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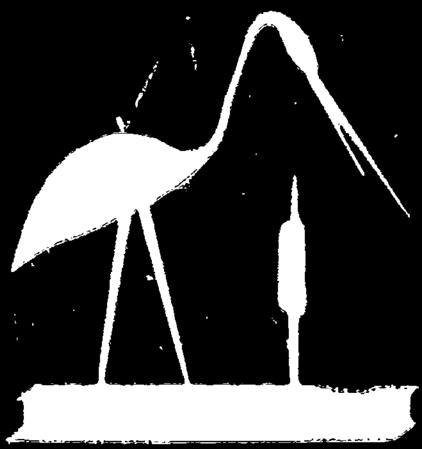
ABSTRACT

This document, developed for elementary and secondary students, is one of a series emphasizing student-oriented problem solving related to environmental matters. It is designed to guide others in initiating, continuing, or expanding their environmental education program. Volume 4 is intended for use by cadre who have used similar materials at a training workshop and is organized in two sections: Chapter 1 on awareness activities and Chapter 2 on transitional activities. Awareness activities are designed to orient students toward a concern for environmental problems and a realization that the problems are appropriate subjects for study. Process skills dealt with at the awareness level include observation of solid waste sources and components, categorizing of solid waste problems, comparisons, measurement, inferring, and questioning. Transitional activities are directed toward real community concerns and involve the students in predicting, data collection, data processing, data evaluation, and formulation of hypotheses. Each activity identifies the situation and notes open-ended questions, equipment needed, procedure, past studies, limitations, and a bibliography. A bibliography and glossary are appended. (BT)



A Curriculum Activities Guide to SOLID WASTES and ENVIRONMENTAL STUDIES

VOLUME FOUR

Other Publications in the Series

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The Cover: The bird symbolizes a four-foot metal sculpture now in Cleveland, fabricated by a Tilton School summer trainee - out of solid waste.

A CURRICULUM ACTIVITIES GUIDE TO SOLID WASTE AND

ENVIRONMENTAL STUDIES

Volume 4

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PREFACE

This publication is one in a series of documents designed to guide others in initiating, continuing, or expanding their environmental education program.

Volume IV was prepared in the course of a plan which began with an environmental studies course for students in Cleveland, Ohio in 1967 and 1968. The course became a training program for teachers and students at Tilton, New Hampshire in the summers of 1969 and 1970, at Quincy, Massachusetts and Newtown, Pennsylvania, and again in Cleveland in 1971, and finally the full-time responsibility for the Institute for Environmental Education in 1972.

The teachers, students, and administrators who taught, directed, and then wrote the results of their experiences into the guide series have increased in numbers and sophistication. They now occupy positions of responsibility in education and governmental institutions throughout the country.

This Volume, and these people, are one of the forces behind the new, exciting, promising, and certainly pervasive national environmental education movement.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the people who participated in the summer training sessions; those who helped generate funds; still others who analyzed, suggested, and aided in redesign; and finally the many who were part of putting the whole series together. They number in the hundreds now and they all contributed a piece to the whole.

A few of these are: Jack Baker, Jack Ingersoll and Rowland McKinley of University School; George Watkins, Three Rivers Watershed District; Peter Mott, Moses Brown School; Alan McGowan, Center for the Biology of Natural Systems and Scientists Institute for Public Information; Tony Governanti, Bob Graham and Phil Murphy of Tilton School; Ned Ames and Bill Felling of the Ford Foundation; Kay Bela, Bernie Lukco and Robert Snider of the Environmental Protection Agency; Walter Bogan and George Lowe of the Office of Environmental Education (HEW); Ray Whitehead of Quincy Public Schools; Peter Gail and Tom Offutt of the Institute for Environmental Education; and, finally, and especially, the crew that put this book together.

This Guide was organized and edited by the team of John Hershey and Alan Sexton (two of the four staff who edited Volumes I and II) and Patricia Sparks. They compiled contributions from conference participants and the Documentation Task Force (DTF) staff writers. The staff writers were Peter Goldie, David Kriebel, Robert Lippincott, Jerry Ruddle, Ronald Spencer, Tim Tanaka, and Melissa Weiksnar.

The efforts of Bette Connelly, Sue Faulkner, Diana Geist, and Claire Pilzer made the writers' imperfections tolerable to the DTF staff. And, at the Institute, Sally Gardner retyped a second edition, which differs from the first in a few minor aspects and by the reassignment of Chapter 3 activities to Chapter 2, for reasons given in the Introduction.

Special thanks go to Donald L. Wright, Director of Project KARE who encouraged the effort to formulate the DTF in conjunction with the Institute for Environmental Education, and Alan C. Harman, Executive Director of Montgomery County Intermediate Unit #23, who facilitated the DTF effort in a myriad of ways from board approval to accounting procedures. The cooperation of the Intermediate Units of Bucks, Chester, Delaware, and Philadelphia Counties and the Roman Catholic Archdiocese of Philadelphia is likewise appreciated.

Since the DTF began, there have been several personnel changes. Matthew M. Hickey has succeeded Donald L. Wright as Director of Project KARE. Alan D. Sexton has succeeded Mr. Hickey as the Assistant Director of Project KARE. John T. Hershey became Manager of Environmental Programs for the University City Science Center, Philadelphia, Pennsylvania. Mr. Hickey and Mr. Sexton are currently administering the DTF from which will come further edited materials disseminated by the Institute for Environmental Education.

Joseph H. Chadbourne
President
Institute for Environmental
Education

A CURRICULUM ACTIVITIES GUIDE

TO

SOLID WASTE

AND

ENVIRONMENTAL STUDIES

INTRODUCTION

We find that there is no distinct set of records which can be used to define or become "environmental education". That is because environmental education is a general process which is applied to special problems. The book contains illustration of the process applied to one problem, solid waste.

The general definition of environmental education is treated in the 1970 Environmental Education Act Guidelines, available from the U. S. Office of Environmental Education (HEW), and is analyzed as a learning theory by William Stapp in "Development, Implementation, and Evaluation of Environmental Education Programs (K-12)", also available from the Office.

Our special definition of environmental education, derived from attempting to implement the 1970 Act, and coined by one of the Institute staff, Thomas W. Offutt III, is that environmental education is "precareer experience". It is experience in the process of attempting to understand and cope with present problems, in order to prepare to understand and cope with future problems. The "problems" are the problems of society. They are chosen for study by those to whom the problems make a difference.

In this sense, environmental education, or precareer experience, is for everyone, of all ages, in all disciplines, and in every community.

The benefits to the persons involved in environmental studies are that they learn a common process from studying unique problems. The skills and knowledge specific to both are applicable in school and community. In addition students invariably become more self-directed in the acquisition of new learning tools, they demonstrate more understanding toward teachers, they become more engrossed in the functioning of society, and they are clearly more aware of their increasing competence in shaping that society.

The entire publication series is literally a guide to assist administrators, teachers, and students to initiate, continue, or expand this meaning of environmental education. This Volume is intended for use by cadre who have used similar materials at a training workshop. It is simply a crutch until the teacher and his students feel sufficiently confident to prepare their own materials.

Volume IV is organized in two sections: Chapter I on awareness activities and Chapter II on transitional activities. These are the two phases through which teachers and students seem to progress enroute to a fully operational program.

"Awareness" activities are designed to orient students toward a concern for environmental problems and a realization that the problems are appropriate subjects for study. These activities have been developed with process skills in mind. The skills include (a) observing, (b) categorizing, (c) comparing, (d) measuring, (e) foundation for transitional activities in which students take a larger share in determining the study problem.

"Transitional" activities are directed toward real community concerns. Students begin the activity in the community, observing the nature and scope of the concern, determining available resources, assessing the level of community cooperation, and calculating their potential role in understanding and attempting to cope with the concern. The necessary tools include all of the disciplines, the rigors of investigation encourage professional behavior, and the complexity of problems reveals one of Barry Commoner's conclusion that "everything is connected to everything else".

The guide format is a questioning sequence. The progression is (a) those questions that lead to the activity, (b) those that initiate the activity, (c) those that continue the activity, (d) those that expand the activity, and (e) those that can be used to evaluate the activity. The distinctions from step to step are sometimes unclear, perhaps too fine, possibly not necessary. Since it is not the format that is important but the results, then - by all means - modify it.

Though there is an order to the questioning sequence, there is not an order to the activity sequence. Select the ones that are most appropriate.

The activities of the fully operational program, which is the function of Chapters I and II, are too long and too specialized to include here. Examples are prepared as "Case Histories". These are descriptions of other groups, their problems, the data, interpretations, and mistakes as they are reported to the Institute. Case Histories can be used as examples to discuss with administrators, parents, colleagues to represent your program. They also contain many useful procedures. And, finally, they stand as an exciting chronicle of the positive, creative, constructive things that young people are doing.

Others can learn from your discoveries. With your permission, we would be pleased to serve as a disseminator. Your purchase dollars have helped keep this work going. We hope you parted with them happily.

Good luck,

Staff of Project KARE and the Institute for Environmental Education

CHAPTER 1

The following activities are concerned with environmental awareness. These activities deal with the individual's awareness of environmental solid-waste problems and his subsequent responsibility as a school and community member.

The activities below are in no special order. They deal with three major questions: What is the problem? Why is there a problem? Why should you care? Use the chart provided to select appropriate activities. The teacher may select one or two activities to begin the unit and then allow students' concerns and interests to dictate future choices.

ACTIVITY	GRADE LEVEL PRIMARY K-2	GRADE LEVEL PRIMARY 3-6	GRADE LEVEL SECONDARY 7-9	GRADE LEVEL SECONDARY 10+up	TIME IN CLASS PERIODS	ORIENTATION	*PROCESS SKILLS	PAGE NUMBERS
A	x	x	x	x	1	Class	a,b,d,f	4
B		x	x	x	2	Individual	All	9
C	x	x	x	x	**1	Individual/ Community	a,b,c,e	15
D		x	x	x	1	Individual/ Class	b,c	20
E		x	x	x	2-4	Class/ Community	a,c,e,f	23
F	x	x	x	x	1-2	Individual/ Class	c,e,f	28
G	x	x	x	x	*1	Community	a,c,f	32
H		x	x	x	1	Individual/ Class	b,c,e,f	36
I		x	x	x	1-2	Individual	a,b,c,e,f	43
J		x	x	x	1	Individual/ Community	a,b,c	49
K		x	x	x	2	Community	b,e,f	53

*Process skills:
a. observing
b. categorizing
c. making qualitative comparisons
d. measuring
e. inferring
f. questioning
**field

REV:A:1

A. "Gee, Do We Throw Out All This?"--Or An Introduction To Wastebaskets

I. Introduction

The activity introduces the problem of solid waste. By examining the contents of a classroom wastebasket, students at any grade level may become aware of the kinds and amounts of waste created in the classroom. During the course of the activity, which takes about one class period, students react by contributing many ideas for minimizing waste. No special equipment is required for this activity.

II. Questions

1. To lead into the activity ask
   a. Why do we have wastebaskets?
   b. What is waste?
2. To initiate the activity, ask
   a. What kinds of waste are generated here? (procedure)
3. To continue the activity, ask
   a. Can this be reported on a per capita basis?
   b. What is the daily volume of such wastes?
4. To expand the activity, ask
   a. What kinds of waste are generated by the rest of the school?
   b. What's going to happen to the waste when we're finished with it?
   c. If you were going to minimize trash in your school, what factors would be considered?

5. To help the teacher evaluate the students' efforts, ask
   a. What were their reactions to the activity?
   b. Did each contribute a fair amount to the investigation process?
   c. Did they raise meaningful questions?
   d. Did they find the activity motivating or a waste of time? Did it make any type of impact on the individual students?

III. Equipment

1. Full wastebaskets
2. Scales
3. Materials for recording data

IV. Procedure

1. This involves dumping the contents of a wastebasket where the students can observe the wastes. Note: If the school has a dumpster for collecting trash, samples can be collected from there.
2. Depending on the age of the group, observations should be recorded.

V. Past Studies

This activity has served as a good introductory investigation, because the whole class gets involved. John Hershey has used this activity with second graders, who were amazed at seeing the variety of wastes present. "Gee--do we throw out all this?" was a typical reaction; but perhaps more importantly they wondered how these materials might have been put to better use.

These students noticed that milk cartons comprised a large percentage of the volume. They filled a grocery bag with empty cartons, then proceeded to crush other cartons to see how many more could fill another grocery bag.

VI. Limitations

A student may possess a negative attitude about going through trash--possibly accompanied by an attitude of uncooperation. Let the custodian know that you're doing this project--he or she may have some pertinent information.

If the school operates an incinerator, the activity can be modified to include this situation.

Looking through dumpsters may have some prohibitive implications--check this with a proper authority.

VII. Bibliography

Citizen Handbook on Recycling (A How to-do-it Guide for Individuals and Groups), Tuberculosis, Health, Respiratory Disease and Clean Air Organization, Unpublished, 1970-71. Excellent guidelines for recycling projects and several past community experiences. Also presents a list of "Hints on Sound Ecological Living" and an invaluable appendix on recycling agencies in the Philadelphia-Camden and surrounding areas.

Cheney, Richard L., Glass Containers and the Environment, Glass Container Manufacturers Inst. Inc. Short booklet containing GCMI director's speech that includes 5 recommendations to achieve long range solution to the solid waste problem. Also included is a list of industrial organizations engaged in research to develop sol·d waste management systems.

Give Glass a Second Chance (Conducting a Community Glass-Recycling Project), Amherst Jay-Cees, Amherst, New York, Unpublished, 1972. A complete and detailed outline of a very successful, short-term glass recycling project in Amherst, New York. It spells out the program from conception to post clean-up with all incurred costs and equipment. Also included are a question and answer conclusion section and photographs of the project.

Litter Facts, Public Affairs Dept., Glass Container Manufacturers Institute. Litter Facts is a short, well-written pamphlet on solid waste disposal in general. The factual information is well presented, and worthwhile tips are provided for those interested in starting recycling efforts.

Paper Stock Institute of America (A Vital Industry Serving the Nation's Economy and Environment), Paper Stock Institute, New York. A small booklet explaining the Paper Stock Institute and a paper recycling process.

A Pledge and a Promise, Anheuser Busch, Inc., St. Louis, Missouri, 1970. Defines solid waste, describes the problem, discusses the complexity and some possibilities for alleviating the problem. An excellent introductory pamphlet for students grade 6 and up.

Recycling and The Can in the Seventies, The Can People, 1971. A short question and answer booklet concerning can recycling. Compares benefits of recycling steel and aluminum. Discusses litter, packaging, returnable cans and pros and cons of recycling.

Solid Waste Management and Litter Control, Glass Container Manufacturers Inst., Inc., 1971. A short booklet outlining governmental, industrial, and public roles in glass solid waste programs deemed necessary by the GCMI, Inc.

B. You, Your Family and Solid Waste

I. Introduction

In this activity, students consider the magnitude of the solid waste problem. Students examine their own waste disposal patterns and those of their families. In so doing, they learn how much solid waste they discard over a period of time and the nature of that waste. The activity is designed for students from grade four through college and may require one or several days to complete, depending on how long data collection continues.

II. Questions

1. To lead to the activity, ask
   a. Do you have any idea how much solid waste is descarded in your house each day?
   b. What is meant by discarded?
   c. How many ways are there of discarding wastes?
2. To initiate the activity, ask
   a. How much trash and garbage (solid waste) do you personally

discard each day?

b. To what extent are you required to separate your garbage?

3. To continue the activity, ask

a. What is the most common form of solid waste in your household?

b. Does solid waste vary from household to household?

4. To expand the activity, ask

a. Where and how do people acquire their habits regarding solid waste disposal attitudes?

b. What happens to solid waste when it leaves your home?

c. Where does it all go?

d. What does the term "final disposal" mean?

e. What are some other sources of solid waste?

f. From the information collected in this activity, do you think you could make a solid waste key? Try it.

5. To evaluate the activity, ask

a. Was the collected information realistic?

b. Did the students use their information to generate further research?

III. Equipment

1. Bathroom scale

2. Data collection sheet

3. Pen or pencil

IV. Procedure

1. Over the period of one or several days, weigh all the trash and garbage discarded in your household. (You may weigh the waste

directly by placing it on the scale, or by weighing yourself and the wastes together, then deducting your weight.)

2. Divide the weight of the waste by the number of persons in your household, then by the number of days on which data collection occurred.
3. Look at your results. Compare them with the rest of the class. Determine the average amount of solid waste discarded per person per day.
4. Using the figures from your class and the approximate national population of 200,000,000 people, determine how much personal solid waste is discarded per day, per week and per year for the entire country.

V. Past Studies

An activity similar to the above was conducted in a graduate course at Temple University under the direction of Dr. Albert Schatz. The purpose was to make the students more aware of the solid waste problem and their contribution to the problem. The activity generated much discussion and led to a concern for additional wastes from industrial, commercial, and natural sources.

VI. Limitations

1. Younger students may need some help in weighing the discarded trash.
2. Students will need to make their parents aware of their activity so they can be cooperative.

VII. Bibliography

Citizen Handbook on Recycling, See Ch. 1, A, VII

Glass Containers and the Environment, See Ch. 1, A, VII

Cleaning our Environment: The Chemical Basis for Action (A Report by the Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs), American Chemical Society, Washington, D. C., 1969. Deals with 4 major concerns: air, water, solid wastes, and pesticides. For each, there is an introduction to the problem, background information, a discussion of the chemical factors, control factors, the environmental effects, and recommendations for change. The book is technical and best suited to the needs of secondary or college students.

Give Glass a Second Chance, See Ch. 1, A, VII

No Deposit, No Return (Man and His Environment: A View to Survival), Huey D. Johnson, Editor, Addison-Wesley Publishing Co., Reading, Mass. An anthology of papers presented at 13th National Conference of the U. S. National Commission for UNESCO. Provides excellent background to the problems societies face because of environmental exploitation. An excellent reader for students at the secondary or college level.

Paper Stock Institute of America (A Vital Industry Serving the Nation's Economy and Environment), Paper Stock Institute, New York, New York. A small booklet explaining the Paper Stock Institute and a paper recycling process.

A Pledge and a Promise, See ch. 1, A, VII

Recycling and The Can in the Seventies, See Ch. 1, A, VII

Solid Waste Management and Litter Control, See Ch. 1, A, VII

C. Litterbug Survey

I. Introduction

Fines exist for litterbugs almost everywhere in the United States. Strangely, though, there are many places you can find where there is much litter in evidence. In this activity, we'll make a survey to find out just how much litter exists along the streets of the community. Classes may go as groups or teams to carry out this exercise during the school day. If time is not available, they may do this activity going to and coming from school. The activity is an awareness activity for almost any grade level. The activity may be carried out in the field in less than an hour.

II. Questions

1. To lead to the activity, ask questions like
   a. How much is a litterbug fined in your community?
   b. Do you know of anyone who has ever been fined this amount or any similar fine? What does this mean to you?
   c. Which street around your school has the least litter?
2. Initiate the activity by asking
   a. How can we find out which street has the least litter?
   b. What kind of litter are we most likely to find?
3. Continue the activity after the street collections with discussion questions like

a. Which street had the most (total)? The most of each kind?

b. Can you see why each street has litter and of what sort? (Take into account the traffic volume in terms of cars and pedestrians and other possible specific sources of litter, e.g., if you were standing in front of a hamburger stand, what kind of litter would you expect to be most common?)

4. Evaluation of students' performances should take into account questions like

   a. Was student resourcefulness evident in supplying answers to the questions about quantities of litter?

   b. Did the students attempt to secure a comparable sample along the streets, collecting from a standard area?

5. To expand the activity, initiate discussion with questions like

   a. What can you do to prevent litter? Would adding your own barrels, signs, and assistance to the police force in enforcement of the litter laws have any positive effects?

   b. What do you need to change? about people? about local laws? about packaging laws?

III. Equipment

1. Paper trash bags for each member of the class
2. Classroom blackboard for display of totals
3. Bathroom scale or other available scale
4. Local map of community's streets
5. A pair of gloves for each glass collector

IV. Procedure

1. Divide the students into 4-man litter collecting teams. Have each member collect one type of trash: paper, bottles and glass, cans, all other debris.
2. Send each team out with bags to collect the trash they see and can retrieve from a block (or other predetermined street area, if blocks are not regular or streets are not in blocks).
3. After 20-30 minutes have everyone return. Make sure the trash is separated into 4 piles for each team (paper, bottles and glass, cans, all other debris).
4. Have each team compare its 4 piles with the others, first by sight, then by weight (weigh a student, then student plus trash, then subtract student's weight from weight of both). Have the students make their own bar graphs.
5. Make a display of the results.

V. Past Studies

A Project KARE Local Action Program, Allegheny West, at Rhodes Middle School in the spring of 1972 had kids collect trash from playgrounds and streets. The kids were very surprised by the volume of trash they found and this led to class discussion.

VI. Limitations

This activity has very few limitations in that the equipment is universal and trash is plentiful. The activity not only forces the students to look closely at the streets they see often, but also gives them the satisfaction of cleaning them up. There are, however, a few possible drawbacks:

1. An analogous portion of each street should be examined in order to get a true value of litter volume.
2. Broken glass, common street litter, can be dangerous It's a good idea to supply gloves for the glass collector of each team.
3. Supervision is a variable.
4. Plan ahead for disposal of collected materials.

VII. Bibliography

The Litter Facts Book, See Ch. 1, A, VII

No Time to Waste, Continental Can Company, New York, 1971. This is an excellent tool for elementary classes. The reading level is very basic and the comic book format is a great interest holder.

Schools and The Environment, Ames, Edward A., Ford Foundation Office of Report, New York, 1969. A short treatise on education and its role in promoting environmental awareness. Listed are a few innovative schools and some Ford Foundation grants received in environmental education.

D. Musical Mess

I. Introduction

This activity is designed to allow the student to become aware of the amount and diversity of litter on the highways and streets and to turn this awareness into a musical experience. This activity can be used for any age student. The time required depends on the number of students.

II. Questions

1. To lead to the activity, ask
   a. What is litter?
   b. What different kinds of litter are found in the streets and roads?
2. To initiate the activity, ask
   a. Does litter make sounds? What kinds of sounds?
   b. How many different sounds can be produced with one piece of litter?
   c. Are the sounds contrasting or do they blend?
3. To continue the activity, ask
   a. How can these sounds be organized into a musical composition?
4. To expand the activity, ask
   a. How could this activity be used to communicate the problem of litterbugs littering?
5. To evaluate the activity, ask
   a. Did the composition have a beginning and an end?
   b. Did the composition hold together?
   c. What element (or elements) held it together?
   d. Was any particular form identifiable?
   e. Were dynamics employed?
   f. How was variety achieved?
   g. Did the composition use only percussion instruments?

III. Equipment

1. Tape recorder
2. Litter
3. Students

IV. Procedure

1. Have students obtain objects of litter that will make a sound or sounds that can be repeated audibly; encourage some variation. This can be done individually or as a class, depending on drive and independence of the students.
2. After they have decided upon their particular sounds and produced them for the entire class with a focus on listening, divide the class into groups of about 5 or 6 students. Each group may choose a conductor.
3. Give each group about 10-15 minutes to organize a "musical" composition.
4. Tape all the compositions as they are performed for the class.
5. Replay the tape and use the evaluation questions as a guide.

Note: For best quality recording, use 7 3/4, highest recording speed, to pick up the widest range of frequency.

V. Past Studies

1. 7th grade inner-city girls used this activity. The outstanding characteristic of most of the compositions was the evident rhythmic patterns.
2. A sing-out group on the way home from a performance stopped to pick up litter and began producing sounds and organizing their productions.

VI. Limitations

Space is needed to allow the students to compose without distracting other groups.

VII. Bibliography

Litter Facts, See Ch. 1, C. VII

Manhattanville Music Curriculum Program Synthesis, Ron Thomas, Director.

Related Listening: Varese, Elgar, Poeme Electronique Col. ML5478, MS6146, Cage, John. Construction in Metal K08P-1498.

E. Unscenic Site Census or Litterbug Bugging

I. Introduction

The focus of this awareness activity is on litter, its diversity, and its density in various areas of the community. In surveying the amount and density of wastes, students become more sensitive to litter problems. The activity appeals to students of all ages. It takes one or more class periods to complete and requires no special equipment.

II. Questions

1. To lead into the activity, ask
   a. Have you ever littered?
   b. What made you litter?
   c. Where did you litter?
   d. When did you litter?
   e. What was the item you littered?
   f. How much did you litter?
   g. Why is there littering?

h. Is it a problem?

i. What types of anti-litter incentives are there?

2. To initiate the activity, ask

   a. What is the litter situation like in this community?

   b. Where are there occasions to litter?

   c. What part of the community is hardest hit by the litterbugs?

   d. How can we determine this?

   e. Is there a relationship between litter location and type?

3. To continue the activity, ask

   a. What type of debris did you find?

   b. What is the weight of each type?

   c. What is the comparative volume?

   d. Can this be expressed graphically?

4. To expand the activity, ask

   a. Who is responsible for suggesting remedies for problem spots?

   b. Are there any laws regarding littering?

   c. Are they enforced?

   d. Is the community willing to install more litter baskets?

   e. Does litter vary from season to season? In weight? Volume? Type?

5. To evaluate the activity, ask

   a. Did the students attempt to draw meaningful conclusions from data?

   b. Did they express a desire to take constructive action other than picking litter up?

   c. Did they make use of the allotted time efficiently?

d. Did they talk to any litterbugs and delve deeper into the reasons for littering?

e. Did they relate stores, churches, schools, etc. to litter concentrations?

III. Equipment

1. Paper trash bags (paper, not plastic, please!)
2. Field data recording equipment, (e.g., clipboard with graph paper to identify site of litter, camera)
3. Group data recording materials (charts, blackboard, etc.)
4. Scales

IV. Procedure

1. Divide the students into groups and dispatch them to predetermined sites in the school community. To conduct the study by streets is probably easiest.
2. As trash is picked up and bagged, the location of items should be recorded. (Be as specific only as is reasonable.)
3. Upon returning to the classroom, the students should separate the litter into categories.
4. Results should be graphically represented.

V. Past Studies

In Eggertsville, New York, the delicatessen located across the street from and patronized by the students of St. Benedict Elementary School was known by its storefront carpet of candy wrappers. The town clerk was reluctant to install a litter basket--after 2 years, the litter problem is only somewhat eased, because the can is always full!

VI. Limitations

1. Sometimes litter is dangerous to handle, either because it is unsanitary or can inflict wounds.
2. The term, litter, may need to be limited before going into the field.
3. Remind students of private property and trespassing.
4. Litter may not be recognized as a problem to get excited about, depending on the location of the school.

VII. Bibliography

The Litter Facts Book, See Ch. 1, C, VII

Policies for Solid Waste Management, Ad Hoc Committee on Solid Waste Management, National Academy of Engineering, National Academy of Sciences, U. S. Department of Health, Education and Welfare, 1970. An excellent report on solid waste problems and policy changes required to attack them. A comprehensive set of recommendations and plans of action are supplemented by a selected bibliography.

A System Study of Solid Waste Management in the Fresno Area; Final Report on a Solid Waste Management Demonstration, Aerojet-General Corporation, Public Health Service Pub. No. 1959, 1969. This study attempted to determine an optimum solution and to develop technology for handling the local waste problems.

Solid Waste Management: The Federal Role, Vaughn, Richard D. U.S. Department of Health, Education and Welfare, Bureau of Solid Waste Management, 1970. A small booklet introducing the

solid waste problem. It discusses collection and transport, recycling and reuse, processing and disposal, training, technical assistance, and planning.

F. Reactions to Solid Waste Problems

I. Introduction

This activity is a study of human reaction to the problem of solid waste. Its grade level application is unlimited, because it serves as an awareness activity, but can also be used by more advanced students as a lead-in to studies in behavior and psychology. By observing the behavior of others, the students will gain insight into how this problem relates to large-scale environmental efforts.

II. Questions

1. To lead to the activity, ask
   a. What status must an issue have for someone to consider it a problem?
   b. How are people made aware of problems?
   c. Why do we make them aware of problems?
2. To initiate the activity, ask
   a. Is solid waste disposal seen as a problem by the people in the school?
   b. If not, can they be made to recognize it as a problem?
   c. How might someone in the school react to trash in the corridor or on the school grounds?
3. To continue the activity, ask
   a. Does the kind of trash make a difference ?

b. Does location make a difference?

c. Are there differences in reaction between persons alone and in groups?

d. Does time of day make a difference?

e. Does location of litter receptacles make a difference?

4. To expand the activity, ask

a. Do you think your family would react to the solid waste problems the same way you did? Explain.

b. Now that you are aware of solid waste as a problem, what action would you take to remedy the situation?

5. To evaluate the activity, ask

a. How carefully did they set up the experiment?

b. Were they able to logically interpret their data?

c. Were they able to suggest any remedial action for the problem?

d. How scrupulous were they about clean-up?

III. Equipment

1. Trash

2. Data recording material--e.g., cameras, blackboard

IV. Procedure

1. Strategically position trash and observers.

2. Record the reactions.

Note 1: This activity may take place around a school sports event at which concessions are sold.

Note 2: The teacher may want to try this activity on the class first without their knowledge - say having several pieces of paper on the floor and having hidden the wastebasket.

V. Past Studies

At Stewart Jr. High School in Norristown, Pennsylvania, a group of Deanna Rosenbaum's elementary school students overturned a wastebasket in front of the principal's office. The students watched the reactions of those who passed it. Sometimes, someone would pick up and deposit the trash in the adjacent wastebasket. When they left, it was overturned again for the next party.

VI. Limitation

1. Consult proper authorities before throwing trash in front of their doorways, moving property, etc.
2. Depending on scheduling, observations during the class period may be difficult.
3. If you are not allowed to conduct the investigation with real trash, perhaps posters or exhibits made with trash could be used instead.

VII. Bibliography

Litter Facts, See Ch. 1, C, VII

Policies for Solid Waste Management, See Ch. 1, E, VII

A Systems Study of Solid Waste Management in the Fresno Area; Final Report on a Solid Waste Management Demonstration, See Ch. 1, E, VII

Solid Waste Management: The Federal Role, See Ch. 1, E, VII

G. Where is the Waste Walk?

I. Introduction

This activity involves a tour of the community. Students are given a question guide to help them identify the types and sources of solid waste pollution in their community. The activity is suitable for all who can read the question guide. It requires no special equipment and takes a one-day field trip to complete.

II. Questions

1. To lead to the activity, ask
   a. How would you characterize your community?
   b. Is your community polluted in any way?
2. To initiate the activity, ask
   a. What are the probable sources of solid waste pollution in your community?
   b. Where are you most likely to find evidence of solid waste pollution?
3. To continue the activity, ask
   a. In what ways did you see solid waste management in effect?
   b. What violations of solid waste management did you notice?
4. To expand the activity, ask
   a. How could you as an individual improve the problem of solid waste management?
   b. What actions could we as a class take to improve the solid waste management in the community?
5. To evaluate the activity, ask
   a. How did the students react to being out of the classroom?
   b. To what extent were the students observant of their surroundings?

III. Equipment

1. Questionnaire
2. Pencil or pen
3. Binoculars (optional)

IV. Procedure

1. The students are to work in groups. They are to use the following questionnaire as a guide.
2. The students should be encouraged to add information to the questionnaire even if no questions relate directly to that information.
3. Questionnaire:

   a. As you leave the school, look about you. What is the first evidence of solid waste you see?

   b. Are there any trash receptacles along the sidewalk?

   c. Pick a leaf off a tree. Rub it with a piece of white paper. Did any dirt rub off on the paper? If yes, where does this dirt come from?

   d. Sniff the air as you walk along. Is it clean and fresh? List all the odors you smell.

      1.
      2.
      3.
      4.
      5.

      What causes odors? Where do they originate?

   e. List all the different places where you find litter.

      1.
      2.
      3.
      4.
      5.

f. Do you see any "do not litter" signs?

g. Do you see any "no dumping" signs? Has someone been dumping here? If yes, what?

h. How is solid waste stored by the various establishments you pass?

i. How many trash receptacles are filled to overflowing?

j. Do you see any trash compactors?

k. How does the community dispose of its solid waste, waste water, and industrial waste?

l. Do you see any black smoke? If yes, where is it coming from? How is this a form of solid waste?

m. Do you see any evidence of abandoned cars or appliances? If present, are these hazards and/or pollutants?

n. Walk along the waterways. Do you see any pipes emptying into the water? If yes, can you tell where they come from? Is anything flowing out of them? What does it look like?

V. Past Studies

A group of junior high school students at the Bristol Jr.-Sr. High School in Bristol, Pennsylvania, used a questionnaire similar to the one above in making a survey of their community's pollution problems. They are using this information to establish in- depth studies of specific pollution problems in their community.

VI. Limitation

1. The major limitation is the questionnaire. Teachers should modify the questionnaire to suit their needs.

2. A route needs to be planned with periodic rest spots so that groups that get separated can get together again.

VII. Bibliography

Environmental Education Objectives and Field Activities, Major, James M. and Cissell, Charles A., Paducah Public School, Environmental Education Staff, 10th and Clark Streets, Paducah, Ky. 42001, 1971. A collection of interdisciplinary activities. Primarily oriented to outdoor education. Offers many helpful hints.

H. Ecologically Yours?

I. Introduction

This activity is a survey of habits of students and their families, using a series of 30 "ecological habits" The students will initially check those which they or their families have acquired. They will then try to convert their families to as many desirable new habits as possible. Most students who can read will be able to participate in the activity.

II. Questions

1. To lead into the activity, ask
   a. Does your family contribute to the solid waste problem?
   b. Are some families worse than others?
   c. Why are there differences?
   d. What is meant by the terms "ecological habits" or "ecological living"?
2. To initiate the activity, ask
   a. What habits do you or your family have (from the list)?

b. How long have you had them?

c. Can you change any habits?

d. What will make you change or acquire habits?

3. To continue the activity, ask

a. Do you agree or disagree with this statement: "What used to be called stingy is now referred to as ecological." Explain.

b. Whose standards were you using?

c. Who says these habits are "ecological?"

d. "Some people spend more time separating garbage and other waste, and more gas transporting stuff to recycling centers than it's worth." Evaluate.

e. Could you convert your family at all?

4. To evaluate the students' efforts, ask

a. How did the students react to the activity (resentment, enthusiasm, frustration)?

b. Did they act according to belief or forced criteria?

c. Did they expand the concepts involved in the activity to real solid waste problems?

III. Equipment

None foreseen

IV. Procedure

1. Students should regard the following list of habits, evaluate them as to ecological validity and decide whether or not they

are employed in their households.

Avoid buying aerosol cans. They are dangerous and their disposal presents problems. Sixteen percent of the cost of a product in an aerosol can goes for the container.

Buy bulk, dry dog chow. Fortify the chow with unsaturated oils, bouillon, vegetables, cottage cheese, or leftovers.

If you must buy canned goods, buy all-aluminum cans and save them to be reused. They can be identified by the lack of side and bottom seams.

Aluminum foil should be used, reused, reused again, and then recycled.

Put your pop-top inside the can as soon as you have pulled the tab.

Buy only returnable bottles. Return them.

Reuse jars for other purposes, e.g., sorting nuts and bolts, leftovers, canning and freezing fruits and vegetables.

Do not accept plastic bags at the grocery store or dry cleaners.

Obtain as few plastic bags as possible; wash, dry and reuse them several times.

Use a durable metal tape dispenser rather than disposable plastic ones.

Ball-point and felt-tip pens are wasteful. Fountain pens last much longer and can be economically refilled.

Collect styrofoam egg and meat containers. Return them to the dairy or meat market responsible for them.

Specifically ask for fresh meat wrapped in paper rather than in plastic.

Do not purchase frozen foods packaged in plastic cooking pouches.

Refuse bags at a store and tell them why.

Take your own shopping bags with you.

Use a lunch box instead of a paper bag.

Save and bundle your newspapers.

Share magazines. Set up a system whereby each neighbor buys one magazine subscription and then circulates the magazines among the group.

Write on both sides of the page.

Use foldable stationery that becomes its own envelope.

Use the backs of used sheets of paper for notepads.

Use cloth napkins, cloth towels, and sponges.

Reuse the wax paper liners of cereal boxes as wrapping materials for foods.

Avoid disposable diapers and diaper liners.

Return used coat hangers to your dry cleaners for reuse.

Don't throw away leftovers. They make casseroles and lunches and can even be added to pet foods.

Don't throw away items you can no longer use. Give them directly to people who can use them, or donate them to groups or organizations that will see that they reach potential users.

Bring your own drinking glass or coffee mug to occasions where disposables will be used.

Use cloth handkerchiefs instead of paper ones.

Do not buy individually wrapped slices of cheese.

Use paper clips instead of staples.

Note: These "habits" have been adapted from those appearing in the Everyman's Guide to Ecological Living, (see bibliography).

2. They will decide to which habits they will try to convert their families. A time limit may be set.

V. Past Studies

Seventh graders at Germantown Academy queried their parents and checked their households for poor practices. They were amazed at how interested their parents were in all the facets of environmental concerns. Each student elected to try to carry out a summer project on his property.

VI. Limitations

A discussion in a stimulating atmosphere will foster the flow of the activity, as students will daily have experiences with habit-forming attempts to relate.

VII. Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological Living, MacMillan, New York, New York, 1971. Probably one of the best references on individual and limited group environmental action activities stressing the acquisition of "ecological habits." It contains supplementary facts. It sells for $.95 and is highly recommended. It should present no problem for the average reader, as it is not technical in presentation.

Howard, Jane, "The Diary of a Polluter", Time, Inc., New York, New York, published in Life Magazine, April 23, 1971, p. 71-72. A day in the life of an American girl shows our dependence on all that is not good for Mother Earth. It is the type of article by which students will see the finger pointed at them as contributors to the problems. Especially good is the emphasis on solid waste.

Swatek, Paul, The User's Guide to the Protection of the Environment (The Indispensable Guide to Making Every Purchase Count.), Ballantine Books, New York, New York, 1970. Gives a factual interpretation of the implications of our food, shelter, clothing, and lifestyle in general. It emphasizes ecologically vs. non-ecologically sound purchases and suggests action on the part of the individual. Students in grade seven and up can handle the straight-forwardness of the book.

Trash is Taking Over, Environmental Science Center, Golden Valley, Minnesota, 1970. The booklet explores, through the medium of the story, the concern for solid waste litter and provides the method to show the extent and source of the problem. It provides a method for discovering the kinds of solid wastes in a community and what can be done about them. It is good to read to early elementary classes and may be used and read by upper elementary students themselves.

Meadows, Donella and Meadows, Dennie L. and Randers, Jorgen and Behrens, William W. III, The Limits to Growth(A report for the

Club of Rome's Project on the Predicament of Mankind), Universe Books, New York, New York, 1972. "In the summer of 1970, an international team of researchers at M.I.T. began a study of the implications of continued worldwide growth. They examined the five basic factors that determine and, in their interactions, ultimately limit growth on this planet--population increase, agricultural production, nonrenewable resource depletion, industrial output, and pollution generation. The M.I.T. team fed data on these five factors into a global computer model and then tested the behavior of the model under several sets of assumptions to determine alternative patterns for mankind's future. The Limits to Growth is a non-technical report of their findings." Numerous graphic projections appear. High school students may have moderate difficulty understanding many parts without explanation, but it really points out the fate of uncontrolled growth and wastefulness.

I. Scrap Crafts

I. Introduction

This activity gives students a chance to express their personal attitudes toward pollution through creative art forms. Students will be asked to examine the contents of a trash "container" (roadside, dumpster, etc.) and to create art objects with the discarded materials. Students will become more aware of the waste problem, and, through their art, communicate an awareness to others. This early transitional activity can be used with any age group. It can be conducted in as little as one class period, but student interest often extends the activity several days.

II. Questions

1. To lead to the activity, ask
   a. How can we communicate our concern about the solid waste problem to others?
   b. Is there any way of communicating our concern without generating more waste?
   c. Could art be used as a means of communicating concern?
2. To initiate the activity, ask
   a. What types of art forms might be effective?
   b. Where can we go to gather materials?
3. To continue the activity, ask
   a. What can we do with our creations?
   b. Should they be displayed? Where?
   c. Who should see them?
   d. What do you want to see happen when people see the work?
4. To expand the activity, ask
   a. How could we assess the effectiveness of our art forms as a means of communication?
   b. How might the impact of the art forms be increased?
5. To evaluate the students' efforts, ask
   a. What was the reaction of the students to the activity?
   b. Did they involve themselves with planning and executing the project?

c. Did they incorporate concerns from previous activities into this one?

d. Did they express concern for additional wastefulness if the activity yielded any?

e. Were they concerned about what happened once the art work was finished?

f. Did any of the art works exhibit aesthetic and/or creative qualities?

III. Equipment

1. Refuse

2. Construction materials, possibly including

   a. scissors

   b. adhesive tapes or liquids

   c. paper clips or staples

   d. marking implements (pen and ink, paint and brushes, crayon, etc.)

   e. string

Note: Encourage the students to create as little additional waste as possible by using just what trash they have. Discourage magic markers where crayons can be used, staples where paper clips can be used, etc.

IV. Procedure

1. Begin by taking your class to the scene of actual "pollution"--a nearby body of water, junkyard, roadside, etc.

2. Have them observe the trash and react to it and then start collecting it. Some of it may be used in the actual making of the projects.

3. Plan the projects and collect any additional materials individuals may need.
4. Create.
5. Get reactions to the work--especially aesthetic appraisals.

V. Past Studies

People are usually startled when made to see and to think about the use of something they considered useless or finished.

1. A judged environmental art contest held Earth Day, 1970, included not only posters and collages but also an assortment of oddities ranging from mobiles to a piece of artwork made using an old toilet. Awards consisted of humorous yet "ecologically sound" type gifts, e.g., waste paper baskets (?) and fly swatters (instead of DDT).
2. A team in Tilton, New Hampshire, decided that the items of metal trash were heavy enough to require welding. Some of the collection they had to work with resembled parts of animals and plants. Pieces were spread out on the floor and arranged and rearranged by trial and error. They adopted the theme that pollution is killing our natural flora and fauna, and that possibly in the future man might only be able to enjoy synthetic plants and animals made from these pollutants. They produced a heron-type bird, a cattail, a turtle, and a skull and cross bones. Three years later, this bird is still rusting and remains a beautiful piece of art in the offices of the Institute for Environmental Education.

3. At a KARE Local Action Program, the School Environmental Contamination Study at the Hartcarft School in the spring of 1972, the first grade constructed a display board of all trash collected in the classroom. This was a whole class activity which successfully involved young children utilizing an action-oriented, interdisciplinary, binary learning approach.

VI. Limitations

1. Enthusiasm. Be enthusiastic and interested in this project and your students will be too.
2. Make sure the necessary precautions are taken when working with so-called unsanitary trash and also with broken items with sharp edges.
3. Transporting refuse may be a problem--heavy duty paper bags or garbage cans might be helpful.
4. No special clothing is necessary, but make sure the students can expect to handle trash extensively.
5. If time or accessibility is a limiting factor, students can be asked to bring in solid waste for the project from individual scavanging.

VII. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. I & II, Institute for Environmental Education, Cleveland, Ohio, Second Edition, May, 1971; Government Printing Office ($4.50/set).

Fun with Pure-Pak Plasticartons, Ex-Cell-O Corporation, Detroit, Michigan, 1969. Creative art objects made with plastic cartons. Complete with diagrams, material and directions. Ideal for all ages.

Ickis, Marguerite, Handicrafts and Hobbies for Pleasure and Profit, Careystone Press, New York, New York, 1948. Ar interesting idea book of crafts and art projects written for the amateur and the professional, utilizing many different materials.

Mattil, E. J., Meaning in Crafts, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1965. An excellent collection of day-to-day craft ideas for elementary level art handicraft activities. The materials and end products are multiple and diverse.

Paper, People and Pollution, Scott Paper Company, Philadelphia, Pa., Volume I, pgs. 4-93--4-96. This booklet is available by writing to SCOTT, Scott Paper Company, Scott Plaza, Philadelphia, Pa. 19113.

J. Web of Waste

I. Introduction

In this activity, students will use the information gathered on a tour of the community to make a map of waste sources and routes. In so doing, they will develop a picture of solid waste complexity. They will determine how the system of disposal is interconnected. The activity provides an excellent introduction to an industrial analysis. Students of all age levels can participate in the activity. No special equipment is needed. The activity takes from three to five class periods to complete.

II. Questions

1. To lead into the activity, ask

   a. Do you live in a clean, moderately clean, or dirty community?

   b. What industry is present in your community?

2. To initiate the activity, ask

   a. What type of community do you live in?

   b. What kind of work do your parents do?

   c. Do your parents work in the community?

   d. Can you describe the physical environment where you live?

3. To continue the activity,ask

   a. How is solid waste disposal related to the quality of life?

   b. What questions does your map answer?

   c. What questions are left unanswered?

4. To expand the activity, ask

   a. How could the efficiency of solid waste disposal be increased from an economic standpoint and from a community standpoint?

   b. What proportion of the solid waste problem is industrial, commercial, and/or residential?

5. To evaluate the students' participation in the activity, ask

   a. Did the students show indications of relating their lives to those of their community?

   b. Did the activity open discussion toward community action?

   c. Were suggestions given to further the activity?

III. Equipment

1. Map of the community

2. Results of community tour
3. Translucent paper
4. Masking tape
5. Stars or symbol stickers in assorted colors
6. Colored pencils or pens
7. Map of sewage piping system in the community

IV. Procedure

1. Place a map of your community on the wall or blackboard.
2. On that map, locate all the industries, municipal buildings, hospitals and commercial establishments. Mark the location of each in some manner.
3. Place a translucent piece of paper over the map. Transfer the location of all buildings noted above. Include all waterways also.
4. Transcribe the details of the sewage pipe lines onto your map. Distinguish between storm sewers and sanitary sewers.
5. Examine the map. Where is the sewage treatment plant located? Can you determine if all the industries use the system. Note any obvious inadequacies. What added information do you need to fully examine solid waste disposal in your community?

V. Past Studies

A 1972 Local Action Program, Planned Development or Urban Sprawl (PDUS), at Central Bucks West High School, Doylestown, Pa., used mapping as the basis of a transportation study. The map, measuring 12' x 24', was a 3-D relief map of the Central Bucks area. The map is to serve as a focal point for showing the effects of development in the area.

VI. Limitations

1. If no map is available, students can make their own by locating the major roads and buildings from there.

2. If you are located in a large urban area, you may prefer to examine only a sector of the city.

VII. Bibliography

Storin, Diane, Investigating Air, Land and Water Pollution, Pawnee Publishing Company, Inc., Bronxville, New York, 1971. A collection of activities for students in grades 7-12. Provides background information, materials needed, questions and procedures.

K. Wrapping Rapping

I. Introduction

This activity is suitable for students who already have some awareness of the solid waste problem. It is an early transition activity, and it is one in which the families of the students play an important role. Due to the impracticalities of shopping with an entire class, students will be asked to shop with their families for a week, paying careful attention to the wastefulness involved with food merchandizing. Students then evaluate the types and volumes of solid wastes their families acquire through grocery shopping. No special equipment is needed in the classroom. The activity is suitable for grades four through ten. Data sharing will take one to three class periods.

II. Questions

1. To lead into the activity, ask
   a. Have you been grocery shopping lately?
   b. How does your family get groceries?
   c. What do you consider when you buy food?
   d. What are your priorities from these considerations--nutritional value, price, convenience, presentation?
   e. Does packaging influence your buying patterns?
2. To initiate the activity, ask
   a. How much packaging do you buy in a week?
   b. How much of a product which you buy is intended to be thrown away?
   c. Can we compare packaging-consumption differences among families?
   d. Is there wastefulness in a supermarket?
3. To continue the activity, ask
   a. What are the relative percentages of the packaging materials (glass, paper, plastic, metal, etc.) which you have purchased?
   b. Can these be categorized in terms of needed and excess packaging?
   c. How does this fit in with the concept of wastefulness?
   d. How much do you know about the packaging of materials--either by previous knowledge or by what appears on each package?
   e. What is the environmental impact of each type of packaging?
   f. Could any of the packaging have harmful side effects?

4. To expand the activity, ask
   a. Do you have any remedial suggestions for any problems which you have seen?
   b. Who controls the packaging used - for instance, who determines the standard packaging of ice cream cones?
   c. Is there a relationship between packaging and popularity, sanitary needs or cost?
   d. How willing are companies to release information about packaging?
5. To evaluate the activity, ask
   a. How cooperative were the students?
   b. What was the quality of the data they collected?
   c. Have they begun to show a favorable attitudinal change?
   d. To what degree did students involve their families?
   e. Did the students contact anyone who is responsible for determining the kind of packaging used?

III. Equipment

1. The students will need
   a. kitchen, bathroom, baby and/or postage scales, if available
   b. notebook and pencil
2. In the classroom, data sharing will require
   a. blackboard and chalk
   b. a calculator (extraneous, but nice to have for the mathematical operations which will result)

IV. Procedure

1. In the grocery store

a. Students should record each item purchased--a sample data sheet follows:

Date____________

Time____________

Type of Store_________________

	Packaging																	
Item	Glass jar	Metal lid	Plastic lid	Plastic container	Heavy-duty paper	Wax paper	Foil paper	Styrofoam	Saran	Pulp tray	Plastic bag	Tin can	Aluminum can	Aerosol can	Plasti-pak carton			Weight of product

b. Other examples of what students consider to be wastefulness in the stores should be recorded.

2. At home

a. Each bag of groceries should be weighed

b. As each item is unpacked, the weight should be recorded if it appears on the product. Otherwise, the product should be removed from its packaging and then weighed.

c. The total weight of the bagged groceries should be compared to the total weight of packaging, i.e.:

Bag weight:________________

Product weight:____________

Packaging weight:__________

d. They may take a typical bag of groceries and remove all the packaging from the products. This is then cleaned (where necessary) and put back into the bag to get an idea of packaging volumes.

3. At school

a. When the data comes in, much can be done with them, e.g., average amount per family, differences in per person weights in families, etc.

b. Students may wish to discuss the differences of the weights.

V. Past Studies

1. Students from one school removed all the packaging from the groceries at the check-out counter of a supermarket. The volume of packaging vs. the volume of groceries was compared by placing each in a bag.

2. The author of this activity, upon trying it, was surprised to notice that of 64.5 pounds of groceries 12.5 pounds were actually packaging. When items such as tin foil and wax paper are purchased,

these are considered to be packaging. She had not realized that nearly every item purchased included plastic of some kind as part of its packaging.

3. One enterprising student wrote a letter to a produce company to express concern over the fact that they were wrapping bananas in plastic. The reply follows:

Dear Miss Weiksnar:

I have at hand your recent letter expressing concern over the packaging of ________ bananas in plastic bags and relating this practice to environmental pollution.

It is true that plastics are part of the solid waste disposal problem. It is also true that plastics are increasingly replacing glass, metal, kraft paper and cardboard as a packaging material in many areas because they offer distinct advantages over the other materials, i.e., its light weight, which reduces both the expense and burden of transportation; resistance to mold, rust and bacterial growth, thus enhancing its value for health and sanitation purposes; and its impermeability which affords the high cleanliness factor so important in foods and drugs.

For fresh produce, and very specifically bananas, pre-packaging in the field, or harvest time wrapping, produces a significant decrease in bruising, scarring and all kinds of external damage. Pre-packaging minimizes human handling with the obvious benefit of greater sanitation and it affords more rapid movement of product at the store level. All these factors bring improvements both in the quality of the end product and in the efficient presentation of the product to the ultimate consumer and user.

Now to our product in particular. ________ bananas have registered significant decreases in bruising and scarring since the introduction of the cluster bag. Naturally, this, in turn, delivers you a better-than-ever-before product. We would like to point out that until recently polyethylene slip sheets have been utilized to cushion bananas within a fiber board carton during shipping. As of the past month, these slip sheets have been replaced by the individual polyethylene bags with each cluster of fruit separately enclosed. Contrary to many impressions, polyethylene film presents no insurmountable problems as a pollutant. It is extremely susceptible to degradation by sunlight and to a lesser extent by soil - you may have noticed that polyethylene film, when exposed to sunlight, will, in a matter of relatively few weeks, start to yellow, crack and break up into smaller and smaller segments. It is also readily combustible, burns with a smokeless flame and produces no toxic vapors provided sufficient oxygen is supplied. The increased protection afforded by these bags has resulted in markedly higher quality fruit with a decided reduction in scarring and/or bruising of peel and pulp - a definite added consumer benefit.

Pollution of our environment is a recognized and acknowledged problem. Packaging materials of all kinds contribute to the problem, particularly when it is further compounded by careless litter, inefficient collection and even more inefficient incineration or improper methods of landfill dumping.

Society has never backtracked or foresworn progressive new methods which afford convenience, luxury, quality or efficiency. It is against human nature. When methods have been found that have a derogatory feature, science and man's ingenuity have gone forward to eliminate the defective elements while maintaining the advantageous ones. Thus, science and industry are spending vast sums to develop bio-gradable films, to perfect incineration methods of existing non bio-degradable solids and to generally improve the whole pollution problem.

We at ________ bananas share your concern with the need to attack the total environmental pollution problem. In the meantime, during this period of research, the desire to deliver better quality produce and economic realism cannot be completely ignored by our company or the produce industry.

Thank you for expressing your feelings to us.

VI. Limitations

1. Some families shop during the school day and may be unwilling to change this pattern.
2. Students may be unwilling to be very precise in data collection. Emphasis should be placed on the necessity of accuracy for meaningful results.
3. Although not a limitation to conducting the activity, the families of the whole class may shop exclusively at supermarkets. Interesting

comparisons might be made between supermarket, food co-op, market, and specialty shop purchasing, if possible.

VII. Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological Living, MacMillan, New York, 1971. Probably one of the best references on individual and limited groups environmental action activities stressing the acquisition of "ecological habits." It contains supplementary facts and it is highly recommended. It should present no problem for the average reader, as it is not technical in presentation. Price $.95,

Plastics in Solid Waste, Sub-Council Report, 1971-March, National Industrial Pollution Control Council, Superintendent of Documents, U.S. Government Printing Office, Washington, D. C., March, 1971. Comprehensible booklet, grades 5 and up, dealing with the plastic industry summary, the volume of plastics in solid waste, the industry's current activities, the immediate problem, reclamation of plastics, the industry's response to immediate problems, and research and development in the longer term. Packaging is considered. This is a non-technical report.

Swatek, Paul, The User's Guide to the Protection of the Environment (The Indispensible Guide to Making Every Purchase Count) Ballantine Books, New York, 1970. Gives a factual interpretation of the implications of our food, shelter, clothing and lifestyle in general. It emphasizes ecologically vs. non-ecologically sound purchases and suggests action on the part of the individual. Students from grade 7 upward could handle the straightforwardness of the book.

CHAPTER 2

The following transition activities place a strong emphasis on student involvement. Student response is widely encouraged.

The focus of the transitional activities is a real problem study of the community. By dealing with these problems, the students are required to use the community as a resource. Transitional activities allow the students to extend themselves by using equipment, references, audio-visual aids, human resources, and other components of the community at large. In so doing, students greatly increase their awareness of community organizations, the availability of materials and equipment, the level of community cooperation, and their potential roles as community members.

Because these activities are done within the context of the community, they are not contained as part of a single discipline nor do they remain contained within the four-walled classroom. In dealing with real problems as an educational approach the tools from many disciplines are essential. Many components of society are considered when dealing with environmental problems. These involve economic, political, social and legal factors.

Like the awareness activities, transitional activities are process-oriented. The processes involved, however, are of a higher order and include: (a) predicting, (b) data collection, (c) data processing, (d) date evaluation, and (e) the formulation of hypotheses. The transitional activities provide the basis for the third level of activity, problem studies. Students gain confidence by performing the transitional activities and using these as a foundation from which they can design and develop their own problem investigations. Successes in the transition activities allow students to handle problems of a larger and larger scope. Since the activities are open-ended, all student contributions are considered. The expectations for each student vary according to the level of the students' interests and abilities.

Use the chart given below to select those activities that best suit your needs and the interests of your students. The intent of the chart is to provide a quick assessment of the activities according to grade level, time required, process skills considered and specified equipment or resources needed.

ACTIVITIES & PAGE NUMBERS	GRADE LEVEL K-2	3-6	7-9	10+up	MINIMUM TIME IN CLASS PERIODS	PROCESS SKILLS	SPECIAL EQUIPMENT AND RESOURCES
A - 64	x	x	x	x	1	a,b,d	Old Appliances
B - 68		x	x	x	2	a,b,c,d	None
C - 73			x	x	3	a,b,c,d	None
D - 77	x	x	x	x	1	b,c,d	None
E - 81			x	x	2	a,b,c,d	None
F - 85			x	x	2	a,b,c,d	None
G - 90	x	x	x	x	4	a,b,c,d,e	Oven and Sludge
H - 94			x	x	2	a,b,c,d,e	Collection Devices
I - 100			x	x	2-4	a,b,c,d,e	Field Trip,Water Eq
J - 105			x	x	1-4	a,b,c,d,e	Microscopes
K - 109	x	x	x	x	2-3	a,b,c,d,e	None
L - 113			x	x	1-4	a,b,c,d,e	Water Proof Boxes
M - 117		x	x	x	2-4	a,b,c,d,e	None
N - 121		x	x	x	1(week wait)	a,b,c,d,e	Aquariums
O - 124		x	x	x	2	a,b,c,d,e	Foods, Millipore
P - 128			x	x	2(week apart)	a,b,c	Fats
Q - 133		x	x	x	2	a,b,c,d	Outside Area
R - 140		x	x	x	2	a,b,c,d	None
S - 145		x	x	x	1-3	a,b,c,d	Microscopes
T - 150			x	x	1	a,b,c,d,e	Fume Hood, Goggles
U - 156	x	x	x	x	2	a,b,c,d,e	None
V - 161			x	x	2	a,b,c,d,e	None
W - 166	x	x	x	x	2(long obs.)	a,b,c,d,e	None
X - 170			x	x	1	a,b,c,d,e	None

Process Skills:

a. predicting
b. data collection
c. data processing
d. data evaluation
e. formulation of hypotheses

REV:A:1

A. Devastation Delight (or Learning by Undoing)

I. Introduction

In this activity, students consider the concept of waste by discovering how much material is or is not wasted by disassembling discarded merchandise--e.g., small appliances. A transition activity, it is adaptable for any grade level and can probably be conducted in one class period.

II. Questions

1. To lead into the activity, ask
   a. Can solid wastes be classified as either simple or compound?
   b. Where does "junk" fit into the hierarchy of refuse?
   c. What types of compound wastes are generated?
   d. Are these a more serious problem than more simple forms of refuse?
2. To initiate the activity, ask
   a. Can you "simplify" these wastes?
   b. What parts are wastes?
   c. How many different materials went into the product?
   d. Why was the product discarded?
   e. What is "planned obsolescence"?
   f. Was the original product necessary?
3. To continue the activity, ask
   a. What is a resource?
   b. What is a natural resource?

c. What are renewable resources?

d. What are non-renewable resources?

e. What substitutes are there for these materials?

4. To expand the activity, ask

a. How long was the product made to last? The parts?

b. Do any organizations make use of discarded appliances?

c. What wastes does this product contribute?

d. Are all the wastes visible?

5. To evaluate the students' efforts, ask

a. How thorough was the disassembly?

b. How far beyond the confines of a classroom did the students pursue the activity?

c. What was done with the information learned?

d. What was done with the disassembled product?

III. Equipment

1. Discarded appliance of some sort--e.g., electric can opener, toaster, dishwasher

2. Disassembly tools--e.g., screwdrivers, pliers, scissors, flashlight

IV. Procedure

1. Have students obtain discarded appliances.

2. Disassemble the item as thoroughly as possible.

3. Report the findings. Note the students' reactions.

V. Past Studies

Studies like this have often shown that a fancy or "high quality" exterior is often filled with shoddy and poorly planned inner workings.

Two of the most commonly observed faults: poor design, i.e., wasted space, inefficient layout; and sacrifice of safety and durability for price. Questions about planned obsolescence may arise; for example, one student was told by a repair man that a fan motor needed lubrication, but since it had a sealed case, the whole motor would have to be replaced. This student then took the motor, opened it up, lubricated it and resealed it.

VI. Limitations

1. It's a good idea to avoid obtaining the appliances from dumps because of potential health hazards.
2. Limit the size or complexity of the product to be disassembled if time will be a limiting factor.
3. Have someone who "knows what he's doing" with each group that is disassembling.
4. Do not allow television sets to be disassembled, even by someone who "knows what he's doing."

VII. Bibliography

"1970 National E.Q. Index," National Wildlife Magazine, Washington, D.C. A monthly magazine which situates the degree of environmental degradation. It has an easy to read style, with many colorful pictures and diagrams. Multiple copy purchasing entitles one to discounts, and a filmstrip and teacher's kit are also available.

Young, James F., Materials and Processes, General Electric Company, 1945. In textbook form, a one volume study of materials and

manufacturing processes used by design engineers. Although of average difficulty for the high school student, it considers many facets of appliances which may be used in the activity, Devastation Delight.

The Way Things Work (An Illustrated Encyclopedia of Technology), Simon & Schuster, Rockefeller Center, 630 Fifth Avenue, New York, New York, 1967. "From the ball point to the computer, from the Polaroid camera to the atomic clock, with 1071 two color drawings and diagrams." Very technical but good. I hear there is a Volume II but haven't seen it. One problem is a lot of common items aren't included while very complicated things are. Missing, for example, are flashlights, doorknobs, and chainsaws.

B. Recycled Paper in Schools

I. Introduction

This transitional activity begins by introducing students to the volume of paper used by their school. Students consider possible constructive action by studying the feasibility of recycled paper in the school. The activity requires one to two days for preliminary investigations and perhaps up to a week for remedial action to take place. Grades 5 and up would be most capable of conducting this study.

II. Questions

1. To lead to the activity,ask

   a. What paper products are found in this classroom?

   b. What do we use paper for?

   c. Is much of it wasted?

d. How much paper do you use in a day?

e. Can you trace the path of a piece of paper, starting from you all the way back where it came from and then to where it ends up?

2. To initiate the activity, ask

a. Where does the paper come from?

b. Who buys it?

c. Who in the school is responsible for buying paper?

d. How much paper does the school use in one day?

e. What does recycled paper mean?

f. Are there uses for recycled paper in the school?

g. Can you represent a tree by a certain quantity of newspaper?

3. To continue the activity, ask

a. Should we encourage the use of recycled paper?

b. Can we take action on this problem?

c. What do we have to know in order to take action on the problem?

d. How do people react to "recycled paper"?

4. To expand the activity, ask

a. Who should know about the use of recycled paper in the school?

b. Is the manufacturing of recycled paper polluting more than that of virgin fibers?

c. How much waste paper is recyclable?

d. What is a two-wastebasket system?

e. What outlets are there for used paper? Does demand fluctuate?

5. To evaluate the students' efforts, ask

   a. What type of action was taken?

   b. How was their enthusiasm level?

   c. How adequate was their research?

   d. How critical were they--e.g., did any favorable attitudinal changes take place?

   e. What did they learn, in terms of both process and content?

III. Equipment

No unusual equipment is required; paper and pencils are needed for notes

IV. Procedure

The students will investigate the issue of recycled paper and will determine whether or not they can promote its use in the school community.

V. Past Studies

Students of the Nichols School in Buffalo have impressed many people by representing trees with bundles of newspapers, determined by the fact that it takes seventeen trees to produce one ton of newsprint.

Two juniors at Nottingham Academy in Buffalo traced the source of the school's ditto and mimeo paper to the Diocesan Purchasing Division, which also buys for all parochial schools in the Buffalo Metropolitan Area. The man in charge of paper buying was appreciative of information concerning recycled paper and bid for some to be tried in the 1972-73 school year.

VI. Limitations

Before the students attempt to convert those responsible for purchases, they should be well informed on the issues. Teachers can help by asking the students questions to which the students will get the answers before a premature meeting.

VII. Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological Living, See Ch. 1, K, VII

Industrial and Specialty Papers, Robert H. Mosher, Editor, Chemical, New York, New York, 1968. A three volume "encyclopedia" of paper types and manufacturing processes. Very technical for classroom use, although an excellent reference. Especially helpful are the sections on professional terminology.

Paper From Paper, Not From Trees, Marcal Paper Mills, Inc., East Patterson, New Jersey. This booklet is best used from grade 5 upward. Its colorful format will help to hold children's attention as they get into some very basic facts on paper recycling. The booklet will trace the paper as refuse resource all the way through until it becomes new paper again.

Paper Made From Paper Made From Paper, Housewives to End Pollution, Compilors, Erie and Niagara Counties Regional Planning Board, Grand Island, New York, May, 1971. This is a compilation of the varieties of recycled writing and book papers and printing bristols. Information is printed on each sample concerning sizes, colors, textures, etc. which are available. It does not advocate specific brands; nor does it give prices; rather it can be given to printers, purchasing agents, etc. who usually are impressed by the types available.

C. Product Packaging Design

I. Introduction

In this activity, junior and senior high school students examine packaging as a solid waste problem. The purpose of packaging from consumer and producer/advertiser viewpoints is considered also. Students will design and make packages for products in order to consider the utility and advertising value of a specific design. Several class periods are needed to complete the study; however, no special equipment is needed.

II. Questions

1. To lead into the activity, ask
   a. What is meant by packaging?
   b. What is meant by overpackaging?
   c. How many types of packaging can you list?
   d. Can these be divided into necessary and unnecessary?
2. To initiate the activity, ask
   a. What comes first--the product or the packaging?
   b. How dependent is a product on its packaging?
3. To continue the activity, ask
   a. What was the reason for designing such a package?
   b. What was the most difficult part of the design?
   c. How often did the problem of solid waste enter your mind at the various stages of development?
   d. How important are the concepts of reuse? recycling?

disposability?

4. To expand the activity, ask

   a. Could you design a T.V. commercial to advertise your product?

   b. In what other ways could you present your product for advertising?

   c. Is advertising a product necessary?

5. To evaluate the activity, ask

   a. How efficiently did the students work?

   b. How realistic were the students' designs?

   c. How well did the students make use of the available resource materials?

III. Equipment

The students will need materials for product design and advertising campaigns. This probably includes standard "art" supplies--paper, scissors, marking pens, etc.

IV. Procedure

This can be handled in one of two ways.

1. A group of students (no more than 6 or 8) is responsible for four jobs: (a) designing a product, (b) naming it, (c) packaging it, and (d) promoting it.

2. Each of the four jobs is handled by a different group, so that the total responsibility for one product was not controlled by one group. (If there are not four groups, lumping of jobs is permissible.)

V. Past Studies

This activity was conducted with a 10th grade communications class at Nottingham Academy in Buffalo. Although it was used in the unit on advertising, less emphasis on the advertising campaign can make it an effective activity from the packaging standpoint.

VI. Limitations

The teacher has a very limited role in this activity. The activity will probably take up to a week to complete--a deadline is recommended. Frustration levels can run very high in this activity, so the teacher should review the progress of the design frequently.

VII. Bibliography

David, Alec, Packaging and Print (The Development of Container and Label), C. N. Potter, New York, New York, 1968. An excellent reference; predominantly illustrations. The text is very readable--grades 7 and up should have no difficulty, and the information given is very helpful. Much emphasis is on packaging in the first half of this century.

Generating New Product Ideas, The Conference Board, Inc. New York. This is a professional guide to "creativity," suitable for grades 7 and up.

McHarg, Ian L., Design with Nature, Doubleday, Garden City, New York. This book combines a wealth of technical information about land use planning and ecological planning with a good discussion of the philosophy of the kind of thinking that must accompany ecological planning. It places equal emphasis on the practical and the practical and theoretical aspects of ecological thinking.

Packaging's Role in Physical Distribution, American Management Association, New York, 1966. A booklet containing information about packaging considerations; readable by most high school students.

Sperling, Jo Ann, The Emergence of the Packaging Executive, American Management Association, New York, 1970. With an emphasis on careers, the booklet points out the responsibilities and pressures of the packaging executive. Because of its slant toward careers, it would be most useful for high school students.

D. Cafeteria Crisis

I. Introduction

In this activity, students learn about their school cafeteria as it relates to the issue of solid waste. It is a late awareness activity which has many opportunities for expansion into the area of action. The basic activity, a tour of the cafeteria, talking with the personnel, working in it, or any combination of these, can be conducted in a class period. No equipment is needed, and grades 2 through 12 can be included.

II. Questions

1. To lead into the activity, ask
   a. Do people in industrial roles think differently about wastes than we do?
   b. How is the school cafeteria an industrial operation?
   c Is solid waste a problem?
2. To initiate the activity, ask
   a. What types of input are there into the kitchen daily?
   b. How are these packaged differently from those we purchase

for individual use?

c. How do the products change as they go through the cafeteria?

d. What kinds of waste are produced by the cafeteria?

e. What kinds of waste are produced by those who use the cafeteria?

f. Are all the wastes produced visible?

3. To continue the activity, ask

a. How are these wastes categorized?

b. What happens to each category?

c. What is the status of composting?

d. Are your ideas about wastefulness the same as those of the people in the kitchen?

e. Are waste and convenience synonymous?

4. To expand the activity, ask

a. What types of sanitary laws govern the operations of a commercial kitchen?

b. Do these conflict with "wastefulness?"

c. Can you suggest any remedial action to any undesirable situations?

d. How would these suggestions be received?

e. Do people see the cafeteria as a solid waste disposal problem?

f. Could we let people know what happens behind the scenes?

g. What other establishments in the community might have similar problems?

5. To evaluate the students' efforts, ask

a. What information did they find?

b. How well did they perform their investigations?

III. Equipment

Preliminary investigations will require no special equipment.

IV. Procedure

The students will conduct a study of the school cafeteria and its role in solid waste problems. The construction of a flow chart may be encouraged.

V. Past Studies

Among actions taken in various school cafeterias are

1. Signs encouraging ecological habits--carrying lunchboxes instead of bags, using bread bags instead of new sandwich bags, discouraging food wasting, etc. (Amherst Senior High School, Amherst, New York)
2. Kitchen managers can sometimes be persuaded to switch from disposable plastic to paper cups if they will not use non-disposable glasses.

VI. Limitations

This activity is a fantastic learning experience. However, that does not imply that results will necessarily occur. Students must be led to understand legal and public health aspects of cafeterias, before they become discouraged over an inability to take constructive action.

VII. Bibliography

Cailliet, Gret, et. al., The Everyman's Guide to Ecological Living, See Ch. 1, K, VII

Joslyn, M. A., Food Processing Operations: Their Management, Machines, Materials, and Methods, Avi Publishing Company, Westport, Conn., 1963-65. A rather technical, two-volume set, packaging is considered

in the second volume.

Longree, Karla, Quantity Food Sanitation, Interscience, New York, 1967. A moderately technical, useable in high schools, text considering food sanitation, but not emphasizing waste and packaging.

West, Bessie Brooks, Food Service in Institutions, Wiley, New York, 1966. A very comprehensive, though somewhat technical guide. The guide considers little about packaging, but much about the health aspect; thus, students can draw corollaries.

E. The Magnitude of Solid Waste Problems--As Seen by the Community

I. Introduction

Dealing with solid waste in our disposal-oriented society is a controversial issue, one of the reasons being that the magnitude of the problem is evaluated differently by most leaders in a community. This investigation is a survey by mail which attempts to determine how various people in the community view solid waste problems. The students will split into teams, conduct the investigation, and evaluate the responses. This could not only alert students (grades 6 through 12) to the particulars of the problem and potential solutions, but could also arouse the potential school and community interests that would exert important public pressure. This activity provides a direct lead into work with recycling and solution seeking.

II. Questions

1. To lead to the activity, ask

   a. What solid wastes are generated in the community?

b. How are these disposed of?

c. Are there any solid waste problems in your community?

2. To initiate the activity, ask

   a. Who says that an issue is or is not a problem?

   b. What is a problem?

   c. Who is connected with the problem?

   d. Would they have any facts or opinions which might be helpful to us?

3. To continue the activity, ask

   a. What niches do the following occupy in the problem:

      1. industry

      2. the community at large

      3. garbage disposals

      4. sanitation men

      5. junk and scrap dealers

      6. local, state, and federal government?

   b. How responsibly are these roles enacted?

4. To expand the activity, ask

   a. How is the problem viewed by different people?

   b. This activity might well expand into an environmental simulation, if a particular problem is isolated.

5. To evaluate the activity, ask

   a. How extensive was the investigation?

   b. How effective were the letter constructions?

   c. How was the evaluation of data relayed?

   d. What activities did the students end up pursuing?

III. Equipment

1. Paper and envelopes--school letterhead or recycled paper products
2. Appropriate writing implements
3. Postage
4. Data repository

IV. Procedure

1. Have the students select a specific issue, if a "hot" one is available.
2. Draft appropriate letters to appropriate people connected with the problem to obtain their evaluation of the problem.
3. Have the whole class or school sign the letters, if appropriate.
4. Evaluate all materials received.

V. Past Studies

Students of the John F. Kennedy Preparatory School in St. Nazianz, Wisconsin, under the auspices of Father Melvin Tracy, conducted a survey by mail of the solid waste situation, specifically disposal sites, in Manitowac County. A 100-page report of the survey has been compiled. Copies or information can be obtained by writing Fr. Melvin Trac, JFK Prep, St. Nazianz, Wisc.

VI. Limitations

1. Letters should be screened to assure that they reflect the constructive interests of the class as a whole.

VII. Bibliography

Marx, Wesley, Man and His Environment: Waste, Harper and Row, New York, 1971. Deals with the causes, problems and treatments of solid waste.

Small, William E., Third Pollution: The National Problem of Solid Waste Disposal, Praeger, New York, 1971. A general reference for most students grade 5 and up.

F. Recycling: Investigating By Mail

I. Introduction

Recycling is an ecologically sound method of dealing with solid waste in our disposal-oriented society. This investigation is a survey by mail of the many factors involved in the problem of recycling. The students will be split into teams and conduct the investigation, compiling a scrapbook of answers from many different organizations. This will not only alert students grades 6-12, to the particulars of the problem and potential solutions, but it could also arouse the potential school and community interest that would exert important public pressure. The activity can be used as a preliminary step in the process of developing a community or school recycling project.

II. Questions

1. Questions which lead into the activity:
   a. How is solid waste disposed of in your community?
   b. What are the problems with these methods?
   c. How practical would it be to recycle paper? aluminum? glass? other?
2. To initiate the activity, ask
   a. Is there or has there been a recycling project in your community? If so, who, what, when, where and how effective was it?
   b. Where can you write to find out about the practicality of

recycling?

c. What is your congressman's knowledge of the problem and his position regarding solid waste legislation?

3. Questions which continue the activity

a. What other stages of the recycling process have you not examined?

b. What part does packaging play in the waste problem?

c. What do your school and community think of the concept of recycling?

4. Questions to evaluate the activity

a. How extensive was the search?

b. How effective was the letter construction?

c. Was the scrapbook circulated broadly?

d. Did the students want to do other related projects?

III. Equipment

1. Paper
2. Pencils
3. Stamps
4. Envelopes
5. Data repository (cardboard box)
6. Scrapbook
7. Glue
8. Scissors
9. Tape

IV. Procedure

1. Split the class in teams of three. However, the number of teams and number per team depends somewhat upon the number in class and the extent of their involvement.

2. Have each team select an organization or topic upon which they will do research and finally formulate a letter requesting information or inviting a speaker. The letters could be sent to

-Your state and national congressmen

-Glass container corporations which make NO DEPOSIT, NO RETURN bottles. Determine their corporate policies and the locations of recycling centers.

-Aluminum companies to determine locations of recycling centers and their corporate policies.

-Any local offices of state or federal agencies. (The EPA, any offices of HEW or other environmental branches.)

-Paper companies for recycling center information, prices, and corporate policy.

-The local sanitation department of determine local methods of solid waste disposal and provisions for recycling, possibly arranging for a tour or a speaker.

-The community at large in the form of a questionnaire to determine attitudes and habits concerning solid waste.

-Local supermarkets to determine policies on recycling and waste packaging.

3. Have the whole class or school sign the letters. Numbers add weight

to these letters.

4. Collect everything you receive and make a scrapbook.

5. As an outgrowth of the letters, speakers and/or tours, start a recycling movement on an appropriate scale: the school, home and/or community for newspaper, glass, aluminum, or anything else you can discover and recycle.

6. Display and circulate the scrapbook around your school and community. Perhaps you might even send it to the President.

V. Past Studies

This has not been completed as a class activity. However, many individuals and organizations have contacted many or all of the above types of corporations and agencies with varying degrees of success. The response will vary according to letter working, time factors, number of signers of the letter, and level of recycling concern by companies local to you. Some results are guaranteed, and outgrowth possibilities are varied and exciting.

VI. Limitations

Keep the information organized as this search moves along. Keeping a cardboard box as a data bin usually solves this problem. The size of the class and completeness of research are the only other limiting factors except those mentioned in Past Studies Section.

VII. Bibliography

A Bibliography for the Layman--Selected Books and Publications Dealing with ENVIRONMENTAL POLLUTION, The Pennsylvania Action Committee

for Clean Air, Sept. 1970. This is an excellent bibliography on many facets of "environmental pollution" and governmental agencies involved environmental problems. Other materials (films, questionnaires) are listed in a very few spots.

G. Grow Sludge Grow

I. Introduction

This activity deals with a form of recycling that is currently being researched in depth by the U.S. Department of Agriculture. Students thus gain direct exposure to current research and may find that their results are of value to the research effort. The activity is suited to all age groups. Sludge is the only special equipment necessary and may be obtained free from most sewage treatment plants. The activity requires 3-4 weeks to complete, though only 3 or 4 full class periods are needed. Observations and maintenance require a few minutes each day.

II. Questions

1. To lead into the activity, ask
   a. Have you ever planted a garden?
   b. What basic needs must be met for a plant to grow and produce?
2. To initiate the activity, ask
   a. Have you ever used fertilizer? What type?
   b. Why is it necessary?
   c. What makes manure a good fertilizer?
   d. What is sludge?
   e. How does sludge differ from manure?

3. To continue the activity, ask

   a. In what forms is sludge used?

   b. What is digested sludge?

   c. What is meant by ultimate disposal?

4. To expand the activity, ask

   a. What factors make sludge a poor fertilizer?

   b. In what ways can sludge be treated to take advantage of its fertilizing qualities? Is this economically feasible?

   c. Does sludge provide other benefits (other than as fertilizers)?

   d. How can solid wastes be removed from sewage?

5. To evaluate the activity, ask

   a. Did the students attempt to expand the activity by controlling other variables?

   b. Was there a cooperative effort on the part of the students to utilize resources outside the classroom? e.g., local farmers, sewage treatment manager, letters to Department of Agriculture, etc.

III. Equipment

1. Dry sludge: Prior to using the sludge, place it in an oven at 300 degrees F for 30 minutes or in an autoclave for 15 minutes to destroy any pathogens that might be present

2. Three (3) large petri dishes

3. Filter paper

4. Beaker

5. Corn or bean seeds

IV. Procedure

1. Set up the petri dishes with filter paper in each.
2. Make a solution of sludge, using 3-4 teaspoons of sludge to 100 ml of water.
3. In the first petri dish, place 6 seeds, and add enough water to saturate the filter paper.
4. In the second petri dish, place 6 seeds, and add enough sludge solution to saturate the filter paper.
5. Place 6 seeds in the sludge solution. Allow them to remain for a 24-hour period before putting into the petri dish.
6. Place the seeds from #5 in the petri dish, and saturate the filter paper with sludge solution.
7. Observe each dish until growth occurs. Note when growth has begun and the development in each dish.
8. Compare all results. What are your findings?

V. Past Studies

Students at Central Bucks West, Doylestown, Pa., grew plants to monitor air pollution. The sludge was obtained from the Doylestown Sewage Treatment Plant. They were greatly amazed by the rapid growth of the plants. One detrimental effect was noted, the abundance of mold growth.

VI. Limitations

1. A major limitation is the attitude toward using sludge. Some students have negative feelings toward handling sewage in any form.
2. Another concern is the possibility of viable pathogens in the sludge that could lead to disease. Be sure the students follow the safety procedures listed in the appendix.

VII. Bibliography

Agricultural Benefits and Environmental Changes Resulting From the Use of Digested Sewage Sludge on Field Crops, Environmental Protection Agency, U.S. Government Printing Office, Washington, D. C., 1971. A report of agronomic field studies and greenhouse studies using digested sludge. Good background for sludge usage. Readable by students of grades 7 and up.

H. Particulates in Air

I. Introduction

The following activity examines particulate contamination using two simple but varied techniques. The lesson is designed to examine qualitatively and quantitatively the extent of particulate contamination in a given sector of the community and relate this contamination to its likely sources. The equipment used is extremely simple with many built-in errors. The activities provide an opportunity to reinforce the values of accuracy and the need for controls. The activity is suitable for students from grade 7 and up.

II. Questions

1. To lead into the activity, ask
   a. What constitutes air pollution?
   b. What are the sources of air pollution?
   c. How is solid waste considered a factor in air pollution?
2. To initiate the activity, ask
   a. What are particles?
   b. What is meant by particulate air contamination?

3. To continue the activity, ask

   a. What are the sources of particulate contamination?

   b. What sources of particulate contamination are there in your community?

4. To expand the activity, ask

   a. What is the federal allowable amount of particulate air contamination?

   b. How do your results compare with this standard?

   c. To what extent is particulate air contamination harmful?

   d. What community controls do you feel are needed to limit particulate air contamination?

5. To evaluate the activity, ask

   a. What was the mortality rate on detection devices?

   b. Were the students impressed with their findings?

   c. What were the students' reactions to the controls and their effect on particulate air contamination?

III. Equipment

Part I

Activity A

1. 15 or more 7 x 3 cards
2. Hole punch
3. 1 inch width of transparent cellophane tape

Part I

Activity B

1. 15 or more clothes hangers
2. 15 or more 3 inch glass slides

3. Petroleum jelly
4. Can
5. 1 inch width cellephane tape
6. Balance
7. Applicator sticks

Part II

Activity A

1. Microscope
2. Notebook
3. Pencil

Activity B

1. Balance
2. Conversion table (given below)

IV. Procedure

Part I

1. Construction of Collector A
   a. Fold the 7 x 3 card in half lengthwise.
   b. Using a hole punch, punch out 5 evenly spaced holes in one half of the card.
   c. From one side carefully place the tape over the holes so that 5 small sticky pockets are created on the other side.
   d. Protect these pockets by sealing and by folding the other half over the holes and secure with the tape ends until ready for use. Make as many cards as time allows.
2. Construction of Collector B

a. Bend the coat hanger around a can into a circular shape.

b. Place the tape around the bottom with the sticky side out so it will hold the glass slide.

c. Apply a thin layer of petroleum jelly to the slide. Avoid touching the jellied surface.

d. Carefully weigh the slide and record.

e. If more than one slide is used be sure to label the slides BEFORE applying the jelly.

f. Slides that are not to be used right away should be placed in a box with a lid to prevent contamination or damage.

Note: The collectors are to be taken home, placed and hung in areas that are to be examined. CAUTION: The collectors should not be placed where they are likely to be damaged by rain or direct wind. Secure them when necessary. The collectors will be left out for one week and then returned to class. Some collectors may be lost or damaged.

3. Examination of Collector A

a. Examine the collectors under the microscopes on low power.

b. Describe what you see and make diagrams in your notebook.

c. Examine samples of other members in your group and compare to your own. Note differences and similarities.

d. When examination is completed, tape your collector on a sheet of white paper.

e. Get together with your group and devise a 1-5 rating of color density of the samples. Compare and relate the density of the

the samples. Compare and relate the density of the particles and the source of the samples.

4. Examination of Collector B

   a. Weigh your slide very carefully and note any increase in weight. Record.

   b. Using the figures you have, find the amount of particulate matter in 1 square mile in a one week period.

      1 gram = 1.102×10^{-6} tons

      1 square in. = 2.490×10^{-10} sq. miles

      3 sq. in. = 7.47×10^{-10} miles (size of the slide)

Note: If 1 gram = 1.102×10^{-6} tons, your obtained weight times this number will give you the amount of particulate matter you have in tons. Divide the weight you received by the area of your slide in square miles to obtain the number of tons per square mile.

   c. Place your results, your name and the source of the sample on the chart provided on the blackboard.

V. Past Studies

An adaption of the above activity was done by students of the writer at Stamford High School, Stamford, Connecticut. The original purpose was to collect pollen grains during the hay fever season. Students were surprised to find out how much soot was in the air. Pollen grains were less numerous than soot particles.

VI. Limitations

1. The collectors are not very sophisticsted and may be damaged

by natural forces. The more collectors available, the better the results.

VII. Bibliography

Reynolds, William G. and Ward, Roger W. "Simplified Airborne Solid Sampling," The Science Teacher, Vol. 38 No. 1, Jan. 1971. p. 49-50. A description of a collector for particulates. Primarily for use by teachers. Gives procedure for use.

Warner, Barry, "Particulates Provide Proof of the Pollution Problem," The Science Teacher, Vol. 37 No. 5, May, 1970, p. 78-79. Describes a collector for particulates and gives the procedure for use. Primarily for use by teachers or high-ability senior high students.

I. Sewage Treatment

I. Introduction

In this activity, students learn about sewage and waste water treatment. The students learn how sewage is processed in their town and in neighboring communities. New laboratory techniques and equipment will be introduced which will enable students to determine the efficiency of various sewage treatment procedures and to appreciate, in a more precise way, the problems in an important, but often neglected or unnoticed part of everyone's life. The time required for the activity may vary from two to four periods, depending on the difficulty of the selected procedure, student interest, and time and equipment available. The activity is designed for students from grade seven upward.

II. Questions

1. To lead into the activity, ask

a. What happens to the sewage and waste waters that leave your home?

b. Does your community have a sewage system?

2. To initiate the activity, ask

a. What type (primary, secondary, or tertiary) waste water facilities does your community have? (consult local authorities, i.e., local health department of sanitary engineer)

b. Are different types of wastes (sewage, run-off) treated the same?

c. How effective is the treatment?

d. How could it be improved?

3. To continue the activity, ask

a. Are the methods of elimination of pollutants which you have encountered the most effective methods possible?

b. If not, why not?

c. What tests can be performed to determine the effectiveness of treatment plants?

4. To expand the activity, ask

a. Is the sewage treatment in your community adequate?

b. What factors could cause a change in the sewage load in your community?

c. To what extent does zoning in your community allow for residential and industrial expansion?

d. Would you want to drink the water coming from the final sewage treatment stage?

e. What factors would have to be considered in purifying this water for drinking?

(1) the technology required?

(2) the cost of processing?

(3) paying for the processing?

(4) advantages and disadvantages to you and the community?

(5) ecological effects on life in the stream resulting from a change in effluent?

5. To evaluate the activity, ask

   a. What can you as individuals or group members do to improve the sewage system in your community?

   b. Do you feel you could explain the workings of the sewage treatment in your community to a younger student?

III. Equipment

1. Sample bottles
2. Microscope slides and cover slips
3. Microscope
4. Dropper
5. A LaMotte, Hach, or Delta water analysis kit
6. An identification book for identifying microorganisms

IV. Procedure

1. Make a trip to your local sewage treatment plant. Ask the plant manager to give you a tour of the plant. Discuss with him the various steps in sewage treatment. What level of treatment is used?
2. Take samples at the final sewage treatment stage.
3. Determine the nitrate level in the water using the water analysis kit. What is the significance of this level?
4. Determine the the pH. Why is pH important in processing sewage?

5. Examine your samples for clarity. Is the water clear or cloudy? How would you expect the water from tertiary treatment to appear?
6. Examine a sample microscopically. Identify the organisms you find using the identification books.

V. Past Studies

1. A group of students from Quincy, Mass., found their bay to be suffering from rapid biological aging (eutrophication). Also, it was being polluted by "storm" drains from a combination (storm-sewage system). They studied the advantages and disadvantages of secondary treatment, the dangers of daily chlorination, and the problems of algae.
2. Another group of students from Quincy, Mass., made a study of the effects of sludge being pumped into the bay at a rate of two million gallons a day. They concerned themselves with BOD, eutrophication, and floating solids.

VI. Limitations

1. If there is no treatment plant in your community, you will have to take field trips. Supplementary teaching aides may be required.
2. Samples should be drawn only at the terminal treatment stage because of the danger of disease. Hands must be washed thoroughly.

VII. Bibliography

Cleaning Our Environment: The Chemical Basis for Action, A report by the Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs, American Chemical Society, Washington, D. C., 1969. Deals with four major concerns: air, water, solid wastes and pesticides For each there is an introduction to the problem, background information a discussion of the chemical factors, control factors, the environmental

effects, and recommendations for change. The book is technical and best suited to the needs of secondary or college students.

J. Landfills Basic

I. Introduction

Students in seventh grade and below are introduced to the underlying concepts of a sanitary landfill in this activity. A drinking glass is used to enable students to observe microbial action on solid waste items in a mini landfill. The activity may be initiated in one class period and the results observed a few minutes a day as about one week passes. No special equipment is required.

I. Questions

1. To lead into the activity, ask
   a. Why do some people bury their garbage?
   b. What's it like underground?
   c. What happens to the garbage down there?
2. To initiate the activity, ask
   a. What kinds of materials do people throw away?
   b. What happens to these items in a landfill?
   c. What kinds of things do we want in our landfill?
   d. How long does it take for the materials to change?
3. To continue the activity, ask
   a. Are there any empty spaces where materials have decomposed?
   b. Are they really empty?
   c. Is there anything at all in those spaces?
   d. What happened to the garbage that used to be there?
   e. Is it truly "gone"?
   f. What materials did not change?

4. To expand the activity, ask
   a. Were the physical conditions the same for each landfill?
   b. If these conditions were changed, would you expect changes in the rate of decomposition?
5. To evaluate the students, ask
   a. Were the landfills well maintained?
   b. Were the materials used in it representative types?
   c. Were observations well kept?

III. Equipment

Each team needs:

1. 3 or 4 see-through drinking glasses or beakers
2. Soil-enough to fill the glasses, taken from several inches below surface
3. Aluminum foil
4. Various samples of litter, trash, or garbage (The size should vary between that of a bean to a grape.)
5. Microscopes
6. Slides

IV. Procedure

1. Have students obtain the soil and litter samples, if possible.
2. Vary the litter in the soil in the glasses at various depths, but place the litter against the inner surface of the glass to allow the observations of microbial action.
3. Make sure the soil is firmly packed, with an inch of air space at the top; the soil should be moist but not wet.
4. Cover the glasses with a piece of aluminum foil.
5. Observe daily for signs of mold and decomposition. Students may wish to perform microscopic observations as well.

V. Past Studies

1. This activity was conducted by the writer to test its feasibility for classroom use. The above writing represents the variations on the basic activity.

VI. Limitations

1. Do not use meat products in the landfill as they tend to produce offensive odors.

VII. Bibliography

Schatz, Albert and Vivian, Teaching Science With Garbage (An Interdisciplinary Approach to Environmental Education From the Points of View of Science, Math, and Social Studies) Rodale Press, Inc., Emmaus, Pa. This activity is adapted from Teaching Science With Garbage. A delightful idea-book that lists 30-odd activities and lists facts and questions that deal with garbage and teaching. They compile a healthy interdisciplinary bundle.

Wilcomb, Maxwell J., and Hickman, H. Lanies, Jr., Sanitary Landfill Design, Construction and Evaluation, Report (SW-88ts). U.S. Environmental Protection Agency, Solid Waste Management Office, Superintendent of Documents, U.S. Government Printing Office, Washington, D. C., 1971. A very practical, very readable guide to the realistics of a sanitary landfill; readable from grade five upward. Cost $.30.

K. Litter'Limination

I. Introduction

This activity takes a step toward answering the provocative question - what happens to litter! By simulating biological processes in vitro, the students will become acquainted with the biodegradability status of various types of litter. This activity is suitable for any age level.

II. Questions

1. To lead into the activity, ask
   a. What can happen to litter?
   b. What do non-natural processes do to it (e.g. cars)?
   c. What do animals (including man) do to it?
   d. What do natural forces (e.g. wind and rain) do to it?
2. To initiate the activity, ask
   a. Does litter disappear?
   b. What is meant by the term "biodegradable"?
   c. What types of litter are biodegradable?
3. To continue the activity, ask
   a. What materials show signs of biodegrading?
   b. What types of growths resulted?
   c. Did sunlight affect the process?
   d. Did moisture affect the process?
   e. How "real was this experiment?
   f. Why did we use soil?
   g. What is soil?
4. To expand the activity, ask
   a. Could succession be observed in the system?
   b. In what other systems could biodegradability be observed?
5. To evaluate the students, ask
   a. How logically was the experiment set up?
   b. Did the investigation provoke further questions?
   c. Did the students progress in terms of understanding the concept(s)

of biodegradability?

III. Equipment

Each team needs:

1. Container, glass, metal or plastic, 6-8" in diameter and 3-4" deep.
2. Moist but not waterlogged soil, perferably loam, from garden or under shrubbery.
3. Thin, clear transparent plastic.
4. Rubber band.
5. Variety of material to biodegrade or not to as the case may be - litter can be picked up from roadside, kitchen scraps, etc.

IV. Procedure

1. Firmly pack soil an inch or so deep in the container.
2. Obtain litter. Do not include protein materials such as jello, meat, or cheese, because these may cause unpleasant odors. Make sure someone includes materials such as steel wool, glass, plastics, etc.
3. Place litter on the surface of the soil, allowing plenty of room between pieces.
4. Cover container with the plastic, secured by the rubber band.
5. Observe growth of molds and subsequent decomposition - an especially important consideration is time. Watch for signs of succession.

V. Past Studies

Tim Horne, at George School, Newtown, Pa., set up an experiment to test the biodegradability of litter (cans, bottles, plastic, paper) as the litter is exposed to the elements out of doors.

VI. Limitations

If displays are made for out-of-doors, be sure to protect them from vandalism. Occasionally, students have encountered difficulties when mounting of biodegradability?

litter, because the mounting materials degraded too rapidly. The students will probably have to determine their own standards.

VII. Bibliography

Litter Facts, See Ch. 1, A, VII

Teaching Science With Garbage....See Ch. 2, J. VII

Scientific Experiments on Environmental Pollution, Elbert C. Weaver, Editor, Holt, Rhinehart and Wilson, New York, 1968. There is one biodegradability of solids activity in this booklet; the rest deal with air pollution and with water. A fairly technical orientation makes the activities suitable for grade nine upward.

L. Landfills Advanced

I. Introduction

This activity will be particularly relevant to students whose community is serviced by a sanitary landfill. Students will build a model landfill and investigate problems and controversies concerned with landfill construction and operation. Students will perform concurrent research and (with their model) shall learn material which may be shared, perhaps with younger grades.

II. Questions

1. To lead into the activity, ask
   a. Why is garbage sometimes buried?
   b. What's it like underground?
   c. What happens to the garbage down there?
2. To initiate the activity, ask
   a. Is the sanitary landfill an efficient means of dealing with wastes?

b. How economical is it?

c. How efficient is it?

d. Does it deal effectively with the solid waste put into it?

e. Can a landfill be simulated?

3. To continue the activity, ask

a. How long does it take various materials to decompose?

b. What stages does the decomposition process take?

c. What types of settling have taken place?

d. What can be said about organic vs. inorganic matter in landfills?

4. To expand the activity, ask

a. What community problems are associated with landfills?

b. Are landfills an acceptable way of disposing of wastes?

c. Compare and contrast landfills and compost piles.

5. To evaluate the activity, ask

a. Is the simulation well constructed?

b. Does the student feel he has gained an understanding of landfills?

c. Was research conducted to an adequate degree?

d. Did the student contribute to the group work?

III. Equipment

Students will probably need the following materials, most of which they should be responsible for obtaining. This may be conducted as a class or group activity.

1. Large container for landfill

2. Soil

3. Garbage

4. Stones to simulate rock layers and water table
5. Unlimited extras

IV. Procedure

1. In your landfill box place a thin layer of soil.
2. Place about an inch of garbage over the soil.
3. Pack down the garbage.
4. Place a thin layer of soil over the garbage and pack down.
5. Continue layering garbage and soil until the box is full.
6. Work with another group of students to set up a controlled study. Leave one landfill undisturbed. Pour a cup of water into the other each day to simulate rainfall. Compare the decomposition in each landfill after a week has passed. Note the amount of settling in each landfill.

V. Past Studies

The class of Mrs. Pam Gallagher at the Lower Moreland Junior High School, Pa., experimented with landfills in plastic containers. Students were involved in studying the physical conditions that were most favorable for decomposition of garbage in the landfill. Emphasis was placed on sanitary landfill as one means of waste disposal.

VI. Limitations

1. A wooden box allows for viewing at only one dimension. A pane of glass could be used in one side.
2. Odors may offer some difficulties in the controlled studies.

VII. Bibliography

Cleaning Our Environment: The Chemical Basis for Action, See Ch. 2, I, VII

Municipal Refuese Disposal, American Public Wroks Association, United States Department of Health, Education and Welfare, United States Public Administration Service, Chicago, Ill., 1970. A very complete, excellent text, considering any facets of the solid waste disposal problem which students need to know. Although somewhat technical, high school students could make good use of it.

Wilcomb, Maxwell J., and Hickman, H. Lanies Jr., Sanitary Landfill Design, Construction and Evaluation, Report (SW-88ts), United States Environmental Protection Agency, Solid Waste Management Office, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1971. A very practical, very readable guide to the realistics of a sanitary landfill; readable from grade 5 upward. Cost - $.30.

M. Particulates in Water

I. Introduction

This transition activity introduces students to the problem of particulates in water. They examine water quality in terms of the amounts of suspended particles and sedimentation and consider probable sources of this form of pollution. The activity is suited for grades four through twelve. It requires no special equipment and requires from two to four class periods to complete.

II. Questions

1. To lead into the activity, ask

   a. What makes water cloudy?

   b. What is sediment?

c. How can sediment be considered a pollutant?

2. To initiate the activity, ask

   a. What are particulates in water?

   b. Of what do these particulates consist?

   c. What are some sources of particulates in water?

3. To continue the activity, ask

   a. What effects does sediment have on fish and shellfish populations?

   b. How are sediments treated in channels and harbors?

   c. What effects do particles in water have on power turbines and pumping equipment?

   d. How does the speed of the water affect the amount of sediment?

4. To expand the activity, ask

   a. How is the cost of particulate pollution in water transmitted to you?

   b. How could particulate pollution of water be decreased?

   c. How can the problem of particulates in water be treated?

5. To evaluate the activity, ask

   a. Did the students work together or separately?

   b. Did the students compare their findings?

   c. To what extent did the students offer suggestions for improvement of the situation?

III. Equipment

1. Three 100 ml graduated cylinders
2. White 8" x 11" card or paper
3. Record sheet for data
4. Thermometer

IV. Procedure

1. Locate three different sample areas along the water-way you are to examine. Each should be as different from the other as possible.
2. Collect a 100 ml water sample from each area and record its temperature .
3. Hold the sample against the white card. Rate the cloudiness from lesser to greater (1-5).
4. Return your samples to class. Allow them to sit overnight so that the particles can settle out.
5. Measure the depth of sediment in each cylinder.
6. Examine your results. Note any relationships between the location, rate of flow, water temperature and the amount of cloudiness or sediment.

V. Past Studies

Students at Germantown Academy built a check dam on the Wissahickon Creek. In the first few months, several inches of sediment collected above the dam. It was identified as the result of erosion and discharge from a factory upstream. The water below the dam was measurably clearer (JTU). They determined why these things occurred.

VI. Limitations

1. Be prepared for wet clothing. Many students find it difficult to resist deep water.
2. Bring along a specimen box or container. You never know what you will find of interest.

VII. Bibliography

Ruckelshaus, William D. and Dominick, David D., A Primer on Waste Water

Treatment, Environmental Protection Agency, U. S. Government Printing Office, Washington, D. C., March, 1971. An excellent introduction to sewage treatment. Deals with types of treatment, types of pollutants, and future of waste water treatment. A good background source for students from grade 7 upward.

Water Pollution, Addison Wesley, Inc. Publishing Company, Teachers Guide. A good introductory resource. It must be supplemented if detailed studies are undertaken.

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Volumes I & II

See Ch. 1, I, VII

A Curriculum Activities Guide...... Volume III

Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106. This volume in the series describes methods for constructing the equipment needed to run tests described in Volume II.

N. Solid Waste in Water and Its Effect on Aquatic Animals

I. Introduction

This activity will test the effects of solid waste on aquatic organisms. Students will make daily observations of aquaria to which solid waste has been added. They will record their observations and evaluate them. The activity is seen as an introduction to more in-depth studies of solid waste effects on aquatic life. The activity requires a minimum of one week to complete. Aquaria that have been established prior to the activity are suggested. Students from the upper elementary grades through senior high school can benefit from this activity.

II. Questions

To lead into the activity, ask

a. How often have you passed a stream or river that was filled with debris?

b. Why do you think people dump trash near into waterways?

2. To initiate the activity, ask

a. What effects do you think litter and garbage have on the animal life in these waters?

b. What happens over a period of time to the solid waste in these waterways?

3. To continue the activity, ask

a. What effect does the solid waste seem to have on the animals?

b. What did the waste do to the water?

c. How did the animals respond to the waste?

d. What positive effects did the waste have on the animals, if any?

4. To expand the activity, ask

a. How could the effects on wildlife be reversed?

b. What economic factors have to be considered if we are to clear our waterways of solid wastes?

c. How can we stop people from dumping wastes into our waterways?

5. To evaluate the activity, ask

a. Did the students make in-depth observations?

b. Was there much interaction between the various groups?

c. Did the students speculate on the effects of the waste on the animal life?

III. Equipment

1. Four aquariums, 20 gallons each, with assorted animals and plants

2. Garbage and trash items

3. Observation sheet

IV. Procedure

1. Observe your aquarium for several days and record the behavior of the animals. Note the physical conditions in the aquarium.
2. Add a single solid waste item and again observe the animals for a few days.
3. Add another solid waste item and again observe for a few days. Continue to do this as long as time permits.
4. Make sure you record all your observations.

V. Past Studies

1. The writer became involved indirectly in the above activity while teaching at Log College Jr. High School, Warminster, Pa. Someone threw some pennies in the classroom aquarium. Several fish were found dead during class. When the pennies were noticed, several students wondered what really had happened to the fish. A discussion ensued on heavy metal poisoning.

VI. Limitations

1. If the aquarium is not set up several weeks in advance of the activity other factors may interfere with the results. Be sure to use a control aquarium.

VII. Bibliography

Clean Water for Mid-America, Public Information Office, Great Lakes Region, FWPCA, Dept. of Interior, Chicago, Illinois, April, 1970. An introductory pamphlet on water quality. Deals with the middle states region. Concerns itself with the roles of the states, cities and industries. Good for upper elementary through senior high school.

O. Packaging Effects on Microorganisms

I. Introduction

This activity shows students how packaging differences affect the microorganisms of their foods. By comparing bacteria and/or yeast concentrations of fresh, canned, and/or frozen foods, students will observe the sanitary differences among different packaging processes. This activity is suitable from grade five upward.

II. Questions

1. To lead into the activity, ask
   a. What microorganisms are found on foods?
   b. What is their source?
   c. Are these good or bad?
   d. Why is packaging necessary?
   e. Is the microorganism content of foods important?
2. To initiate the activity, ask
   a. What factors affect the microorganism content of foods?
   b. What comparisons can be made?
3. To continue the activity, ask
   a. How important is the sanitary quality of foods?
   b. What laws govern this?
   c. What common diseases are there associated with contaminated foodstuffs?
4. To expand the activity, ask
   a. Do you think your attitudes toward buying packaged foods have changed as a result of this activity? Explain.
   b. What factors are highlighted in the home preparation of foods as a result of this activity?

5. To evaluate the students' efforts, ask

   a. How rigorously was the procedure followed?

   b. What happened with the results?

   c. How did packaging play a role in the investigations?

III. Equipment

1. Food samples-these may include:

   a. canned vs. fresh vs. frozen vegetables and fruits

   b. butcher vs. grocery store meats

   c. bulk vs. packaged butters and cheeses

2. Millipore laboratory-set up

   a. Sterifil unit(s), Millipore Corp., Bedford, Mass - See bibliography

   b. media - total count medium, yeast and mold medium and MF-Endo medium are suggested

   c. petri dishes

   d. distilled water

   e. alcohol and flame for sterilizing forceps

   f. incubators

IV. Procedure

1. Obtain the foods to be tested. Note the packaging.
2. Prepare the filters according to the Millipore instructions.
3. Place the food in sterile distilled water using sterile forceps.
4. Pour into the funnel unit.
5. Rinse off the microorganisms by gently agitating the unit.
6. Remove the food with sterile forceps.
7. Filter the distilled water.

8. Use residue to streak the plates. Be sure to follow sterile technique.

9. Incubate the plates for 48-72 hours.

10. Observe the plates; determine and record your findings.

V. Past Studies

This activity was conducted at the Institute for Environmental Education in Cleveland during a 1972 summer training session. Especially evident was the difference between fresh fruits in open markets and supermarkets, which superpackage them. Studies were also done to determine the bacterial content of bulk butter, butter sold out in the open, and packaged butter.

VI. Limitations

Students should actually do the selecting of foods. If the students are not familiar with, say, the "farmers market," then, if possible, they should see the contrasts with supermarkets.

VII. Bibliography

Hersom, A. C., Canned Foods (An Introduction to Their Microbiology), Chemical, New York, 1964. This is a fairly technical text, although high school students could handle it. It emphasizes the rigorous laboratory analyses which can be performed and also contains informative text.

Millipore - Experiments in Microbiology, The Millipore Corporation, Bedford, Mass. This student manual is an experiment-oriented introduction to the many procedures which can be carried out using Millipore equipment and which are basically the same type of testing done in professional laboratories. An introductory section on microorganisms

provides adequate background to conduct the investigations.

Thatcher, F. S., Microorganisms in Foods (Their Significance and Methods of Enumeration), University of Toronto Press, Toronto, Ontario, 1968. A fairly technical, largely informative text. Many advanced techniques are discussed, most of which are too elaborate for the average high school student.

P. The Present Tense of Soap

I. Introduction

In this activity, a common waste material will be used to produce a helpful product. The activity deals with the concept of recycling and points out that this is in no way a new concept. Because the activity involves the use of lye, students must be informed about the dangers of lye. Close supervision is suggested. The activity is suitable for students in grades seven through college. The activity requires two class periods, a week apart.

II. Questions

1. To lead into the activity, ask
   a. What do you do with left over animal and vegetable fats?
   b. Are these wastes or by-products?
   c. What did the early Americans do with fats?
   d. What was fat used for during World War II?
2. To initiate the activity, ask
   a. What is soap?
   b. Is a detergent soap? Explain.
3. To continue the activity, ask
   a. Is fat disposal a problem in this country?

b. How did our forefathers make soap?

4. To expand the activity, ask

   a. How is soap manufactured today?

   b. How does home-made soap compare with manufactured soap?

   c. Why is water purity a consideration in making soap?

5. To evaluate the students' efforts, ask

   a. How did the students respond to the activity?

   b. To what degree did they apply the knowledge gained in performing the activity?

   c. How well did the students work together?

III. Equipment

1. Fats - a little over 6 lbs. or 13 cups

   a. Kitchen grease

   b. Tallow (beef, sheep or mutton fat)

   c. Lard (pork and bacon fat)

   d. Poultry fats (should not be a major source)

   e. Vegetable oils (should not be a major source)

   f. Candle stubs

2. Three enamel pots (do not use aluminum)

3. Cold water (rain water or distilled water is preferable)

4. Heat source (Bunsen burner)

5. Wooden stirring stick

6. 2 or 3 thicknesses of cheese cloth

7. Gloves or vaseline for the person working with lye

8. 13 oz. container of lye

9. Measuring cup or scale

10. Molds (cardboard or cigar boxes, pyrex cake pan or wooden mold)

11. Cutting tool made of a strong thin wire suspended between two sticks of wood

IV. Procedure

1. Collect fats.
2. Clarify fats by boiling 1 part fat to 2 parts water. Filter through two to three thicknesses of cheesecloth.
3. Place two and a half pints of cold water in the enamel pan. Gradually add 13 oz. of lye while stirring with a wooden stick. Let the liquid mixture cool to room temperature.
4. Heat six pounds or thirteen cups of fat to the point that it is completely melted.
5. Gradually pour the lye solution into the fat while stirring constantly. This should be done over a 15-20 minute period.
6. Stir slowly for another half hour or until the solution begins to thicken.
7. Fill the molds with the slurry.
8. Set the molds in a warm place, undistrubed for a week.
9. When the soap has hardened, cut or flake it.
10. Be sure to wash your hands when finished!

V. Past Studies

1. Soap making was done in the seventh grade classes of the writer at Log College Jr. High School, Warminster, Pa. Some of the soap was used in the classroom. The rest was taken home by the students. The students were excited about the activity because it was something they had heard about from their grandparents but never had done before.

REV:A:1

2. Soap was also made by the graduate students of Dr. Albert Schatz at Temple University as an example of recycling. The interest and enthusiasm ran high. Much discussion centered around other ways of recycling in the home.

VI. Limitations

1. Not all age levels will be able to conduct the entire activity.
2. Lye must be handled carefully. Should anyone get any on his clothes, skin or in his eyes, neutralize it with diluted vinegar and then wash it with water.

VII. Bibliography

Cailliet, Greg, et. al., See Ch. 1, K, Vii

Schatz, Albert and Vivian, See Ch. 2, J, VII

Smith, Paul E., Reviser of text by Carpenter and Wood, Our Environment: How We Adapt Ourselves To It, Allyn and Bacon, New York, 1958. The first half of this practical science textbook is concerned with meteorology and beyond, but the second half describes health, farm and garden, and conservation practices. Students from grade five upward can find simplified information, which includes sewage and water treatment, agricultural control, and foods. A very informative text to have on hand.

Q. C.O.M.P.O.S.T.O. (Constructing Organic Matter Piles Obliterating Stagnant Throw-Outs-Outside)

I. Introduction

In this activity, students construct a compost pile outside the school building and assume the responsibility for its maintenance. Depending on the materials used in the compost, additives may need to be purchased, because the compost pile constructed in this activity is assumed to be of considerable size. If constructed by an extracurricular group of interested students and teachers, timing would be less of a problem than if conducted by a class. Getting the compost under way might take a week's worth of class time, after which maintenance may be necessary. This activity is suitable for students from grade 3 upward.

II. Questions

1. To lead into the activity, ask
   a. What essentials are needed for plant growth?
   b. From where do plants get what they need to grow?
   c. What essentials are needed for animal growth?
   d. From where do animals get what they need to grow?
   e. What are organic wastes?
   f. How do we dispose of these wastes?
2. To initiate the activity, ask
   a. What is decay?
   b. What are the by-products of decay?
   c. What decays?
   d. What is compost?
   e. What goes on inside a compost pile?
3. To continue the activity, ask
   a. Can we support a compost pile?
   b. Where will it be located?
   c. What materials will we want in it?
   d. Why would we want to avoid adding some materials?
   e. Who will contribute to it?

f. Who will take the responsibility for its maintenance?

g. What will be done with the "finished" compost?

h. Is a compost pile economically feasible?

4. To expand the activity, ask

a. What materials should be added to make a better quality material?

b. Do certain materials decompose better than others?

c. What organisms facilitate the decomposition process?

d. How does composting differ from landfill operations?

III. Equipment

1. Supply of organic wastes. The compilation of a compost pile is not an activity for which an exact materials list exists. For a large pile out of doors, garden wastes (leaves, grass clippings, undiseased plant refuse) are quite sufficient. If manure is available, it too is a good additive. Of course, some soil is needed as well as lime to "sweeten" the soil.

2. For the confines of the pile, a pit can be dug (which provides soil for the pile). In this case, obtain shovels. To stake out the area, have string and wooden posts. If the pile will be constructed completely above ground, have some fencing so materials don't blow all over the place (wooden staves or chicken fencing). If a wooden or cement platform is available for this, seepage can then be collected and returned to the pile for nutrient renewal purposes.

3. A supply of water should be nearby (i.e.hose).

4. Pitchforks will be needed to turn the compost.
5. Those who work with the compost pile should wear appropriate clothing.

IV. Procedure

1. By going through the "continue" questions, general criteria for the pile will be determined.
2. The site should be confirmed and cleared with proper authorities. If possible, a shaded area is good so that evaporation is minimized.
3. No set procedure can be outlined below. Preparation of the area might include digging a trench and setting up confines.
4. Materials should be layered in the pile if several different ones are used. That is to say that not all leaves should be at the bottom, all manure in the middle, and all the garden scraps on top. Six inches is a good layer depth.
5. Each layer should be moistened, but not drenched.
6. The top should be flat or concave so that rain water is not repelled.
7. Materials may be continuously added to the pile.
8. The pile should be "turned" once (6-7 weeks after construction) to aerate and promote equal decomposition of matter. Make sure that the materials that were on the outside get inside. Moisten it if necessary.
9. When material is sufficiently rotted, it is ready for use.
10. Have students visit the pile periodically to make observations.

V. Past Studies

1. Council Rock High School in Newtown, Pa., under the direction of Mr. Vance Bachman, established a spot on school property where the

public could bring their leaves. In a three-week period, the size of the pile had decreased 30-40% by the decomposition. The community was then invited to partake of the finished product.

2. Nottingham Academy in Buffalo inconspicuously maintains a compost pile for leaves and garden scraps in a shaded area of its city campus. Very few students and faculty realize that it exists!

VI. Limitations

1. There is always a fear that compost piles attract flies, rats and dogs. If properly maintained (i.e., not neglected), not even an odor problem will be present.
2. Although the pile will keep through the winter, try to set up the pile so that it has some time to get going before the snow sets in.
3. If prohibited from establishing a large pile out of doors, consult the activity C.O.M.P.O.S.T.I., which directs a small pile that may be maintained indoors.

VII. Biblipgraphy

McGauley, P. H., American Composting Concepts, EPA Solid Waste Management Office, U.S. Government Printing Office, Washington, D. C., 1971. A paper reviewing the status of composting as a process for the management of municipal solid wastes. Evaluates compost in terms of economic and environmental values in long and short runs.

Breidenbach, Andrew W., Composting of Municipal Solid Wastes in the United States, U.S. Government Printing Office, Washington, D. C. Discusses large-scale composting, including case histories, somewhat technical but not too difficult for the high school student.

Dust, James O., The Compost Pile, Agricultural Extension Service of Penn State University, University Park, Pa., April, 1970. An excellent introduction and guide to composting on a home gardening scale. It discusses the practical importance of composting and the building of the pile. Directions are given for a large pile without specific directions for a very small scale attempt. Grades 9 and up might find it interesting.

Rodale, J. I., and Staff, Encyclopedia of Organic Gardening, Rodale Bodes, Inc., Emmaus, Pa., 1971. An alphabetical listing of thousands of garden products, processes and plants. A virtual bible of gardening organically, including an excellent section on composting.

Robinson, Jeanne, "Making Compost Is Like Making Soup", Organic Gardening and Farming Magazine, Emmaus, Pa., May 1972. Describes the steps and variety of materials used to rejuvenate a barren piece of property. Very interesting for any grade level.

R. C.O.M.P.O.S.T.I. (Construction Organic Matter Piles Obliterating Stagnant Throw-Outs-Inside)

I. Introduction

This activity is designed for classes in which an outdoor compost pile is prohibitive because of a lack of either space, time, or permission. The activity allows students of any age, especially those in elementary school, to see composting in action--indoors. Students are encouraged to bring in kitchen scraps which will decompose in a trash can, facilitated by soil. Once the materials are added, they will be decomposed within a week to three weeks. An old blender is a helpful piece of equipment. Equipment requirements, however unusual, are not extraordinary.

II. Questions

1. To lead into the activity, ask
   a. From where do plants get what they need to grow?
   b. From where do animals get what they need to grow?
   c. What are organic wastes?
   d. How could we dispose of these wastes?
   e. Is there a good and a bad way to "get rid" of them?
2. To initiate the activity, ask
   a. What is decay?
   b. What decays?
   c. What is compost?
   d. What goes on inside a compost pile?
   e. What are the by-products of decay?
3. To continue the activity, ask
   a. What are good materials for decomposing?
   b. Do certain materials decompose better than others?
   c. What will be done with the "finished" compost?
4. To expand the activity, ask
   a. What materials, if added, would make a better quality compost?
   b. What organisms facilitate the decomposition process?
5. To evaluate the activity, ask
   a. How cooperative were the students about bringing in materials?
   b. What was their reaction to the project?
   c. Did they express an enthusiasm to take the activity beyond the

the confines of the classroom?

III. Equipment

1. Container (e.g., handled trash can) of soil: topsoil, garden soil, etc.
2. Container (e.g., handled trash can) in which to make the compost
3. Old blender, if available
4. Small shovel for transferring materials
5. Slack lime for sprinkling atop mixture
6. Thermometers
7. Kitchen scraps the students bring in
8. Earthworms

IV. Procedure

1. Have students collect kitchen scraps in a container which can be covered and brought to school, e.g., coffee can with plastic lid, reusable plastic storage boxes. (horrors, but...)
2. These wastes should consist only of materials such as vegetable and fruit scraps and peels, coffee grounds, egg shells; greasy scraps or any meat, cheese or egg products invite odors and pests so stick mostly to greens.
3. If possible, run these scraps through a blender, or else instruct students to make sure the pieces are reasonably small.
4. Alternate layers of soil with layers of scraps.
5. Make sure the pile is moist. Introduce worms.
6. Sprinkle a few teaspoons of lime on every other food layer or so.
7. Take periodic temperature readings of both the inner and outer regions of the soil.

8. When soil is "done," use it. Keep the operation going as long as enthusiasm permits.

V. Past Studies

1. When kitchen scraps are put through a blender, they will decompose in about a week.

2. In a compost pile consisting of kitchen scraps, tomato seeds yielded tomato plants two feet tall. Another compost heap had to be started.

VI. Limitations

1. The only limitation might be that the idea of a compost heap indoors is repulsive to some people. A properly maintained compost pile is no nuisance.

VII. Bibliography

McGauley, P. H., American Composting Concepts. See Ch. 2, Q, VII

Breidenbach, Andrew W., Composting of Municipal Solid Wastes in the United States, See Ch. 2, Q, VII.

Dust, James O., The Compost Pile, See Ch. 2, Q, VII

Rodale, J. I., and Staff, Encyclopedia of Organic Gardening, See Ch. 2, Q, VII.

Robinson, Jeanne "Making Compost Is Like Making Soup". See Ch. 2, Q, VII.

S. Compost Awareness Activity or Soiled Waste

I. Introduction

The purpose of the activity is to make students aware of the soil and how composting plays a vital role in soil enrichment. Through both sensual and scientific experimentation, students will gain an increased awareness of different types of soils and composted materials. There are four different parts to this activity--they can be combined as necessary for grades K-12. Ordinary science laboratory equipment is needed to conduct this activity. It can be completed in one to three class periods.

II. Questions

1. To lead intothe activity, ask
   a. Where do plants get the materials to make them grow?
   b. What is soil?
   c. What is compost?
2. To initiate the activity, ask
   a. What can you see in each soil sample--i.e., identifiable matter, living,dead, or inorganic?
   b. What does it feel like? (Do not look while doing this.)
   c. How does it smell?
   d. What is its color?
3. To continue the activity, ask
   a. What microorganisms are in the soil?
   b. What are they doing?
   c. What is the percentage of organic matter in the soil?
   d. Can you distinguish the samples once they've been dried?
4. To expand the activity, ask
   a. What is pH?
   b. How is it important in soils?
   c. What is the pH of the soils we are working with?
5. To evaluate the activity, ask

a. How exacting were the students in making clear and accurate observations?

b. Were they "turned on" by the activity? What interested them most/least?

c. What were the quality and the quantity of questions raised beyond the activity?

III. Equipment

1. Soils and compost pile samples--at least four
2. White surface on which to place samples for observation (mortars, Porcelain, white glass, etc.)
3. Marking pencil for identification of samples
4. Small (50 ml or so) beakers
5. Medicine droppers
6. Microscopes (as most organisms are bacteria, the higher the scope can magnify the better--perhaps going into oil immersion)
7. Slides and cover glasses
8. Aluminum or other suitable drying pans
9. Drying oven or drying lamps
10. Soil scoops--trowels or laboratory spatulas
11. Soil pH test kit--if desired
12. Distilled water
13. Scale
14. Hand lenses

IV. Procedure

1. Make sensual observations of the soil samples provided.

Hand lenses may be used. Students should collect the samples if possible.

2. Place an amount of soil in a beaker. Add distilled water to make a suspension. Swirl to mix. With medicine dropper, prepare slides. Note diversity and density (one, several, all over the place) of microorganisms. Samples can be left to propagate and daily or bi-weekly check-backs can be made on succession and change.
3. Weigh standard amounts of each sample. Place in drying oven until all moisture has been evaporated. Weigh again--evaluate results.
4 Analyze the pH of each sample. Make sure the source is known. If compost is involved, find out what material (especially if slack lime to raise pH) contributed to the compost.

V. Past Studies

1. In one study (the author's), four samples were used: dry, trampled soil; compost from a farm; compost made mostly from leaves and garden wastes; and some from a home in which tomato plants over two feet tall had grown from seeds from contributed tomato wastes. Sensual differences were prominent especially in terms of microorganisms.
2. In the same study, one student was amazed at the concentration of bacteria from the sample of worn, trampled soil--in general, the plethora of uni-cellular bodies which didn't seem possible from some pretty worn-out looking soil.

VI. Limitations

1. This activity is best tried when snow and frozen ground are not in control of circumstances.
2. High magnification (e.g., 950X) microscopes are especially good,

since most microorganisms are bacteria and algae which require higher magnification. If such are not available, the students may become discouraged and think that nothing is in the soil. Be ready to give help to frustrated students.

VII. Bibliography

Bahr, Robert and Reemer, Rita, The Organic Classroom: Introduction to Environmental Education, the Organic Way. An interdisciplinary approach, Rodale Press, Inc., Emmaus, Pennsylvania 18049, 1972. Book of classroom activities for elementary school children in particular. Organic living is a theme--growing plants, crafts, etc. Worth looking at by any science teacher.

T. Learning by Burning

I. Introduction

In Learning by Burning, high school students investigate the combustion characteristics of commonly discarded materials. Results obtained here are then related to large scale problems concerned with municipal incinerators. Conducted using the resources of a standard high school laboratory, the activity takes place in one class period--although follow-up may extend several days.

II. Questions

1. To lead into the activity, ask
   a. Why is incineration such a popular method of refuse disposal?
   b. What problems are there in conjunction with incineration?
2. To initiate the activity, ask
   a. Do all materials burn the same way?

b. What happens when common refuse materials are burned?

3. To continue the activity, ask

   a. Is smoke produced?

   b. What color is it?

   c. Are particles detached and carried away in the smoke?

   d. Does the material melt or burn?

   e. Will the material remain ignited when removed from the flame?

   f. How completely will it burn?

   g. What is the consistency of all the remaining ash residue?

   h. Are undesirable fumes or odors produced?

4. To expand the activity, ask

   a. What is pyrolysis?

   b. Is there a difference between incineration and burning?

   c. What is the temperature of the flame produced by the bunsen burner?

   d. What is the temperature at which municipal waste is incinerated?

   e. How does the ash from burned materials compare with from an incinerator?

   f. Can an incinerator be accurately simulated within the confines of a classroom?

5. To evaluate the activity, ask

   a. How carefully did the students conduct the investigation?

   b. How was the quality of the data?

   c. How much did the activity interest them?

III. Equipment

1. Goggles

2. Bunsen burners
3. Long (at least 10") handled tongs
4. Asbestos pads
5. Five to ten materials per team to burn--e.g., different plastics, paper, metal, synthetic materials, rags, packaging, organic wastes, etc. Students may provide these.
6. Fume hood
7. White paper or other surface for comparison of residue
8. Fire extinguisher or fire blanket
9. Burn medication

Note: Items eight and nine are not suggesting that the activity causes devastation of the lab. However, the activity should not be conducted unless these supplies are available should the need for them arise.

10. Samples of incinerator residue from outside source
11. Scales or balances

IV. Procedure

1. Students should elect whether or not to combust materials based on size or weight. A data sheet may be prepared.
2. In a very well ventilated room, students should place the sample in the tongs and then place them in the fire of a bunsen burner. The time and procedure will be standardized (as students collect data), based on discussion and observations which arise as different materials are burned.

Note: Any materials, including all plastics, must be burned under the flame hood. If the suction interferes with the flame, waft the fumes into the hood. Students should never breathe vapors--waft them, but only under careful supervision by the teacher.

V. Past Studies

1. One student made the mistake of inhaling some of the vapors from burning Saran Wrap. Adequate ventilation cannot be overly emphasized!

2. At a constant temperature, the differences in burning properties of common laboratory throw-outs--metal foil, plastic cover slips, powder pillows, frayed rope--fascinated the author. These properties are not considered by students and the differences are really interesting!

VI. Limitations

1. The teacher's discretion will determine whether or not such an activity can be carried out by the group--here group personality and maturity become factors.

2. Excellent ventilation is a major requirement. Weather may be a factor here--e.g., the activity would not be conducted on a hot, muggy day, or when blowing snows and open windows would pose a problem.

3. In some instances, the teacher may decide to declare a particular material undesirable for burning.

VII. Bibliography

Moore, H. Carlton, P. E., "Honolulu's Second-Generation Incinerators: Solid Waste Plans Consider Pollution Factors and the Changes Occurring in Refuse Content," American City Magazine, May 1972. Describes the new Honolulu incinerator - the practical considerations in its design, and its operation. Grades eleven upward.

Proceeding of 1970 National Incinerator Conference, Papers presented at 1970 National Incinerator Conference in Cincinnati, May 17-20, 1970, The American Society of Mechanical Engineers, New York, N.Y. 10017, May 1970. Thirty-one papers cover almost any aspect of incineration. Although parts would be too technical for the average high school student, many excellent diagrams and flow charts appear.

Ostrowski, E.T., "Recycling of Tin-Free Steel Cans, Tin Cans, And Scrap from Municipal Incinerator Residue," Iron and Steel Engineer July 1971. Although the charts and diagrams make the article look more difficult than it really is, it is comprehensible by high school students.

Weaver. Elbert C., Scientific Experiments in Environmental Pollution, Holt, Rinehart, and Winston, Inc., 1968. Eighteen activities--all science laboratory oriented--for high school students in air, water, and solid waste pollution. The last activity deals with some problems of incineration.

"Stop-Odor Incinerator Has Built-In Safeguards," Chemical Engineering, October 1971.

"Take the Pressure Off the Incinerator: Stationary Packers and Transfer Trailers Absorb Peak Loads of Refuse," American City Magazine, May 1972. Case history of Dearborn Heights success. Describes daily maintenance considerations in incinerator operation. Grade seven upward.

U. Packaging Patterns

I. Introduction

This activity is a comparative evaluation of packaging. The students get a feeling of how present packaging trends have evolved. The activity can also be approached from the present tense--how foods and their packaging compare today throughout the world. Questions will then be modified to accommodate the time and place. Although this activity is research rather than field oriented, it will provide background knowledge for further investigations. This activity is most practical for grade five upward. Older students might present an abstraction to a younger group to give them a perspective of the situation.

II. Questions

1. To lead into the activity, ask
   a. What foods do you consume in a week?
   b. How long have these foods been available?
   c. How many have appeared only recently because of technological advancements?
   d. How widely available have these foods been throughout the world?
2. To initiate the activity, ask
   a. Suppose you were living__________in the year__________. Of what would your food menu for one week consist?
   b. Where would you obtain these foods?
   c. How would they be packaged?
   d. How would packaging affect how sanitary these foods are?
   e. How would they be stored?
3. To continue the activity, ask
   a. How did transportation play a role in determining packaging?
   b. What types of regulations were there regarding food packaging?

   c. When were they introduced?

4. To expand the activity, ask

   a. What types of developments led to these laws (technical, scientific, attitudinal, etc.)?

   b. How did the industry occupy a role at this time in terms of influencing/controlling packaging?

   c. What can we do with what we have learned?

   d. What connotations did the word "waste" carry?

5. To evaluate the activity, ask

   a. What was the quality of the research conducted?

   b. How well were the findings presented?

   c. Did the students demonstrate that the activity benefitted them in some way?

III. Equipment

Students may require equipment for presenting their projects. Other than that, no specific equipment is needed.

IV. Procedure

1. Having gone through the questions, help students select a specific time and place to research. Also, use discretion to determine whether the activity is best conducted individually or in groups.
2. Sources may range from interviews to books, magazines, and newspapers of the times, if available.
3. Research may be presented in ways ranging from a simple oral presentation to preparation of a sample meal, including packaging, to some type of skit. Encourage creativity!

V. Past Studies

1. Students in a project such as this may take a genuine interest in knowing the way that people do things differently from the way they do. Others may take a "so what" attitude.
2. Looking through books on current packaging trends--international as well as our evolution--really "turns some people on." Several references of this type are in the bibliography.
3. Occasionally, one runs into students who do not have an apprecia-tion of history, whether they are excited about the present or not. In an activity such as this, they are apt to see history's relevance to a real, present problem.

VI. Limitations

1. Accessibility of adequate research materials may be prohibitive. Check local universities! Assisting in this activity may be history teachers. Involve as many people as possible to make it truly interdisciplinary.
2. Time may be a limitation. Perhaps the activity will not be good to conduct during class periods, except the introduction and the presentation.

VII. Bibliography

Cronwel, William and Weidemann, Kurt, Packaging, An International Survey, Frederick A. Praeger, New York, N. Y. 10003, 1968. Quadralingually presented (English, German, French and Spanish), the entire book consists of glossy black and white pictures of packaging around the world--and packaging is a very broad term. There is much shown, however, about foodstuff packaging. Any

student can look through the pictures. The introduction is only two pages long.

Guss, Leonard M., Packaging Is Marketing, American Management Association, 1967. Contains excellent bibliography of books, articles, and reports: American Management Association Publication, public documents, unpublished material, and miscellaneous. It starts out, out, "We live in a world of packaging," and covers (I) the Nature and Scope of Packaging, (II) Packaging and the Function of Protection, (III) Packaging and the Functions of Physical Supply, (IV) Packaging and the Functions of Exchange, (V) Packaging and the Law, (VI) The Social Values of Packaging, (VII) The Determinants of Packaging, (VIII) Packaging and the Ultimate Consumer, and (IX) Company Organization for Packaging. Grades seven and up - excellent reference.

Little, Arthur D., The Role of Packaging in the U.S. Economy, Report to the American Foundation of Management, Research, Inc., American Management Association, 1966. Considers packaging from the business point of view. Especially good are flow charts of metal, glass and plastic packaging materials. Not too technical for grades seven and up - very readable.

V. Magic Holes

I. Introduction

This transitional activity begins with increasing the students' awareness of waste disposal routes and capitalizes on their interest to allow exploration into the treatment of waste products. The activity may be carried out by students from grade four upward. A 40-60 minute discussion period should be allowed before the students group for the projects, which grow out of the discussion. The project time is variable, depending on the degree of community involvement.

II. Questions

1. To lead to the activity, ask
   a. Where do things go when you are finished with them?
   b. Who provides the services for this?
   c. What are some magic holes which you use?
   d What magic holes did our forefathers have?
2. To initiate the activity, ask
   a. What magic holes are there in your classroom?
   b. Is the wastebasket a magic hole?
   c. What are some of the magic holes in the school? In your home?
3. To continue the activity, ask
   a. How can we show the flow of wastes as they move from the magic holes to their ultimate end?
   b. What happens to the waste as it moves along?
   c. How does it move along?
   d. Where can it get lost?
4. To expand the activity, ask
   a. How would you diagram the flow of wastes?
   b. Is your community tied together by waste disposal services? Is it anything like a road map?

c. How could you tag solid waste for periodic recovery if you were to examine its flow through the system?

d. How can we measure how much and how many waste products are processed?

5. To evaluate the activity, ask

a. Did the students think of new ways to process waste products?

b. What level of involvement was noted?

c. Did they want to go to processing centers?

d. Did they work with their parents?

III. Equipment

1. Construction materials:

a. Boxes

b. Straws

c. Cans

d. Paste

e. Tape

f. Paper

g. Paint

h. Thumb tacks

2. Community map

IV. Procedures

1. In class, pursue the sequence of questions and get the students to focus on how to tell others what they have learned.

2. Let students group to carry out projects which illustrate their findings. Some suggested projects include making a model of a sewage treatment plant and diagramming waste flow; mapping trash

removal or sewage routes; comparing waste management systems.

3. Let the students tell others of their findings. Encourage peer education in and out of the classroom.

V. Past Studies

1. Excitement runs high as more and more discoveries are made. In Norristown, Pennsylvania, elementary school students were investigating how the classroom sink worked. A few students noticed a water tower on a nearby hill and there was a rush to the windows. Through discussion, the students related the tower to the workings of the sink and soon understood the gravity fed water supply and the sewage system. They also explored the storm drainage system. One idea that emerged was a message system to find out "how far" the storm run off went.

2. A middle school student, attending a Tilton School summer workshop in Tilton, New Hampshire, constructed a non-working model of a secondary treatment plant. His explanation of how it worked was a fine demonstration of the knowledge he acquired in constructing the model.

VI. Limitations

Occasionally it is difficult to obtain information from local government service employees. If you explain fully what you are doing with a positive orientation, in all probability the workers will be helpful. One of the outgrowths of this activity will be a desire to go to see what is going on. Arrangements may be difficult to make.

VII. Bibliography

Clean Water for Mid-America, Public Information Office, Great Lakes

Region, FWPCA, Department of Interior, Chicago, Illinois 60605, April 1970. An introductory pamphlet on water quality, concerned with the roles of the states, cities and industries in the middle states region. Good for upper elementary through senior high school.

Municipal Refuse Disposal, United States Public Administration Service, Chicago, Illinois, 1970. A very complete, excellent text, considering any facets of the solid waste disposal problem which students need to know. Although somewhat technical, high school students could make good use of it.

Ruckelshaus, William D., and Dominick, David D., A Primer on Waste Water Treatment, See Ch. 2, L, VII

Small, William E., Third Pollution, The National Problem of Solid Waste Disposal, Praeger, New York, N. Y., 1971. A general reference for most students from grade 5 upward.

W. Managing Plastic Wastes

I. Introduction

This transitional activity deals with the decomposition rates of plastics and introduces the recycling potential of plastics. Once students realize the difficulty involved in degrading plastics naturally they are encouraged to examine chemical degradability, incineration, and the recycling of plastics as potential means of management. The activity may be completed by students of any age and requires no special equipment.

II. Questions

1. To lead into the activity, ask
   a. How many foods are packaged in plastic containers?
   b. How else is plastic used in packaging?

c. What happens to the palstics you discard?

2. To initiate the activity, ask

   a. Is the burning of plastic ecologically sound?

   b. What happens to plastic when you bury it?

3. To continue the activity, ask

   a. What necessary factors need be present for natural degradation of substances such as leaves or food products?

   b. How can we increase the rate of decomposition of plastics?

   c. What is the basic problem in the slow degradability of plastics?

4. To expand the activity, ask

   a. What research is being conducted to reduce the problem of plastic wastes?

   b. How can you recycle plastics in your own home?

   c. How can plastics be recycled on a national level?

5. To evaluate the activity, ask

   a. Were the students able to relate the problem of plastics to their own environment?

   b. Did they engage in meaningful discussions?

III. Equipment

The equipment used is variable. The main intent is to bury various types of plastic material and observe periodically for degradability.

IV. Procedure

1. Select a wide range of plastic materials.
2. Bury the materials in designated plots so that they can be identified and unearthed for examination.

3. Some classes have used large glass bottles such as pickle bottles and buried their plastics indoors.
   a. If the indoor approach is used, the soil in the containers must be kept moist to approximate that which would be outside.
   b. Some classes have used plastic containers for the activity. The logical flaw here is often not apparent at first.
4. The plastics should be examined each week as long as the activity continues.
5. Note any changes in the materials buried.

V. Past Studies

The degradability of plastics was examined in a class conducted at Temple University for a graduate course in environmental science. The plastics were weighed before and after they had been buried.

VI. Limitations

The main limitation is losing the items buried because of inadequate marking of outdoor sites.

VII. Bibliography

"Don't Incinerate Plastic Bottles; Make Concrete Bridges With Them," American City Magazine, May 1972. Connolly, Hugh H., Plastic Wastes in the Coming Decade, EPA Solid Waste Management Office, 1970. A statement by the Solid Waste Management Office determining the need to examine packaging practices and recycling possibilities for plastics.

"Plastics in Refuse No Incinerator Hazard," American City Magazine, January 1972. Tells that the study of the effect of plastics, especially

polyethylene, in incinerators, points out that plastics are not detrimental to incinerator operation. It suggests that copies of the report can be obtained from its sponsors: The Society of the Plastics Industry, 250 Park Avenue, New York, N.Y. 10017.

X. The Ultimate in Waste Disposal

I. Introduction

This activity is a tool which can be used to evaluate the students' work on solid waste. By using it at the end of the unit, they will incorporate knowledge and skills they have acquired and apply them to their problem. This involves the use of the questioning approach by the students. In designing the ultimate, they must present a series of questions to which they need answers to solve the problem. In this way, teachers can evaluate how the questioning process influences the students' thinking. Hopefully, in pursuit of the solution to the problem, the students will have an opportunity to interact with their community.

II. Questions

1. To lead into, initiate, continue, and expand the activity, state the following:
   a. You are a consulting engineer called upon by our city (town, etc., or whatever) to design the ultimate in waste disposal to the year 2020. You must consider the present problems in pursuing the solution.
2. To evaluate the activity, ask
   a. How much knowledge and understanding of solid waste problems

did the students demonstrate?

b. How did their questions work?

c. What was the quality of the recommendations?

d. Did the activity reveal a lot about the effect of the block on the students?

III. Equipment

1. Unless students will attempt to design a scientific ultimate, no equipment is needed.

IV. Procedure

1. Present the problem to the students.
2. Let them know that, in seeking the solution, they must plot out a series of questions which will be their investigation guide.
3. They may split into factions (e.g., industrial, commercial, domestic) or each group may concentrate on the design of the ultimate and then compare results.
4. This is an excellent place for simulation exercises.
5. Whether or not anything written is required is decided by the teacher.

V. Present Studies

1. The questioning approach is a logical means of dealing with the investigation of a problem. A high school senior in Buffalo is presently conducting a feasibility study for paper recycling in her town. The outline prepared with the questioning approach was formulated easier than with mere notations, because questioning leads to other questions (consequently a more thorough view).

VI. Bibliography

Goldstein, Jerome, Garbage As You Like It, A Plan to Stop Pollution,

Rodale Books, Inc., Emmaus, Pennsylvania, 1969. A wonderful approach to the uses of garbage. It contains 21 chapters of ideas, facts, formulas and possibilities. An appendix, "Technical and Mechanical Aspects of Composting," is simply presented. Suitable for grade seven upward.

Y. A Realistic Environmental Problem Simulation (REPS)

REPS allows a group of students to simulate realistically a probable sequence of events related to an environmental problem a year or more into the future. The simulation is based on a real problem in the students' environment, and the students play the roles of all the important people involved in the problem. During the simulation, time passes relatively quickly, thus allowing the students to speed up the normally slow ecological, economic, political, and social processes.

The REPS is divided into sequential sections. Each section involves a process and product. The first section describes the selection of the REPS and how the background is developed for that REPS. The second section contains the rules for the simulation and descriptive material on the control and participation roles. A broad variety of circumstances may be dealt with effectively. REPS have been completed in as little time as one day; on the other hand, they may take as long as a month and a half.

I. Selection

The REPS depends on the selection of a proper subject. Many factors enter into the selection process, but the most important single factor is the interest of the participants. Therefore, the subject or problem to be considered for the REPS must be something that interests the participants. At this point, we have not had any REPS that have failed because of a poor subject or problem selection. The problem usually enlarges itself to fit the number and the maturity of the participants. Selection of a problem which could be simulated by less than 15 students would be difficult if the problem is to be covered satisfactorily. To choose a problem that is too small would be difficult. Because the selection process requires compromise on the part of all individuals involved, you should consider the selection over a period of time. To introduce the subject with a few moments notice would be unwise if the participants did not have a basic awareness of their environment. That is to say, you can't spring a problem on a relatively unsophisticated audience.

There appears to be a risk for the teachers when the problem is selected. Whenever discussions not based on lesson plans or text books develop in classrooms, the teacher may not have very much information on the subject at hand. A teacher might feel this is risky business. However, it represents one of the best opportunities for students to see someone "thinking on his feet," or better still, it represents an opportunity for teachers to learn from students. This occurs more effectively when teachers are listening.

The selection process continues as the symptoms are translated into a set of causes which begin to define an environmental problem. At this point, the discussion should turn to causes of the problems. An effective way to handle this is to simply list those people or functions which are causing the problem. If a person or organization is allowing a problem to develop or to continue to exist, then the group should look to see who allows that person to continue doing the wrong thing. As the discussion continues, more and more names of people, jobs that people perform, and organizations that control the things that people can and cannot do will appear.

When more names or descriptions are not forthcoming, let the discussion turn to classifying those items which appear on the list. Usually four or five major classifications emerge. These major classifications represent the teams that will participate in the REPS.

II. Scenario

The scenario is a background statement which acts as a source document for the research phase of the REPS. The scenario is divided into parts which correspond to the four or five teams identified in the problem selection process. The scenario is completed as a two step process: (1) gathering of all pertinent data and (2) compiling and publishing.

The data are gathered by temporarily assigning the participants to study groups. For a class of 35, five teams of from 5 to 8 students could be formed. Let the participants work in study groups for several hours or class periods to define the scope of the simulation teams. Typical teams representing local government, state government, federal government, agencies, citizens' organizations, business, industry, etc., will be formed. The group should determine the names and positions of many important people. The relationships of these people to the problem should be blocked out also.

Once the study groups have roughed out the initial list of names and relationships, participants should rotate to other teams. At this point, interviews, phone calls, and letters may be written to secure basic information about the important people. More names and agencies will be added to the list. After some progress has been made, the relationships should be refined thorough group discussion. The groups should rotate through all teams so the participants have some experience in each team area. Don't worry about the complications of receiving mail and delayed interviews. The participants can pass the mail along and appointments may be kept by future group members. All that is needed is a log or bulletin board which notes future commitments for action relative to each simulation team.

The scenario may be written when the last study group rotation occurs. Each study group assembles the materials (those which have been written from interviews, letters, pamphlets, and other documents) into a background package.

Thirty students at Germantown Friends School carried out the above procedure in 1 1/2 weeks (full-time effort) and assembled a five-section, 320-page document. Three days were needed to print, collate, and bind. Usually the document is under 100 pages and is dittoed by hand. There is little need to number pages consecutively, but it is handy to use section oriented paging such as II-3 or C-15.

III. Research

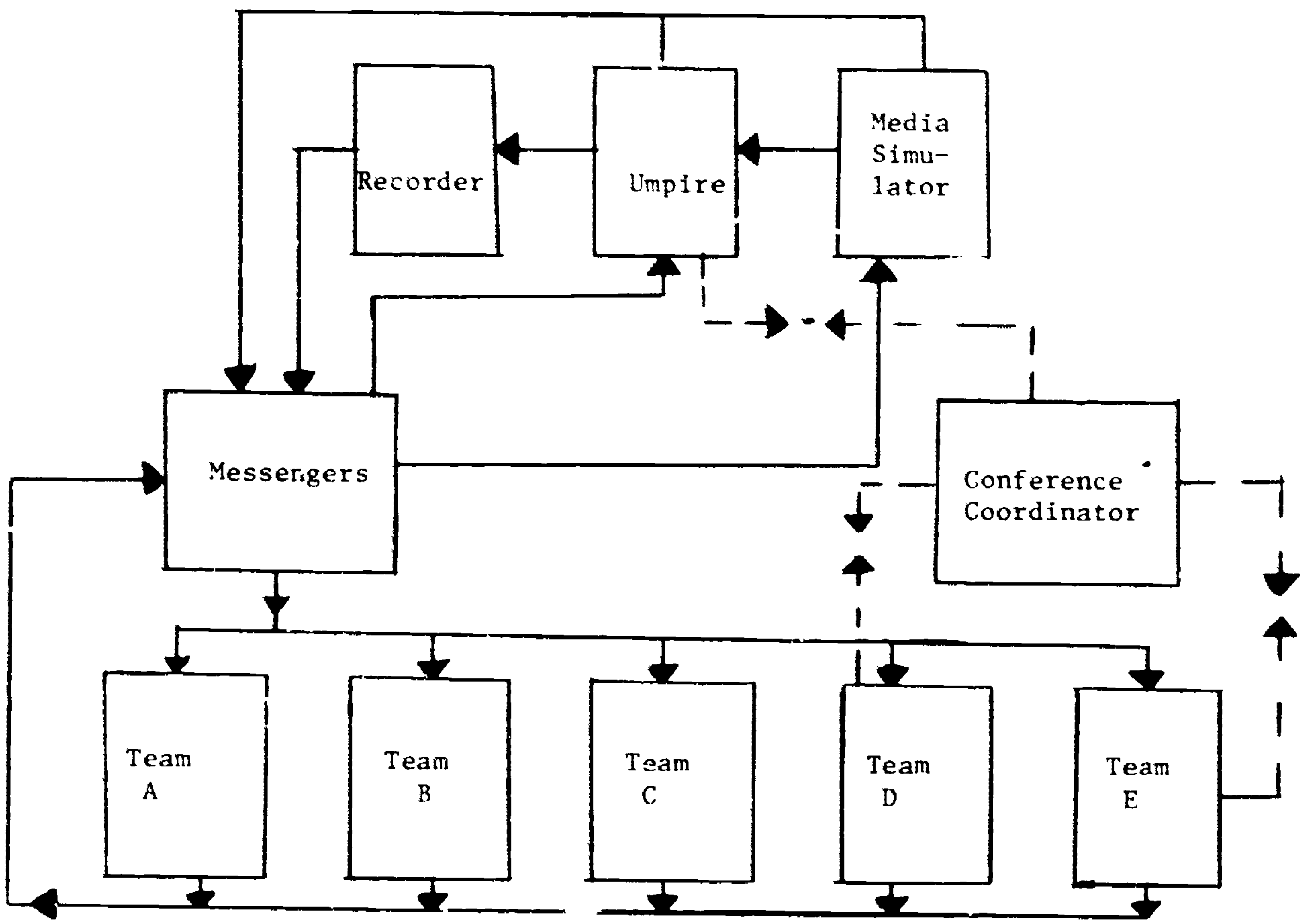
The participants choose individual (or agency) roles and group into the simulation teams. Then each researches his role, using the scenario as a starting point. The scenario is most helpful for him when he wishes to learn of his relationship to others. The research phase is an in-depth study and requires a detective-like attitude.

IV. Simulation

The basic organization is shown in the figure below. Five functions are performed by a control group in association with the simulation teams.

The control group consists of an umpire, a recorder, a conference coordinator, a media simulator, and a team of messengers.

All communication during the simulation takes place via written messages. Messages originate from the teams and are carried by messenger to the umpire.



Simulation Teams

The umpire validates the message by writing "valid" in the lower left corner of the message blank. The judgement of whether or not the message is valid is determined by considering its rationality, i.e., is the message one that would be submitted by a person playing the particular role or is it something not in the realm of possibility? The umpire also makes judgements affecting the operation of the simulation. If, during a particular simulation, a reorganization of some sort is needed, the umpire can stop the simulation to effect the necessary repairs.

The recorder keeps a running log of the messages and the order in which the messages are dispersed. When the recorder gets the message from the umpire who has validated it, he will put a number on it indicating the order in which the message was received by him. He will also, for further reference, put the time at which he received the message to the nearest minute. Then he will deliver the message to a messenger, who will distribute it to the various teams.

Under certain circumstances, a team may wish to communicate with another team secretly. Under these circumstances, the team originating the message should write "secret" next to the word subject on the message form, so that the recorder will know it's a secret message. When the recorder receives the message, he will distribute it immediately through the messengers to the indicated recipient. The recorder will hold the remaining copies of the message for a period of fifteen minutes and then have the messengers distribute the remaining copies to the remaining teams.

The media controller simulates the manner in which the media would cover the particular events transpiring. The principal function would be to combine the effects of several individual messages on a situation and comment on them in an editorial way. If the simulation fails to become dynamic and active, the media can stimulate it by introducing messages that would throw new light on situations which should be developing.

The conference coordinator accepts requests from various teams when they wish to meet with other teams. A conference may be held between two teams. The time limit on a conference is five minutes. The coordinator will send a message indicating when and where it will be held. The time he indicates as the beginning of the conference determines the end of the conference, i.e., five minutes later. The participants must arrive on time (with a spokesman) in order that the conference will move swiftly under the direction of the conference coordinator. The short duration of the conference precludes many topics being discussed; therefore, the conference should be for a particular purpose.

The messengers continually circulate and act as extensions of the umpire in many cases. They carry messages back and forth and try to clarify the game situation for the various teams. The particular emphasis is on the rules and how to interpret the rules.

The rules for REPS are as follows:

1. During the simulation, the members of the teams must stay in the rooms designated for the teams. No communication among teams may take place directly, except in cases of conferences, which are prearranged.
2. During the simulation, the period of time representing one month transpires in ten minutes. That is to say, during every hour of the simulation, one half year has transpired.
3. Conferences may be called by sending a message to the conference coordinator. The conference coordinator will reply to the message with another message, indicating the time and the place of the conference. The conference may last no longer than five minutes; therefore, do not try to take on too many things in a five-minute period. Conferences are limited to discussions between two teams.
4. If teams have press releases which they wish the media simulator to handle, they should fill out the message form with the material to be covered by the press and direct it to the media simulator.

5. All messages will be sent to all teams at the same time, unless the messages are marked "secret." If the message is marked "secret," in the box marked "subject" by spelling out in capital letters "secret," then the recorder will only send that message to the team designated; however, after a fifteen minute delay, that message will be sent to the remaining participating teams. When teams receive copies of the messages that they have sent, they will know that everyone is in possession of the secret information.

V. Recapitulation and Outgrowths

After the simulation is over, a thorough discussion of what happened will take place. This happens informally, because the participants cannot prevent it from happening. Almost without exception, the students will wish to repeat the simulation from a certain point in the simulation. They will also wish to do more research before a repeat. If possible, plan for and allow this to happen. Other things also happen. Usually students discuss the rationality of the simulation, and they also wish to take actions they feel are necessary to deal with the problem they simulated. The teacher should consider these action-oriented outgrowths as powerful potential learning experiences.

VI. Bibliography

Chesler, Mark, Role-Playing Methods in the Classroom, Science Research Associates, Inc., Chicago, Illinois, 1966. An excellent introduction to role-playing and its place in the classroom. Presents rationale as well as application.

Egan, James M., Simulex II, Procedures for Inter-Nation Simulation. Dept. of Pol. Science, Univ. of N.H., New England International Studies Ass'n. New Hampshire Council on World Affairs. The basic workbook from which the authors were trained by Univ. of N. H. staff.

Kersh, B. Y., Classroom Simulations: A New Dimension in Teacher Education, NDEA Title VII, Teaching Research Division, Project No. 886, Washington, D. C., 1963. A general introduction to simulation and its applications in the classroom.

Klietsch, Dr. R., An Introduction to Learning Games and Instructional Simulations: A Curriculum Guideline, Instructional Simulations and Co., 1969. A rather technical introduction to games and simulations. Orientation is social-psychological.

Z. Debating

Debates are often used to help students focus on the issues in a problem situation. For this reason, they have been extensively used in social studies classes. Until recently, debates have been relatively uncommon in science courses. With the growing emphasis on multidisciplinary education, social-scientific issues such as those of solid waste management are becoming far more common in science courses. As such, debating of these issues is seen as a viable approach toward problem-solving.

In setting up a debate, certain guidelines need to be followed. First, the students should decide what they want to debate. If they have difficulty in selecting a topic area, then a list of suggested topics might be provided. Do not assign an affirmative or negative position until the topic has been researched.

In order to achieve total involvement, more than one topic should be selected. Each student should be provided several days to research his topic. Make sure the students are familiar with the resources available to them, most notably the Readers' Guide to Periodic Literature.

Provide a class period to become familiar with the various resources.

On the day of the debate, write the proposition clearly on the chalk board and indicate clearly which students are supporting the proposition and which are not. Each group should have an opening statement to support its stand. No more than four students should be in a group. Large numbers of students tend to address themselves to one another rather than the whole class.

Students are to follow these guidelines:

1. Show respect for your opponents.
2. Show respect for your opponents' views.
3. Avoid argumentation without logical defense.
4. Do not interrupt. You must wait your turn.
5. You must take notes on your opponents' statements so you have a basis for defense or logical argument.
6. Cross-examination techniques may be used. You may question your opponents' stand rather than support your own if this is necessary.
7. Ten to fifteen minutes should be allowed for class questions at the end of the debate. Do not entertain any question from the class during the debate.

Debates provide students with an opportunity for self-expression and rational thought in a courteous atmosphere. In researching a topic, the student gains competence in an area and thus feels more confident in being able to substantiate his stand. Debating provides for a gaming atmosphere, which is more acceptable and interesting to students than a project report or lecture. In a gaming atmosphere, more total involvement by class members occurs. When related topics are researched by the entire class, overlaps are seen in class discussions after each debate. Each person has a role to play and is reinforced in his position through exposure to the various views presented. Suggested solid waste issues include the following:

Resolved: Every family in this community should be required to recycle its newspapers, bottles and cans.

Resolved: Disposable bottles should be banned.

Resolved: Automobile manufacturers should be required to make automobiles that are guaranteed to last a minimum of five years.

Resolved: Open dumps are a health hazard and thus should be banned.

Resolved: Styrofoam use should be banned because of its inability to degrade.

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Samalonis, Bernice L., Methods and Materials for Today's High Schools, 1970, Van Nostrand Rumbold Company, New York. Presents a collection of teaching methods, their uses and applications.

APPENDICES

Appendix A Draft

Bibliography

During this age of the "information explosion" students as well as teachers must learn to use the resource materials available to them. The following books and pamphlets were found to be particularly useful in developing this guidebook. The list is in no way complete. Teachers are encouraged to write to many of the industries, agencies and associations listed in part L of the Bibliography for additional materials.

Bibliography

A Core References

These references are recommended as basic to a unit in solid waste.

Schatz, Albert and Vivian, Teaching Science with Garbage (An Interdisciplinary Approach to Environmental Education from the points of view of Science, Math, and Social Sciences), Rodale Press, Inc., Emmaus, Pa. A delightful idea-book that lists 30 odd activities and lists facts and questions that deal with garbage and teaching. A good interdisciplinary bundle.

A Pledge and A Promise, Aneuser-Busch,Inc.,St. Louis, Missouri, 1970. Defines solid waste. Describes the problem, discusses the complexity and some possibilities for alleviating the problem. An excellent introductory pamphlet for students from grade 6 upward.

Litter Facts, Public Affairs Department, Glass Container Manufacturers Institute, Inc., New York, New York. Litter Facts is a short, well written pamphlet on solid waste disposal in general. The factual information is well presented and worthwhile tips are provided for those interested in starting recycling efforts.

Cleaning our Environment: The Chemical Basis for Action, A Report by the Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs, American Chemical Society, Washington,D.C., 1969. Deals with 4 major concerns: air, water, solid wastes and pesticides. For each there is an introduction to the problem, background information, a discussion of the chemical factors, control factors, the environmental effects and recommendations for change. The book is technical and best suited for secondary or college students.

Citizen Handbook on Recycling (A How-to-do-it Guide for Individuals and Groups), Tuberculosis, Health, Respiratory Disease and Clean Air Organizations, Unpublished, 1970-1971. Excellent guidelines for recycling projects and several past community experiences. Also, there is a list of "Hints on Sound Ecological Living" and an invaluable appendix of recycling agencies in the Philadelphia-Camden and surrounding areas.

Cailliet, Greg, et.al., The Everyman's Guide to Ecological Living. MacMillan, New York, New York, 1971. Probably one of the best references on individual and limited group environmental action activities stressing the acquisition of "ecological" habits. It contains supplementary facts. Selling for $ .95, it is highly recommended. It should present no problem for the average reader and is not technical in presentation.

Guidelines for Local Governments on Solid Waste Management, U.S.

Environmental Protection Agency, Superintendent of Documents, United States Government Printing Office, Washigton, D.C., 1971. Presents 10 guides on solid waste management to assist local elected and appointed policy making officials. A valuable resource for upper elementary grades and beyond.

Kiefer, Irene, The Role of Packaging in Solid Waste Management, U.S. Environmental Protection Agency, Superintendent of Documents, United States Government Printing Office. Washington, D.C., 1971. An excellent basic introduction to the problem of packaging and solid waste suited for upper elementary grades and beyond.

Sorg, Thomas J. and Hickman, H. Lanier, Jr., Sanitary Landfill Facts, U. S. Department of Health, Education and Welfare, Superintendent of Documents, United States Government Printing Office, Washington, D.C., 1970. A basic introduction to sanitary landfills. Suitable for all readers. An excellent non-technical resource.

Sean, Edmund, "The Mess We're In," Ranger Rick Reprint, National Wildlife Federation, Washington, D.C., July, 1970. An elementary booklet with some great color photos. Good for little people. It has some "How You can Help" suggestions and a fantastic litter box.

Boettcher, R. A. , Air Classification of Solid Wastes, U.S. Environmental Protection Agency,Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1972. Results of a study to determine the technical feasiability of using air classification to process or treat dry solid wastes. Provides background for investigative studies; best suited for senior high students.

Darnay, Arsen and Franklin, William E., The Role of Packaging in Solid Waste Management 1966-1976, U.S. Department of Health, Education and Welfare, Bureau of Solid Waste Management, Rockville, Maryland, 1969. An excellent background on the problems of packaging and solid waste. Suggested for junior and senior high students.

Mission 5000 (A Citizens' Solid Waste Management Project), U.S. Environmental Protection Agency, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1972. A colorful report on EPA's solid waste management project. A three point project, to reduce pollution of land, air, and water, to make your community a better place in which to live and take the first step toward modern solid waste management. Cost: $.50.

Engdahl, Richard, Solid Waste Processing (A State of the Art Report on Unit Operations and Processes), U. S. Department of Health, Education and Welfare, Superintendent of Documents, U.S. Government Printing Office, Washington, D. C., 1969. An excellent resource on solid waste management. Provides a non-technical background; suitable for junior and senior high students.

B. General Reference on Solid Waste Management

Lefke, Louis, W., Progress in Solid Waste Management and Needed Development, U. S. Department of Health, Education and Welfare, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. ,1970. A brief but very useful pamphlet that discusses a variety of concerns related to solid waste disposal. Suited for junior and senior high students.

Solid Waste Management (Abstracts from the Literature), Franklin Institute Research Laboratories, U. S. Environmental Protection Agency, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 1964-1968. Abstracts from a wide range of international and domestic sources. Suitable for senior high students.

Solid Waste Management in Residential Complexes, Greenleaf/Telesca Planners, Engineers and Architects, U. S. Environmental Protection Agency, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 1971. A report aimed at the developer-designed in identifying the internal solid waste problems in new building projects; to provide early guidelines for system requirements in the conceptual planning stages of such projects, etc. Suited for senior high school students.

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Golueke, C.G., and McCaughey, P.H., Comprehensive Studies of Solid Waste Management, U.S.Department of Health, Education and Welfare, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 1970. An examination of solid waste using a systems approach. Provides much background information that could be of assistance in junior and senior high school classes.

Toftner, Richard and Clark, Robert M., Intergovernmental Approaches to Solid Waste Management, U. S. Environmental Protection Agency, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 1971. Outline of an integrated management system that includes planning, operations and control on a rational regional basis. A basic text for junior and senior high students.

Wiley, John S. and Gartrell, F. E., and Smith, H. Gray, "Concept and Design of the Joint U. S. Public Health Service (TVA Composting Project, Johnson City, Tennessee)", Compost Science reprint, U. S. Department of Health, Education and Welfare, Environmental Control Administration, Washington, D. C., 1968. Provides the background and development of a compost unit. A non-technical report suitable for upper elementary through senior high students.

Hart, Samuel A., Solid Wastes Management in Germany, U. S. Department of Health, Education and Welfare, public Health Service, NCUTH, Cincinnati, Ohio, 1968. A report of an investigation to evaluate the possibilities of applying German technology to U. S. needs. Readable by students from grade 7 upward.

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Kenilworth Dump. Suited for Junior and Senior high students.

Black, Muhich, Klee, Hickman and Vaughan, National Solid Wastes Survey--An Interim Report, U.S. Department of Health, Education and Welfare, Public Health Service, Consumer Protection and Environmental Health Service, Environmental Control Administration, October 24, 1968. The Bureau of Solid Waste Management considers the survey data summarized in this report to be the best indicator of solid waste management practices currently (1968) available. So do we. It is quite readable with many bar graphs and pie wedges.

Kruth, M.A., Booth, D.H. and Yates, D.L., Creating and Countrywide Solid Waste Management System, U.S. Environmental Protection Agency, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 1972. Many illustrations are provided which help tell the story of solid waste and solid waste management. Suitable at all age levels.

Comprehensive Studies of Solid Waste Management--Third Annual Report, U.S. Environmental Protection Agency, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1971. Examines solid waste problem from a systems approach. Demonstrates technology, economics, population and other system elements. Readable by senior high students and teachers. Excellent resource. Cost: $1.75.

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C Composting

Carnes, Richard A. and Lossin, Richard D., "An Investigation of the pH Characteristics of Compost," Compost Science reprint, Sept.-Oct.,1970. A very technical and limited report on pH and moisture content of compost. Many graphs and basic procedures for determination of pH.

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1515 Massachusetts Avenue, N.W.
Washington, D. C. 20005

American Association of University Women
2410 Virginia Avenue, N.W.
Washington, D. C. 20006

American Chemical Society
1155 16th Street, N.W.
Washington, D. C.

American Forestry Association
919 17th Street, N.W.
Washington, D. C. 20006

American Geological Institute
2201 M Street, N.W.
Washington, D. C. 20037

American Industrial Arts Association
1201 16th Street, N.W.
Washington, D. C. 20036

American Institute of Architects
1735 Massachusetts Avenue, N.W.
Washington, D. C. 20036

American Society for Engineering Education
One Dupont Circle, N.W.
Washington, D. C. 20036

Association of Classroom Teachers
National Education Association
1201 16th Street, N.W.
Washington, D. C. 20036

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Washington, D. C. 20036

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Educational Relations Section
Soil Conservation Service
Department of Agriculture
Washington, D. C. 20250

Educational Resources Information Center (ERIC)
Clearinghouse on Teacher Education
One Dupont Circle, N.W.
Suite 616
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Educational Resources Information Center (ERIC)
Clearinghouse on Science, Mathematics, & Environmental Education
1460 West Land Avenue
Columbus, Ohio 43221

Educational Services Department
National Audubon Society
1130 Fifth Avenue
New York, New York 10028

Environmental Protection Agency
Clean Water
Attention Publications Office
Washington, D. C. 20460

Environmental Resources, Inc.
2000 P Street, N.W.
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Izaak Walton League of America
1326 Waukegan Road
Glenview, Illinois 60025

Minnesota Environmental Education Steering Committee
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National Association of Conservation Districts
1025 Vermont Avenue, N.W.
Washington, D. C. 20005

Publications Unit
National Air Pollution Control Administration
5600 Fishers Lane
Rockville, Maryland 20852

Sierra Club
220 Bush Street
San Francisco, California 94104

Wilderness Society
729 15th Street, N.W.
Washington, D. C. 20005

Glossary

This glossary is a compilation of terms dealing with solid waste and solid waste management. The principle contributor was:

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ABANDONED MOTOR VEHICLE - A motor vehicle that applicable State laws deem to have been abandoned.

ABANDONED VEHICLES - Passenger automobiles, trucks and trailers that are no longer useful as such which have been abandoned on streets, highways and other public places.

ABRASION - Wearing away of surface material, such as refractories in an incinerator or parts of solid waste handling equipment, by the scouring action of moving solids, liquids, or gases.

ACTIVATED SLUDGE - Process removes organic matter from sewage by saturating it with air and adding biologically active sludge.

ADSORPTION - An advanced way of treating wastes in which activated carbon removes organic matter from waste water.

AERATION TANK - Serves as a chamber for injecting air into water.

AGGREGATE - Crushed rock or gravel screened to sizes for use in road surfaces, concrete, or bituminous mixes.

ALGAE - Plants which grow in sunlit waters. They are a food for fish and small aquatic animals and, like all plants, put oxygen in the water.

ASH - The incombustible material that remains after a fuel or solid waste has been burned.

ASH-FREE BASIS - The method whereby the weight of ash in a fuel sample is subtracted from its total weight and the adjusted weight is used to calculate the percent of certain constituents present. For example, the percent of fixed carbon (F C) on an ash-free basis is computed as follows:

$$\frac{\text{F C (weight)} \times 100}{\text{Fuel Sample (weight)} - \text{Ash (weight)}} = \text{\% ash-free F C}$$

ASH PIT - A pit or hopper located below a furnace where residue is accumulated and from which it is removed.

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ASH SLUICE - A trench or channel in which water transports residue from an ash pit to a disposal or collection point.

BACKFILL - The material used to refill a ditch or other excavation, or the process of doing so.

BACTERIA - Small living organisms which often consume the organic constituents of sewage.

BAGASSE - The fibrous residue that remains after juice is extracted from sugar cane or sugar beets.

BALER - A machine used to compress and bind solid waste or other materials.

BEARING CAPACITY - The maximum load that a material can support before failing.

BECCARI PROCESS - A composting process developed by Dr. Giovanni Beccari in 1922. Anaerobic fermentation is followed by a final stage in which decomposition proceeds under partially aerobic conditions; the process was later modified by Verdier and Bordas.

BIODEGRADABLE - The significant breaking down by microorganisms of the physical and/or chemical structure of a compound.

BLADE

Earth - A heavy broad plate that is connected to the front of a tractor and is used to push and spread soil or other material.

Landfill - A U-blade with an extension on top that increases the volume of solid wastes that can be pushed and spread, and protects the operator from any debris thrown out of the solid waste.

U-Blade - A dozer blade with an extension on each side; they protrude forward at an obtuse angle to the blade and enable it to handle a larger volume of solid waste than a regular blade.

BOD - Or biochemical oxygen demand, is the dissolved oxygen required by organisms for the aerobic decomposition of organic matter present in water. It is used as a measure in determining the efficiency of a sewage treatment plant.

BRIQUETTER - A machine that compresses a material, such as metal turnings or coal dust, into small pellets.

BUCKET - An open container affixed to the movable arms of a wheeled or tracked vehicle to spread solid waste and cover material, and to excavate soil.

BULKY WASTE - Large items of refuse such as appliances, furniture, large auto parts, trees and branches, stumps, and similar large items not easily crushed or reduced in volume using light landfilling equipment.

BULL CLAM - A tracked vehicle that has a hinged, curved bowl on the top of the front of the blade.

BURNER

Conical - A hollow, cone-shaped combustion chamber that has an exhaust vent at its point and a door at its base through which waste materials are charged; air is delivered to the burning solid waste inside the cone. Also called a teepee burner.

Primary - A burner that dries out and ignites materials in the primary combustion chamber.

Refuse - A device for either central or on-site volume reduction of solid waste by burning; it is of simple construction and all the factors of combustion cannot be controlled.

Residential - A device used to burn the solid wastes generated in an individual dwelling.

Secondary - A burner installed in the secondary combustion chamber of an incinerator to maintain a mimimum temperature and to complete the combustion of incompletely burned gases Sometimes referred to as an afterburner.

BURNING RATE - The quantity of solid waste incinerated or the amount of heat released during incineration. The rate is usually expressed in pounds of solid waste per square foot of burning area per hour or in BTU'S per square foot of burning area per hour.

CAPACITY (INCINERATOR)

Design - The number of tons of solid waste that a designer anticipates his incinerator will be able to process in a 24-hour period if specified criteria are met.

Firm - The processing capacity of an incinerator when its largest independent unit is not operating.

Rated - The number of tons of solid waste that can be processed at an incinerator per 24-hour period when specified criteria prevail.

CARBONACEOUS MATTER - Pure carbon or carbon compounds present in the fuel or residue of a combustion process.

CARBON DIOXIDE (CO_2) - A colorless, odorless, non-poisonous gas that forms carbonic acid when dissolved in water; it is produced during the thermal degradation and microbial decomposition of solid wastes.

CARRY-CLOTH - A large piece of canvas or burlap used to transfer solid waste from a residential solid waste storage area to a collection vehicle.

CELL - Compacted solid wastes that are enclosed by natural soil or cover material in a sanitary landfill.

CENTRAL GARBAGE GRINDER - A conveniently located facility that mechanically pulverizes food wastes collected from many sources in a community.

CHARGE - The quantity of solid waste introduced into a furnace at one time.

CHARGING CHUTE - An overhead passage through which waste materials drop into an incinerator.

Glossary

CHARGING CUTOFF GATE - A modified charging gate used in continuous-feed furnaces that do not have high temperatures near the charging hopper. A sliding steel plate at the bottom of the charging hopper closed on a machined seat at the top of the charging chute.

CHARGING GATE - A horizontal, movable cover that closes the opening on a top-charging furnace.

CHARGING HOPPER - An enlarged opening at the top of a charging chute.

CHLORINATOR - A device for adding chlorine gas to sewage to kill infectious germs.

CLINKERS - Hard, sintered, or fused pieces of residue formed in a fire by the agglomeration of ash, metals, glass, and ceramics.

COAGULATION - The act of removing solid waste from the central storage point of a primary source.

Alley - The picking up of solid waste from containers placed adjacent to an alley.

Carryout - Crew collection of solid waste from an on-premises storage area using a carrying container, carry-cloth, or a mechanical method.

Contract - The collection of solid waste carried out in accordance with a written agreement in which the rights and duties of the contractual parties are set forth.

Curb - Collection of solid waste from .tainers placed adjacent to a thoroughfare.

Franchise - Collection made by a private firm that is given exclusive right to collect for a fee paid by customers in a specific territory or from specific types of customers.

Municipal - The collection of solid waste by individuals or companies from residential, commercial, or industrial premises; the arrangements for the service are made directly between the owner or occupier of the premises and the collector.

Setout/Setback - The removal of full and the return of empty containers between the on-premises storage point and the curb by a collection crew.

COLLECTOR (INCINERATOR)

Bag-Type - A filter in which the filtering medium is a fabric cylindrical bag.

Cyclone - A collector in which an inlet gas stream is made to move vortically; its centrifugal forces tend to drive suspended particles to the wall of the cyclone.

Dust - Any device used to remove dust from exhaust gas.

Fly Ash - Equipment used to remove fly ash from combustion gases.

Mechanical - A device in which inertial and gravitational forces separate dry dust from gas.

Multicyclone - A dust collector consisting of a number of cyclone collectors that operate in parallel; the volume and velocity of combustion gas can be regulated by dampers to maintain efficiency over a given load range.

COMBINED SEWER - Carries both sewage and storm water run-off.

COMMERCIAL WASTE - All solid waste originated in commercial establishments.

COMMINUTOR - A device for the catching and shredding of heavy solid matter in the primary stage of waste treatment.

COMPACTOR

Mobile - A vehicle with an enclosed body containing mechanical devices that convey solid waste into the main compartment of the body and compress it.

Sanitary Landfill - A vehicle equipped with a blade and with rubber tires sheathed in steel or hollow steel cores; both types of wheels are equipped with load concentrations to provide compaction and a crushing effect.

Stationary - A machine that reduces the volume of solid waste by forcing it into a container.

COMPOST - Relatively stable decomposed organic material.

COMPOSTING - A process for biological decomposition of organic waste in a nuisance-free manner through controlled environment either aerobic or anaerobic, producing a stable residue which may be used as a soil conditioner. A controlled process of degrading organic matter by microorganisms.

Mechanical - A method in which the compost is continuously and mechanically mixed and aerated.

Ventialted Cell - A composting method in which the compost is mixed and aerated by being dropped through a vertical series of ventilated cells.

Windrow - An open-air method in which compostable material is placed in windrows, piles, or ventialted bins or pits and is occasionally turned or mixed. The process may be anaerobic or aerobic.

CONSTRUCTION AND DEMOLITION WASTES - Waste building materials and rubble resulting from construction, remodeling, repair, and demolition operations on houses, commercial buildings, pavements and other structures.

CONTAINER TRAIN - Small trailers, hitched in series that are pulled by a motor vehicle; they are utilized to collect and transport solid waste.

CONVEYOR

Apron - One or more continuous chains that are supported and moved by a system of sprockets and rollers; they carry overlapping or interlocking plates that move bulk materials on their upper surface.

Drag - A conveyor that uses vertical steel plates fastened between two continuous chains to drag material across a smooth surface.

Flight - A drag conveyor that has rollers interspresed in its pull chains to reduce friction.

Inclined Plate - A separating device that operates by feeding material onto an inclined steel plate belt conveyor so that heavy and resilient materials, such as glass, bounce down the conveyor, and light and inelastic materials are carried upward by the motion of the belt.

Residue - A conveyor, usually a drag- or flight-type, used to remove incinerator residue from a quench trough to a discharge point.

Screw - A rotating helical shaft that moves material, such as incinerator siftings, along a trough or tube.

COOLING SPRAYS - Water sprays directed into flue gases to cool them and, in most cases, to remove some fly ash.

CORES - Are the wood, metal, paper or other sorts of cores on which cord, fabrics, wire and other raw materials are supplied to the fabricated rubber products indus They are usually returnable and reusable, but if damaged in the rubber plant they are disposed of the other solid wastes at that location.

COUNTER STOCK - The stiff board-like material made of textile, and paper fiber and used as protection stiffening of shoe toes, heels, and uppers. Sin is concealed, much plant scrap is used in its production.

CULLET - Clean, color-sorted, crushed glass that is u glassmaking to speed up the melting of silica sa

CURING BAG - A tire-like structure of rubber compound some fabric which is inserted inside an uncured when it is placed in the curing mold to provide and internal heat. The curing bag is expendable several hundred uses.

CURED STOCK - Any rubber compound, with or without fa which has been subjected to heat and is no longe thermoplastic.

CUT - Portion of a land surface or an area from which or rock has been or will be excavated. The dist between an original ground surface and an excava surface.

CUT AND COVER (CUT AND FILL) - An infrequently and in correctly used term referring to the trench meth sanitary landfilling.

CUT-OFF TRENCH - A trench that is filled with material that is impermeable or very permeable to the flow of gas or water. The barrier is used to prevent the movement of gas or water or to intercept them and to direct them to another location. See GAS BARRIER.

DAMAGED STOCK - In-process material which has been made useless for its intended purpose by accidental semi-curing, by color change, by errors in preparation, by water or steam damage, or other processing accidents. Usually such materials can be blended off in small amounts with fresh material, but some cannot be utilized or sold to others for some value and become solid waste.

DAMPER - A manually or automatically controlled valve or plate in a breeching, duct, or stack, that is used to regulate a draft or the rate of flow of air or other gases.

Barometric - A hinged or pivoted plate that automatically regulates the amount of air entering a duct, breeching, flue connection, or stack; it thereby maintains a constant draft in the incinerator.

Butterfly - A plate or blade installed in a duct, breeching, flue connection, or stack that rotates on an axis to regulate the flow of gases.

Guillotine - An adjustable plate, utilized to regulate the flow of gases, installed vertically in a breeching.

Sliding - A plate normally installed perpendicularly to flow of gas in a breeching and arranged to slide across it to regulate the flow.

DANO BIOSTABILIZER SYSTEM - An aerobic, thermophilic composting process in which optimum conditions of moisture, air, and temperature are maintained in a single, slowly revolving cylinder that retains the compostable solid waste for one to five days. The material is later windrowed.

DECOMPOSTION - The reduction of the net energy level and change in chemical composition of organic matter, as by microorganisms.

DEGRADABLE WASTES - Substances which are changed in form and/or reduced in quantity by the biological, chemical, and physical phenomena characteristic of natural waters.

DENSITY

Sanitary Landfill - The ratio of the combined weight of solid waste and the soil cover to the combined volume of the solid waste and the soil cover.

$(W_{sw} + W_{soil}/V_{sw} + V_{soil})$

Solid Waste - The number obtained by dividing the weight of solid waste by its volume.

DESTRUCTIVE DISTILLATION - The airless heating of organic matter that results in the evolution of volatile substances and produces a solid char consisting of fixed carbon and ash. See LANTZ PROCESS.

DIFFUSED AIR - A technique by which air under pressure is forced into sewage in an aeration tank. The air is pumped down into the sewage through a pipe and escapes out through holes in the side of the pipe.

DIGESTION - Digestion of sludge takes place in tanks when the materials decompose, resulting in partial gasification, liquefaction, and mineralization of pollutants.

DIRECT-DUMP TRANSFER SYSTEM - The unloading of solid waste directly from a collection vehicle into an open-top transfer trailer or container.

DISPERSION - The dilution or removal of a substance by diffusion, turbulence, etc. Technically, a two-phase system involving two substances, the first of which is uniformly distributed in a finely divided state through the second (the dispersion medium).

DISPOSAL

Ocean - The deposition of waste into an ocean or estuarine body of water.

On-Site - The utilization of methods or processes to eliminate or reduce the volume or weight of solid waste on the property of the generator.

Waste - The orderly process of discarding useless or unwanted material.

DISPOSAL AREA - A site, location, tract of land, area, building, structures, or premises used or intended to be used for partial and/or total refuse disposal.

DISSOLVED OXYGEN - Refers to oxygen which is dissolved in water. Dissolved oxygen is essential for aerobic decomposition of organic matter and for fish and other aquatic life.

DISSOLVED SOLIDS - Organic and inorganic matter which often renders water unpalatable.

DISTILLATION - In waste treatment consists of heating the effluent and then removing the vapor or steam. When the steam is returned to a liquid it is almost pure water. The pollutants remain in the concentrated residue.

DOMESTIC WASTE - All types of refuse which normally originate in the residential household or apartment house.

DULONG'S FORMULA - A formula for calculating the approximate heating value of a solid fuel based on its ultimate analysis.

DUMP - A land site where solid waste is disposed of in a manner that does not protect the environment.

DUMP, OPEN - The consolidation of waste from one or more sources at a central out-of-doors disposal area, which has little or no management and which does not conform to the requirements of a landfill or sanitary landfill.

DUMP, OPEN BURNING - An open dump where burning is permitted in an uncontrolled manner.

DUMP, CONTROLLED OPEN BURNING - An open dump where burning is controlled by some responsible person. Burning is not confined to an incinerator but is practiced in the open on the ground.

DUMPING - An indiscriminate mehtod of disposing of solid waste. Meaning the unloading or emptying of a container.

DUNNAGE - Wood, cardboard, or paper which is used to secure raw materials or equipment in rail cars or trucks. There is a strong trend to returnable dunnage, but there is still much that must be disposed of at the receiving point as solid waste.

DUST - Fine-grain particulate matter that is capable of being suspended in air.

DUST-LOADING - The amount of dust in a gas; usually expressed in grains per cubic foot or pounds per thousand pounds of gas.

ECOLOGY - The science that deals with the interrelationships of organisms and their living and non-living surroundings.

ECOSYSTEM - The interdependence of organisms and their surroundings.

EFFLUENT - The substances that flow out of a designated source. An outflow of water such as from a septic tank or a waste treatment plant. Liquid that comes out of a treatment plant after completion of the treatment process.

EFFLUENT SEEPAGE - Diffuse discharge onto the ground of liquids that have percolated through solid waste or another medium; they contain dissolved or suspended materials.

ELASTOMER - An elastomer is a substance which is capable of being altered by curing to a condition in which if stretched to a limited degree at room temperature it will return to substantially its original dimensions in a short time when released. All of the so-called rubbers and a few other orgnaic substances are elastomers.

ELECTRODIALYSIS - A process which utilizes direct current and an arrangement of permeable-active membranes to achieve separation of the soluble minerals from the water.

ELECTROSTATIC PRECIPITATOR - A device that collects particulates by placing an electrical charge on them and attracting them onto a collecting electrode.

ELUTRIATION - Separation of solid waste into heavy and light fractions by washing.

ENVIRONMENT - The conditions, circumstances, and influences surrounding and affecting the development of an organism or group of organisms.

EROSION

Accelerated - Erosion of soil material at a faster than natural rate. Accelerated erosion occurs when vegatal cover is destroyed or is affected by some activity of man.

Refractory - The wearing away of refractory surfaces by the washing action of moving liquids, such as molten slags or metals, or the action of moving gases.

EXTRUSION - A process by which a thermoplastic material is forced through a forming die to produce continuous lengths of pipe, tubes, and a variety of profiles. Extrusion is applied to uncured rubber, to many plastics, to metals, and many other thermoplastic materials.

FABRIC - Fabric for the pusposes of this report means any sheet goods made of natural or man-made textile fibers by weaving, knitting, braiding, or non-woven processes. It includes fabrics laid in place of tire cord.

FABRICATOR - For the purposes of this report a fabricator is any installation which receives raw materials or semi-processed goods from others and converts them into complex finished products for consumer or industrial sale.

FACULTATIVE - Able to live and grow with or without free oxygen.

FAIRFIELD-HARDY DIGESTER (COMPOSTING) - A patented product of Fairfield Engineering Company, Marion, Ohio, which decomposes garbage, sewage sludge, industrial, and other organic wastes by a controlled continuous aerobic-thermophilic process.

FARM TIRES - Includes all off-the-road tires which are used in agriculture ranging from those on garden tractors to those on massive specialized ploughing and harvesting rigs. The heavily lugged tires used on standard size farm tractors account for the largest share of the total weight. Farm tires seldom wear out in the usual sense, but are destroyed by irreparable damage from stones or roots or environmental degradation.

FIELD CAPACITY (OF SOLID WASTE) - The amount of water retained in solid waste after it has been saturated and has drained freely. Also known as moisture-holding capacity.

FITTINGS - Those ferrous, non-ferrous, or plastic parts which are purchased from others and made an integral part of fabricated rubber products. Examples would be brass hose couplings, inner tube valves, metal or plastic zippers for footwear, shoe eyelets, and buckles for arctics.

FLAPS - A tape used to protect casings and inner tubes from abrasion of damaged metal wheels.

FLAREBACK - A burst of flame from a furnace in a direction opposed to the normal gas flow; it usually occurs when accumulated combustible gases ignite.

FLOC - A clump of solids formed in sewage by biological or chemical action.

FLOCCULATION - The process by which clumps of solids in sewage are made to increase in size by chemical, physical, or biological action.

FLUE - Any passage designed to carry combustion gases and entrained particulates.

FLUE GAS - Waste gas from a combustion process.

FLUE GAS SCRUBBER OR WASHER - A type of equipment that removes fly ash and other objectionable materials from flue gas by the use of sprays, wet baffles, or other means that require water as the primary separation mechanism.

FLUIDIZED BED TECHNIQUE - A combustion process in which heat is transferred from finely divided particles, such as sand, to combustible materials in a combustion chamber. The materials are supported and fluidized by a column of moving air.

FLUXING - Dissolving or melting of a substance by chemical action.

FLY ASH - All solids, including ash, charred paper, cinders, dust, soot, or other partially incinerated matter, that are carried in a gas stream.

FOOD PROCESSING WASTE - Waste resulting from operations that alter the form or composition of agriculture products for marketing purposes.

FOOD WASTE - Animal and vegetable waste resulting from the handling, storage, sale, preparation, cooking and serving of foods; commonly called garbage.

FOULING - The impedance to the flow of gas or heat that results when material accumulates in gas passages or on heat absorbing surfaces in an incinerator.

FUEL BED - The layer of solid fuel or solid waste on a furnace grate or hearth.

FUNGI - Simple plants that lack a photosynthetic pigment. The individual cells have a nucleus surrounded by a membrane, and they may be linked together in long filaments called hyphae, which may grow together to form a visible body. Simpler fungi are involved in the stabilization of solid waste and sewage. Small non-chlorophyll-bearing plants which may play a useful role in trickling filter treatment operations.

GARBAGE - Garbage is the solid or semi-solid animal and vegetable waste resulting from the handling, preparation, cooking and serving of foods, including cans, bottles and cartons in which it was received and wrappings in which it may be placed for disposal. Garbage does not include commercial and industrial waste from meat packing plants, food processing plants such as canneries and crop wastes from farms, nor market wastes which originate in wholesale and retail stores or markets engaged in the storage, processing and selling of food products.

GARCHEY SYSTEM - A patented system in which residential waste is temporarily stored in a water-filled flushing device mounted under a sink; it is conveyed through tubes to a central holding tank.

GAS BARRIER - Any device or material used to divert the flow of gases produced in a sanitary landfill or by other land disposal techniques. See CUT-OFF TRENCH.

GENERATION - The act or process of producing solid waste.

GRAVEL - Rock fragments from 2 mm to 64 mm (.08 to 2.5 inches) in diameter; gravel mixed with sand, cobbles, boulders, and containing no more than 15 percent of fines.

GRINDING - The mechanical pulverization of solid waste.

HAMMERMILL - A broad category of high-speed equipment that uses pivoted or fixed hammers or cutters to crush, grind, chip, or shred solid wastes.

HARDPAN - A hardened, compacted, or cemented soil layer.

HEARTH

Burning - A solid surface to support the solid fuel or solid waste in a furnace during drying, ignition, or combustion, without air openings in it. The surface upon which material is placed for combustion.

Cold Drying - A surface upon which unheated waste material is placed to dry or burn; hot combustion gases are then passed over the material.

Drying - A solid surface in an incinerator upon which wet waste materials or liquids or waste matter that may turn to liquid before burning are placed to dry or burn with the help of hot combustion gases.

Hot Drying - A surface upon which waste material is placed to dry or burn; hot combustion gases first pass over the wastes and then under the hearth.

HEAVY MEDIA SEPARATION - Separation of solid wastes into heavy and light fractions in a fluid medium whose density lies between theirs.

HYDROLOGY - Science dealing with the properties, distribution, and flow of water on or in the earth.

IGNITION TEMPERATURE - Lowest temperature of a fuel at which combustion becomes self-sustaining.

IMPACT MILL - A machine that grinds material by throwing it against heavy metal projections rigidly attached to a rapidly rotating shaft.

INCINERATION - The controlled process by which solid, liquid, or gaseous combustible wastes are burned and changed into gases and the residue produced contains little or no combustible material. Consists of burning the sludge to remove the water and reduce the remaining residues to a safe, non-burnable ash. The ash can then be disposed of safely on land, in some waters, or in caves or other underground locations. The controlled process of burning solid, semi-solid, liquid or gaseous combustible wastes in an enclosed device, producing an inoffensive gas and a sterile residue containing little or no combustible material. The process is used to reduce the volume or weight of waste material or to change the characteristics of hazardous wastes to a safer form.

INCINERATOR - An engineered apparatus used to burn waste substances and in which all the factors of combustion--temperature, retention time, turbulence, and combustion air--can be controlled.

Batch Fed - An incinerator that is periodically charged with solid waste; one charge is allowed to burn down or burn out before another is added.

Cell-type - An incinerator whose grate areas are divided into cells, each of which has its own ash drop, underfire air control, and ash grate.

Central - A conveniently located facility that burns solid waste collected from many different sources.

Chute Fed - An incinerator that is charged through a chute that extends two or more floors above it.

Continuous Feed - An incinerator into which solid waste is charged almost continuously to maintain a steady rate of burning.

Controlled-Air - An incinerator with two or more combustion areas in which the amounts and distribution of air are controlled. Partial combustion takes place in the first zone, and gases are burned in a subsequent zone or zones.

Direct Fed - An incinerator that accepts solid waste directly into its combustion chamber.

Flue Fed - An incinerator that is charged through a shaft that functions as a chute for charging waste and has a flue to carry the products of combustion.

Industrial - An incinerator designed to burn a particular industrial waste.

Multiple Chamber - An incinerator consisting of two or more chambers, arranged as in-line or retort types; interconnected by gas passage ports or ducts.

Municipal - A privately or publicly owned incinerator primarily designed and used to burn residential and commercial solid wastes.

On-Site - An incinerator that burns solid waste o
property utilized by the generator thereof.

Open-Pit - A burning device that has an open top
system of closely spaced nozzles that place a
high-velocity air over the burning zone.

Retort-type - A multiple-chamber incinerator in w
gases travel from the end of the ignition cham
pass through the mixing and combustion chamber

INDORE PROCESS - An anaerobic composting method that o
in India; it is similar to the Bangalore process
modified by Van Maanen. Organic wastes are place
alternate layers with human or aniaml excreta in
pile. The piles are turned twice in six months a
is used to keep the compost moist.

INFILTRATION AIR - Air that leaks into the chambers or
an incinerator.

INOCULUM - Microorganisms placed in a culture medium,
compost, etc.

INTERCEPTOR - Sewers in a combined system control the
the sewage to the treatment plant. In a storm, t
some of the sewage to flow directly into a receiv
This protects the treatment plant from being over
case of a sudden surge of water into the sewers.
ceptors are also used in separate sanitation syst
collect the flows from main and trunk sewers and

to the points of treatment.

INTERFLOW - That portion of precipitation that infiltrates into the soil and moves laterally under its surface until intercepted by a stream channel or until it resurfaces down a slope from its point of infiltration.

ION - An electrically charged atom or group of atoms which can be drawn from waste water during the electrodialysis process.

JUNK - Unprocessed materials suitable for reuse or recycling.

LAGOONS - Ponds, usually man-made to regid specifications, in which sunlight, algae, and oxygen interact to restore water to a reasonable state of purity.

LANDFILL - Same as a sanitary landfill, except, cover material is applied from time to time as required, instead of daily or more frequently. To be acceptable, landfills must be restricted in inert, non-combustible, non-putrescible solid waste materials.

LANTZ PROCESS - A destructive distillation technique, in which the combustible components of solid waste are converted into combustible gases, charcoal, and a variety of distillates.

LATERAL - Lateral sewers are the pipes that run under the streets of a city and into which empty the sewers from homes or businesses.

LATEX - A suspension of very small solid rubber particles in a water solution. Natural rubber exudes from the tree in this form and most synthetic rubbers are produced in this form or easily converted to a latex. Latex is used in the manufacture of foam, dipped goods, carpet backings, and other coatings and adhesives. They are distinguished from cements which are solvent solution.

LEACHATE - Liquid that has percolated through solid waste or other medium and has extracted dissolved or suspended materials from it.

LEDGE PLATE - A plate that is adjacent to or overlaps the edge of a stoker.

LIFT - In a sanitary landfill, a compacted layer of solid wastes and the top layer of cover material.

LITTER - Wantonly discarded material.

LOAM - A soft, easily worked soil containing sand, silt, and clay.

LYSIMETER - A device used to measure the quantity or rate of water movement through or from a block of soil or other material, such as solid waste, or used to collect percolated water for quality analysis.

MANURE - Primarily the excreta of animals; may contain some spilled feed or bedding.

MECHANICAL AERATION - Uses mechanical energy to inject air into water, causing the waste stream to absorb oxygen from the atmosphere.

MICROBES - Minute plant, animal, or protist life. Some microbes which may cause disease exist in sewage.

MICRON - A measure of dust-particle diameter equal to 1/1,000 of a millimeter (1/25,400 of an inch).

MILLED REFUSE - Solid waste that has been mechanically reduced in size.

MINERAL FILLERS - Fine ground mineral powders which are added to rubber compounds to improve properties, to increase density or decrease cost. Common ones are clays, whiting, magnesia, zinc oxide, asbestos, and lead compounds.

MIXED LIQUOR - A mixture of activated sludge and waters containing organic matter undergoing activated sludge treatment in the aeration tank.

MOISTURE CONTENT (SOLID WASTE) - The weight loss (expressed in percent) when a sample of solid waste is dried to a constant weight at a temperature of 100°C to105°C.

MOLDING - The process of forming rubber products with heat and pressure in precision formed molds. Various forms of molding are compression, transfer, injection, slush, rotational, and open mold. Compression molding is the traditional process for rubber products, but injection molding is becoming more common because of greater efficiency. Plastics are molded by very similar processes.

MOLDING WASTE - The overflow from the molding process including that from the air release channels built into the mold. Mold waste is always cured so it cannot be conveniently re-mixed.

MUNGO - The waste of milled wool that is combined with other fibers to make low-quality cloth.

NATURAL RUBBER - Rubber originating from natural sources, almost entirely the cultivated rubber tree of Southeast Asia, Indonesia, Ceylon, West Africa, and a few minor tropical sources. It is marketed as either solid rubber or the concentrated latex.

NONDEGRADABLE WASTES - Substances that are not changed in form and/or reduced in quantity by the biological, chemical, and physical phenomena characteristic of natural waters. Although nondegradable wastes may be diluted by receiving water, they are not reduced in quantity.

OFFAL - Intestines and discarded parts, including paunch manure, of slaughtered animals.

OPACITY RATING - The apparent obscuration of an observer's vision that equals the apparent obscuration of smoke of a given rating on the Ringelmann Chart.

ORGANIC CONTENT - Synonymous with volatile solids, except for small traces of some inorganic materials such as calcium carbonate, that lose weight at temperatures used in determining volatile solids.

ORGANIC MATTER - The carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

ORSAT - An apparatus used to analyze flue gases volumetrically by measuring the amounts of carbon dioxide, oxygen, and carbon monoxide present.

OSBORNE SEPARATOR - A device that utilizes a pulsed, rising column of air to separate small particles of glass, metal, and other dense items from compost.

OXIDATION - The addition of oxygen which breaks down organic wastes or chemicals in sewage by bacterial and chemical means.

OXIDATION POND - A man-made lake or body of water in which wastes are consumed by bacteria. It is used most frequently with other waste treatment processes. An oxidation pond is basically the same as a sewage lagoon.

PALLETS - Wood, paper, or plastic supports for piles of bags, bales, or rolls of raw material to facilitate semi-automatic handling. They may be either disposable or returnable. One-trip pallets or damaged returnable pallets become solid waste at the point of delivery.

PATHOGEN - An organism capable of producing disease.

PEAT - Partially decomposed organic material.

PERCENT MOISTURE CONTENT (SOLID WASTE) - The percent of moisture contained in solid waste; it can be calculated on a dry or wet basis.

1. Wet = $\dfrac{100\ (\text{water content of sample})}{\text{Dry weight of sample \& water content of sample}}$

2. Dry = $\dfrac{100\ (\text{water content of sample})}{\text{Dry weight of sample}}$

PERCOLATION - A qualitative term that refers to the downward movement of water through soil, solid waste, or other porous medium.

PERMEABILITY - The capacity of a porous medium to conduct or transmit fluids.

PIGMENTS - Pigments are organic or inorganic powders used to color products. They include many mineral products such as titanium oxide or zinc oxide which make white products. The terms, pigment and mineral filler, are often used interchangeably.

PNEUMATIC TIRES - Tires containing an enclosed air space and having an elastic and resilient body, the combination giving a smooth, jolt-free motion to vehicle on rough road-beds.

POLLUTION - The condition caused by the presence in the environment of substances of such character and in such quantities that the quality of the environment is impaired or rendered offensive to life. Pollution results when animal, vegetable, mineral or heat wastes or discharges reach water, making it less desirable for domestic, recreation, industry, or wildlife uses. Pollution is the contamination of any air, water or land so as to create a nuisance or render such air, water or land unclean or noxious, or impure so as to be actually or potentially harmful or detrimental or injurious to public health, safety, or welfare, to domestic, commercial, industrial or recreational use, or to livestock, wild animals, birds, fish, or other aquatic life or to plant life.

POLYELECTROLYTES - Synthetic chemicals used to speed the removal of solids from sewage. The chemicals cause the solids to flocculate or clump together more rapidly than chemicals like alum or lime.

POLYMER - A high molecular weight material made up of similar repreated units of simple structure. All rubbers are polymers but the term includes most plastics and many biolc al materials.

POLYVINYL CHLORIDE (PVC) - A common plastic material that can release hydrochloric acid and phosgene when burned.

PRIMARY TREATMENT - Removes the material that floats or will settle in sewage. It is accomplished by using screens to catch the floating objects and tanks for the heavy matter to settle in.

PRODUCT PACKAGE - Most consumer items and many industrial products are marketed in some type of package for protection, identification, or customer appeal. The package may be a cardboard box, a paper jacket, paper wrapping, or a multitude of other types. Sometimes boxed items are shipped together in an outer case. This material becomes solid waste at the point of ultimate consumption.

PULVERIZATION - The crushing or grinding of material into small pieces.

PUSH PIT - A storage system sometimes used in stationary compactor transfer systems. A hydraulically powered bulkhead that traverses the length of the pit periodically pushes the stored waste into the hopper of a compactor.

PUTREFACTION - The decomposition of organic matter by micro-organisms and oxidation, resulting in odors.

PUTRESCIBLE - Organic matter capable of being decomposed by microorganisms.

PYROLYSIS - The chemical decomposition of a material by heat in the absence of oxygen.

PYROMETER - An instrument for measuring or recording temperatures.

Optical - A temperature-measureing instrument that matches the intensity of radiation at a single wavelength from a tungsten filament with the intensity of the radiation at the same wavelength emitted by a heat source.

Radiation - A device that determines temperature by measuring the intensity of radiation at all wavelengths emitted by a material having a high temperature.

PYROMETRIC CONE EQUIVALENT (PCE) - An index to the refractoriness of a material; it is obtained by a test that provides the number of a standard pyrometric cone that is closest in its bending behavior to that of a pyrometric cone made of the material when both are heated in accordance with the ASTM Standard Method of Test for Pyrometric Cone Equivalent of Refractory Materials.

QUALITY CONTROL - This incorporates all physical, chemical, or service testing of raw materials, in-process material, and finished product to insure that products meet the desired or required test specification. It would include all research and development products where this work is associated with a producing facility. Much of the raw material and in-process material could be returned to process, but much would be subjected to curing for test purposes and this, together with spoiled finished product, would be disposed of as solid waste.

QUENCH TROUGH - A water-filled trough into which burning residue drops from an incinerator furnace.

RASPER - A grinding machine in the form of a large vertical drum containing heavy hinged arms that rotate horizontially over a rasp-and-sieve floor.

RATED LOAD - The maximum load that a crane is designed to handle safely.

RECEIVING WATERS - Rivers, lakes, oceans, or other water courses that receive treated or untreated waste waters.

RECLAMATION - The restoration to a better or more useful state, such as land reclamation by sanitary landfilling, or the obtaining of useful materials from solid waste.

RECOVERABLE RESOURCES - Materials that still have useful physical or chemical properties after serving a specific purpose and can, therefore, be reused or recycled for the same or other purposes.

RECOVERY - The process of obtaining materials or energy resources from solid waste. Synonyms: Extraction, Reclamation, Salvage.

Energy - Energy available from the heat generated when solid wastes are incinerated.

RECYCLING - The process by which waste materials are transformed into new products in such a manner that the original products may lose their identity.

REFRACTORY - Nonmetallic substances used to line furnaces because they can endure high temperatures. In addition, they should normally be able to resist one or more of the following destructive influences: abrasion, pressure, chemical attack, and rapid changes in temperature.

Castable - A hydraulic-setting refractory, suitable for casting or being pneumatically formed into heat-resistant shapes or walls.

High Alumina - A refractory product containing 47.5 percent more alumina than regular refractories.

Plastic - A blend of ground fireclay materials in a plastic form, that is suitable for ramming into place to form monolithic linings or special shapes. It may be air-setting or heat-setting and is available in different qualities of heat resistance.

REFUSE CHUTE - A pipe, duct, or trough through which solid waste is conveyed pneumatically or by gravity to a central storage area.

REINJECTION - Reintroduction of fly ash into a furnace to burn out all the combustibles.

REJECTS - Finished product which is judged by test to not conform to established quality standards. In some cases a reject can be repaired (belting and hose), or sold commercially as second or third quality (footwear), or reprocessed (heels and soles). In many cases repair or sale as off-quality cannot be tolerated and the item must be made unserviceable and disposed of as solid waste (tires, inner tubes, hose).

RETREADING - The process by which sound tire carcasses which have had the tread worn beyond safe levels by normal operation are rejuvenated by molding on a new tread equivalent in safety performance to the original.

REUSE - The reintroduction of a commodity into the economic stream without any change.

RINGELMANN CHART - Printed or photographically reproduced illustrations of four shades of gray, that an observer can use to estimate the density of smoke emitted from an incinerator. A clear stack is recorded as 0, and 100 percent black smoke as 5. Number 1 has a 20 percent density, and 2 through 4 are progressively 20 percent more dense.

RIPARIAN RIGHTS - Rights of the landowner to water on or bordering his property; they include his right to prevent upstream water from being diverted or misused.

RUBBER - An unfortunately vague word having many different common and technical meanings. Originally meaning the crude natural product. It now covers all the synthetic elastomers, compounds of them, and fabricated products. It also refers to the "rubbery" properties of things that may not be elastomers at all. Then specifically it may refer to such things as waterproof footwear, prophylactics, and many other items.

RUBBER COMPOUND - Intimate mixtures of elastomers, oils, mineral fillers, pigments, chemicals, sulfur, and other modifying materials. It usually refers to uncured material.

RUBBER MILL - An open mixer for making rubber compounds consisting of two powered rolls operating in opposite or the same directions, at various rotational ratios, and either smooth or grooved in various ways.

RUBBISH - A general term for solid waste--excluding food waste and ashes--taken from residences, commercial establishments, and institutions. Non-putrescible wastes, such as cardboard, paper, tin cans, wood, glass, bedding, crockery or litter of any kind.

RUBBLE - Broken pieces of masonry and concrete.

RUNOFF - That portion of precipitation or irrigation water that drains from an area as surface flow.

SALTS - Are the minerals that water picks up as it passes through the air, over and under the ground, and through household and industrial uses.

SALVAGE - The utilization of waste materials.

SALVAGE, METAL - A commercial enterprise engaged in the purchase of salvaged metals for resale, or processing and resale of these metals to metal consuming industry.

SALVAGING - The controlled removal of waste materials for utilization. The controlled removal of reusable materials. Not to be confused with scavenging.

SAND - A course-grained soil, the greater portion of which passes through a No. 4 sieve, according to the Unified Soil Classification System.

SAND FILTERS - Remove some suspended solids from sewage. Air and bacteria decompose additional wastes filtering through the sand. Cleaner water drains from the bed. The sludge accumulating at the surface must be removed from the bed periodically.

SANDY LOAM - A soft, easily worked soil containing 0 to 20 percent clay, 0 to 50 percent silt, and 43 to 85 percent sand, according to the U. S. Department of Agriculture classification code.

SANITARY LANDFILL - A site where solid waste is disposed using sanitary landfilling techniques. A controlled method of disposing of refuse on land without creating air, land or water pollution or nuisances or hazards to public health or

safety, by utilizing the principles of engineerin
the refuse to the smallest practical volume, and
with a layer of earth at the conclusion of each d
tion, or at such more frequent intervals as may l

SANITARY LANDFILLING - An engineered method of disposi
waste on land in a manner that protects the envir
spreading the waste in thin layers, compacting it
smallest practical volume, and covering it with s
end of each working day.

SANITARY LANDFILLING METHOD

Area - A method in which the wastes are spread an
on the surface of the ground and cover material
and compacted over them.

Quarry - A variation of the area method in which
are spread and compacted in a depression; cover
is generally obtained elsewhere.

Ramp - Another variation of the area method in whi
material is obtained by excavating in front of
face. A variation of this method is known as
progressive slope sanitary landfilling method

Trench - A method in which the waste is spread and
in a trench. The excavated soil is spread and
over the waste to form the basic cell structure

Wet Area - A method used in a swampy area where pr are taken to avoid water pollution before proceedings with the area landfill technique.

SANITARY SEWERS - Sanitary sewers, in a separate system, are pipes in a city that carry only domestic waste water. The storm water runoff is taken care of by a separate system of pipes.

SANITATION - The control of all the factors in man's physical environment that exercise or can exercise a deleterious effect on his physical development, health, and survival.

SATELLITE VEHICLE - A small collection vehicle that transfers its loads into a larger vehicle operating in conjunction with it.

SCAVENGER - One who participates in the uncontrolled removal of materials at any point in the solid waste stream.

SCRAP - Discarded or rejected material or parts of material that result from manufacturing or fabricating operations and are suitable for reprocessing.

Home - Scrap that never leaves the manufacturing plant and is reprocessed there. Also known as revert scrap.

Obsolete - Scrap that results when material becomes worn or otherwise unusable for its original prupose.

Prompt Industrial - Scrap that is left over from the fabrication of iron and steel products.

SECATOR - A separating device that throws mixed material onto a rotating shaft; heavy and resilient materials bounce off one side of the shaft, while light and inelastic materials land on the other and are cast in the opposite direction.

SECONDARY MATERIAL - A material that is utilized in place of a primary or raw material in manufacturing a product.

SECONDARY TREATMENT - The second step in most waste treatment systems in which bacteria consume the organic parts of the wastes. It is accomplished by bringing the sewage and bacteria together in trickling filters or in the activated sludge process.

SEDIMENT - The material that settles to the bottom of a lake.

SEDIMENTATION TANKS - Help remove solids from sewage. The waste water is pumped to the tanks where the solids settle to the bottom or float on the top as scum. The scum is skimmed off the top, and solids on the bottom are pumped to incineration, digestion, filtration or other means of final disposal.

SEEPAGE - Movement of water or gas through soil without forming definite channels.

SEMI-PNEUMATIC - A tire of heavy construction having an air space within it usually at atmospheric pressure. They provide much less cushioning than pneumatic tires and are used on light weight equipment or industrial units.

SEPARATORS - Sheets of plastic, paper, or treated fabric which are used to temporarily separate prepared pieces of tacky uncured rubber prior to assembly. The trend is to plastic film which can be recovered after use and reprocessed in the fabricating plant as many as six or eight times. Treated paper and fabric can be used over several times, unless they have been cut, and then must be discarded as solid waste.

Ballistic - A device that drops mixed materials having different physical characteristics onto a high-speed rotary impeller; they are hurled off at different velocities and land in separate collecting bins.

Inertial - A material separation device that relies on ballistic or gravity separation of materials having different physical characteristics.

Magnetic - Any device that removes ferrous metals by means of magnets.

SEPTIC TANKS - Used for domestic wastes when a sewer line is not available to carry them to a treatment plant. The wastes are piped to underground tanks directly from the home or homes. The bacteria in the wastes decompose the organic waste and the sludge settles on the bottom of the tank. The effluent flows out of the tank into the ground through drains. The sludge is pumped out of the tanks, usually by commercial firms, at regular intervals.

SETTLING VELOCITY - The velocity at which a given dust will fall out of dust-laden gas under the influence of gravity only.

SEWAGE SLUDGE - A semiliquid substance consisting of settled sewage solids combined with varying amounts of water and dissolved materials.

SEWAGE TREATMENT RESIDUES - Coarse screenings, grit, or sludge from wastewater treatment units.

SEWERS - A system of pipes that collect and deliver waste water to treatment plants or receiving streams.

SHREDDER - A machine that reduces discarded automobiles and other low-grade sheet and coated metal in a continuous operation to fist-size pieces.

SIFTINGS - The fine materials that fall from a fuel bed through its grate openings during incineration.

SILICA (SiO_2) - The oxide of silicon, a major constituent of fireclay refractories, alone or in chemical combinations.

SILT - Mineral soil grains intermediate between clay and sand (0.05 to 0.002 mm in diameter). Waterborne sediment whose individual grains have diameters approaching those of silt. Soil material that contains at least 80 percent silt, less than 12 percent clay, and less than 20 percent sand. A fine-grain soil having liquid limits and plasticity indexes that plot below the "A" line on the Unified Soil Classification System plasticity chart.

SINTERING - A heat treatment that causes adjacent particles of a material to cohere below a temperature that would cause them to melt.

Glossary

SLAG - A mineral substance formed by chemical action and fusion at furnace operating temperatures.

SLAGGING OF REFRACTORIES - Destructive chemical action that forms slag on refractories subjected to high temperatures. Also a molten or viscous coating produced on refractories by ash particles.

SLUDGE - A semi-liquid sediment. The solid matter that settles to the bottom, floats, or becomes suspended in the sedimentation tanks and must be disposed of by filtration and incineration or by transport to appropriate disposal sites.

SOIL - The unconsolidated natural surface material present above bedrock; it is either residual in origin (formed by the in-place weathering of bedrock) or has been transported by wind, water, or gravity.

SOLID TIRES - A solid mass of rubber built up on the rim of a metal wheel with no substantial air space. Usually limited now to small heavily loaded wheels and rollers such as air-craft tail wheels, industrial tractors, and conveyor rolls and casters.

SOLID WASTE - Useless, unwanted or discarded material with insufficient liquid content to be free flowing. Unwanted waste or discarded materials resulting from commercial, industrial and agricultural operations and normal community activities.

Wastes include solids, liquids and gases. Wastes which are solids, or semi-solids containing insufficient liquid to be free-flowing are classed as solid waste. Solid waste is refuse and includes in part the following: garbage; rubbish; ashes and other residue after burning; street refuse; dead animals; animal waste; abandoned vehicles; agricultural, commercial and industrial waste; construction and demolition waste; sewage treatment residue. See also WASTE.

Agricultural - The solid waste that results from the rearing and slaughtering of animals and the processing of animal products and orchard and field crops.

Commercial - Solid waste generated by stores, offices and other activities that do not actually turn out a product.

Industrial - Solid waste that results from industrial processes and manufacturing.

Institutional - Solid wastes originating from educational, health care, and research facilities.

Municipal - Normally, residential and commercial solid waste generated within a community.

Pesticide - The residue resulting from the manufacturing, handling, or use of chemicals for killing plant and animal pests.

Residential - All solid waste that normally originates in a residential environment. Sometimes called domestic solid waste.

SOLID WASTE MANAGEMENT - The purposeful, systematic control of the generation, storage, collection, transport, separation processing, recycling, recovery and disposal of solid wastes.

SOOT - Agglomerations of tar-impregnated carbon particles that form when carbonaceous-material does not undergo complete combustion.

SPECIAL WASTES - Hazardous wastes by reason of their pathological, explosive, radioactive, or toxic nature; or wastes which require special treatment prior to disposal in ordinary disposal facilities, or special facilities.

SPOIL - Soil or rock that has been removed from its original location.

SPONGE - Cellular rubber products made from softened solid rubber products containing chemical agents which decompose to gases during the curing process.

STERILIZATION - The destruction, by chemical or physical means, of a microorganism's ability to reproduce; to render something barren. The destruction of all living organisms. In contrast, disinfection is the destruction of most of the living organisms.

STOKER - A mechanical device to feed solid fuel or solid waste to a furnace.

Chain Grate - A stoker that has a moving chain as a grate surface; the grate consists of links mounted on rods to form a continuous surface that is generally driven by a shaft with sprockets.

Incinerator - A mechanically operable moving grate arrangement for supporting, burning, and transporting solid waste in a furnace and discharging the residue.

Inertial Grate - A stoker consisting of a fixed bed of plates that is carried on rollers and activated by an electrically driven mechanism; it draws the bed slowly back against a spring and then releases it so that the entire bed moves forward until stopped abruptly by another spring. The inertia of the solid waste carries it a small distance forward along the stoker surface, and then the cycle is repeated.

Oscillating Grate - A stoker in which the entire grate surface oscillates to move the solid waste and residue over the grate surface.

Reciprocating Grate - A stoker consisting of a bed of bars or plates arranged so that alternate pieces, or rows of pieces, reciprocate slowly in a horizontal sliding mode and act to push the solid waste along the stoker surface.

Rocking Grate - A stoker consisting of a bed of bars or plates on axles. When the axles are rocked in a coordinated manner, the solid waste is lifted and advanced along the surface of the grate

Rotary Kiln - A cylindrical inclined device that rotates, thus causing the solid waste to move in a slow cascading and forward motion.

Traveling Grate - A stoker that is essentially a moving chain belt carried on sprockets and covered with separated small metal pieces called keys. The entire top surface can act as a grate while moving through the furnace but can flex over the sprocket wheels at the end of the furnace, return under the furnace, and re-enter the furnace over sprocket wheels at the front.

STORAGE - The interim containment of solid waste, in an approved manner, after generation and prior to ultimate disposal.

STORM SEWERS - Storm sewers are a separate system of pipes that carry only runoff from buildings and land.

STREET REFUSE - Material picked up [illegible]n streets and sidewalks are swept manually and mechanically. Litter from public receptacles, and dirt removed from catch basins.

SURFACE CRACKING - Discontinuities that develop in the cover material at a sanitary landfill due to the surface drying or settlement of the solid waste. (These discontinuities may result in the exposure of solid waste, entrance or egress of vectors, intrusion of water, and venting of decomposition gasses.)

SUSPENDED SOLIDS - The small particles of solid pollutants which are present in sewage and which resist separation from the water by conventional means.

TOPSOIL - The topmost layer of soil; usually refers to soil that contains humus and is capable of supporting good plant growth.

TOPOGRAPHIC MAP - A map indicating surface elevations and slopes.

TREAD - That part of the tire casing which comes in contact with the road. It contains no fabric and is especially designed for abrasion resistance and maximum skid resistance under all driving conditions. This part of a sound tire can be effectively replaced by retreading.

TRICKLING FILTER - A support medium for bacterial growth, usually a bed of rocks or stones. The sewage is trickled over the bed so that bacteria and other organisms can break down the organic wastes. The organisms collect on the stones through repeated use of the filter.

TRIMMINGS - Almost all fabricated rubber products are assembled from sheet or strip rubber compound, fabric or metal by hand or semi-automatic operations. This requires much hand or machine trimming of excess material to make the final shapes required. Many of these trimmings may be reprocessed but the remainder is discarded as solid waste.

VIRUS - The smallest form of microorganism capable of causing disease.

WASTE - See also SOLID WASTE.

Bulky Waste - Items whose large size precludes or complicates their handling by normal collection, processing, or disposal methods.

Construction and Demolition Waste - Building materials and rubble resulting from construction, remodeling, repair, and demolition operations.

Hazardous Waste - Those wastes that require special handling to avoid illness or injury to persons or damage to property.

Wood Pulp Waste - Wood or paper fiber residue resulting from a manufacturing process.

Special Waste - Those wastes that require extraordinary management.

Yard Waste - Plant clippings, prunings, and other discarded material from yards and gardens. Also known as yard rubbish.

WASTE PROCESSING - An operation such as shredding, compaction, composting, and incineration, in which the physical or chemical properties of wastes are changed.

WASTE SOURCES - Agricultural, residential, commercial, industrial activities that generate wastes.

WASTE TREATMENT PLANT - A series of tanks, screens, filters, and other processes by which pollutants are removed from water.

WATERSHED - Total land area above a given point on a stream or waterway that contributes runoff to that point.

WET DIGESTION - A solid waste stabilization process in which mixed solid organic wastes are placed in an open digestion pond to decompose anaerobically.

WET MILLING - The mechanical size reduction of solid wastes that have been wetted to soften the paper and cardboard constituents.

YARD RUBBISH - Prunings, grass clippings, weeds, leaves, and general yard and garden wastes.

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