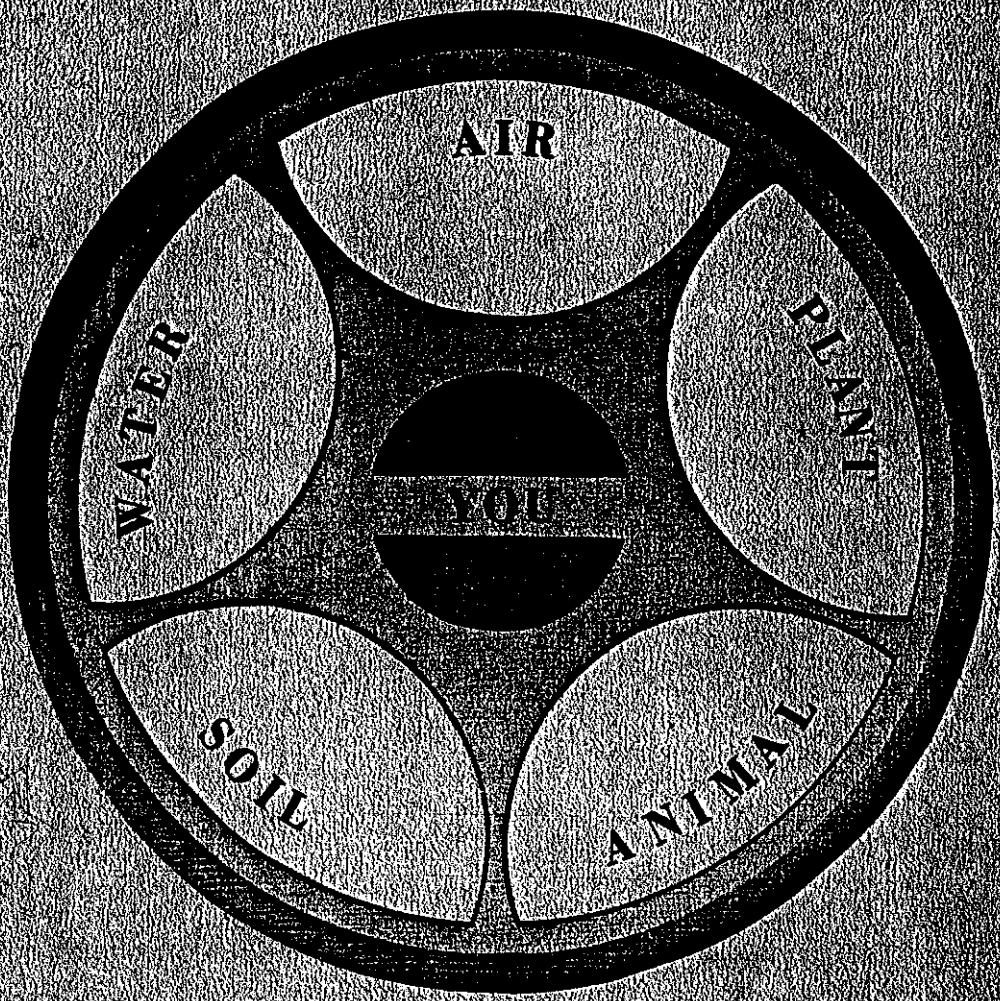
4-H Bulletin 330B
Extension Bulletin E-763
Resource Development Series

ECOSYSTEM ANALYSIS

"BASIC" ECOLOGY AND MANAGEMENT



MICHIGAN STATE UNIVERSITY
COOPERATIVE EXTENSION SERVICE
Resource Development and 4-H — Youth Programs

PREFACE

ECOSYSTEM ANALYSIS is an introductory approach to Basic Ecology and Management. It is an outgrowth of a need for Environmental Conservation (Extension) programs designed for high school age youth.

This Teacher's Guide is designed to help teachers and leaders teach basic environmental concepts and skills for on-the-site ecosystem analysis. It should be considered as a beginning, hopefully encouraging teachers as well as students, to get involved in problem-solving and decision-making concerns for today and tomorrow.

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Acknowledgements: 4-H Youth Developmental Committee for Natural Resources and Environmental Conservation

FFA Committee on Environmental Skills Contest

April, 1973
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN 48823

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. G.S. McIntyre, Director, Cooperative Extension Service, Michigan State University, E. Lansing, Mich.

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TEACHER'S GUIDE TO:

ECOSYSTEM ANALYSIS

Environmental evaluation is becoming very important as we become more concerned about the quality of life on this great spaceship--EARTH. Our environment is defined as all that surrounds us. This includes living matter and non-living matter. It includes the good things we want in life as well as the bad things we don't want.

There have been many emotional statements on how long life, as we know it, will continue on this planet. Many of these have been based on scientific evidence. However, this scientific evidence has been used by different people to reach different conclusions. Regardless of the scientific evidence, one thing is certain to continue to exist--CHANGE. As change occurs we must be aware of it and be involved to influence any proposed man-made changes. We must be aware of present environmental conditions and how this change will affect the environment.

Evaluating the environment involves an on-the-spot analysis of the various factors which comprise the existing ecosystem. An ecosystem is a group of organisms--large and small--interacting with each other and their environment.

The process of ecosystem analysis includes: first, an overview of the total site; second, evaluation of the various components--water, air, soil, and biota (living matter); third, identifying the limiting factors to establish the use suitability indices of the site; and finally, an evaluation for the environmental quality. Given a situation with alternatives, decisions are then made as to the recommended use, the limitations, and suggested practices and/or corrective actions to maintain a quality environment.

SITE OVERVIEW

Any site--large or small--is a system of interacting processes involving biotic and abiotic components. How the site (system) is adjusting to its physical, chemical, and biological potential is of utmost importance.

The overview is a consideration of the site in its totality. It is important to identify the character of the site, the present use and function of the area, and signs of environmental quality.

A. CHARACTER OF THE SITE

The site character includes physical, biological, geographical, and political (land value, tax evaluation, land use) features. It involves consideration of the area surrounding the site as well as the site itself.

LOCATION	___Urban Area	___Rural Area
AFFECT BY POPULATION	___Yes	___No
STABILITY	___Stable	___Unstable
COMPLEXITY	___Simple	___Complex
PRODUCTIVITY	___Low	___High
LAND USE DEMANDS	___Heavy	___Light

LOCATION. This is an important factor because it relates to the pressure man will put on this ecosystem. Population density oftimes affects the character of the site.

AFFECT BY POPULATION. This factor is directly related to the location. The nearness of people can have a great affect on the use of the area.

STABILITY. In evaluating this characteristic we must consider the stage of natural succession and the pressure of encroachment of man from the surrounding areas. Natural succession is a process of change which undergoes many stages. Some stages are more stable than others. Man's activities affect the process of natural succession and have a direct effect on site stability. Encroachment is the activity of man in and around the site as applied or applying to changing the site. This pressure of encroachment may be obvious such as the presence of growing residential areas or be hidden such as the use zoning or tax rate affecting the stability of the site.

COMPLEXITY. Here we consider the number of different types of life present. Many different species of plants and animals (including man) and their related life support systems indicate a very complex ecosystem while a simple ecosystem is represented by many individuals of a single species.

PRODUCTIVITY. This is a look at the ecological productivity of the site--the total amount of living matter (biomass) and the apparent quality and quantity of growth.

LAND USE DEMANDS. Consider the intensity of the use of the land--are many demands being made on the land--urbanization, industrialization, high-demand crops, row crops, grassland, forest, etc.?

B. PRESENT LAND USE

Present land use is man's major use of the land today. It may be used primarily for agriculture, natural resources, recreation, residential, or industry and commerce.

Present land use is directly related to the function of the site and has an influence on the various components, limiting factors, and the best site use rating.

AGRICULTURE	NATURAL RESOURCES	RECREATIONAL	RESIDENTIAL	INDUSTRIAL COMMERCIAL

AGRICULTURE. Land being used predominantly for the production of food and/or fiber including cropland and pasture.

NATURAL RESOURCES. Land being used predominantly for maintaining, improving and developing natural resources; forests, wildlife habitat, marshland, ponds, streams, etc.

RECREATIONAL. Land being used primarily for recreation; picnic area, golf courses, playgrounds, campgrounds, parks, nature trails, etc.

RESIDENTIAL. Land being used for homes and the associated services; sewage disposal, water supply, power supply, streets, sidewalks, etc.

INDUSTRIAL AND COMMERCIAL. Land being used by industry and/or commerce and the associated development; parking lots, water sources, waste disposal, transportation and shipping routes, etc.

C. PRIMARY FUNCTION OF THE SITE

The primary function is the "prime" or major activity of the site. This activity results in products which help identify the primary function as productive, protective, multiple - use, or man-made.

THE PRIMARY FUNCTION - IDENTIFY

PRODUCTIVE	PROTECTIVE	MULTIPLE-USE	MAN-MADE

PRODUCTIVE. Ecological productivity--plants and animals.

PROTECTIVE. Watershed, wilderness, etc.

MULTIPLE-USE. More than one use--lakes, streams, etc.

MAN-MADE. Developed by man to meet his needs.

THE PRODUCTS OF THE SITE - CHOOSE____ITEMS

1. Food and Feed
2. Wood and fiber
3. Mining and drilling
4. Wildlife cover
5. Erosion control
6. Watershed management
7. Greenbelt zones
8. Esthetic value
9. Waste disposal
10. Transportation
11. Industrial production
12. Supply and services
13. Water supply
14. Landfill

D. SIGNS OF ENVIRONMENTAL QUALITY (EQ)

The following ten items can help in determining "overview signs" of EQ for the site. These visible characteristics are easily noticed and must be assessed to aid in the final evaluation.

Select the appropriate characteristic of each sign as an indicator of environmental improvement or degradation.

1.	Soil erosion	___Not evident	___Evident
2.	Plant life	___Vigorous, dense	___Sickly, sparse
3.	Air pollution	___Not noticeable	___Noticeable
4.	Animals (Birdlife)	___Present	___Absent
5.	Water pollution	___Not visible	___Visible
6.	Storm sewers, ditches	___Adequate	___Overloaded
7.	Swamp areas	___Maintained	___Filled in
8.	Solid waste--litter	___Clean	___Problem
9.	People pressure	___Light--medium	___Heavy--crowded
10.	"Color of site"	___Green	___Brown-black

SITE COMPONENTS

Each site - ECOSYSTEM - has a number of basic component parts --water, air, soil, and biota (plants and animals). An in-depth study of each component must be made to accurately assess the total site ecosystem. The results gathered in this section will be used in identifying the limiting factors, use suitability indices, and the suggested practices and/or corrective actions needed for maintaining environmental quality.

A. WATER COMPONENT OF THE SITE

Important considerations in the water component of the site are (1) type of surface water, (2) water temperature, (3) dissolved oxygen content, (4) turbidity of the water, (5) chemical nutrients--nitrogen and phosphorous, and (6) biochemical oxygen demand.

1. TYPE OF SURFACE WATER

In deciding the type of surface water, first recognize whether it is standing water or flowing water. Each of these categories has a number of types.

Standing Water:	Flowing Water:
___Lake	___River-Stream
___Pond	___Spring
___Swamp	___Drainage Ditch
___Bog	___Other_____

LAKE. A lake is defined as a body of water that is too deep to have rooted vegetation growing across its surface.

POND. A pond is usually smaller and shallower than a lake and is capable of supporting rooted vegetation all the way across its surface.

SWAMP. A swamp is usually classified as wet lowlands that will support trees and shrubs. There is surface water present at all times.

BOG. A bog is usually a mat of sphagnum moss that supports more grass than a swamp has. This mat will "vibrate" with each step and if thick enough, (6-8 in.) will support people, but water will seep through to cause wet feet.

RIVER-STREAM. It is very difficult to differentiate between these two types of flowing water. Generally they are characterized by eroded banks and wider stream beds than the other categories of flowing water.

SPRING. A spring is an underground stream coming to the surface.

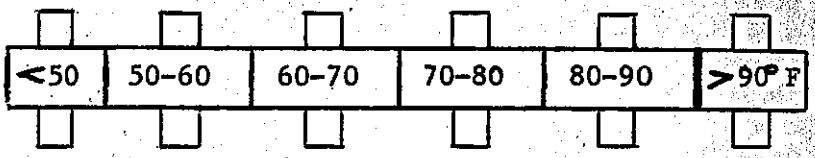
DRAINAGE DITCHES. Man-made ditches to drain surplus water.

2. TEMPERATURE OF WATER

The temperature of water has a great effect on the amount of life in the water. As temperature increases, the oxygen content decreases. However, as temperature increases, plant life is promoted, thereby requiring more oxygen to aid the decay of dead vegetation.

Temperature at surface

Temperature at bottom (if deeper than 3')



The temperature of surface water can very easily be measured, whereas measuring the bottom temperature is more difficult. A sample can be made by dropping a container to the bottom, letting it fill, quickly pulling to the surface, and measuring the temperature. This procedure is not as accurate as other methods but is very reasonable and adequate. There are several instruments on the market that will give a more accurate reading.

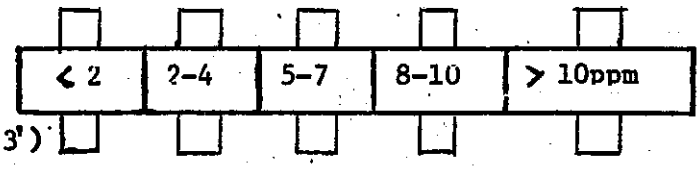
3. DISSOLVED OXYGEN

The Dissolved Oxygen (D.O.) content will affect the type and amount of life found in the water. The higher quality fish are found in waters with high D.O. levels. As the D.O. level decreases, many fish (other than rough fish) cannot survive. A high D.O. level is necessary in the early stages of their life cycle.

D.O. is directly related to water temperature. The colder water has a greater capacity to hold oxygen. Therefore, temperature and D.O. combine to affect the quality of life in water.

D.O. at surface

D.O. at bottom (if deeper than 3')



D.O. is measured in parts per million (ppm).

A D.O. level less than 2ppm is considered extremely bad with few if any fish present.

D.O. levels of 2-4 ppm are bad with just the poorest quality fish living here.
D.O. levels of 5-7 ppm are fair for fish life.
D.O. levels of 8-10 ppm are considered good with many high quality fish present.
A D.O. level over 10 ppm is considered extremely good for fish life, but is uncommon.

A suggested test procedure is in the appendix.

4. TURBIDITY OF WATER

This is a measurement of the cloudiness of water caused by humus, silt, organic debris, and other products suspended in the water. Turbidity affects the amount of light that can enter into the lower levels of the water thereby affecting the temperature and the dissolved oxygen level.

<25ppm very low	25-80 low	80-200 medium	200-400 high	> 400 ppm very high

A certain amount of turbidity is desirable. Water will generally have a low productivity when turbidity is below 25 ppm, as well as when the turbidity is over 200 ppm.

The easiest method of testing turbidity is to prepare standards to which the samples in question can be compared. (One ppm is one milligram of soil per liter of water. Therefore, 25 mg soil in one liter of water will give a 25 ppm turbidity reading.)

5. CHEMICAL NUTRIENTS IN WATER

Just recently, we have become concerned about the level of nutrients in our water. The major nutrients--nitrogen and phosphorous--combine to cause excess algae and aquatic weed growth when they are present in high amounts. This resultant growth dies during the winter and settles to the bottom where decomposition begins. The aerobic process of decomposition requires oxygen, thereby interfering with fish life.

NITROGEN. This nutrient enters water through several means--surface runoff carrying fertilizer, effluent carrying human and/or animal wastes, ground water or seepages, and bacterial fixation. A certain quantity is essential in the life process of protein formation and is released through decomposition. At levels above 10 ppm, nitrate-nitrogen is dangerous to human infants as well as aquatic life.

VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH

Test_____ppm

The test procedure is described in the appendix. The very low range is 0, low 1-3 ppm, medium 4-6 ppm, high 7-10 ppm and very high over 10 ppm. The optimum level for nitrate-nitrogen in water is under 7.0 ppm.

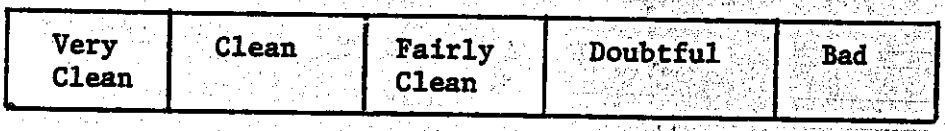
PHOSPHATES. This nutrient is often classified as the most serious pollutant to our bodies of water because of its affect on algae growth. It is normally used in very small quantities by plants, thereby giving a very low pollutant level. Phosphates enter the water through sewage and effluents, detergents, industrial wastes, and surface run-off carrying fertilizers.

Given_____ppm

Because of the various forms and types of phosphates, testing is extremely difficult. A suggested test procedure is in the appendix. In general, we classify the low range as under 0.5 ppm, medium 0.5-1.0 ppm, and high over 1.0 ppm. The optimum level for phosphates is under 1.0 ppm.

6. BIOCHEMICAL OXYGEN DEMAND

The Biochemical Oxygen Demand (B.O.D.) is the amount of oxygen needed to decompose dead and decaying organic matter and to meet the demand of living organisms. This measurement is compared with the dissolved oxygen (D.O.) test. If the B.O.D. test result is as great or nearly as great as the D.O., aquatic animals may not have enough oxygen to sustain life.



Given_____ppm

The test for B.O.D. takes five (5) days to complete. The results then are expressed in parts per million dissolved oxygen absorbed in five days. Very clean water has less than 1 ppm B.O.D., clean 1-2 ppm, fairly clean 3-4 ppm, doubtful 5-10 ppm and bad over 10 ppm. A suggested test procedure is in the appendix.

B. AIR COMPONENT OF THE SITE

Clear air is as important as clean water. Although we cannot see clean air, we cannot live without it. The average person breathes 35 pounds of air each day, which is more than the food we eat and the water we drink combined.

Air pollution may be defined as contamination of the air by waste products of man's activities. This pollution limits visibility, may be injurious to life, and certainly interferes with the enjoyment of life.

There are many types of aerial garbage (pollutants): carbon monoxide--the odorless, tasteless, poisonous gas that depletes the oxygen content of our blood, causing death. Sulfur dioxide--the gases given off during coal and oil burning, causing metals to rust, limited visibility, irritations of the eyes, nose, throat, and possibly the lungs. Nitrogen oxides--these status-symbol pollutants (so called because they only occur in highly advanced countries) are yellowish-brown in color and have a pungent, sweetish odor, which is detectable at 1 to 3 parts per million. Hydrocarbons--these unburned chemicals are, generally, dangerous only in very high concentrations. However, they may react in the atmosphere to form smog.

1. VISIBILITY

Visibility is defined as the distance one can see. High visibility would allow us to see to the horizon. However, as stated above, this visibility may be limited by pollution. As we evaluate the environment we must know what is causing the reduced visibility.

Time of Day:_____

Clear	Haze	Fog	Smog

CLEAR. Unlimited visibility.

HAZE. A slightly limited visibility caused by "particulate matter" under dry weather conditions.

FOG. A limited visibility caused by the condensation of water vapor in the air.

SMOG. A mixture of smoke and fog. The limited visibility resulting from the sun's effect on certain pollutants in the air, notably those from automobile exhaust --the chemical changes brought about by the radiant energy of the sun acting upon various polluting substances. The products are known as "photochemical smog".

2. PARTICULATE MATTER

Particulate matter may be solid or liquid droplets. These particles may settle out of the air to soil clothing and dirty window sills or may stay suspended to cause irritations to the respiratory system or do other damage. The density of particulate matter is very important in evaluating air quality.

Check all three locations:

	Very Low	Low	Moderate	High	Very High
Location 1	____	____	____	____	____
Location 2	____	____	____	____	____
Location 3	____	____	____	____	____

VERY LOW. No particulate matter present; "Clear"

LOW. Less than 20% density; "Hazy"

MODERATE. 20-40% density; "Grayish"--particulate matter definitely present

HIGH. 40-60% density; "Dark"

VERY HIGH. Over 60% density; "Very dark"

NOTE: The Ringelmann Smoke Chart can be helpful in determining the particulate matter density. The MSU version of this chart is in the appendix.

Ringelmann Smoke Chart*

A series of charts indicating the density of smoke and fumes. The charts, numbered 0 to 5, simulate various densities by presenting different percentages of black.

Chart 0 - has no black
Chart 1 - equivalent to 20% black
Chart 2 - equivalent to 40% black
Chart 3 - equivalent to 60% black
Chart 4 - equivalent to 80% black
Chart 5 - equivalent to 100% black

*Circular 8333 U. S. Department of Interior, Bureau of Mines

3. PARTICULATE SIZE

Particulates are described by type and size. Particulate size is of special significance in determining air pollution. The unit used to describe particulate size is the micron. A micron is equal to 1/1,000 of a millimeter or 1/25,000 of an inch. We can see particles over 10 microns in diameter with the naked eye. Raindrops are 400 to 5,000 microns and fog droplets are 5 to 60 microns in size.

Check all three locations:

	A Visible as individual particles	B Visible as a group of particles	C Visible only when extremely dense; detect by odor
Location 1	____	____	____
Location 2	____	____	____
Location 3	____	____	____

GROUP A. Large particles (over 10 microns) that settle out of the air near the source including soil, coarse dust, large fly ash, pollen, etc.

GROUP B. Small particles (1.0-10.0 microns) that may travel some distance in air currents to be troublesome for some distance from the source. This group includes dust and fine fly ash.

GROUP C. Minute particles (under 1.0 microns) that travel great distances and present problems over large areas including fumes, smoke, and aerosals.

4. PARTICULATE TYPE

The type of particulate matter must be identified in order to locate the source of pollution. The larger particles are easily detected and the source is nearby. Although these particles do not travel great distances, this type of pollution is of great concern in the immediate vicinity.

	Soil	Fly Ash	Pollen	Other
Location 1	____	____	____	____
Location 2	____	____	____	____
Location 3	____	____	____	____

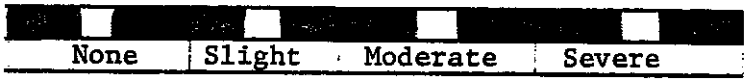
SOIL. The mineral and/or organic particles of soil.

FLY ASH. Impurities remaining after burning coal and other materials.

POLLEN. Yellowed colored powder from the stamen of flowers. It is a great concern of people with allergies, but otherwise not harmful. Pollen size may range from very small (1 micron) to extremely large (over 20 microns).

5. NOTICABLE EFFECTS ON PLANTS

Many plants are extremely sensitive to air pollution. They are readily available for observation as they show effects more rapidly than animals. Many times shrubs are used to monitor air pollution and as an aid in reducing air pollution as well as for ornamental values.



NONE. Healthy plants with no visible abnormality.

SLIGHT. Few abnormal spots on plants or few plants affected.

MODERATE. More plants or more of the plant damaged.

SEVERE. Reduced stands, deformed plants, stunted plants, and so on.

It is important to not confuse abnormalities due to nutrient deficiencies with abnormalities due to air pollution.

C. SOIL COMPONENT OF THE SITE

The soil is extremely important in overall environmental quality since it serves as the base for all life. It is the filter, storage, and reduction center for organic materials - solids, liquids, and gases - basic to sustaining life. It is the home for many micro-organisms, which are fundamental in decomposition and growth activities.

Most of our food comes either directly from the soil as cereals, fruits and vegetables or indirectly through animals (meat, milk, and eggs) as they consume grass and other feed crops. Soil--land use--is the foundation for man's activities.

As we evaluate the soil component, we must consider the location, slope, texture, color, water table depth, erosion, and permeability. Each factor is important in understanding this component.

1. POSITION

The position of our site has great effects on its usage. A floodplain site does not lend itself well to subdividing because of the occurence of seasonal floods but may lend itself very well to vegetable farming where the growing season is short and the need for irrigation is high.

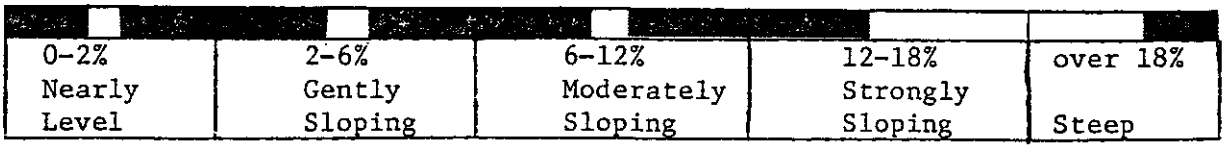
FLOODPLAIN. The lowland area adjacent to a river or stream. This area will experience flooding from time to time.

TERRACE. The area near a river or stream but high enough above the waterbed to avoid flooding on a seasonal basis.

UPLAND. The area away from rivers and streams and not subject to flooding.

2. SLOPE

The slope or lay of the land is important because it affects the amount of erosion and water runoff. The steepness also affects the speed of water runoff and the ease of cultivation. As the steepness increases, the uses of the land become more limited. Slope is expressed in percent which represents the number of feet of rise or fall in a 100 foot distance.



NEARLY LEVEL. Has no limitation on its use. Any limitations are a result of other factors.

GENTLY SLOPING. Has some erosion and must have erosion control practices applied to stabilize the site.

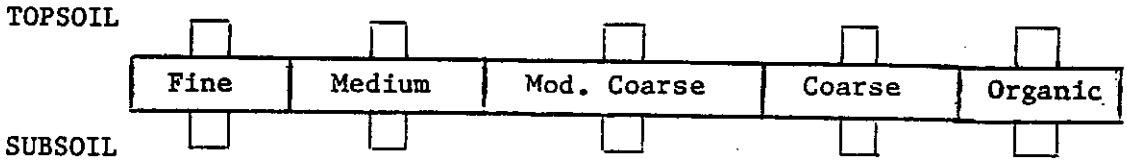
MODERATELY SLOPING. Has a greater erosion problem and must be used very carefully to avoid losing soil.

STRONGLY SLOPING. Has severe limitations and should be maintained with permanent vegetation such as grass or trees. Using this land as building sites would require careful planning to avoid a great loss of soil.

STEEP. Should be maintained in permanent vegetation, preferably trees. This land is too steep for any other use if the environment is to be maintained.

3. TEXTURE

Soil texture has a very important effect on moisture holding capacity, permeability, fertility, and erosion. Texture refers to the percentage of sand, silt, and clay. These three soil particles have distinct characteristics which allow us to determine the soil texture by rubbing a sample between our thumb and fore-finger. Sand is gritty, silt is smooth and floury, and clay is sticky when moist.



FINE-TEXTURED SOILS include clay, clay loam, silty clay loam and sandy clay loam textural classes. They are made up mostly of clay and silt but sandy clay loam contains a noticeable amount of sand. They are sticky and plastic when moist and can be formed readily into a ribbon when pressed between the thumb and fore-finger. Clay has over 40 percent clay particles, clay loam and silty clay loam have between 27 and 40 percent clay particles, while sandy clay loam has between 20 and 35 percent clay and over 45 percent sand.

MEDIUM-TEXTURED SOILS include silt loam and loam textural classes. Silt loam has more than 50 percent silt particles. Loam consists of about equal parts of sand, silt and clay particles.

MODERATELY COARSE TEXTURED SOILS include sandy loam and loamy sand textural classes. They are made of mostly different sized sand particles with less than 20 percent of clay particles present. These soils are difficult to mold when moist.

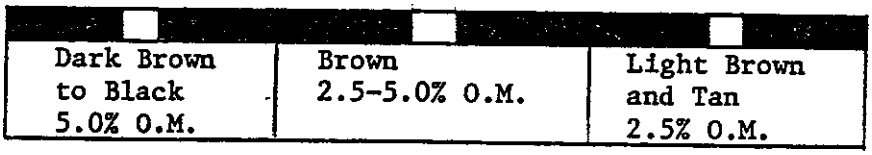
COARSE-TEXTURED SOILS include coarse and medium sands with some gravel. They contain 85 percent sand particles with a harsh, gritty feel even when moist. They will not form a stable mold when moist.

ORGANIC SOILS are mucks and peats. They are made up largely of woody and fibrous materials.

4. COLOR

Soil color is a very noticeable characteristic. The true color is easier to determine when the soil is moist rather than when soil is dry. Color indicates the organic matter content in topsoil and the natural drainage effects in subsoil.

TOPSOIL

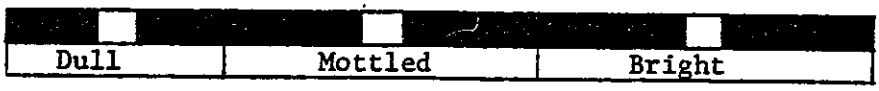


DARK BROWN. Very dark brown or black colors indicate a high organic matter content. The darkest colored surface layers have the highest organic matter content and were usually developed under naturally very poorly drained conditions.

BROWN. Grayish brown or dark grayish brown colors indicate a moderate amount of organic matter present. Most well and imperfectly drained soils having fine and medium textures are in this color group.

LIGHT BROWN. Light gray, pale yellow, or pale brown colors indicate soils that are low in organic matter. Most of the well-drained soils are in this color group.

SUBSOIL



DULL. Mainly gray colors usually with rust-brown and orange streaks and spots. These dull colors indicate that the soil developed under naturally, poorly drained conditions with the water table at or near the surface of the ground during part of the year. Artificial drainage is necessary on these soils.

MOTTLED. Mixed yellow and brown colors with some grays with many rust-brown and orange streaks and spots. This color pattern indicates the soil was developed under imperfectly drained conditions. Artificial drainage is usually needed on these soils.

BRIGHT. Reds, yellows, and brown are the principal colors. These bright solid colors indicate a soil which was formed under good natural drainage conditions.

5. DEPTH

When we consider the depth of a soil, we are concerned about the water table or impervious layers. The water table or the impervious layer (layer that water can't penetrate) can have a considerable affect on the use of the site. A shallow soil (high water table or impervious layer) may make the site unsuited for building, whereas a deep soil (low water table) may make the site ideal for many uses.

Depth to Water Table or Impervious Layer (i.e. marl or bedrock):

< 10" Very Shallow	10-20" Shallow	20-40" Mod. Deep	40-72" Deep	> 72" Very Deep

6. EROSION

Erosion is the gradual process of losing soil. It is most evident when rills and gullies are formed. However, much soil is lost before this without detection. This latter type, known as sheet erosion, is more dangerous than the former type--gully erosion. Erosion occurs as a result of wind or water action on exposed soil.

Erosion is rather difficult to recognize and classify. Attention must be given to the amount of subsoil in the surface layer.

SLIGHT. All, or nearly all, the original surface soil is present.

MODERATE. A mixture of original surface soil and subsoil.

SEVERE. Mainly subsoil. Gullies or wind blow-outs may be present.

VERY SEVERE. Severely gullied or deep wind blow-outs.

7. PERMEABILITY

Permeability is the rate at which water enters and moves through the soil. This is very important in its effect on drainage and run-off. Permeability is measured in inches per hour.

Very Slow <.05"/hr.	Slow .05-0.8"/hr.	Moderate 0.8-2.5"/hr.	Rapid 2.5-5.0"/hr.	Very Rapid >5.0"/hr.

See the permeability-percolation test procedure in the appendix.

D. BIOTA COMPONENT OF THE SITE

The biota component is the living portion of the site. This living portion involves plants and animals from trees and large animals to microscopic plants (fungi, etc.) and animals (protozoan, etc.) These living organisms may live below the surface as well as above, in water as well as soil, and may be producers or decomposers as well as consumers.

1. SOIL ORGANISMS

The soil is the home of innumerable kinds of plant and animal life ranging in size from those too small to be seen with a powerful microscope to large ones such as earthworms. Most of the soil organisms are so small you will not be able to see them without a microscope.

These organisms have a great effect on the characteristics of the soil. At the same time, such soil characteristics as soil structure, air movement, water movement, organic matter content, acidity, and management, all strongly affect the number of organisms in the soil.

Plant life that is too small to be seen without a microscope includes bacteria, fungi, and algae. Bacteria (one-celled organisms) may have a population of one (1) to four (4) billion per gram of soil. Fungi, which include molds, do not contain chlorophyll and therefore, cannot manufacture their own food. A gram of soil may contain 8,000 to one (1) million of these. Soil algae are microscopic plants that contain chlorophyll and may have as many as 100,000 present per gram of soil under favorable conditions.

Animal life in the soil includes protozoa, microscopic animals larger than bacteria; nematodes, larger and more complicated than protozoa but some still too small to be seen without a microscope; and earthworms, ants, snails, spiders, mites, and various worms and insects.

The animal life may be classified as follows:

WORMS--animals without legs such as night crawlers and earthworms.

GRUBS--worm-like animals with legs.

SNAILS--animals with spiral shaped shells; snails without shells are called slugs.

INSECTS--animals with three pairs of legs; may have hard shells or soft bodies and may be winged or wingless.

SPIDERS, MITES AND TICKS--animals with four pairs of legs.

ANIMALS with more than four pairs of legs.

OTHER--animals not classified into the above groups.

2. AQUATIC ORGANISMS

The aquatic organisms are all the plant and animal life in water (i.e. pond or stream). They include the fish--large and small--as well as the submerged plants and the microscopic organisms in the aquatic community. By various sampling methods (see appendix) we can identify the major aquatic organisms of the site.

3. DOMINANT PLANTS

The dominant plants that are present can tell us much about the natural succession of the site as well as the present use. These plants are classified as follows:

WEEDS (including aquatic plants)
Annual or Perennial

GRASSES AND SEDGES

SHRUBS

TREES UNDER 30 FEET
Deciduous or Coniferous

TREES OVER 30 FEET
Deciduous or Coniferous

4. DOMINANT ANIMALS

The dominant animals present also tell us much about natural succession. As we consider this factor we must not always expect to see the animals, but instead, should look for evidence of their presence (i.e. droppings, tracks, burrows and nests, etc.). Animals may be classified as follows:

MAMMALS
Small--mice, squirrels, rabbits, etc.
Large--possum, porcupine, muskrat,
Very Large--deer, elk, bear, etc.

BIRDS
Song Birds--robins
Game Birds--pheasant, quail, etc.
Waterfowl--ducks, geese, etc.
Other--owls, hawks, etc.

AMPHIBIANS AND REPTILES
Frogs, toads, snakes, etc.

FISH (Consider only when the site is predominantly water.)

5. FOOD WEB (P-C-D RELATIONSHIP)

When considering the food web we are concerned about the relationship of producer, consumer, and decomposer organisms as they function to maintain

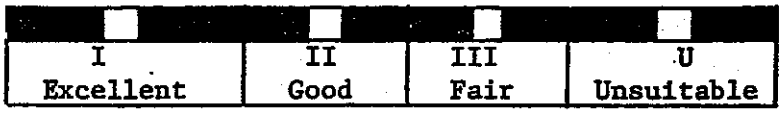
the quality environment. Producer organisms are those which use sunlight to produce food for the community (i.e. green plants). Consumer organisms are those that depend on the producers for their survival. Consumers may be herbivorous--feed on plants--or carnivorous--feed on other animals. Decomposer organisms feed on dead plants and animals to break them down into their constituent substances and release these substances (water, nitrogen, carbon dioxide, etc.) for use by the producers. The decomposers make the cycle complete so that each of the three groups depend on the others for their food.

SUITABILITY FOR USES

As consideration is given to the suitability of the site for various uses, a major indicator is found in the characteristics of the component parts--as tested and evaluated in SITE COMPONENTS. A review of the water, air, and soil components' physical characteristics will help identify any "LIMITING FACTORS" and assist in determining the "USE SUITABILITY INDEX" of the site for each planned use. It also identifies those characteristics which make the site especially good for certain uses.

A. USE SUITABILITY INDEX (U.S.I.)

The use suitability index is the degree of suitability of the site for a specific use--an indicator of the capability of the ecosystem to meet man's use needs.



I. EXCELLENT. The site has only slight limitations and is extremely suitable for the use.

II. GOOD. The site has moderate limitations for the use which can be overcome with management practices.

III. FAIR. The site has severe limitations for the proposed use and requires intensive management practices to maintain the environmental quality.

U. UNSUITABLE. The site has very severe limitations for the proposed use. These limitations are too extensive and/or severe to be overcome by management practices.

B. LIMITING FACTORS (L.F.)

The limiting factor (L.F.) is the characteristic or condition of the site that limits the suitability of the site for a proposed use. It is the factor which is the key to determining the USE SUITABILITY INDEX--the factor which determines the suitability of the site for a proposed use. The L.F. represents the weakest-link-in-the-chain of characteristics that must be considered for any specific proposed use. It also is important in determining the management practices needed to maintain E.Q. NOTE: More than one L.F. is usually involved in determining U.S.I.

The site component factors you have evaluated that are especially important in determining U.S.I. and L.F. are found in the Appendix as "SITE COMPONENT CHARTS".

C. EXAMPLE

Determine the U.S.I. and L.F. for the following use: RESIDENTIAL--Homes with septic tanks.

The "Site Component Charts" indicate that the air, water, and biota components are suitable for this use, however, the soil component evaluation gave us the following information:

Position: Upland - I
Slope: Moderate - III
Subsoil Texture: Fine - III
Subsoil Color: Mottled - II
Depth: Deep - I
Erosion: Severe - III
Permeability: Slow - III

Using the "SITE COMPONENT CHART - SOIL" we find the U.S.I. as III - Fair with the L.F. being slope, texture, erosion, and permeability. These factors are the "weakest-link-in-the-chain" for this site and limit its suitability for this use.

E. Q. EVALUATION

This part of ecosystem analysis is the most difficult but the most important if a quality environment is to be maintained. As we consider the ecological factors, we must also consider economic, social, and political factors such as land values, tax rates, zoning ordinances, population growth, and others.

It is important to consider the "human needs" factors if we are to ably make decisions as to the "best" use of the site, the limitations to E.Q., and the corrective practices or actions to maintain or improve the environmental quality.

A. BEST USE FOR THE SITE

To select the best use for the site consider the USE SUITABILITY INDEX and the "human needs" data. (A sample of the data to consider is found in the Appendix.)

Agriculture	Natural Resources	Recreational	Residential	Industrial Commercial

See "SITE OVERVIEW" for a description of these use categories.

B. LIMITATIONS TO E.Q.

As the site is evaluated, several items can be identified as being limitations to a quality environment. These limitations should be considered in line with the BEST USE that is proposed for this site.

Select_____items

1. Site Location
2. Site Stability
3. Solid Waste--Litter
4. Water Quality
5. Stream Sedimentation
6. Air Quality
7. Flooding
8. Steep Slopes
9. Soil Erosion
10. Permeability
11. Animal Waste
12. Toxic Materials

C. SUGGESTED PRACTICES AND CORRECTIVE ACTIONS

Not only must limitations be identified but the necessary actions needed to maintain a quality environment must also be identified. We must be positive in analyzing an ecosystem in that these corrective actions will improve our environment. Several practices may be suggested as necessary corrective actions. The following list of practices is only a few possibilities. Let your imagination and technology identify other possibilities as they become available and practical.

Select_____practices

1. Monitor for pollution
2. Stabilize stream banks
3. Treat waste water
4. Replace septic tank with sewer system
5. Control weeds for pollen control
6. Install air pollution controls
7. Control erosion
8. Install windbreaks
9. Improve wildlife habitat
10. Install artificial soil drainage
11. Rezone as Greenbelt
12. Plant shrubs and trees for noise control, site barriers, etc.

APPENDIX

APPENDIX A - Water Component
- Oxygen Tests
- Chemical Nutrient Tests

APPENDIX B - Air Component
- Smoke Chart
- Particulates

APPENDIX C - Soil Component
- Permeability Test

APPENDIX D - Biota Component
- Soil Organisms
- Aquatic Organisms
- Plant Succession Chart
- P-C-D Relationships

APPENDIX E - Suitability for Use
- Site Component Chart - Water
- Site Component Chart - Air
- Site Component Chart - Soil

APPENDIX F - Human Needs Data
- Urban
- Suburban
- Rural

APPENDIX G - Selected References

APPENDIX A

DISSOLVED OXYGEN (DO)

DO values reflect the quantity of molecular oxygen dissolved in water- measured in ppm. Procedure: Refer to the Hach Kit or the La Motte Kit. Complete directions are included:

Hach Chemical Company
P. O. Box 907
Ames, Iowa 50010

La Motte Chemical Products
Educational Products Division
Chestertown, Maryland 21620

BIOCHEMICAL OXYGEN DEMAND (BOD)

BOD values reflect the quantity of molecular oxygen required for the decomposition of organic compounds by aerobic biochemical processes. BOD values serve as an index of the pollution strength of wastes by measuring the amount of oxygen which may be removed from water supplies as these wastes are being aerobically stabilized. If the BOD value is as great or nearly as great as the dissolved oxygen (D.O.), the aquatic animals may not have enough oxygen to sustain life. BOD is measured in ppm dissolved oxygen absorbed in 5 days. Procedure: Refer to the Hach or La Motte kits.

PHOSPHATE TEST

The phosphate ion exists in both organic and inorganic forms. With the exception of bottom sediments, and samples containing algae and suspended particles which may possess organic phosphorous as a major phosphorous form, emphasis is placed on analytical evaluations of the inorganic forms.

Procedure: Refer to the HACH Kit or the LA MOTTE Kit. Both are excellent "teaching tools". Usually, accuracy of test will be reinforced by a testing - sampling by an authorized agency.

APPENDIX A

NITRATE-NITROGEN TEST

A. MATERIAL NEEDED

1. Nitrate Powder. This chemical reagent can be obtained from the soil testing laboratory, crop and soil sciences department, M.S.U., East Lansing, Michigan 48823. Cost is $1.00 per vial.
2. Several small bottles.
3. Distilled water. (May use drinking water if it does not contain nitrates.)
4. Water samples. (Well water, tile water, river water, rain water, melted snow, or irrigation water.)
5. Measuring cup.

B. PROCEDURE

1. Use clean bottles and equipment rinsed with distilled water.
2. To a clean bottle add 1/4 cup of water sample.
3. Add a pinch (1/8 teaspoon or less) of nitrate powder.
4. Shake continuously for 5 minutes.
5. Shake intermittently for another 10 minutes.
6. Let stand for 5 minutes.
7. Read color within next 10 minutes.
8. Compare the color of the liquid with the color chart (found in container with nitrate powder.)
9. If color is dark reddish-pink, dilute with 1/2 cup of distilled water, shake and reread the color of the diluted sample.

WARNING: The nitrate powder used in this procedure is a mixture of several chemical reagents and should be used only for chemical purposes. This material can be toxic if swallowed.

APPENDIX B

PARTICULATE MATTER - DENSITY

A first concern in air quality is the determination of particulate matter density. The "smoke chart", on the following page, can help check for air pollution; the density of particulate matter.

Mount the smoke chart on a board or heavy cardboard. Drill a hole in the center of the circle. Hold the chart at arm's length. View the air through the hole and compare to the nearest level of blackness on the chart.

Take more than one reading to get good results. Don't look toward the sun. The background should always be clear of tall buildings and dark clouds.

PARTICULATE MATTER - SIZE and TYPE

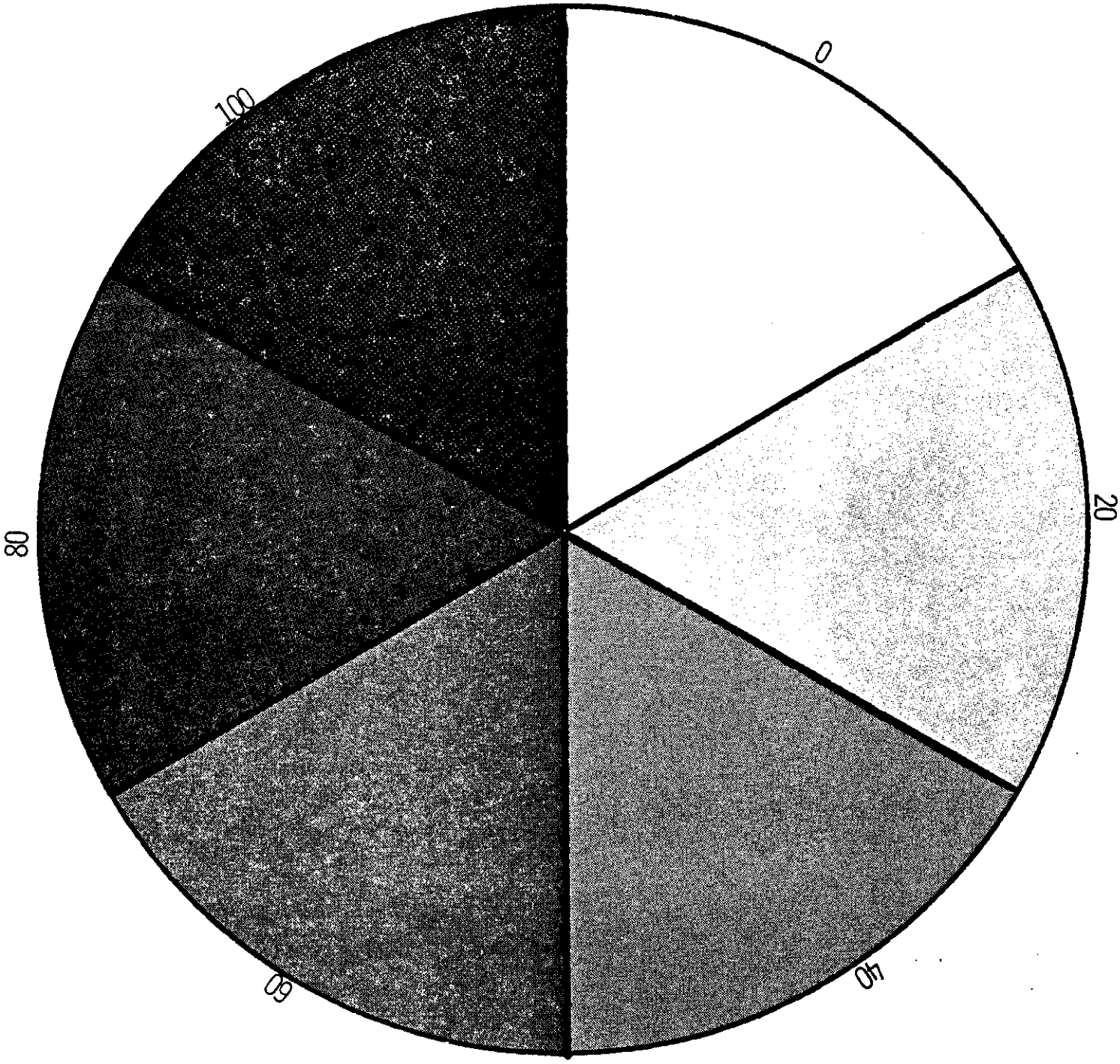
To determine the size and type of particulate matter in the air, establish three, or more, "check-point" locations. Every effort should be made to select check-point locations that will reflect the average condition of the site.

Procedure: Place a stake (3 to 4 feet high) at each location. Place a small (1" x 4") or (2" x 6") flat surface on the top of each stake. Use a 4" to 6" length of masking tape, folded and connected, with the "sticky" portion exposed. Place this on top of the flat surface.

Observe each location after 24 hours. Check for quantity of particulate matter, size and type. Note: A small hand lens (5-10 power strength) will be very helpful especially in determining the type of particulate matter.

APPENDIX B

SMOKE CHART



APPENDIX C

PERMEABILITY TEST

A. EQUIPMENT NEEDED

1. Large metal fruit or vegetable juice cans.
2. Board 1" thick, 4" wide, 12" long.
3. Hammer
4. 12" ruler
5. Watch with second hand
6. Container of water

B. PROCEDURE

1. Remove one end of the juice cans below the rim. This will give a sharp edge that can be driven into ground easily. Remove the other end leaving the rim. Mark the can two (2) inches from the end without the rim.
2. In the desired location, drive the can into the ground up to the two inch mark. Place the board over the can and tap with the hammer until the desired depth is reached. Be careful not to disturb the natural situation--leaving all plant materials and soil as they were when you arrived on the site.
3. Add the water and record the time for one inch of water to be absorbed.

APPENDIX D

SOIL ORGANISMS - SAMPLING METHODS

A. EQUIPMENT NEEDED

1. Heavy paper bags (shopping bags are excellent.)
2. A spade
3. Several small bottles or jars
4. A hand lens
5. A ruler or yard stick
6. Several sheets of white paper
7. One foot square of 1/2 inch hardware cloth or screen

B. PROCEDURE

1. Measure an area 1-foot square and collect the soil to a 2-3 inch depth. Take samples from several locations on the site (i.e. fence rows, badly eroded spots, cultivated areas, wooded areas, etc.
2. Remove the soil and place in bag. Watch for burrows of worms or other animals and insect egg masses or pods.
3. Pour the samples on separate sheets of white paper. (Examining indoors works best to prevent small specimens from blowing away.)
4. Carefully examine the soil for the living organisms. The screen may be helpful in locating the smaller organisms which may otherwise not be found.
5. Place the different organisms in separate jars according to the seven categories:

   Worms
   Grubs
   Snails
   Insects
   Spiders, Mites, Ticks
   Animals
   Other

APPENDIX D

AQUATIC ORGANISMS - SAMPLING METHODS

A. EQUIPMENT NEEDED

1. Hand screen
2. Sieve net
3. Plankton net
4. Dip net
5. Large jars with covers
6. Boots or waders
7. Hand lens
8. White lined dishes about 2 inches deep
9. Small bottles or jar

B. PROCEDURE

1. The hand screen is most useful in fast moving streams. It is held in the current by one person while another turns stones on the upstream side. The dislodged organisms are washed downstream onto the screen which is then lifted from the water. The catch is then dumped into a white lined dish for examination or into a large jar for transporting to the laboratory.

   A hand screen can easily be made with two wooden handles and a sheet of wire screen 1 foot by 2 feet. Saw slots into the handles insert the screen and nail in place. If the edges of the screen are folded, there will be no projections to prick fingers.

2. The sieve net is most useful in collecting bottom forms. It will gather mud and sift it in one operation while gathering the organisms found at the bottom of ponds. The collection is then dumped into the white lined dishes or into the jars.

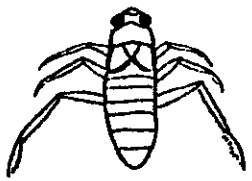
3. The plankton net is useful in collecting microscopic life in open water. This net is easily made from No. 12 silk bolting cloth.

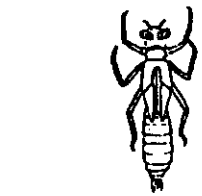
4. The dip net is useful when making collections in and around weed beds in ponds.

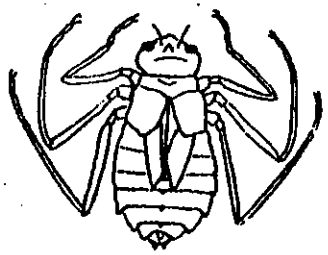
5. Once the collection is made, examination is carried out by use of the white dishes or trays. The living organisms are easily spotted by their activity. They can then be removed from the sample and placed in smaller jars for further identification.

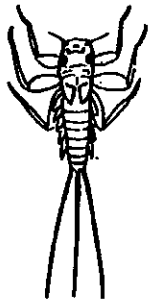
WING PADS ONLY

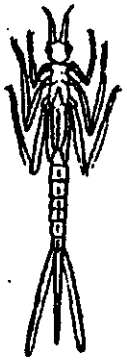
- without tails (caudal cerci)
  - with pointed or blunt "beak" (no extendible lower lip) → NYMPHS (Hemiptera) (TRUE BUGS)
  - extendible lower lip (labium) → DRAGONFLIES (Odonata Anisoptera)
- with tails (caudual cerci)
  - 2 tails → STONEFLIES (Plecoptera)
  - 3 tails
    - hair-like tails → MAYFLIES (Ephemeroptera)
    - plate-like tails → DAMSELFLIES (Odonata Zygoptera)











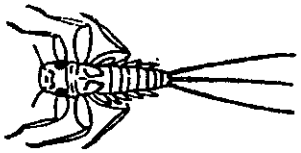
ARTIFICAL KEY TO THE ORDERS OF AQUATIC INSECTS

(This KEY should allow for recognition of Michigan aquatic insects with about 90 percent efficiency. Only the active stages found in the water are treated; i.e. larvae, nymphs and adult Coleoptera and Hemiptera.)

Six jointed legs

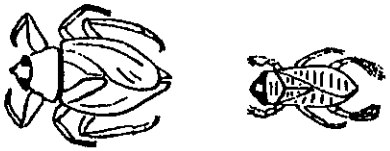
STONEFLIES (Plecoptera)

MAYFLIES (Emphemeroptera)

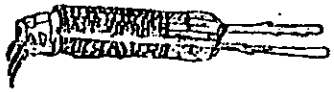


DRAGONFLIES AND DAMSELFLIES (Odonata)

TRUE BUGS (Hemiptera)



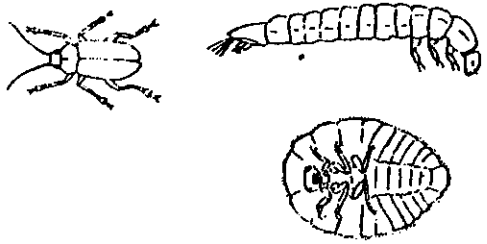
CADDISFLIES (Prichoptera)



MOTHS (Lepidoptera)

DOBSONFLIES, ALDERFLIES AND FISHFLIES (Megaloptera)

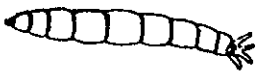
BEETLES (Coleoptera)



No jointed legs, at most pseudopods or creeping welts

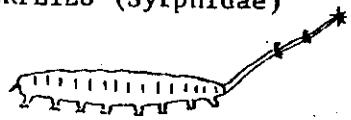
TRUE FLIES (Diptera)

CRANEFLIES (Tipuliade)

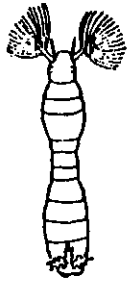


SOLDERFLIES (Stratiomyiidae)

FLOWERFLIES (Syrphidae)

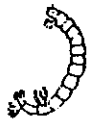


BLACKFLIES (Simuliidae)



DIXIDS (Dixidae)

MIDGES (Chironomidae)



BITING MIDGES (Certopogonidae)

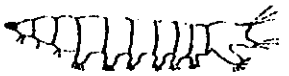
DEERFLIES AND HORSEFLIES (Tabanidae)

MOTHFLIES (Psychodidae)

SNIPEFLIES (Rhagionidao)

MOSQUITOES (Culicidao)

DANCEFLIES (Emphididae)



SIX JOINTED LEGS

Portable case of mineral or organic matter

No case

Without Wing pads (developing wings)

With wing pads (developing wings) or wings (wings may be hidden under covers)

with anal hooks

without anal hooks

wings hidden under covers

wing pads only (GO TO NEXT PAGE)

without lateral filaments (may have ventral gills)

with lateral filaments

with fleshy abdominal prolegs

without fleshy abdominal prolegs

without pointed (or blunt) "beak"

with pointed (or blunt) "beak"

CADDISFLIES (Trichoptera)

DOBSONFLIES, ALDERFLIES, FISHFLIES (Megaloptera)

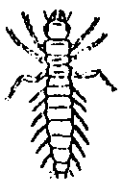
AQUATIC MOTHS (Lepidoptera)

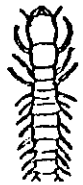
Larvae

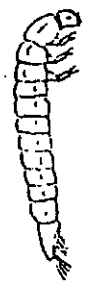
BEETLES (Coleoptera)

Adults

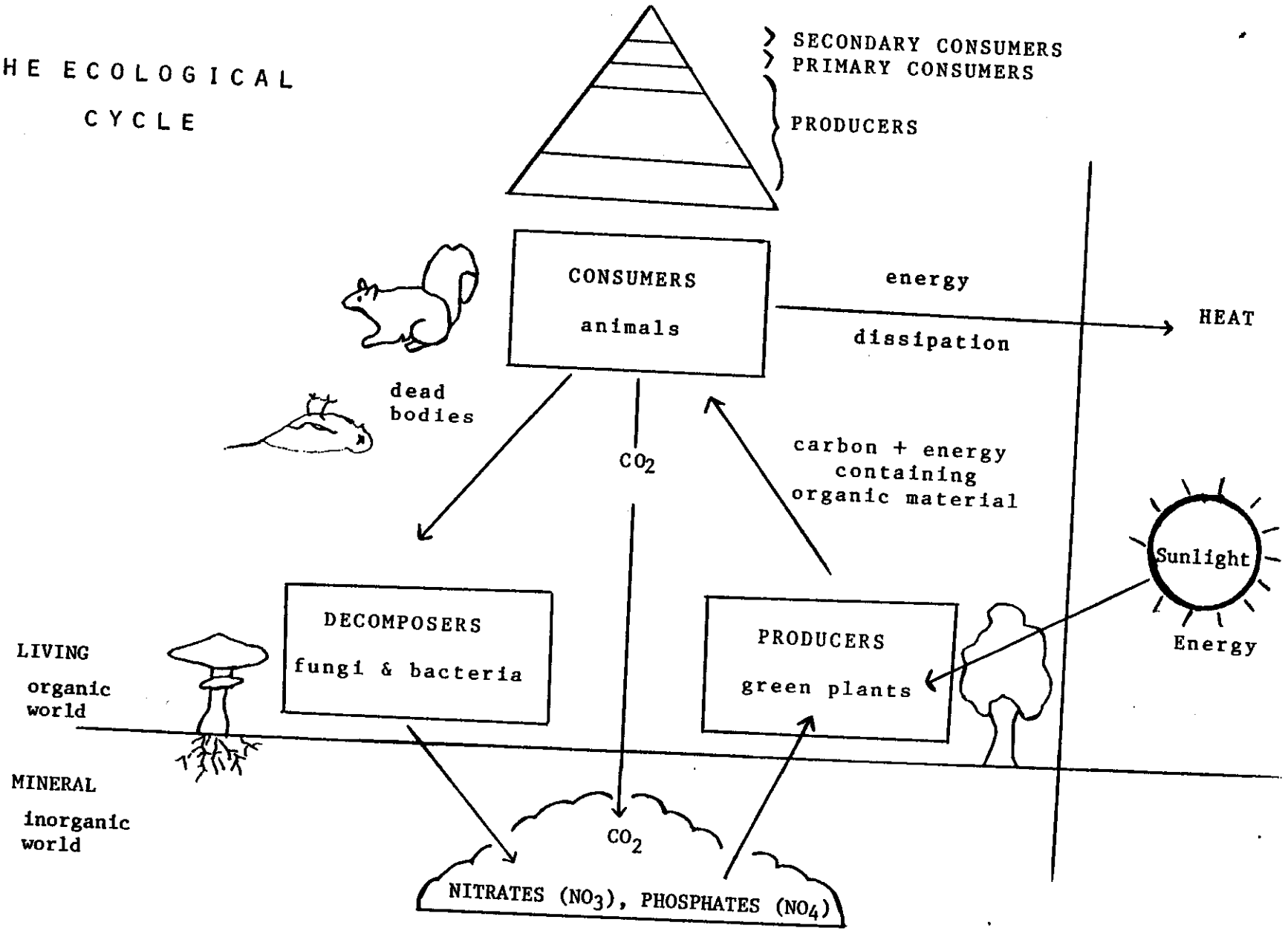
TRUE BUGS ADULTS (Hemiptera)







THE ECOLOGICAL CYCLE



APPENDIX D "Producer-Consumer-Decomposer Relationship"

APPENDIX E

SITE COMPONENT CHARTS
To Determine
SUITABILITY FOR USE

The following SITE COMPONENT CHARTS for AIR, WATER and SOIL are designed to assist in making decisions as to the suitability of the site for different uses. They offer the opportunity to assemble data and check findings for the site component "factors" investigated. The charts show the Use Suitability Index (U.S.I.) for many of the "Use Determining Factors." Note: These are not absolute values, but rather guidelines and trends.

The "factors" investigated are recognized as exhibiting U.S.I. characteristics; I (Excellent), II (Good), III (Fair), or U (Unsuitable) for a specific use. Example - An Air component factor of very high Particulate Matter indicates a U (unsuitable) for Recreational Use. A water component factor of clean Biochemical Oxygen Demand is an indication of a I (excellent) for Agriculture - Cropland use.

In addition, the plant and animal communities (the Biota Component of the Site) serve as "bioindicators" of the suitability of the Present Use of the site and give insight to the character of the ecosystem.

SITE COMPONENT CHART -- AIR

U. S. I. Characteristics of AIR "FACTORS"	AGRICULTURE -Cropland	NAT. RESOURCES -For. and Wild.	RECREATIONAL -fish pond	RESIDENTIAL -Homes w/S.T.	INDUST./COMM -Shoppi
Particulate Matter					
V. Low	I	I	I	I	I
Low	I	I	I	I	I
Moderate	II,III	II	II	II	II
High	III,U	III,U	III,U	III	III
V. High	III,U	III,U	U	U	III,U
Noticeable Effects on Plants					
None	I	I	I	I	I
Slight	II	II,III	II,III	II	II
Moderate	III	III,U	III,U	III	III
Severe	U	U	U	U	U

APPENDIX E

SITE COMPONENT CHART -- WATER

U. S. I. Characteristics of WATER "FACTORS"	AGRICULTURE -Cropland	NAT. RESOURCES -For. and Wild.	RECREATIONAL -fish pond	RESIDENTIAL -Homes w/S.T.	INDUST./COMMERC. -Shopping Cente
Temperature:					
< 50°	I	I	I	I	I
50-60°	I	I	I,II	I	I
60-70°	II	II	II,III	I,II	I,II
70-80°	III	III	III,U	II,III	II,III
80-90°	III,U	III,U	U	III,U	III,U
Dissolved Oxygen (D.O.)					
< 2 ppm	III,U	U	U	III,U	III,U
2-4	II	III,U	III,U	II	II
5-7	I	I	I	I	I
8-10	I	I	I	I	I
> 10 ppm	I	I	I	I	I
Turbidity (ppm)					
V. Low	I	II	II	I	I
Low	I	I	I	I	I
Medium	II,III	II,III	II,III	II	II
High	III,U	III,U	III,U	III	III
V. High	U	U	U	U,III	U,III
Chemicals Nutrients: (NITROGEN)					
V. Low	III	II,III	II,U	II,III	II,III
Low	II	I,II	II	I,II	I,II
Medium	I	I	I	I	I
High	II	II,III	I,II	II,III	II,III
V. High	III,U	III,U	III,U	III,U	III,U
Chemical Nutrients: (PHOSPHATES)					
Low	II	II	II	I,II	I,II
Medium	II	II	I,II	II,III	II,III
High	III,U	III,U	III,U	III,U	III,U
B. O. D.					
V. Clean	I	I	I	I	I
Clean	I	I	I,II	I	I
Fairly Clean	II	II	II,III	II	II
Doubtful	III	III	III,U	III	III
Bad	U,III	U	U	U,III	U,III

APPENDIX E

SITE COMPONENT CHART — SOIL

U.S.I. CHARACTERISTICS OF SOIL "FACTORS"	AGRICULTURE - Cropland	NAT. RESOURCES - Forestry and Wildlife	RECREATION - Fish Pond	RESIDENTIAL - Home with Septic Tank	INDUSTRIAL/ COMMERICAL - Shopping Center
1. Position:					
Floodplain	III	II	II, III	U	U
Terrace	I	I	I, II	II, III	II
Upland	I	I	I	I, II	I
2. Slope:					
Nearly Level	I	I	I	I	I
Gently Sloping	II	I	II	II	II
Moderately Sloping	III	I	II	III	III
Strongly Sloping	U	II	U	III	U
Steep	U	III	U	U	U
3. Texture: (Subsoil)					
Fine	I	I	I	III	II
Medium	I	I	II	II	I
Moderately Coarse	II	I	III	I	I, II
Coarse	III	II	U	I	II, III
Organic	III	II		U	U
4. Color: (Subsoil)					
Dull	II	I	III, II	III, U	III
Mottled	I	I	II, I	II, III	II
Bright	I	I	I	I	I
5. Depth:					
Very Deep	I	I	I	I	I
Deep	I	I	I	I	I
Moderately Deep	II	I	I	I	I
Shallow	III	II	II, III	III	III
Very Shallow	U	III	III, U	U	U
6. Erosion:					
Slight	I	I	I	I	I
Moderate	II	I	II	II	II
Severe	III	II	III	III	III
Very Severe	U	III	U	U	U
7. Permeability:					
Very Slow	II	II, III	III, II	U	III
Slow	I	I, II	II, I	III, II	II
Moderate	I	I	I	I	I
Rapid	II	II	III	I	I, II
Very Rapid	III	II, III	U	II	II, III

HUMAN NEEDS

In recognizing human needs, each site must be considered as a part of the whole environment; an ecosystem with man as part of the "community of living organisms". A number of conditions combine to reflect the potential of a site in meeting human needs. In choosing the "Best Use" for the site, the decision should be made in light of your "site findings", plus, the apparent conditions in the area regarding man's activities and needs. These conditions vary, depending on where the site is located; rural, suburban or urban.

RURAL - The site is often considered for only a few uses, until the pressures from an expanding community, or transportation, recreation or industrial development are realized. This often causes a conflict between a much needed "productive or protective" use and a man-oriented use. Consider the following conditions in a rural area:

- -Land values
- -Tax rates
- -Zoning ordinances
- -Population growth
- -Commerce and Industry
- -Recreational Development
- -Community development
- -Needed services

SUBURBAN - the site is invariably affected by both rural and urban activities and human needs. People living in a suburban area tend to travel a great deal; to work, to play, to most everything. One should expect transportation and services to be high priority factors, also housing, commerce centers and recreation. Consider both rural and urban conditions for human needs in - suburban area.

URBAN - the site may be considered for a great number of uses. It is often under extreme pressure for certain uses that meet the needs of a "growing economy". Consider the following conditions for meeting human needs in an urban area:

- -Local government action re: zoning, development, etc.
- -Taxes (for the site)
- -Population; trends -- housing needs
- -Water supply - source
- -Sewage and storm sewage facilities - age and adequacy
- - Industrial activity and commerce
- -Energy - source, capacity for expansion
- -Transportation; streets, highways, rail, air
- -Recreation; parks, golf courses, camp grounds

EXAMPLE: An Urban Site Situation - The Human Needs FACTORS

Present concern is for more housing and shopping centers. The local government is being pressured by developers to rezone many areas. Undeveloped land values are rising rapidly. Taxes are high and rising.

The area which surrounds the site reflects a "healthy growing" city with a population of 400,000. Growth estimates are 2% per year. There are five major shopping centers and needs for more housing. The water supply is adequate for the present, but sewage treatment facilities need to be improved and enponded.

Employment - labor force exceeds 185,000 - 216 industries, one major university, 80 public schools, five hospitals. Recreation facilities include 10 golf courses, 70 parks, 11 theaters and a civic center. Local government is seeking additional tax dollars for more services.