topic II

TOPIC II - THE CHANGING ENVIRONMENT

How Changeable Is Our Environment?

Time Emphasis: 5 days

	INVESTIGATION	LTI - #1	LTI - #2	LTI - #3	A-1a	C-1a	C-1b	LTI - #4	LTI - #5	LTI - #6	LTI - #7	LTI - #8	LTI - #9	LTI -#10	LTI -#11	LTI -#12	LTI -#13	LTI -#14
	Estimated Time (Periods)				1	.5	.5											
TOPIC OUTLINE	A. The nature of change																	
	A-1 Characteristics of change — *How Can Changes Be Described?*																	
	A-1.1 Occurrence of events — A-1.11	■										■	■			■		
	A-1.12																	
	A-1.13		■															
	A-1.2 Frames of references — A-1.21		■							■	■	■	■	■				
	A-1.3 Rate of change — A-1.31			■					■	■	■	■	■	■	■		■	■
	A-1.32																	
	A-1.4 Cycles-noncycles — A-1.41	■		■	■					■		■	■					
	A-1.42																	
	A-1.5 Predictability of change — A-1.51	■	■	■	■					■		■	■		■			
	A-1.6 Occurrence of change — A-1.61	■	■									■	■		■			
	B. Energy and change																	
	B-1 Relationship between energy and change — *What Is the Relationship of Energy to Change?*																	
	B-1.1 Energy flow and exchange — B-1.11																	
	B-1.12																	
	C. Environmental change																	
	C-1 Man's influence on the environment — *How Does Man Modify the Environment?*																	
	C-1.1 Environmental balance — C-1.11					■												
	C-1.12					■	■											
	C-1.2 Environmental pollution — C-1.21					■	■	■										
	C-1.22							■										
	C-1.23					■	■	■										
	C-1.24							■										
PROCESS OF INQUIRY OBJECTIVES	Mathematical Skill — PIO-1																	
	Measurement Skill — PIO-2	■																■
	Creating Models — PIO-3			■														
	Analysis of Error — PIO-4																	
	Data Analysis — PIO-5	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■
	Multimedia: Check Multimedia Section of Supplement for reference to this topic	Weather Watch	Earthquake Watch	Sun's Path Watch	Sunspot Analysis	Roadside Pollutants	Air Pollution - Human Mortality	Air Pollution Watch	Stream, Pond, or Lake Temperature	Big Dipper	Planet	Moonrise-Moonset	Sunrise-Sunset	High Noon	Tide	Haze	Radioactivity	Soil Temperature

TOPIC II - THE CHANGING ENVIRONMENT (continued)

	LTI - #15	LTI - #16	LTI - #17	LTI - #18	LTI - #19	FE - 1	FE - 2	FE - 3	FE - 4	FE - 5							
A-1.11							X										
A-1.12				X													
A-1.13																	
A-1.21						X	X		X								
A-1.31	X		X		X	X	X										
A-1.32		X															
A-1.41										X							
A-1.42																	
A-1.51																	
A-1.61		X							X	X							
B-1.11																	
B-1.12																	
C-1.11																	
C-1.12																	
C-1.21																	
C-1.22																	
C-1.23																	
C-1.24																	
PIO-1						X											
PIO-2						X	X	X	X	X							
PIO-3						X											
PIO-4																	
PIO-5	X	X	X	X	X	X	X	X	X	X							
	Soil Moisture	Soil Erosion	River	Stream pH	Stream Sediment	School Building and Grounds	Pit	Stream	Cemetery	Beach							

MATRIX FOR

LONG-TERM INVESTIGATIONS AND FIELD EXPERIENCES

Long-Term Investigations	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
*LTI - # 1 Weather		■	—	—	—	—	■							
*LTI - # 2 Earthquake		■	—	—	—	—	—	—	—	—	—	■		
*LTI - # 3 Sun's Path		■	—	■										
*LTI - # 4 Air Pollution		■												
LTI - # 5 Stream, Pond, or Lake Temperature		—	—	—	—									
LTI - # 6 Big Dipper		—	—	—										
LTI - # 7 Planet		—	—	—										
LTI - # 8 Moonrise - Moonset		—												
LTI - # 9 Sunrise - Sunset		—	—	—										
LTI - #10 High Noon		—	—	—										
LTI - #11 Tide		—												
LTI - #12 Haze		—	—	—	—	—	—							
LTI - #13 Radioactivity		—												
LTI - #14 Soil Temperature		—	—	—	—	—								
LTI - #15 Soil Moisture		—	—	—	—	—	—	—						
LTI - #16 Soil Erosion		—	—	—	—	—	—	—	—					
LTI - #17 River		—	—	—	—	—	—	—	—					
LTI - #18 Stream pH		—	—	—	—	—	—	—	—					
LTI - #19 Stream Sediment		—	—	—	—	—	—	—	—					

Field Experiences	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
FE - # 1 School Building and Grounds		▨	▨						▨	▨			▨	▨
FE - # 2 Pit		▨							▨	▨				
FE - # 3 Stream		▨						▨	▨	▨				
FE - # 4 Cemetery		▨							▨		▨			
FE - # 5 Beach		▨			▨		▨	▨	▨	▨				

*The first four Long-Term Investigations (LTI) are found as complete write-ups in the Supplement under the topics as indicated by the blackened-in matrix (i.e. Weather Long-Term Investigation (LTI-#1) is written up in Topics II and VII. The remaining investigations (#5 through #19) do not appear as write-ups.

It is suggested by the bold horizontal line in the matrix that a Long-Term Investigation should be started in topic II and the results of that investigation may be used to reinforce understandings in a topic at the end of the line (i.e. Soil Temperature Investigation (LTI-#14) is started in topic II and may be concluded with specific understandings in topic VI).

Partial shading in the Matrix for Field Experiences indicates topics containing understandings that may be realized by that field experience.

LONG-TERM INVESTIGATIONS

These investigations can be started in Topic II and continued until appropriate end points in later topics as indicated in the matrix for "Long-Term Investigations and Field Experiences" sheet. Some are suitable as individual projects, others could be group or class projects. The teacher can evaluate each to decide which are appropriate for his class, the school location, or geographic position of the community.

1. *Weather

2. *Earthquake

3. *Sun's Path

4. *Air Pollution

5. Stream, Pond, or Lake Temperature:
   Observe and measure surface temperatures or temperatures at various depths. Readings can be taken weekly.

6. Big Dipper:
   Observe and measure the angle of tilt of the handle stars each evening at the same time. Readings could be taken weekly.

7. Planet:
   Observe the positions of planets in terms of their direction and angle of elevation, or relative to the star field background. Readings could be taken as frequently as twice a week. Specific planets whose motions are particularly interesting include Venus and Mars.

8. Moonrise - Moonset:
   Same procedure as sunrise - sunset. This can also be expanded to include a full moon investigation. The readings for the full moon investigation should be taken a few days before to a few days after full moon.

9. Sunrise - Sunset:
   Observe and measure the position and time of sunrise and sunset. Readings can be taken as frequently as twice a week.

10. High Noon:
    Observe and measure the elevation of the sun at its highest point. The local standard time should be noted for each reading. Readings can be taken twice each week.

11. Tide:
    Observe and measure high and low point of the tides. Readings should be taken daily. Students may team up so that one measures a high and the other measures a low tide.

12. Haze:
    Observe and measure the visibility to determine the extent of haze. This can be done in conjunction with the weather investigation. Readings can be taken daily.

13. Radioactivity:
    Observe and measure the amount of radioactivity, by the number of particles trapped on an air filter. Use a fiber glass filter in a Buchner funnel which has been fastened to a vacuum pump. Place funnel outside and pump for 3-5 hours. Place the filter on a sheet of black and white Polaroid film (ASA 3000). The particles will show as bright spots. Readings can be taken weekly.

14. Soil Temperature:
    Observe and measure temperatures on the surface and at 10-cm. intervals down to 1 meter. Readings can be taken daily.

15. Soil Moisture:
    Observe and measure amounts of moisture by removing and drying samples of soil at selected locations. Readings can be taken weekly. Electrical resistivity could also be used as an indicator of moisture.

16. Soil Erosion:
    Observe and measure a fresh road cut, pile of soil, or other exposed soil surface for the effects of erosion. Readings can be taken twice a week.

17. River:
    Measure the stream flow in a stream by constructing a weir or use a spillway. Other methods can also be imployed to determine the discharge. Readings can be taken daily.

18. Stream pH:
    Measure the pH of a stream. This can be done in several ways. Students can measure the pH of several points at the same time, or an analysis of the pH at one point can be made over a period of time. Readings in this case can be taken weekly. Caution: pH paper may not be sensitive enough.

19. Stream Sediment:
    Measure the amount of sediment being carried by a river in suspension. Readings can be taken twice a week or more frequently depending on the circumstances.

Easy

LTI #1: WEATHER LONG-TERM INVESTIGATION

QUESTION:

How can changes be described?

MATERIALS:

Rain gauge, wind gauge, barometer, sling psychrometer, maximum-minimum thermometer (optional), cloud code chart, weekly U.S. weather map, instructions for climatological observers (circular B). The last three items can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402; order, (a) Cloud Code Chart No. 30.22: C 62/2/958, 10¢, (b) Instructions for Climatological Observers, Circular B, No. C 30 4:B/962, 50¢, (c) Weekly Weather Map, subscription rate $4.50 per year. Be sure to include payment (not purchase order) with your order.

SUGGESTED APPROACH:

1. The teacher should refer to the concluding investigation VII-A-la before beginning this LTI.
2. Discuss the purpose of this investigation, how to handle and use the instruments, ways of recording data, and how responsibility for daily measurements will be distributed and rotated. The purpose is to obtain sufficient data so that identifiable patterns can be found and analyzed in topic VIII.
3. Following the introductory investigation, allow groups of students about 5 minutes each day to make and record their weather observations.

PRECAUTIONS:

1. Most of the instruments used are somewhat fragile.
2. Periodically check measurements, dew point calculations, and graphing for accuracy and consistency.
3. Guard against investigation becoming routine and meaningless by periodically having the students look for patterns among weather variables and, on the basis of these, make predictions about future weather. Tie in local data with U.S. weather map.
4. Develop some way of obtaining data, especially temperature and pressure, over weekends and vacations; thermographs and barographs are the best means but newspaper reports and home readings do work.
5. Freezing of the wet bulb on a psychrometer can cause trouble later on in the Watch. It may take 10 minutes to get a reading with the dry bulb below 0°C. (Remove sleeve from wet bulb and moisten bulb with damp tissue paper.)

TYPICAL RESULTS:

In the beginning, students may have difficulty taking accurate readings but they quickly become quite professional about it.

MODIFICATIONS:

1. Data may be kept individually or as a class on a large wall chart.
2. Many of the instruments can be homemade. If possible, these should be checked for reliability against commercial instruments.
3. Once students begin to recognize patterns and make predictions based on these patterns, they could make predictions for the whole school.

REFERENCES:

Investigating the Earth, pp. 26-27, Teacher's Guide, pp. 51-55, 65.
Our Planet in Space, pp. 226-231, 242-246, 258, 264-279.

LTI #1: WEATHER WATCH

QUESTION:

How can changes be described?

INTRODUCTION:

Weather is one of the most talked about subjects and one of the most puzzling. You can describe the weather right now, but can you predict what it will be tonight, tomorrow, or next week? To be able to predict the weather you will need to know what weather patterns exist in your area. This can be accomplished by collecting weather data over a long period of time.

OBJECTIVES:

When you finish this investigation you should be able to:

1. make accurate daily measurements of temperature, barometric pressure, wind speed and direction, dew point, precipitation, cloud cover and type.
2. record the collected data in a well-organized table.
3. graph the collected data against time.

METHOD:

1. Every day at the same time, measure the air temperature, barometric pressure, amount of precipitation during the last 24 hours, cloud type and percentage of cover, wind speed and direction, and dew point. You won't make all these measurements yourself; the job will be shared by other students in the class.
2. Record the data on a table or graph-chart.
3. After you have collected data for about 2 weeks, begin to look for patterns and try to relate your data to the U.S. weather map.

QUESTIONS:

(A-1.11) 1. Describe the changes which you are able to observe taking place in the atmosphere.

(A-1.61) 2. Describe what you would consider the most natural state of your atmospheric environment. Would it be static or changing?

(A-1.41) 3. Describe the cyclic nature of the changes observed.

(A-1.51) 4. After observing the changes in the atmosphere for a few weeks, attempt a prediction of future events.

Supplementary Sheet

LTI #1

MODEL DATA SHEET FOR WEATHER WATCH

Date Time								
Air Temperature in °C.	40							
	30							
	20							
	10							
	0							
	-10							
	-20							
	-30							
Atmospheric Pressure in mb.	1040							
	1030							
	1020							
	1010							
	1000							
	990							
Wind direction, speed, and sky cond.								
Cloud type								
Weather								
Precip. in inches	0.5							
	0.3							
	0.1							

Adapted from ESCP

Easy

LTI #2: EARTHQUAKE LONG-TERM INVESTIGATION

QUESTION:

How can changes be described?

MATERIALS:

World map, colored pins (100 each of 3 colors or large acetate sheet and felt pens - 3 colors) data cards (obtained from U.S.Coast and Geodetic Survey (Seismology Division), Washington Scientific Center, Rockville, Maryland, 20850; request Preliminary Determination of Epicenters).

SUGGESTED APPROACH:

1. Teacher should refer to concluding investigation XII-A-2a before beginning this LTI.
2. Discuss with the students some natural changes that occur on the earth and how these changes can be described. Include in your discussion the fact that earthquakes represent very dramatic changes.
3. Point out that earthquakes occur often and can be described in terms of location on and depth beneath the earth's surface. Ask how a continuous record of these events might be recorded so as to provide for easy interpretation.
4. Have groups of two students each plot on a wall map data of a few earthquakes.
5. Have one or more groups continue this exercise on a once or twice per week basis until the class is ready to analyze the data in topic XII.

PRECAUTIONS:

If Pacific Ocean-centered maps are used, the students may find longitude plotting confusing. The map will have both east and west longitude plotted on the same side of the prime meridian.

MODIFICATIONS:

Individual maps could be used in place of one wall map.

LTI #2: EARTHQUAKE WATCH

QUESTION:

How can changes be described?

INTRODUCTION:

Many destructive natural changes occur on the earth. Probably one of the worst in terms of human experience is the earthquake. In 1964, the Alaskan earthquake caused tremendous damage and in 1969 it was the Peruvian earthquake; however, a tremendous number of unpublicized less destructive earthquakes occur every month.

OBJECTIVE:

When you finish this investigation you should be able to:

1. plot location and depth data, for earthquakes, on a world map or globe.

METHOD:

1. Devise and use a system for plotting location and depth data for earthquakes on a world map.
2. Continue plotting earthquake data, during your free time, until your teacher asks you to stop.

QUESTIONS:

(A-1.13) 1. Describe some of the changes which might occur during an earthquake.

(A-1.61) 2. Would you describe the change that occurs during an earthquake as being natural? Explain.

(A-1.21) 3. What frames of reference would you use to describe an earthquake?

(A-1.51) 4. Describe the possibility of determining in advance where and when an earthquake will occur.

Easy

LTI #3: SUN'S PATH LONG-TERM INVESTIGATION
(refer to investigation IV-A-1C)

QUESTION:

How can changes be described?

MATERIALS:

Transparent hemisphere mounted on cardboard square, grease pencil, or water soluble pens.

SUGGESTED APPROACH:

1. This investigation is best accomplished with a student grouping of two.
2. This investigation requires multiple readings throughout the same day and should be done as close to September 20 as possible.
3. Follow the directions on the student sheet to plot the position of the sun, at various times of the day, on the plastic hemisphere.
4. One of the hemispheres should be selected as a master sphere for the class and stored in a safe place. Subsequent readings should be made and recorded on the master sphere (i.e., October 20, November 20, December 22, etc.)

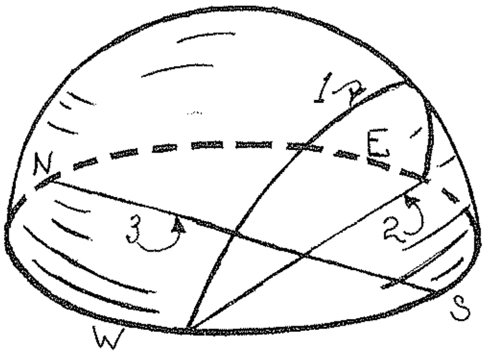
PRECAUTIONS:

1. Baseboards on which the hemispheres are placed must be oriented the same way for successive recordings. Line up a marked edge of the baseboard with a marker line on the sidewalk or ground, as shown in the figure on the student sheet. Be sure surface is horizontal.
2. The hemisphere must be placed so that buildings, trees, and other obstructions will not cut off the sun's rays during the time recordings are made.
3. In the event of a cloudy day or if cloudiness develops during a day on which readings have begun, see an alternate procedure in "Modifications."

TYPICAL RESULTS:

The diagram below represents a typical example of results that students should attain.

Additional construction lines are shown which can be used to complete the analysis.



1. Sun's path extended to the horizon
2. E-W line connecting the sunrise-sunset points which is parallel to an east-west line (on September 20 and March 20 it would be the E-W line)
3. A line perpendicular to the E-W line which is the true N-S line

MODIFICATIONS:

1. In the event that overcast skies exist on the day chosen for this investigation, it may be possible to plot points using the following method: Have a student stand facing the hemisphere with his back to the sun. By moving toward or away from the hemisphere he can select a position where the bright spot (cloud covered sun) reflected from the hemisphere and the reflection of his head line up. At that point the center of the hemisphere (x), the point on the hemisphere, his head, and the sun are in line. A second student should mark that spot on the sphere with the grease pencil.

2. Magnetic declination can be found by dropping a vertical line from the Zenith through the apex of each curve to establish a true N-S line and then measuring the angular difference between this line and the magnetic compass bearing.

REFERENCES:

Investigating the Earth, pp. 27, Teacher's Guide, pp. 56-57.

LTI #3: SUN'S PATH WATCH

QUESTION:

How can changes be described?

INTRODUCTION:

Man has always had a great interest in the sun and for some men it has represented a God. In this investigation you will have an opportunity to examine more closely the apparent movement of the sun and look for evidence of change.

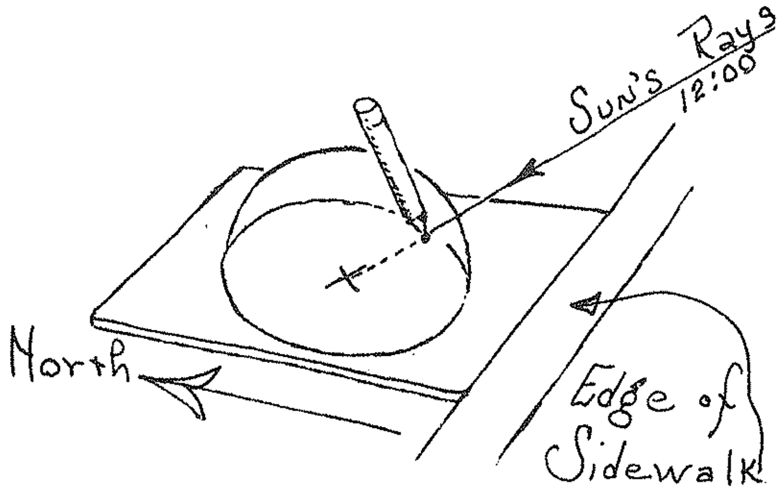
OBJECTIVES:

When you finish this investigation you should be able to:

1. construct an arc on the transparent hemisphere representing the apparent sun's path across the sky on a particular day of the year.

METHOD:

1. At various hours of the day, including solar noon, plot the positions of the sun on a plastic hemisphere by placing the cardboard along the line on the ground and placing the grease pencil so that its shadow falls on the "x" in the center of the cardboard (see diagram below). Be sure to record the time.



2. When all of the points, taken at various times of the day, have been plotted on the hemisphere, connect them so as to illustrate the path the sun followed on that particular day.

QUESTIONS:

1. Describe the apparent path followed by the sun across the sky.

(A-1.31) 2. How could you describe the sun's changing position across the sky?

(A-1.51) 3. Predict the sun's behavior for tomorrow.

(A-1.41) 4. How can you best describe the sun's daily behavioral pattern over an extended period of time.

Easy

LTI #4: AIR POLLUTION LONG-TERM INVESTIGATION

QUESTION:

How does man modify the environment?

MATERIALS:

Variation #1 - Plastic Clorox bottle (1/2 gal.), knife, support post (3 ft.), glass slides, clear grease (i.e., vaseline), microscope.
Variation #2 - Jar (1 gal.), support post (3 ft.), sticky white paper, spray clear lacquer.
Variation #3 - Good quality (15 denier) nylon hose, cardboard slide mounts (2 in. X 2 in.), projector, ringstand and clamp (2 required).

SUGGESTED APPROACH:

1. Discuss briefly with students prior to beginning the investigation some of the current problems raised by environmental pollution. Recent articles in newspapers and magazines should be helpful.

2. You may wish to have students perform only one of the three suggested variations.

3. After completing the investigation a more thorough discussion of pollution can be conducted. References to local problems are particularly desirable. This long-term investigation applies most directly to topic II, however, the concluding discussion will have to be held during a future topic, to which it may not apply.

   Variation #1: Students should compare their location counts at different locations by referring to Supplementary Sheet #1 (Ragweed Pollen Survey).

PRECAUTIONS:

1. The investigation should be conducted sometime within the interval from mid-August to mid-September when ragweed pollen is wind-blown. In the Supplementary Sheet #1, for a municipality, the yearly index number is several times greater than the average weekly pollen count per square centimeter.

2. Care must be taken to see that any materials to be exposed have not been previously contaminated.

3. This long term investigation does not have a concluding investigation in a later topic. When completed, the teacher must provide time during which the data can be analyzed.

BACKGROUND INFORMATION

Variation #1

Hay fever, caused primarily by pollen from ragweed, affects more than one million persons in New York State, making it a major public health problem.

Variation #3

Dirty air costs each person in New York State $65 a year according to the New York State Department of Health. Clothes get dirtier and wear out faster. In this investigation, students will be made aware of the effects of air pollution on a common item of clothing.

LTI #4: AIR POLLUTION WATCH

QUESTION:

How does man modify the environment?

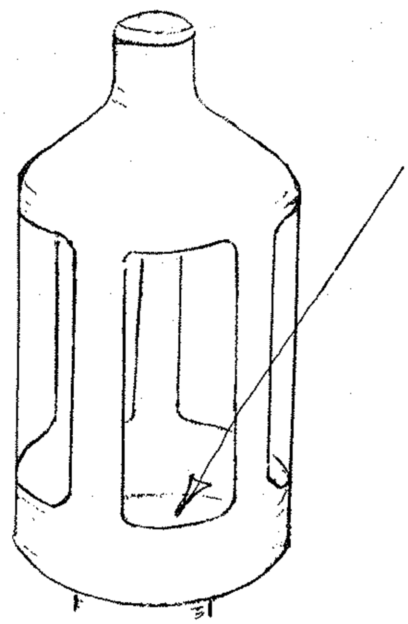
INTRODUCTION:

Much attention has been given in recent years to the problems associated with air pollution. There may be present in the air a high content of pollutant material without its presence being easily detected. Nor do we yet know about the long range effects of some air pollutants.

METHOD:

Variation #1 (Pollen Sampling)

Make a pollen sampler by cutting a Clorox bottle as illustrated.



Nail it to one end of the support pole or fence post and place the mounted shelter in an area free from obstructions.

Place a greased slide inside the bottle.

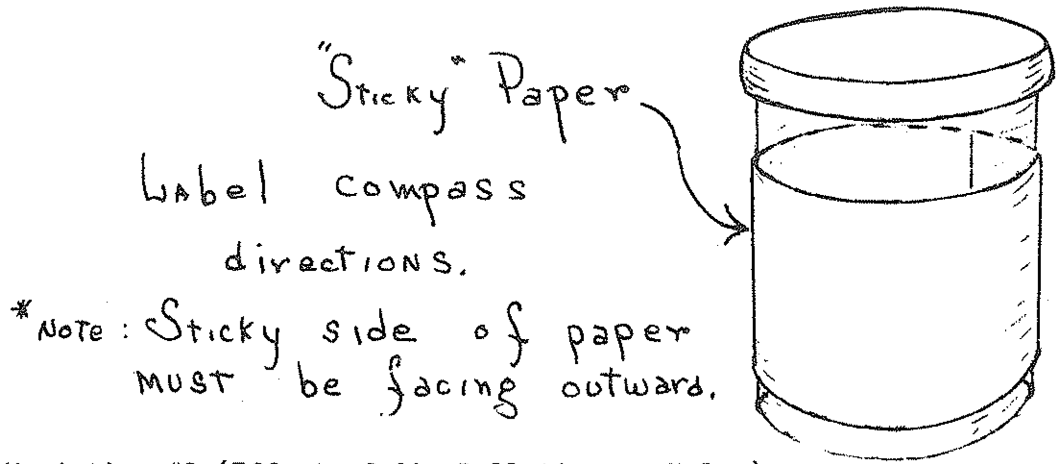
The vertical distance from the slide to the upper cut portion of the jar should be 6 inches. The upper part of the jar provides protection from rain and particulate fallout.

After a 24-hour exposure examine the slide under 100X magnification. Count the pollen per square centimeter.

Variation #2 (Particulate Sampling)

Make a wind-blown particle sampler by wrapping a strip of sticky white paper completely around the jar as shown.

Mount the jar on the support pole outdoors in an area free from obstructions. Expose for 1 week then spray the sticky paper with clear lacquer to preserve the particles in place. Mark the compass directions on the paper. Compare the concentration of particles at each compass point with the accompanying standard photographs. Estimate the number of particles collected per square inch from each direction.



Variation #3 (Effect of Air Pollution on Nylon)

Stretch a 2 in. X 1 in. piece of nylon hose over one-half of a cardboard slide mount. Glue it in place, and then glue the second slide mount to it, completing the slide mount. Prepare a second sample in the same manner. Place both samples on the school roof in a horizontal position. Leave one sample exposed for 30 days, the other sample for 90 days. At the end of each exposure period, examine the sample for broken threads. Place a sample inside as a control sample. Observe and record the number of broken strands for each sample.

QUESTIONS:

Variation #1

(C-1.21) 1. Why is it correct to refer to pollen in the air as pollution?

(C-1.22) (C-1.23) 2. Describe the source of these pollutants.

(C-1.24) 3. Would the pollen count be higher or lower in the winter as compared to the summer-fall season?

Variation #2

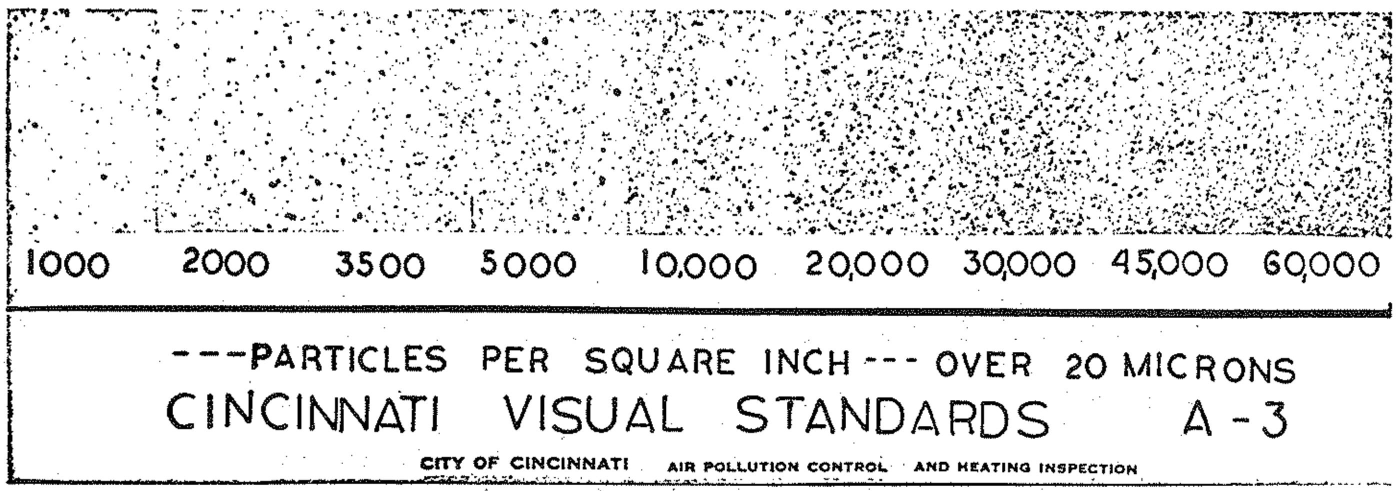
(C-1.22) (C-1.23) 1. What is the source of the particulates for each compass direction?

Variation #3

(C-1.21) 1. Describe the effects of air pollution on nylon.

SUPPLEMENTARY SHEET #2

(PARTICULATE MATTER STANDARD SHEET)



NOTE: The reproduction of the standard particles per square inch is not a true reproduction of the photographic standards, and should not be used for measuring or estimating the number of particles collected per square inch of sticky paper.

Introduction to Field Experiences

Each of the field experiences represents an attempt to extend the process of inquiry beyond the classroom. The field experiences are organized around the characteristics of the possible sites rather than a particular syllabus topic. The accessibility of the site should determine whether it is most desirable to deal with several problems on a single visit, or to make multiple visits to deal with the problems as they relate to the particular syllabus topics. If a student has carried out an investigation related to one of the problems for study as part of a long-term watch, the teacher may wish to use that student as a resource person or leader when the appropriate field experience is used. The field experiences have been keyed to the investigations—understandings matrix for the specific topics.

The format of the field experiences sheets includes three columns as follows:

Problems for Study: Each problem constitutes, in effect, a separate investigation and can be adapted by the teacher to fit the local situation. The characteristics of the site may suggest additional problems which the teacher can identify by an advanced visit.

Suggested Approach: The suggested approach contains ideas which can be translated into student procedures. Where a suggestion relates closely to one of the in-class investigations in the supplement, appropriate reference has been made. Students should be encouraged to devise their own procedures for problems which have been identified by either the teacher or the student. An advance trip by the students can help to orient them in planning procedures. If this is not possible an alternative would be to show pictures and to describe the site. Preplanning is essential since equipment needs must be anticipated, and the time factor should be determined.

Equipment: The equipment suggestions should serve only as a guide. The procedures to be employed should determine the actual equipment needs. The teacher should strongly encourage the students to plan for equipment needs so that the field time can be most efficiently spent.

Student Questions: At the end of each field experience are student questions which correspond by number to the Problems for Study. They are intended to be used as leading questions and can be added to or modified for student use as the teacher sees fit. They may also be used as introductory questions to initiate the Problems for Study.

N.B. *Before attempting any field experience or field trip:*

1. *obtain permissions for access where necessary.*
2. *determine the school policy for field trip activities regarding student permission slips, means of transportation, and insurance coverage.*
3. *identify students with handicaps which may limit their participation.*
4. *obtain simple first aid equipment and be familiar with simple first aid practices for the occasional minor mishaps.*

USING THE SCHOOL BUILDING AND GROUNDS AS A FIELD RESOURCE

FE #1

Location possibilities: The school building and grounds have been chosen as the first field resource because of the lack of transportation problems.

Possible Problems for Study	Suggested Approach	Equipment
1. Observation	1. See Investigation I-A-1b: Puddle Puzzle.	None
2. Altitude of the sun	2. Using the shadow cast by a stick it is possible to indirectly measure the angle of the sun's rays. (See also HIGH NOON WATCH and Investigation III-B-1a.)	Student astrolabes, or large protractor, or devil level Measuring tapes or meter sticks
3. Reading and observation of barometric pressure differences	3. Barometric pressure readings should be taken at each floor level. The following are possible outcomes of this investigation: skill in instrument reading, change occurring through space, the relationship between altitude and pressure, and the possible cause of barometric pressure. (Caution: If a mercury barometer is used it is suggested that you tap the column before taking a reading.	Barometer (mercury type works best) Tape measure
4. Weathering	4. Evidence of weathering may be obtained by observation of bricks, concrete, metal flooring, paint, rock (as used in window ledges, steps, or base), and mortar between bricks. If parts of the building were constructed at different times, have students look for evidence of differential weathering. Students may also look for evidence of weathering resulting from varying exposures to wind, sun, and precipitation.	Hand lens Metric rulers
5. Erosion	5. Stair treads in all but the newest schools show such signs of wear as: rounding of edges, polish on metal treads, and uneven surfaces. Students can speculate on the possible causes of differential erosion on the various parts of a particular staircase or between two staircases (For example, there tends to be less erosion on upper stories, back stairways, and on the extreme inside edges of treads.)	
6. Order of events	6. If there is construction in the area, there are likely to be piles of scrap lumber. This lends itself to a study of the sequence of events that resulted in forming the pile. Students can dismantle the pile in a "pick-up-sticks" fashion, marking each piece for identification. In addition, sun-bleaching or grayness resulting from weathering might be evidence of overturning or interruption of deposition. Bushes and shrubs may act as "intrusions" which have continued to grow as the pile accumulated.	Gloves Tags Felt tip marker
7. Contouring a hill	7. Locate one student at the base of a hill. Have him balance a carpenter's level (horizontally) on a vertically positioned meter stick. After levelling the carpenter's level he should be able to sight along its top edge while rotating it in a horizontal plane. His line of sight should traverse the hillside, passing all points with an elevation one	Meter stick Stakes Hammer Carpenter's level or transit

Possible Problems for Study	Suggested Approach	Equipment
	meter higher than the point on which the meter stick is resting. Have students locate themselves at approximately equal intervals along the hillside. The student with the level can then direct them up or down the hillside until their feet are on his line of sight, at which point a stake can be driven. When finished, a line of stakes should follow the contour of the hill. The instrument man can then move uphill to one of the stakes and the operation can be repeated. After each sequence another row of stakes following a contour one meter higher than the previous will result. If at least one set of stakes are positioned in a straight line up the hill, their horizontal position can be measured and a profile constructed. This could be expanded into a contour mapping exercise by determining the horizontal position of all stakes.	

Student Key Questions:

1. See questions for Investigation I-A-1b.

2. What is the size of each of the angles? Which of these angles is measuring the altitude of the sun? Explain, using a diagram to help. (To be used with Investigation III-B-1a.)

3. What was the barometric reading at each of the floor levels? What was the change in height between each floor? What was the total change from top to bottom? What is the relationship between barometric pressure and elevation? What is the fundamental cause of atmospheric pressure?

4. What evidences of weathering can you observe in the materials of the building? What factors seem to influence their rate of weathering? Starting with those that weather fastest, make a list of building materials that seem to be weathering. How can you measure the amount of weathering on one type of building material? How does the amount of weathering of this material compare for all parts of the building? What factors do you think may have caused the different amounts of weathering?

5. Knowing the date of erection or remodeling of the school building, how can the rate of wearing away of stair treads be calculated? How does the amount worn away compare for the different parts of any one tread? How does it compare for different treads on the same set of stairs? How does it compare for treads on different staircases? How can school traffic patterns be inferred from the amount of wear on the stairs?

6. From your observations, what can you infer about the order in which the pile accumulated? What are the limitations of the method you used to determine the order in which the scraps were put on the pile? What assumptions did you have to make? What evidence did you find that some of the boards had undergone natural weathering? How much of the surface was bleached or weathered? What does this indicate about the sequence of events as the pile formed? How might a geologist use similar techniques in the field to determine the sequence of events shown by a series of rock layers?

7. Describe what is meant by contouring a hillside. How can the instrument-man's line of sight be described? What points on the hillside will it intersect? What measurements should you have before attempting to prepare a profile of an area? A contour map?

USING A PIT AS A FIELD RESOURCE

FE #2

Location possibilities: Building site excavations, gravel pits

Possible Problems for Study	Suggested Approach	Equipment
1. Evidence of change a) taking place over an extended time b) as the site is visited on a single trip	1. Students should make observations of evidence that suggests change. If the site can be revisited, students can record measurements or take photographs to study change over a period of time. It may be helpful to get students started with a question such as: "What kinds of observations suggest change?"	Camera
2. Weathering	2. Students should look for evidence of weathering, such as sizes and orientation of particles. Other observable factors related to weathering might include: plant life, animal traces, differential weathering of single particles or of different rock types, and evidence of soil formation.	Hand lens Shovels or trowels Dilute HCl; 10:1
3. Soil profiles	3. Students can test different sections of the pit at various levels for such things as mineral composition, particle size, the presence of $CaCO_3$, topsoil, colloids and humus.	Hand lens Dilute HCl; 10:1 Shovels or trowels Water Test-tubes
4. Deposition and sedimentation a) as viewed on side walls b) at the base of slopes c) graded bedding	4. Students can look for evidence of layering. They should compare the material within the layers and between layers in terms of particle composition, orientation, shape, and size. In addition, students should be encouraged to look for other evidence which provides clues as to whether the material is transported or residual. From the evidence collected (including observations from problems 1, 2, and 3) students should develop a model of the sequence of events that occurred in the area.	Hand lens Dilute HCl; 10:1 Shovels Instrument for measuring angle (Devil level, Brunton compass, or carpenter's level) Measuring tapes

Student Key Questions:

1. Which of your observations suggest that a change has occurred? What events might have caused these changes? What changes have occurred between visits? What might have caused these changes?

2. What was the cause of the weathering of the material in the pit? What evidence suggests that the materials in the pit have undergone differential weathering? What could have caused this?

3. How many different soil layers are present? What evidence can be used to determine how long the process of soil formation has been going on in this area? From your observations, how do the layers compare in terms of particle composition and size?

4. How do the materials in the various parts of the pit compare in terms of particle composition? particle size? particle shape? particle orientation? Which agents of erosion and/or deposition have been active in this area? What evidence suggests that the material present is residual? is transported? What possible sequence of events could have occurred in the area that could account for the composition of the pit?

USING A STREAM AS A FIELD RESOURCE

FE #3

Location possibilities: Creek, construction site, drainage ditch, gutters

Possible Problems for Study	Suggested Approach	Equipment
1. Stream velocity	1. Students can determine the velocity of a stream with floating markers such as styrofoam balls or matchsticks placed at strategic points in the stream: a) across the stream bed b) across the stream at places of varying gradient c) outside and inside of a curve See Investigation IX-B-2a for techniques for determining stream velocity.	Stop watch or watch with sweep second Markers (floating) Measuring tapes
2. Gradient	2. Careful choice of a stream where gradient differences are great enough to be calculated is essential. Have two students move to positions along the stream bank holding the ends of a 100 ft. piece of string. Have them pull the string until it is taut and hold it just above the water level. Have a third student hook a line level near the midpoint of the string. This student should then instruct the student at the appropriate end to raise his end until the string is level. A fourth student can measure the height to which the string has been raised.	Meter stick Line level
3. Discharge	3. The profile of the stream bed can be determined by measuring the depth at various intervals across the stream. The cross-sectional area can be estimated from the profile by averaging. The average stream velocity should be determined. An estimate of the discharge can be obtained from the product of the cross-sectional area and the velocity. The smaller the stream, the more immediate will be the effects of run-off due to rains. Therefore, measurements before and following storms will be more noticeable than on larger streams.	Meter stick or measuring tape String (with markers attached for measuring depth) Markers (floating) Stop watch
4. Erosional features	4. With careful observation, features such as meanders, potholes, waterfalls, rapids, cut banks, plungepools, and gorges can be found in small streams as well as large ones. The cause, location, and degree of erosion that was necessary to form the feature should be theorized.	
5. Suspended load	5. In larger streams, water samples can be collected in glass jars at various depths and locations along the stream bed. The jars should be coded and the sample allowed to settle. The amount, type, and size of sediments should be analyzed relative to their depth and positions along the stream. It may also be desirable to collect samples from a given location at different times (e.g., before and after heavy precipitation).	Large-mouthed jars Hand lens Watch Stream map

Possible Problems for Study	Suggested Approach	Equipment
6. Deposition a) order of b) placement in bed c) micro-features such as ripple marks, cross bedding, or graded bedding	6. Features such as sandbars, deltas, alluvial fans, braided streams, and levees can be found both in small and large streams. The cause, location, and degree of deposition that was necessary to form the feature should be theorized. Take samples of bar or delta areas using cores corresponding to the size of the stream. Although less desirable, a soil auger can be used in more compacted areas.	Plastic tube, or lipstick tube, or soil auger Hand lens Stream map
7. Interrelation of stream variables to stream's character	7. By combining the appropriate approaches outlined above, the students should be able to relate the stream's velocity, discharge, and gradient to the nature of the stream bed and the effects of erosion and deposition. N.B. In most, if not all of the above approaches, an excellent teaching aid would be a map of the stream. Its detail would depend upon the nature of the study and the stream. This could be teacher-prepared for a hand-out, student-prepared on site, or a composite of student maps.	
8. Pollution	8. If so desired, and planned in advance, it should be possible to run a chemical analysis for pollutants on site. For additional information regarding techniques see Investigation VIII-A-3a and the sources listed at the end of that investigation. Other excellent sources include: <u>Simplified Procedures for Water Examinations</u>, American Water Works Association, 2 Park Avenue, New York, New York. $6. <u>Simplified Laboratory Procedures for Wastewater Examination</u>, Water Pollution Control Federation, 3900 Wisconsin Avenue, Washington, D.C. $3.	See Investigation VIII-A-3a

Student Key Questions:

1. What is the velocity of the stream at your station? At which station did the stream flow fastest? slowest? What factor(s) do you think were responsible for the difference in stream velocity?

2. What was the stream gradient at your station? At which station was the stream gradient greatest?

3. What are the limitations of the method you used for determining stream discharge? How does the rate vary with change in weather conditions? What is the time delay?

4. What are some possible causes of each of the erosional features you observed? How are these features likely to be affected in the future? Why?

5. How can the similarities and differences in the appearance of the water samples taken at various positions be accounted for at the time they were collected? How do they compare after they have been allowed to settle? How do the samples from different locations compare? Why? How do the samples collected at different times compare? Why?

6. How are the core samples taken at each point related to the stream characteristics at that point?

7. How are each of the characteristics of the stream that you measured related? How are each of the measured characteristics related to other observed characteristics of the stream?

8. For appropriate questions see Investigation VIII-A-3a.

USING A CEMETERY AS A FIELD RESOURCE

FE #4

Location Possibilities: Cemetery (preferably one that is long-established)

Possible Problems for Study	Suggested Approach	Equipment
1. Differential weathering on tombstones due to: a) lettering style: etched or raised b) rock type used c) exposure direction d) protection by surroundings e) vertical or horizontal position f) elevation in relation to the surroundings g) exposure time h) man versus nature	1. The nature of tombstones - with their dates - make them ideal for studying weathering rates. A prior visit to the cemetery is desirable so that sections of varying age can be located. (CAUTION: not all death dates reflect the date of erection of the monument.) You might try introducing the problem by asking students what kind of rock, where placed, and/or type of lettering he would choose if he wanted to have an "everlasting" monument. Students can observe individual monuments for evidence of weathering due to surroundings, prevailing weather direction, and exposure of lettering. Pitting, obliteration or obscuring of lettering, rounded edges and loss of polish are examples of evidence of weathering. In comparing the amount of weathering among several monuments, care should be taken to keep the rock type as a constant.	Hand lens Dilute HCl, 10:1 (N.B. use with discretion at base only)
2. Chemical weathering due to lichen, moss, etc.	2. A number of variables in the biochemical realm that affect weathering can often be observed on headstones. Simple plants will grow more abundantly on certain rock types, resulting in a faster rate of weathering. Compass direction and protection (e.g., shaded or sunny) will affect their abundance. One factor often overlooked is the weathering due to plant acids at different heights on the stone. Tombstones tend to weather faster near the base if grass is present.	Hand lens Magnetic compass
3. Hillside creep indicated by inclination of headstones	3. If a cemetery or part of a cemetery is on a relatively steep hillside, creep may occur. The amount of creep can be estimated by measuring the angular displacement from a vertical position of the headstone. The age obtained from the monument can be used to estimate the rate of creep. If possible, measure the displacement of several tombstones of the same age at different elevations on the hill.	Instrument to measure angle (Brunton, Devil level, astrolabe, or carpenter's level) Meter stick Plumb line String and weight
4. Chronological order of cemetery development	4. By determining the dates on the monuments in each plot it should be possible to construct a map showing the chronological development of the cemetery.	
5. Study of land/soil usage	5. Students can speculate as to why a cemetery was built at this site. If available, students should first be provided with maps showing other cemeteries. This will enable them to look for a pattern. Some of the reasons for placement could be esthetic beauty, good drainage, easily dug soil, near a church, the poorest land available in a farming area, the only land available, or proximity to a settled area. While some of these factors are sociological, many can be woven into an earth science frame of reference.	Topographic maps of area Soil maps of area Aerial photos (not essential) Older maps of area showing growth and development Soil testing kits

FE #4

Student Key Questions:

1. What evidence did you find that the tombstones have undergone weathering? What factors do you think are responsible for variations in the degree of weathering? What effect does each of these factors have on the appearance of the surface of the monument?

2. What relationship, if any, did you find between plant type and rock type? How were the plants distributed on all sides of the stone? What evidence suggests that plants are very important or unimportant agents of weathering for the stones you studied?

3. What is the relationship between age of headstone and angular displacement? What is the relationship between position on the hill and the angular displacement? What is your estimate for the rate of creep?

4. Which part of the cemetery is oldest? youngest? Why do you think the sections were developed in the order suggested by your map?

5. What is the drainage of the area like? What indications are there of the depth of the water table? What is the type of topsoil? What is the underlying soil? What are the underlying rocks probably like? How deep is the bedrock? With the population increasing as it is, do you think that the present use of this land will continue to remain the same?

USING A BEACH AS A FIELD RESOURCE

Location possibilities: Ocean beaches, both tidal and lagoonal; lake beaches; river beaches

Possible Problems for Study	Suggested Approach	Equipment
1. Wind erosion and deposition	1. Look for dunes (stationary or migrating), man-made barriers, distribution of plants, and frosted sand grains.	
2. Origin of beach material	2. Students should examine the composition, size, and roundness of the beach particles, and the percent of shell fragments. A comparison should be made with the materials observed farther inshore. Students should theorize about possible origin of the beach sand.	Hand lens Probe needles Dilute HCl
3. Behavior and nature of waves on water a) motion of waves b) longshore drift	3. Floating markers can be set on the water at intervals in a line perpendicular to the beach. At least some of the locations should be far enough from the shore to be beyond the point where the waves are breaking. The motions of each marker should be described and then compared. In particular, a comparison should be made between the motion of those markers close to shore and those further out. Longshore currents can easily be detected by the motion of the markers close to the beach. Water-marking dye may be used in addition to or in place of the floating markers.	Bright, visible floating markers such as beach balls or large styrofoam balls Rowboat Water-marking dye (non-poisonous)
4. Evidence of tidal zones	4. Look for abrupt or gentle changes in beach slope, changes in composition and size of beach material, and the position of driftwood and/or living organisms such as kelp beds or clam beds.	
5. Comparisons of change in beaches over an extended time	5. Students can attempt to locate beach area features on old topographic maps or photographs, if they are available. If the map or photograph is sufficiently old, many of the features will be altered or missing. Students should be encouraged to theorize as to the causes of the changes. Periodic measurements or photographs can be made as part of a long-range watch in an attempt to determine both the nature of any changes and the rates at which they occur.	Topographic maps Photographs
6. Sea and land breezes	6. This problem requires two visits, one within a few hours of sunrise and the other in midafternoon. Wind speed and direction, air, soil, and water temperatures,and barometric pressure readings should be taken some distance from the shore over the land and, if possible, over the water.	Aneroid barometer Thermometers Hand wind speed indicators Local, recent offshore and inland weather report
7. Man's struggle with the beach	7. Man - in his attempt to maintain a beach in its present condition or alter it to fit his needs - often interferes with on-going natural processes. Evidence for this includes constructing groins or jetties; dredging; erecting wind barriers; planting grasses and shrubs; filling in lagoons; killing natural vegetation; constructing buildings; roads, bridges, and docks. Students should look for evidence of man-made alterations and make inferences as to the effects of these	Topographic maps

Possible Problems for Study | Suggested Approach | Equipment

alterations. In addition they can attempt to project the future of the beach.

Student Key Questions:

1. What features can you observe that suggest wind erosion at this site? wind deposition? Do you think that the net effect of the wind at this site has been destructive? Explain. What has man done at the site to aid these processes? to retard them?

2. How many different kinds of particles did you observe? What is the relative abundance of each type? How much variation did you find in particle size? shape? Where did the material on the beach come from? How did it get there? How does the material at the beach compare with that farther from shore? Why?

3. How does each marker move? How do you account for any similarities and differences in the type of motion and the rate of motion among the markers?

4. What evidence can you see that indicates a change in water level? How many different water levels does the evidence suggest? How are the levels similar? Different? Why?

5. List and observe features along the beach that you can find on your topographic map or photograph. Which of these features, if any, appear to have been altered? How? Which features shown on the map can no longer be found on the beach? What processes might have brought about the destruction or disappearance of these features? What additional changes, if any, would you expect to find if you were to observe the beach several days later? several months later? several years later?

6. How does the soil temperature compare with the water temperature? Why? How does the air temperature over the land compare with the air temperature over the water? Why? Explain the direction wind blows in terms of air pressure?

7. What evidence suggests that man has altered the beach? Which of these alterations has he done to maintain the beach as it is? Which have been done to change the beach to fit his needs? What do you think will be the long-range effect of these alterations?

Easy (1)

II-A-1a: SUNSPOT ANALYSIS

QUESTION:

How can changes be described?

MATERIALS:

Telescope (or binoculars), graph paper, sunspot data (see supplementary sheet).

SUGGESTED APPROACH:

1. For many students, this will be the first time they will observe sunspots. If possible, begin the investigation on a sunny day by observing sunspots with a telescope or binoculars. This can be done by pointing the telescope or binocular in the general direction of the sun and then moving it until a circular shadow forms on the ground. TAKE CARE THAT AT NO TIME DOES ANYONE LOOK THROUGH THE EYEPIECE. EVEN A MOMENTARY IMAGE CAN CAUSE DAMAGE. A piece of paper placed perpendicular to the plane of the eyepiece should provide a good image. Focus the telescope or binocular until a clear image is produced.

2. Discuss briefly with students the nature of sunspots. This may be deferred until after the students have graphed the data.

3. Have students graph the data from 1900 to 1969 and interpret it. (see student direction sheet). A variation would be to assign the plotting of the complete record of sunspots (1750-1969) to a small group of students.

TYPICAL RESULTS:

A general pattern should emerge yielding an average sunspot cycle of about 11 years.

MODIFICATIONS:

If the existence of sunspots is demonstrated as suggested in the approach, it may be possible for students to collect their own data over a period of time. This data can then be explored to determine if there is a shorter range cycle (i.e. weekly or monthly).

REFERENCES:

Investigating the Earth, pp. 20-21, Teacher's Guide, pp. 45-47.
Sky and Telescope - Monthly listing of sunspots.
Preliminary Report and Forecast of Solar - Geophysical Activity, prepared by Space Disturbance Forecast Center, ESSA, U.S. Department of Commerce, Boulder, Colorado 80302

II-A-1a: SUNSPOT ANALYSIS

QUESTION:

How can changes be described?

INTRODUCTION:

Sometimes changes in nature appear to follow a pattern. This may not always be obvious at first but, if studied over a period of time it may become apparent. One of the best ways to study the behavior of something over a long period of time is to make many individual measurements and graph your results. This gives you a picture-like way of seeing relationships which might otherwise remain hidden.

In this investigation you will graph data which was collected over a period of many years by many observers.

OBJECTIVES:

When you have finished this investigation you should be able to:

1. choose an appropriate scale and prepare a graph, given a set of data.
2. identify, from a graph of sunspot data, the times of maximum and minimum activity.
3. Describe the characteristics of the curve from a graph of sunspot data.

METHOD:

Plot the data from 1900-1969 that appear on the accompanying table. Use the graph to answer the questions that appear below.

QUESTIONS:

(A-1.41) 1. Describe the pattern shown by the graph?

(A-1.51) 2. How many sunspots will there be in the year that you graduate from high school?

(A-1.51) 3. When will the next sunspot maximum be reached?

Supplementary Sheet #1

ANNUAL SUNSPOT NUMBERS

Year	No. Sunspots	Year	No. Sunspots	Year	No. Sunspots
1750	83	1794	41	1838	103
1751	47	1795	21	1839	85
1752	47	1796	16	1840	63
1753	30	1797	6	1841	36
1754	12	1798	4	1842	24
1755	9	1799	6	1843	10
1756	10	1800	14	1844	15
1757	32	1801	34	1845	40
1758	47	1802	45	1846	61
1759	54	1803	43	1847	98
1760	62	1804	47	1848	124
1761	85	1805	42	1849	95
1762	61	1806	28	1850	66
1763	45	1807	10	1851	64
1764	36	1808	8	1852	54
1765	20	1809	2	1853	39
1766	11	1810	0	1854	20
1767	37	1811	1	1855	6
1768	69	1812	5	1856	4
1769	106	1813	12	1857	22
1770	100	1814	13	1858	54
1771	81	1815	35	1859	93
1772	66	1816	45	1860	95
1773	34	1817	41	1861	77
1774	30	1818	30	1862	59
1775	7	1819	23	1863	44
1776	19	1820	15	1864	47
1777	92	1821	6	1865	30
1778	154	1822	4	1866	16
1779	125	1823	1	1867	7
1780	84	1824	8	1868	37
1781	68	1825	16	1869	73
1782	38	1826	36	1870	139
1783	22	1827	49	1871	111
1784	10	1828	62	1872	101
1785	24	1829	67	1873	66
1786	82	1830	71	1874	44
1787	132	1831	47	1875	17
1788	130	1832	27	1876	11
1789	118	1833	8	1877	12
1790	89	1834	13	1878	3
1791	66	1835	56	1879	6
1792	60	1836	121	1880	32
1793	46	1837	138	1881	54

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Supplementary Sheet #2

ANNUAL SUNSPOT NUMBERS, Continued

Year	No. Sunspots	Year	No. Sunspots	Year	No. Sunspots
1882	59	1910	18	1938	109
1883	63	1911	5	1939	88
1884	63	1912	3	1940	67
1885	52	1913	1	1941	47
1886	25	1914	9	1942	30
1887	13	1915	47	1943	16
1888	6	1916	57	1944	11
1889	6	1917	103	1945	33
1890	7	1918	80	1946	92
1891	35	1919	63	1947	151
1892	72	1920	37	1948	136
1893	84	1921	26	1949	134
1894	78	1922	14	1950	83
1895	64	1923	5	1951	69
1896	41	1924	16	1952	31
1897	26	1925	44	1953	13
1898	26	1926	63	1954	4
1899	12	1927	69	1955	38
1900	9	1928	77	1956	141
1901	2	1929	65	1957	189
1902	5	1930	35	1958	184
1903	24	1931	21	1959	158
1904	42	1932	11	1960	112
1905	63	1933	5	1961	53
1906	53	1934	8	1962	37
1907	62	1935	36	1963	27
1908	48	1936	79	1964	10
1909	43	1937	114		

Adapted from:

Investigating the Earth, Teacher's Guide.

Challenging (0.5)

II-C-1a: ROADSIDE POLLUTANTS

QUESTION:

How does man modify the environment?

MATERIALS:

Student sheet.

SUGGESTED APPROACH:

1. Conduct a discussion concerning how an investigation might be conducted, and how one was conducted, to determine the amount of pollutants contained in roadside vegetation and soil.
2. Assign the investigation as homework.
3. Following the completion of the assignment, conduct a discussion of:
   a) relationship between metal concentration and distance from highway.
   b) relationship between metal concentration and depth in soil.
   c) possible sources of the metals.
   d) effect of an increase in numbers of automobiles in U.S. — alternatives such as mass transport systems.
   e) land use for transportation vs. agriculture, which should have priority?

TYPICAL RESULTS:

1. Observations might include:
   a) increasing concentrations of metals with increasing distance from road and decreasing concentrations of metals with increasing depth in the soil.
2. Inferences might include:
   a) source of pollutants
      1) lead - from leaded gasolines used by autos
      2) nickel - from some gasolines and atmospheric abrasion of auto parts containing nickel.
      3) zinc and cadmium - from oils and some tires
      4) zinc - from galvanized auto parts, tanks and conduits

MODIFICATIONS:

1. In many areas of New York State new 4-lane expressways are being constructed or planned. Find out what is being planned in your area. Perhaps you could invite opposing guest speakers such as a conservationist opposing construction and a highway planner encouraging construction.

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BACKGROUND INFORMATION:

1. Some pertinent information about lead:

   a) Most gasolines contain lead additives — unleaded gas is available.

   b) Lead, typical of that used in gasoline, has been detected at distances of over 100 miles from the nearest metropolitan area.

   c) In 1964 — 100,000 tons of lead, representing 10% of the U.S. consumption during that year was discharged into the atmosphere as a result of gasoline combustion.

   d) Concentrations of 0.5 parts per million in the human bloodstream will cause lead poisoning symptoms. Death may result at higher levels.

2. In the year 1900, the auto industry was just beginning; in 1934, there were 24,933,403 autos registered in the U. S.; in 1954, there were 58,622,547; in 1964, there were 86,297,133 and in 1970, over 100,000,000.

REFERENCES:

Contamination of Roadside Soil and Vegetation with Cadmium, Nickel, Lead, and Zinc by Lagerwerff and Specht; U.S. Soils Laboratory, Beltsville, Maryland, 20705; pp. 583-586; Environmental Science and Technology, Vol. 4, Number 7, July 1970.

Wheels, Wings and Water — a report on New York State's mobility — 1969, State of New York Legislative Document (1969) Number 86; Senator Edward J. Speno, Chairman of Committee on Mass Transport.

II-C-1a: ROADSIDE POLLUTANTS

QUESTION:

How does man modify the environment?

INTRODUCTION:

Scientists working in Maryland collected samples of vegetation and soil alongside a busy highway. They analyzed the samples to determine the quantity of four metallic pollutants (cadmium, nickel, lead, and zinc). The results have been organized in the data table below.

Pollutants Found in
Roadside Grass and Soil

(Expressed in parts per million mass)

Metal	Meters from Road	Grass	0-5 cm. depth	5-10 cm. depth	10-15 cm. depth
Cadmium	8	0.95	1.45	0.76	0.54
	16	0.73	0.40	0.38	0.28
	32	0.50	0.22	0.20	0.20
Nickel	8	5.0	4.7	1.0	0.81
	16	3.8	2.4	0.90	0.60
	32	2.8	2.2	0.62	0.59
Lead	8	68.2	522	460	416
	16	47.5	378	260	104
	32	26.3	164	108	69
Zinc	8	32.0	175	94	72
	16	28.5	66	48	42
	32	27.3	54	46	42

Sampling site is west of U.S. 1, Beltsville, Maryland
Average traffic conditions - 20,000 cars per 24-hr. day.

OBJECTIVES:

When you have finished this investigation you should be able to:

1. Analyze numerical data and identify relationships represented by the data.

METHOD:

1. Examine the data table and draw some inferences concerning:

    a) The pattern of metal concentrations with increasing distance from the highway.

    b) The pattern of metal concentrations with increasing depth in soil.

    c) The relative concentrations of the four metals.

QUESTIONS:

1. What patterns in the data are you able to observe?

(C-1.12) (C-1.11) 2. What effect has man had on this natural environment?

(C-1.21) 3. Why are these four metals considered to be pollutants?

(C-1.23) 4. What do you infer to be the primary sources of these pollutants? What are some other possible sources?

Easy (0.5)

II-C-1b: AIR POLLUTION - HUMAN MORTALITY

QUESTION:

How does man modify the environment?

MATERIALS:

Student sheet.

SUGGESTED APPROACH:

1. Conduct a discussion concerning how an investigation measuring the effect of air pollution on human death rate might be conducted.
2. Assign the investigation as homework.
3. Following the completion of the assignment, conduct a discussion of:
   a) particulate matter composition.
   b) type of relationship between particulate matter and death rate.
   c) general effects of air pollution on man.

PRECAUTIONS:

1. The base for the "unit increase in particulate matter" was not identified, however the fact that the highest increase experienced was 5 units provides a general reference scale.

MODIFICATIONS:

1. Ask a local doctor to discuss air pollution health problems with the students.
2. Ask your government representatives to discuss present and predicted legislation controlling air pollution.

BACKGROUND INFORMATION:

1. Particulate matter contains, among other things, known toxic substances such as lead, the carcinogenic hydrocarbon, benzopyrene, and asbestos.
2. A recent study during which autopsies were performed on the lungs of 300 ex-residents of heavily polluted St. Louis and on an equal number from relatively unpolluted Winnipeg, Canada proved:
   a) among cigarette smokers 4 times as many individuals from St. Louis had severe emphysema as those from Winnipeg.
   b) among nonsmokers 3 times as many individuals from St. Louis had mild to moderate emphysema as those from Winnipeg.
3. Air pollution also:
   a) rots and soils clothes, discolors house point, rusts metals, mars monuments, decreases visibility, can ground planes and make driving dangerous.

b) stunts the growth of vegetables, shrubs, flowers; damages fruit trees, sickens cattle, and ruins crops.

REFERENCES:

Short-term Effects of Air Pollution on Mortality in New York City by Thomas Hodgson, Jr., Cornell Medical College, New York, N. Y.; pp. 589-597; Environmental Science and Technology, Vol. 4, Number 7, July 1970.

II-C-1b: AIR POLLUTION - HUMAN MORTALITY

QUESTION:

How does man modify the environment?

INTRODUCTION:

A short time ago the Surgeon General of the U.S. in his testimony before Congress admitted that "substantive evidence of the direct effect of common day-to-day air pollution on health is lacking." Since that time investigations have been conducted that better identify the relationship between air pollution and health problems. The data table below was adapted from such an investigation.

Expected Increase in Deaths Resulting From a Unit Increase in Particulate Matter in the Atmosphere.

*Increases may be as large as 5 units per day (on rare occasions).

Category of Deaths	Average Number of Daily Deaths for Study Period	% Increase in deaths from unit increase in particles
Pneumonia	9.40	20
Bronchitis	0.81	21
Arteriosclerotic Heart Disease	85.80	8
Hypertensive Heart Disease	8.33	19
Other Diseases of the Heart etc.	18.03	9
Respiratory and Heart Diseases	150.55	9

Based on a 2-1/2 year study in New York City. (November 1962-May 1965) (Data table adapted from Environmental Science and Technology, July 1970)

OBJECTIVES:

When you have finished this investigation you should be able to:

1. analyze numerical data and identify relationships represented by the data.

METHOD:

1. Examine the data table and draw some inferences concerning:

   a) the increases in deaths due to increases in particulate matter pollution.

   b) the types of diseases that are most drastically affected by an increase in particulate matter.

QUESTIONS:

1. What patterns in the data are you able to observe?

(C-1.12)
(C-1.23) 2. What do you think the sources of this particulate matter are?

(C-1.21) 3. Why is this atmospheric environment referred to as being polluted?

SUPPLEMENTARY MATERIALS FOR TOPIC II

The nature of Topic II requires a great deal of information that is available from a wide variety of sources.

Materials are included under the following headings:

1. Government agencies which publish literature dealing with environmental pollution.
2. List of Free Earth Science Teaching Materials available from the New York State Museum and Science Service.
3. A Bibliography of topics including the following:

   - Laboratory Manuals and Supply Catalogs on Pollution
   - Films on Pollution
   - Filmstrips on Pollution
   - Air Pollution
   - General Environmental Pollution
   - Water Pollution
   - Pesticide Pollution
   - Radiation Pollution
   - Population Problems
   - Solid Wastes Pollution
   - Magazines, Journals, and Periodicals on Pollution
   - Ragweed Pollen Survey

Government Agencies which publish literature dealing with environmental pollution:

1. Federal Government

   a. Federal Water Pollution Control Administration
   Department of Interior
   4676 Columbia Parkway
   Cincinnati, Ohio 45226

   b. National Air Pollution Control Administration
   United States Public Health Service
   Department of Health, Education and Welfare
   801 North Randolph Street
   Arlington, Virginia 22203

   c. Environmental Control Administration
   United States Public Health Service
   Department of Health, Education and Welfare
   P.O. Box 30200
   Cincinnati, Ohio 45230

   d. United States Atomic Energy Commission
   Division of Technical Information
   Washington, D. C. 20545

   e. Bureau of Mines
   Department of the Interior
   4800 Forbes Avenue
   Pittsburgh, Pennsylvania 15213

2. New York State Government

   a. Division of Air Resources
   New York State Department of Health
   84 Holland Avenue
   Albany, New York 12208

   b. Division of Pure Waters
   New York State Department of Health
   84 Holland Avenue
   Albany, New York 12208

   c. Division of General Engineering and Radiological Health
   New York State Department of Health
   84 Holland Avenue
   Albany, New York 12208

   d. New York State Conservation Department
   State Office Campus
   Albany, New York 12226

   e. New York State Department of Agriculture and Markets
   State Office Campus
   Albany, New York 12226

LIST OF FREE EARTH SCIENCE TEACHING MATERIALS AVAILABLE FROM THE NEW YORK STATE MUSEUM AND SCIENCE SERVICE

Free Loan Sets of Minerals, Rocks, and Fossils

1. Loan set of rocks and minerals of New York State; set contains 30 mineral and rock samples plus item 5 below.
2. Loan set of representative fossils of New York State; set contains 20 fossils, plus item 18 listed below.

Free Subscriptions

1. Geogram, a triannual publication of the Geological Survey.

2. Museum Education, a monthly publication describing educational activities and services of the New York State Museum.

Free Publications and Reprints

1. Geological Map of New York State. This is an 8 1/2" x 11" geological map on which is superimposed the grid of 15' topographic guadrangles of the State. It is designed for hand-coloring by students.

2. Mineral resources map of New York State, 8 1/2" x 11".

3. Price list of available geological maps issued by the New York State Museum and Science Service.

4. Price list of publications in geology and paleontology published by the New York State Museum and Science Service.

5. "Rocks and Minerals of New York State," a 20-page illustrated booklet giving definitions and properties of minerals and rocks, criteria for identification, and descriptions of individual minerals and rocks. This leaflet (#10) contains the two 8 1/2" x 11" maps referred to above. One copy free to teachers; cost for others - 25¢.

6. "Some Mineral Collecting Localities of New York State," a pamphlet describing 36 mineral collecting localities within the State; pamphlet also contains the two 8 1/2" x 11" maps referred to above.

7. "The Field Identification of Rocks," a 22-page booklet illustrated with photographs which aid teachers and students in the identification of rocks. One copy free to teachers; cost for others - 25¢.

8. "An Open Letter to Fossil Collectors," lists 14 books useful in the identification and study of fossils as well as other brief notes of interest to fossil collectors.

9. "Mirror to the Past," a color-illustrated leaflet describing the major phyla and classes of fossil invertebrates found in New York State.

10. "300 Million Years Ago," a color-illustrated leaflet describing fossil fishes of New York State.

11. "Prehistoric Mammals of New York," an illustrated leaflet discussing the fossil mammals of New York State

12. "Mammoths and Mastodons, Ice-Age Elephants of New York State," an illustrated 31-page leaflet (#13). One copy free to teachers; cost for others - 50¢.

13. "An Ancient Beachhead," a color-illustrated leaflet describing the fossil plants of New York State.

14. "The Oldest Forest and the Naples Tree," a 24-page illustrated leaflet (#14). One copy free to teachers; cost for others - 25¢.

15. "Geological History of the Adirondack Mountains," a color-illustrated leaflet describing the geological evolution of the Adirondacks over the past billion years.

16. "Field Guide to the Central Portion of the Southern Adirondacks," a 34-page geological guide to the area (#12). One copy free to teachers; cost for others - 75¢.

17. Educational Leaflet #18, an 85-page geological guide to the Mohawk Valley and the area from the Capital District northward into the southern Adirondacks in the Lake George area. One copy free to teachers; cost for others - 50¢.

18. "An Introduction to Invertebrate Fossils of New York," a 17-page illustrated leaflet (#19). One copy free to teachers; cost for others - 25¢.

19. "Geology of New York - a short account," a 49-page illustrated leaflet (#20), with a large color bedrock map. One copy free to teachers; cost for others - $1.00.

SEND REQUESTS AND CHECKS TO:
Museum Office
N.Y.S. Museum and Science Service
Albany, New York 12224

MAKE CHECKS PAYABLE TO:
N.Y.S. Education Department

LABORATORY MANUALS AND SUPPLY CATALOGS ON POLLUTION

A Teachers' Packet for Conservation Information and Education, New York State Conservation Dept. Education, Albany, N. Y.

ABATES Packet, New York State Health Department, Division of Pure Waters, 84 Holland Avenue, Albany, N. Y.

Air Pollution Experiments, High School Edition, Cooperative Extension Service, College of Agriculture and Environmental Science, Rutgers University, New Brunswick, N.J.

Air Pollution Experiments for Junior and Senior High School Science Classes by Donald C. Hunter and Henry C. Wohlers, Air Pollution Control Association, 4400 Fifth Avenue, Pittsburgh, Penna.

Conserving our Waters and Clearing the Air, Study Unit for Science and Social Studies Classes, Teachers Guide, Student Manual, Reference Materials, American Petroleum Institute, 1271 Avenue of the Americas, New York, N.Y.

Environmental Pollution Educational Module, Ward's Natural Science Establishment, P. O. Box 1712, Rochester, N.Y.

Microbiological Analysis of Water, Millipore Corporation, Bedford, Mass.

Science Demonstration Equipment, LaMotte Chemical Products Company, Educational Products Division, Chestertown, Md.

Scientific Experiments in Environmental Pollution by Elbert C. Weaver, Holt, Rinehart and Winston, Inc., New York, N.Y.

Simplified Laboratory Procedures for Wastewater Examination, Water Pollution Control Federation, 3900 Wisconsin Avenue, Washington, D. C., $3.00.

Simplified Procedures for Water Examination, American Water Works Association, 2 Park Avenue, New York, N. Y., $6.00.

Teaching About Air Pollution, Albert B. Carr, reprint from School Science and Mathematics. P. O. Box 246, Bloomington, Ind.

Water and Wastewater Analysis Procedures, Hach Chemical Company, P. O. Box 907, Ames, Iowa.

FILMS ON POLLUTION*

Tom Lehrer Sings "Pollution"
With Each Breath
The First Mile Up
Air Pollution in the News
Ill-Winds on a Sunny Day
Moto Gaz
Take a Deep Breath
Air Pollution, Everyone's Problem
Our Air
The Runaround

*Available from the New York State Department of Health Film Library, 84 Holland Ave., Albany, N.Y.

FILMSTRIPS ON POLLUTION

Crisis of the Environment, New York Times, Book and Educational Division, 229 West 43rd Street, New York, N. Y., $97.50.

Environmental Pollution - Our World in Crises, Ward's Natural Science Establishment, P. O. Box 1712, Rochester, N. Y., $40.00.

Water for Tomorrow, Air for Tomorrow, Land for Tomorrow, KDI Instructional Systems, Inc., 1810 Mackenzie Drive, Columbus, Ohio, $35.00 each.

AIR POLLUTION

A Primer on Air Pollution, Mobil Oil Corporation, 150 East 42nd Street, New York, N.Y.

Air and Water Pollution, (Problems in American Society Series), edited by Gerald Leinwand, 1969, Washington Square Press.

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Air Pollution, 1966, University of the State of New York, State Education Department, Albany, N.Y.

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Air Pollution Primer, 1969, National Tuberculosis and Respiratory Disease Association.

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Clear the Air, Alfred Lewis, 1965, McGraw-Hill Book Company.

Clearing the Air, United States Department of the Interior, Bureau of Mines, Pittsburgh, Penna.

Clearing the Air - A Layman's Guide to Atmospheric Purity, American Petroleum Institute, 1217 Avenue of the Americas, New York, N.Y.

Guide to the Appraisal and Control of Air Pollution, 1969, American Public Health Association, 1740 Broadway, New York, N. Y.

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Physicians' Guide to Air Pollution, 1968, American Medical Association, 535 North Dearborn Street, Chicago, Ill.

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The Federal Air Pollution Program, Public Health Service Publication No. 1560, National Center for Air Pollution Control. Public Health Service, Washington, D. C.

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The Unclean Sky, 1966, Louis J. Battan, Anchor Books, Doubleday and Company, Garden City, N. Y.

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WATER POLLUTION

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Solid Wastes and Air Pollution, Richard D. Vaughan, Consumer Protection and Environmental Health Service, Department of Health, Education and Welfare, Washington, D. C.

Solid Waste Practices in Berkshire County - Center of Environmental Studies, Williams College, Williamstown, Mass.

Wealth Out of Waste, Bureau of Mines, United States Department of the Interior, Pittsburgh, Penna.

MAGAZINES, JOURNALS, AND PERIODICALS ON POLLUTION

All Clear, published bimonthly, All Clear Publishing, Inc., 299 Forest Avenue, Paramus, N.J.

Audubon, published bimonthly, National Audubon Society, 1130 Fifth Avenue, New York, N. Y.

Catalyst for Environmental Quality, published quarterly, Catalyst for Environmental Quality, P.O. Box 4155, New York, N.Y.

C. F. Newsletter, The Conservation Foundation, 1250 Connecticut Avenue, N.W., Washington, D. C.

ECO-Action Bulletin, Environmental Action News, 33 E Minor Street, Emmaus, Penna.

Environment, published ten times yearly, Committee for Environmental Information, 438 N. Skinker Boulevard, St. Louis, Missouri.

Environmental Science and Technology, published monthly, American Chemical Society, 1155 Sixteenth Street, N. W., Washington, D. C.

Health News. Monthly by New York State Department of Health, Albany, N. Y.

Journal of the Air Pollution Control Association, 4400 Fifth Ave., Pittsburgh, Penna. $20. per year (library and institution rate) includes articles and abstracts (monthly).

Journal of the American Water Works Association, by American Water Works Association, 2 Park Ave., New York, N.Y.

Journal of Water Pollution Control Federation, 3900 Wisconsin Ave., Washington, D. C.

National Wildlife, published bimonthly, National Wildlife Federation, 1412 Sixteenth Street, N. W., Washington, D. C.

New York State Water Resources Situation. Monthly, prepared by the U.S. Geological Survey, Water Resources Division, Box 948, Albany, N. Y.

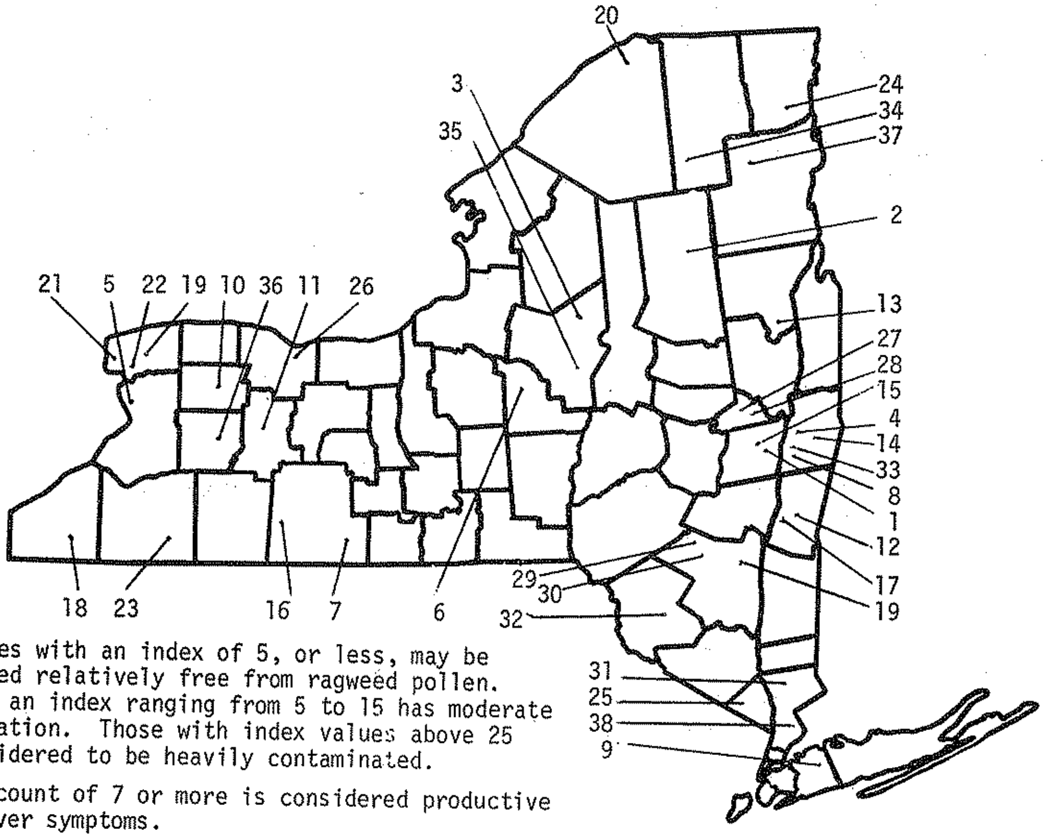
New York's Waters. Monthly by New York State Department of Health, Albany, N. Y.

The Conservationist, published bimonthly, New York State Conservation Department, Albany, N.Y.

Willing Water. Monthly by American Water Works Association, 2 Park Ave., New York, N.Y.

NEW YORK STATE DEPARTMENT OF HEALTH

RAGWEED POLLEN SURVEY



Localities with an index of 5, or less, may be considered relatively free from ragweed pollen. One with an index ranging from 5 to 15 has moderate contamination. Those with index values above 25 are considered to be heavily contaminated.

A daily count of 7 or more is considered productive of hayfever symptoms.

Map Location	Municipality	Index 67	Index 68	Index 69	Hayfever Days 67	Hayfever Days 68	Hayfever Days 69
1	Albany	24	26	26	18	18	18
2	Blue Mnt Lake		2		1		
3	Boonville	15	14	19	11	0	13
4	Brunswick	55	9	13	41	6	9
5	Buffalo	21	33	69	14	18	35
6	Canastota		31			22	
7	Corning	35	21	24	25	14	16
8	E. Greenbush	65	16	15	45	11	10
9	Garden City	22	13	34	14	9	25
10	Batavia	14	29	26	11	21	19
11	Geneseo	31	29		22	20	
12	Ghent	23	24	38	16	17	23
13	Glens Falls	15	18	15	11	12	25
14	Grafton	18	2	19	12	1	6
15	Guilderland	15	21	21	11	14	13
16	Hornell	10	15	19	7	11	14
17	Hudson	10	11	17	7	6	12
18	Jamestown		33	43	1	25	34
19	Lockport	28	18	25	21	13	17

Map Location	Municipality	Index 67	Index 68	Index 69	Hayfever Days 67	Hayfever Days 68	Hayfever Days 69
20	Massena	44	35	42	25	22	26
21	Niagara Falls	24	29	34	17	18	23
22	North Tonawanda	34	34	38	25	22	23
23	Olean	18	29	23	12	20	16
24	Plattsburg	6	13	6	4	9	4
25	Ramapo	5	43		3	25	
26	Rochester	34	31		26	20	
27	Rotterdam	18	10	15	13	7	9
28	Schenectady	11	70	23	7	25	15
29	Shandaken		2	3		1	1
30	Shandaken		6	10		4	7
21	Shrub Oak		14	13		10	9
32	South Fallsburg	4	11	8	2	7	5
33	Troy	77	2	20	54	1	14
34	Tupper Lake		8	22		5	16
35	Utica	23	17	16	18	12	12
36	Warsaw	28	46	34	21	30	22
37	Whiteface Mtn Wilmington	0	5		0	3	
38	White Plains	3	16	22	1	11	16
39	Woodstock		7	4		4	2