A Home for the Firehouse

A town planner's perspective

— by Jeff Blossom

Introduction

Problem

Where is the best place to locate a new fire station?

A common task for town planning offices is to help determine the best location for public service facilities such as fire stations. Several criteria need to be considered when looking for the best site for a fire station. First off, planners must identify available land. The land must be an appropriate size, and it must be buildable—for example, free of waterways, or wetlands. The site must be on or near major roads, to allow for quick access to the entire service area, which must not overlap the service areas of existing fire stations.

This exercise uses spatial analysis software and publicly available geographic data to identify potential sites for a new fire station. Along the way, you will learn the process involved in performing a site suitability analysis—not just for a fire station, but for any new facility location task.

Location

Town of Hudson, Massachusetts

Time to complete the lab

Two hours

Prerequisites

Cursory familiarity with ArcGIS software

Keywords: workflow process, site suitability, planning

Data used in this lab

- Parcels, roads, wetlands, fire stations, town-owned parcel list
- Geographic coordinate system: NAD 1983
- Datum: NAD 1983
- Projected coordinate system: Massachusetts Mainland State Plane (meters)

Student activity

Working with town planners, one of your responsibilities is to help determine the best location for public service buildings such as fire stations. That task comprises several considerations. First, you must identify available land—preferably vacant land already owned by the town. The land must be of an appropriate size, and it must be buildable—free of waterways, swamps, or other wetlands. Then, you must consider transportation. Fire stations must be on or near major roads, to allow for quick access to the entire service area. You also need to ensure that the location is not too close to existing fire stations, so that the new station service area doesn't overlap that of any existing fire stations. Other, more complex factors may be important to consider as the planning process continues, but these are enough criteria to allow for an initial determination of suitable sites.

In this exercise, you will use spatial analysis software and publicly available geographic data to identify potential sites for a new fire station. You will follow a common spatial analysis workflow and gain an understanding of the site suitability analysis process—not just for finding a home for a new fire station, but for locating any new facility.

For this exercise, the criteria used to determine suitable locations for the new fire station are that it

- must be a town-owned property,
- must be a property at least one acre in size,
- must contain less than 20% wetlands,
- must be located on a major road, and
- must be located a sufficient distance from existing stations.

Now how do you go about accomplishing the analysis? The first step is to check whether the data layers you need exist and are available for use. Web searches determined the following:

- Town-owned properties can be listed from the town of Hudson online database.
- MassGIS has Hudson parcel, wetlands, and major road datasets available for download.

After ensuring the needed data layers are available, it's time to plan the sequence of events needed to perform this analysis. The goal is to end up with a parcel dataset containing only those parcels that meet the criteria. First, town-owned properties must be identified on the map and selected from all Hudson properties. Next, town-owned properties under one acre must be deleted. Then the

percentage of wetlands must be calculated for each parcel. Finally all parcels not located on major roads must be eliminated.

Prepare the data
- Copy the parcels, wetlands, existing fire stations, and roads data.

Create maps
- Create an overview map of Hudson.
- Create a map of available parcels.
- Create a wetlands map.
- Create a site suitability map.

Analyze results
- Determine the most suitable site for a new fire station.
- Compare the results to the actual site of the new fire station.

PREPARE YOUR WORKSPACE

1 Create a *SpatiaLABS* folder under the *C:* folder and a *Fire_Station* subfolder.

2 Locate Fire_Station.zip and extract it into the C:\SpatiaLABS\Fire_Station workspace.

3 Examine all data in the Fire_Station folder (you should have *Parcels*, *Wetlands*, *Existing_Fire_Stations*, and *Major_Roads* shapefiles and *Town_owned.dbf* table).

CREATE AN OVERVIEW MAP OF HUDSON, MASSACHUSETTS

1 Start ArcMap and add the *Parcels* shapefile. This shapefile contains locations of all properties in the Town of Hudson. Next add the Streets basemap.

    Question 1:   *Hudson is in what part of Massachusetts?*

    Question 2:   *How many properties are in the town? (Open the Parcels attribute table to check this.)*

2 Make an overview map showing where Hudson is in relation to the surrounding area. On your map include the following: Hudson, MA, clearly labeled; a scale bar, a north arrow, and a data source citation that reads: "Parcels—Office of Geographic Information (MassGIS),

Commonwealth of Massachusetts, Information Technology Division. Basemap—ESRI Streets"
Your map should look like map 1 below.

Map 1. Overview of Hudson, MA.

> **Question 3:**   *Why are data source citations important to include on a map?*

FIND THE TOWN-OWNED PROPERTIES

The list of town-owned properties was generated by the query "Owner Name = Town of Hudson"
from the Town of Hudson Assessor online database. This list is necessary to accomplish the first
task of the analysis: mapping town-owned properties.

1   Add the *Town_owned.dbf* table to your map and open it.

Question 4:   *How many town-owned properties are there?*

Question 5:   *What percentage of properties does the Town of Hudson own?*

Question 6:   *How might you use ArcMap basemaps to find out if the properties are vacant?*

Now you need to map these town-owned properties to the *Parcels* shapefile. This will be accomplished using a table join. This operation matches two common fields between tables, bringing the columns of one table into the other.

2   First, inspect the *Parcels* and *Town_owned* tables for a common field. To do this, open the *Parcels* attribute table. In the *Table* window, click the *Table Options* button and click *Arrange Tables » New Horizontal Tab Group* so you can view the Parcels and Town_owned tables at the same time.

There do not appear to be fields with matching values. The *AccountNum* field in the *Town_owned* table contains five digits. These values are not identical to the nine-character *MAP_ID* field in the *Parcels* table. A phone call to the Hudson Assessor's Department reveals that *AccountNum* does contain the map and parcel numbers but with the two leading zeros truncated from the map number before the dash and one leading zero truncated from the parcel number after the dash. So, for example, account number 09069 matches MAP_ID number 0009-0069.

Now you've identified that the common fields between the two tables are the AccountNum field in the Town_owned table and the MAP_ID field in the Parcels layer.

For a table join to work, the fields being joined must be the same type, and the values within must be identical. First you'll check whether the fields are the same type.

3   Right click the *AccountNum* field and click *Properties*. This field is type "Double," meaning it is a double-precision number.

4   Right-click the *MAP_ID* field, click *Properties*, and note that this field is type "String," or text.

The field types need to match, so first you will change the format of the *AccountNum* field to String. In ArcMap, field types cannot be changed, so you'll create a new field type *String* and copy the values from *AccountNum* to it.

5   Click the *Town_owned* table, click *Table Options*, and then click *Add Field*. Name the new field **AccountTxt** and specify *Text* for type. Leave the length at *50*. Click *OK* to add the field.

6   Right-click directly on the *AccountTxt* field header (see below) and click *Field Calculator*.

AccountNum	AccountTxt
3004	
9003	
9022	
9069	

7   In the *Field Calculator* dialog box, double-click *AccountNum* so that your calculation expression reads *AccountTxt = [AccountNum].* See below.
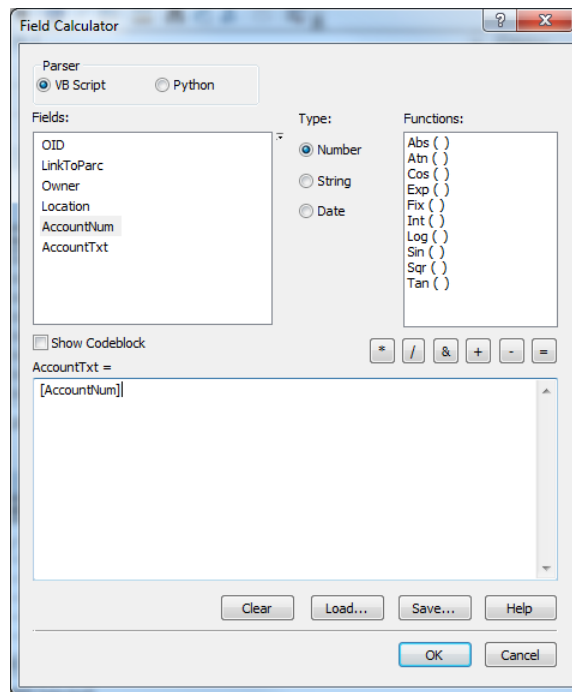

8   Click *OK*, and the values from the *AccountNum* field will be copied to the *AccountTxt* field.

Now you must change the format of the values in the Parcels *MAP_ID* field to match the *AccountTxt* field. You'll add a new field to the *Parcels* table and format these values.

9   Click in the *Parcels* table, click the *Table Options* button, and click *Add Field*. Name the field **Map_ID2**, type **Tex**t, and click *OK*.

The Hudson assessor explained that the first two zeros of the *MAP_ID* number are not used in the account number. The field calculation below will copy the *MAP_ID* values to the *Map_ID2* field while also eliminating these two leading zeros.

10 Right-click the *Map_ID2* field and click *Field Calculator*. In the expression box, enter **right ([MAP_ID],7)**. See figure below.
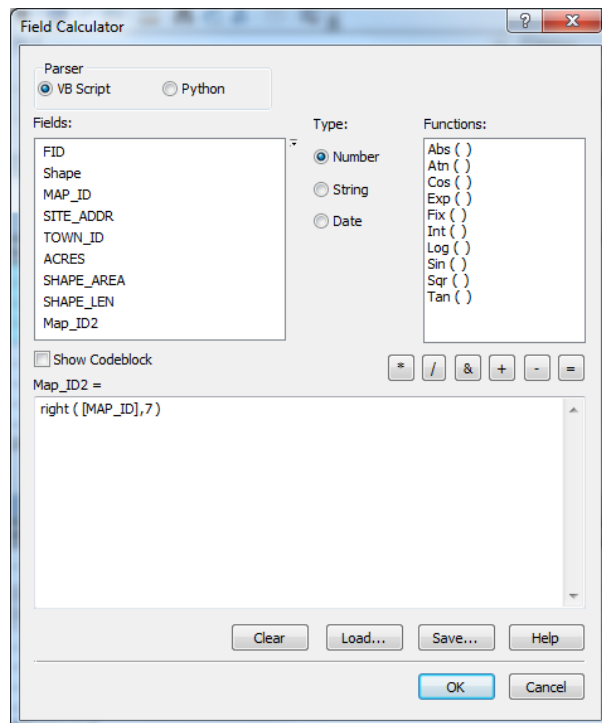

This copies the first seven characters from the right of the text string contained in the *MAP_ID* field to the *Map_ID2* field. Since these are all nine-character strings, it eliminates the first two zeros.

The assessor also said that the first zero of the parcel number (the numbers following the dash) is not used in the account number. So you'll do a search and replace function to eliminate these. You also want to eliminate the dash so that the number format matches that of the *Town_owned* table's *AccountTxt* field of five digits.

11 In the table of contents, right-click the *Parcels* layer and click *Edit Features » Start Editing*. Click in the *Map_ID2* field to highlight it.

12 Click *Table Options » Find and Replace*.

13 In the *Find and Replace* dialog box, click the *Replace* tab. In the text box after *Find what:*, enter *-0* making sure to type zero as opposed to the letter O. Leave the text box after *Replace with* blank. See figure below.
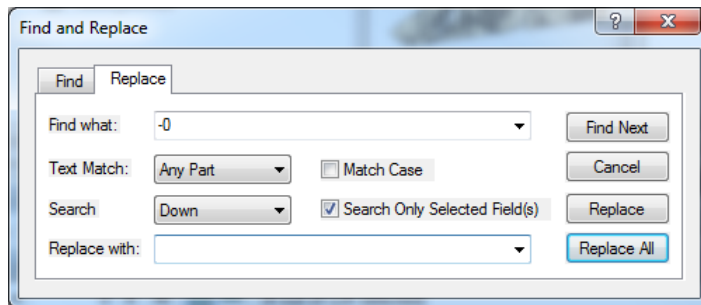
14 Click *Replace All*, and now your *Map_ID2* field values will match the *AccountNum* values.

15 Click *Editor » Stop Editing* and click *Yes* to save your edits.

> **Question 7:** *Why could it be dangerous to your data to perform text string calculations?*

Now the tables are ready to be joined.

16 In the map table of contents, right-click the *Parcels* layer and click *Joins and Relates » Join*.

17 In the *Join Data* dialog box, specify *Join attributes from a table*, selecting the *MapID2* field in box no. 1, the *Town_owned* table in box no. 2, and the *AccountTxt* field in box no. 3.

18 Click *OK* to activate the join.

Now the fields from the *Town_owned* table will be appended to the *Parcels* table.

19 Scroll all the way to the right of the *Parcels* table to see these fields.

20 Right-click the *AccountTxt* field and click *Sort Descending*. This will move the parcels that match between the two tables to the top of the list. Compare a few values between the *AccountTxt* and *Map_ID2* fields in the same row to make sure they match.

21 Select all the parcels that match by clicking and highlighting the top row, then pressing and holding Shift while scrolling to the last row that matches, and clicking in the last row.

> **Question 8:** *How many parcels have matching values in the AccountTxt and Map_ID2 fields?*

Now you'll export these parcels to a new shapefile.

22 Right-click the *Parcels* layer and click *Data » Export Data*. Make sure *Export Selected Features* is checked at the top of the *Export Data* dialog box. Click the Browse button, specify *Shapefile* for *Save as type*, and name the new shapefile ***Town_Owned_Parcels***, saved to the *SpatiaLABS\Fire_Station* folder.

23 Make a Hudson parcel map, with town-owned parcels displayed in a different color. Make sure to include a north arrow, scale bar, legend, and data sources on your map. Your map should look like map 2 below.
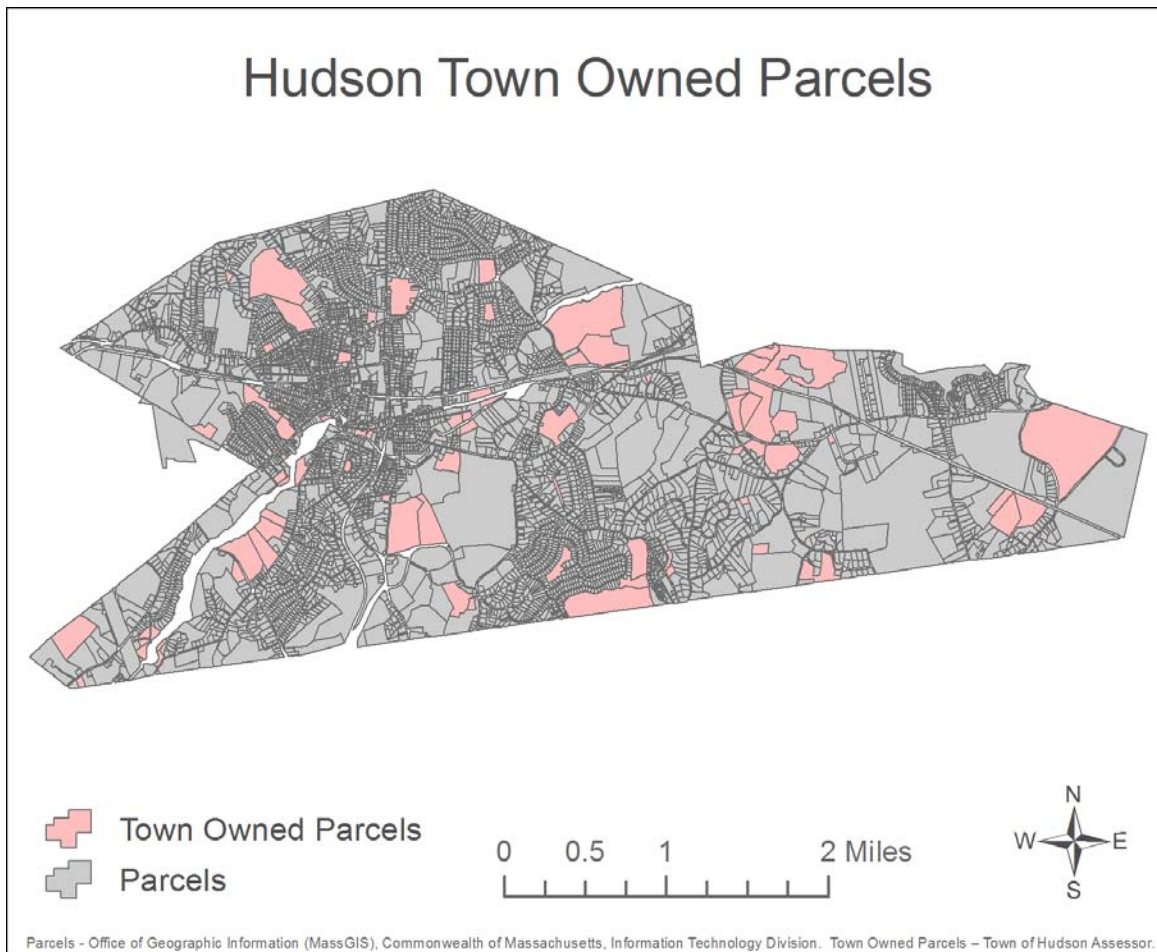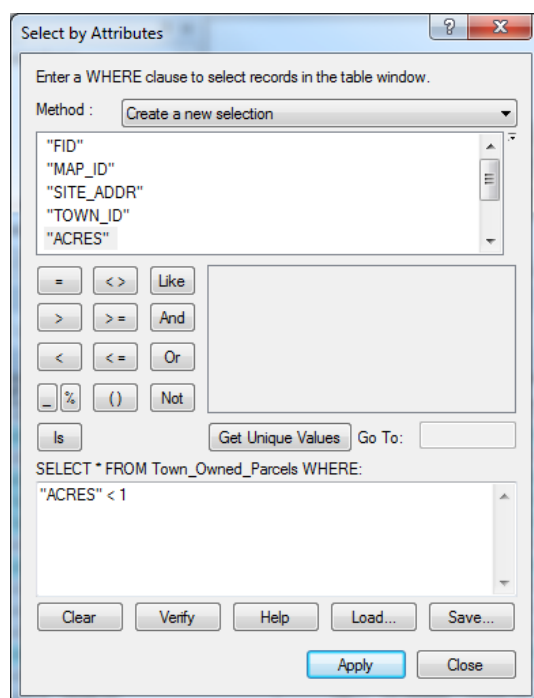

Map 2. Hudson town-owned parcels.

> **Question 9:**   *Examine the map. Does there appear to be any spatial pattern in the location of the town-owned properties? Are there similarities among the sizes of the town-owned properties?*

FIND ALL PROPERTIES OVER ONE ACRE IN SIZE

Now that you've isolated the town-owned parcels, the next step is to find those that are greater than one acre in size. This is the second criterion for fire station site suitability. The acreage of these parcels has been calculated into the *ACRES* field. You'll use a selection on this field to delete all parcels less than one acre in size, leaving just parcels greater than one acre in the *Town_Owned_Parcels* shapefile.

1　Right-click the *Town_Owned_Parcels* layer and click *Edit Features » Start Editing*.

2　Open the *Town_Owned_Parcels* attribute table and click *Table Options » Select by Attributes*. Double-click the "*ACRES"* field and enter *< 1* in the select expression box. See below.


3　Click *Apply* and then *Close*. Forty-three of the 118 town-owned parcels should have been selected. Click *Edit » Delete* or the *Delete* button on top of the table to delete these 43 parcels.

4　Click *Editor » Stop Editing*, and then click *Save Edits*.

INTERSECT WETLANDS AND PARCELS

So far, you've isolated town-owned properties over one acre in size. Now it is time to determine which of these properties meet the less than 20% wetlands criteria. First, you'll make a quick map showing where the wetlands are in relation to town-owned parcels.

1   Add the *Wetlands* shapefile to your map. Symbolize it using the *Wetlands* symbol from the *Symbol Selector*. Add a 40% transparency to your *Town-owned Parcels* and *Parcels* map layers. This will give a muted look to these layers, allowing the wetlands to stand out more. Modify the title, legend, and data sources to reflect this new map. Remember, now your map shows only town-owned parcels over one acre. It should look like map 3 in the following figure.
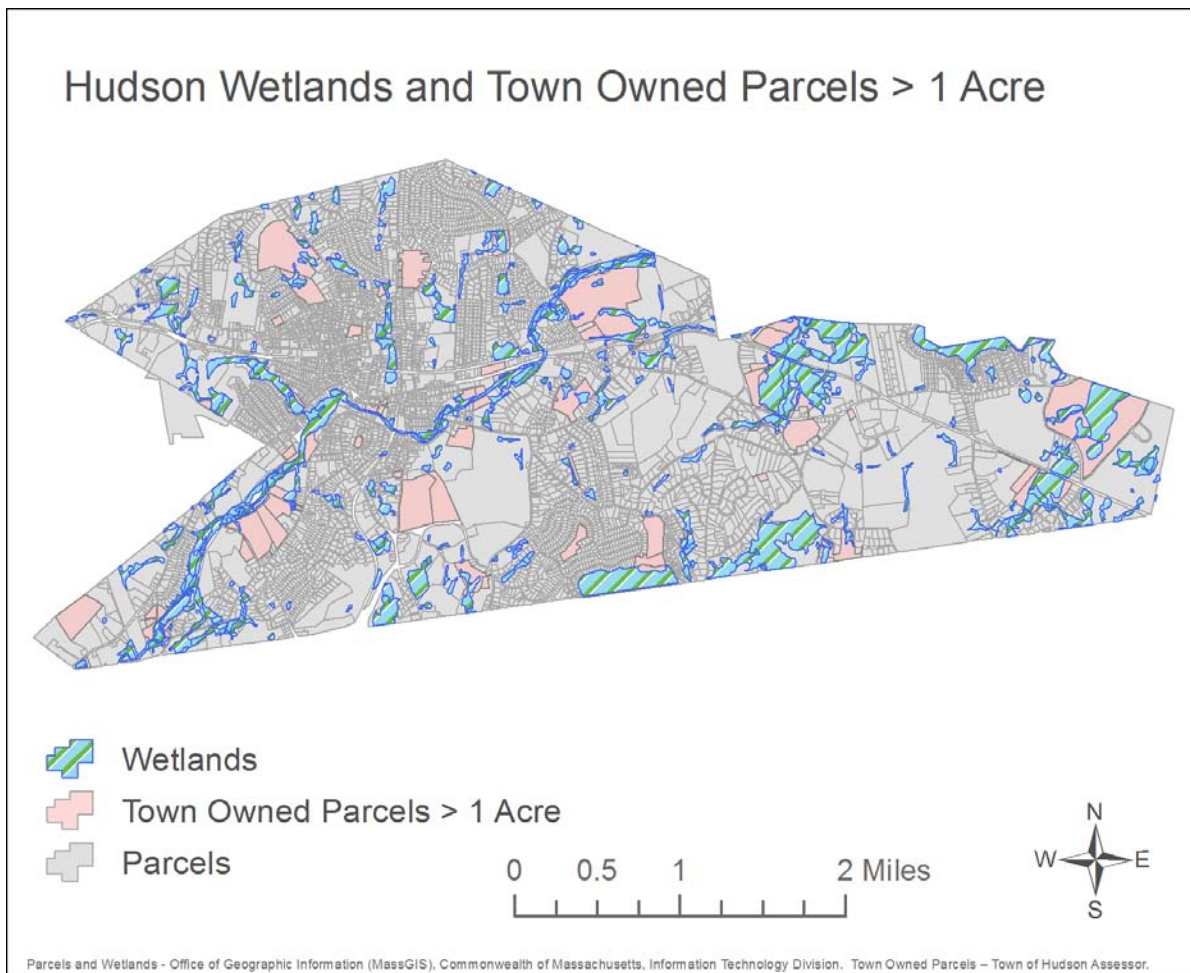
Map 3. Wetlands.

> **Question 10:**   *Add the Imagery basemap. Examine the Wetlands layer as compared to the aerial photo background. Do polygons in the Wetlands layer correlate with swamps or water bodies as seen in the photos?*

To determine the percentage of wetlands on each property, an overlay analysis is necessary. The geometry of the *Wetlands* layer needs to be split by the geometry of the *Parcels* layer. To accomplish this, use the *Intersect* tool.

2   In *ArcToolbox*, expand the *Analysis Tools » Overlay* tools and double-click *Intersect*. This tool takes two or more feature classes and returns the intersected area into a new feature class.

3   For the input features, click the drop-down arrow and click *Town_Owned_Parcels*. Click the arrow again and click *Wetlands*.

4   Specify the output shapefile as *Wetlands_Intersect*. Click *OK* to run the tool.

5   Open the *Wetlands_Intersect* attribute table and notice that fields from both *Town_Owned_Parcels* and *Wetlands* are in this table. The *ACRES* field is from *Town_Owned_Parcels* and lists the total acres for each property.

Now you need to find the portion of this total acreage that is wetlands. New geometry was created by the *Intersect* tool, producing the *Wetlands_Intersect* layer, which contains wetland areas split by properties. The acreage for this layer needs to be determined. Once you have total acreage and wetlands acreage, you can divide wetlands by the total to determine the percentage.

6   In the *Wetlands_Intersect* table, click *Table Options » Add Field*.

7   Name the field ***AcresNew*** and specify *Double* for type. Click *OK* to add the field.

8   Right-click the *AcresNew* field and click *Calculate Geometry*. Click *Yes* to the message that appears. Specify *Acres US* for units and click *OK*. Total acreage for each polygon is calculated.

The *AccountTxt* field is the unique property identifier as created by the Town of Hudson assessor. Sorting the *AccountTxt* field reveals that there are, in some cases, many wetland polygons per parcel, the total acreage of which needs to be summarized. Now it is time to summarize the total acreage of wetlands per parcel.

9   Right-click the *AccountTxt* field and click *Summarize*. This operation creates a table with one row per unique value from the chosen field, in this case *AccountTxt*. Additional fields can be chosen to summarize when running this operation.

10   In the *Summarize* dialog box under *2. Choose one or more summary statistics to be included in the output table,* click *AcresNew* and select the *Sum* check box.

11   Specify the output table to go in the *SpatiaLabs\Fire_Station* folder, naming it
Wetlands_Summary, and specify *dBASE Table* for type. Your *Summarize* dialog box should look
like the figure below.
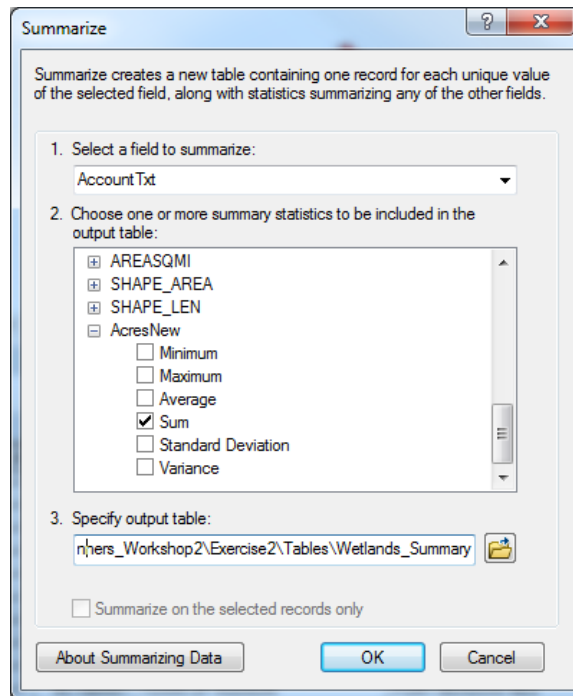
12   Click *OK* to run the summary and *Yes* to add the result to the map.

13   Open the *Wetlands_Summary* table and note the *Sum_AcresNew* field. This contains total acreage
of wetlands for the parcel identified in the *AccountTxt* field.

CALCULATE TOTAL PERCENTAGE WETLANDS PER PROPERTY

To calculate the percentage of wetlands per property, you need the total acres of wetlands and the
property's total acres in the same attribute table. This will allow for using both of these values in a
calculation. Total parcel acres is already in the *Town_Owned_Parcels* layer under the field *ACRES*. So
you will join the *Wetlands_Summary* table to the *Town_Owned_Parcels* table, and then calculate a
new blank field equal to the wetlands acreage.

1   First, create two blank fields in the *Town_Owned_Parcels* table: ***AcresWet*** and ***PctWet***, both type
Double.

2   Right-click the *Town_Owned_Parcels* layer and click *Joins and Relates » Join*. Select the *AccountTxt* field in box no.1, the *Wetlands_Summary* table in box no. 2, and the *AccountTxt* field in box no. 3. See figure below.
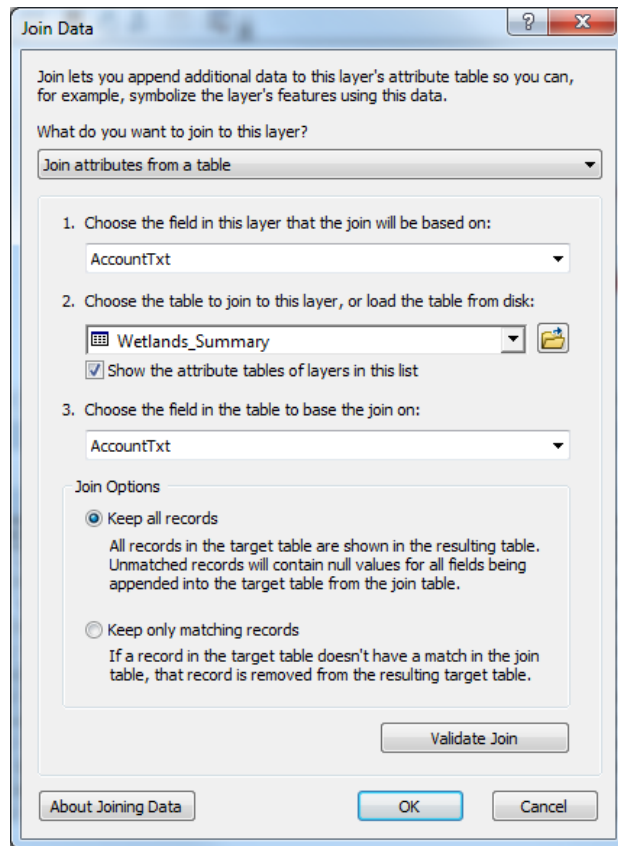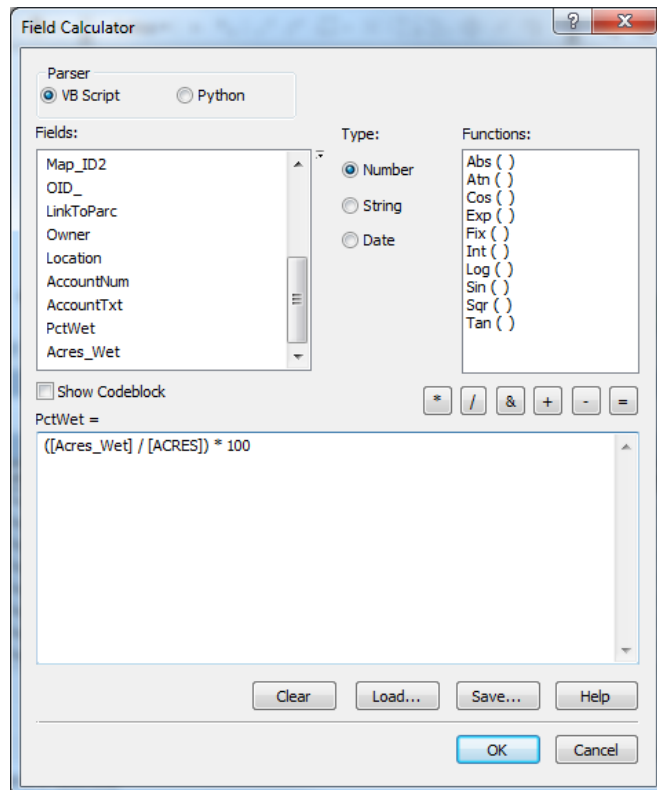

3   Click *OK* to run the join.

4   Right-click the *AcresWet* field and click *Field Calculator*. In the *Field Calculator* dialog box, double-click the *Wetlands_Summary.Sum_AcresN* field. This is the Sum_AcresNew field with the "ew" truncated from the field name since ArcGIS shows only 10 characters of field names when doing table joins. Your *Field Calculator* dialog box should look like the figure below.
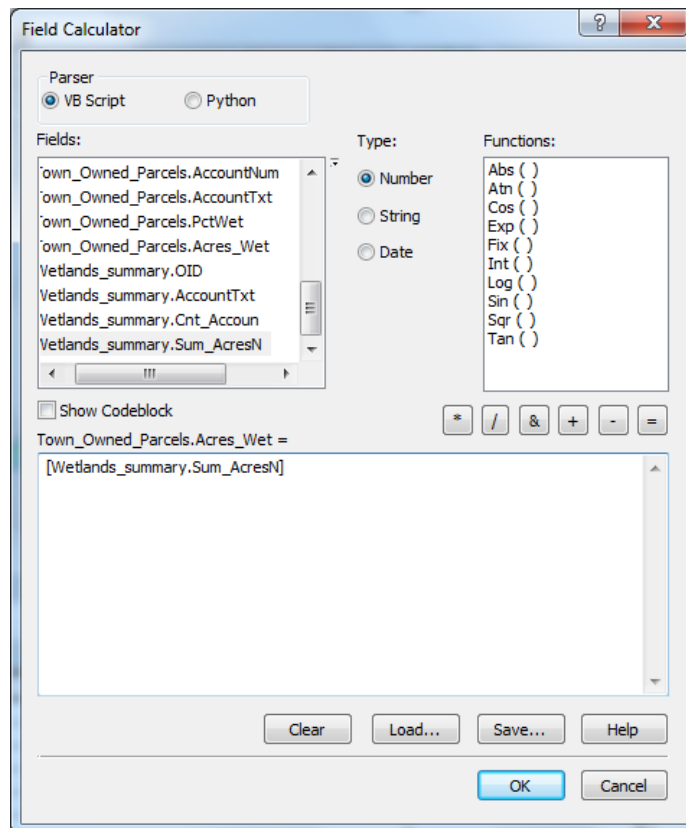
5   Click *OK* to run the calculation.

6   Click *Yes* to the Field calculator error and *OK* to the Field Calculator warning message. These appear because some of the values you are calculating are null. Note that the *AcresWet* field now contains values.

7   Remove the table join by right-clicking the *Town_Owned_Parcels* layer and clicking *Joins and Relates » Remove Join » Wetlands_Summary*. Now you have total acreage in the *ACRES* field and total acres of wetlands in the *AcresWet* field. It's time to calculate the percentage of wetlands per property.

8   Right-click the *PctWet* field and click *Field Calculator*. In the *Field Calculator* dialog box, double-click *AcresWet* and the */* symbol and *ACRES*. Put parentheses around this statement, and then enter *** 100** to multiply the result by 100. This will divide the acres of wetlands by the total acreage and multiply the result by 100, producing percentage of wetlands per parcel. Your dialog box should look like the figure below.

9   Click *OK* to run the calculation.

Now the *PctWet* field contains the percentage of each parcel that is in wetlands.

10 Sort the *PctWet* field in descending order.

> **Question 11:**   *What is the largest percentage of wetlands for a single property?*

Now that you have percentage of wetlands per property, you need to eliminate all properties that have more than 20% wetlands.

11 Right-click the *Town_Owned_Parcels* layer and click *Edit Features » Start Editing*.

12   In the *Town_Owned_Parcels* table, click *Table Options » Select by Attributes*. Double-click the *PctWet* field, the *>* sign, and type *20.* See figure below.
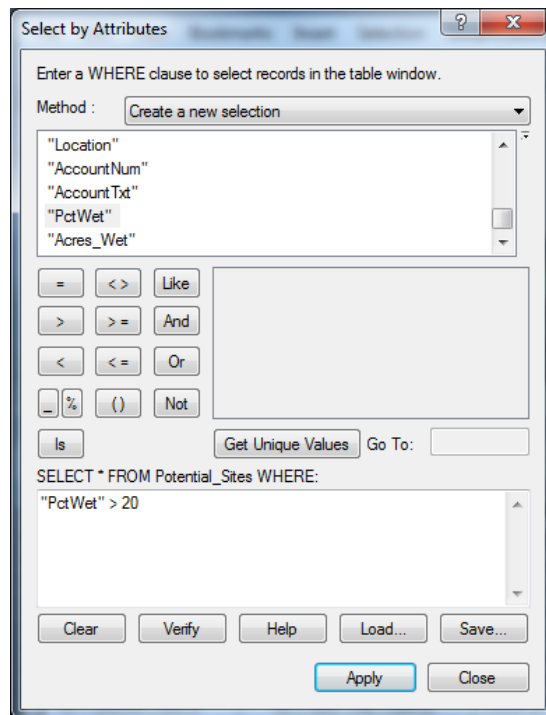
13   Click *Apply* and then *Close*. This will select all parcels with more than 20% wetlands.

        Question 12:   *How many town-owned parcels have more than 20% wetlands?*

14   Click *Edit » Delete* to delete these parcels.

15   Click *Editor » Stop Editing*, and then click *Save Edits*.

DETERMINE PROPERTIES ON A MAJOR ROAD

At this point, you've identified town-owned parcels over one acre with less than 20% wetlands. The final criterion in the site suitability analysis is to find properties that are on a major road. To do this, you'll use the *Select By Location* tool and the major roads shapefile to select all town-owned properties that are on major roads.

In this (and most) road GIS datasets, the roads are mapped as lines along the centerline of the road. Therefore, selecting parcels that intersect major roads may not select all parcels that are actually on a major road if the parcel boundary does not cross the road centerline (as most parcels don't). Also, the positional accuracy of the parcels or roads may be several feet off. So you'll do a spatial selection with a 50-foot buffer to account for this.

1   Add the *Major_Roads* shapefile to your map: click *Selection » Select By Location*.

2   In the *Select By Location* dialog box, click the box next to *Town_Owned_Parcels* to select features from. Specify *Major_Roads* for *Source layer* and leave the *Spatial selection method* as *Target layer(s) features intersect the Source layer feature*. Select the *Apply a search distance* check box. Enter **50** as the distance and change the units to *Feet*.

3   Click *OK*.

> **Question 13:**   *How many properties are selected?*

4   Right-click the *Town-owned Parcels* layer and click *Data » Export Data*. Make sure *Selected Features* is chosen and name the exported dataset ***Potential_Sites***.

The Town of Hudson actually went through this scenario of planning the location of a new fire station in the early 2000s. At that point, two fire stations existed in the town. These are contained in the *Existing_Fire_Stations* shapefile.

5   Add the *Existing_Fire_Stations* shapefile to the map.

6 Create a map that shows the potential new fire station sites, along with the existing sites. Add numeric labels to each potential site for discussion purposes. Your map should look similar to map 4 below.
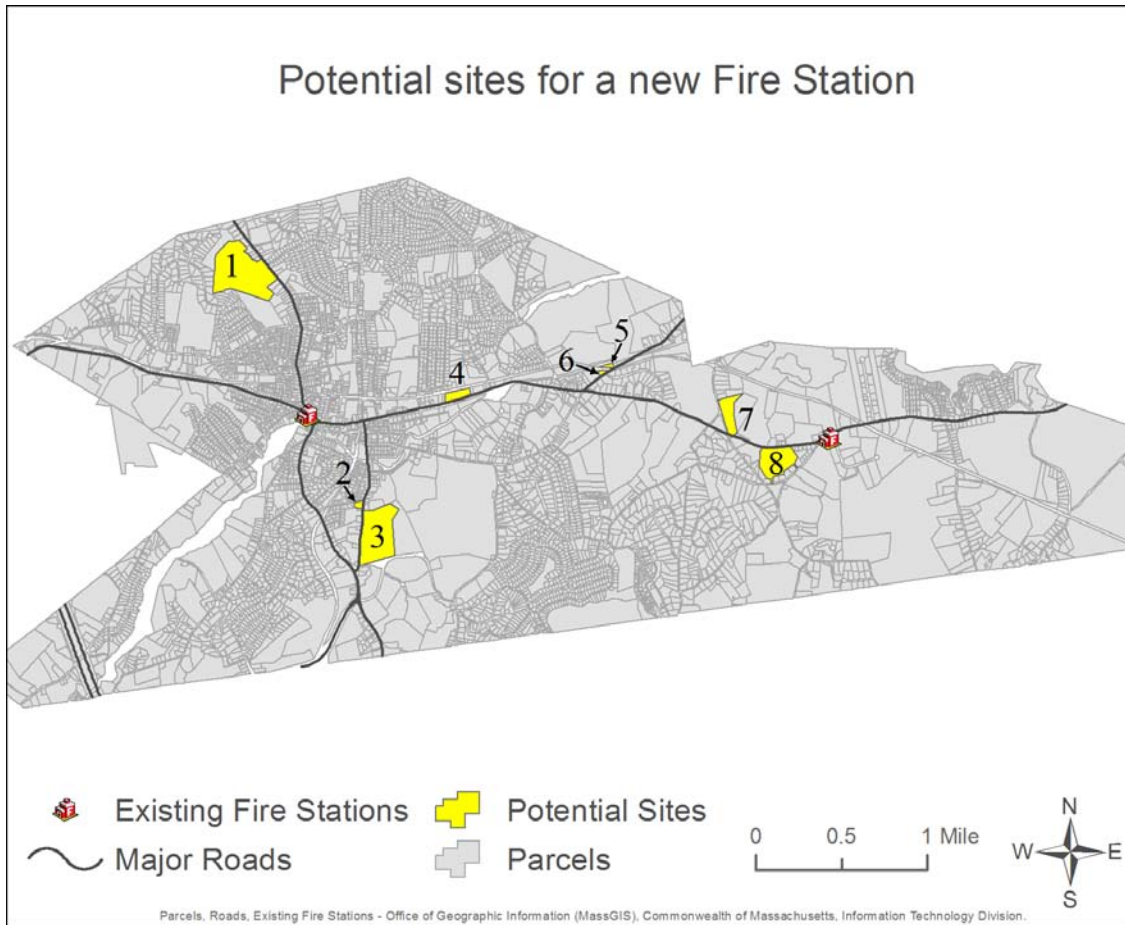
Map 4. Potential sites.

Using your potential sites map, answer the following questions:

Question 14:   *In planning the location of a new fire station, why is it important to know where existing fire stations are located?*

Question 15:   *Which potential site(s) are the most suitable in terms of location in relation to existing fire stations? Discuss the pros and cons of each potential site, referring to the site number you added to each.*

Question 16:   *Name and discuss some other factors not included in this lab that would also be important to consider when locating a new fire station.*

7 The Town of Hudson actually built a new fire station. Do a web search on "town of Hudson, MA new fire station". Find out where the fire station was actually built. Add this location to your map.

Question 17:   *Do any of your potential sites come close to the actual site chosen for the Hudson fire station?*

Submit your work

Submit the following to your instructor:

- Map 1: Overview of Hudson, MA
- Map 2: Hudson town-owned parcels
- Map 3: Wetlands
- Map 4: Potential sites

Credits

Sources of supplied data

Existing_Fire_Stations.shp, courtesy of the Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division.

Major_Roads.shp, courtesy of the Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division.

Parcels.shp, courtesy of the Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division.

Town_owned.dbf, courtesy of the Town of Hudson, MA, Assessor's Department.

Wetlands.shp, courtesy of the Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division.

Instructor resources

Context for the lab

This *SpatiaLAB* is written primarily for undergraduates studying urban planning or human geography.

The lab shows how to use freely available modern-day geographic information to conduct a site suitability analysis. It is intended to promote thinking about how different geographic factors must be evaluated when attempting to make an informed decision regarding the best place to locate a new facility.

Instructors may engage students to discuss additional criteria that may need to be considered in selecting the best place for a new fire station. Another discussion topic would be the thresholds used for the analysis—why 20% wetlands and not some other number? Why only include major roads? Should a broader definition of suitable roads be used?

Using a spatial approach, geographic information systems (GIS) can be one of the most useful tools to perform mapping and analysis tasks for town planners.

This lab uses parcel, roads, wetlands, and fire station location data.

Students are asked to answer 17 questions, perform GIS analyses, and make four maps.

Analysis and visualization tools

ArcGIS 9 or 10 is required to complete this lab.

Answers to questions

Question 1:   *Hudson is in what part of Massachusetts?*

Answer: Eastern Massachusetts, just east of I-495, about 30 miles west of Boston.

Question 2:   *How many properties are in the town?*

Answer: 5,900.

Question 3: *Why are data source citations important to include on a map?*

Answer: Several reasons: To inform the map reader of the origin of the data used to produce the map, to give proper credit to the data creator, and as a disclaimer of sorts for the map maker in case there are errors in the data.

Question 4: *How many town-owned properties are there?*

Answer: 120.

Question 5: *What percentage of properties does the Town of Hudson own?*

Answer: 2%.

Question 6: *How might you use ArcMap basemaps to find out if the properties are vacant?*

Answer: By inspecting the Imagery basemap for visible signs of buildings, or the lack thereof.

Question 7: *Why could it be dangerous to your data to perform text string calculations?*

Answer: By doing global search and replace text string calculations, it is possible to add or remove characters to the text, inadvertently changing and corrupting the values.

Question 8: *How many parcels have matching values in the AccountTxt and Map_ID2 fields?*

Answer: 118.

Question 9: *Does there appear to be any spatial pattern in the location of the town-owned properties? Are there similarities among the size of the town-owned properties?*

Answer: The town-owned properties seem to be equally distributed throughout the town. There's no evidence of clustering in any particular area. The size of most town-owned properties seems to be much larger than other properties. The largest properties in Hudson seem to be town owned.

Question 10: *Add the Imagery basemap. Examine the Wetlands layer as compared to the aerial photo background. Do polygons in the Wetlands layer correlate with swamps or water bodies as seen in the photos?*

Answer: Yes, for the most part. However some areas are difficult to discern due to obstruction by trees or other vegetation. And some of the boundaries do not precisely follow the wetlands as observed in the imagery.

Question 11: *What is the largest percentage of wetlands for a single property?*

Answer: 92%.

Question 12: *How many town-owned parcels have more than 20% wetlands?*

Answer: 31.

Question 13: *How many properties are selected?*

Answer: 8.

Question 14: *In planning the location of a new fire station, why is it important to know where existing fire stations are located?*

Answer: So the new fire station isn't located too close to an existing fire station, which would decrease the fire department's overall effectiveness in responding to a fire anywhere in town.

Question 15: *Which potential site(s) are the most suitable in terms of location in relation to existing fire stations? Discuss the pros and cons of each potential site, referring to the site number you added to each.*

Answer: Site 1 is in the extreme northwest end of town, making it unsuitable since it is not centrally located. Sites 2, 3, 7, and 8 are too close to existing fire stations. This leaves sites 4, 5, and 6, which are all centrally located and at least a mile from existing fire stations. Any of these sites would suffice, but site 4 is perhaps the best as it is on the main road in the center of town, with a large residential area directly to the north of it.

Question 16: *Name and discuss some other factors not included in this lab that would also be important to consider when locating a new fire station.*

Answer: (1) Population distribution. Finding a centrally located property for the station is important, but understanding the population distribution in town is also critical. Are there parts of town that have a higher concentration of people/dwellings that may warrant having a fire station close by? Are there uninhabited parts of town such as open space or parks where a fire wouldn't be as life threatening, thus lowering the need for a nearby station? (2) Property fire susceptibility. It is also important to consider whether there are any large industrial plants or collections of buildings that may be more susceptible to fire. Perhaps there are older parts of town whose structures don't meet current fire codes or areas of town whose heat is provided by natural gas that may have a greater chance of catching on fire. (3) Travel time. This exercise used major roads as criteria to locate the new fire station. However, there may be other factors that affect travel time from a fire station to a potential fire site. Are some major roads consistently clogged with traffic? Are there barriers such as narrow bridges, underpasses, or railroads that may prohibit fire engine travel through certain parts of town? These are a few additional factors; there may be other factors as well.

Question 17: *Do any of your potential sites come close to the actual site chosen for the Hudson fire station?*

Answer: The actual location for Hudson's new fire station (296 Cox Street) is about a quarter mile from site 6. Interestingly, the fire station's location is not on a main road, although it is very close to the main road running east–west through town and appears to be on a somewhat major diagonal street, which would be advantageous for quick travel in many directions.

Data information

The dataset FireStations.zip contains the Parcels, Wetlands, Major_Roads, and Existing_Fire_Stations shapefiles, and the Town_owned.dbf table.

Data sources

Parcels, Wetlands, Roads: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division.

Specific URLs for this data:

Parcels: **http://www.mass.gov/mgis/ftpparcels.htm** (accessed June 2012).

Wetlands: **http://www.mass.gov/mgis/wetdep.htm** (accessed June 2012).

Roads: **http://www.mass.gov/mgis/ftpeotroads.htm** (accessed June 2012).

Fire stations: **http://www.mass.gov/mgis/ftpeotroads.htm** (accessed June 2012).

Town_owned.dbf: Town of Hudson assessor **http://data.visionappraisal.com/HudsonMa/DEFAULT.asp** (accessed June 2012).