Chapter 5 *GIS Applications*

Objectives

In this chapter we will use GRASS to locate imaginary sites which might be used for the location of a landfill in the Spearfish dataset. In doing so we will include data from various layers which will include: roads, streams, geology, slope, soils, and landuse. While the criteria used for the selection of sites in the example are by no means justified, they serve to show how a GIS can be used to suggest answers to similar questions. Real world applications would involve more detailed and defensible criteria.

At the end of this chapter you should be able to:

1. Define the following terms:

    - binary map

2. Use the following commands in GRASS:

    - r.reclass
    - r.report
    - r.mapcalc
    - r.clump
    - d.what.rast
    - r.buffer

3. Explain the difference between a binary data layer and a regular data layer.

4. Structure a problem so that it may be solved as easily and quickly as possible.

DRAFT

Development of Criteria

Before we can begin working exclusively with the computer we must first define the criteria that we will use in finding the imaginary landfill sites. Each data layer will have a different use in the problem so each will have to be defined independently. Here are some arbitrary criteria for each of the layers and a short explanation of why they might be used:

Data Layer	Criteria [†]	Reasoning
roads	within 500 meters	The landfill mus have good access.
streams	beyond 500 meters	To avoid direct runoff into streams.
landuse	away from currently developed areas.	To avoid locating too close to residential areas.
geology	impermeables	Locate on a site which will not be succeptible to penetration by chemicals, etc.
slope	low slopes	To avoid excess erosion near the site.
soils	clays (and loams)	To avoid sandy soils.

[†] *These criteria are general and should be carefully considered in a real world application.*

By using these criteria we hope to find only a few suitable areas which can be used to locate the site. From this we can further reduce the number of areas by looking at their size and characteristics more closely. In this example we will select sites which are greater than ten acres to further reduce the number of suggested sites.

Before we begin

If you haven't already started GRASS do so now. Refer to Chapter 3 for details. Next, execute the following commands to be sure that you have your window set correctly and the graphics display in fixed mode.

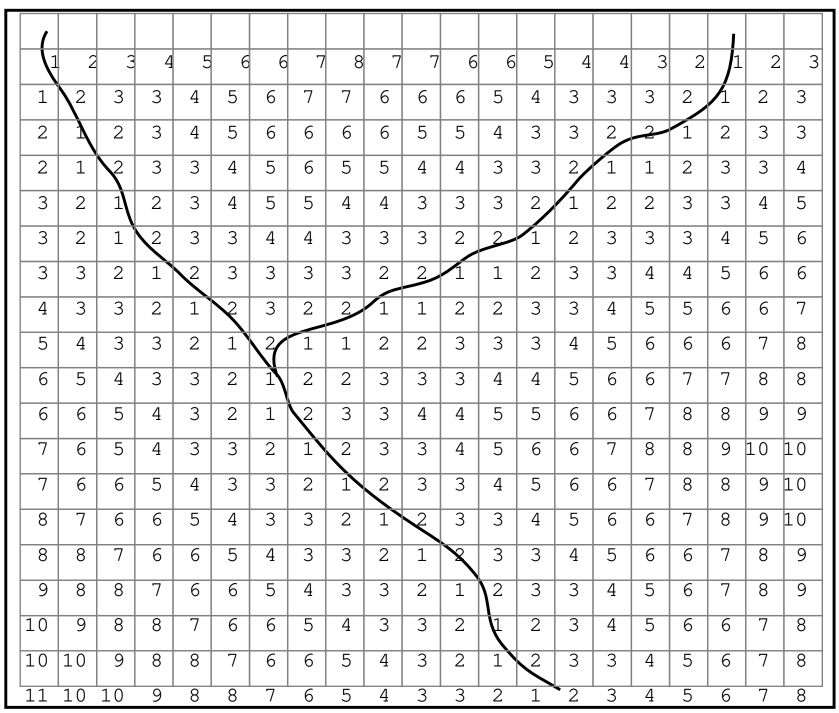
DRAFT

- d.colormode fixed
- g.region -d
- d.frame -e
- g.region -p

Now, write down the values of the rows and columns which will be 140 and 190 respectively from the text terminal. We will use these later.

Distance calculations

To satisfy the first three criteria, within 500 meters of roads, beyond 500 meters of streams, and beyond 500 meters of residential areas, we will have to generate distance data layers. Distance maps are created by representing categories as proximity zones about corresponding categories on an existing data layer. In the following example, distances were calculated in one cell increments from streams. Notice that the streams, the category from which the distances were calculated, are represented as *0* or *no data*. The value of the selected category will always be 0 in a distance map.



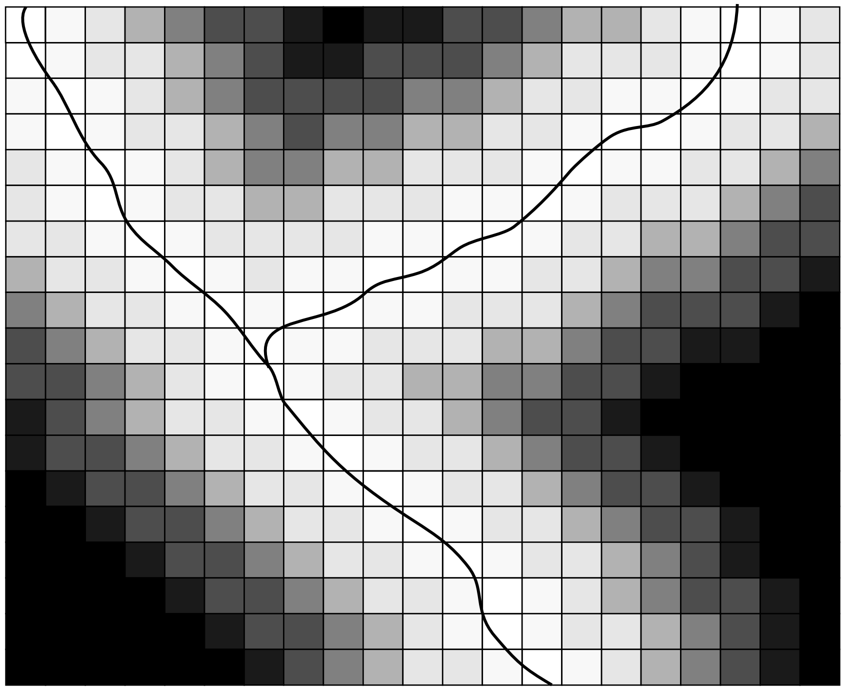
Distance map generated from streams. Notice that the value for the streams is 0.

GRASS represents distance maps in shades of gray similar to the map shown below. Categories can be grouped in the distance

DRAFT

function to generalize the map. Below, cells which are 7 to 10 cells from the streams are all represented in black as the seventh category.

Distance map calculated from streams. The areas which are more than seven cells from the streams are grouped into one category.



To generate the maps, first run the *r.buffer* module.

r.buffer

Specify *roads* as the data layer which contains the categories and *roads.buf* as the new file to contain the distance-from results.

roads
roads.buf

The next screen which appears is used to select the distances by which the categories will be defined in the new file. Notice that the distances are measured in meters. You may change this to any of standard unit of measure (i.e. mile, feet, etc).

Since we are interested only in areas which fall within 500 meters of roads, we can group the data into three categories, those areas of no data, those within the 500 meter boundary and those outside the boundary. See the following figure for category values.

DRAFT

```
                  ENTER MAXIMUM DISTANCE FOR EACH ZONE DESIRED
                       All values in:  meters______
ZONE  1:  500_______    ZONE 21:  0_________    ZONE 41: 0_________
ZONE  2:  33000_____    ZONE 22:  0_________    ZONE 42: 0_________
ZONE  3:  0_________    ZONE 23:  0_________    ZONE 43: 0_________
ZONE  4:  0_________    ZONE 24:  0_________    ZONE 44: 0_________
ZONE  5:  0_________    ZONE 25:  0_________    ZONE 45: 0_________
ZONE  6:  0_________    ZONE 26:  0_________    ZONE 46: 0_________
ZONE  7:  0_________    ZONE 27:  0_________    ZONE 47: 0_________
ZONE  8:  0_________    ZONE 28:  0_________    ZONE 48: 0_________
ZONE  9:  0_________    ZONE 29:  0_________    ZONE 49: 0_________
ZONE 10:  0_________    ZONE 30:  0_________    ZONE 50: 0_________
ZONE 11:  0_________    ZONE 31:  0_________    ZONE 51: 0_________
ZONE 12:  0_________    ZONE 32:  0_________    ZONE 52: 0_________
ZONE 13:  0_________    ZONE 33:  0_________    ZONE 53: 0_________
ZONE 14:  0_________    ZONE 34:  0_________    ZONE 54: 0_________
ZONE 15:  0_________    ZONE 35:  0_________    ZONE 55: 0_________
ZONE 16:  0_________    ZONE 36:  0_________    ZONE 56: 0_________
ZONE 17:  0_________    ZONE 37:  0_________    ZONE 57: 0_________
ZONE 18:  0_________    ZONE 38:  0_________    ZONE 58: 0_________
ZONE 19:  0_________    ZONE 39:  0_________    ZONE 59: 0_________
ZONE 20:  0_________    ZONE 40:  0_________    ZONE 60: 0_________
              AFTER COMPLETING ALL ANSWERS, HIT <ESC> TO CONTINUE
                             (OR <Ctrl-C> TO CANCEL)
```

Notice that the second zone's limit is set very high. Remember those numbers you wrote down? The number used for zone 2 is the result of adding the rows and columns and multiplying by the resolution. It insures that all cells beyond 500 meters will be included in the second zone. A simple way to determine a suitable number to enter for such a value would be to determine a value which is larger than the diagonal distance accross the map. In this case add the rows (140) to the columns (190) which equals 330, then multiply 330 by the resolution (100) which is equal to 33,000. Remember, you can

$$(140 + 190)\,100 = 33000$$

view the current window settings by typing *g.region -p*. When you have finished with this screen use *Esc* to continue.

`[Esc]`

We will now have to wait while r.buffer calculates the distance map. When it finishes, check the map to see if it is what you expectected by using *d.rast roads.buf*.

`d.rast roads.buf`

Streams:

The next distance map to be calculated should be the distance

DRAFT

from streams. The areas we will be interested in are those beyond 500 meters of the streams. First, lets determine which of the categories in the streams map we will use in calculating distances. Generate a report by typing: *r.report streams*. The report will look similar to the one below.

```
r.report streams
```

Report on streams using the r.report command. Categories 1 - 5 are used in the distance calculations.

```
|-----------------------------------------------------------------------|
| Layer:    [streams] in mapset [PERMANENT] Date: Mon Jun 3 09:55:34 |
| Location: spearfish                                                   |
| Title:    Hydrography                                                 |
| Mask:     none                                                        |
|-----------------------------------------------------------------------|
|            north:  4928000.00  east:   609000.00                      |
| Window:    south:  4914000.00  west:   590000.00                      |
|            res:        100.00  res:       100.00                      |
+-----------------------------------------------------------------------+

+-----------------------------------------------------------------------+
| cat#              Name                                                |
|-----------------------------------------------------------------------|
|    0 | no data                                                        |
|    1 | perennial stream                                               |
|    2 | intermittent stream                                            |
|    3 | aqueduct                                                       |
|    4 | shoreline                                                      |
+-----------------------------------------------------------------------+
```

DRAFT

Because we will calculate distances from all of the categories (except 0) we will not need to reclass the map before we run *r.buffer.* However, with landuse we will have to first prepare an intermediate map before running the command.

This time to calculate the map, use a less interactive version of r.buffer, by specifying input and output maps. Start by typing *r.buffer input=streams output=streams.buf distances=500,33000 units=meters*.

```
r.buffer input=streams output=streams.buf
                                        distances=500,33000 units=meters
```

GRASS starts the buffer program running. This should only take a few seconds to finish. You might look at the new data layer using *d.rast streams.dist*.

```
d.rast streams.dist
```

Landuse:

The next distance map that we will calculate will be the buffer zone around land already in use. First, generate a report of the data layer so that we can choose which categories to calculate distances from. Use *r.report landuse*. The results should appear as follows.

r.report landuse

```
+-----------------------------------------------------------------------------+
|                              RASTER MAP CATEGORY REPORT                     |
|LOCATION: spearfish                                  Fri Oct 18 21:29:53 1991|
|-----------------------------------------------------------------------------|
|          north: 4928000    east: 609000                                     |
|REGION    south: 4914000    west: 590000                                     |
|          res:       100    res:     100                                     |
|-----------------------------------------------------------------------------|
|MASK:none                                                                    |
|-----------------------------------------------------------------------------|
|MAP: Land Use (landuse in PERMANENT)                                         |
|-----------------------------------------------------------------------------|
|                                 Category Information                        |
|#|description                                                                |
|-----------------------------------------------------------------------------|
|0|no data                                                                    |
|1|residential                                                                |
|2|commercial and services                                                    |
|3|industrial                                                                 |
|4|other urban                                                                |
|5|reservoirs                                                                 |
|6|bare exposed rock                                                          |
|7|quarries, strip mines and gravel pits                                      |
|8|transportation and utilities                                               |
+-----------------------------------------------------------------------------+
```

For solving the problem, we will involve 6 of the 8 categories above, excluding bare and exposed rock as well as quarries, strip mines and gravel pits as these seem to be acceptable locations to locate.

This means that we will have to calculate our distances from categories 1 - 5 and 8, giving each a buffer of 500 meters. To do this means that we will have to first reclass the landuse map so that categories 6 and 7 are not included in the buffer calculations. Start with the *r.reclass* command.

r.reclass

DRAFT

```
RECLASS:  Program for reassigning category codes

Enter name of data layer to be reclassified
Enter 'list' for a list of existing raster files
Enter 'list -f' for a list with titles
Hit RETURN to cancel request
> landuse
<landuse>

Enter name of NEW RECLASSIFIED map
Enter 'list' for a list of existing raster files
Enter 'list -f' for a list with titles
Hit RETURN to cancel request
> landuse.tmp
```

Specify landuse as the original map layer and landuse.tmp as the new/reclassified map.

landuse
landuse.tmp

```
Please indicate how you would like the reclass table initialized



              0_


  0   All values set to zero
  1   All values set to the same category number
```

Set all of the categories equal to 0 and continue on to the next screen.

[Esc]

DRAFT

```
   ENTER NEW CATEGORY NUMBERS FOR THESE CATEGORIES

   OLD CATEGORY NAME                                            OLD   NEW
                                                                NUM   NUM

no data . . . . . . . . . . . . . . . . . . . . . . . . . . .   0     0____
residential . . . . . . . . . . . . . . . . . . . . . . . . .   1     1____
commercial and services . . . . . . . . . . . . . . . . . . .   2     1____
industrial  . . . . . . . . . . . . . . . . . . . . . . . . .   3     1____
other urban . . . . . . . . . . . . . . . . . . . . . . . . .   4     1____
reservoirs  . . . . . . . . . . . . . . . . . . . . . . . . .   5     1____
bare exposed rock . . . . . . . . . . . . . . . . . . . . . .   6     0____
quarries, strip mines and gravel pits . . . . . . . . . . . .   7     0____
transportation and utilities  . . . . . . . . . . . . . . . .   8     1____


           Next category: end__  (of 8)





               AFTER COMPLETING ALL ANSWERS, HIT <ESC> TO CONTINUE
                             (OR <Ctrl-C> TO CANCEL)
```

Now, place a 1 beside those categories from which we will calculate buffers from. Continue on with the reclass by hitting [Esc]. Since this is only a temporary file, you don't need to bother with the Title and category label page. Simple hit [Esc] again to start the reclass.

[Esc]
[Esc]

We are now ready to generate the buffer map. Use *r.buffer input=landuse output=landuse.dist distances=500,33000 units=-meters* to start the process.

```
r.buffer input=landuse.tmp output=landuse.dist
                                        distances=500,33000 units=meters
```

GRASS calculates the map and returns a prompt to you. *d.rast* the new data layer for a visual check.

Dcell landuse.dist

Generation of Binary Data Layers:

The next step in locating the landfill site is to generate binary maps for the three buffer layers that we have just created (roads.buf, streams.buf, landuse.buf) as well as for the geology, soils, and slope data layers. Binary maps are those which are made up of only 1's and

DRAFT

0's. In our case the 1's will be acceptible areas for locating a landfill and 0's will be unacceptible.

To accomplish this we will use a series of reclassifications to group acceptible categories into the category value 1 as well as group unacceptable categories into the category value 0.

Begin with the roads buffer map. Generate a report of the layer using *r.report roads.buf*. You should see the following.

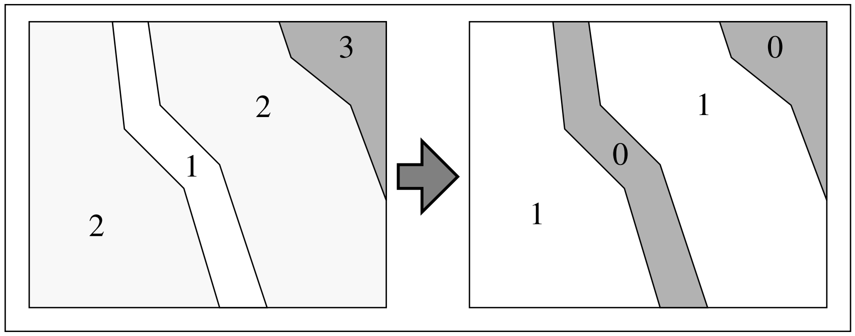
`r.report roads.buf`

```
+-----------------------------------------------------------------------------+
|                         RASTER MAP CATEGORY REPORT                          |
|LOCATION: spearfish                                  Tue Nov  5 13:59:59 1991|
|-----------------------------------------------------------------------------|
|          north: 4928000    east: 609000                                     |
|REGION    south: 4914000    west: 590000                                     |
|          res:       100    res:     100                                     |
|-----------------------------------------------------------------------------|
|MASK:none                                                                    |
|-----------------------------------------------------------------------------|
|MAP: Distance Zones (roads.buf in grassx)                                    |
|-----------------------------------------------------------------------------|
|                            Category Information                             |
|#|description                                                                |
|-----------------------------------------------------------------------------|
|1|distances calculated from these locations                                  |
|2|500 meters                                                                 |
|3|33000 meters                                                               |
+-----------------------------------------------------------------------------+
```

DRAFT

By looking at the report, we see that there are no areas of no data and that there are three categories found in the map. Returning to our criteria we can develop a reclassification scheme for the data. First, the site really can't be located "on" and exitsting road but rather adjoining one. There for category 1, "distances calculated from these locations" is and unacceptible category and should be made to be a 0. Secondly, the site must be within 500 meters of a road which is satisfied only by category 2. Category 2 therefore should be reclassified to category 1 or acceptible. Lastly, those areas beyond 500 meters are unacceptible and should be reclassified as category 0.

Consequently if we were to map our pending reclassification for roads.buf it would look like:



Now reclassify the buffer map to a binary data layer by using *r.reclass*.

r.reclass

```
RECLASS:  Program for reassigning category codes

Enter name of data layer to be reclassified
Enter 'list' for a list of existing raster files
Enter 'list -f' for a list with titles
Hit RETURN to cancel request
> roads.buf
<roads.buf>

Enter name of NEW RECLASSIFIED map
Enter 'list' for a list of existing raster files
Enter 'list -f' for a list with titles
Hit RETURN to cancel request
> roads.landfill
```

After entering the name of the original file followed by the name of the new map GRASS will ask how you would like the data to appear in the reclass menu.

```
Please indicate how you would like the reclass table initialized



               0_


  0   All values set to zero
  1   All values set to the same category number
```

Select *0 - All values set to zero*. GRASS then provides you with a list of categories by which you can select new category numbers to reclass the map. Here we can apply the values that were discussed above. Enter a 1 next to category 2 (500m bufer) and leave the rest of the categories 0.

DRAFT

```
   ENTER NEW CATEGORY NUMBERS FOR THESE CATEGORIES

   OLD CATEGORY NAME                                              OLD   NEW
                                                                  NUM   NUM

  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   0     0____
distances calculated from these locations . . . . . . . . . . .   1     0____
500 meters  . . . . . . . . . . . . . . . . . . . . . . . . . .   2     1____
33000 meters  . . . . . . . . . . . . . . . . . . . . . . . . .   3     0____


           Next category: end__  (of 3)







               AFTER COMPLETING ALL ANSWERS, HIT <ESC> TO CONTINUE
                             (OR <Ctrl-C> TO CANCEL)
```

[Esc]

Hit *[Esc]* to continue to the last page. Here GRASS asks you to enter category labels to the new reclassified map. Enter “Acceptable Roads” for the new title, and since we have two categories, 0-unacceptible and 1-acceptible, we can enter this beside the correct category. See below.

```
[roads.landfill]  ENTER NEW CATEGORY NAMES FOR THESE CATEGORIES

TITLE:  Acceptible Roads__________________________________
CAT   NEW CATEGORY NAME
NUM
 0   unacceptible________________________________________________
 1   acceptible__________________________________________________


           Next category: end__  (of 1)







               AFTER COMPLETING ALL ANSWERS, HIT <ESC> TO CONTINUE
                             (OR <Ctrl-C> TO CANCEL)
```

GRASS reclasses the map. You can display the new map by using *d.rast roads.landfill*.

DRAFT

```
d.rast roads.landfill
```

Streams

Next, we need to reclassify the streams.buf file to become a binary map layer. This time, however, we will use a faster implementation of the r.reclass command.

The streams reclassification will be much like the roads, only for the streams, the acceptible areas are beyond the 500 meter buffer zone. Therefor, categories 0 through 2 will be set to 0 and category 3 will be set to 1. Use the following command to start the command line version of r.reclass.

```
r.reclass input=streams.buf output=streams.landfill
                                        title="Acceptible Streams"
> 0 thru 2 = 0 unacceptible
> 3 = 1 acceptible
> end
```

GRASS reclasses the map and returns the GRASS> prompt. Check that the map is correct by running the following two commands.

```
d.rast streams.landfill
d.what.rast
```

Check to see if the areas you expected to be acceptible or unnacceptible are that.

Landuse

The Landuse map is virtually the same as the streams reclass. Acceptible area will be those beyond 500 meters of a landuse buffer while unacceptible areas are those within the landuse regions and their buffer. Use the following command to perform the reclass.

```
r.reclass input=landuse.tmp output=landuse.landfill
                                        title="Acceptible Landuse"
> 0 thru 2 = 0 unacceptible
> 3 = 1 acceptible
> end
```

Display the map and check it accuracy as you did for streams.

```
d.rast landuse.landfill
```

DRAFT

d.what.rast

Geology

To prepare the geology map for use in our example, we will reclass the original layer into a binary data layer. We will do this by grouping the hard, less permeable rocks as category one (acceptible) and all other areas as 0 (unnacceptible). First, generate a report of the categories in the geolgoy map layer.

r.report geology

```
+-----------------------------------------------------------------------------+
|                          RASTER MAP CATEGORY REPORT                         |
|LOCATION: spearfish                                  Thu Nov 14 16:05:19 1991|
|-----------------------------------------------------------------------------|
|          north: 4928000    east: 609000                                     |
|REGION    south: 4914000    west: 590000                                     |
|          res:       100    res:     100                                     |
|-----------------------------------------------------------------------------|
|MASK:none                                                                    |
|-----------------------------------------------------------------------------|
|MAP: Geology (geology in PERMANENT)                                          |
|-----------------------------------------------------------------------------|
|                             Category Information                            |
|#|description                                                                |
|-----------------------------------------------------------------------------|
|0|no data                                                                    |
|1|metamorphic                                                                |
|2|transition                                                                 |
|3|igneous                                                                    |
|4|sandstone                                                                  |
|5|limestone                                                                  |
|6|shale                                                                      |
|7|sandy shale                                                                |
|8|claysand                                                                   |
|9|sand                                                                       |
+-----------------------------------------------------------------------------+
```

For the reclass, we will use categories 1-3 and 8 as acceptible areas and all others as unacceptible. Run *r.reclass input=geology output=geology.landfill* to start the less-interactive GRASS reclassification program.

```
r.reclass input=geology output=geology.landfill
                                        title="Acceptible Geology"
> 0 4 5 6 7 9 = 0 unacceptible
> 1 2 3 8 = 1 acceptible
> end
```

Display the map and querry it to insure its accuraccy.

```
d.rast geology.landfill
d.what.rast
```


DRAFT

Slope

We are now ready to do some reclassifications of the slope.7 data layer. A report of the data layer shows the following.

r.report slope

```
+-----------------------------------------------------------------------------+
|                          RASTER MAP CATEGORY REPORT                         |
|LOCATION: spearfish                                 Thu Nov 14 16:20:40 1991|
|-----------------------------------------------------------------------------|
|          north: 4928000    east: 609000                                     |
|REGION    south: 4914000    west: 590000                                     |
|          res:       100    res:     100                                     |
|-----------------------------------------------------------------------------|
|MASK:none                                                                    |
|-----------------------------------------------------------------------------|
|MAP: slope reclassed into groups of percent rise (slope.7 in PERMANENT)      |
|-----------------------------------------------------------------------------|
|                             Category Information                            |
|#|description                                                                |
|-----------------------------------------------------------------------------|
|0|no data                                                                    |
|1|0-2%                                                                       |
|2|3-5%                                                                       |
|3|6-10%                                                                      |
|4|11-15%                                                                     |
|5|16-20%                                                                     |
|6|21-25%                                                                     |
|7|>25%                                                                       |
+-----------------------------------------------------------------------------+
```

For our purposes we will accept slopes which are less than or equal to 10% or categories 0 - 3 and disregard those areas over 10% or 4 through 7. Run r.reclass input=slope.7 output=slope.landfill title="Acceptable Slopes" to begin reclassifying the slope map. Execute the following reclass.

```
r.reclass input=slope.7 output=slope.landfill title="Acceptible Slopes"
> 0 thru 3 = 1 acceptible
> 4 thru 7 = 0 unacceprtible
> end
```

Soils

The soils will be the final map which will need to be reclassed. Since this is such an extensive reclass, use the highlighted categories from the report below for the reclass.

r.report soils

DRAFT

```
+--------------------------------------------------------------------------+
|                         RASTER MAP CATEGORY REPORT                       |
|LOCATION: spearfish                              Thu Nov 14 16:29:58 1991|
|--------------------------------------------------------------------------|
|          north: 4928000    east: 609000                                  |
|REGION    south: 4914000    west: 590000                                  |
|          res:       100    res:     100                                  |
|--------------------------------------------------------------------------|
|MASK:none                                                                 |
|--------------------------------------------------------------------------|
|MAP: Spearfish Soils (soils in PERMANENT)                                 |
|--------------------------------------------------------------------------|
|                            Category Information                          |
```

#	description
0	No data
1	**Aab**
2	**Ba**
3	**Bb**
4	**BcB**
5	**BcC**
6	BeE
7	Bhe
8	**Bkd**
9	CBE
10	CaD
11	CaE
12	Cc
13	GBE
14	GaD
15	GcD
16	GdE
17	GeD
18	**HBF**
19	**Ha**
20	**KaB**
21	**LaE**
22	**MaC**
23	**MaD**
24	**McD**
25	**NaB**
26	**NaC**
27	**Nac**
28	NbD
29	NcD
30	**NdB**
31	**NdC**
32	PbE
33	**PcB**
34	**PcD**
35	**Pe**
36	RBF
37	RCF
38	RaE
39	**SaA**
40	**SaB**
41	**SbB**
42	**Sd**
43	**ShA**
44	**Sk**
45	**TaA**
46	**TaB**
47	**TaC**
48	VBF
49	VCE
50	**VaA**
51	**VaB**
52	**VaC**
53	WaA
54	**Wb**

DRAFT

Use the following reclassification rules to perform the reclass.

```
r.reclass input=soils output=soils.landfill title="Acceptible Soils"
> 0 6 7 9 thru 17 28 29 36 thru 38 48 49 53 = 0 unacceptible
> 1 thru 5 8 18 thru 27 30 31 33 thru 35 39 thru 47 50 thru 52 54 = 1
                                                            acceptible
> end
```

Check the map as you have done the others for correctness.

```
d.rast soils.landfill
d.what.rast
```

r.mapcalc

We now have six binary files, all of which have a .landfill extension. Use *g.list rast* to list the seven files. They should be:

- roads.landfill
- streams.landfill
- landuse.landfill
- geology.landfill
- slope.landfill
- soils.landfill

In each case, no data areas (0's) are the areas which are unacceptable for our purposes and all other areas (1's) are acceptable. If we were to add all seven maps together at this time, the only areas which would satisfy all of the criteria would be those areas with a value of 6. In other words, in cells where you find a category value of 6 you know that the corresponding cell in all seven binary maps had a value of 1.

To generate this new map we will use the GRASS *r.mapcalc* (map calculator) function. *r.mapcalc* is capable of mathematical, algebraic and boolean operations on map layers. You need only build an expression for it to use. Use *g.manual* to view the *r.mapcalc* command syntax.

```
g.manual
r.mapcalc
```

To add the six maps together enter the following command.

```
r.mapcalc six.landfill = roads.landfill + streams.landfill +
                  geology.landfill + slope.landfill + soils.landfill +
                  landuse.landfill + owner.landfill
```

DRAFT

r.mapcalc computes the map and returns the prompt to you. *d.rast* the new map to see how it looks. There should be six categories (colors) in the map. Also, use *d.what.rast* to poke around at the categories to see how many nearly qualify and which areas don't come near to qualifying.

```
d.rast six.landfill
d.what.rast
```

Now, so that we can see which areas are category six, reclass the six.landfill map to a binary data layer.

```
r.reclass input=six.landfill output=accept.landfill
> 0 thru 5 = 0
> 6 = 1
> end
```

d.rast accept.landfill. Notice that even though there are discrete areas of possible sites, they are all categorized a one group (category 1). To give each of these discrete areas its own category value we will use the *r.clump* command which "clumps" together contiguous areas within a map layer. Execute the following command to clump the areas.

```
r.clump input=accept.landfill final.landfill
```

d.rast the new file to view the categories. Also, generate a report for the new file.

```
d.rast final.landfill
r.report map=final.landfill units=a,mi,p
```

If this were the real thing, size considerations would enter in at this point. By examining the report, you could determine how to reclassify the map to meet size requirements. Maps and reports could then be generated and included in a formal report or some similar presentation.

This concludes the GIS Applications Example.

DRAFT