GIS Training Exercise

Land Use Analysis at the Neighborhood Scale
Using the Land-Based Classification Standards

Regent Neighborhood
Madison, Wisconsin

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What are the Land-Based Classification Standards?

The Land-Based Classification Standards (LBCS) provide a consistent model for classifying land uses based on their characteristics (APA 2000). The model extends the notion of classifying land uses by refining traditional categories (residential, commercial, agricultural, etc.) into multiple dimensions, such as activities, functions, building types, site development character, and ownership constraints. The LBCS project was funded by several federal agencies and prepared by the American Planning Association (APA). It is the first comprehensive examination and update of classification systems for land use since the publication of the Standard Land Use Coding Manual (SLUCM) in 1965, yet draws on research by Albert Guttenberg initiated in the late 1950's (Guttenberg 1993).   The combination of LBCS and geographic information systems (GIS) provide a powerful tool to conduct both traditional land use analyses and a broad range of new, cross-dimensional analyses.

The Regent Neighborhood LBCS Inventory

The Regent Neighborhood is located on the near west side of Madison, Wisconsin. It is home to nearly 6000 residents and is immediately west of the University of Wisconsin-Madison campus [INCLUDE VICINTIY MAP]. Camp Randall stadium abuts the eastern boundary of the neighborhood. It is primarily residential, containing a mix of privately owned housing, rental properties, and some student housing. There is a variety of land uses, however, with the arterials of Regent Street and University Avenue hosting a mix of commercial, religious, cultural, and community institutions.

During the Spring 2005 semester, 19 students in the URPL969 - GIS Workshop in the Department of Urban and Regional Planning at UW-Madison conducted a Land Based Classification Standards (LBCS) survey of the 375 acre neighborhood. Students with little previous experience with land use coding were orientated to the LBCS system, conducted thorough surveys of the neighborhood, and entered all collected data into a database. The academic goals of the project were to document the time and effort required to conduct an LBCS survey and explore the types of analyses that could be conducted using GIS and a relational database. At the end of the course, GIS analyses were presented at a session on campus and the data were given to the Regent Neighborhood Association to support a City-sponsored neighborhood plan. One of the students from the class was hired by the RNA over the summer to generate maps required for the planning process.

This exercise explores some of the GIS functionality required to use the Land-Based Classification Standards to analyze land use issues at the neighborhood scale.

Software Requirements
ArcGIS 9.2 by Environmental Systems Research Institute of Redlands, CA

GIS Data
Regent_2005.zip file includes the *parcel_2005_feature.mdb* geodatabase.

GIS Functionality Covered
Create an Arc Map Project
Add Data, Join Tables
Create Thematic Maps for LBCS Dimensions
Data Frames, Layer Properties - Symbology, Map Layouts
Perform Queries Across LBCS Dimensions
Queries

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I.   Create an ArcMap Project

The purpose of this section is to create a new Arc Map project, load the parcel map for the Regent Neighborhood study area, and join the database from the LBCS inventory to the parcel map for further mapping and analysis.

Open a New ArcMap Document

From the desktop, double-click on the **ArcMap** icon to launch the program. If there is no desktop icon, go to the **Start** menu and select **ArcGIS→ArcMap**. From the dialog box that immediately appears as the program opens, select **A new empty map**. Always choose this option when starting a new ArcMap project from scratch. Go to the **File** pull-down menu and select **Save As**, then navigate to the appropriate directory in which you want to save your project, name it *regent_lbcsmap* and select the **Save** button.

You will notice that in the "Save as type" drop-down box under "File name" will be the default, **ArcMap Documents**. ArcMap projects will be automatically saved with an *.mxd* file extension, which will be viewable in ArcCatalog and helps to differentiate it from the other file types used in ArcGIS.

Note: It is important to save your projects early and often when working with them in ArcMap. If the program crashes, as it is unfortunately known to do, you will not lose any of your work and save yourself a lot of time if you are conscientious and save often. You can simply re-open ArcMap and your project, and pick up where you left off.

Add data layers

There are two simple ways to add data layers to the ArcMap project: via the **Add Data** button on the "standard toolbar" along the top of the ArcMap interface, or by "dragging and dropping" files from ArcCatalog into the layer table of contents you see on the left side of the ArcMap interface. Feel free to use whichever method works best for you. For this exercise, you will only be adding a single data layer, in this case a geodatabase feature class--other layers include shapefiles, coverages, and raster images.

Standard Toolbar in ArcMap

Using Add Data button: Click the button and in the Add Data dialog navigate to the Regent LBCS folder. Double-click on *parcel_2005_feature.mdb*, and selecting *dccs* within that folder, click **Add**. The data layer appears graphically and in the layer table of contents as a feature class called *parcel_2005* (aka the feature dataset *dccs*).

An Alternative Way to Add Data Using ArcCatalog: Click the ArcCatalog button to launch the program. As ArcMap and ArcCatalog (along with ArcToolbox) are component parts of the ArcGIS software suite, one can open one from another by simply clicking the appropriate button. For example, one can open ArcCatalog and ArcToolbox from ArcMap, or ArcMap and ArcToolbox from ArcCatalog. With ArcCatalog open, depending on the connected folders visible in the table of contents along the left side, you will see that this program is the file-organizing facet of ArcGIS. With ArcCatalog at 'half-size' over ArcMap, navigate to *Regent LBCS→parcel_2005_feature→dccs→parcel_2005*. Now click on *parcel_2005*, holding down the left mouse button, and drag it into the layer table of contents in ArcMap and release the button. The *parcel_2005* feature class will be displayed.
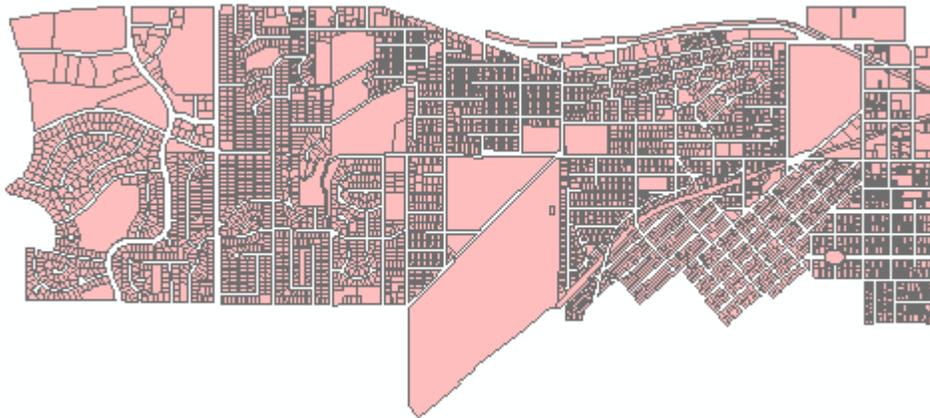
The image above represents the array of lots or parcels in the vicinity of the Regent Street neighborhood as they appeared in 2005. To view the tabular attribute data associated with the

layer, i.e. the specific information (in columns or *fields*) associated with each parcel (each with its own discrete row or *record*), right-click on the layer name and select **Open Attribute Table**. You will notice the shape and numerical identifier columns, along with columns containing information on length and area for each numbered parcel.

Attributes of parcel_2005

| OBJECTID*	Shape*	par_num*	par_num_dash	Shape_Length	Shape_Area
1	Polygon	070920307117	0709-203-0711-7	487.764482	12997.351276
2	Polygon	070922439314	0709-224-3931-4	406.849085	6949.977771
3	Polygon	070922439306	0709-224-3930-6	395.316503	6063.299166
4	Polygon	070922439299	0709-224-3929-9	404.704934	6846.429093
5	Polygon	070922439281	0709-224-3928-1	396.703742	6243.167618
6	Polygon	070922439273	0709-224-3927-3	401.570845	6664.398516
7	Polygon	070922439265	0709-224-3926-5	393.179011	6033.176150
8	Polygon	070922439257	0709-224-3925-7	396.638784	6340.355310

One of the steps in this exercise is to classify each parcel with a land use code for each of four distinct LBCS land use dimensions. Since there is limited attribute data associated with the *parcel_2005* layer, we will have to bring in other data pertaining to LBCS land use codes for each parcel. For this reason we will perform a *join*. A join is defined in ArcMap's GIS dictionary as "appending the fields of one table to those of another through an attribute or field common to both tables," usually for attaching "more attributes to the attribute table of a geographic layer." In our case, the geographic layer is *parcel_2005*. We want to join its attribute table to an Access database table containing LBCS parcel land use codes. The field common to both tables, on which the join will be based, is *par_num* (parcel number).

**Join the LBCS Inventory Database to the Attribute Table for the Parcel Map**

With ArcMap open, right-click on *parcel_2005*, click on **Properties** at the bottom of the context menu, and click the **Joins & Relates** tab at the far right. In the Joins section, click **Add…**
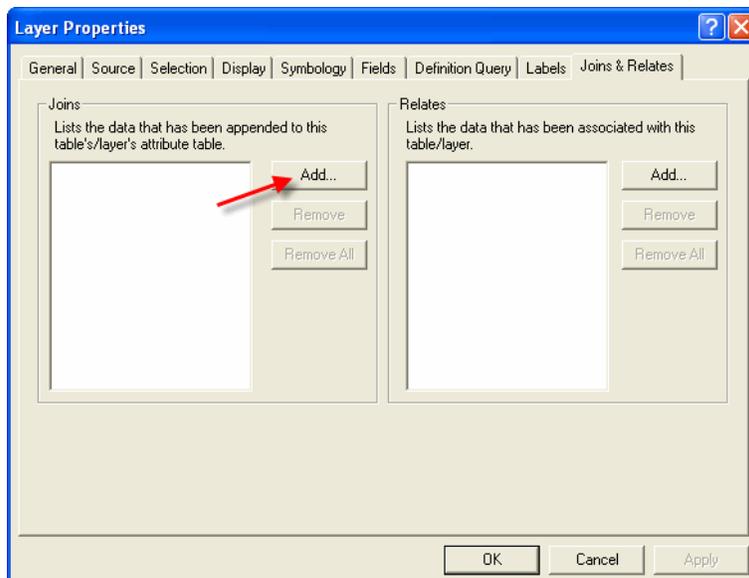
In the Join Data dialog, select *par_num* from the drop-down in #1. For #2, you will navigate to the database table from which you are appending LBCS data; click the folder icon at right and navigate from the Regent LBCS folder to: *Regent_LBCS_2005.mdb*→*Primary_Regent_LBCS* and double-click or click **Add**.
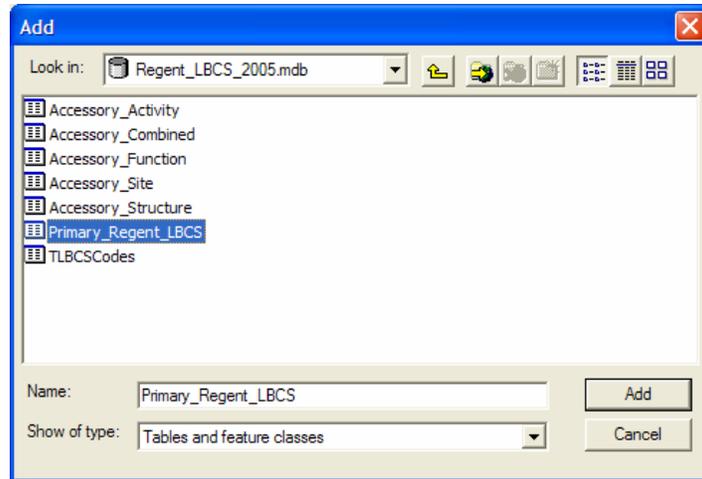

In #3, select *PAR_NUM* from the drop-down (the only option). Click the **Advanced** button and select the "Keep only matching records" radio button and click **OK**.
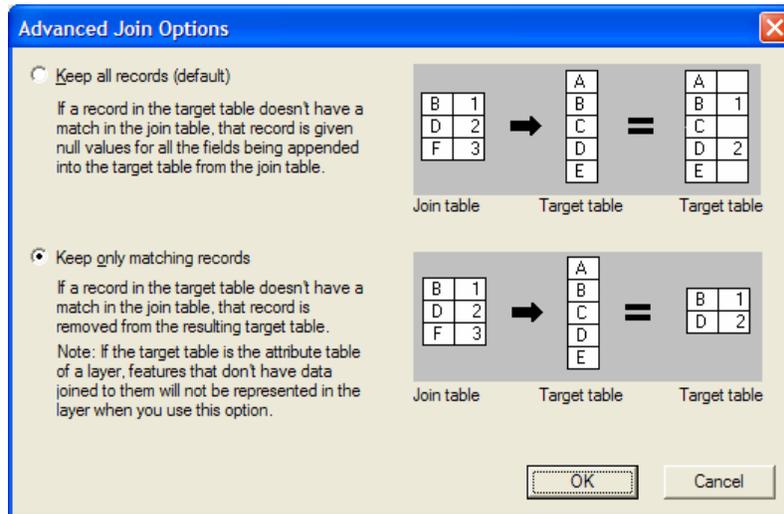
This is done because in the Regent neighborhood study area, only 1518 of 5021 total parcels were surveyed by students to ascertain land uses; thus there are many unmatched parcels that have 'null' values. Our attention with this exercise is restricted only to the study area.

Your Join Data dialog should look like this:
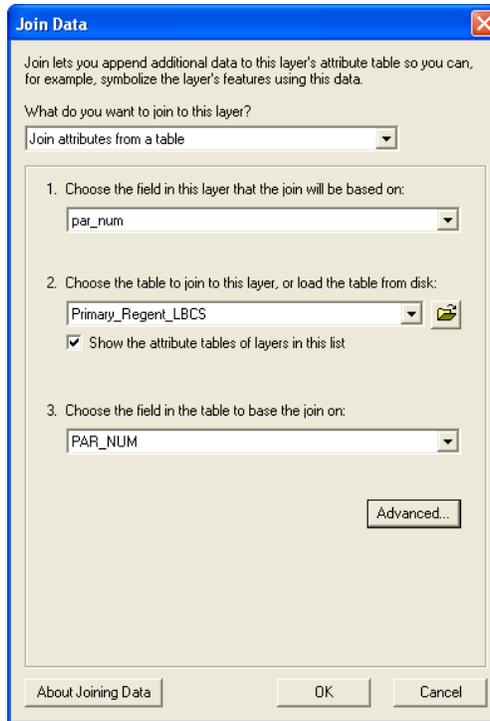
Click **OK** in Join Data, and once again in the Layer Properties dialog to create the join.

Note the change in the *parcel_2005* layer; it has been 'reduced' in size from the original, unjoined parcels layer and now shows only the study area as a result of the join.

Open the layer's attribute table to view the joined data. Along the bottom you will that there are now only 1521 (matched) records, reflecting the join. The five LBCS dimension columns from the *Primary_Regent_LBCS* database table are now appended to the *parcel_2005* table. Close the table.

With the join created, we are ready to color-code land uses for each Regent parcel for each LBCS dimension.

## II. Create Thematic Maps from LBCS Dimensions

The purpose of this section is to create a set of thematic maps that display the four LBCS dimensions that were collected as part of the Regent Neighborhood inventory and include them in a map layout for later printing.

Create new data frames

The next step is to create a map layout with four insets, that is, one Regent neighborhood map color-coded for each of the four LBCS dimensions for which we have data. To do this we need to create a total of four data frames based on the original joined data layer.

On the menu toolbar, select **Insert→Data Frame**. Do this twice more to create a total of four data frames. Now give them meaningful names; 'soft-click' twice on the current default names (this allows you to rename the frame) and enter the new names—Activity, Function, Structure, and Site Development Character, respectively. To copy the layer from our original data frame, right-click on *parcel_2005* in the original data frame and click **Copy**. Right-click on each of the new data frames in turn and click **Paste Layer(s)**.

Your layer table of contents should now look like this:
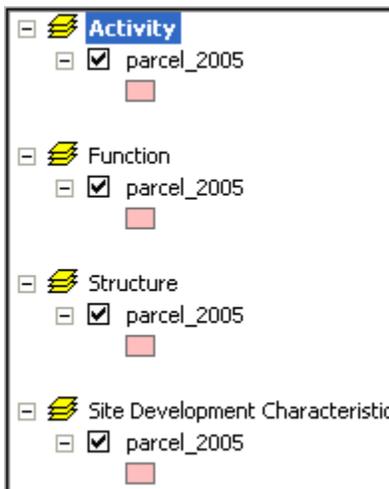
We will now go into the parcel layer of each data frame and color-code them by LBCS code. But before we go on, a word about data frames. When working with various data frames, right-click on the desired data frame and click **Activate** in order to switch to it. The name of the current active data frame will be in bold.

Classify parcels for each LBCS dimension

In order to color-code our 2005 Regent neighborhood parcels by LBCS land use across four dimensions (Activity, Function, Structure, Site Development Character), you will need to open a browser window and navigate to the following URL:
http://www.planning.org/lbcs/standards/Downloads/RLBCSColorForAllDimensions.pdf

Here you will see the most basic, 1-digit level land use codes for each dimension. Surveyed codes from our Regent neighborhood study area are more specific, so we will be generalizing in this exercise and using the prescribed RGB colors from the website above. We will be importing legend files developed for ArcView 3.x and available on the LBCS website at:
http://www.planning.org/LBCS/gis/LBCSAVL/LBCSAVL.zip

The process of color-coding for the first dimension, Activity, will be described. The process for the other dimensions is the same but with different colors, so use this as a template for the remainder.

Activate the Activity data frame and right-click on the data layer. Select **Properties**, and the **Symbology** tab in Layer Properties. Click **Categories** in the Show box at the left and then select **Quantities** and **Graduated colors**.   Select the **Import** box to the right of the "Draw quantities using colors to show value" statement.
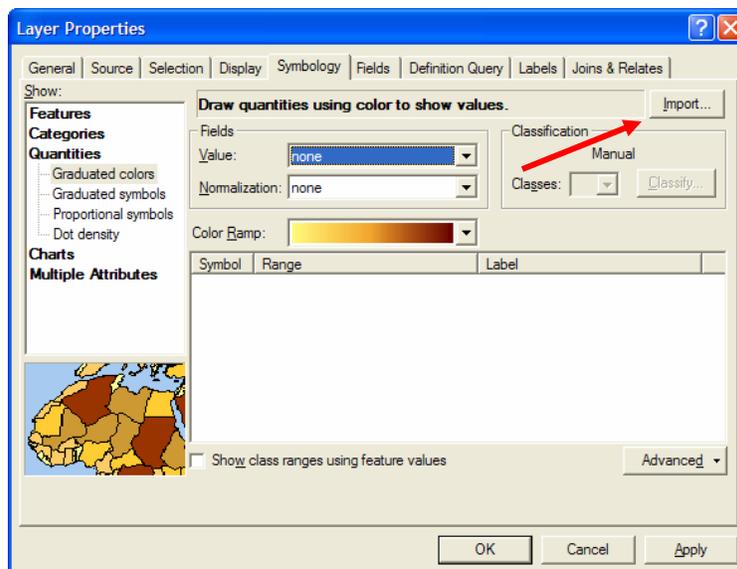
In the Import Symbology dialog box, choose the radio button for **Import symbology definition from an ArcView 3 legend file**. Navigate to the Regent_LBCS folder and select the **Activity.avl** file. Click **OK**.
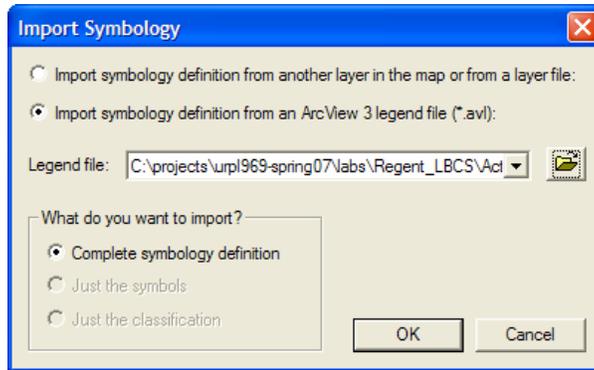
In the Import Symbology Matching Dialog, choose Primary_Regent_LBCS.LBCSActivity for the Value Field. Click **OK**.
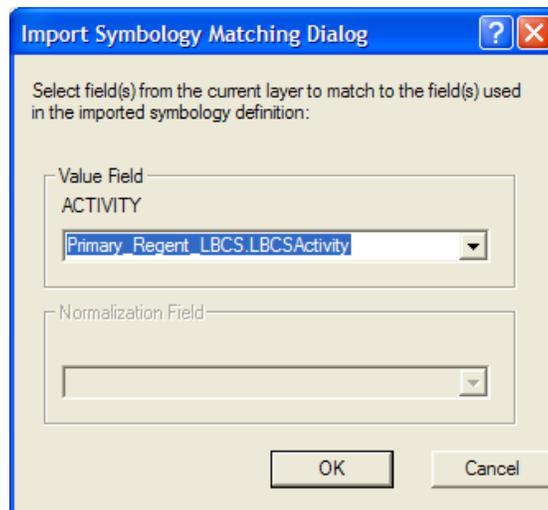
Click OK in the Layer Properties dialog box to complete the process. At this point, the results on your map should look like this:
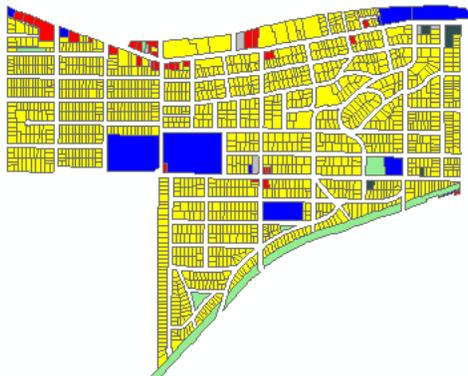
Symbolize the values for the remaining three dimensions the same way. Remember to activate each data frame as you begin. When you are finished, make sure the parcel layer in each data frame is visible. You are now ready to create a four panel poster layout incorporating the thematic map for each dimension.

Create a Map Layout

By default, you view and work with your map layers in the Data View. Maps are created in what is called Layout View. You can switch between them using the buttons in the bottom left corner of the ArcMap interface, to the left of the horizontal scroll bar. The two views are linked, so that any change to an active data frame in the Data View is reflected in the map layout.

Data View   **Layout View**

To begin, click the Layout View button. Since you will be creating a map with each of the four coded Regent neighborhood LBCS dimensions and the study area lies in an east-west orientation, you will change the map layout/paper orientation to Landscape. Go to **File→Page and Print Setup** and under Paper, select the Landscape radio button.   The choices for "Use Printer Paper Settings" and "Show Printer Margins on Layout" should be checked. If not, change them.

Your dialog should look like this:
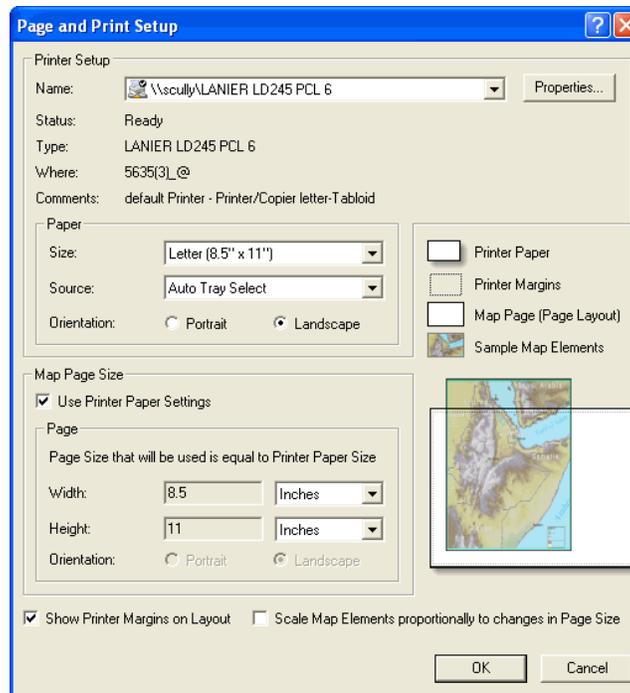
Click **OK**.

You will see that the individual data frames are arrayed mostly within the boundary of the map layout (the dotted line inside the border—this is the *printable area of the map*) and are all overlapping. Click on them individually—a blue dotted line and resizing 'handles' will appear, indicating the data frame is active--and drag them off each other. Shrink them down to a manageable size on the map layout 'page' and order them in two rows—Activity and Function on top, and Structure and Site Development Characteristic on the bottom.

A selected data frame should look something like this:
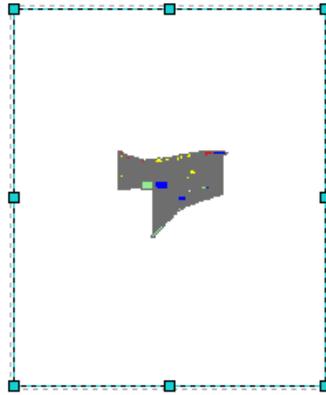
Now resize the data frames so each takes up about a quarter of the page and is stretched lengthwise, leaving room at the top for a title and some along the bottom for a scale bar and north arrow. If you find a data frame size that works and want to easily make the others that exact size, you will use Distribute→Make Same Size. To do this, click on the data frame whose size you want to change, hold down the Shift key and select the frame whose size you want to replicate. The selected frames should look like this:
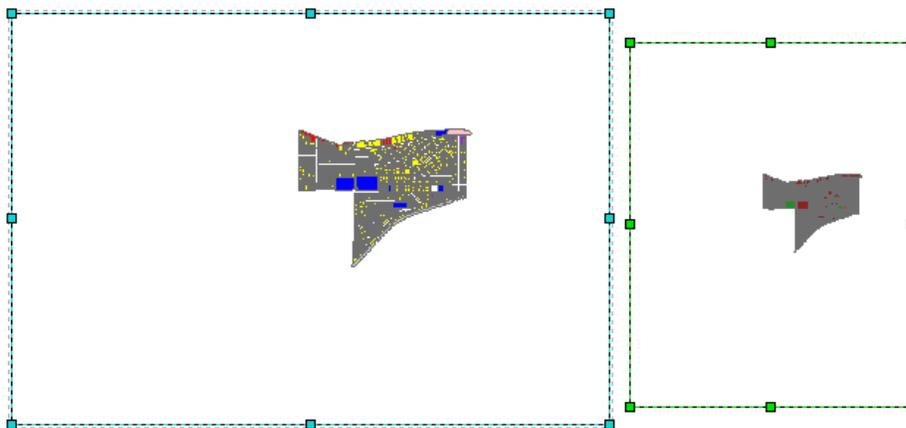

Move your cursor back to the frame to be changed (with green dashed line), right-click and choose **Distribute→Make Same Size**. Your data frames should now all be equally sized and arranged symmetrically on the page, with even space between them and inside the layout edges.

Note: If you make any mistakes with resizing or moving elements in the layout view, or any other mistakes in the process of creating the map layout, click the **Undo** button (or, vice versa, **Redo**).

Once your data frames are sized to your liking, you will need to adjust the scale of your now color-coded Regent neighborhood parcel layer. The Regent neighborhood should fill as much of the space inside each data frame as possible but still leave room for a title. Use the zoom in/out buttons on your *Tools* toolbar-- ⊕ ⊖ --to find an appropriate size, or use the Map Scale box on the standard toolbar-- `1:50,257 ▼` --and manually type in a scale. (Be aware that the zoom in/out, pan, and other tools on your *Layout* toolbar only apply to the Layout View, not the Data View. Do not confuse the two, especially when working with scale.) Depending on the size of your data frame, 1:20,000 is a good estimate. Each data frame's layer should ultimately be at the same scale, just as the data frames themselves are identically sized.

You can also reposition the layer in your data frames if you need to, leaving room for titles; use the **Pan** tool 🖐 on the Tools toolbar for this. When you are done, each data frame should look identical.

Now you'll add legends. The process is the same for each data frame. Before starting, go into Layer Properties in each and delete the title in the Layer column—Primary_Regent_LBCS.LBCS [property]—so that it will not appear in our legend title. Activate the Activity data frame and click **Insert→Legend…**; the Legend Wizard dialog will appear.
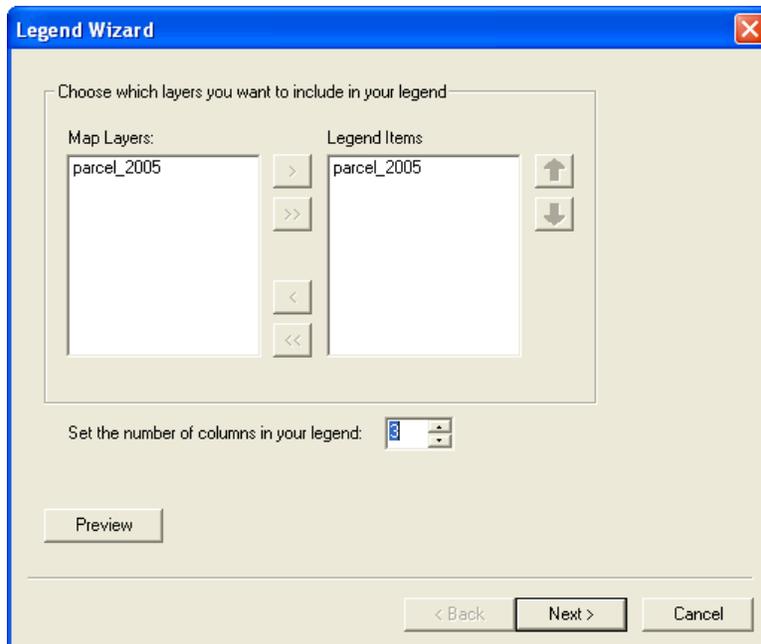
For this data frame, keep the number of columns at the default setting of 1. Click Next, give your Legend a title—**LBCS Activity**—and adjust font properties (~ size 8, centered). Click Next and add a thin border if desired. Go on and change your symbol patch sizes; width of 10 and height of 5 is a good starting point. Click Next, change all legend item spacing to 5, then

click Finish. Move your legend to an appropriate spot in the data frame and adjust size. Your first legend should look something like this:
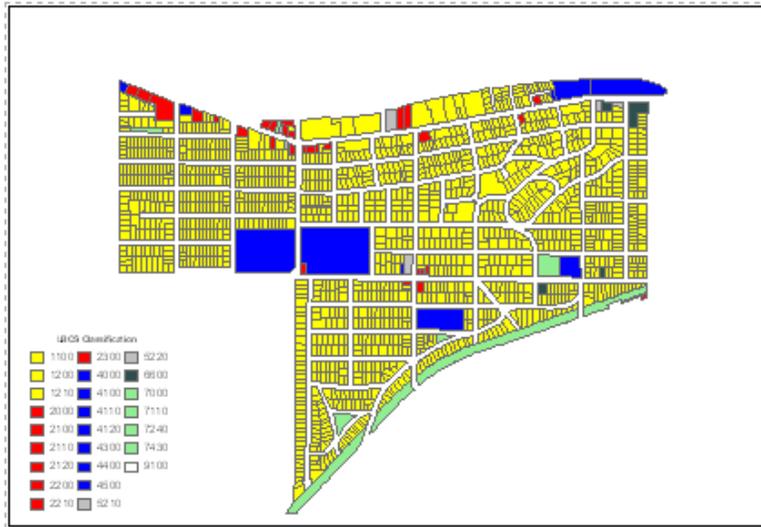
Using the same settings and similar sizes, create the rest of your legends.

Your next and final step is to add titles to your maps and the layout, as well as the other necessary elements such as a north arrow, scale bar, the data sources and your name.

To create the text, you will use the New Text tool on the Drawing toolbar.


Click it and an A with crosshairs appears. Click in the top center of the first data frame and title it Activity. Change your font size and style by right-clicking on the text and choosing **Properties**; in the Text tab, click on **Change Symbol** and choose an appropriate sans serif font style (e.g. Arial) and size. Click OK in the Symbol Selector and Properties dialogs and note the changes. Place your mouse cursor over the text to drag and reposition it. Do the same to title the remaining data frames, using the same font style and size for all. Using the same text tool, add a suitable title for your layout, using a suitable serif font style such as Times New Roman or Book Antiqua in a larger typeface, and center it accordingly.

Add a north arrow (not a compass rose) and scale bar in the bottom center of your map. Go to **Insert→North Arrow…** and select a simple north arrow style. Resize and position it along the bottom center of your layout. Click **Insert→Scale Bar…** and choose a basic 'tick-mark' scale bar style. Right-click on the scale bar, choose Properties, and in the Scale and Units tab change the 'division units' to miles. Now resize and position it near the north arrow, preferably below it. The scale bar and north arrow should be the last thing the map reader notices, so make them as small as you can. However, the scale bar should have meaningful, round increments, so adjust size or change properties if you need to.

Use the text tool to add your map's sources and your name (~ 8-size font) and array them along the bottom. Name should go in the bottom right. Source text should read: 'Sources: 2005 Regent parcel data and LBCS field surveys', while author info should be of the format 'Author: [Name] – [Class] – [date MM/DD/YY]'. Save your project.

Your completed map layout should look something like this:
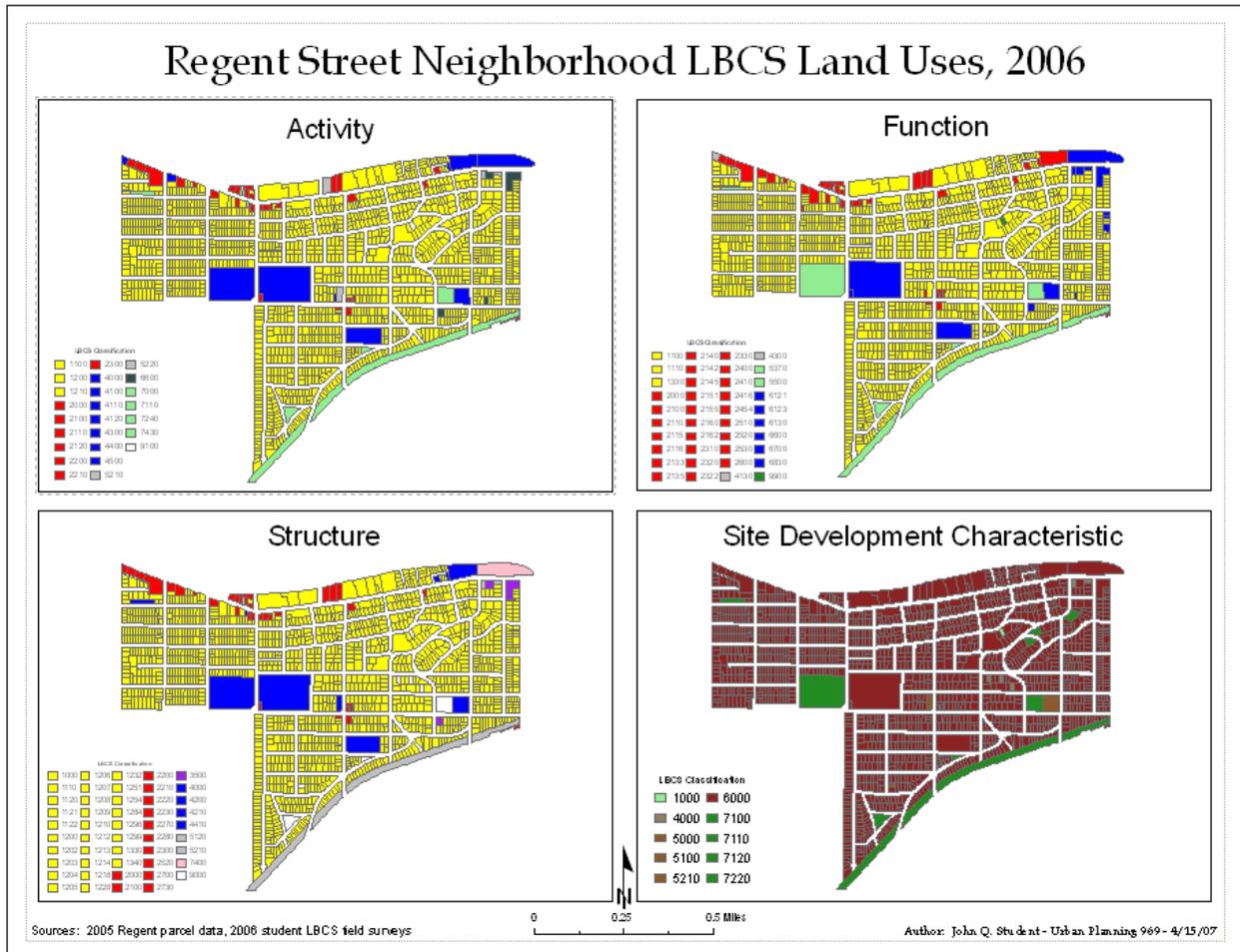
Congratulations, you've created an ArcMap project, performed a join, viewed and classified data, and created a map layout.

## III.   Perform Queries Across LBCS Dimensions

The purpose of this section is to identify and select parcels based on their multiple LBCS dimensions.

The map completed in the previous series of steps capably shows land use classifications across each LBCS dimension and allows for easy comparison. However, GIS is much more than just a data manipulation and cartographic tool. What about data analysis between two or more dimensions in order to determine patterns and interrelationships in the data? What if you want to

compare LBCS codes between, say, Activity and Structure and find all parcels that satisfy a land use criteria that you, the user, specify? For example, we may want to find all commercial activities in residential structures. This would be an interesting question to answer since the Regent neighborhood is so heavily residential in nature. However, there are any number of combinations to be found simply by examining and being familiar with the data.

To perform simple analyses like this in ArcGIS, you can perform *queries* on the joined parcel/LBCS code layer data in its attribute table. We will begin with one that highlights even better the nature of the Regent neighborhood. We will query parcels with household (Residential) activities (Activity 1100) in single-family, detached residential structures, that is, Structure code 1110.

In ArcMap, switch back to the Data View; we can use whatever data frame is activated for this and the layer won't be affected. Right-click on the *parcel_2005* layer and click **Open Attribute Table**. With the table open, click the **Options** button in the lower right corner and click **Select By Attributes…** Defining a query is, in effect, creating an expression based on chosen fields and 'operators' (AND, OR, <, > =, etc.). When applied, records that satisfy the criteria you define in your expression are highlighted in the attribute table, and their corresponding features on the map are selected and outlined.
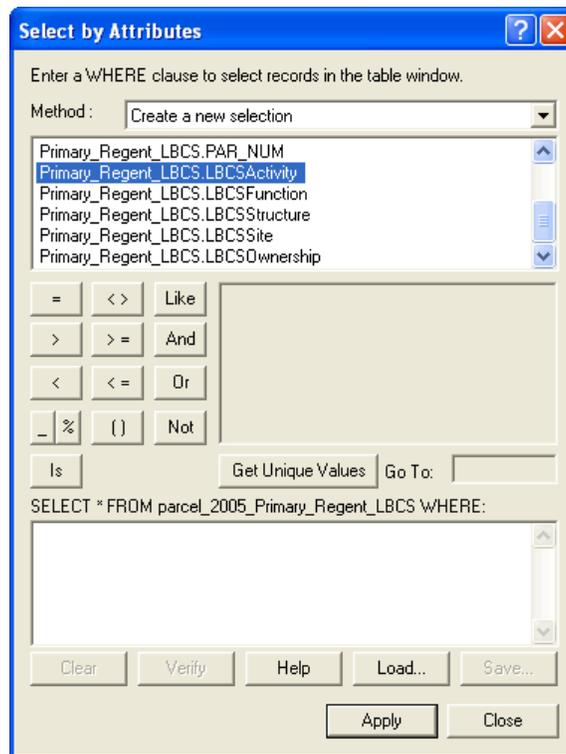

Enter the following query, double-clicking on field names and single-clicking on the operators used and clicking on **Get Unique Values** to show the values for the fields we use:

Primary_Regent_LBCS.LBCSActivity = 1100 AND Primary_Regent_LBCS.LBCSStructure = 1110

Click **Apply** and note the selection in the attribute table and in your layer; 1289 of 1521 parcels are used for basic household residential activites and are single-family, detached (stand-alone) structures.

Your query results should look about like this:
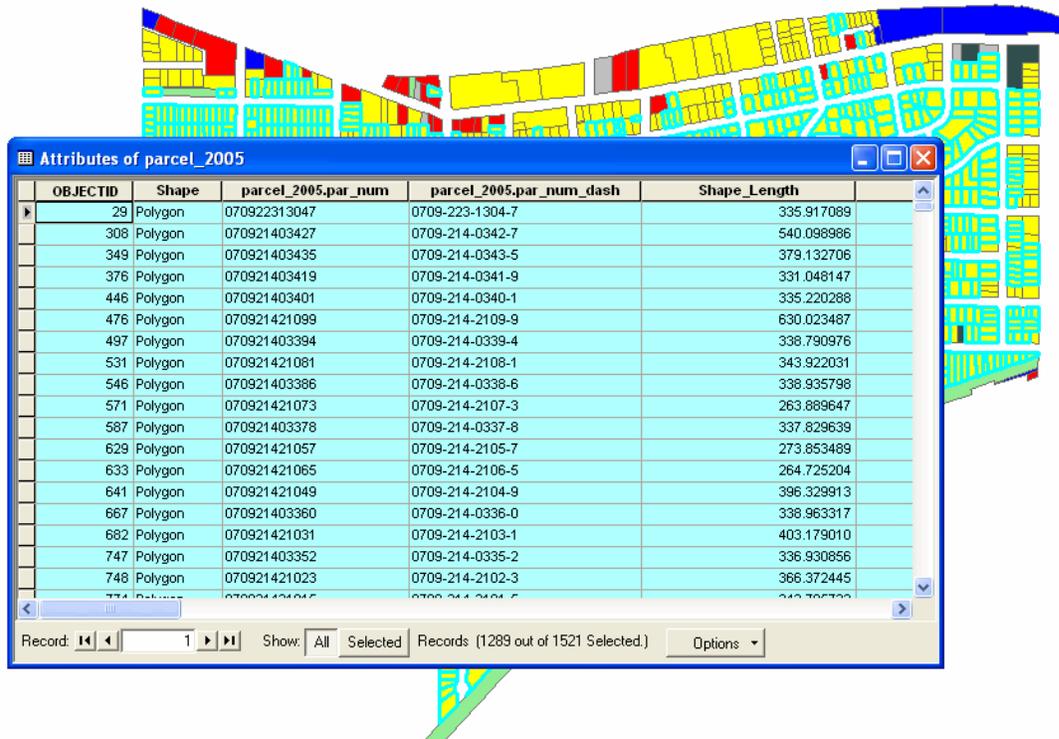
This simple query neatly illustrates the almost uniformly single family residential character of the Regent neighborhood. One could go on and perform another query relating to household activities (1100) in multi-family structures, e.g. two to five units per building. With your attribute table open, click on Options and select **Clear Selection**, which unselects previous query results. Click on Select By Attributes again, click on the **Clear** button, and then enter the following expression:

Primary_Regent_LBCS.LBCSActivity = 1100 AND Primary_Regent_LBCS.LBCSStructure = 1202 OR Primary_Regent_LBCS.LBCSStructure = 1203 OR Primary_Regent_LBCS.LBCSStructure = 1204 OR Primary_Regent_LBCS.LBCSStructure = 1205

(1202, 1203, 1204, and 1205 being the codes for two- through five-unit multifamily structures, respectively)

Click Apply and note the selection. 82 out of 1521 Regent parcels have residential land uses in two-, three-, four-, and five-unit structures. One could easily broaden the query expression to include multifamily structures with up to ten units, which would be the most numerous and thus would give perhaps the most valuable answer.

In certain situations it may be worthwhile to work with your selected data on its own, that is, as its own layer. In order to do this you would export the selected features as a new shapefile by right-clicking on the layer name and selecting **Data→Export Data…**, choosing the appropriate parameters in the Export Data dialog and assigning the exported layer a unique name. It would look as follows:
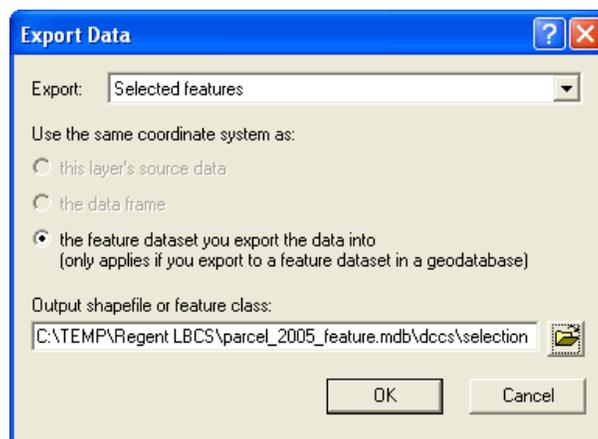
Once you clicked OK, the export would be carried out—all attributes of the selected features being exported into their own new table--and you would have the option of adding the new shapefile/layer to the project, where you could then work with it as you would any other data layer.

IV.   Working With Parcels That Have Multiple LBCS Codes

Create a relate from Parcels to the Accessory_Activity table

Query for all parcels for where the primary activity is commercial (2000 level), but includes a residential function (1100)

Open the Accessory_Activity table. Build a query for all Activities = 1100. Under Options, choose "Related tables." Select Relate 1: Parcel_ 2005_Primary_Regent_LBCS. Examine Attributes of Parcels_2005 table (12 records selected). Select the Selected button for Show:

Under Options, choose Select by Attributes. In the Select by Attributes dialog box, for Method: choose Select from current selection. Build the following query:
Primary_Regent_LBCS.LBCSActivity >= 2000 AND Primary_Regent_LBCS.LBCSActivity <= 2999

The 11 selected records represent all the parcels where the primary activity is commercial and there is an accessory residential activity. Note that all the parcels are along Old University Avenue or at the intersection of Allen and Regent Streets.