COA 690 / 790 Introduction to GIS
Instructor: Wei Wu
4/10/2017
Due: 4/17/2017

Lab 9[1]

You need to complete three exercises in this lab.

Exercise 1 National Wetland Inventory (NWI) data and Table Manipulations

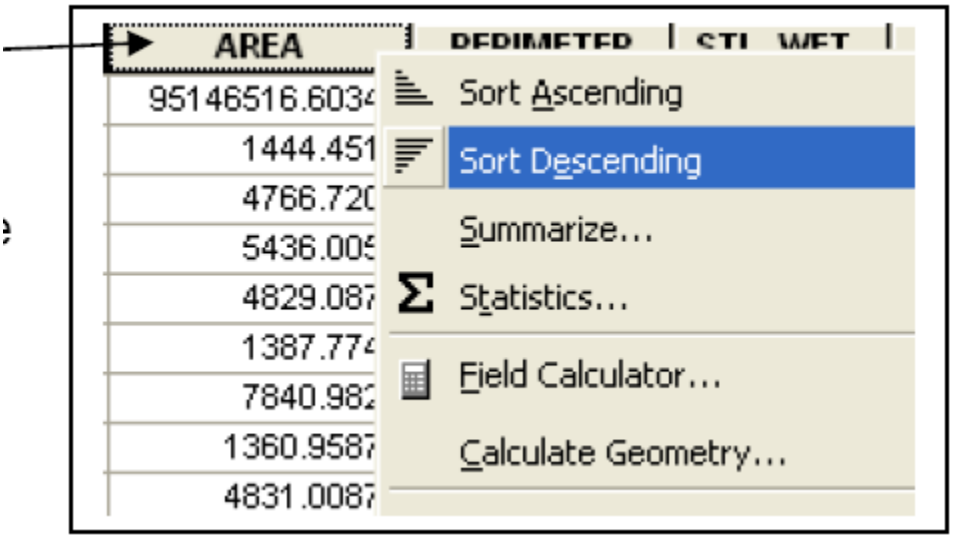
Open a new ArcMap project, and **Add** the data layer *Stil_wetU83.shp* (Wetland data for the Stillwater, Minnesota USGS 7.5 minute quadrangle) to a new, empty project.

Right click on the Stil_wetU83 layer in the table of contents.

Left click on **Open Attribute Table** in the dropdown menu.

You will see the attributes of the wetlands layer. The Field called "Area" displays the area of the polygon in square meters (m^2). The "Wet_type" field displays the type of wetland. Detail codes are attached to the lab.

Right click over the heading of the "Area" column and select **Sort Descending** (as shown below).

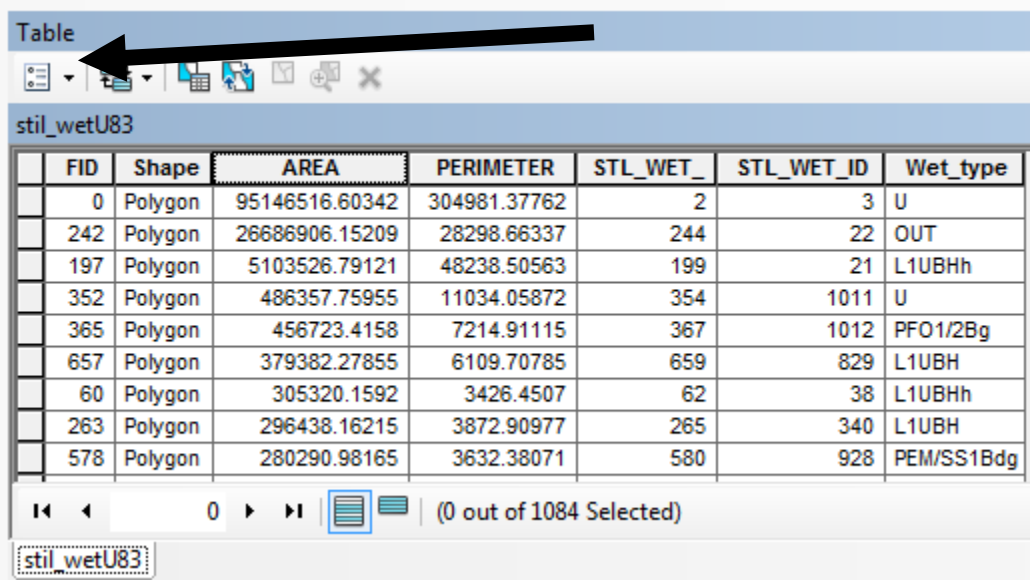


This brings the largest polygons to the top of the table. Notice that the largest areas are coded "U", for uplands, and "Out", area outside the mapping jurisdiction for these data, in this case, in Wisconsin.

[1] Revised based on the labs by Dr. Paul Bolstad

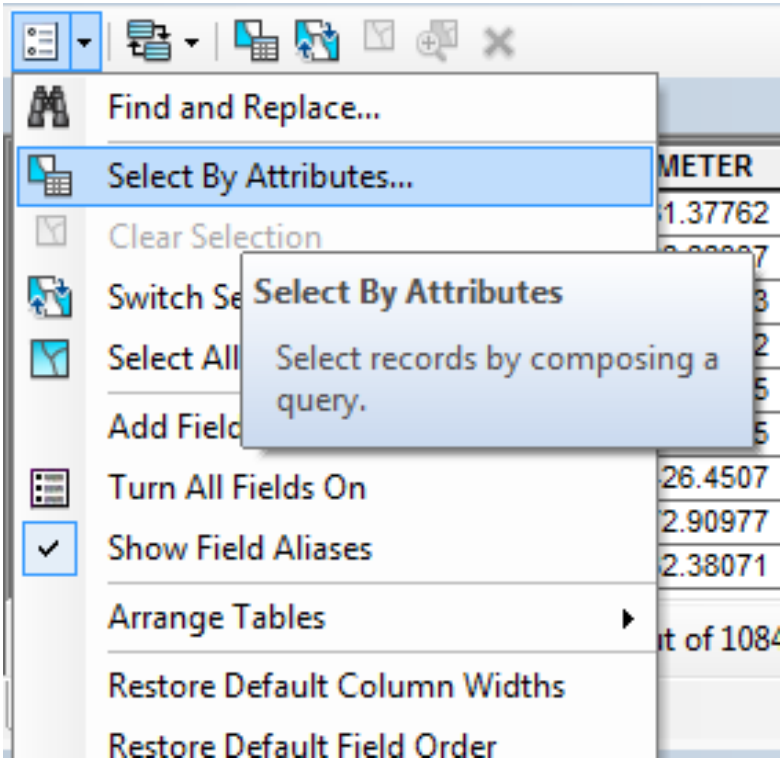
We will be classifying the polygons by their size, which is contained in the “Area” attribute.

Left click on the **Options** button in the top left corner of the data table window.



FID	Shape	AREA	PERIMETER	STL_WET_	STL_WET_ID	Wet_type
0	Polygon	95146516.60342	304981.37762	2	3	U
242	Polygon	26686906.15209	28298.66337	244	22	OUT
197	Polygon	5103526.79121	48238.50563	199	21	L1UBHh
352	Polygon	486357.75955	11034.05872	354	1011	U
365	Polygon	456723.4158	7214.91115	367	1012	PFO1/2Bg
657	Polygon	379382.27855	6109.70785	659	829	L1UBH
60	Polygon	305320.1592	3426.4507	62	38	L1UBHh
263	Polygon	296438.16215	3872.90977	265	340	L1UBH
578	Polygon	280290.98165	3632.38071	580	928	PEM/SS1Bdg

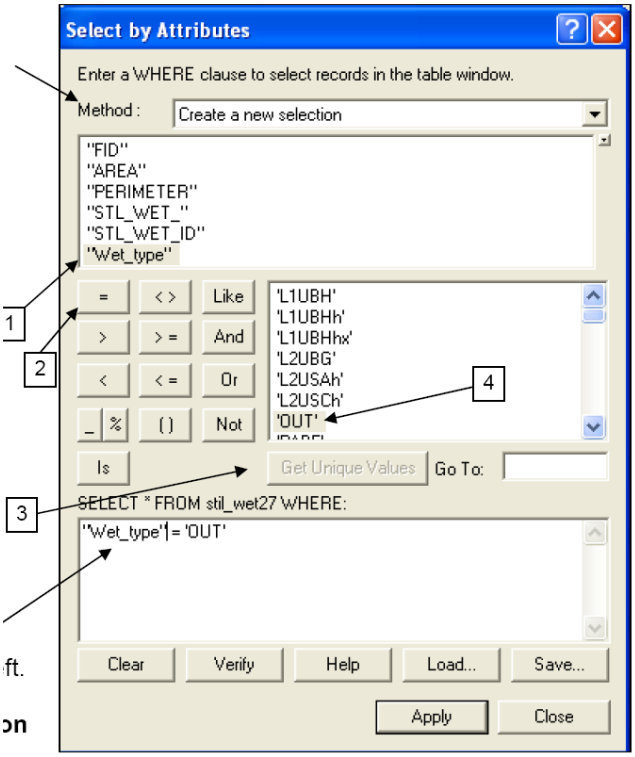
Then left click on **Select By Attributes** in the dropdown menu.



This opens a query builder. You select a Method at the top (use Create a new selection). You use the items listed in the second pane with the operation buttons listed below it to build an expression in the bottom pane.

This expression is applied to the data table to select features.

In the Select by Attributes box, 1) double click on the “Wet_type” field, 2) single click on the = button, 3) single click on the “Get unique Values” button, and 4) scroll to and double click on the “Out” value. Your selection expression should appear as shown to the below.



Remember to use the buttons on the menu to compose the selection expression, e.g., the “Wet_type” = Out”. Typing in a selection via the keyboard is possible, but it is easy to make mistakes in the syntax.

Click **Apply**. This selects all the records in the file that have the “Out” code.

Next click on the **Options** button again (in the top left) and select “Add Field”. This will add a new empty field (column) to you file. Name the field “Size”, select the Type as “Text” and change the Length to 10. Left click on **OK**.

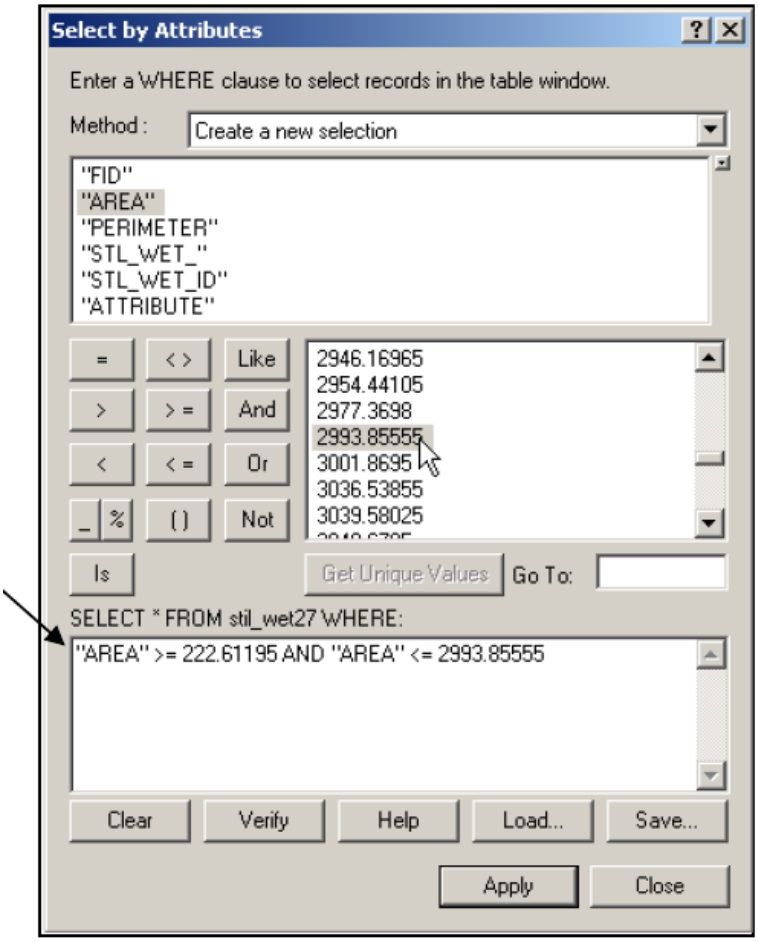
Now right click on the column heading of the “Size” field and Select **Field Calculator**. This will allow you to change the selected values in the “Size” field (column).

Answer “Yes” to the question about calculating values outside an edit session.

In the **Field Calculator**, there is an entry window for expressions in the bottom half, which should have Size= above the entry area. Type “Wisconsin”, with quotes into the window. Left click on **OK.**

Now sort the file by the item Area: Right click on the “Area” column heading in the wetlands attribute table, and left click on **Sort Ascending**.

Left click on the **Options** button again (in the top left), then Select by Attribute. Build the query to select the areas between 222.61195 and 2993.85555, inclusive, as shown in the bottom panel at below.



Left click on **Apply**.

Again, open the **Field Calculator** by right clicking on the “Size” column, and change the “Size” values for the selected records to “Small”.

Do the same steps as above for the "AREA" >= 3001.8695 AND "AREA" <= 9969.29615, use the **Field Calculator** to assign a value of “Medium” to the item Size.

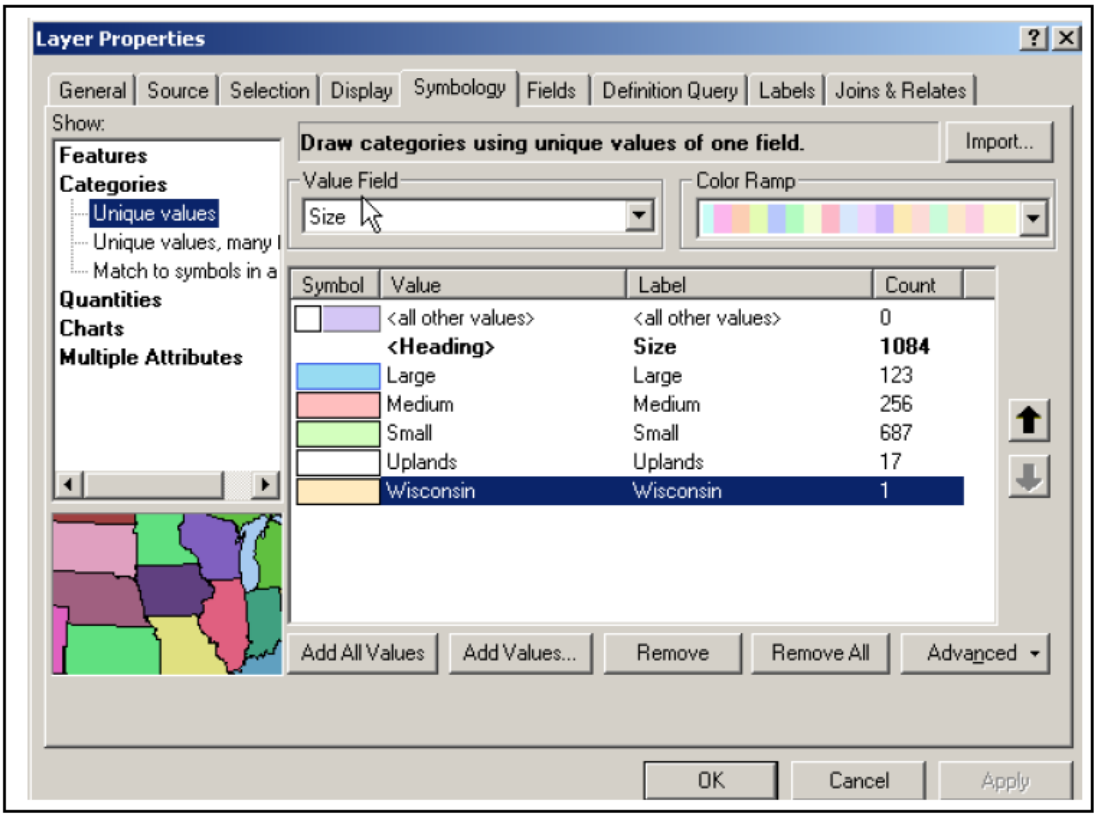
Repeat the process for "AREA" >= 10076.1794 AND "AREA" <= 5103526.79121 OR "AREA" = 95146516.60342. Assign a value of “Large” to the size item for these selected records.

Finally, with the data table still open, select **Options -> Select by Attributes**, select the Wet_type = “U**”** and use the **Field Calculator** to change that record’s value in the Size field to “Uplands”.

Clear Selected Features (on the main ArcMap menu, under Selection).

Close the Table.

Open the **Properties - Symbology** of the stil_wetU83 layer and left click in the Show box to display: **Categories** ->**Unique values**. Change the Value Field to Size. Click on the **Add All Values** button and the then **Apply** and **OK**.



Create Map 1
Create a map to display the modified wetlands data layer with the major components of maps.

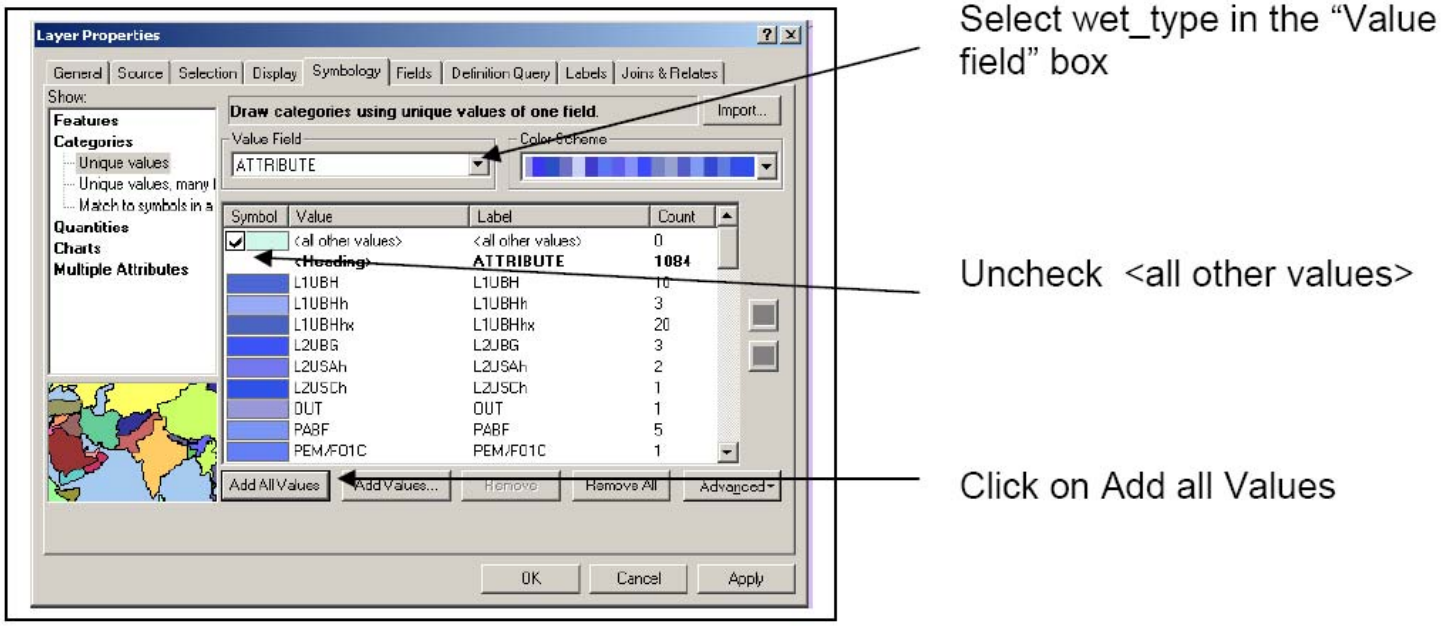
Wetlands Tables
We’ll now assign a new column to identify general wetland types.

Right click on *Stil_wetU83*, and left click on **Open Attribute Table**.

The field, or item, named “Wet_type” contains the wetland classification used by the US Fish and Wildlife Service. A complete list is found at the end of this lab exercise.

Close the table.

Open the **Properties** > **Symbology** tab for the wetlands data. Select **Categories –> Unique values** for the symbology type in the box on the left labeled “Show”, then select wet_type in the “Value field” box. Once you have the proper expression, left click Apply.



This is too many categories. From the zoom tool bar, left click on the identify cursor.

A left click on a polygon will display a popup list of polygon attributes. Examine a few polygons. The item Wet_type specifies the wetland class, as shown by the code table at the end of the exercise.

For simplicity, we will aggregate wetland classes to a few main categories. Readers can only distinguish a limited number of colors or shades on a map. We will reclassify the detailed classes into five groups, aggregating the detailed wetland types into their “parent” categories.

Note that there are several numbers and letters together in a string in the wetland type column, e.g., L1UBHh. These give the wetland System-Subsystem-Class-Subclass and any modifiers, as described in the key at the back of this lab.

The first letter is for the system (L=Lacustrine, P=Palustrine, etc.), the second is for the subsystem (defined for each system), the third is for Class, etc. Your job is to add a system/subsystem column, with appropriate designators for each record. There are many ways to do this; we'll do this by modifying the tables. Could you think of another way to do this?
The basic steps are 1) add a new item (also called a new field or column), 2) select the appropriate records, and 3) assign appropriate values to the new item for these selected records, 4) repeat steps 2 and 3 until all records are processed.

First, we'll add an item.

Open the attribute table and select the Options button in the lower right of the window, then left click on Add Field.

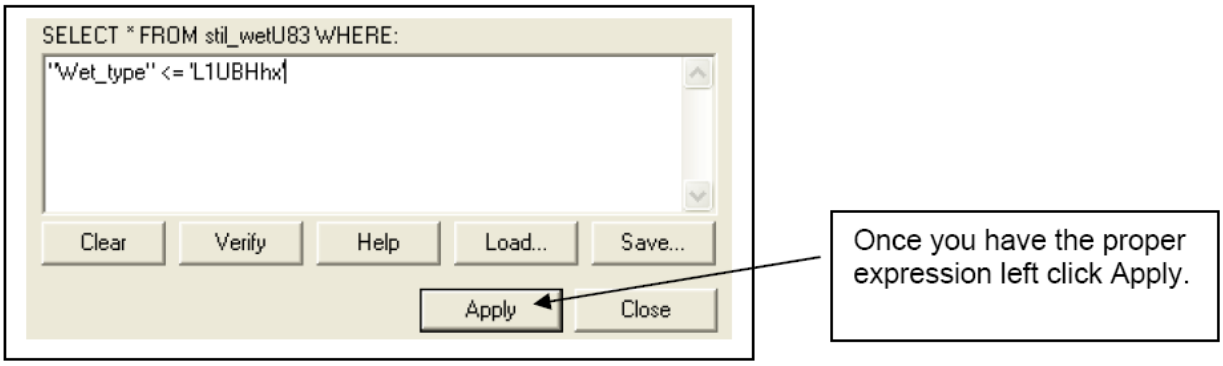
Add a field with a name you can remember, something like "reclassed". Make sure your new field has a "Text" type. Otherwise you will be restricted to only using numbers in your new field. Narrow the columns or expand the window to the right and look at your new field.

Left click on **Editor** in the Edit Toolbar, then **Start Editing**.

Left click on **Options** in the top left of the table window

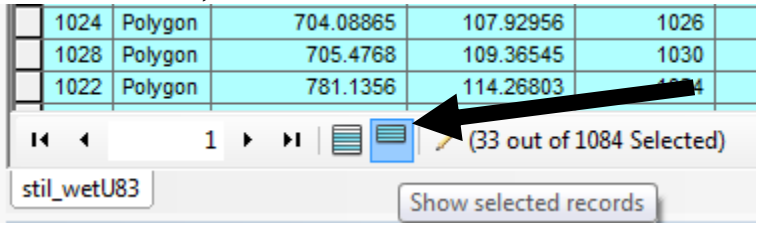
Left click on **Select by Attribute.**

Now we need to select the records to edit. You build a series of expression from the variables and operators shown in the "Select by Attributes window" shown above. Note that you'll always want to **double click** on the Fields and Values (e.g. reclassed and L1UBHhx) you enter in a formula, but only **single click** on the operators(<, =, etc.). In this way you build the expression to select all string values of attribute which meet your criteria. The < , <= or >= operators work in that the string values are ranked in alphabetical order, as an ordinal ranking, with uppercase listed before lower case. The expression in the example below selects all the polygons in the system/subsystem L1.



If you don't have a correct expression, a syntax error window may pop up. If so, clear the expression and try again.

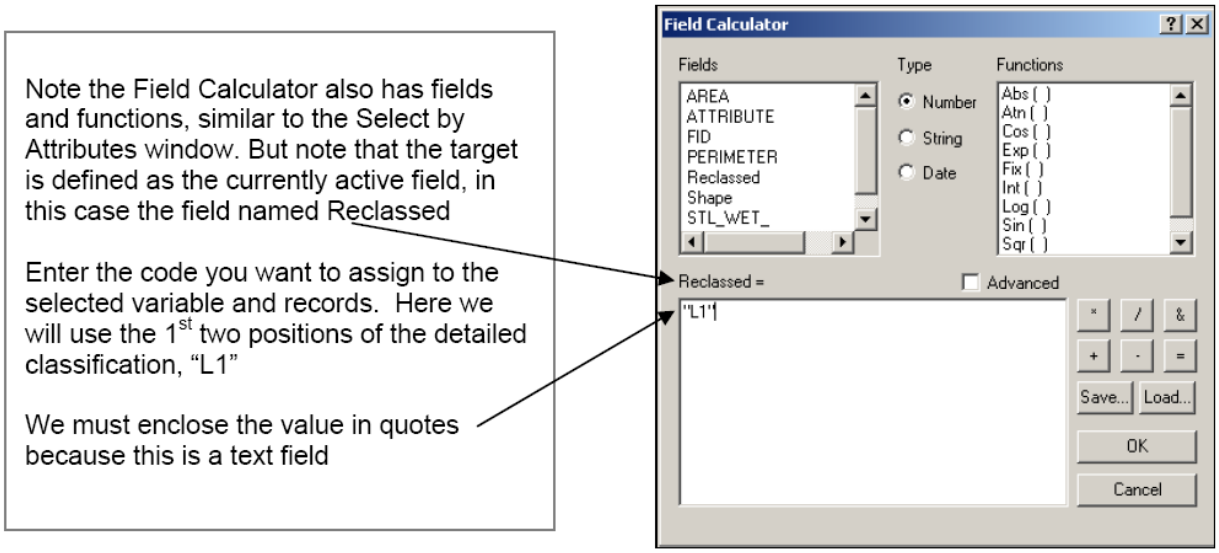
To convince yourself that this operation selected the records you want, click on the **Selected** button, found near the bottom-center of the Table window.



Clicking on the selected button displays only the selected records. Verify your selection only contains records beginning with L1.

Then, revert back to **Show All** records by clicking the button on the left of the **Selected** button.

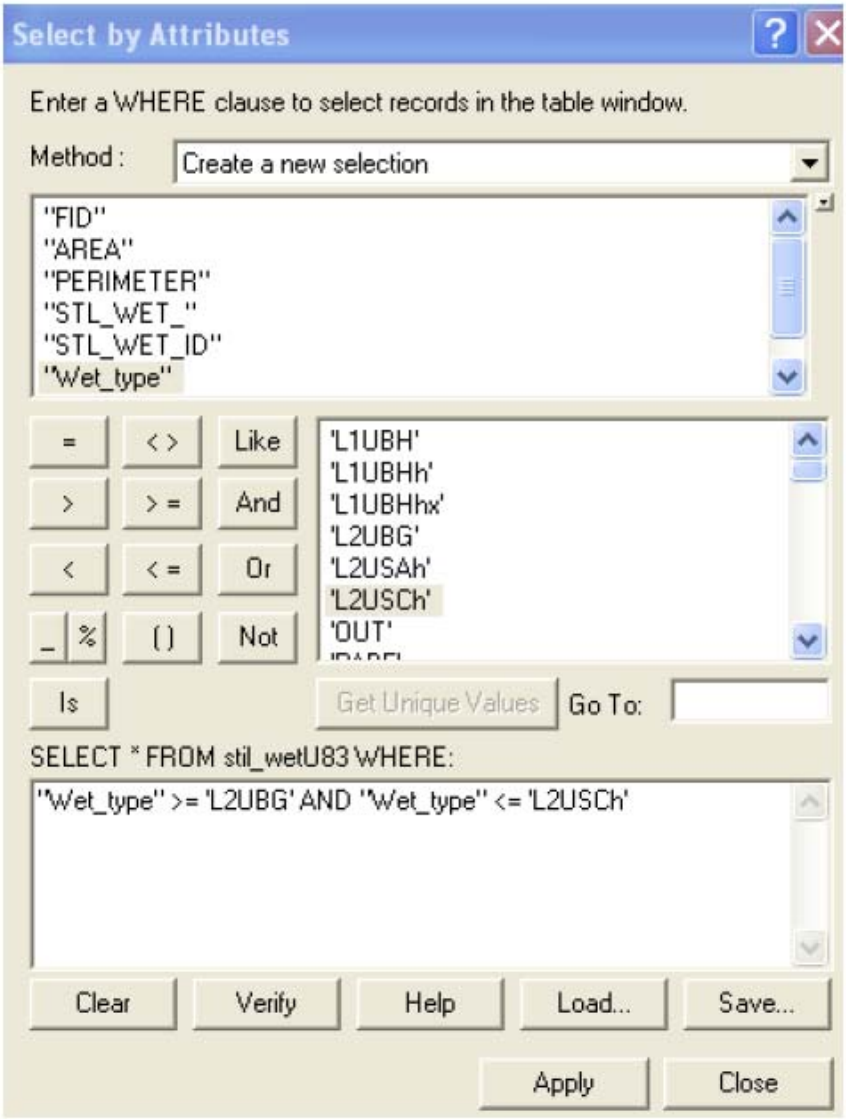
Right click on the "Reclassed" column, and left click on the **Field Calculator** in the dropdown menu.



Click OK. If records are selected, the assignment only occurs for these selected records. Verify that “L1” appears for only the selected records.

Now repeat the process for the next group of items (those with “Wet_type” fields starting with “L2”). This is a bit trickier because it is a compound selection, so we’ll have to use the “And” operation in building our formula.

The example for “L2” is shown in the figure below:



Assign the value “L2” to the Reclassed field, using **Field Calculator** as described above.

Repeat this selection/assignment until Reclassed values have been assigned for each record (five categories, L1, L2, P, U, and OUT). Save occasionally with **Editor- Save Edits**. When you are done, select **Editor -> Stop Editing**, save edits at the end.

Next change your legend display item (**Properties > Symbology**) to your new Reclassed field.

Finally, change the legend symbols used for the Reclassed field to colors and patterns that will display nicely.

Map 2
Produce a map of the wetland data. Use your system/subsystem categories for the legend. Color the upland (U) and OUT polygons white and the others as appropriate to distinguish among them. Remember to include a scale bar (coverage units are meters), North arrow, name, title, description, legend, and a descriptive name to the legend heading.

Reminder: You need to generate two maps from this exercise.

Exercise 2 Creating New Tables

Creating a table and joining it to existing tables is a common operation in GIS analyses. Often, this join involves a many-to-one relationship between tables. Each record in one table matches many records in the second table. For example, a typical county may have approximately 80 different soil types, but over 100,000 different soil polygons of these types. Therefore, we may have properties for each of the 80 different types, e.g., crop productivity, engineering properties, moisture characteristics. We may format these in a table, and join this table to our existing county data layer. The repeated properties aren't copied, just displayed for the appropriate polygon. This saves space, because we don't have redundant copies of the soil properties information saved for each instance of a soil polygon in our data layer.

This exercise will give you practice in creating and joining tables and the other techniques you learned in the lecture.

Create a new Map with a Blank Document.

Add the Soils.shp data layer, set the **Layer Properties – Symbology** to Categories, Unique-Values based on the item soil_type.

Add All Values

Uncheck the "all other values", *(to avoid the extra "all other values" appearing in the legend).*

Select a Color Ramp that you like, then left click **Apply** and **OK**.

Open the soils.shp attribute table. Review the layer attributes, and in particular notice the soil_type attribute. The soil_type attribute contains a code corresponding to the soil type of each individual polygon. Notice there are 15 different soil types designated by numbers between 18 and 69. There are 122 different soil polygons. Our job is to create a new table, enter important information for each of the 15 different soil types, and join this data with the soils data layer.

We need to select join columns in our target and source (new data) data files.

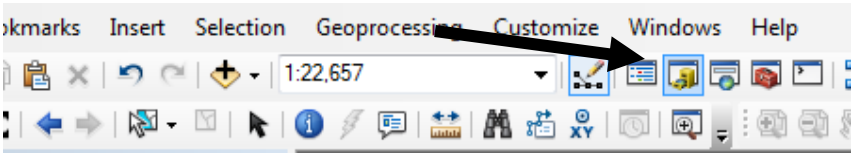
In this exercise you will use the "soil_type" variable in the soils shapefile as the join item, or join column. This is the "index" or "key" variable that will be used to match the rows from the new soil properties table you will create to the soil polygon data in soils.shp. The join item must be similarly defined in both tables, with the same type (long or short integer, text, etc.)

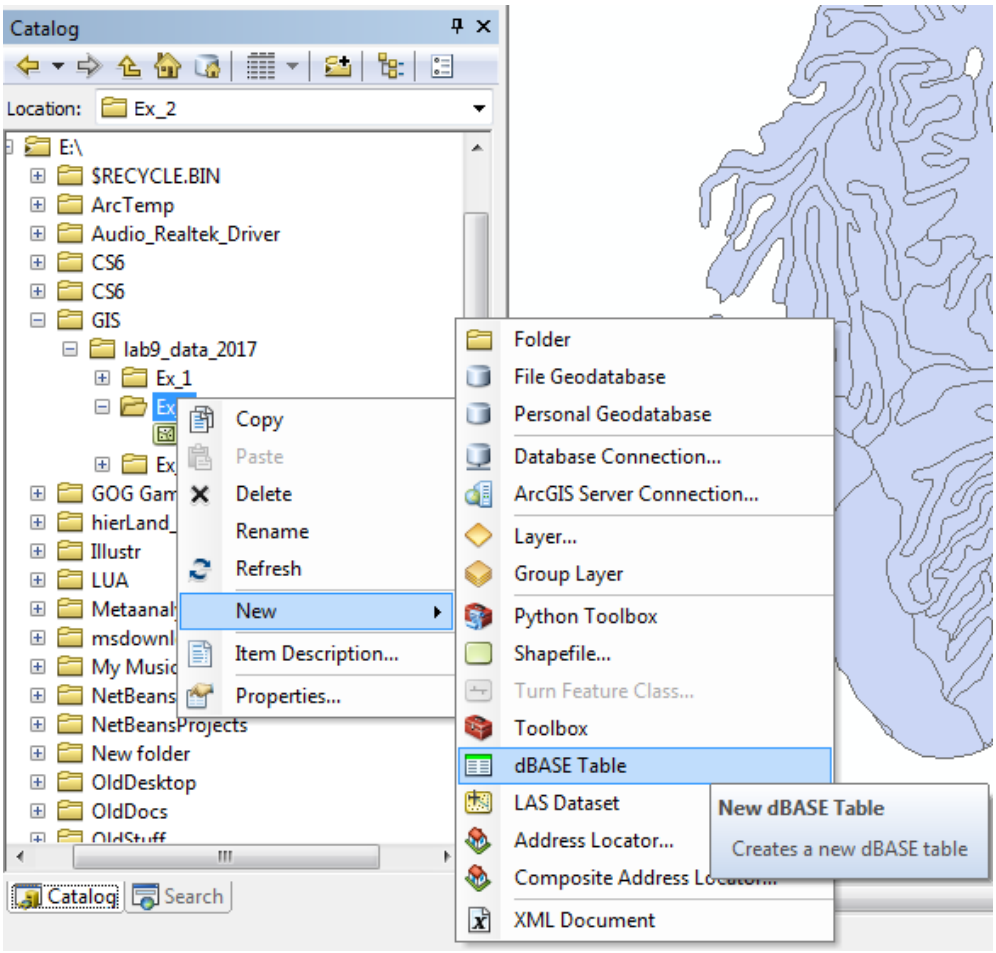
Let's examine the identified join column in the target table. Do this by navigating to the window pane in ArcMap in which you have the soils.shp data, and:

Right click on soils.shp file, then left clicking on Properties -> Fields tab. Note the type, length, and other properties of the soil_type item.

Now we need to create the new data table we'll be joining to soils.shp.

From the main menu bar in ArcMap, left click on the Arc Catalog icon and create a new dbase table a named soilprops.dbf and save it in your Ex_2 directory. (You may need to rename it.)





Double click on soilprops.dbf to open the dbase Table Properties window.

Click on the Fields tab

Click on an empty field (start below the row Field1) and enter the field names; click on the column labeled “Data Type” in the same row to specify a data type.

Create the following fields:

soil_type, long integer
name, text, length of 20
fert_class, double, 10 and 0
drain_cls, double, 10, and 0

You can delete the example field called Field1 only after you have entered new fields and saved the file (Data Management -> Fields in ArcToolbox). Do not delete or alter the OID field. After the field is created by the Apply button you cannot edit the field name, you must delete the field and try again; in short- you cannot change existing field names.

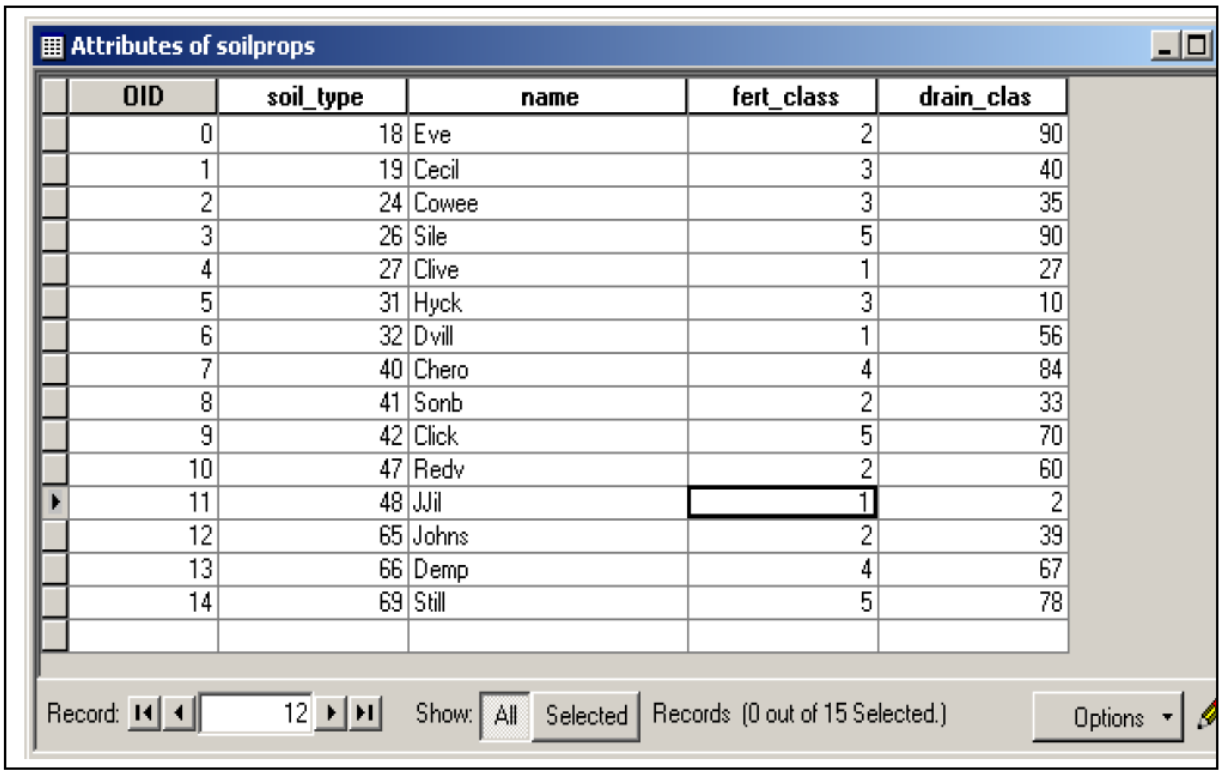
Click Apply and OK to finish. Close ArcCatalog.

In ArcMap, Start Editing.

Add the soilprops table, Right click and Open the table and, enter the values as shown in the figure.

Note that you simply type in the appropriate columns, and a new row is automatically added at the end of the table.

Ignore the OID Field, values will be generated as you add data, they may be different from the figure below. These automatically generated values won't affect your work here.



OID	soil_type	name	fert_class	drain_clas
0	18	Eve	2	90
1	19	Cecil	3	40
2	24	Cowee	3	35
3	26	Sile	5	90
4	27	Clive	1	27
5	31	Hyck	3	10
6	32	Dvill	1	56
7	40	Chero	4	84
8	41	Sonb	2	33
9	42	Click	5	70
10	47	Redv	2	60
11	48	JJil	1	2
12	65	Johns	2	39
13	66	Demp	4	67
14	69	Still	5	78

When you are done entering data, Save and Stop Editing.

With the Attributes of soilprops open, Select **Options** (top left) and Add the Table to the Layout. You need to narrow the columns for the whole table, then **Print** your completed table **(Table 1**).

You can remove the soilprops table from your project., but it's better to keep it in the project for easy joining.

Select the soils layer and join it to the soilprops table. Remember to use the common field soil_type, to join the files.

After you've completed the join, **create map (Map 3)** using the new soils table. We wish to map soils by fertility class.

Recolor the map with a different shade for each of the five fertility classes.

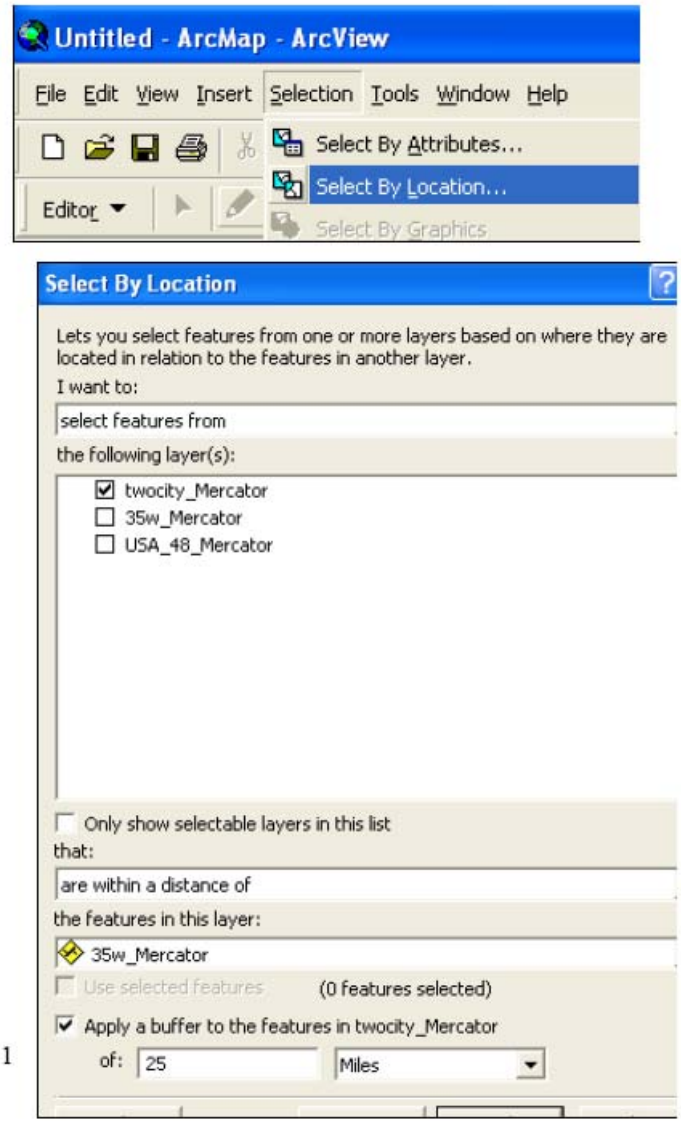
Reminder: You need to print one table and one map in this exercise.

Exercise 3 Select by Proximity and Adjacency
Work in GIS often involves analyzing the locations of features in relation to other features. Two typical types of feature relationships are **proximity** (how close or far apart the features are) and **adjacency** (features that share the same boundary).

Finding points near lines
Open a new data frame, and add the data

-Twocity_Mercator.shp,
-35W_Mercator.shp,
-USA_48_Mercator.shp.

Choose Selection -> Select by Location from the main menu (see figure).



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Specify to:
- select features from
"twocity_Mercator"
-that are within a distance of
"35w_Mercator"
and
- Apply a buffer….of:
25 Miles

Then click Apply and OK

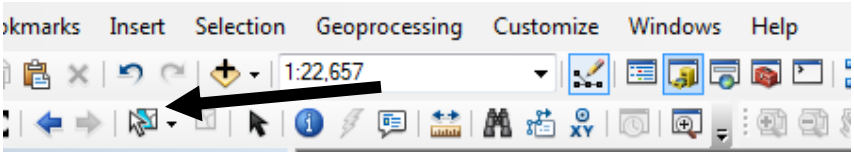
On the Map, the point that represents the city of Minneapolis should be blue, which means it has been selected**.**

We often use this type of operation prior to some other analyses. For example, we may wish to locate a shipping center near a major highway. We could select all the cities less than 25 miles from a highway, and save the selected cities to a new layer for further analyses.

Finding features that intersect other features
Now, we will find all states (polygons) that are intersected by 35W (a line).
First, clear the previously selected features by
Selection -> Clear Selected Features
Select by Location (as above), with
- the "from layer" as USA_48_Mercator
- the "Intersects with" the 35W layer
- an unchecked Buffer box,
- then **Apply** and **OK**
The six polygons representing states that intersect the 35W line should be selected.

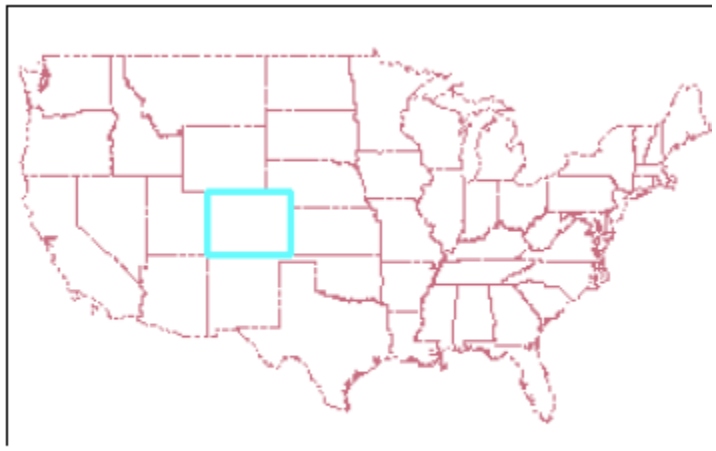
Select by Adjacency
Now we'll select polygons that are adjacent to a selected set of polygons, in this case, all states that share a boundary with a selected set of states.

First, **Clear Selected Features** (as described above)
Activate the manual selection cursor, and click on a state.



You may click and drag to select an adjacent group of states, or you may click and release, then hold the shift key and click on a number of additional states to add to the selected set of states.

For now, just select one state. For the example below, I selected Colorado, a rectangular state in approximately the middle of the USA.



Target feature, Colorado Ac

Then,
left click on **Select -> Select by Location**
In the resulting window, specify:
- I want to: select features from
- in “the following layer(s)” click the checkbox for USA_48_Mercator
- that: touch the boundary of
-the features in the layer USA_48_Mercator
Make sure to leave the checkbox for Apply a buffer to ….. unchecked
-click on **Apply**

You need to print the US map with adjacent selected set of features highlighted like the map shown above. Do not forget the major components of maps.

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

Wetlands codes are typically a string of characters, each corresponding to an attribute in a hierarchy. For example, a wetland might be labeled L1UBG, indicating it is a Lacustrine (System, see below), Limnetic (Subsystem), Unconsolidated Bottom(Class), which is intermittently exposed (modifier G in L1UBG, see modifiers at end of this list). There are at least two shortened designators which may appear on wetlands maps,

U = Uplands, and

OUT = out of the mapped area

Below is the hierarchy.

SYSTEM	SUBSYSTEM	CLASS	SUBCLASS
L=LACUSTRINE	1=LIMNETIC	RB=Rock Bottom	1=Bedrock
			2=Rubble
		UB=Unconsolidated Bottom	1=Cobble-Gravel
			2=Sand
			3=Mud
			4=Organic
		AB=Aquatic Bed	1=Algal
			2=Aquatic Moss
			3=Rooted Vascular
			4=Floating Vascular
			5=Unknown Submergent
			6=Unknown Surface
		OW=Open Water/Unknown Bottom	(used on older maps)
	2=LITTORAL	RB=Rock Bottom	1=Bedrock
			2=Rubble
		UB=Unconsolidated Bottom	1=Cobble-Gravel
			2=Sand
			3=Mud
			4=Organic
		AB=Aquatic Bed	1=Algal
			2=Aquatic Moss
			3=Rooted Vascular
			4=Floating Vascular
			5=Unknown Submergent
			6=Unknown Surface
		RS=Rocky Shore	1=Bedrock
			2=Rubble
		US=Unconsolidated Shore	1=Cobble-Gravel
			2=Sand
			3=Mud
			4=Organic
			5=Vegetated
		EM=Emergent	2=Nonpersistent
		OW=Open Water/Unknown Bottom	(used on older maps)

SYSTEM	SUBSYSTEM	CLASS	SUBCLASS
P=PALUSTRINE		RB=Rock Bottom	1=Bedrock 2=Rubble
		UB=Unconsolidated Bottom	1=Cobble-Gravel 2=Sand 3=Mud 4=Organic
		AB=Aquatic Bed	1=Algal 2=Aquatic Moss 3=Rooted Vascular 4=Floating Vascular 5=Unknown Submergent 6=Unknown Surface
		US=Unconsolidated Shore	1=Cobble-Gravel 2=Sand 3=Mud 4=Organic 5=Vegetated
		ML=Moss-Lichen	1=Moss 2=Lichen
		EM=Emergent	1=Persistent 2=Nonpersistent
		SS=Scrub-Shrub	1=Broad-Leaved Deciduous 2=Needle-Leaved Deciduous 3=Broad-Leaved Evergreen 4=Needle-Leaved Evergreen 5=Dead 6=Indeterminate Deciduous 7=Indeterminate Evergreen
		FO=Forested	1=Broad-Leaved Deciduous 2=Needle-Leaved Deciduous 3=Broad-Leaved Evergreen 4=Needle-Leaved Evergreen 5=Dead 6=Indeterminate Deciduous 7=Indeterminate Evergreen
		OW=Open Water/Unknown Bottom	(used on older maps)


SYSTEM
SUBSYSTEM
CLASS
SUBCLASS
R=RIVERINE
1=TIDAL
2=LOWER PERENNIAL
3=UPPER PERENNIAL
4=INTERMITTENT
5=UNKNOWN PERENNIAL (used on older maps)
RB=Rock Bottom
1=Bedrock
2=Rubble
UB=Unconsolidated Bottom
1=Cobble-Gravel
2=Sand
3=Mud
4=Organic
*SB=Streambed
1=Bedrock
2=Rubble
3=Cobble-Gravel
4=Sand
5=Mud
6=Organic
7=Vegetated
AB=Aquatic Bed
1=Algal
2=Aquatic Moss
3=Rooted Vascular
4=Floating Vascular
5=Unknown Submergent
6=Unknown Surface
RS=Rocky Shore
1=Bedrock
2=Rubble
US=Unconsolidated Shore
1=Cobble-Gravel
2=Sand
3=Mud
4=Organic
5=Vegetated
**EM=Emergent
2=Nonpersistent
OW=Open Water/Unknown Bottom (used on older maps)
*STREAMBED is limited to TIDAL and INTERMITTENT SUBSYSTEMS, and comprises the only CLASS in the INTERMITTENT SUBSYSTEM.
**EMERGENT is limited to TIDAL and LOWER PERENNIAL SUBSYSTEMS.


MODIFIERS
WATER REGIME
Non-Tidal
A=Temporarily Flooded
B=Saturated
C=Seasonally Flooded
D=Seasonally Flooded/Well Drained
E=Seasonally Flooded/Saturated
F=Semipermanently Flooded
G=Intermittently Exposed
H=Permanently Flooded
J=Intermittently Flooded
K=Artificially Flooded
W=Intermittently Flooded/Temporary (used on older maps)
Y=Saturated/Semipermanent/Seasonal (used on older maps)
Z=Intermittently Exposed/Permanent (used on older maps)
U=Unknown
Tidal
K=Artificially Flooded
L=Subtidal
M=Irregularly Exposed
N=Regularly Flooded
P=Irregularly Flooded
*S=Temporary-Tidal
*R=Seasonal-Tidal
*T=Semipermanent-Tidal
*V=Permanent-Tidal
U=Unknown
*These water regimes are only used in tidally influenced, freshwater systems.
WATER CHEMISTRY
Coastal Halinity
1=Hyperhaline
2=Euhaline
3=Mixohaline (Brackish)
4-Polyhaline
5=Mesohaline
6=Oligohaline
0=Fresh
Inland Salinity
7=Hypersaline
8=Eusaline
9=Mixosaline
0=Fresh
pH Modifiers for all Fresh Water
a=Acid
t=Circumneutral
i=Alkaline
SOIL
g=Organic
n=Mineral
SPECIAL MODIFIERS
b=Beaver
d=Partially Drained/Ditched
f=Farmed
h=Diked/Impounded
r=Artificial Substrate