UNIT 33: USING BUFFERS

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Context

Buffering is an important pre-analysis technique which is used to constrain space around individual land features. It combines spatial data query techniques and cartographic modelling. It is generally used for defining all of the spaces within a certain distance of a type of feature, or a subset of features that are selected according to an attribute value. Buffer distances must be set by the user.

Points, lines and polygons can be buffered, as well as raster pixels or groups of pixels. The commands may vary from software to software, but conceptually, the buffer operator is a generic GIS tool. Lines can be buffered to one side or the other as well as equal distances (right,left,and full buffers) on both sides of the line, while polygons can have an inside buffer or an outside buffer in addition to buffers on both sides of the polygon boundary.

The following example is a typical type of problem that can be solved using buffering.

Example Application

Tidewater National Park which includes historical, archaeological, and natural values wishes to improve access to a scenic waterway which runs through the Park. The park management team sees this as an opportunity to examine ways of protecting sensitive areas while creating the best possible access to important features. The stream has a bluff on one bank which has many historical and archaeological sites associated it, and has low marshlands on the other bank which are sensitive to trampling and erosion. The managers would like to identify locations where either paths or scenic lookovers could be provided without damaging the park resources. In addition there are public safety issues which must be addressed. The following constraints have been selected to appropriately protect resource value.

1. **No access can be provided in areas which are less than 1 meter above the stream surface.**
2. **No access can be provided which are within 2 meters of the bluff top.**
3. **Active archaeological digs must be surrounded by a 50 foot buffer.**
4. **Inactive archaeological sites must be surrounded by a 10 foot buffer.**
5. **Historical sites do not need to be buffered, but may need to be redesigned or closed if they impinge on archaeological buffers.**
6. **New paths and scenic overlooks must be easily attached to existing paths without traveling through sensitive areas.**

Figure 1

The GIS technician will be responsible for checking the provided data layers for projection consistency, and providing support to a GIS manager for general data accuracy checking. In addition the technician will perform buffer operations as directed by the manager, intersect buffered data layers, and perform simple analytical tasks.

Learning Outcomes

The following list describes the expected skills which students should master for each level of training, i.e. Awareness/Competency/Mastery.

Awareness:

The expected learning goals of this section are to achieve a general understanding of buffer implementation, the potential uses of these operations, and a working knowledge of basic buffer operation vocabulary.

Competency:

The learning goals of this section are to develop the ability to perform specific buffer operations, and to manipulate buffer command parameters for buffer output control.

Mastery:

The learning goals of this section are to be able to integrate knowledge of buffers to perform high level tasks, and post-buffer analyses.

Preparatory Units

Recommended:

1. Unit 28 - Editing polygon data(Building and Protecting topology only)

2. Unit 34 - Pre/Post overlay tasks; Types of overlay operators
3. Unit 39 - Performing statistical analyses
4. Unit 41 - Using boolean search techniques

Complementary:

1. Unit 7 - Using and interpreting metadata
2. Unit 10 - Projecting data
3. Unit 47 - On screen visualization

Awareness

Learning Objectives:

1. Student can define basic vocabulary relating to buffer functions.
2. Student can explain the types of operations that relate to buffer functions.
3. Student can explain buffer types that are unique to particular data models, i.e. point,lines,polygons,rasters.
4. If software will be used, student can perform the functions in the software that relate to buffer operations.
5. Student can describe a real application of the buffer operation and its implementation.

Vocabulary

- attribute
- buffer
    - uniform buffer
    - right side buffer
    - left side buffer
    - full buffer
- intersect/intersection
- layer
- look-up table
- parameters
- projection
- raster
- reselect
- registration
- select
- topology

Topics

1. Unit Concepts

   Data model capability and functionality vary widely amongst software systems.

   - Name of the buffer command, or the location of the menu item?
   - Parameters of the command
   - Right/left/full buffering functionality

     Figure 2 **Figure 3** **Figure 4**
   - Data model dependent buffering functionality

     Figure 5
   - Attribute value dependent buffering functionality

     Figure 6
   - Proper use of these functions and parameters
   - Pre or post buffer processes that must be run in specific software
     - These might include registration, or topology building processes.

Example Implementation: A forestry buffering application.
[outdated link has been removed]

Competency

Learning Objectives:

1. Student will be able to use buffer operations to perform the following tasks:
   - Invoke buffer function in a software system.
   - Use function parameters to specify a task.
   - Buffer points.
     - Specify buffer distances.
     - Reselect a set of points for buffering.
   - Buffer lines.
     - Specify buffer distances.
     - Specify right, left or full buffer type if software allows.
     - Reselect a set of lines for buffering.
2. Student will be able to use post-buffer operations to perform the following tasks:
   - Intersect buffered layers.

- Calculate area values for buffered layers.

Generic List of Tasks

Pre-Buffer Tasks

1. View descriptions of each layer to be used. Check to be certain that all layers to be intersected share the same projection and the same projection parameters.
   ! If areas are to be calculated and compared, this projection must be an equal area projection.

   Pre-Buffer Tasks - 1

2. Look at the layers using on-screen visualization capabilities.
   ! This step should be repeated often in order to control errors.

   - Check for proper registration, missing data, and known objects in appropriate locations.

   Pre-Buffer Tasks - 2

Buffer Tasks

1. Create a uniform buffer around all points in a point layer.

2. Create a full uniform buffer around the selected arcs.

   - From a line layer select a set set of lines according to an attribute value.
   - create a full variable buffer around these lines. (This can be done with points, polygons, and rasters as well.)

3. Create a right side buffer around the selected arcs.

! Software may require that you recreate topology or update data tables before using the buffered data.

Tasks for Application of Buffer Results

1. Intersect the point buffered and the full variable line buffered layers.

2. Calculate the total area of buffered regions in a single layer.

3. Calculate the area of intersection for the two layers.

4. Repeat the same process for the buffered points and the right side buffered lines.

Mastery

Learning Objectives:

1. Student will be able to use buffer operations to perform the following tasks:
    - Perform a variable buffer based on a selected attribute value.
    - Given a verbal description of a problem involving buffers, the appropriate buffering operation or operations will be selected and performed.
    - Perform spatial analyses on buffered data.
    - Perform descriptive statistical analyses on buffered and ancillary data.

Generic List of Tasks

Buffer Tasks

1. Create a variable buffer around points in a layer based on the variation in values of an attribute.

2. Analyze a verbal problem description, and implement appropriate buffers.

3. Perform distance, area, and other spatial analyses on buffered and intersected data sets.

4. Perform descriptive statistical analyses on buffered and ancillary data sets.

   ! All GIS systems do not have this functionality. Data can be exported to many spreadsheet software systems if necessary.

Follow-up Units

Suggested:

1. Unit 30 - Validating databases
2. Unit 31 - Managing database files
3. Unit 34 - Using overlay operators; Pre/Post overlay tasks
4. Unit 35 - Point in polygon operations; Line in polygon operations
5. Unit 40 - Using reclassification operators

Resources

[outdated links have been removed]

 **A list of GIS Resources.**

 **An example of site selection relative to water resources.**

 **An example of a forestry buffering application (tutorial) .**

Created: May 14, 1997. Last updated: March 11, 1999.

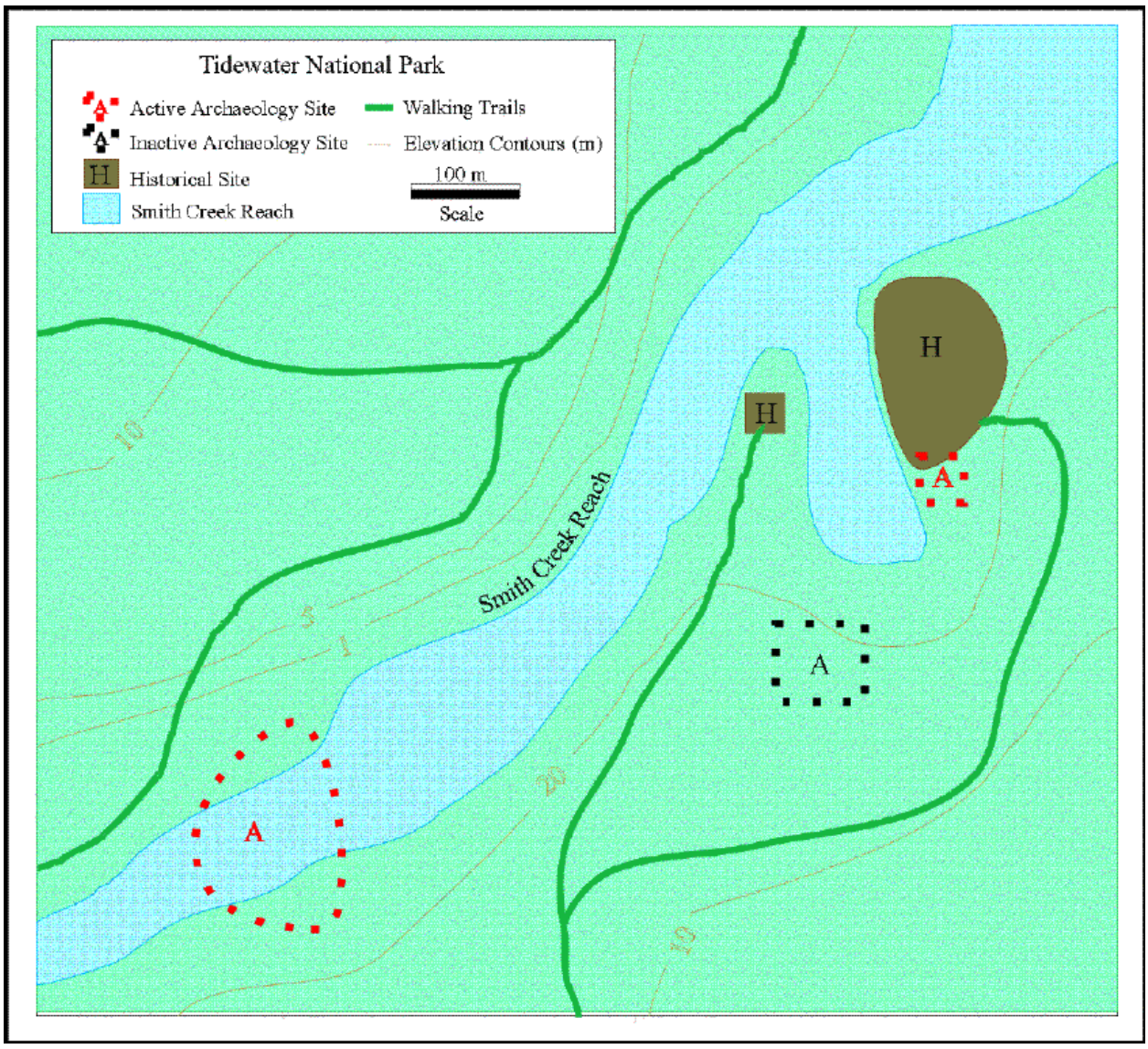
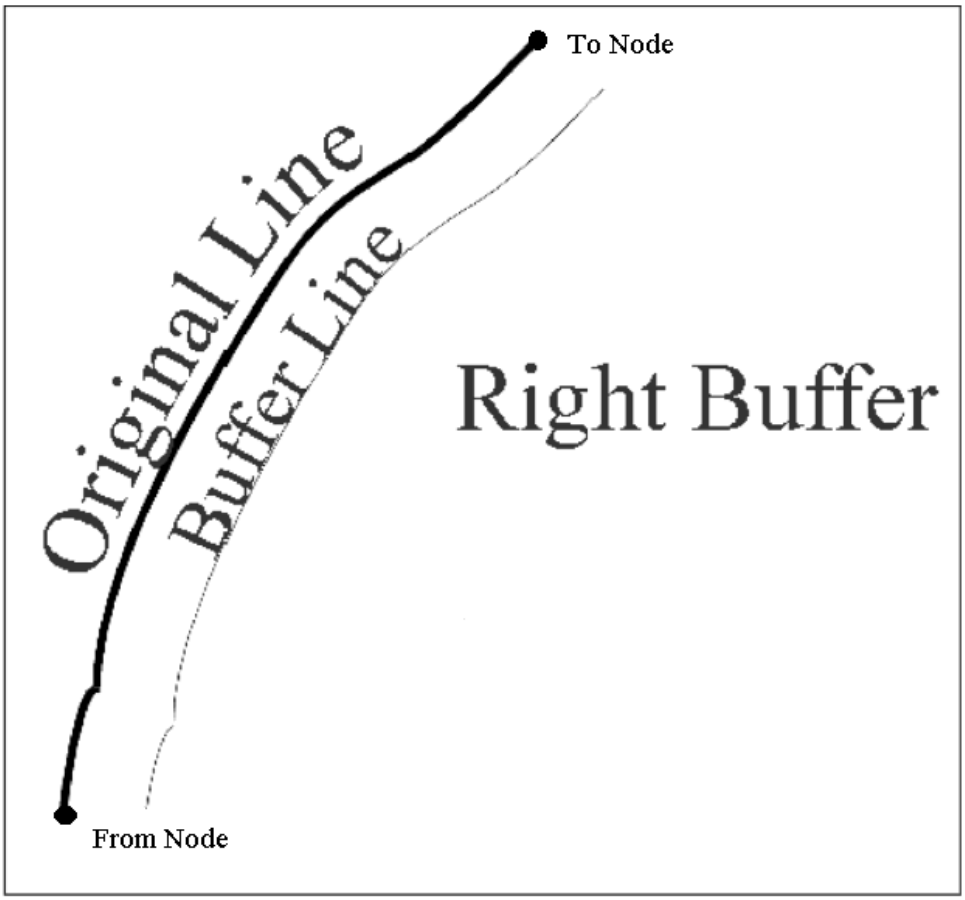
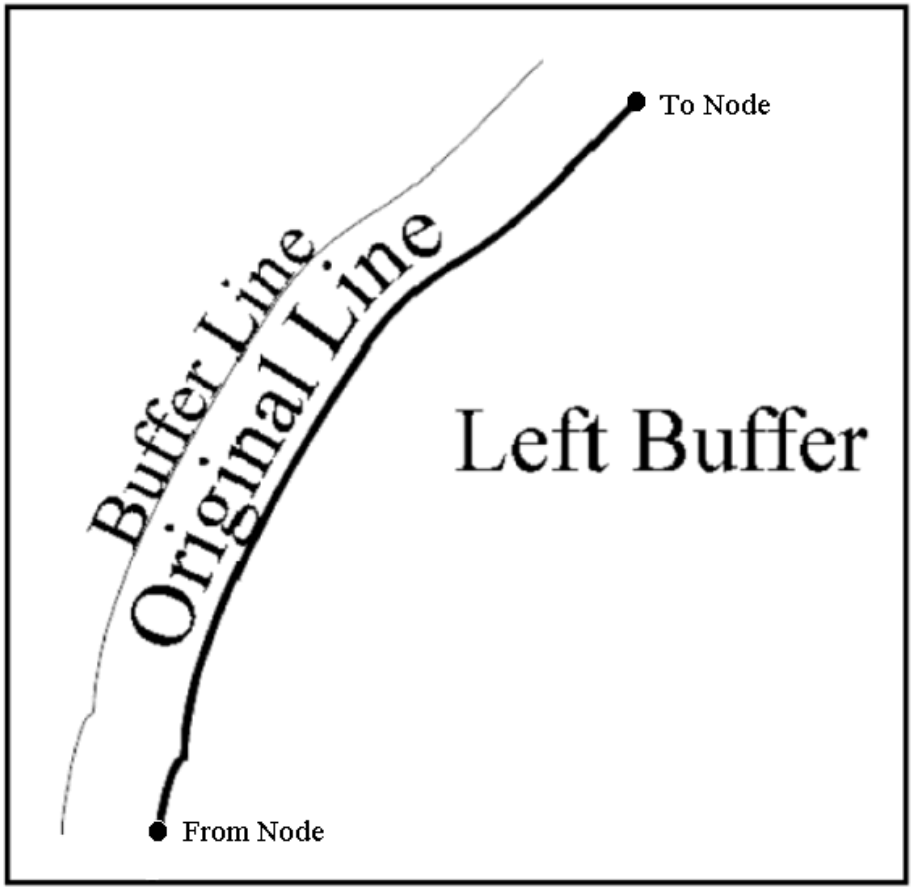

Tidewater National Park
Active Archaeology Site
Inactive Archaeology Site
Historical Site
Smith Creek Reach
Walking Trails
Elevation Contours (m)
100 m
Scale
H
H
A
A
A
Smith Creek Reach
10
5
1
20
15

Figure 1



CCTP Unit 33
Figure 2
NCGIA, Santa Barbara, CA



CCTP Unit 33
Figure 3
NCGIA, Santa Barbara, CA

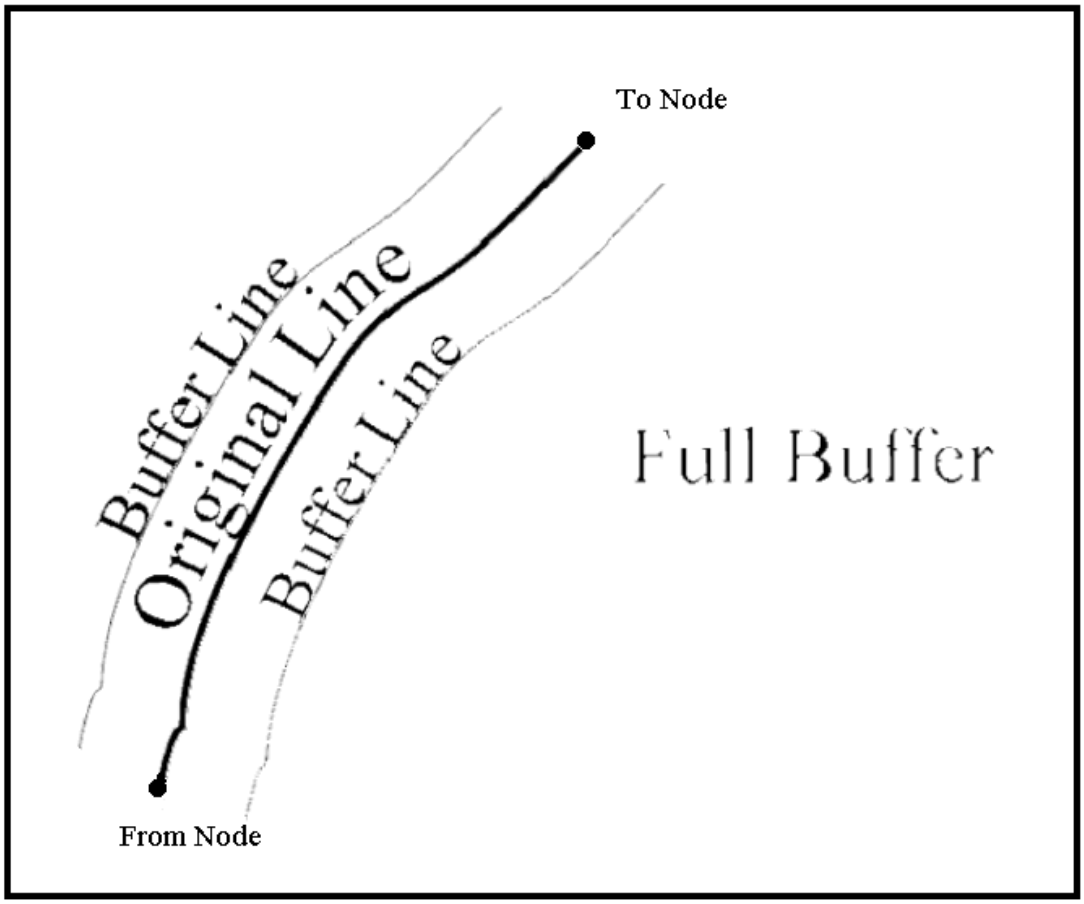

To Node
Buffer Line
Original Line
Buffer Line
Full Buffer
From Node

Figure 4

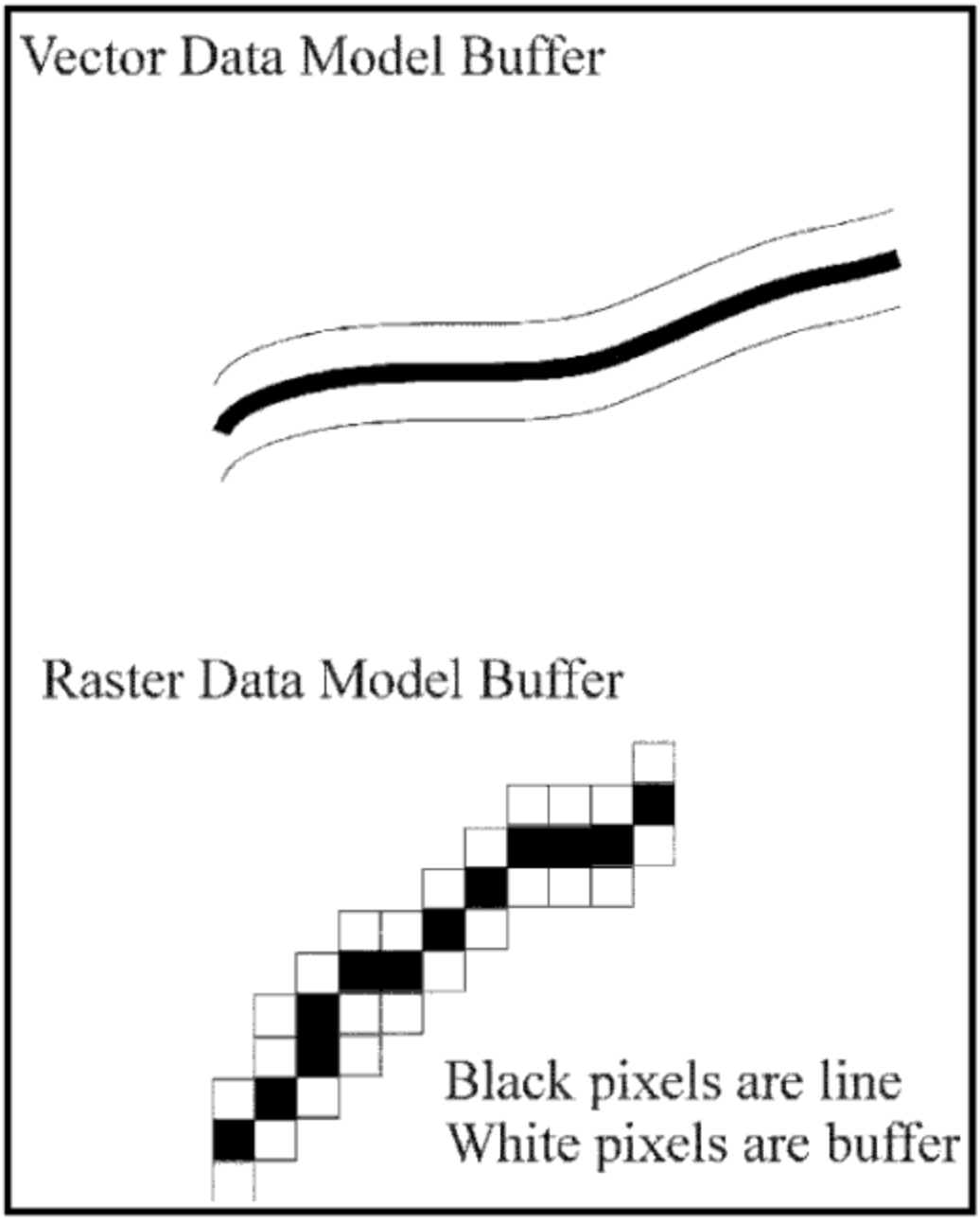

Vector Data Model Buffer
Raster Data Model Buffer
Black pixels are line
White pixels are buffer

Figure 5

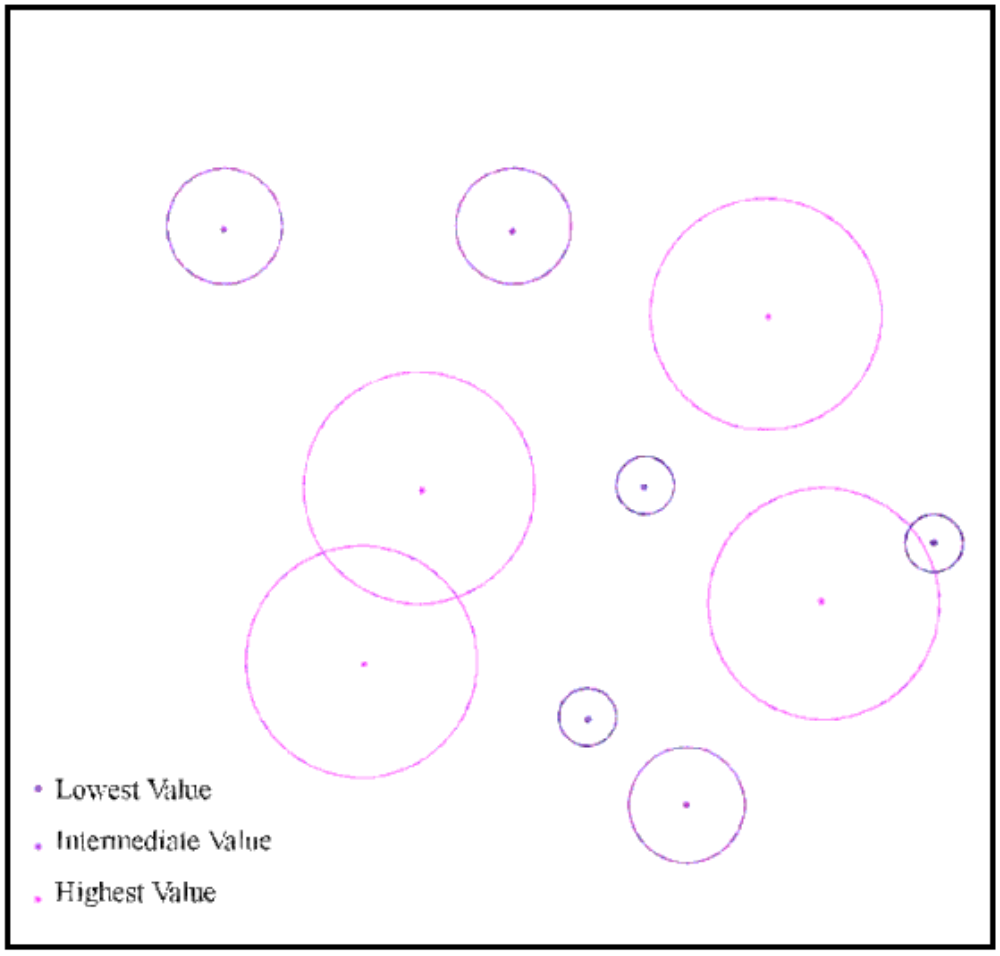


Figure 6

Pre-Buffer Tasks - 1

The following is a listing of how to do this using arc info. All commands for Arc Info will be printed in bold here. Wherever the word "cover" appears, enter the name of the coverage in current working directory.

---

1. Starting from your operating system prompt type ARC
2. When ARC Info starts, type: **lc** or **listcoverages**

   A list of all valid coverages in your current directory will be returned:

```
Arc: lc
 Workspace:
/A/BBQ/U5/LOCAL/ETC/HTTPD/NCGIA/EDUCATION/CURRICULA/CCTP/UNITS/UNIT33

 Available Coverages
 -------------------
  BUFFER            BUFFER2           BUFFER3           BUFFER4
  BUFFEROUT
```

3. Select the coverage you wish and type: **describe cover**

   This will look something like this:

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

                                FEATURE CLASSES

                                    Number of  Attribute     Spatial
Feature Class          Subclass     Features   data (bytes)  Index?
Topology?
-------------          --------     ---------  ------------  -------   -
--------
POINTS                                     8        18

                               SECONDARY FEATURES

Tics                                       4

                                  TOLERANCES

Fuzzy   =                 0.002 N          Dangle  = 0.000 N

                               COVERAGE BOUNDARY

Xmin =                    1.415            Xmax = 6.398
Ymin =                    1.156            Ymax = 4.392

                                    STATUS

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

                           NO COORDINATE SYSTEM DEFINED
```

   Notice that the Coverage Boundary is described. If the units are not expected, for example they are too big or too small, this is a cue that there is a problem. If a coordinate system has been defined, it should be completely described. Further resources for resolving this problem can be found in Unit 10.

Pre-Buffer Tasks - 2

The following is a listing of how to do this using arc info. All commands for Arc Info will be printed in bold here. Wherever the word "cover" appears, enter the name of the coverage in current working directory.

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1. Starting from your operating system prompt type **arc**
2. When ARC Info starts, type: **display 9999**,**display 9999 2**, **display 9999 3**, or **display 9999 4**. These will return increasingly larger viewing windows.
3. Next type **ap** or **arcplot**
   This will initialize arcplot, the visualization module of arcinfo.
4. Set the viewing extent to the extent of the data you will be viewing by typing **mapextent cover**, or **mape cover**
5. If you are viewing points type **points cover**
6. If you are viewing arcs type **arcs cover**
7. If you are viewing polygons, type **polys cover**
8. Look at all of the coverages that you are using on the same screen, set to the same mapextent. If a coverage does not appear, and there was no error message in the command window, a projection problem exists.
9. Type **mapinfo**. This will send a report to your command window listing out positional information for your current viewing window.
