Multi-Criteria Evaluation (MCE) in ArcMap 10
aka “Site Suitability Analysis”

Scenario
In this exercise, imagine you are a new faculty member hired by Old Dominion University and preparing to move to and buy a new home in Norfolk, VA. Since you are a Geography and GIS professor, you will naturally want to use GIS tools to examine the area surrounding campus in order to find the most desirable location to relocate your family. You are married with two children in elementary school. Your relatively low starting salary reinforces your need to get the most for your money while minimizing your daily travel costs.

The following are your minimum requirements:

Location: Must be within 2 miles of your office in the Oceanography & Physics Building.
Demographics: Must have a large proportion of persons married with children.
Property: Must be a residential property between 1500 and 2000
Schools: Must be within walking distance of an elementary school; under ¼ mile
Parks: You would like you home within 1000 feet of a neighborhood park.
Flooding: Should remain “dry” during a Cat 2 Hurricane storm surge

Step 1 Open ArcMap
On the ArcMap – Getting Started dialog box, under Existing Maps, click Browse for more. Browse to your \ArcGIS10_MCE\Data\Inputs folder in the class directory, click on Home_selection.mxd, and click Open. The map shows the several Norfolk data layers that will be critical to your analysis.

There are two bookmarks in this map, Norfolk and OCU_campus. These will allow you to toggle back and forth between the two extents.

Step 2 Finding residential zones.
In this step, you will determine residential zoning areas in Norfolk.

Open the attribute table for the Norfolk_zoning layer. Use the “Table Options” icon to “Select by Attributes” as shown in the image to right.

You will now build a query that selects only the residential zones from within this data layer.

The “Zone_” field in the table refers to the type of zoning. Any zone code beginning with the letter “R” represents a residential zone.

For method use “Create new selection”. 
Double-click on [ZONE_] to add it to the query.

Click the “Get Unique Values” button to view all zone codes. Since these values display in a pseudo-quantitative order, you’ll need to select all values that are >= the “lowest” residential code and <= the “highest” residential code.

Click on >= to add this to the query.

Scroll down through the list of codes and double click on the first “R” code to add it to the query.

Next click “And” to add it to the query. This very important step ensures that your selected codes will meet the condition of being within the low-high range of R codes.

Double-click on [ZONE_] to add it to the query again.

Click on <= to add this to the query. Then double-click on the “highest” R code to add it as your final query item.

**Note:** You’ll see that the “highest” R code is R-9, rather than R-15. This is because the software recognizes the “1” in the code R-15 as being in the same position as the “9” in R-9 and therefore recognizes it R-15 as being a “lower” ordered code.

Click Apply and close the attribute table. You should have 3876 polygons selected.

Right click on the Zoning layer in the Table of Contents and select “Data” – “Export Data”. Export only the selected features to the “Best_sites.mdb” geodatabase found in the Outputs folder for this exercise. Name the feature data set “Res_zones”.

Add these features to the map and remove the Norfolk_zoning layer.

**Step 3 Selecting a single Building features and refining the zoning layer**

Now zoom back to the “ODU_campus” bookmark. Examination of the attribute for the ODU_building1 layer reveals the names of each of these buildings.

From the main ArcMap menu, choose “Selection” – “Select by Attributes”.

Set your Layer to ODU_buildings1 and construct a query in which you select only the
Oceanography and Physics building (hint: use the ‘RefName’ field).

Once you have selected the Oceanography & Physics building, on the Main ArcMap menu choose “Selection” – “Select by Location”.

Use the following parameters in your selection:
- **Selection method:** “Select features from”
- **Target Layer:** “Res_zones”
- **Source Layer:** ODU_Buildings1 (use selected)
- **Spatial Selection Method:** Target layer features are within distance of Source Layer feature
- **Distance:** 2 miles

Apply and close your selection window, then right click on the Res-zones layer and choose “Selection” - “Zoom to selected”. A quick review of the attribute table show that now only 660 zones are within our acceptable range.

Export these selected zones to your Best_sites geodatabase and name the file “Res_zones_2mi”. Add this layer to the map and remove your original “Res_zones” layer.

**Finding desirable census blocks**

You’ve decided that you’d like at least 1/3rd of the households in your neighborhood to be occupied by married families with children.

Examine the attribute table for the Census_blocks layer. Notice that there are fields called “Households” (total number in that block) and “HHSMARRKID” (number that are married with kid).

While you can easily approximate the percentages, you’ll want to create a new field in the table that accurately represents this information.

At the top left of the Census_blocks attribute table, click on the Table Options icon and select “Add Field”.

Name your field “Pct_MarKid”. Type Short Integer. Click OK and the new empty field will appear at the far right of the table.

You need to apply the simple percentage formula to this column:

\[
\text{Pct\_MarKid} = \left( \frac{\text{number of married with kids households}}{\text{total households}} \right) \times 100
\]

However, you realize that some of the blocks in your attribute table have “0” households. This will cause an error when ArcMap attempts to perform the forbidden operation of dividing by zero.
You’ll remedy this by first selecting only the non-zero numbers of households. From the Table Options menu, choose “Select by attributes” and build a query where Households are greater than 0.

At the bottom of your table window, use the toggle button shown in the image to display only the newly selected entries.

Finally, right click on your “Pct_MarKid” field heading and choose “Field Calculator”. Here you will create your percentage formula.

The dialogue pre-fills with: Pct_MarKid =

In the empty space add the following: 

\[
\frac{\text{HHSMARRKID}}{\text{HOUSEHOLDS}} \times 100
\]

This creates a simple percentage column which we may now query for our final group of acceptable neighborhood areas.

From the main ArMap menu, choose “Selection” – “Select by attributes”.

Build a query with the following parameters:

**Layer:** Census_Blocks  **Method:** Select from current selection
**Query:** “Pct_MarKid” > 33

Click OK. 357 polygons are now selected based on your criteria. Export the selection from this layer into your Best_Sites geodatabase and name the feature class “Cens_blk”.

Add this layer to the map and remove the old census_blocks layer.

**Step 5**  
Finding only the zones in desirable census blocks

In this step you will determine which of you residential areas fall within the desirable neighborhoods.
From the main menu, choose “Selection” – “Select by Location”.

Select features from your Target Layer: Res_zones_2mi that intersect with features in your Source Layer: cens_blk

Click OK. Review the attribute table for the Res_Zones_2mi and you’ll see that 120 zones are found to meet your criteria of being residential, within 2 miles from your office, and in family-oriented neighborhoods.

Export this new selection to your Best_sites geodatabase and name it “Res_2mi_fam”.

**Step 6** Find acceptable homes within these zones

In this step, you will find a home that falls within one of the preferred zones while also meeting your square footage requirements.

**On your own:** Build a Select by location query that chooses all features from the “buildings” layer that are within the desired zones.

Your output should include 2943 buildings and should appear similar to the following (when zoomed to the “Larchmont” bookmark):

![Image of buildings within preferred zones]

**On your own:** Build a Select by Attributes query that selects features from the current selection in your buildings layer that are >= 1500 square feet and <= 2000 square feet.

Your selected set of features is now narrowed to just over 600 buildings as shown in the
image of the Larchmont bookmark below:

Export these features to your Best_sites geodatabase and name the file “Homes”.

**Step 7**  
**Final select by location steps**

In this step, you locate a final set of properties based upon their proximity to schools, parks, and flood zones. You’ll use successive Select by Location queries to produce this result.

**First**, select features from Homes (Target) that are within a .75 distance from elementary_schools (Source) and click **Apply** (do not click OK and do not close the selection window).

**Next**, select from the currently selected features in Homes (Target) that are within 1000 feet from parks (Source) and click **Apply** (do not click OK and do not close the selection window).

**Finally, remove** from the currently selected features in Homes (Target) that are within the Source layer cat2surge_polygon.

45 buildings should be selected after this query. Use the bookmarks entitled “North” and “South” (referring to their orientation to the ODU campus) to view their respective locations.

Note that the buildings in the south appear to be located in “island” polygons that are entirely surrounded by potential flood waters.
South

North
Manually selecting your final properties and getting owner information.

In the Table of contents, display only the Homes and Parcels layer. Turn off all other layers.

You’ve decided to only consider the two properties to the north of ODU. Zoom to the North bookmark and click on the selection tool icon.

While holding the shift key, click once on each of the two homes (that were already selected in the prior step).

Now, both the 2 buildings and the parcels should be selected.

Export the selected Parcels to the Best_sites geodatabase and name it “Best_homes”.

Join a table: Finally, you’ll need to get the owner information for these two parcels. If you examine the attribute table for the Parcels layer, you’ll notice that there is no owner contact information listed.

Let’s join a table to the Parcels layer in order to provide this necessary information.

From the Home_selection database, add the data table “ownership”. Right click and open this table to examine the data. You’ll note that the table contains owner information for each parcel and also contains the LRSN number which we will use to link the table to the parcels layer.

In the Table of Contents, right click on the Parcels layer and select “Joins and Relates” – “Join…”.

At the Join dialogue use the following parameters:

What to join: “Join attributes from table”
1. Field to base join on: “LRSN”
2. Table to join: “ownership”
3. Field to base join on: “LRSN”

Join options: “Keep only matching records”

Click OK. If prompted to create an index, click Yes.

Review the attribute table of the Parcels layer again. Because we have joined the ownership
information, the table now contains all information from the matching records from both tables. At the bottom of the table, use the toggle button to show only the selected features.

The attribute table now reveals that one of our two properties is owner occupied and the other is not. We are have the name of the owners with whom we need to make contact to initiate our home purchase!