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ABSTRACT

These resource materials have been developed to provide inservice teachers with encouragement and assistance for field studies and in the use of their communities' resources. The subject of this monograph is Little Talbot Island State Park on Florida's northeast coast. This guide presents geological background information on the area, suggested activities for study in several curriculum areas, safety factors to be considered, and maps and routes. Information considered beneficial to teachers as they plan to visit these areas is also included. The appendix includes a teacher trip evaluation form, a student trip evaluation form, a student field guide, and behavioral objectives and activities. (BT)

LITTLE TALBOT ISLAND:

A RESOURCE FOR DEVELOPING FIELD STUDIES

by Dr. Felicia West

Resource Monograph Number 3

P. K. YONGE LABORATORY SCHOOL
COLLEGE OF EDUCATION
UNIVERSITY OF FLORIDA
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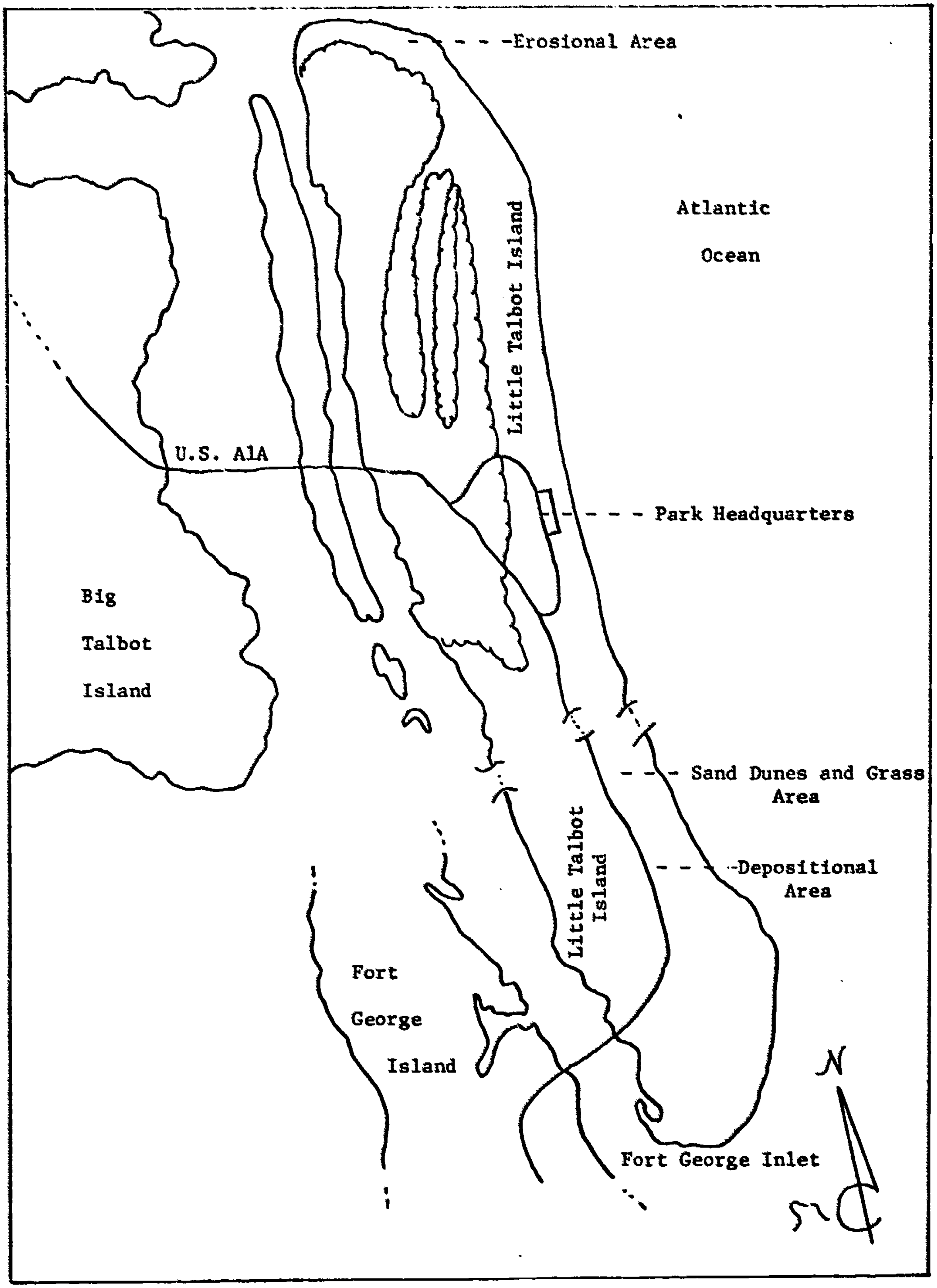
-Erosional Area
Atlantic
Ocean
Little Talbot Island
U.S. A1A
Park Headquarters
Big
Talbot
Island
Sand Dunes and Grass
Area
Little Talbot
Island
Depositional
Area
Fort
George
Island
Fort George Inlet
N

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P. K. Yonge Science Department

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Dr. Felicia E. West

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PREFACE

As one becomes more and more aware of the need to understand the earth and its forces and processes responsible for changes associated with the earth as well as its water and its air, a concomitant need develops to encourage teachers and students to study these forces and processes firsthand through the use of field studies. It is believed that in-service teachers need encouragement and assistance as they become involved in the use of this teaching technique and in the use of their communities' resources. With this need in mind, a series of monographs has been prepared by Dr. Felicia E. West at P. K. Yonge Laboratory School. The series presents a case study and resource guides to sites characteristic of four geological areas in the state of Florida.

The case study presents the methods and techniques of planning which include familiarization with the area by the teacher, development of goals and objectives for the study, pre-trip classroom activities, field trip activities, follow-up activities, and evaluation by the students and teachers involved. In addition, administrative details and the logistics of planning are treated.

Field resource guides were developed for Little Talbot Island State Park on Florida's northeast coast; for the Devil's Millhopper, a large "collapse sink" near Gainesville; for the Cedar Keys area on Florida's west coast; and for the Flagler Beach area on the Florida east coast. Material which relates to the area between Gainesville and the east and west coasts is included in the guides for the coastal area. Each of these guides presents geological background information on the area, suggested activities for study in several curriculum areas, safety factors to be considered, and maps and routes. Information considered beneficial to teachers as they plan to visit these areas is also included.

The subject of this monograph is Little Talbot Island. The area was visited in the 1770's by William Bartram, the famed naturalist, when Fernandina on Amelia Island was a small settlement called "Now Settlement" and Jacksonville was a small settlement called "Crawford". Fort Clinch was constructed in the second half of the 1800's on Amelia Island while Fernandina had by that time become a relatively important trading center. Of course, now what was once Crawford has become the "Bold New City of the South".

In addition, to a challenge to inquiry into the history of Little Talbot Island, particularly since little has been written, the island offers opportunities to examine some unique botanical and geological characteristics.

It is hoped that the information included in this monograph will provide some stimulus, assistance, and encouragement to teachers as they plan field studies to this highly interesting site. Your reactions to these materials will be appreciated and aid us in preparing similar materials in the future.

Additional copies of this monograph as well as others in the series may be had by contacting P. K. Yonge Laboratory School.

J. B. Hodges, Director
P. K. Yonge Laboratory School
and Professor of Education

CONTENTS

INTRODUCTION

This document discusses educat: l purposes, age levels, teaching units, and activities to which the site is best adapted; teaching aids available; safety factors to be considered; times available for visitation; and number restrictions on visitors. It is suggested that the teaching style strive to sustain inquiry by encouraging questions, explanations, extrapolations, and speculations based upon the problems themselves.

In developing field guides for the study of the site within the framework of earth science, many of the subject matter schemes around which the Earth Science Curriculum Program (ESCP) is built should be kept in mind and these schemes encompass:

- universality of change
- flow of energy in the universe
- adaptation to environmental change
- conservation of mass and energy in the universe
- earth system in space and time
- uniformitarianism, a key to interpreting the past

The three major process schemes which are to be woven throughout the program are:

1. Science as Inquiry: a search for accurate knowledge and a recognition of the incompleteness and uncertainty of present knowledge; unsolved problems; logical and systematic developments of conclusions from accurate observations and well-chosen hypotheses.

2 Comprehension of Scale: using scales of measurement or units appropriate to the problem; the use of models for the enlargement or reduction of a scale; skill in devising and using models; and an intuitive feeling for scale in the real world and in models.

3 Prediction: extrapolation from the known to the unknown in either space or time; making logical interpretations of past events from fragmentary records; and interpreting past events on the basis of given data

The survey to select sites for the development of the field guide included exploration, observation, and interpretation of each site. Sites which showed only a few processes or features, but showed them at their best, were not eliminated. Some of the following evidences of dynamic changes on the earth's surface are illustrated by the sites reported in this series of monographs.

a. Stream evolution

b. Beach erosion and deposition

   (1) Atlantic Coast - relatively high energy

   (2) Gulf Coast - relatively low energy

c. Dune formation and evolution

d. Coastal features and their formation

   (1) Barrier bars

   (2) Lagoons

   (3) Islands

   (4) Spits and others

e. Relic terraces as evidence of glacial-eustatic fluctuations of sea level

f. Karst topography and its development in the lime-sink area

g. Geologic history of Florida from fossil records

h. Economic geology

(1) Lime rock quarries

(2) Phosphate mines

(3) Heavy mineral mines

The exact sites and routes were selected in order that as many concepts and principles as possible could be developed. Worthwhile student activities are suggested; sets of slides, for which representative prints are included in the monograph, were produced to aid in the teacher's pre-planning and post-discussion of the trip; a bibliography of literature available for the area is included for the teacher's use; and any additional information considered useful to the teacher making the trip is made available.

Two means of assessing field trip experiences were developed in conjunction with The Case Study of Hogtown Creek. These are included as appendices. Appendix A is for the teacher; Appendix B is for the student. Included also from the case study are models for a student field guide (Appendix C) and for development of behaviorial objectives and activities for field trips (Appendix D).

A list of sites for which additional trips have been developed, subjects of other monographs, is given below.

a. The Devil's Millhopper - Karst topography, fossil and stratigraphic records. (Resource Monograph #2)

b. Atlantic Coast from St. Augustine to Flagler Beach - Coastal features and their formation. (Resource Monograph #4)

c. Cedar Keys area on the Gulf Coast - Coastal features and their formation. (Resource Monograph #5)

RESOURCE GUIDE FOR FIELD STUDY AT LITTLE TALBOT ISLAND

Background and Location

The six miles between Nassau Sound and the mouth of the St. Johns River is occupied mainly by Little Talbot Island. This island is a barrier island and is an extension of the Sea Islands chain of the Georgia coast. It has sand dunes at the northern end while a long sand spit has developed at the southern end. The length of the island has nearly doubled in the last 90 to 100 years, as revealed by examination of a U.S.C.G.S. map of the island dated 1871. The northern end of the island is being eroded by the wave action of the Atlantic and the eroded materials are added to those being deposited at the southern end. Plate I illustrates the extent of erosion taking place at the northern end

The island is separated from the mainland by vast salt marshes and tidal creeks. Its beach is generally wide with a gentle slope (Plate 2). When standing on the beach dune ridge looking westward across the island, a change in the vegetation is quite evident (Plate 3). The shore has evidently been moving eastward for some time. Other

PLATE 1

Degree of Erosion

PLATE 2

Beach Area

PLATE 3

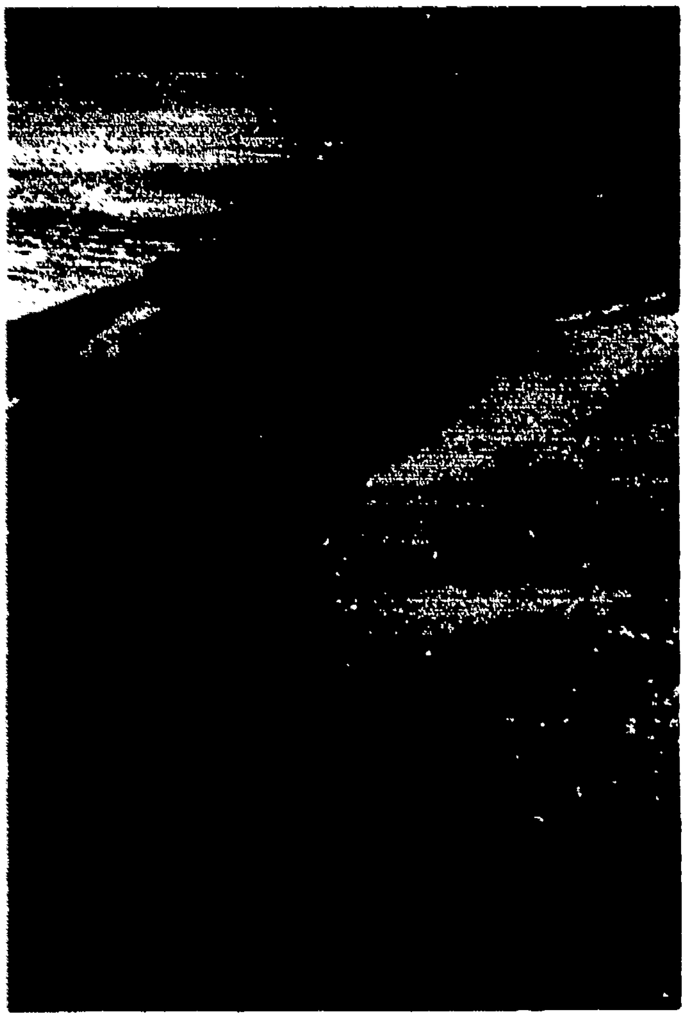
Changes in Vegetation

evidence for this is to be found in the pieces of broken sea shells which may be found at relatively shallow depths in some places on the island. There have also been places behind the foredune where wind has created blowouts, exposing the old beach floor with its relic sea shells. The beach itself is hard and firm in places, but there are sections where there appear to be excessive amounts of muddy, clayey sediments exposed. These areas are presumably located where erosion has removed the sandy sediments, exposing the muddy sediments of a relic lagoonal area.

The sand is primarily quartz in content but does contain a relatively high percentage of heavy minerals. These give the sands and the beach a black color (Plate 4) as they are separated, because of their greater density, from the quartz sands by the swash and backwash of the sea. As the backwash moves out to sea, the water loses the force to carry the heavier minerals. Hence, they lag behind the lighter quartz sand. For this reason such mineral deposits are referred to as "lag minerals" and are evidence for assuming an eroding beach. The layers, or bedding, found in the beach sands by troughing would thus seem to indicate periods of erosion and deposition.

Evidence found on the beach implies a fluctuating sea level over the past ages. Reworked sea shells, generally recognized because of their darker color and well worn surfaces, indicate that they are being thrown up on the present beach after being eroded from some long submerged relic beach area. Additional evidence to be considered is the

PLATE 4



Heavy Minerals

presence of oyster shells on the beach. The current set of beach conditions is not typical of the environmental conditions under which oysters thrive. This would seem to indicate that a lagoonal area must have existed in past ages and is now submerged under the rising waters of the Atlantic.

The beach features produced by wind and waves are excellent for student observations (Plates 5 and 6). The island exists in association with a salt marsh, a tidal creek, an undisturbed inlet with its offshore bar, and a series of erosional and depositional features. Because of the diversity of the island, investigations related to several phases of the science curricula may be conducted.

The entire island is a Florida State Park. It is located on the northeastern shore of Florida between the mouth of the St. Johns River and Fort George on the south and Fernandina and Amelia Island on the north It is separated from Amelia Island by Nassau Sound, one of the few undisturbed inlets on the Florida Coast. The area is easily accessible. From the south one has two alternatives. One can travel from Jacksonville along Interstate 95 until it intersects Florida 105 and then travel east to Fort George and the Park. The second alternative permits the traveler to move east from Jacksonville via Florida 10 or U.S. 90 toward the beaches. As these highways intersect with A1A, one can travel north to Mayport. Here a ferry is available to carry cars and buses across the St. Johns River to Fort George and intersect again with Florida 105. From the north one has no alternatives. Entrance to the island is via U.S. A1A.

PLATE 5

Foredune

PLATE 6

Cross-bedding in Sand Dune

The journey from the Gainesville area may be made in approximately one and one-half to two hours, if one does not use the ferry route. The journey is somewhat longer if the ferry route is used, but this is sometimes the more desirable route, since to many students a ferry ride is a new and fascinating experience.

Grade Level to Which the Site is Best Adapted

Since this is a Florida State Park, it is visited annually by thousands of children of all ages. This site is adaptable to all age levels as long as the objectives and activities are appropriate to the student's levels.

Safety Factors, Hazards, or Special Conditions to Consider

Although this is a State Park, there are three "hazards" to be recognized for all ages, even graduate level geology students. The Park is an ocean park and ocean swimming is one of the hazards. The area has strong long-shore currents which result in severe runouts. During the school year, there is no lifeguard on duty. It is advisable to insist on a "No Swimming Allowed" rule. Visiting the area in the cooler seasons of the year helps decrease the desire to "take a dip".

The second hazard is the reptilian inhabitants of the island. The Rangers have advised that there are many poisonous snakes on the island.

One cannot allow such a warning to go unheeded. If investigations are being made which require observations of the central portion of the island, it is suggested that this journey be made with caution and under the supervision of an adult.

The third "hazard" is the insect population. Deer flies, mosquitoes, and sand fleas may make a visit to the island uncomfortable. Deer flies are quite numerous in the spring months of the year; sand fleas and mosquitoes are present many months out of the year However, the insects are not a sufficiently severe obstacle to prevent satisfying accomplishment of the objectives and activities of the trip. A can of insect repellent reduces this "hazard" to a mere nuisance. Precautions should be taken, particularly if one is allergic to bites from these insects.

Teaching Units to Which the Site is Best Adapted

This site has great versatility and offers opportunities for investigations related to many aspects of the science curriculum. Studies related to earth science and biology are especially enhanced by a field trip to this area. Features related to earth science studies are illustrated in Plates 1 through 6. Some of the plates illustrate vegetative cover which offer opportunity for botanical investigations. The succession of vegetation growth as the shore has moved eastward for the past several hundreds of years offers the opportunity to study the conditions necessary for the various plants to thrive.

The Rangers have advised that the sea turtle uses the north end of the island as a breeding ground. The movement of the small turtles back to the sea may be witnessed during a visit at the appropriate time of the year. Since the island is fairly small but, at the same time provides great versatility in terms of habitat for animal life, studies of these are rewarding.

A partial list of areas of instruction where this site may serve in supplementary activities follows:

1. Mathematics - Statistical and graphical measurements of various processes and forces such as wind velocities, longshore currents, specific gravity of sea water and waters from other areas, and percentage of mineral content of sand.

2. Earth science - Determination of gradient of the beach, investigations of tides, currents, and sand movements, profiles of sand dunes, and many other activities.

3. Oceanography - Beach structure and water studies.

4. Botany - Plant succession and environmental conditions.

5. Zoology - Study of animal life on the island, in the sand dunes, and on the beach as well as in the shallow waters.

6. Geography - Study of the beach debris and its possible origins, study of the island as a part of the overall structure of the Florida peninsula, and changing climates evidenced by the rise and fall of sea level.

7. Art - Photography such as making slides for school uses, construction of models for class use, or the sketching of the more interesting areas of the island.

8. Agriculture - Use of plant life for beach dune stabilization, nutrient content of sand dune areas, and topics related to vegetative cover on such surfaces.

9. Sociology - Laws pertaining to the enlargement of the island by natural causes; mineral rights in such areas.

10. English - Cooperation with other teachers in writing reports and research papers on the island; searching the literature for information on such areas; debates on conservation or pollution problems.

11. Home Economics - Planning a lunch or menus for several meals if a two-day trip to the island is planned.

12. History - Researching the history of the island in books about the history of Florida and through interviews with persons knowledgeable about the history of that specific area.

Days and Hours Available for Visiting

Since this is a state park, it is always available. The gates open at sunup and close at sundown. It is "open" year-round except for the concession stands and lifeguard service. The campground is available for a small fee for overnight camping.

School visits should be made during the school year but preferably not on weekends in early fall or late spring. The camp and park area become rather crowded on weekends; thus tables (covered) , which may serve as a laboratory area in the field, may not be available.

Number of Restrictions on Visitors

There is no restriction on the number of visitors who may enter the park. It is advisable, however, to notify the Rangers prior to the visit about the number of students making the visit. It is suggested that the teacher visit the park the week before the field trip, chat with the Rangers about the visit, and walk over the route the field trip will take. Inquiries by mail should be addressed to the Chief Ranger at the park.

Accommodations

A small lunch counter is open during the late spring and summer months. Machine venders in the central area serve the park in the winter but are quite expensive. Restrooms are located in this area. A playground and many picnic shelters are available. The campground is equipped with electrical hook-ups, fireplaces, showers, and flush toilets. Water is also available near each campsite and in the picnic area.

Admission Fees

There are no admission fees to the park other than the bridge tolls at both ends of the island. These fees are minimal--50 cents for automobiles and slightly higher for buses. The ferry fee must be considered if entrance is gained by the ferry. This fee is determined by the number of axles on your vehicle.

Educational Purposes Possible of Achievement

Since 10 individual teachers may have several different purposes or objectives in mind with regard to field trips, it seems impossible to name those that are possible of achievement. It will suffice to say that the site is appropriate as a supplement to the curriculum either in introducing a unit or as a culminating activity. It may also be used to give depth and/or breadth to the curriculum. The possibilities for utilization of this site are innumerable and its only limiting parameters are the teacher's needs and abilities.

Suggested Activities for Use at This Site

A list of several activities which have been used is presented to serve as a point of departure for teachers desiring to use this site.

1. Field activity - No field trip to a beach is complete without the collection of debris from the beach. This debris may be the remnants of sea animal life, modern and/or ancient, bits of volcanic rock which

drifted from some foreign shore; remains of vertebrate animals or bits and pieces of Indian pottery; slag from coal burning ships, and light bulbs of foreign make. This activity appeals to most children and stimulates their inquiry.

A related class activity might be a study of the land masses near Florida and the directions of the prevailing ocean currents. Resource material to aid in the identification of marine plant and animal life is available in any library. Students should be encouraged to pick up anything that is a curiosity on the beach and bring it back to school for identification. This stimulates interest in a geographical unit or a unit on oceanography and ocean currents.

2 <u>Field activity</u> - The surface sediments on various parts of the island should convince your students that the shore line has changed position over the past four to six thousand years. Many places on the island offer evidence of one sort or another that the ancient beach was near the western side of the island. Students may use a hand coring instrument to sample the sand at depth in various places on the island. Comparisons may be made between this sand and sand from the present dunes near the shore line of today. Concentrations of heavy minerals give the beach sands a characteristic black look in some areas. The concentration is sufficient for mining along Trail Ridge and may be correlated with the presence of these same minerals on the beach.

A related class activity certainly should involve a discussion of the effect of glaciation on the fluctuation of sea levels. The relic dunes of peninsular Florida should be discussed as to their possible origin and their significance.

3. Field activity - Observation of shore line features is a primary activity if the study involves oceanography. There are sand dunes, ripple marks, erosional features, blowouts, wave actions, examples of cross-bedding and many other features available for study.

The class activity should vary on the basis of the purpose of the field trip. If it is introductory, there will be a minimum of class activity prior to the trip; if it is supplementary, the students should have considerable background relative to what features they should be looking for.

4. Field activity - Much of the plant life along a coastline exists behind the barrier formed by the first dune ridge. The strong winds and the salt spray limit the vegetation in the "pioneer zone." A study of the environmental conditions governing this pioneer zone through the first swale behind the foredune proves quite interesting to students of plant succession. This study might involve the moisture content of the surface sands, the temperature gradient from 12 to 18 inches below the surface through 36 to 48 inches above the surface, the wind velocities at various points over the entire area, and the nutrient content of the soils or sands. Samples of sand may be collected and the site of collections recorded and brought back to the laboratory at school for further study.

Class activities may involve the development of a wind velocity meter and an instrument for getting temperatures at various depths and heights. One group of students developed a wind velocity meter calibrated with an automobile speedometer. The meter was mounted on a car and the deflection noted at various speeds. This was done on a calm day by recording deflections while moving in various directions and averaging the results. For example, the deflection occurring at 15 miles per hour was determined while moving east, south, north, and west. The amounts of deflection for all directions were averaged to determine an acceptable value for a 15 mile-per-hour wind. Other students have developed anemometers by which relative wind velocities were measured.

An instrument for measuring temperatures at various depths and heights consisted of three thermometers, an iron rod, a piece of lath, and a few cup hooks. The iron rod should be about the same size as the thermometer and is used to drill a hole in the sand to prevent breaking thermometer. The thermometer is inserted in the hole, allowed to stabilize, and the temperature is recorded. The piece of lath with the cup hooks attached every six inches is used to mount thermometers at various distances above the surface of the ground. Students must be reminded that the distance above the ground is measured to the thermometer bulb and not the end by which it is suspended. Figures 1 and 2 illustrate these two instruments as they were constructed by the students.

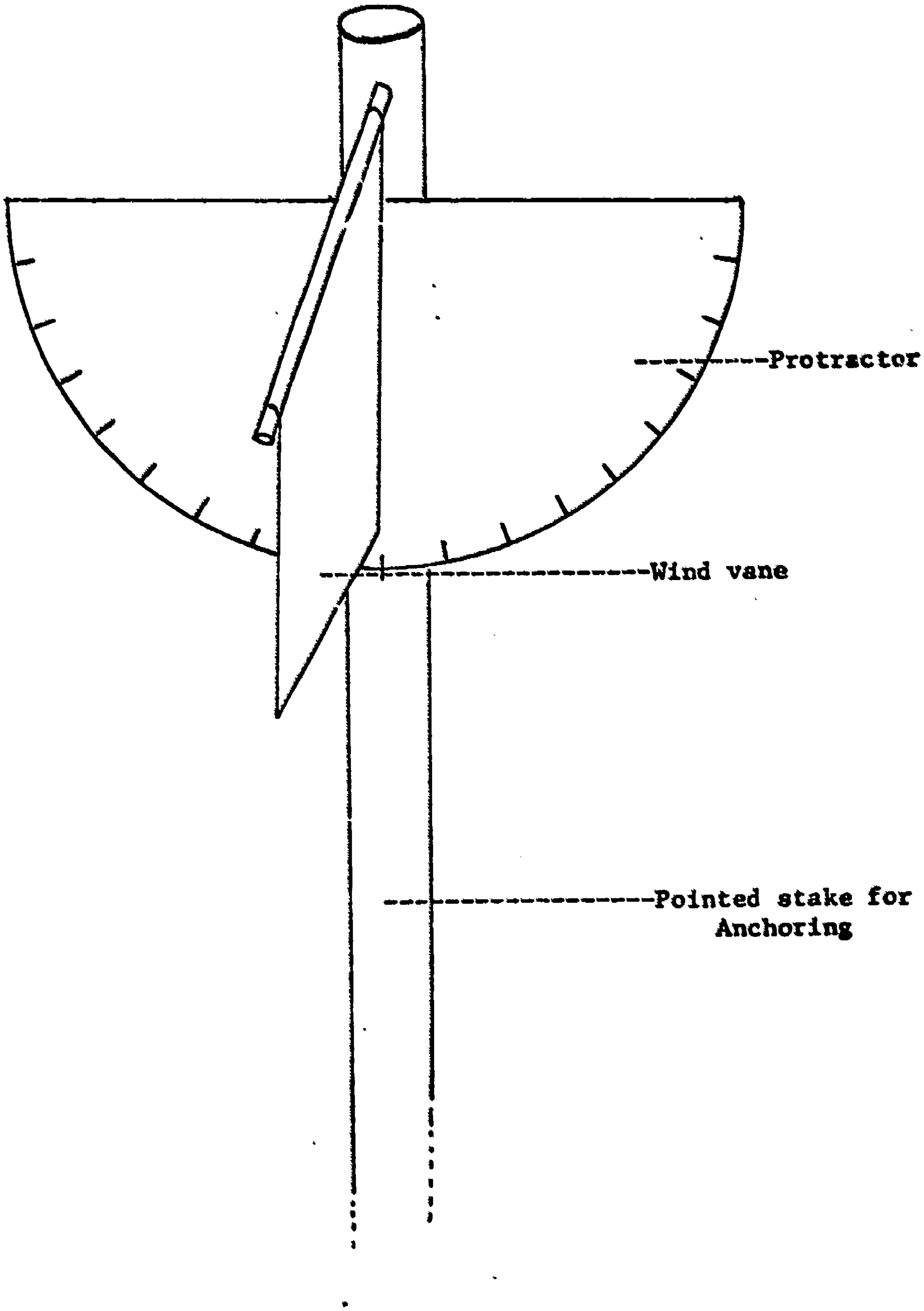


Figure 1: Wind Velocity Instrument

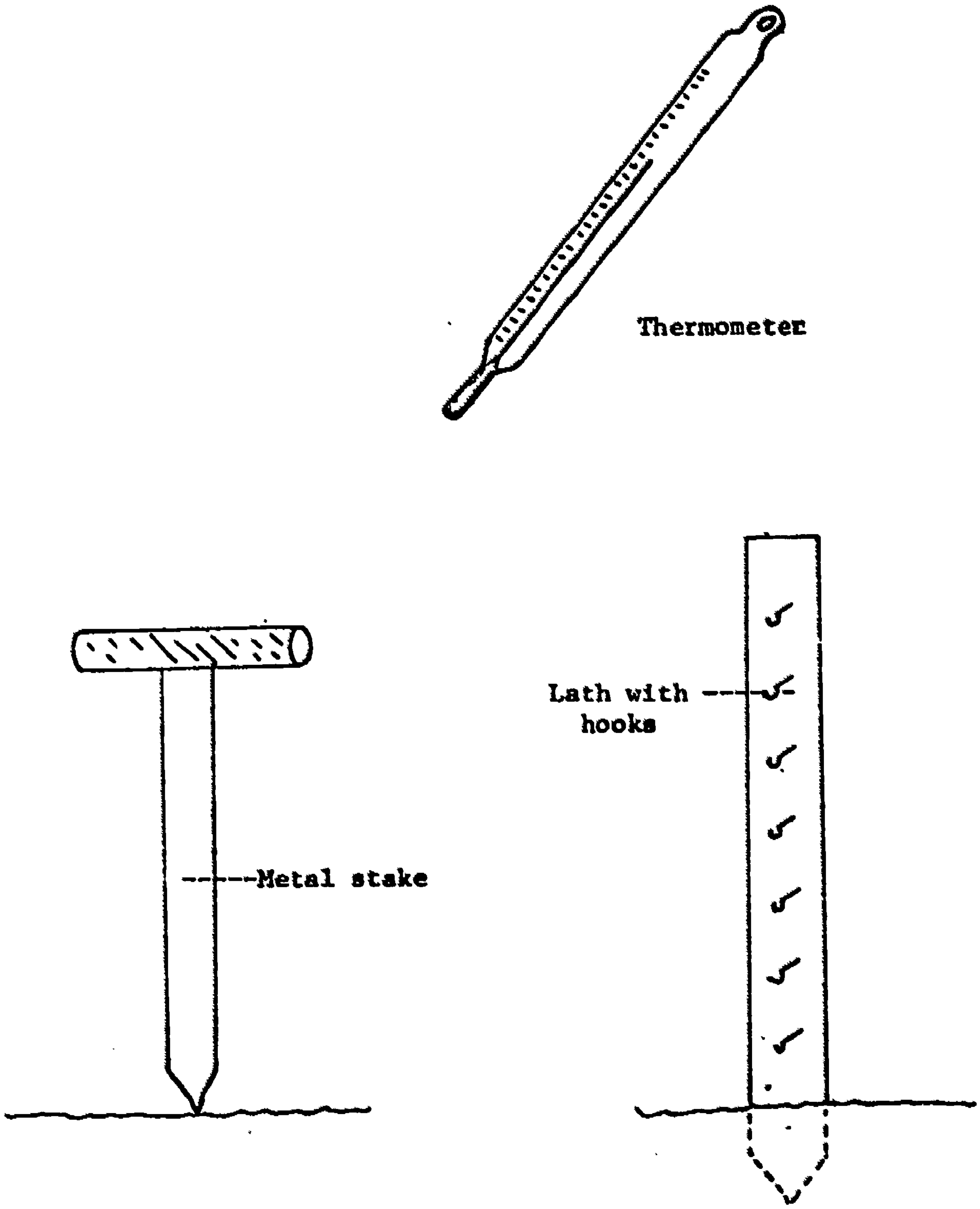


Figure 2: Materials for Temperature Observations

5. Field activity - The class may collect a sample of sea water. This can be returned to the classroom and used in follow-up activities. The student may determine the amount of dissolved materials present in a liter of salt water. Since this island has a small creek on one side and the ocean on the other, samples of varying degrees of salinity may be collected and examined. There is also an intermittent stream draining the center of the island. This stream as well as water which will fill shallow holes dug in the sand behind the foredune is relatively sweet water. This may be sampled and the same analyses be made back in the classroom.

The student may be introduced at this time to the relation between this fresh water and the sea water. The question of why the fresh water surface stands higher than the sea water and the problem of salt water intrusion as man depletes the fresh water supply may be raised at this point. The student may begin this study by determining the relative densities of the two fluids. The depth of this study will depend on the level of the student with whom you are working.

Class activity prior to the trip should prepare students for making such analyses, determining specific gravity and so on. Preparation prior to the trip has some advantages to preparation after the trip. Perhaps it is the anticipation factor which seems to maintain interest for a period of time necessary to acquire the knowledge and skills essential to successful accomplishment of the trip's objectives. Student interest decreases rapidly if follow-up activities are stretched out over a long period of time. An additional follow-up activity which should interest students involves freezing some salt (sea) water. The ice should be separated and examined separately from any sea water which does not freeze. Both samples should be analyzed for salinity, specific gravity, conductance, boiling point, and so forth.

6. Field activity - A relatively simple activity involves the comparison of the size of sand particles on different parts of the beach. This may be done with a binocular microscope and a grid. Since the heavy minerals are also present, the identification of certain of these may take place here also.

Since this activity is concerned with the deposition of materials of varying densities and sizes, a class activity may involve settling rates of known sand sizes. A glass tube may be rigged to stand upright (about 30 inches). The tube may be filled with water and the settling rate of various sizes of sand determined.

7. Field activity - Collection of samples of sand from various areas so that moisture content may be studied back at school. Samples must be stored in airtight containers for classroom processing according to the following procedures:

a. Weigh container and moist soil (sand) __________

b. Weight of container alone __________

c. Weight of moist soil __________

d. Weight of container and dry soil __________

e. Weight of empty container __________

f. Weight of dry soil ____________

g. Weight of moisture lost (c-f) ____________

h Percent of moisture (g/c x 100) ____________

These activities may appear to students to be isolated tasks and , indeed, will be isolated and meaningless if a set of specific objectives are not developed prior to the study being made.

These suggested activities are to serve as guides for teachers who might desire to use this area of the State for study. However, it is preferable to limit study to one curricular area at the time and to a few specific problems.

<u>Teaching Aids and Printed Materials Available</u>

There are no teaching aids available other than the slides and collections of materials made by the writer. Seemingly printed material about the island is nonexistent. Much of the information presented and all knowledge based on geological research is the result of the writer's many visits to the island as a member of various geology classes as a student of Dr. H.K. Brooks. Frequently, teachers must rely on such activities to accumulate knowledge about areas for which no published material exists. The general features of the island and its relationship to adjacent islands are shown on the map. (See inside front cover). A list of references related to this general area is presented in the bibliography to serve as background resource material for teachers.

The appendices of this monograph contains sample field trip evaluation forms for students and teacher, a student field trip guide for an investigation of Hogtown Creek to serve as a model for developing guides to other sites, and procedures for developing behaviorial objectives for field studies.

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APPENDIX A

TRIP EVALUATION FORM (TEACHER)

ITEM	EVALUATION 1	2	3	4
1. Are the goals relevant, realistic and worthwhile?				
2. Do the objectives state clearly what effect the field study should have on the learner's behavior?				
3. Are the objectives relevant, realistic and worthwhile?				
4. Is the field guide well-organized and clearly understood?				
5. Are the guide questions for each stop relevant and significant?				
6. Are activities sufficiently varied to stimulate interest in a number of areas?				
7. Are the activities supplying relevant data?				
8. Do activities appear to be sufficiently sophisticated for this age group?				
9. Do the activities and observations warrant missing a day in the classroom?				
10. Was the time allotted for this trip adequate?				
11. Were the portions of the creek to be studied chosen to best advantage for this age group?				
12. Are the welfare and safety of the children adequately considered in the study and its activities?				

CODE FOR EVALUATION

1. Very good as described. 2. Satisfactory or acceptable. 3. Needs revision. 4. See comments and suggestions on next page.

APPENDIX B

TRIP EVALUATION FORM (STUDENT)

Please answer the following questions. Do not identify yourself. You are being asked to convey your feelings and beliefs about the field trip to Hogtown Creek and to offer suggestions that will help make this a better field trip for future use. (Place your answers in the space following each question; if additional space is needed use the back of the form.)

1. Do you believe that the field trip was successful in terms of the general goals as stated in your field guide? If not, please specify the goals you believe were not accomplished.

2. Please specify any mistakes you believe were made or any difficulties you may have encountered that were related to:

   A. Resource sites used

   B. Guides (non-teacher)

   C. Teachers

   D. Other students

   E. Weather

   F. Transportation

   G. Size of group

   H. Activities

   I. Other

3. Do you believe that the conduct of the group was satisfactory? If not, what changes would you suggest?

4. Do you believe the trip was really worth the time and effort spent on it?

5. Do you believe the same educational results could have been obtained equally well through other methods such as the use of slides, movies, laboratory activities or reading assignments?

6. Which aspect of the trip might be improved?

   A. Pre-planning

   B. Size of groups

   C. Number of ideas presented

   D. Observations made

   E. Number of sites visited

   F. Length of the field trip

   G. Follow-up activities in the classroom

   H. Others

7. List the activities on the trip that you think were:

   A. Most valuable

   B. Least valuable

8. Did you develop any new interests as a result of the trip? If so, what interests were they?

9. Did the trip make you change your attitude?

   A. Toward anyone in the room?

   B. Toward the teachers involved?

   C. Toward science?

10. Were your teachers "different" on the trip? How?

11. Did you learn anything on this trip about working with people? If so, what did you learn?

APPENDIX C

STUDENT FIELD GUIDE FOR AN INVESTIGATION OF HOGTOWN CREEK

INTRODUCTION

The revised form of the Student Field Guide is presented in the following pages. Since some of the activities have been revised after the students' participation, some of the activities and the associated instruments have been changed. The two instruments that have been revised are those used in the determination of gradient and cross-sectional area. In the Observational Record Guides space for student comments has not been allotted in this copy; in the students' working field guide, sufficient space is allowed for their comments.

The major change, as is evidenced by the map of the area under study, is the deletion of the visit to Hogtown Sink, the terminus of the Creek. This visit will be incorporated into a separate trip that will involve a study of karst topography. This change was based on the responses of the students who regarded the stop at the sink undesirable. These responses coupled with the necessity to shorten the trip resulted in the change.

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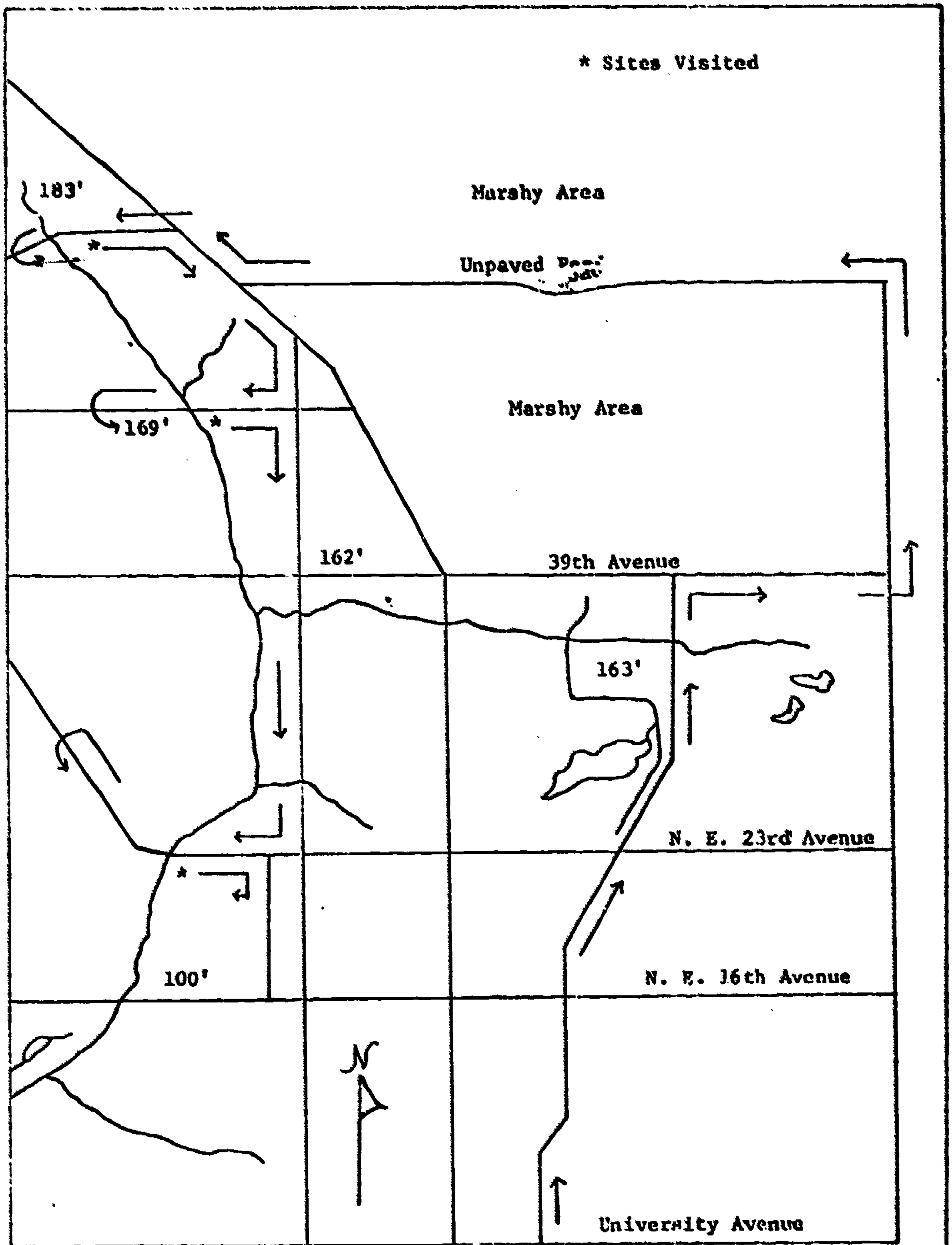


Route for Hogtown Creek Field Trip

Primary Goals

1. To develop in the student an awareness of the uniformitarianistic qualities and of the universality of the natural forces and processes through which the earth's topographic features have evolved.

2. To carry the student out of the confining classroom and into the direct empirical and quantitative observations of natural and physical phenomena at work in shaping the earth's surface.

3. To emphasize science as a process of inquiry by providing the opportunity for the student to observe, collect and process data, and make interpretations.

4. To develop an understanding and concern for our natural habitat in order to involve the student in the perpetuation of a quality environment.

Performance-Based Objectives

1. When the student completes his observations of the erosional and depositional features of Hogtown Creek, he will be able to identify similar features from slides with at least 70 per cent accuracy.

2. The student will view the processes, forces and related features involved in the evolution of Hogtown Creek and will view slides of the Colorado River and the Grand Canyon. The students will then be able to describe orally on tape or in essay form at least six of the similarities and/or differences between the processes and

forces shaping these two great valleys with at least 70 per cent accuracy.

3. During the field trip the student will demonstrate at least once his ability to manipulate the various instruments by measuring gradient, velocity and cross-sectional area. His data will agree within a selected tolerance of the instructor's data for each activity (20 per cent tolerance for gradient, 10 per cent tolerance for cross-sectional area and 5 per cent tolerance for velocity).

4. The student will demonstrate his ability to interpret data on gradient, velocity, discharge rate, and cross-sectional area either in a taped oral discussion or by written assignment by correlating the quantitative measurements with the structural characteristics of the stream. He will do this with at least 70 per cent accuracy.

5. The student will demonstrate his ability to evaluate his observations and accumulated data by identifying at least two of the effects man has already had on the evolution of Hogtown Creek and by hypothesizing what one future effect of man's actions will be.

6. The student will be able to interpret the conditions under which the sediments were laid down after viewing depositional structures along the Creek. He will do this by examining a core sample of sediments in the laboratory and interpreting the relationships of the various types of sediments in the core in oral or written discussions.

7. The student will demonstrate a positive attitude by making positive vocal contributions in the form of questions or comments at least once during any discussion occurring during the field study.*

Summary of Activities

Stop no. 1:

Gradient determination and velocity of water.

Eighteen-inch core samples of sediments.

Surface samples of flat stream bed and of deep holes in stream bed.

Samples of sediments from slip-off slopes and cut banks.

Cross-sectional area.

Stop no. 2:

Gradient determination and velocity of water.

Samples of resistant materials in stream bed - just above water level and just below water level.

Samples of materials associated with issue of springs in banks of the stream.

Samples of wet stream bed - flat portion, pot holes, slip-off

* This objective was not placed in the students' field guides. It is believed that the presence of this objective would in itself affect the students' behavior and therefore was omitted from all except the teacher's guide.

slopes, and cut banks.

Stop no. 3:

Gradient determination and velocity of water.

Samples of wet stream bed - slip-off slopes, cut banks, terraces, and sand bars.

Collect samples from oxbow or old meander scars. (Scrape away organic trash on surface and collect 18 inches of sediments in 6-inch lengths.)

Cross-sectional area.

INTRODUCTION TO STOP NO. 1

Hogtown Creek drains part of an area lying between the high central plateau and the lime sink region. The drainage area has an elevation ranging from about 190 feet above sea level to about 60 feet above sea level. The elevation of the branch where you will begin your study is approximately 175 feet above sea level. Your last stop will be near the 100 foot contour as you finish your observations. The terminus of the creek which will be visited at a later date lies at about the 60 foot level. The creek ultimately drains into Hogtown Sink in the southwest corner of the Prairie.

The brank of the creek that you will investigate first originates just southeast of Paradise. The upland area of this creek is typically one of lakes (ponds) and swamps. Because of man's interference, it is sometimes difficult to determine visually whether the land drains into Hogtown Creek or into one of the Hatchett Creeks, two additional streams draining this upland area.

As you leave P.K. Yonge campus and ride toward your first stop, please watch the landscape and plant cover with the following questions in mind:

1. How have the topographic features changed as you moved from the campus to the upland area of the stream?

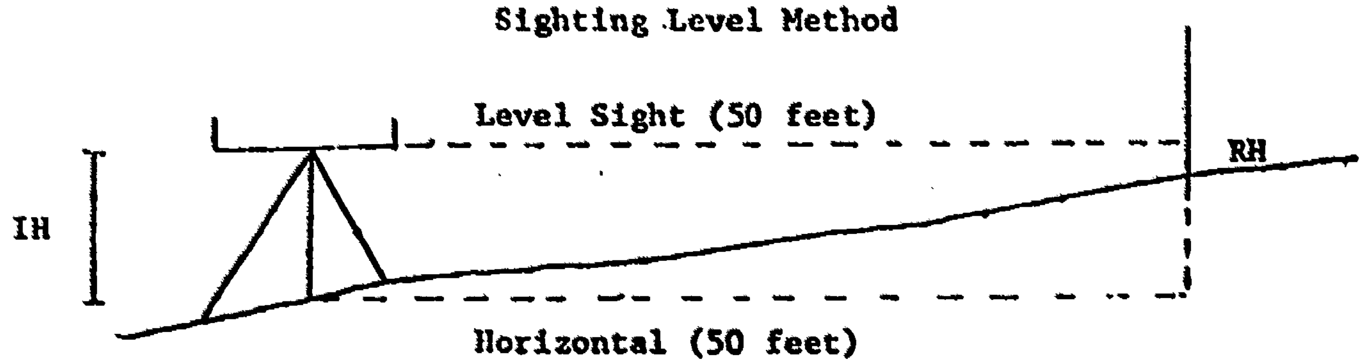
2. Are the shrubs and trees different from those which you find on the campus? How?

3. Is there any evidence along the way that might indicate a perched water table? What is your evidence?

4. What effects do you think man's clearing of this land and developing a series of drainage ditches might have on the Creek itself?

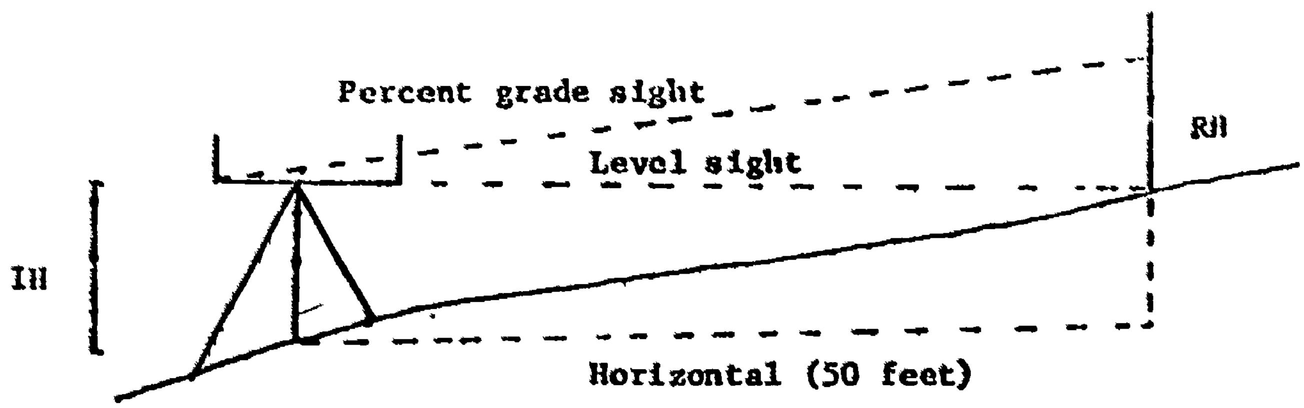
5. From looking at the land surface can you tell anything about the surface?

Sighting Level Method



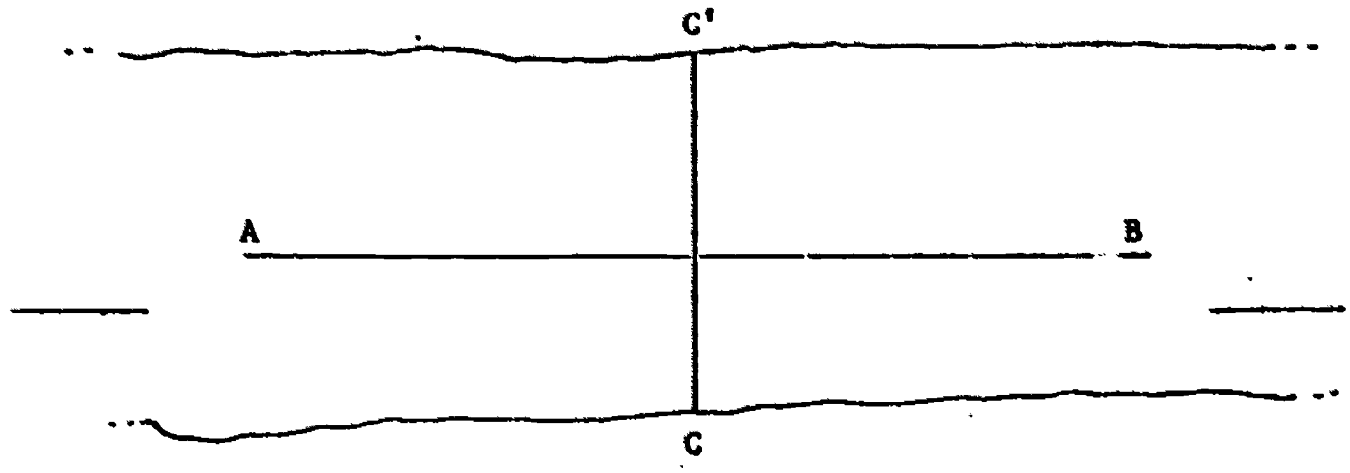
Record IH (Instrument Height) and RH (Rod Height)

Percent of Grade Method



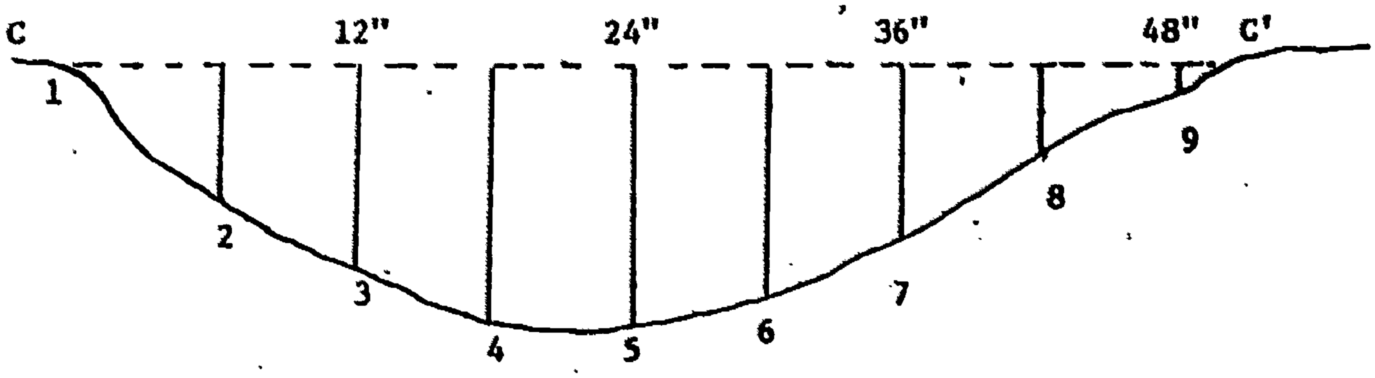
Record IH (Instrument Height) and RH (Rod Height)

Figure 1: Determination of Gradient



Distance from point A to B: 10 feet

C - C' Midpoint between A and B (Cross-sectional data should be collected here).



Depth of water is recorded every six inch interval. Tape stretched from C to C' must be right at water level. Depth is measured with a meter stick.

Figure 2: Velocity and Cross-sectional Area

OBSERVATIONAL GUIDE

STOP NO. 1

FEATURES AND COMMENTS:

1. Note the drainage of the area at this site.

2 Note the sediments through which the stream is cutting. Are they particularly resistant ?

3. Can you find a section of the stream where it encounters more resistant sediments? Describe the area please.

4. Does this appear to be a typically youthful stream? Why or why not?

5. Can you account for the meanders that are present here?

6. Find and list as many erosional features in this section as you can.

7. Find and list as many depositional features in this section of the stream as you can.

8. Evidence of man's interference with this stream. Is there any? Describe your evidence for or against.

9. Other observations. Use back of page if necessary.

INTRODUCTION TO STOP NO. 2

You shall leave the first site and proceed down in elevation to the second site. The elevation here is about 150 feet above sea level, and is an interesting place to visit. The creek flows through a private yard and garden; the owner has given you permission to visit here. Please show him consideration by being careful with his trees and shrubs, and do not damage the creek banks so that erosion will become a problem for him. Because of the nearness of the residence to the creek, please keep your conversations at a reasonable level.

The small groups will gather their data and make their collection of samples. Following this the large group will assemble and everyone will look at the stream together, searching for and discussing the features on the Observational Guide Sheet. Many other features may be noted that do not appear on this list. As you collect your data and make your observations, keep in mind the following questions.

1. What evidence is there here to indicate that this stream has undergone a setback in its progress toward maturity and old age?

2. Do you see any evidence of differential erosion?

3. How do you account for the presence of springs at the level at which they are found issuing from the banks?

4. How do the sediments through which the stream is cutting its way here differ from the sediments at the previous stop? Are there any similarities between these two groups of sediments?

5. The main source of water for Hogtown Creek is ground water. Through man's interference the rate of run-off has been increased and has been channelled into Hogtown Creek. Do you see any effects of this periodic flooding during times of heavy rainfall? What effect does it have on the immediate terrain? Can you see any influence this periodic flushing might have on organisms living in the creek?

OBSERVATIONAL GUIDE

STOP NO. 2

FEATURES : COMMENTS:

1. Change in Gradient.
2. Materials being added.
3. Meanders.
4. Rejuvenation.
5. Waterfalls and rapids.
6 Deep valley sides.
7. Higher stand of water level.
8. Hanging valleys.
9. Alluvial fans.
10. Potholes.
11. Abrasion.
12. Pollution.
13. Velocity in relationship to physical characteristics of the stream.
14. Stream competency.
15. Temporary base level.
16. Faunal evidence of past history.

INTRODUCTION TO STOP NO. 3

Your next site to visit is one located on the 100 foot contour behind the Gainesville Mall and Gainesville High School. Through the courtesy of the owner of the land, you have been given permission to investigate this portion of the stream.

This segment of the stream has some features that are better developed than what you have seen before. Please be alert to any changes in the physical appearance of the stream. As you proceed through your quantitative measurements and your collections, keep in mind the following questions:

1. Does any evidence show that the competency of the stream varied from time to time?

2. Is the stream here presently involved in down-cutting or lateral erosion?

3. How has man's interference affected the stream in this area?

4. Notice that the creek flows in a valley which is much wider and still has fairly steep banks. Does it follow that this stream once filled this entire valley and was much larger than it is now?

5. Are there any significant changes in the character of the sediments through which this creek is cutting its way at this point?

APPENDIX D*

BEHAVIORAL OBJECTIVES AND ACTIVITIES

Development of the Objectives

The preliminary investigation of the study area suggested the educational potential of Hogtown Creek. The next task was to maximize the potential on the basis of general and performance-based objectives. The general objectives served as a logical point of departure in undertaking the development of the objectives for the field study.

Since two of the basic beliefs of earth science are uniformitarianism and universality of change through various processes and forces, students should be provided opportunities to develop awareness of these beliefs. Students' observations of the forces and processes at work in the Hogtown system and comparison of this system with similar systems in other areas could suggest the universality of the processes and forces. Further comparisons made with other stream systems should also suggest the concept of uniformitarianism. On this basis the first primary goal is stated as follows: "To develop in the student an awareness of the concepts of uniformitarianism and the universality of the natural forces and processes through which the earth's topographical features have evolved."

*Adapted from "Chapter III", A Case Study of Hogtown Creek, P. K. Yonge Laboratory School, Gainesville, Florida. January, 1973.

Field trips are believed to have an advantage as a teaching technique because the student can become actively involved. Some students will become involved from the planning stages to the final evaluation in a field study, but all students can be involved in making direct empirical and quantitative observations. Student's involvement emphasize science inquiry: he observes, collects, and processes data and culminates his activities by making interpretations based on his data. From these basic beliefs and assumptions additional goals were developed: (1) To carry the student out of the confining classroom and into direct empirical and quantitative observations of natural and physical phenomena at work in shaping the earth's surface, and (2) to emphasize science as a process of inquiry by providing the opportunity for the student to observe, collect, and process data and make interpretations.

Just as the Russian Sputnik moved science educators in the fifties, the environmental press of today is demanding the attention of all educators. Only through education of young and old can concern for the quality of our environment be generated. Hogtown Creek, nearly a lifeless sewer in the not too distant past, may be observed on the basis of what man does to his natural environment. From this concern for the environment came the last of the four primary goals: "To develop an understanding and concern for our natural habitat in order to involve the student in the perpetuation of a quality environment."

The writing of the general objectives stated above was not difficult, but evaluation on the basis of these.as stated may prove to be impossible. It is, therefore, desirable, in fact, mandatory, that these general objectives be supplemented by a set of specific objectives on which to base evaluation.

Preparation of specific objectives for field study requires much thought and careful planning as well as teacher familiarity with the area under study. Skill in the technique of writing behavioral objectives is gained only by reading and doing.

The procedures followed may be categorized as: (1) literature research and (2) the actual writing of the behavioral objectives. Based on several references from the literature, the following model is suggested:

1. State the over-all goals or objectives.
2. Develop a list of behavioral objectives which apply to each over-all goal.
3. Plan teaching strategies to achieve the objectives.
4. Select methods of evaluation which will determine the degree of attainment.
5. Feedback and revise.

Following this general format the first general goal was considered: to develop in the student an awareness of the uniformitarianistic qualities and of the universality of the natural forces and processes through which the earth's topographic features have evolved. For this study, the "forces and processes" were limited to those related to streams, their dynamics and their characteristic features. The processes and forces at work in a stream produce peculiar and specific features regardless of the time and place. It was considered educationally profitable for students to observe a system first hand in which the forces were currently producing the features. To extend this personal observation toward acquisition of the concepts of universality and uniformitarianism some additional activity was needed. Hence, students were shown slides of similar features in several stream systems of other times and other places. They were asked to apply their "field knowledge" to identify and account for these features. Through this activity it was predicted that the students' concepts of both universality and uniformitarianism would be enhanced and extended. A measure of the student's ability to relate the observed features in Hogtown Creek to features elsewhere was considered a measure of his grasp of these concepts.

This now had to be expressed in behavioral terms to be of value to both teacher and student. A breakdown of a behavioral objective indicated that it should include a statement of (1) the educational intent of the teacher, (2) what the learner will be doing when he demonstrates his achievement of the teacher's intent, and (3) how the teacher will know when the student is demonstrating his achievement. The objective should be represented by at least one task, which must be designed to elicit this behavior and should meet certain criteria. That is, the tasks (1) must be usable or practicable, (2) must be based on acceptable principles of learning, (3) must be suitable for the various levels of the learners, and (4) must be universal for all groups in our society.

A grasp of the concepts of universality and uniformity could only occur in this situation if the student could observe certain features and processes in the field and then relate them to other systems. Two activities thus became apparent: (1) the student had to make observations at the creek under study, and (2) the student had to observe slides of other systems. In the field situation it was believed necessary to guide the student as he made his observations. Since this was just one of the tasks anticipated for him, it was necessary that this one receive the same emphasis as the more specific quantitative tasks. An observational guide sheet for this first activity was developed for each student and incorporated into the field guide. All significant features which had been observed at each site during the preliminary investigation were listed. Sufficient space was provided for students to specify where they noted these features and the conditions under which they were occurring. Prior to beginning any of the quantitative studies, students and their designated teacher-guide walked a specified portion of the creek valley in the vicinity of each site. The tour was paced slowly enough for students to see, to ask, to comment orally, and finally to record in writing. Where certain features might have been overlooked, using questions, the instructor aided and encouraged the students in their observations.

The behavioral objective for the first activity was now developed in parts:

1. The educational intent of the teacher: The student will be able to identify stream related erosional and depositional features.
2. Learner activity: He will demonstrate his ability to identify these features by making identification from a set of slides which he has not seen previously.
3. How the teacher will know when he demonstrates this ability: The student will record his identifications either orally on tape or on a written observational sheet.
4. Definition of acceptable performance: The student will make his identifications with at least 70 percent accuracy.

Combining all of the parts into the whole resulted in the following statement:

"When the student completes his observations of the erosional and depositional features of Hogtown Creek, he will be able to identify similar features when viewing these features on slides. He will demonstrate his ability by recording his identifications orally on tape or in written form on an observational record sheet. He will make the identifications with at least 70 percent accuracy."

The second activity related to the first primary objective required the student to relate his observations to another stream system. The Grand Canyon of the Colorado River and Hogtown Creek are relatively the same age. Although they are so unlike in scale, they are very similar in active forces, processes, and features. Hence, the Colorado River was selected as the stream system for students to use in their comparison activity. Because of individual differences in reading competence and other learning skills, several techniques were used to introduce students to the Grand Canyon and the Colorado River. A fellow teacher brought his personal slide collection of the area and spent a class period in "show and tell". A second technique used an older student from another class as the "teacher". The student accepted the responsibility of searching the Grand Canyon and the Colorado River and presenting a summary to the earth science class. His presentation was taped for those who were absent or who needed to listen again. A third method used the Learning Resource Center available at the school to provide materials for the class related to the Colorado system. The materials kit included books, pamphlets, articles, reprints, film strips, and documentary films.

The materials and resources presented a description of the

Colorado River system since it could not be visited in person. No interpretation of the geological history of the system was attempted or, in fact, desired. The movie, for example, presented information about the amount of sediments carried, the flow rate, the length of the stream, and its use for irrigation. Students, then, used the information to compare and contrast the streams on the basis of features produced, forces at work, and unique characteristics of flow rate, gradient, velocity, and load. Slides used in teaching activities were not used later in evaluating learning.

Once the student had been introduced to the stream system by one or all of the methods above, he was asked to relate the two systems on the basis of their similarities and differences. Again, based on individual differences, at least two ways had to be designed for students to demonstrate attainment of the objective.

Stating the objectives in parts as described previously proved a productive way to proceed.

1. Educational intent of the teacher: The student will be able to describe similarities and differences between Hogtown Creek and the Colorado River.
2. Learner activity: Oral discussion recorded on tape or a written essay will be the vehicle by which the student may demonstrate his ability to recognize the specified similarities and differences.
3. How will the teacher know when he demonstrates this ability: The student will discuss or write about at least six similarities and/or differences. The teacher will listen to the tape or will read the essay to determine if the student is successful in making the comparison.

4. Degree of success: The student will describe at least six of the similarities or differences with at least 70 percent accuracy.

The parts of the objective were next structured into a whole and became the second behavioral objective: "The student will view the processes, forces, and related features involved in the evolution of Hogtown Creek and will view slides of the Grand Canyon and the Colorado River. The student will then describe orally on tape or in essay form at least six of the similarities or differences between the processes, forces, and features characteristic of these two great valleys with at least 70 percent accuracy."

Both objectives offer two ways for identification of the student's achievement level. The method of identification must be determined by each individual teacher on the basis of his own student population and its needs. A ninth grader with a reading level of 4.2, for example, cannot, fairly and honestly, be expected to write an essay as a demonstration of his competence in making observations. In the evaluation process, the teacher must always strive to measure the student's achievement exactly relative to the objective as it is stated. If correct spelling of "meander" is part of the objective, a student's recording the feature as a "mianter" is not acceptable. If identification of this feature is the objective, the student's ability to spell the word correctly should not be considered in the evaluation. It is certainly desirable to move the student forward in all areas of his intellectual growth and development, however, and correct spelling should be encouraged continually. Since one of the purposes of the behavioral objective is to make clear to the student what is expected of him, what is expected must be specified in the objective if it is to be of any value either to the student or the teacher.

The last objective developed in the field guide was aimed at the affective domain. This domain refers to values, attitudes, feelings, and appreciations. The observable behaviors in this domain are open to interpretation; hence, the teacher must make inferences from the observed behavior. Further, objectives in this domain do not necessarily relate specifically to any one of the primary objectives. Rather, it simply seeks to identify positive behaviors exhibited by students. Since students in the study were not aware of this objective, they were not biased by their desire to meet a specific objective.

The objective reads: "The student will demonstrate a positive attitude by making positive oral contributions in the form of questions and comments at least once during any discussion occurring during the field study." In the evaluation of this objective, the teacher used a checklist. The names of the students were recorded as they participated in the discussions, made comments, or participated in the activities in some way not characteristic of their previously observed behavior. Some students who participated through voluntary comments and questions were exhibiting a unique behavior for those particular students. In the informal, relaxed atmosphere of the outdoor study, students who never contributed voluntarily in the classroom became actively involved.

Such evaluations may result from conversations at lunch breaks or rest stops as well as during the study. Two students who had been discipline problems in the classroom performed on an acceptable basis in the field. One commented, "This ain't boring at all; we thought it would be different and no fun. Can we do this again?" On a later field trip these two students did more than their share in carrying equipment and successfully completing their quantitative measurements. By the end of the third field trip, these boys were able to tease and be teased; good rapport developed between them, the class, and the teacher; and they completed all of their designated tasks. Other students showed a positive attitude about school activities in general. These examples are given to emphasize to the teacher that open-mindedness and flexibility are mandatory when dealing with the evaluation of objectives in the affective domain. It also points out that the evaluation must be made by the teacher who knows the students.

The implication of affective objectives to the teacher is fairly clear. These serve to alert the teacher to ways and means of arousing the curiosity of students, of getting them involved, and for developing materials and techniques to meet the individual needs of students, particularly those who tend to be reluctant about learning.

Both the goals and the objectives were presented to the evaluation group as part of the initial field guide. The goals and objectives were revised in response to the individual evaluator's suggestions and are presented next in their revised form.

PRIMARY GOALS:

1. To develop in the student an awareness of the universality of the natural forces and processes through which the earth's topographic features have evolved;

2. To carry the student out of the confining classroom and into direct empirical and quantitative observations of natural and physical phenomena at work in shaping the earth's surface;

3. To emphasize science as a process of inquiry by providing the opportunity for the student to observe, collect and process data, and make interpretations;

4. To develop an understanding and concern for the natural habitat in order to involve the student in the perpetuation of a quality environment.

BEHAVIORAL OBJECTIVES:

1. When the student completes his observations of the erosional and depositional features of Hogtown Creek, he will identify similar features from slides with at least 70 percent accuracy.

2. The student will view the processes and forces involved in the evolution of Hogtown Creek and will view slides of the Colorado River and the Grand Canyon. The student will then describe orally or in written form the similarities and differences between the processes and forces shaping these two valleys with at least 70 percent accuracy.

3. During the field trip the student will demonstrate at least once his ability to manipulate the various instruments by measuring gradient, velocity, and cross-sectional area. His data will agree within a selected tolerance of the instructor's data for each activity (20 percent tolerance for gradient, 10 percent tolerance for area, and 5 percent tolerance for velocity).

4. The student will demonstrate his ability to interpret data on gradient, velocity, discharge rate, and cross sectional area either in a taped oral discussion or by written assignment by correlating the quantitative measurements with the structural characteristics of the stream. He will do this with at least 70 percent accuracy.

5. The student will demonstrate his ability to evaluate his

observations and accumulated data by identifying at least two of the effects man has already had on the evolution of Hogtown Creek and by hypothesizing what one future effect of man's actions will be.

6. The student will interpret the conditions under which sediments were laid down after viewing depositional structures along the Creek. He will do this by examining a core sample of sediments in the laboratory and interpreting the relationships of the various types of sediments in the core in oral or written discussions.

7. The student will demonstrate a positive attitude by making positive vocal contributions in the form of questions or comments at least once during any discussion occurring during the field study.

The teacher is reminded that the seventh objective is an affective one and should not be included in handouts to students or called to their attention at any time. Awareness of this objective would in itself affect the students' behavior and should therefore be omitted from the field guide.

Development of the Activities

Once the objectives were stated and the students' behaviors or activities were stipulated, the teacher's task was to design activities for the classroom which would prepare students for successful participation in the field as well as the follow-up activities to apply the observations made in the field. In addition, any additional instruction needed prior to any student evaluation had to be planned.

Some of the questions for the teacher to consider when planning appropriate activities are illustrated by the following:

1. What skills should the learner develop prior to the field study?
2. What classroom activities may relate to developing these necessary skills?
3. What aids are necessary for the in-field study?
4. How may the level of achievement be evaluated to the best advantage of the student?
5. What follow-up activities will be needed to extend the learning experiences of the field activity?

In order that teachers may observe the methods and techniques used in meeting the objectives in this study, activities related to the first four behavioral objectives as stated previously are presented. The first and second behavioral objectives require that the student make and interpret his observations of Hogtown Creek and then relate these to the structures and features associated with the Colorado River. It was assumed that few students have had previous opportunities to participate in such an activity. Reading levels in the class ranged from fourth grade to twelfth grade. Achievement levels indicated a comparable range. These classifications, along with the lack of experience, were considered in all phases of development of the related activities.

The classroom introduction to this kind of activity may be approached in several ways. In the process of this study, slides from various regions were used, and students were asked to view and then to write observations, pointing out all interrelationships they could. The procedure may include the presentation of a view of a youthful river in which both rapids and waterfalls are present. The valleys are steep sided indicating that the river's primary function at the moment is one of down-cutting rather than lateral erosion. The rapids indicate the same function. Waterfalls indicate that there has been a change in the rock structure and composition in the area over which the stream is flowing. A steep gradient is indicated by the observed features. An estimation of the stream's competency may be based on the same observations.

Several other techniques may be used to emphasize and develop observational skills. The class may be asked to describe the dress of one of the students who is asked to leave the room. Each student may be given a soil sample and asked to observe the sample with a hand lens. Each may examine a flower in detail and record observations. Since the study specifically involves streams, students may be asked to observe a stream table in action. The features developed by the stream on the table are similar, although on a smaller scale, and may be altered by increasing or decreasing the gradient, the flow rate, or the stream bed. In this way, the student may learn to associate certain structures and features with the related stream dynamics.

Several "practice sessions" introduced students to the field activity and alerted the teacher to the needs of certain class members. In view of these needs an additional aid was structured for the actual field study. The investigator made one last pre-trip examination of the sites, noting specific features available for students observational activities. These were listed on an "observational record sheet" with space left for students' comments and were incorporated into the field guide. During the field trip itself, students used this as a guide as they participated in the empirical observational aspects.

Since this was one of the activities in which all participated, the following procedures were used in the field. Prior to beginning any quantitative studies, students and the teacher-guide surveyed the full length of each stream segment under study. This was done informally and slowly, involving such activities as small group discussions, individual assistance for students, careful examination of specific features, and calling attention to features which had not been presented during earlier investigations. In general, this procedure supplied students with an overview as well as background information about the Creek and its characteristics. It was, on a small scale, a "pre-trip investigation" of the site to be studied. Once this was accomplished, students proceeded with other activities.

The additional activity necessary to meet the second objective was related to the student's gaining some knowledge about the Colorado River. This, of course, was done vicariously and, in consideration of the range of reading abilities, was accomplished in various ways. The wide range of differences meant that information about the river had to be presented in ways which insured that all students were given the opportunity to achieve the second objective successfully. These are the ways information about the Colorado River was presented:

1. An advanced student from the tenth grade assumed responsibility for an in-depth study of the literature relating to the Colorado River and the Grand Canyon. The student then presented information orally and informally to the class in a lecture-discussion-question-answer experience. This was taped for use by anyone who desired to listen again.

2. A seventh grade core teacher who had vacationed along the Colorado River many times had a collection of colored slides of the area. These slides with his commentary were presented during a class session. The presentation was conducted slowly with both the teacher

and the visitor discussing, questioning, and commenting on each slide as it was presented.

3. The P. K. Yonge Learning Resource Center developed kits for the Colorado River study. Kits contained reading materials, film loops, film strips, maps, and documentary films.

Use of sample of the rocks and sediments of the area would have been valuable but were not available for this study. An effort will be made to secure representative samples prior to the next study involving Hogtown Creek and the Colorado River.

The student had now, in a sense, participated in two field trips--one first-hand and the second vicariously. Theoretically the class was now in a position to make the desired comparisons between the two stream systems.

The first objective stipulated that the students identify features from slides showing structures similar to those viewed at Hogtown Creek. The slides presented various rivers and stream systems in the United States and Canada. Students were given a set of guide questions, and background information was supplied orally with each slide as it was shown. The set of slides was made available for students to view individually if they desired, and their identifications could be oral (taped) or written.

Because of the need to minimize the reading and writing limitations of students, the evaluation of achievement of the second objective was made through one of the following procedures;

1. The student wrote a short essay discussing the similarities and differences between the two systems.
2. The teacher and student discussed the similarities and differences together.

3. The student chose to tape his conclusions by himself.

There are many additional and perhaps more efficient techniques. These examples should serve only as a point of departure for individual teachers to adjust their evaluation methods to the individual needs of their students.

The third objective called for quantitative measurements and specified that students demonstrate manipulative skills in the use of various instruments. Several factors were considered: (1) students knew little or nothing relative to the concepts involving gravitational forces; (2) some students' mathematical skills were inadequate; and (3) the class was to produce its own instruments. These factors controlled the procedures the teacher used to develop the needed basic understandings before attending to the development of the equipment and the techniques for using the equipment.

Since two of the quantitative measures involved gravity, the initiating activity introduced some basic understandings about about gravity and its effect on flowing water. Gravitational acceleration was introduced by using an inclined plane. Students were able to observe (but were not required to measure) that the farther the marble rolled down the inclined plane, the faster it was moving. The slope of the land was likened to the inclined plane and the water to the marble. The idea that the water surface was a plane surface essentially parallel to the surface of the stream bed was demonstrated by using a small home-made flume through which water was allowed to flow. An additional point emphasized was that gravity was moving the water downslope to the lowest level the water could reach under the circumstances. This was also demonstrated through the use of the stream table. The water sources were turned off after the elevation difference between the "lake level" at the one end of the table and the "spring head" at the other end of the table was determined. Students were then questioned about the effect of measuring the elevation between two points using the bottom of the stream bed rather than the water surface. Toothpicks were placed at two points, carefully selected by the teacher. One was placed at a spot where a deep hole had developed in the stream bed and the other at a point where a temporary base level had developed. As the variances in the gradient were noted, students were introduced to the necessity of using the water surface for determining the gradient. This was also emphasized in the classroom using two cardboard slopes--one smooth and one with similated potholes. Students could see that water flowing down such an eneven slope would present a relatively smooth surface and would give a more realistic and accurate measurement of the overall slope. A student constructed a small, glass-front box, similar to an ant farm, in which water may be viewed as it flows over an uneven surface.

Velocity was the second measure requiring some basic instructions. A marble rolled across the classroom floor introduced the relationship between distance and time. Allowing the marble to come to a dead stop and measuring the relationship between distance and time gave students the opportunity to note differences in velocity at different points in time. The concept of gravitational force was discussed as the force which produces the velocity in moving water, using the small flume into which water was poured while the flume was level and then when elevated. In addition, students could see that the marble eventually stopped its movement along the floor and could associate this with frictional force. Questioning led students to determine why water in streams does not continually accelerate as it moves down stream.

The equilibrium existing between the gravitational force and the frictional forces was suggested but was not discussed in detail. Some questions were raised by students, some by the teacher, but no conclusions were drawn prior to completion of the study. Questions raised concerned such things as the effect of the shape of the stream channel, the volume of the water, and the effect of the curves in the stream on the velocity of the water. The mathematics department was asked to review and extend the students' skills in the manipulation of velocity relationships and in computing areas and volumes since many of the questions raised by the students suggested a weakness in these skill areas.

The students and the teacher were now able to concentrate on the development of the needed instruments. Although the school has alidades and a surveyor's transit, part of the study called for students to develop simple but usable instruments. The investigator and two volunteer students who showed some interest in this aspect of the study began working on a gradient instrument. Because of the nature of the creek and the anticipated sophistication of the instruments, the linear distance over which the gradient would be measured was predetermined at 50 feet. If lenses had been incorporated into the instrument, for example, additional time would have been required to introduce the necessary information concerning lenses and light characteristics.

Every effort was made to keep the construction of this instrument simple and inexpensive. The materials included a metal tube, some thread, two small wooden strips, scrap metal pipe, nuts and bolts, and two line levels. The greatest difficulty arose in aligning cross hairs at each end of the tube for sighting. This was done by arbitrarily selecting a point on the circumference at one end and determing the corresponding point on the other end with a plumb bob. After this was accomplished, the other three points (90° apart) were marked off at both ends and the cross hairs attached. A line level was attached to the tube (Figure 5) in order that the tube could be sighted level. The tube was then attached to a length of pipe for support in such a way that the tube could be adjusted into a horizontal position. In order to be certain that the pipe maintained a vertical position, small flat washers were used as plumb bobs since no circular level was available. These were crude methods of leveling, but the materials were available at little or no cost.

While two students worked on this instrument, others worked on producing floats of different densities. These were produced by loading fishing floats with lead weights and were used quite effectively in measuring velocities where the water was relatively deep. In extremely shallow areas the old "leaf on the water" method was used and proved satisfactory also. The investigator preferred the float method where possible because it involved the students with the concept of different densities.

The cross-sectional area materials were even more simple than the preceeding materials. A calibrated piece of twine was stretched across the Creek right at the water level. The string was calibrated in six-inch units to record the depth of the stream for every six inches along the string (Figure 6). Students calibrated the string using permanent ink to mark each foot interval in blue and each half-foot in red. The depth was measured with a meter stick to which a plastic coffee lid was attached, preventing its sinking into the soft bottom of the stream bed.

Although a chalk line was used to measure the linear distance between the instrument man and the rod for the gradient measure, an additional method was needed to measure the actual flow distance of the Creek. A student suggested pacing the Creek, but this was discarded when the rest of the group decided that he could not make each pace the same distance. The idea of using a bicycle wheel was then presented by a student. Upon its acceptance two students volunteered for this project. A starting point was marked on the wheel donated by a student. The circumference was determined, and the spokes were used to calibrate the rest of the wheel. Students pushed the wheel up the middle of the Creek from the rod man to the instrument man and recorded the actual flow distance.

Two additional pieces of equipment needed were the "rod" for the gradient measurement and a stop watch for the velocity activity. Students calibrated the rod, and the physical education department volunteered the use of a stop watch. This completed the list of the instruments needed for the study.

By the day of the field trip, the class members had practiced using the gradient instruments, the bicycle wheel, and the stop watch. The cross-sectional area project had been practiced on the chalkboard. A simulated stream channel was drawn on the black board and a string attached to represent the water level. The depth of water under the string was then determined (Figure 6) and the area was computed.

Data collected on the field study were recorded on the appropriate sheet in the students' field guides. Students were encouraged to record their data in the field even though they were not actually involved in the measurements at each site. The importance of accurate and complete records was continually emphasized.

Upon return to the classroom, data were shared with the students who had been unable to record in the field. Then each student computed the gradient over the 50-foot linear distance. The average velocity of the water was computed for the three sites investigated. Students computed the cross-sectional area using mathematical skills in finding areas of rectangles and triangles. In addition, two students were asked to plot a scaled diagram of the measured area on a piece of graph paper. The mass of the entire paper was determined; the stream-bed profile was cut out of the sheet and its mass determined. Students then calculated the cross-sectional area of the stream using the following relationship. Mass of the paper (total): Area of the paper (total) = Mass of the profile: Area of the profile. The class results were nearly identical with the results obtained by the two students with the scale. The major difference was the length of time required to calculate the area. Others in the class chose to duplicate their efforts and calculated the area both ways.

Computation of the discharge rate required additional instruction because it was difficult for students. A calibrated burette aided in teaching this relationship. The burette was filled with water and the rate with which it emptied was demonstrated and calculated. Students calculated discharge rate using the cross-sectional area and the distance the level of the liquid lowered over a given time. Since the burette was calibrated, their calculations were easily checked. Following this activity, students moved to calculations related to the stream.

The fourth objective called for students to correlate data with characteristics of the stream channel. Several students asked to revisit each site as they worked on this activity. Since this was physically impractical, the slides of each of the sites were made available.

Through vicariously revisiting they not only saw the pictures but could hear, in memory, the rush of water down the canyon or the slow drip of spring water from the contact between the clay and the overlying sands.

These activities serve only as suggestions. They were satisfactory for the investigator, the teacher, and the students of this particular class. They might not be as satisfactory for another teacher at a different time with a different set of students. How successfully the students performed under these circumstances with each activity served as a basis for revision or extension of each activity by the instructor. The teacher is reminded that to reach the educational intent is the primary objective. This can only be achieved successfully if the proper vehicle, the appropriate fuel, and the most effective routes are provided for the participants on such an educational journey.