U.S.D.A. SOIL CLASSIFICATION SYSTEM

DICTATES SITE SURFACE MANAGEMENT

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ABSTRACT

Success or failure of site surface management practices greatly affects long-term site stability. The U.S. Department of Agriculture (U.S.D.A.) soil classification system best documents those parameters which control the success of installed practices for managing both erosion and surface drainage. The U.S.D.A. system concentrates on soil characteristics in the upper three meters of the surface that support the associated flora both physically and physiologically.

The U.S.D.A. soil survey first identifies soil series based on detailed characteristics that are related to production potential. Using the production potential, land use capability classes are developed. Capability classes reveal the highest and best agronomic use for the site. Lower number classes are considered arable while higher number classes are best suited for grazing agriculture.

Application of ecological principles based on the U.S.D.A. soil survey reveals the current state of the site relative to its ecological potential. To assure success, site management practices must be chosen that are compatible with both production capability and current state of the site.

INTRODUCTION

The Texas Low-Level Radioactive Waste Disposal Authority is charged with the responsibility of locating, designing, installing, operating, and closing a disposal facility for radioactive waste generated in Texas (1). Siting criteria were developed by the Authority based on both federal and state requirements (2,3,4,5,6). Selected siting criteria were added by the Authority that are more stringent than required by current laws and regulations.

A facility conceptual design was developed considering the performance objectives of 10 CFR 61 (7). Ideally, the disposal area will comprise 50 acres, centered within a 200 acre area. A required 100 foot buffer zone will be contained within the 50 acre area and the remainder of the acreage will provide an extended buffer zone (2,4). The 50 acre area will require intensive management while the extended buffer zone area will be managed extensively.

A thorough knowledge of the land mass comprising the site is essential to support both development and management decisions. The Nuclear Regulatory Commission acknowledges that the Unified Soil Classification (USC) and the U.S.D.A. Soil Classification systems can be mutually supplemental, and using the dual system may be attractive (8). The Authority feels that the systems are synergistic. Just as the USC system affects engineering decisions, the U.S.D.A. system impacts surface management decisions of an agronomic nature. The soil survey provided by the U.S.D.A. system documents the scientific parameters on which both intensive and extensive management decisions must be based to best benefit long-term site stability and aesthetics.

SOIL CLASSIFICATION

Surface character of any land mass is a reflection of the complex of factors comprising the habitat. Ecologists most commonly identify these factors as edaphic (soil), climatic (weather), physiographic (relief), and biotic (flora and fauna) (9). None of the factors can be considered alone because each interacts with the other. Hans Jenny suggested the following formula for soil development (10).

$$S\ (soil) = f\ (C,P,R,T,B,)$$

where: C = climate
P = parent material
R = relief
T = time
B = biotic

Soils develop in layers either from parent material in place or from materials transported by water or wind. The layers are called horizons and are designated by letters in the soil profile such as depicted in Fig. 1. A soil profile may be as thin as a few centimeters and usually is not thicker than three meters. The U.S.D.A. Soil Classification System considers each mineral horizon, and based on percentage of soil particles (sand, silt, and clay), determines its soil texture.

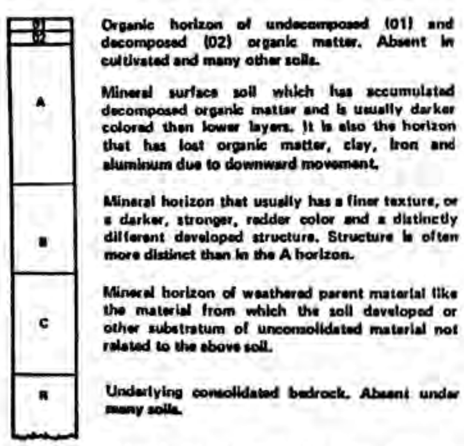

Fig. 1. Hypothetical soil profile showing the letter designation used in describing the major kinds of horizons usually present.

The soil textural triangle illustrated in Fig. 2, defines 12 soil texture classes (11). Textural classes serve as the basis for defining soil series identified on U.S.D.A. soil survey maps. Numerous other characteristics such as listed in Table I, are defined for each soil series to determine the inherent production capacity and desired management practices. The soil series serves as the basis for the present soil classification system. Soils in the United States are divided into 14,000 different soil series (12).

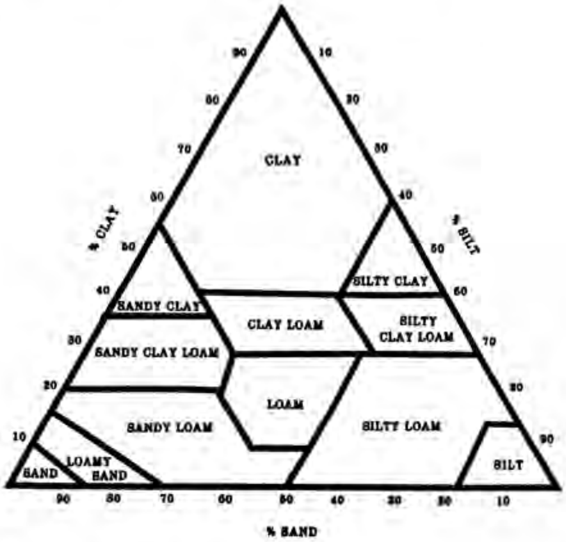

Fig. 2. Soil textural triangle.

TABLE I

Soil Characteristics Determined for Each U.S.D.A. Soil Series

Structure	Color
Consistency	Permeability
Depth	Cutans
Slope	Voids
Erosion	Concretions
Runoff	Drainage

Infiltration Rate
Water Storage Capacity
Wilting Point
Chemical Properties
Lithologic Discontinuities
Organic Matter Content

The U.S.D.A. soil series are considered together with climate and topography to define land use capability classes. These capability classes are designated by Roman Numerals I through VIII (13). Ascending numerals indicate progressively greater limitations on production and use alternatives, as well as narrower choices of management decisions. Production classes are further divided into capability subclasses designated by small letter subscripts (i.e., e, w, s, or c). Meanings of subscripts designations are as follows: "e" shows that the main limitation is risk of erosion; "w" indicates that water in or on the soil interfere with use; "s" shows production is limited by shallow or stony conditions; and "c" indicates that climatic factors are *limiting*. Capability classes I and II are arable without limitations on production and without problems requiring special management. Classes III and IV are usually considered arable, but only if wise conservation practices are incorporated. Classes V, VI, VII, and VIII are considered nonarable and best suited to grazing animal production, including wildlife, and possible recreational uses. Class I land is never assigned a subscript because few, if any, production limitations are associated.

ECOLOGICAL CONSIDERATIONS

Soils and vegetation are intricately related and, in fact, develop concomitantly. Therefore, vegetation is a function of the habitat factors, as follows (14):

V (vegetation) = f (S,R,C,T,B)

Where: S = Soil
R = Relief
C = Climate
T = Time
B = Biotic (fauna)

If left undisturbed, both soils and vegetation develop to a state of relative stability described as ecological climax (9). On a climax soil, erosion is at a minimum, horizontal development has progressed as far as possible under existing climate, downward leaching of soluble materials is in balance with upward transport by water and plants, and deposition of organic material is in balance with decay rates. Associated climax vegetation is also in a state of dynamic equilibrium (9). These unique natural landscapes are expressions of climate; where climate is the cause and vegetative climax the effect (15). Vegetative climaxes in the United States range from tundra to scrub, grasslands, forests, and tropical climaxes. In each, species are stratified as dominants and subdominants. The dominant species constitute the highest and best the site is capable of producing under existing habitat factors. Seldom is a site encountered that is in the climax state. In some cases, the site has not developed to the climax state, but, in most cases, a disclimax exists due to disturbance, most commonly caused by man. Land managers must work within sound ecological principles to ensure the success of applied practices. Land use capability classes delimited by the *U.S.D.A. soils* classification system are predicated on the interaction of all habitat factors to document production potential. To determine the current status of the site relative to its capability, an inventory of the vegetative cover is required. Species identified by the inventory are separated into categories as: decreasers; increasers; or invaders.

Decreaser species are those that should be dominant on the site. They are the most desirable and under climax conditions comprise 60 to 80 percent of the total vegetative cover. Because they are the most desirable, decreaser species are first to react to use pressure. They are so named because under heavy use pressure they decrease relative to total composition. Increaser species are subdominant and are intermediate in desirability. Under climax condition, these species make up 20 to 40 percent of the total vegetative cover. Under use pressure, they increase in importance to a point, then under abuse conditions, they also begin to decrease. Invader species are least desirable and comprise 10 percent or less of the total vegetative cover on an area in climax condition. Under use pressure these species increase and under abuse conditions may appear to be dominant. Vegetative inventory data is applied to the condition guide depicted in Fig. 3 to determine the condition of the site relative to its maximum production capacity. As vegetation deteriorates on an area, so does the soil condition; though at a much slower rate. It must be remembered that best adapted species are best competitors (9).

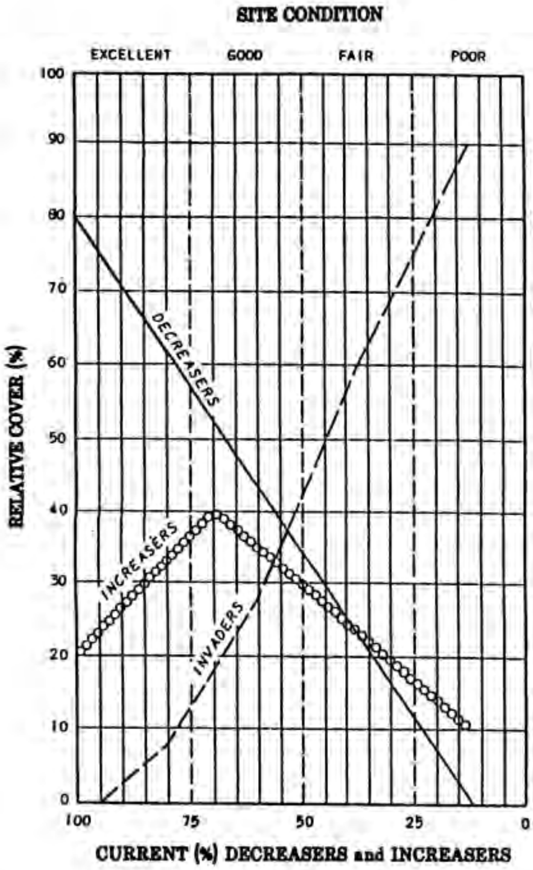

Fig. 3. Site condition guide based on percent composition of vegetative types.

SITE MANAGEMENT

Ecology is the foundation of intelligent land management (9). Land use capability and current site condition serve as the basis for sound management decisions. Requirements stipulated in laws and regulations relative to siting and licensing low-level radioactive waste disposal facilities will likely preclude siting on land capability classes V, VI, VII, and VIII. Also, it is unlikely that disposal sites will utilize class I or II land due to their designation as prime farmland. Therefore, it is probable that a low-level radioactive waste disposal facility will be located on land capability class III or IV lands. Both classes are arable, but only if inherent limiting characteristics are recognized and dealt with.

Ideally, a low-level radioactive waste disposal site will be of sufficient size to provide an extended buffer zone around the disposal area. In semi-arid and humid regions, extensive and intensive management systems will be utilized respectively on the two areas.

Intensive Management

The controlled disposal area of a facility will likely be reduced to a bare ground state because of grading and draining needs. Revegetation for erosion control will be a critical effort that requires proper consideration for success. If the land is class III or IV, the operation is even more critical. Species to be used must be selected from those native to the area or from adapted-introduced ones and attention must be given to hardiness and vigor of the species. A turf forming cover will probably be desired. Intensive management practices are required annually or periodically within a year, including: renovating, fertilizing, weed control (mowing or herbicide spraying), and, if possible, supplemental watering.

Extensive Management

The extended buffer zone around the actual disposal area will best be managed extensively within its natural potential. Some cultural practices may be required, but not on an annual or more frequent basis. Practices such as brush management (mechanical and/or chemical), water development, fencing, and controlled utilization may be needed. Management practices should be based on production capacity with attention to wildlife species endemic to the area. Proper management will provide habitat to support species for monitoring purposes. Managing the extended buffer zone in a natural state with the objective of promoting an ecological climax condition will greatly improve the aesthetics of most areas.

CONCLUSION

Any land area is a complex of habitat factors capable of producing a unique natural landscape. Understanding the habitat factors and their interrelationship is basic to wise management decisions. The U.S.D.A. soil classification system best provides the data needed to design and carry out desired site surface management objectives. Site surface management decisions based on sound scientific data will enhance both success of practices utilized and long-term site stability. Site management within its ecological limits will provide the most passive long-term maintenance. Principles discussed herein are applicable to any land area including low-level radioactive waste disposal sites.

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