Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1984 Volume VI: Geology and the Industrial History of Connecticut

Know Your Watershed

Curriculum Unit 84.06.11
by Deborah L. Turnbull

The objective of this unit is to teach students the importance of knowing the watershed in which they live. The unit is divided into four parts; watershed, hydrologic cycle, surface water and ground water. The strategy for each section is to provide teachers with background information and then to suggest in-the-classroom, in-the-playground, and in-the-field curricula units to enhance classroom lectures. A Teacher's Box accompanies this unit and contains a slide show of the flora, fauna, chemistry, geology, and land use of a local river, along with maps of importance.

Watershed

Watershed is a relatively new word to many people. It refers to an area drained by a stream or river. Think of a mud puddle in your yard. The area of yard it drains is termed its watershed and may be an acre or so large. On a bigger scale, let's look at the Quinnipiac River, a river familiar to all of us who live in New Haven. It drains a watershed of some 363 square miles.(1) On an even grander scale, the Mississippi River drains a watershed of 1,243,000 square miles. These large watersheds are made up of many smaller ones, such as your back yard. The Muddy River, a tributary of the Quinnipiac River, will be the river we will focus on in this unit, along with its watershed of some 18 square miles.(2)

Figure 1—Watershed
(figure available in print form)

The watershed you live in may include farmland, urban development, or industrial plants and may be flat, hilly, or mountainous. You, along with other people, plants, and animals, are all part of the watershed community. All our lives depend on the watershed, on water, and we in turn influence what happens to the watershed. What people do to the water upstream affects you and what you do to the water you live by affects the larger watershed downstream. Figure 1 illustrates a typical watershed.

After the initial introduction, explore the school site with your students to investigate the flow of surface water on the school grounds as related to the larger concept of watershed. Curriculum Unit #1, *The School Site Watershed: Puddle Study* , has been designed to accompany this portion of the unit. It includes a lesson on developing a key and a mapping activity and is located at the end of this unit. Also, topographic maps of the Branford and Wallingford quadrangles, the two quadrangles that the Muddy River runs through, can be found in the Teacher's Box. You may wish to teach a lesson in reading and interpretation of map symbols. It could be a lesson in math taught by discussing height and depth with the use of contour lines. Use the map to locate the watershed of the school from the slopes, hills, and mountains of the area which drains down into it. If your school is located in a different quadrangle, use of the Teacher's Resource section of this unit will help you locate it. You will find wetland areas on your map which will help give your students a sense of how water-rich our region is. This understanding should be balanced with an understanding of the fragile nature of water quality.

Hydrologic Cycle

The hydrologic cycle is a term referring to the circulation of water between land masses, the ocean and the atmosphere. Water vapor condenses in the atmosphere and falls to the earth in the form of rain, snow or sleet. Almost all of the water seeps into the earth. Part of this portion remains as ground water, part flows through to eventually reach streams, and much is evapotranspirated by plants. A small part flows over the land surface as surface flow. When this part evaporates, as well as when the flowthrough portion is evapotranspirated, the water returns to the atmosphere to complete the cycle. Please see Figure 2 for an illustration of the hydrologic cycle.

Figure 2—The Hydrologic Cycle
(figure available in print form)

The hydrologic cycle in a drainage basin can be described by a water budget as the total amount available and as receipts and disbursements of water. The receipts of water in the basin consist of the various forms of precipitation. Some 91% of the water that falls to earth infiltrates into the ground. Most of this does not become part of the ground water, which is water in the saturated zone. The saturated zone is the subsurface zone in which all open spaces are filled with water. The water table is the upper limit of this zone.(3) Disbursements consist mostly of the evapotranspiration of this infiltrated water, stream flow out of the water shed and ground water flow (which is small compared to the other two). The budget always balances although the amounts in each element of the budget may vary somewhat from year to year. The approximate amounts involved in each element for the Quinnipiac River basin are shown in Figure 2. These amounts are derived by measuring an area of land times the thickness of the layer of water. The figures are the annual water budget. The most recent set of data show that the mean monthly precipitation is fairly uniform throughout the year, the average being 3.95 inches per month. Mean monthly runoff follows a seasonal cycle with maximum amounts in the spring and minimal amounts in the late summer. The combination of causes for this include increased evapotranspiration and evaporation during the summer, storage of water as ice and snow during the winter, and increased ground water runoff in the spring. (4)

Water moving through the hydrologic cycle has its composition altered by interaction with the chemical and physical properties of the medium through which it moves. Precipitation dissolved particles and gases from the atmosphere. So, if rain moves through soot and motor exhaust, one result will be that it will pick up sulfate and nitrate ions and fall to the land surface as acid rain. Surface waters that move through the farm lands will pick up pesticides and fertilizers and may in turn add to the eutrification of the pond or lake into which the water flows. Ground water naturally is more mineralized than surface water due to its underground storage and longer contact with rock.

After introducing the hydrologic cycle to your students, here are a few ideas to help you illustrate the basic concepts: 1. As part of Curriculum Unit #2, have students visit the four sites marked on the surficial maps of the Branford and Wallingford quadrangles along the Muddy River, noting land use and its possible effects on the river's water quality; 2. Obtain the film "Buttercup" from ACES (listed in your Teacher Resource section) and have students list all the uses of water through which "Buttercup" passes; 3. Have students use surficial geology maps of the Wallingford and Branford quadrangles to chart the flow of the Muddy River and the various types of land use it passes through and possible effects on the quality of the river water.

The average family of four uses 255 gallons per day of water for their household.(5) A more thorough discussion of water use and ideas for water-saving devices and appliances for your home can be found in the booklet "You Can Conserve Water," which can be found in the Teacher's Box.

Surface Water

Almost all water that appears in streams, lakes, ponds and rivers has also participated in underground flow. Water reaches streams by the flow of water below ground, termed flowthrough, for the most part, and also by the flow of ground water, a much slower process. About 9% of the water that arrives to the earth by precipitation joins streams by direct flow over the land surface.(6)

Streams will be the focus of this portion of the unit. The stream is a dynamic, shifting habitat which is subject to greater changes than the larger bodies of water such as lakes. And, in the stream itself, there are a variety of habitats or niches depending on its physical characteristics. The location of the stream and speed of the flow will determine whether the bottom will be composed of silt, sand, rubble, or bedrock. The nature of this substratum will determine the types of plants and animals that live there. The amount of streamflow passing any point within a basin varies continuously depending on season, size of the stream drainage basin, precipitation, evapotranspiration, surface and ground water storage, topography, and the influence of man on the stream and surrounding areas. Streamflow data is produced by the U.S. Geologic Survey and is used for determination of water supply potential and to estimate mean annual flow, duration of flow, and magnitude and frequency of floods.

Eventually streams run into a larger body of water such as a pond, lake, river or another stream. Bodies of freshwater with increasing size to deeper waters are creek, brook, stream and river. Conditions change along the length of the stream as it progresses from the cold, swift-moving headwaters to the slow-moving muddy waters of the mouth. In the small space of, say, 6 feet of stream length, one can find rapids or riffles over hard or rocky bottoms and calm pools with muddy bottoms. The plant and animal species found in these two environments will be very different.(7)

Curriculum Unit #2 has been designed to accompany the surface water section. This curriculum, entitled *Stream Exploration* , is a field trip where students will study a site or sites along the Muddy River (or another river), analyzing flora and fauna and their interactions, water chemistry, geological history from maps and observations, physical stream environment, and land use. Geological background for teachers will be covered in the Ground Water section of this unit.

Each organism that lives in the stream is specially adapted to its environment. The most diverse environments, and hence the place where you will find species of organisms, is that of the gravel and rubble-bottom portion of the stream. Due to the turbulent waters running over this type of bottom, more oxygen is mixed from the atmosphere, and thus the area can support many types of organisms.

Pelagic organisms which float or swim freely are phytoplankton, zooplankton, insects, fish and amphibians. Phytoplankton, a producer in the stream environment, are tiny plants that live near the surface using energy from the sun, carbon dioxide, and nutrients, such as phosphates and nitrates, to produce their own food. You can either purchase a phytoplankton net or make one by tying a knot in the tubular section of a stocking and securing the other end around a circularly-shaped coat hanger. Hold the net at the riffle area (an area over the gravel section of a stream) for 10 minutes to collect the plankton as they pass through and view them under a compound microscope. The zooplankton, or the animal portion of the plankton population that float or weakly swim near the surface of the stream, can be collected in the same manner. Zooplankton and phytoplankton species, along with all other plants and animals mentioned in this unit, can be identified using the book, *A Field Guide to the Study of Fresh Water Biology* , listed in your Teacher Bibliography section.

The largest and most popular of the stream animals are the fish and are the only vertebrates that live directly in the water. They can be collected by direct netting or by turning over rocks upstream and holding the net downstream while another person walks through the stream, moving the fish into the met.

You will find most amphibians living in the slow-moving pools alongside the riffle areas or on the banks of the stream.

Bottom organisms can be found attached to or living under the rocks. Algaes, such as blue-green algaes, can be found attached to rocks. Also, larger water plants, such as *Elodea* , can be found. Many insects spend their larval stages under rocks and invertebrates, such as clams, snails, and crayfish can be found.

Surface organisms, such as water spiders and water beetles, can be seen floating or gliding along the water surface tension.

And don’t forget to look for clues of the animals who visit the stream habitat. Look for footprints of mammals, such as raccoon, fox, muskrat, and a variety of bird species.

Have your students do a sketch map which should include: river course, width and flow, shallow and deep sections, river bed conditions (sand, clay, gravel, boulder), eddies in stream flow, bank conditions (slope, composition, undercutting), river obstructions and extent of flood plain. Flood plain is that area of land adjacent to the stream that is flooded by the stream during especially high waters.

Also, look for human impact on the area, such as water impoundment, recreational use, vicinity to farm lands, runoff of water from roads, channeling of stream, etc.

To check for water quality, sample at least the first five parameters with Hach or LaMotte test kits: dissolved oxygen, carbon dioxide, pH, temperature, density, dissolved solids, iron, manganese, chloride, nitrate, hardness, trace elements, bacteria, sediment and turbidity. Table 1 illustrates the source and significance of the first five parameters. A discussion of the others can be found in the U.S. Geological Survey *Water Resources, Quinnipiac River Basin* , listed in the Teacher Bibliography section.

If the minimum flow of a stream is inadequate for a projected rate of use, a dam and a reservoir may be constructed to store water for subsequent release. An example of this can be seen on the Muddy River at the Mackensie or Big Pine Reservoir. The amount of storage provided here depends on the amount of water needed, loss due to evaporation, and seepage from the reservoir into ground water storage.

TABLE 1 SOURCE AND SIGNIFICANCE OF SOME COMMON CONSTITUENTS OF WATER

(figure available in print form)

Floods can and have occurred in every month of the year in the Muddy River and Quinnipiac River Basins. Due to rapid snowmelt and rain, however, flooding is most common in the spring. A study on the magnitude, frequency of flood flows, and probability of occurrence can be found in the U.S.G.S. publication, *Water Resources, Quinnipiac River Basin* .

Ground Water

Ground water, that water that percolates to the water table, is water in the saturated zone. The geological formation that contains sufficient saturated, permeable materials to yield significant quantities of water for use is termed an aquifer. We will look at ground water from the perspective of its availability for human use depending on its medium of storage—bedrock, stratified drift or till. These geological terms, along with a discussion of the geological history of the land surrounding the Muddy River, follows. Curriculum Unit #2 contains areas of geologic investigation for you to visit while on a field trip with your students.

The deeper we go into geologic history, the harder it is to decipher past events. The world itself is some 4,600 million years old. The oldest rocks in North America are found in Ontario and Minnesota and are about 3,500 million years old.(8) The rocks in the Eastern and Western Connecticut highlands are about 500 million years old, and the Connecticut Valley was formed about 100 million years ago when the Eastern and Western highlands were pulled apart during the formation of the Atlantic Ocean. The Quinnipiac River basin, and hence the Muddy River basin, lie in the Connecticut Valley lowland area.

The term bedrock refers to the solid rock that forms the Earth's crust. It is sometimes exposed at the surface for us to see, but more commonly buried beneath deposits. The bedrock in the Connecticut Valley consists of sedimentary and igneous bedrock units with some metamorphic units at the far Eastern and Western perimeters. Sedimentary rocks are formed of sediments originating from the weathering of other rocks and can be transported by water. The types of sedimentary rocks found in the Quinnipiac River basin are sandstone, siltstone and shale, with lesser amounts of conglomerate and limestone. Igneous rocks are formed by solidification of molten or partially molten magma and in this basin consist principally of basalt (or diabase) units and are interbedded with, and include, the sedimentary rocks. To the Eastern and Western boundaries, metamorphic bedrock underlies the basin. Metamorphic rock forms in the solid state by heat and pressure from other already existing rocks and here consists of gneiss's shist and phyllite. The Connecticut Valley Urban Area project maps of the Wallingford and Branford quadrangles, provided for you in the Teacher's Box, show the configuration of the bedrock surface if all Earth materials covering it were removed. The surficial maps of both quadrangles show areas of exposed bedrocks that are of potential interest for field trips for you and your students.(9)

Bedrock aquifers underlie both quadrangles and include sedimentary, igneous and metamorphic rock types. Bedrock aquifers are sources of water for many homes that are not connected to public water supplies. Due to their relative porosity, sedimentary rock aquifers are the most productive, followed by igneous and then metamorphic rock aquifers.

The millions of years following the formation of the Connecticut Valley were characterized by erosion and a rising of the land. Due to this erosion, a blanket of eroded rock covered much of Connecticut. It is probable that the Muddy River existed at this time. The Muddy River slows through the Wallingford and Branford quadrangles through areas of lesser elevation. The river was present here before glaciation and apparently took the path of least resistance draining the surrounding land of some 18 square miles on its way down to its intersection with the Quinnipiac River.(10)

Around 10 million years ago, the climate was getting colder and ice was accumulating in Antarctica. Giant ice sheets formed, called glaciers, and moved southward to cover all of New England, even the highest mountains, and its outer limit was about where Long island is today. As the glaciers moved across Connecticut, they froze onto the loose, already eroded material and moved it forward, scraping the solid bedrock beneath it. These glacial grooves or striations are shown on the surficial maps of the Wallingford and

Branford quadrangles. Some of the material scraped off the land surface by the glacial ice north of Connecticut was brought here by the moving ice and dumped. The general term for this type of land is glacial drift and, depending on how it was deposited, bears different names.(11)

The term "ice contact stratified drift" refers to materials deposited in the presence of ice and meltwater during deglaciation. It is usually sorted and includes sand, gravel, and small amounts of silt and clay arranged in layers by glacial meltwater. For the majority of its trip downhill to Long island Sound, the Muddy River runs through this type of material. The average depth of this stratified drift is 100 feet in thickness. Due to its porosity, stratified drift is the most productive type of aquifer. And, areas of stratified drift that are adjacent to streams, so that they are capable of quick recharge after use, are the most favorable areas for drilling wells. Plate A of the *Water Resources, Quinnipiac River Basin* U.S.G.S. publication, shows sites of wells drilled for the abovementioned reasons along the Muddy River. Also, note the surface water station at the Big Pine or Mackenzie Reservoir.(l2)

Till, a predominantly nonsorted sediment, consisting of boulders, gravel, sand, silt, and clay deposited directly by glacial ice, can be seen covering the majority of the Branford/Wallingford quadrangles. It averages about 25 feet in thickness. The amount of water available in all is relatively small. Due to its thinness of cover, wells drilled in till often run dry during summer months.(13)

The quality of ground water, as is the quality of surface water, is determined by the physical environment and the effects of man. A discussion of ground water quality in this part of Connecticut can be found in the *Water Resources, Quinnipiac River Basin* U.S.G.S. publication. In general, the quality of water is considered good, with caution in the areas of discharge of sewage, industrial and animal wastes, spreading of chemical fertilizers and road salt, solid waste disposal and intrusion of salty water in coastal aquifers due to overpumping of wells.(14)

CURRICULUM UNIT #1

The School-Site Watershed: Puddle Study

Objectives To investigate the flow of surface water on the school grounds as related to larger watersheds, and to teach keying and mapping skills. Make special note that the surface flow of water is only a small portion of the total flow.

Field Site The immediate environment of the school, preferably recently after a rain storm. If you cannot go outside, construct a watershed from paper, gluing objects to the paper (the waterways, houses, hills, urban areas, etc.). Have the students use the key side of the paper to make a key for each object glued on and proceed as below.

Materials
Pencils

Paper

Transit boards, an example of which can be found in the Teacher's Box.

Procedure The transit boards are constructed by taking a square piece of board approximately 8" x 8" (use peg board, styrofoam, or other soft wood), a piece of string marked at one-foot intervals, divide the first foot evenly into two-inch intervals. Attach the string to the middle of any edge of the board with a tack or a piece of tape.

To do this exercise, the paper should be folded in the following manner: take a sheet pf paper 8 1/2" x 11", fold one third of the paper over. This leaves a place for students to take notes on the area of land they are mapping. If you are investigating a tide pool or other areas where you expect to find organisms, fold that side panel over in half and label as organisms and number found.

(figure available in print form)

(figure available in print form)

(figure available in print form)

After introducing the watershed concept, explore the school site and discuss drainage of rainfall from the school grounds. Have small groups list sites where water is drained, including all drain pipes, gutters, storm drains, streams and ditches. This could lead to a number of different mapping activities.

Where are the puddles found? These puddles can be explored in a number of ways. One way is to use the transit boards you have constructed. If you desire to just map water flow, divide students into groups of two. Have one student hold the board and be the recorder. That student is responsible for recording spot to scale that the second student calls out. The second student walks the line to points of inflow of water into the puddle. Since the board can translate the angle by virtue of the string placement, and the one-foot to 2" scale tells the length, you can translate the puddle watershed onto your piece of paper. If your puddle contains plants and animals, have the students make a key on the side of the sheet of paper. Use the symbol decided upon to make the spot on your sheet of paper. Your limitation to size of the area mapped is determined by the length of string and the size of your board.

Obtain a topographic map which contains your school to use with your class in identifying wetland areas and outlining small watersheds. You may wish to teach a lesson in reading and interpretation of map symbols. It could be a lesson in math by discussing heights and depths with the use of contour lines. A compass is valuable for learning about maps and seeing how useful they can be. The compass is, in itself, a good way to discuss direction and basic geometry skills. Use the map to locate the watershed of the school from the slopes, hills, and mountains of the area which drain down into it.

CURRICULUM UNIT #2

Stream Exploration

***Objectives** To explore the stream and discover the variety of life forms and their environmental adaptations, test for water quality, note land use patterns, note evidence of geologic formation.*

***Field Site** The field sites noted on the surficial geology maps of the Wallingford and Branford quadrangles are accessible to you and your students with minimum difficulty. Site #1 shows the beginning of the stream in a freshwater swamp in Wallingford. Sites #2 and #3 are the best for this curriculum study. Site #4 is located where the Muddy River intersects the Quinnipiac River and is a good one to visit for land use and the change from fresh to brackish water. The slide show that accompanies this unit shows flora, fauna, land use and points of geologic interest along the river.*

Materials

Personal equipment, including boots or waders
Fish and plankton nets, Travel
White-bottomed pans (refrigerator trays, bleach bottle bottoms)
Hand lenses, collection jars or plastic bags
Field guides as noted in Bibliography
100-foot tape, yardsticks, tennis balls or other objects that float
Watch
LaMotte chemistry kits for oxygen, carbon dioxide, pH, and a thermometer and hydrometer
Surficial geology maps of the Wallingford and Branford quadrangles provided for you in the Teacher's Box

***Timing** A day per site, but each trip could easily be expanded to a few days. Three to five periods for post-trip activities.*

Stream Survey Form

1. State _____ River System _____
   Name of Stream __________
   Stream Section __________
   From: _____ To: _____
   Length of Section: __________
   Sketch (show trails, roads, tributaries, surrounding land use)
2. Flora and Fauna
   a. Flora:
      Note species, size, color, abundance, growth, habits, etc.
         1. seedplants—emergent, floating, submerged, by stream margins.
      2. Algae or plankton—those that float or cover the bottom.
   b. Fauna:
      Note species, size, abundance, feeding habits, stages or ages found, special adaptations or activities
      1. Invertebrates and vertebrates
      Freeswimming
      Walking on surface
      Sessile on vegetation
      Sessile on stones, logs, rocks, bottoms
      Burrowers
      Tube dwellers
3. Water Chemistry and Weather Conditions

Oxygen _____		Air Temperature _____
Carbon Dioxide _____	Cloud Cover _____	
pH _____		Time _____
Temperature _____	Precipitation _____	
Density _____		Wind Velocity _____
Salinity _____		Low Tide _____
		High Tide _____

*Note: To determine salinity from density and temperature, see the tables in Micky Weiss's book, *Investigating the Marine Environment: A Sourcebook* , listed in the Bibliography.

4. Physical Characteristics of the Stream
   Average Width and Depth __________
   Bottom Type __________
   Pool or Riffle __________

Character of Watershed: mountainous, hilly, flat, swampy, wooded, open, cultivated, uncultivated, etc.

____

____

Surrounding land use observed __________

____

Character of subsoil, bedrock __________

____

Volume and velocity of water __________

____

____

* Note: To determine water velocity and flow:

Velocity:

1. Locate two points 100 feet apart

2. record the time it takes for a float to drift between the two points

3. compute the number of feet traveled per second by dividing the time in seconds into the distance

Volume or rate of flow:

R = WDaL

T

where R = volume of flow in cubic feet per second

W = average width of stream in feet

D = average depth in feet

a = constant factor for bottom type

smooth sand = 0.9

rough rocks = 0.8

L = length of stream section measured

T = time in seconds to float the measured distance.(15)

Notes

---

1. Mazzaferro, David L. et al., *Water Resources Inventory of Connecticut* , Connecticut Department of Environmental Protection, 1978, p. 1.
2. United States Department of Agriculture, *What Is A Watershed* ?, U.S. Government Printing Office, 1974, p. 1.
3. Gordon, Robert, lecture June 5, 1984.
4. Mazzaferro, David L. et al., *Water Resources Inventory of Connecticut* , Connecticut Department of Environmental Protection, 1978, pp. 5-6.
5. United States Corps of Engineers, *You Can Conserve Water* , Connecticut Department of Environmental Protection, p. 8.
6. Gordon, Robert, lecture May 22, 1984.
7. Butzow, John W. et al., *What Adventures Can You Have in Wetlands* , *Lakes, Ponds and Puddles* ?, University of Maine, 1980, p. 22.
8. Rodgers, John, “The Geologic History of Connecticut,” *Discovery* , Vol. 15, No. 1, 1980, p. 25.

9. Gordon, Robert, lecture May 22, 1984.
10. Ibid.
11. Mazzaferro, David L. et al., *Water Resources Inventory* of *Connecticut* , Connecticut Department of Environmental Protection, 1978, p. 57.
12. Flint, Richard F., *Surficial Map of Wallingford* , Department of Agriculture and Natural Resources, 1964.
13. Ibid.
14. Mazzaferro, David L. et al., *Water Resources inventory* of *Connecticut* , Connecticut Department of Environmental Protection, 1978, p. 61.
15. Needham, James, *A Guide to the Study of Fresh Water Biology* , Holden-Day Inc., San Francisco, p. 104.

Teacher and Student Bibliography

Bradshaw M. J. et al. *The Earth's Changing Surface* . New York, 1978. A good text for high school students, well illustrated.

Butzo, John W. et al. *The Northern New England Marine Education Project* . University of Maine, 1980. A series of fresh and salt water infusion units designed for teachers with little background in the sciences for use in their classrooms. The background sections and keys to plants and animals are also useful to students on the junior and senior high school level.

Flint, Richard F. *The Surficial Ceology of the Branford Quadrangle* . Department of Agriculture and Natural Resources, 1964. Excellent overview of the glacial geology of Connecticut with an introduction to the bedrock geology. Good teacher background and the map is excellent to use in class with junior and senior high school students.

Flint, Richard F. *The Surficial Geology of the Wallingford Quadrangle* . Excellent overview of the glacial geology of the Wallingford quadrangle with an introduction to the bedrock geology. Good teacher background and the map is excellent to use in class with junior and senior high school students.

Mazzaferro, David L. et al. *Water Resources Inventory of Connecticut* . Connecticut Department of Environmental Protection, 1978. A booklet examining the development, management, use, conservation, and protection of water resources in the Quinnipiac River watershed. Contains excellent maps and illustrations. Excellent teacher reference. Students on the senior high school level can make good use of the maps.

Needham, James G. *A Guide to the Study of Fresh Water Biology* . HoldenDay, Inc. San Francisco, 1962. An excellent guide to the identification of fresh water algae, invertebrates, and fishes and to methods of sampling and analyzing aquatic organisms and their environment. The glossary aids in its potential use by teachers and senior high school level students.

Renn, Charles E. *Our Environment Battles Water Pollution* . LaMotte Chemical Products Company, 1969. A good overview of the water pollution problem, its causes and possible solutions. Suitable for teachers and for use by senior high school students.

Renn, Charles. *A Study of Water Quality* . LaMotte Chemical Products Company, 1968. A good background guide to water quality, especially designed for use with LaMotte chemical kits. Suitable for use by teachers and senior high school students.

Rogers, John. “The Geological History of Connecticut,” *Discovery* , Vol. 15, No. 1, 1980. An excellent overview of the geological history of Connecticut for use by teachers.

Schumm, Stanley A. *The Fluvial System* . New York 1977. An excellent introduction to the geology of rivers suitable for teacher background information.

Shelton, John S. *Geology Illustrated* . San Francisco, 1966. An excellent introduction to geological structure and processes that is well illustrated. Good teacher background and useful as a text for accelerated senior high school students.

The Peterson Field Guide Series , sponsored by the National Audubon Society. A visual approach to a variety of subjects, including animal tracks, trees, flowers, insects and many more. Useful for field identification by junior and senior high school students as well as teachers.

U.S. Army Corps of Engineers. *You Can Conserve Water* . Connecticut Department of Environmental Protection. A booklet available free from the DEP overviewing the hydrologic cycle, water supply, and conservation measures and techniques implementable by individual residential consumers. Suitable for junior and senior high school students as well as teachers.

U.S. Department of Agriculture. *What is a Watershed* . U.S. Government Printing Office, 1974. Excellent introduction to watershed for junior and senior level high school students as well as teachers.

Weiss, Micky. *Investigating The Marine Environment: A Sourcebook* . Project Oceanography, 1979. An excellent analytical lab and field book for teachers and senior level high school students. Techniques can be used in fresh or salt water systems.

Teacher Resources

ACES

205 Skiff Street

Hamden, Connecticut 06517

248-9119

Good resource library for films, books and curricula on water related subjects, flora, conservation, fauna, and geology.

Connecticut Audubon Society

314 Unguowa Road

Fairfield, Connecticut

259-6305

Good source for field trip books and for seasonal field trips to familiarize teachers with upland and coastal habitats or interest.

Macalaster Bicknell Company

169-181 Henry Street

New Haven, Connecticut 06510

624-4191

Distributors of scientific instruments such as microscopes, glassware, hydrometers and thermometers needed to test salinity, and chemical kits for water quality testing.

Hach Chemical Company

PO Box 389

Loveland, Colorado 80537

303-669-3050

LaMotte Chemical Company

Chestertown, Maryland 21620

301-778-3100

Distributors of the chemical kits to do water testing. Also, their service department is very helpful in giving advice as to the appropriate kits to use.

New Haven Water Company

90 Sargent Drive

New Haven, Connecticut 06511

624-6671

Good resource for maps of local watersheds. Also open for small tours through the facility's laboratories.

Schooner, Incorporated

60 South Water Street

New Haven, Connecticut 06519

865-1737

Provides adjunct marine and upland water field trip services to students, teachers and public membership. Field classes take place aboard the J. N. CARTER, Schooner's 66-foot sailing research vessel and at various sites of biological interest along Long island Sound. Hands-on marine life programs available for elementary aged students. Also, college accredited teacher workshops available.

Teacher's Center, Incorporated

425 College Street

New Haven, Connecticut 06510

776-5987

Good resource library for films and curricula categorized by subject matter and rented in self-contained boxes (much like the Teacher's Box that accompanies this unit).

The State of Connecticut

Department of Environmental Protection

Natural Resources Center

Room 553

165 Capitol Avenue

Hartford, Connecticut 06106

566-5599

Resource books and maps on water resource, water quality, conservation, soils,surficial geology and bedrock geology of Connecticut.

Virginia Institute of Marine Science

Glouster Point, Virginia 23062

Attn: MEMS

804-642-2111

A computerized bibliography of all marine and water related curricula in the United States by subject and grade level. A $5.00 search fee is required. Microfiche can be purchased or borrowed free of charge.