questions that we have. Would you gentlemen try to make the answers to these questions as brief as is possible and still contain the necessary amount of information. We would appreciate it, because there are quite a few questions. We had talked, in terms of the agenda, of the moderator identifying some key water issues. I think nobody has done that better than the five individuals who spoke this morning. I think perhaps the best thing at this point would be to get on to the questions themselves. Before we do that, however, let me ask you to go down the list, one at a time, and identify yourselves and tell me a little bit of where you’re from. I have that, because I have it on the list, but I think everybody would like to know who you are and where you’re from.

I'm Herb Buxton with the USGS. I worked with the USGS office on Long Island for about eleven years, and currently work at the New Jersey District Office.

My name is Tom Maher. I used to be with the Nassau County Health Department. I was the County representative on the 208 Technical Advisory Committee. Presently I'm a principal with Dvirka & Bartilucci, consulting engineers, and responsible for working with Suffolk County in the development of the comprehensive water management plan.

My name is Joe Baier, and I'm Director of Environmental Quality for the Suffolk County Department of Health Services. I think you heard all the rest of it earlier this morning.

Russ Slayback of Leggette, Brashears and Graham, consulting groundwater hydrogeologists, and groundwater consultant to the Suffolk County Water Authority.

Jim Mulligan of the Nassau County Department of Public Works. I've been working for the County for 24 years, and I think Mr. Gaffney covered everything else this morning as well.

I'm Ray Cowen. I'm the Regional Director of the New York State Department of Environmental Conservation, Region I, Nassau and Suffolk Counties. Have 19 years with the agency, and I'm an engineer by training.

Bruno Nemickas, Acting Chief of the U.S. Geological Survey here on Long Island. I've been with the Survey for more than 25 years.

I'm Mike LoGrande, Chairman of the Suffolk County Water Authority. I've been drinking Suffolk County water for more than 25 years.

My name is Mike Burke. I'm with the State Health Department. I'm the Director of the Bureau of Public Water Supply Protection. I've been with the Bureau for about 17 years now.

I'm Bruce Brownawell. I'm a professor in the Waste Management Institute at the Marine Sciences Research Center of the State University of New York at Stony Brook. My research is concerned with the transport and degradation of organic contaminants primarily in both surface and groundwater environments.

My name is Aldo Andreoli and I'm happy with the introduction I received earlier this morning.

Doug DiLillo, private business person here on Long Island. I've been studying groundwater quality issues here on Long Island since 1986, and in particular have studied the effects of land uses and organic contamination.
My name is **Ed Kaplan**, I'm a scientist at Brookhaven National Laboratory where I've been for about 18 years. I study, among other things, groundwater sampling, computer models. I also teach environmental systems analysis here at the University. When I'm on the Island I try not to drink bottled water.

My name is **Charles Rich**, I'm a principal hydrogeologist at C.A. Rich, Consultants, private consulting groundwater geologists. I've worked on Long Island since 1973. I participated in the hydrogeologic zone concept of the 208 and our clientele includes developers, municipalities, and environmental groups.

**Tom Whiteside**, Vice President and Manager of Production for Long Island Water Corporation. I'm a professional engineer.

**Robert Gaffney**

Gentlemen, thank you very much for the introductions. Let's get the format down. The questions that I have are those that have been directed from members of the audience. They have been put on cards. Some are addressed to specific individuals. Most of them are questions that don't have an individual's name on them, so what I would ask you to do is to volunteer to answer the questions as you feel they are within your area of expertise, or you have something particularly important or lively to say. If nobody volunteers, I have some idea of what area they deal with and I will then select or ask somebody to answer the question. Somehow, I don't think that will be a problem.

1. **LIRPB in 1986 identified an area it characterized as Region II, as an area of declining water quality in its Special Groundwater Protection Area Study. What are the causes of this problem, what steps should town government be taking in order to minimize or alleviate these problems; i.e., less development, no development, etc., and has problem in Region II been increasing or decreasing?**

**Tom Maher**

Zone II was selected as part of the 208 Plan. The reason for that was that it was an area of degraded water quality caused by intensive industrial activity, mostly in east central Nassau County. As far as what steps are being taken to alleviate the problem - a number of those industrial facilities have been designated as State/Federal Superfund sites. There are a number of investigations presently ongoing, as well as active remediation programs. Generally, with respect to water quality - although we have yet to see the improvement of those remediation programs, I think you will see the improvement in the near future.

**Robert Gaffney**

Does anybody want to address that specific part about what should we do to resolve this - specifically, less development, no development, more development restrictions? Anybody have any comments about that part of the question?

**Joe Baier**

Just to add a little bit more about where Suffolk County is concerned, there is a very small portion in Suffolk County in Zone II - it's in the southwest sewer district, and as such those discharges then are addressed as part of the sewering issue - and we should see eventual improvement in shallow groundwater quality.

**Robert Gaffney**

Specifically the question, what steps should town government take?

**Tom Maher**

As far as town government is concerned, those areas have already been developed to the maximum degree possible. Really don't see much of a role for towns. I think it is more of a role for state and federal governments to pass the money for cleanup programs. Perhaps towns could take a role of petitioning state or federal governments to become more involved.
Mike LoGrande

Towns are now beginning to realize they have to take their cues from higher levels of government and preserve areas. Zoning, zoning densities, yields, etc. — items that towns traditionally deal with — are going to have to be modified in the future to reflect state-of-the-art information that is now becoming available in regard to governing land use in these areas. For example, the Pine Barrens zoning is in the hands of the towns, three towns in particular. It is time for municipalities to sit down collectively and determine what the land use patterns are going to be on the basis of protecting the groundwater supply and still not killing the economy but selecting development that is compatible with our environmental goals.

Aldo Andreoli

I would like to make a comment about an issue that I think the State needs to look at in the future. The 208 study made specific reference to Zones, III, II and I, which are all part of the same recharge area, but there are differences in quality in those waters. Obviously in Zone II, especially in Nassau County, water quality has been severely impacted by the aircraft industry. Its quality is not what it should be. Current State requirements say that all groundwater is potentially to be used for drinking water. It all has a GA classification, but one realizes that all waters are not the same quality. You can be on the shoreline, a few feet away from salt water, and yet the water that is there is still, theoretically, considered as drinking water quality. Obviously there aren’t any wells there. Other states have taken this into consideration—that waters have different levels of quality, depending on where they are. The 208 took that step by saying there are areas of more importance and less importance in terms of water supply, but the State has not come to that point, and I think that is one of the issues that the State will have to wrestle with - should they have varying groundwater classifications as they do for surface waters? Surface waters have AA, A, B, C, or D classifications based on their use. Groundwater has as a general classification, which is inconsistent with some of the states around us. New Jersey has adopted groundwater standards classifying groundwater depending on its use. So has Connecticut.

Charles Rich

I just want to make a quick point about the zonation of Long Island's upper glacial aquifer. When that concept was developed as part of the 208 in 1977, it was never intended that these hydrogeologic zones be a permanent map of deep flow recharge zones on Long Island. Clean water did not enter the picture. It was simply a geologic mapping where vertical components flow either up or downward, or generally something in between. It is a 15 year old concept and I would strongly recommend that it be updated, perhaps at the local level, either through a groundwater classification system, or a more globalized mapping of the zones. There are transitional zones, say between Zone II and III. Conditions change over time as we heard this morning. We made some additional stresses on the aquifer, so that the zone map needs revision.

Robert Gaffney

2. If California is able to transport water hundreds of miles cost effectively, isn't the ten mile limit mentioned for the Pine Barrens too limited and shouldn't it be reassessed?

Joe Baier

California transports hundreds of millions of gallons. We only pump 200 million gallons a day. They are transporting many, many hundreds of gallons over long distances because they don't have it locally. We have it locally. That is the difference. Our analysis of treatment vs. transmission only went as far as 40 miles. Once you went beyond the ten mile barrier, in certain instances you couldn't get a break out. If you took 20 million gallons you would probably get as far 20 miles, but then you have to figure out where you're going to get that 20 million gallons from; since now you begin to cause other problems that you don't anticipate - creating large pumping centers can cause the localized drawdown effect, as happened several years ago in Jamaica. We have to be careful with scenarios like that. That is why we have never followed the California scenario. Now I am sure if California had had aquifer systems available to it, as we have here, people wouldn't have to go hundreds of miles away to get water.
Robert Gaffney

3. I have heard mention that one of the answers to long-term water problems that exist on Long Island might be the massive pumping of water from the east end to the west end? Is this viable?

Mike LoGrande

When you pump anything you have to go from the west to the east because the east end of Long Island, meaning the North Fork and the South Fork, has virtually no water. You saw this morning, there is no Magothy aquifer on the North Fork, just upper glacial. Our single biggest problem in shipping water on Long Island is the fact that we have no major changes in elevations. If anything, they represent elevation barriers - if you try to ship water from the Pine Barrens and go across Ronkonkoma moraine, with very high elevations, you will have substantial cost in energy input to move water any distance. When you are dealing with California, or Europe, there is no problem in dealing with higher elevations going by gravity to lower elevations. On Long Island you just can't do that. Generally, it's flat. In the case of the SCWA, just pumping the water that we deal with now, costs us somewhere around $80,000 a day, $12 million a year, for electricity. You can imagine what the energy cost would be if we tried to transport water for longer distances. Technologically we could do it; in respect to economically feasibility, it is virtually impossible.

Mike Burke

You don't have to go to California or Europe for an example. New York City has a major aqueduct system but it is a gravity system with surface supply, no pumpage. The miracle of the New York City system is that it is all gravity.

Robert Gaffney

4. What is the impact of population density on the quality of groundwater, i.e. zoning?

Joe Baier

This is an issue I'm sure everybody will have some comment on. As I mentioned this morning, if you took an area and say let's zone it for one acre, let's zone it for half-acre, let's zone it for quarter of an acre - you can just imagine it in your own mind if it's large open space areas vs. no open space areas. Totally urbanized development where there is not a vacant piece of land, one house right after another, presents the ultimate use of the land. We found through studies - USGS, 208, and Health Department studies - that using nitrogen as the limiting parameter, because there is a long-definable standard for nitrogen, there were certain density limits that should not be exceeded because you will run a high risk of exceeding the 10 mg/l standard. The basic premise of regulations developed out of the 208 was to keep the nitrogen level in the groundwater below unsewered developments at about 4 to 6 ppm. Densities that reflected that 4 to 6 ppm range from one to two houses per acre.

Robert Gaffney

5. A lot of discussion has been held regarding the impact of having one or two houses per acre as opposed to taking a piece of property and clustering all the houses at one end and keeping the rest in open space. What is the impact on the groundwater of these two proposals?

Aldo Andreoli

Zoning controls what type of activity takes place on a piece of property. Residential development has a different impact from industrial, depending on what type of industries or commercial use. In terms of the clustering concept, which is a tool planners have used successfully for a number of years, it has been possible to keep large areas intact and reduce the infrastructure needed to support that project in terms of public water, sewers, roads, etc.
Less of the land is trafficked upon when houses are not spread all over the landscape. This has a significant and valuable impact in terms of preserving groundwater quality.

**Ed Kaplan**

It should be emphasized that density is only a part, it is not even half the coin. The most important part is the zoning. Let's imagine no residences in the Pine Barrens, but instead industry, such as electroplating industry, where you have the possibility of introducing into the groundwater system some organic chemical that could contaminate miles and miles of subsurface that you would never get if you had residences there. You have to look at the type of use in addition to density.

**Doug DeLillo**

There is a significant relationship between the impact on groundwater and the amount and intensity of land use and the potential for organic chemical impacts. The 208 study showed that one or two residences per acre would yield concentrations which would not be detrimental to the aquifer. In large vacant parcels such as Pine Barrens or other SGPA areas, the amount of high quality water that can be recharged due to maintenance of open space is probably the most significant policy making aspect. It is open space that allows for recharge regardless of what type of development and use takes place for that area. Clustering of large parcels, allowing a large percentage of property to remain as open space, will allow the most significant amount of recharge.

**Robert Gaffney**

6. *If groundwater pollution is correlated with development, as shown in USGS report, WR1-86-4142, published 1989 — with or without sewering — would continued development eventually result in treatment of most of our public water supply?*

**Herb Buxton**

I am not sure that was a direct conclusion of that report. I think what the authors might have been saying is that they are looking at data and to that date were not able to identify a trend or a difference between areas that had been sewered or had not been sewered. What those facts communicate is consistent with what was discussed this morning - contamination has been long-lived in these areas and it has propagated downward through a significant percentage of the groundwater system. Implementation of sewers may not be an instant correction to that kind of problem, and it may take a significant period of time for cleaner recharge to flush contamination out of the system. I think the conclusions of that report were a lot closer to saying we should continue to see how long it will take for sewering type practices to improve water quality.

**Bruno Nemickas**

Mr. Mulligan showed earlier this morning, long-term sewerage in southwest Nassau actually has resulted in a leveling off and decrease in nitrogen.

**Robert Gaffney**

7. *What is the possibility that intensive farming done in both Nassau and Suffolk Counties in the late 19th or early 20th century, with manure and other things used as fertilizer, would affect the nitrate level at this point?*

**Jim Mulligan**

The decrease we are seeing in part of western Nassau County brings the nitrate level down to a certain level, but the remaining part is the left over impact from past farming practices. It has had an impact and would if those practices were to continue.
Herb Buxton

One of the slides from this morning showed the distribution of age of groundwater in a section. To further discern whether nitrate concentration was a real indication of the age of groundwater, we compared the age with the distribution of nitrate that we had measured that was at a depth. We observed nitrate concentrations at an instant in time and mapped them out over that section. The depth to which the nitrate had propagated down represented a travel time of about 75 years. Nitrate had been getting into the ground as early as the turn of the century, which would indicate that some of our earlier impacts, man's earlier impact at the land surface, including agriculture, was the cause of some of that early nitrate contamination.

Bruce Brownawell

With organic chemical contamination, you have heard about nitrate, you don’t expect any specific correlation with population density or development. It depends on the type of activity going on. Organic chemical contamination can come from either a point source, which depends on zoning or land use, or from agricultural biocides. Neither case is necessarily correlated with the intensity of development.

Ed Kaplan

The previous speakers commented that we had an excellent filtering medium in sand and gravel. That can work against you also. If you try to filter out something that is dissolved, that doesn’t stick to particles, it goes right through. So we’re sitting on an area with a poor filtering medium for the kinds of chemicals we are dealing with nowadays - the organics. I am reminded of a study done several years ago that looked at various kinds of SPDES permits that were issued in and around Massapequa and looked at groundwater quality data from various sources. There appeared to be some very strong correlations with certain types of activities such as dry cleaners, for example. We could say where they were located just by looking at the groundwater contamination, tracing back to where the activity led to the contamination.

Doug DeLillo

It is also possible that areas where nitrogen levels are not decreasing significantly, where it is sewered, might reflect ongoing activities such as lawn fertilization. It would be reflective of continuously high usage of overlying land by human activities. One other thing also interesting in that USGS report in regard to organics, is that it does show significant differences between undeveloped property and any other land use category. Among the 12% of the total number of wells in the study that were located on undeveloped property, none showed organic contamination. Have exact relationship between open space and quality of water that shows the open space value to recharge.

Charles Rich

Should note that the report was based 903 wells, and some of the wells were in open spaces of Long Island and also showed quality levels of nitrate levels - open space is not panacea. It is important to the managers on Long Island to pass naturally drinkable water on to future generations. We have to understand the system much better than I perceive we currently understand it. Not saying we shouldn’t be confident, but there is a lot we still have to get into.

Tom Maher

Several years ago, I participated in a contaminated aquifer investigation in Nassau County. We looked at all of the wells, both in public water supply and monitoring wells, in Nassau County. What became very clear is that organic chemical contamination is really associated with industrial land use. I don’t think you can attribute it to residential development, even dense residential development.

Russell Slayback

It is really industrial use of property — some cottage industries can impact, but primarily larger industries are responsible for the problem.
That is the same thing that Gus Guerrera found in the Queens County study. As densely developed as it was, there was a very strong correlation between industrial/commercial use and contaminated wells. In residential areas, even with high density row houses, wells were uncontaminated.

Robert Gaffney

8. Most of the detailed analysis of the groundwater flow has been carried out at the Suffolk/Nassau County boundary where the west/east component of flow is insignificant. However, in the central Pine Barrens a significant amount of water flows into Peconic Bay. How much of the water seeping or discharging into Peconic Bay originates in the areas now under consideration for development, i.e., Ridge?

Herb Buxton

We conducted that analysis along the Nassau/Suffolk border — think that is intended to provide insight into how things work. The same type of operation holds for the Peconic Bay area. You may recall the slide showing recharge areas of Magothy, Lloyd, shorelines and streams. There was an area surrounding the Peconic River that indicated that water recharging around that area went right to Peconic river — strips along shoreline that went out along shoreline also discharged to shoreline. It is similar to what happens at the Nassau/Suffolk border in that areas closest to stream and shore discharge directly to those bodies. The further inland the more that water goes deeper down to Lloyd. The deep recharge area splits at the forks on the East End, just like the actual geometry of the island.

Robert Gaffney

9. Specifically — this must be from someone who has specific interest in the area — how much of the water seeping or discharging into Peconic Bay originates from the area now under consideration for development, i.e., Ridge?

Herb Buxton

The Peconic River itself does go partially as far as the Ridge; area just north of the Peconic River.

Joe Baier (addressed to Herb Buxton)

Would you care to quantify how great the distance? We recognize that, yes, there is a general flow from areas adjacent to shoreline of river towards the river. Is there a boundary - 100 feet; 1000 feet or miles? Just in gross terms, that might help.

Herb Buxton

As I remember from the illustrations we prepared, it is probably as much as several thousand feet in either side of river. In order of magnitude of the size of that contributing area to the stream, it may be half mile. The Scenic & Recreation Rivers Act provides one-half mile protection on either side.

Joe Baier

That is the extent; we're not talking about miles or an entire community.

Robert Gaffney

In watching the slides, one thing that occurred to me — and perhaps this is such a sophisticated audience that everybody is familiar with groundwater issues — but, nevertheless, I remember it was a revelation at one point that when we talk about water underground we're not talking about water as it would be in a reservoir nor a river but talking about saturated sand, etc. When we are talking about a river, we are not talking about a whole stream. Could someone touch on the geology of how that works? We're talking about water moving, not through empty space but through an amalgam of sand and gravel. Could someone address that?
Joe Baier

The stream bed is a depression in land contour and since the groundwater contour is basically straight across, you wind up getting groundwater in the stream. Lake Ronkonkoma, rather than a stream, is just a kettle hole in the ground. The surface of that lake is the groundwater table and the groundwater is moving across that lake and out the other side — going in one end and out the other. If there were a channel at the other side, you would have a stream and more water would get into it as that depression went further along. That is how stream beds are formed.

Robert Gaffney

When you used the analogy of a plume of contamination from a light fixture and a string that took it across this room, I am sure there was a time when I would have considered the aquifer some sort of empty cavern underneath the ground, full of liquid water. It is not that way.

Aldo Andreoli

You are looking at what happens when a contaminant gets into the system. The analogy to a lake does not apply. If there is a contaminant dripping down from the ceiling into this body of water, if this were a lake, given time this would be dispersed throughout the entire system. That does not happen in groundwater. It is moving through sand, and there isn’t this lateral or vertical dispersement that you would have in a free body of water. This contaminant stays almost intact, at the concentration it was when released, and water acting as vehicle carries it along, maintaining the same integrity. The only thing that disturbs it is if it runs into clay, or other geological formation. There may be a stream and, if so, it may be diverted toward the steam; but the contaminant concentration remains the same, unlike what it would be if the same contaminant were dumped into Long Island Sound.

Ed Kaplan

I disagree somewhat. First of all, I think it is a semantic argument. You can think of groundwater as a reservoir because it is there. The water we need to drink is there. We have to mine it, pump it, get it out of the ground. But it is a reservoir. Second, water does flow; however, recent literature shows it doesn’t flow uniformly even if sand and gravel are uniformly distributed. There are different areas where, for different reasons, water will move more slowly. Third, when a contaminant reaches the water table, if its denser than water, it will move down as it moves out. If less dense, it will stay near the top. There is dispersion, as it moves, like ridges. The contaminant, if it is a continual drip of contamination, will form plumes. There is a concept here that a contaminant will stay there, move, and zip it is out. That is under one type of situation where all the contaminants hit the groundwater at once. If that doesn’t occur, in the majority of cases you get long fingers of contamination that get longer and longer and longer unless something happens to them while underground, like bacteria destroying them, which happens frequently.

Robert Gaffney

10. Who decides what drinking water standards should be and how are limits set?

Mike Burke

There are a variety of ways to set drinking water standards, depending on the kind of contaminant you are talking about. There are some differences, but basically these days, there are organic chemical standards, established primarily by Federal government. EPA is the standard setter for most standards in drinking water. Basically, EPA looks at the organic chemical contaminant in relation to potential adverse health effects. If it has classified the contaminant as a carcinogen, there is one method for developing a standard, which is to establish a goal of 0 and then establish an actual drinking water standard, with maximum a contaminant level as close as possible to 0; taking into account the technology and to some degree, cost. If it considers the contaminant a non-carcinogen, EPA looks to health effect studies, which are primarily animal studies to date. It looks for the no adverse effect level, calculating out from animal studies, extrapolating from large doses to animals to small doses for
humans, adding a safety factor, an uncertainty factor, and coming up with a number. Add to that number a little bit for technology and you get to that number and measure it.

The State has done pretty much the same in terms of newly regulated chemicals, adopting the Phase 2 and 5 federal standard. However, in 1987/88/89 when New York adopted the first round of volatile organic chemical standards, we took a little different approach. The State Health Department policy is to reduce contamination from these kinds of compounds; for example, synthetic organic chemicals, volatile, pesticides etc. They shouldn’t be in the water supply; therefore, reduce concentrations to the extent practical. When you look at them that way, we established the standards. For some individual ones where EPA had lower numbers than our general numbers, we established a standard based on technologically what we could reach; analytically what we could measure; and then tried to compare that standard to health effects data and found out we were in the range of 5 parts per billion for specifics and 50 parts per billion for all the others. We are now at that stage as EPA pumps out individual numbers for compounds. The schedule is 25 every three years. We will adopt those numbers if they are more stringent than ours. If they are less stringent, we will reassess them individually. Other contaminants are also done on a risk assessment.

Jim Mulligan

This was an issue in 1977, when we started to develop standards. What most people are not aware of is the safety factor involved in setting standards on the order of 1,000 to 10,000.

These days that varies. The margin of safety will be at a factor of 10, 100 or 1,000 - the more uncertain, the higher the margin of safety. There is a tremendous margin of safety in the standards. Theoretically you could drink more contamination and probably not incur the cancer or whatever result of drinking it for a long term. In engineering, if you are building a bridge, you generally have a factor of safety of 2 to 3. We are talking about a very large safety factor.

Mike Burke

As for risk assessment, at least in terms of looking at carcinogens, the assumption that still exists is that there is no threshold for these compounds; therefore, the objective of the regulation is to basically eliminate them if you can. If we can prevent pollution from occurring in the first place, then we don’t have to worry about the level of exposure after treatment. Once it’s there, then standards are set. There is no maximum number any more in terms of risk level. That used to be a kind of magic number to be looked at. New Jersey legislation requires the State to establish organic chemical standards at one in a million risk level as calculated through studies. EPA these days thinks more in terms of $10^{-4}$ to $10^{-6}$ as the acceptable risk level. Our goal is not to deal with risk level but to drive it down as low as we can, taking into account the practicality of technology.

Robert Gaffney

11. How can the rise in sea level between 18,000 and 10,000 years ago be responsible for saltwater intrusion in south shore Brooklyn and Queens and in the Magothy in Long Beach, where USGS data shows there was a fresh water supply source in the early 1900s?

Jim Mulligan

There is a tremendous lag in the time that it takes for saltwater to move landward as a result of rise in sea level. The reason it takes so long in the Lloyd Aquifer, the reason it is still off-shore, is that the Lloyd aquifer cannot rid itself of fresh water for that saltwater to drive in, because of confining Raritan clay above it. It has to lose fresh water, actually drive it out of the Lloyd vertically upward for saltwater to come in. Because it is such a tight unit, because it is clay material, it takes a very long time to occur. Because pressure difference is essentially there, it will take hundreds of years.
Herb Buxton

If the question was phrased in reverse, the answer would be that, probably, because of a very low sea level stance in the distant geologic past, we have a large buffer of fresh water in confined aquifers. When the sea level was very low, fresh water filled up to a significant distance off shore and, as the sea level rises, sea water is gradually pushing fresh water out. There is a similar situation in very deep aquifers in New Jersey. There are wells five miles offshore in New Jersey that tap the same aquifers as the Lloyd and Magothy, and those show freshwater five miles offshore. It is very different from place to place. It is a fact while sea levels were very low in geologic past, freshwater was able to be stored in deep aquifers.

Bruno Nemickas

The Brooklyn/Queens saltwater intrusion is due to pumping, not entirely due to sea level. Brooklyn was overpumped basically, and created a drawdown that allowed saltwater to move in eastward into Queens.

Robert Gaffney

12. When and how will the Suffolk County Department of Health Services, NYSDEC, and USEPA ever effect cleanup of the Deer Park groundwater supply?

Joe Baier

I must plead ignorance as to the specific area in Deer Park, that the questioner refers to, but there may have been a special spill or industry that impacted there. I'm not sure which it would be. Assuming there is industrial spill, it could be a Superfund site, which would be registered on the state or federal level for cleanup. There are specific regulations and requirements that have to be met before cleanup can actually be effectuated. Perhaps NYSDEC could answer.

Robert Gaffney

Second part to question - When or how will USEPA ever admit that cleanup of Long Island groundwater is not economically feasible and the only solution is source removal and natural purification?

Ray Cowen

I'm not totally familiar with what is going on in Deer Park - there are several inactive hazardous waste sites in various stages of remediation. In the country as a whole, not just Long Island, there is growing realization that we could spend the entire Federal budget on cleaning up inactive hazardous waste sites in this country. I don't think this would necessarily be the best expenditure of public funds at this point, to chase every last molecule in groundwater. If the question suggests we should be moving in that direction on a national basis, that seed has been planted. There has been no distinct movement on the part of agencies on Long Island to step up to that issue, but I will tell you that that is a consideration under way. In the program of inactive hazardous waste site remediation, we do concentrate efforts on the removal of the source. That is the most bang for the buck. There is no sense removing the plume until you remove the source. It is the first thing we do, and common sense management of our funds will lead us to remove more sources rather than chasing plumes in the future.

Aldo Andreoli

I can't disagree with that. It is very difficult to try and chase plumes once they hit the ground. You have to prevent their occurrence. Once a plume has formed, there really are not enough resources to clean it up and that is part of the dilemma we now have. We are now struggling with contaminants that are in our system, many discharged before there was recognition of their effects and before we had the ability to test for them. With pesticides, when the Department of Health looked at agricultural activities, they had to go to the manufacturers to figure out how to test for them. The sophistication we now have in terms of analyzing has expanded enormously and to try to return the aquifer is a very expensive proposition. We should concentrate on preventing it from happening again.
Remediation is a very young field - it grew up as a result of Superfund. Technologies grew up and lots of monies were spent. What has been learned is yes, you can reduce sources; the idea that you can restore underground supplies to drinking water standards in a 20-50 year time frame is not realistic. You can spend more resources than available to treat one subsurface contamination site, let alone all.

One point that has not been made is the influence of pumpage on plumes - you will recall the story about a pencil thin plume from a dry cleaner; there was no public water supply well in close proximity to that plume - but if a high capacity well were within several thousand feet of such a plume, we can change that plume and pull it into a public supply well. This is the cause of much of the limited organic chemical contamination that has occurred in Suffolk County. Continuing to pump those wells and treating with granular activated carbon is a form of pump and treat remediation that serves the purpose of managing that plume and limiting the ability of that water to be pulled downward.

Part of Federal and State programs remediate groundwater supply, not only source remediation, but also for protection of public water supply. In areas where there is public water, provisions will be made for treatment. If it is private water that is contaminated, provisions will be made either for the extension of municipal water into that area, for the development of a community supply system, or for setting up a district to provide the impacted area with filters so the public's health is protected. This is not necessarily to remediate groundwater per se, but merely to protect the health of those who could be impacted.

Robert Gaffney

13. Is any type of development compatible with groundwater protection? If so, what kind? We talked about that very briefly when we discussed zoning, but does anyone want to add anything?

Russell Slayback

I think I made the point that any human habitation involves some degradation of groundwater quality. One must always view groundwater quality in the context of drinking water standards, which are inherently conservative to begin with. One can set goals to keep the contaminant concentrations several steps below prevailing drinking water standards as a safety factor; however, we have very conservative drinking water standards and if we manage the contamination that is caused by human habitation so that those standards or guidelines are not exceeded, we will have done our job.

Robert Gaffney

14. How about Northville spill?

Aldo Andreoli

There is no question there has been a spill at each of their facilities, unfortunately, and some of them have been among the largest that have occurred. There are programs currently going on in terms of remediation and have been for a number of years. The source of the problem in one case was a loose fitting that, over ten years, allowed the escape of an enormous amount of product into the groundwater. I think, to the credit of that company, they have addressed that and have attempted to come up with variety of technologies to address these issues, including pump and treatment, discharging and biological remediation. They are at the forefront in a number of technologies now attempting to address, after the initial floating product, the matter of the dissolved product. Northville is also trying to devise a model in terms of the direction of product flow in order to calculate decay. There are a number of relevant health risk studies. This is not an unusual situation. There are a variety of companies across the Island with similar kinds of problems. We have attempted to address them. The important question is, is it jeopardizing public water at this point and if it is, what steps can be taken? Those issues are being worked on or already addressed. The cleanup is still an ongoing process and the company will probably be faced with continuation of that process for many years.

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to come. The final reports and methods addressing these are still being worked on. We hope to have answers in coming months as to what the entire picture will look like. It is not an easy problem. Just look at gas stations: a good 30-35% of all the stations on this island have had a leak and this is not unique to Long Island but is found throughout the entire country. Probably 30% of gas stations in the country have leaks. Long Island has been investigating them and steps have been taken to remediate problems. The rest of the country is much further behind. It's inevitable that if you have a toxic product, a portion will get out. We need to cut down so it is not 30%, but reduced to 20, 10, 5 and hopefully as close to 0 as we can. Once the product gets out, dealing with it is difficult, expensive, and a long term commitment. Vigilance is the key.

Robert Gaffney

15. Are there any plans under discussion to increase groundwater protection by requiring the testing and/or upgrading of residential heating oil tanks or by licensing the installation of new underground home heating oil tanks?

Joe Baier

No, there is no consideration. Our regulations presently exempt tanks less than 1100 gallons; so, if a homeowner has a tank over 1100 gallons, it is covered by the standards. Regulations require that tanks holding 1100 gallons or more must be tested for tightness, depending on the age of the tank. We don't have plans to get into the next area.

Robert Gaffney

What is the incidence of contamination from home heating oil tanks?

Joe Baier

That's one area for which data is lacking and that is probably one of the reasons we have not ventured into this area. There are no definitive studies; no idea how many tanks are underground, or if they are leaking.

Robert Gaffney

Home heating oil storage is not a high volume type of operation; unlike a gas station. If a homeowner had significant leakage from his tank he would know very soon that there was a problem.

Jim Mulligan

We know underground home heating oil tanks are mostly 500 gallon tanks. In a lot of cases the rotting out of the tank itself is plugged by the soil material it is in contact with. We are not looking at major leaks; we're looking at very slow leaks. It turns out that, based on literature review and on field surveys in Levittown, #2 fuel oil is not a major groundwater concern because it does not readily pass through the soil but adheres to it. It is not a threat like gasoline. We had a case in Levittown where we found a leaking tank and tested the groundwater in the immediate vicinity. There was no contamination whatsoever. I'm not saying that in every instance there would be no contamination, but even if there were, it would be minimal, as compared to gasoline.

Robert Gaffney

16. This is for USGS. Why are the terms water table and upper glacial aquifer used interchangeably?

Herb Buxton

I think that is just our slipping at little bit with our terminology. The water table is located in the upper glacial aquifer throughout Long Island except in a few spots where, literally, the deeper aquifer, the Magothy, comes up at a very high altitude. There, basically in central Nassau County, the water table is actually in the Magothy. The upper glacial aquifer is upper-
most and in the vast majority of cases, that is where water table is. We tend to refer to it as upper glacial or water table aquifer.

Robert Gaffney

17. This is for Jim Mulligan. NCDPW - What are the estimated costs to treat groundwater with volatile organic concentrations in excess of 1000 ppm? Is it not more than four cents per thousand gallons?

Jim Mulligan

The cost would be greater if concentration were great enough. The cost would be driven up because you would need larger blowers, etc. The higher the contaminant concentrations, the more heavily contaminated the water, the more likely that the cost would be driven up; but instead of four cents per thousand, it might be six cents per thousand, even for higher concentrations. It still would not be some outrageous number. Air strippers, if designed well, can remove 99.9% of contamination. It depends on the type of power, air to water ratio, type of packing put in it, and lots of other technical parameters.

Bruce Brownawell

With an activated carbon system, the primary operating cost is replacement of carbons. The spent carbon is expensive to dispose of. That would be the major cost. Don't know what percentage of the overall operating cost that would be.

Charles Rich

The latest technology in air stripping is to purchase a shallow air stripper; it is quiet and a little bit more energy efficient than the towers. It's the size of a desk. In an application for a dry cleaner, the typical cost has been $75,000 for installation.

Robert Gaffney

18. What hazards may be introduced to groundwater by private residential septic tanks? How do we reduce or eliminate these risks?

Ray Cowen

The hazards would be whatever people use in their homes for cleaning agents, solvents, etc. An educational program is one way to solve it. Most of the towns on Long Island now have STOP Programs - stop throwing out pollutants - where you can go to a municipal facility on some scheduled basis and drop off pesticides, solvents, etc. That is the appropriate way to dispose of chemicals; not to throw them down the toilet or drain. This is the most positive way of controlling that situation.

Joe Baier

Several speakers have mentioned previously that the cottage industry can be a source of contamination. These homeowners will eventually use some sort of cleaning or rehabilitation product and bring into the home a hazardous material which ends up in the cesspool system. This is one of the biggest sources of industrial or solvent-involved organic chemical contamination problems.

Robert Gaffney

We have more questions than we can cover this afternoon. Those questions that are not answered here today will be answered in the Proceedings.

19. Does a change in the Clean Water Act that would allow for advanced primary, in place of tertiary, treatment of sewage have any application on Long Island, and if so where? Any benefits; any detriments?
Aldo Andreoli

Not tertiary. Perhaps the question was regarding advanced secondary treatment. My office struggled for a long time with tertiary treatment. It preceded the state in doing this; again, because of concern that nitrates were getting into and being discharged into groundwater. For some time, it has been required that all plants be upgraded to secondary treatment. That's been a requirement that all of our plants currently meet; except, perhaps, Port Jefferson. All our plants are basically secondary. Most of the plants are required to provide tertiary treatment. That is the state of the art for sewage treatment. If you have a collection system that handles domestic waste and you are providing tertiary treatment in terms of removal of nitrates, you are producing an effluent that is close to the drinking water standard.

Bruce Brownawell

The question may have been concerned with the comparison of primary vs. secondary for discharge into coastal waters. That has tremendous implications, not only advanced primary to secondary, but the potential need for tertiary treatment for New York City in terms of the discharge of treated waste to marine environment, because it is a several million dollar problem for western Long Island Sound. That's a very controversial area.

Joe Baier

For a good fifteen years now, Suffolk County has had a requirement that wastewater treatment plants maintain their nitrogen discharge below 10 mg/l. This is specific only to Suffolk County. It has been in effect for a number of years now. Effluent from any plant designed and built in the last fifteen years must be below 10 mg/l.

Robert Gaffney

20. What effect will proposed changes of Article 7 have on groundwater?

Joe Baier

That is something that will warrant further discussion. The Board of Health will be meeting in two weeks on this. There are two primary changes: lift the present requirement of 250 gallons or 1000 lbs. of storage in the deep recharge area and allow for industrial discharges into a sewage treatment plant if SCDPW is operating the plant. Those are the two basic changes. We've tried to analyze the impact and don't think it will be detrimental.

Robert Gaffney

21. What is estimated cost of providing GAC (granular activated carbon) and/or air stripping for most of the 1000 public supply wells on Long Island, if more developmental contamination and increased standards require this?

Jim Mulligan

There are many assumptions in this. That's the number I was talking about before - the four cents per thousand gallons for an air stripper and a capital investment cost of about $500,000. A granular activated carbon unit can either cost less or more than that, depending on how it is installed. It can be housed outside or in a building. If its in a building, we're looking at around $800,000; if it is outside, GAC may be cheaper than air stripping. It varies. It's in the neighborhood of from 3 - 8 cents per thousand gallon increase in basic cost.

Mike Burke

Five or six years ago, we were probably in the vanguard of the health departments talking in terms of potentially inevitable need for the treatment of all drinking water supplies on Long Island. This was based on the late 70s early 80s findings of organic contamination. The situation is not the same today. We do not have the same ratio. We find less now than five six years ago, because, then, perhaps we were looking at the most vulnerable sites.
Joe Baier

When we started looking in the early 80s, we found many contaminated wells. We do not find that any more; we're not having to shut down wells. We have been finding an average of about two wells a year where standards are exceeded.

Robert Gaffney

22. Isn't it cheaper to prevent contamination rather than correct the damage after it occurs?

Joe Baier

Is it cheaper to remediate than it is to prevent? You have to deal with what is already there; with whatever contamination is in the aquifer. If we had a magic wand and could say tomorrow there is no more violation of groundwater - we would still have to deal with what is there. What is there is going to be there for a long time. Occasionally, contaminated water is going to enter a public supply well. That is why we have monitoring and sampling.

Robert Gaffney

So the answer to this question is, in many ways, that even if it is cheaper to prevent contamination, it is certainly not public policy at federal, state or county level to prevent all contamination, and we must deal with what is already there. Otherwise we wouldn't be spending a lot of money for fiberglass tanks and doing a lot of the other things that are being done, so the effort is made I would assume to make sure that we have remediation as a tool to deal with the things over which we have no control. That makes me feel a lot better, because like many people, the more you hear that it becomes less expensive to fix the problem after it happens than prevent it in the first place, you tend to think that maybe the economics will drive the situation; but, clearly that has not been the history thus far.

Mike LoGrande

Effectively what we are doing today, the treatment we are supplying today has nothing to do with very recent developments. We are most likely dealing with the contaminants that were put in the '60s and '70s. We are noticing, too, that there are less than 10% of our wells in the SCWA system with GAC filters. We are effectively cleaning the upper glacial aquifer as well as upper portion of Magothy by continually pumping and removing the contaminants from the water supply. The operation of the various county articles, SPDES permits, greater public awareness, is changing what in the past were very careless practices. We are continuing to clean up the water, filter it, to insure that water at the tap is the purest water by any standards. The total result is that the aquifers are getting better not worse, even TEMik is disappearing in many areas. VOC concentrations are decreasing in most wells. We do pick up one or two new VOC contaminated wells a year, but we put in filters immediately. Instead of abandoning them and leaving the contaminant sitting there, with GAC filter systems we are cleaning up those areas.

Robert Gaffney

23. How reliable or accurate are models in predicting water contamination?

Jim Mulligan

I think groundwater models today can be built with a high degree of accuracy. What they are, in essence, are mathematical simulations of how groundwater flows, and once you know the flow regime, you can drop these particles of contamination into the flow regime and see where contaminants move, how they move, and how quickly or slowly they move. It helps in remediation and cleanup. You can predict where it is going and know where to put wells to pump the contaminated water out. We are able to do things today with saltwater intrusion models that we couldn't do ten years ago. We have made some great advances. Models can be highly accurate, if done correctly.
Ed Kaplan

They are useful tools; can't predict, but you can estimate. Models are only as good as the person who constructed it; only as good as the data used; only as good as the person interpreting it. They help to gain insight, but that is all.

Herb Buxton

As for models in general, the easiest way to understand the advantage of using models is to understand that they let us test concepts or first guesses at how things work in the subsurface. They let us test them. In the past we might have thought water transmitting properties of the upper glacial were such and such, that the recharge rates, such and such. When we built the first complete model and used it to simulate the altitude of the water table, the model incorrectly placed it far below its actual location. That is the biggest advantage it gives to us; it allows us to eliminate mistakes. Models are a real learning tool if we keep basing them on good firm data, and use our best technical insights to make sure all processes in the real world are in the model. Even when we make estimates into the future, we have to make sure we design monitoring that will keep checking to make sure our estimates into the future are correct. Models are outstanding tools for water resource management.

Bruce Brownawell

Modeling is critically important for groundwater management because of the difficulty of getting below the ground and sampling. One can't get down and sample in time and space in a way that one can in shallow surface water, for example. In terms of planning, it's critically important to have models. Models are reasonably good, depending on how heterogeneous the subsurface environment is for water flow models and for contaminants that are soluble, like nitrates and sulfur. They are not so good if one is interested in cleaning up or understanding plumes, or for organic chemical or metal contaminant problems. Luckily, we do not have too many problems with metal contaminants, because they stick to the earth so strongly; we don't have to worry about them, with the notable exception of chromium. Models are not so good for things like organic chemicals, especially when they're introduced as liquid bases. It is hard to predict how fast you can clean up the situation. The early models that were applied were off by orders of magnitude in respect to cleanup time.

Robert Gaffney

24. Is it cheaper to remediate than take precautions to prevent in the first place? If treating contaminated wells is cost effective, why are some wells shut down completely rather than being treated?

Jim Mulligan

The reason that some of the water suppliers in Nassau County are choosing not to treat the well once it is contaminated is that, basically, they have an excess supply of water and they can afford to. They have the luxury of not using that well and installing necessary treatment. This is basic reason why 35 out of 70 wells have not been treated.

Joe Baier

Some of the wells may be very old and it may not be just where the water supplier wants the well in the first place.

Bruce Brownawell

Let me play devil's advocate for a minute. The technology for cleanup at the well head is excellent, well understood and relatively cost effective; but one has to make sure that it is operated correctly. It is difficult and expensive to monitor the system and we have to make sure, from a public health standpoint, that enough money goes into cleanup to protect the public health.
Mike Burke

It is nice to talk about water supply wells, treatment, cleaning up the contamination; but public water suppliers are not in the business of cleaning up wells. All these treatments treat to a certain degree, depending on the contaminant you are talking about, and the degree of risk - carcinogen vs. non-carcinogen threshold. If you shut the well down and do not have other impact factors, other issues come in like economics. I hope you don't have impression that public water suppliers will clean up all the contamination; remediate contamination. That is not the case.

Robert Gaffney

25. As demonstrated, there are numerous regulations protecting groundwater. However, is enforcement of these regulations likely with limited personnel in regulatory agencies?

It is certainly an issue for every municipality that is facing the downsizing of its staff.

Ray Cowen

Can DEC regulate with reduced personnel? I think so. We have an element of surprise on our side; don't announce when and where we will inspect various facilities. We also have public sentiment and awareness on our side. Industry can no longer afford to be caught violating environmental regulations. The press alone is enough of a deterrent to that sort of activity. We are finding more compliance than in the past. Certainly, there is always an element that will go out of its way to circumvent regulations; but I think in combination with my staff, county staff and just public awareness we are in fact making a good showing in that area.

Mike Burke

The Health Department perspective is that, unfortunately, we are not in that situation. We are very good at passing regulations but not so good with resources to implement and enforce these regulations. Currently, the Health Departments at both state and county levels don't have the ability to implement new regulations coming down. It is definitely a problem. It is a major issue from our perspective.

Mike LoGrande

There is a meeting in Albany today calling for the inclusion in the Governor's budget of a charge of half a penny per thousand gallons of water — effectively imposing a tax on drinking water to support health services. The more important issue is the question of priorities. We are dividing up a very small pie and that pie is getting smaller. It is a question of devoting enough money to the primary responsibility of government, which is health, and second, safety. Health and safety of people should come before anything else.

Joe Baier

A lot of attention has to be given to the question of enforcement, so that the various agencies have the wherewithal to continue the primary responsibility of enforcing regulations.

Robert Gaffney

26. How do we know that the high rate of breast cancer on Long Island is not related to drinking water?

Mike Burke

This is a tough question. Obviously there is a higher rate. The Health Department has done a number of studies and has not found a correlation between water and breast cancer. The reviews are continuing; but, so far, there is nothing we can find.

Mike LoGrande

Let's put that question in reverse. Why do people come to the conclusion that whatever ails them comes from the water supply. That is because they consume the product every day; and, ever since Love Canal, we have become so conditioned to thinking that what we put into our
bodies is destroying us. If you look at scientific and medical evidence, everything tells us that in all probability it is not water. But no one can say for certain and, if there is a little bit of doubt, people go along with doing things they should not — like going out and buying bottled water. Bottled water is the least tested; has the least stringent requirements on it; yet people go out and buy it because of all the unnecessary fears going around. What we really need is, somehow to get the scientific community to explain the health effects in common every day terms, so families do not have to go around living in fear of what they’re drinking, or maybe what they’re eating. If we could somehow at least settle the water problem once and for all! Where better than at Stony Brook can you find a research institution that could help out to convey that kind of information to the general public? We are here today because of misconceptions: people play on these misconceptions. People are always ready to give credence to horror stories. Look at the data and information. There is a major gap between what is true and what people believe. Some people make a good living off that. Our responsibility is to see that people’s fears are allayed and they can rest easy and be more aware of the real truth of the situation.

Robert Gaffney

27. One last question for the entire group. In your opinion, what is the most significant gap in our understanding of and our ability to manage our groundwater resources? If you could change one thing with a magic wand, what would you change? What is the most significant gap - please identify the gap and what should be done about it?

Jim Mulligan

I don’t think it is scientific gap. The question implies that we might be lacking some information about the groundwater system. While there are some questions for which we don’t have the answer; i.e. the location of the Lloyd freshwater/saltwater wedge offshore - that is a technical question. However, when you ask how can we better manage Long Island’s groundwater supply, we are looking very hard at what we have tried to do today; we are looking at data and trying to arrive at a consensus as to what the state of our aquifer is and what we, as a community, can or can’t do to manage that aquifer. That is where the lack of consensus is and that, in essence is what is preventing us from managing. It is not the technical knowledge that we need. We have that. I don’t think it’s a technical thing as much as a sociological thing.

Ray Cowen

If there is a gap, it is that we should have had an auditorium today that would hold 2.7 million people, because I think everyone on Long Island should have heard what was said here today. We had some profound things that were said, and I hope the people in the audience heard and understood that. The experts that we have assembled here have no axe to grind; facts were laid on the table and I hope people understand that there is a general misconception on Long Island about the groundwater resource. It has been whipped and beaten for the last 20 or 30 years and used for every single purpose that you can imagine; to get every program we have done on Long Island passed. Maybe it’s a good thing we did that - we have a lot of good protective programs in place. We should never ever repeal those. I am not suggesting that. What I am suggesting is that maybe it’s time to look at some of the other values that we have here on the Island. If we are talking about Pine Barrens - certainly in my agency, we look at open space value; wildlife habitat; ecology of the pine barren itself; and, if you were listening today, I think you heard that it is not necessarily for groundwater that we need to protect the pine barrens. There are a myriad of other equally prestigious reasons for protecting the pine barrens and we should consider that. Again, if there is a gap, it is a gap in a general understanding of the groundwater system on Long Island — how it functions and what it is. I wish we had 2.7 million people here today to hear this.

Joe Baier

As far as my own specific situation at our agency, I would like to have resources to continue the work that we are doing; to enforce the regulations that would enable us to continue the quality of life that we have here in Suffolk County.
Ed Kaplan

I think the biggest gap is our understanding of how people affect the place we live in, and also our fears and understandings of where we want to be. I don't know of any person who goes into a space and leaves that space the way he found it. We as a people, as human beings, change the environment that we live in. We have to accept that fact; but also to accept the fact that we need to know what we value; what we want to allow to change; what we want to insist not be changed and say to ourselves, "there is a lot of information we know and some we don't know. In this particular case, there is a lot we don't know yet. We have to identify those issues that are important, and for each of those issues we have to identify what we do know, what we don't know. We need to get the information and try to make some sense out of it without being hysterical. If we want to have something in the next century — if we want our children to have clean water and air — I think we have to say to ourselves, what is it we are willing to give up? What do we want to do?

Doug DeLillo

In the same vein, there is a question that should be raised. Should we allow pristine areas of our aquifers to be degraded? On Long Island, we have portions of our aquifer that are considered to be pristine with respect to certain contaminants, and I think that public officials should take a position and finally adopt a public policy which addresses the question, should we maintain aquifers in a pristine state rather than permit them to degrade?

Aldo Andreoli

I would like to reemphasize that I think scaring people about their water in order to advance other agendas doesn't serve the general good. I think these other agendas could very well be carried on their own merit. If the agenda is to maintain open space, or maintain aquifers in pristine condition, fine. You don't have to use scare tactics, saying to people that if this is not done, then your children and your children's children's water supply is going to hell in a hand-basket. That is an abuse of the truth and one needs to put things in perspective. There is enough reason to maintain open space for its own merits. Your children's children deserve the open space. I am in favor of that, but don't scare people to the point that they feel they must rush out and buy bottled water. The quality is good. We have heard enough information today from everyone involved in this business to confirm that we probably have the best water quality. It is protected and will be protected. The water supply should not be used as a surrogate for other agendas.

Bruce Brownawell

This is perhaps not the most significant but, as an environmental chemist, the problems I would change would be to have more money for research to help understand some of the long term problems that are going to be with us for the next generation, even if we don't contaminate the groundwater to any additional extent. We have some long-term problems that I would like to have some more understanding of. Another thing I would like to understand better, in terms of public health and resource management, is to understand the long-term effects, if any, of synthetic organic contaminants on man. We have been exposed to these contaminants for somewhat less than a generation. It is extremely hard to use epidemiological information to get low risk sub-acute toxicity measurements of these contaminants. I would like to know what those risks are in order to manage the resource.

Mike Burke

I have a quick, biased view of health effects future but I would like to re-stress that the biggest gap on Long Island is general understanding and all the kinds of misconceptions and unresolved differences as to what the story really is. I think today was an excellent start in that direction; trying to get facts. Let's move on with issues.

Russell Slayback

As I listened to the four speakers before me, I was astonished by the number of things I was going to say that were already said. I think that says to me that the professional community is pretty much all on the same page. The biggest gap is our ability to convey our under-
standing of the groundwater system and the impacts that affect it to the general public, especially a general public that is honestly confused. As to the technical questions that I am most curious about because they are going to affect water use and water treatment, we are just starting to analyze for Phase 2 and Phase 5 organics. It is my impression that they are unlikely to have a major impact on Nassau and Suffolk Counties, but that remains to be determined factually. A second question concerns the vagaries of our knowledge of virus mobility in the sub-surface. It is my understanding from the literature, that viruses are generally well treated by long travel in the unsaturated zone but they have generally high mobility if the water table materials are very coarse sand and gravels. We need more data; there have been documented cases of virus migration involving far greater distances than anyone ever appreciated a few years ago.

Charles Rich

I think we are very lucky here. I sampled the wells at Love Canal for the Attorney General. Ukraine and Poland have problems that are not being talked about. I know of a village in central Germany where the folks who are drinking well water are told that that water has gone through the human body five times. You don't have that problem here. At Love Canal, I had to explain to people why their houses were being pushed into their basements. I don't see that here on Long Island and that is thankfully due to all the creative research that has gone on since 1903, when the first water table map was done. We should consider ourselves lucky we have that kind of resource.

We all assume rainfall is going to continue; it is a God-given assumption. We're sitting here, assuming we will have 44 inches of rain every year going into the next century and the century beyond. I strongly recommend that we continue this type of increasing pressure of learning about the water resources. There are a lot of things we don't know. I put in seven wells last month in an area that showed the water table at 122 feet above mean sea level. There is not a water table map on this island that shows the water table this high in that area. I don't want you all to get the impression that, at least in my opinion, we can be overly cavalier or overly confident about our understanding. I think there are many things we don't know. Viruses are one issue, as was mentioned. A lot of future problems will arise and we will have to have a non-polarized society, equipped to address these issues. Whether they involve Nassau and Suffolk County regulatory authorities responding to those problems individually, or the private sector trying to police itself in a cost effective way; economics or the almighty dollar is the driving intent. The private sector should police itself; that would be a big step forward. I think we should continue with these forums and have lots more people attending in the future.

Robert Gaffney

28. Where do we go from here?

A very valid question. I think we have to continue to search for truth. That is what science is about. We want to find it as absolute or as close to it as we can; strip away some of the things that are not true, and deal with those things that will help people in policy making positions make reasonable and responsible policy. We have to continue this process. Another summit to seek opposing views? I'm not sure what those opposing views are. I think this panel represents the state of scientific and geological knowledge about the groundwater. There could be different interpretations about what to do with that information; but I'm not so sure anyone is in dispute with anyone else about which way the water flows, how it moves or anything else. As to hardcore information and the science of it, we have the best representation that we could; but if anyone wants to come forward and dispute any information here today, I am certainly willing to deal with it.

Hold another summit to discuss opposing views? Yes, I think we would want to expand on what has gone on here today.

Will there be a form of peer review? I think peer review will happen in and of itself. I believe we have as good a group of people to review and interact on scientific and geological issues
as you can find. A transcript will be available and I invite everyone to get a copy of it, distribute and review the scientific and technical information put forward.

Should the invitation to speakers have been broadened? What about those allowed to attend the conference? The number of questions answered was unlimited. The number of people invited was unlimited as well.

We sought one major step forward in the pursuit of truth, of science, so that we know what we are dealing with; so we know how to deal with it. In commenting on the last question about what the respondents would do differently — a lot of people answered from the heart. Many people feel that there is more to the water agenda than just water. That is the subject for the next summit. We still need to deal with clean air, with open space, farmland preservation, and all other environmental considerations and programs that have made Nassau and Suffolk leaders throughout the country. These need to be examined and reexamined. This is the first of what I hope will be several summits - this one deals with the science and geology of the water system, both quantity and quality, and where it goes in the future. I think we have accomplished that. I’m sure that everybody here can appreciate the wealth of knowledge and experience that exists on this panel. I want to thank every one of you for being here today and assisting us. I want to thank everyone in the audience for being here. I think together we made a major leap forward in our understanding of our environment here on Long Island. Thank you very much.

Additional Questions and Responses

Due to time constraints, the following questions could not be covered during the Panel Discussion. Several members of the Panel have provided assistance to the Long Island Regional Planning Board in the preparation of responses.
**Question #1** - There are some 100 sewer plants in Suffolk County. Of those many discharge to groundwater. Of those that discharge to groundwater, how many meet the discharge standard of 10 mg/l?

There are 118 sewage treatment plants in Suffolk County with 103 discharging to groundwater. Of these plants, 45 currently use tertiary treatment for nitrogen removal, another 35 are either under consent orders to upgrade to tertiary treatment or will be placed under consent orders when their current SPDES permits are renewed. The remaining plants are exempt under Part 703 of State Environmental Conservation Law, since they are existing facilities that treat less than 30,000 gallons/day.

**Question #2** - As demonstrated, there are numerous regulations protecting groundwater. However, is the enforcement of these regulations likely with limited personnel in our regulatory agencies?

Enforcement is a problem in view of recent budgetary cuts, early retirement and other factors that make total enforcement extremely difficult.

**Question #3** - What special educational programs should we expect to see to better educate consumers about disposal of household products or hazardous materials so as to not contaminate our drinking water resources?

Region I of Long Island, which includes Nassau and Suffolk County, has one of the most active programs for dealing with household hazardous waste products. Several years ago, a STOP Executive Committee was created to deal primarily with this issue.

STOP stands for Stop Throwing Out Pollutants. This organization, made up of public and private individuals has been very active in trying to both educate the public, and enact appropriate legislation that would help to reduce the amount of pollutants citizens dispose of daily. One such piece of legislation the Committee supported was enacted into law by the Suffolk County Legislature in 1990 and requires retail establishments to provide notification to their customers as to the environmental hazards associated with improper disposal of certain consumer products. A special advisory committee is being established pursuant to this law to help develop the most effective educational program to address this important issue.

**Question #4** - Based on Slayback's speech, at $1.21 for treatment and at a cost of $0.1 per gallon at the tap, I think you guys at SCWA can safely claim that in Suffolk "water is cheaper than air" (25 cents per tireful).

No answer required.

**Question #5** - As we have restricted landfill development in the deep recharge zones; (a) doesn't this increase the possibility of fouling L.I. Sound's wetlands and bay areas by moving the sites closer to the Island's margins? and (b) what further recommendations do we have to protect the deep recharge area, specifically to restrict development in this area?

a) The 1983 Long Island Landfill Law prohibits the operation of any new landfill after 1990 that is constructed solely for the purposes of accepting raw garbage. Specialized landfills can be located out of the deep-flow recharge areas but can only accept the products of resource recovery (ie. ash or items such as composted material or construction/demolition material). In a case where such a landfill is being proposed, it must conform to very strict guidelines and at the very least have double composite liners (four liners) in addition to an elaborate monitoring system in order to ensure that no material leaves those sites.

b) The recently completed Special Groundwater Protection Plan contains a great many recommendations to protect the deep-flow recharge areas. Every library in the Nassau/Suffolk region has a copy of this plan or you can contact the Regional Planning Board to purchase your own copy.

**Question #6** - What is the best tool for local planners to use in evaluating potential groundwater impact? Please comment on the BURBS model used to exhaustion.
While models may be useful in developing overall master plans and making general predictions regarding groundwater contamination, they're not the most effective way to evaluate site specific situations. The State Environmental Quality Review Act (SEQRA) is the best tool that local planners can use in order to evaluate potential groundwater impacts. Article 15 of the Environmental Conservation Law establishes very specific and stringent Water Quality Standards and Classifications. It is illegal for any proposed activity to contravene these water quality standards or classifications. When Environmental Impact Statements are required pursuant to SEQRA the local governments reviewing these documents should insist that a section be dedicated to discussing the proposed project in terms of how it will or will not exceed those water quality standards and classifications. Up until recently, this procedure has not been followed by most governments.

For further discussion, see response to question 23.

**Question #7** - How does Nassau County explain the fact that the number of Magothy wells with higher concentrations of inorganic chemical contamination is increasing, even though the number of wells tested dropped from approximately 360 in 1989 to 304 in 1991, or about 15%?

The movement of contaminants from the surface down into the glacial and eventually into the Magothy aquifer takes a great deal of time to occur, sometimes several decades. Several years ago a contaminant was found in one of the public wells in Nassau County that was attributed to a metal plating works plant that was in operation during World War II and had been closed down since the late 1940's. Although most of the county is currently sewered, and we have very sophisticated regulatory programs for controlling new discharges to our glacial aquifer, contaminants that have already been released years ago are slowly migrating down into the Magothy and are currently being detected. Furthermore, our detection limits have been getting more and more sophisticated and the allowable concentration for groundwater standards have been continuously lowered. These are the primary reasons why the instances of inorganic and organic chemical contamination have been found to be increasing in a number of Nassau County’s Magothy wells. See response to question 22.

**Question #8** - In general, what can be said about the quality of only the recharge now occurring in developed area? How does the quality of this water differ according to the land use in which it is generated? Is it impaired severely enough to warrant regulation on its own?

The quality of runoff from developed areas discharging to the ground has not proved to be an issue of concern. The Nationwide Urban Runoff Program initially looked at runoff from a variety of developed and undeveloped areas and found that even in the most congested regions where water from the Long Island Expressway was being collected in recharge basins, samples had only slightly elevated chlorides and some lead as a result of the use of leaded gasoline. With the elimination of leaded gasoline, and better storage procedures for road salt, even these two contaminants have become relatively minor in terms of their impact on groundwater.

Most of the 13 municipalities on Long Island that approve site plans for development have some type of requirement that all runoff generated from a project be dealt with and remain on-site. As funding and other opportunities become available, existing runoff that previously entered streams, bays and creeks is being diverted to leaching pools and catch basins in an effort to try to reduce the impact from such runoff (ie. primarily bacteria, that has been identified as an issue affecting surface bodies of water).

**Question #9** - If water is pumped within 1 to 3 miles of use, and transporting water laterally over 10 miles is cost prohibitive, is the preservation of the “Pine Barrens” really an “open space” (aesthetic goal), rather than a needed water supply preservation need?

Absolutely.

**Question 10** - New York City has been ordered to either protect its Catskill watersheds from future increased developmental pollution - or to spend billions of dollars on treatment. Shouldn’t Long Island protect its SGPA watersheds in preference economically to building treatment plants at most well sites?
We agree. This is the position of the Long Island Regional Planning Board and is reflected in the SGPA Plan.

**Question 11 -** How effective are the ground discharge Sewage Treatment Plants (STPs) used in Suffolk - which are not permitted in Nassau?

The STPs operated by the County of Suffolk are effective. Past problems dealt with developer-owned and operated facilities, which in many cases were not effective. See response to question #1.

**Question #12 -** There seems to be a hierarchy of sensitive areas for groundwater preservation: 1) core watershed corridor, 2) SGPA's, 3) hydrogeologic zones. Has our zoning history reflected this hierarchy? How can we improve our zoning to better reflect this hierarchy?

Historically, decisions made on zoning have not been tied directly to scientific investigations and recommendations. Over the past decade or so, this has begun to change. As our knowledge of the groundwater system increased over the past several decades, our ability to understand and make predictions as to what land-use relationships caused the greatest degree of concern for our water quality, a number of municipalities began to implement different types of zoning in order to reflect that information. Furthermore, a number of townships have eliminated commercial and industrial zoning in these same sensitive areas, while other towns have upzoned to 1,2, and 5 acres as a way to further reduce the potential for adverse impact to our groundwater resources.

As a result of the 208 Study, Nassau County Health enacted Articles 10 and 11 and Suffolk County Health enacted Articles 6,7, and 12, in order to protect these same sensitive recharge areas.

**Question #13 -** Your qualitative comments on the effects of wells and sewers on surficial water and streams are alarming, given the sensitivity of Pine Barrens and Peconic headwaters to stream stress. But have you quantified this? How many wells, and of what size, matter ecologically?

The probable concern of surface water (streams) is the effect that areawide sewer programs may have on streamflow and lake levels. For Suffolk County, the concern was the Southwest Sewer District. In response to a request from EPA, Suffolk County completed a Flow Augmentation Needs Study (FANS) and presented a plan to implement supplemental streamflow should any impacts be noted. The sewer district has been in operation since 1982, and the state of the streams, lake levels, and stream wetlands is annually reviewed by the Department of Public Works. The Department of Health Services also participates in data collection and analysis. Through 1992, no impacts of the sewer program have been seen on any of the above areas. Monitoring continues.

**Question #14 -** Is it realistic to assume we have the entire 70 trillion gallons of fresh potable groundwater located in Nassau's aquifers available for use via pumping - or are we limited essentially by the 50 feet located above sea level?

Obviously, we do not have the entire 70 trillion gallons of potable water available for our complete use. The point that was being made was that sometimes there seems to be contradictions when we ask the question, “do we have an adequate water supply?” depending on who is responding to the question. For water purveyors a drop of 1,2, or 3 feet in the water table has absolutely no impact on their ability to pump potable water to their customers. On the other hand, from an environmental standpoint a drop of 1,2 or 3 feet in a wetlands area such as Hempstead Lake or the Peconic River, can have some very dramatic impacts. Many scientists believe that Nassau County is currently at equilibrium. That is, approximately an equal amount of water is lost from the system as is being recharged. Suffolk County pumps approximately the same amount as Nassau County but has twice the landmass. Therefore, we have a long way to go before we reach the same concerns that are faced in Nassau. However, from the environmental prospective (ie. surface water wetlands and stream-flow issues), more information is needed to ensure that we do not have excessive withdrawals that would impact these sensitive ecosystems.
**Question #15** - Can the groundwater zones in Suffolk County be broken down into any additional protective zones, i.e., Lloyd Recharge Area?

Long Island's Sole Source Aquifer already has an excessive number of divisions and trying to create additional ones would only create further confusion. While Nassau and Suffolk Counties were the first geographical areas in New York State to be declared Sole Source Aquifers, Brooklyn and Queens filed a petition and later received a similar designation. The 208 Study in 1978 established the concept of hydrogeologic zones I-VIII. The Long Island Groundwater Management Plan highlighted the concept of deep-flow recharge areas with respect to Zones I, II and III, which later became incorporated into Suffolk County's Regulatory Program through Articles 6 and 7. Within the area of a deep-flow recharge area, the Suffolk County Water Authority had recently coined a new term, Core Watershed Area. We also have several townships creating Water Overlay Districts for their own individual deep-flow recharge areas. Superimposed on all of this we have the jurisdictional boundaries of the Suffolk County Pine Barrens Commission and various Critical Environmental Areas that have been created by local municipalities, the Counties and the State of New York. At this point, any further categories would only add to the confusion we currently have.

**Question 16** - (Buxton's Particle Tracking Analysis of LI) Recharge areas show that increased Magothy pumping to meet increased demand expands the surface recharge area that feeds the Magothy. What implications does this have for future contamination control?

Overpumping can be a problem if it creates a drawdown from existing contamination plumes.

**Question 17** - You mentioned that with the current levels of recharge vs. use resulting from our present degree of development, Suffolk's water quantity is OK. What are implications to water quality given increased development desires?

With the enactment of Sanitary Code regulations, new changes of zoning that have occurred at the town level to protect water sensitive areas and through the imposition by the State Department of Environmental Conservation of more stricter discharge standards for both industries and sewage treatment plants, the quality of water that is discharged from developed areas is far cleaner than it was a decade ago. In several years we should begin to see, as Nassau is now currently beginning to see, an improvement in the quality of our glacial aquifer, where in the past contamination had been found. It will take many decades, however, for all of those contaminated areas to finally "flush" themselves clean, eventually discharging into our marine environment.

**Question #18** - Water quality has been represented from data supplied from public supply wells. How many of all wells have been affected by organic contamination? What percentage show any level of organics?

An exact number cannot be given for this question, although in general terms, many people in the water field have stated that approximately 10 percent of the public water supply wells have been impacted by contamination. Precise data regarding contamination in every public water supply well field is kept by both Health Departments, the State Health Department, the Department of Environmental Conservation and the Long Island Water Commission. In trying to tabulate this information, we find that some wells are abandoned, others are closed for repairs in order to meet guidelines, others are restricted in their use and others are voluntarily not used under certain circumstances. The 1991 Long Island Water Commission Annual Report provides an overview of this entire issue for the Nassau and Suffolk region.

**Question #19** - Streams and lakes are affected by a decrease in groundwater quantity. How does the resultant deterioration of our streams and lakes affect both the local economy and ecology?

The decrease in surface fresh waters is, beyond any question, ecologically negative. It can have a direct impact on freshwater wetlands that then would impact all species depending on the freshwater ecosystems.
In Suffolk County the surface waters are in generally good condition and have not suffered a decline. In Nassau County the main impact has been on the South Shore, particularly in the Lake Hempstead system which now appears to be somewhat stabilized.

Question #20 - Will residential underground fuel oil tanks ≤1,000 gallons made of single wall steel construction have to be removed and cleaned up?

The 208 study observed that single wall steel fuel tanks constituted “a ticking time bomb”. Thus far the major emphasis for enforcement has related to commercial and industrial tanks. In the judgment of the LIRPB, attention should be paid to residential tanks, particularly those twenty years old or older.

Question #21 - If New York City can pump water from its upstate reservoirs in the Catskills, why can’t Long Island transport water from the Pine Barrens?

Water generally moves downhill only! The New York City water system depends on large areas of surface water located at much higher elevations than the city, that uses gravity to transport that water. Here on Long Island, the highest mound of groundwater is located in the Huntington-West Hills area. To transport water from the Pine Barrens, since there is no large underground “reservoir”, a large number of wells would need to be installed at various depths into the Magothy aquifer, all pumping simultaneously into a water conduit that would then have to be pumped up-gradient to the western townships. Such an undertaking would amount to a major engineering feat that would cost multi-millions of dollars, as opposed to a more cheaper alternative that simply requires the installation of a carbon filter on a contaminated well.

Question #22 - Can you 1) interpret the “net reduction” in terms of development over critical SGPA? 2) Has enforcement decreased with regulations? Describe, with numbers, enforcement.

1) A net reduction of aquifer capacity can occur in a localized area when an areawide sewer program is implemented. A localized net reduction effect occurs because the consumptive use of water exceeds the localized recharge. Given this situation, added to several years of less than normal rainfall, and impacts on the water table, streams, and lakes can occur. Net reduction would have no effect on SGPA’s as most of them are in the center of the county, and any regional changes in the water table would not impact the groundwater in a specific SGPA. Further, no sewer programs are planned for the Central Suffolk SGPA where the Peconic headwaters are located.

2) The Department of Health Services keeps regular statistics on enforcement activities. The following excerpts are presented to indicate the extent of enforcement activities, comparing 1992 to 1991.

<table>
<thead>
<tr>
<th></th>
<th>1992</th>
<th>1991</th>
</tr>
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<tbody>
<tr>
<td>Tanks Registered</td>
<td>1,912</td>
<td>2,463</td>
</tr>
<tr>
<td>Inspections</td>
<td>16,701</td>
<td>14,575</td>
</tr>
<tr>
<td>Samples - organics</td>
<td>754</td>
<td>401</td>
</tr>
<tr>
<td>Samples - metals</td>
<td>817</td>
<td>510</td>
</tr>
</tbody>
</table>

The reduction in tank registration reflects a slowdown in new tank installations, but its continuance at the 2000 level indicates that existing old tanks are still being discovered as a result of our inspection program. Our increased sampling and inspection activities are the direct result of the reduction in tank replacement work and the ability of County inspectors to now return to other required inspection work.

Question #23 - Seems to me that a potential solution of moving the wells from the barrier beach just extends again the salt H2O intrusion - is that your best idea from a think tank or computer model? How does something just disappear?

The purpose in moving wells from the barrier beach to inland positions is to remove the influence of well pumpage from incurring greater salt water intrusion. In fact, the salt water in-
trusion was encouraged by the barrier beach wells. Their relocation inland could in fact reverse existing salt water intrusion.

Question #24 - The University is conducting a GEIS on their master plan - would it be worth the expenditure to do soil borings to ascertain possible soil contamination over the years? Scientists are only beginning to evaluate how contaminants in the ground are affected by natural biological activity in the soil.

You are absolutely correct that we are only now beginning to look at natural biological processes that exist in our soil "vadose zone". A whole new field entitled bio-remediation has recently emerged that is looking at how biological organisms affect various types of contaminants. Scientists in universities such as Polytechnic Institute and SUNY's Waste Management Institute have been working on ways both to identify the bacteria and to enhance their growth in order to remediate various types of organic based contamination. Considering the resources we have in terms of institutes of higher learning, the experts in bio-technology and our extensive knowledge of Long Island's groundwater system, we should be able to merge these two concerns and produce a new viable economic field here on Long Island that would deal primarily in bio-remediation.

Question #25 - Describe the business need to hook up to tertiary treatment sewer plants with outfall pipes and the quest to use Stony Brook University and the SWSD (2nd treatment) plant.

The prime reason to hook up industrial uses is to insure against groundwater contamination. All industries that discharge to an STP must first pre-treat their wastes. By then discharging to a public STP, we are providing an extra measure of protection should the 1st treatment malfunction.

Question #26 - a) How is the general public going to learn what we just did? b) Is residential zoning greater than 1 acre needed?

a) The full proceedings will be printed. Each attendee will receive a copy. Copies will also be posted in every library in both counties.

b) The SGPA Plan calls for five acre residential zoning for the large vacant parcels within the SGPA.

Question #27 - Seems to me, if you can't answer why you have a central band of heavy chemical contamination, there is a flaw in a computer model or an underlying cause and effect in water use.

The computer model is not flawed. The central band of heavy contamination, in our opinion, is directly attributable to past commercial/industrial activities within that corridor.

Question #28 - Have groundwater nitrate concentrations improved under Suffolk sewered areas as was shown in Nassau County?

It will take literally more than a decade in order for our monitoring wells to show an improvement in respect to nitrates as a result of the construction of sewage treatment plants. We expect that by the end of the century (7 years) we will be able to document such improvement through our monitoring well system.

Question #29 - What are the most current significant sources of contamination here on Long Island? How should we be dealing with them? How does development affect water quality? How much, where and what types of development should be allowed to happen in the nine SGPA's? How does ECL 55 affect goals or does it set them? What are they, what should they be?

Although all types of development cause some type of measurable impact on our ecosystem, some activities are fairly benign while others are far more severe. Over the last 15 years, we have had a number of studies and investigations resulting in plans and recommendations as to how we can control development and restrict those activities that have been shown to be the source of most of our contamination problems. The 208 Study began this investigation, which later led into the National Urban Runoff Program. That was followed by the Long Island...
Groundwater Management Plan, the Suffolk County Comprehensive Water Supply Plan, the New York State Water Resources Planning Council Strategy and the Long Island component of that strategy and, most recently, the completion of the Special Groundwater Protection Area Plan. This latest plan draws upon the information in all of the previous plans, and charts a course that will provide the so called “balance” between economic growth and environmental protection. Through a process of changing commercial/industrial zoning, upzoning residential areas, restricting certain incompatible uses within critical recharge areas, and the utilization of Best Management Practices, we will greatly minimize the impact from development while allowing the island’s economic base to grow.

See response to question 7.

**Question #30 - If all types of development cause some type of pollution, how do we reach a “balance” between economic and environmental concerns?**

We will probably never achieve a “balance” since it is virtually impossible to achieve a consensus between competing interests. If the issue is preservation of pristine groundwaters then economic development must be severely limited. The most that could be achieved is to place development in less sensitive areas. Here again, however, the development allowed should not exceed reasonable carrying capacity of those areas.

**Question #31 - What policies must govern to protect Suffolk County’s streams, ponds, and lakes from the fate of similar features in Nassau due to surface water draw downs from wells and STPs?**

New York State requires a well permit from anyone who is installing a well that has a capacity of greater than 40 gallons per minute. Several years ago, the Long Island Water Commission enacted legislation to strengthen that state law and among other items requires every water purveyor to develop a water conservation plan. Before allowing any new permits or the renewal of existing permits, the DEC must determine if any potential adverse impact on all the surrounding natural resources is likely to result from the issuance of that permit. We are not only concerned with the effect draw downs may have on wetlands and surface bodies of waters, but also how they change the directional flow of contamination plumes. One of the major distinctions between Nassau and Suffolk County is that 90 per cent of Nassau is sewered, with all of that water being discharged into the marine environment. It is, therefore, considered a consumptive use, whereby, the groundwater is not being replenished from the water that is being withdrawn. With the exception of the Southwest Sewer District and some smaller sewage treatment plants that discharge into the marine environment, most of the water that is pumped out of Suffolk’s groundwater system is recharged back into it. Based on current zoning and what we anticipate to be the future population once Suffolk County reaches its maximum growth potential, the Suffolk County Comprehensive Water Supply Plan shows that we will be withdrawing far less water than is presently going into the system and is being discharged naturally by our streams, lakes, and sub-surface flow. With all other factors remaining the same, we will not have the same situation occur in Suffolk as has occurred in Nassau County.

**Question #32 - Many Suffolk streams and ponds, such as the Calverton Ponds ecosystem, contain rare plants and animals which would suffer from even a small drop in the water table. What regulations would protect them?**

Once again, New York State DEC administers a well permit program that must take into consideration before the issuance of a permit all potential impacts to the surrounding environments. Every notice for a new or renewed public water well is published in the Environmental Notice Bulletin, which comes out weekly, and a 30 day comment period is open to the general public. Furthermore, the Division of Fish and Wildlife, within the DEC, maintains lists of all endangered plant and animal species in the Long Island region and should be commenting on all such well permits before they are issued by the Division of Regulatory Affairs. While there is a specific procedure in effect, it is not clear as to whether there is adequate manpower to ensure that such reviews always take place. Both Counties and the USGS produce maps yearly indicating groundwater table elevations and flow directions.
**Question #33** - Is it true that hydrocarbons flow south on Long Island regardless of groundwater flow direction?

Absolutely not. Contamination flows with the direction of groundwater, not against it. Site specific work should be done any time there is a question as to the direction of groundwater at a particular location. In general, however, land that is located north of Long Island Expressway has groundwater underneath it that is moving in a northerly direction, while land to the south has water moving in a southerly direction. This changes when you come into the watershed areas such as those of the Carmens River or more importantly the Peconic River, where the flow is predominantly in an eastward direction. When a contaminant is released into the groundwater system, it moves with the predominant direction of flow of the groundwater at that location. It does not radiate 360 degrees and contaminate groundwater in all directions.

**Question 34** - I am one of the 200,000 or so Suffolk County residents who does not pay for his drinking water, I drink from under my home, it is pristine. Why must there be acceptable levels of degradation in SGPAs? Why must we put ourselves in a position that results in us paying, throughout our lives, to maintain water purity? Why can't development take place which spends nothing on water treatment, sewers, etc., because there is no groundwater degradation?

If there are no acceptable levels of degradation to our environment, including our water system, then we must prohibit all further development and exclude any additional people from locating here on Long Island. You may presently have acceptable water coming from a private well, but where is the waste going that is coming out of your toilets? Each and every cesspool located throughout the bi-county region, results in some measurable degree of contamination. If improper chemicals, however, are not disposed of into these septic systems, then in most cases that degradation will not exceed drinking water standards. Since the fertilization of lawns with nitrogen, as well as the addition of chemical pesticides and herbicides, also have the potential of contaminating groundwater, should we prohibit their use throughout the Island and ban stores such as Pergament, Home Depot, Frank's Flowers and similar facilities from selling these items? Should it also be a crime for any homeowner to apply fertilizer to his lawn? If the answer to these questions is no, then you are agreeing to some degree or level of degradation. Through proper planning and an enhanced, elaborate regulatory program, we hope to be able to control virtually all the sources of contamination, such that public and private water supplies will not be impacted or need to be treated with expensive carbon filtration.

**Question 35** - Since approximately 8-10% of the water pumped is for drinking and cooking - the other 90% is for irrigation, fire fighting activities and flushing the john and washing the car and dog, yet all water pumped must meet drinking water standards, which cost millions and millions of dollars. Do you ever see the need for a two pipe system in the future?

For many years, there have been people advocating the use of a two pipe system both for public water, as well as for discharges. For example, is it necessary to treat all of the waste water coming from a house (ie. showers, dishwasher and washing machine) with the same standards we require for sewage. In the last several years, there have been proposals to try to segregate this so-called “grey water” and use it for irrigation on-site, while only the true sewage is treated through our cesspool or sewage treatment plants. With respect to having a two piping system for drinking water, there are numerous problems including the obvious increase in cost, the need to have a very active and effective cross connection control program and the fear that the many people who do their own home improvements may inadvertently connect one system to another; thereby, contaminating the potable water supply line. A more cost effective approach would be simply to provide a filter, at the point of use in the home, to be used solely for drinking purposes. Then people will be raising questions as to the potential health risks from contaminants that may be vaporized while they are taking a shower, or absorbed through their skin. While there appears to be some merit for having a dual system for the discharge of different types of waste water, having a dual system for a public water supply appears to create more problems than it would solve.
Question 36 - How does something just disappear (matter is neither created or destroyed) if leave water well alone. Doesn't it mean you just don't know what happened or where it went (contaminant)?

This statement indicating that a particular pollutant “disappeared” meant that we were unable to track it for a variety of reasons. The contaminant may become so diluted with clean water that is was now below detection levels. It might have encountered micro-organisms that biologically transformed it into carbon dioxide and water. In the case of certain metals with a positive charge, they may have become absorbed onto soil particles and are no longer being picked up down gradient where they were first identified.

Question #37 - The rhetoric of the activists has caused mass confusion re: the purity to ingest public water! When will the public elected officials clarify this subject and save consumers dollars needlessly spent on bottled water? When are we going to publicly address, in the media, a consolidated position re: how excellent our supplied drinking water really is?

It is the opinion of the LIRPB that the public water supplies are of an extremely high quality and there is no justification for the purchase of bottled water. The primary purpose of this Summit was to clarify this subject.

Question 38 - Specifically, how did the increase in impervious surface over the last 20-30 years affect the groundwater system? What role do recharge basins play with respect to an increase in impervious surface? Recharge basins - these are depositories of road salt, road oils, fertilizers and other substances. What steps are taken to clean them up to prevent them from being a focus of contamination?

Where in the past, runoff, as a result of rainwater falling on impervious surfaces, was discharged into our streams and rivers, this resulted in a net loss of our groundwater recharge. Development has also had an effect in changing stream-flow patterns. Nassau County has been working over the past several years to develop specialized recharge basins that allow for gradual flow into nearby streams and creeks. Previous studies and evaluations of recharge basins have shown that these are not major or even minor sources of groundwater contamination. Both Nassau and Suffolk counties have taken active steps to advise the public that these are important watershed recharge areas and that hazardous or toxic materials should not be located in close proximity such that they might eventually cause contamination at these sites. Allowing these basins to vegetate actually helps increase the breakdown of certain organic contaminants that normally might be recharged if the basin only contained porous sand and gravel. See question #8.

Question 39 - Since Brookhaven National Lab has one of the largest areas of contamination on Long Island and is right in the middle of the Pine Barrens, won't that contamination eventually affect the entire water supply?

As stated previously, the release of a contaminant into Long Island's groundwater system does not radiate 360 degrees in all directions. Contamination discharged anywhere on the 5,000 acres of Brookhaven National Labs is generally moving in an easterly direction towards Peconic Bay. It would virtually be impossible for contamination discharged at the surface on Lab property to travel in a westerly direction under William Floyd Parkway. The laboratory is currently undertaking an extensive evaluation and clean-up of all identified contamination sources. Approximately $12 million dollars is spent each year in this remediation program. Where such contamination has been identified, it has been found to be in discreet plumes, moving in specific directions. The identification of these directions helps to ensure that such contamination can and will be cleaned up in the future.

Question #40 - a) With reference to the Oyster Bay Special Groundwater Protection Area what recommendations for land use planning by the Town would be recommended: what density of residential use? What commercial development?

The plan recommends that acquisition of the Underhill property and the general objective of five acre residential zoning. Commercial development in all SGPAs is recommended for se-
vere curtailment. It is recommended that vacant industrial land, unless it is part of an infilling program for already existing industrial usage be changed to residential zoning.

b) What is a special groundwater protection area, and what restrictions apply to them? What role does the municipality, county, and state (DEC) play in regulating SGPAs? Should a sewage treatment plant that discharges its effluent into the groundwater be permitted to be built in SGWPA?

A special groundwater protection area is one that is in a deep recharge zone and has relatively little existing development. The municipalities exercise the prime control through zoning and subdivision regulations. The two counties exercise control through their planning commissions and health departments which have enacted special articles to control contamination throughout the Island and especially in SGPAs. New York State (DEC) exercises control through SEQRA, SPDES and other programs. The LIRPB would like to see STPs discharge outside SGPAs.

c) How much area of the Central Pine Barrens is already protected thru acquisition, preservation, etc. I understand that 60% is protected. If this is the case, how much area is needed to protect the groundwater considering the entire area is zoned 2A, 5Ac, 10Ac. What is the standard for commercial development in a Special Groundwater Protection Area?

Approximately 40% of the Central Pine Barrens is already protected. The Plan calls for strong limits on commercial development. In regard to the Pine Barrens, it is our opinion that the groundwater can be protected if the SGPA Plan is implemented; however, there is a terrestrial concern that would raise the amount of acres to be preserved if the Pine Barrens is to be protected as a unique ecosystem.

d) How is such development reconciled with the goal of acquiring land within SGPAs?

The objective of the plan is to maximize preservation within the Central Pine Barrens and therefore a policy of development could not be reconciled with this objective.

Question #41 - a) Does the increase in the cost of water due to the treatment of the water, include all costs such as land, manpower, energy, materials, etc?

It includes all costs except land.

b. If Nassau County has 800 wells from which to "pool" data, why is it that the information presented in the Nassau County Groundwater & Public Water Supply Facts 1992 edition is only based on data collected from 300 public water supply wells from the Magothy, 25 from the Glacial, and 38 from the Lloyd? Why not do reporting from all wells available for testing? How can any conclusions be reached on groundwater conditions in the Lloyd when so few sampling sites exist?

The report you referred to was produced by the Nassau County Health Department. We agree with your conclusion that data from all the wells should be used. We also agree that more information should be gained from the Lloyd stratum. In the past five years Nassau County has installed twenty more monitoring wells.

c) You are assuming a lot of constants to maintain "stabilized" level - you don't indicate possible drought, unexpected population change, introduction of a new contaminant, or a build-out scenario - (life is not a constant - choose theory).

Land uses and other constraints indicate a stable if not declining population over the future. The issue of droughts is of little concern, since the data over that past half century indicate that even a major drought such as in the 1960s results in only a 3 to 4 foot decline in water level. This has no impact whatsoever on the ability to provide potable water.

d) How can you remove a component of the ecosystem (e.g., river and streams) and say it is not related to groundwater. That's like saying blood has nothing to do with circulatory system.

We did not say that surface waters are not related to groundwater. Surface waters are merely a manifestation of groundwater exposed by topographical features.
e) Is your 10 year warning on saltwater intrusion like the old early warning system for missiles - which meant when the radar station went off the air, the missiles were already launched - how do you know there will not be conforming variables in ten years?

The 10 year warning system on salt water intrusion is more than adequate. Even though "a missile is launched" our system means it will take 10 years for the missile to land. This affords more than adequate time to take proper remedial action.

**Question 42** - One gallon of motor oil can contaminate 1 million gallons of water. What is being done to encourage driveway mechanics to properly dispose of their waste oil?

New York State has a law, enacted several years ago, requiring that all gasoline stations that do repair on motor vehicles be required to accept motor oil from private individuals. These regulations also require the proper storage and disposal of waste oil. This law was amended last year to require that other types of retail outlets that sell large quantities of oil such as AID Auto Store, K Mart, Pergament's and Caldor etc. also provide facilities to the general public to accept waste oil. Suffolk County's Article 12 provisions have been mailed to all gasoline retailers in the county advising them of the proper regulations that need to be followed for all underground storage tanks that contain toxic or hazardous materials, including waste oil.

**Question 43** - Evapotranspiration is an important function to our ecological system. Why is this loss (caused by development) not factored into the water quality equation?

Evapotranspiration has been factored into our equation in looking at the water balance for our groundwater system. In fact, recent evidence indicates that while plants do tend to give off a lot of water during the hot summer months, especially in eastern farming regions of the county, recharge can actually be enhanced or increased through development that traps water from impervious surfaces and quickly transports it to a sub-surface recharge area such as a leaching pool. In fact, some developers have utilized this type of information to show that their proposal was less damaging to the environment than the current farming activity occurring on a particular piece of property.

**Question #44** - I would like to see the transcript of this "Summit" printed on recycled paper using soy based ink.