Geospatial Technologies Division Student Training Manual

September 1998

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Geospatial Technologies Division
Student Training Manual

by

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Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report was prepared under Stategy 4.3.1, *Develop Data Management and Analysis Capabilities,* of the Operating Plan (USFWS 1993). This report was developed with funding provided by the Long Term Resource Monitoring Program.

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by

Lynne DeHaan

Abstract

This manual provides training for student interns in Geographic Information Systems (GIS). The manual provides an overview of GIS and uses standard operating procedures generated at the Environmental Management Technical Center (EMTC). Included are exercises for digitizing, editing, attributing, projecting, mapjoining, manipulating, analyzing, and displaying geographic data. Training with this manual allows students to receive hands-on experience with GIS to prepare them for projects at the EMTC.

Introduction

The purpose of this manual is to give students an overview of Geographic Information Systems (GIS) by using standard operating procedures specific to the Environmental Management Technical Center (EMTC). Along with this manual, the students will refer to two other sources: (1) *Understanding GIS: The ARC/INFO Method* (ESRI 1994) and (2) *Long Term Resource Monitoring Program Standard Operating Procedures: Production ARCEDIT Digitizing* (Arndt and Olsen 1994). Students will learn GIS concepts and techniques ranging from digital data entry to presenting analytical results in a map. This overview will provide students with the information needed to undertake projects at the EMTC and successfully complete those projects.

Viewing Project Data

Read pages 3-1 through 3-20 of the manual *Understanding GIS: The ARC/INFO Method* (ESRI 1994) before doing the following exercise.

After reading the introductory pages, copy over the project directory. Move to your workspace and create a directory called "ugis."

    sun% **mkdir ugis**

Change directories into ugis and copy the project directory at the sun% prompt.

    sun% **cd ugis**
    sun% **cp -r /net/suns02/usr2/esri/aidata72/ugis/data .**

The above path name may change with different versions of ARC/INFO. If it does not work, contact your supervisor.

The final period indicates that you will be giving the files the same name as found in their source directory.

Move to the subdirectory data located in the ugis directory.

    sun% **cd data**

Copy over the files needed for this exercise from the sun% prompt.

    sun% **cp /net/suns02/usr2/esri/aidata72/ugis/aml/projdb.* .**

Go into ARC and run the program to look at the LANDUSE coverage.

    sun% **arc**
    Arc: **&run projdb.aml 9999**

This opens an ARCPLOT session where you can display the LANDUSE coverage and list its attributes. To display the LANDUSE coverage, select the **DRAW** menu from the **PULLDOWN** menu and choose LANDUSE.
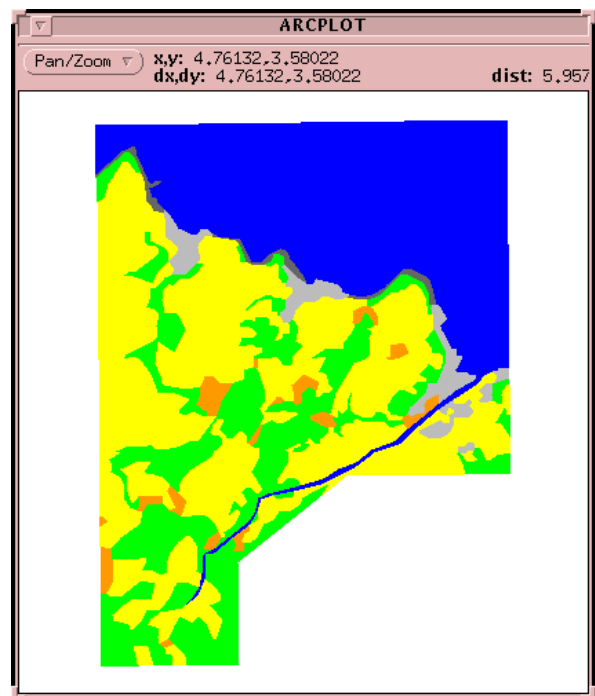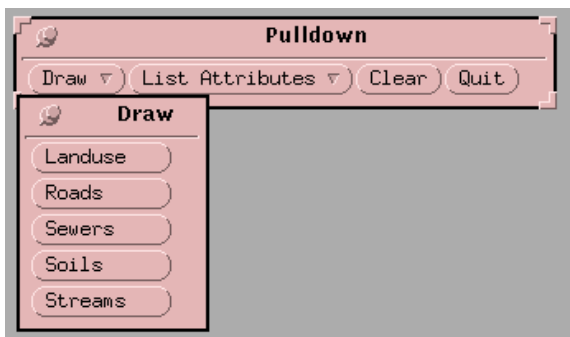
Notice on the display that the lower right-hand corner is missing. You will digitize this portion later.

To list the attributes for the LANDUSE coverage, select the **LIST ATTRIBUTES** menu and choose LANDUSE.

Click on the *QUIT* button in the lower right-hand corner of the menu to exit the display.

Quit out of ARC and move up one directory.

    Arc: **quit**
    sun% **cd ..**
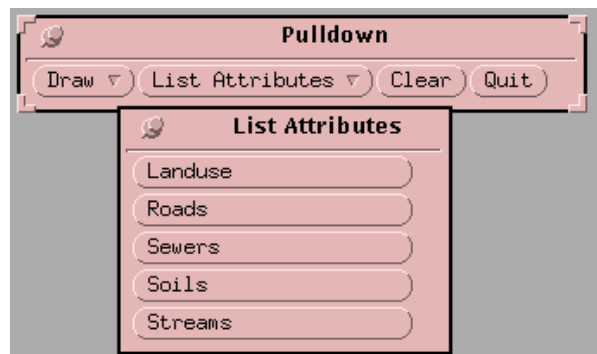
Digital Data Entry

The following exercises coincide with Chapter 4 in the *Understanding GIS* (ESRI 1994) manual. You will be using EMTC's Production ARCEDIT (PAE) Digitizing Standard Operating Procedure (SOP) for digitizing. However, you will adhere to the naming conventions used in the book.

Read pages 4-1 through 4-14 in the *Understanding GIS* (ESRI 1994) manual before you begin digitizing. When you complete the reading, create a new workspace at the same level as your data directory. The following commands create and move you to a workspace or directory named "land," where data you generate will be stored. Check and see what directory you are currently in. Make sure you are in the ugis directory.

    sun% **pwd**
    sun% **mkdir land**
    sun% **cd land**

The first coverage that you create will be called TICCOV. This coverage will only contain the tics that you register. You will not be digitizing line work into this coverage. You will be creating a new coverage called LANDDG01 from the coverage called TICCOV. LANDDG01 will be the coverage used for digitizing. This is done to demonstrate that a new coverage can be created from an existing coverage by using the tics and bounding (bnd) file from the existing coverage.

Creating the Tic Coverage

To begin creating the first coverage, TICCOV, refer to Appendix J in the PAE SOP provided. The tic IDS (22, 23, 24, 34, 33, 32) are located on the map provided. After entering the tics for the first time, refer to the **Map Registration** portion of the SOP located on page 2. When registering your tics, make sure the root mean square error is below 0.005. If you get a value above 0.005, try entering the tics again. If you unable to get the required value contact the supervisor. Save your work after registering the tics. To do this, choose **FILE** and then SAVE. Draw the tics and the tic IDS for the coverage TICCOV. Go into **DRAW** and choose **DRAW SETTINGS**. Under **DRAW SETTINGS** click on the box next to **Tics w/ids**. Then click on *DRAW*. The tics with the IDS should be displayed.

Creating the Digitizing Coverage

After registration is complete with an acceptable error and the tics are saved, you will create a new coverage for digitizing. Quit PAE using the **EXIT** menu with the EXIT PAE SYSTEM option. At the ARC: prompt you will create a coverage for
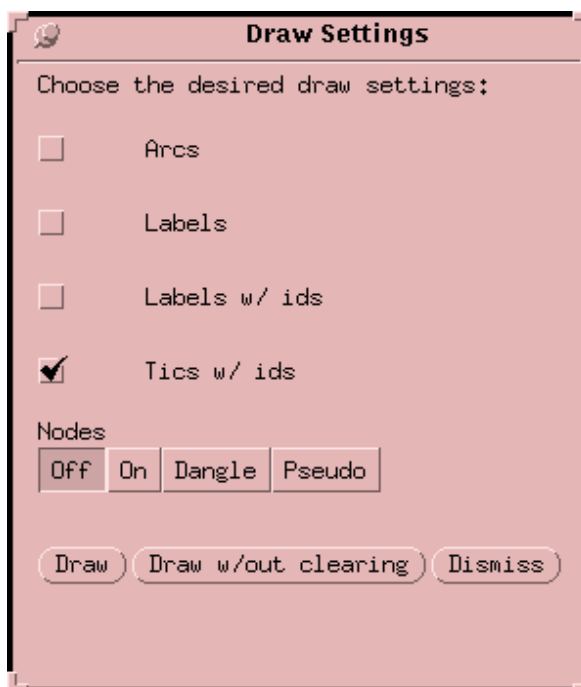
digitizing from an existing coverage. Look at the usage for the **CREATE** command.

> Arc: **usage create**
> *Usage: create <out_cover> {tic_bnd_cover}*
> Arc: **create landdg01 ticcov**

TICCOV is the coverage you created tics for. With the **CREATE** command you copied the tics and bnd file from the original coverage TICCOV to the new coverage LANDDG01.

Digitizing and Verifying

To digitize the coverage LANDDG01 start PAE and begin on page 3 of the PAE SOP, **Digitizing with PAE**. Under the **COVERAGE** menu choose the CHOOSE EDIT COVERAGE option. The edit coverage will be LANDDG01. Set *ARCS* as the initial edit feature. Under the **SET TOLERANCES** submenu, choose *OTHER* for the scale and *INCHES* for the units. Another menu will pop up where you will enter a 1 for the map scale. Continue in the SOP and begin digitizing. Save periodically while digitizing, approximately every 15 ARCs or every 15 minutes. When you finish digitizing and have saved the ARCs, quit PAE to the ARC: prompt.

Your present workspace should contain two coverages. Make sure they exist by listing the coverages.

> Arc: **listcoverages**

This command will list the available coverages located in the present workspace. You can also list information about a coverage using the **DESCRIBE** command. The following figure is an example of the output from a describe. The main items you should examine in the output are Topology, Number of Polygons, Polygon Labels, and Status.

```
Arc: describe luat10
                Description of SINGLE precision coverage luat10

                        FEATURE CLASSES

                            Number of  Attribute     Spatial
Feature Class       Subclass  Features  data (bytes)  Index?  Topology?
-------------       --------  --------- ------------  ------- ---------
ARCS                           281
POLYGONS                        62          26                  Yes
NODES                          222

                        SECONDARY FEATURES

Tics                             9
Arc Segments                   936
Polygon Labels                  61

                          TOLERANCES

Fuzzy    =             0.100 V        Dangle  =             0.000 N
                        COVERAGE BOUNDARY

Continue?
Xmin =              4008.982         Xmax =               6130.714
Ymin =              4577.147         Ymax =               7376.990

                            STATUS

The coverage has not been Edited since the last BUILD or CLEAN.

                    NO COORDINATE SYSTEM DEFINED
```

Every coverage except for the original digitized coverage should always have topology. The number of polygon labels should be one less than the number of polygons. Make sure when you check a coverage that the status states, "The coverage has not been Edited since the last BUILD or CLEAN." If it states something else, then topology probably does not exist for that coverage.

Use the **DESCRIBE** command on your newly digitized coverage.

    Arc: **describe landdg01**

Information about your coverage should appear. Notice that topology does not exist for this coverage. There are not any polygons yet because topology has not been built for polygons. Also, the status states, "The coverage has edit masks, use BUILD or CLEAN to restore topology." That is how an original digitized coverage should be. Once the coverage is cleaned those items will change.

<div align="center">Generating a Stream Coverage</div>

Create a workspace called "strm" at the same level as your data and land directories.

    Arc: **quit**
    sun% **cd ..**
    sun% **pwd** (make sure you are in the ugis directory)
    sun% **mkdir strm**
    sun% **cd strm**

After you move into the strm directory, copy over a file to be used in this exercise.

    sun% **cp ../data/streams.lin streams.lin**

"Streams.lin" is an ASCII text file that will be used to create a linear coverage. In ARC, display the file to see what it contains.

    sun% **arc**
    Arc: **&term 9999**

This sets the terminal device for you to see the streams.lin file.

    Arc: **&popup streams.lin**

The display shows groups of numbers followed by **END**. The numbers are the coordinates of the line, and **END** represents the end of a line.

Click on the *QUIT* button in the lower right-hand corner of the popup window.

```
                    Text
         200
    4260.012695    7083.697266
    4130.632812    7030.388184
    4078.262695    6964.579590
END
         201
    4284.175781    7001.191406
    4217.370605    6933.967773
    4168.378418    6860.235840
    4057.750244    6819.538086
END
         202
    4424.687988    6832.868164
    4375.368652    6804.522461
    4333.999023    6792.350098
    4238.725098    6788.042480
END
         203
    4494.872070    6792.724121
    4439.057617    6667.505371
    4372.215332    6630.590820
    4335.681641    6599.306641
    4341.035645    6550.817871
    4312.208984    6513.946289
END
         204
    4160.121094    6533.819336
    4243.848145    6537.182129
    4312.208984    6513.946289
END
         205
    4160.121094    6533.819336
    4040.349609    6493.578125
END
```

Instead of digitizing, you will be using the **GENERATE** command to create the linear coverage.

    Arc: **usage generate**
    Usage: GENERATE <cover>
    Arc: **generate strmgn01**

You will name this coverage STRMGN01.

The **GENERATE** command has its own subcommands, and you will be using the **COPYTICS** subcommand.

    Generate: **usage copytics**
    Generate: COPYTICS <cover>
    Generate: **copytics ../data/template**

The **COPYTICS** subcommand copies the tics from an existing coverage called TEMPLATE located in the data directory.

The next subcommand used is **INPUT**. This command allows you to specify the file that contains the *x,y* coordinates for the stream coverage.

    Generate: **input streams.lin**

At this point, the **GENERATE** command only knows which file to read—not which type of feature it will be creating. You must specify which type of feature will be read from the file, in this case, lines.

    Generate: **lines**
    Creating Lines with coordinates loaded from STREAMS.LIN.

Type **QUIT** to end the GENERATE session.

    Generate: **quit**
    Externalling BND and TIC...

This completes the creation of the linear stream coverage. Make sure the data exist by displaying them in ARCPLOT.

    Arc: **display 9999**
    Arc: **arcplot**
    Arcplot: **mapextent tics strmgn01**
    Arcplot: **linecolor blue**
    Arcplot: **arcs strmgn01**
    Arcplot: **tics strmgn01**

Quit ARCPLOT after displaying the data.

    Arcplot: **quit**

6
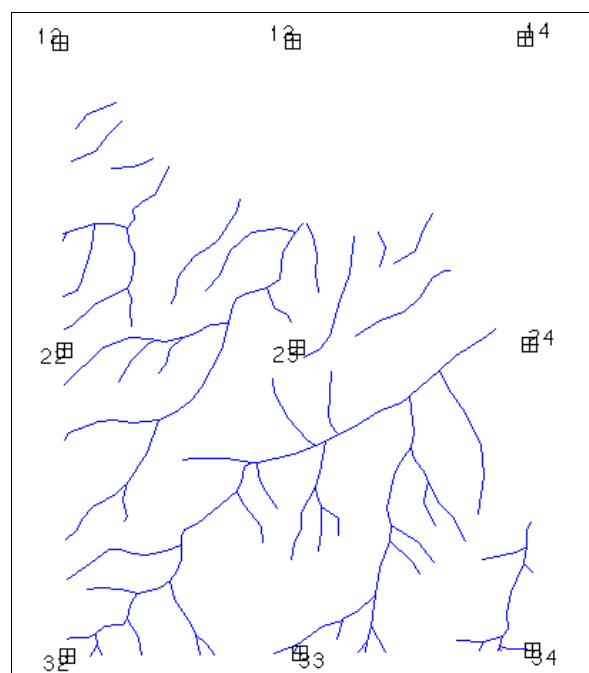
Creating Topology and Editing a Coverage

The following exercises deal with creating topology and editing a coverage. Please read pages 5-1 through 5-10 in the *Understanding GIS* (ESRI 1994) manual before you continue with the exercises.

Polygon Topology

For this exercise, you will need to move into the land directory.

    Arc: **quit**
    sun% **cd ../land**

Use the PAE SOP for the procedure of cleaning or building a coverage. To clean the coverage and create initial topology, refer to page 3 of the SOP, **Topology/Editing**. Below is an example of the **CLEAN** menu.

The coverage to be cleaned is LANDDG01. Clean the coverage for polygons, select table inches for the map units, and select 1:6,000 for the basemap scale. The desired output coverage name will be LANDCN02.

After the clean is complete, check for nodeerrors. From the **ERRORS** menu choose NODE ERRORS. Enter in the coverage to check, LANDCN02. If you have nodeerrors it will list them in the command tool. If there are no errors it will state "*Total number of Dangling Nodes: 0.*" If errors exist, you will edit them in PAE. On page 4 of the PAE SOP, use step 3 from **Topology/Editing** to edit the dangles.

Quit PARC to the ARC: prompt. Before making any edits, copy the cleaned coverage to a new name.

    Arc: **copy landcn02 landed03**

Continue on page 4 of **Topology/Editing** to edit the coverage. Use the LANDED03 coverage when making edits. If you make any edits, you will need to build the coverage to recreate the topology.

Before building the edited coverage, copy it to a new name.

    Arc: **copy landed03 landbd04**

Now you can build the LANDBD04 coverage. In PARC choose **TOPOLOGY** and the BUILD option.

Enter LANDBD04 as the coverage to be built.

After building the coverage, check for nodeerrors again by using the procedure given previously. If there are nodeerrors, go back into PAE and edit them.

Note: If you do not make any changes at all, copy the LANDCN02 coverage to a new name, LANDAT05.
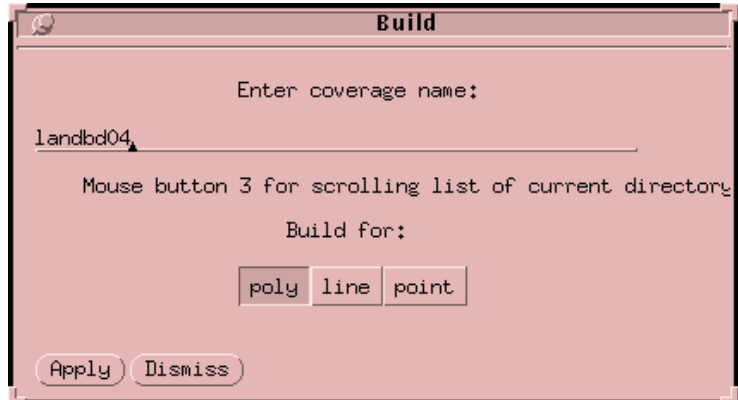
    Arc: **copy landcn02 landat05**

       If you do make changes, copy the LANDBD04 coverage to LANDAT05.

    Arc: **copy landbd04 landat05**

You will be using LANDAT05 for the following exercises.

Line Topology

You will now create topology for the stream coverage created previously. Make sure you are in the strm directory before creating topology for the stream line coverage. Also, before building the coverage, copy the original coverage to a new name.

    Arc: **quit**
    sun% **cd ../strm**

Go into ARC to copy the coverage.

    Arc: **copy strmgn01 strmbd02**

This time you will build the coverage from command line. The ARC command **BUILD** creates topology for coverages. Look at the usage for the **BUILD** command.

Arc: **usage build**
Usage: BUILD <cover> {POLY|LINE|POINT|NODE|ANNO.<subclass>}
Arc: **build strmbd02 line**

Make sure you specify LINE or STRMBD02 are to be built as a polygon coverage.

List the ARC attribute table for the stream coverage. Notice that the fnode# and tnode# are 0.

Arc: **list strmbd02.aat**

Now you need to create ARC-node topology. The **GENERATE** command does not create topology. The **RENODE** command will update the coverage and create topology by numbering the fnode# and tnode# in the aat of the STRMBD02 coverage.

Arc: **usage renode**
Usage: RENODE <cover>
Arc: **renode strmbd02**
119 unique nodes built for STRMBD02

Now list the stream attribute table, and compare the fnode# and tnode# to the original listing of the aat. The fnode# and tnode# should now have values.

Arc: **list strmbd02.aat**

```
Arc: list strmbd02.aat
Record  FNODE# TNODE# LPOLY# RPOLY#      LENGTH STRMBD02# STRMBD02-ID
   1      1      3      0      0      224.036      1        200
   2      2      5      0      0      301.175      2        201
   3      4      7      0      0      195.379      3        202
   4      6     13      0      0      357.137      4        203
   5     12     13      0      0      155.996      5        204
   6     12     15      0      0      126.351      6        205
   7     11     16      0      0       54.019      7        206
   8     15     17      0      0       21.776      8        207
   9     15     19      0      0       41.949      9        208
  10      9     20      0      0      295.601     10        209
  11     14     21      0      0      168.441     11        210
  12     16     23      0      0      300.108     12        211
  13     13     24      0      0      282.869     13        212
  14     16     25      0      0      547.422     14        213
  15     10     26      0      0      323.220     15        214
  16     12     27      0      0      380.758     16        215
  17      8     28      0      0      580.344     17        216
  18     23     29      0      0      199.195     18        217
  19     23     30      0      0      260.674     19        218
  20     24     31      0      0      172.671     20        219
  21     24     33      0      0      344.187     21        220
  22     22     34      0      0      538.513     22        221
Continue? ▲
```

Arc: **quit**
sun% **cd ../land**

Attributing

Read the **Attributing** section of the PAE SOP on page 5 before beginning the following exercises.

The following exercises cover attributing, which involves adding descriptive information to each of the polygons of the coverage. Make sure you are in your land directory.

    sun% **pwd**

You will be using the new coverage LANDAT05 for attributing.

Adding Items to the Feature Attribute Table

Refer to page 5, **Attributing**, in the PAE SOP. You will begin here for attributing. Perform steps 1 and 2 and then use the following command for step 3.

Type **ADDITEM** at the ARC: prompt and press "Enter."

    Arc: *additem <in_info_file> <out_info_file> <item_name> <item_width> <output_width> <item_type> {decimal_places} {start_item}*

Now, enter the information for the item you will be adding.

    Arc: **additem landat05.pat landat05.pat temp-id 4 5 b**

The item, TEMP-ID, is now added to the feature attribute table of LANDAT05. You will be attributing this item with the values located on the map.

Return to the PAE SOP **Attributing** section and continue with step 4.

Creating and Populating an Info Data File

After attributing the TEMP-ID, you will create a new data file that will contain more attribute information. To do this, you will need to be in INFO. Type **INFO** at the ARC: prompt.

    Arc: **info**

    INFO EXCHANGE CALL
    30/10/1995 10:50:08
    INFO 9.42 11/11/86 52.74.63*
    Copyright (C) 1994 Doric Computer Systems International Ltd.
    All rights reserved.
    Proprietary to Doric Computer Systems International Ltd.
    US Govt Agencies see usage restrictions in Help files (Help Restrictions)
    ENTER USER NAME>**ARC**

Type **ARC** at the ENTER USER NAME> prompt.

INFO is case sensitive, so turn on the Caps Lock key.

You will be defining or creating a new data file.

    ENTER COMMAND> **DEFINE LANDUSE.DAT**
    ITEM NAME, WIDTH [,OUTPUT WIDTH], TYPE [,DECIMAL PLACES] [,PROT.LEVEL]
       1
    ITEM NAME>**TEMP-ID**
    ITEM WIDTH>**4**
    OUTPUT WIDTH>**5**
    ITEM TYPE>**B**
       5
    ITEM NAME>**LU-CODE**
    ITEM WIDTH>**3**
    OUTPUT WIDTH>**3**
    ITEM TYPE>**I**
       8
    ITEM NAME> (Press "Enter" to return you to the original prompt)
    ENTER COMMAND>

Now check the directory listing to make sure the file exists.

    ENTER COMMAND>**DIR**

Your directory should be listed.

Make sure that you defined the items correctly. Check the item definitions by using the **ITEMS** command.

    ENTER COMMAND> **ITEMS**

The two items you added should be listed.

Stay in INFO and enter in the attribute information for these two items by using the **ADD** command.

    ENTER COMMAND> **ADD**

Enter the value for each item from the list provided.	TEMP-ID	LU-CODE
1	59	400
TEMP-ID>**59**	60	200
LU-CODE>**400**	61	400
2	62	200
TEMP-ID>**60**	63	200
LU-CODE>**200**	64	300
	65	200
	66	300
	67	300
	68	200
	69	300
	70	200
	71	300
	72	300
	73	300
	74	300
	75	200
	76	300
	77	300

Keep adding the data until you reach the final record. After completing the final record, press "Enter." List the information you just added to the data file.

ENTER COMMAND> **LIST**

You have completed entering in the data. You can quit INFO by typing **Q STOP**. This will return you to the Arc: prompt.

ENTER COMMAND> **Q STOP**

Turn off the Caps Lock key.

Joining Two Info Files

Next, you will be joining the information in the LANDAT05.PAT with the information in the LANDUSE.DAT. The command **JOINITEM** joins two info files into one based on a common item, in this case, TEMP-ID. The **JOINITEM** occurring here is a one-to-one relation because each TEMP-ID occurs only once in the pat.

Arc: **usage joinitem**
*Usage: JOINITEM <in_info_file> <join_info_file> <out_info_file> <relate_item> <start_item}
{linear|ordered|link}*

The arguments are as follows:
<in_info_file> Name of the file to which the items will be joined
<join_info_file> Name of the file containing the additional attributes
<out_info_file> Name of the file to be created (this is usually the same as the in_info_file)

<relate_item> Name of the relate item (in this case, temp-id)
<start_item> Name of the item in the in_info_file after which the additional items will appear in the table

Enter in the arguments for the **JOINITEM** command.

Arc: **joinitem landat05.pat landuse.dat landat05.pat temp-id temp-id**
Joining LANDAT05.PAT and LANDUSE.DAT to create LANDAT05.PAT

After the join is complete, build the coverage and list the attribute table.

Arc: **build landat05 poly**
Arc: **list landat05.pat**

The first record in every pat represents the outer polygon, and has a negative AREA and an LU-CODE of 0.

You can also display the coverage and its attributes graphically in ARCPLOT.

```
                                    cmdtool - /bin/csh
Arc: list landat05.pat
Record          AREA       PERIMETER LANDAT05# LANDAT05-ID TEMP-ID LU-CODE
     1       -19.950        17.929       1          0         0       0
     2         2.298        12.856       2          5        60     200
     3         1.822        12.113       3          6        61     400
     4        11.760        42.052       4          7        59     400
     5         0.640         4.216       5          8        62     200
     6         0.169         2.811       6          9        76     300
     7         0.035         0.953       7         10        64     300
     8         0.388         3.428       8         11        65     200
     9         0.139         1.685       9         12        77     300
    10         0.014         0.602      10         13        63     200
    11         0.299         3.102      11         14        75     200
    12         0.855         6.891      12         15        68     200
    13         0.440         3.792      13          1        71     300
    14         0.034         0.790      14          2        67     300
    15         0.134         1.499      15         16        66     300
    16         0.545         3.524      16         17        74     300
    17         0.071         1.075      17         18        72     300
    18         0.113         1.675      18         19        73     300
    19         0.016         0.548      19          3        69     300
    20         0.181         1.750      20          4        70     200
Arc:
```

Arc: **display 9999**
Arc: **arcplot**
Arcplot: **mapextent landat05**

This sets the geographic area that you want displayed. Draw the polygons of the coverage by using the **POLYGONS** command.

Arcplot: **polygons landat05**

Draw the attributes of the polygons by using the **POLYGONTEXT** command.

Arcplot: **polygontext landat05 lu-code**

Quit ARCPLOT.

Arcplot: **quit**
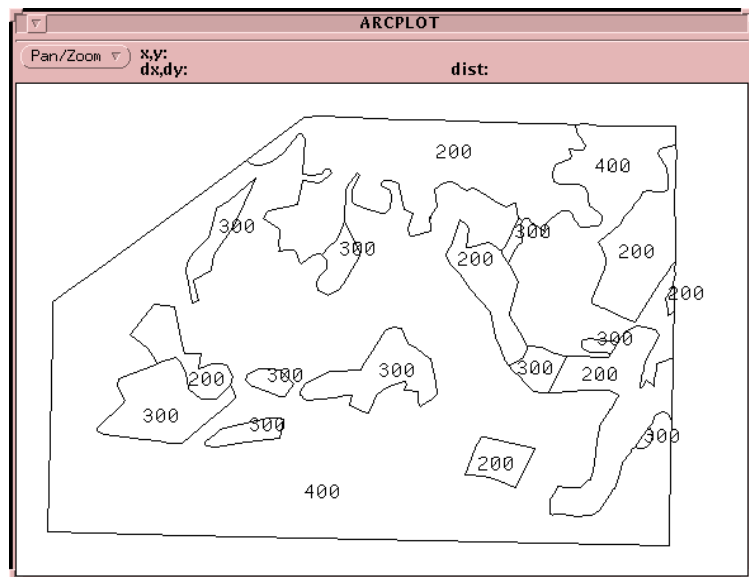
Now add a second set of information. Perform the same procedures used in the section *Creating and Populating an Info Data File*.

> Arc: **info**
> ENTER USER NAME> **ARC**
> ENTER COMMAND> **DEFINE COST.DAT**
>   1
> ITEM NAME> **LU-CODE**
> ITEM WIDTH> **3**
> OUTPUT WIDTH> **3**
> ITEM TYPE> **I**
>   2
> ITEM NAME> **COST/HA**
> ITEM WIDTH> **6**
> OUTPUT WIDTH> **6**
> ITEM TYPE> **I**

Press "Enter" to get back to the original prompt. Add the attribute information.

> ENTER COMMAND> **ADD**
>   1
> LU-CODE> **200**
> COST/HA> **15000**
>   2
> LU-CODE> **300**
> COST/HA> **10000**
>   3
> LU-CODE> **400**
> COST/HA> **10000**

Press "Enter" and list the table.

> ENTER COMMAND> **LIST**

Make sure the items are correct by using the **ITEMS** command and then quit INFO.

> ENTER COMMAND> **Q STOP**

Again you will be using the **JOINITEM** command. In this case, a many-to-one relation will occur because there are repeated LU-CODE values. Each LU-CODE will receive a corresponding COST/HA value, even though each LU-CODE occurs more than once.

> Arc: **joinitem landat05.pat cost.dat landat05.pat lu-code lu-code**
> *Joining LANDAT05.PAT and COST.DAT to create LANDAT05.PAT*
> Arc: **list landat05.pat**

You will notice that the item COST/HA is now added to the pat.

For the following exercise, you will be working with the linear stream coverage. You will add attribute information from a text file to create a data table. Make sure you are in the strm directory. Copy the built coverage to a new name before starting the exercise.

    Arc: **w ../strm**
    Arc: **copy strmbd02 strmat03**
    Arc: **cp ../data/streams.tab streams.tab**

Streams.tab is a tabular file containing attribute information for streams. Look at the file.

    Arc: **&term 9999**
    Arc: **&popup streams.tab**
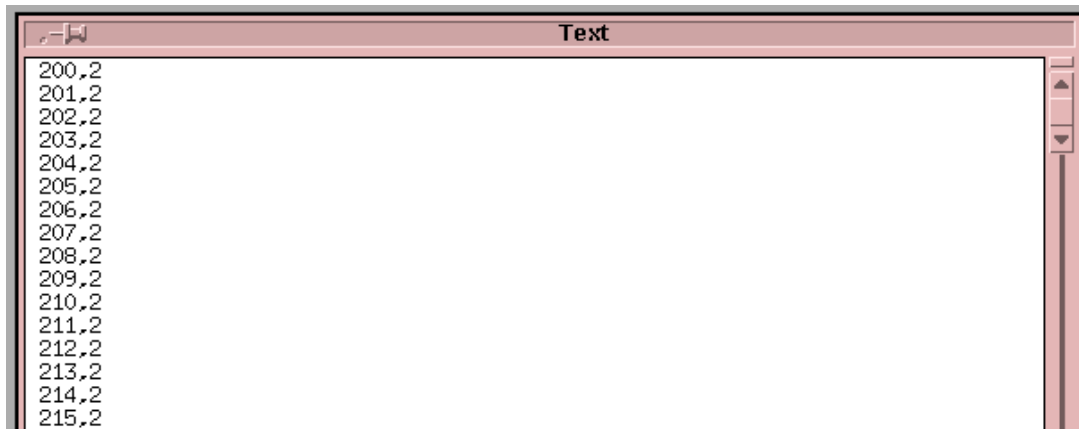
Click on the *QUIT* button in the lower right-hand corner of the popup window.

Enter INFO and create a new data file.

    Arc: **info**
    ENTER USER NAME> **ARC**
    ENTER COMMAND> **DEFINE STREAMS.DAT**
       1
    ITEM NAME>**STRMAT03-ID**
    ITEM WIDTH> **4**
    OUTPUT WIDTH> **5**
    ITEM TYPE> **B**
       5
    ITEM NAME> **STRM-CODE**
    ITEM WIDTH> **1**
    ITEM OUTPUT WIDTH> **1**
    ITEM TYPE> **I**

Press "Enter" and list the items.

    ENTER COMMAND> **ITEMS**

The items should appear with their definitions.

Now add the data from the streams.tab file to the streams.dat by using the **ADD FROM** command. When using this command, you must type in the path name of your workspace before the streams.tab file name.

    ENTER COMMAND>**ADD FROM /net/sun02/usr2/arc_work/*user-id*/ugis/strm/streams.tab** where *user-id* is your user initials, e.g., lta0.

    106 records should be added.

List streams.dat.

    ENTER COMMAND>**LIST**

After listing the file, quit INFO by using **Q STOP**.

At the ARC: prompt you will perform a **JOINITEM** again.

    Arc: **joinitem strmat03.aat streams.dat strmat03.aat strmat03-id strmat03-id**
    Joining STRMAT03.AAT and STREAMS.DAT to create STRMAT03.AAT

Display the results graphically.

    Arc: **display 9999**
    Arc: **arcplot**
    Arcplot: **mapextent strmat03**
    Arcplot: **arclines strmat03 strm-code**

Two different classes of streams should be displayed based on the STRM-CODE item. The major streams should be drawn in white and the minor streams in red.

    Arcplot: **quit**
    Arc: **quit**
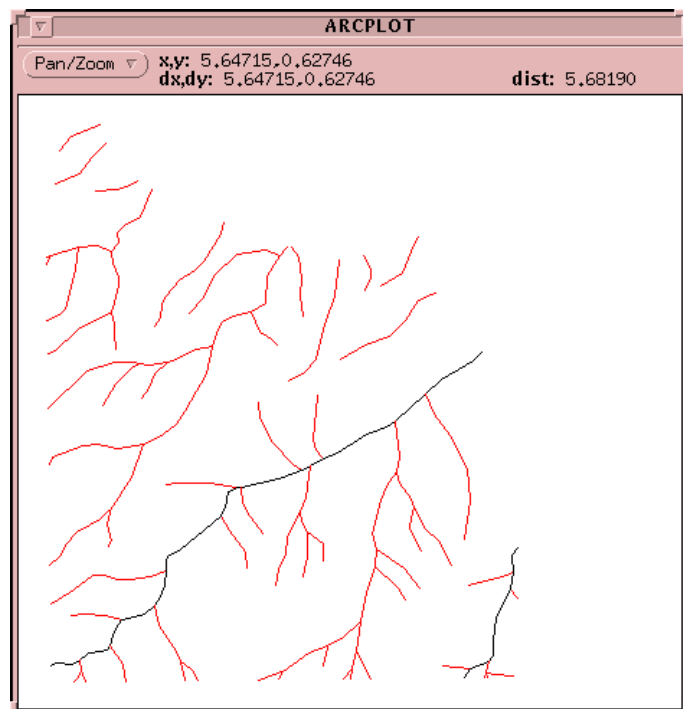
Map Projection and Map Joining

In the following exercises, you will learn to project data to real-world coordinates and append adjacent coverages. Read pages 7-6 through 7-13 in the *Understanding GIS* (ESRI 1994) manual before beginning the exercises.

Displaying Coverages

Move to your data directory to display the coverages.

> sun% **cd ../data**
> sun% **arc**
> Arc: **display 9999**
> Arc: **arcplot**
> Arcplot: **mapextent soils**
> Arcplot: **shadeset colornames**
> Arcplot: **polygonshades soils suit soils.lut**
> Arcplot: **linesymbol 10**
> Arcplot: **arcs roads**
> Arcplot: **linesymbol 3**
> Arcplot: **linecolor black**
> Arcplot: **arcs sewers**
> Arcplot: **linecolor 1**
> Arcplot: **polygons luat10**
> Arcplot: **linecolor red**
> Arcplot: **identify luat10 poly ***
>   Click on a polygon to display an item listing.

Notice that these coverages overlay each other. They overlay because they are in the same projection and use the same coordinate system. The LANDAT05 coverage has not yet been georeferenced, or moved to the same projection and coordinate system. It is still in digitizing units, which are table inches.

Quit ARCPLOT.

Projecting a Coverage

In this exercise you will convert LANDAT05 from table inches to UTM meters.

Updating Tics

The first step in projecting is to convert tic values to decimal degrees. Move to your land directory and create an empty coverage from LANDAT05.

> Arc: **w ../land**
> Arc: **create georef01 landat05**
> Arc: **list georef01.tic**

Notice that the *x*tic and *y*tic values are in digitizer units.

Update the tic coordinates of GEOREF01 to decimal degrees. You will be doing this in INFO. Make sure to enter each *x*tic value as a negative value.

```
Arc: info
ENTER USER NAME> ARC
ENTER COMMAND> SEL GEOREF01.TIC
ENTER COMMAND> UPDATE PROMPT
$RECNO1> 1
           1
IDTIC    =       22
XTIC     =       4.614
YTIC     =       9.125
IDTIC> <CR>  (Always press "Enter" on the IDTIC item. You do not want to change it.)
XTIC> -74.0
YTIC> 41.0625
$RECNO> 2
           2
IDTIC    =       23
XTIC     =       8.886
YTIC     =       9.146
IDTIC> <CR>
XTIC> -73.9875
YTIC> 41.0625
```

Here are the values to enter for each record. Continue until you have completed the last record.

$recno	*x*tic	*y*tic
3	-73.9750	41.0625
4	-73.9750	41.0500
5	-73.9875	41.0500
6	-74.0000	41.0500

If you make a mistake, use the **UPDATE PROMPT** command again.

After entering the tics, return to the original prompt and list the tic file.

```
ENTER COMMAND> LIST
```

After listing the tic file, quit INFO.

```
ENTER COMMAND> Q STOP
```

Defining the Projection

Next you want to specify the projection and coordinate system of the coverage. Display the usage for the **PROJECTDEFINE** command at the ARC: prompt.

    Arc: **usage projectdefine**
    Usage: projectdefine <cover|grid|file|tin> <target>
    Arc: **projectdefine cover georef01**

This states that you want to define a projection for the coverage GEOREF01.

    Define Projection
    Project: **projection geographic**
    Project: **units dd**
    Project: **parameters**

Describe the coverage and look at the COORDINATE SYSTEM DESCRIPTION.

    Arc: **describe georef01**

The results of the describe should show that the projection is GEOGRAPHIC and the units are decimal degrees.
(DD).

Projecting the Tic Coverage

The tics that you entered are in reference units or decimal degrees. To get the coverage referenced to a planar coordinate system, you need to project the tics. List the arguments for the **PROJECT** command by typing **PROJECT** at the ARC: prompt.

    Arc: **project <CR>**
    Arc: project <cover|grid|file> <input> <output> {projection_file} {nearest|bilinear|cubic}

Enter the information for your projection.

    Arc: **project cover georef01 geoutm02**
    ****
    * The INPUT projection has been defined .... *
    ****
    Use OUTPUT to define the output projection and END to finish.

    Project: **output**
    Project: **projection utm**
    Project: **units meters**
    Project: **zone 18**
    Project: **xshift -580000**
    Project: **yshift -4540000**
    Project: **parameters**
    Project: **end**

After projecting a coverage you must build it.

    Arc: **build geoutm02**

List the tic file for GEOUTM02. Notice that the tics are in UTM coordinates.

    Arc: **list geoutm02.tic**

Transforming the Original Coverage

Next you will transform the coverage itself, not the tics, from digitizer units to real-world coordinates. **TRANSFORM** is the command used to convert coverage coordinates by using the control points (or tics). Refer to the online help or the ARC manuals to get a better understanding of the **TRANSFORM** command. Before using the command, create an empty coverage that will contain the projected tics.

    Arc: **create landtr06 geoutm02**

When using **TRANSFORM**, it compares the tic-ids of the input coverage tics and output coverage tics to make a transformation calculation. The features of the input coverage are then copied to the output coverage by using the calculated transformation. The original coverage, LANDAT05, is not altered.
Display the arguments for the **TRANSFORM** command.

    Arc: **usage transform**
    Usage: transform <in_cover> <out_cover> {affine|projective}

Enter the arguments to run the transform.

    Arc: **transform landat05 landtr06**

The transform operation will display a report. The main items you want to examine in the report are the input RMS error and the *x* and *y* error. They should all be as close to 0.000 as possible. You may get something like 0.005, which is acceptable for the exercise. The larger the number, the greater the deviation is between the input and output coverage tic locations. A large RMS error may occur because (1) the original tics were not digitized correctly or accurately, (2) the original map sheet was distorted from shrinking or stretching, or (3) the real-world coordinates were not entered in correctly.

After a coverage is transformed it must also be built.

    Arc: **build landtr06**

You will want to describe the coverage LANDTR06 to see the coordinate information.

    Arc: **describe landtr06**

```
                          cmdtool - /bin/csh
              Description of SINGLE precision coverage landtr06

                          FEATURE CLASSES

                          Number of  Attribute    Spatial
Feature Class      Subclass  Features  data (bytes) Index?  Topology?
-------------      --------   --------  ------------ ------  ---------
ARCS                             49
POLYGONS                         20         30                 Yes
NODES                            37

                        SECONDARY FEATURES

Tics                              6
Arc Segments                   1621
Polygon Labels                   19

                           TOLERANCES

Fuzzy   =            0.493 N       Dangle  =              2.465 N

                        COVERAGE BOUNDARY

Continue?
Xmin =            4735.133       Xmax =              6141.218
Ymin =            4584.255       Ymax =              5562.937

                            STATUS

The coverage has not been Edited since the last BUILD or CLEAN.

                   COORDINATE SYSTEM DESCRIPTION

Projection           UTM
Zone                  18
Units              METERS              Spheroid     CLARKE1866
Xshift        -580000.00000           Yshift       -4540000.00
Parameters:
```

Mapjoining Coverages

In this exercise you will be mapjoining the coverage you digitized and transformed with an existing coverage. The following list summarizes the procedures used for mapjoining.

- Edgematch adjacent coverages so that the features on adjacent borders match.
- Check the item definitions in the adjacent coverages by looking at the feature attribute tables.
- Mapjoin the coverages. You can mapjoin as many as 500 coverages.
- Dissolve the adjacent map sheet borders.

Copying Coverages

Copy the coverages you need from the data directory into the land directory. You will need four additional coverages to complete this exercise.

    Arc: **copy ../data/landtr landtr**
    Arc: **copy ../data/luat10 luat10**
    Arc: **copy ../data/clipcov clipcov**
    Arc: **copy ../data/linkcov linkcov**

Continue by comparing the adjacent coverages for edgematching errors. You will check the item definitions in the adjacent coverages and check that the attributes are consistent across map sheet borders. In ARCPLOT you will compare the adjacent coverages.

Arc: **display 9999**
Arc: **ap**
Arcplot: **mapextent landtr**

LANDTR is the extent of the coverage area that you want to display.

Arcplot: **arcs luat10**
Arcplot: **linesymbol 2**
Arcplot: **arcs landtr**

The LANDTR coverage slightly overlaps the LUAT10 coverage. A clip coverage will be used to create a common or adjacent boundary between the two coverages. Draw the coverage that will be used to clip the LANDTR coverage.

Arcplot: **linesymbol 3**
Arcplot: **arcs clipcov**
Arcplot: **quit**

Clipping a Coverage

Next, perform the clip on the LANDTR coverage.
Do a usage on the **CLIP** command to see the arguments.

Arc: **usage clip**
Usage: CLIP <in_cover> <clip_cover> <out_cover> {POLY|LINE|POINT|NET|LINK|RAW} {fuzzy_tolerance}

After looking at the usage, enter in the arguments for your coverages.

Arc: **clip landtr clipcov landcp07 poly**

After the clip is complete, copy the clipped coverage to a new name.

Arc: **copy landcp07 landem08**

View the results of the clip process by using the LANDEM08 coverage.

Arc: **display 9999**
Arc: **arcedit**
Arcedit: **edit landem08**
Arcedit: **drawenvironment arc node**
Arcedit: **draw**

The arcs and nodes of the LANDEM08 coverage will be drawn.

22

Display the LUAT10 coverage in the background to compare the border with the LANDEM08 border. Background coverages are used for display purposes only. They cannot be edited.

> Arcedit: **usage backcoverage**
> *Usage: backcoverage <cover> {symbol}*
> Arcedit: **backcoverage luat10 4**
> *LUAT10 is now background coverage 1 with draw symbol 4*

Draw the features for the background coverage.

> Arcedit: **backenvironment arc node**
> Arcedit: **draw**

Use the **PAN/ZOOM** menu and CREATE a window around an area with adjacent ARC and node features.
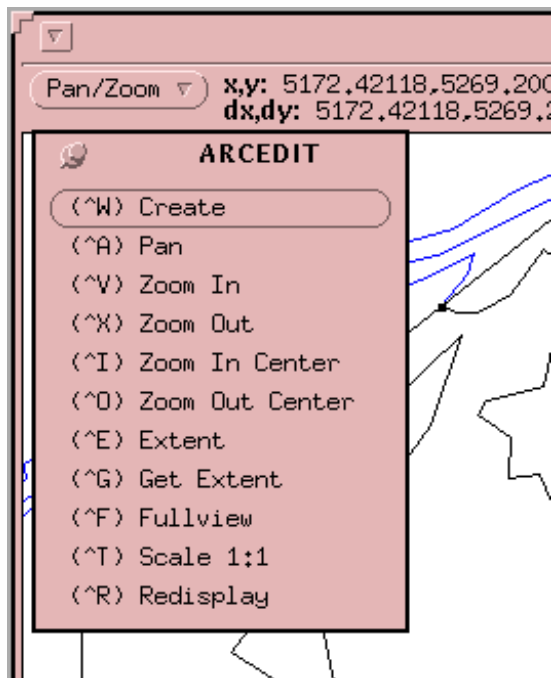
Notice that in some areas the ARCs and nodes do not match up perfectly. Remain in ARCEDIT for the next exercise.
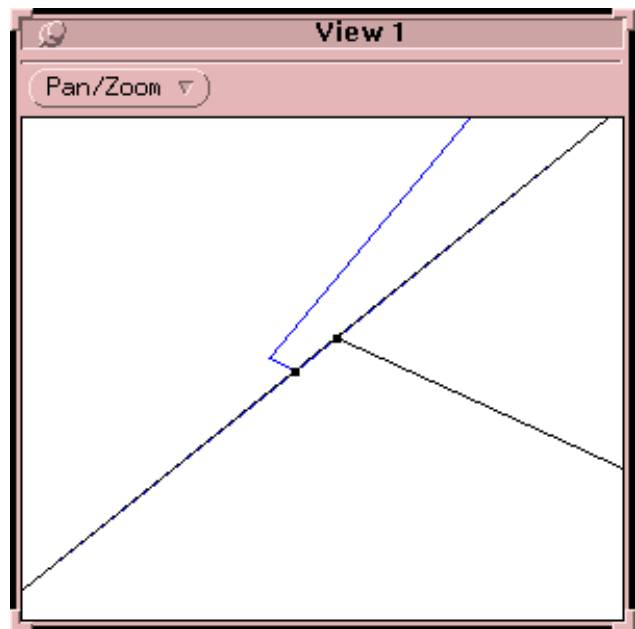
Edgematching Adjacent Coverages

The edgematching process will match up adjacent features between two coverages. To do this, a feature called a link is used. A link connects the specified features between the adjacent coverages. After the connection is made, an adjustment called rubber sheeting is performed to match the linked features.

There are two types of links:

(1) Identity links, which have the same from- and to- locations. They act as nails during the adjustment.
(2) Adjustment links, which are represented by arrows. The from- and to- locations are different for adjustment links. They cause features to be moved and to snap together.

Continue in ARCEDIT and go through the adjustment process.

    Arcedit: **editfeature link**
    Arcedit: **drawenvironment link**
    Arcedit: **draw**

For this exercise, you want to copy some links from LINKCOV to the LANDEM08 coverage.

    Arcedit: **get linkcov**
    Copying the links from LINKCOV into LANDEM08...
    5 link(s) copied

After the links are copied, they will be displayed as arrows because they are now part of the edit coverage. When the adjustment is performed, the links will snap the features together.

    Arcedit: **adjust**

A standard adjustment for edgematching occurs along the edges of the adjacent coverages. The edgematch connects the features of the adjacent coverages, making the data continuous. This adjustment was only a demonstration. Remove your present edit coverage so that you can start an edgematching session on your own coverages.

    Arcedit: **removeedit landem08**
    All changes since last SAVE will be lost!
    Continue? <Y/N>: **Y**
    Removing LANDEM08
    Arcedit:

During this edgematch, nodes from the edit coverage LANDEM08 will be snapped to nodes of the snap coverage LUAT10. The edgematching session contains a series of menus. From these menus, the user specifies the operations to be performed. Begin the edgematching session.

    Arcedit: **edgematch**

The first menu will appear. Enter LANDEM08 as the edit coverage, LUAT10 as the snap coverage, and node as the coverage feature class to be adjusted and as the snap coverage feature class. The snap coverage is also a current background coverage. You will not need any other background coverages.

After applying the **COVERAGE** menu information (*right*), the coverages appear in the graphics window and the **EDGEMATCHING** menu appears (*below*). This menu controls the settings for the environment, controls the usage of links, performs the adjustment, undeletes the changes made, and saves the changes made during the edgematch session.
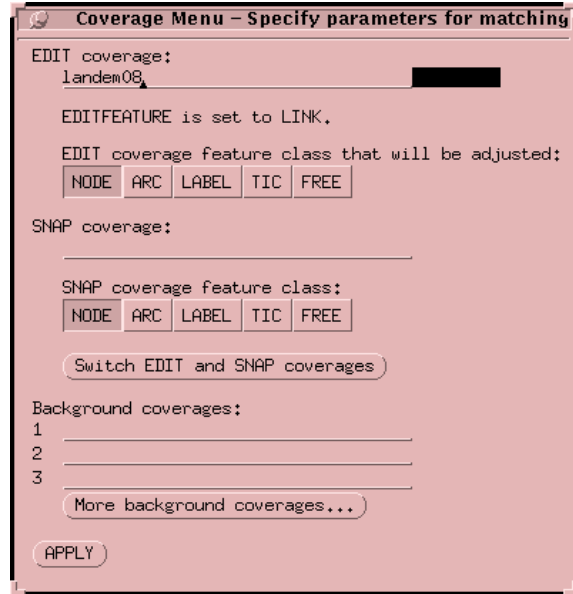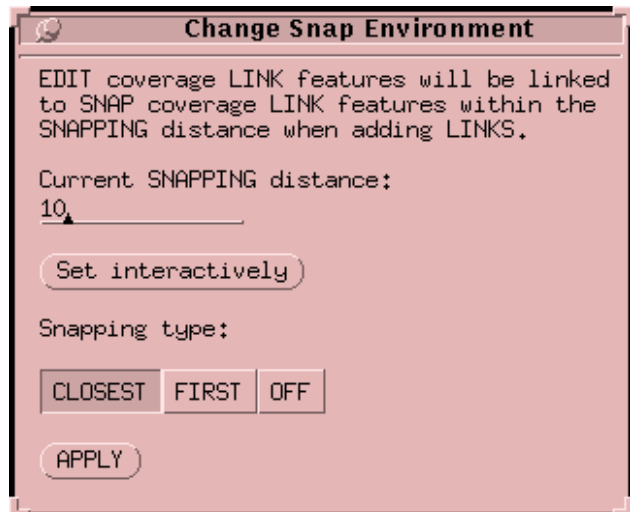
```
┌─────────────────────────────────────────┐
│ ◎   Coverage Menu – Specify parameters for matching │
├─────────────────────────────────────────┤
│ EDIT coverage:                          │
│    landem08,                    ▓▓▓▓▓▓▓▓ │
│                                         │
│    EDITFEATURE is set to LINK,          │
│                                         │
│    EDIT coverage feature class that will be adjusted: │
│    ┌──────┬─────┬───────┬─────┬──────┐  │
│    │ NODE │ ARC │ LABEL │ TIC │ FREE │  │
│    └──────┴─────┴───────┴─────┴──────┘  │
│ SNAP coverage:                          │
│    _____  │
│                                         │
│    SNAP coverage feature class:         │
│    ┌──────┬─────┬───────┬─────┬──────┐  │
│    │ NODE │ ARC │ LABEL │ TIC │ FREE │  │
│    └──────┴─────┴───────┴─────┴──────┘  │
│    ( Switch EDIT and SNAP coverages )   │
│ Background coverages:                    │
│ 1  _____  │
│ 2  _____  │
│ 3  _____  │
│    ( More background coverages... )     │
│ (APPLY)                                 │
└─────────────────────────────────────────┘
```

```
┌─────────────────────────────────────┐
│ ◎      Edgematching Menu            │
├─────────────────────────────────────┤
│ SETTINGS:                           │
│  ( Coverages... )                   │
│  ( Link Features... )               │
│  ( Draw Environment... )            │
│  ( Snap Environment... )            │
│  ( Selection Distance... )          │
│  ( Grain Tolerance... )             │
│                                     │
│  ( Save/Get Links... )              │
│  ( Switch EDIT and SNAP coverages ) │
│  ( Type Interactively )             │
│                                     │
│ LINKS:                              │
│  ( Add Interactively )              │
│  ( Add Automatically )              │
│  ( Hold Selected Features )         │
│  ( Delete Many )   ( Delete Box )   │
│                                     │
│ Limit area where links added:       │
│  ┌──────┬─────┬─────────┐           │
│  │ NONE │ BOX │ POLYGON │           │
│  └──────┴─────┴─────────┘           │
│ Limit Adjustment Area:              │
│  ┌──────┬─────┬─────────┐           │
│  │ NONE │ BOX │ POLYGON │           │
│  └──────┴─────┴─────────┘           │
│  (ADJUST) (OOPS)  (SAVE) (STEPS)    │
└─────────────────────────────────────┘
```

Setting a snapping tolerance allows links to be added automatically if they are within a specified distance. Set the snapping distance to 10 by clicking the *SNAP ENVIRONMENT*... button.

```
┌─────────────────────────────────────┐
│ ◎    Change Snap Environment        │
├─────────────────────────────────────┤
│ EDIT coverage LINK features will be linked │
│ to SNAP coverage LINK features within the  │
│ SNAPPING distance when adding LINKS,   │
│                                     │
│ Current SNAPPING distance:          │
│ 10,_____                 │
│                                     │
│ ( Set interactively )               │
│                                     │
│ Snapping type:                      │
│                                     │
│ ┌─────────┬───────┬─────┐           │
│ │ CLOSEST │ FIRST │ OFF │           │
│ └─────────┴───────┴─────┘           │
│                                     │
│ ( APPLY )                           │
└─────────────────────────────────────┘
```

To perform an edgematch, links need to be added. Links will be added automatically for nodes within a distance of 10 m of each other by clicking on the *ADD AUTOMATICALLY* button. Click on the *ADD AUTOMATICALLY* button. Four links should have been added to LANDEM08. Both identity and adjustment links will appear. The links with the arrows will connect the nodes between the two coverages. From the **PAN/ZOOM** menu, choose the CREATE option and create a window around one of the adjustment links. Notice how the link connects the node from the edit coverage to the snap coverage. You will be adding two more identity links or nails at the two corners in the upper left portion of the coverage LANDEM08.
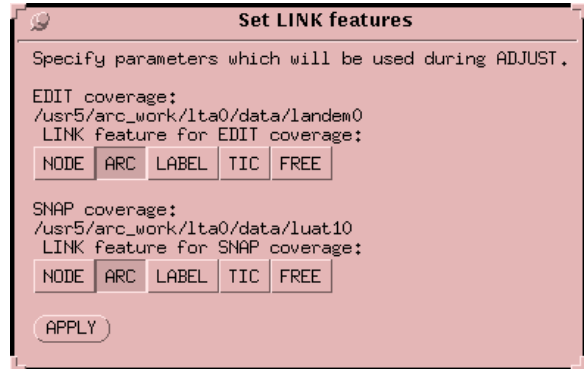
First, create a window of the lower left of these two corners by using the **PAN/ZOOM** menu and CREATE option. Zoom in close to the corner so that you can add the link interactively.
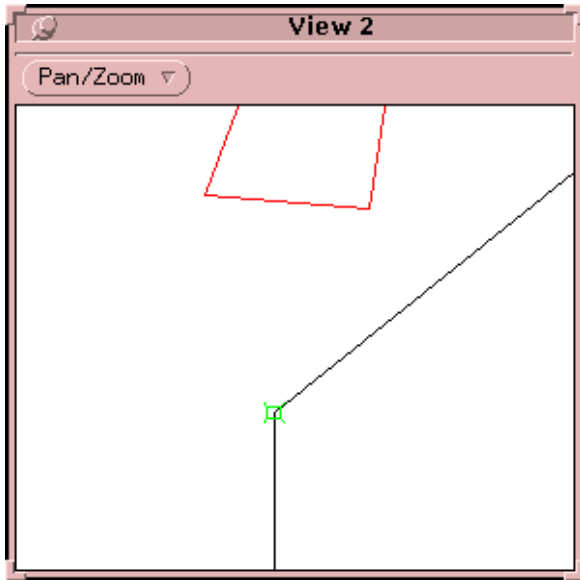
Next, set the link feature to ARC for both coverages so that links can be made between ARCs instead of nodes. Do this by clicking on the *LINK FEATURES* button and setting each link feature to ARC.

Interactively add an identity link at the first corner. Once you press the *ADD INTERACTIVELY* button this menu will appear.
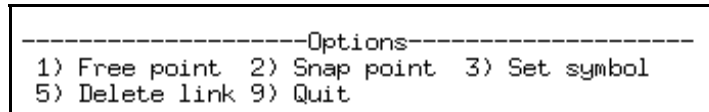
Remember, for an identity link, the from- and to- locations must be the same. When entering the link, position the cursor over the corner and click the middle mouse button (or a 2) for the snap point. This enters the from- point. To enter the to- point, keep the cursor in the same position and click the middle mouse button again. This should create a box around the corner.

Zoom into the other corner and use the same procedure to add another identity link. Press the Ctrl key and the right mouse button (Ctrl 9) at the same time to quit adding links. If the links are added incorrectly you can delete them and add new links. Press the *DELETE MANY* button and click on the links to be deleted using the left mouse button. After selecting the links, press the Ctrl key and the right mouse button (Ctrl 9) to quit and the links will be deleted. Use the procedure given previously to add the links again.

Once the links are entered correctly, the display should show three identity links and three adjustment links. Next, adjust the coverage so that the adjustment links connect the adjacent features. Click on the *ADJUST* button from the **EDGEMATCHING** menu.

Adjusting coverage LANDEM08
Building the adjustment structure from the links for the first pass...
Proximal tolerance set to 1.000...
Generating convex hull...

Building Triangular Irregular Network...
     adjusting ARCs...
     adjusting LABELs...
Updating the adjustment structure for the second pass...
     adjusting ARCs...
     adjusting LABELs...

The features between the two coverages should now match up. Each of the links should be identity links or green boxes. From the **PAN/ZOOM** menu do a REDISPLAY. If you want, zoom into the linked areas to see if the features are aligned. After you have checked the edgematch, you will want to save the adjusted coverage. Click on the *SAVE* button at the bottom of the **EDGEMATCHING** menu. Once the save is complete, pull the pin on the **EDGEMATCHING** menu to exit the edgematching session. Also quit ARCEDIT.

Since you made edits on the LANDEM08 coverage, you need to rebuild polygon topology for that coverage.

Arc: **build landem08**

After the build is complete, check the item definitions between LUAT10.PAT and LANDEM08.PAT. The items between the two coverages must match in order to perform the mapjoin.

Arc: **items luat10.pat**

```
COLUMN    ITEM NAME        WIDTH OUTPUT   TYPE N.DEC  ALTERNATE NAME        INDEXED?
   1    AREA                4     12      F     3                              -
   5    PERIMETER           4     12      F     3                              -
   9    LUAT10#             4      5      B     -                              -
  13    LUAT10-ID           4      5      B     -                              -
  17    LU-CODE             3      3      I     -                              -
  20    COST/HA             6      6      I     -                              -
```

Arc: **items landem08.pat**

```
COLUMN    ITEM NAME        WIDTH OUTPUT   TYPE N.DEC  ALTERNATE NAME        INDEXED?
   1    AREA                4     12      F     3                              -
   5    PERIMETER           4     12      F     3                              -
   9    LANDEM08#           4      5      B     -                              -
  13    LANDEM08-ID         4      5      B     -                              -
  17    LU-CODE             3      3      I     -                              -
  20    COST/HA             6      6      I     -                              -
```

If the two items LU-CODE and COST/HA match between the two coverages, then you are ready to perform the MAPJOIN.

Mapjoining Adjacent Coverages

The **MAPJOIN** command is used to join two or more adjacent coverages. It can append as many as 500 coverages. The **MAPJOIN** command will maintain unique Cover-IDs (for the features) and Tic-IDs (for the tic file) for the coverages used in the mapjoin. Once the mapjoin is executed it will prompt you for the coverages you want to append.

Arc: **usage mapjoin**
Usage: MAPJOIN <out_cover> {feature class...feature class|template_cover}
{NONE|FEATURES|TICS|ALL}{clip_cover}
Arc: **mapjoin landmj09 poly**
Enter Coverages to be MAPJOINed (Type END or a blank line when done):
= =

Enter the 1st coverage: **LUAT10**
Enter the 2nd coverage: **LANDEM08**
Enter the 3rd coverage: **END**

Appending coverages...
Sorting...
Partial process enabled. 43% of the coverage will be processed.
Intersecting...
Assembling polygons...
Creating PAT...
Arc:

When the mapjoin is complete, view the results.

Arc: **display 9999**
Arc: **arcplot**
Arcplot: **mapextent landmj09**
Arcplot: **arcs landmj09**

The coverage borders will still exist. You can see the ARCs that define the borders. Display the coverages without displaying the borders.

Arcplot: **clear**
Arcplot: **linecolor 6**
Arcplot: **textsize .075**
Arcplot: **usage dropline**
Usage: DROPLINE <cover> <item> {lookup_table} {NOTEXT}

A **DROPLINE** draws only the borders and labels for the polygons that have different values for the item specified by the user. Use the **DROPLINE** command and specify LU-CODE as the item to draw borders and labels.

Arcplot: **dropline landmj09 lu-code**

The ARCs and labels for LU-CODE should be displayed. Adjacent polygons with the same LU-CODE have their boundaries dropped. This is apparent where the coverage borders used to be. If some ARCs remain where the coverage borders are located, they are probably sliver polygons. You can edit them later in ARCEDIT.

Instead of just visually dropping the border ARCs, you can drop boundaries between adjacent polygons and save the changed data into a new coverage using the **DISSOLVE** command at the ARC: prompt. Quit ARCPLOT to the ARC: prompt and execute the **DISSOLVE** command.

> Arc: **usage dissolve**
> *Usage: DISSOLVE <in_cover> <out_cover> <dissolve_item|#ALL>*
> *{POLY|LINE|NET|REGION.subclass}*
> Arc: **dissolve landmj09 landds10 #all**
> *Dissolving LANDMJ09 by #ALL to create LANDDS10*
> *Creating LANDDS10.PAT format...*
> *Dissolving...*
> *Number of Polygons (Input, Output) = 81   77*
> *Number of Arcs   (Input, Output) = 321 207*
> *Creating LANDDS10.PAT...*

By using the #ALL option, the dissolve takes all of the items past the COVER-ID in the feature attribute table and treats them as one item to dissolve on.

Display the results of the dissolve in ARCPLOT.

> Arc: **display 9999**
> Arc: **arcplot**
> Arcplot: **mapextent landds10**
> Arcplot: **arcs landds10**

If you notice that ARCs still exist where the coverage borders are, go into PAE and edit them. They may be sliver polygons so be sure to check whether labels exist within the ARCs. If there are labels, delete them along with the ARCs.

If you edited the coverage, be sure to run a **BUILD** afterward to restore topology.

After viewing the display, quit ARCPLOT. If no edits need to be made, you have created a final land use coverage to be used with the other coverages in the project database.
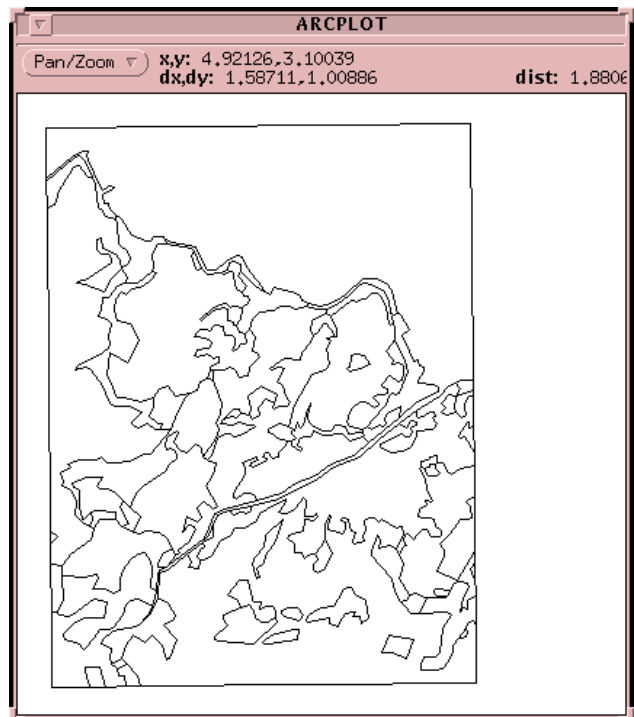
Before proceeding to the next set of exercises, prepare the data directory for analysis. First, move to the data directory. Then copy the LANDDS10 and STRMAT03 coverages to this directory.

Arc: **copy ../land/landds10 landds10**
Arc: **copy ../strm/strmat03 strmat03**

Kill the existing STREAMS and LANDUSE coverages.

Arc: **kill streams**
Arc: **kill landuse**

Rename your coverages. These will be used in the next set of exercises.

Arc: **rename strmat03 streams**
Arc: **rename landds10 landuse**

Manipulating and Analyzing Data

Before beginning the following exercises, read pages 8-1 through 8-11 of the *Understanding GIS* (ESRI 1994) manual.

Creating a Buffer Coverage

The first exercise has you create a buffer around the SEWERS coverage. A buffer creates polygons around existing coverage features. Display the arguments for the **BUFFER** command at the ARC: prompt.

Arc: **usage buffer**
Usage: BUFFER <in_cover> <out_cover> {buffer_item} {buffer_table} {buffer_distance}
{fuzzy_tolerance} {LINE|POLY|POINT|NODE} {ROUND|FLAT} {FULL|LEFT|RIGHT}

Enter in the following arguments to run the buffer. You will be using the # sign to replace two of the arguments. The # sign is a place holder for optional arguments that are skipped.

Arc: **buffer sewers sewerbuf # # 300**
    Buffering...
    Sorting...
    Intersecting...
    Assembling polygons...
    Creating new labels...
    Finding inside polygons...
    Dissolving...
    Creating SEWERBUF.PAT...
Arc:

A buffer coverage displaying the area within 300 m of the sewers was created from the SEWERS coverage. Go into ARCPLOT and view the buffer coverage SEWERBUF.

Arc: **display 9999**
Arc: **arcplot**
Arcplot: **mapextent sewerbuf**
Arcplot: **arcs sewers**
Arcplot: **polygons sewerbuf**

As the buffer creates the polygon coverage, it also adds an item to the existing pat. List the items for the SEWERBUF coverage and then list the pat.

Arcplot: **items sewerbuf poly**

Arcplot: **list sewerbuf poly**

The new item is INSIDE. This item separates the area inside the buffer zone from the area outside the buffer zone. The area inside the buffer zone is represented by the value of 100. The area outside the buffer zone is represented by the value of 1.
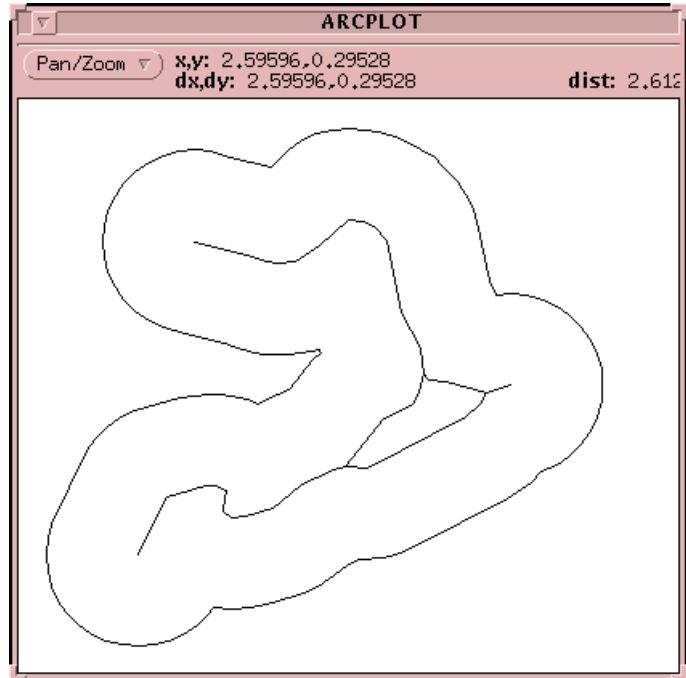
Next, create a 20-m buffer around streams in the STREAMS coverage. Potential sites for the lab can only be considered if the area is at least 20 m from any streams. Create STRMBUF by buffering an area of 20 m around the streams in the coverage. Remember to do this at the ARC: prompt.

Arc: **buffer streams strmbuf # # 20**

After the buffer is finished, view the results in ARCPLOT.

Arc: **display 9999**
Arc: **arcplot**
Arcplot: **mapextent strmbuf**
Arcplot: **polygons strmbuf**
Arcplot: **list strmbuf poly**

Remember that INSIDE = 100 represents the area inside the buffer boundary. Quit ARCPLOT.

Erasing Features From a Coverage

Before performing this exercise, read page 8-15 of the *Understanding GIS* (ESRI 1994) manual to get an idea of the next process you will be running.

In this exercise, you will be using the **ERASE** command to find the area located outside the 20-m buffer and inside the 300-m buffer. With the **ERASE** command, two coverages are overlaid and the features that overlap are erased. Display the arguments for the **ERASE** command.

Arc: **usage erase**
Usage: ERASE <in_cover> <erase_cover> <out_cover> {POLY|LINE|POINT|NET|LINK|RAW}
{fuzzy_tolerance}

You will erase features in the SEWERBUF coverage with features from the STRMBUF coverage. The new coverage will be called BUFFCOV.

Arc: **erase sewerbuf strmbuf buffcov**
Erasing SEWERBUF with STRMBUF to create BUFFCOV
Sorting...
Intersecting...
Assembling polygons...
Creating new labels...
Creating BUFFCOV.PAT...
Arc:

Once the erase is complete, you will display the results in ARCPLOT. A new command, **RESELECT**, will be used to select a subset of features from the BUFFCOV coverage.

Arc: **display 9999**
Arc: **arcplot**
Arcplot: **mapextent sewerbuf**
Arcplot: **polygons sewerbuf**
Arcplot: **linecolor red**
Arcplot: **polygons strmbuf**
Arcplot: **reselect buffcov poly inside = 100**
BUFFCOV polys: 8 of 11 selected
Arcplot: **polygonshades buffcov 7**

While looking at the graphic and your display in ARCPLOT, notice that the area greater than 20-m from STRMBUF and within 300 m of SEWERBUF is shaded. You will be using the BUFFCOV coverage in later exercises.

Quit ARCPLOT to complete this exercise.
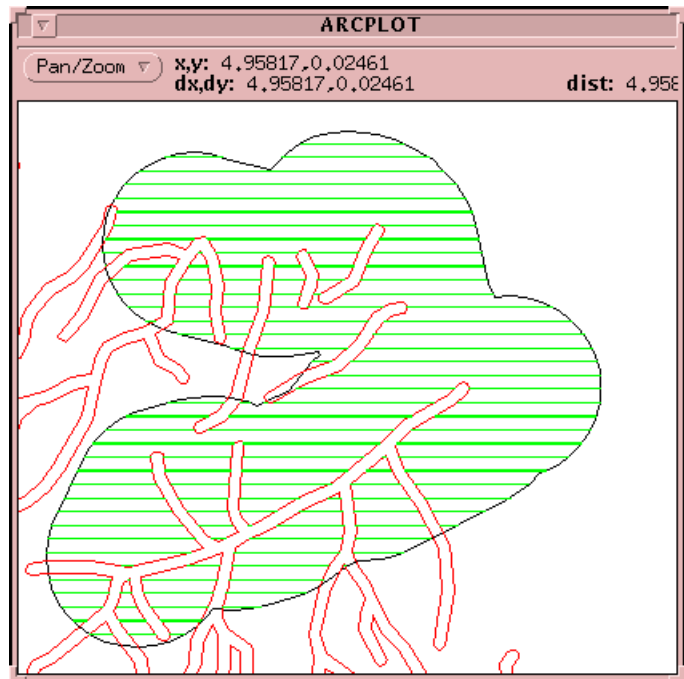
Overlaying Coverages for Analysis

Before beginning the next exercise, read pages 8-18 through 8-20 in the *Understanding GIS* (ESRI 1994) manual.

You will combine land use information and soil stability information to identify the polygons suitable for development. By using the **IDENTITY** overlay command, you will combine spatial features and attribute information from LANDUSE and SOILS into one coverage. Display the arguments for the **IDENTITY** command.

Arc: **usage identity**
Usage: IDENTITY <in_cover> <identity_cover> <out_cover> {POLY|LINE|POINT} {fuzzy_tolerance} {JOIN|NOJOIN}

Enter in the arguments to perform the identity operation.

Arc: **identity landuse soils landsoil**
 Producing identity of LANDUSE with SOILS to create LANDSOIL
 Sorting...
 Intersecting...
 Assembling polygons...
 Creating new labels...
 Creating LANDSOIL.PAT...
** Item 'AREA' duplicated, Join File version dropped **
** Item 'PERIMETER' duplicated, Join File version dropped **
** Item 'AREA' duplicated, Join File version dropped **
** Item 'PERIMETER' duplicated, Join File version dropped **
Arc:

The comments in the double asterisks indicate that the items AREA and PERIMETER already exist in both of the coverages, so they do not need to be copied.

Display the results of the identity in ARCPLOT. You will be using the **RESELECT** command to select brushland polygons that contain soil suitable for development.

Arc: **arcplot**
Arcplot: **mapextent landsoil**
Arcplot: **polygons landsoil**
Arcplot: **reselect landsoil poly lu-code = 300 and suit ge 2**
LANDSOIL polys: 40 of 446 selected
Arcplot: **polygonshades landsoil 3**

Quit ARCPLOT when you finish viewing the results.

Use the **IDENTITY** command again to overlay the LANDSOIL and BUFFCOV coverages. The result will display the areas that lie outside the stream buffer, within the sewer buffer, and have a land use and soil type suitable for development.

Arc: **identity landsoil buffcov finalcov**

After the final coverage is created, view it in ARCPLOT. The important items contained within the FINALCOV.PAT are INSIDE, LU-CODE, SUIT, and AREA. These will be used to determine a suitable site for the lab.

    Arc: **display 9999**
    Arc: **arcplot**
    Arcplot: **mapextent finalcov**
    Arcplot: **polygons finalcov**

After looking at the items of finalcov, quit ARCPLOT.

Tabular Analysis

In the following exercise, you will be performing tabular analysis on the feature attribute table of FINALCOV. Before performing the analysis, you need to add more items to the info table. Add items with the **ADDITEM** command you used in the *Attributing* exercises.

    Arc: **additem finalcov.pat finalcov.pat ha 4 6 f 2**
    Adding HA to FINALCOV.PAT to produce FINALCOV.PAT
    Arc: **additem finalcov.pat finalcov.pat cost 4 7 b**
    Adding COST to FINALCOV.PAT to produce FINALCOV.PAT
    Arc: **additem finalcov.pat finalcov.pat suitable 1 1 i**
    Adding SUITABLE to FINALCOV.PAT to produce FINALCOV.PAT

The item HA will contain a hectare calculation, COST will contain a purchase cost calculation, and SUITABLE will be used to select the polygons that meet the requirements for the proposed lab site. Examine the items of FINALCOV and list the pat.

    Arc: **items finalcov.pat**
    Arc: **list finalcov.pat**

Notice that the newly added items are all 0. They will be updated when you perform the tabular analysis.

When performing tabular analysis, you will use logical and arithmetic equations. Some of the following commands are used in tabular analysis.

RESELECT— selects a subset of the presently selected set based on the criteria the user specifies.

ASELECT— adds to the presently selected set of features.

Some operators used with the **RESELECT** and **ASELECT** commands include EQ for equal, LT for less than, GT for greater than, and CN for contains specified characters.

CALCULATE— calculates and assigns values to the selected set of features on the basis of criteria specified by the user.

Some operators used with the **CALCULATE** command include * for multiplication, / for division, and + for addition.

Performing Tabular Analysis

You will first be selecting and defining certain criteria for the most suitable sites for the proposed lab. After the selection is complete, the selected polygons should be brushland, with suitable soils, within the buffer area of sewers and streams, and be at least 2,000 m². Go into ARCPLOT to begin the exercise.

>   Arc: **arcplot**
>   Arcplot: **reselect finalcov poly lu-code = 300 and suit ge 2 and inside = 100 and area ge 2000**
>   *FINALCOV polys : 8 of 628 selected*

Any of these eight polygons are suitable sites for the proposed lab. Because these locations are suitable, assign them a SUITABLE value of 1 using the **CALCULATE** command.

>   Arcplot: **usage calculate**
>   *Usage: CALCULATE <cover> <feature_class> <target_item> = <arithmetic_expression>*
>   *Usage: CALCULATE <info_file> INFO <target_item> = <arithmetic_expression>*
>   Arcplot: **calculate finalcov poly suitable = 1**

This allows you to use the SUITABLE item to select suitable sites for the lab instead of using the multiple expression with **RESELECT**. List the items you used in this process.

>   Arcplot: **list finalcov poly lu-code,suit,inside,area,suitable**

Now use the **CALCULATE** command to estimate a purchase cost. First convert the area to hectares, then calculate a cost for each polygon.

```
Arcplot: list finalcov poly lu-code,suit,inside,area,suitable
Record  lu-code suit inside        area suitable
  173   300     2    100      5640.191 1
  228   300     2    100      5495.015 1
  286   300     2    100      7125.877 1
  309   300     3    100      7540.565 1
  323   300     2    100      2653.453 1
  333   300     2    100      3087.506 1
  347   300     2    100      2701.034 1
  473   300     2    100      2558.246 1
```

>   Arcplot: **calculate finalcov poly ha = area / 10000**
>   Arcplot: **calculate finalcov poly cost = ha * cost/ha**

```
Arcplot: list finalcov poly area,ha,cost/ha,cost
Record        area   ha cost/ha   cost
  173     5640.191 0.56   20000  11280
  228     5495.015 0.55   20000  10990
  286     7125.877 0.71   10000   7125
  309     7540.565 0.75   15000  11310
  323     2653.453 0.27   10000   2653
  333     3087.506 0.31   10000   3087
  347     2701.034 0.27   10000   2701
  473     2558.246 0.26   10000   2558
```

List the results of the calculations.

>   Arcplot: **list finalcov poly area,ha,cost/ha,cost**

Investigate and evaluate the results by displaying them in ARCPLOT.

Arcplot: **mapextent finalcov**
Arcplot: **polygonshades finalcov suitable**
Arcplot: **arcs template**
Arcplot: **linecolor red**
Arcplot: **arcs roads**

List the attributes of one of the sites by using the **IDENTIFY** command.

Arcplot: **identify finalcov poly ***, where the * lets you select a polygon interactively. Click within one of the polygons and the attributes for that site will be displayed. Look at as many sites as you wish using the **IDENTIFY** command.

Clear the selected polygons from FINALCOV and reselect the eight potential lab sites.

Arcplot: **clearselect**
Arcplot: **reselect finalcov poly suitable = 1**
FINALCOV polys: 8 of 628 selected

List certain items for the selected set.

Arcplot: **list finalcov poly suitable,cost,cost/ha,ha**

You can also draw text from the items in the pat. In this case, you will draw the text for the COST item.

Arcplot: **textcolor red**
Arcplot: **polygontext finalcov cost**

Think about any potential problems or assessments associated with the sites at this time. Some are suggested in the *Understanding GIS* (ESRI 1994) manual.

- Larger sites have a higher purchasing cost.
- Sites closer to the road may cost less to develop than sites farther from the road.
- When using the overlay operations, sliver polygons were created that, when combined with adjacent polygons, became suitable sites but were too small if they stood alone. You may have to study those sites further.

Evaluating Sliver Polygons

In the next exercise you will evaluate the areas adjacent to the sliver polygons. You may stay in ARCPLOT for this exercise.

First you will be refining the analysis by selecting the areas with LU-CODE = 300, SUIT GE 2, and INSIDE = 100.
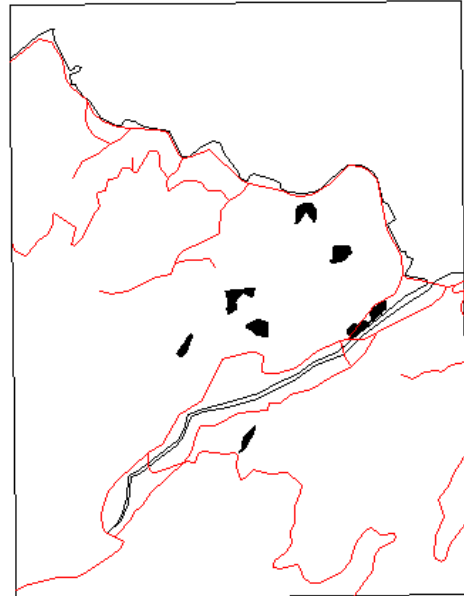
Arcplot: **clear**
Arcplot: **clearselect**
Arcplot: **reselect finalcov poly lu-code = 300 and suit ge 2 and inside = 100**
FINALCOV polys : 15 of 628 selected

List pertinent items for the selected set.

　　Arcplot: **list finalcov poly area,ha,cost,suitable**

Notice that some of the polygons are small in area. These are probably the sliver polygons. Now be aware of the polygons whose SUITABLE is 0 and whose AREA is greater than 500 m^2. They may be adjacent to suitable sites. Display the selected polygons.

　　Arcplot: **mapextent poly finalcov**
　　Arcplot: **polygons finalcov**

Reselect for polygons that are not yet potential sites.

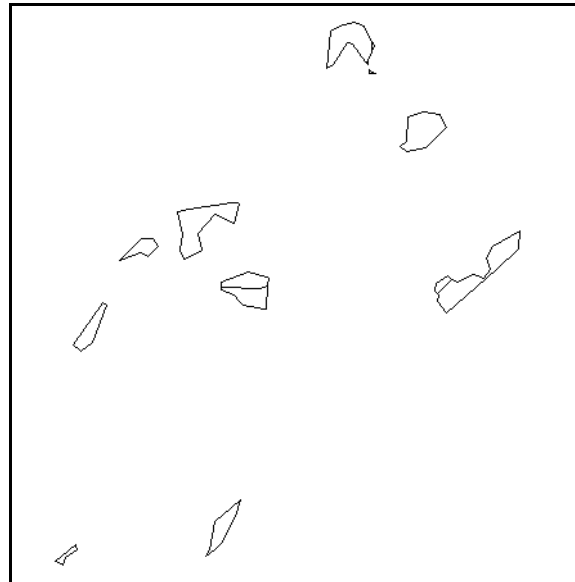　　Arcplot: **reselect finalcov poly suitable = 0**
　　FINALCOV polys: 7 of 628 selected

Calculate the HA values.

　　Arcplot: **calculate finalcov poly ha = area / 10000**

List the pertinent items.

　　Arcplot: **list finalcov poly area,ha,cost/ha,suitable**

These polygons meet all the criteria for the sites except for area. Select for the polygons with an area greater than 500 m^2.

　　Arcplot: **reselect finalcov poly area gt 500**
　　FINALCOV polys: 3 of 628 selected

List the pertinent items.

　　Arcplot: **list finalcov poly area,ha,cost/ha,suitable**

Check whether any of the selected areas are next to another suitable site.

```
Arcplot: list finalcov poly area,ha,cost/ha,suitable
Record          area     ha cost/ha suitable
   313     1721.481    0.17   10000  0
   327      580.889    0.06   15000  0
   513      646.498    0.06   15000  0
```

　　Arcplot: **polygonshades finalcov 1**

You should see that one of the selected polygons is adjacent to an existing suitable site, but the other two are not.

Eliminating and Analyzing Sliver Polygons

Now you want to get rid of sliver polygons and redefine the criteria for additional potential suitable sites. To get rid of sliver polygons you will use the **ELIMINATE** command at the ARC: prompt.

The **ELIMINATE** command allows you to delete or eliminate polygons on the basis of criteria specified by the user. The criterion you will be using is AREA less than (LT) 50. The features eliminated are assumed to be sliver polygons and they will dissolve into an adjacent polygon.

> Arc: **usage eliminate**
> *Usage: ELIMINATE <in_cover> <out_cover> {NOKEEPEDGE|KEEPEDGE} {POLY|LINE} {select_file}{BORDER|AREA}*
> Arc: **eliminate finalcov elimcov**
> *Eliminating polygons in FINALCOV to create ELIMCOV*
> *Enter a logical expression. (Enter a blank line when finished)*
> >: **RES AREA LT 50**　　　(you must be in all caps for the reselect)
> >: **<CR>**　　　　　　　(this is a hard return)
> *Do you wish to re-enter expression (Y/N)?* N
> *Do you wish to enter another expression (Y/N)?* N
> *　125 features out of 628 selected.*
> *Number of Polygons (Input,Output) =　 628　　504*
> *Number of Arcs　　　(Input,Output) =　 1389　1263*
> *　　Creating ELIMCOV.PAT...*
> Arc:

Display the results of the eliminate in ARCPLOT. Select a set of features with LU-CODE = 300, SUIT GE 2, and INSIDE = 100.

> Arc: **display 9999**
> Arc: **arcplot**
> Arcplot: **reselect elimcov poly lu-code = 300 and suit ge 2 and inside = 100**
> *ELIMCOV polys : 11 of 504 selected*

Display the selected set.

> Arcplot: **mapextent poly elimcov**
> Arcplot: **polygons elimcov**
> Arcplot: **polygonshades elimcov suitable**

Three polygons will not be shaded as suitable sites. However, one is adjacent to an existing suitable site, so change this polygon to be a suitable site by updating the SUITABLE value to 1.

> Arcplot: **reselect elimcov poly one ***

Click within the polygon. Only that polygon should be selected.

> Arcplot: **polygonshades elimcov 74**

The polygon you selected should be shaded in red.

Update the SUITABLE item to 1.

    Arcplot: **calculate elimcov poly suitable = 1**
    Arcplot: **clear**

Select the polygons whose SUITABLE item is 1.

    Arcplot: **aselect elimcov poly suitable = 1**
    ELIMCOV polys : 9 of 504 selected
    Arcplot: **polygonshades elimcov 74**
    Arcplot: **polygons elimcov**

Now you need to update the values for the HA and COST items for the newly modified polygons.

    Arcplot: **calculate elimcov poly ha = area / 10000**

    Arcplot: **calculate elimcov poly cost = ha * cost/ha**

List the results of the **CALCULATE** commands.

    Arcplot: **list elimcov poly area,ha,cost/ha,cost,suitable**

In this case, the refining of the analysis verified
the original criteria you set. It did not significantly
change the results.

```
Arcplot: list elimcov poly area,ha,cost/ha,cost,suitable
Record          area    ha cost/ha    cost suitable
   112      5688.768  0.57  20000   11377 1
   154      5495.015  0.55  20000   10990 1
   196      7125.877  0.71  10000    7125 1
   218      7540.565  0.75  15000   11310 1
   231      2653.453  0.27  10000    2653 1
   235       580.889  0.06  15000     871 1
   240      3087.506  0.31  10000    3087 1
   254      2701.034  0.27  10000    2701 1
   369      2558.246  0.26  10000    2558 1
```

Displaying a Map

In the following exercises you will be presenting your analysis in a graphical display. Read pages 9-1 through
9-17 in the *Understanding GIS* (ESRI 1994) manual before beginning the exercises.

Defining a Lookup Table

You will be displaying two types of roads, improved and semi-improved, on the map you create. To show
the two classes of roads with different symbols, you will create a lookup table. Make sure you are in the data
directory before you begin.

    sun% **arc**
    Arc: **info**

Remember to use all caps when you are in INFO.

    ENTER USER NAME> **ARC**
    ENTER COMMAND> **SELECT ROADS.AAT**
    45 RECORD(S) SELECTED

Now check the items of the ROADS.AAT and observe the item definition of RD-CODE.

    ENTER COMMAND> **ITEMS**

The item RD-CODE has an input and output width of 1 and is an integer field. Create a lookup table with this item and a new item called SYMBOL.

    ENTER COMMAND> **DEFINE RD.LUT**
      1
    ITEM NAME> **RD-CODE**
    ITEM WIDTH> **1**
    ITEM OUTPUT WIDTH> **1**
    ITEM TYPE> **I**
      2
    ITEM NAME> **SYMBOL**
    ITEM WIDTH> **2**
    ITEM OUTPUT WIDTH> **2**
    ITEM TYPE> **I**

Press "Enter" on the third item and list the items.

    ENTER COMMAND> **ITEMS**

For a lookup table to work, it must be in ascending order. Therefore, add your information in ascending order.

    ENTER COMMAND> **ADD**
      1
    RD-CODE> **1**
    SYMBOL> **6**
      2
    RD-CODE> **2**
    SYMBOL> **78**

On the third record press "Enter" and list the table.

    ENTER COMMAND> **LIST**

Quit INFO by typing **Q STOP**. You will use this lookup table when you draw the roads in ARCPLOT.

Legends are used to explain map symbols of features on a graphical display. In ARC/INFO a legend is a text file created in a texteditor. For each symbol there are two lines. The first line represents the symbol number used to display the feature and the second line is the descriptive text. When entering the symbol number, always precede it with a period. This tells the symbol set which specified symbol number to use. Open up a texteditor and create a legend for a linear coverage. Enter the following information as shown.

sun% **textedit &**

.6
Improved Road
.78
Semi-improved Road

Save the file as rd.key in the data directory.

Now display the legend. If you are at the sun% prompt, go into ARC.

Arc: **&term 9999**
Arc: **&popup rd.key**

After checking the file, quit the **&POPUP** menu and display the legend.

Arc: **display 9999**
Arc: **arcplot**

To specify the dimensions of the symbol display, use the **KEYBOX** command.

Arcplot: **usage keybox**
Usage: KEYBOX <width> <height>
Arcplot: **keybox 0.5 0**

Specify the location where you want to place the legend by using the **KEYPOSITION** command.

Arcplot: **usage keyposition**
Usage: KEYPOSITION < | xy>*
Arcplot: **keyposition ***

Using the * allows you to specify the location interactively. Position the cursor in the upper left-hand corner of the display window and click any mouse button. This will be the location of the upper left corner of the first legend box.

Draw the legend using the **KEYLINE** command.

Arcplot: **usage keyline**
Usage: KEYLINE <key_file | CLASS > {NOBOX} {NOTEXT}

You will be using the above argument.

    Arcplot: **keyline rd.key nobox**

By using the NOBOX option, the legend is drawn without boxes around the symbols.

Quit ARCPLOT. Next you will create a map of your analysis.

Creating a Map Composition

Many commands are introduced to you in this next exercise. The following list contains the basic steps in creating a map. The steps will help you understand the sequence of commands you specify in ARCPLOT.

- Indicate whether you want to display the map on the screen or on a graphics plotter.
- Specify the geographic location on the Earth's surface that you want to display (i.e., which coverage extent to use as the geographic location).
- Specify layout parameters about the map such as page size, map scale, and position of the geographic features.
- Draw the features you want on the map such as roads, streams, or land use types.
- Complete the map by adding descriptive cartographic elements such as titles, legends, scale bar, or north arrow.

Keep these guidelines in mind as you create the map. Make sure you are in the data directory for this exercise. You need the coverages TEMPLATE, FINALCOV, and ROADS for this exercise. If FINALCOV is not in the data directory, copy it from the directory where it presently resides. Go into ARCPLOT.

    Arc: **arcplot**

Once in ARCPLOT, you can specify if you want your map to display on the screen or be put into a graphics file or digital file. For this exercise, you will draw the map on the screen first and then create the graphics file later.

    Arcplot: **display 9999**

Specify the geographic location of the data you want displayed. Use the **MAPEXTENT** command. Think of the map extent as "your window to the world." It is defined by the boundary or bnd file of the coverage that you specify. Once the map extent is set, only those portions of the coverages that fall within that extent will be displayed. Map extent has to be defined every time a map is created or activated.

    Arcplot: **mapextent finalcov**

Now specify the parameters of the map such as page size, position of the features, and the scale of the map.

The graphics page (i.e., the physical page where the map elements are drawn) is set by the **PAGESIZE** command. Page size is usually in the units of inches or meters.

    Arcplot: **pagesize 10 8**

There is an optional command you can use to set the area within the map where the data will be placed. **MAPLIMITS** defines a boundary that the data will not extend beyond. Map limits can be changed within a map several times, depending on what the user wants or defines.

    Arcplot: **maplimits .25 .25 6.75 7.75**

Now position the features within the map limits. The command **MAPPOSITION** positions the features within the defined area by using a position the user specifies.

    Arcplot: **usage mapposition**
    Usage: MAPPOSITION </LL/LR/UL/UR/CEN/xy> <*/LL/LR/UL/UR/CEN/xy>*
    Arcplot: **mapposition cen cen**

Using the CEN CEN option will place the features in the middle of the defined map limits area.

Next you will specify the scale at which you want the coverages to be drawn. Scaling is performed on the basis of the coverage units (e.g., meters or feet). First specify the units the coverage is stored in, and then specify the scale to draw the coverage at.

    Arcplot: **mapunits meters**
    Arcplot: **mapscale 17000**

You now want to draw the coverage features. Coverage features can be displayed using different symbols. Just for practice, draw the ARCs of the TEMPLATE coverage with two different line symbols.

    Arcplot: **linesymbol 2**
    Arcplot: **arcs template**

Notice that the ARCs are drawn in red. Change the line symbol again.

    Arcplot: **linesymbol 1**

After setting the line symbol, notice that what is drawn is not affected. Setting a symbol only affects what is drawn afterward, not beforehand.

    Arcplot: **arcs template**

Now the ARCs should show in white. Clear the screen and open a map composition so that the features will be saved.

    Arcplot: **clear**

Once a map composition is opened, all features added will be saved. Each feature or coverage that is added is saved as a map element. You can manipulate map elements by moving them, resizing them, or deleting them. The command **MAP** opens a map composition that you can start adding features or elements to.

    Arcplot: **map sites.map**

The first element added to the map is a template of neatlines or borders, the north arrow, and the scale. These items are stored in a current map composition called border.map. To draw an existing map into another map composition use the **PLOT** command.

Arcplot: **plot border.map**

The elements drawn are common cartographic elements of a map. There is an empty area where you will add the other data layers from the analysis. Since a GIS is displayed in layers, you need to think about the order in which you want to place the features. In this case, you will want the roads on top of the potential sites, with the study area boundary as the last element drawn. If you draw elements in the incorrect order on a map, they can be reordered or deleted and re-added. You want to display only the potential sites so you need to select for them before you draw them.

Arcplot: **reselect finalcov poly suitable = 1**
FINALCOV polys : 8 of 628 selected

Now that the correct polygons are selected, you need to shade them. To shade polygons of a coverage use the **POLYGONSHADES** command. Before shading a coverage, you must decide which shade set you want to use. Various shade sets can be found at the back of the *Map Display, Query, and Output* manual. You will use the default shade set, which is plotter.shd.

Arcplot: **polygonshades finalcov 3**

The 3 specifies the color you want to shade the features with—in this case, green. The selected set of features should be the only ones shaded. Now draw the polygon lines for the selected features using the present line symbol (1). This line symbol will be drawn in black on paper, but will show up on the screen as white.

Arcplot: **polygons finalcov**

Draw the ROADS coverage using a red line symbol. To draw ARCs using a specified line symbol use the **ARCLINES** command.

Arcplot: **arclines roads 2**

Notice that all of the roads are drawn in red. What you really want to display are the two classes of roads, improved and semi-improved. Earlier you created a lookup table to be used in drawing the roads as different classes. Before drawing the roads with the lookup table, delete the roads you just drew by using the **MDELETE** command. The **MDELETE** command deletes only the selected elements in the map composition. The last element you add will always be the selected element unless you change it. Adding the roads was your last step so it will now be selected.

Arcplot: **mdelete**

Now that the ARCs disappeared from the screen and map, you can redraw the map using the **MFRESH** command.

Arcplot: **mfresh**

You will use the **ARCLINES** command again to draw the roads, but this time you will specify the item RD-CODE in the lookup table RD.LUT to draw on.

    Arcplot: **arclines roads rd-code rd.lut**

The roads should appear with two different symbols, a thick red line for the improved roads and a dashed red line for the semi-improved roads.

Using symbol 1, draw the study area boundary.

    Arcplot: **arcs template**

Now you will be drawing text that identifies the polygons you shaded earlier. The item you will draw text on will be Cover-ID. This item is used because it is a unique identifier that can be used to cross-reference with a written report. Set the size of the text by using the **TEXTSIZE** command and draw the text by using the **LABELTEXT** command.

    Arcplot: **textsize .15**
    Arcplot: **labeltext finalcov finalcov-id**

The text of the selected polygons should appear next to the polygon feature.

Finally, you will be adding additional information to the map by drawing the legend and the title. The legend will be drawn using the **KEYLINE** command you used earlier. First you must set the parameters of the legend before you draw it by specifying the text and the size of the legend you want.

    Arcplot: **textset font**
    Arcplot: **textsymbol 14**
    Arcplot: **textsize .20**
    Arcplot: **keybox .5 0**
    Arcplot: **keyposition 7.0 7.2**
    Arcplot: **keyline rd.key nobox**

The legend should appear on the map.

Next draw the title to complete the map. Set the text you want to use for the title, then add the title by using the **TEXT** command.

    Arcplot: **textsymbol 16**
    Arcplot: **textsize .30**

Before adding the title you must also specify where you want to place it using the **MOVE** command.

    Arcplot: **move 0.8 7.4**

The position specified by the **MOVE** command will place the text with the lower left corner of the text as the reference point. Now add the title.

    Arcplot: **text 'Potential Sites for Aquaculture Lab'**

You can always reposition an element (e.g., the title) using the **MMOVE** command. If you need to reposition or center the title, use the **MMOVE** with the * option.

    Arcplot: **mmove ***

The asterisk allows you to interactively select where you want to move from and to. Once the title is correctly positioned, the map is complete.

To make a hard copy of the map, first create a graphics file, plot the map into the graphics file, and then send it to the plotter. The command for creating a graphics file is **DISPLAY** with the 1040 option.

    Arcplot: **display 1040**
    Enter graphics filename: **sites.gra**
    Arcplot: **plot sites.map**

When you type display 1040 the display window will disappear. The .gra extension is the naming convention for graphic files. **PLOT** is the command used when plotting the map into the graphics file.

Before sending the map to the plotter, draw the graphics file. You can draw graphics files from the ARC: prompt.

    Arcplot: **quit**
    Arc: **display 9999**
    Arc: **draw sites.gra**

The graphics file will now be drawn. It should look exactly like the map.

    Hit <CR> to continue: **<CR>**

Remember <CR> is a carriage return.

Before sending the map to the plotter, you will need to convert the graphics file to an rtl format, which the plotter can interpret and print.

    Arc: **rtl sites.gra sites.rtl**
    Arc: **quit**

Now send the map.

    sun% **lp -d hpdj1 sites.rtl**

The printer designation may change, so please check with your supervisor if the above command does not work.

Creating an Area Report

One of the last steps that you can perform when analyzing data sets is creating and printing a report. A report will show items such as a date, a title, headings, and the information that you specify based on the items in the feature attribute table. To create a report you will use INFO.

    Arc: **info**
    ENTER USER NAME> **ARC**
    ENTER COMMAND> **SELECT FINALCOV.PAT**
      628 RECORD(S) SELECTED

After selecting the info file from which the report will be created, select the records that are suitable sites for development.

    ENTER COMMAND> **RESELECT SUITABLE = 1**
      8 RECORD(S) SELECTED

Use the **OUTPUT** command to specify the path name and text file name that will hold the report information. Use the INIT parameter to ensure that the new file will replace any existing file of the same name.

    ENTER COMMAND> **OUTPUT ../FINAL.REP INIT**

Use the **REPORT** command to begin creating a report of items from FINALCOV.PAT.

    ENTER COMMAND> **REPORT**

When creating a report, you will be prompted to define each column in the report. You will enter the name of the item for the column, the formatting options, and a text heading for the column. The first prompt will be COLUMN CONTENT, or an item name—in this case, FINALCOV-ID.

    2 ENTER COLUMN CONTENT> **FINALCOV-ID**

For the REPORT OPTIONS prompt press "Enter" and the default option will be used to list the item values for FINALCOV-ID.

    ENTER REPORT OPTIONS> **<CR>**

For the next prompt, enter SITE# for the COLUMN HEADING.

    ENTER COLUMN HEADINGS> **SITE#**

Press "Enter" for the second COLUMN HEADING.

    ENTER COLUMN HEADINGS> **<CR>**

Enter the following information for the other two columns, AREA and COST.

    7 ENTER COLUMN CONTENT> **AREA**

ENTER REPORT OPTIONS> **\<CR\>**
ENTER COLUMN HEADINGS> **AREA**
ENTER COLUMN HEADINGS> **\<CR\>**

20 ENTER COLUMN CONTENT> **COST**
ENTER REPORT OPTIONS> **\<CR\>**
ENTER COLUMN HEADINGS> **COST**
ENTER COLUMN HEADINGS> **\<CR\>**

Press "Enter" at the next prompt to stop entering columns into the report.

28 ENTER COLUMN CONTENT> **\<CR\>**

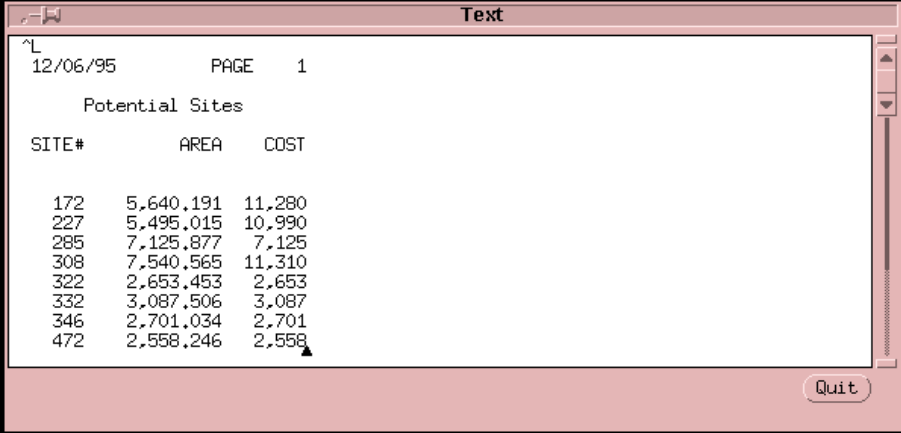Enter the title of the report at the next prompt.

ENTER REPORT TITLE> **'Potential Sites'**

Now send this information to the output file created earlier, final.rep.

DO YOU WISH TO EXECUTE THIS FORM (Y OR N) > **Y**
OUTPUT TO PRINTER (Y OR N) > **Y**
LINES PER PAGE?> **\<CR\>**
ENTER REPORT OPTIONS> **\<CR\>**

When INFO is finished sending the information to final.rep, quit INFO using **Q STOP**. Display the report in a &popup window and then send it to the printer.

Arc: **&term 9999**
Arc: **&popup**
final.rep

```
┌─┌┐─────────────────────── Text ───────────────────────────┐
│ ^L                                                       ▲ │
│  12/06/95       PAGE    1                                  │
│                                                         ▼ │
│        Potential Sites                                     │
│                                                           │
│  SITE#        AREA    COST                                │
│                                                           │
│                                                           │
│    172    5,640,191  11,280                               │
│    227    5,495,015  10,990                               │
│    285    7,125,877   7,125                               │
│    308    7,540,565  11,310                               │
│    322    2,653,453   2,653                               │
│    332    3,087,506   3,087                               │
│    346    2,701,034   2,701                               │
│    472    2,558,246   2,558▲                              │
│                                                           │
│                                              ( Quit )     │
└───────────────────────────────────────────────────────────┘
```

Quit the &popup window and print the report.

Arc: **lp -d south5si final.rep**

The print command and printer destination may vary. If the command does not work, contact the supervisor.

In the following exercise, you will be creating another map for display. The map you generate will display the potential sites, the surrounding land cover, improved roads, and the streams. Before starting the ARCPLOT session to create the map, edit the final.rep file. Delete the first two lines containing the page number and date.

    sun% **textedit final.rep &**

Once the textedit window appears, make the changes and save the file. Then start an ARCPLOT session.

    Arc: **display 9999**
    Arc: **arcplot**

To make a map, you must first open a new map composition by using the **MAP** command.

    Arcplot: **map lab.map**

Once the map composition is open, set the parameters for the map. Each time a new map is created or activated, you need to set the parameters. Remember, there are five commands used to set the parameters of a map.

1. **PAGESIZE** - sets the size of the map
2. **MAPEXTENT** - sets the geographic extent of the map
3. **MAPUNITS** - sets the units the data will be displayed in (inches, meters, or feet)
4. **MAPSCALE** - sets the scale of the map
5. **MAPPOSITION** - sets the position where the data will be displayed within the viewing area
Set the parameters for your map.

    Arcplot: **pagesize 36 24**
    Arcplot: **mapextent 4550 5090 6090 6740**

When using map extent you can either use coordinates or specify a coverage to set the geographical location of the map.

    Arcplot: **mapunits meters**
    Arcplot: **mapscale 3000**
    Arcplot: **mapposition cen cen**
    Arcplot: **maplimits 1 0 18.5 23**

Now that the map is set up, you can add coverage features and other elements. To add features, you will use the commands given in the section *Creating a Map Composition*.

The first feature to display on the map is the polygons of the LANDUSE coverage. You will shade them by using the **POLYGONSHADES** command. Use the **SHADESET** command to specify a shade set.

    Arcplot: **shadeset carto.shd**

To shade the LANDUSE coverage based on LU-CODE, a lookup table is already created called labplot.lut. Use the lookup table to shade the coverage.

Arcplot: **polygonshades landuse lu-code labplot.lut**

Select the suitable sites from FINALCOV and draw them using a thick, black line.

Arcplot: **reselect finalcov poly suitable = 1**
FINALCOV polys: 8 of 628 selected
Arcplot: **linesymbol 5**
Arcplot: **polygons finalcov**

Next draw the streams according to the major and minor code. To draw the ARCs of a coverage that have different values, use the **ARCLINES** command.

Arcplot: **arclines streams strm-code streams.lut**

The ARCs were drawn by using the item STRM-CODE and the streams.lut lookup table. Select the improved roads and draw them with a red line.

Arcplot: **reselect roads arcs rd-code = 1**
ROADS arcs: 18 of 45 selected
Arcplot: **linesymbol 2**
Arcplot: **arcs roads**

Draw the IDs that correspond to each of the suitable sites. First specify a text size and then use **POLYGONTEXT** to draw the Ids.

Arcplot: **textsize 16 pt**
Arcplot: **polygontext finalcov finalcov-id**

Next, add a reference map that shows the larger extent of the location you are displaying. The reference map will be smaller than the other portion of the map. Set new parameters to draw in the reference map.

Arcplot: **maplimits 19.5 0.25 26.5 10**
Arcplot: **mapextent template**
Arcplot: **mapscale auto**

By using an automatic map scale, the coverage will fit as large as possible in the specified map limits. Shade the TEMPLATE coverage as land and water. First you will shade the land.

Arcplot: **reselect template poly lu-code ne 500**
TEMPLATE polys: 2 of 3 selected
Arcplot: **polygonshades template 329**

To shade the water, use the **NSELECT** command. **NSELECT** changes the unselected set of features to the selected set and vice versa.

Arcplot: **nselect template poly**
TEMPLATE polys: 1 of 3 selected
Arcplot: **polygonshades template 431**

Draw a box on the reference map showing the area of the suitable sites by using the **BOX** command. First make sure ARCPLOT knows what units the coordinates are in when you give the **BOX** command.

Arcplot: **units map**

This sets the units to the same units as the map.

Arcplot: **linesymbol 5**
Arcplot: **box 4550 5090 6090 6740**

Draw the ARCs for the TEMPLATE coverage.

Arcplot: **linesymbol 1**
Arcplot: **arcs template**

Keep in mind that the **ARCS** and **POLYGONS** commands are different. When you reselected on the polygons the ARCs were not affected. Therefore, all of the ARCs should have been displayed.

Set the units back to page units for adding the rest of the elements.

Arcplot: **units page**

Add the report you edited earlier. Set the text parameters and position for the text file.

Arcplot: **textfont triumvirate**
Arcplot: **textquality proportional**
Arcplot: **textsize 36 pt**
Arcplot: **move 20 21**

The **MOVE** command positions elements where the user specifies. Use the **TEXTFILE** command to display final.rep.

Arcplot: **textfile final.rep**

Now add more boxes and lines to separate additional elements.

Arcplot: **linesymbol 5**
Arcplot: **box 0 0 36 24**
Arcplot: **linesymbol 1**
Arcplot: **box 0.25 0.25 35.75 23.75**

These boxes create a double-lined border.

Use the **LINE** command to separate different parts of the map.

    Arcplot: **line 27.75 23.75 27.75 0.25**
    Arcplot: **line 27.75 5 35.75 5**
    Arcplot: **line 31.75 5 31.75 0.25**

Add a north arrow to the map. A north arrow has been created and is stored in the NORTHARR coverage.

    Arcplot: **maplimits 28 1 31.5 5**
    Arcplot: **mapextent northarr**
    Arcplot: **arcs northarr**

Add the university logo, which is stored in the ULOGO coverage.

    Arcplot: **maplimits 31.5 1 36 5**
    Arcplot: **mapextent ulogo**
    Arcplot: **mapscale auto**
    Arcplot: **annotext ulogo**

To enlarge the logo, use the **MFIT** command with the * option to draw the box interactively.

    Arcplot: **mfit ***

Start the box in the upper left-hand corner of the small area and drag it to the lower right-hand end of the area. The logo will be redrawn at a larger size. If the logo is not centered, you can use the **MMOVE** command to reposition it.

The **ANNOTEXT** command adds annotation or text from a coverage to the map. The ULOGO coverage is stored as annotext.

Draw the scale beneath the north arrow. Show the scale as a representative fraction. Set the parameters for the scale and draw it.

    Arcplot: **textsize .40**
    Arcplot: **move 28.5 0.5**
    Arcplot: **text 'Scale 1:3,000'**

Finally, you will add legends and a title. There are two legends, labplot.key designating land cover and labmap.key designating the roads and streams. Specify the area where you want to put the legends by using the **KEYAREA** command. Also, specify the size of the legend boxes by using the **KEYBOX** command.

    Arcplot: **keyarea 28.5 22 35 5.5**
    Arcplot: **keybox .6 .6**
    Arcplot: **keyseparation 1 1**

KEYSEPARATION specifies the distance between each symbol box. First display the labplot.key.

Arcplot: **textsize .6**
Arcplot: **keyshade labplot.key**

Specify the symbol box size for the labmap.key and draw the legend.

Arcplot: **keybox .6 0**
Arcplot: **keyline labmap.key nobox**

Add the title for the map. First set the text parameters, then use the **TEXTFIT** command to add the title.

Arcplot: **textfont 'times bold'**
Arcplot: **textsize .8**
Arcplot: **textfit 'Potential University Lab Sites' 2 22.75 25.75 22.75**

Now that the map is complete, convert it to a graphics format.

Arcplot: **display 1040**
Enter output filename: **lab.gra**
Arcplot: **plot lab.map**

Quit ARCPLOT. Check with the supervisor to make sure the plotter is available, and send the map to the plotter.

Arcplot: **quit**
Arc: **rtl lab.gra lab.rtl**
Arc: **quit**
sun% **lp -d hpdj1 lab.rtl**

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13. ABSTRACT (Maximum 200 words)

This manual provides training for student interns in Geographic Information Systems (GIS). The manual provides an overview of GIS and uses standard operating procedures generated at the Environmental Management Technical Center (EMTC). Included are exercises for digitizing, editing, attributing, projecting, mapjoining, manipulating, analyzing, and displaying geographic data. Training with this manual allows students to receive hands-on experience with GIS to prepare them for projects at the EMTC.

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