TECHNICAL NOTES

August 9, 2007

MO-1 Technical Note Number 40 (Revision 1)

Re: NASIS - DMU Data Population Guide

This technical note provides guidance on populating NASIS data elements (fields) in the Data Mapunit (DMU) object. Those data elements required to be populated for initial and update soil surveys within MO-1 are highlighted in blue (gray shading in black and white copies). Highlighted data elements are required before a soil mapunit is correlated and the data mapunit is certified.

Certain data elements are required to be populated for the following reasons:

1) elements that are fundamental data for classification and correlation of any NCSS soil survey
2) elements needed for creating descriptions of mapunits and taxonomic units
3) elements used to generate standard interpretations and soil survey manuscript tables
4) elements needed for the WEPS, RUSLE2, and other national models.

Also included with this technical note are MO-1 NASIS Guides to be used in data population.

Note: Refer to MO-1 Technical Note 34 (Attachment B) for the minimum data field to populate for Miscellaneous Areas.

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MO-1 NASIS DMU Data Population Guide (Highlighted Fields Are Required)

Data Mapunit Table

DMU Description

For soil survey areas that are not part of an MLRA update, the DMU description consists of a combination of the soil survey area symbol and the mapunit symbol. Numeric mapunit symbols may need to be padded with 1 or 2 zero's if mapunit symbols vary in number of characters. This is necessary in order for the data mapunits to sort correctly in NASIS.

Examples with numeric mapunit symbols: OR674023; WA007356. Example with alpha mapunit symbol (no zero padding needed): ID632AbC. Example with alpha-numeric mapunit symbol: WA643001M.

Refer to MO-1 Technical Note 44 for guidance on DMU descriptions for MLRA update soil survey areas.

Farm Class

This field will move to the Correlation table in the Legend object in the next release of NASIS.

Use respective state guide to populate if available. In Washington use WA NASIS Guide 1. Oregon uses the national criteria for prime farmland designation in addition to meeting ≥ 70 frost-free days.

See NSSH section 622.03 Exhibit 622-1 for definition and Code of Federal Regulations 7CFR657. A prime farmland designation **must** match across state boundaries. Consult respective State Soil Scientist for criteria for assigning soils of statewide or unique importance.

HEL

Mapunit HEL class. If mapunit is HEL for either water or wind, the mapunit is HEL. This field may have to be populated in the near future due to current "unfrozen" status of state HEL lists.

HEL Water

Enter the HEL class for the mapunit as a result of water erosion.

HEL Wind

Enter the HEL class for the mapunit as a result of wind erosion.

Interpretive focus

Data population is optional.

Order of Mapping

Data population is optional.

Prod Index

Data population is optional. This field is an index of the capacity of a data mapunit to produce a specific commonly grown plant, under a defined management system. This field could be used to store the Land Evaluation (LE) part of a Land Evaluation and Site Assessment (LESA) system. This field will move to the Correlation table in the Legend object in the next release of NASIS.

IA; NH; VT columns

Used by other states. Do not enter data.

Certification Status

Code should be "0" until required data in MO-1 Technical Note 46 have been entered, after which change to "1". Use code "2" after data has been validated and reviewed (i.e., standard interpretations generated and

reviewed). Use code "3" only after final correlation and all corrections have been made to data. See MO-1 Technical Note 46 for further guidance.

Data Mapunit Crop Yield Table

Do not enter data in this table. Crop yield data in MO-1 are entered in the Component Crop Yield table.

Data Mapunit Text Table

As a rule, the Mapunit History table will be used to record correlation decisions. Refer to MO-1 Technical Note 25 for clarification. Discuss with your SDQS before entering data in the DMU text field. When entered, notes in the DMU text table, should apply to the data mapunit as a whole. Notes that apply to only one component should be entered in the Component Text Table.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Date

Author

Kind Enter the kind of note from the choice list.

Category Consult MO-1 Technical Note 25 for a list of Categories and Subcategories.

Subcategory Same as above.

Text Enter notes that apply to the category and subcategory. If data is to be extracted for the mapunit description, enter the data exactly as you wish it to appear in the MUD.

Component Table

Seq If two or more major components have the same percent composition, enter a sequence number. The component named first in the mapunit name should be assigned sequence #1; the second component is sequence #2, and so on. If no sequence # is given, the default component sort will be by descending component percent, then alphabetically by component name. If a sequence number is assigned to one component, assign one to all components.

Comp % Enter percentage of each component of the mapunit (including minor components - formerly called inclusions) in RV column. Leave Low and High values blank unless you have collected data and made estimates of the range in composition. Total of all components (RV) must not exceed 100%. The MO recommends that the sum of component percentages for major and minor components equal 100 percent (see MO-1 Technical Note 24).

Component Name Major and minor component names will be entered in mixed upper and lower case. With complexes that have two phases with the same component name, enter the phase names in the respective Local Phase field. See NSSH 627.04 for guidance in naming components. See MO-1 Technical Note 24 for guidance in naming minor components that do not fit within the range of characteristics of existing soil series.

Kind Enter from the choice list. Unnamed soils will be left blank, as there is presently no category for them. The "Miscellaneous Area" category has a specific list of acceptable terms in the NSSH Exhibit 627-1.

Major Component Populate "yes" for major components (included in mapunit name). Populate "no" for minor components (not included in mapunit name).

Local phase Enter applicable phase (i.e. dry, moist, stony). See NSSH section 627.06 for definition and guidance for phase names.

SIR phase Phase names from Soil Interpretation Records (SOILS-5 forms) are from converted 3SD data. This data is only used for reference. Do not populate.

Slope Gradient Enter slope range for the component. It will generally, but not necessarily be the same as the slope range in the mapunit name. RV value should be the dominant slope, not the average and must fall between the low and high values. See NSSH section 618.52 for definition.

Slope Length USLE Do not enter, even if this data has been collected.

Runoff Class Population is optional. There is a NASIS calculation that uses the Runoff Class criteria in NSSH section 618.49(c).

T factor Use criteria from NSSH Exhibit 618-14 and manually enter value. See NSSH section 618.62 for definition. If T factor is less than 5, ensure that a corresponding restriction is populated in the Component Restriction table. Exceptions include components where the T factor is reduced because of high carbonates or gypsum. MO-1 NASIS report "CHECK - Component Restrictions and T Factors 2" can be used to compare the manually entered value with a model based value. Since this calculated value does not use NSSH criteria, it should be used only as a tool for comparison. Values differing by more than 1 class should definitely be reviewed.

WEI Use criteria from NSSH Exhibit 618-16. See NSSH section 618.72 for definition. The National NASIS report "UTIL - Comparison of WEG/WEI, stored vs calculated (TEST)" can be used to check entries.

WEG Same as above WEI.

Erosion Class This field is generally not populated in MO-1. Data population is optional. Enter from choice list. See the Soil Survey Manual, Chapter 3 for definitions and guidance.

Cover Kind 1 Data population is optional. Enter from choice list.

Cover Kind 2 Data population is optional. Enter from choice list.

Hydric Condition Enter data only if the component is a hydric soil. Select from choice list. "Farmable under natural conditions" refers to components that can be

farmed without removal of woody vegetation and/or manipulation of the water regime. See the National Food Security Act Manual, Part 514.21 for additional guidance on what constitutes "farmable under natural conditions".

Drainage Class Enter only one drainage class for each component. Use MO-1 Technical Note 27 for guidance in assigning drainage classes. If a mapunit includes the same component with different drainage classes, they should be entered as separate components and the local phase should be populated for each to differentiate them. This field will move to the new Correlation Component table in the Legend object in the next release of NASIS.

Elevation Enter range in meters from conversion chart distributed in MO-1 Technical Note 16.

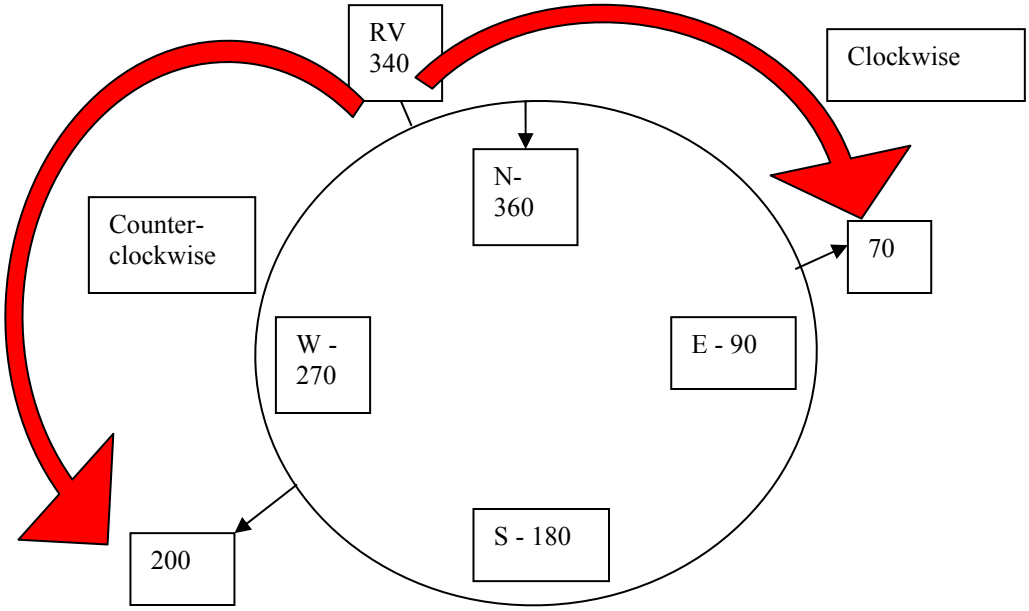
Aspect Counter Clockwise

Enter the azimuth in a counter-clockwise direction from the representative aspect. See the diagram below. See NSSH section 618.51 for definition.

Aspect Representative

Enter the dominant azimuth. RV aspect is used in the criteria for two forest management interpretations - Potential Fire Damage Hazard and Potential Seedling Mortality. If Aspect Representative is not populated, the forest management interpretations will use a default north aspect.

Aspect Clockwise Enter the azimuth in a clockwise direction from the RV. See the diagram below.



Aspect RV = 340 degrees and ranges from 200 degrees counter-clockwise to 70 degrees clockwise

Albedo Dry

Use the following guide to populate albedo (RV) for the first mineral horizon or saturated organic layer. See NSSH section 618.04 for definition. If the modal pedon for the component is in NASIS, albedo can be calculated if the pedon is linked in the Component Pedon table.
Albedo dry = (0.069 x dry color value) - 0.114

Dry Color Value	Albedo
2	0.02
2.5	0.06
3	0.09
4	0.16
5	0.23
6	0.30
7	0.37
8	0.44

MAAT

Mean annual air temperature. Enter values in tenths of a degree Celsius from MO-1 Technical Note 16. See NSSH section 618.10 for definition.

MAP

Mean annual precipitation. Enter values in millimeters from MO-1 Technical Note 16. See NSSH section 618.10 for definition.

REAP

Relative effective annual precipitation**.** Populate only if local guides have been developed with concurrence from plant specialists such as foresters and range conservationists.

Frost Free Days

Enter from local guide based on soil moisture and temperature regimes based on 32 degrees Fahrenheit. See NSSH section 618.10 for definition

Nirr LCC

Enter numeric value for capability class from the respective state guide. In Idaho, use ID NASIS Guide 1. In Washington use WA NASIS Guide 2. In Oregon use OR NASIS Guide 1. This field will move to the new Correlation Component table in the Legend object in the next release of NASIS.

Nirr Subcl

Enter alpha character for subclass from the respective state guide. In Idaho, use ID NASIS Guide 1. In Washington use WA NASIS Guide 2. In Oregon use OR NASIS Guide 1. This field will move to the new Correlation Component table in the Legend object in the next release of NASIS.

Nirr LCU

Do not populate. Land Capability units are not used in MO-1.

Irr LCC

Enter numeric value for capability class if the soil is irrigated from the respective state guide. In Idaho, use ID NASIS Guide 1. In Washington use WA NASIS Guide 2. In Oregon use OR NASIS Guide 1. This field will move to the new Correlation Component table in the Legend object in the next release of NASIS.

Irr Subcl

Enter alpha character for subclass from the respective state guide if the soil is irrigated. In Idaho, use ID NASIS Guide 1. In Washington use WA NASIS Guide 2. In Oregon use OR NASIS Guide 1. This field will move

to the new Correlation Component table in the Legend object in the next release of NASIS.

Irr LCU Do not populate. Land Capability units are not used in MO-1.

Prod Index Index of the capacity of a component to produce a specific commonly grown plant, under a defined management system. This field could be used to store the Land Evaluation (LE) part of a Land Evaluation and Site Assessment (LESA) system. This field will move to the new Correlation Component table in the Legend object in the next release of NASIS.

Cons Tree Shrub Group Conservation Tree/Shrub Group (CTSG). Consult with the State Forester before populating. Criteria for assigning the CTSG are in the National Forestry Manual, Exhibit 537-13. MO-1 NASIS report "UTIL - Compare Calculated CTSG to Populated CTSG" can be used to check the calculated and stored values.

Windbreak Suitability Obsolete - do not populate. This field has been replaced by Conservation Tree/Shrub Group above.

Range Prod If component occurs on rangeland or grazed forestland, enter forage production in pounds per acre per year. This data is furnished by the respective state specialist.

Forage Suitability Group Columns Forage Suitability Group codes are furnished by State and field agronomists and range conservationists. See National Range and Pasture Handbook, Chapter 3 for more information on Forage Suitability Groups.

Ord Species Obsolete - do not populate

Local Plant Name Obsolete - do not populate. This field is used with Ord Species above

Wildlife Interps If wildlife interpretations are to be included in the survey manuscript, they must be calculated manually and entered into these fields. Otherwise, leave blank. Data fields included are: Grain Habitat, Grass Habitat, Herbaceous Habitat, Shrub Habitat, Conifer Habitat, Hardwood Habitat, Wetland Habitat, Water Habitat, Rangeland Wildlife, Openland Wildlife, Woodland Wildlife and Wetland Wildlife.

Soil Slip Pot Soil slippage potential. Populate only if criteria have been developed locally for the survey area or MLRA. NSSH Exhibit 618-17 can be used as a starting place to develop a local guide.. See NSSH section 618.58 for definition. Certain national forest management interpretations will display "landslides" as a limiting feature even when the soil slippage potential is populated as "low".

Frost Action Enter data using NSSH Exhibit 618-5 as a guide. See NSSH section 618.29 for definition. Local guide development is needed that would provide criteria based on MLRA, soil temperature regime, etc.

Init Subsid Initial Subsidence. Populate with values greater than zero for components that are Histosols, or in Histic or Thapto-histic subgroups. A few very poorly drained mineral soils that are high in diatomaceous earth or that have thin organic layers are also subject to subsidence. Populate with 0 (zero) for low, RV, and high for all other soils. See NSSH section 618.60 for definition and formula.

Total Subsid	Total Subsidence. Populate only if Initial Subsidence is greater than zero, otherwise leave blank. Enter the total amount of subsidence expected. See NSSH section 618.60 for definition and formula.
Hydrologic Group	Enter data from choice list using definitions in NSSH section 618.35. MO-1 NASIS report "CHECK - Hydrologic Group Differences (stored vs. derived)" can be used to check entries. Components where the derived hydrologic group is more than one class different should be reviewed. MO-1 NASIS report "EXPORT - Hydrologic group data" can be used to bring the soil properties used in determining hydrologic group into a spreadsheet for review.
Corrosion Concrete	Enter data from choice list using NSSH Exhibit 618-2. See NSSH section 618.11 for definition.
Corrosion Steel	Enter data from choice list using NSSH Exhibit 618-1. See NSSH section 618.11 for definition.
Taxonomic Class	Calculated field. This field must be recalculated any time there is a change in any of the subsequent classification fields. Taxonomic classification reports are generated from data in the Taxonomic Class field. Be sure that subgroup, great group, suborder and order entries are all in agreement.
Order	Enter data from choice list.
Suborder	Enter data from choice list.
Great Group	Enter data from choice list.
Subgroup	Enter data from choice list.
Particle Size	Enter data from choice list.
Particle Size Mod	Enter data from choice list.
CEC Activity Cl	Enter data from choice list. See Soil Taxonomy, 10th Edition, page 303-304 for definition and criteria.
Reaction	Enter data from choice list using classes listed in NSSH section 618.48. Enter "not used" if Reaction is not part of the taxonomic classification of the component.
Temp Class	Enter data from choice list. Data in this field are used to construct the taxonomic name. Make sure it agrees with the subgroup. Populate as "not used" for components with a cryic temperature regime.
Moist Subclass	Taxonomic moisture subclass. Enter data from choice list. See NSSH section 618.65 for definitions and classes. National Soil Survey Technical Note 9, available at http://soils.usda.gov/technical/technotes/note9.html provides additional guidance in populating moisture classes and subclasses. In most cases the moisture subclass is NOT the same as the taxonomic moisture class (regime).
Temp Regime	Taxonomic temperature regime. Enter data from choice list. .See NSSH section 618.66 for definition.

Keys to Taxonomy Edition Used Enter data from choice list.

CA; FL; IN; MI; VA Columns Used by other states. Do not enter any data in these fields.

SIR # Soil Interpretation Record Number. This is an obsolete field for reference only. Do not populate.

Component Crop Yield Table

Populate this table if the component is used for producing crops and/or crop yield data or estimates are available. This table will move to the new Correlation Component Crop Yield table in the Legend object in the next release of NASIS.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Crop Name Enter crop name from choice list. If there are no crop yields to populate, leave this table blank.

Units Enter unit of measurement from choice list.

Nirr Yield Enter the nonirrigated yield in the RV column. Generally only RV (average) yields are populated. Low and high yield values are optional. Consult with the State Soil Scientist on whether to populate low and high yields.

Irr Yield Enter the irrigated yield in the RV column if the crop is grown under irrigation on the component. Generally only RV (average) yields are populated. Low and high yield values are optional. Consult with the State Soil Scientist on whether to populate low and high yields. If irrigated yields are populated, the irrigated land capability class and subclass should also be populated in the Component table.

Prod Index Crop Productivity Index. Populate if a crop productivity index has been developed, such as for the Land Evaluation part of a LESA. Consult with the State Soil Scientist before populating this field.

VA Soil Prod Grp Do not enter populate. Only Virginia uses this field.

Component Canopy Cover Table

In MO-1 this table is used to record average canopy cover for forest **understory** species. Forest overstory tree species should be entered in the Component Forest Productivity table. Enter when data is provided by a vegetation specialist such as a forester or range conservationist.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Canopy Cover % The sum of the canopy cover % values is typically less than 100 percent. If multiple canopy strata, such as herbaceous and shrub, occur on the component, this value can exceed 100 percent.

Local Plant Symbol Enter plant symbol from Local Plants Table choice list. If you want to use a plant symbol that is not in the Local Plants Table, contact the MO database manager to have it entered in the table. .

Local Plant Name Plant name is entered automatically when the symbol in entered.

Component Existing Plants Table

This table is designed to record range and forest understory plant species by percent on a dry weight basis. On forested components, this data is normally only collected if the component is used for livestock grazing. Enter when data is provided by a vegetation specialist such as a range conservationist..

Some data in this table for older soil survey areas may actually be on a canopy cover basis rather than dry weight and should be moved to the Component Canopy Cover table.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Local Plant Symbol Enter plant symbol from Local Plants Table choice list. If you want to use a plant symbol that is not in the Local Plants Table, contact the MO database manager to have it entered in the table.

Local Plant Name Plant name is entered automatically when the symbol in entered.

Understory Prod % Enter if data is provided by respective specialist. This field is generally populated for grazeable forestland. The unit of measure is percent on an air dry weight basis, not canopy cover.

Range Prod % Enter if data is provided by respective specialist. This field is populated for components that occur on rangeland. The unit of measure is percent on an air dry weight basis, not canopy cover.

Component Existing Woodland Table

This is an obsolete table. Do not populate. Data from this table has been converted to the Component Forest Productivity table.

Component Forest Productivity Table

Productivity data for this table should be provided by a forester. All commercial tree species that commonly grow on the component should be populated regardless of whether productivity data is available.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Local Plant Symbol Enter plant symbol from Local Plants Table choice list. If you want to use a plant symbol that is not in the Local Plants choice list, contact the MO database manager to have it added to the list.

Local Plant Name Plant name is entered automatically when plant symbol is entered.

Site Index Base Enter numeric code for the curve number used to determine site index. Choose from choice list.

Site Index Enter data when provided by a forester. Normally only the RV (mean) value is populated.

Site Index Std Dev Site Index Standard Deviation. Enter data when provided by a forester

Productivity ft3/ac/yr CMAI Culmination of mean annual increment (CMAI) Enter data when provided by a forester. Normally only the RV (mean) value is populated.

Productivity CMAI Age The age of trees when CMAI occurs. Enter data when provided by a forester.

Component Forest Productivity - Other Table

This table is used for documenting other types of measurement such as board feet or cords of wood.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Site Index Base Enter data if provided by a forester.

Site Index Enter data if provided by a forester.

Productivity Enter data if provided by a forester.

Units Enter data if provided by a forester.

Component Ecological Site Table

Populate this table if components are correlated to ecological sites in the survey area. Data will be entered using a choice list of official ecological site ID's and names from the Ecological Site Information System (ESIS) database linked to NASIS. See MO-1 Technical Note 39 for additional guidance. Range conservationists and/or foresters should be consulted when assigning ecological sites to components. Generally, only one ecological site is assigned to a component.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Ecological Site ID Enter from choice list.

Ecological Site Name Populated automatically when Ecological Site ID is populated.

Component Other Vegetative Classification Table

This table is used to populate vegetative classification information other than NRCS ecological sites. Examples include Forest Service plant association, Indian Nation habitat types, etc. The choice lists are maintained by the MO-1 database manager.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Other Veg Class Type Name Enter from the choice list by selecting the respective vegetative classification reference used in the survey project.

Other Veg Class ID Enter from the choice list. This list is maintained by MO-1 and is a local choice list based on specific vegetative classification references. Contact the MO-1 database manager to request additions to the choice list.

Other Veg Class Name Populated automatically when Other Veg. Class ID is populated..

Component Potential Ecosystem Table

This is an obsolete table. Do not populate. Data from this table has been converted to the Component Ecological Site and Component Other Vegetative Classification tables

Component Potential Windbreak Table

Populate if applicable and if data is provided by specialist.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Height Enter the expected height at 20 years of age. Normally only the RV (average) height is populated.

Local Plant Symbol Enter plant symbol from Local Plant Table using the choice list.

Local Plant Name Plant name is entered automatically when plant symbol is entered.

Component Trees to Manage Table

Populate if data is provided by a forester. This table represents the preferred tree species for forest management. Care is needed in data population because the preferred species may change given economic and individual preference.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Local Plant Symbol Enter plant symbol from Local Plant Table using the choice list.

Local Plant Name Plant name is entered automatically when plant symbol is entered.

Component Geomorphic Description Table

Populate based on local guides developed for the survey area. The "Field Book for Describing and Sampling Soils" provides information on the Geomorphic Description System. Definitions of geomorphic terms are available in the NSSH Part 629 at: ftp-fc.sc.egov.usda.gov/NSSC/Soil_Survey_Handbook/629_glossary.pdf

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows. MO-1 NASIS mapunit description reports will sort landforms by sequence number.

Feature Type Enter from the choice list. Landform is required for all components except miscellaneous areas. Landscape, microfeature, and anthropogenic feature are optional.

Feature Name Enter the feature name from the choice list. This field is needed to populate the landform column in the hydric soils report.

Feature Modifier This is an optional text entry to further describe the landform or landscape. Many MO-1 NASIS reports, including mapunit description reports, will place the feature modifier in front of the feature name.

Feature ID Enter a numeric value starting with 1 if you want to identify a landform feature that occurs on another landform feature such as "dunes on terraces".

Exists On Feature ID If describing one feature existing on another, enter the appropriate Feature ID of the feature that this one occurs on. It's appropriate to populate a landform on a landform, or microfeature on a landform. Do not populate a landform on a landscape. The example below demonstrates the correct method for populating the Feature ID and Exists on Feature ID for "dunes on terraces".

Component Geomorphic Description

Seq	Feature Type	Feature Name	Feature Modifier	Feature ID	Exists On Feature ID	RV?
	Landform	dunes		1	2	yes
	Landform	terraces		2		yes

RV Populate as "yes" for all landforms and landscapes where the component commonly occurs. Some landforms or landscapes could be populated as "no" if the component rarely occurs on them. At least one RV landform is required for the hydric soil reports.

Component Two Dimensional Surface Morphometry Table

Populate based on local guides developed for the survey area. This table is generally only applicable for "hill" or "mountain" landforms. The "Field

Book for Describing and Sampling Soils" provides information and diagrams on surface morphometry terms.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows. MO-1 NASIS mapunit description reports will sort Hillslope profile by sequence number.

Hillslope Profile Populate from choice list.

Component Three Dimensional Surface Morphometry Table

Populate based on local guides developed for the survey area. The "Field Book for Describing and Sampling Soils" provides information and diagrams on surface morphometry terms.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows. MO-1 NASIS mapunit description reports will sort geomorphic component by sequence number.

Geomorphic Component - Mountains

Geomorphic Component - Hills

Geomorphic Component - Terraces

Geomorphic Component - Flat plains

Component Slope Shape Surface Morphometry Table

Populate based on local guides developed for the survey area. In most cases, no more than 4 rows should be populated in this table to cover the most common across slope and down slope shape combinations.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows. MO-1 NASIS mapunit description reports will sort slope shape rows by sequence number.

Shape Across Populate from choice list.

Shape Down Populate from choice list.

Component Microrelief Surface Morphometry Table

Data population is optional. Populate based on local guides developed for the survey area.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Microrelief Populate from choice list.

Component Erosion Accelerated Table

This table is normally not populated in MO-1. Coordinate with State Soil Scientist and Soil Data Quality Specialists on when to populate.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Kind Populate from choice list

RV

Component Surface Fragments Table

Enter data in this table if the mapunit component is a phase with rock fragments on the surface of the soil. Priority should be given to populating surface stones and boulders in this table. All rock fragment size fractions can be entered if data is available.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Cover % Enter percent of surface that is covered by each rock fragment size class (Low-RV-High). Values for stones and boulders should generally agree with Soil Survey Manual surface rock fragment classes in Table 3-12.

Spacing Enter distance between fragments using Soil Survey Manual Table 3-12 guidelines (RV is recommended, lows and high are optional).

Kind Enter kind of rock from choice list

Size Enter standard rock fragment sizes from the Soil Survey Manual. The following table provides guidance on size fractions to populate. The decision on whether to divide gravel into fine, medium, and coarse fractions can be made locally. If gravel fragments tend to be concentrated in one size fraction, such as fine gravel in soils formed from highly weathered granitic rock, it would be beneficial to populate the fine gravel separately. If the textural modifier for the surface mineral horizon is “fine gravelly”, then fine gravel should be populated in a separate row. It becomes less important to divide the gravel fractions in soils where the gravel sizes are fairly equally distributed from 2 to 75 mm.

Fragment Shape	Rock Fragment Term	NASIS Fragment Size: L-RV-H (mm)
Nonflat	gravel	2 - 40 - 75
Nonflat	fine gravel	2 - 4 - 5
Nonflat	medium gravel	5 - 15 - 20
Nonflat	coarse gravel	20 - 50 - 75

Fragment Shape	Rock Fragment Term	NASIS Fragment Size: L-RV-H (mm)
Nonflat	cobbles	75 - 160 - 250
Nonflat	stones	250 - 425 - 600
Nonflat	boulders	600 - ? - ? (RV and high based on local knowledge)
Flat	channers	2 - 75 - 150
Flat	flagstones	150 - 265 - 380
Flat	stones	380 - 490 - 600
Flat	boulders	600 - ? - ? (RV and high based on local knowledge)

Shape Enter shape from choice list.

Roundness Enter from choice list.

Cementation Enter from choice list.

Component Parent Material Group Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Group Name A calculation is available for this field.. Enter data in the Component Parent Material Table. The parent material group can be manually edited after it is calculated.

RV Enter yes for the representative group name, or all groups if you want them all to be listed in the mapunit description.

Component Parent Material Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Vertical Order Used to designate the depth sequence in which parent material occurs, when more than one parent material exists, such as volcanic ash over colluvium from basalt. If only one parent material (i.e. no lithologic discontinuity), then no entry is required.

Textural Modifier Enter if needed from choice list. This is a general textural description of the parent material and is most commonly used for alluvium.

General Modifier User specified term used to describe the nature of the parent material.

Kind Enter from choice list.

Origin Enter from choice list.

Component Month Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Month Enter one record for each of the 12 months.

Flooding Frequency Enter Frequency for each class of flooding, including rare. If the soil is not flooded during the month, enter “none”. A component will have only one assigned frequency; i.e., if a soil component has an occasional flooding frequency, occasional will be the only entry used for each month in which flooding occurs. See NSSH section 618.26 for definitions of flooding frequency classes.

Flooding Duration Enter Duration from choice list. A component will have only one assigned duration. Do not populate Flooding Duration if the Flooding Frequency is “none” , “very rare” or “rare”.

Ponding Frequency Enter Frequency from choice list. See NSSH section 618.46 for definition and frequency classes. A component will have only one assigned frequency. If the component is not ponded, enter “none”.

Ponding Duration Enter Duration from choice list. A component will have only one assigned duration. Do not populate Ponding Duration if the Ponding Frequency is “none” or “rare”.

Ponding Depth Generally should be entered in 15 cm (6-inch) increments (Low-RV-High). Populate for all Ponding Frequencies except “none” and “rare”.

Daily Precip Data population is optional. Enter average daily precipitation for the month from weather station data.

Daily ET Data population is optional.

Component Soil Moisture Table

Data for the Wet state are required to display water table depths in the “Water Features” manuscript and Soil Data Mart / Web Soil Survey reports. Data for Moist and Dry states are optional. Consult MO-1 Technical Note 21 for instructions on populating data for the Wet state in this table. Data should be populated for components that have a water table within 2 meters of the soil surface at some time during a normal year.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Moisture Status Enter from choice list.

Top Depth Enter depths according to examples in Technical Note 21 (Low-RV-High).

Bot Depth Enter depths according to examples in Technical Note 21 (Low-RV-High).

Component Soil Temperature Table

Data population in this table is optional.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Monthly Temp

Top Depth

Bot Depth

Component Restrictions Table

Entries are for duripans, bedrock, densic material, fragipans and other root restricting layers such as abrupt textural change, strongly contrasting textural stratification, etc. (Refer to MO-1 Technical Note 34).

If component T factor is less than 5, this table will generally be populated with some type of restriction. Exceptions include soils high in carbonates or gypsum.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Kind Enter from choice list

Hardness Enter from choice list

Top Depth Populate the distance from the soil surface to the upper boundary of the restrictive layer (Low-RV-High). Organic duff surface horizons on forested soils are included in determining the depth to the restrictive layer. For example, if depth to bedrock ranges from 50 to 100 cm from the mineral surface with an RV depth of 75 cm, and the component typically has a 3 cm thick organic duff surface horizon, the populated top depth would be 53-78-103 cm (L-RV-H). The RV top depth should agree with the top depth of the layer in the Component Horizon table. The Low and High top depths should agree with the taxonomic unit description and/or official series description range in characteristics, with adjustments downward for organic duff horizons.

Bot Depth Do not populate.

Thickness Enter as needed (Low-RV-High). If bottom depth is within 60 inches, enter restriction thickness. Thickness is dominantly used for duripans, fragipans, etc. It should not be populated for bedrock or densic material. The RV thickness should agree with the layer thickness in the Component

Horizon table. The Low and High thickness values should agree with the taxonomic unit description and/or official series description range in characteristics.

Component Diagnostic Features Table

Data population in this table is optional.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Kind Enter from choice list.

Top Depth

Bot Depth

Component Taxonomic Family Mineralogy Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Mineralogy Enter from choice list. Populate with “not used” for components with a component kind of “taxon above family”, such as Andic Dystroxerepts.

Component Taxonomic Family - Other Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Family Other Enter from choice list if needed.

Component Taxonomic Moisture Class Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Moisture Class Enter from choice list. This field represents the taxonomic moisture regime for the component. The moisture class cannot always be determined from the taxonomic classification. For example, Lithic Argixerolls can have either a xeric or aridic moisture class. In these cases, the official series description will need to be reviewed in order to determine the moisture class.

Component Interpretation Table

The only interpretation that should be populated in this table is the “hydric soil rating. The hydric rating will move to the Component table in the next release of NASIS.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Kind Enter “hydric soil rating” from choice list.

Rating Enter “yes” or “no” depending on whether the component meets hydric criteria, but see exceptions below. The National NASIS report “UTIL - Hydric Soil Validation” can be used to check hydric soil ratings against the hydric criteria. This report is to be used as a guide and to help identify potential errors in hydric ratings. There may be differences between the calculated and stored hydric ratings, caused by special circumstances such as flood protection or artificial drainage. Some components have field indicators of hydric soils but may not technically meet the hydric criteria - these should be populated as hydric “yes”.

Component Interpretation Restriction Table

This table is currently used to populate the hydric criteria when the hydric rating in the Component Interpretations table is “yes”. The hydric criteria will move to the new Component Hydric Criteria table in the next release of NASIS.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Restriction Populate only for the hydric soil rating. Enter restriction from choice list. (Choices are 1, 2a, 2b1, 2b2, 2b3, 3, and 4.) If a component meets more than one criteria class, a separate row should be used for each criterion that is met. The restrictions correspond to the category codes for the Criteria for Hydric Soils. The current hydric soil criteria are available at http://soils.usda.gov/use/hydric/criteria.html.

Component Pedon Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

User Pedon ID Enter the User Pedon ID for the NASIS pedon that was used to develop the Component Horizon data. In most cases this will be the modal or typical pedon for the series or the modal pedon for the mapunit. This should be populated for the component where the modal or typical pedon is located.

Describer’s Name Populated automatically from the User Pedon ID

Soil Name as Sampled Populated automatically from the User Pedon ID

Rep Pedon? Populate as “yes” if this is the representative or typical pedon for the component.

Component Text

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Kind Enter from choice list.

Category Consult MO-1 Technical Note 25 for a list of recommended Categories and Subcategories.

Subcategory

Text

Horizon Table

Data in this table consists of a record for each horizon listed in the typical pedon for the survey area. In some cases, as in highly stratified material, horizons may be combined. Data that was converted from 3SD contains layer data and will need to be split into individual horizons during the update process. This layer data has horizon designations of H1, H2, H3, etc. Also, any join units copied from adjoining surveys that have not had the layer data split into horizons will need to be updated..

Seq It is not necessary to enter a sequence for each horizon. These rows are sorted by horizon depth.

Designation Horizon designation is a calculated field. Do not enter manually except in rare instances. This field must be recalculated every time there is a change in the Disc, Master, Sub columns or the Horizon Designation Suffix table. This field can be calculated for the entire selected set at the same time, or just for the rows selected. It is a good idea to calculate the Designation for each component after they are entered so the entries can be checked for errors or omissions. Layer data that was converted from 3SD will have to be split out by horizon and in many cases, the percent passing sieves and other values will need to be revised to reflect the texture range for each horizon.

Horizons that have a dual designation such as B/E or A/C, and that also have a subscript on the first horizon, will have to be entered manually. For example, if the horizon designation is Bt/E, the horizon designation will be calculated as B/Et. Horizons that have a subscript on the second master horizon are not a problem and can be calculated.

Disc Enter a numeric value for the discontinuity if one is present.

Master Enter the master horizon from choice list.

Sub Enter numeric value if the horizon is subdivided. (i.e. for a Bt1, enter a “1”.

Top Depth Enter the depth, in centimeters, from the soil surface to the top of each horizon. The value in the RV column should be the horizon depth in the typical pedon for the survey area. The Low and High values represent the range in depth to the top of each horizon, not the thickness. The RV top depth is required. Low and High top depths are optional.

Bottom Depth Enter the depth, in centimeters, from the soil surface to the bottom of each horizon. The value in the RV column should be the horizon depth in the typical pedon for the survey area. The Low and High values represent the range in depth to the bottom of each horizon, not the thickness. . In the case where the bottom horizon is lithic or paralithic bedrock, add 25 centimeters to the top of the bedrock layer as the bottom

depth. The RV bottom depth is required. Low and High bottom depths are optional.

Thickness Data population is optional. This field is typically not populated. The RV is the thickness of each horizon in the typical pedon. The Low and High values are the range in thickness from the range in characteristics. Usually this value will be taken from the pedon description in the taxonomic unit description or official series description.

Total Fragment Volume Total fragment volume for the horizon, including pararock, by percent. The RV value should agree with the total fragment volume for the horizon in the typical pedon. The RV should also agree with the sum of the RV % values in the Horizon Fragments table. Low and high values should agree with the range in characteristics from the taxonomic unit description.

Note: The low values for this field are NOT equal to the sum of all the low values in the Horizon Fragment table. Likewise, the high values are NOT equal to the sum of all the high values in the Horizon Fragments table. It's unlikely that all the low values, or all the high values in the Horizon Fragments table would exist in individual pedons.

Rock >10 Rock fragments greater than 10 inches in diameter by weight. Do not include pararock fragments. Enter the range in weight percent of the whole soil. Low and high values should be rounded to the nearest 5 percent. The RV should agree with the greater than 10 inch rock fragments described in the typical pedon, converted to a weight basis, rounded to the nearest whole number. Use MO-1 NASIS Guide 1A to convert volume field estimates to weight for a soil bulk density of 1.5 g/cm3. For bulk density values representing significant differences from the 1.5 default value use MO-1 NASIS Guide 2B or the MO-1 NASIS Excel spreadsheet.

Rock 3-10 Rock fragments 3 to 10 inches in diameter by weight. Do not include pararock fragments. Enter the range in weight percent of the whole soil. Round the low and high values to the nearest 5 percent. The RV should agree with the 3 to 10 inch rock fragments described in the typical pedon, converted to a weight basis, rounded to the nearest whole number. Use MO-1 NASIS Guide 1A to convert volume field estimates to weight for a soil bulk density of 1.5 g/cm3. For bulk density values representing significant differences from the 1.5 default value use MO-1 NASIS Guide 2B or the MO-1 NASIS Excel spreadsheet.

#4 Percent passing the # 4 sieve as a weight percentage of the less than 3 inch fraction. As a rule of thumb, the percent passing #4 can be calculated by adding 5 to 10% to the percent passing the #10. Consider parent material and fine gravel in this calculation. Low and high values should be rounded to the nearest 5 percent, RV should be rounded to the nearest whole number.

#10 Percent passing the # 10 sieve as a weight percentage of the less than 3 inch fraction Enter values based on MO-1 NASIS Guide 1A or 1B using %gravel vs. %cobble and stones, or use the MO-1 NASIS Excel spreadsheet. Low and high values should be rounded to the nearest 5 percent, RV should be rounded to the nearest whole number.

#40 Percent passing the # 40 sieve as a weight percentage of the less than 3 inch fraction. Enter values based on ranges given in MO-1 NASIS Guide 3 (Blewitts table) and % passing # 10 sieve and texture. MO-1 NASIS

Guide 4 gives the maximum possible ranges. Our recommendation is to use narrower ranges given in MO-1 NASIS Guide 3 (Blewitts tables). Low and high values should be rounded to the nearest 5 percent, RV should be rounded to the nearest whole number.

#200

Percent passing the # 200 sieve as a weight percentage of the less than 3 inch fraction. Enter values based on ranges given in MO-1 NASIS Guide 3 (Blewitts table) and % passing # 10 sieve and texture. MO-1 NASIS Guide 4 gives the maximum possible ranges. Our recommendation is to use narrower ranges given in MO-1 NASIS Guide 3 (Blewitts tables). Low and high values should be rounded to the nearest 5 percent, RV should be rounded to the nearest whole number.

Total Sand

The NASIS Particle-size Estimator calculation can be used to populate the RV value for total sand. Texture, clay% and taxonomic particle-size class are needed for the calculation. This calculation will allow a manual entry of the Total Sand RV. If the various sand sizes are populated using lab data, then the total sand value should also come from the lab data. Combinations of a calculated Total Sand RV and manually entered various sand fractions from lab data, will result in validation errors if the sand fractions do not add up to the total sand. The Low, RV, and High values are required, and should be based on the textures in the Horizon Texture Group table.

Sand Fractions - vcos, cos, ms, fs, vfs

Enter manually if lab data is available to support estimates. RV Sand fraction values can be calculated with the Particle-size Estimator. Calculations should be checked to see if they appear reasonable. The RV values are required. Low and high values are optional

Total Silt

The NASIS Particle-size Estimator calculation can be used to populate the RV value for total silt. Texture, clay% and taxonomic particle-size class are needed for the calculation. It can also be entered based on lab data or field estimates. The Low, RV, and High values are required, and should be based on the textures in the Horizon Texture Group table.

Coarse Silt

Enter only if lab data is available to support estimates.

Fine Silt

Enter only if lab data is available to support estimates.

Total Clay

Enter total clay range (low-RV-high) for the textures listed in the Horizon Texture Group table. For soils with andic properties, enter the field estimated clay.

CaCO3 Clay

Enter if applicable and data is available.

OM

Enter organic matter range for the horizon (low-RV-high). This data will have to be adjusted on components where horizons are split from layers converted from 3SD. Where applicable, this value must support the taxonomic classification. See NSSH section 618.39 for definition. See MO-1 Technical Note 34 for guidance on populating data for saturated and unsaturated organic horizons. Low , RV, and high values should be rounded to the nearest 0.1 percent if organic matter is less than 1 percent. Low and high values should be rounded to the nearest whole number if organic matter is greater than or equal to 1 percent, RV values should be rounded to the nearest 0.5 percent.

Db 0.1 bar H20 Do not enter unless lab data is available. The National Soil Survey Laboratory normally determines bulk density at 0.1 bar tension only for sandy horizons.

Db 0.33 bar H20 Enter estimates for all horizons using local or state guides or lab data. See NSSH section 618.06 for definition. MO-1 NASIS Guides 5 to 9 can be used to estimate bulk density. Step 1 – determine consolidation class from Guide 5; Step 2 – determine bulk density from Guide 6 or Guide 8. For volcanic ash influenced soils use Guide 7. Adjust for organic matter as needed with Guide 9. Values should be rounded to the nearest 0.05 g/cm3.

Db 15 bar H20 This field can be calculated using the Water Content calculation. Do not manually enter unless lab data is available.

Db oven dry This field can be calculated using the Water Content calculation. Do not manually enter unless lab data is available

Dp Particle density. Do not enter unless lab data is available.

Ksat Saturated Hydraulic Conductivity. Enter low, RV and high values according to the guidance in MO-1 Technical Note 26. See MO-1 Technical Note 34, Attachment D for additional guidance on populating Ksat for restrictive layers. Do not populate Ksat for bedrock horizons.

AWC Available Water Capacity. Enter low, RV, and high values. Use MO-1 NASIS Guide 10 for non-volcanic ash influenced soils. For volcanic ash influenced soils, use MO-1 NASIS Guide 11. See NSSH section 618.5 for definition.

0.1 bar H20 This field can be calculated using the Water Content calculation for horizons with sandy textures. Do not manually enter unless lab data is available. Water content is for the whole soil, including rock fragments, on a volumetric basis. Most water content lab data is on a weight basis for the less than 2 mm fraction.

0.33 bar H20, 15 bar H20, Satiated H20 These fields can be calculated using the Water Content calculation. Do not manually enter unless lab data is available. Water content is for the whole soil, including rock fragments, on a volumetric basis. Most water content lab data is on a weight basis for the less than 2 mm fraction.

LEP Linear Extensibility Percent. Use MO-1 NASIS Guide 12 or lab data to determine values for low, RV, and high.. See NSSH section 618.37 for definition.

LL Liquid Limit. For horizons without andic properties and not meeting vitrandic subgroup criteria, use the MO-1 NASIS report “CHECK - Liquid limit and plasticity index” to estimate liquid limit. This report uses the formulas in the National NASIS calculation (see MO-1 NASIS Guide 13). The values in this report can then be evaluated and manually entered. The national formulas have also been incorporated into the MO-1 NASIS Excel spreadsheet. Use MO-1 NASIS Guide 14 for horizons with andic soil properties or those that meet vitrandic subgroup criteria. See NSSH section 618.39 for definition.

Low and high LL values should be rounded to the nearest 5. RV values should be rounded to the nearest whole number. Calculated LL values of less than 15 should be populated as zero in NASIS.

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PI Plasticity Index. For horizons without andic properties and not meeting vitrandic subgroup criteria, use the MO-1 NASIS report "CHECK - Liquid limit and plasticity index" to estimate plasticity index. This report uses the formulas in the National NASIS calculation (see MO-1 NASIS Guide 13). The values in this report can then be evaluated and manually entered. The national formulas have also been incorporated into the MO-1 NASIS Excel spreadsheet. Use MO-1 NASIS Guide 14 for horizons with andic soil properties or those that meet vitrandic subgroup criteria. See NSSH section 618.45 for definition.

Low and high PI values should be rounded to the nearest 5. RV values should be rounded to the nearest whole number.

For a dual Unified classification (CL-ML, SC-SM, GC-GM), the PI must be 4, 5, 6, or 7.

AASHTO Group Index This field should be calculated using the Horizon table AASHTO Group Index calculation after populating the %passing 200 sieve, liquid limit, and plasticity index.

Kw Calculate using the nomograph in NSSH Exhibit 618-12. Adjust for rock fragments using NSSH Exhibit 618-13. See NSSH section 618.55 for definition. The formula from the nomograph has been incorporated into the MO-1 NASIS Excel spreadsheet Output sheet.

Kf Calculate using the nomograph in NSSH Exhibit 618-12. See NSSH section 618.55 for definition. The formula from the nomograph has been incorporated into the MO-1 NASIS Excel spreadsheet

CaC03 Use lab data to estimate if available. Populate low, RV, and high values. Entries should agree with taxonomic classification, such as for calcic horizons and carbonatic mineralogy. Enter zero in all 3 fields if CaC03 is not present.

Gypsum Use lab data to estimate if available. Populate low, RV, and high values. Enter zero in all 3 fields if gypsum is not present.

SAR Sodium Adsorption Ratio. Use lab data to estimate if available. Populate low, RV, and high values. Enter zero in all 3 fields if extractable sodium is not present or negligible (SAR < 0.1).

EC Electrical Conductivity (saturated paste). Use lab data to estimate if available. Populate low, RV, and high values. Enter zero in all 3 fields if soluble salts are not present or negligible (EC < 0.1 mmhos/cm). See NSSH section 618.18 for definition. A local guide is needed for this field.

CEC-7 Cation Exchange Capacity - pH 7. Use lab data to estimate if available. This field should be populated for all horizons regardless of pH. Populate low, RV, and high values. For horizons without andic properties, use MO-1 NASIS Guide 15 to estimate. The national NASIS report "UTIL - Comparison of CEC and ECEC, stored vs calculated" can also be used to

estimate CEC-7 for horizons without andic properties. The values in the report can be evaluated and manually entered.

For soils with andic soil properties, use locally developed guides for consistency. In the absence of a local guide, use MO-1 NASIS Guide 16 for soils with andic soil properties.

Low and high values should be rounded to the nearest 5 if values are greater than 5. RV values should be rounded to the nearest whole number.

ECEC

Effective Cation Exchange Capacity. Use lab data to estimate if available. Populate low, RV, and high values. ECEC is required for all horizons of a component when either the low, RV, or high pH in H_2O is less than 5.5 in any horizon, and is optional otherwise.

The national NASIS report "UTIL - Comparison of CEC and ECEC, stored vs calculated" can also be used to estimate ECEC. The values in the report can be evaluated and manually entered.

Low and high values should be rounded to the nearest 5 if values are greater than 5. RV values should be rounded to the nearest whole number.

Sum of Bases

Data population is optional. Enter if lab data is available, otherwise leave blank. Sum of bases is affected by fertilizer applications.

pH H20

Populate low, RV, and high values. The low and high values should correspond to the reaction classes in NSSH section 618.48. The RV value should agree with the typical pedon.

Reaction Class	Range in pH
Ultra acid	1.8 - 3.4
Extremely acid	3.5 - 4.4
Very strongly acid	4.5 - 5.0
Strongly acid	5.1 - 5.5
Moderately acid	5.6 - 6.0
Slightly acid	6.1 - 6.5
Neutral	6.6 - 7.3
Slightly alkaline	7.4 - 7.8
Moderately alkaline	7.9 - 8.4
Strongly alkaline	8.5 - 9.0
Very strongly alkaline	9.1 - 11.0

pH CaCl2

Populate low, high, and RV values for saturated organic horizons such as muck, mucky peat, and peat. The low and high values should correspond to the reaction classes in NSSH section 618.48. The RV value should agree with the typical pedon. Use lab data if available. The pH in $CaCl_2$ is generally about 0.5 units lower than pH in H_2O.

Free Iron	Data population is optional. Enter if lab data is available. Otherwise, leave blank.
Oxalate Iron	Data population is optional. Enter if lab data is available. Otherwise, leave blank
Ext. Acidity	Data population is optional. Enter if lab data is available. Otherwise, leave blank
Ext. Al	Data population is optional. Enter if lab data is available. Otherwise, leave blank
Bray 1 Phos	Data population is optional. Enter if lab data is available. Otherwise, leave blank.
Oxalate Phos	Data population is optional. Enter if lab data is available. Otherwise, leave blank.
Water Soluble Phos	Data population is optional. Enter if lab data is available. Otherwise, leave blank
Total Phos	Data population is optional. Enter if lab data is available. Otherwise, leave blank
Excav Diff	Data population is optional.
Excav Diff Moisture	Data population is optional.
SIR Layer	Obsolete. Do not populate. Used as a reference only to layers on the original SOILS-5 form for data converted from 3SD.

Horizon Designation Suffix Table

Seq	Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.
Suffix	Enter the suffix from the choice list. If more than one suffix applies to the horizon, enter each suffix on a separate row.

Horizon Texture Group Table

	No more than 5 textures should generally be entered for each horizon. There should be only one texture for the surface mineral horizon according to NSSH Part 618.67.
Seq	Enter a sequence number only if you want the textures listed in a specific order. If you use a sequence number in one row, enter a number in all rows.
Tex Mod & Class	This is a calculated field. The entry will be calculated from the entries in sub tables. This field must be recalculated each time there is a change in one of the sub tables. Each texture class must be entered on a separate row unless the texture is stratified. First, open a row in this table, then

open a row in the texture and texture modifier sub tables. When entries have been made in these tables, calculate the Texture Mod & Class.

Stratified? Enter “yes” if this horizon is stratified, otherwise, enter no. If yes, enter the two extreme ranges of textures only.

RV? Enter yes in the row that has the texture of the typical pedon. All other rows should be “no”. The RV texture will be printed in the mini profile in the NASIS mapunit description. Each horizon should have a single RV texture.

Horizon Texture Table

Seq Do not populate unless the horizon is stratified. Populate for stratified horizons if you want textures to be listed in a particular order when calculated. There should be only one texture for each corresponding row in the parent Horizon Texture Group table unless it is stratified.

Texture Enter only valid USDA textures from the choice list. When stratified, use only the two extreme textures in separate rows. See NSSH section 618.67 for definition and classes. A “Multiple Textures” validation in the Horizon Texture Group table is available to check against having multiple textures in the Horizon Texture table..

InLieu Enter value from choice list for anything that is not a valid USDA texture. See NSSH section 618.67 for definition and classes.

Horizon Texture Modifier Table

Seq Sequence numbers are not necessary unless you want the modifiers listed in a specific order. If so, enter a number in all rows. Otherwise null sequence values will be listed first. If multiple modifiers are listed for the same texture, i.e. “gr” and “mk”, sequence numbers are needed to ensure the modifiers occur in the proper order when the texture class is calculated.

Modifier Enter value from choice list. See NSSH section 618.67 for definition and classes. The NSSH Exhibit 618-11 is used to determine the textural class modifier.

Horizon Fragments Table

The volume percent, kind, size and hardness fields populated in this table can be used in a National calculation to determine percent passing the sieves.

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Vol % List percent by volume for each size class from range in characteristics. Values must agree with percent passing sieves, and total of RV column must agree with texture modifiers. Enter volume percent of all fragments larger than 2mm using standard fragment size ranges. Enter para-fragments in separate rows from hard fragments. Para-fragments are moderately cemented or softer.

Kind List dominant rock type from choice list.

Size Enter standard rock fragment sizes from the Soil Survey Manual. The following table provides guidance on size fractions to populate. The decision on whether to divide gravel into fine, medium, and coarse fractions can be made locally. If gravel fragments tend to be concentrated in one size fraction, such as fine gravel in soils formed from highly weathered granitic rock, it would be beneficial to populate the fine gravel separately. If the textural modifier is “fine gravelly”, then fine gravel should be populated in a separate row. It becomes less important to divide the gravel fractions in soils where the gravel sizes are fairly equally distributed from 2 to 75 mm.

Fragment Shape	Rock Fragment Term	Fragment Size: L-RV-H (mm)
Nonflat	gravel	2 - 40 - 75
Nonflat	fine gravel	2 - 4 - 5
Nonflat	medium gravel	5 - 15 - 20
Nonflat	coarse gravel	20 - 50 - 75
Nonflat	cobbles	75 - 160 - 250
Nonflat	stones	250 - 425 - 600
Nonflat	boulders	600 - ? - ? (RV and high based on local knowledge)
Flat	channers	2 - 75 - 150
Flat	flagstones	150 - 265 - 380
Flat	stones	380 - 490 - 600
Flat	boulders	600 - ? - ? (RV and high based on local knowledge)

Shape Entries are optional. This field should be populated for horizons that have both nonflat and flat fragments such as gravel and channers.

Roundness Entries are optional.

Hardness Enter hardness of fragments as degree of cementation. Classes are defined in the choice list.. If unknown or extremely variable, use “moderately cemented” for para fragments and “indurated” for lithic fragments.

Horizon AASHTO Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Aashto See NSSH section 618.20 for definition. Also reference NSSH Exhibit 618-8 for textural triangle and particle-size limits of the AASHTO classification system. Calculate using NSSH Exhibit 618-04. Low, RV, and high values for percent passing sieves, liquid limit, and plasticity index should be used together to determined AASHTO classes. For example, do not use the low liquid limit with the high plasticity index values.

The MO-1 NASIS report "UTIL - AASHTO & Unified: calculated and stored (L, RV, H)" can be used to calculate the AASHTO classes for the low, RV, and high percent passing sieves, liquid limit, and plasticity index values. The report can also be used to compare calculated and stored classes.

RV Enter "yes" for the representative classification in each horizon. There should be only one RV AASHTO class for each horizon.

Horizon Unified Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Unified See NSSH section 618.20 for definition. Also reference NSSH Exhibit 618-8 for textural triangle and particle-size limits of the Unified classification system. See MO-1 NASIS Guide 17 and 18 to determine estimated Unified classification. For coarse-grained soils, determine sand and gravel class using MO-1 NASIS Guide 19. For fine-grained soils, determine Unified class using MO-1 NASIS Guide 20.

Low, RV, and high values for percent passing sieves, liquid limit, and plasticity index should be used together to determined Unified classes. For example, do not use the low liquid limit with the high plasticity index values.

The MO-1 NASIS report "UTIL - AASHTO & Unified: calculated and stored (L, RV, H)" can be used to calculate the Unified classes for the low, RV, and high percent passing sieves, liquid limit, and plasticity index values. The report can also be used to compare calculated and stored classes.
Dual classes such as CL-ML or SC-SM require a plasticity index of 4, 5, 6, or 7.

RV Enter "yes" for the representative classification in each horizon. There should be only one RV Unified class for each horizon.

Horizon Pores Table

Data population for horizon pores is optional.

Horizon Structure Group Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Structure Group This field is calculated from entries in the Horizon Structure child table. After it is calculated it can be edited. For example, “moderate fine granular structure and moderate medium granular structure” can be edited to “moderate fine and medium granular structure”.

RV Enter “yes” for the structure group of the representative pedon**.**

Horizon Structure Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Grade Populate for all structure types except massive and single grain.

Size Populate for all structure types except massive and single grain.

Type Populate from choice list.

Structure ID Populate only if one structure parts to another.

Parts to Structure ID Populate only if one structure parts to another. See the example below for how to populate “moderate coarse prismatic structure parting to moderate medium subangular”.

Horizon Structure					
Seq	Grade	Size	Type	Structure ID	Parts to Structure ID
	moderate	coarse	prismatic	1	2
	moderate	medium	subangular blocky	2	

Horizon Consistence Table

Data population for horizon consistence is optional.

Horizon Text Table

Seq Entries are not necessary, however if you enter a sequence number in one row, enter a number in all rows.

Kind Enter the kind of note from the choice list.

Category Consult MO-1 Technical Note 25 for a list of Categories and Subcategories.

Subcategory

Text

WA NASIS Guide 1
Important Farmlands
Mapping Unit Evaluations*

United States Department of Agriculture
Natural Resources Conservation Service
Spokane, Washington

Revised February, 2003

		EROSION HAZARD				CHEMISTRY		WATER						
	WATER NEEDS FOR CROP	WATER AVERAGE SLOPE % X "K" FACTOR	WIND "I" FACTOR X "C" FACTOR	TEMPER-ATURE REGIME	pH	E.C. (ELECTRICAL CONDUCTIVITY) mmhos/cm	E.S.P. (EXCHANGEABLE SODIUM PERCENT)	GROWING SEASON WATER TABLE	FLOODING FREQUENCY	SATURATED HYDRAULIC CONDUCTIVITY (µm/s)	DEPTH TO RESTRICTIVE LAYER	SURFACE ROCK FRAG LARGER THAN GRAVEL(>3")	AVAILABLE WATER CAPACITY (INCHES TO 40")	LAND CAPA-BILITY CLASS AND SUBCLASS
PRIME FARM-LAND	IRR OR ENOUGH PRECIP-TO ANNUAL CROP (7 OUT OF 10 YRS)	LESS THAN 2	LESS THAN 60	MESIC OR FRIGID	4.5 TO 8.4	LESS THAN 4	LESS THAN 15	NO INTER-FERENCE WITH COMMON CROPS	LESS THAN ONCE EVERY 2 YEARS (**NONE,RARE,OCCA SIONAL**)	≥ 0.42 (**SLOW** OR BETTER)	≥20" TO RESTRICTION (**MODERATELY DEEP** OR DEEPER)	LESS THAN 10 PERCENT	IRR >2.5" NIRR ENOUGH FOR ANNUAL CROP	I, IIe, IIw, IIs, IIc, IIIe, IIIw, IIIs, IIIc, IVw, IVs, Vw, VIw
FARM-LAND OF STATE-WIDE IMPORT-ANCE	IRR OR CAN BE ALT. YR. CROP-PING MUST HARVEST 75% OF PLANT-INGS	IRR <6.5 NIRR <13 MLRAs 7&8; <15 MLRA 9	ANY	MESIC OR FRIGID	4.5 TO 9.0	LESS THAN 8	LESS THAN 40	ALLOWS COMMON CROPS OR HAY TO BE HARVESTED			>20" TO BEDROCK OR OR HARDPAN >20" TO S-SKEL MATERIAL, ANY SLOPE 10-20" TO S-SKEL MATERIAL <5 % SLOPES	UP TO 15% IF LESS THAN 10" IN DIAMETER	IRR >2.5" NIRR -ENOUGH FOR ALTERNATE YEAR CROPPING	IIIe, IIIw, IIIs, IIIc, IVe, IVw, IVs, IVc.,Vw, VIw VIe in MLRA-9

UNIQUE FARMLAND	DEPENDENT ON UNIQUE CROPS GROWN, SOIL CHARACTERISTICS, AND CLIMATE. LIMITED TO TREE FRUITS, VINEYARDS, AND CRANBERRIES.
FARMLAND OF LOCAL IMPORTANCE	OTHER LAND AS DETERMINED BY THE LOCAL AGRICULTURAL COMMITTEE, UNITS OF GOVERNMENT, ETC.

* Failure for a map unit to meet any one criteria would cause next lower rating; however, since some map units are broader than these terms, additional local criteria may be needed for final determination.

** Prime farmland designation must agree across state boundaries.

WA NASIS Guide 2
Criteria for Placing Washington Soils into Capability Classes

United States Department of Agriculture
Natural Resources Conservation Service
Spokane, Washington

Revised May 2003

SUBCLASS

	e	e	e	e	s	w	w	w	s	s	s	s	s	s	c	c	c
CAP. CLASS	PERCENT SLOPE - (IRR)	PERCENT SLOPE - (NIRR)	WATER EROSION INDEX **(1)**	WIND EROSION INDEX **(2)**	ROOTING DEPTH	DRAINAGE CLASS	DEPTH TO WATER TABLE	DAMAGING FLOOD HAZARD	SURFACE TEXTURE	SURFACE TEXTURE MODIFIER	SUBSOIL KSAT **(3)**	SALINITY (MMHOS/CM) **(4)**	SODICITY (SAR)	AVAILABLE WATER CAPACITY	AVERAGE ANNUAL PRECIP. (NIRR)	GROWING SEASON (>32 F) **(6)**	TEMP. REGIME
I	0-2	0-3	≤0.30	≤8	≥40"	WELL, MOD. WELL	≥36"	NONE, RARE	ALL EXCEPT C, SIC, SC, S, COS, FS, LS, LFS, LCOS	NONE	42 ≥ KSAT ≥ 1.4 (Moderately Rapid, Moderate, Moderately Slow)	≤2	≤5	≥7.5	>23"	≥140 DAYS	MESIC, ISO-MESIC
II	0-5	0-8	≤1.0	≤13	≥40"	ANY	≥30"	NONE, RARE	ALL EXCEPT C, SIC, SC, S, COS, LCOS	NONE, GR	42 ≥ KSAT ≥ 0.42 (Moderately Rapid, Moderate, Moderately Slow, Slow)	0-4	≤12	≥5.0"	>12"	≥100 DAYS	MESIC, ISO-MESIC
III	0-8	0-15	≤4.50	≤20	≥20"	ANY	≥18"	NONE, RARE OCCAS.	ANY	NONE, GR, CB	ANY	0-8	≤12	≥3.75"	>9"	≥80 DAYS	MESIC, ISO - MESIC, FRIGID, ISO-FRIGID
IV	0-15	0-30	ANY	ANY	≥20"	ANY	≥12"	ANY	ANY	NONE, GR, GRV, CB., CBV, ST	ANY	0-16	≤12	≥2.0"	>9"	≥50 DAYS	MESIC, ISO-MESIC, FRIGID, ISO-FRIGID
V	0-2	0-3	≤0.3	≤8	≥40	ANY	ANY	ANY	ANY	ANY	ANY	0-4	≤5	≥3.75"	ANY	≥50	MESIC, ISO-MESIC, FRIGID, ISO-FRIGID
VI	0-30	0-40	ANY	ANY	≥10"	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	≥1.3" **(5)** UPPER 10"	ANY	≥30	ANY
VII	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY
VIII	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANY	ANT	ANY	ANY	ANY	ANY	ANY	ANY

1. **WATER EROSION INDEX = ("K" FACTOR X SLOPE) / "T" FACTOR**
2. **WIND EROSION INDEX = (WIND ANNUAL "C" FACTOR X "I" FACTOR) / "T" FACTOR**
3. **SATURATED HYDRAULIC CONDUCTIVITY (um/s) - SLOWEST LAYER IN UPPER 40 INCHES**
4. **SURFACE LAYER**
5. **AWC =>1.3" IN UPPER 10" IS FOR NIRR, DO NOT USE FOR WET SOILS WITH WATER TABLE =<12" DURING JUNE TO AUGUST**
6. **LOW VALUE OF RANGE IN FROST-FREE DAYS**

To determine nonirrigated capability and subclass, rate each soil property and soil climate property across the chart from left to right. The lowest level (higher capability class number) reached is the nonirrigated capability for the soil at the lowest class-determining slope phase. The subclass is that factor which brought you to the lowest class level (higher capability class number). If the factor is (w) or (s), use that subclass until the (e) erosion limitation reaches the same level in the chart, then the subclass is (e). Subclass (c) is only used on 0-2% IRR or 0-3% NIRR class determining phases and when all other factors (e, w, and s) are at class 1.

ID NASIS Guide 1

United States Department of Agriculture
Natural Resources Conservation Service
Boise, Idaho

Guide for Placing Soils in Capability Classes in Idaho

Revised March, 1980

Capability Class	Depth Inches		Surface Soil Texture		Coarse Fragments Surface[1]	Subsoil Permeability		Slope Group	Percent slope[3] IRR			Slope Group	Percent slope[3] NIRR			Erosion Hazard Runoff	AWC Inches Surf. Ft Per. Ft. To 60"	Drainage Class Water Table (inches)	Overflow	Alkali & Salinity	Frost Free Days 32° F	ETp Irr.	ETa Dry	Development Units IRR NIRR	Index Crops
	IRR	NIRR	IRR	NIRR		IRR	NIRR	IRR	L	M	H[2]	NIRR	L	M	H[2]										
I	≥40	≥40	SL to SiCL	SL to SiCL	< 20% gravel	Mod. Slow to mod rapid	Mod. Slow to mod rapid	A	3	2	1	A	4	3	2	None or **Slight** V. slow slow	1.5 1.5 >7.5	Well & Mod. Well >50		Free	≥140	32° 20	32° 20	5000 5000	Corn or Sorghum for Grain
II	≥40	≥40	SL to SiC	SL to SiC	GR	Slow to rapid	Slow to rapid	B	6	4	2	B	12	8	4	Moderate Medium	1.0 1.0 >5.0	Somewhat Excessive to Somewhat Poorly >30	Rare	Slight	≥100	32° 14	32° 14	3500 3500	Corn and Sorgum for silage
III	≥20	≥40	LS to C, <60%clay, organic	LS to C, <60%clay	Stony	Very slow to very rapid (v. slow below 20")	Very slow to very rapid (v. slow below 40")	C	10	8	4	C	20	15	10	**High** Rapid	0.75 0.75 >3.75	Somewhat Excessive to Poorly 20+	Occasional	Moderate	≥70	10	10	2500 2500	Small grains for grain
IV	≥10	≥20	S to C >60%clay, organic	S to C	GRV, CB	Very slow to very rapid (v. slow below 10")	Very slow to very rapid (v. slow below 20")	D	16	12	8	D	30	25	20	**V. High** V. Rapid	0.6 0.5 >2.5	Excessive to Poorly <20	Occasional	Moderate	≥50	6	9	1500 2000	Marginal production of at least one cultivated crop
V	≥20	≥20	SL to C organic	SL-C	CBV, STV, STX (Cl .3)	Very slow to very rapid (v. slow below 20")	Very slow to very rapid (v. slow below 20")	A	3	2	1	A	4	3	2	None or Slight	--- 0.75 >3.75	Excessive to Very Poorly	Frequent	Slight	Any	4	8	1000 2000	Pasture, range, woodland (soils respond to mgmt)
VI	≥10	≥10	LS to C organic	LS to C	GRX, STV	Any	Very slow to rapid	E	40	30	20	E	40	35	30	V. high	--- 0.75 >2.0	Any	Frequent	Strong	Any	4	8	1000 2000	Pasture, range, woodland (soils respond to mgmt)
VII	-	-		Any	STX	-	Any	-	-	-	-	F	75	60	50	V. high	-	Any	Any	Any	Any	-	2	500 NIRR	Pasture, range, woodland (soils do not respond to mgmt)
VIII	-	-		Any	-	-	Any	-	-	-	-	G	>75	>60	>50	-	-	Any	Any	Any	Any	-	-	-	No plant of production of value

[1] USDA Textures and Modifiers [2] Use K factors L=0-0.2, M=0.2-0.4, H=0.4+ [3] Maximum slope
Subclass – use s,w,c only on 0 to 4 percent slopes except very stony or rocky soils = s for all slopes. Use e above 4% slopes.

Definitions for ID Capability Class Guide (ID NASIS Guide 1)

Permeability

Class	In/hr
Very Slow	Less than 0.06
Slow	0.06 – 0.2
Moderately Slow	0.2 – 0.6
Moderate	0.6 – 2.0
Moderately Rapid	2.0 – 6.0
Rapid	6.0 – 20
Very Rapid	More than 20

Stoniness

Class	Modifier	Symbol	Description
0			Stones are more than 100 ft. apart
1	Stony	ST	Stones 30 – 100 ft. apart
2	Very stony	STV	Stones 5 – 30 ft. apart
3	Extremely stony	STX	Stones 2.5 – 5 ft. apart
4	Extremely stony soils and rubble		Stones less than 2.5 ft. apart
5	Rubbleland		Land paved with stones

Gravel and Cobble Classes

Symbol	Modifier	Percent Gravel or Cobbles (volume)
CB GR	Cobbly or Gravelly	15 – 35
CBV GRV	Very cobbly or gravelly	35 – 60
CBX GRX	Extremely cobbly or gravelly	60 – 90

Drainage

Drainage Class	Description
Very poorly	Water table at or near the surface most of the time
Poorly	Soil wet much of the time, seasonally near the surface
Somewhat poorly	Soil periodically wet but not all the time, drainage needed for crops
Moderately well	Profile wet for short time each year
Well	No water table
Somewhat excessively	Water removed rapidly
Excessively	Water removed very rapidly

Salinity

Class	Approx. salt	Conductivity
Non saline	0 – 0.15	0 – 4
Slightly saline	0.15 – 0.35	4 – 8
Moderately saline	0.35 – 0.65	8 – 15
Strongly saline	Above 0.65	Above 15

Alkalinity

Class	Definition
Non alkali	May have few insignificant spots
Slightly alkali	Up to 5% alkali spots
Moderately alkali	5 to 35% alkali affected
Strongly alkali	More than 35% of area affected

Soil Erodibility

Soil Erodibility	Low	Med.	High
K factor	0 – 0.22	0.22 – 0.45	0.45+

OR NASIS Guide 1

United States Department of Agriculture
Natural Resources Conservation Service
Portland, Oregon

Revised June 1977

Guide for Placing Soils in Capability Classes in Oregon

Capability Class	Depth Inches		Surface Soil Texture		Permeability within Effective Depth in./hr [1]	Max Slope %[2]		Erosion Hazard	Available Water Capacity[3] (In.) to 60 inches	Drainage Class	Overflow	Alkali & Salinity[4]	Frost Free Days 32° F[5]	ETp Irr.[5]	ETa Dry[5&6]
	Irr.	Dry	Irr.	Dry		Irr.	Dry								
I	≥40	≥40	SL to SiCL	VFSL to SiCL	0.2 – 6.0	≤ 3	≤ 3	None or Slight	≥7.5 ≥1.5 /ft.	Well & Mod. Well	None to Rare	Free 0-4	≥140	32° 20	32° 20
II	≥40	≥40[7]	SL to SiCL Gravelly	SL to SiCL Gravelly	0.06 – 20.0	≤ 5	≤ 12	Moderate	≥5.0 ≥1.0 /ft.	Somewhat[8] Excessive to Somewhat Poorly	Occasional (1 in 10 yrs)	Slight 4-8	≥100	32° 14	32° 14
III	≥20	≥40[9]	LS to C & organic. CB or GR	SL to C & organic. CB or GR	<0.06 – 20.0	≤ 8	≤ 20	High	≥3.75 ≥0.75 /ft.	Excessive[10] to Poorly	Frequent (1 in 5 yrs)	Moder-ate 8-15	≥70	10	10
IV	≥10	≥20	S to C ST or GRV	S to C. GRV, CBV, or ST	<0.06 – >20.0	≤ 12	≤ 35	Any	≥2.5 ≥0.5 /ft.	Excessive to Poorly	Frequent (1 in 5 yrs)	Strong >15	≥50	6	6
V	≥20	≥20	Any- GRV. CBV, or STV	Any- GRV. CBV, or STV	<0.06 – >20.0	≤ 3	≤ 3	None or Slight	≥3.0	Somewhat Excessive to Very Poorly	Very Frequent (each yr)	Slight <8	Any	4	10
VI	≥10	≥10	Any- GRV. CBV, or STV	Any- GRV. CBV, or STV	Any	-	≤ 60	Any	≥2.0	Any	Any	Any	Any	4	8
VII	Any	Any	Any- CBX or STX	Any- STX	Any	-	≤ 90	Any	Any	Any	Any	Any	Any[11]	-	2
VIII	Any	Any	-	Any	Any	Any	Any	Any	Any	Any	Any	Any	Any	-	-

[1] Permeability of the least permeable subsurface horizon.
[2] The irrigated column refers to surface irrigation systems. The dryland column includes non-irrigated and sprinkler systems.
[3] Available water between field capacity and wilting point.
[4] Alkali soils have exchangeable sodium in excess of 15 percent. Figures shown in this column indicate salinity classes by conductivity of the extract in millimhos per centimeter
[5] Temperature and Water Balance for Oregon Weather Stations. Special Report 150, May1963. Oregon Agr. Exp. Sta. Column figures are minimums.
[6] Udic soils with excessive cloud cover (precipitation in excess of 60 or 70 inches) excluding coastal terraces and coastal bottom lands are Class VI up to 60 percent slopes and Class VII above 60 percent slopes.
[7] Depth to fragipan may be 30 or more.
[8] Poorly drained when protected by dikes and pumped.
[9] Depth to fragipan may be 20 or more.
[10] Very poorly drained when protected by dikes and pumped.
[11] All Cryorthods regardless of slope.
Subclass – use w, s, and c only on 0 to 3% slopes; use e above 3% slopes.

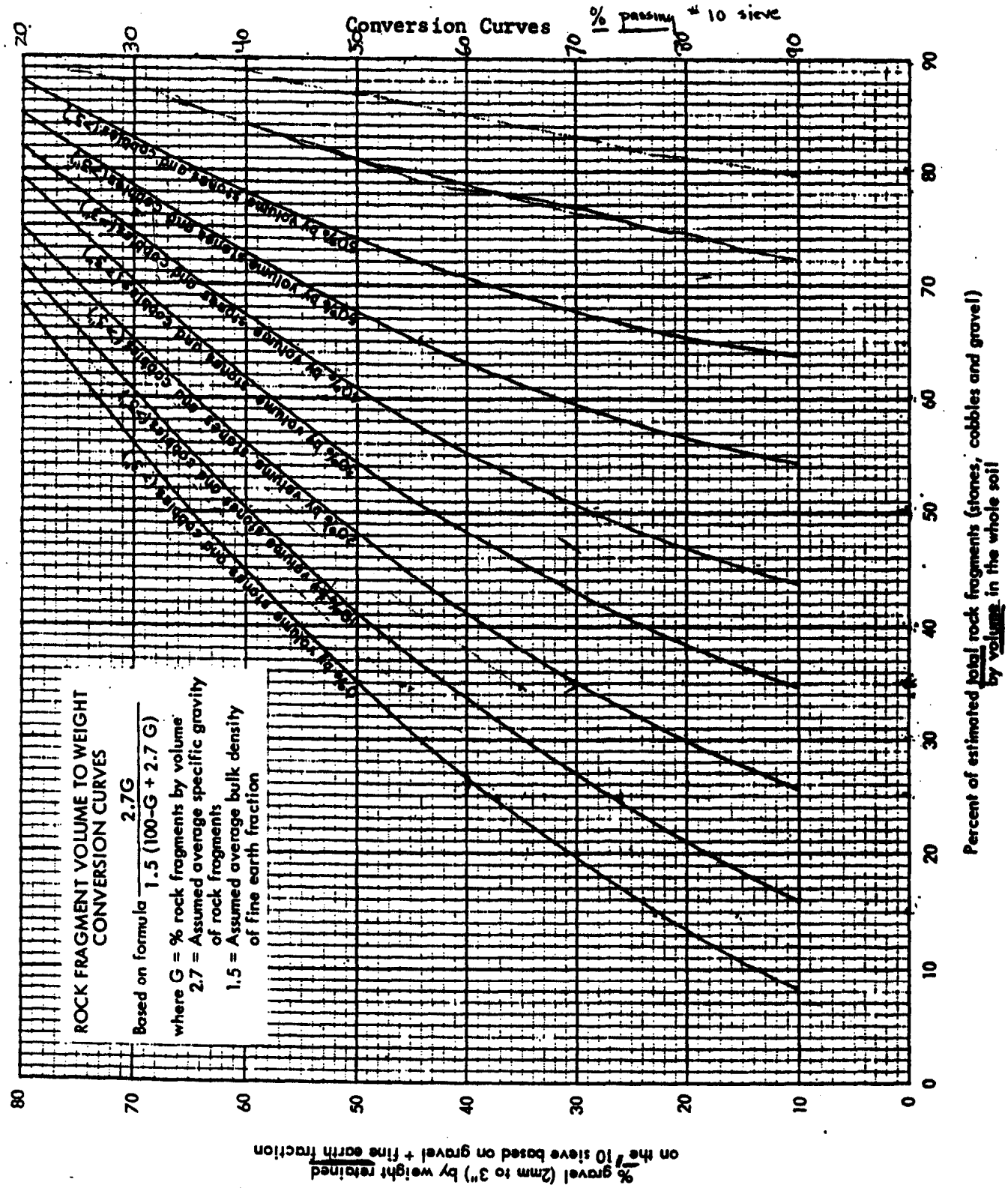
NASIS Guide 1A

Conversion of Volume to Weight for Cobbles And Stones
And
Adjusting Percent Gravel by Volume to Materials Passing #10 Sieve - Bulk Density 1.5 g/cm3

Cobbles & Stone Vol.		Gravel By Volume																
0		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	>3"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	#10	100	90	85	75	70	60	55	50	45	40	35	30	25	25	20	15	10
5	>3"	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	#10	100	90	85	75	65	60	55	50	45	40	35	30	25	20	15	10	5
10	>3"	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	#10	100	90	80	75	65	60	50	45	40	35	30	25	20	15	10	10	5
15	>3"	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	
	#10	100	90	80	70	65	55	50	45	40	35	30	25	20	15	10	5	
20	>3"	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30		
	#10	100	90	80	70	60	55	50	40	35	30	25	20	15	10	5		
25	>3"	40	40	40	40	40	40	40	40	40	40	40	40	40	40			
	#10	100	90	80	70	60	50	45	40	35	25	20	15	10	5			
30	>3"	45	45	45	45	45	45	45	45	45	45	45	45	45				
	#10	100	85	75	65	55	50	45	35	30	25	20	15	10				
35	>3"	50	50	50	50	50	50	50	50	50	50	50	50					
	#10	100	85	75	65	55	45	40	35	25	20	15	10					
40	>3"	55	55	55	55	55	55	55	55	55	55	55						
	#10	100	85	70	60	50	45	35	30	20	15	10						
45	>3"	60	60	60	60	60	60	60	60	60	60							
	#10	100	85	70	55	45	40	30	20	10	5							
50	>3"	65	65	65	65	65	65	65	65	65								
	#10	100	85	70	55	45	35	30	20	10								
55	>3"	70	70	70	70	70	70	70	70									
	#10	100	80	65	55	40	30	20	10									
60	>3"	75	75	75	75	75	75	75										
	#10	100	75	60	50	35	25	15										
65	>3"	75	75	75	75	75	75											
	#10	100	70	55	40	25	15											
70	>3"	80	80	80	80	80												
	#10	100	60	40	30	15												
75	>3"	85	85	85	85													
	#10	100	50	30	15													
80	>3"	90	90	90														
	#10	100	30	15														

MO-1 NASIS Guide 1B

Chart 1 - Rock Fragment Volume to Weight



How to use MO-1 NASIS Guide 1B
Rock Fragment Volume to Weight Conversion Curves

The rock fragment conversion curves can be used for converting all rock fragments (stones, cobbles, and gravel) from volume to weight and obtain appropriate entries for the >3" fraction and percent of fine earth fraction passing the #10 sieve. These curves are based on the assumption that the specific gravity of rock fragments is 2.7 and bulk density of the fine earth fraction is 1.5. They also take into account the two separate bases of 100% that must be used to make these computations: the first 100% base is the whole soil, and the second 100% base is gravel plus fine earth fraction.

Procedure:

1. Summate the estimated total rock fragment content of the whole soil in percent by volume (stones, cobbles, and gravel) of a major soil horizon and enter at the appropriate percent by volume value on the horizontal axis (abscissa) of the curves.

2. Move vertically along the percent by volume value line obtained in 1 above until intersecting the appropriate curve representing the percent by volume of rock fragments >3" (stones and cobbles) that are present in the whole soil. For soils having percent by volume values of rock fragments >3" ending in 5, interpolate between curves and along the vertical line.

3. Move horizontally from point obtained in 2 above to the vertical axis (ordinate) and read value. This value, in percent, is the amount of gravel by weight retained on the # 10 sieve, based on the gravel plus fine earth fraction. Subtract this value from 100 to obtain percent of fine earth fraction materials passing the #10 sieve.

4. To obtain the entry for percent by weight of rock fragments >3" present in the whole soil enter at the appropriate percent by volume of estimated rock fragments >3" on the horizontal axis (abscissa) of the curves.

5. Repeat steps 2 and 3 above but use 0 percent cobbles and stones curve. The value obtained is the percent by weight of >3" fraction (stones and cobbles) present in the whole soil. Enter this value in the >3" fraction column.

Example: A soil contains 35% by volume of stones and cobbles and 35% by volume of gravel. Determine entries for >3" fraction and fine earth fraction passing #10 sieve.

Solution:

a) Enter horizontal axis (abscissa) at 70% (estimated total rock fraction in the whole soil by volume)

b) Move vertically along 70% line to intersection of interpolated point % distance between 30% and 40% cobbles and stones by volume curves.

c) Move horizontally to the vertical axis (ordinate) and read value of 67%. This value is the percent by weight of gravel retained on the #10 sieve based on the gravel plus fine earth fraction. Subtract this value from 100%. The resultant value, 33% is the amount by weight of fine earth fraction passing the #10 sieve.

d) Enter horizontal axis (abscissa) at 35% (estimated total stones and cobbles in the whole soil). Move vertically along 35% line to intersection with 0% stones and cobbles curve. Move horizontally to vertical axis (ordinate) and read value of 50%. This is the percent by weight value entry for rock fragments >3" based on the whole soil.

Note: Weight values for % rock fragments >3" fraction and % gravel may often total in excess of 100 if appreciable stones, cobbles, and gravel are present in the whole soil because there are two different bases of 100% being utilized.

MO-1 NASIS Guide 1C

Conversion of Volume to Weight for Cobbles And Stones And Adjusting Percent Gravel by Volume to Materials Passing #10 Sieve

For Volcanic Ash Soils Using a Bulk Density of 0.78g/cc

Cobbles & Stone Vol.		Gravel by Volume																
0		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	>3"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	#10	100	85	75	60	55	45	40	35	30	25	20	20	15	10	10	5	5
5	>3"	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	
	#10	100	85	75	60	50	45	40	35	30	25	20	20	15	10	5	5	
10	>3"	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	
	#10	100	85	70	60	50	45	35	30	25	20	15	15	10	5	5	5	
15	>3"	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40		
	#10	100	85	70	55	50	40	35	30	25	20	15	15	10	5	5		
20	>3"	45	45	45	45	45	45	45	45	45	45	45	45	45	45			
	#10	100	85	70	55	45	40	35	25	20	15	10	10	5	5			
25	>3"	55	55	55	55	55	55	55	55	55	55	55	55	55				
	#10	100	85	70	55	45	35	30	25	20	10	5	5	5				
30	>3"	60	60	60	60	60	60	60	60	60	60	60	60					
	#10	100	80	65	50	40	35	30	20	15	10	10	15					
35	>3"	65	65	65	65	65	65	65	65	65	65	65						
	#10	100	80	65	50	40	30	25	20	10	5	5						
40	>3"	70	70	70	70	70	70	70	70	70	70							
	#10	100	80	60	45	35	30	20	15	5	5							
45	>3"	75	75	75	75	75	75	75	75	75								
	#10	100	80	60	40	30	25	15	5	5								
50	>3"	80	80	80	80	80	80	80	80									
	#10	100	80	60	40	30	20	15	5									
55	>3"	80	80	80	80	80	80	80										
	#10	100	75	55	40	25	15	5										
60	>3"	85	85	85	85	85	85											
	#10	100	70	50	35	20	10											
65	>3"	90	90	90	90	90												
	#10	100	65	45	25	10												
70	>3"	90	90	90	90													
	#10	100	55	30	15													
75	>3"	95	95	95														
	#10	100	45	20														
80	>3"	95	95	95														
	#10	100	35	10														

Bulk Density 0.78g/cc

MO-1 NASIS Guide 2A

Typical Specific Gravity of Various Rock Types (g/cm3)

Rock Type	Specific Gravity
Andesite	2.5 - 2.8
Basalt	2.8 - 3.0
Diabase	2.6 - 3.0
Diorite	2.8 - 3.0
Dolomite	2.8 - 2.9
Gneiss	2.6 - 2.9
Granite	2.6 - 2.7
Gypsum	2.3 - 2.8
Limestone	2.3 - 2.7
Marble	2.4 - 2.7
Mica, schist	2.5 - 2.9
Quartzite	2.6 - 2.8
Rhyolite	2.4 - 2.6
Sandstone	2.2 - 2.8
Shale	2.4 - 2.8
Slate	2.7 - 2.8
Talc	2.6 - 2.8

Formula for Converting Rock Fragments in the soil from % by volume to % by weight:

$$W = \{D_p \times G/[D_b \times (100 - G) + (D_p \times G)]\} \times 100$$

Where: W = % rock fragments by weight
D_p = specific gravity of rock fragments (g/cm3)
G = % rock fragments by volume
Db = bulk density of the fine earth fraction (less than 2mm, g/cm3)

NASIS Guide 2B

Conversion of Rock Fragments from Volume to Weight - Rock Specific Gravity = 2.60

Soil Bulk Density < 2mm (g/cm3)	Rock fragments - percent by volume															
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	Rock fragments percent - by weight (specific gravity = 2.60 g/cm3)															
0.65	17	31	41	50	57	63	68	73	77	80	83	86	88	90	92	94
0.70	16	29	40	48	55	61	67	71	75	79	82	85	87	90	92	94
0.75	15	28	38	46	54	60	65	70	74	78	81	84	87	89	91	93
0.80	15	27	36	45	52	58	64	68	73	76	80	83	86	88	91	93
0.85	14	25	35	43	50	57	62	67	71	75	79	82	85	88	90	92
0.90	13	24	34	42	49	55	61	66	70	74	78	81	84	87	90	92
0.95	13	23	33	41	48	54	60	65	69	73	77	80	84	86	89	92
1.00	12	22	31	39	46	53	58	63	68	72	76	80	83	86	89	91
1.05	12	22	30	38	45	51	57	62	67	71	75	79	82	85	88	91
1.10	11	21	29	37	44	50	56	61	66	70	74	78	81	85	88	90
1.15	11	20	29	36	43	49	55	60	65	69	73	77	81	84	87	90
1.20	10	19	28	35	42	48	54	59	64	68	73	76	80	83	87	90
1.25	10	19	27	34	41	47	53	58	63	68	72	76	79	83	86	89
1.30	10	18	26	33	40	46	52	57	62	67	71	75	79	82	86	89
1.35	9	18	25	33	39	45	51	56	61	66	70	74	78	82	85	89
1.40	9	17	25	32	38	44	50	55	60	65	69	74	78	81	85	88
1.45	9	17	24	31	37	43	49	54	59	64	69	73	77	81	84	88
1.50	8	16	23	30	37	43	48	54	59	63	68	72	76	80	84	87
1.55	8	16	23	30	36	42	47	53	58	63	67	72	76	80	83	87
1.60	8	15	22	29	35	41	47	52	57	62	67	71	75	79	83	87
1.65	8	15	22	28	34	40	46	51	56	61	66	70	75	79	83	86
1.70	7	15	21	28	34	40	45	50	56	60	65	70	74	78	82	86
1.75	7	14	21	27	33	39	44	50	55	60	64	69	73	78	82	86
1.80	7	14	20	27	33	38	44	49	54	59	64	68	73	77	81	85

NASIS Guide 2B - continued

Conversion of Rock Fragments from Volume to Weight - Rock Specific Gravity = 2.70

Soil Bulk Density < 2mm (g/cm3)	Rock fragments - percent by volume															
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	Rock fragments percent - by weight (specific gravity = 2.70 g/cm^3)															
0.65	18	32	42	51	58	64	69	73	77	81	84	86	89	91	92	94
0.70	17	30	41	49	56	62	68	72	76	79	83	85	88	90	92	94
0.75	16	29	39	47	55	61	66	71	75	78	81	84	87	89	91	93
0.80	15	27	37	46	53	59	65	69	73	77	80	84	86	89	91	93
0.85	14	26	36	44	51	58	63	68	72	76	80	83	86	88	90	93
0.90	14	25	35	43	50	56	62	67	71	75	79	82	85	88	90	92
0.95	13	24	33	42	49	55	60	65	70	74	78	81	84	87	89	92
1.00	12	23	32	40	47	54	59	64	69	73	77	80	83	86	89	91
1.05	12	22	31	39	46	52	58	63	68	72	76	79	83	86	88	91
1.10	11	21	30	38	45	51	57	62	67	71	75	79	82	85	88	91
1.15	11	21	29	37	44	50	56	61	66	70	74	78	81	85	87	90
1.20	11	20	28	36	43	49	55	60	65	69	73	77	81	84	87	90
1.25	10	19	28	35	42	48	54	59	64	68	73	76	80	83	86	89
1.30	10	19	27	34	41	47	53	58	63	68	72	76	79	83	86	89
1.35	10	18	26	33	40	46	52	57	62	67	71	75	79	82	85	89
1.40	9	18	25	33	39	45	51	56	61	66	70	74	78	82	85	88
1.45	9	17	25	32	38	44	50	55	60	65	69	74	78	81	85	88
1.50	9	17	24	31	38	44	49	55	60	64	69	73	77	81	84	88
1.55	8	16	24	30	37	43	48	54	59	64	68	72	76	80	84	87
1.60	8	16	23	30	36	42	48	53	58	63	67	72	76	80	83	87
1.65	8	15	22	29	35	41	47	52	57	62	67	71	75	79	83	87
1.70	8	15	22	28	35	41	46	51	57	61	66	70	75	79	82	86
1.75	8	15	21	28	34	40	45	51	56	61	65	70	74	78	82	86
1.80	7	14	21	27	33	39	45	50	55	60	65	69	74	78	82	85

NASIS Guide 2B - continued

Conversion of Rock Fragments from Volume to Weight - Rock Specific Gravity = 2.80

Soil Bulk Density < 2mm (g/cm3)	Rock fragments - percent by volume															
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	Rock fragments percent - by weight (specific gravity = 2.80 g/cm3)															
0.65	18	32	43	52	59	65	70	74	78	81	84	87	89	91	92	94
0.70	17	31	41	50	57	63	68	73	77	80	83	86	88	90	92	94
0.75	16	29	40	48	55	62	67	71	75	79	82	85	87	90	91	93
0.80	16	28	38	47	54	60	65	70	74	78	81	84	87	89	91	93
0.85	15	27	37	45	52	59	64	69	73	77	80	83	86	88	90	93
0.90	14	26	35	44	51	57	63	67	72	76	79	82	85	88	90	92
0.95	13	25	34	42	50	56	61	66	71	75	78	82	85	87	89	92
1.00	13	24	33	41	48	55	60	65	70	74	77	81	84	87	89	91
1.05	12	23	32	40	47	53	59	64	69	73	77	80	83	86	88	91
1.10	12	22	31	39	46	52	58	63	68	72	76	79	83	86	88	91
1.15	11	21	30	38	45	51	57	62	67	71	75	79	82	85	87	90
1.20	11	21	29	37	44	50	56	61	66	70	74	78	81	84	87	90
1.25	11	20	28	36	43	49	55	60	65	69	73	77	81	84	86	89
1.30	10	19	28	35	42	48	54	59	64	68	72	76	80	83	86	89
1.35	10	19	27	34	41	47	53	58	63	67	72	76	79	83	85	89
1.40	10	18	26	33	40	46	52	57	62	67	71	75	79	82	85	88
1.45	9	18	25	33	39	45	51	56	61	66	70	74	78	82	85	88
1.50	9	17	25	32	38	44	50	55	60	65	70	74	78	81	84	88
1.55	9	17	24	31	38	44	49	55	60	64	69	73	77	81	84	87
1.60	8	16	24	30	37	43	49	54	59	64	68	72	76	80	83	87
1.65	8	16	23	30	36	42	48	53	58	63	67	72	76	80	83	87
1.70	8	15	23	29	35	41	47	52	57	62	67	71	75	79	82	86
1.75	8	15	22	29	35	41	46	52	57	62	66	71	75	79	82	86
1.80	8	15	22	28	34	40	46	51	56	61	66	70	74	78	82	85

MO-1 NASIS Guide 3

Normal Percent Passing the #40 and #200 Sieves

Blewitts Table

Table 2A. Normal Percent Passing **#40 Sieve.** Corrected for Various Percent Passing #10 Sieve

Soil Class Name	Percent Passing The # 10 Sieve										
	100	90	80	70	60	50	40	30	20	10	5
Silt	95-100	85-90	75-80	65-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Silty Clay	95-100	85-90	75-80	65-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Silty Clay Loam	95-100	85-90	75-80	65-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Clay	90-100	80-90	70-80	65-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Silt Loam	90-100	80-90	70-80	65-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Clay Loam	90-100	80-90	70-80	65-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Loam	85-95	75-85	65-75	60-65	50-55	40-50	35-40	25-30	15-20	5-10	0-5
Very Fine Sandy Loam	85-95	75-85	65-75	60-65	50-55	40-50	35-40	25-30	15-20	5-10	0-5
Sandy Clay	85-95	75-85	65-75	60-65	50-55	40-50	35-40	25-30	15-20	5-10	0-5
Loamy Very Fine Sand	90-95	80-85	70-75	60-65	50-55	45-50	35-40	25-30	15-20	5-10	0-5
Fine Sandy Loam	70-85	65-75	55-65	50-60	40-50	35-45	25-35	20-25	15-20	5-10	0-5
Sandy Clay Loam	80-90	70-80	65-75	55-65	50-55	40-45	30-35	25-30	15-20	5-10	0-5
Very Fine Sand	75-90	65-80	60-75	50-65	45-55	35-45	30-35	20-25	15-20	5-10	0-5
Sandy Loam	60-70	55-65	45-55	40-50	35-40	30-35	25-30	15-20	10-15	5-10	0-5
Fine Sand	65-80	55-70	50-65	45-55	35-45	30-40	25-30	20-25	10-15	5-10	0-5
Loamy Sand	50-75	45-70	40-60	35-50	30-45	25-30	20-30	15-20	10-15	5-10	0-5
Sand	50-70	45-65	40-55	35-50	30-45	25-35	20-30	15-20	10-15	5-10	0-5
Coarse Sand	50-70	45-65	40-55	35-50	30-45	30-45	20-30	15-20	10-15	5-10	0-5
Coarse Sandy Loam	60-70	55-65	45-55	40-50	35-40	30-35	25-30	15-20	10-15	5-10	0-5
Loamy Coarse Sand	50-75	45-70	40-60	35-50	30-45	25-30	20-30	15-20	10-15	5-10	0-5
Loamy Fine Sand	75-90	65-80	60-70	45-60	40-50	35-45	25-35	20-25	15-20	5-10	0-5

Table 2B. Normal Percent Passing **# 200 Sieve.** Corrected for Various Percent Passing #10 Sieve

Soil Class Name	Percent Passing The # 10 Sieve										
	100	90	80	70	60	50	40	30	20	10	5
Silt	90-100	80-90	70-80	60-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Silty Clay	90-95	80-85	70-75	65-70	55-60	45-50	35-40	25-30	15-20	5-10	0-5
Silty Clay Loam	85-95	75-85	65-75	60-65	50-60	40-50	35-40	25-30	15-20	5-10	0-5
Clay	75-95	70-85	60-75	50-65	45-55	40-50	30-35	20-30	15-20	5-10	0-5
Silt Loam	70-90	65-80	55-70	50-65	40-55	35-45	30-35	20-25	15-20	5-10	0-5
Clay Loam	70-80	65-70	55-65	50-55	40-50	35-40	30-35	20-25	10-15	5-10	0-5
Loam	60-75	55-70	50-60	40-50	35-45	30-40	25-30	20-25	10-15	5-10	0-5
Very Fine Sandy Loam	50-65	45-55	40-50	35-45	30-40	25-30	20-25	15-20	10-15	5-10	0-5
Sandy Clay	45-60	40-55	35-45	30-40	25-35	20-30	20-25	15-20	10-15	5-10	0-5
Loamy Very Fine Sand	40-60	35-55	30-45	30-40	25-35	20-30	15-25	10-15	5-10	0-5	-
Fine Sandy Loam	40-55	35-50	30-45	30-40	25-35	20-30	15-20	10-15	5-10	0-5	-
Sandy Clay Loam	35-55	30-50	30-45	25-40	25-35	20-30	15-20	10-15	5-10	0-5	-
Very Fine Sand	35-55	30-50	30-45	25-35	20-30	20-25	15-20	10-15	5-10	0-5	-
Sandy Loam	30-40	25-35	25-30	20-30	15-25	15-20	10-15	10-15	5-10	0-5	-
Fine Sand	20-35	20-30	15-30	15-25	10-20	10-15	10-15	5-10	0-5	-	-
Loamy Sand	15-30	15-25	15-25	10-20	10-20	10-15	5-10	5-10	0-5	-	-
Sand	5-15	5-15	5-10	5-10	5-10	0-5	0-5	0-5	-	-	-
Coarse Sand	5-15	5-15	5-10	5-10	5-10	0-5	0-5	0-5	-	-	-
Coarse Sandy Loam	30-40	25-35	25-30	20-30	15-25	15-20	10-15	10-15	5-10	0-5	-
Loamy Coarse Sand	15-30	15-25	15-25	10-20	10-20	10-15	5-10	5-10	0-5	-	-
Loamy Fine Sand	30-50	25-40	20-30	20-30	15-25	15-20	10-15	5-10	0-5	-	-

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Maximum Percent Passing the #40 and #200 Sieves

Gravel	LFS			LVFS[1]			COSL		
Vol.	#10	#40	#200	#10	#40	#200	#10	#40	#200
0	100	75-100	10-55	100	60-100	35-65	100	15-75	15-65
5	90	70-90	10-50	90	55-90	30-60	90	10-70	10-60
10	85	65-85	10-45	85	50-85	30-55	85	10-65	10-55
15	75	60-75	10-40	75	45-75	25-50	75	10-60	10-50
20	70	55-70	5-40	70	40-70	25-45	70	10-55	10-45
25	60	45-60	5-35	60	35-60	20-40	60	10-45	10-40
30	55	40-55	5-30	55	35-55	20-35	55	10-40	10-35
35	50	40-50	5-30	50	30-50	20-35	50	10-40	10-35
40	45	35-45	5-25	45	25-45	15-30	45	5-35	5-30
45	40	30-40	5-25	40	25-40	15-25	40	5-30	5-25
50	35	20-35	5-20	35	20-35	10-25	35	5-25	5-25
55	30	25-30	5-15	30	20-30	10-20	30	5-25	5-20
60	25	20-25	5-15	25	15-25	10-15	25	5-20	5-15
65	25	20-25	5-15	25	15-25	10-15	25	5-20	5-15
70	20	15-20	0-10	20	10-20	5-15	20	5-15	5-15
75	15	10-15	0-10	15	10-15	5-10	15	0-15	0-10
80	10	5-10	0-5	10	5-10	0-5	10	0-10	0-5

Gravel	SL			FSL			VFSL		
Vol.	#10	#40	#200	#10	#40	#200	#10	#40	#200
0	100	55-90	15-70	100	55-90	15-70	100	85-100	30-80
5	90	50-80	10-65	90	50-80	10-65	90	75-90	25-70
10	85	45-75	10-60	85	45-75	10-60	85	70-85	25-65
15	75	40-70	10-55	75	40-70	10-55	75	65-75	25-60
20	70	40-65	10-50	70	40-65	10-50	70	60-70	20-55
25	60	35-55	10-40	60	35-55	10-40	60	50-60	20-50
30	55	30-50	10-40	55	30-50	10-40	55	45-55	15-45
35	50	30-45	10-35	50	30-45	10-35	50	45-50	15-40
40	45	25-40	5-30	45	25-40	5-30	45	40-45	15-35
45	40	25-35	5-30	40	25-35	5-30	40	35-40	10-30
50	35	20-30	5-25	35	20-30	5-25	35	30-35	10-30
55	30	15-25	5-20	30	15-25	5-20	30	25-30	10-25
60	25	15-25	5-20	25	15-25	5-20	25	20-25	10-20
65	25	15-20	5-20	25	15-20	5-20	25	20-25	5-20
70	20	10-20	5-15	20	10-20	5-15	20	15-20	5-15
75	15	10-15	0-10	15	10-15	0-10	15	10-15	5-10
80	10	5-10	0-5	10	5-10	0-5	10	5-10	5-10

MO-1 NASIS Guide 4 (continued) - Maximum Percent Passing the #40 and #200 Sieves

Gravel Vol.	COS			S			FS		
	#10	#40	#200	#10	#40	#200	#10	#40	#200
0	100	0-75	0-40	100	0-90	0-40	100	75-100	0-40
5	90	0-70	0-35	90	0-80	0-35	90	70-90	0-35
10	85	0-65	0-35	85	0-75	0-35	85	65-85	0-35
15	75	0-55	0-30	75	0-70	0-30	75	60-75	0-30
20	70	0-50	0-30	70	0-65	0-30	70	55-70	0-30
25	60	0-45	0-25	60	0-55	0-25	60	45-60	0-25
30	55	0-40	0-20	55	0-50	0-20	55	40-55	0-20
35	50	0-40	0-20	50	0-45	0-20	50	40-50	0-20
40	45	0-35	0-20	45	0-40	0-15	45	35-45	0-20
45	40	0-30	0-15	40	0-35	0-15	40	30-40	0-15
50	35	0-25	0-15	35	0-30	0-15	35	25-35	0-15
55	30	0-25	0-10	30	0-25	0-10	30	25-30	0-10
60	25	0-20	0-10	25	0-25	0-10	25	20-25	0-10
65	25	0-20	0-10	25	0-20	0-10	25	20-25	0-10
70	20	0-15	0-10	20	0-20	0-10	20	15-20	0-10
75	15	0-15	0-5	15	0-15	0-5	15	10-15	0-5
80	10	0-10	0-5	10	0-10	0-5	10	5-10	0-5

Gravel Vol.	VFS			LCOS			LS		
	#10	#40	#200	#10	#40	#200	#10	#40	#200
0	100	50-100	25-55	100	10-75	10-50	100	10-90	10-50
5	90	45-90	25-50	90	10-70	10-45	90	10-80	10-45
10	85	45-85	20-45	85	10-65	10-45	85	10-75	10-45
15	75	40-75	20-40	75	10-60	10-40	75	10-70	10-40
20	70	35-70	20-40	70	5-55	5-40	70	5-65	5-40
25	60	30-60	15-35	60	5-45	5-35	60	5-55	5-35
30	55	30-55	15-30	55	5-40	5-30	55	5-50	5-30
35	50	25-50	15-30	50	5-40	5-25	50	5-45	5-30
40	45	25-45	10-25	45	5-35	5-25	45	5-40	5-25
45	40	20-40	10-25	40	5-30	5-20	40	5-35	5-25
50	35	20-35	10-20	35	5-25	5-20	35	5-30	5-20
55	30	15-30	10-15	30	5-25	5-15	30	5-25	5-20
60	25	15-25	5-15	25	5-20	5-15	25	5-25	5-15
65	25	15-25	5-15	25	5-20	5-15	25	5-20	5-15
70	20	10-20	5-10	20	0-15	0-10	20	0-20	0-10
75	15	10-15	5-10	15	0-15	0-10	15	0-15	0-10
80	10	5-10	0-5	10	0-10	0-5	10	0-10	0-5

Gravel Vol.	L			SIL			SI		
	#10	#40	#200	#10	#40	#200	#10	#40	#200
0	100	50-100	50-90	100	50-100	50-100	100	80-100	80-100
5	90	45-90	45-80	90	45-90	45-90	90	70-90	70-90
10	85	45-85	45-75	85	45-85	45-85	85	65-85	65-85
15	75	40-75	40-70	75	40-75	40-75	75	60-75	60-75
20	70	35-70	35-65	70	35-70	35-70	70	55-70	55-70
25	60	30-60	30-55	60	30-60	30-60	60	50-60	50-60
30	55	30-55	30-50	55	30-55	30-55	55	45-55	45-55
35	50	25-50	25-45	50	25-50	25-50	50	40-50	40-50
40	45	25-45	25-40	45	25-45	25-45	45	35-45	35-45
45	40	20-40	20-35	40	20-40	20-40	40	30-40	30-40
50	35	20-35	20-30	35	20-35	20-35	35	30-35	30-35
55	30	15-30	15-25	30	15-30	15-30	30	25-30	25-30
60	25	15-25	15-25	25	15-25	15-25	25	20-25	20-25
65	25	15-25	15-20	25	15-25	15-25	25	20-25	20-25
70	20	10-20	10-20	20	10-20	10-20	20	15-20	15-20

MO-1 NASIS Guide 4 (continued) - Maximum Percent Passing the #40 and #200 Sieves

75	15	10-15	10-15	15	10-15	10-15	15	10-15	10-15
80	10	5-10	5-10	10	5-10	5-10	10	5-10	5-10
Gravel Vol.	**SCL**			**CL**			**SICL**		
	#10	#40	#200	#10	#40	#200	#10	#40	#200
0	100	20-100	20-75	100	55-100	55-90	100	80-100	80-100
5	90	20-90	20-70	90	50-90	50-80	90	70-90	70-90
10	85	20-85	20-65	85	45-85	45-75	85	65-85	65-85
15	75	15-75	15-55	75	40-75	40-70	75	60-75	60-75
20	70	15-70	15-50	70	40-70	40-65	70	55-70	55-70
25	60	10-60	10-45	60	35-60	35-55	60	50-60	50-60
30	55	10-55	10-40	55	30-55	30-50	55	45-55	45-55
35	50	10-50	10-40	50	30-50	30-45	50	40-50	40-50
40	45	10-45	10-35	45	25-45	25-40	45	35-45	35-45
45	40	10-40	10-30	40	25-40	25-35	40	30-40	30-40
50	35	5-35	5-25	35	20-35	20-30	35	30-35	30-35
55	30	5-30	5-25	30	15-30	15-25	30	25-30	25-30
60	25	5-25	5-20	25	15-25	15-25	25	20-25	20-25
65	25	5-25	5-20	25	15-25	15-20	25	20-25	20-25
70	20	5-20	5-15	20	10-20	10-20	20	15-20	15-20
75	15	0-15	0-10	15	10-15	10-15	15	10-15	10-15
80	10	0-10	0-5	10	5-10	5-10	10	5-10	5-10

Gravel Vol.	**SC**			**SIC**					
	#10	#40	#200	#10	#40	#200	#10	#40	#200
0	100	35-100	35-75	100	80-100	80-100	100	55-100	55-100
5	90	30-90	30-70	90	70-90	70-90	90	50-90	50-90
10	85	30-85	30-65	85	65-85	65-85	85	45-85	45-85
15	75	25-75	25-55	75	60-75	60-75	75	40-75	40-75
20	70	20-70	20-50	70	55-70	55-70	70	40-70	40-70
25	60	20-60	20-45	60	50-60	50-60	60	35-60	35-60
30	55	20-55	20-40	55	45-55	45-55	55	30-55	30-55
35	50	20-50	20-40	50	40-50	40-50	50	30-50	30-50
40	45	15-45	15-35	45	35-45	35-45	45	25-45	25-45
45	40	15-40	15-30	40	30-40	30-40	40	25-40	25-40
50	35	15-35	15-25	35	30-35	30-35	35	20-35	20-35
55	30	10-30	10-25	30	25-30	25-30	30	15-30	15-30
60	25	10-25	10-20	25	20-25	20-25	25	15-25	15-25
65	25	10-25	10-20	25	20-25	20-25	25	15-25	15-25
70	20	5-20	5-15	20	15-20	15-20	20	10-20	10-20
75	15	5-15	5-15	15	10-15	10-15	15	10-15	10-15
80	10	5-10	5-10	10	5-10	5-10	10	5-10	5-10

[1] LVFS if classified in coarse-loamy family all entries in table are acceptable
LVFS if classified in coarse-silty issue error message if:

a) Passing #10 < 85
b) Passing # 10 = 85 and any range of values given for Passing #40
c) Passing #10 > 85: Retained values on #10 plus #40 > 15 and any range of values gi passing #200
d) Passing # 10 = 100: Passing #40 < or = 85
e) Passing #10 = 100: Retained values on #40 plus #200 > or = 50

MO-1 NASIS Guide 5

Bulk Density, 1/3 Bar

Step 1 - Determine the Consolidation Class from NASIS Guide 5.

Step 2 - Determine initial bulk density with NASIS Guide 6.

Step 3 - Use NASIS Guide 9 to adjust bulk density for organic carbon content.

Illustrations of the Five Classes of Relative Consolidation

Class	Example
Very Low	Alluvium that is presently wet and has never been drier than wet. Hydraquents.
Low	Aeolian or water-laid deposits that are deep enough and occur in a dry enough climate that they have only infrequently or never been subject to alternatives from dry to wet since initial deposition.
Moderate	A broad range of alluvium that has been subject over periods measured in thousands of years to at least occasional wetting and drying.
High	Sediments subject frequently to alternations in water state over long periods of time. Commonly, but not necessarily, these soil materials occur at depths where the overburden pressure is considerable and have low extensibility.
Very High	Basal glacial till; soil material with strong imprint of rock; soil material highly compressed in earth-moving operations or harvest operations.

Guidelines to the Use of Consistence and Family Texture Classes to Estimate Consolidation Class.[1]

Consistence Class	Family Textural Classes[2]			
	Sandy	Coarse-loamy Coarse-silty	Fine-loamy Fine-silty	Clayey
Loose	Low	Low	N/A	N/A
Soft, Very Friable	Moderate	Moderate	Low	Low
Slightly Hard, Friable	Moderate	Moderate	Moderate	Moderate
Firm	High	High	High	High
Very Firm, Extremely Firm	Very High	Very High	Very High	Very High

[1] The Very Low class pertains to sediments that are fluid as the term is used in chapter 4 of the new Soil Survey Manual. This range of consolidation is not considered here.

[2] Applied only to <2mm; >2mm excluded.

MO-1 NASIS Guide 6

Bulk Density, 1/3 Bar

Bulk Density Estimates for Combinations of Consolidation Class and Family Texture Classes

Consolidation Class[1]	Bulk density for combinations of family texture classes of <2mm and proportion of 2 – 0.25mm.[2]								
	Sandy		Coarse-loamy[3]		Fine-loamy[3]		Coarse-silty[3]	Fine-silty[3]	> or = 35%clay
	Well Graded	Other	Well Graded	Other	Well Graded	Other			
	g/cm^3								
Very High	2.00	1.90	1.60	1.50	1.50	1.40	1.40	1.40	See Table MO-1 NASIS Guide 8
High	1.85	1.75	1.50	1.45	1.45	1.35	1.35	1.30	
Moderate	1.75	1.65	1.40	1.30	1.30	1.30	1.30	1.25	
Low	1.60	1.50	1.30	1.20	1.15	1.10	1.10	1.05	

[1] The very low class is not considered here.

[2]Family textural classes applied to the <2mm only;> 2mm is excluded.
Well graded material has ¼ to ¾ of the 2-0.002mm in the 2-0.25mm range and of this 2-0.25 mm less than 2/3 is either 2-1 or 0.5-0.25mm. Employ non-carbonate clay on a carbonate-containing basis.

[3]Bulk density has been reduced from Grossman's original estimates based on local and regional lab results.

Go to MO-1 NASIS Guide 9 to adjust the values in the table above for organic carbon content.

MO-1 NASIS Guide 7

Bulk Density of Horizons with Volcanic Ash Influence

Approximate mean annual precipitation - inches Ammonium Oxalate Extractable Fe + ½ Al	9-18 0.4 - 0.9	18- 50/70 1.0-2.0	50/70 + >2.0
Clean Ash (meets Andic Soil Properties)	0.90-1.20	0.75-0.90	0.60-0.85
Mixed Ash (meets Vitrandic subgroup criteria)	1.00-1.35	0.85-1.10	0.80-1.10
Pumice > 65%	0.50-0.85	0.50-0.85	0.50-0.85

MO-1 NASIS Guide 8

Bulk Density Estimates for Horizons with ≥ 35% Clay

Clay %	Bulk Density
35	1.30-1.50
40	1.25-1.45
45	1.20-1.40
50	1.20-1.35
55	1.15-1.30
60	1.10-1.25
65	1.05-1.20
70	1.05-1.15
75	1.00-1.15
≥ 80	1.00-1.15

MO-1 NASIS Guide 9

Bulk Density, 1/3 Bar

Use this guide to adjust the bulk density values from NASIS guides 6 and 8 for organic carbon / organic matter content.

D_b Mineral	Organic Carbon Percent															
	0.5	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
	Organic Matter Percent															
	0.9	1.7	3.4	5.2	6.9	8.6	10.3	12.1	13.8	15.5	17.2	20.7	24.1	27.6	31.0	34.5
0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21
0.40	0.40	0.40	0.39	0.39	0.38	0.38	0.37	0.37	0.36	0.36	0.36	0.35	0.34	0.33	0.33	0.32
0.60	0.59	0.58	0.57	0.55	0.54	0.53	0.52	0.50	0.49	0.48	0.47	0.45	0.43	0.42	0.40	0.39
0.80	0.78	0.77	0.74	0.71	0.68	0.66	0.64	0.62	0.60	0.58	0.56	0.53	0.50	0.48	0.46	0.43
1.00	0.97	0.95	0.90	0.85	0.81	0.78	0.75	0.72	0.69	0.66	0.64	0.59	0.56	0.52	0.49	0.47
1.05	1.02	0.99	0.94	0.89	0.85	0.81	0.77	0.74	0.71	0.68	0.65	0.61	0.57	0.53	0.50	0.47
1.10	1.07	1.03	0.97	0.92	0.88	0.83	0.79	0.76	0.73	0.70	0.67	0.62	0.58	0.54	0.51	0.48
1.15	1.11	1.08	1.01	0.96	0.90	0.86	0.82	0.78	0.74	0.71	0.68	0.63	0.59	0.55	0.52	0.49
1.20	1.16	1.12	1.05	0.99	0.93	0.88	0.84	0.80	0.76	0.73	0.70	0.65	0.60	0.56	0.52	0.49
1.25	1.20	1.16	1.09	1.02	0.96	0.91	0.86	0.82	0.78	0.74	0.71	0.66	0.61	0.57	0.53	0.50
1.30	1.25	1.20	1.12	1.05	0.99	0.93	0.88	0.84	0.80	0.76	0.73	0.67	0.62	0.57	0.54	0.50
1.35	1.30	1.25	1.16	1.08	1.01	0.95	0.90	0.85	0.81	0.77	0.74	0.68	0.63	0.58	0.54	0.51
1.40	1.34	1.29	1.19	1.11	1.04	0.98	0.92	0.87	0.83	0.79	0.75	0.69	0.63	0.59	0.55	0.51
1.45	1.39	1.33	1.23	1.14	1.07	1.00	0.94	0.89	0.84	0.80	0.76	0.70	0.64	0.59	0.55	0.52
1.50	1.43	1.37	1.26	1.17	1.09	1.02	0.96	0.91	0.86	0.81	0.77	0.71	0.65	0.60	0.56	0.52
1.55	1.48	1.41	1.30	1.20	1.11	1.04	0.98	0.92	0.87	0.83	0.78	0.71	0.66	0.61	0.56	0.53
1.60	1.52	1.45	1.33	1.23	1.14	1.06	1.00	0.94	0.88	0.84	0.80	0.72	0.66	0.61	0.57	0.53
1.65	1.57	1.49	1.36	1.25	1.15	1.08	1.01	0.95	0.90	0.85	0.81	0.73	0.67	0.62	0.57	0.53
1.70	1.61	1.53	1.40	1.28	1.19	1.10	1.03	0.97	0.91	0.86	0.81	0.74	0.67	0.62	0.58	0.54
1.75	1.66	1.57	1.43	1.31	1.21	1.12	1.05	0.98	0.92	0.87	0.82	0.75	0.68	0.63	0.58	0.54
1.80	1.70	1.61	1.46	1.34	1.23	1.14	1.06	0.99	0.93	0.88	0.83	0.75	0.69	0.63	0.58	0.54
1.85	1.75	1.65	1.49	1.36	1.25	1.16	1.08	1.01	0.94	0.89	0.84	0.76	0.69	0.63	0.59	0.55
1.90	1.79	1.69	1.52	1.39	1.27	1.17	1.09	1.02	0.96	0.90	0.85	0.77	0.70	0.64	0.59	0.55
1.95	1.83	1.73	1.55	1.41	1.29	1.19	1.11	1.03	0.97	0.91	0.86	0.77	0.70	0.64	0.59	0.55
2.00	1.94	1.77	1.59	1.44	1.31	1.21	1.12	1.04	0.98	0.92	0.87	0.78	0.71	0.65	0.60	0.55
2.20	2.05	1.92	1.70	1.53	1.39	1.27	1.17	1.09	1.02	0.95	0.90	0.80	0.72	0.65	0.61	0.56
2.40	2.22	2.07	1.82	1.62	1.45	1.33	1.22	1.13	1.05	0.96	0.92	0.82	0.74	0.67	0.62	0.57

Units are g/cm^3

MO-1 NASIS Guide 10

Available Water Capacity for Horizons <u>without</u> Volcanic Ash Influence

	Bulk Density (g/cm^3)				
	0.75	**1.00**	**1.25**	**1.50**	**1.75**
Texture	**AWC, rock fragment free (cm/cm) *, Electrical Conductivity = 0 ****				
C	0.23	0.18	0.14	0.10	0.06
SIC	0.23	0.19	0.15	0.11	0.07
SICL	0.24	0.21	0.18	0.15	0.12
CL	0.23	0.18	0.15	0.12	0.09
SCL	0.20	0.17	0.14	0.11	0.08
L	0.21	0.19	0.17	0.15	0.13
SIL	0.24	0.22	0.20	0.18	0.16
SI	0.26	0.24	0.22	0.20	0.18
VFSL	0.18	0.16	0.14	0.12	0.10
FSL	0.17	0.15	0.13	0.11	0.09
SL	0.16	0.14	0.12	0.10	0.08
COSL	0.13	0.11	0.09	0.07	0.05
LVFS	0.15	0.13	0.11	0.09	0.07
LFS	0.16	0.13	0.10	0.07	0.04
FS	0.14	0.11	0.08	0.06	0.04
LS	0.09	0.08	0.07	0.06	0.04
LCOS	0.08	0.07	0.06	0.05	0.03
S	0.07	0.06	0.05	0.04	0.03
COS	0.07	0.06	0.05	0.03	0.02

*** Correction for rock fragments;**

$AWC_{corrected} = AWC_{fragment\ free} \times [1 - (\%\ rock\ fragments / 100)]$

Example: texture is silt loam, bulk density = 1.25 (g / cm^3), and rock fragments = 25%

$AWC_{corrected} = 0.20 \times [1 - (25 / 100)] = 0.15$ cm / cm

**** Correction for saline soils;**

$AWC_{corrected} = [AWC_{fragment\ free} \times ((-0.0625 \times EC) + 1)]$

Example: texture is silt loam, bulk density = 1.25 (g / cm^3) Electrical conductivity (mmhos/cm or dS/m) = 9

$AWC_{corrected} = [0.20 \times ((-0.0625 \times 9) + 1)] = 0.0875$, round to 0.09 cm / cm

Note: If a saline soil contains rock fragments, use both correction formulas

The NASIS Excel spreadsheet will calculate AWC automatically using the selected bulk density, rock fragment content, and electrical conductivity.

MO-1 NASIS Guide 11

Available Water Capacity for horizons influenced by volcanic ash or with amorphous mineralogy

Vitrandic or Vitritorrandic / Ashy[1]					Andic / Ashy[2]				Andic / Medial[3]			
Bulk Density	**0.75**	**1.00**	**1.25**	**1.50**	**Bulk Density**	**0.75**	**1.00**	**1.25**	**Bulk Density**	**0.75**	**1.00**	**1.25**
Texture	**AWC (cm/cm)**				**Texture**	**AWC (cm/cm)**			**Texture**	**AWC (cm/cm)**		
C	0.28	0.22	0.17	0.12	**C**	0.30	0.23	0.18	**C**	0.32	0.25	0.20
SIC	0.28	0.23	0.18	0.13	**SIC**	0.30	0.25	0.20	**SIC**	0.32	0.27	0.21
SICL	0.29	0.25	0.22	0.18	**SICL**	0.31	0.27	0.23	**SICL**	0.34	0.29	0.25
CL	0.28	0.22	0.18	0.14	**CL**	0.30	0.23	0.20	**CL**	0.32	0.25	0.21
SCL	0.24	0.20	0.17	0.13	**SCL**	0.26	0.22	0.18	**SCL**	0.28	0.24	0.20
L	0.25	0.23	0.20	0.18	**L**	0.27	0.25	0.22	**L**	0.29	0.27	0.24
SIL	0.29	0.26	0.24	0.22	**SIL**	0.31	0.29	0.26	**SIL**	0.34	0.31	0.28
SI	0.31	0.29	0.26	0.24	**SI**	0.34	0.31	0.29	**SI**	0.36	0.34	0.31
VFSL	0.22	0.19	0.17	0.14	**VFSL**	0.23	0.21	0.18	**VFSL**	0.25	0.22	0.20
FSL	0.20	0.18	0.16	0.13	**FSL**	0.22	0.20	0.17	**FSL**	0.24	0.21	0.18
SL	0.19	0.17	0.14	0.12	**SL**	0.21	0.18	0.16	**SL**	0.22	0.20	0.17
COSL	0.16	0.13	0.11	0.08	**COSL**	0.17	0.14	0.12	**COSL**	0.18	0.15	0.13
LVFS	0.18	0.16	0.13	0.11	**LVFS**	0.20	0.17	0.14	**LVFS**	0.21	0.18	0.15
LFS	0.19	0.16	0.12	0.08	**LFS**	0.21	0.17	0.13	**LFS**	0.22	0.18	0.14
FS	0.17	0.13	0.10	0.07	**FS**	0.18	0.14	0.10	**FS**	0.20	0.15	0.11
LS	0.11	0.10	0.08	0.07	**LS**	0.12	0.10	0.09	**LS**	0.13	0.11	0.10
LCOS	0.10	0.08	0.07	0.06	**LCOS**	0.10	0.09	0.08	**LCOS**	0.11	0.10	0.08
S	0.08	0.07	0.06	0.05	**S**	0.09	0.08	0.07	**S**	0.10	0.08	0.07
COS	0.08	0.07	0.06	0.04	**COS**	0.09	0.08	0.07	**COS**	0.10	0.08	0.07

1) Vitrandic or Vitritorrandic – meets subgroup criteria.

2) Andic / Ashy – horizon meets criteria for Andic Soil Properties Criteria 2, Ashy, Ashy-skeletal, or Ashy-pumiceous substitute particle size class.

3) Andic / Medial – horizon meets criteria for Medial, Medial-skeletal, or Medial-pumiceous substitute particle size class.

Correction for rock fragments: $AWC_{corrected} = AWC_{fragment\ free} \times [1 - (\%\ rock\ fragments / 100)]$

MO-1 NASIS Guide 12

Guide for Assigning Linear Extensibility Percent (LEP) to Horizons

Linear extensibility percent is the linear expression of the volume difference of natural soil fabric at 1/3 bar or 1/10 bar water content and oven dryness. The volume change is reported as percent change for the whole soil, including rock fragments.

The major factors that influence LEP are clay content, clay mineralogy, and volumetric rock fragment content.

The National Soil Survey Laboratory reports the Coefficient of Linear Extensibility (COLE) based on the formula:

$$COLE = [(Dbd/Dbm)^{1/3} - 1]\ [1-(Volume\ \% > 2\ mm/100)]$$

Where: Dbd = bulk density oven dry on a less than 2 mm base
Dbm = bulk density at 1/3 or 1/10 bar on a less than 2mm base
Volume % > 2 mm = rock fragment > 2mm by volume

LEP = COLE * 100

The LEP is used to assign shrink-swell classes to horizons as follows:

Shrink-swell Class	LEP	COLE
Low	< 3	<0.03
Moderate	3 - 5.9	.03 - .059
High	6 - 9	.06 - .09
Very High	> 9	> 0.09

Lab data for soils within a soil survey area or MLRA are the best source of information for assigning LEP values to horizons.

The guides on the following pages are to be used when local data is not available or is incomplete. These guides were developed by analyzing LEP lab data for 5500 horizons from pedons sampled in Idaho, Oregon, and Washington. Horizons were placed into the following four clay activity groups and regression equations were developed to predict LEP for each group

	Clay Activity Group			
	Low (3)	Moderate (5)	High (7)	Very High (9)
CEC-7 of mineral fraction to Clay Ratio	< 0.40	0.40 - 0.59	0.60 - 0.80	> 0.80
Dominant Clay Minerals	CA - calcite CL - chlorite GI - gibbsite KH- halloysite KK - kaolinite MI - mica NX - non-crystalline	VC - vermiculite-chlorite VM - vermiculite-mica	VR - vermiculite MC - montmorillonite-chlorite MM - montmorillonite-mica	MT - montmorillonite MV - montmorillonite-vermiculite

.

MO-1 NASIS Guide 12 (continued)

Linear Extensibility Percent (LEP) - Low (3) Clay Activity Group

% Clay	% Rock Fragments by Volume																
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
6	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1
8	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1
10	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2
12	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2
14	1.1	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.2
16	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3
18	1.4	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3
20	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.3
22	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4
24	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4
26	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4
28	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.4
30	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.6	1.4	1.3	1.2	1.1	1.0	0.8	0.7	0.6	0.5
32	2.6	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.0	0.9	0.8	0.6	0.5
34	2.7	2.6	2.4	2.3	2.2	2.0	1.9	1.8	1.6	1.5	1.4	1.2	1.1	1.0	0.8	0.7	0.5
36	2.9	2.7	2.6	2.4	2.3	2.2	2.0	1.9	1.7	1.6	1.4	1.3	1.2	1.0	0.9	0.7	0.6
38	3.0	2.9	2.7	2.6	2.4	2.3	2.1	2.0	1.8	1.7	1.5	1.4	1.2	1.1	0.9	0.8	0.6
40	3.2	3.0	2.9	2.7	2.6	2.4	2.2	2.1	1.9	1.8	1.6	1.4	1.3	1.1	1.0	0.8	0.6
42	3.4	3.2	3.0	2.9	2.7	2.5	2.4	2.2	2.0	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.7
44	3.5	3.3	3.2	3.0	2.8	2.6	2.5	2.3	2.1	1.9	1.8	1.6	1.4	1.2	1.1	0.9	0.7
46	3.7	3.5	3.3	3.1	2.9	2.8	2.6	2.4	2.2	2.0	1.8	1.7	1.5	1.3	1.1	0.9	0.7
48	3.8	3.6	3.5	3.3	3.1	2.9	2.7	2.5	2.3	2.1	1.9	1.7	1.5	1.3	1.2	1.0	0.8
50	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0	0.8
52	4.2	4.0	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.3	2.1	1.9	1.7	1.5	1.2	1.0	0.8
54	4.3	4.1	3.9	3.7	3.5	3.2	3.0	2.8	2.6	2.4	2.2	1.9	1.7	1.5	1.3	1.1	0.9
56	4.5	4.3	4.0	3.8	3.6	3.4	3.1	2.9	2.7	2.5	2.2	2.0	1.8	1.6	1.3	1.1	0.9
58	4.6	4.4	4.2	3.9	3.7	3.5	3.2	3.0	2.8	2.6	2.3	2.1	1.9	1.6	1.4	1.2	0.9
60	4.8	4.6	4.3	4.1	3.8	3.6	3.4	3.1	2.9	2.6	2.4	2.2	1.9	1.7	1.4	1.2	1.0
62	5.0	4.7	4.5	4.2	4.0	3.7	3.5	3.2	3.0	2.7	2.5	2.2	2.0	1.7	1.5	1.2	1.0
64	5.1	4.9	4.6	4.4	4.1	3.8	3.6	3.3	3.1	2.8	2.6	2.3	2.0	1.8	1.5	1.3	1.0
66	5.3	5.0	4.8	4.5	4.2	4.0	3.7	3.4	3.2	2.9	2.6	2.4	2.1	1.8	1.6	1.3	1.1
68	5.4	5.2	4.9	4.6	4.4	4.1	3.8	3.5	3.3	3.0	2.7	2.4	2.2	1.9	1.6	1.4	1.1
70	5.6	5.3	5.0	4.8	4.5	4.2	3.9	3.6	3.4	3.1	2.8	2.5	2.2	2.0	1.7	1.4	1.1
72	5.8	5.5	5.2	4.9	4.6	4.3	4.0	3.7	3.5	3.2	2.9	2.6	2.3	2.0	1.7	1.4	1.2
74	5.9	5.6	5.3	5.0	4.7	4.4	4.1	3.8	3.6	3.3	3.0	2.7	2.4	2.1	1.8	1.5	1.2
76	6.1	5.8	5.5	5.2	4.9	4.6	4.3	4.0	3.6	3.3	3.0	2.7	2.4	2.1	1.8	1.5	1.2
78	6.2	5.9	5.6	5.3	5.0	4.7	4.4	4.1	3.7	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.2
80	6.4	6.1	5.8	5.4	5.1	4.8	4.5	4.2	3.8	3.5	3.2	2.9	2.6	2.2	1.9	1.6	1.3

LEP = (% clay * 0.08) * (1 - (% rock fragments/100))

MO-1 NASIS Guide 12 (continued)

Linear Extensibility Percent (LEP) - Moderate (5) Clay Activity Group

% Clay	% Rock Fragments by Volume																
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
4	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1
6	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.1
8	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2
10	1.2	1.1	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.2
12	1.4	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3
14	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.7	0.6	0.5	0.4	0.3
16	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4
18	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.6	0.5	0.4
20	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.6	1.4	1.3	1.2	1.1	1.0	0.8	0.7	0.6	0.5
22	2.6	2.5	2.4	2.2	2.1	2.0	1.8	1.7	1.6	1.5	1.3	1.2	1.1	0.9	0.8	0.7	0.5
24	2.9	2.7	2.6	2.4	2.3	2.2	2.0	1.9	1.7	1.6	1.4	1.3	1.2	1.0	0.9	0.7	0.6
26	3.1	3.0	2.8	2.7	2.5	2.3	2.2	2.0	1.9	1.7	1.6	1.4	1.2	1.1	0.9	0.8	0.6
28	3.4	3.2	3.0	2.9	2.7	2.5	2.4	2.2	2.0	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.7
30	3.6	3.4	3.2	3.1	2.9	2.7	2.5	2.3	2.2	2.0	1.8	1.6	1.4	1.3	1.1	0.9	0.7
32	3.8	3.6	3.5	3.3	3.1	2.9	2.7	2.5	2.3	2.1	1.9	1.7	1.5	1.3	1.2	1.0	0.8
34	4.1	3.9	3.7	3.5	3.3	3.1	2.9	2.7	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0	0.8
36	4.3	4.1	3.9	3.7	3.5	3.2	3.0	2.8	2.6	2.4	2.2	1.9	1.7	1.5	1.3	1.1	0.9
38	4.6	4.3	4.1	3.9	3.6	3.4	3.2	3.0	2.7	2.5	2.3	2.1	1.8	1.6	1.4	1.1	0.9
40	4.8	4.6	4.3	4.1	3.8	3.6	3.4	3.1	2.9	2.6	2.4	2.2	1.9	1.7	1.4	1.2	1.0
42	5.0	4.8	4.5	4.3	4.0	3.8	3.5	3.3	3.0	2.8	2.5	2.3	2.0	1.8	1.5	1.3	1.0
44	5.3	5.0	4.8	4.5	4.2	4.0	3.7	3.4	3.2	2.9	2.6	2.4	2.1	1.8	1.6	1.3	1.1
46	5.5	5.2	5.0	4.7	4.4	4.1	3.9	3.6	3.3	3.0	2.8	2.5	2.2	1.9	1.7	1.4	1.1
48	5.8	5.5	5.2	4.9	4.6	4.3	4.0	3.7	3.5	3.2	2.9	2.6	2.3	2.0	1.7	1.4	1.2
50	6.0	5.7	5.4	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3.0	2.7	2.4	2.1	1.8	1.5	1.2
52	6.2	5.9	5.6	5.3	5.0	4.7	4.4	4.1	3.7	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.2
54	6.5	6.2	5.8	5.5	5.2	4.9	4.5	4.2	3.9	3.6	3.2	2.9	2.6	2.3	1.9	1.6	1.3
56	6.7	6.4	6.0	5.7	5.4	5.0	4.7	4.4	4.0	3.7	3.4	3.0	2.7	2.4	2.0	1.7	1.3
58	7.0	6.6	6.3	5.9	5.6	5.2	4.9	4.5	4.2	3.8	3.5	3.1	2.8	2.4	2.1	1.7	1.4
60	7.2	6.8	6.5	6.1	5.8	5.4	5.0	4.7	4.3	4.0	3.6	3.2	2.9	2.5	2.2	1.8	1.4
62	7.4	7.1	6.7	6.3	6.0	5.6	5.2	4.8	4.5	4.1	3.7	3.3	3.0	2.6	2.2	1.9	1.5
64	7.7	7.3	6.9	6.5	6.1	5.8	5.4	5.0	4.6	4.2	3.8	3.5	3.1	2.7	2.3	1.9	1.5
66	7.9	7.5	7.1	6.7	6.3	5.9	5.5	5.1	4.8	4.4	4.0	3.6	3.2	2.8	2.4	2.0	1.6
68	8.2	7.8	7.3	6.9	6.5	6.1	5.7	5.3	4.9	4.5	4.1	3.7	3.3	2.9	2.4	2.0	1.6
70	8.4	8.0	7.6	7.1	6.7	6.3	5.9	5.5	5.0	4.6	4.2	3.8	3.4	2.9	2.5	2.1	1.7
72	8.6	8.2	7.8	7.3	6.9	6.5	6.0	5.6	5.2	4.8	4.3	3.9	3.5	3.0	2.6	2.2	1.7
74	8.9	8.4	8.0	7.5	7.1	6.7	6.2	5.8	5.3	4.9	4.4	4.0	3.6	3.1	2.7	2.2	1.8
76	9.1	8.7	8.2	7.8	7.3	6.8	6.4	5.9	5.5	5.0	4.6	4.1	3.6	3.2	2.7	2.3	1.8
78	9.4	8.9	8.4	8.0	7.5	7.0	6.6	6.1	5.6	5.1	4.7	4.2	3.7	3.3	2.8	2.3	1.9
80	9.6	9.1	8.6	8.2	7.7	7.2	6.7	6.2	5.8	5.3	4.8	4.3	3.8	3.4	2.9	2.4	1.9

LEP = (% clay * 0.12) * (1 - (% rock fragments/100))

MO-1 NASIS Guide 12 (continued)

Linear Extensibility Percent (LEP) - High (7) Clay Activity Group

% Clay	% Rock Fragments by Volume																
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
4	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.1
6	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.2
8	1.4	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3
10	1.8	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4
12	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.6	0.5	0.4
14	2.5	2.4	2.3	2.1	2.0	1.9	1.8	1.6	1.5	1.4	1.3	1.1	1.0	0.9	0.8	0.6	0.5
16	2.9	2.7	2.6	2.4	2.3	2.2	2.0	1.9	1.7	1.6	1.4	1.3	1.2	1.0	0.9	0.7	0.6
18	3.2	3.1	2.9	2.8	2.6	2.4	2.3	2.1	1.9	1.8	1.6	1.5	1.3	1.1	1.0	0.8	0.6
20	3.6	3.4	3.2	3.1	2.9	2.7	2.5	2.3	2.2	2.0	1.8	1.6	1.4	1.3	1.1	0.9	0.7
22	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0	0.8
24	4.3	4.1	3.9	3.7	3.5	3.2	3.0	2.8	2.6	2.4	2.2	1.9	1.7	1.5	1.3	1.1	0.9
26	4.7	4.4	4.2	4.0	3.7	3.5	3.3	3.0	2.8	2.6	2.3	2.1	1.9	1.6	1.4	1.2	0.9
28	5.0	4.8	4.5	4.3	4.0	3.8	3.5	3.3	3.0	2.8	2.5	2.3	2.0	1.8	1.5	1.3	1.0
30	5.4	5.1	4.9	4.6	4.3	4.1	3.8	3.5	3.2	3.0	2.7	2.4	2.2	1.9	1.6	1.4	1.1
32	5.8	5.5	5.2	4.9	4.6	4.3	4.0	3.7	3.5	3.2	2.9	2.6	2.3	2.0	1.7	1.4	1.2
34	6.1	5.8	5.5	5.2	4.9	4.6	4.3	4.0	3.7	3.4	3.1	2.8	2.4	2.1	1.8	1.5	1.2
36	6.5	6.2	5.8	5.5	5.2	4.9	4.5	4.2	3.9	3.6	3.2	2.9	2.6	2.3	1.9	1.6	1.3
38	6.8	6.5	6.2	5.8	5.5	5.1	4.8	4.4	4.1	3.8	3.4	3.1	2.7	2.4	2.1	1.7	1.4
40	7.2	6.8	6.5	6.1	5.8	5.4	5.0	4.7	4.3	4.0	3.6	3.2	2.9	2.5	2.2	1.8	1.4
42	7.6	7.2	6.8	6.4	6.0	5.7	5.3	4.9	4.5	4.2	3.8	3.4	3.0	2.6	2.3	1.9	1.5
44	7.9	7.5	7.1	6.7	6.3	5.9	5.5	5.1	4.8	4.4	4.0	3.6	3.2	2.8	2.4	2.0	1.6
46	8.3	7.9	7.5	7.0	6.6	6.2	5.8	5.4	5.0	4.6	4.1	3.7	3.3	2.9	2.5	2.1	1.7
48	8.6	8.2	7.8	7.3	6.9	6.5	6.0	5.6	5.2	4.8	4.3	3.9	3.5	3.0	2.6	2.2	1.7
50	9.0	8.6	8.1	7.7	7.2	6.8	6.3	5.9	5.4	5.0	4.5	4.1	3.6	3.2	2.7	2.3	1.8
52	9.4	8.9	8.4	8.0	7.5	7.0	6.6	6.1	5.6	5.1	4.7	4.2	3.7	3.3	2.8	2.3	1.9
54	9.7	9.2	8.7	8.3	7.8	7.3	6.8	6.3	5.8	5.3	4.9	4.4	3.9	3.4	2.9	2.4	1.9
56	10.1	9.6	9.1	8.6	8.1	7.6	7.1	6.6	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0
58	10.4	9.9	9.4	8.9	8.4	7.8	7.3	6.8	6.3	5.7	5.2	4.7	4.2	3.7	3.1	2.6	2.1
60	10.8	10.3	9.7	9.2	8.6	8.1	7.6	7.0	6.5	5.9	5.4	4.9	4.3	3.8	3.2	2.7	2.2
62	11.2	10.6	10.0	9.5	8.9	8.4	7.8	7.3	6.7	6.1	5.6	5.0	4.5	3.9	3.3	2.8	2.2
64	11.5	10.9	10.4	9.8	9.2	8.6	8.1	7.5	6.9	6.3	5.8	5.2	4.6	4.0	3.5	2.9	2.3
66	11.9	11.3	10.7	10.1	9.5	8.9	8.3	7.7	7.1	6.5	5.9	5.3	4.8	4.2	3.6	3.0	2.4
68	12.2	11.6	11.0	10.4	9.8	9.2	8.6	8.0	7.3	6.7	6.1	5.5	4.9	4.3	3.7	3.1	2.4
70	12.6	12.0	11.3	10.7	10.1	9.5	8.8	8.2	7.6	6.9	6.3	5.7	5.0	4.4	3.8	3.2	2.5
72	13.0	12.3	11.7	11.0	10.4	9.7	9.1	8.4	7.8	7.1	6.5	5.8	5.2	4.5	3.9	3.2	2.6
74	13.3	12.7	12.0	11.3	10.7	10.0	9.3	8.7	8.0	7.3	6.7	6.0	5.3	4.7	4.0	3.3	2.7
76	13.7	13.0	12.3	11.6	10.9	10.3	9.6	8.9	8.2	7.5	6.8	6.2	5.5	4.8	4.1	3.4	2.7
78	14.0	13.3	12.6	11.9	11.2	10.5	9.8	9.1	8.4	7.7	7.0	6.3	5.6	4.9	4.2	3.5	2.8
80	14.4	13.7	13.0	12.2	11.5	10.8	10.1	9.4	8.6	7.9	7.2	6.5	5.8	5.0	4.3	3.6	2.9

LEP = (% clay * 0.18) * (1 - (% rock fragments/100))

MO-1 NASIS Guide 12 (continued)

Linear Extensibility Percent (LEP) - Very High (9) Clay Activity Group

% Clay	% Rock Fragments by Volume																
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
4	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.2	0.2
6	1.3	1.3	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.7	0.7	0.6	0.5	0.5	0.4	0.3	0.3
8	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4
10	2.2	2.1	2.0	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.4
12	2.6	2.5	2.4	2.2	2.1	2.0	1.8	1.7	1.6	1.5	1.3	1.2	1.1	0.9	0.8	0.7	0.5
14	3.1	2.9	2.8	2.6	2.5	2.3	2.2	2.0	1.8	1.7	1.5	1.4	1.2	1.1	0.9	0.8	0.6
16	3.5	3.3	3.2	3.0	2.8	2.6	2.5	2.3	2.1	1.9	1.8	1.6	1.4	1.2	1.1	0.9	0.7
18	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0	0.8
20	4.4	4.2	4.0	3.7	3.5	3.3	3.1	2.9	2.6	2.4	2.2	2.0	1.8	1.5	1.3	1.1	0.9
22	4.8	4.6	4.4	4.1	3.9	3.6	3.4	3.1	2.9	2.7	2.4	2.2	1.9	1.7	1.5	1.2	1.0
24	5.3	5.0	4.8	4.5	4.2	4.0	3.7	3.4	3.2	2.9	2.6	2.4	2.1	1.8	1.6	1.3	1.1
26	5.7	5.4	5.1	4.9	4.6	4.3	4.0	3.7	3.4	3.1	2.9	2.6	2.3	2.0	1.7	1.4	1.1
28	6.2	5.9	5.5	5.2	4.9	4.6	4.3	4.0	3.7	3.4	3.1	2.8	2.5	2.2	1.8	1.5	1.2
30	6.6	6.3	5.9	5.6	5.3	5.0	4.6	4.3	4.0	3.6	3.3	3.0	2.6	2.3	2.0	1.7	1.3
32	7.0	6.7	6.3	6.0	5.6	5.3	4.9	4.6	4.2	3.9	3.5	3.2	2.8	2.5	2.1	1.8	1.4
34	7.5	7.1	6.7	6.4	6.0	5.6	5.2	4.9	4.5	4.1	3.7	3.4	3.0	2.6	2.2	1.9	1.5
36	7.9	7.5	7.1	6.7	6.3	5.9	5.5	5.1	4.8	4.4	4.0	3.6	3.2	2.8	2.4	2.0	1.6
38	8.4	7.9	7.5	7.1	6.7	6.3	5.9	5.4	5.0	4.6	4.2	3.8	3.3	2.9	2.5	2.1	1.7
40	8.8	8.4	7.9	7.5	7.0	6.6	6.2	5.7	5.3	4.8	4.4	4.0	3.5	3.1	2.6	2.2	1.8
42	9.2	8.8	8.3	7.9	7.4	6.9	6.5	6.0	5.5	5.1	4.6	4.2	3.7	3.2	2.8	2.3	1.8
44	9.7	9.2	8.7	8.2	7.7	7.3	6.8	6.3	5.8	5.3	4.8	4.4	3.9	3.4	2.9	2.4	1.9
46	10.1	9.6	9.1	8.6	8.1	7.6	7.1	6.6	6.1	5.6	5.1	4.6	4.0	3.5	3.0	2.5	2.0
48	10.6	10.0	9.5	9.0	8.4	7.9	7.4	6.9	6.3	5.8	5.3	4.8	4.2	3.7	3.2	2.6	2.1
50	11.0	10.5	9.9	9.4	8.8	8.3	7.7	7.2	6.6	6.1	5.5	5.0	4.4	3.9	3.3	2.8	2.2
52	11.4	10.9	10.3	9.7	9.2	8.6	8.0	7.4	6.9	6.3	5.7	5.1	4.6	4.0	3.4	2.9	2.3
54	11.9	11.3	10.7	10.1	9.5	8.9	8.3	7.7	7.1	6.5	5.9	5.3	4.8	4.2	3.6	3.0	2.4
56	12.3	11.7	11.1	10.5	9.9	9.2	8.6	8.0	7.4	6.8	6.2	5.5	4.9	4.3	3.7	3.1	2.5
58	12.8	12.1	11.5	10.8	10.2	9.6	8.9	8.3	7.7	7.0	6.4	5.7	5.1	4.5	3.8	3.2	2.6
60	13.2	12.5	11.9	11.2	10.6	9.9	9.2	8.6	7.9	7.3	6.6	5.9	5.3	4.6	4.0	3.3	2.6
62	13.6	13.0	12.3	11.6	10.9	10.2	9.5	8.9	8.2	7.5	6.8	6.1	5.5	4.8	4.1	3.4	2.7
64	14.1	13.4	12.7	12.0	11.3	10.6	9.9	9.2	8.4	7.7	7.0	6.3	5.6	4.9	4.2	3.5	2.8
66	14.5	13.8	13.1	12.3	11.6	10.9	10.2	9.4	8.7	8.0	7.3	6.5	5.8	5.1	4.4	3.6	2.9
68	15.0	14.2	13.5	12.7	12.0	11.2	10.5	9.7	9.0	8.2	7.5	6.7	6.0	5.2	4.5	3.7	3.0
70	15.4	14.6	13.9	13.1	12.3	11.6	10.8	10.0	9.2	8.5	7.7	6.9	6.2	5.4	4.6	3.9	3.1
72	15.8	15.0	14.3	13.5	12.7	11.9	11.1	10.3	9.5	8.7	7.9	7.1	6.3	5.5	4.8	4.0	3.2
74	16.3	15.5	14.7	13.8	13.0	12.2	11.4	10.6	9.8	9.0	8.1	7.3	6.5	5.7	4.9	4.1	3.3
76	16.7	15.9	15.0	14.2	13.4	12.5	11.7	10.9	10.0	9.2	8.4	7.5	6.7	5.9	5.0	4.2	3.3
78	17.2	16.3	15.4	14.6	13.7	12.9	12.0	11.2	10.3	9.4	8.6	7.7	6.9	6.0	5.1	4.3	3.4
80	17.6	16.7	15.8	15.0	14.1	13.2	12.3	11.4	10.6	9.7	8.8	7.9	7.0	6.2	5.3	4.4	3.5

LEP = (% clay * 0.22) * (1 - (% rock fragments/100))

MO-1 NASIS Guide 13

Liquid Limit (LL) and Plasticity Index (PI)

Use this guide for horizons that <u>do not</u> meet andic properties criteria

The MO has made an extensive review of available laboratory data for liquid limit and plasticity index for soils in Idaho, Oregon, and Washington. Measured liquid limit and plasticity index values were compared to predicted values using the formulas in NASIS and the National Soil Survey Handbook (NSSH), Exhibit 618.07. The correlations between measured and predicted LL and PI values using the NSSH formulas were better than those with MO-1 NASIS Guide 14 in the previous version of Technical Note 40. The previous NASIS Guide 14 did not use organic matter as a predictive factor and therefore underestimated LL and PI for horizons with significant amounts of organic matter.

Therefore, for horizons that do not meet andic properties, we recommend using the formulas in NSSH Exhibit 618.07 to predict LL and PI. Use MO-1 NASIS Guide 16 for horizons that meet andic soil properties. The formulas are given below.

Liquid limit = 11.6 + (1.49 x 15 bar H_20) + (0.78 x OM) + (0.6 x LEP) + (0.26 x noncarbonate clay

Where:

OM = % organic mater
LEP = linear extensibility percent
15 bar H_20 = gravimetric water content at 15 bar tension. It can be predicted with the following equation:

Calculated 15 bar H_20 = [% noncarbonate clay x (1 - % organic matter / 100) x 0.4] + % organic matter

Plasticity index = -1.86 + (0.69 x 15 bar H_20) - (0.69 x OM) + (0.13 x LEP) + (0.47 x noncarbonate clay)

When the calculated PI is less than 0.5, the PI is set to zero (nonplastic). When the calculated LL is less than 15 or PI is less than 0.5, the LL is set to zero.

The MO-1 NASIS Excel spreadsheet (v. 8) contains the above formulas for LL and PI.

The MO-1 NASIS report “CHECK - Liquid limit and plasticity index” also contains the above formulas and can be used to compare calculated and stored LL and PI values.

MO-1 NASIS Guide 14 - Estimating Liquid Limit and Plasticity Index for Horizons with Andic Properties

	Plasticity Index				Liquid Limit				
	Andic / Ashy			Andic / Medial	Andic / Ashy			Andic / Medial	
OM %	**0 to <5**	**5 to <10**	**10+**	**Any**	**0 to <5**	**5 to < 10**	**> 10**	**0 to < 7**	**7 +**
Texture	L-RV-H	L-RV-H	L-RV-H	L-RV-H	L-RV-H	L-RV-H	L-RV-H	L-RV-H	L-RV-H
C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CL	0-2-5	0-4-5	5-7-10	5-7-10	30-35-40	40-45-55	40-50-55	45-50-55	55-60-65
COS	0-0-0	0-0-0	0-0-0	N/A	0-15-20	20-25-30	20-25-30	N/A	N/A
COSL	0-2-5	0-2-5	0-2-5	0-2-5	15-20-25	25-30-35	25-35-40	30-35-40	50-55-60
FS	0-0-0	0-0-0	0-0-0	N/A	25-30-35	35-40-45	35-45-50	N/A	N/A
FSL	0-2-5	0-2-5	0-2-5	0-2-5	20-25-30	25-30-35	30-35-45	35-40-45	50-55-60
L	0-2-5	0-4-5	5-7-10	5-7-10	25-30-35	35-40-45	35-45-50	40-45-50	50-55-60
LCOS	0-0-0	0-0-0	0-0-0	N/A	0-15-20	20-25-30	20-25-30	N/A	N/A
LFS	0-0-0	0-0-0	0-0-0	N/A	15-20-25	25-30-35	25-35-40	N/A	N/A
LS	0-0-0	0-0-0	0-0-0	N/A	0-15-20	20-25-30	20-25-30	N/A	N/A
LVFS	0-0-0	0-0-0	0-0-0	N/A	15-20-25	25-30-35	25-35-40	N/A	N/A
S	0-0-0	0-0-0	0-0-0	N/A	0-15-20	20-25-30	20-25-30	N/A	N/A
SC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SCL	0-2-5	0-4-5	5-7-10	5-7-10	30-35-40	40-45-55	40-50-55	45-50-55	55-60-65
SI	0-2-5	0-2-5	0-2-5	0-2-5	20-30-35	30-35-40	35-40-45	40-45-50	50-55-60
SIC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SICL	0-2-5	0-4-5	5-7-10	5-7-10	30-35-40	40-45-55	40-50-55	45-50-55	55-60-70
SIL	0-2-5	0-4-5	5-7-10	5-7-10	30-35-40	40-45-55	40-50-55	45-50-55	55-60-70
SL	0-2-5	0-2-5	0-2-5	0-2-5	15-20-25	25-30-35	25-35-40	35-40-45	50-55-60
VFS	0-0-0	0-0-0	0-0-0	N/A	0-15-20	20-25-30	20-25-30	N/A	N/A
VFSL	0-2-5	0-2-5	0-2-5	0-2-5	25-30-35	35-40-45	35-45-50	40-45-50	50-55-60

Andic / Ashy – Horizon meets criteria for Andic Soil Properties criteria #2 and Ashy, Ashy-Skeletal, or Ashy-Pumiceous substitute particle size class.
Andic / Medial - Horizon meets criteria for Medial, Medial-Skeletal, or Medial-Pumiceous substitute particle size class.

MO-1 NASIS Guide 15

Cation Exchange Capacity - by Ammonium Acetate at pH 7

Use this guide for horizons that do not meet andic soil properties criteria

The National Soil Survey Laboratory (NSSH) developed guidance for estimating cation exchange capacity (CEC) using percent clay, clay activity group, and percent organic matter in 1989 (West NTC Bulletin W430-9-2). Five clay activity groups were established, of which four occur in the Pacific Northwest. The NSSH procedure for estimating CEC will be used in MO-1 for horizons that do not meet andic soil properties criteria.

Step 1 - Select a Clay Activity Group from the table below. Local guides will need to be developed by MLRA, using available laboratory data for CEC to clay ratios and clay mineralogy, to select appropriate clay activity groups. Soils with lithologic discontinuities such as volcanic ash over glacial till may not have the same clay activity group for each horizon.

	Clay Activity Group			
	Low (3)	Moderate (5)	High (7)	Very High (9)
CEC-7 of mineral fraction to Clay Ratio	< 0.40	0.40 - 0.59	0.60 - 0.80	> 0.80
Dominant Clay Minerals	CA - calcite CL - chlorite GI - gibbsite KH- halloysite KK - kaolinite MI - mica NX - non-crystalline	VC - vermiculite-chlorite VM - vermiculite-mica	VR - vermiculite MC - montmorillonite-chlorite MM - montmorillonite-mica	MT - montmorillonite MV - montmorillonite-vermiculite

Step 2 - Use the tables in the following pages to determine the CEC, using the clay activity group, percent clay, and percent organic matter.

The formulas in the tables have been incorporated into the MO-1 NASIS Excel spreadsheet (version 8).

MO-1 NASIS Guide 15 (continued)

Estimated Cation Exchange Capacity (CEC) - **Low (3)** Clay Activity Group

meq/100 grams or cmol/kg

Percent Organic Matter	Percent Clay																															
	0	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
0	0	1	1	2	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	11	12	13	13	14	14	15	16	16	17	17	18
1	2	3	3	4	4	5	6	6	7	7	8	9	9	10	10	11	12	12	13	13	14	15	15	16	16	17	18	18	19	19	20
2	4	5	5	6	6	7	8	8	9	9	10	11	11	12	12	13	14	14	15	15	16	17	17	18	18	19	20	20	21	21	22
3	6	7	7	8	8	9	10	10	11	11	12	13	13	14	14	15	16	16	17	17	18	19	19	20	20	21	22	22	23	23	24
4	8	9	9	10	10	11	12	12	13	13	14	15	15	16	16	17	18	18	19	19	20	21	21	22	22	23	24	24	25	25	26
5	10	11	11	12	12	13	14	14	15	15	16	17	17	18	18	19	20	20	21	21	22	23	23	24	24	25	26	26	27	27	28
6	12	13	13	14	14	15	16	16	17	17	18	19	19	20	20	21	22	22	23	23	24	25	25	26	26	27	28	28	29	29	30
7	14	15	15	16	16	17	18	18	19	19	20	21	21	22	22	23	24	24	25	25	26	27	27	28	28	29	30	30	31	31	32
8	16	17	17	18	18	19	20	20	21	21	22	23	23	24	24	25	26	26	27	27	28	29	29	30	30	31	32	32	33	33	34
9	18	19	19	20	20	21	22	22	23	23	24	25	25	26	26	27	28	28	29	29	30	31	31	32	32	33	34	34	35	35	36
10	20	21	21	22	22	23	24	24	25	25	26	27	27	28	28	29	30	30	31	31	32	33	33	34	34	35	36	36	37	37	38
11	22	23	23	24	24	25	26	26	27	27	28	29	29	30	30	31	32	32	33	33	34	35	35	36	36	37	38	38	39	39	40
12	24	25	25	26	26	27	28	28	29	29	30	31	31	32	32	33	34	34	35	35	36	37	37	38	38	39	40	40	41	41	42
13	26	27	27	28	28	29	30	30	31	31	32	33	33	34	34	35	36	36	37	37	38	39	39	40	40	41	42	42	43	43	44
14	28	29	29	30	30	31	32	32	33	33	34	35	35	36	36	37	38	38	39	39	40	41	41	42	42	43	44	44	45	45	46
15	30	31	31	32	32	33	34	34	35	35	36	37	37	38	38	39	40	40	41	41	42	43	43	44	44	45	46	46	47	47	48

For soils with >60 percent clay or >15 percent organic matter, use the following formula:

CEC = (% clay x 0.3) + (% organic matter x 2)

MO-1 NASIS Guide 15 (continued)

Estimated Cation Exchange Capacity (CEC) - **Moderate (5)** Clay Activity Group

meq/100 grams or cmol/kg

Percent Organic Matter	Percent Clay																															
	0	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
3	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
4	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
5	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
6	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
7	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
8	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
9	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
10	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
11	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
12	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
13	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
14	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
15	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

For soils with >60 percent clay or >15 percent organic matter, use the following formula:

CEC = (% clay x 0.5) + (% organic matter x 2)

MO-1 NASIS Guide 15 (continued)

Estimated Cation Exchange Capacity (CEC) - **High (7)** Clay Activity Group

meq/100 grams or cmol/kg

Percent Organic Matter	Percent Clay																														
	0	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
0	0	1	3	4	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27	28	29	31	32	34	35	36	38	39	41	42
1	2	3	5	6	8	9	10	12	13	15	16	17	19	20	22	23	24	26	27	29	30	31	33	34	36	37	38	40	41	43	44
2	4	5	7	8	10	11	12	14	15	17	18	19	21	22	24	25	26	28	29	31	32	33	35	36	38	39	40	42	43	45	46
3	6	7	9	10	12	13	14	16	17	19	20	21	23	24	26	27	28	30	31	33	34	35	37	38	40	41	42	44	45	47	48
4	8	9	11	12	14	15	16	18	19	21	22	23	25	26	28	29	30	32	33	35	36	37	39	40	42	43	44	46	47	49	50
5	10	11	13	14	16	17	18	20	21	23	24	25	27	28	30	31	32	34	35	37	38	39	41	42	44	45	46	48	49	51	52
6	12	13	15	16	18	19	20	22	23	25	26	27	29	30	32	33	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54
7	14	15	17	18	20	21	22	24	25	27	28	29	31	32	34	35	36	38	39	41	42	43	45	46	48	49	50	52	53	55	56
8	16	17	19	20	22	23	24	26	27	29	30	31	33	34	36	37	38	40	41	43	44	45	47	48	50	51	52	54	55	57	58
9	18	19	21	22	24	25	26	28	29	31	32	33	35	36	38	39	40	42	43	45	46	47	49	50	52	53	54	56	57	59	60
10	20	21	23	24	26	27	28	30	31	33	34	35	37	38	40	41	42	44	45	47	48	49	51	52	54	55	56	58	59	61	62
11	22	23	25	26	28	29	30	32	33	35	36	37	39	40	42	43	44	46	47	49	50	51	53	54	56	57	58	60	61	63	64
12	24	25	27	28	30	31	32	34	35	37	38	39	41	42	44	45	46	48	49	51	52	53	55	56	58	59	60	62	63	65	66
13	26	27	29	30	32	33	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54	55	57	58	60	61	62	64	65	67	68
14	28	29	31	32	34	35	36	38	39	41	42	43	45	46	48	49	50	52	53	55	56	57	59	60	62	63	64	66	67	69	70
15	30	31	33	34	36	37	38	40	41	43	44	45	47	48	50	51	52	54	55	57	58	59	61	62	64	65	66	68	69	71	72

For soils with >60 percent clay or >15 percent organic matter, use the following formula:

CEC = (% clay x 0.7) + (% organic matter x 2)

MO-1 NASIS Guide 15 (continued)

Estimated Cation Exchange Capacity (CEC) - **Very High (9)** Clay Activity Group

meq/100 grams or cmol/kg

Percent Organic Matter	Percent Clay																														
	0	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
0	0	2	4	5	7	9	11	13	14	16	18	20	22	23	25	27	29	31	32	34	36	38	40	41	43	45	47	49	50	52	54
1	2	4	6	7	9	11	13	15	16	18	20	22	24	25	27	29	31	33	34	36	38	40	42	43	45	47	49	51	52	54	56
2	4	6	8	9	11	13	15	17	18	20	22	24	26	27	29	31	33	35	36	38	40	42	44	45	47	49	51	53	54	56	58
3	6	8	10	11	13	15	17	19	20	22	24	26	28	29	31	33	35	37	38	40	42	44	46	47	49	51	53	55	56	58	60
4	8	10	12	13	15	17	19	21	22	24	26	28	30	31	33	35	37	39	40	42	44	46	48	49	51	53	55	57	58	60	62
5	10	12	14	15	17	19	21	23	24	26	28	30	32	33	35	37	39	41	42	44	46	48	50	51	53	55	57	59	60	62	64
6	12	14	16	17	19	21	23	25	26	28	30	32	34	35	37	39	41	43	44	46	48	50	52	53	55	57	59	61	62	64	66
7	14	16	18	19	21	23	25	27	28	30	32	34	36	37	39	41	43	45	46	48	50	52	54	55	57	59	61	63	64	66	68
8	16	18	20	21	23	25	27	29	30	32	34	36	38	39	41	43	45	47	48	50	52	54	56	57	59	61	63	65	66	68	70
9	18	20	22	23	25	27	29	31	32	34	36	38	40	41	43	45	47	49	50	52	54	56	58	59	61	63	65	67	68	70	72
10	20	22	24	25	27	29	31	33	34	36	38	40	42	43	45	47	49	51	52	54	56	58	60	61	63	65	67	69	70	72	74
11	22	24	26	27	29	31	33	35	36	38	40	42	44	45	47	49	51	53	54	56	58	60	62	63	65	67	69	71	72	74	76
12	24	26	28	29	31	33	35	37	38	40	42	44	46	47	49	51	53	55	56	58	60	62	64	65	67	69	71	73	74	76	78
13	26	28	30	31	33	35	37	39	40	42	44	46	48	49	51	53	55	57	58	60	62	64	66	67	69	71	73	75	76	78	80
14	28	30	32	33	35	37	39	41	42	44	46	48	50	51	53	55	57	59	60	62	64	66	68	69	71	73	75	77	78	80	82
15	30	32	34	35	37	39	41	43	44	46	48	50	52	53	55	57	59	61	62	64	66	68	70	71	73	75	77	79	80	82	84

For soils with >60 percent clay or >15 percent organic matter, use the following formula:

CEC = (% clay x 0.9) + (% organic matter x 2)

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CEC-7 Guide for Horizons with Andic Properties

meq/100 grams or cmol/kg

MLRA	Soil Properties	CEC-7	
		A horizon	B horizon
4A	Isomesic, isofrigid Udic Medial family	50 to70 RV=60	30 to 50 RV=40
1	Mesic, frigid, cryic Udic Medial family	40 to 60 RV=50	30 to 50 RV=40
3 (Cascade Mts.)	Mesic, frigid, cryic Udic Medial family	30 to 50 RV=40	20 to 40 RV=30
3 (Cascade Mts.)	Mesic, frigid, cryic Udic/xeric Ashy family	20 to 40 RV=30	15 to 35 RV=25
3 (Olympic Mts.)	Cryic Udic Medial family	50 to 70 RV=60	40 to 60 RV=50
6	Mesic, frigid Xeric Ashy family	20 to 40 RV=30	15 to 35 RV=25
43	0 to 15% clay	15 to 35 RV=25	10 to 25 RV=15
	15 to 25% clay	25 to 50 RV=35	20 to 45 RV=30

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UNIFIED Soil Classification System

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

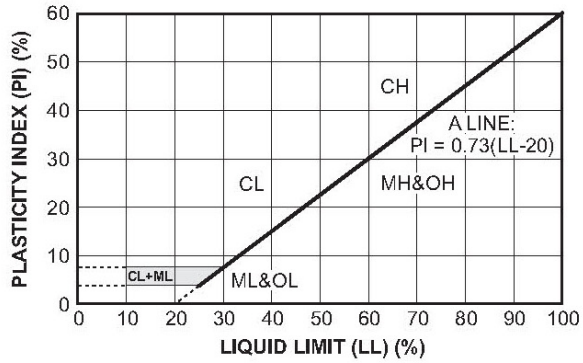
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART



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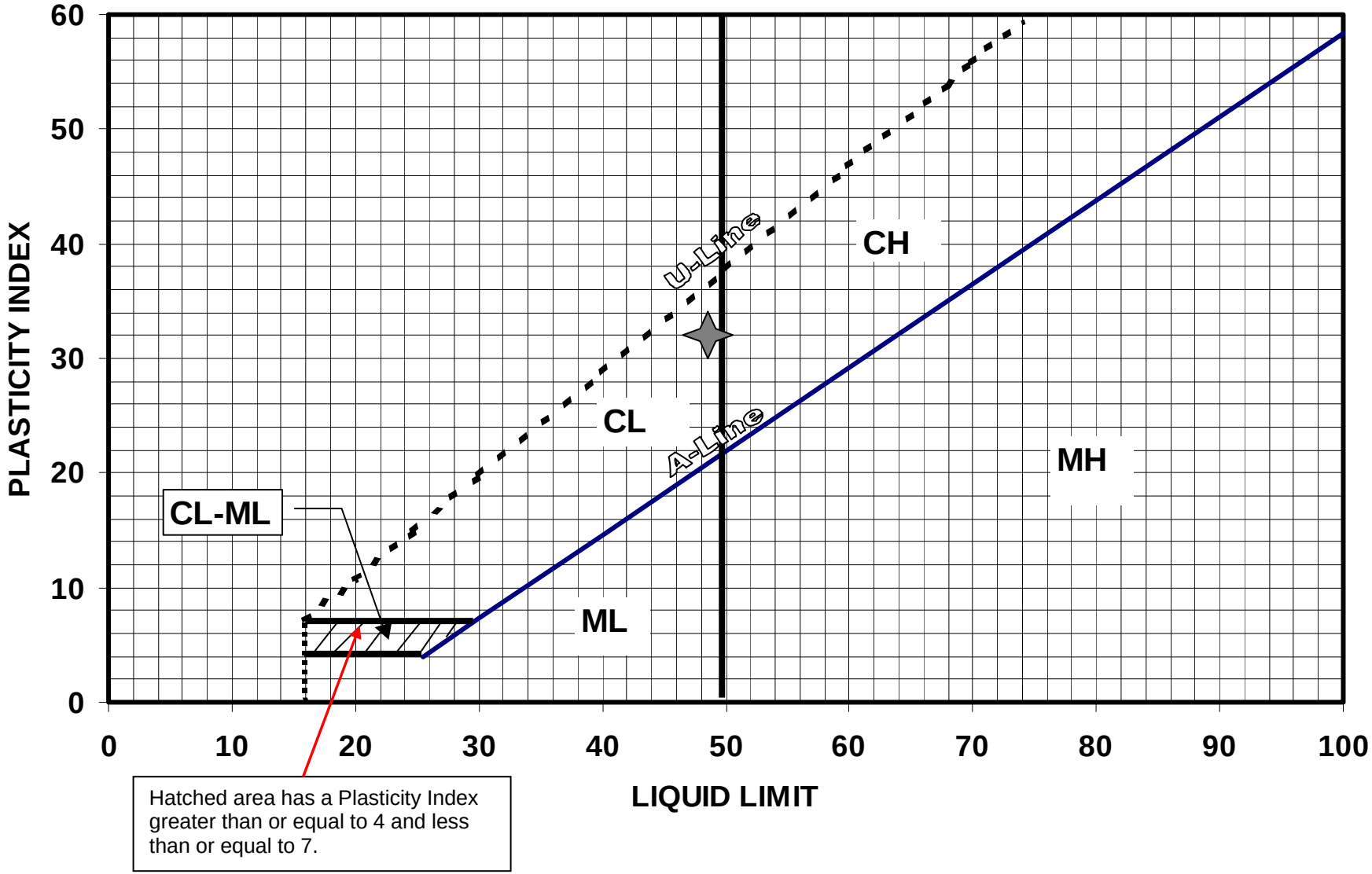
Unified Soil Classification - Liquid Limit / Plasticity Index Graph



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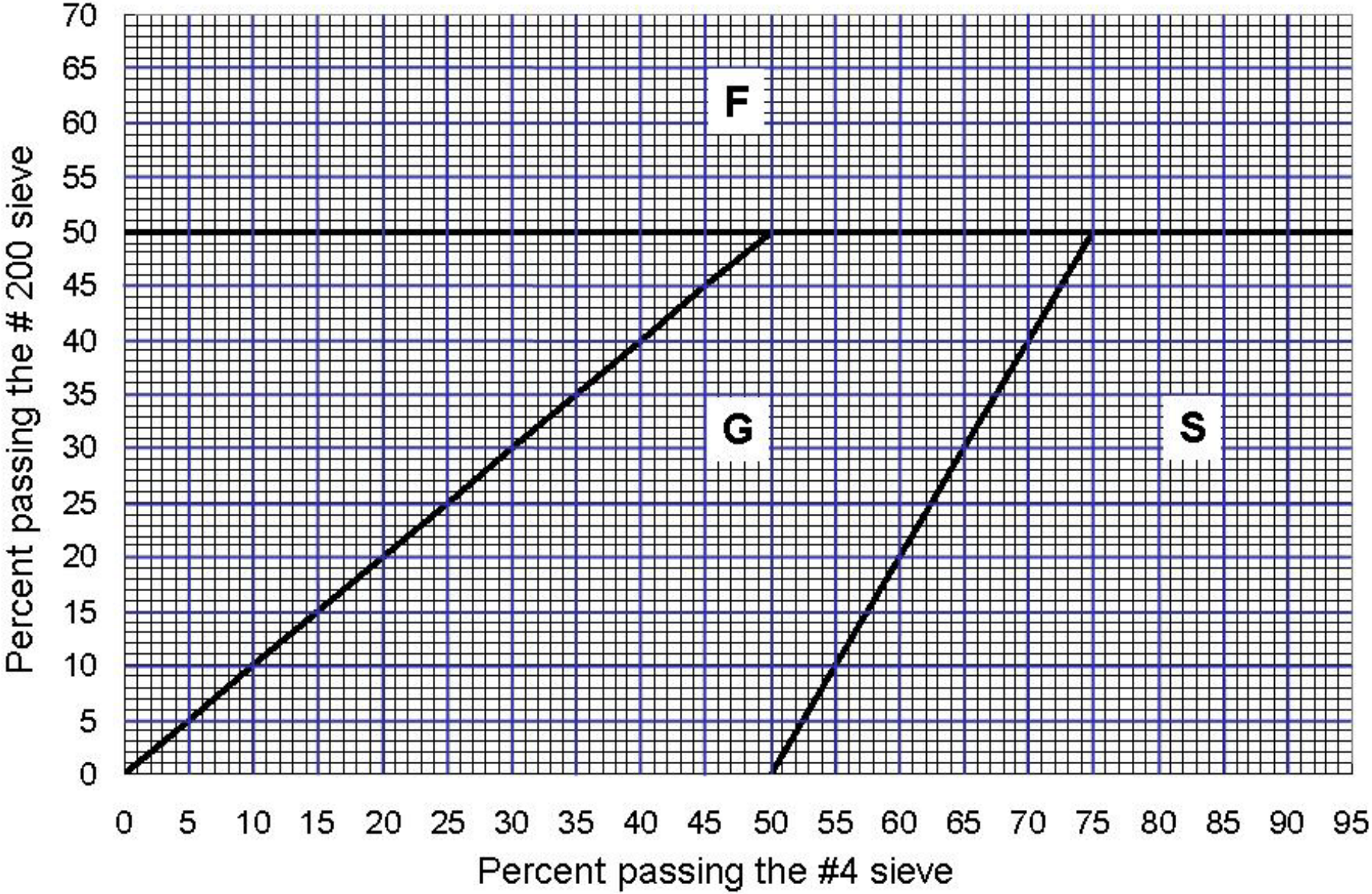
To determine Unified fine grained (F), sandy (S), or gravelly (G) soils



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AASHTO Soil Classification

Classification of Soils and Soil-Aggregate Mixtures for the American Association of State Highway and Transportation Officials (AASHTO) System.

General Classification	Granular Materials (35% or less passing No. 200)							Silt-Clay Materials (More than 35% passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve analysis, % passing:											
No. 10 (200 mm)	50 max	...	...	...	...	...	...	...	...	...	...
No. 40 (425 µm)	30 max	50 max	51 min	...	...	...	...	...	...	...	...
No. 200 (75 µm)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing No. 40 (425 µm)											
Liquid limit	...		...	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min*
Usual types of significant constituent materials	Stone Fragments Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General rating as subgrade	Excellent to Good					Fair to Poor					

* Plasticity index of A-7-5 subgroup is equal to or less than *LL* minus 30. Plasticity index of A-7-6 sub group is greater than *LL* minus 30.

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