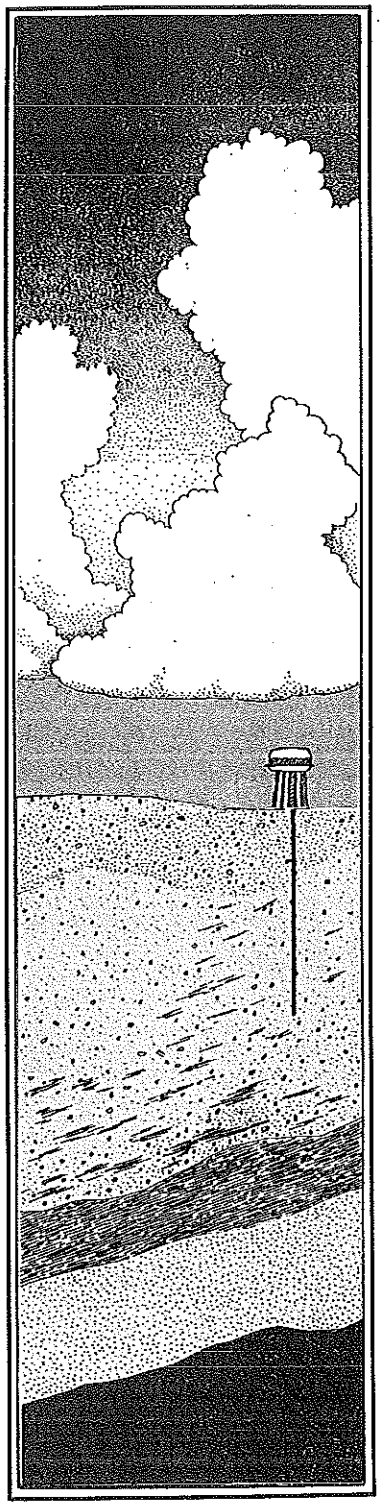
LONG ISLAND WATER RESOURCES

A Curriculum Activities Guide



Grades K–6

Museum of Long Island Natural Sciences
State University of New York at Stony Brook

StonyBrook

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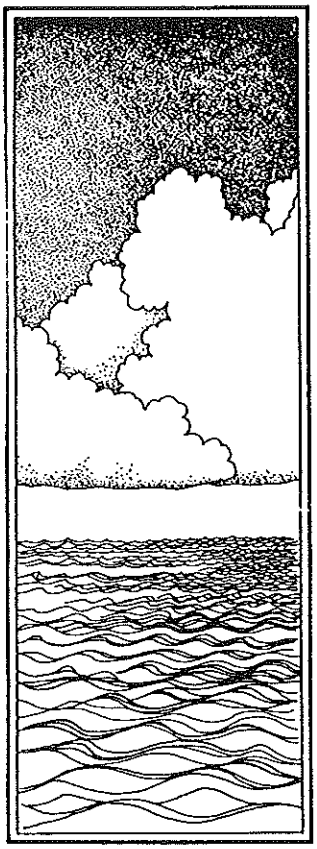

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Project Sponsored by

New York State Legislative Commission on Water Resource Needs of Long Island

Foreword

Any effort to protect a significant natural resource must include public education strategies. Whether the natural asset is California redwoods, bald eagles, great whales, tropical rainforests or Pine Barrens overlying Long Island's purest reserves of groundwater there is no chance that proper conservation practices will emerge in the absence of widely accepted citizen expectations. There is a qualitative difference, however, between information transfer that simply raises concerns and that which truly informs.

As reports of major gasoline leaks and other significant contamination events crowd our newspapers with increasing frequency, Long Islanders have become aware that many local public drinking sources and supplies are at risk. Our population has learned from news sources to be concerned about how poor land use planning and the contamination potential of our chemical intensive society now threaten our well being. Their growing concern has, in turn, stimulated Legislative initiatives designed to protect and preserve potable supplies of groundwater.

It is unfortunate that this education process has been mostly reactive rather than anticipatory for we are now in a race against time to take corrective actions before our drinking water source areas are lost forever. Clearly, as the next generation moves through our schools we must reverse these modalities of learning. It is the present generation that will assume responsibility for managing the water resources that shall, in turn, sustain the health and safety of all future generations. Neither our children or our grandchildren should be handicapped by ignorance. Unlike all too many adults of this generation, they need not have to learn how vital Long Island's groundwater supply is by casual inference or as the result of crisis. It is within this context that we are grateful that the New York State Legislative Commission on Water Resource Needs of Long Island has wisely sponsored the creation of this curriculum.

This curriculum strives to accelerate the ultimate protection of Long Island's water resources by providing a structured, interdisciplinary approach to learning about this vital subject within our public schools. It endeavors to provide basic information about our water system, the problems it faces and solutions to those problems. It presumes that all Long Islanders need to be informed about their responsibilities to the groundwater resources of the island that they live upon. It recognizes that as Long Island's resource management options lapse any wise public policies that we or any future generation may adopt will take on even greater significance as time goes on. Its goal is to assure that proper long term care of the ground and surface waters of Long Island will be sustained in perpetuity through the broad consensus of an informed citizenry.

Steven Englebright
Project Director

Rationale

The purpose of this guide is to provide a resource book that enables both teacher and student to learn about Long Island's water through understanding and appreciating this enormous, fragile resource and how we affect it. The activities found in this curriculum are designed to encourage a way of thinking that leads to the discovery of methods and tools that can allow Long Islanders to preserve their water while maintaining an acceptable quality of life.

HOW TO USE THIS GUIDE

The activities in this curriculum guide are arranged in two parts:

1) Teacher Information Pages
2) Student Activity Pages

Teacher Information Pages

The Teacher Information Pages are located at the beginning of each activity.

This section contains the following parts:

a. Objectives
b. Suggested Grade Level and Discipline
c. Elementary Syllabus References
d. Behavioral Objectives
e. Materials
f. Background Information
g. Procedure
h. References
i. Question Answers

Student Activity Pages

The Student Activity Pages are the pages located at the end of each activity. Depending on the topic and arrangement, each activity contains some or all of the following parts:

a. Vocabulary List
b. Student Procedures
c. Information Sheets
d. Observation or Data Sheets
e. Read Sheets
f. Work Sheets
g. Analysis Sheets
h. Question Sheets

Table of Contents

Activities

I THE WATER CYCLE

Resources

OVERVIEW OF OBJECTIVES

Long Island Water Resources Curriculum

I THE WATER CYCLE

1. CLOUD DIARY: Precipitation and the Water Cycle.

   OBJECTIVE: Students observe and record cloud and weather conditions over a duration of several days. Using these observations, students classify cloud forms. Through interpretation of their observations, relationships between cloud and weather conditions are inferred.

2. HOW DOES RAINFALL REACH AN AQUIFER?: Soil Drainage and the Water Cycle.

   OBJECTIVE: Students observe soil types and conditions in their schoolyard and conduct an experiment that illustrates how soil characteristics affect water drainage. The connection between soils and groundwater recharge is discussed.

3. HOW DO OCEANS BECOME CLOUDS? Evaporation and the Water Cycle.

   OBJECTIVE: Students discover by experimentation how temperature and air movement affect evaporation. Through identification of factors affecting evaporation rates, students are able to predict general rates of evaporation under various conditions and gain an understanding of the role of evaporation in Long Island's water cycle.

4. WATER LEAVES THROUGH THE LEAVES: Plant Transpiration and Water Cycle.

   OBJECTIVE: Through experimentation, students observe transpiration in plants and infer that plants take up water from the soil and lose it through their leaves. These experiments demonstrate that plants transpire and are a part of the water cycle.

5. THE WATER CYCLE STORY: A Reading Comprehension Lesson.

   OBJECTIVE: Through reading comprehension, students are introduced to the water cycle and are able to identify, on a picture worksheet, where evaporation, condensation and transpiration take place and where groundwater is located.

6. WATER GAMES

OBJECTIVE: A crossword puzzle and word search game reinforces concepts and vocabulary introduced in the water cycle story.

II LONG ISLAND'S LAKES, PONDS AND STREAMS: Surface Expressions Of Groundwater

7. AQUATIC ENVIRONMENTS

OBJECTIVE: Students are introduced to the hydrogeology of a Long Island pond, lake or stream through field observation and data recording.

8. POND LIFE

Part 1: Food Chain Tag

OBJECTIVE: A schoolyard tag game introduces students to the concepts of food chains, communities and balanced communities. A modification of the activity demonstrates how changes in environmental conditions can bring about changes in a community's population.

Part 2: Ponding

OBJECTIVE: Students visit a freshwater area and observe aquatic plants and animals. Attention is given to the adaptations plants and animals have evolved for life in and near the water. Working with a partner, students compare and contrast plants and animals found in a pond community.

III CONTOURS OF LAND AND WATER

9. LONG ISLAND'S GEOGRAPHY: A Mapping Lesson.

OBJECTIVE: Students are introduced to Long Island's geography through a mapping lesson. The information learned through this exercise is a prerequisite to understanding Long Island's geology and water resources in the later grades.

10. Mapping Long Island's Geology and Water Resources

OBJECTIVE: Using maps that present Long Island geology and hydrology characteristics, students discover the following information about their town:

a. its land surface elevation,

b. the type of glacial landform it is located on,

c. the water table elevation below it and

d. the average annual precipitation or rainfall received.

IV PEOPLE AND WATER: Pollution And Supply

11. WATER: A Picture Book for Kindergarten and 1st Grade.

OBJECTIVE: A cut and staple picture book introduces students to the importance of water, how we obtain it on Long Island and why it is important to conserve it.

12. GROUNDWATER AND GARBAGE DON'T MIX: Waste Production and Water Resources on Long Island.

OBJECTIVE: Waste production is used to investigate lifestyle differences and societal changes by comparing and contrasting today's garbage disposal practices with those of Colonial Americans and pre-Columbian Native Americans.

13. THE GREAT MANMADE RIVER: Water Resources, Technology and Limitations.

OBJECTIVE: Students read and comprehend a dilemma that concerns a water pipeline project in the Middle East. Pros and cons are discussed and students arrive at a conclusion about the viability and sustainability of the water project.

WATER
The Most Important Substance On Earth

WATER AND LIFE GO BACK A LONG WAY

Imagine life on earth without water. An uncommon originality would certainly be in order. Water has been a well-spring for life from the very beginning and has had a major role in the evolution of life ever since. The characteristics and distribution of life has, by and large, been determined by water.

WATER, ITS CHEMISTRY AND PROPERTIES

Water is the most important, abundant and unique substance on earth. Its chemical structure is responsible for many characteristics that make water basic to life. A water molecule is composed of two hydrogen atoms covalently bonded to an oxygen atom, as shown in figure 1. The nature and arrangement of this bond causes a polarity to exist between the ends of the molecule. The two hydrogen atoms exhibit a local positive charge while the oxygen atom exhibits a local negative charge. Water molecules have mutual attraction because of their polarity. This attraction is known as a hydrogen bond. It occurs when the negative oxygen end of the molecule has an attraction for the positive hydrogen atoms of another molecule. Hydrogen bonding produces many of water's qualities that are essential to life and the environmental mechanics that support it. Clouds, for example, would not form if not for hydrogen bonding. The mutual attraction of water molecules keeps the cloud mass together.

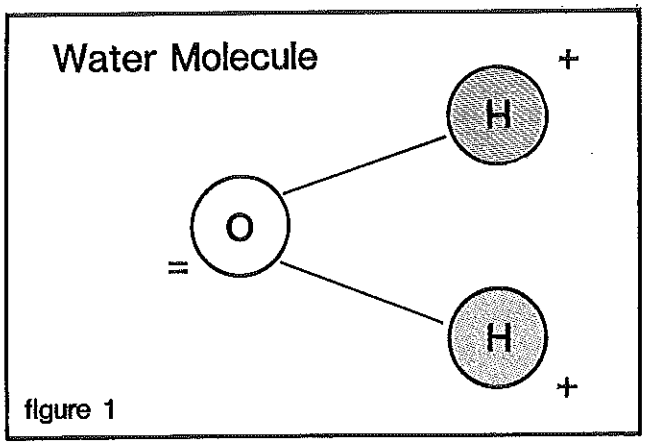


figure 1

SURFACE TENSION

Surface tension, also called cohesive tension, is another property resulting from hydrogen bonding. Molecules of water are attracted to one another and give the liquid's surface an encasing film. This occurs because the molecules of the surface can only attract those water molecules adjacent and beneath them. This molecular cohesion is the force that holds water drops together as they coalesce in clouds and later fall to earth. When they land on your raincoat, surface tension makes the droplets bead up. Many aquatic insects, such as the water strider, skim along this surface film that is their habitat.

ADHESION, COHESION AND CAPILLARY ACTION

Water molecules also are attracted to the solids they come in contact with. This attraction is called adhesion. The adhesive force of attraction causes water to be retained in soil, making it accessible for use by plants. Water is able to defy gravity by the forces

of cohesion and adhesion working in unison. This behavior is called capillary action and occurs in small tubes, such as those found in tree trunks, or in small spaces such as those found between soil particles. Capillary action works by the combined attraction of water molecules for themselves and for other substances.

WATER'S PHYSICAL CHARACTERISTICS

Pure water is odorless, tasteless, colorless and transparent. It has a neutral pH and is non-toxic. Water is an excellent solvent and is rarely found in a pure state. Most substances are soluble, to some degree, in water because of its polar nature. These soluble materials include all the inorganic substances required by living things. Water's solvency makes it a superior source of trace minerals and salts needed by living things. The composition of dissolved substances in water depends on the characteristics of the localities where it is found.

Living things are best able to use water when it is liquid. Water occurs in the liquid state over a wide temperature range (0^{o}C-100^{o}C or 32^{o}F-212^{o}F). It vaporizes above 100^{o}C and freezes below 0^{o}C. Water is the only substance that is found, naturally, in all three states (solid, liquid and gas).

WATER AND TEMPERATURE CHANGES

Water undergoes very distinct changes as its temperature changes. As water cools it becomes more dense. The density of water continues to increase until it reaches 4^{o}C. Cool, dense water sinks to the bottom of the water body it is contained in. As the temperature drops below 4^{o}C, water density decreases. Molecules of freezing water form a crystalline arrangement making the water less dense. The lighter water rises towards the surface and "floats" above the more dense water. Ice forms and floats evidencing its low density.

This property of water is important to living things. If it did not occur, lakes and ponds would freeze from the bottom up. The insulating and life-protecting ice surface would not form. Aquatic plants and animals in temperate and northern climates would be unable to survive the winter season.

THE WORLDWIDE DISTRIBUTION OF WATER

Oceans cover most of the earth. Over 70% of our planet's surface is water. Most of the world's water (97%) is saltwater and is unuseable. Over 3/4 of the free water is locked up in glaciers and ice caps. All totalled, less than 1% of the earth's water is fresh and useable.

The World's Supply of Water

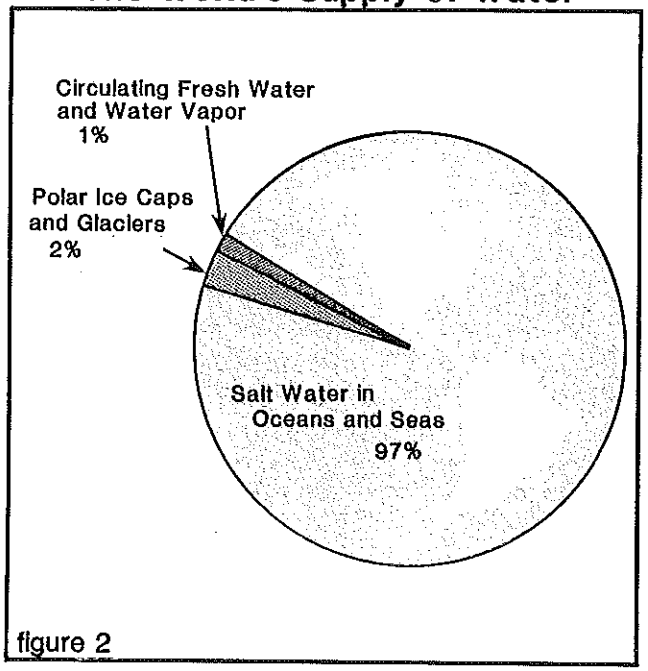


figure 2

Water resources are found throughout the world in many forms and places. These include groundwater, rivers, streams, lakes, reserviors, springs, precipitation and atmospheric water.

WATER IS ESSENTIAL TO HUMAN ACTIVITIES

Water is an essential part of almost all human activities. Water is indispensible to our agriculture and is used in the manufacture of virtually everything we use. Activities within our homes would come to a standstill without an adequate supply of water.

The Water Cycle

The water cycle is a continuous exchange of water between land, ocean and atmosphere. Since the amount of water is constant, the water cycle can be considered a closed system. The ocean's saltwater makes up 97% of earth's water. The remaining 3% is freshwater. Nearly 2% of the freshwater is frozen in glaciers and ice sheets. The remaining 1% is made up of atmospheric water vapor, groundwater and all the freshwater lakes, ponds, streams and rivers.

Though all water on earth is included in the cycle, not all forms and locations cycle at the same rate. For example, glaciers and groundwater restrict and restrain water movement for extended periods, sometimes spanning thousands of years.

EVAPORATED WATER RISES, CONDENSES AND FORMS CLOUDS

The ocean is the water cycle's largest storage area. The sun provides energy for the evaporation of great quantities of ocean water. This water vapor rises, meets colder air and condenses on particles of ocean salt, dust and pollutants. During condensation, water changes from a gas to a liquid. The newly formed water droplets would fall to earth if not for the continually rising warm air currents keeping them aloft. As water droplets collide, they form larger drops. The surface tension of water makes this possible. Larger and heavier water drops fall when air currents can no longer negate their downward movement. Precipitation falls.

WATER FALLS FROM CLOUDS AND RETURNS TO EARTH

As water falling from clouds reaches the earth, it may continue in one of three possible directions. It can:

a. evaporate before or after it reaches earth's surface,

b. enter the ground and be taken up by plants to be used and then transpired, or

c. enter the soil bound for the groundwater.

LONG ISLAND'S WATER CYCLE

Long Island's average annual precipitation is 44 inches. About half of our precipitation returns to the atmosphere by evapotranspiration (evaporation and plant transpiration). Most evapotranspiration occurs during the warm months when days are longer, plants are in full leaf and the earth absorbs most of the sun's heat.

GROUNDWATER IS LONG ISLAND'S SOLE SOURCE OF FRESHWATER

Groundwater is Long Island's sole source of freshwater. Precipitation is the only source of groundwater and its replenishment. Under natural conditions, about 50% of our annual rainfall enters the groundwater.

Gravity causes rainwater to move downward through the soil layers to the aquifer. Aquifers are porous rock deposits that hold water. Groundwater occupies the spaces between the loose rock particles that form the aquifer. Groundwater is in slow, though constant, motion. It may travel only 2 or 3 feet per year.

The top of the water-saturated aquifer is called the water table. Groundwater wells must be deep enough to tap the water below the water table. Most lakes, streams and ponds found on Long Island are groundwater-fed and their water levels are determined by the water table level.

Under natural conditions, water recharging the aquifers roughly equals the water exiting the groundwater. A system in just such balance is said to be in equilibrium. Precipitation enters the groundwater by way of the land's surface and leaves by one of several routes which include:

a. stream or river outflow

b. spring outflow

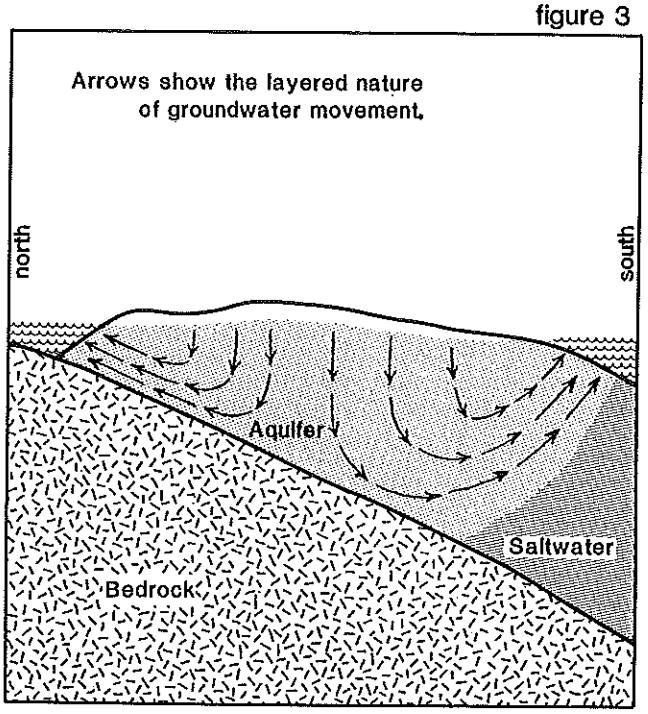
c. outflows that occur, in varying depths, under the surface of Long Island as shown in Figure 3.

As groundwater returns to the ocean via one of these passages, Long Island's water cycle completes its revolution to begin another round of exchanges between land, sea and sky.

PEOPLE HAVE CHANGED LONG ISLAND'S HYDROLOGIC SYSTEM IN MANY WAYS

Long Island's natural hydrologic system has been changed by human development. Before the arrival of Europeans, Native Americans made use of Long Island's water resources. They were a part of the natural system because they used water on its own terms. Their lifestyles were sculpted by water. Camps were made near water. They hunted by, fished in and drew water from lakes and streams. After the arrival of Europeans, the ways of using the water supply changed profoundly. Surface water supplies and the areas around them no longer dictated settlement patterns. Shallow wells could be dug throughout the Island and the supply appeared boundless.

figure 3



The problems of water quality and quantity faced today are rooted in the past. Though the problems don't stretch back as far as colonial days, our attitude towards natural resource use does.

Development of Long Island's water supply came in stages as the population grew and unfurled from west to east. Modifications in the systems that tap the water supply and disposed of its wastes were

forced as a growing population gave rise to pollution problems.

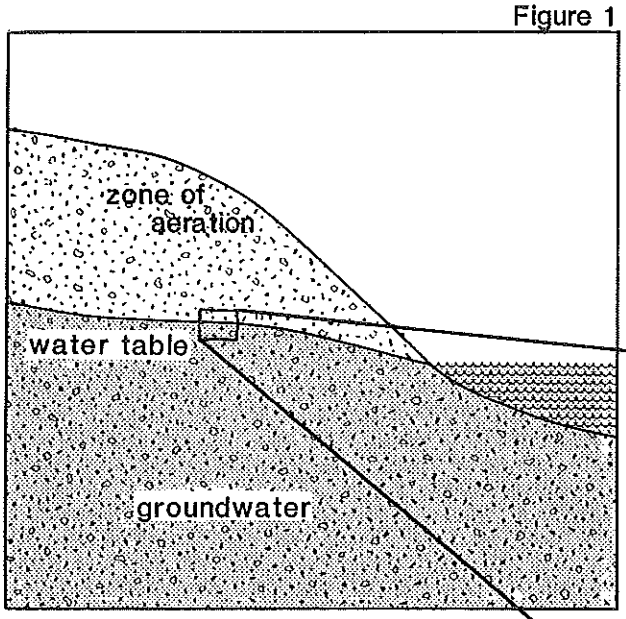
Private wells and cesspools gradually but steadily lead to public water wells that supply water and extensive sewer systems that dispose of waste waters out to sea. Even today, as population grows and expands across Long Island, we kindle the quality and quantity problems that originated long ago but continue to leave us with an ever-shrinking water supply.

LONG ISLAND'S GROUNDWATER
Underground and Misunderstood

GROUNDWATER IS LONG ISLAND'S SOLE SOURCE OF DRINKING WATER

Groundwater is the most hidden portion of Long Island's Water Cycle. Its invisibility leads to misconceptions about its distinct and fragile characteristics. Though vastly misunderstood, groundwater is indispensible because it is Long Island's only source of fresh drinking water.

Figure 1

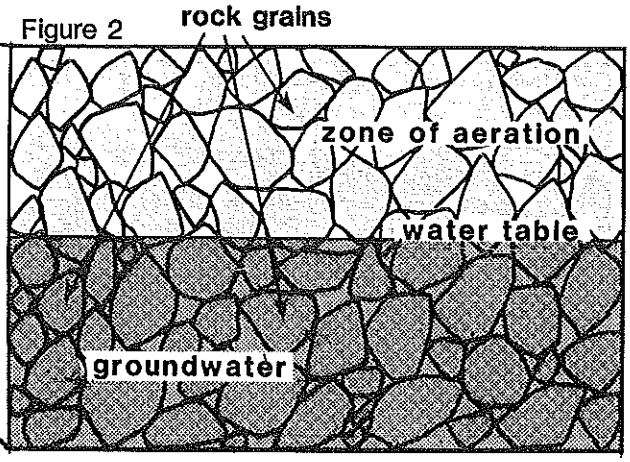


Zones of Underground Water

RAINFALL IS LONG ISLAND'S SOLE SOURCE OF GROUNDWATER

All the water contained in Long Island's groundwater initially arrived by cloud. The groundwater now below us and all the water that will eventually become groundwater fell and will fall as rain or snow. Precipitation bound for the groundwater must traverse the soil between the land's surface and the surface of the groundwater or water table as shown in Figure 1. Water that reaches the land and filters through the soil does not always descend to the groundwater reservior. It may remain in the Zone of Aeration until it is absorbed by a plant or returns to the air by evaporation. The soil in the Zone of Aeration is unsaturated because the spaces or pores between the soil particles are not filled with water as they are in the groundwater or Saturated Zone as shown in Figure 2. In unsaturated soil, air fills the spaces between the soil grains. Water is held in this area by capillary attraction or adhesion. Water on its way to the groundwater percolates, by gravity, through layers of soil until it reaches the water table. Below the water table, the pore spaces between sand, gravel and clay are completely filled or saturated with water.

Figure 2



Enlargement of Water Table Area in Figure 1

The water table is the topmost level of the groundwater. This level varies throughout Long Island and water table elevations roughly conform to the contours of the land's surface elevation. The water table also fluctuates seasonally and is influenced by variations in rainfall.

The depth of the water ranges between one and one hundred feet below the

surface of Long Island. Many of our lakes and ponds are exposed sections of groundwater. The level of these surface water bodies is the same as that of the water table.

Some elevations of this variable water table rise as high as 90 ft. above sea level. The aquifer system then extends down from this height to a depth that, in some places, approaches 2,000 ft. below sea level.

AQUIFERS AND CONFINING LAYERS

A rock formation or group of formations that holds water and allows water to move through it is called an aquifer. Long Island's groundwater system contains three major aquifers. These aquifer formations are as follows:

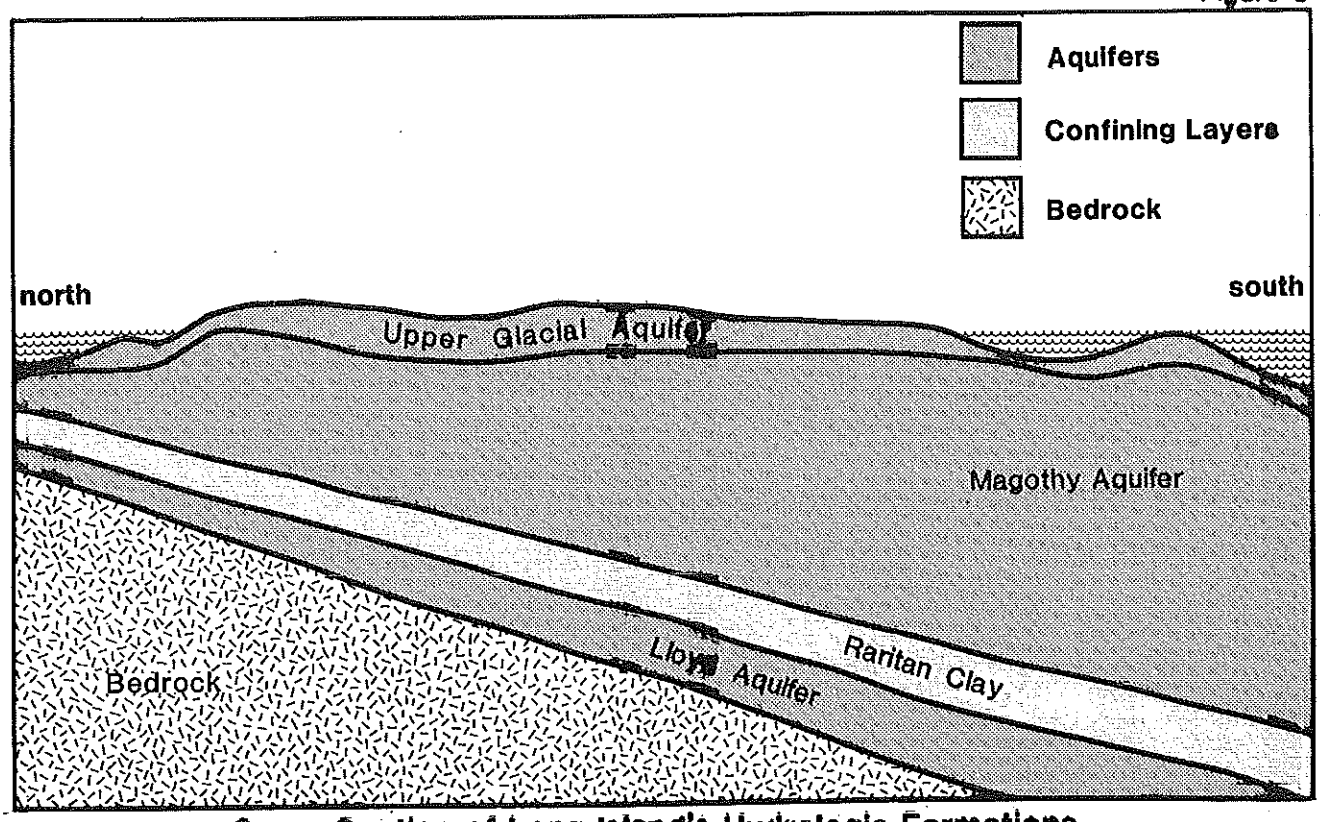
1. The Upper Glacial Aquifer,
2. The Magothy Aquifer and
3. The Lloyd Aquifer

Confining layers are another type of formation found in Long Island's hydrologic system. The Raritan Clay, located above the Lloyd Aquifer and below the Magothy Aquifer, is one such formation. A confining layer is characteristically impermeable throughout most of its formation due to its rock composition. Water moves slowly through confining layers and little water is stored in them. A cross section of Long Island's 3 major aquifers and 1 major confining layer is found in Figure 3.

ALL LONG ISLAND'S AQUIFERS ARE INTERCONNECTED

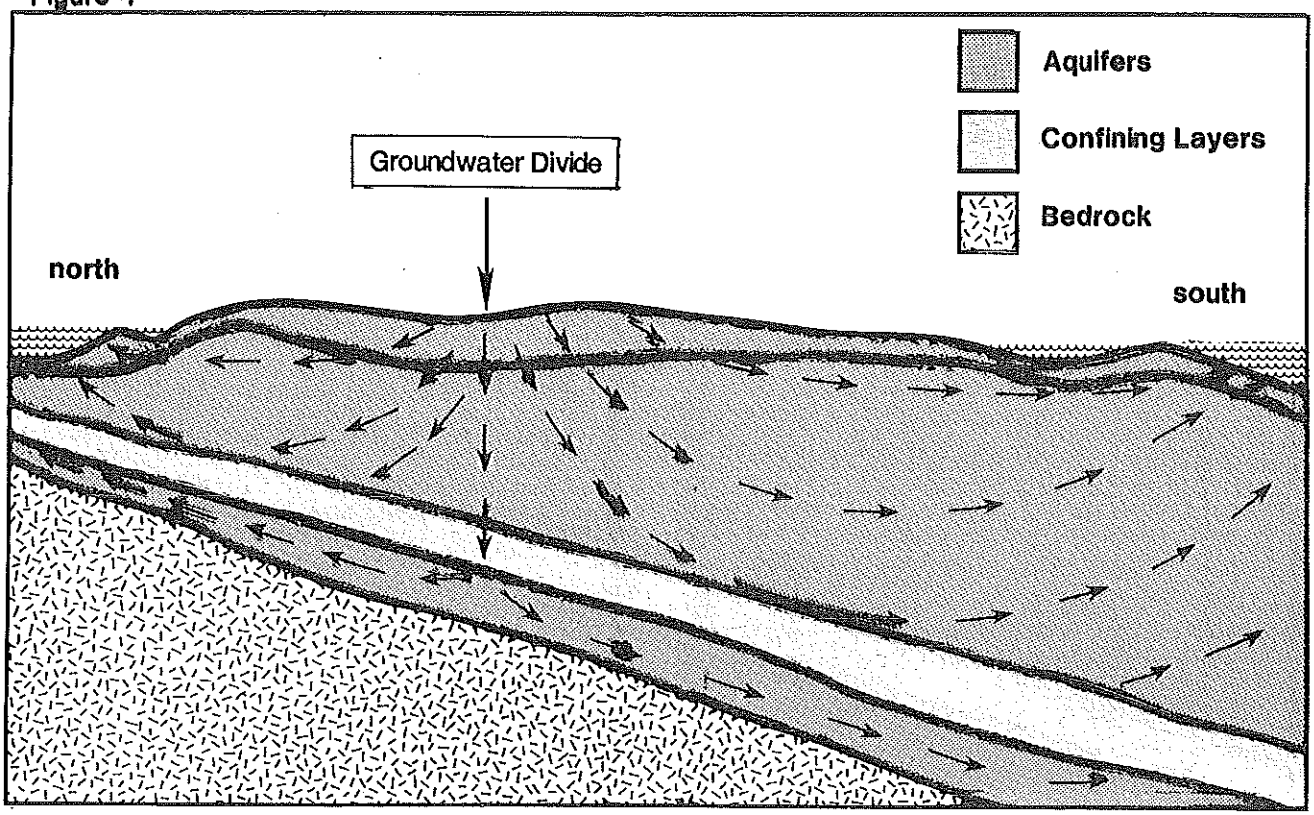
The sediment deposits beneath Long Island are divided into several aquifer and confining layers because they are of different geologic origin and rock composition. They are, however, integral parts of one large system

Figure 3



Cross Section of Long Island's Hydrologic Formations

Figure 4



Generalized Groundwater Movement Patterns

that is interconnected by the groundwater that moves through and between them. Diagrams of this groundwater system often convey an impression of each aquifer as separate and isolated. Readers should caution themselves against this interpretation as problems associated with the water in one aquifer will most likely, in time, travel through the rest of the system.

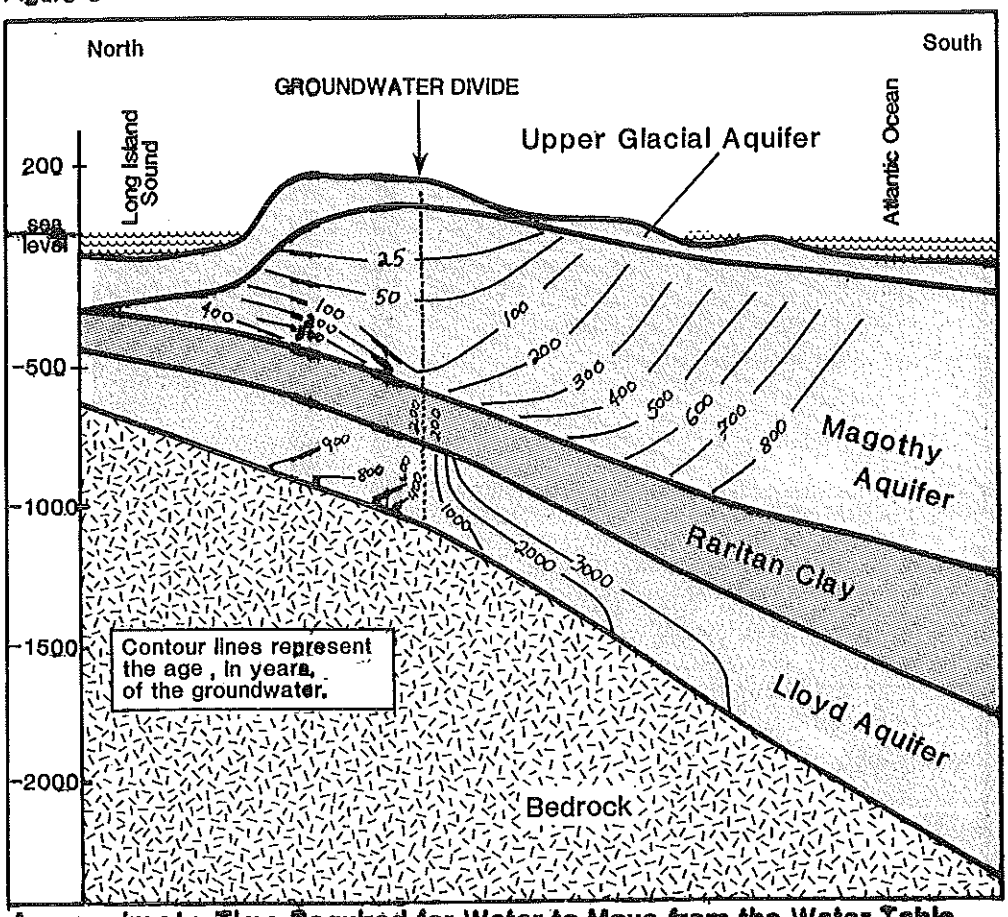
RAINWATER REPLENISHES OUR AQUIFERS

Rainwater that travels through the soil and reaches the groundwater is called recharge. Water is constantly leaving the groundwater system by natural outflow or by human use. Recharging water replenishes the water that leaves the system. In developed areas on Long Island, recharge basins or "sumps" are excavated to facilitate natural groundwater replenishment. These artificial recharge areas are necessary because paving and building construction has disturbed natural rainwater infiltration patterns and increased surface runoff.

GROUNDWATER MOVES THROUGH THE AQUIFER SYSTEM

Water that enters Long Island's aquifers is in constant motion. Water movement or flow patterns in this system are dynamic and vary according to location. Groundwater movement patterns are illustrated in Figure 4. Along the central east-west corridor of our island, groundwater moves vertically downward towards the underlying bedrock and arcs back upwards towards both of the coasts. The groundwater divide is the area where groundwater moving

Figure 5



Approximate Time Required for Water to Move from the Water Table to Points Within Long Island's Groundwater System

SOURCE: Modified from Franke and Cohen, 1972.

Water can remain in Long Island's aquifer system for thousands of years.

vertically eventually separates into north or south flows as illustrated in Figure 4. Moving north and south away from the Ronkonkoma Moraine and towards the coasts, groundwater in the system moves primarily horizontally and shallow towards coastal waters. As a result of this shallow horizontal movement, water recharging in areas near the coast has a shorter residence time in the aquifer system.

GROUNDWATER MOVES SLOWLY

Groundwater movement occurs very slowly. Its rate of movement can be measured in feet per year. Figure 5 shows approximations of the time required for groundwater to travel from the water table to various locations in Long Island's regional groundwater system. Groundwater movement time varies considerably depending on its location. For example, water entering a shallow flow region near the coast may take 25 years to reach coastal waters while water at the groundwater divide's water table may require 3,000 years to reach the base of the Lloyd Aquifer.

LONG ISLAND'S GROUNDWATER IS PLENTIFUL AND FRAGILE

The water-holding capacity of the aquifers below Nassau and Suffolk Counties is quite extensive. Trillions of gallons of freshwater are contained within this system. These water-bearing geologic formations are the only source of potable water for all of Long Island's present and future needs.

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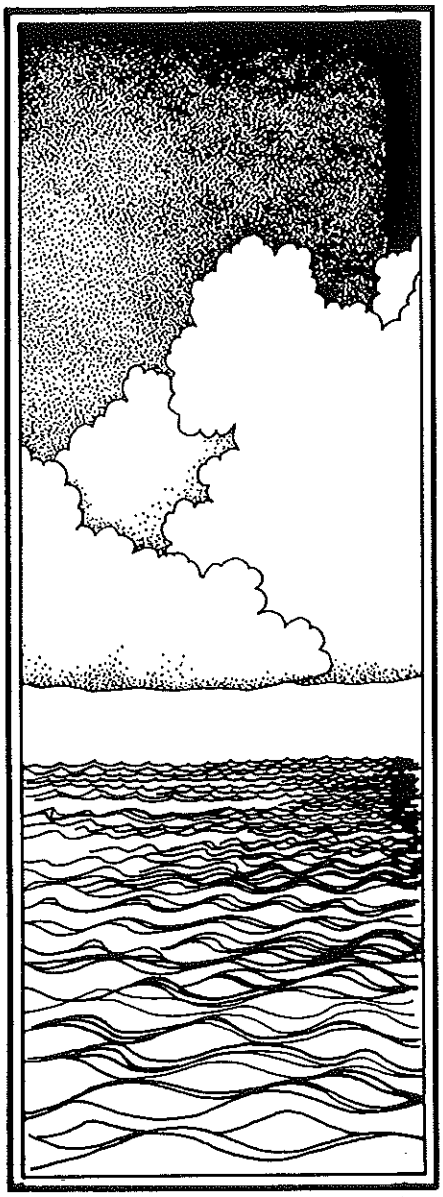
CLOUD DIARY

Precipitation and the Water Cycle



CLOUD DIARY
Precipitation and the Water Cycle

OBJECTIVES

Students observe and record cloud and weather conditions over several days duration. Using these observations, students classify cloud forms. Through interpretation of their observations, relationships between cloud and weather conditions are inferred.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grades 4-6
Science
Math
Art

ELEMENTARY SYLLABUS REFERENCES

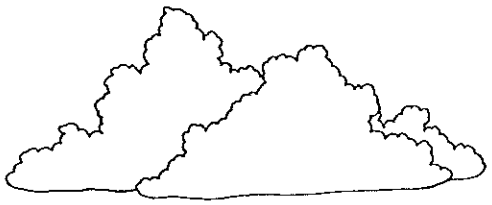
ELEMENTARY SCIENCE: IIID.

MATH COMPONENT:

FOURTH GRADE: Use Table 1 on Worksheet B. A frequency table can be done with Table 1.

FIFTH GRADE: Use Table 1 on Worksheet B. A circle graph can be done in conjunction with Table 1.

SIXTH GRADE: Complete Tables 1, 2 and 3. Use percentage concept.



BEHAVIORAL OBJECTIVES

Upon completion of this activity students should be able to:

a. classify clouds into three basic forms: cumulus, stratus and cirrus,
b. observe and record cloud forms and weather conditions over several days duration,
c. interpret the data and generalize about the relationship between cloud forms and weather conditions.

MATERIALS

MATERIALS FOR EACH STUDENT:

Cloud Form Identification Sheet
Cloud Form Observation Sheets (number dependent on the duration of the experiment).
Worksheets A and B
Question Sheets A and B
Pen or Pencil

MAJOR UNDERSTANDINGS

Clouds are an important part of the water cycle because their rain production continues the exchange of water between ocean, atmosphere and land.

All of Long Island's groundwater is from precipitation that has fallen from clouds.

Clouds are made of water droplets formed when water vapor in the atmosphere condenses.

In order for condensation to occur water vapor must have a surface to condense on.

Clouds are found at a variety of elevations.

Clouds take on distinct forms.

Cloud forms are associated with specific elevations.

There is a relation between cloud forms and weather conditions.

BACKGROUND INFORMATION

Clouds and the Water Cycle

Clouds are the most visible part of the water cycle. Our almost daily encounter with them can cause us to lose sight of their significant influence on our water resources and on our quality of life.

Water Droplets Make Up Clouds

Clouds are made of water droplets formed by the condensation of water vapor. This condensation occurs as water vapor rising on air currents meets cooler air at higher elevations in the atmosphere. In order for condensation to take place, water vapor must have a surface on which to condense. This surface is provided by materials such as salt crystals, dust and pollutants.

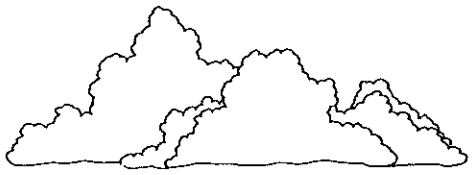
Clouds contain water droplets which, because of gravity, are too heavy to remain high in the atmosphere. They remain elevated because of constantly rising warm air currents. As water droplets coalesce through collision with other droplets within the cloud, they become larger. An increase in weight accompanies this increase in size. When the upwelling air can no longer support these heavier droplets they begin to fall as precipitation.

Cloud Classification

Clouds are found at a variety of heights and take on many distinctive forms and are classified accordingly. During the CLOUD DIARY activity, students will differentiate cloud masses into three forms: cumulus, stratus and cirrus. These words are of Latin origin. Their English translations are descriptive of their form: cumulus means "heap", stratus means "spread out" and cirrus means "hair" or "curl".

Cumulus Clouds

Cumulus are rotund, cottonball-like clouds usually associated with fair weather. They form when pockets of warm air, near ground level, rise because they are less dense than the surrounding air. This warm air mass condenses as it rises to cooler elevations. Cumulus clouds are generally associated with fair weather. A cumulus may sometimes thicken to become a cumulonimbus or thunder cloud. These clouds can produce short but intense local storms of rain and hail. Strong winds, thunder and lightning also accompany these storms. Cumulonimbus clouds are often associated with cold fronts.



Stratus Clouds

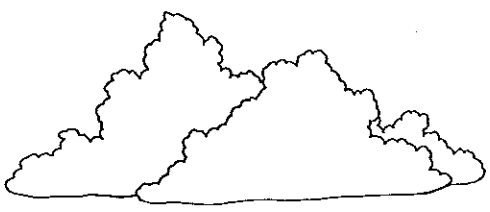
Stratus clouds are blanket-like and can cover large areas of the sky. They form when an air layer is forced to rise gradually over a stable air layer of greater density. As the less dense air layer is forced to rise, it condenses as it reaches cooler elevations. These clouds can produce heavy rain for long periods of time especially when thick, dark and at low altitudes. Stratus clouds are usually associated with warm front systems.

Cirrus Clouds

Cirrus clouds form very high in the sky and are made of thin layers of ice crystals. Cirrus ice crystals are too light to fall unless the cloud thickens. These clouds usually indicate a change in the weather. Heavier clouds at lower levels may soon follow. These lower clouds are likely to produce rain or snow.

Clouds and Weather Conditions

Since there is a relationship between clouds and weather conditions, cloud observation easily lends itself to the beginner's study of meteorology. By stepping out of doors for a few minutes a day, an experiment of extended duration using inter-disciplinary skills can lead the student through the full range of the problem solving process.



PROCEDURE

Length of Investigation

Cloud observation: 7 to 14 days

Each cloud observation session: 15 minutes

NOTE: An investigation of more than 7 days is recommended. The more observations completed, the greater the likelihood of obtaining results that show clear cloud form-weather condition associations.

1. Cloud Observation

a. Begin this activity by introducing clouds, what they are, their different forms and characteristics. Stress that clouds are an important part of Long Island's water cycle because all groundwater originates as precipitation.

2. Cloud Form Observation Sheet

a. Handout investigation sheets. Each sheet has room for one day's entry. If weather permits, take students outside. Encourage them to visualize shapes of familiar objects in the clouds.

b. Have them fill out their CLOUD OBSERVATION SHEET. The CLOUD IDENTIFICATION INFORMATION SHEET will help them answer questions 7 and 8.

c. The back of the observation sheet can be used for a quick sketch of cloud formations.

d. Collect sheets.

e. Repeat steps a-d for the duration of the experiment.

3. Worksheet A: Cloud Identification

a. Return the student's CLOUD OBSERVATION SHEETS.

b. Instruct students to complete this sheet by recording the cloud type for each day in column 1 (Question 7 on OBSERVATION SHEET) and the weather conditions in column 2 (Question 9).

4. Worksheet B: Cloud Analysis

Table 1

a. Students should fill in column 1 (Number of Days Observed) with the number of days each type of cloud formation was observed.

b. Column 2 (Number of Days of Precipitation) should be filled in with the number of days of rain or snow for each cloud type.

c. Column 3 (Number of Days of No Precipitation) should be filled in with the number of days it did not rain or snow for each cloud type.

5. Worksheet B: Cloud Analysis

Table 2

a. Have students use column 1 from Table 1 to figure out the percentage of days each cloud type produced precipitation. This number should be entered in column 2 of Table 2 for each cloud type.

c. Subtract the figure in column 2 from 100 to arrive at the percentage of days each cloud type produced no precipitation. This number should be entered in column 3 of Table 2 for each cloud type.

6. Questionsheets A and B

a. Instruct students to answer questionsheets A and B.

MODIFICATIONS

This activity is designed to be adaptable to your particular needs, in terms of grade level and time constraints. It may be used as a simple cloud observation and identification. Cloud-weather analysis can be investigated using Table 1 singly or in combination with Table 2.

Include other weather variables such as temperature, humidity, wind direction and speed.

FURTHER ON

How does rain form?

How does precipitation get into our groundwater aquifers?

How do seasonal weather patterns affect cloud formations?

How do clouds and precipitation affect the way we live, work and play?

What are conditions like before, during and after rain or snowfall?

How do clouds and precipitation patterns affect animals, farm crops and gardens?

Broaden the cloud investigation by including the more complex varieties: cirrostratus, cirrocumulus, altocumulus, altostratus, stratocumulus, nimbostratus and cumulonimbus.

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THE RAIN BOOK, Susannah Howick, Brenda Irvine and Clifford J. Anastasiou, Western Education Development Group, 1980.

WATCHING FOR THE WIND, James G. Edinger, Doubleday Anchor, 1967.

Cloud Diary
Precipitation and the Water Cycle

Vocabulary

WATER VAPOR: Water in a gas state or form.

CONDENSATION: The change in state or form from a gas to a liquid.

EVAPORATION: The change in state or form from a liquid to a gas.

CLOUD: A great mass of small water droplets that come from condensation occurring in the air.

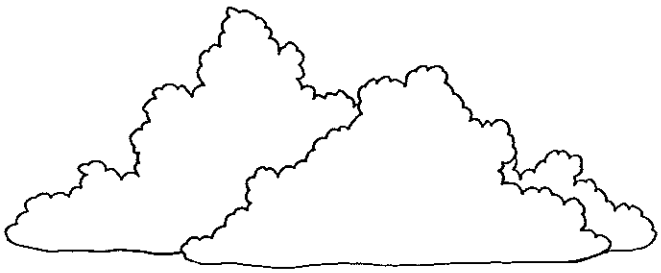
PRECIPITATION: Any form of water that falls from the atmosphere and reaches the ground. Rainfall is used to mean precipitation.

CUMULUS CLOUDS: Cumulus clouds are puffy, cottonball-like clouds with flat bottoms. They are found at low altitudes and are generally fair weather clouds.

STRATUS CLOUDS: Stratus are grey, layered clouds that blanket the sky. They are low altitude clouds that can produce precipitation.

CIRRUS CLOUDS: Cirrus clouds are found high in the atmosphere. They are feather-like clouds made up of ice crystals and usually mean fair weather.

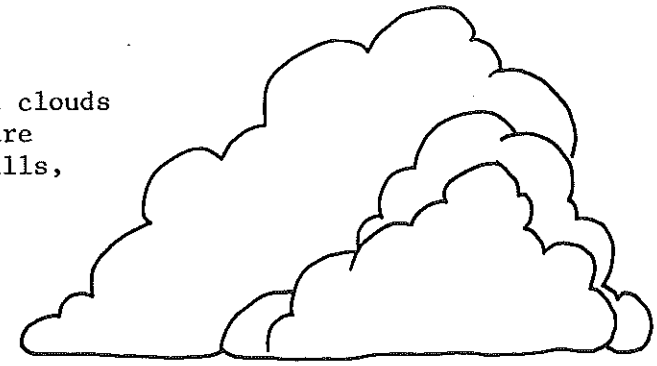
FOG: A cloud layer that is in contact with or lying very close to the land or sea surface.



Cloud Form Identification Sheet

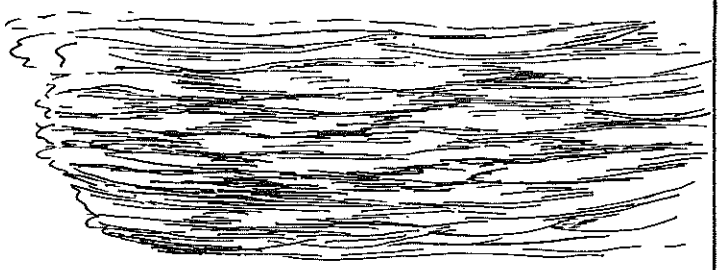
Cumulus Clouds

Cumulus are puffy, cottonball-like clouds with flat bottoms. Their shapes are constantly changing into knobs, hills, bumps and domes. They are fair weather clouds but can sometimes develop into rain clouds or thunderheads. Cumulus clouds are low altitude clouds.



Stratus Clouds

Stratus clouds are low, grey and blanket the sky. These clouds are precipitation producers.



Cirrus Clouds

Cirrus clouds are the highest clouds. They are white and feathery and are commonly referred to as "mare's tails". Cirrus clouds are made up of frozen water vapor - ice crystals.

name _____

CLOUD FORMS
Observation Sheet

1. Are there any clouds in the sky?
   yes_____
   no_____
2. Describe the most common cloud shape:
   puffy_____
   feather-like_____
   layered_____
   fish scale-like_____
3. How high are the clouds?
   very high_____
   low_____
   medium high_____
   very low (fog)_____
4. How fast are they moving?
   slowly_____
   medium speed_____
   quickly_____
5. What color are they?
   white_____
   dark grey_____
   grey_____
6. Is there more than 1 type of cloud?
   yes_____
   no_____
7. What is the most common type?
   cumulus_____
   cirrus_____
   stratus_____
8. What is the second most common type?
   cumulus_____
   cirrus_____
   stratus_____
9. What are the weather conditions?
   rain/snow_____
   partly cloudy_____
   very cloudy but dry_____
   clear_____

Directions

1. **Enter the day number in the box at the top left corner of this page.**
2. **Observe cloud formations and answer the questions in the grey box on the left side of this page.**
3. **In the box below, write out the answers you choose for questions 1 - 9. This will help your cloud analysis.**

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

name _____

Cloud Diary Worksheet A

Fill in the table below using questions 7 and 9 from your CLOUD FORMS Observation Sheets.

Day	Type of Cloud (cumulus, cirrus, stratus) question #7	Weather Conditions (clear, cloudy, partly cloudy, rain, snow) question #9
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

name _____

Cloud Diary — Worksheet B

TABLE 1

Type of Cloud	Column 1 = Number of Days Observed	Column 2 = Number of Days of Rain or Snow	Column 3 + Number of Days of No Rain or Snow
Cumulus			
Stratus			
Cirrus			
No Clouds Observed			

TABLE 2

Type of Cloud	Column 1 Percentage of Total Days Observed	Column 2 Percentage of Days Cloud Produced Rain or Snow	Column 3 Percentage of Days Cloud Produced No Rain or Snow
Cumulus			
Stratus			
Cirrus			
No Clouds Observed			

name _____

Cloud Diary — Questionsheet A

Circle the best answer to each question.

1. Clouds form when water vapor _____.

   a. evaporates
   b. condenses
   c. precipitates
   d. transpires

2. Which cloud is made of ice crystals?

   a. cummulus
   b. cirrus
   c. stratus

3. Which clouds are low altitude clouds?

   a. cumulus and cirrus
   b. cirrus and stratus
   c. stratus and cumulus

4. Which clouds produce the most rain and snow?

   a. cumulus
   b. cirrus
   c. stratus

5. Which clouds are found at very high altitudes?

   a. cumulus
   b. cirrus
   c. stratus

6. Where does the water that clouds are made of come from?

   a. groundwater
   b. glaciers
   c. oceans, lakes and rivers
   d. the sun

name _____

Cloud Diary Questionsheet B

Circle the best answer to each question.
Answer question 3 by filling in the blanks with the correct answer.

1. Which cloud type was observed the most number of days?

   a. cumulus
   b. cirrus
   c. stratus

2. Which cloud type was observed the least?

   a. cumulus
   b. cirrus
   c. stratus

3. List the following:

   a. total number of days of cloud observation _____
   b. total number of days of precipitation _____
   c. total number of days of no precipitation _____

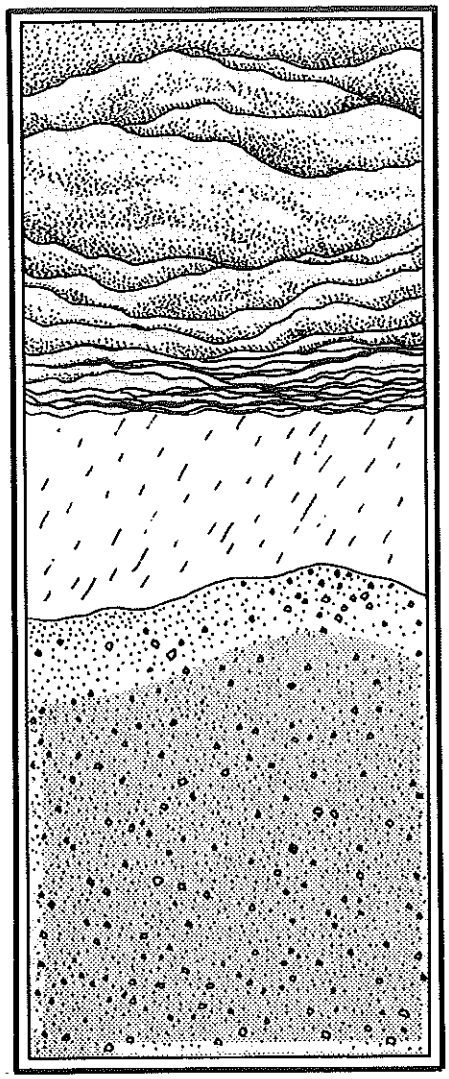
4. Using Table 2, predict which cloud type is most likely to produce precipitation.

   a. cumulus
   b. cirrus
   c. stratus

5. Using Table 2, predict which cloud type is least likely to produce precipitation.

   a. cumulus
   b. cirrus
   c. stratus

HOW DOES RAINFALL REACH AN AQUIFER?



Soil Drainage and the Water Cycle

HOW DOES RAINFALL REACH AN AQUIFER?
Soil Drainage And The Water Cycle

OBJECTIVES

Students observe soil types and conditions in their schoolyard and conduct an experiment that illustrates how soil characteristics affect water drainage. The connection between soils and groundwater recharge is discussed.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grades 4-6
Science

ELEMENTARY SYLLABUS REFERENCES

Elementary Science References: IIC.,1., IIID.,2.,4., IIIE.,2.

BEHAVIORAL OBJECTIVES

Upon the completion of this activity, students should be able to:

a. identify different soil types and conditions in the schoolyard,

b. predict the rates of water drainage through different types and conditions of soil,

c. discuss the relationship between soil types and conditions and Long Island's groundwater.

MATERIALS

coffee cans with top and bottom removed
stopwatches or watches with a second hand
1 pint of water for each test site
hammer

Each student should have:
DATA TABLE
QUESTION SHEET

MAJOR UNDERSTANDINGS

A portion of the precipitation that falls to earth enters the ground and recharges the aquifer.

A factor in the potential of water to reach the groundwater is the composition and condition of the soil it must pass through.

The rate at which water moves through soil is dependent upon the soil's porosity and permeability.

On Long Island, the porosity and permeability of soil varies according to location.

Long Island's surface material was transported here and shaped by glaciation.

Long Island's surface displays two major glacial landforms: moraines and outwash plains.

Morainal soils are unsorted while outwash plain soils are sorted.

Outwash plain soils are more porous and permeable than morainal soils.

HOW DOES RAINFALL REACH AN AQUIFER?
Soil Drainage And The Water Cycle

Outwash plain soils allow precipitation to swiftly filter down to the groundwater aquifers beneath them.

Human activities on the land's surface determine the quality of the groundwater below.

Soils that allow rapid drainage of water also allow for a greater likelihood of aquifer contamination.

The largest reservoir of clean groundwater remaining on Long Island is located beneath the outwash plains of central Suffolk County.

Knowledge of soil characteristics, as they relate to the mechanics of groundwater recharge, is an important land use planning tool.

BACKGROUND INFORMATION

RAINWATER MUST MOVE THROUGH SOIL TO REACH GROUNDWATER

As water falling from clouds continues through the hydrologic cycle it reaches the earth and may diverge into one of three possible directions. It can:

1. evaporate once it reaches earth's surface,
2. enter the ground and be taken up by plants to be transpired, or
3. enter the ground to recharge the aquifer.

Water bound for the groundwater aquifer must traverse the soil between the land's surface and the water table. An important factor in the water's potential to transit this distance is the composition of the soil.

How far and fast water moves through soil depends upon the size, porosity and permeability of the soil particles. If spaces between soil particles are large and unconnected the attraction between water molecules and soil particles will not be strong enough to overcome the weight of the water. This is characteristic of coarse sandy soil. Water movement through this type of soil is rapid. In less sandy, more finely textured soil, the attraction between water and soil is greater. The spaces between soil particles are smaller allowing for stronger capillary attraction. Water movement through these soils would be slower. Soil that has been compacted by traffic, be it foot or machinery, also has its particles brought closer together. This results in less space for water to move through and greater capillary force. Water moves through compacted soil very slowly.

LONG ISLAND'S SOILS

Long Island's soils are composed of unconsolidated or loose rock material such as sand, clay, silt, gravel, cobble and boulders. All this material has been transported from northern areas by glaciers. The porosity and permeability of these soils varies according to location. Their location has largely been determined by glaciations; as most of Long Island's surface was formed and shaped by the deposition and action of glaciers. This is evidenced by the two types of glacial landforms that dominate Long Island's landscape: moraines and outwash plains. These landforms can easily be distinguished from one another on the bases of soil porosity and permeability.

HOW DOES RAINFALL REACH AN AQUIFER?
Soil Drainage And The Water Cycle

SORTED AND UNSORTED ROCKS

A major difference between the soils of moraines and outwash plains is in the degree of rock sorting and the size and variety of rock particle sizes. Moraine soils were deposited by ice and are not sorted. The outwash plain soils are morainal material that was transported and sorted by the voluminous meltwaters that the receding glaciers produced.

RICH SOILS OF THE MORAINAL HILLS

Unsorted quartz gravel, sand, clay, silt, cobble and boulders constitute the morainal hills left behind by the glaciers. Rock material of various sizes are randomly interspersed throughout this soil. Smaller rock particles such as clay and silt fit between the larger sands and gravels making the soils less porous and less permeable. These soils have good water holding ability. The hardwood deciduous forests that grow upon these soils reflect their water content. The organic matter found in the top soil accumulations increases the soil's ability to retain water.

SANDY SOILS OF THE OUTWASH PLAINS

Meltwater from the glaciers carried and sorted the finer morainal deposits; the sands, clays and silt, and formed the broad and flat outwash plains that occur south of the moraines. The rock particles in sorted soil are approximately the same size. These soils have a greater porosity because there is not a significant amount of smaller rocks to fill in the pore spaces. These soils tend to be excessively well-drained; water movement through them is very rapid. These sandy soils support, for the most part, Pine Barrens vegetation. The fire ecology and soil acidity of the Pine Barrens prevents any significant accumulation of top soil. The forest litter that would eventually become top soil periodically burns as fires sweep throughout this desert-like ecosystem. The soils of the outwash plains, with their coarse, sorted sand and minimal top soil layer, allow precipitation to swiftly filter down to the groundwater reserves beneath them.

POLLUTED WATER PASSES THROUGH LONG ISLAND'S SOIL AS EASILY AS PRISTINE WATER

Human activities on the land's surface determine the quality of the groundwater below. The concentration of contaminants in our aquifers is related to the amount of pollutants released on top of the ground (or into cesspools), where groundwater recharge begins. Soils that allow rapid drainage of precipitation also allow for a greater likelihood of aquifer contamination. Less permeable soils lengthen the time a contaminant is exposed to oxygen or decomposing organisms that might break it down to a less harmful substance. Soils with slow permeability can sometimes trap pollutants by adhesion and arrest the travel of poisons.

SOIL CHARACTERISTICS ARE IMPORTANT LAND USE PLANNING TOOLS

Today, the largest reserve of clean groundwater remaining on Long Island is located beneath the outwash plain areas of central Suffolk County. The Pine Barrens are located above these same outwash sands. This is why the relationship between the groundwater supply and the Pine Barrens is so significant. Land use decisions

based on local geography are the most effective and least costly means of protecting and sustaining natural resources. Long Island soil characteristics should be an important land use planning parameter for preserving and conserving our aquifers because of the mechanics of groundwater recharge.

PROCEDURE

1. Initiate discussion about different types and conditions and how groundwater recharge is affected by these variations.

2. Survey the school yard for soil types and conditions. Record and number these categories.

3. Hand out SOIL DATA SHEETS. Have students record the numbered test sites on the Data Table in the test site column.

4. Students should look over the test sites and predict which site water will drain through first. Prediction should be entered in #1 on Data Sheet.

5. Divide the class into as many groups as you have test sites. Assign a test site to each group.

6. At each test site, the assigned group should take a coffee can and push it down into the soil. A hammer may be needed if the soil is compacted. The can should be set a few inches into the soil. All cans should be inserted at the same depth.

7. The water should be poured into each of the cans and timed until it has completely moved into the soil. Students should record the start time and finish time.

8. Figure out the total drain time.

9. Back at the classroom, each group should share their results with the class. A chart can be drawn on the board and a representative from each group can record their results.

10. Students should check their predicions against the actual results.

11. Answer question sheets.

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PINE BARRENS: ECOSYSTEM AND LANDSCAPE, Richard T. T. Forman, Editor, Academic Press, New York, 1979.

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HOW DOES RAINFALL REACH AN AQUIFER?
Soil Drainage And The Water Cycle

SOIL SURVEY OF SUFFOLK COUNTY, NEW YORK, USDA - Soil Conservation Service, April 1975.

THE HEATH HEN, Long Island Pine Barrens Society, Volume 1, No.'s 1-4, 1980-1982.

QUESTIONSHEET ANSWERS

Question Sheet

1:c
2:a moraines, b outwash plains
3:c
4:b
5:a
6:c

NOTES

Soil Drainage and the Water Cycle

Vocabulary

ROCK PARTICLES: Fragments of larger rocks. Most of Long Island is made up of these loose rocks that include sand, clay, silt, gravel and boulders.

PORE SPACES: The spaces between loose rock particles that are filled with air or water.

GROUNDWATER: Water that exists underground and is stored in the pore spaces between rock particles. The water that makes up groundwater comes from rain that falls on the land's surface and sinks down through the soil.

RECHARGE WATER: Water that sinks down through the ground to refill the groundwater supply.

SOIL POROSITY: The percentage of pore spaces in a sample of soil compared to its volume.

POROUS SOIL: Soil that has a high percentage of pore spaces when compared to its volume. For example, coarse grain sand is very porous. Porous soils allow water to move quickly through them. They can hold a lot of groundwater.

SOIL PERMEABILITY: The rate at which water passes through soil.

COMPACTED SOIL: Soil that has had its porosity or pore spaces reduced because its rock particles have been pushed closer together. Water moves slowly through compacted soil.

UNSORTED SOIL: Soil that has rock particles of all different sizes.

SORTED SOIL: Soil that has rock particles that are mostly all the same size.

LANDFORMS: A natural feature on the land's surface. On Long Island most of our landforms were formed by glaciers.

MORAINE: A landform made of unsorted rocks of all different sizes. These rocks were brought down and deposited by glaciers.

OUTWASH PLAIN: A flat plain formed when meltwaters from a glacier carried and deposited rock particles away from the moraine. The meltwater sorted rocks by weight. Long Island's outwash plains contain a lot of sand.

name _____

Soil Drainage — Data Sheet

Test Site	Start Time	Finish Time	Total Drain Time

1. Predict in which site the water will drain through first.

   _____

2. Was your prediction correct? _____

3. Which site drained most rapidly? _____

4. Which site had the longest drain time? _____

5. Why did the test site in question 4 take so long to drain?

   _____

6. List one characteristic of soil that helps it to drain fast.

   _____

name _____

Soil Drainage Questionsheet

Circle or fill in the correct answer to each question.

1. Long Island's land surface was shaped by:

   a. rivers
   c. glaciers
   b. the wind
   d. the ocean

2. List two major glacial landforms that are found on Long Island.

   a. _____ b. _____

3. Water from rain and snow keep groundwater levels high. This water enters and refills the groundwater through which of the following?

   a. lakes
   c. the soil
   b. the ocean
   d. rivers

4. Which of the following landforms is very sandy and allows rainwater to rapidly drain through to the groundwater below?

   a. moraines
   b. outwash plains

5. Polluted water will drain through soil to the groundwater as quickly and as easily as clean water. Which soil type would be most important to protect if you wanted to protect the groundwater?

   a. sandy outwash plain soils

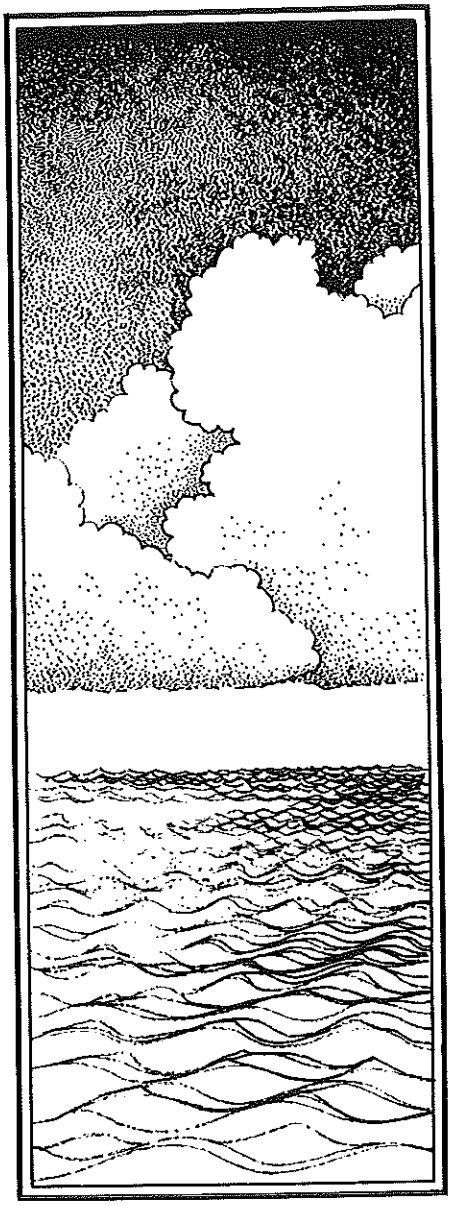
   b. rich soil found on the moraines

6. Long Island's groundwater system depends on rainwater draining through the soil layers to keep the groundwater levels up. If people make buildings and pave over most of the land, what will happen to groundwater levels beneath Long Island?

   a. Groundwater levels will stay the same.
   c. Groundwater levels will fall.
   b. Groundwater levels will rise

HOW DO OCEANS BECOME CLOUDS?

Evaporation and the Water Cycle



HOW DO OCEANS BECOME CLOUDS?
Evaporation and the Water Cycle

OBJECTIVES

Students discover by experimentation how temperature and air movement affect evaporation. Through identification of factors affecting evaporation rates, students are able to predict general rates of evaporation under various conditions and gain an understanding of the role of evaporation in Long Island's water cycle.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Science
Grades 3-6

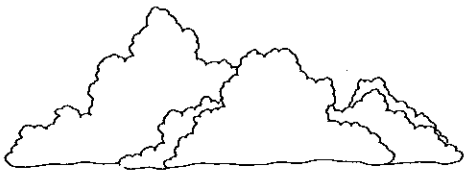
ELEMENTARY SYLLABUS REFERENCES

Elementary Science References: IIC.,1., IID.,3., IIID.,1.,2.,4., IIIE.,1.,2.

BEHAVIORAL OBJECTIVES

Upon completion of this activity students should be able to:

a. identify factors that affect the rate of evaporation.
b. predict rates of evaporation under different conditions.
c. associate the process of evaporation with Long Island's water cycle.



MATERIALS

1 5 ml graduated cyliner
7 petri dishes or other small, wide dish
electric fan
refrigerator/freezer
stopwatches or watches with second hands

EACH GROUP:

stopwatch or watch with second hand

EACH STUDENT:

Data Sheets A and B
Evaporation Question Sheet
pencil

MAJOR UNDERSTANDINGS

Evaporation plays a major role in the redistribution of water on our planet.

As water evaporates it changes from a liquid to a gas.

The sun is the source of heat that propels evaporation and, therefore, the entire water cycle.

The ocean is the source of most of the water evaporating from earth.

The evaporation rate is dependent upon:
1. temperature
2. humidity
3. wind speed
4. the amount of the water's surface-area exposed to the air.

Evaporation on Long Island returns less than half the annual precipitation to the atmosphere.

More than half of the annual precipitation on Long Island reaches and recharges the groundwater aquifers.

BACKGROUND INFORMATION

EVAPORATION CAUSES WATER TO RISE FROM EARTH TO FORM CLOUDS

Evaporation is the only way water can continue its cyclic journey and be redistributed throughout the hydrosphere. As water evaporates, it changes from a liquid to a gas. Energy, in the form of heat, is needed for this transformation to occur. The sun is the source of heat and its energy propels the entire water cycle.

THE OCEANS ARE THE SOURCE OF MOST WATER EVAPORATING FROM EARTH

Most water evaporating from the earth's surface leaves via the oceans which contain 97% of our planet's water. Lakes, rivers, soil, glaciers and plants contribute a considerably smaller portion of evaporated water to the cycle.

EVAPORATION RATES VARY

The evaporation rate, or the time it takes a given amount of water to evaporate, is largely dependent upon the following:

1. temperature,
2. humidity,
3. wind speed and
4. the amount of the water's surface area exposed to the air.

TEMPERATURE AND EVAPORATION

In all bodies of water, molecules in the liquid state move about and have a strong attraction for one another. This attractive force is called cohesion. As the sun's energy heats water, its molecules begin to move faster and faster. With increased speed, their collisions involve much greater force. As they continue their barrage upon one another, a molecule near the water's surface is hit so hard that it overcomes the attractive force of the surrounding molecules. It enters the air as a gas. Increasing heat intensifies the pelting. Greater numbers of molecules leave the body of water. The air becomes more humid.

Temperature increases the rate of evaporation. The evaporation rate is high in the summer and low in the winter because of the temperature difference between seasons.

HUMIDITY AND EVAPORATION

Humidity refers to the amount of water vapor that is present in the air. There is a definite limit to the amount of water that can be held in the air at a given temperature. When this limit is reached the air is said to be saturated. No more evaporation can occur. If the temperature rises, the air will be able to hold more water vapor. When the temperature falls, its potential to hold water also falls.

WIND AND EVAPORATION

Wind increases the movement and number of collisions between water molecules at the water's surface. This brings about an increase in water molecules that can escape the attraction or cohesion of other water molecules. Wind causes a rise in the rate of evaporation.

SURFACE AREA AND EVAPORATION

Whenever water surface area is available, there is more opportunity for water molecules to leave the surface by evaporation. Water molecules can only evaporate from a body of water through its surface. Increased surface area results in an increase in the rate of evaporation.

EVAPORATION AND OUR BODIES

A better understanding of the evaporation process may be found by examining the evaporation-based cooling system of our own bodies. The human body perspires to protect against overheating. As liquid evaporates from the skin it cools the body.

Water has an exceptional capacity to store or hold heat. When a liquid, such as perspiration, evaporates, the vapor molecules take heat with them as they leave the skin. Our bodies produce perspiration mainly for this reason.

This cooling method works best in dry air, as water vapor more easily enters unsaturated air. Many Long Island summer days are so uncomfortable because of the combination of heat and high humidity. Increased air moisture inhibits evaporation. Perspiration remains on our skin and we end up feeling just sweaty and hot. The cold of many Long Island winter days is also exacerbated because of the nature of our cooling system. Cold air usually holds little moisture. The occasional winter's day may bring a combination of cold and moisture. The moisture finds its way to our skin, then evaporates causing cooling. In such an instance, heat regulating systems works against us.

EVAPORATION AND LONG ISLAND'S WATER CYCLE

On Long Island, evaporation returns to the atmosphere slightly less than half of our annual rainfall. This recycling moisture includes evaporation from land surfaces, vegetation, lakes, streams and ponds, and transpiration from plants. The plants draw water from the soil's unsaturated zone: that segment of soil above the water table. More than half of our annual rainfall traverses the soils unsaturated zone to recharge the groundwater.

Evaporation from Long Island's freshwater lakes, ponds and streams averages about 34 inches per year. This appears to be a considerable amount of water. However, since these surface waters are only a small portion of Long Island's surface, the volume of evaporated water is negligable when compared to the total yearly evaporation. Evaporation from these freshwater bodies amounts to no more than a fraction of an inch of our total evaporation.

The importance of evaporation is often obscured by its covert nature. It is a process constantly going on around us and even on us though we are seldom aware of it.

PROCEDURES

1. Initiate discussion about evaporation and its role in Long Island's water cycle. Explain that the rate of evaporation is affected by different factors and that this experiment will identify some of those factors.

Evaporation and the Water Cycle

Vocabulary

EVAPORATION: The change in state from a liquid to a gas or vapor.

EVAPORATION IN THE WATER CYCLE: Most of the water that evaporates in the water cycle comes from the oceans. The sun is the source of energy that causes evaporation and keeps the water cycle in motion.

RATE OF EVAPORATION: The amount of evaporation that takes place over a given period of time.

WATER VAPOR: Water in a gas form.

HUMIDITY: The amount of water vapor present in the air.

THE SURFACE AREA OF WATER: The surface area of a body of water that is exposed to the air.

name _____

Evaporation — Observation Sheet A

HOW DOES WIND AFFECT EVAPORATION?

1. Predict in which dish water will evaporate first.
   a. dish #1
   b. dish #2
   c. dish #3
   d. dish #4

Dish	Condition	Start Time	Finish Time	Total Evaporation Time
#1	**Still Air**			
#2	**Still Air**			
#3	**Close To Fan**			
#4	**Far From Fan**			

2. In which dish did the water evaporate first? _____

3. Why did the water in this dish evaporate first? _____

_____

4. Compare dish #1 with dish #2. Which one evaporated first?

_____

5. Both were in the same air condition. Why did one evaporate faster than the other? _____

6. If you hung clothing out on a line, in which weather condition would you expect them to dry the fastest? (Circle one.)
   a. a clear, windy day
   b. a clear, windless day

name _____

Evaporation — Observation Sheet B

HOW DOES TEMPERATURE AFFECT EVAPORATION?

1. Predict in which dish water will evaporate first.

   a. dish #5

   b. dish #6

   c. dish #7

   d. dish #8

Dish	Condition	Start Time	Finish Time	Total Evaporation Time
#5	**Warm Place**			
#6	**Room Temperature**			
#7	**In Freezer**			
#8	**In Refrigerator**			

2. In which dish did the water evaporate first? _____

3. Why did the water in this dish evaporate first? _____

4. In which dish did the water take longest to evaporate? _____

5. Why did the water in this dish take so long to evaporate? _____

6. Describe how air temperature affects the rate of evaporation.

name _____

Evaporation Question Sheet

Circle the best answer to each question.

1. Clouds are formed when evaporated water rising above the earth condenses. Which of the following is the major source of this water vapor?

a. the sun
b. clouds
c. the ocean
d. plants

2. In which season is the rate of evaporation highest?

a. fall
b. spring
c. winter
d. summer

3. In which season is the rate of evaporation lowest?

a. fall
b. spring
c. winter
d. summer

4. How much of the rainfall that reaches Long Island evaporates before it enters the groundwater?

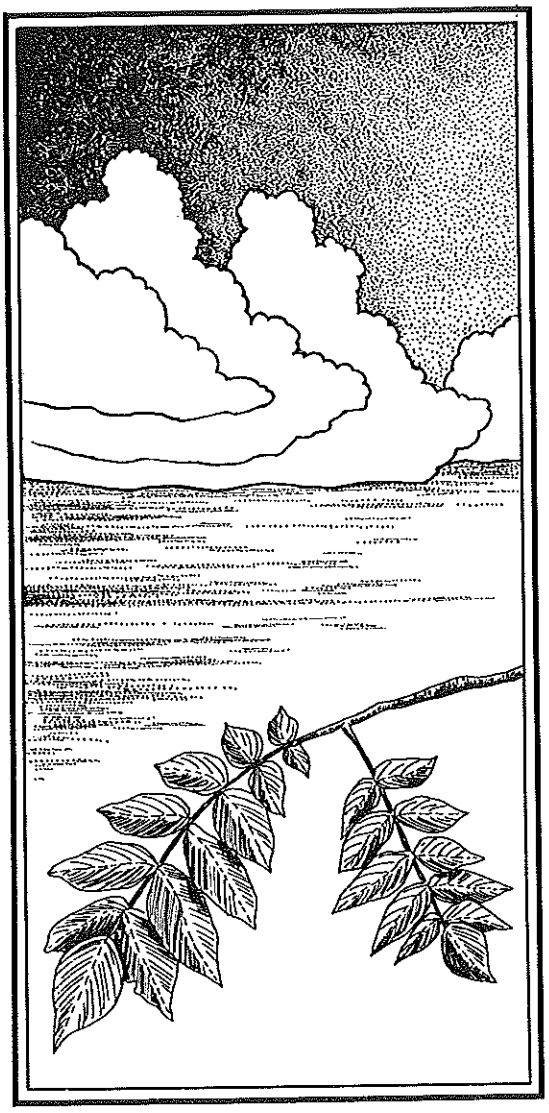
a. exactly half
b. more than half
c. less than half
d. more

5. Which of the following temperatures would make water evaporate fastest?

a. $32^{o}F$
b. $80^{o}F$
c. $10^{o}F$
d. $50^{o}F$

WATER LEAVES THROUGH THE LEAVES

Plant Transpiration and the Water Cycle



WATER LEAVES THROUGH THE LEAVES
Plant Transpiration and the Water Cycle

OBJECTIVES

Through elementary experiments, students observe transpiration in plants and infer that plants take up water from the soil and lose it through their leaves. These experiments demonstrate that plants transpire and are a part of the water cycle.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Science
Grades 3-6

ELEMENTARY SYLLABUS REFERENCES

Elementary Science References:
IID., IIID.

BEHAVIORAL OBJECTIVES

Upon completion of this activity students should be able to:

a. infer that a plant's leaves are where evaporation takes place.
b. describe the path water takes as it moves through a plant.

MATERIALS

1 geranium plant (or other non-waxy leaved plant)
1 plastic bag
tape or twistee tie
medium to large piece of transparent plastic sheeting

MAJOR UNDERSTANDINGS

A portion of the precipitation that falls to earth enters the ground and is taken up by plants.

Water enters a plant through its roots and transpires through its leaves.

Water gives plants structure, transports nutrients to their cells and removes wastes.

Most transpiration occurs during the warm months when plants are in full foliage.

Water leaves plants in a vapor form.

BACKGROUND INFORMATION

As water, falling from the clouds, continues through the hydrologic cycle it reaches the earth and may diverge into one of three possible directions. It can:

1. evaporate once it reaches the earth's surface,
2. enter the ground to recharge the aquifer, or
3. enter the ground and be taken up by plants.

WATER IS TAKEN UP BY A PLANT'S ROOTS

Water taken up by a plant's roots is transported to its parts bringing nutrients, giving the plant structure and removing wastes. Tremendous quantities of water evaporate from plants. A typical red maple may lose fifty gallons or more during a single summer day. Almost all

transpiration or plant water loss occurs during the warm seasons when trees and other plants are in full foliage.

TRANSPIRATION TAKES PLACE AT A PLANT'S LEAVES

Water rises in plants by cohesive tension. Water exists in a plant's transport tubes (xylem) in a continuous column. At the top of this column are the leaves where evapotranspiration takes place. As water evaporates from the leaf surface, the cohesive force, which holds the water molecules together, moves water up the xylem tube to replace the water lost to evaporation. All the water in the xylem tube is under tension and is pulled upward as the water on the leaf evaporates. Plants have no active structure that pumps needed materials from the soil to their parts. Transpiration is responsible for the circulation of nutrients and water necessary for plant cell functioning and growth.

This evaporated water is now water vapor in the air. It may find its way upward to become part of a cloud as it continues in motion through the water cycle.

PROCEDURE

1. Initiate discussion about transpiration in plants, how they take up water, why they need this mechanism. With this activity, water, cycling through the hydrosphere, enters an ecological system.

2. INDOOR DEMONSTRATION

   a. Place a plastic bag over the leaves of a geranium plant (or other non-waxy leaved plant). Use a twistee tie or tape to seal the bag so it encloses the leaves.
   b. Place the plant in full sunlight for 1 or more hours.
   c. Have students observe and answer questions on Transpiration Question Sheet.

This activity can be expanded to include plants originating in different environments demonstrating how water availability can affect plant form and function. (This satisfies Elementary Science Syllabus Section IIIB., 1.: Different kinds of plant and animal populations exist in various environments.) Suggestions on other plants to use include:

   a. cactus and other succulents,
   b. waxy or leathery leaved plants,
   c. evergreen plants such as pine, junipers.

3. OUTDOOR DEMONSTRATION

   Transpiration can be easily demonstrated on a lawn, outdoors.
   a. cover a section of a lawn with a transparent piece of plastic sheeting. Water will soon bead up on the underside.
   b. Place another plastic sheet on bare ground to use as a control.

Since almost all of the above ground structure of grass is leaves, this quickly demonstrates transpiration through leaves.

REFERENCES

BOTANY: An Introduction to Plant Science, Wilfred W. Robbins et.al., John Wiley and Sons, New York, 1966.

QUESTIONSHEET ANSWERS

Question Sheet

1:recording of experiment
2:b
3:b
4:a.gives plants a structure
  b.bring nutrients to plant
    cells
  c.removes wastes
5:vapor or gas
6:a.up to a cloud
  b.condenses on a surface

NOTES

name _____

Transpiration Question Sheet

DIRECTIONS

1. **Record your observations below.**
2. **Answer the questions below by filling in the blank or circling the best choice.**

1. Record what you observed during this experiment. _____

_____

_____

2. Where did the water that collected on the plastic bag come from?

a. the air
c. the roots
b. the leaves
d. the flowers

3. Plants take up water through their roots. What part of the plant does most water leave through?

a. the stem
c. the seeds
b. the leaves
d. the flowers

4. List two uses a plant has for water?

a. _____

b. _____

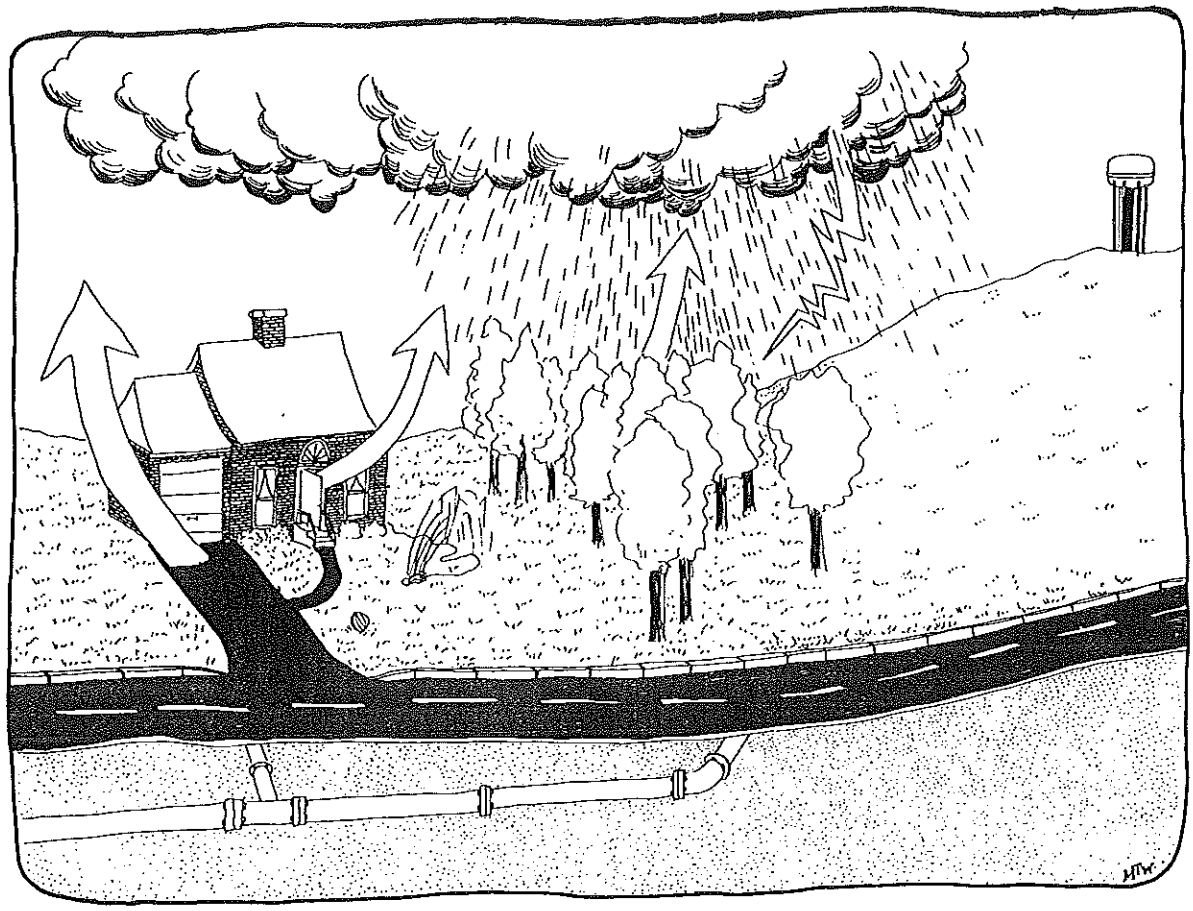
5. Plants lose water from their leaves but we can't see it happening. What form has the water changed into?

_____

6. List one place water may go after it evaporates from a plant leaf.

_____

THE WATER CYCLE STORY



THE WATER CYCLE STORY
A Reading Comprehension Lesson

Objectives

Through reading comprehension, students are introduced to the water cycle and are able to identify, on a picture worksheet, where evaporation, condensation and transpiration are taking place and where groundwater is located.

Grade Level

Grade 2
Reading
Science

Science Syllabus References

I C
1: 1.13, 1.2, 1.5
2: 2.3

I D
1: 1.2, 1.3

Materials

The Water Cycle Story (4 sections)
Water Cycle Worksheet
Vocabulary List
Crayons or colored pencils: red, yellow, blue and green

Procedure

1. Discuss Long Island's water cycle with your students.

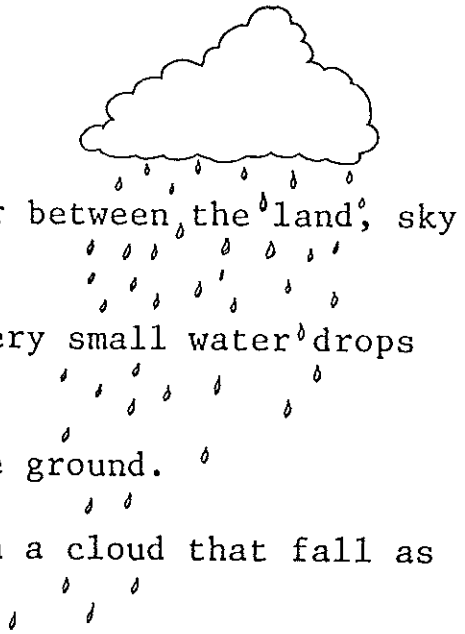
2. Read each section (4 in all) with or to your students.

3. After each section, students should color in the worksheet as directed by the story.

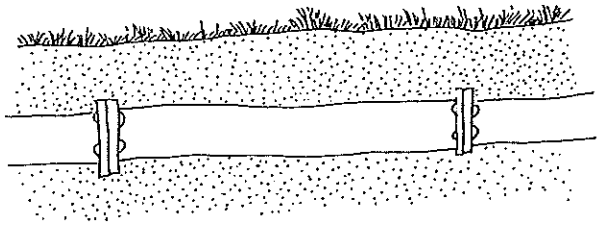
Take Note

This activity can be done over the course of a week. Use this activity as an introduction to more in depth water cycle activities.

Water Words



Water Cycle	The cycling of water between the land, sky and ocean.
Clouds	A large number of very small water drops found in the sky.
Fog	A cloud found on the ground.
Raindrops	Water drops found in a cloud that fall as rain.
Sun	The source of energy that keeps the water cycle moving.
Water Vapor	Tiny particles of water that we can't see.
Evaporation	The changing of liquid water into water vapor.
Ocean	The large bodies of salt water that cover much of the earth's surface.
River	A natural stream of water that empties into an ocean, lake or another river.
Ice	Water frozen into a solid form.
Condensation	The changing of water vapor into liquid water.
Thunderstorm	A short, powerful rainstorm that produces thunder and lightening.
Gust	A powerful rush of wind.

Groundwater	Water found below the surface of the earth.
Pipe	Long, hollow tubes that take water up from the ground and bring it to places where it is needed. 
Well	A hole drilled into the earth to bring groundwater to the surface.
Roots	The part of plants that takes up water from the ground.
Transpiration	The evaporation of water from the leaves of plants.

THE WATER CYCLE STORY 1

The story below is part of a story about the water cycle. Read this part and follow the directions at the end of the story.

Up in the Clouds

Once upon a time it was a hot August day. Rain clouds began to cover the sky. This is a story about a few of the raindrops that were up in the clouds that day and what happened to them as they fell to a part of earth called Long Island.

Eva Evaporates

Eva Skywater was the first raindrop to fall on Long Island that day. She landed on a blacktop driveway. She hit hard. It wasn't at all like the soft soil she had landed on the last time she fell to earth. And, boy, was that road hot!

Earlier that morning, the sun had heated that driveway as hot as a frying pan. When Eva landed, the driveway hissed as if she were a scrambled egg just poured onto a hot griddle.

Suddenly, before she knew what was happening, Eva disappeared. She was floating in the air. In fact, she had become like air. She was now a gas called water vapor. Eva had EVAPORATED. She was so light that she began to rise back up to the sky. Eva Skywater was once again becoming water in the sky.

Color in the arrow on the Water Cycle Sheet that stands for EVAPORATION. Color this arrow red.

THE WATER CYCLE STORY 2

The story below is part of a story about the water cycle. Read this part and follow the directions at the end of the story.

Falling Again

Eva was on her way back up to the sky. At about a mile high, she met two of her friends. They had been together in the cloud earlier that day. Eva wondered where her friends had gone after it had rained. Wherever they had been, they were water vapor now. She could hardly see them at all!

Eva's friends were named Connie and Denny. She loved to listen to their travel stories. Connie and Denny had been all over the world. The water cycle was like that. Catch the right wind, drift down the right river and you could end up anywhere! The story Eva liked best was the one about the years Denny had spent in the dark underground. Eva had never been very far under the ground. She was no homebody, either. She had been in all 7 oceans. She had flowed with most of the world's rivers. Then there was the time she was locked up in the ice near the north pole. But Eva had never been underground.

Eva, Connie and Denny spent all afternoon trading stories. The air began to get colder. They talked and talked, and all the while the friends started to look different. As the air got chilly, they were able to see each other better. They were becoming raindrops again. They quickly finished their stories because they knew they would be falling soon.

Our water friends were changing. They had floated up to the sky as water vapor which you cannot see. It got cold, and they changed to raindrops, a form of water you can see. Eva, Connie and Denny were going through condensation. So many of the other water vapors were going through condensation that they were making a cloud.

On the Water Cycle Sheet, color in the area where condensation happened in the story. Color this area yellow.

THE WATER CYCLE STORY 3

The story below is part of a story about the water cycle. Read this part and follow the directions at the end of the story.

Under the Ground

A bright light and a loud noise frightened and surprised Eva and her friends. Well, it was August and it looked as if they had become a late afternoon thunderstorm. Strong winds were blowing everyone around. One powerful gust pushed a friend of Eva's right into view. It was Sandy. Everyone was happy to see him.

They were falling fast. No one could talk, so everyone just smiled at each other. Before long, the winds caused everyone to drift apart. They were all almost on land.

Sandy landed on the soft soil of a forest on Long Island. He was one of the first drops to land on the dry sandy soil. The landing had caused dust to fly all around and it was all over Sandy. He looked like he was covered with cake flour.

As the other drops fell, Sandy was able to clean himself off. More and more raindrops fell. Sandy began moving between the sand and he was slowly going underground. It was dark. Sandy had been there before so he wasn't frightened of the dark. He moved so slowly between the sand. He had become groundwater.

He had been groundwater before. One time he stayed under for 123 years. Then one day, a huge pipe sucked him up and then he came out of a faucet. A kid put Sandy and the others into a pot and heated them up. Then the kid put in a packet of powder that smelled sweet. Little white, soft puffy things floated at the top. Sandy was at the top, right next to those floating things. Suddenly, Sandy felt himself rising with the steam. Soon he was out the door and headed back up to the sky.

---

1. On the Water Cycle Sheet, color in the area that stands for groundwater. Color this area blue.

2. Can you see another arrow that stands for evaporation? Color this arrow red.

THE WATER CYCLE STORY 4

The story below is part of a story about the water cycle. Read this part and follow the directions at the end of the story.

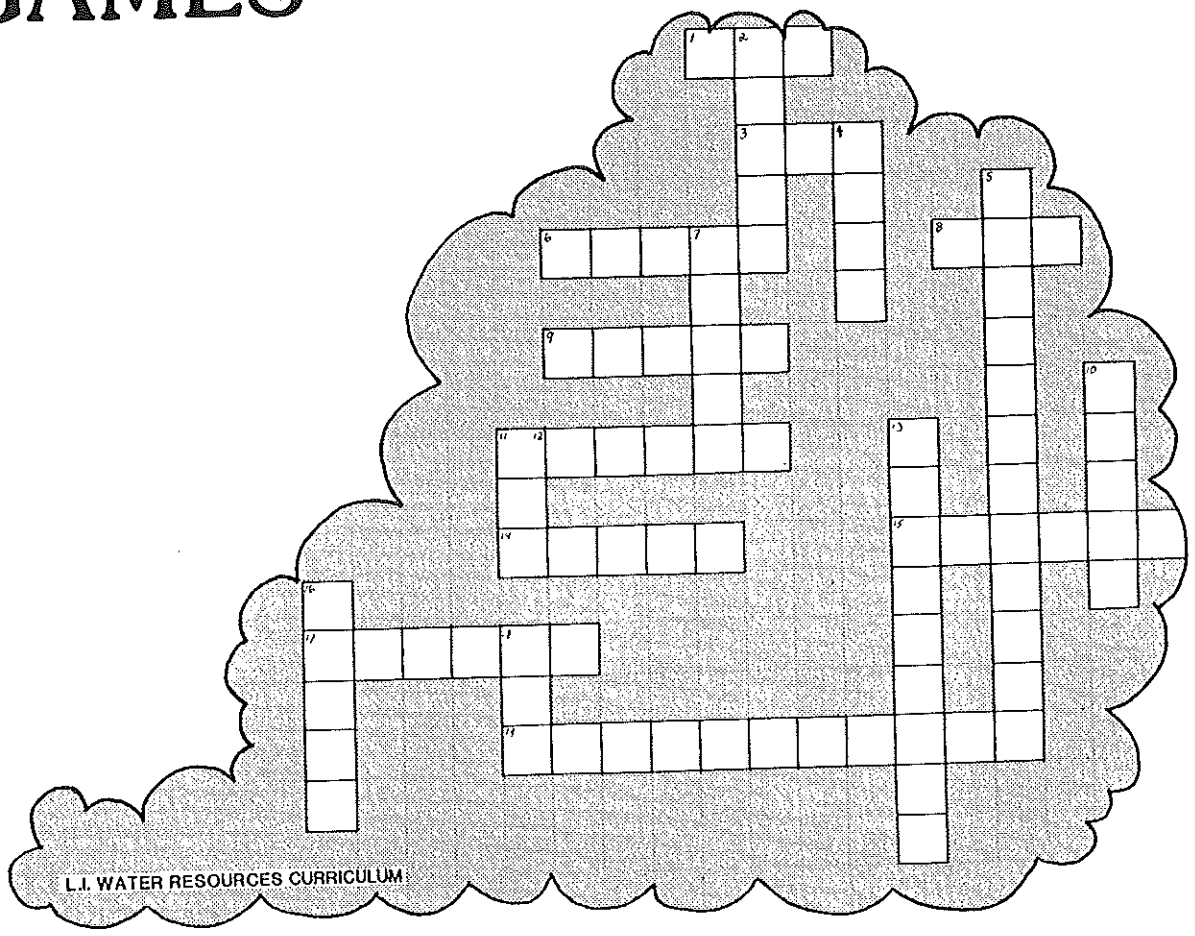
Up a Tree

During the thunderstorm, another raindrop landed very close to Sandy. Her name was Rose. Rose followed Sandy into the soil. It seemed as if she would become groundwater, for sure. Rose was still close to the surface when she had to make her way through a bad tangle of roots. Before she even knew what happened, Rose was sucked up by a tree root. Rose rose up the tree. She moved up through the trunk. After the water in the tree got to a certain height they weren't going straight up anymore. They would go up, then sideways, then right, then left, then back up again. Gosh, this was getting confusing. And Rose was getting dizzy. At last she saw a light. Then she came out of a hole in a leaf. She was out! A wind came by and lifted her high. Once, again, Rose rose back up to the sky.

When water evaporates from a plant we say the water transpired. Color the arrow that stands for TRANS-PIRATION. Color this arrow green.

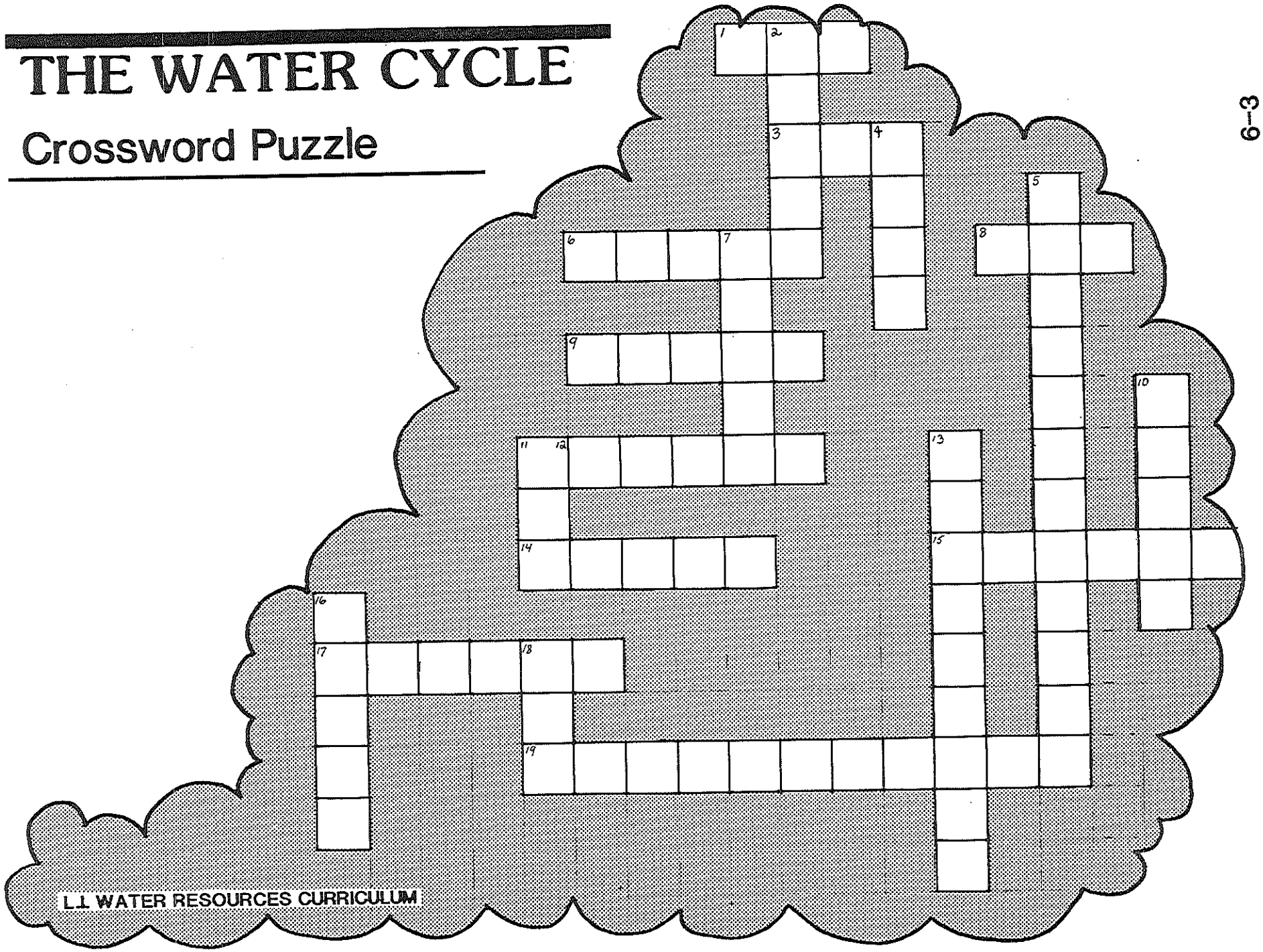
WATER CYCLE WORKSHEET

WATER WORD GAMES



THE WATER CYCLE

Crossword Puzzle

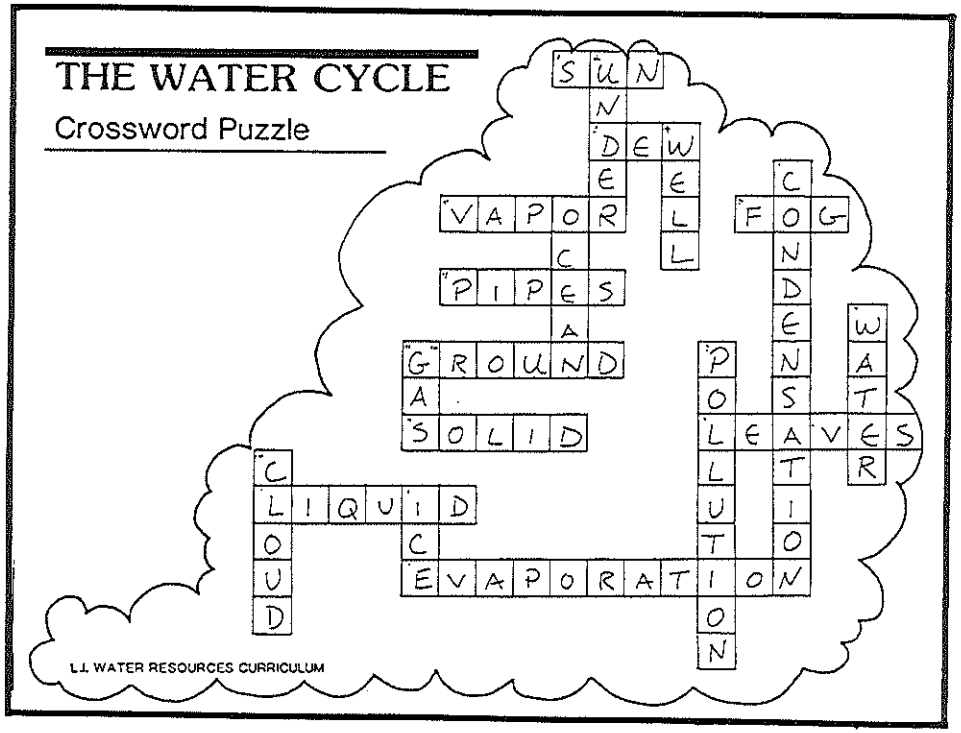


Answer Sheet

Water Word Search

Q	I	C	E	T	E	M	O	V	G	X	T	H	E	L
T	O	Y	R	A	G	K	R	E	R	O	S	E	O	W
V	E	L	L	U	N	V	A	P	O	R	N	A	N	A
W	V	F	C	L	O	U	D	S	U	B	O	R	V	T
E	E	E	O	G	E	H	U	N	N	A	W	K	L	E
L	T	M	N	G	P	C	N	A	D	N	T	S	U	R
L	S	I	D	O	M	I	K	H	W	I	C	P	B	C
U	H	A	E	V	A	P	O	R	A	T	I	O	N	Y
X	M	J	N	R	N	H	O	J	T	O	F	L	P	C
C	O	N	S	E	R	V	E	P	E	N	S	L	I	L
M	T	W	A	J	M	I	G	M	R	Y	E	U	H	E
K	D	H	T	A	D	Z	H	Q	I	R	A	T	C	P
S	T	E	I	I	R	K	R	I	S	I	N	I	Y	O
V	E	W	O	M	I	V	M	O	M	V	T	O	A	R
T	R	A	N	S	P	I	R	A	T	I	O	N	G	I

Groundwater
Drip
Ice
Conserve
Rain
Well
Fog
Save
Pollution
Vapor
Water Cycle
Evaporation
Condensation
Transpiration
Clouds
Snow



Water Word Search

Try to find the hidden words in this word scramble. The words may be read across, down or diagonally. The longest word contains 13 letters. The shortest contains 3. There are 16 words in all.

Q I C E T E M O V G X T H E L
T O Y R A G K R E R O S E O W
V E L L U N V A P O R N A N A
W V F C L O U D S U B O R V T
E E E O G E H U N N A W K L E
L T M N G P C N A D N T S U R
L S I D O M I K H W I C P B C
U H A E V A P O R A T I O N Y
X M J N R N H O J T O F L P C
C O N S E R V E P E N S L I L
M T W A J M I G M R Y E U H E
K D H T A D Z H Q I R A T C P
S T E I I R K R I S I N I Y O
V E W O M I V M O M V T O A R
T R A N S P I R A T I O N G I

Groundwater
Drip
Ice
Conserve
Rain
Well
Fog
Save
Pollution
Vapor
Water Cycle
Evaporation
Condensation
Transpiration
Clouds
Snow

THE WATER CYCLE
Crossword Puzzle

Across

1. The water cycle would stop without the heat of the _____.

3. _____ drops are sometimes found on a lawn in the morning.

6. When water evaporates, it becomes _____.

8. _____ is a cloud near the ground.

9. Water comes to our homes by underground _____.

11. Rain must go under the _____ to become groundwater.

15. Transpiration happens when water evaporates from the _____ of plants.

17. Water at room temperature is in _____ form.

19. _____ makes puddles disappear.

Down

2. Long Island gets drinking water from _____ the ground.

4. A _____ brings groundwater up from under the ground.

5. _____ makes clouds appear.

7. An _____ is a large body of saltwater.

10. _____ is one of the most important things on earth.

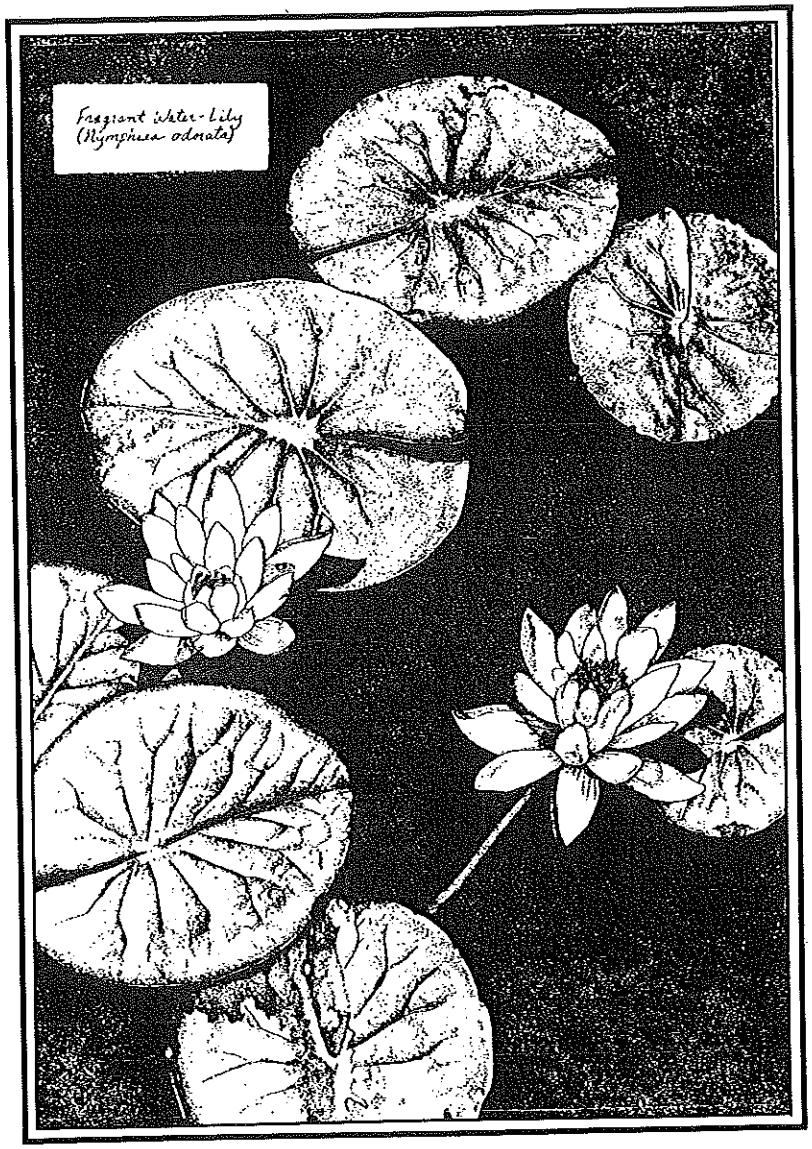
12. Water vapor is a _____.

13. _____ makes water harmful to drink.

16. _____ are made up of raindrops.

18. Water at the north pole is _____.

AQUATIC ENVIRONMENTS



Surface Expressions of Groundwater

LONG ISLAND'S LAKES, PONDS AND STREAMS
Surface Expressions of Groundwater

AQUATIC ENVIRONMENTS

OBJECTIVES

Students are introduced to the hydrogeology of a Long Island pond, lake or stream through field observation and data recording.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grades 4-6
Science
Geography

ELEMENTARY SYLLABUS REFERENCES

Science: IIID., IIIE.

This section encourages direct observation of the physical environment. It should accompany Activity #8 to present an overview of the elements and the interactions of living and nonliving objects that form the ecology of a pond, lake or stream.

BEHAVIORAL OBJECTIVES

Upon completion of this activity, students should be able to:

a. define what is meant by a groundwater-fed surface body of water.
b. recognize that most of Long Island's surface water bodies are groundwater-fed.
c. observe a water environment on Long Island and record specific data found at it.

MATERIALS

FOR EACH STUDENT:

Aquatic Environments Observation Sheet

Aquatic Environments Question Sheets

MAJOR UNDERSTANDINGS

Most streams, ponds and lakes on Long Island are groundwater-fed.

Kettle holes are depressions in the land formed during glacial times.

Whan a kettle hole's bottom dips below the water table, a kettle hole is formed.

Most ponds and lakes on Long Island are in kettle holes.

Other types of ponds found on Long Island are perched, coastal or manmade.

Manmade ponds were formed during Colonial days when streams were damned to power water mills.

Manmade ponds are usually called mill ponds.

Vernal ponds are intermittent and occur in the spring when the water table rises.

Streams, lakes and ponds that are groundwater-fed have beds and channels that are lower than the water table.

The quality of water in ponds, lakes and streams is only as good as the groundwater that emerges into them.

LONG ISLAND'S LAKES, PONDS AND STREAMS
Surface Expressions of Groundwater

Water levels in lakes, ponds and streams are lowered as a consequence of sewering, groundwater mining, disrupted recharge patterns or drought.

Freshwater ponds, lakes and streams provide a habitat for aquatic plants and animals.

Freshwater ponds, lakes and streams provide water for animals in the surrounding forests.

Freshwater wetlands are important to the quality of life on Long Island.

BACKGROUND INFORMATION

Long Island is transversed by streams and specked with ponds and lakes. Most are groundwater-fed. Freshwater bodies that exist because of groundwater seepage have beds or channels that are lower than the water table. Ponds, lakes, and streams are the groundwater system's most tangible parts.

PONDS AND LAKES

Long Island's lakes and ponds have various origins. Ponds or lakes can be:

glacial kettle hole ponds or lakes,
coastal ponds or lakes,
perched ponds or lakes, or
manmade ponds or lakes.

KETTLE HOLE LAKES AND PONDS

Most of our natural lakes and ponds were shaped during glacial times. They are called kettles and were formed when large blocks of ice broke free from a glacier. Many ice chunks were buried in the outwash sediments that were carried and transported by water as glacial melting progressed. The sediments that covered these ice blocks provided insulation from the sun's heat and delayed thawing. Eventually, the ice pieces did melt. The soil material deposited above the ice then caved in and formed a hole in the ground. These depressions are kettle holes. When kettle holes dip below the water table, a kettle pond or lake is formed. Lake Ronkonkoma is a kettle lake and is also Long Island's largest lake.

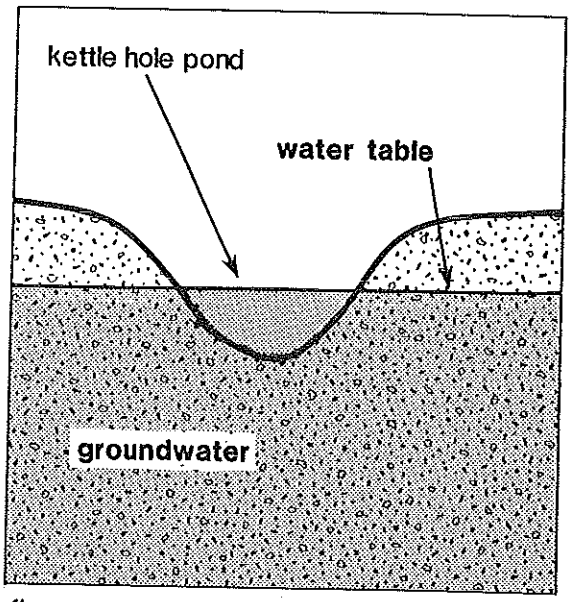


figure 1 **Kettle Hole Pond**

In spring, as the water table rises many kettle holes become ponds. These are called vernal ponds. Ponds of this variety are superior breeding areas for salamanders and other amphibians because their intermittence makes them unsuitable for predators such as fish and snapping turtles.

LONG ISLAND'S LAKES, PONDS AND STREAMS
Surface Expressions of Groundwater

COASTAL PONDS

Coastal ponds are found abutting a bay, harbor, or sound. They are formed when water currents cause sandbars to migrate, cutting off a small portion of a water body from itself. Many of our north shore harbors would be isolated from Long Island Sound if not for jetties preventing sandbar migration from closing harbor entrances.

MANMADE LAKES AND PONDS

Other ponds on Long Island are manmade. They were formed during colonial days when streams were dammed to power water mills. Hempstead Lake and Belmont Lake are dammed lakes. Smaller manmade ponds found on Long Island are locally called mill ponds.

PERCHED LAKES

Perched lake water levels are maintained directly by percipitation. Their lake beds are located above the water table and are made of impermeable clay. They are not associated with the groundwater system. Lake Success is a perched lake.

LONG ISLAND STREAMS

Long Island streams are almost totally groundwater fed (95% groundwater, 5% runoff). Conversely, mainland rivers have huge tributary systems and their flow comes mostly from surface runoff. Flooding and drought are problematic in these regions and cause wide fluctuations of river water levels. Long Island's groundwater-fed streams fluctuate seasonally, though not to any great degree. Flooding is negligible except where tides influence stream water levels. Low flow in streams can be a consequence of groundwater mining (overpumping), sewering, disrupted recharge patterns, or drought.

Many Long Island streams flow in broad shallow valleys formed thousands of years ago by glacial meltwater. Most streams begin at freshwater marshes or springs and flow south towards the bay. These steams move slowly because the slope of the land to the south is gradual. Most Long Island streams meander through tidal marsh wetlands as they approach the bay. Tides influence streamflow at these lower reaches.

STREAMFLOW AND GROUNDWATER

Streamflow begins where the stream channel intersects the water table. Groundwater is steadily in motion towards the sea. 40% of the natural outflow of groundwater leaves by streamflow. The amount of groundwater leaving the system by stream, in 1981, was roughly equivalent to the total usage of groundwater in Nassau and Suffolk counties.

Groundwater levels are altered by human activities. Sewering, overpumping, and shrinking open space all contribute to lowered groundwater levels. Streams, lakes, and ponds are surface manifestations of the groundwater system. Their levels change as the water table fluctuates.

SEWERING

Long Island's most populated areas are sewered. Sewer systems were built to prevent wastewater in high density areas from entering and degrading the underlying aquifers. All Long Island's sewer systems discharge wastewater into coastal waters. By releasing this water into ocean or sound, sewers also prevent groundwater replenishment. Reduced groundwater recharge effects the system in a variety of ways. These effects include the following:

6. Compare the results of the classes' groups.

The LITTER SURVEY can be used as an introduction to GROUNDWATER AND GARBAGE DON'T MIX - an activity that explores water pollution problems that are associated with garbage disposal and landfills.

Use this activity to investigate social studies issues such as values and esthetics:
Why do people litter?
Are they purposely inconsiderate or just careless?
Is litter ugly?
Why is it ugly?
Is it ugly to everyone?
Could any garbage found contribute to water pollution?
Can litter hurt wildlife?

MODIFICATIONS AND OPTIONS

1. Research the history of the surface water you are studying. How was it formed? How has it been changed?

2. Obtain a United States Geologic Survey (USGS) topographic map of the area surrounding your study site. Examine the lake, pond or stream in relation to the other geographic forms around it. If your pond was a millpond, what stream flows into it? Where does the water flowing out of it go?

Water Mills and Millponds

The divergence of the European colonial settler's economy from the Native American's can be illustrated by the study of water mills on Long Island. We find these wooden buildings near ponds and streams, scattered throughout Long Island, and seldom realize their historical significance. In colonial and post-colonial days, they were the focus of local industry and agriculture. All that remains of many of these bygone hubs of local community are the ponds formed to control the streamflow that powered the mills.

MILLS HAD DIVERSE USES

Mills had diverse uses. Saw mills cut logs into boards, while grist mills ground grain into flour. There were mills that produced fine woolens and clothes.

MILLPONDS FORMED WHEN STREAMS WERE DAMMED

Mills were built on the banks of streams. A dam would be constructed to slow the stream, creating a stillwater pond or millpond. A sluice-gate gave the miller control over the speed and amount of water that flowed through the mill.

MILLS WERE POWERED BY WATER

Water moved through the mill and turned its huge paddle wheel by hitting the paddles. This wheel was connected to gears that turned when the wheel moved. In a grist mill, the gears would turn a grindstone or millstone. The water-wheel could be stationed vertically or on its side horizontally. A vertical wheel could have water channeled under or over it. Some Long Island mills were even powered by tidal movement.

NATIVE AMERICANS, COLONISTS AND MILLS

If we compare the grain grinding process used by the Native American with that of the colonist, the vast differences in their economic and social structures can be better understood. The Native American used a mortar and pestle-like tool to grind grain. Considerable energy would be spent to produce flour or meal for a few people. The Colonist, in contrast, harnessed water power using a method that was labor saving. Large quantities of grain could be processed quickly with little effort.

The ability of the colonists to use the power of water to transform raw materials into goods to sell or barter advanced their capital-based system. This soon led to a complete replacement of the Native American's economic approach to the resources and stewardship of the land.

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QUESTIONSHEET ANSWERS

Question Sheet

1:c
2:b
3:b
4:b
5:b
6:c
7:b
8:c
9:d
10:c
11:a,b,c,e and g

NOTES

Vocabulary

POND: A standing body of water that is shallow enough for plants that attach themselves to the bottom to grow over most of the area.

STREAM: Running water flowing through a channel.

CHANNEL: The bed of a stream.

GROUNDWATER: Underground water that exists and moves in the spaces between rocks. This water comes from rain and snow that falls on the land and drains down through the soil.

WATER TABLE: The surface of the groundwater.

MORAINE: A hilly landform made of rocks of all different sizes. These rocks were brought and deposited by glaciers.

OUTWASH PLAIN: A flat plain formed when meltwaters from a glacier carried and deposited rock particles away from the moraine. The meltwater streams sorted the rocks by weight. Long Island's outwash plains contain a lot of sand.

KETTLE HOLE: A hole in a moraine or outwash plain formed when an ice block from a glacier is covered by sand and rocks that were carried by streams coming from a melting glacier. When the ice block melted, the sand and gravel that had been on top of the ice settled and a hole in the land was made.

KETTLE HOLE LAKE OR POND: A lake or pond formed when a kettle hole's bottom is below the water table.

MANMADE POND: An artificial pond formed when a stream is damned. Streams were damned when water flow needed to be controlled to power a water mill.

VERNAL POND: A pond that forms in a hollow during the spring when the water table rises.

RUNOFF: Rainwater that falls and flows in broad sheets over the land's surface and drains off into streams.

EROSION: A process that takes rocks and pieces of rocks from one place and deposits them in another place.

BANK: The ground along the edge of a stream, lake or pond.

name _____

AQUATIC ENVIRONMENTS — Observation Sheet

DIRECTIONS
Circle the answer that best completes the sentence or answers the question.

The area visited is a:
a. lake
b. pond
c. stream

The banks:
a. are in a natural condition.
b. show signs of humans (houses, docks, lawns).
c. both a. and b.

The banks are:
a. sandy
b. muddy
c. rocky
d. covered with plants
e. steep
f. flat

Do the banks show signs of erosion?
a. yes
b. no

What color is the water?
a. blue
b. blue-green
c. green
d. yellowish-green

How does the water smell?
a. pleasant
b. unpleasant
c. doesn't smell

Do you see animals or signs of animals? Record them. (Signs might include: tracks, feathers, bones, shells. Animal life includes: insects, amphibians, reptiles, birds and mammals.)

a. _____

b. _____

c. _____

Do you see litter in or near the water? List the objects you find.

a. _____

b. _____

c. _____

Answer these questions only if you are at a stream.

What is the stream's source?

_____

What is the name of the body of water the stream flows into?

_____

What is the speed of the water?
a. very fast
b. fast
c. medium
d. slow
e. hardly moving

Any other observations?

name _____

Litter Survey Analysis Sheet

Directions

1. Enter the name of the litter item in Column A.
2. Enter the material or materials it is made from in Column B.
3. Enter what the item was used for before it became garbage in Column C.

	Column A Litter Item What is it?	Column B Material What is it made out of?	Column C Use What was it used for?
1.			
2.			
3.			
4.			
5.			
6.			

name _____

AQUATIC ENVIRONMENTS Questionsheet

DIRECTIONS

Answer the questions below by circling the best choice.

1. Many Long Island lakes and ponds are found in kettle holes. What formed the kettle holes?

   a. the ocean
   b. people
   c. glaciers
   d. meteorites

2. What is a vernal pond?

   a. a pond in a forest
   b. a pond that appears in the spring when groundwater levels are high
   c. a pond that gets water from storm drains
   d. a pond that supports fish

3. Where does most of the water in Long Island's ponds and streams come from?

   a. rainfall
   b. groundwater
   c. sewers
   d. storm drains

4. A large amount of Long Island's groundwater naturally flows into the bays and ocean through streams. If this lost water was not replaced, the water table would drop. How do the aquifers get refilled?

   a. by underground streams
   b. by rainfall
   c. by lake and pond drainage
   d. through sewers

5. If more water is removed from the ground than is replaced by rainfall, what will happen to groundwater levels?

   a. increase
   b. decrease
   c. stay the same

6. What is groundwater mining?

   a. removing minerals from groundwater.
   b. maintaining normal groundwater levels.
   c. taking more water out of the ground than is replaced.
   d. thinking about groundwater problems.

7. If a water table pond is in an area where groundwater is mined or overpumped, what will happen to the pond's water level?

a. increase
b. decrease
c. stay the same

8. Why are sewers built on Long Island?

a. to increase groundwater levels
b. to stop groundwater from leaving the aquifers by stream or river
c. to prevent groundwater pollution
d. to increase the amount of water in lakes and streams

9. What happens to wastewater after it enters the sewer system?

a. It is treated and pumped back into the groundwater.
b. It is taken to a landfill and dumped.
c. It is treated and processed into farm fertilizer.
d. It is treated and pumped into the ocean or Long Island sound.

10. Rainfall is the only source of new groundwater. How does rain get to the groundwater?

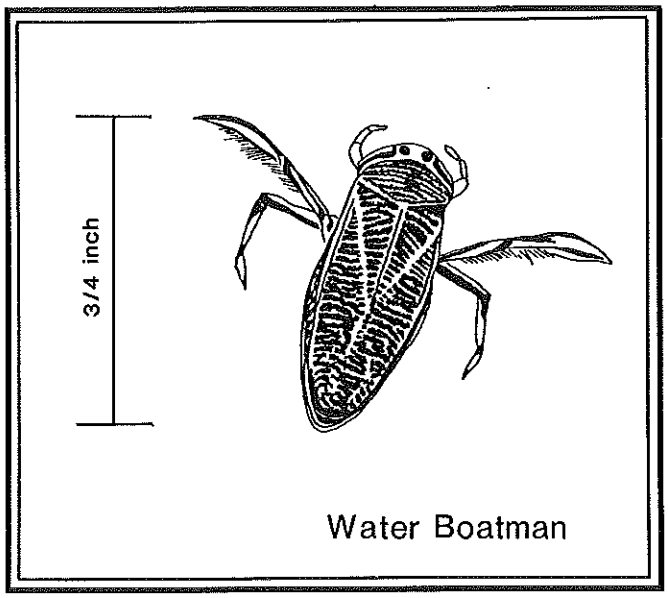
a. through lakes and ponds
b. through streams
c. through soil
d. through sewers

11. Rain can reach the groundwater only by draining through soil. Circle the items below that can harm rainfall drainage patterns.

a. parking lots
b. houses
c. roads
d. forests
e. concrete sidewalks
f. ballfields
g. apartment and office buildings
h. nature preserves

POND LIFE

Plants and Animals in Long Island's Waters



Water Boatman

POND LIFE

PART 1: Food Chain Tag

OBJECTIVES

A schoolyard tag game introduces students to the concepts of food chains, communities and balanced communities. A modification of the activity demonstrates how changes in environmental conditions can bring about changes in a community's population.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grades 4-6
Science

ELEMENTARY SYLLABUS REFERENCES

Science:
IIB., IIIE.

BEHAVIORAL OBJECTIVES

Upon completion of this activity, students should be able to:

a. define a food chain.
b. define community as it applies to an ecosystem such as a pond.
c. associate the terms producer and consumer with the life forms of a pond.
d. describe what is meant by a balanced community.
e. describe how harmful materials can be concentrated as they move through the food chain.

MATERIALS

1 large box of breakfast cereal (large flakes)
40 marbles
sandwich-size plastic bags (1 per student)
headband cloth for each student (4 different cloth colors to represent the 4 types of animals in the food chain)

MAJOR UNDERSTANDINGS

Ecology is the study of the interactions of plants and animals with each other and with the environment in which they live.

The environment is the total set of conditions, both living and nonliving, that surround organisms and influence where and how they live.

Organisms survive in their habitats only if they adapt to the living and nonliving environments that surround them.

Plants provide the basic food supply for animals because plants are the only living organisms that can use the sun's energy to make food.

The different kinds of plants and animals in a given area may be dependent upon each other for food and other needs.

Plants and animals in a given area that are dependent on each other form a community.

A balanced community exists when there are more plants than plant eaters and there are more plant eaters than animal eaters.

Green plants are called producers because they manufacture food for themselves and animals by photo-synthesis.

Animals are consumers because they get their food energy either directly or indirectly from plants.

A food chain represents, in a simplified way, the transference of the sun's energy from producers to consumers.

A food chain is rare in nature because dependencies among plant and animals are complex.

A food web represents the complexity of interwoven food chains.

In a food web, a particular type of plant or animal may be eaten by different types of animals, each of which in turn may be eaten by more than one type of animal.

Plankton form the foundation for the pond life food web.

Changes in environmental conditions, such as the pollution of water, may bring about changes in the community of life forms that depend upon the water supply.

Toxic substances can become concentrated as they move up the food chain.

BACKGROUND INFORMATION

ECOLOGICAL COMMUNITIES

The different kinds of plants and animals found in a given area, such as a pond, may be dependent upon each other for food and other needs. The plants and animals in a given environment that are dependent upon one another form a community.

FOOD CHAINS

A prominent way plants and animals are dependent upon one another is through a food chain. A food chain is a simplified interpretation of the transference of the sun's energy from plant to animal. Animals either directly or indirectly receive energy from plants by eating them or by consuming animals that eat plants.

PRODUCERS AND CONSUMERS

Green plants have the singular ability to convert the energy of the sun to food energy which earth's plants and animals are able to use. Plants are called producers because they can manufacture food. Animals are called consumers because they are dependent upon food energy produced by plants and must eat food to receive energy.

PLANKTON AND THE POND LIFE FOOD CHAIN

Water environments influence, in specific ways, the life forms that are able to survive in them. In a pond ecosystem, the foundation of the food chain is quite different than that which we find on land. The source of energy in the pond life food chain is phytoplankton. Plytoplankton are microscopic plants that exist suspended in pond water. They are primarily consumed by microscopic pond animals called zooplankton. Larger animals, in turn, eat the plant and animal plankton. These interactions continue up through the pond community in a linear fashion, connecting the plankton with the larger predatory animals.

FOOD WEBS ARE INTERWOVEN FOOD CHAINS

Interactions within an ecological community, as they take place in nature, are more accurately illustrated using the concept of a food web. A food web can be thought of as a series of meshing or crisscrossing food chains. In a food web, several plant eating consumers may prey upon the same type of producer organism. Several animal-eating consumers may, in turn, prey upon the same type of consumer organism. The greater the number of alternate pathways in a food web, the more stable the community because there is more than one source of food for each type of organism. A balanced community exists when there are more plants than plant eaters and more plant eaters than animal eaters.

HARMFUL SUBSTANCES CAN BECOME CONCENTRATED AS THEY MOVE UP THE FOOD CHAIN

Harmful materials sometimes enter our ponds, lakes and streams. When these materials come into contact with our surface water (and our groundwater) they readily diffuse into them. When dangerous substances enter our environs, their initial concentration may not cause immediate obvious damage. However, after entering the food web, they can become concentrated by moving along the chains that crisscross the food web. This process is called bioaccumulation and is particularly deleterious to top carnivores such as osprey, tuna fish, blad eagles and humans.

PROCEDURE — FOOD CHAIN TAG

1. Hold a classroom discussion on pond ecology. The pond ecology vocabulary list will offer assistance in modelling a classroom presentation.
2. Select students to be the various pond organisms.
   a. Hand out the headbands. Each species should all have the same color headband.
   b. Explain the rules of the Food Chain Tag.

Game Rules

The students will play the roles of pond community animals: water fleas, killifish, largemouth bass and osprey. Four different colors of cloth can be fashioned as headbands to represent the four kinds of pond organisms. There should be twice as many water fleas as killifish, twice as many killifish as largemouth bass, twice as many largemouth bass as osprey. A class of 30 can be divided in the following manner:

16 water fleas
8 killifish
4 largemouth bass
2 osprey

I WATER FLEAS feed by picking up plankton flakes and collecting them in plastic bags.

II KILLIFISH feed only on water fleas. A killifish catches a water flea by tagging it. The water flea is then out of the game and must give all of his/her cereal to the killifish. The killifish collects the water flea's plankton in a plastic bag.

III LARGEMOUTH BASS feed only on killifish. When a bass captures a killifish, the same procedure as with #2 takes place.

IV OSPREY feed only on largemouth bass. Once again, the same procedure as with #2 takes place.

3. Take the students outside. Disperse the cereal.

> The breakfast cereal will represent plankton; microscopic plants and animals that form the bases for the pond life food web. The food chain tag game illustrates one strand in the food web. The cereal should be scattered on the school grounds in an area about 60x60 feet.

4. Set up a small demonstration to show your students the game before the entire class participates. This is a good place to further develop the concept of a balance in nature.
   a. Choose 5 water fleas, 5 killifish, 2 bass and 1 osprey to serve as a demo-group.
   b. Allow this group to play, following the instructions provided in the GAME RULES section.
   c. Have them play until all the members of one species group are captured.
   d. The captured students should join the observers. The remaining students in the demonstration group should check their plastic bags. If they have no food they must join the observers. Stress that in order to survive animals must eat. Not only must an animal not get caught; it must eat, too.
   e. Discuss whether the survivors of the demonstration group represent a balanced community. In a balanced community there are more plants (producers) than plant eaters (primary consumers) and more plant eaters than animal eaters (secondary consumers). In addition, if one of the species has been eliminated, the balance of nature has been considerably affected.

5. Begin the game with the entire class.
   a. Let the water fleas feed on the plankton for 1 minute before releasing the killifish.
   b. Let the killifish feed for 1 minute before releasing the bass.
   c. Let the bass feed for 1 minute before releasing the osprey.

   The players who have been caught should go to a pre-arranged area.

6. The game should stop before any consumer group is completely eliminated.

7. Divide the class into survivors and non-survivors. Those who have fed and were not caught are the survivors.

8. Record the numbers of survivors according to species. Students will need these numbers for their worksheets.

9. Have students complete Worksheet A.

PROCEDURE — HARMFUL MATERIALS IN THE FOOD CHAIN TAG

This game is similar in format to the previous activity, FOOD CHAIN TAG. The only difference involves placing 2 marbles in the plastic bag of each water flea. The marbles represent a harmful substance such as DDT. The water fleas acquire the poison by eating contaminated phytoplankton.

1. This food chain game should be organized and played in the same manner as the previous activity. The only change is in the addition of the marbles.

2. After the game ends and the feeding frenzy complete, each animal should count the number of marbles in his/her bag. Use the following toxicity ratings to determine the survivors of this game:

Survivors

a. 2 marbles represents a toxic level that has no visible effect on the organism.
b. 4 marbles represents a toxic level where the organism gets sick.

Non-survivors

c. 6 marbles represents a toxic level where the organism cannot reproduce.
d. 8 marbles represents such a toxic concentration that the amimal is killed by the harmful substance.

> NOTE: Non-survivors in this game includes those unable to successfully reproduce.

3. Record the number of survivors according to species. Students will need these numbers for their worksheets.

4. Have students complete Worksheet B.

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QUESTIONSHEET ANSWERS

Question Sheet A
3.,b;4.,a;5.,c;6.,c;
7.,a. increase, b. increase,
c. decrease, d. decrease,
e. decrease.

Question Sheet B

4.,a. improper pesticide use,
b. polluted groundwater seeping into a pond,c.a truck spill near a pond; 5., by eating the animal plankton; 6., by eating fish that ate other contaminated animals; 7.,c.

Vocabulary

FOOD CHAIN: A sequence where an animals that eats a plant may in turn be eaten by another animal.

FOOD WEB: Two or more food chains that are connected. A particular plant or animal may be eaten by different types of animals, each of which in turn may be eaten by more than one type of animal.

PRODUCER: A green plant that makes (or produces) its own food. Plants are the bases of all food webs because of their ability to make food from the sun's energy.

CONSUMER: Animals that eat plants or other animals.

POPULATION: A group of plants or animals in an area that are all the same type. Example: all the grey squirrels in one area are a population.

COMMUNITY: A group of plants and animals in an area, such as a pond, that are dependent on each other for food and other needs.

BALANCED COMMUNITY: A community that exists when there are more plants than plant eaters and there are more plant eaters than animal eaters.

PLANKTON: Microscopic plants and animals that form the foundation for the pond life food web.

PHYTOPLANKTON: Microscopic plants that drift suspended in water. They are the foundation for the pond life food web because they make food from the sun's energy.

ZOOPLANKTON: Microscopic animals that drift suspended in water. They eat phytoplankton.

LOW ON THE FOOD CHAIN: Animals that eat plants.

HIGH ON THE FOOD CHAIN: Animals that eat other animals. Animals highest on the food chain eat animals that have eaten other animals.

SURVIVOR: A plant or animal that makes or finds enough food to survive and also escapes being caught and eaten by other animals. Only survivors get to produce young for the next generation.

TOXIC SUBSTANCES: Any material that enters the environment and harms living things. These substances can also harm an animal's ability to have young. Sometimes they can even cause death. Harmful substances include pesticides, sewage, detergents, gasoline and fertilizers.

name _____

Food Chain Tag — Questionsheet A

1. Record your observations below.

2. Answer the questions below by filling in the blank or by circling the best choice.

1. List the number of pond animals that survived the game.

   a. water fleas _____

   b. killifish _____

   c. largemouth bass _____

   d. osprey _____

2. Are the animals that remain a balanced community? (Circle one).

   a. yes
   b. no

   If no, explain why. _____

   _____

3. What do the cereal flakes represent in this game?

   a. algae
   b. plankton
   c. pollution
   d. minerals and vitamins

4. What would happen to the population of plankton if the water fleas didn't survive? The population would:

   a. increase
   b. decrease
   c. disappear
   d. stay the same

5. What would happen to the population of the plant plankton if it could not receive sunlight? The population would:

   a. increase
   b. decrease
   c. disappear
   d. stay the same

name _____

Food Chain Tag — Questionsheet A

continued

6. What would happen to the populations of all the animals in the food chain if the plant plankton did not survive? They would all:

a. increase
b. decrease
c. disappear
d. stay the same

7. If there were a lot of killifish one year and they ate so many water fleas that the water flea population decreased but survived, how do you think this would change the plankton, killifish, largemouth bass and osprey populations the following year? Place an arrow pointing up ↑ next to the animal populations that would increase. Place an arrow pointing down ↓ next to the populations that would decrease.

a. plant plankton _____
b. animal plankton _____
c. killifish _____
d. largemouth bass _____
e. osprey _____

name _____

Food Chain Tag — Questionsheet B

1. Record your observations below.
2. Answer the questions below by filling in the blank or by circling the best choice.

1. List the animals whose populations disappeared by poisoning or being unable to reproduce.

   _____

   _____

   _____

2. Were these animals high or low on the food chain? (Circle one).

   a. high on the food chain
   b. low on the food chain

3. List the animal populations that were reduced because some animals couldn't reproduce.

   _____

   _____

   _____

4. List 2 ways that a toxic substance could get into the water.

   a. _____

   b. _____

5. How would the water fleas get the toxic substance in their bodies?

   _____

6. How would an osprey get the toxic substance in its body?

   _____

7. Which animals in a food chain are most harmed by toxic materials?

   a. animals that eat phytoplankton

   b. animals that eat zooplankton

   c. animals that eat animals that eat animals that eat plankton

   d. animals that eat animals that eat plankton

PART 2: Ponding

OBJECTIVES

Students visit a freshwater area and observe aquatic plants and animals. Attention is given to the adaptations plants and animals have evolved for life in and near water. Working with a partner, students compare and contrast plants and animals found in a pond community.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grades 4-6
Science

ELEMENTARY SYLLABUS REFERENCES

Science:
IIIB., IIIE.

BEHAVIORAL OBJECTIVES

Upon completion of these activities, students should be able to:

a. observe and record characteristics of two different aquatic plants,

b. observe and record characteristics of two different aquatic animals,

c. identify and describe the similarities and differences between two aquatic plants,

d. identify and describe the similarities and differences between two aquatic animals.

MATERIALS

dip nets (if available)
hand lenses
clear jars w/lids
labels
large jars w/lids (for taking water samples back to school for observation)
white pans (for observation)
white styrofoam egg cartons
kitchen sieve
microscope (for use back at school)
microscope slides
slide cover slips
eye dropper
FOR EACH STUDENT:

Pond Life Observation Sheets A and B

Pond Life Comparison Sheets A and B

Dipnets and kitchen sieves can be used to collect aquatic creatures or moved through murky water to encounter the unexpected. The sieve can be used to scoop up some of the pond bottom to see what may lurk in the mud.

Jars with lids are handy for temporary creature capture. They are easily passed around for the whole class to observe. Use white pans and white styrofoam egg cartons to make aquatic zoos. White containers are preferable because they make the animal stand out.

If microscopes are available, take water samples back to school as a follow-up to your field activities. Use an eye dropper to transfer water samples from jar to slide.

Children should wear old clothes on ponding expeditions. Also, a change of sneakers may be in order.

HOMEMADE EQUIPMENT

Dipnet

Tape a kitchen sieve to an old broom handle, dowel, or even a sturdy but light tree branch. Duct tape will hold the sieve on securely.

Waterscope

A clean, empty half-gallon milk container can be made into a water scope by cutting away the bottom, stretching plastic wrap over it, and securing it with a tight rubberband. Observe water-life on the pond bottom by placing the milk container in the water and looking through the top.

MAJOR UNDERSTANDINGS

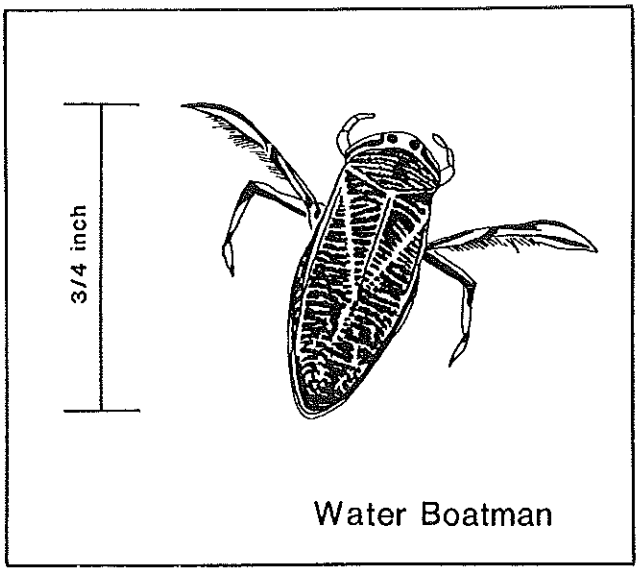
Different kinds of plants and animals exist in different environments.

Different kinds of plants and animals exist in the same environment.

BACKGROUND INFORMATION

Ponding is the catching and observing of aquatic creatures. It is an activity that can be taken up at lakes, ponds or streams. However, it is generally easier to capture small aquatic animals in shallow ponds where they are both abundant and accessible.

Though they appear silent and serene as we enter their environs, our freshwater ponds and streams are places where life abounds. Intricate food webs that shape the communities of these bodies of water remain concealed until we take the time to study their patterns and observe their habits. Microscopic plants and animals comprise the base of the water community's food pyramid. Algae forms the scum on stagnant ponds and the green hairy growth found on submerged rocks. Minute forms of life give the water distinctive color and affect the amount of sunlight that reaches the water. Moss covers rocks or may form floating mats that provide cover for many types of animals. As you observe plants in and near the water's edge, you'll notice the special adaptations that have evolved to contend with submergence and living near the water. Some plants anchor themselves to the pond bottom while others, like duckweed, float unattached along the surface.



Water Boatman

Invertebrates, such as insects, are easily found in ponds and streams. Water striders, whirligig beetles and dragonflies all have adaptations that distinguish them as aquatic animals. Larger animals like reptiles, amphibians, birds and mammals will be less evident. Still, they may be heard or smelled. Evidence found around the pond can tell of their presence or passing: a feather, a bone, a shed dragonfly larval case, or tracks on a sand flat or mud bank.

PROCEDURE

1. The activities found in this section should follow Activity #7: Aquatic Environments.

2. Instruct students in the proper treatment of plants and animals. Stress that they should not uproot any plant or denude them of leaves. Always keep water animals wet and out of the sun. Do not let the water they are kept in get warm - it may not contain sufficient oxygen for their needs.

3. Children can collect, observe and record the characteristics of pond plants and animals. Have them complete Pond Life Observation Sheets A and B, and Pond Life Comparison Sheets A and B. They can do these activities in groups or singly.

FIELD TRIP ACTIVITY

The following activity is designed for field trip use. It is written as a pond activity but may be adapted for use at other freshwater areas. Listings for aquatic plant and animal identification sources can be found at the end of this section, although an introduction to pond studies need not be geared to naming things. Observation and learning new perception skills should be paramount during this first time out.

An activity used to encourage observation and to provide an introduction to how scientists identify things is as follows:

1. Collect several interesting objects such as: an insect or tadpole in a jar, an unusual leaf, a snail, a piece of driftwood, a seed head.

2. Divide your class into 4 groups.
   a. Each group should get an object. NOTE: No groups should see the object of another group. This activity can best be enacted out of doors where groups can be spaced widely apart.
   b. One student should be appointed the group's scribe.

3. Each student should have a chance to hold and observe their groups' object.
   a. Each student should think of one word that best describes the object.
   b. The scribe should record each student's word.
   c. The object can be passed around the group circle more than once to gather a larger repertoire of descriptive terms.

4. After all words are recorded, each group should go over them and narrow the list down to the four or five most descriptive words.

5. Groups should exchange lists.
   a. Each group now tries to identify and name the other groups object.

At the completion of this activity, you may wish to introduce your students to scientific keys and how descriptive words are important in identifying objects and being able to accurately communicate observations.

name _____

Pond Life — PLANTS — Observation Sheet A

Directions

1. Find two pond plants.
2. Record information about each plant by answering the questions in the grey boxes below.
3. Make a quick sketch of each plant in the empty box to the right of the grey boxes.

1. This plant is:
   a) completely in water,
   b) completely out of water,
   c) partly in, partly out of water.

2. This plant is :
   a) rooted in the ground,
   b) rooted in pond mud,
   c) floating on water, not rooted.

3. This plant is:
   a) supported by the water,
   b) can stand upright on its own.

4. Are there many plants of its kind in the area?

5. What kind of plant is it?

PLANT #1

1. This plant is:
   a) completely in water,
   b) completely out of water,
   c) partly in, partly out of water.

2. This plant is:
   a) rooted in the ground,
   b) rooted in pond mud,
   c) floating on water, not rooted.

3. This plant is:
   a) supported by the water,
   b) can stand upright on its own.

4. Are there many plants of its kind in the area?

5. What kind of plant is it?

PLANT #2

name _____

Pond Life — ANIMALS — Observation Sheet B

Directions

1. Find two pond animals.
2. Record information about each animal by answering the questions in the grey boxes below.
3. Make a quick sketch of each in the empty box to the right of the grey boxes.

1. What color is it?

2. How large is it? (Draw a line as long as it is).

3. Are there others like it? How many?

4. Describe one adaptation that helps it live in or near the water.

5. What do you think the animal is?

ANIMAL #1

1. What color is it?

2. How large is it? (Draw a line as long as it is).

3. Are there others like it? How many?

4. Describe one adaptation that helps it live in or near the water.

5. What do you think the animal is?

ANIMAL #2

name _____

Pond Life — PLANTS — Comparison Sheet A

1. Locate two aquatic plants.
2. In box A, list 3 ways these plants are the same.
3. In box B, list 3 ways these plants are different.

The box to the right contains some plant characteristics you may wish to compare.

A Similarities
How are these plants the same?

1

2

3

B Differences
How are these plants different?

1

2

3

- .color
- .plant size
- .leaf size
- .leaf shape
- .leaf veins
- .# of leaves
- .leaf texture
- .leaf attachment to stem
- .rooted/not rooted
- .in water/out of water

name _____

Pond Life — ANIMALS — Comparison Sheet B

1. Locate two aquatic animals.
2. In box A, list 3 ways these animals are the same.
3. In box B, list 3 ways these animals are different.

The box to the right contains some characteristics you may wish to compare.

A Similarities
How are these animals the same?

1

2

3

- .color
- .body size
- .legs/no legs
- .# of legs
- .# of body parts
- .antennae
- .mouth parts
- .eyes
- .skin texture
- .wings/no wings
- .fins/no fins
- .movement
- .habitat

B Differences
How are these animals different?

1

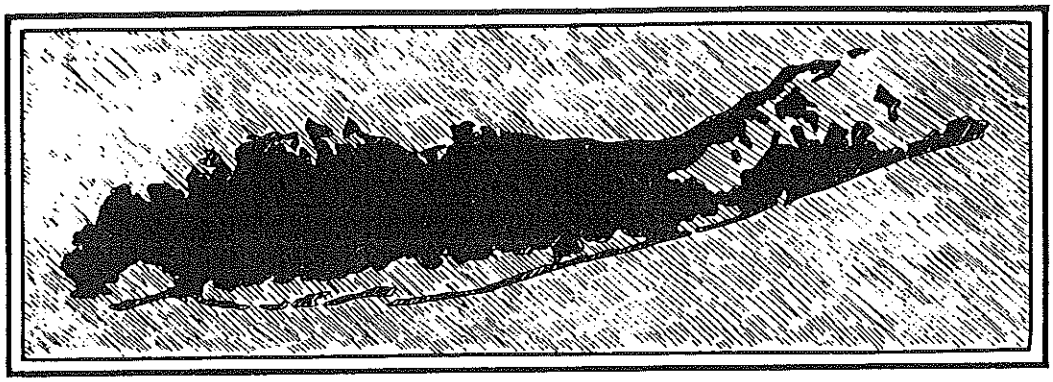
2

3

Important!

Return animals to the area where they were found.

LONG ISLAND'S GEOGRAPHY



LONG ISLAND'S GEOGRAPHY
A Mapping Lesson

Objectives

Students are introduced to Long Island's geography through a mapping lesson. The information learned through this exercise is a prerequisite to understanding Long Island's geology and water resources in the later grades.

Grade Level

Grade 2
Geography

Materials

Long Island Geography Instruction Sheet
Long Island Geography Worksheet
Pencil or Pen

Procedure

1. Discuss Long Island's geography with your students. Familiarize your students with the locations of the places and bodies of water used in this exercise. Be sure to identify the location of the students' community on the map.

2. Instruct your students to fill in the blank boxes on the worksheet with the correct name.

Long Island Geography

Directions

On the list below are names of places on Long Island and bodies of water that surround it.

1. Using this list and what you know about Long Island's geography, fill in the blank boxes on the worksheet with the correct name.

2. Locate where your town is found on the map. Mark the spot with an X.

Long Island Sound

Atlantic Ocean

Montauk Point

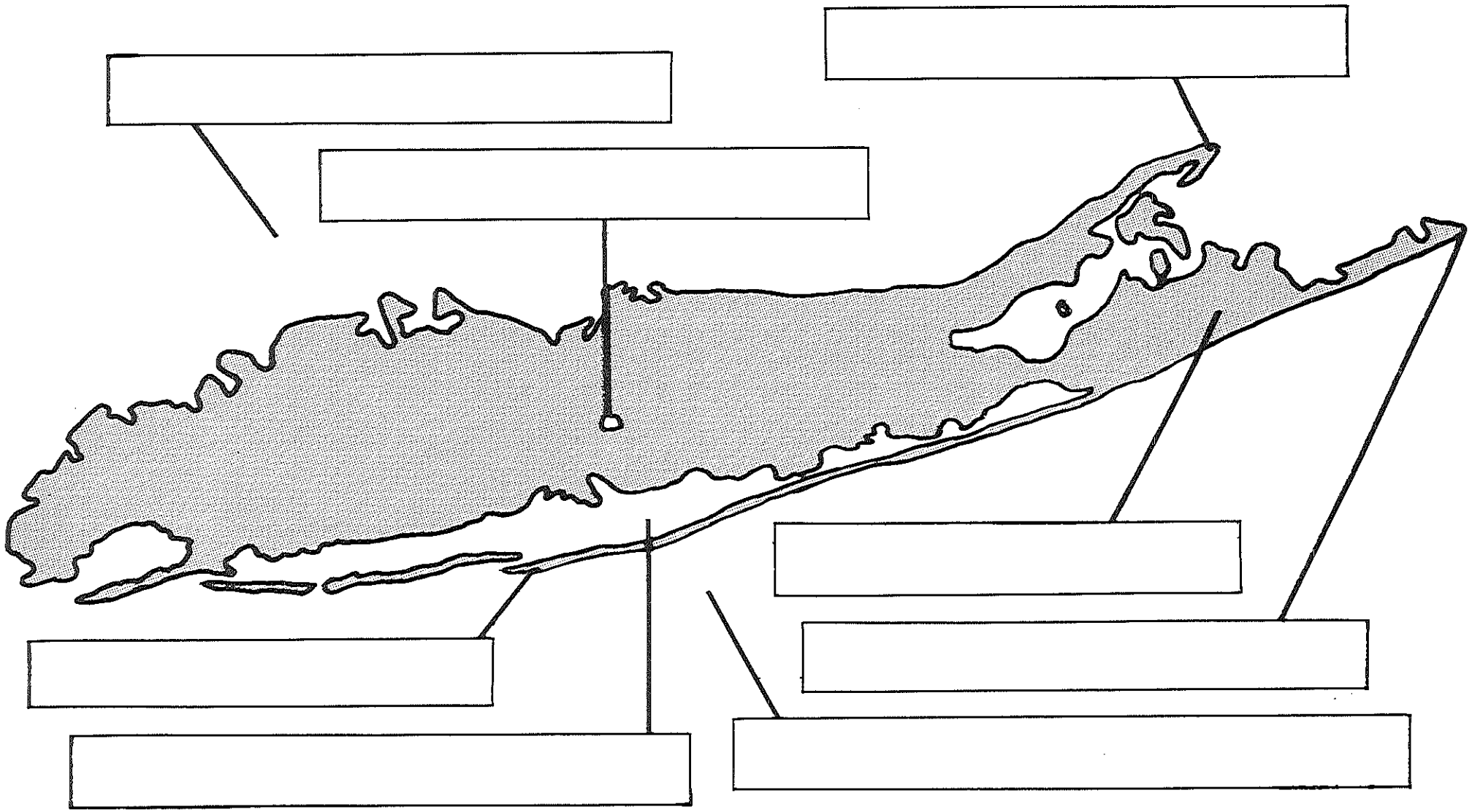
North Fork

Fire Island

Great South Bay

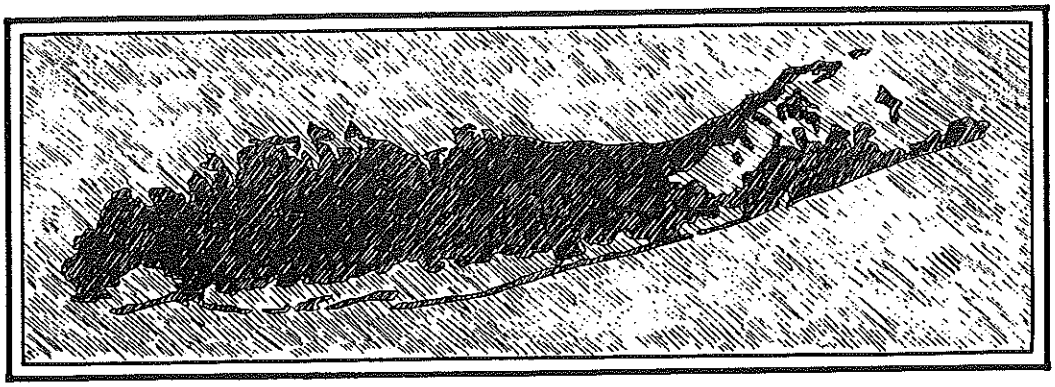
South Fork

Long Island Geography Worksheet



CONTOURS OF LAND AND WATER

Mapping Long Island's Geology and Water Resources



CONTOURS OF LAND AND WATER
Mapping Long Island's Geology and Water Resources

OBJECTIVES

Using maps that present Long Island geology and hydrology characteristics, students discover the following information about their town:

1. land surface elevation,
2. the type of glacial landform it is located on,
3. water table elevation below it,
4. average annual precipitation received.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grades 4-6

Science
Social Studies

ELEMENTARY SYLLABUS REFERENCES

Elementary Science References: IIID.

Social Studies Program, Grades 4-6

Concepts and understandings found on the following pages:

Grade 4 Program, page 56.
Grade 5 Program, page 38.
Grade 6 program, page 80.

BEHAVIORAL OBJECTIVES

1. TOPOGRAPHIC MAP: Generalized Contour Map of Long Island's Land Surface Elevation

   Upon completion of this activity, students should be able to:

   a. explain what a contour map is.

   b. locate their town on the map and record its elevation.

2. LANDFORM MAP: Map of Glacial Landforms on Long Island

   Upon completion of this activity, students should be able to:

   a. define the terms moraine and outwash plain.

   b. locate their town on the landform map.

   c. identify and record what type of landform their town is located on.

3. WATER TABLE ELEVATION MAP: Generalized Contour Map of the Topmost Level of Long Island's Groundwater

   Upon completion of this activity, students should be able to:

   a. explain what the water table is.

   b. locate their town on the map and record the height of its water table.

   c. determine the depth to the water table.

4. AVERAGE ANNUAL PRECIPITATION MAP: Generalized Map of the Variations in Average Annual Precipitation on Long Island

   Upon completion of this activity, students should be able to:

   a. define average annual precipitation.

b. locate their town on the map and record its average annual precipitation.

5. MAP COMPARE AND CONTRAST: Drawing Conclusions about Long Island's Geology and Hydrology by Using Information Gathered Directly from Maps.

Upon completion of this activity, students should be able to:

a. compare and contrast information gathered from maps.

b. associate Long Island's surface geology with its glacial past.

c. associate Long Island's natural water table elevations with land surface elevations and glacial landforms.

d. associate Long Island's variations in average annual precipitation with variations in land surface elevation.

e. associate high average annual precipitation with high land surface elevations.

MATERIALS

Vocabulary List
Student Procedure Sheets
Maps 1-4
Question Sheets A-F
Colored pens or pencils: purple, green, orange, blue, yellow and red

MAJOR UNDERSTANDINGS

Long Island's land surface was shaped by continental glaciers.

The two major glacial landforms that influence Long Island's topography are moraines and outwash plains.

Long Island's moraines were formed as rocks and boulders carried from northern areas by the glaciers were deposited.

Moraines are associated with high, varying elevations while outwash plains are gently sloping, broad expanses of low altitude.

There are two major moraines found on Long Island: the Harbor Hill moraine to the north and the Ronkonkoma moraine to the south.

Moraines form the backbone of Long Island's north and south forks.

Long Island's outwash plains formed as the glaciers that advanced upon it melted.

There are two major outwash plains on Long Island: the Hempstead outwash plain and the Terryville outwash plain.

The Hempstead outwash plain is located south of the Ronkonkoma moraine.

The Terryville outwash plain is located between the Harbor Hill moraine and the Ronkonkoma moraine.

The surface of the groundwater is the water table.

Regionally, the surface of the water table varies as land elevations change.

Water table elevations will tend to be higher in areas of high elevation and low in areas of low elevation.

In a natural state, a groundwater system is in equilibrium with the water entering the system being roughly equivalent to the water leaving the system.

Water table levels fluctuate according to precipitation amounts and drought conditions.

Human activities influence water table levels.

Some activities that influence water table levels include: groundwater mining by over-pumping and sewer systems by interference with groundwater recharge patterns.

Long Island's average annual precipitation is 44 inches.

The island-wide variation of this average is between 40 and 48 inches.

The gradient of precipitation amounts is oriented north-south.

Average annual precipitation amounts are greatest towards the north.

Average annual precipitation amounts on Long Island are lowest on the south shore and on the south and north forks.

Land topography influences variations in average annual precipitation levels.

BACKGROUND INFORMATION

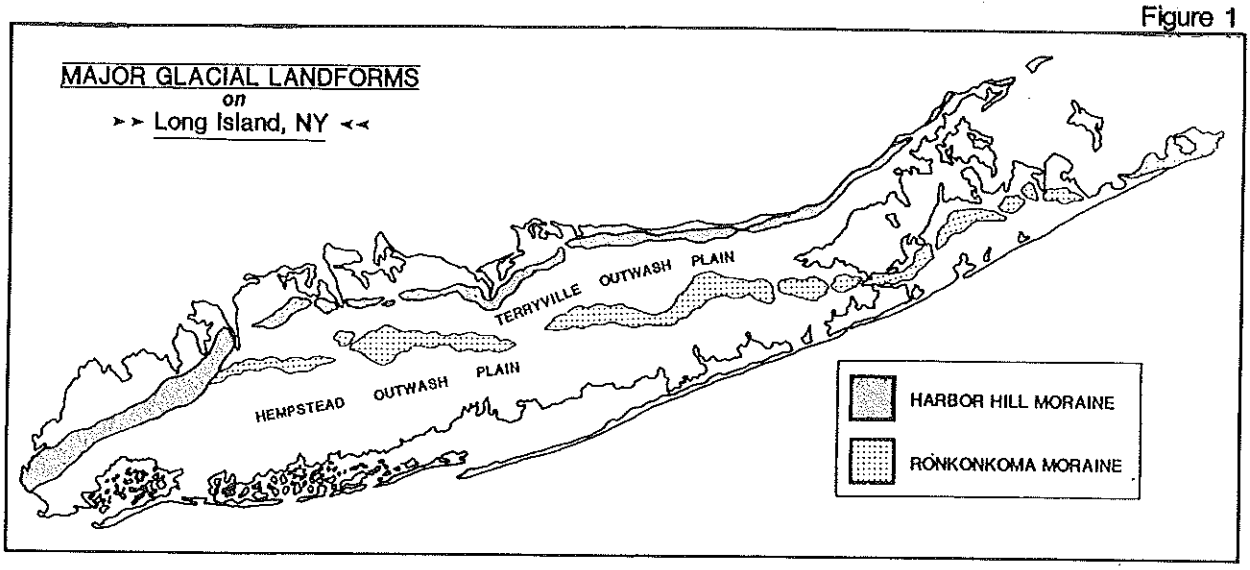
THE GLACIATION OF LONG ISLAND

Long Island's land features are a legacy of the continental glacier that advanced upon it about 50,000 years ago. At this time, the glacier reached the area where the Ronkonkoma termal moraine is today. Here the stagnant glacier deposited rock material it had gathered as it moved across Canada and New England. This collection of unsorted rock material formed a series of hills called a moraine. The Ronkonkoma moraine ranges west to east across Long Island and forms the backbone the south fork.

As the glacier receded, its melt-waters produced streams of high velocity which traveled long distances outward and southward from the glacial front. These rivers carried great loads of the smaller and finer rock material from the moraines. As the velocity of the meltwaters decreased the loads of sand and silt settled. This deposition soon began to fill the stream beds, causing the rivers to frequently change course. As a consequence of this incessant meandering, the hollows in the landscape began to fill, resulting in the formation of the Hempstead outwash plain. Outwash plains are broad, gently sloping expanses of rock particles that are sorted or nearly all the same size. Outwash deposits contain a great deal of sand.

The ice sheet moved northward as glacial melting continued. After some time, the glacier again stopped. At this standstill the Harbor Hill moraine formed. During this time, a lobe of ice overrode

Figure 1



the Ronkonkoma moraine just west of Lake Success, extending as far south as Staten Island. This is why the two moraines appear to merge at the west end of Long Island.

The Harbor Hill moraine runs west to east along the northern portion of Long Island and forms the backbone of the north fork. The eventual melting of this glacier occurred approximately 15,000 years ago. Its meltwater rivers are responsible for the formation of the sandy Terryville outwash plain lying between the Harbor Hill and Ronkonkoma moraine.

This glacial design on Long Island's topography can be seen on Figure 1 shown above and on Map Worksheets 1 and 2. Though its land surface is of glacial origin, these remant features are continually being reshaped by the erosive forces of nature and the activities of humans.

WATER TABLE ELEVATIONS

The surface of the groundwater is called the water table. Regionally, the surface of the groundwater varies as land surface elevation changes. For example, the water table in areas of high elevations will, under natural conditions, generally, be higher than the water table occurring under less elevated landscape near the coast.

Water table elevations can change. Under natural conditions, water table levels vary from year to year and are dependent on precipitation amounts. Human actions also affect water table levels. When more groundwater is removed than is replaced by rainfall, the water table is lowered. This condition is called groundwater mining. Groundwater mining occurs in Nassau and Queens counties and is associated with high population densities and sewer systems. Sewers, on Long Island, transport wastewater to the ocean or sound. Groundwater

taken out of the system is not replaced as would happen in a home disposal system such as a cesspool or septic tank. Sewers lower groundwater levels.

In coastal areas, groundwater mining causes saltwater intrusion. When this happens, saltwater encroaches upon the coastal boundary between salt and fresh groundwater. This interface moves. Aquifers previously bearing freshwater becomes contaminated with saltwater. The aquifer becomes unfit for human consumption.

BENEATH THE WATER TABLE

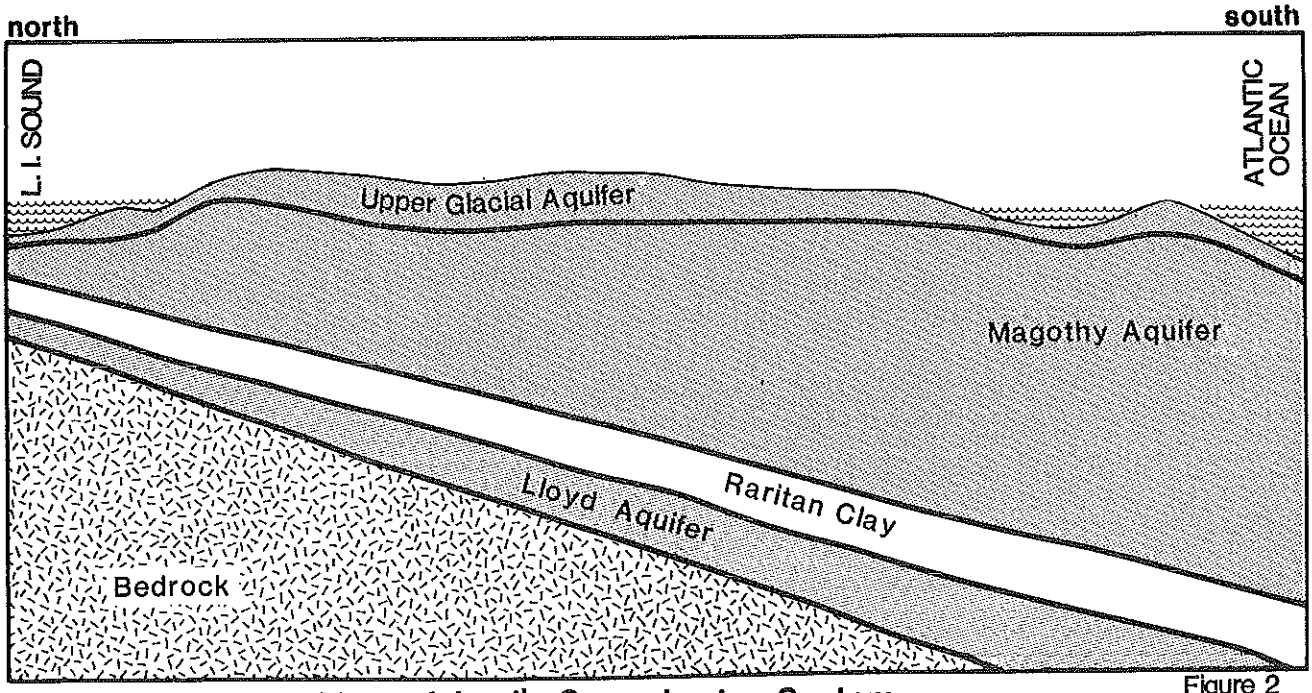
The water table is the top of a large tiered system of aquifers that underly Long Island. Figure 2 shows a north-south cross-sectional representation of Long Island's groundwater system. The aquifers and confining layers are classified under different names for the following reasons:

1. they were formed during different geologic periods.
2. they differ in their rock composition,
3. they differ in the amount of water they can hold and
4. they differ in the amount of water that can be pumped out of them.

PRECIPITATION ON LONG ISLAND

Rainfall is the only source of replenishment for our only source of water: our groundwater. Long Island has an annual precipitation average of 44 inches. This average is an island-wide figure; actual annual rainfall varies markedly from place to place.

The precipitation gradient is oriented north-south with greater rainfall accumulations occurring in the north-west portion of Long Island. Along the south shore and east on the north and south forks, precipitation amounts fall below the 44 inch average. Two factors that contribute to this contrast



Cross Section of Long Island's Groundwater System Figure 2

in rainfall amounts are as follows:

1. the higher elevations of the Ronkonkoma and Harbor Hill morainal areas cause an uplifting of air moving across Long Island. As the air moves upwards it cools. Cooling decreases the ability of air to hold moisture and increases the amount of precipitation that falls.

2. The ocean and Long Island Sound have a moderating effect on coastal land and air temperatures. Inland areas experience greater extremes of temperature. This contributes to greater increases in precipitation in warmer months because higher mid-island temperatures cause air masses to rise because warm air is less dense. In winter months, air moving into the colder mid-island areas cools. When cooled, air cannot hold as much moisture. Rain or snow falls.

It should be noted that rainfall variations are influenced, in combination, by the factors mentioned above.

PROCEDURE

1. Present material on maps, mapping and Long Island geology and water resources.

2. Hand out maps, procedure sheets and vocabulary lists.

3. Students should complete map coloring. Though students are provided with instruction sheets, they will need assistance.

4. Follow-up mapping activities with question sheets.

MODIFICATIONS

Individual maps can be completed as separate activities. Instruction and question sheets are designed to stand by themselves if need be.

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QUESTIONSHEET ANSWERS

TOPO MAP

Question Sheet A

1:b
2:c
3:b
4:a
5:a

LANDFORM MAP

Question Sheet B

1:c
2:b
3:b
4:a
5:b
6:a
7:a

WATER TABLE MAP

Question Sheet C

1:b
2:b
3:c
4:a

RAINFALL MAP

Question Sheet D

1:a
2:c
3:a

MAP COMPARISON

Question Sheet F

MAPS 1 and 2
1:b
2:b
3:b
4:a

MAPS 1,2 and 3
1:a
2:b
3:a

MAPS 1 and 4
1:b
2:b

NOTES

Student Procedures

1. Topographic Map

The numbers on this map represent land elevation in feet above sea level.
The change in elevation between each contour line is 60 ft..
Sea level is at 0 ft..

1. Locate your town on the map. Mark it with an X.

2. Find the legend on MAP 1 and use it to color the land elevation contours.

   a. Locate the 5 small blackened areas on the map. These are closed contour lines representing the highest elevations on Long Island (300 ft.).

   b. The contour lines outside these blackened areas should be colored according to the color legend. The space between the blackened areas and the next contour line (240 ft.) should be colored in red.

   c. Continue to work your way out from the areas already colored.

   d. The last area to be completed is between the line labeled 60 ft. and the coastline which is at 0 ft. (0-60 ft.: green)

3. Find the elevation of your town and record in on #2 on Worksheet E. If your town is between two contour lines, estimate the elevation.

2. Glacial Landform Map

1. Locate your town on the map. Mark it with an X.

2. Find the legend on MAP 2 and use it to color in the Landform Map.

3. Label Long Island's specific glacial landforms.

4. Find which landform your town is located on and record it on #3 on Worksheet E.

Student Procedures

3. Water Table Elevation Map

The numbers on this map represent the height or elevation of the water table in feet above sea level.

There is an elevation change of 20 feet between contour lines, except for 0 - 20 ft. where there is 10 ft. between contours.

Sea level is at 0 ft..

1. Locate your town on the map. Mark it with an X.

2. Find the legend on MAP 3 and use it to color in the water table elevation contours.

   a. On MAP 3, locate the area in western Long Island that has a small closed contour line with the number 80 inside it. Color this circle red.

   b. Locate the area to the right of Long Island's middle that has a small closed contour line with the number 60 inside it. Color this circle yellow.

   c. Use the same method of coloring as you did with MAP 1: Land Elevation Contour Map. Start with the smaller circles already completed. Color your way out from those circles until your map is complete.

3. Find the water table elevation below your town and record it on #4 on Worksheet E. If your town is between two contour lines, estimate the elevation.

4. Use the elevations of the land and water table in your town to figure out the depth to the water table. Record this depth on #5 on Worksheet E.

Student Procedures

4. Average Annual Rainfall Map

The numbers on this map represent Long Island's average annual rainfall in inches.
There is a change of 2 inches between contour lines.

1. Locate your town on the map. Mark it with an X.

2. Find the legend on MAP 4 and use it to color in the annual precipitation contours.

   a. Locate the line labeled 48. Color all the land above this line red.

   b. Color the land between lines 48 and 46 yellow.

   c. Color the land to the right of the near vertical line labeled 44 orange.

   d. Continue coloring the map according to the above color code.

3. Determine what the average annual precipitation in your area is. Record it on #6 on Worksheet E.

Vocabulary

SEA LEVEL: The average between high and low tide at any place. This would be the level of the oceans if there were no tides.

LAND ELEVATION: The height of the land's surface above sea level.

CONTOUR LINE: A line drawn on a map that connects all places at the same height.

TOPOGRAPHIC MAP: A map that shows details of the land's surface. Land elevation is shown by contour lines.

NORTH FORK: The peninsula on Long Island's eastern north shore.

SOUTH FORK: The peninsula on Long Island's eastern south shore.

CONTINENTAL GLACIER: A vast area of ice and snow which covers large areas. Its surface is almost flat. Long Island's landscape was shaped by continental glaciers.

LANDFORM: A natural feature of the earth's surface.

GLACIAL LANDFORM: A natural feature of the earth's surface shaped by a glacier.

MORAINE: A hilly landform made of rocks of all different sizes. These rocks were brought and deposited by glaciers.

OUTWASH PLAIN: A flat plain formed when waters from a melting glacier carried and deposited rock particles away from the moraine. The meltwaters sorted the rocks by weight. Long Island's outwash plains contain a lot of sand.

RONKONKOMA MORAINE: This moraine was deposited by a glacier about 60,000 years ago and is Long Island's most southern moraine. It runs west to east along Long Island's center and forms the backbone for the south fork.

HARBOR HILL MORAINE: This moraine was deposited by a glacier about 23,000 years ago and is Long Island's most northern moraine. It runs west to east along Long Island's north shore and forms the backbone for the north fork.

HEMPSTEAD OUTWASH PLAIN: The outwash plain found south of the Ronkonkoma Moraine.

Vocabulary

TERRYVILLE OUTWASH PLAIN: The outwash plain that is located between the Harbor Hill moraine to the north and the Ronkonkoma moraine to the south.

AQUIFER: An underground layer of rock material (such as sand) which holds water and allows that water to percolate through it.

GROUNDWATER: Water that exists underground in the spaces between sand and other rock particles. The groundwater found in an aquifer comes from rainwater that falls on earth and sinks or percolates through the soil.

WATER TABLE: The surface of the groundwater.

PRECIPITATION: Any form of water that falls from the atmosphere and reaches the ground. Rainfall is sometimes used to mean precipitation.

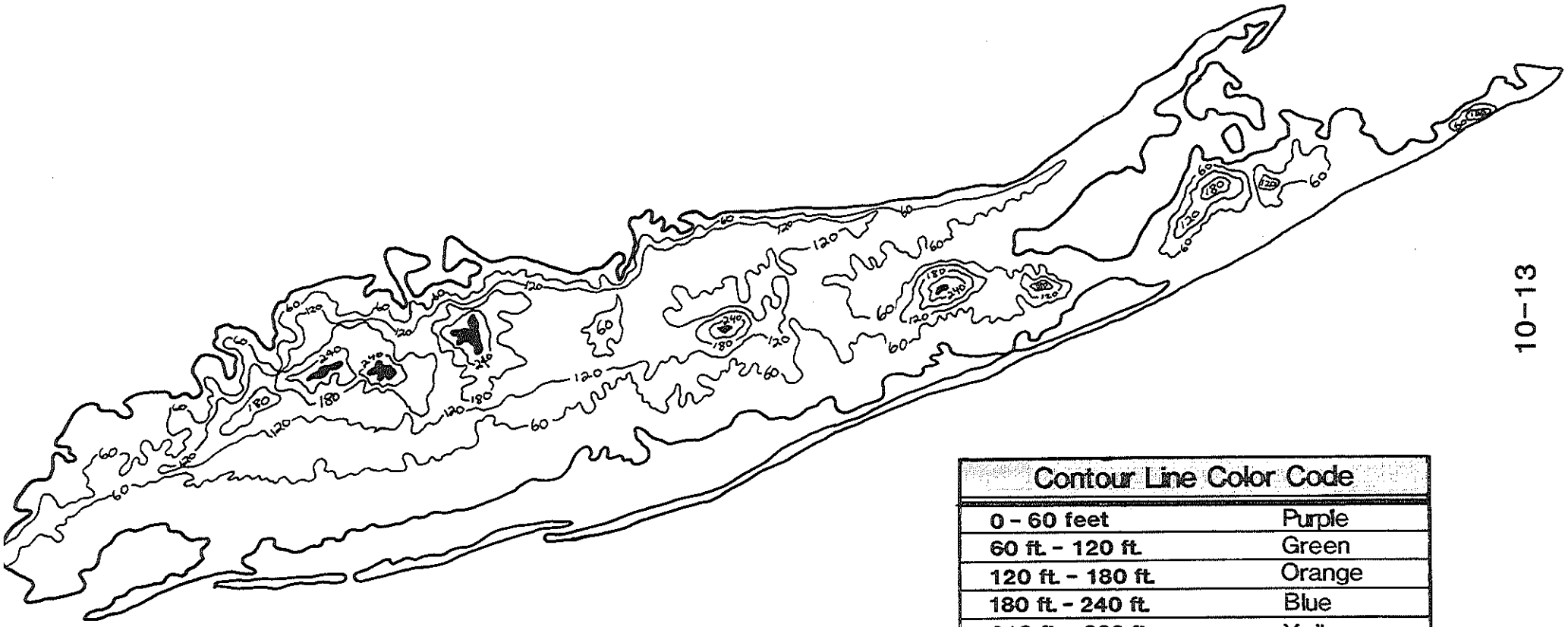
ANNUAL PRECIPITATION: The amount of rainfall that falls in one year.

AVERAGE ANNUAL PRECIPITATION: The average of several years of annual precipitation amounts.

name _____

Map #1 Topographic Map of Long Island

Contour Lines Are In Feet



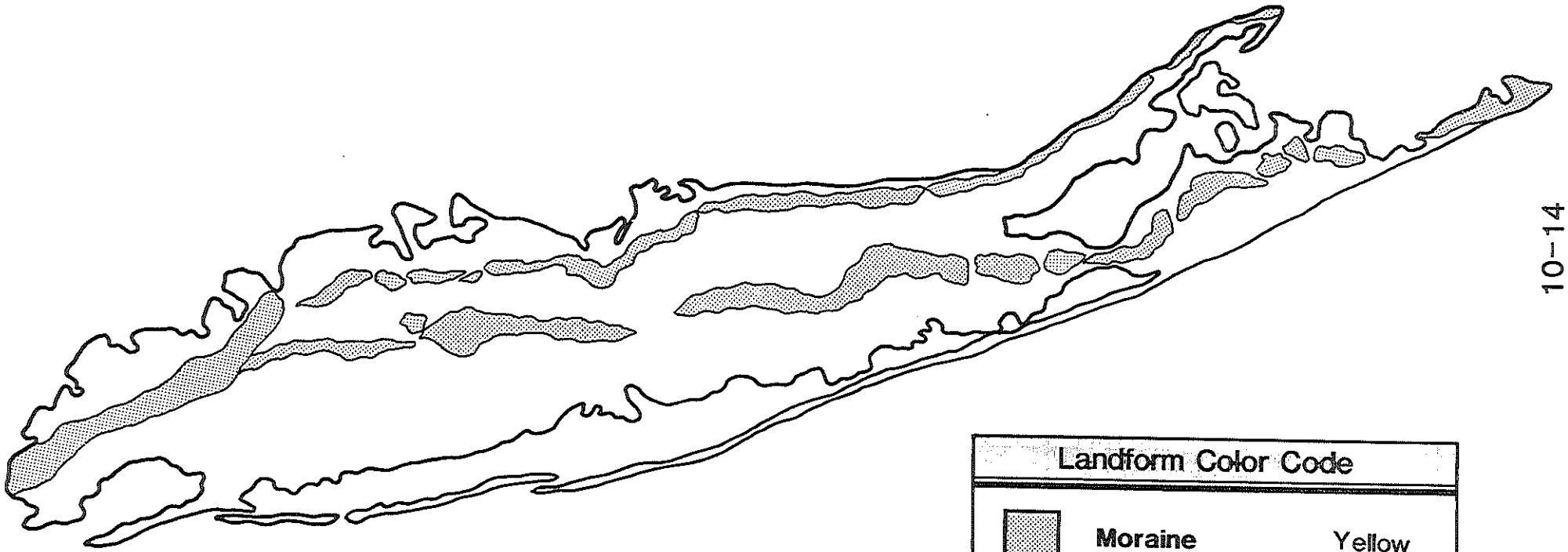
Contour Line Color Code	
0 - 60 feet	Purple
60 ft. - 120 ft.	Green
120 ft. - 180 ft.	Orange
180 ft. - 240 ft.	Blue
240 ft. - 300 ft.	Yellow
300 feet	Red

10-13

Source: TOPOGRAPHIC MAP OF LONG ISLAND, NY, United States Geological Survey, Professional Paper 82, Plate 11, 1913.

Name _____

Map #2 Glacial Landforms on Long Island



Landform Color Code	
Moraine	Yellow
Outwash Plain	Green

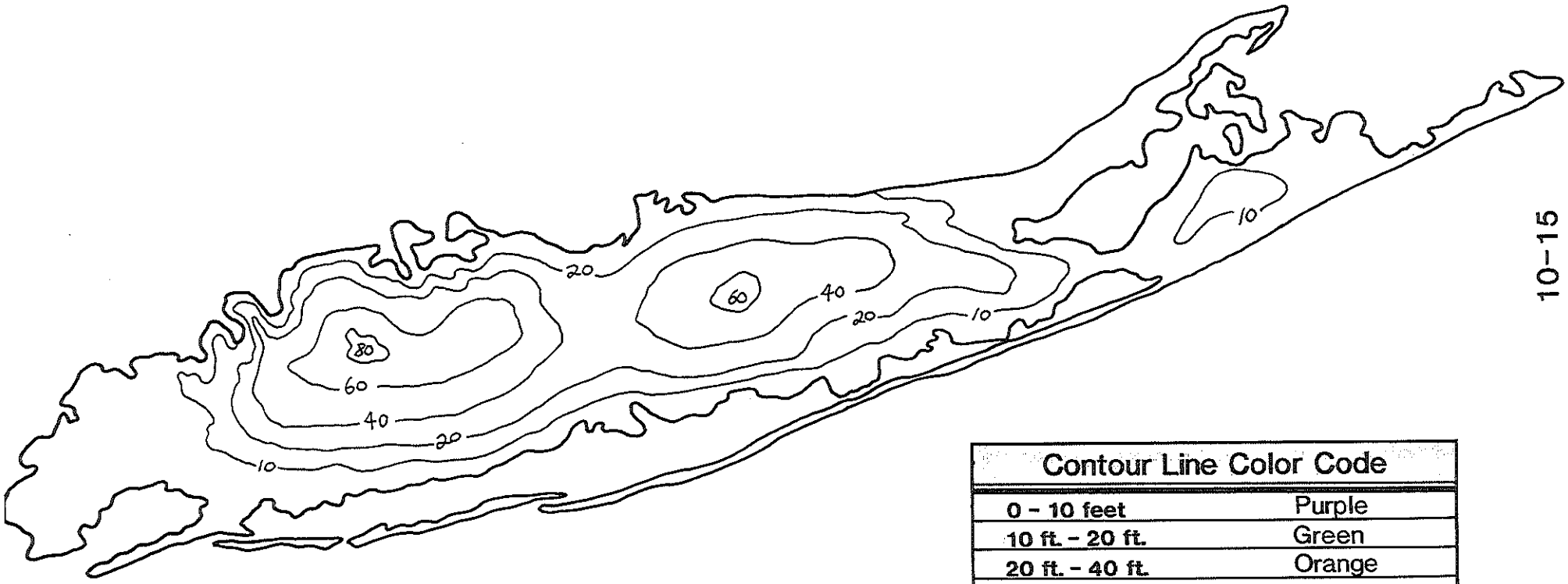
10-14

Source: GEOLOGIC MAP OF LONG ISLAND, NY, United States Geological Survey, Professional Paper 82, Plate 1, 1913.

name _____

Map #3 Water Table Elevations

Contour Lines Are In Feet



Contour Line Color Code	
0 - 10 feet	Purple
10 ft. - 20 ft.	Green
20 ft. - 40 ft.	Orange
40 ft. - 60 ft.	Blue
60 ft. - 80 ft.	Yellow
80 ft.	Red

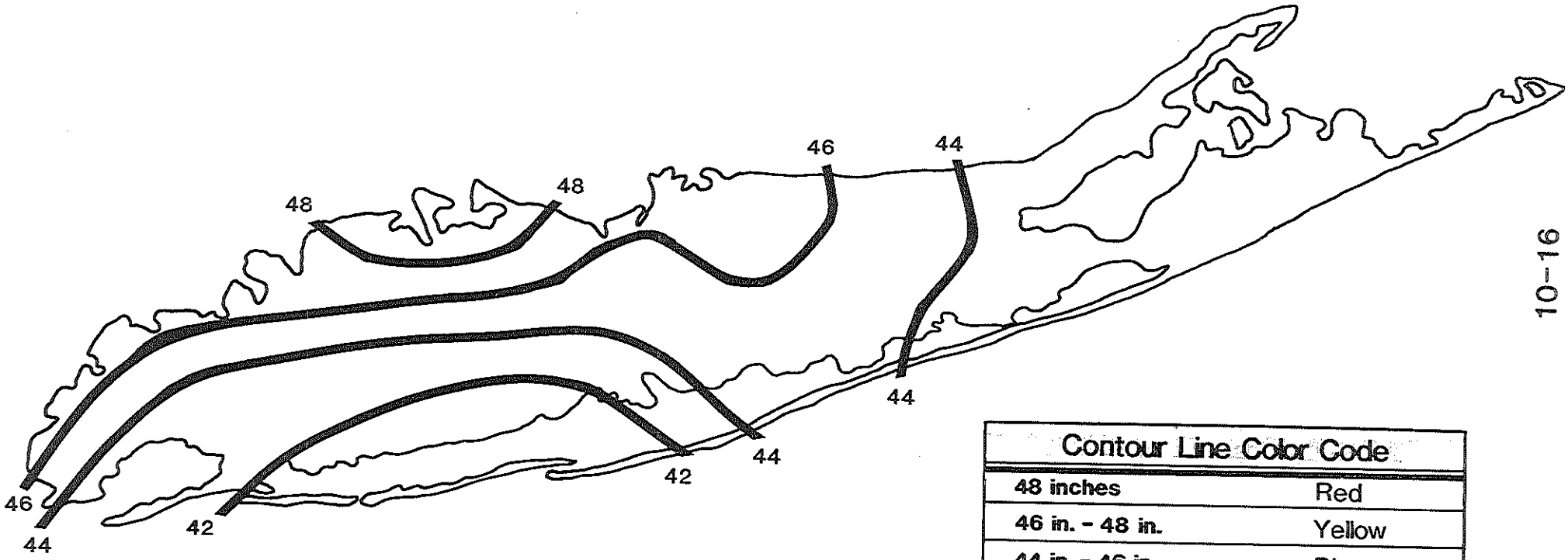
10-15

Source: AN ATLAS OF LONG ISLAND'S WATER RESOURCES., New York Resources Commission Bulletin 62, 1968.

name _____

Map #4 Average Annual Precipitation

Contour Lines Are In Inches



Contour Line Color Code	
48 inches	Red
46 in. - 48 in.	Yellow
44 in. - 46 in.	Blue
42 in. - 44 in.	Orange
40 in. - 42 in.	Green

Source: LONG ISLAND PRECIPITATION PATTERNS AND DROUGHT PROBABILITY, Atmospheric Sciences Research Center, ASRC Publication No. 1000, SUNY at Albany, NY, 1985.

name _____

Topo Map — Questionsheet A

Map #1: Topographic Map of Long Island

DIRECTIONS

1. **Color in Map #1.**
2. **Answer the following questions using Map #1.**

1. What is a contour line?

a. a line drawn on a map that stands for the borders of a lake.

b. a line drawn on a map that connects all places at the same elevation above or below sea level.

c. a line on a map that stands for ocean water depth.

d. a line on a map that stands for sea level.

2. What is sea level:

a. the height of the sea at high tide.

b. the height of the sea at low tide.

c. the average of high tide and low tide.

d. the height of the sea during a solar eclipse.

3. A wide space between contour lines on a map shows gently sloping land elevation. Which portion of Long Island is most gently sloping?

a. the north shore area

b. the south shore area

c. the south fork

4. Which portion of Long Island has the steepest shoreline?

a. north shore

b. south shore

5. Which of Long Island's forks has the lowest elevation?

a. north fork

b. south fork

name _____

Landform Map — Questionsheet B

Map #2: Glacial Landforms on Long Island

DIRECTIONS

1. **Color in Map #2.**
2. **Answer the following questions using Map #2.**

1. What made Long Island's landforms?

a. ocean waves
c. glaciers
b. wind
d. people

2. Which landform was formed by glacial meltwater streams?

a. moraines
b. outwash plains

3. Which landform has the highest land elevations?

a. Terryville outwash plain
c. Hempstead outwash plain
b. Ronkonkoma moraine
d. Harbor Hill moraine

4. Which moraine has the larger outwash plain south of it?

a. Ronkonkoma moraine
b. Harbor Hill moraine

5. While the younger moraine was forming it covered part of the older moraine. Which moraine partially covers the other?

a. Ronkonkoma moraine
b. Harbor Hill moraine

6. Which moraine was deposited first?

a. Ronkonkoma moraine
b. Harbor Hill moraine

7. Which moraine extends farthest out into the sea?

a. Ronkonkoma moraine
b. Harbor Hill moraine

name _____

Water Table Map — Questionsheet C

Map #3: Water Table Elevations Map of Long Island

DIRECTIONS

1. **Color in Map #3.**
2. **Answer the following questions using Map #3.**

1. On which portion of Long Island are water tables highest?

a. north and south fork
b. central Long Island
c. south shore
d. north shore

2. Which of Long Island's forks have the highest water table elevations?

a. north fork
b. south fork

3. On which portion of Long Island does the water table have a steep slope?

a. northeastern
b. southeastern
c. northwestern
d. southwestern

4. Which portion of Long Island has the highest water table elevation?

a. west central
b. east central
c. south shore
d. north shore

name _____

Rainfall Map — Questionsheet D

Map #4: Average Annual Precipitation on Long Island

DIRECTIONS

1. **Color in Map #4.**
2. **Answer the following questions using Map #4.**

1. Which portion of Long Island receives the least amount of annual precipitation?

a. the south shore and the north and south fork.

b. the north shore

c. central Long Island

2. Which of the following is true?

a. annual precipitation amounts get lower moving from the south to the north shore.

b. annual precipitation amounts get higher moving from central Long Island to the east.

c. annual precipitation amounts get higher moving from the south to the north shore.

d. annual precipitation amounts get lower moving from the tip of the south fork to the west.

3. Which portion of Long Island receives the greatest amount of annual precipitation?

a. northwestern shore

b. northeastern shore

c. central Long Island

d. southeastern shore

name _____

Map Data — Worksheet E

DIRECTIONS

Answer the following questions using Maps 1 - 4.

1. What town do you live in? _____

2. What is the elevation of your town? _____

3. What glacial landform is your town located on?

   a. Harbor Hill moraine
   c. Terryville outwash plain
   b. Ronkonkoma moraine
   d. Hempstead outwash plain

4. What is the elevation of the water table below your town?

   _____

5. Using the elevations of the land and water table in your area, figure out how deep you would need to dig to reach the water table.

   _____

6. What is the average annual rainfall or precipitation that your town receives?

   _____

name _____

Map Comparisons — Questionsheet F

Compare the maps listed below and circle the best answer to each question.

Compare Maps 1 and 2.

1. Which glacial landform has the highest elevations?

   a. outwash plain

   b. moraine

2. On which outwash plain are the highest elevations found?

   a. Hempstead outwash plain

   b. Terryville outwash plain

3. The Harbor Hill moraine formed the north fork. The Ronkonkoma moraine formed the south fork. What moraine formed the fork with the highest land elevations?

   a. Harbor Hill moraine

   b. Ronkonkoma moraine

   Which moraine has the largest number of hills of high elevation?

   a. Ronkonkoma moraine

   b. Harbor Hill moraine

Compare Maps 1, 2 and 3.

1. Which moraine has the highest water table elevations below it?

   a. Ronkonkoma moraine

   b. Harbor Hill moraine

2. Which moraine has the lowest land and water table elevations along its entire length?

   a. Ronkonkoma moraine

   b. Harbor Hill moraine

Compare Maps 1 and 4.

1. What is the largest amount of average annual precipitation (in inches) found on Long Island?

   a. 42 inches c. 52 inches

   b. 48 inches d. 44 inches

2. The highest levels of precipitation are found near which of the following areas?

   a. areas of low elevation

   b. areas of high elevation

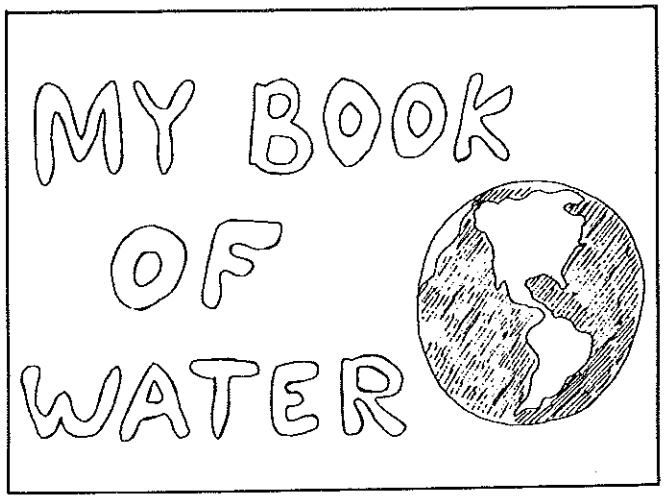
3. Compare the north and south fork's water table elevations to their land surface elevations. Circle the sentence below that best explains the connection between the land surface and water table elevation.

   a. Water tables are higher where land surfaces are higher.

   b. Water tables are lower where land surfaces are higher.

   c. Water tables are high where land surfaces are low.

WATER PICTURE BOOK



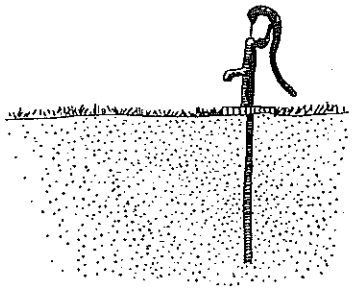
WATER

Picture Book

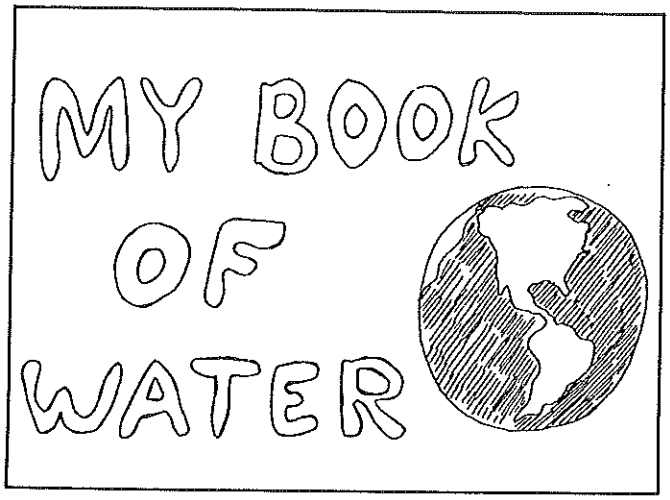
Grades K-2

Directions

1. Read with or to your students.
2. Cut out each frame and staple together to make a picture book. Staple the left side of the booklet.
3. Discuss the contents of the booklet.



Picture Book

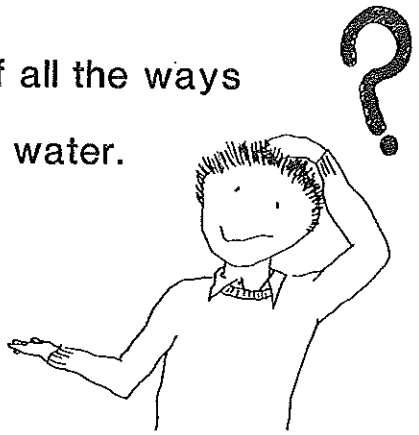


1)

Everyone on earth needs water to live.

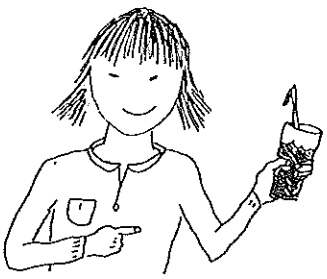
2)

Think of all the ways we use water.



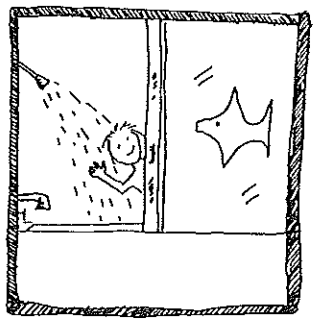
3)

We need water to drink.



4)

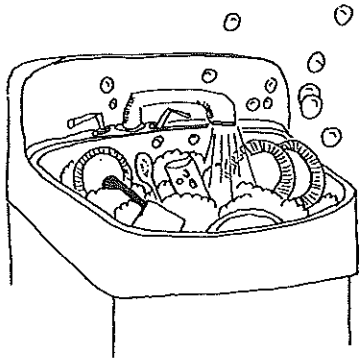
We need water to keep clean.



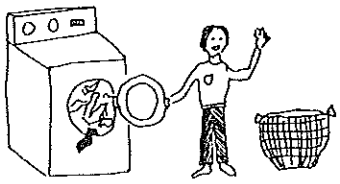
Picture Book Worksheet

5) We also need water to live in our homes.

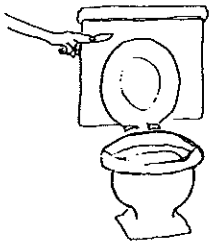
6) We need water to wash the dishes.



7) We need water to clean our clothes.



8) We need water to flush the toilet.



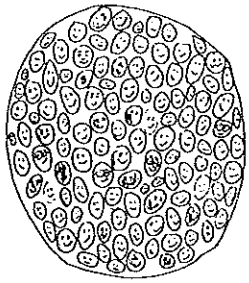
9) Can you think of other ways we need water?

10) Where does our water come from?

Picture Book Worksheet

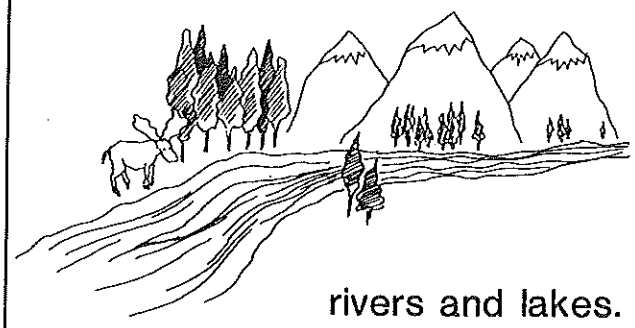
11)

People all over the world get water from different places.



12)

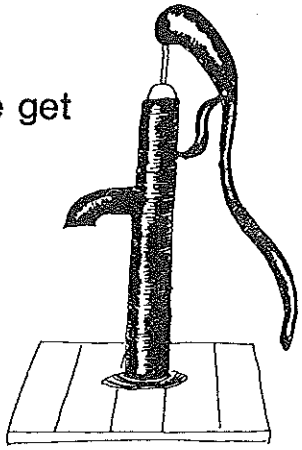
Many people get water from



rivers and lakes.

13)

Many people get water from wells.



14)

Wells get water from under the ground.

15) Water that comes from under the ground is

GROUND WATER

16)

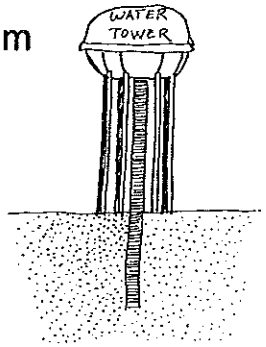
On Long Island, all our water comes from the ground.

Picture Book Worksheet

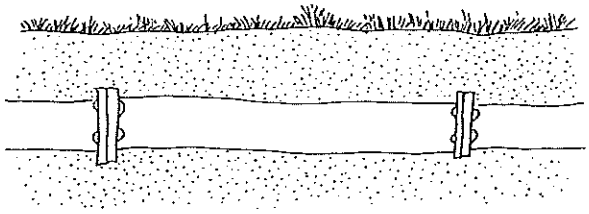
17) Groundwater comes from rain and snow.

18) It falls on the ground and sinks into the soil. The rain becomes groundwater.

19) We pump it from the ground.

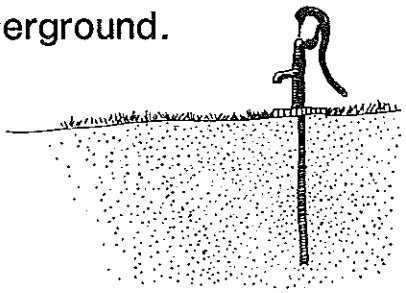


20) Then the water comes to our homes in underground pipes.



21) Many people live on Long Island.

22) There is a lot of water underground.



Picture Book Worksheet

23)

If the water becomes polluted, we can't drink it.

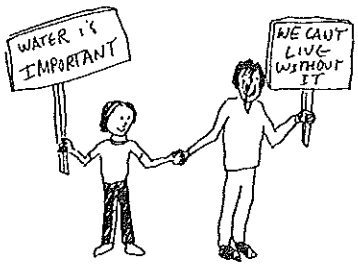
24)

We have to conserve water

so there is enough for everyone.

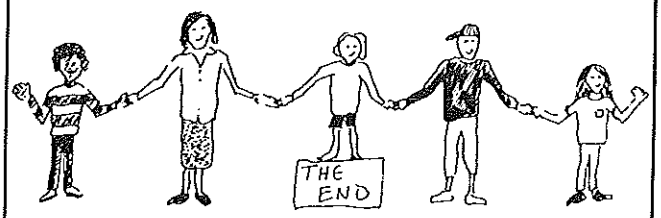
25)

We need to take care of our groundwater.



26)

We need everybody's help to keep our water pure and healthy.



THE END

GROUNDWATER AND GARBAGE DON'T MIX

Waste Production and Water Resources

GROUNDWATER AND GARBAGE DON'T MIX
Waste Production and Water Resources on Long Island

OBJECTIVES

Waste production is used to investigate lifestyle differences and societal changes by comparing and contrasting disposal practices with those of Colonial Americans and pre-Columbian Native Americans.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grades 4-6
Social Studies

ELEMENTARY SYLLABUS REFERENCES

Social Studies Program, Grades 4-6

Concepts and understandings found on the following pages:

Grade 4 Program, pages 40, 42, 52, 64, 78.
Grade 5 Program, pages 42, 46, 48, 56.
Grade 6 Program, pages 40, 60, 62, 90, 92, 94.

BEHAVIORAL OBJECTIVES

Upon completion of this activity, students should be able to:

a. list, for each item on the Garbage List, an alternative to throwing it out.
b. reconstruct, using the Garbage list of 20th Century American Life, the waste disposal practices of:
   1. a family living in America 200 years ago,
   2. an Indian group living in North America before Columbus.
c. Compare and contrast the life styles and waste disposal practices of:
   1. a 20th century American family,
   2. an American family living 200 years ago,
   3. an American Indian group living in North America before Columbus.

MATERIALS

Vocabulary List
Student Procedure Sheet
Garbage Day Read Sheet
Recycling Information Sheet
Worksheet A, B and C
Question Sheets

BACKGROUND INFORMATION

WASTES ARE JUST MISPLACED RESOURCES

Waste is an inevitable product of life. All life forms require resources to carry on. Wastes are produced as organisms utilize these resources. In earth's natural systems, waste generated by living things becomes enrichment for other forms of life.

The term "waste" implies something that is of no use - though many wastes produced are useless, many are not. Many are just misplaced resources. And our society misplaces alot of them.

GROUNDWATER AND GARBAGE DON'T MIX
Waste Production and Water Resources on Long Island

GARBAGE BECOMES A GROUNDWATER PROBLEM WHEN IT IS THROWN AWAY

Waste is an inevitable product of our society. We will always produce it. We will always have to throw some of it away. Waste becomes a water problem at this juncture because the more we throw away the more it threatens our surface and groundwater supplies.

As industrial society and highly populated metropolitan areas have grown, a situation has been created where waste production has been ultra-centralized. Most garbage is landfilled without regard for its potential value or reuse. Many new types of wastes are different, too. Some are toxic and hazardous.

MANY WASTES CAN BE RECYCLED

A good deal of our waste production results from not closing the circle in the recycling process. Oil, glass, paper, food, plastics and metals can all be reused. Recycling not only preserves our quality of life by conserving and protecting resources, it also benefits us financially. Recycled materials require less energy to remanufacture into new products. Raw materials do not have to be mined, refined or harvested. Consequently, goods made with recycled materials cost less to produce. Towns operating recycling centers profit by selling used materials to industry. Less waste means less landfill space needed. The more we decrease the amount of waste we produce, the more we protect our water supply.

MANY WASTES ARE PRODUCED IN THE MANUFACTURE OF PRODUCTS AND ARE THROWN AWAY BEFORE WE BUY THEM

In addition to the garbage we discard, there are the wastes produced during the manufacturing process that are thrown away prior to our consumer purchases. They can be quite nasty. Some of these hidden wastes include metal sludges, corrosive acids and toxic cyanides left over from the production of televisions, microwave ovens and blenders. The manufacture of newspapers, books and magazines leaves behind oils, toxic sludges and solvents. By-products of electronic equipment production include heavy metals, flammable alcohols, corrosive acids and toxic organic chemical wastes.

DO INDIVIDUALS HAVE ANY CONTROL?

What can individuals do about how manufacturers dispose of their wastes besides becoming frustrated? Do we have any control? One method is to practice responsible buying by asking the following questions before purchasing goods.

1. Do I really need this product?
2. Is this product recyclable?
3. Is the product and/or its packaging made from biodegradable materials? When thrown away will it ever actually go away?
4. Does the product's list of ingredients include any hazardous ones?
5. What sorts of waste by-products are produced in the manufacture of this product?
6. All things considered, do I still really need or want this product?

ANY SUBSTANCE RAINFALL COMES INTO CONTACT WITH CAN REACH GROUNDWATER

On Long Island, the barriers between waste and water are tenuous, at best, because of the nature of our water supply system and the numbers of people who reside here. Any substance that rainfall comes into contact with as it filters down to the groundwater can potentially taint the supply; our aquifers are replenished solely by snow and rain water.

Clearly alternatives to the landfilling of wastes will have to be implemented in the not too distant future. A most important place to start curtailment of waste production is with ourselves. We can begin by consciously purchasing both recyclable and recycled goods. By learning about the hidden costs of products: the waste by-products produced in manufacture and the destination of those products after they outlive their usefulness, we are better able to exert the modicum of control we have over the amount and types of wastes produced.

PROCEDURE

1. Introduce background material on wastes, recycling, landfills and groundwater pollution. Discussion can include how the amounts and types of garbage produced in America today are unprecedented when compared with America's past and also with other regions of the world today.

2. Divide the class into pairs or groups.

3. Distribute handouts.

4. Have students read GARBAGE DAYS.

5. Working in groups, students should complete Activities 1-3 that follow the reading sheet. They will need the Garbage List, the Household Recycling Info. Sheet and Worksheets A, B and C.

6. Have students complete the Analysis Sheet at the end of this section.

REFERENCES

HOUSEHOLD HAZARDOUS WASTE, Massachusetts Dept. of Environmental Management, Bureau of Solid Waste Disposal, 1984.

GROUNDWATER: New Perspectives, New Initiatives, The Journal of Freshwater, Volume 9, Freshwater Foundation, 1985.

TOWARDS HAZARDLESS WASTE: A Guide for Safe Use and Disposal of Hazardous Household Products, Sally Toteff and Cheri Zehner, Municipality of Metropolitan Seattle and The Seattle-King County Dept. of Public Health, 1985.

TOXIC SUBSTANCES: How Toxic is Toxic? Bureau of Toxic Substance Assessment, NY State Health Dept., Albany, 1984.

WISCONSIN NATURAL RESOURCES: Special Recycling Edition, July/August 1985; Volume 9, Number 4.

Vocabulary

LANDFILL: A place where waste material is dumped in specific areas, compacted by heavy machinery, and buried with soil.

GROUNDWATER: Water which exists underground in the spaces between the sand or rock grains called "pores'. The water contained within the groundwater comes from rainwater that falls on earth and sinks or percolates through the soil.

TOXIC SUBSTANCE: A substance poisonous or deadly to certain types of organisms.

SOLID WASTE: Anything and everything a family, business, or institution considers useless or unwanted. This includes garbage, rubbish, ashes, street sweepings and trash.

RECYCLABLE MATERIALS: "Waste" materials such as glass, metals, and paper which can be remanufactured into useable items.

Student Procedures

1. Read the story, GARBAGE DAY.

2. Worksheet A

   a. Use the Household Recycling Info. Sheet to find other uses for the garbage items listed on Worksheet A. Can you think of other ways to reuse these wastes besides the ones given? If so, write them down.

   b. If you can't find or think of a way to reuse or recycle an item, write, NO APPARENT WAY TO REUSE OR RECYCLE. Then state a reason why it can't be reused.

3. Worksheet B

   Do you think an American family living 200 years ago would have been able to buy, use or throw away any of the items on the Garbage List: For each item on Worksheet B:

   a. write YES if you thought they would have bought, used or thrown away any item on the list,

   b. write NO if you didn't think they would have,

   c. write what this family would have used in place of each item that they couldn't buy.

4. Worksheet C

   Do you think a Native American Group living in America before the arrival of Columbus would have used or thrown away any of the items on the Garbage List? For each item on Worksheet C:

   a. write YES if you thought they would have used or thrown away any item on the list,

   b. write NO if you didn't think they would have,

   c. write what this group would have used in place of the items they couldn't use. (For example, they may have used clay pots for glass jars).

Garbage Day Read Sheet

An everyday ordinary scene on a Long Island street: one or two garbage cans, waiting at the curb, filled to the rim with large plastic bags containing garbage. Soon the garbage truck will come. After it's taken away, where is it put? What happens to it?

The garbage truck continues on its route. When the container in back is full it is driven to the local landfill. At the landfill, the truck deposits its load. Once empty, the truck leaves to collect more trash in other neighborhoods.

At the landfill, the garbage is covered with sand and compacted with heavy machinery. Covering the garbage keeps away rats and insects. Compacting the garbage makes room for more. The garbage is out of sight and well disposed of. Right? Maybe, maybe not.

Storm clouds move in and rain falls, soaking the soil-covered landfill. When rain falls on soil, it sinks or filters down through it. This happens at the landfill, too. The water sinks into the buried garbage and may become polluted. If something toxic or harmful was buried as garbage, the rainwater may become very polluted. If the landfill has no protective liner below it or one that is leaky, the polluted water may continue to move through the soil until it reaches the groundwater.

The water in groundwater doesn't stay in one place. It is constantly flowing underground. It moves in one direction but it is not like a river. It moves through the spaces between the rocks and sand underground.

Groundwater doesn't move very fast at all. It may only move a few hundred feet per year. (One mile is over 5,000 ft.) When polluted water reaches the groundwater it begins to move with the groundwater. Because groundwater moves, water polluted beneath a landfill can, after some time, contaminate water wells that Long Islander's need for fresh, clean drinking water.

But before the garbage truck arrives, let's look into the trash cans and find out whether all these "wastes" really should end up in the dump. The following list is what we discovered in the garbage pails. Read over the list.

Garbage List

1	empty coffee can with lid
4	quarts of used motor oil, tightly sealed in a gallon
1	plastic milk container
6	aluminum soda cans (returnable)
1	broken clock/radio
1	empty spray can of oven cleaner
4	newspapers
3	magazines
10	plastic bags from bread and vegetables
2	large plastic bags of grass clippings and leaves
5	aluminum TV dinner trays
4	glass jars (non-returnable)
1	empty gallon plastic milk container
1	styrofoam egg carton
5	packaging, bags, cups and trays from a fast food take-out dinner for a family of 5

name _____

Recycling Information Sheet

NEWSPAPERS	These can be recycled. Some towns pick up newspapers. They can also be brought to a recycling center. They are then sold to companies that recycle paper.
PAPER BAGS	These can be reused. Paper bags can also be used to wrap packages that are to be mailed.
GLASS BOTTLES	Soda and beer bottles should be returned to the store. Glass jars can be used to store things around the house. Non-returnable bottles can be taken to a recycling center. They will be sold to companies that recycle glass. Some towns will pick up glass bottles.
PLASTIC CONTAINERS	Soda bottles should be returned to the store. Plastic containers can be used to store things. Plastic cups and bowls can be used in art and craft classes so they can be donated to schools and youth groups. Bird feeders can be made of plastic milk bottles.
METAL CONTAINERS	Soda and beer cans should be returned to the store. Coffee cans can be used to store things.
GRASS CLIPPINGS AND LEAVES	Clippings can be left on the lawn to recycle them. They can also be used as mulch in the garden or around shrubbery. Leaves can be composted and used to improve the soil.
FOOD SCRAPS	Meat scraps can be fed to pets. Vegetable scraps can be added to a compost pile.
PLASTIC BAGS	Plastic fruit and vegetable bags, bread bags and other bags can be reused.
MAGAZINES	Magazines can be donated to nursing homes. School art classes can also use them for art projects.
ALUMINUM	Pie pans, baking trays and TV dinner trays can be cleaned and reused. They can also be taken to a recycling center. Some towns will pick up aluminum.
USED MOTOR OIL	The waste oil should be put in a container and tightly sealed. The container can be taken to a car service station that does car repairs. They must accept it. Town landfills and recycling centers may also collect waste oil. This oil is cleaned and used to make other petroleum products.

SOURCE: Edited from "Understanding Our Groundwater", Solid Waste Disposal Sheet SW-1, Cooperative Extension of Nassau and Suffolk County, New York

name _____

Garbage Day Worksheet A, B or C

1. **Find A, B or C in the top right corner of this sheet. Circle one of the letters to show which worksheet this is.**
2. **Read the Student Procedure Sheet for directions.**

empty coffee can with lid	
used motor oil	
aluminum soda cans	
broken clock-radio	
can of oven cleaner	
newspapers	
meat and vegetable scraps	
old magazines	
plastic bags	
grass clippings and leaves	
TV dinner trays	
glass jars	
plastic milk container	
styrofoam egg carton	
fast food dinner packaging	

name _____

Garbage Day — Question Sheet

DIRECTIONS

Answer the following questions.

1. Did present-day Americans, Americans of 200 years ago and Native Americans living before Columbus' arrival use and throw away similar items?

   a. yes

   b. no

2. List all the items on the Garbage List that the American family, living 200 years ago, would have used and thrown away.

   _____

   _____

3. Why did Americans of 200 years ago throw away so much less garbage than we do today?

   _____

   _____

4. List 3 items or materials, on the Garbage List, that had not even been invented 200 years ago.

   a. _____

   b. _____

   c. _____

5. What sorts of items or materials (if any) would the Americans of 200 years ago have used for the same purposes as the items you listed above?

   _____

   _____

name _____

Garbage Day — Question Sheet

6. List 2 items from the Garbage List that a Native American family would have thrown away.

   a. _____

   b. _____

7. List 2 things you would expect a Native American, living long ago, to have thrown away?

   a. _____

   b. _____

8. List 2 items or materials that a Native American would have used in place of the items or materials found on the Garbage List. (For example, what kinds of materials would they have used to make containers or bags?)

   a. _____

   b. _____

9. When a Native American, living long ago, threw something away, would it have looked like litter? _____

   If you think it wouldn't, why not? _____

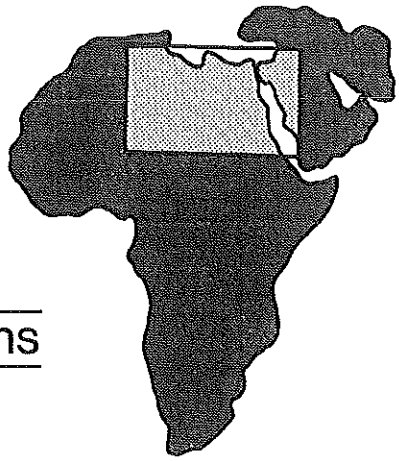
   _____

10. List 2 ways you can reduce the amount of garbage you throw away.

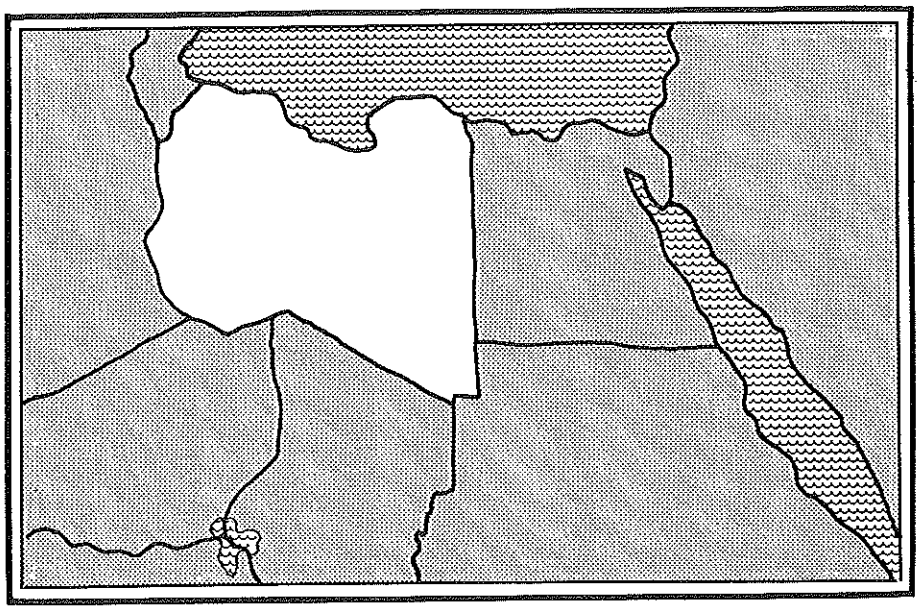
    a. _____

    b. _____

THE GREAT MANMADE RIVER



Technology, Water Resources and Limitations



THE GREAT MANMADE RIVER
Water Resources, Technology, and Limitations

OBJECTIVES

Students read and comprehend a dilemma that concerns a water pipeline project in the Middle East. Pros and cons are discussed and students arrive at a conclusion about the viability and sustainability of the water project.

SUGGESTED GRADE LEVEL AND DISCIPLINE

Grade 6
Social Studies

ELEMENTARY SYLLABUS REFERENCES

SOCIAL STUDIES PROGRAM 6

Concepts and understandings found on the following pages: 40, 54, 60, 62, 68, 80, 84, 86, 90, 92, 94, 96, 98.

BEHAVIORAL OBJECTIVES

Upon completion of this activity, students should be able to:

a. research physical and cultural geographic information about a Middle Eastern country and about Long Island.

b. compare and contrast this information and come to conclusions about the differences in our water resources.

c. read and comprehend a story about a water project in a Middle Eastern country.

d. develop a list of pros and cons that concern this project.

e. come to a conclusion about the viability and sustainability of this water project.

MATERIALS

Vocabulary List
Worksheet A and B
Read Sheet
Question Sheet

MAJOR UNDERSTANDINGS

Geographic and climate conditions have, historically, shaped human cultures, economics, populations and settlement patterns.

Nature has finite resources.

Availability and allocation of limited resources must be reconciled with the unlimited needs and wants of the human groups who use them.

Geographic features influence land usage.

The lifestyles of desert people are shaped by water scarcity.

Adaptations to desert living include nomadic lifestyles and water-conserving agricultural practices.

Regions with abundant freshwater resources can become deserts if the water supplies become polluted.

Some desert countries, such as those found in the Middle East, have developed wealth through the discovery and production of oil resources.

The effects of geography can be moderated by technology.

Technology created to alleviate conditions of water scarcity should be sustainable.

On Long Island, we affect our water resources by pollution, overuse and modification of recharge dynamics.

By affecting the quality and quantity of a water supply, we increase the limitations our resources place upon us and decrease the amount of control we have over our lives.

A clean, plentiful water supply is not a right.

Regions with abundant water supplies can become like deserts if the water becomes polluted.

BACKGROUND INFORMATION

THE AVAILABILITY OF WATER HAS FUNDAMENTALLY SHAPED HUMAN CULTURES

Geography and climate influence societies worldwide. Freshwater availability, in particular, has fundamentally shaped human culture, economics, populations and settlement patterns. Even with such sway, the importance of water is often slighted. Until recently, people living in water-rich places such as Long Island seldom considered the possibility of ever wanting for water. Access to freshwater was even thought to be a basic human right. However, in lands where dry conditions are widespread and evident, people are perpetually mindful of scant freshwater. Their values, lifestyles and behavior are molded by limitations imposed by scarcity of water.

THE LIMITATIONS OF DESERTS HAVE SHAPED THE PEOPLES WHO LIVE IN THEM

All aspects of life conform to the desert, especially food production. Farming is a people's most basic connection to the land and its vagaries; agricultural adaptations to desert extremes are unique. Irrigation methods, seed varieties and planting timing are honed by a parched landscape. Nomadic peoples of the desert have traditionally coped with harsh circumstance by forsaking rooted agriculture altogether. Their land is harsh and too barren to support them in any one location for too long; they just just move on.

Historically, the economic potential and development of a region has been intractably affected by geography and climate. However, with the advent of the 20th century, the importance of water as a factor determining and defining a nations' economic advancement has been replaced with another fluid - oil. Mexico and many Middle Eastern countries are places where this fluid exchange has taken place.

LIMITATIONS IMPOSED BY GEOGRAPHY AND CLIMATE CAN BE MODERATED BY TECHNOLOGY

The effects of geography can be moderated by technology. New found wealth has enabled desert countries to overcome many economic and social problems that stem from environmental conditions. But can wealth from oil surmount water shortage and alter the adaptations that people have developed to cope with scarcity? If so, how would cultures, economics, popula-

tions and settlement patterns change? Are there different ways to approach solving environmental problems? Are there ways that are ill-advised?

HUMAN NEEDS AND WANTS ARE INFINITE– THE EARTH'S RESOURCES ARE NOT

The resources the earth provides have finite limits. Human groups, potentially, have unlimited wants and needs. Planning for resource use should be based on the meshing between human needs and the limitations of nature. Technology created to change conditions of scarcity should be sustainable and provide not only for the needs of a society but also for those of its descendants.

The reading material and worksheets in this section concern a water project in Libya. It exemplifies the conflict between ability to control nature and a willingness to understand that humans are, themselves, controlled by the limitations imposed by nature.

ALL WATER SUPPLIES ARE FINITE AND SUSCEPTIBLE TO POLLUTION

Although Long Island is far from a desert, even water-rich regions can have severe water problems. We live atop a reservior of groundwater. Though it seems inexhaustible, this water supply is limited and susceptible to pollution from above. The shear quantity of water in this system can create a false sense of security.

We control our water resources through use and modification of its physical dynamics. Its finiteness and fragility control us. By affecting quantity and quality we increase the limitations our water supply places upon us and decrease our own control over it. Access to freshwater is not a right.

WATER-RICH REGIONS BECOME DESERTS IF THE WATER SUPPLY IS OVERUSED OR POLLUTED

The origins of the word desert can be traced to the Latin word; deserere, which means to abandon. Humans perceive the world through the eyes of their needs. This word describes a reaction to a land that cannot support life. Those who stay on the land live with it or they must leave. Regions with naturally abundant freshwater resources can become deserts if the water supply is overused or polluted.

PROCEDURE

1. Have students complete Worksheet A as homework. Some research is involved so provide enough time for completion.

2. Present material on the physical and social geography of the Middle East and of Long Island. The concepts that apply to water resources issues are discussed in the background material of this section.

3. Divide the class into groups of 4 or 5 and have each group choose a leader/spokesperson.

4. Hand out copies of the story, "The Great Manmade River", to each student.

5. After reading the story, each group should discuss the pros and cons of the water project. Using Worksheet B, each group should:

   a. compile a group pro and con list.

   b. come to a conclusion as to whether the water project should be undertaken.

c. come up with an alternate plan that would make use of the extensive groundwater reserves, but be sustainable for the future.

FURTHER ON

1. People of the desert have evolved ways to cope with lack of water. Some of their adaptations include nomadic lifestyles and agricultural practices such as drought-resistant seed selection and water-conserving irrigation practices. These modes have been passed down from generation to generation and are learned through experience. Depending on the culture and its methods of skill transmission, a way of life evolved to cope with a limited water supply could disappear in a generation - 50 years. This length of time is approximately the planned lifespan of the Libyan pipeline. What consequence could this loss have for future generations who won't have the benefit of a working water pipeline?

2. Increased food production as a result of irrigation will cause human populations to grow. The capacity of the land to support a larger population will last only as long as irrigation is continued. What will the future bring for a country that increases its farm production through irrigation then runs out of water? Who will be responsible?

3. The oil supplies of earth are running out. Estimates of the longevity of the world petroleum supply assert that by the 2030 90% of the oil reserves will be gone. We will have effectively run out of oil. In the meantime, the petroleum market is volatile. As the supply dwindles, the market will become more and more erratic. The money Libya receives from its harvest of oil is the source of the funds needed to construct and operate the pipeline system. What will happen when Libya's oil exports are reduced as the oil supply diminishes? Will there be money to maintain the system and keep it working? Will the pipeline have funds to keep working up to the end of its predicted lifespan?

4. Is this project a sound one? Are there places on earth where we must recognize limits placed upon us by natural forces? Should we develop systems, such as the pipeline project, with the prognostication that we will be able to devise other technology to solve the problems already forseen?

5. A water resource dilemma that Long Island faces is similar, in some respects, to that of the Libyans; it is one of a limited water supply. The problem that looms ahead for us is from a large and ever increasing population threatening and limiting our finite water supply through overuse and pollution rather than a natural scarcity of water. Though Long Island's problem is one of water quality more than quantity, we face the possibility of having our water supply "cut off" by running out of pure water. Are we counting on developing new technology to solve our water supply problems? What will happen if we develop Long Island beyond the land's ability to fulfill the needs of its inhabitants?

REFERENCES

ALDINE UNIVERSITY ATLAS, Norton Ginsburg, Aldine Publishing Co., London, 1969.

HUMAN ECOSYSTEMS, W. B. Clapham, Jr., Macmillian Publishing Co., New York, 1981.

The Wall Street Journal, Gerald F. Seib, "Libya Launches $25 Billion Project to Quench Sahara Nations Thirst", October 3, 1985.

U.S. Water News, "Khadafy Accused of Water War", January, 1986.

NOTES

The Great Manmade River Dilemma

Vocabulary

GEOGRAPHY: The study of the earth's surface. This includes its physical features, climate, soils, vegetation, resources and people.

CLIMATE: The average weather conditions of a place throughout the seasons.

GROUNDWATER: Underground water that exists and moves in the pore spaces between rocks. This water comes from rain and snow which falls on the land's surface and sinks down through the soil.

DESERT: A land where rainfall amounts are small or undependable. The plants and animals that live in deserts have special adaptations that help them to survive dry conditions.

IRRIGATION: Farmland watering by people in places where rainfall amounts are too low for crops to grow naturally.

WATER PIPELINE: A system of pipes that carry water from an area where it is plentiful to an area where it is scarce.

WATER SCARCITY: A lack of enough water.

NATURAL RESOURCE: Materials found in nature that are valuable such as water, trees and minerals.

SCARCITY: A shortage or lack of something wanted such as a natural resource.

TECHNOLOGY: The knowledge, ways and tools that people use to change their environment to get what they want and need.

ENVIRONMENT: Our surroundings. This includes nature and manmade environments.

PROS AND CONS: Reasons for and against something.

PROS: Reasons for.

CONS: Reasons against.

LIFESTYLE: A way of life that shows the values and attitudes of a person or culture.

name _____

The Great Manmade River — Worksheet A

Use the library to find the following information.

Libya

1. What is Libya's population? _____

land area? _____ square miles

annual rainfall? _____

population per square mile? _____

New York

2. What is New York's population? _____

land area? _____ square miles

annual rainfall? _____

population per square mile? _____

Circle the correct answer.

1. Which of the following has the larger land area?

   A. New York

   B. Libya

2. Which of the following has the least amount of rainfall?

   A. New York

   B. Libya

3. Which of the following has the greatest number of people per square mile?

   A. New York

   B. Libya

The Great Manmade River — Read Sheet

A Desert Country

Libya is a country in the Middle East. Throughout history, countries in this desert region have been poor and underpopulated because they have very little water. Recently, Libya and other Middle Eastern countries have become wealthy because of the discovery of oil under the desert. A country without enough water still has big problems that even money can't solve. Or can it?

Groundwater Discovery

Almost no one lives in Libya's southeastern desert. Back in the 1960's, geologists were in this area exploring for oil. During their search, they discovered large reserves of groundwater in the sands below the desert. The government wanted the Libyan people to have use of this water even though they lived far from it. A decision had to be made on whether to move the people to the water or the water to the people.

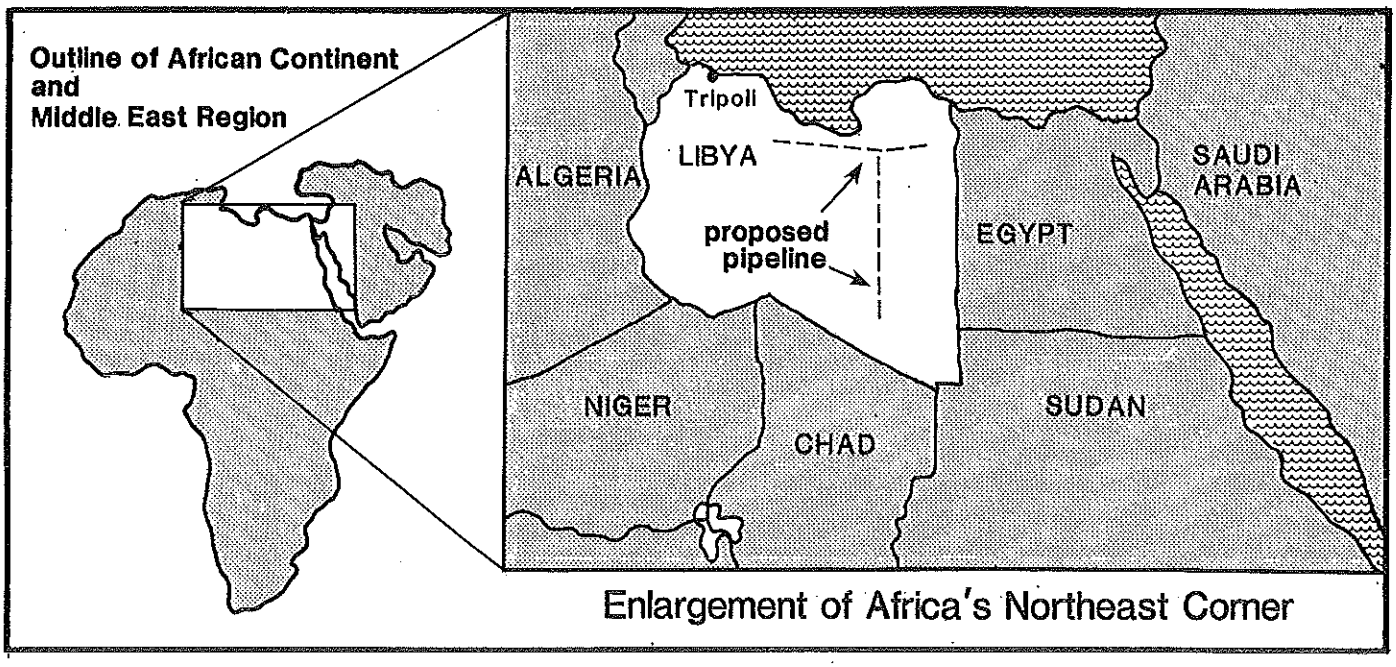
A decision was made to move the water to the people. An enormous concrete pipeline system was planned to move water to the country's populated areas.

A Pipeline Is Planned To Move Water

The pipeline will carry water north to Libya's Mediterranean coast. Once at the coast, the plan calls for water to be piped both east and west. In later years, more pipeline would bring water west to Libya's capital, Tripoli, then further east towards the Egyptian border. Construction would also begin on a separate pipeline to tap more groundwater that has been discovered in Libya's western desert.

25 Billion Dollar Pipeline

When this pipeline project is finished 2,500 miles of concrete pipe will have been laid. In addition, a system large enough to irrigate almost half a million (500,000) acres of land will be constructed. The total cost will be about 25 billion dollars. When complete, the amount of water pumped and carried by the pipeline will be equal to the daily production of all oil wells in the world. This pipeline is expected to last at least 50 years.



Name _____

The Great Manmade River

Question Sheet

Circle the correct answer. For question 4, use the bottom of this sheet and continue on the back.

1. Why is Libya's population small when compared to its land area?

   a. The desert is too hot.

   b. The desert is too sandy to grow crops.

   c. There is not enough rainfall.

   d. Sandstorms harm the people's cattle, sheep and goats.

2. What is the main reason why lack of water keeps population levels low?

   a. There is not enough water to drink.

   b. There is not enough water to grow crops.

   c. There is not enough water for cattle to drink.

   d. There is not enough water to take showers.

3. If the pipeline is built it will make the irrigation of large land areas possible. Hundreds of thousands of acres of desert will produce food. As food production increases what will happen to the population?

   a. It will decrease.

   b. It will increase

   c. It will stay the same.

   d. It will fall then rise again.

4. The water pipeline will provide Libya with a new water supply. It is predicted that the pipeline will last 50 years. Write an essay about what might happen when the water runs out after 50 years.

name _____

Pros and Cons

Add more pros and cons to the list below and come to your own conclusion about the pipeline project.

PROS	CONS
1. The pipeline would turn desert into farm land.	1. The pipeline is very expensive.
2.	2.
3.	3.
4.	4.

1. Do you think the pipeline should be built? Why?

2. Come up with a plan to use Libya's groundwater that will last into the future.

Other Curriculum Resources

A CURRICULUM ACTIVITIES GUIDE TO WATER POLLUTION AND ENVIRONMENTAL STUDIES - Volume one and two, John Hershey et al, 1972.

Volume 1: contains activities covering the hydrologic cycle, human activities, ecological perspectives and social and political factors.

Volume 2: is an appendix to Volume 1 and is a technical reference guide organized into 4 parts: chemistry, bacteriology, aquatic biology and engineering and physics.

A CURRICULUM ACTIVITIES GUIDE TO WATERSHED INVESTIGATION AND ENVIRONMENTAL STUDIES, Peter A. Gail, et al., 1974.

Primarily addresses surface watershed studies in an interdisciplinary manner.

(Institute for Environmental Education, 32000 Chagrin Boulevard, Cleveland, Ohio 44124, contact for prices.)

A GUIDE FOR TEACHING REGIONAL ENVIRONMENTAL PLANNING, Martin T. Hetherington et al.

(Science and Mathematics Teaching Center, E-37 McDonel Hall, Michigan State University, East Lansing, Michigan 49924, free.)

GROUNDWATER: A VITAL RESOURCE - Student Activities, compiled by Cedar Creek Learning Center in cooperation with Tennessee Valley Authority, 1986.

(Tennessee Valley Authority, Office of Natural Resources and Economic Development, Environmental Energy Education Program, Knoxville, Tennessee 37902, free.)

INVESTIGATING YOUR ENVIRONMENT - Teaching Materials for Environmental Education, U.S.D.A. Forest Service, Washington, D.C., 1980.

UNDERSTANDING THE GAME OF THE ENVIRONMENT - An Illustrated Guide to Understanding Ecological Principles, David R. Houston, Agricultural Information Bulletin No. 426, U.S.D.A. Forest Service, Washington, D.C., 1979.

(U.S.D.A. Forest Service, P. O. Box 2417, Room 3233, Washington, D.C. 20013, available free.)

PROJECT WILD: an interdisciplinary, supplementary environmental and conservation curriculum.

(Mike Cavanagh, New York State Dept. of Environmental Conservation, 50 Wolf Road, Room 507, Albany, NY 12233, phone # (518) 457-0849, contact for more information.)

THE RAIN BOOK (Grades 2-7). 1980

THE LAKE BOOK (10-12). 1981

THE POND BOOK (4-7). 1977

THE ESTUARY BOOK (7-12). 1981

THE CREEK BOOK (3-7). 1978

THE BEACH BOOK (2-7). 1978

THE SNOW BOOK (2-7). 1978

These are creative environmental activity and idea books.

(Western Education Development Group, The University of British Columbia, Vancouver, British Columbia, Canada V6T 1W5, write for a book list and order form.)

BIOLOGICAL ENVIRONMENTAL PICTORAL INVESTIGATIONS, Paul W. Richard, Laboratory School at the University of Northern Colorado, 1978.

A student activity guide for exploring environmental topics through the use of pictures. Classroom use. Grades 7-8. (Stonecrop, P.O. Box 685, Greeley, Co. 80632, $4.75 plus 15% postage and handling.)

CARE OF A SMALL PLANET:
1) THE HUMANITIES, Margaret Cottom-Winslow, 1980.
2) THE SCIENCES, Paul F. Brandwein, 1980.
3) THE SOCIAL SCIENCES, Rudolph Schwartz, 1980.

Three separate, overlapping text that explore environmental concepts through science, social science and humanities. Classroom and lab use. Grades 7-8. (Harcourt Brace Jovanovich, Inc., 757 Third Ave., New York, NY 10017, Student Resource Books, $4.50 each, Teacher guide, $1.20.)

ENCOUNTER WITH THE NORTHWEST ENVIRONMENT: NATURAL AND URBAN, Environmental Planning and Management Associates, 1980.

Provides a framework for exploring a regional environment and setting up a system of environmental learning sites. Both natural and urban sites are considered. Grades 9-12.
(ERIC, Clearinghouse for Science, Mathematics and Environmental Education, 1200 Chambers Road, Columbus, OH 43212, contact for price.)

ENVIRONMENTAL EDUCATION ACTIVITIES MANUAL, William B. Stapp and Dorothy A. Cox, 1979.

Contains materials that integrate an environmental education model into the learning activities of students K-12.
(William B. Stapp/Dorothy A. Cox, 32493 Shady Ridge Drive, Farmington Hills, MI 48108, contact for price.)

ENVIRONMENTAL ENCOUNTER: Experiences in Decision-making for the Built and Natural Environment, Joanne Henderson Pratt et al., 1979.

(Reverchon Press, P. O. Box 19647, Dallas, TX 75219, $14.95/softbound.)

INVESTIGATING YOUR ENVIRONMENT: Biological Sciences Curriculum Study, Regents of the University of Colorado, 1975.

An instructional module supporting specific environmental explorations. Grades 9-12. Science, social studies. (Addison-Wesley Publishing Company, 2725 Sand Hill Road, Menlo Park, CA 94025, teacher handbook $6.00, student hardbook $6.60.)

WE CAN HELP: Environmental Education Teaching Resources, Minnesota Environmental Science Foundation, 1975.

Environmental education teaching resource packet with multiple outdoor investigations designed to enhance information gathering. Grades K-12.
(Jenny Publishing Company, 57 Queen Avenue, South Minneapolis, MN 55405. Contact for prices.)

TUNING THE GREEN MACHINE, An Integrated View of Environmental Systems, Institute for Environmental Education, Oceana, Dobbs Ferry, NY, 1978.

Other Curriculum Resources continued

THE STORY OF DRINKING WATER - Teacher's Guide, Advanced Level, Grades 7,8,9, Rosalie Bock, 1984.
(American Water Works Association, Public Information Dept., 6666 W. Quincey Avenue., Denver, CO 80235, write for curriculum samples, price list and order form.)

THE SEARCH FOR SOLUTIONS TEACHING NOTES
This is a compendium of science classroom activities often including water and water - resources - related topic. Published 3 times a year. (THE SEARCH FOR SOLUTIONS TEACHING NOTES, Playback Associates, 708 3rd Avenue, New York, New York 10017, contact to be placed on mailing list, free.)

Groundwater and Surfacewater Information

A GUIDE TO THE STUDY OF FRESHWATER ECOLOGY, William A. Andrews, Contours Series: Prentice Hall, Englewood Cliffs, NJ 1977. Also by same author:

A GUIDE TO THE STUDY OF ENVIRONMENTAL POLLUTION

A GUIDE TO THE STUDY OF SOIL ECOLOGY

A GUIDE TO THE STUDY OF TERRESTRIAL ECOLOGY

THE FRESHWATER SOCIETY
Innovative public education material. (Ginny Lee, Freshwater Society, 2500 Shadywood, Box 90, Navarre, MN 55392, phone # (612) 471-7467, contact for more information, a publication list and an order form.)

UNDERSTANDING OUR GROUNDWATER, Cooperative Extension of Suffolk County.
This is a series of 9 bulletins and 56 fact sheets. Topics include groundwater resources, conservation pollution, land use, groundwater management. (David Newton, Cooperative Extension of Suffolk, 246 Griffing Ave., Riverhead, NY 11901, contact for publication list/order form.)

A CITIZEN'S HANDBOOK ON GROUNDWATER PROTECTION, Wendy Gordon, Natural Resources Defense Council, 1984.
(Natural Resources Defense Council, 122 East 42nd Street, New York, NY 10168, $10.00 /paper.)

GROUNDWATER MANAGEMENT, A Handbook for the South Fork, Group for the South Fork, 1982.
Though this booklet deals with Long Island's South Fork much of the information is applicable to other regions of Long Island.

GUIDE TO DRINKING WATER QUALITY TESTS AND WATER TREATMENT SYSTEMS, Group for the South Fork, 1986.
This guide contains information that will aid in understanding laboratory test results for drinking water and the options available for treatment.
(Group for the South Fork, Inc., Box 569, Bridgehampton, NY 11932, $3.00, each booklet.)

The Pine Barrens and Other Long Island Environments

THE PINE BARRENS OF RONKONKOMA - A Guide for the Hiker to the Long Island Pine Barrens, Lawrence G. Paul, New York - New Jersey Trail Conference, 1986.

A GUIDE TO LONG ISLAND PRESERVES - The Nature Conservancy.

(The Nature Conservancy, Long Island Chapter, P. O. Box 72, Cold Spring Harbor, NY 11724, phone # (516) 367-3225, contact for prices and ordering information.)

GUIDEBOOK TO FIELD EXCURSIONS, New York State Geological Association Guidebook, 1975. Copies can be purchased from:

(Dr. Daniel Merriam, Dept. of Geology, Syracuse University, Syracuse, NY 13210, or: Dr. Manfred P. Wolff, Dept. of Geology, Hofstra University, Hempstead, NY 11550, contact for price.)

A GUIDE TO THE PLANT COMMUNITIES OF THE NAPEAGUE DUNES, Ann F. Johnson, Southampton, NY, 1985.

(Ann F. Johnson, 37 South Main Street, Southampton, NY 11968, $6.00/paper.)

NATIVE AND NEAR NATIVE - An Introduction to Long Island Plants, Albert Hostek, 1976.

(The Environmental Centers of Setauket-Smithtown, Inc., Box 257, Smithtown, NY 11787, $6.70/paper.)

FILM: "LONG ISLAND WILDERNESS...THE PINE BARRENS".

22 minutes. Produced by the Museum of Long Island Natural Sciences, SUNY at Stony Brook. Informative overview of Long Island's Pine Barrens formations. Available to public school districts through BOCES.

BOCES I: Westhampton Beach, 288-6400
BOCES II: Central Suffolk, 277-7405
BOCES III: Western Suffolk, 543-0855
BOCES IV: Nassau, 877-1910, x 200

Available to community and adult groups through the Suffolk County Cooperative Library System, 286-1600.

Land Use Planning Information

COOPERATIVE EXTENSION OF SUFFOLK COUNTY publishes several bulletins, fact sheets and a directory on LANDUSE.

(David Newton, Cooperative Extension of Suffolk County, 246 Griffing Avenue., Riverhead, NY 11901, contact to obtain a LANDUSE PLANNING AND MANAGEMENT publications list and order form.)

DESIGN WITH NATURE, Ian L. McHarg, Natural History Press, New York, 1969.

REAL WORLD EXPERIENCE WITH TDRs Transferable development rights) An Update, Stanley D. Schiff.

(Piedmont Environmental Council, 28-C Main Street, Box 460, Warrenton, Virginia 22186.)

Organizations Involved in Groundwater Issues

Many organizations both public and private are involved in the management and protection of Long Island's groundwater and surface water resources. The major ones are listed below and on the following page. Following each organization's name and address is a brief description of their activities and involvements. This list should by no means be considered complete. Local town environmental agencies, educational institutions and private environmental organizations are also good sources of information and assistance.

Cooperative Extension of Suffolk County
246 Griffing Avenue
Riverhead, NY 11901
phone (516) 727-7850

Cooperative Extension of Nassau County
1425 Old Country Road., Bldg. J.
Plainview, NY 11803
phone (516) 454-0900
Responsibilities include information dissemination and education.

Long Island Regional Planning Board
H. Lee Dennison Building
12th Floor
Veteran's Highway
Hauppauge, NY 11788
phone (516) 360-5200
Responsibilities include studies, planning, education.

New York State Commission on the Water Resource Needs of Long Island
State Office Building
Veteran's Highway
Hauppauge, NY 11788
phone (516) 360-6206
or
43 S. Middle Neck Road
Great Neck, NY 11021
phone (516) 482-7722
Responsibilities include studies, legislation, education.

New York State Department of Environmental Conservation
Building 40
SUNY at Stony Brook
Stony Brook, NY 11794
phone (516) 751-7900
Responsibilities include regulations, management, monitoring, law enforcement, permit issuance, planning and education.

Suffolk County Department of Health Services
225 Rabro Dr., E.
Hauppauge, NY 11788
phone (516) 348-2917
or
Suffolk County Center
Riverhead, NY 11901
phone (516) 548-3888

Suffolk County Planning Department
County Center
Hauppauge, NY 11788
phone (516) 979-2922
Can provide information on land use, zoning, mapping, population distribution and growth and other planning data.

Suffolk County Water Authority
Sunrise Highway at Pond Road
Oakdale, NY 11769
phone (516) 589-5200
Responsibilities: distribution of water, monitoring, planning, education.

U.S. Soil Conservation Service
127 East Main Street
Riverhead, NY 11901
phone (516) 727-2315
Can provide information and advice on soils, land use, erosion control and water management. Soil maps.

U.S. Geological Survey
5 Aerial Way
Syossett, NY 11790
phone (516) 938-8830
Responsibilities include studies, maps, monitoring, education.

Water Resources Program
Center for Environmental Research
Hollister Hall
Cornell University
Ithaca, NY 14853
This center is involved in many groundwater and land use studies on Long Island.

ACTION for the Preservation and Conservation of the North Shore of Long Island, Inc.
328 Main Street
Huntington, NY 11743
Mailing address:
P. O. Box 492
Huntington, NY 11743
phone (516) 271-3029
Information collecting and disseminating organization. Contact for speakers. Newsletter 8/year - $10.00.

The Coalition for the Protection of Long Island's Groundwater
c/o Long Island Citizens Campaign
518 Broadway, Massapequa, NY 11758
phone (516) 798-6556
A coalition of Long Island civic and environmental groups involved in issues related to L.I.'s groundwater.

Group for the South Fork, Inc.
Box 569
Bridgehampton, NY 11932
phone (516) 537-1400
Information collecting and disseminating organization. Contact for speakers. Publications, newsletter.

The Long Island Pine Barrens Society
P. O. Box 9
Smithtown, NY 11787
A private, non-profit environmental organization committed to the preservation and understanding of Long Island's Pitch Pine - Scrub Oak woodlands. Education, information dissemination and field trips.

The Nature Conservancy - Long Island Chapter
P. O. Box 72
Cold Spring Harbor, NY 11724
phone (516) 367-3225
A national, private, non-profit conservation organization committed to preserving natural diversity by protecting ecologically unique lands. Preserves are open to the public. Prior permission must be obtained.