**NEW MEXICO OVERBURDEN**
**AND SOILS INVENTORY AND HANDLING GUIDELINES**
**Updated September 8, 2009**

These "Guidelines" have been compiled in an attempt to improve mutual understanding of overburden and soil sampling, analysis and handling which will enhance successful revegetation and reclamation of areas disturbed during surface mining operations. See Sections 19.8.8.803, 8.810, 9.906, 20.2004 through 20.2008, 20.2016 and 20.2056 NMAC, the New Mexico Coal Surface Mining Commission Rule.

In addition to these guidelines, early consultation between Mining and Minerals Division (MMD) and the applicant will lead to better mutual understanding for both parties. The first consultation should be initiated by the mine applicant's representative as early as possible.

## OVERBURDEN EVALUATION

### Pre-Application Meeting

overburden sampling ultimately depends on site specific factors: the homogeneity of the geology, what is known or not known about the likelihood of there being undesirable overburden, topography, and the type of mining. As such, a "pre-application meeting" will be helpful in deciding on the appropriate number of drill holes, their locations, and related matters, such as their possible establishment as water monitoring wells. The permittee should arrange to have a meeting with MMD, preferable before exploration drilling is done. If the proposed permit area includes Federal or Indian land or coal, OSM representatives should be invited to participate in the meeting.

### Sampling Density

The intensity of drill holes needed to characterize the geologic column in a given area depends on those factors, referred to in the preceding paragraph. Density of drill holes in North Dakota, Montana, Wyoming and Colorado range from 1 to 16 holes per section (640 acres). When the area to be mined has been extensively explored and the strata is quite uniform, one drill hole per section may be adequate for the initial evaluation. At least two drill holes are needed for all except very small permits. The number of additional drill holes needed can be determined after initial drill hole data and other available information has been carefully evaluated. Subsequent drilling or highwall sampling may be needed to adequately characterize and locate different materials. Strata that is exceptionally high in toxic materials, e.g. 10 parts per million of selenium, should be accurately

located unless the mining operation results in placement of the entire selenium bearing strata below the root zone and above the water table. The drill hole samples may be supplemented or partially replaced by samples taken from highwalls. Overburden sample sites should be shown on a map, preferably the geology map.

**Sampling Intervals**

Major lithologic units should be sampled in 10 foot increments. All major lithologic units less than 10 feet and more than two feet thick should be sampled. An eight foot layer of shale that contains several two or three-inch thick sandstone lenses may be represented by a single sample with documentation identifying lithologic changes. All carbonaceous shale seams thicker than 1 foot, however, should be described and sampled separately.

Sampling intervals should begin at a depth no greater than five feet below the original ground surface. The lower interval should extend at least two feet into the stratum immediately below the lowest coal seam to be mined.

A single sample should consist of a composite of material from a single sampling interval from a single drill hole. Combining samples from two or more intervals is unacceptable. combining samples from the same lithologic units from different drill holes is also unacceptable.

**Drilling and Sampling Techniques**

Acceptable drilling methods include continuous coring and chipping. If continuous coring is used, the drilling medium should be air (preferably) or water that is not excessively saline or high in any minerals. Water with EC of 2.0 mmhos or higher may influence subsequent analyzed values. Drilling mud that has a high SAR should not be used, since it will contaminate the samples. Drill stem joint lubricants which contain metal additives should be avoided.

It will generally be difficult or impossible to recover unconsolidated samples using a drill that is designed for penetrating rock. Where the unconsolidated material (regolith) has any appreciable thickness, it is recommended that it be sampled with a thin walled tube. Sobek (1978) describes a sampling technique which is acceptable.

## Overburden Analysis

Some parameters needed to accurately characterize overburden are difficult to analyze. It is important that a well equipped laboratory having experienced technicians be selected to process samples.

The 19.8 NMAC regulations (19.8.803.B.1.b NMAC) list parameters to be evaluated. These regulations (19.8.803.B.1.h NMAC) provide for waiver of analysis of some parameters. 19.8.803.B.1.b NMAC provide for additional data or analysis. Additional parameters which will be useful to help the mine operator decide on the potential value of overburden material for topdressing include: electrical conductivity; soluble Ca, Mg, and Na; saturation percentage, $CaCO_3$ percentage, acid-base potential, and texture. SAR should be calculated. Analysis for $CaCO_3$ percentage is not beneficial on samples that show slight or no effervescence when treated with 10 percent hydrochloric (HCl). Acid-base potential is generally not needed for samples that react when treated with 10 percent HCl.

All of a given sample should be ground to less than 2 mm. Coal operators are strongly advised to keep sample splits in their possession. If for any reason the analyses are unsatisfactory, retention of the sample splits will allow a company to avoid the delay and expense of redrilling.

The following are acceptable methods for sample analysis. If the laboratory uses or plans to use other methods, MMD should be advised prior to doing the analysis.

a. pH (saturated paste): L.A. Richards, ed. 1954. *Diagnosis and Improvement of Saline and Alkali Soils. Agricultural Handbook No. 60*. USDA Washington, D.C. (p. 102: method 21a, and p. 84: method 2, with the following change: the saturated paste should be allowed to set for at least two hours after the last adjustment (addition of water or soil).

b. Electrical Conductivity (saturated paste extract): Richards, 1954. (pp. 84-90).

c. Soluble Ca, Mg, and Na (saturated paste extract).(Calculated SAR) Richards, (p. 26).

d. Texture (hydrometer or pipette): C.A. Black, ed. 1965. *Methods of Soil Analysis. Part 1*. American Society of Agronomy. Madison, Wisconsin. (pp. 562-566: method 43-5 or pp. 552-562: method 43-4).

e. <u>Saturation Percentage</u>: Richards, 1954 (pp. 197: method *27a)*. f.

f. <u>Calcium Carbonate Percentage</u>: Richards, 1954 (p. 105: method 23c).
Samples representing coal seams and samples that when ground do not effervesce when treated with 10% HCl should be analyzed for the acid potential and the neutralization potential.

g. <u>Acid Potential</u>: A.A. Sobek, et. al. 1978. *Field and Laboratory Methods Applicable to Mine Soils*. U.S. Environmental Protection Agency. Cincinnati, Ohio (EPA-600/278-054).(pp. 60-62: method 3.2.6) . The acid potential must be calculated from pyritic sulfur. (Under no circumstances should any hydrogen peroxide techniques be used to measure the acid/base potential.

h. <u>Neutralization Potential</u>: Sobek, 1978. (pp. 47-50: method 3.2.3).

i. <u>Selenium</u> (total) : Black, 1965. (pp. 1118-1122: method 80-82).

j. <u>Selenium</u> (water soluble): ASA Monograph #9 1965 edition, method 80-3.2.1.

k. <u>Boron</u> (water soluble): Black, 1965. (pp. 1062-1063: method 75-4).

<u>Data Presentation</u>

All data should be presented in a consistent, coherent form. Table A is an example of a satisfactory format. Other parameters would, of course, be shown. Data from a single sample or location should all be presented in one table. It is particularly important that all strata that can be correlated from one hole to another with confidence be identified. If need be, provide the strata with names, letters or numbers for this purpose.

The dimensions of each characteristic (mmho/cm, meq/1, mg/l, etc.) must be shown, and an adequate reference must be reported for each analytical method.

<u>Waiver of Analyses</u>

The overburden analyses suggested in these guidelines are in addition to the analyses listed in 19.8.8.803.B.1.d NMAC. However, coal operators are reminded that 19.8.8.803.B.1.g NMAC allows the Director to waive analyses for parameters that are of little significance. If an operator believes that some of the parameters in 19.8.8.803.B.1.d NMAC are of little significance at his mine, he may request that the requirement to analyze for these parameters be waived. Documentation to justify the waiver should accompany the request.

## SOIL SURVEYS AND SAMPLING

### Soils Meeting

An early meeting between mine and regulatory personnel will help assure compliance with aspects of the regulations dealing with soil and may save time and expense for the mine operator. The purpose of this meeting will be both to decide what intensity of soil inventory is needed and, as much as possible with the information at hand, to decide what overburden and soil handling alternatives will be practical.

### Soil Survey

The application should include an Order 2 or more detailed soil survey for all areas where the surface will be disturbed by mining activities. If the soils survey is Order 2 or less intense, a grid system prior to stripping soil is generally needed to adequately characterize potential topdressing material. Consociations are the preferred mapping unit, but complexes may be used where necessary. Associations do not provide enough detail. The map scale should be **1"=500'** or larger. The maximum size of inclusions of similar soils in a mapping unit should be no more than s acres. The maximum size of mapping inclusion of dissimilar soils should be no more than 1 acre. Appropriate symbols may be used to represent dissimilar soils of areas up to 3 acres so long as the symbols are adequately defined. Soil maps and profile descriptions should conform to the conventions and standards of the *National Soils Handbook*, Soil Conservation Service, USDA, Sept. 1983 and *Soil Survey Manual*, Soil Conservation Service, USDA, 1981.

### Soil Sampling and Analysis

19.8.8.810.A.4 NMAC states that sampling and analysis will be adequate to define present and potential productivity. The number of samples needed from each mapping unit to adequately characterize the usefulness of material from that unit for topdressing or topsoil depends on many factors. These include: (1) the total extent of the mapping unit in the permit area; **(2)** the purity of the unit or number of entities in the mapping unit; (3) the relative size of the mapping unit within the proposed area of disturbance; (4) the nature of the material in the mapping unit; and (5) the abundance or scarcity of suitable topdressing.

Unless the operator knows that surface material is not suitable or is not needed for topdressing, each taxonomic unit within the permit area should be sampled at least once. Guidelines for the minimum number of profiles to sample which will adequately characterize mapping unit suitability as a source of topdressing is presented in the following table.

| Percent of Area | | Consociations Acres | Number of Profiles |
|---|---|---|---|
| Less than 10% | or | 25 or less | 1 |
| 10 to 25% | or | **25-100** | 2 |
| 25 to 50% | or | **101-500** | 3 |
| 50 to 100% | or | 500 or more | 4 |

Use Percent of Area or Acres column, whichever results in less sampling.

Complexes

Same as above for each named component of the mapping unit.

Samples should be collected from the major genetic horizons (A, B, Cca, etc.) which are at least four inches thick. Depth of sampling can generally be limited to five feet or to bedrock whichever is less.

Adequate characterization requires analysis for pH, EC, soluble Ca, Mg, and Na (calculated SAR) , texture, saturation percentage, boron, selenium, and calcium carbonate percentage (calcium carbonate percentage is needed only on samples that effervesce when subjected to 10% HCl). The analytical methods to be used are the same as listed for analysis of overburden. If it is known that boron and selenium are not excessive in a given taxonomic unit, analysis for those elements may be waived.

Data should be presented in a format similar to that in Table B. Adequate reference is needed for analytical methods if these differ from those used for overburden analysis.

## SOILS AND OVERBURDEN HANDLING

### Soils Accounting

Each application should include an accounting of the volume of soil that will be used for reclamation. An accounting should be made for each separate "logical soil handling **unit"** within the permit. A logical soil handling unit is an area that will neither import nor export soil.

For each logical soil handling unit, the credit side of the account should consist of the average depth of soil that will be removed from each soil mapping unit; times the total area of the mapping unit that will be disturbed. The volume for all mapping units should then be totaled, and the volume of soil in stockpiles added to this total. For example:

| Mapping Unit | Depth to be Removed | Acres Expected to be Disturbed | Volume (Acre-Feet) | volume cu. Yds. |
|---|---|---|---|---|
| A | 9" | 43 | 32 | 52,000 |
| B | 17" | 94 | 133 | 214,838 |
| C | 5" | 19 | 8 | 12,772 |
| D | 0" | 21 | - | |
| E | 26" | 54 | 117 | 188,756 |
| F | 20" | 32 | 53 | 86,043 |
| | | 263 | 343 | 554,439 |
| Previous Volume of Soil in Stockpiles | | | 101 | 164,125 |
| Grand Total | | | 444 | 718,564 |

The grand total (444 acre-feet in the example) represents the total volume of soil available for reclamation of the total soil liability area (the acreage disturbed to date and not topsoiled, plus the acreage where disturbance is anticipated) within the soil handling unit.

The debit side of the account, for each soil handling unit, should simply consist of the average depth of soil that will be replaced on graded spoil. This should be determined and agreed on during the permitting process. In general, soil should be replaced to a depth equal to the average depth of pre-mine soils within the disturbed area, or to a depth suitable to accomplish the post-mine land use objectives. The total volume can be divided by acreage of the soil liability area to get the acre feet available. For example:

| | |
|---|---|
| Acreage Disturbed to date, and Not Topsoiled: | 86 acres |
| Acreage Expected to be Disturbed, but not Disturbed to Date | 263 acres |
| Total Soil Liability Area: | 349 |

(444 acre-feet)-(349 acres)+1.3 ft. = 151/2 inches

If the Director and mine operator have agreed, for example, that 12 inches is adequate, the operator can save enough material to meet that depth plus an allowance for handling loss, usually 10 percent.

If topdressing substitutes are to be employed, they should be added into the credit side of the account. If separate classes of materials will be used as the new "topsoil" and the new "subsoil", separate accounts should be made for each class.

Annual reports should include a topdressing mass balance. This should include the volume of material in each topdressing stockpile, a map showing the acreage disturbed but not topdressed and the acreage of each separate disturbed area printed on the map. In addition, to maintaining a topdressing mass balance for the "logical soil handling unit", coal operators should consider topdressing needs for the entire permit and/or lease area where future mining is planned. If an overall mass balance is considered, excess topdressing from one "logical soil handling unit" can be used on areas where topdressing is insufficient to assure reclamation success.

Topdressing Protection

Research confirms the value of topsoil as a topdressing material. Careful handling of the soil material improves retention of microorganisms and nutrients. It is best to replace the soil as stripping proceeds.

When soil material must be stockpiled, seeding affords better protection than other methods. If the stockpile is to be left less than two years, leaving a rough surface or seeding the area with annual plants will provide adequate protection. If the stockpile is to be left more than two years, seeding to the perennial vegetation that will eventually be used for reclamation is the best and generally the most economical method of protecting the soil material.

In addition to measures directed at stabilizing the surface of the stockpile, berms are generally needed to prevent topdressing loss. Depending on the site and shape of the pile, berms around the top may be desirable and berets around the base are essential. The top berm will prevent concentrated flow from the top which causes side slope erosion. The lower berms should be large enough to contain the probable maximum precipitation or be designed with a spillway. This berm must be large enough to contain the 10-year/24-hour precipitation event. Cross dikes are needed in situations where water drains to a low point in the beret. The slope of the berm governs the number and spacing of cross dikes.

Topsoil Redistribution

Topsoil or a suitable substitute should be replaced over spoil material in lifts. The first lift should be no more than 6 inches thick and mixed with a few inches of overburden by disking or chiseling to break up the abrupt topdressing/overburden contact. The remaining topdressing is then spread and manipulated to minimize compaction. The final surface should be firm but not so compact that seed cannot be covered.

Erosion Control

The degree of erosion on reclaimed land depends on six major factors, five of which can be substantially impacted by the mine. The factors include: precipitation; type of surface material; length of slope; slope gradient; ground cover; and man installed measures. The long term precipitation is available from weather records and is the only factor that cannot be influenced by man to reduce erosion.

Generally sandier material or material containing rocks or gravel are less erosive than silty or clayey material. Judicious handling and replacement of available material which result in less erosive material on the surface is desired. Chiseling or deep disking regraded soil/spoil improves water intake, reduces runoff and subsequent erosion.

Slope length, gradient and shape have more impact on slope stability or lack of stability than other factors. These features are easily altered to afford good stability during mine spoil regrading and shaping. By planning early in the mining sequence for final slope configuration, companies can substantially reduce time and expense later. The types of landscape design which have been used effectively is a convex steeper upper slope with a concave, gentler lower slope constructed during reshaping. The convex/concave slopes are less erosive than plain slopes because there is less water on the steeper part of the slope and less velocity on the lower slopes where there is more water.

**Requirements for Covering Toxic Material and Reconstructing Soils**

It is apparent that rebuilding the "soil" as a suitable plant growth medium after mining can be done only on case-by-case situations. It should be understood that the manipulation and placement of soils and overburden is to ensure a desirable plant growth medium and to assure adequate coverage of toxic material. The following items are pertinent:

1. Materials defined as toxic should be covered by an adequate cover of non-toxic material. At present, materials with an acid-base deficiency of five tons or more of $CaC0_3$ per thousand tons are considered toxic. See definition of Toxic Forming Materials under Definitions in 19.8 NMAC. However, many elements are toxic to the biotic community when excessive amounts or unfavorable balances are present.

2. Reclaimed soils should not, on the average, have a productivity less than that of the natural soils that they replace. (See 19.8.20.2065 NMAC). Productivity should be evaluated in terms of the characteristics listed in Table C and by comparing plant response on mine soils to plant response on pre-mine soils.

3. If there is no significant economic difference in soils to be used for reclamation, the alternative soil having the highest productivity should be used.

Most questions and decisions will involve Requirement No. 2 which is by far the most encompassing. The concept of productivity takes into account the entirety of soil characteristics, and its inclusion in the requirements is intended, in part, to encourage imaginative thinking. Generally, reclaimed areas with good productivity will imitate a good mature soil. The most suitable material comprises the surface layer, and progressively less suitable material forms the "subsoil". For example, if it is possible to produce a reclaimed soil consisting of two feet of loam with an SAR of 10 over two feet of loam with an SAR of 28, this would be far preferable to four feet of loam with a uniform SAR of 19.

Topsoil Substitutes

Topsoil, as defined in 19.8 NMAC means the A horizon, and other non-toxic surface soil material suitable for use as a plant root medium. Suitable soil material includes all unconsolidated, weathered material that is supporting or capable of supporting plants and meets the good and marginal values for the parameters listed in Table C and Table D. Where soil material is absent or the amount of suitable material is inadequate to support the post-mining land use and better quality material is in the regolith or overburden, this material may be used as the topdressing. In that case, suitability may be established by comparing quality of potential topdressing material to the on-site surface material.

TABLE A

OVERBURDEN ANALYSES
DRILL HOLE 84-14

| Drill Hole # | Sample Interval ft | pH | mmhos/cm EC | % CaCO3 | % Sat | meq/l Ca | meq/l Mg | meq/l Na | SAR | ppm B | ppm Se | ppm Mo | ppm Cu | % Sand | % Silt | % Clay | Texture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 84-14 | 0-3 | 8.85 | .71 | 0.3 | 21.7 | .71 | .08 | 6.58 | 10.47 | .02 | .4 | .80 | .40 | 86.0 | 4.4 | 9.6 | Loamy Sand |
| | 3-11 | 8.11 | .57 | 0.2 | 22.0 | 1.28 | .31 | 4.76 | 5.34 | .02 | .1 | .21 | .26 | 78.4 | 12.3 | 9.2 | Sandy Loam |
| | 11-13 | | | | | | | | | | | | | | | | |
| | 13-18 | | | | | | | | | | | | | | | | |
| | 18-22.5 | | | | | | | | | | | | | | | | |
| | 22.5-32 | | | | | | | | | | | | | | | | |
| | 32-42 | | | | | | | | | | | | | | | | |
| | 42-53 | | | | | | | | | | | | | | | | |
| | 53-60 | | | | | | | | | | | | | | | | |
| | 60.0-65.3 | | | | | | | | | | | | | | | | |
| | 69.1-71.0 | | | | | | | | | | | | | | | | |
| | 71.0-72.5 | | | | | | | | | | | | | | | | |
| | 72.5-83.0 | | | | | | | | | | | | | | | | |
| | 83-86 | | | | | | | | | | | | | | | | |
| | 86-90 | | | | | | | | | | | | | | | | |
| | 90-92 | | | | | | | | | | | | | | | | |
| | 92-99 | | | | | | | | | | | | | | | | |
| | 102.7-114 | | | | | | | | | | | | | | | | |
| | 114-124 | 8.71 | 2.62 | 2.1 | 71.9 | .11 | .05 | 25.23 | 89.20 | .34 | .3 | .76 | 5.45 | 56.4 | 13.6 | 30.0 | S Clay Loam |
| | 124-129.3 | 8.95 | 1.91 | 1.4 | 55.4 | .05 | .02 | 18.73 | 100.12 | .54 | .1 | 1.36 | .47 | 67.2 | 11.6 | 21.2 | S Clay Loam |
| | 134.1-138.5 | | | | | | | | | | | | | | | | |
| | 138.5-145.9 | | | | | | | | | | | | | | | | |
| | 145.9-147.4 | | | | | | | | | | | | | | | | |
| | 147.4-156.5 | | | | | | | | | | | | | | | | |
| | 156.5-166.0 | | | | | | | | | | | | | | | | |
| | 166-171 | | | | | | | | | | | | | | | | |
| | 171-181 | | | | | | | | | | | | | | | | |
| | 181-191 | | | | | | | | | | | | | | | | |
| | 191-195.1 | | | | | | | | | | | | | | | | |
| | 198.7-203 | | | | | | | | | | | | | | | | |
| | 203-210 | 8.55 | 2.71 | 3.4 | 32.9 | .14 | .06 | 25.23 | 79.78 | .02 | .5 | 1.06 | 1.55 | 62.4 | 12.0 | 25.6 | S Clay Loam |

This is an example. In practice, all data for all depths will be included.

**TABLE B**
**SOIL ANALYSES**
**SAMPLE FORMAT**

| SERIES | SAMPLE No. | DEPTH (in.) | pH | EC mmhos/cm | EXTRACTABLE CATIONS Meq/l Ca | Mg | Na | SAR | B ppm | Se ppm | SAND % | SILT % | CLAY % | $CaCO_3$ % | SATURATI % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Samson | 1A1 | 0-5 | 7.44 | 1.11 | 12.91 | 1.10 | .78 | .29 | .76 | .2 | 68 | 13 | 19 | .5 | 34 |
| | 1C1 | 5-13 | 7.80 | .64 | 19.29 | 2.71 | 1.91 | .36 | .76 | .2 | 60 | 13 | 27 | 3.2 | 46 |
| Jarey | 2A1 | 0-7 | 7.77 | .53 | 12.91 | .70 | 1.26 | .48 | .29 | .2 | 58 | 21 | 21 | 0 | 35 |
| | 2B2 | 7-18 | 7.69 | .42 | 17.41 | 1.12 | 3.45 | 1.13 | .29 | .2 | 50 | 21 | 29 | 1.5 | 51 |
| | IIC1 | 18-36 | 8.05 | .79 | 14.10 | 1.35 | 5.02 | 2.49 | .26 | .2 | 52 | 21 | 27 | 3.1 | 43 |
| | IIC2 | 36-60 | 8.11 | 1.53 | 21.35 | 1.88 | 8.60 | 2.52 | .26 | .2 | 44 | 29 | 27 | 14.6 | 41 |

TABLE C
SOIL AND SOIL SUBSTITUTE SUITABILITY RATINGS

| Characteristics | Suitable: Good | Suitable: Marginal | Generally Unsuitable |
|---|---|---|---|
| pH (saturated paste) | 6.0-8.4 | 5.5-6.0<br>8.4-8.8 | <5.5<br>>8.8 |
| EC mmhos/cm 1/ | <4.0 | 4.0-12.0 | >12.0 |
| SAR | sandy loam & coarser <12.0 | 12.0-18.0 | >18.0 |
| | loams & clay loams <10.0 | 10.0-16.0 | >16.0 |
| | 40% clay <8.0 | 8.0-14.0 | >14.0 |
| Texture 2/ | ls, sl, l, sil, with <35% c | s, lcs, cl, sicl with <45% c | < 6%c<br>>45%c |
| Saturation % | 25-80 | 25-80 | <25 >80 |
| $CaCO_3$ % | 0-15 | 15-30 | >30 |
| Coarse fragments<br>3 inch 3/ %<br>3 inch | <15<br><3 | 15-35<br>3-10 | >35<br>>10 |
| Erosion factor K | <.37 | >.37 | |
| Acid-base poten. | +5 T $CaCO_3$ equiv./1000T | +) T $CaCo_3$ equiv./1000T | -$CaCO_3$ equiv. |
| Boron 4/ | <5 ppm | <5 ppm | >5 ppm |
| Selenium (Total) | <.2 ppm | .2-.5 | >.5 ppm |
| Selenium (Water Soluble) | <.1 ppm | .1 ppm | >.1 ppm |

1/ When high sodicity is a problem, an EC lower than 2 mmhos/cm intensifies the problem.

2/ ls=loamy sand; lcs=loamy coarse sand; sl=sandy loam; l-loam; sil=silt loam; scl=sandy clay loam; s=sand; cl=clay loam; sicl=silty clay loam; c=clay.

3/ Depends on post mine land use. Values are not valid for cropland.

4/ Native species will apparently tolerate more than 5 ppm.

## TABLE D
## POTENTIAL ROOT ZONE OVERBURDEN SUITABILITY RATINGS

| Characteristics | Suitable: Good | Suitable: Marginal | Generally Unsuitable |
|---|---|---|---|
| pH (saturated paste) | 6.0-8.6 | 5.5-6.0<br>8.6-9.0 | <5.5<br>>9.0 |
| EC mmhos/cm 1/ | <8.0 | 8.0-16.0 | >16.0 |
| SAR | | | |
| sandy loam & coarser | <12.0 | 12.0-20.0 | >20.0 |
| loams & clay loams | <10.0 | 10.0-16.0 | >16.0 |
| 40% clay | <8.0 | 8.0-14.0 | >14.0 |
| Texture 2/ | ls, sl, l, sil, with 35% c | s, lcs, cl, sicl with 45% c | <6%c<br>>45%c |
| Saturation % | >25<br>25-85<br><85 | 25-85 | <25<br>>85 |
| Acid-base poten. | +5 T $CaCo_3$ equiv./100T | +0 T $CaCO_3$ equiv./1000T | $-CaCO_3$ equiv. |
| Boron | <5 ppm | 5-10 ppm | >10 ppm |
| Selenium (Total) | <0.2 ppm | 0.2-0.5 ppm | >0.5 ppm |
| Selenium (Water Soluble) | <.1 ppm | .1 ppm | >.1 ppm |

1/ When high sodicity is a problem, an EC lower than 2 mmhos/cm intensifies the problem.

2/ ls=loamy sand; lcs=loamy coarse sand; sl=sandy loam; l=loam; sil=silt loam; scl=sandy clay loam; s=sand; cl=clay loam; sicl=silty clay loam; c=clay.