Chapter 2 Soils

Contents:

FL652.0204a General

Knowledge of soils is essential for the efficient use of water for crop production. Soil survey maps for the areas mapped in the state are now available online through the NRCS Web Soil Survey (WSS), http://websoilsurvey.nrcs.usda.gov/app/. See Exhibit FL2-1 for instructions on how to use and access the NRCS WSS. The WSS is replacing the familiar, traditional paper copies of soil survey reports. As new and updated soil surveys are completed, NRCS is distributing the results of these surveys by means of the WSS instead of published reports. The WSS allows NRCS to update the information more rapidly and ensures a single source for official data. Those without computer access can still acquire soil survey information from an NRCS field office or local library.

Important physical and chemical characteristics of each kind of soil are recorded in soils handbooks or soil survey publications. This information is also available online through the NRCS Soil Data Mart, http://soildatamart.nrcs.usda.gov/. See Exhibit FL2-2 for instructions on how to access and use the NRCS Soil Data Mart. Some characteristics of these soils that are important to understanding soil-moisture plant relationships are discussed in this guide. They include available water capacity, permeability, intake rate, slope, wetness (drainage and depth to water table), and surface texture.

FL652.0204b Physical soil characteristics

Available Water Capacity

The available water capacity (AWC) of a soil is a measure of its capacity to make water available for plant growth. The AWC is the amount of water held between field capacity (FC) and the permanent wilting point (WP) as shown in Figure FL2-1. AWC is expressed as the water retained between 0.33 bar and 15 bar tension for fine to medium textured soils and between 0.10 bar and 15 bar for moderately coarse to very coarse textured soils. AWC of a soil is primarily related to the soil texture, organic matter content, and bulk density. A formula for the computation of available water capacity is

$$AWC = (d_b \times T \times P_w)/ (d_w \times 100)$$

Where:

AWC = Available water capacity in inches

d_b = Bulk density

$$= \frac{\text{Weight of ovendry soil sample in grams}}{\text{Field volume of sample in cm}^3}$$

T = Thickness of soil horizon under consideration in inches

P_w = Moisture content between field capacity and wilting point in percentage by weight

d_w = Density of water taken as 1

There are two methods concerning when to irrigate. One method is based on the percentage of AWC within the root zone and the other is based on soil moisture tension. This difference in concept is shown in Figure FL2-2 which shows moisture release curves for three soils. In this figure moisture content is expressed as a percentage of AWC rather than a percentage by weight. FC is 100 percent of AWC and the WP is 0 percent of AWC (15 bars). Tension at any moisture level is different for the three soils. At the 50 percent level, for example, moisture tension for the clay is 4.3 bars; for the loam, 2 bars; and for the sand, 0.60 bars.

Moisture is more readily available to plants at low soil moisture tension (near field capacity). Since tension values are so different in the three soils shown in Figure FL2-2, it is possible that crop response would be different if the soils were irrigated when available moisture depletes to the 50 percent level. However, for most soils, irrigation should be started when the soil moisture content is no lower than the 50 percent level.

Figure FL2-1. Soil Moisture Content – Types of Water in the Soil

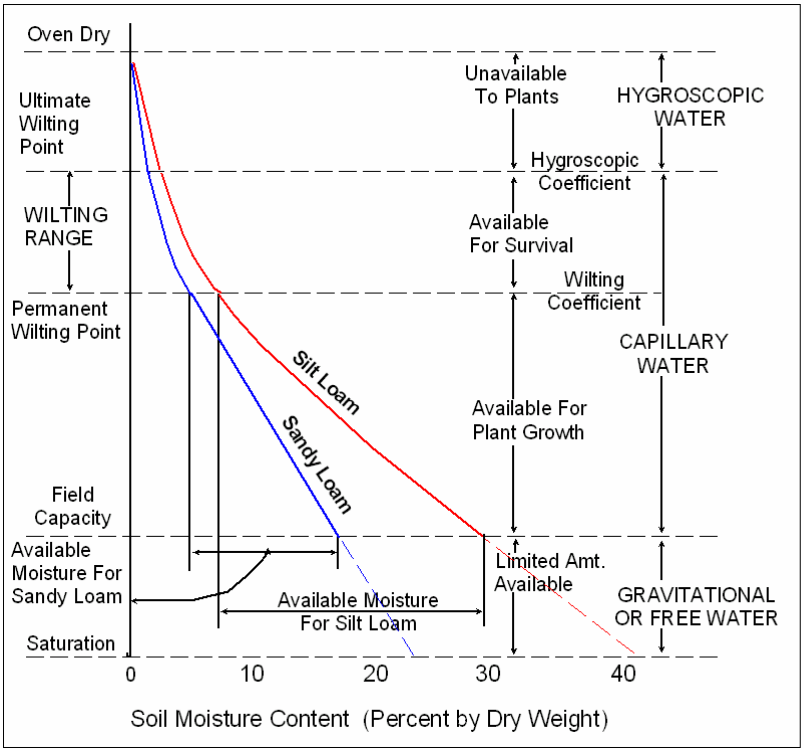
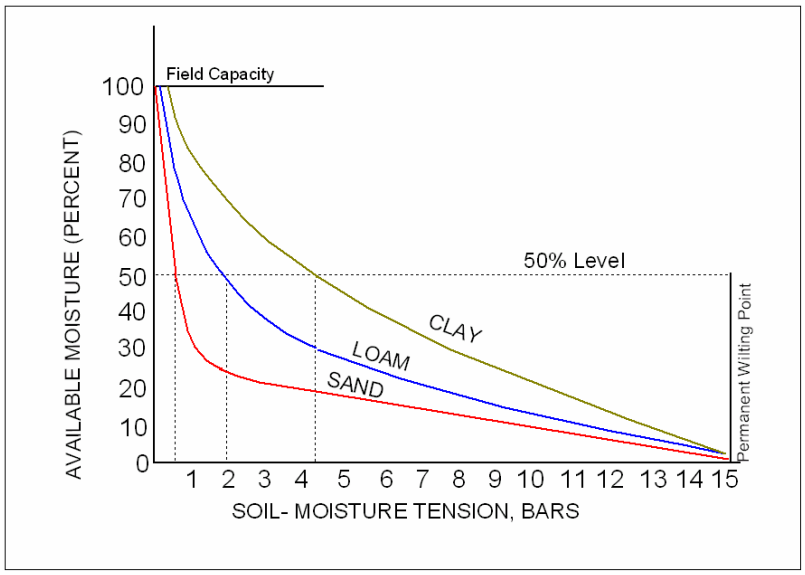


Figure FL2-2. Moisture Release Curves for Three Soils



The NRCS Soil Data Mart can be used to generate reports on physical soil properties for Florida soils, including AWC. For example, the water holding capacity for 36 inches of rooting depth on an Alpin soil is:

0'-1', 0.056 in./in. × 12 in. = 0.67 in.

1'-2', 0.050 in./in. × 12 in. = 0.60 in.

2'-3', 0.050 in./in. × 12 in. = 0.60 in.

Total AWC for 36 in. depth = 1.87 in.

The weighted AWC for the rooting depth is obtained by dividing the total AWC by the rooting depth. For the above example, the weighted AWC is:

1.87 in./36 in. = 0.052 in./in.

Permeability

Permeability is the quality of soil that enables it to transmit air and water. It is independent of the viscosity of water. The permeability of a soil is based on the most restrictive layer in the soil. The relative permeability of soils is described by the terms listed in Table FL2-1.

Table FL2-1. Relative Permeability of Soils

Term	Permeability Rate (in/hr)
Very slow	<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 - 20.0
Very rapid	>20

Permeability rates for Florida soils are shown as saturated hydraulic conductivity, K_{sat} (µm/sec) in the Physical Soil Properties report in the NRCS Soil Data Mart. These values can be converted to in./hr. for design purposes.

Intake Rate

Intake rate is a measure of soil's capacity to absorb irrigation water from the surface, and move it into and through the soil profile. It is an expression of several factors, including infiltration and percolation. The term, "basic intake rate" is the rate at which water percolates into soil after infiltration has decreased to a low and nearly constant value.

Infiltration is the downward flow of water from the surface through the soil. Water enters the soil through pores, cracks, worm and decayed root holes, and cavities introduced by tillage. Surface sealing or crusting will restrict infiltration.

Percolation is the movement of water through the soil profile. In order for irrigation water to be effective in replenishing the soils water supply, it must be able to move through the profile, or percolate, to a predetermined irrigation depth. The percolation rate is governed by the permeability of the soil or its hydraulic conductivity. Both terms are used to describe the ease with which soil transmits water and air.

The amount of moisture already in the soil greatly influences the rate at which water enters the soil. The soil takes in and absorbs irrigation water rapidly when water is first applied to the field surface. As the irrigation application continues, the surface soil gradually becomes saturated and the intake rate decreases until it reaches a nearly constant value.

The intake of any soil is limited by any restriction to the flow of water into or through the soil profile. The soil layer with the lowest transmission rate, either at the surface or directly below it, usually determines intake rate. The most important general factors that influence intake rate are the physical properties of the soil and, in sprinkler irrigation, the plant cover. But for any given soil, other factors may affect the intake rate.

Since so many factors affect the water intake, it is not surprising that it varies so much among soils. Furthermore, the intake characteristics of a given field vary from place to place, from irrigation to irrigation, and from season to season. The intake characteristics that must be considered in sprinkler irrigation design differ from those for surface methods.

Actual measured intake rates are unavailable for Florida soils. Intake rates are estimates based on the characteristics of the top two feet of the soil. If the soil has a water table within two feet of the surface, the intake rate is assigned as if the soil is drained. Typically, for a well-drained soil, the intake rate is estimated at 3.0 in./hr. For other

soil types, consult with a soil scientist to determine an intake rate value.

Slope

Slope refers to the incline of the surface of the soil area. A simple, or single, slope is defined by its gradient, shape, and length. Slopes may also be defined as single or complex depending on the nature of the area. Soil slope is expressed in terms of percentage. It is the difference in elevation in feet for each 100-feet horizontal. A soil with a slope of 45 degrees is a slope of 100 percent since the difference in elevation of two points 100 feet apart horizontally is 100 feet.

Soil slope and intake rate are important factors in determining runoff.

Wetness

Wetness is expressed as a function of soil drainage and depth to water table. Internal soil drainage is a natural condition of the soil that refers to the frequency and duration of periods when the soil is free of saturation. For example, in well drained soils the water is removed readily but not rapidly; in poorly drained soils the root zone is waterlogged for long periods unless artificially drained. In excessively drained soils water is removed so completely that most plants suffer from lack of water.

Except for very young soils, the natural soil drainage conditions are reflected in soil morphology. The drainage class shown for the various soils is the drainage that existed during the development of the soil as opposed to altered drainage as the result of artificial drainage. Table FL2-2 lists classes (with their abbreviations) to define natural soil drainage in broad terms.

Table FL2-2. Drainage Classes of Soils

Drainage Class	Abbreviation
Very poorly drained	VP
Poorly drained	P
Somewhat poorly drained	SP
Moderately well drained	MW
Well drained	W
Somewhat excessively drained	SE
Excessively drained	E

High water table is defined as the top of the zone of saturation at the highest average depth elevation during the wettest season. It persists in the soil for more than a few days. The depth to water table is given for each soil in the Water Features report in the NRCS Soil Data Mart.

The presence of a saturated zone (water table) is a prime factor in determining soils adaptability for irrigation. If a saturated zone is at a shallow depth, a hazard always exists that heavy rains can raise the saturated zone to depths shallow enough to slow or inhibit plant growth. Thus, soils with wetness limitations are given different considerations than other similar soils that do not have a wetness limitation.

Surface Texture

Surface texture is displayed in the Engineering Properties report in the NRCS Soil Data Mart, for all soil series. The abbreviations in Table FL2-3 are used to describe soil texture.

Table FL2-3. Soil Texture Abbreviations

Soil Texture	Abbreviation
Sand	S
Coarse sand	COS
Fine sand	FS
Loamy coarse sand	LCOS
Loamy sand	LS
Loamy fine sand	LFS
Coarse sandy loam	COSL
Sandy loam	SL
Fine sandy loam	FSL
Very fine sandy loam	VFSL
Loam	L
Silt loam	SIL
Clay loam	CL
Sandy clay loam	SCL
Silty clay loam	SICL
Silty clay	SIC
Sandy clay	SC
Clay	C
Muck or peat	MK or PT
Additional Textural Modifiers	
Channery	CN
Gravelly	GR
Shaley	SH

Restrictive Features

Certain soil features affect design, layout, construction, management or performance of an irrigation system. Those features important in design and management of most irrigation systems are wetness or ponding and the need for drainage, flooding, available water capacity, intake rate, permeability, susceptibility to wind or water erosion, and slope. Soil features that influence construction are large stones and depth to bedrock or cemented pan. The features that affect performance of the system are rooting depth, amount of salts or sodium, and soil acidity. These properties, limits, and restrictive features are shown in Table FL2-4. Particular soils with restrictive features are displayed in the Engineering Properties report in the NRCS Soil Data Mart.

Table FL2-4. Irrigation Restrictive Features

Property	Limits	Restrictive Factors
Fraction >3 in. (wt. %)[1/]	>25	Large Stones
Depth to High Water Table(ft)	<3	Wetness Ponding
Available Water Capacity (in./in.)[1/]	<0.10	Droughty
USDA Texture (Surface Layer)	S, FS, VFS, LS, LFS, VFSL	Fast Intake
USDA Texture (Surface Layer)	SIC, C, SC	Slow Intake
Wind Erodibility Group	1, 2, 3	Soil Blowing
Permeability (in./hr.) (0-60")	<0.2	Percs Slowly
Depth to Bedrock (in.)	<40	Depth to Rock
Depth to Cemented Pan (in.)	<40	Cemented Pan
Fragipan (Great Group)	All Fragi	Rooting Depth
Bulk Density (g/cc) (0-40")	>1.7	Rooting Depth
Slope (%)	>3	Slope
Erosion Factor (K) (Surface Layer)	>0.35	Erodes Easily
Flooding	Common	Floods
Sodium Absorption Ratio (Great Group)	>12 (Natric, Halic)	Excess Sodium
Salinity (mmho/cm)	>8	Excess Salt
Soil Reaction (pH)	<3.6	Too Acidic
----------	None of Above	Favorable

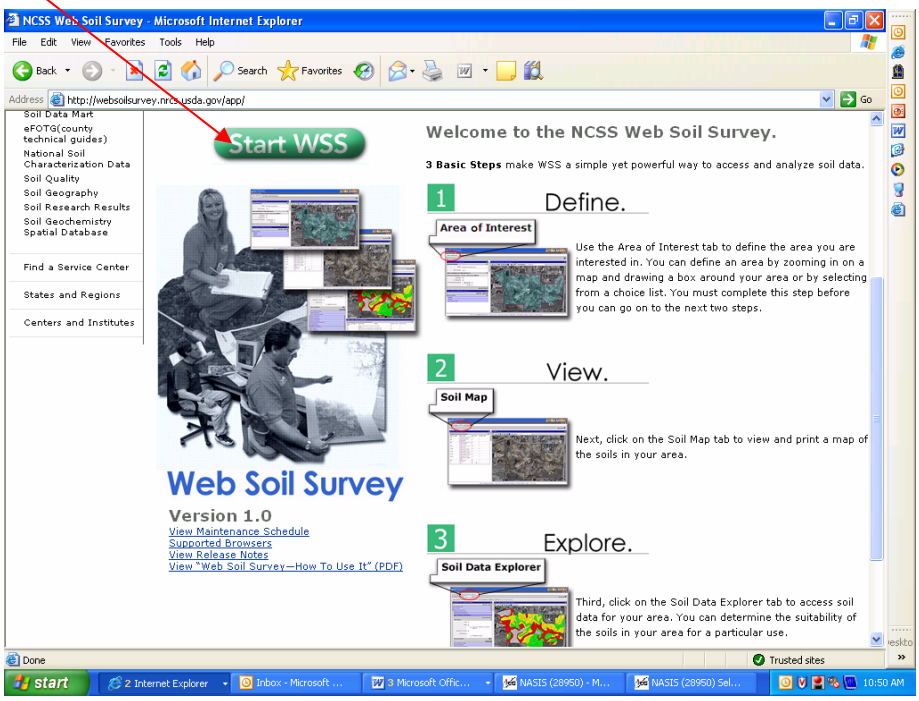
1/ Weighted average to 40 inches.

Exhibit FL2-1. Navigating and Using the Web Soil Survey

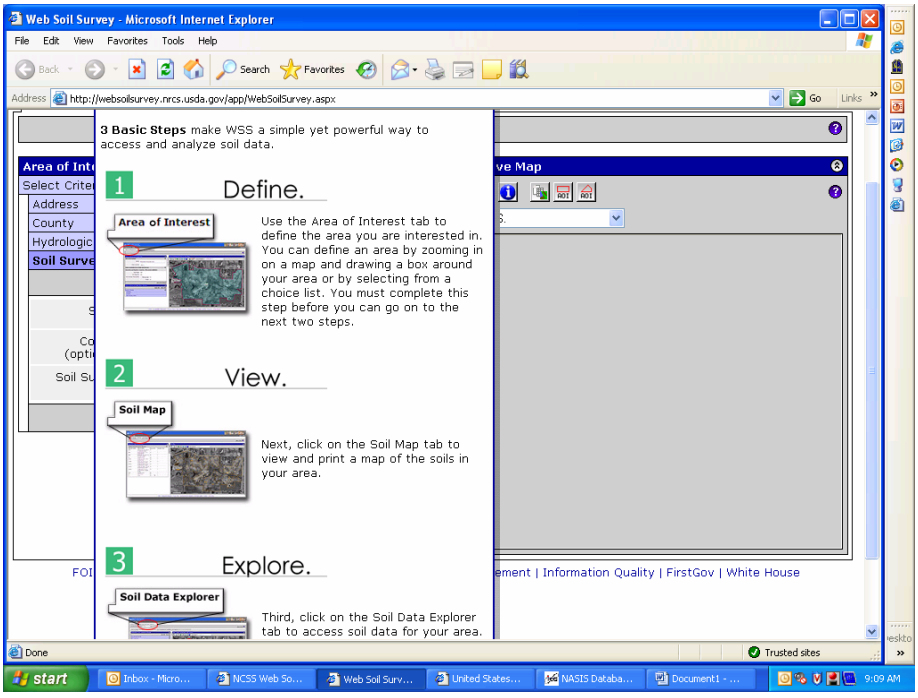
Accessing web soil survey: (ctrl + click link below)

http://websoilsurvey.nrcs.usda.gov/app/

Click on "Start WSS" button.



There are 3 basic steps in using Web Soil Survey (WSS): Define, View, Explore.



1) DEFINE: The first step in using Web Soil Survey is to define your area of interest.

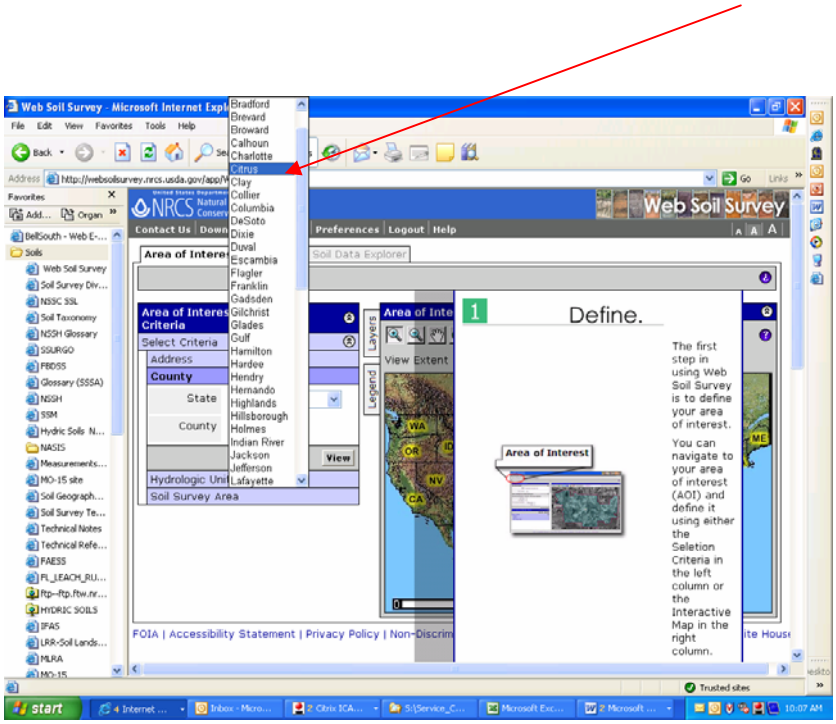
You can select an area in the continental United States, Alaska, Hawaii, the Pacific Basin, Puerto Rico, or the U.S. Virgin Islands. You select an area by zooming in on a locator map or by specifying street address, county, or survey area.

You can navigate to your area of interest (AOI) and define it using either the Selection Criteria in the left column or the Interactive Map in the right column.

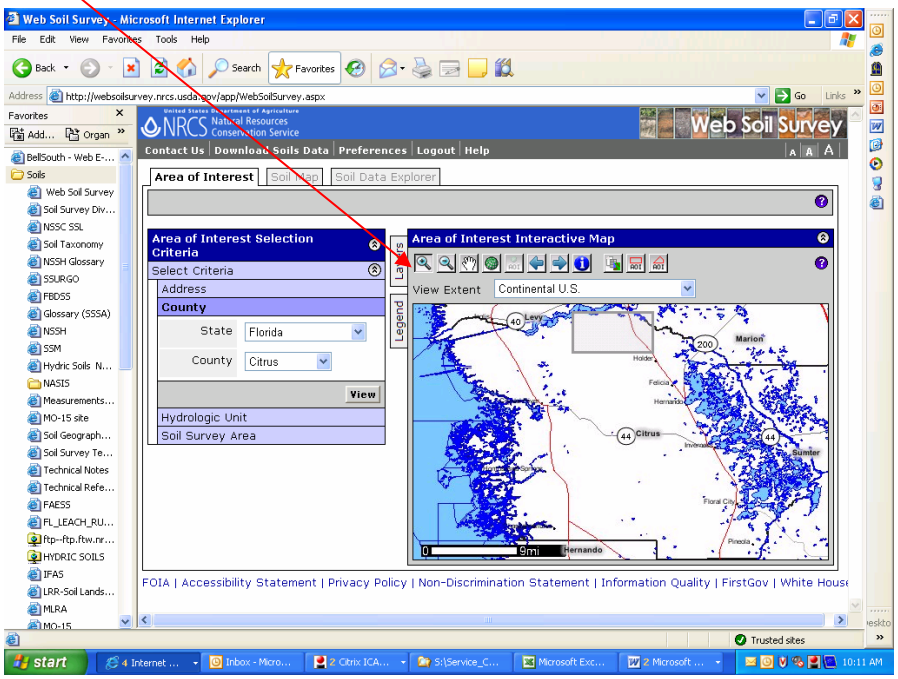
Note: The specified AOI must be smaller than 10,000 acres.

Click the upside-down help button on the above button bar to close a help window.

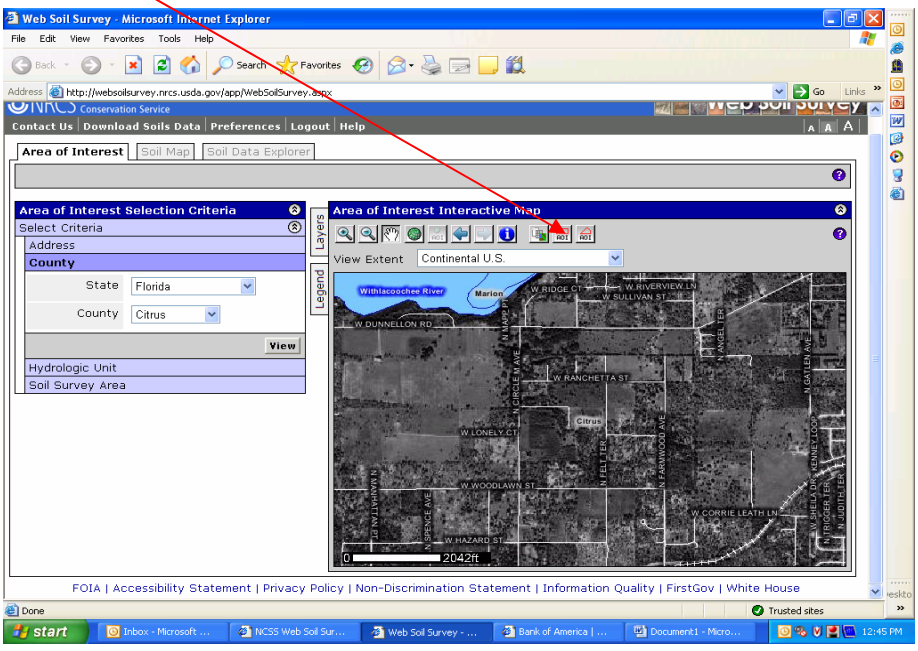
For this example, using Selection Criteria on the left side of the screen, select Citrus County, Florida.



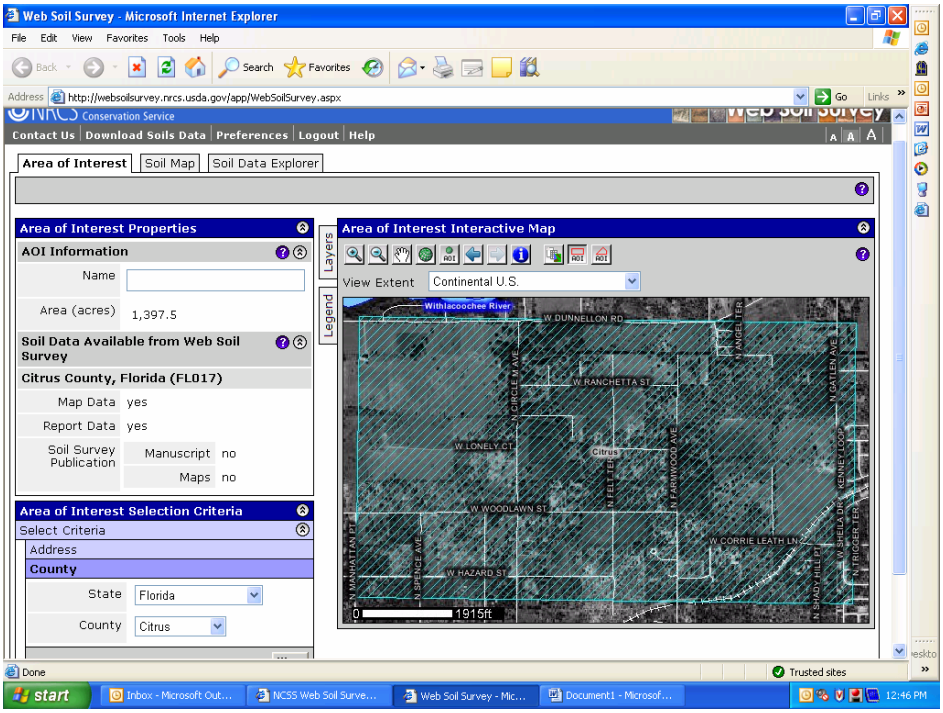
Using the Magnify tool (left side of tool bar); choose the exact area for viewing. In this case, the gray shaded area in northern Citrus County, near the Withalacoochee River is selected.



To define the AOI, use the Interactive Map, and select the button at the top of the page with the red rectangular AOI label. This selection will show a crosshair that will allow you to select the preferred area in rectangular shape.



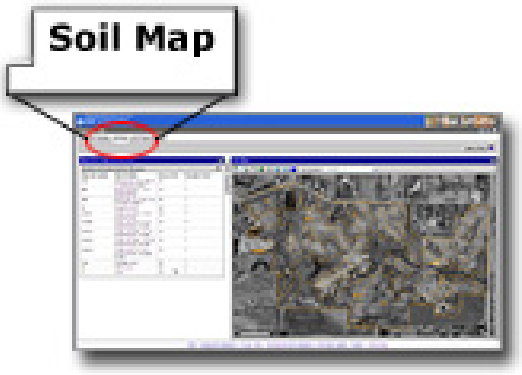
The defined AOI will show up in a crosshatched pattern and the soil data within your AOI is ready for viewing.



2) VIEW: The second step in using Web Soil Survey is to look at the Soil Map for your area of interest. The soil map shows the map unit symbols in your AOI.

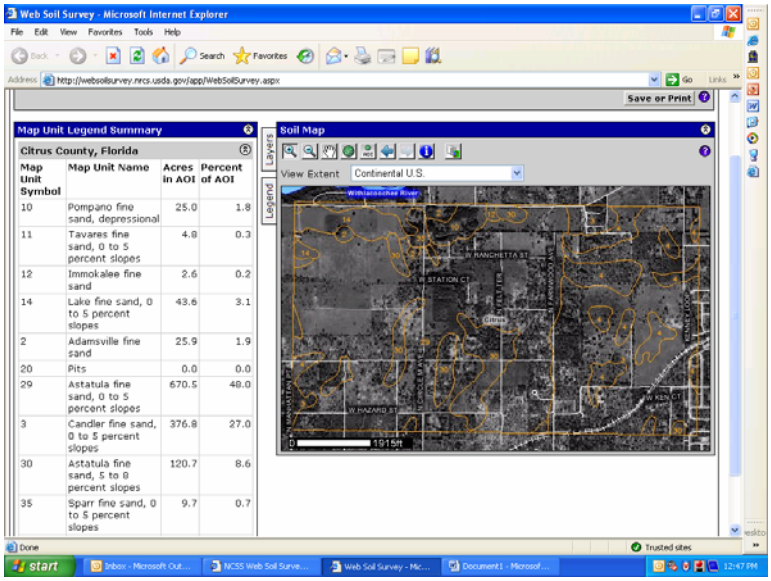
Soil maps are not yet available for all areas. The maps that are available consist of aerial photography overlain by lines that indicate the boundaries of the various types of soil.

The Map Unit Legend Summary table in the left column shows you the name and map symbol of each map unit, the percent of each map unit in the AOI, and the total acreage of each map unit in the AOI.



Once the AOI is selected, the map can be viewed by clicking on the "Soil Map" tab on the top left of the screen.

In addition, Map Unit Symbol, Map Unit Name, the Acres in AOI and Percent of AOI are viewable in the Map Unit Legend Summary in the far left column.



Viewing and printing the soil map

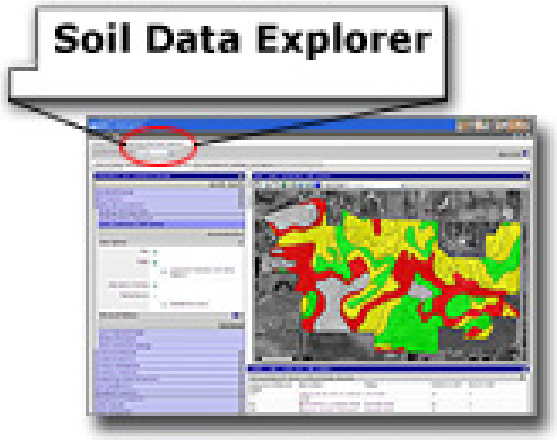
While using Web Soil Survey, you may want to refer back to your soil map. You can do so on the screen by clicking the Soil Map tab, or you can print the soil map by clicking the Save or Print button:

Closing the help window

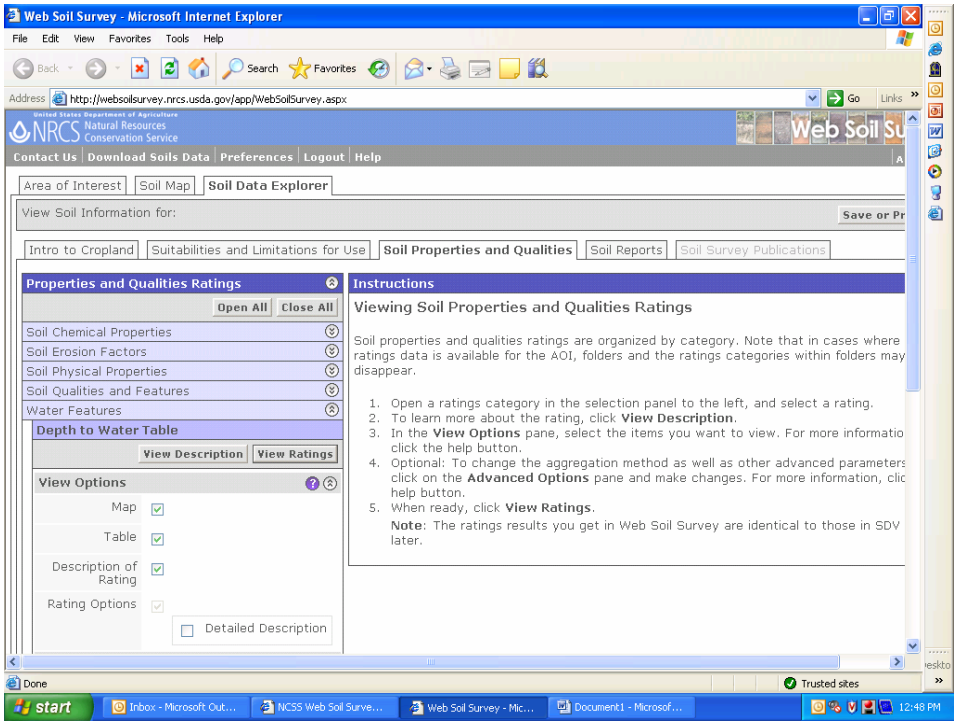
Click the upside-down help button  on the above button bar to close a help window.

3) Explore: The third and final step in using Web Soil Survey is to explore all of the available information associated with the soils in your area of interest. The Soil Data Explorer allows individuals to generate thematic maps based on land use rating and limitations, or by specific physical or chemical data attributes.

The Web Soil Survey can display the properties and qualities of the soils. It can also show interpretations about the suitabilities and limitations of the soils for many uses. Examples of properties and qualities include available water capacity and pH. Examples of suitabilities and limitations include interpretations about how productive the soils are for various crops and about how well the soils would function as a site for buildings. The information can be displayed in tables and, in many cases, on maps.

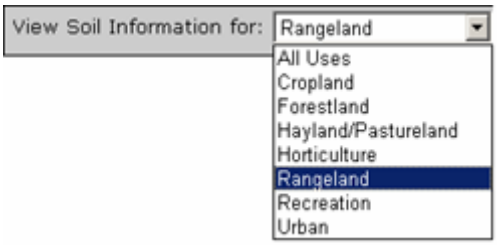


Click on the Soil Data Explorer tab to bring up the Explorer window.

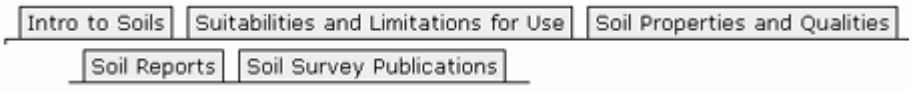


Finding relevant information

You can view soil information about a specific use, such as cropland, forestland, rangeland, urban development, and so forth, by selecting the use from the drop-down list on the button bar.

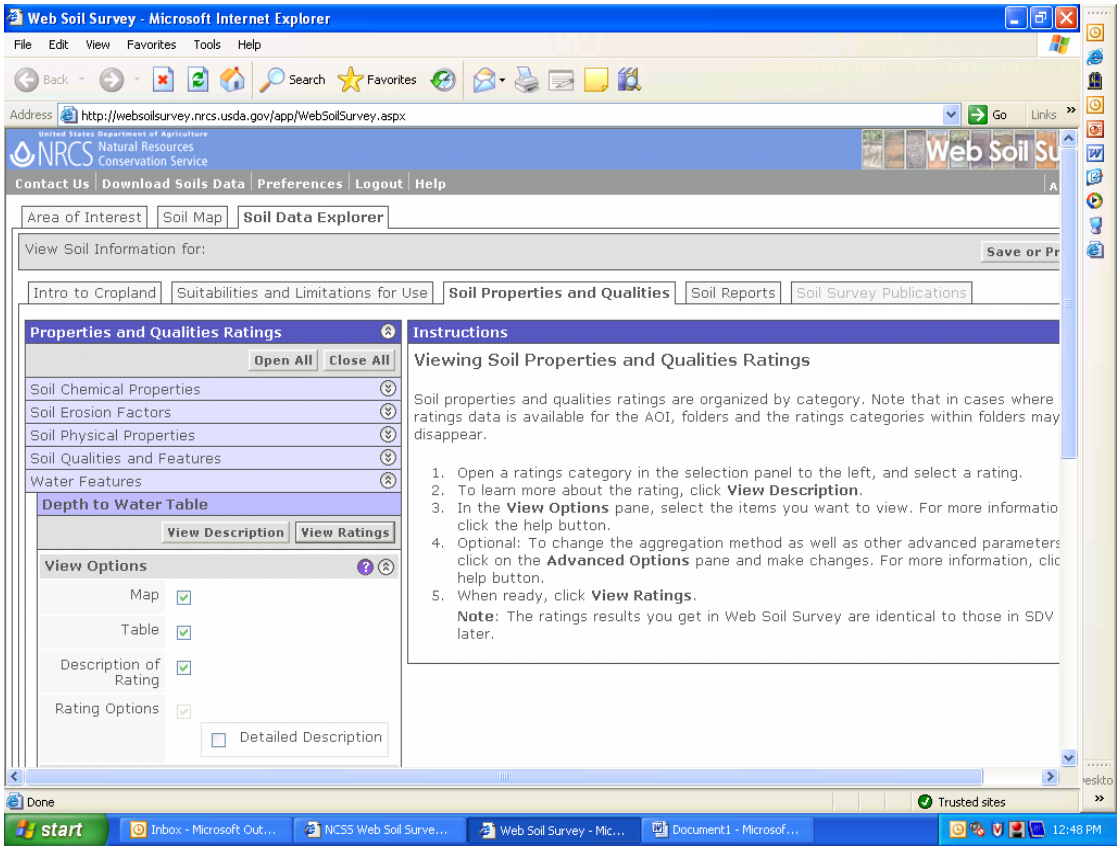


To get a particular type of soil information, use the Soil Data Explorer's inner tabs:

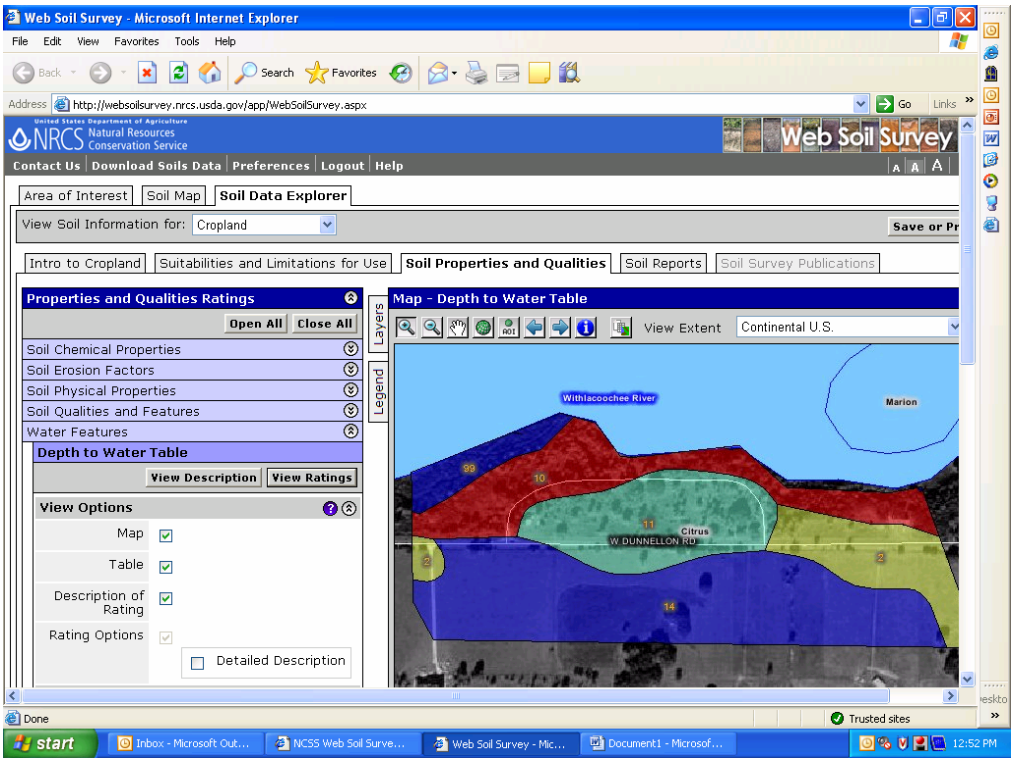


Depending on the use that you select in the drop-down list, the tabs and the contents of the tabs will change.

For example, click on the Soil Properties and Qualities tab.

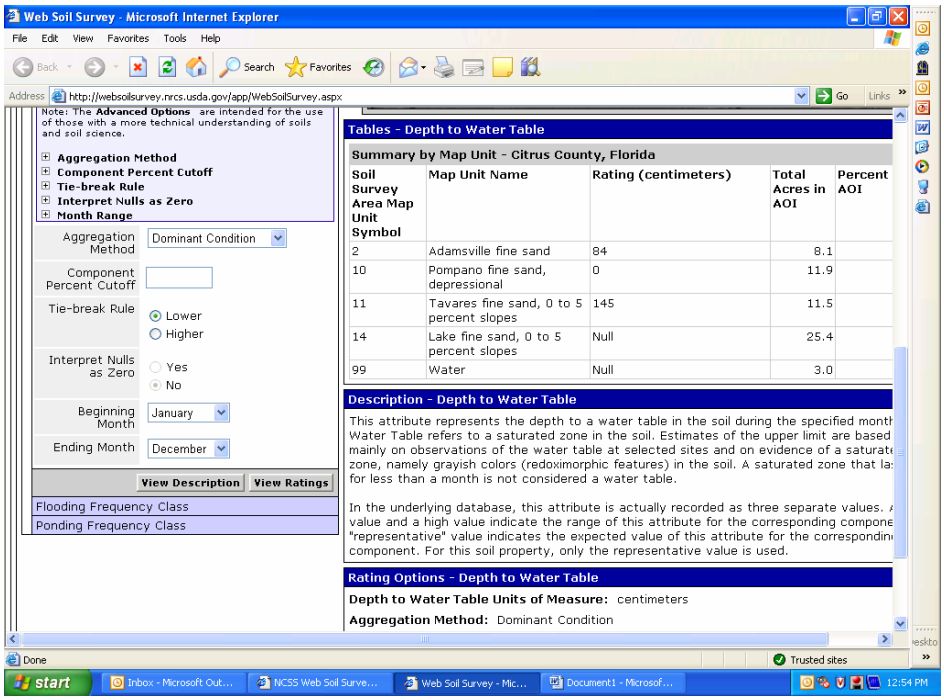


By clicking on Water Features, then Depth to Water Table and View Ratings, you can view the depth to the top of the seasonal high water table based on actual tabular data. An example from northern Citrus County, FL illustrates the water table depths near the Withalacoochee River, the actual depth to the top of the water table, total acres within your AOI, and the percent of the AOI with that rating.



The Legend tab on the left side of the map provides the Map Legend, including the soil ratings (in centimeters) and other map features.

As you scroll down the screen, you'll see the attribute table that illustrates the actual depth to the top of the water table for each map unit in your AOI, the total acres within your AOI, and the percent of the AOI with that rating.



Other choices for thematic maps for Suitabilities and Limitations include Building Site Development for Shallow Excavations or Commercial Buildings, Cropland Productivity, Forestland Management, Hydric Soils Rating, Land Capability Classification, among others. For Soil Properties and Qualities, Chemical attributes such as, Cation Exchange Capacity, pH, Calcium Carbonate Equivalent, OR Physical Properties, such as Available Water Capacity, Organic Matter, Saturated Hydraulic Conductivity, Percent Sand, Silt, and Clay among others can be displayed thematically.

All maps can be printed locally for use.

Printing or saving the information you want

In Web Soil Survey, you select information in the left column and view it in the right column. When you want to print or save the information in the right column, click the Save or Print button:

Closing the help window

Click the upside-down help button  on the above button bar to close a help window.

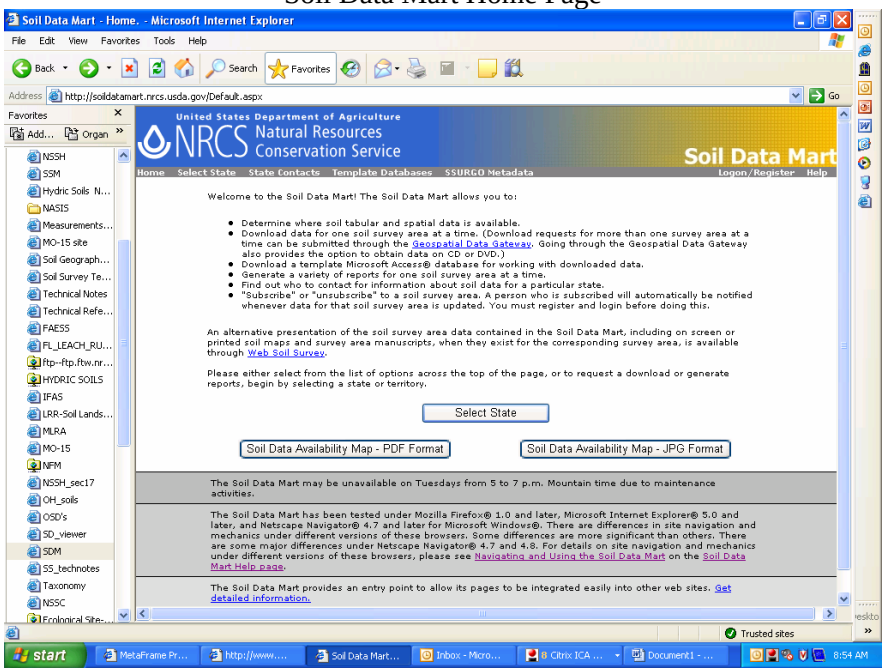
Exhibit FL2-2. Navigating and Using the Soil Data Mart

The Soil Data Mart allows one to generate and print reports or download data (spatial and/or tabular).

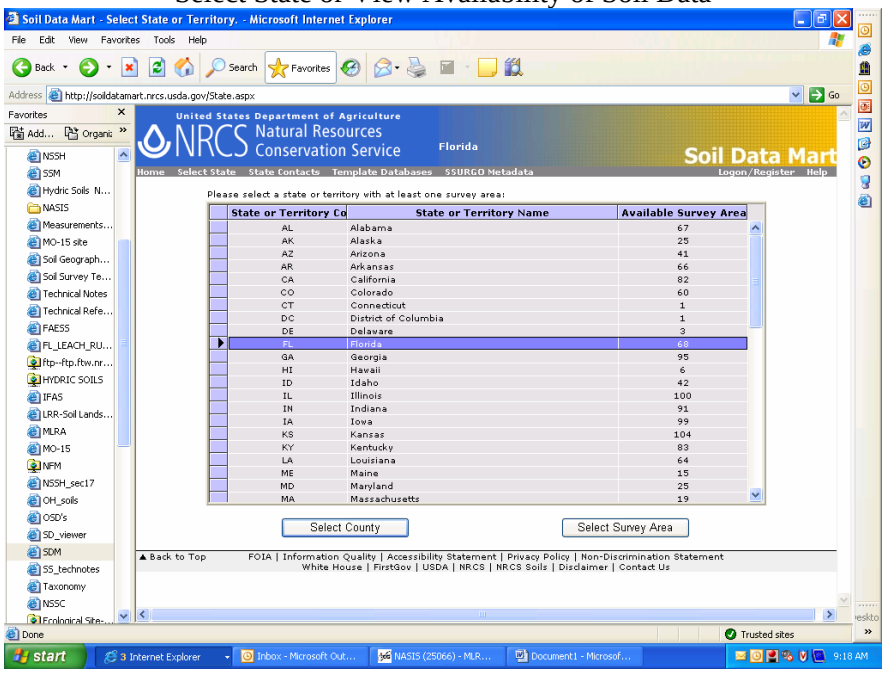
Accessing soil data mart: (ctrl + click link below)

http://soildatamart.nrcs.usda.gov

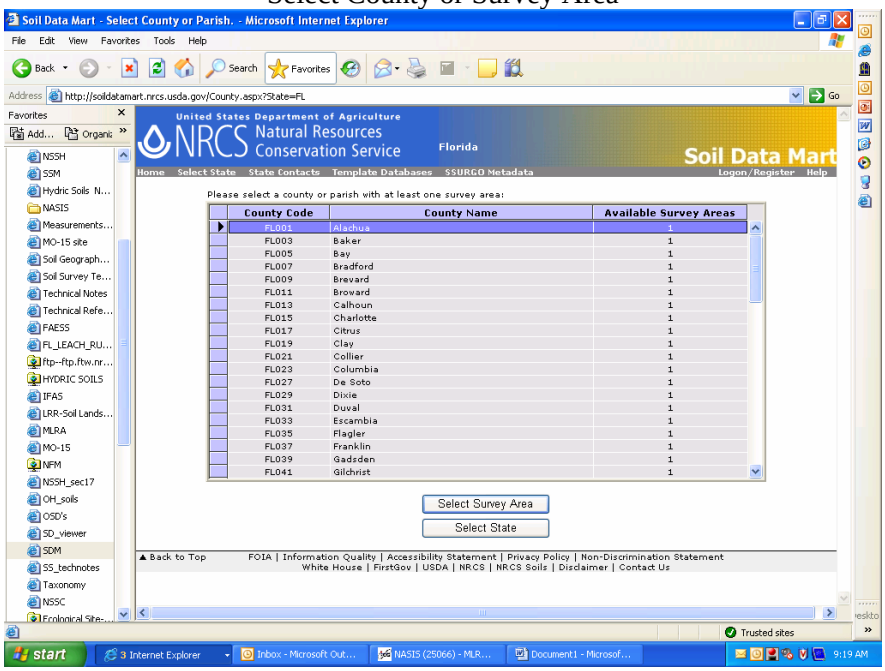
Soil Data Mart Home Page

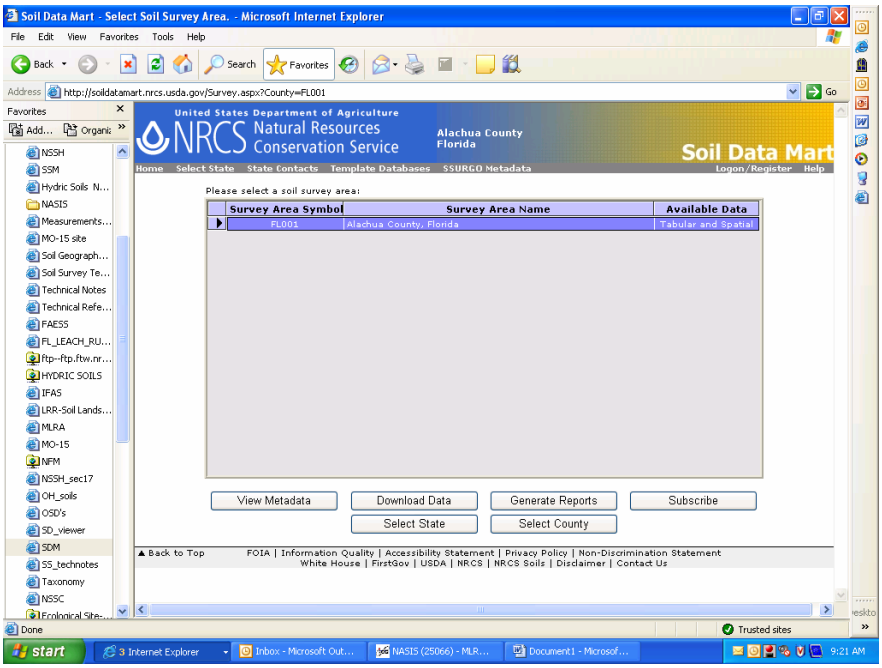


Select State or View Availability of Soil Data



Select County or Survey Area

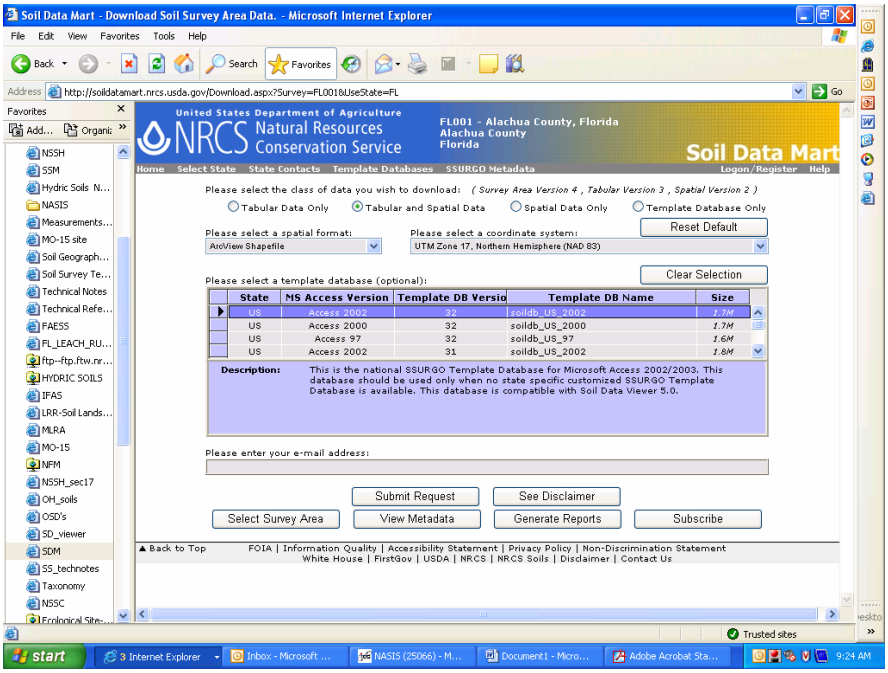




At this point, a decision is made as to download data directly or to generate and review specific soil reports. Other functions include viewing metadata or to add an email address to the County's subscription list to be notified when the data is updated.

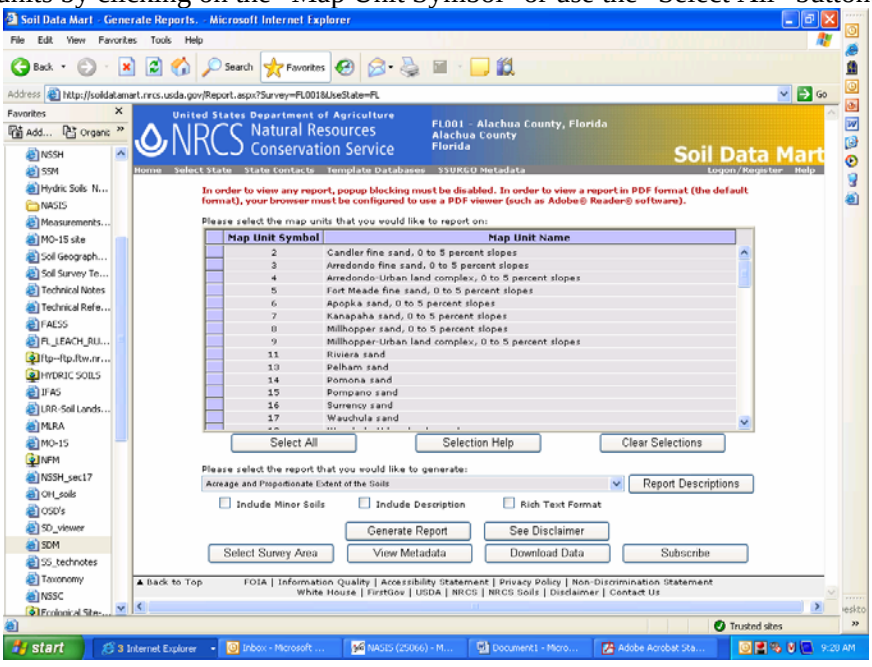
Downloading data

Either spatial or tabular data can be downloaded by selecting the specific data type. Spatial data can be downloaded by format type and coordinate system. Tabular data is downloaded and then viewed using Microsoft Access. Individuals may select the most applicable version for their computer. Enter an email address and submit a request. Notification will be received depending on one's location within the queue nationwide.

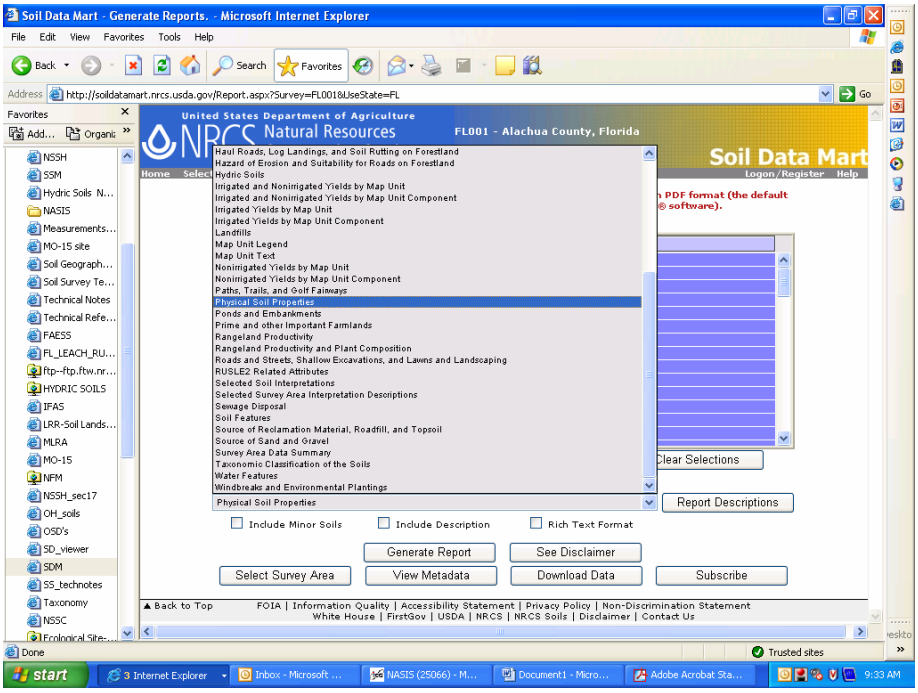


Generating Reports

To generate reports, determine which map units or all map units that you want a report for. Either select individual map units by clicking on the "Map Unit Symbol" or use the "Select All" button.



Then, using the drop down list, choose the report to view. For example, view the Saturated Hydraulic Conductivity (kSat) data for all map units in Alachua County. Select “Alachua County, Florida”, then select “All Map Units”, navigate to “Generate Reports”, and finally choose “Physical Properties Report”.



Click Generate Report and Physical Properties Report opens in a new window.