



## **GEO TUTORIAL**

ON-SCREEN DIGITIZING  
USING QGIS

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The Geospatial Education and Outreach Project (GEO Project) is a collaborative effort among the Geosystems Research Institute (GRI), the Northern Gulf Institute (a NOAA Cooperative Institute), and the Mississippi State University Extension Service. The purpose of the project is to serve as the primary source for geospatial education and technical information for Mississippi.

The GEO Project provides training and technical assistance in the use, application, and implementation of geographic information systems (GIS), remote sensing, and global positioning systems for the geospatial community of Mississippi. The purpose of the GEO Tutorial series is to support educational project activities and enhance geospatial workshops offered by the GEO Project. Each tutorial provides practical solutions and instructions to solve a particular GIS challenge.

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## ON-SCREEN DIGITIZING USING QGIS

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### REQUIRED RESOURCES

- QGIS (3.16.9-Hannover)

### FEATURED DATA SOURCES

- Tutorial data: [https://www.northerngulf institute.org/projects/rgmg/Q\\_Digitize.zip](https://www.northerngulf institute.org/projects/rgmg/Q_Digitize.zip)
- Sanborn Fire Insurance Map from Biloxi, Mississippi, May 1914. Map. Retrieved from the Library of Congress, <[www.loc.gov/item/sanborn04432\\_005/](http://www.loc.gov/item/sanborn04432_005/)>.

### OVERVIEW

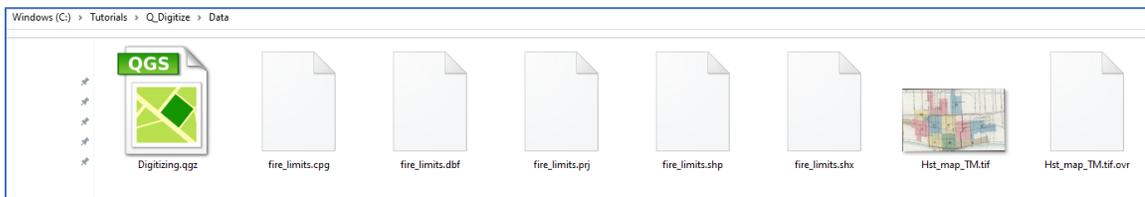
This tutorial demonstrates how to **digitize points, lines, and polygons in QGIS**. More specifically, it focuses on the on-screen digitizing, also known as heads-up digitizing, since it is carried out while you look directly at the computer screen. The **on-screen digitizing** is a process of tracing features on a raster dataset and converting these features to vector layers for effective use in a GIS. Learning how to digitize is vitally important for any GIS expert, as it allows you to create new spatial datasets, required for mapping or geospatial analysis.

To perform the steps listed below, you will use a georeferenced **historic fire insurance map from Biloxi, Mississippi** as a raster dataset based on which you will trace the vector features. The key objective is to digitize city blocks and fire hydrants within the *fire limits* zone, as well as a segment of railroad located just to the north of that zone. This will allow you to practice creating vector features of different geometry types. You will also learn how to use essential QGIS digitizing tools.

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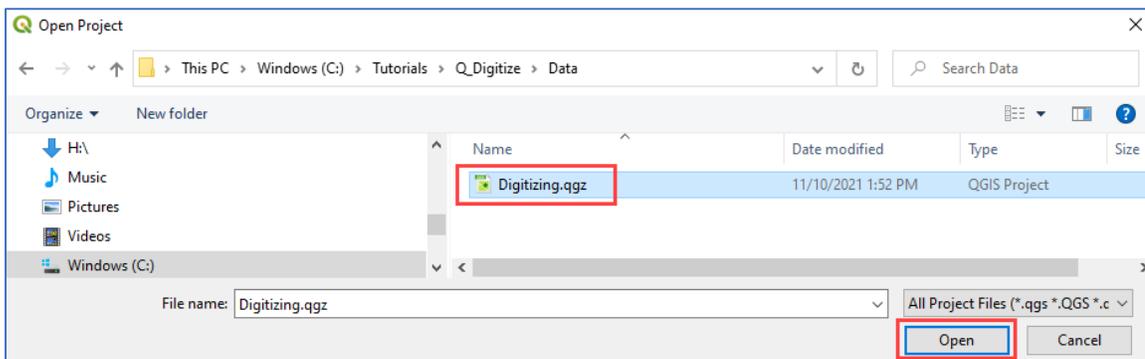
## STEP 1. DOWNLOAD THE TUTORIAL DATA

- A. The original historic map used in this tutorial is available online in the Library of Congress Sanborn Maps collection. However, it is not georeferenced and cannot be directly used in digitizing process. If you would like to review the original map, you can access **Image 1 of Sanborn Fire Insurance Map from Biloxi, Mississippi, May 1914** using the following link: [http://www.loc.gov/resource/g3984bm.g3984bm\\_g044321914/?sp=1](http://www.loc.gov/resource/g3984bm.g3984bm_g044321914/?sp=1)
- B. For the purpose of this tutorial, the georeferencing process has been already completed. In addition, the original map has been cropped to the area that needs digitizing. You can download the georeferenced map and other datasets required for this tutorial using the link provided in the data sources section.
- C. Save the zipped file to your local drive, preferably to a folder where you will store all files created in this tutorial. Extract the content of the zipped folder to the same directory and review available datasets.



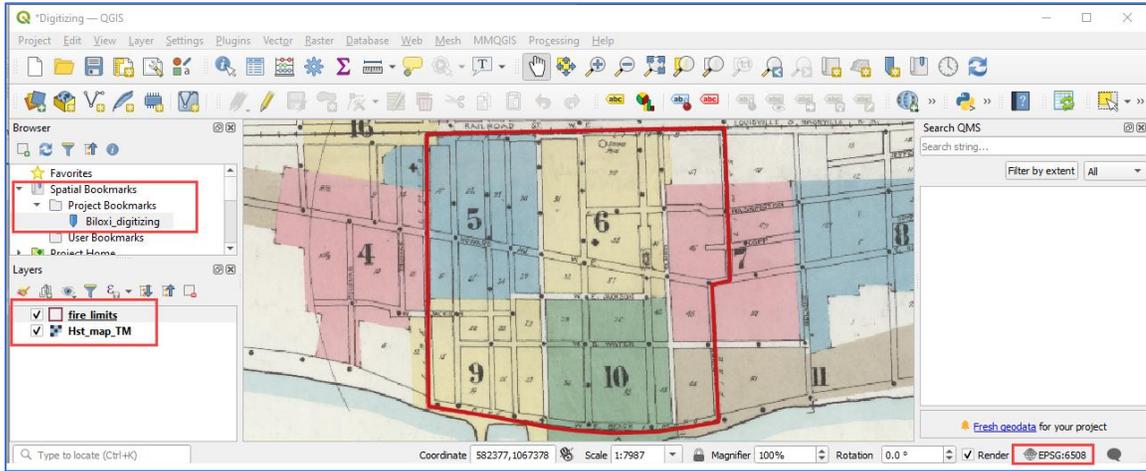
## STEP 2. START QGIS AND OPEN AN EXISTING PROJECT

- A. Start QGIS and then open the **Digitizing.qgz** project (*Project > Open*). Browse to the folder where you saved your tutorial data. Select the project name and click *Open*.



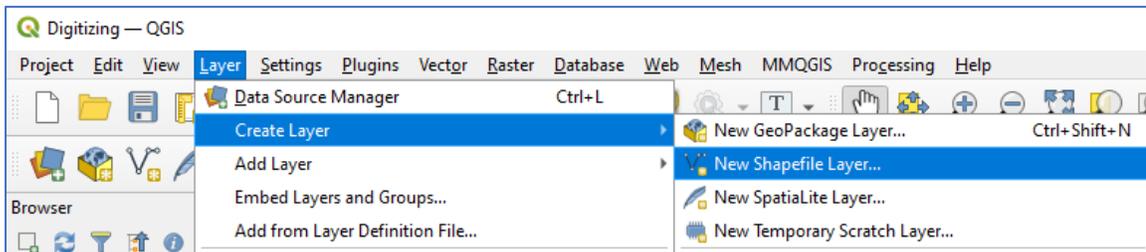
- B. The **Digitizing.qgz** project will automatically open to the extent that needs digitizing. This area corresponds to the *fire limits* zone, delineated on the **Sanborn Fire Insurance Map** with a solid red line. To help you during the digitizing process, the QGIS project has this area bookmarked. This way you can easily return to the same location (*Browser window > Spatial Bookmarks > Biloxi\_digitizing*). The project coordinate reference system (CRS) is set to *NAD83(2011) / Mississippi TM*, commonly used for this geographic location. The project has two available layers: the *fire\_limits* and *Hst\_map\_TM*. Review their properties (*right-click on the layer name > Properties*). Note that the *fire\_limits* layer is a vector type, represented by a small square icon next to the layer's name. The *Hst\_map\_TM* is a raster layer, and it is symbolized by a small,

pixelated square. For practice, turn on and off each layer (*click the checkmark next to the layers' name*), also zoom in and out to the extent of each layer (*right-click on the layer name > Zoom to Layer*).

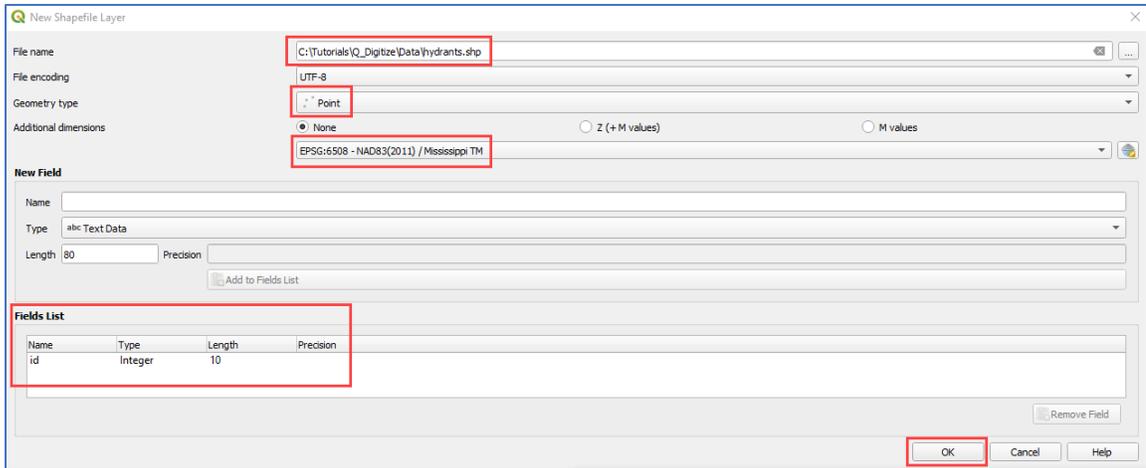


### STEP 3. CREATE A NEW POINT LAYER AND DIGITIZE HYDRANTS

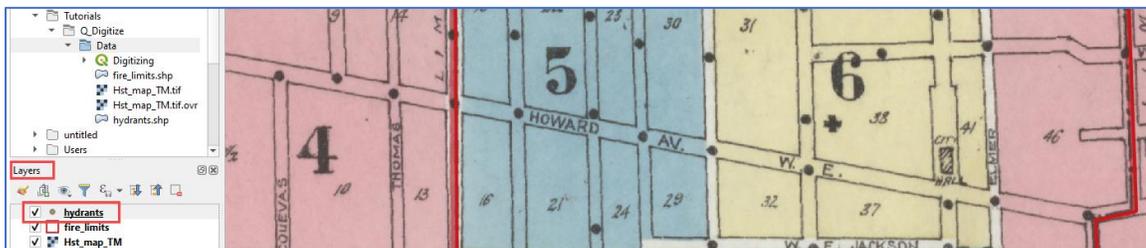
- A. The objective of this step is to digitize hydrants located within the outlined *fire limits* zone. You will start this tutorial by working with points, as point features are the most basic and easy to digitize. Before you can start digitizing you need to create a layer that will hold the digitized features. Create a new shapefile (*Layer > Create Layer > New Shapefile Layer...*).



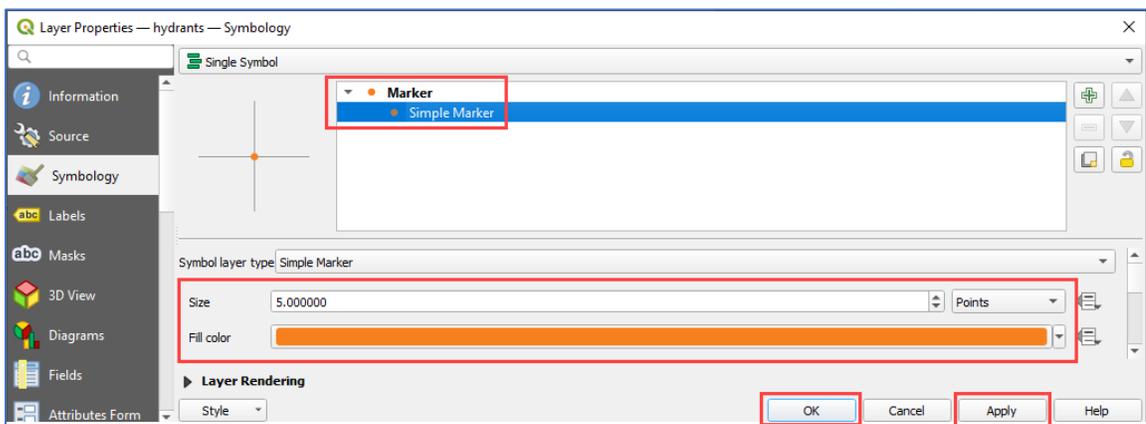
- B. Navigate to your tutorial *Data* folder and name the shapefile **hydrants.shp**. Change the *Geometry Type* to *Point*. Make sure that the CRS is set to *NAD83(2011) / Mississippi TM*. Note that the *id* column (integer field type, length 10) is added automatically. Click *OK*.



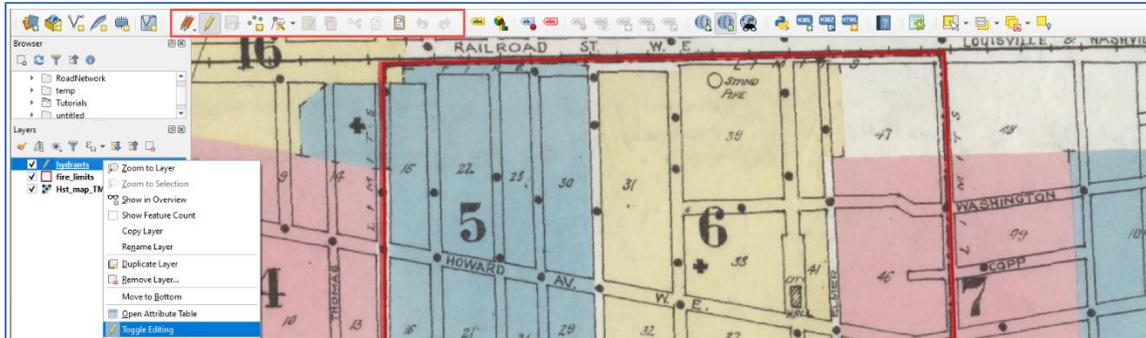
- C. The empty *hydrants* layer will be automatically added to the *Layers* panel. Note a small point marker next to the *hydrants* layer's name, indicating that this is a point layer. The color of this marker was assigned randomly, and it may be unsuitable for your digitizing needs. This can be easily adjusted by changing the symbology properties.



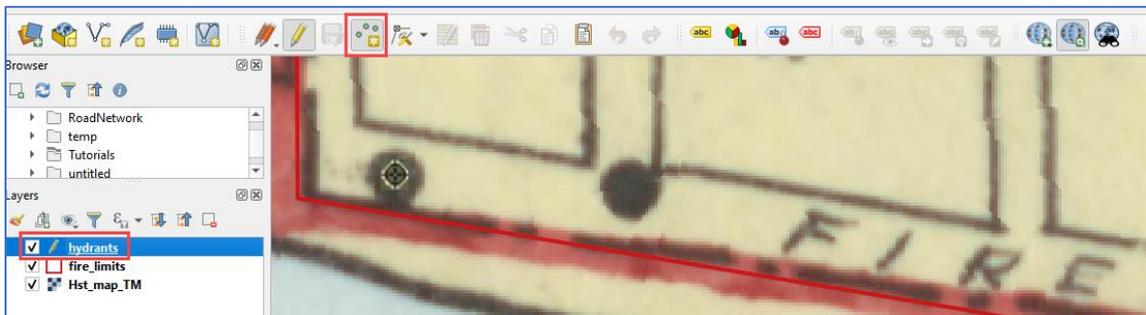
- D. On the historic map, hydrants are represented with solid black point symbols. To clearly distinguish newly digitized hydrant features from the original ones, it might be helpful to modify the symbology of the layer and select a contrasting color. Right-click the *hydrants* layer and select *Properties > Symbology*. Select the *Simple Marker* symbol, change *Size* to *5 Points*, and select orange as the *Fill color*. Click *Apply* and then *OK*.



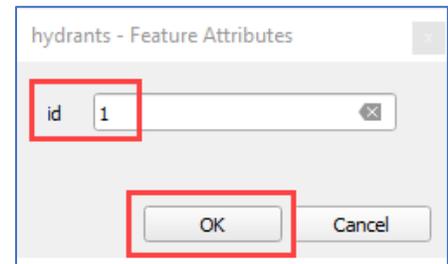
- E. To be able to digitize points you need to activate editing for the *hydrants* layer. Make sure this is the active layer by clicking on it, then right-click and select the *Toggle Editing* button. This action enables point editing tools on the digitizing toolbar. Also, a tiny pencil appears next to the layer's name indicating that this layer is being currently edited.

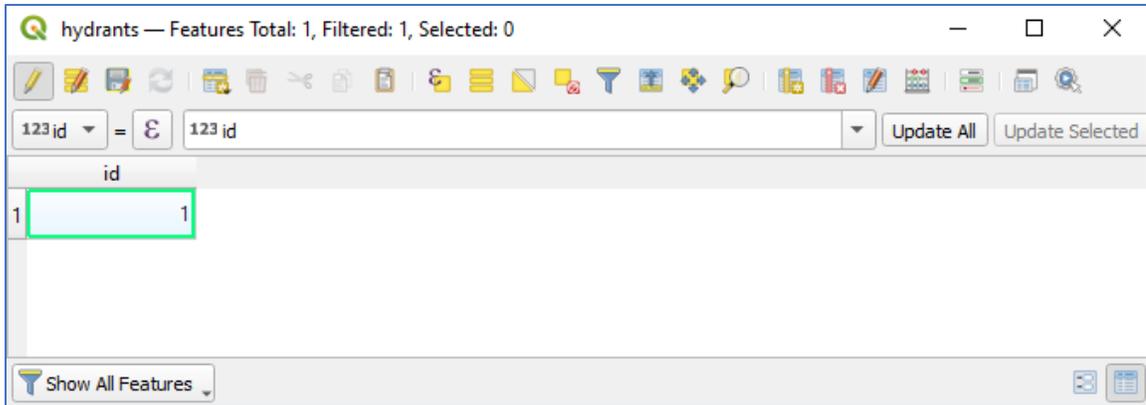


- F. Click on the *Add Points Feature* button . Hover the mouse cursor over the map and note that the cursor changed shape from an arrow to a scope-style symbol. This means that you are ready to add point features to the *hydrants* layer.

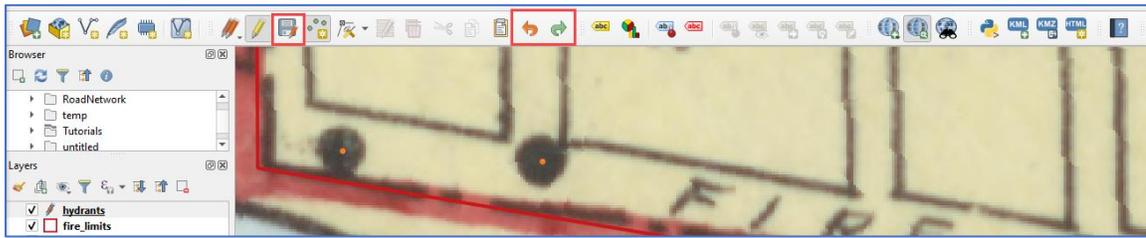


- G. Simply click on one of the solid black points visible on the historic map. The *Feature Attributes* window will automatically appear. Type *1* into the *id* line and click *OK*. This will create the first point.
- H. Verify that the point was created correctly by opening the attribute table. Right-click on the *hydrants* layer and select *Open Attribute Table*. At this stage, the table should contain only a single record.

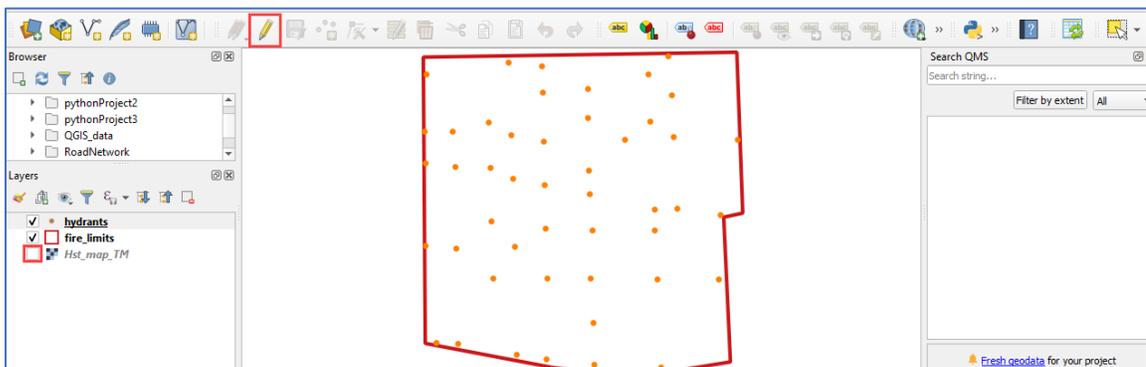




- I. Continue adding points for hydrants located within the *fire limits* zone. Make sure to assign successive feature *id* numbers to newly added points. Use the undo (*Ctrl+Z*) and redo (*Ctrl+Shift+Z*) buttons in case you make mistakes. You can also enable the Undo/Redo panel to see your editing history. Periodically save your edits (*Save Layer Edits*).



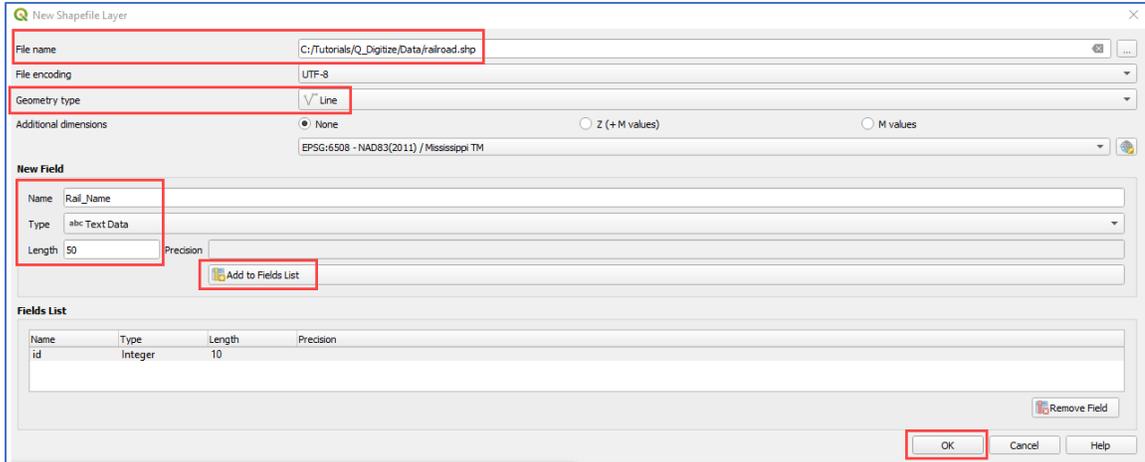
- J. Once finished you should have 47 hydrants traced. To view the digitized points more clearly, turn off the *Hst\_map\_TM* layer. Make sure to save all edits and click on the pencil button (*Toggle Editing*) to close the editing session. Turn on the *Hst\_map\_TM* layer back on, before proceeding to the next step.



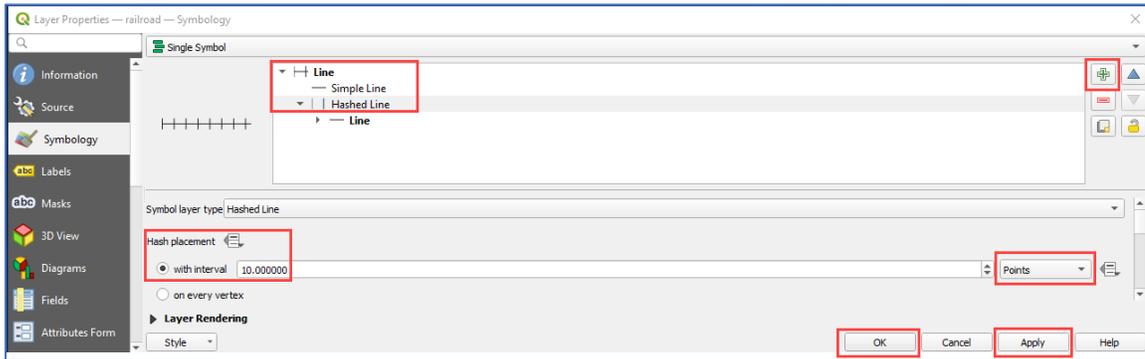
#### STEP 4. CREATE A NEW LINE LAYER AND DIGITIZE THE RAILROAD

- A. In this step, you will digitize a short section of the *Louisville and Nashville Railroad* located just to the north of the *fire limits* zone. The process of digitizing line features is very similar to digitizing points. First, you create an empty layer and then you toggle editing to create features. The key

difference is that each time you click you create a vertex that connects line segments. Create a line shapefile (*Layer > Create Layer > New Shapefile Layer...*) called **railroad.shp**. This time, choose *Line* as the *Geometry Type*, create an additional text field called *Rail\_Name* (text field type, length 50), click the *Add to Fields List* button to add this field to the list, and then *OK* to create the layer.



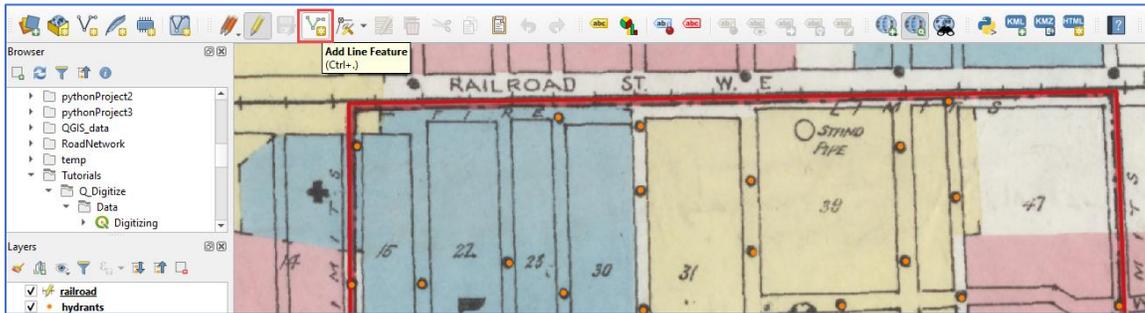
- B. The *railroad* layer will be loaded on top of the *hydrants* layer in the *Layers* panel. Note a small line symbol next to the layer's name indicating a line geometry type. Click the layer to activate it. Change the symbology of the line layer (*Properties > Symbology*). To create a basic railway symbol, to the existing *Simple Line* symbol you need to add an extra line symbol (click the green plus sign). Change the *Symbol Layer Type* of the added line to a *Hashed Line* and choose the *Hash placement with an interval* of 10 points. Select a dark gray color for both the simple as well as the hashed line. Click *Apply* and then *OK* to accept changes in *railroad* layer symbology.



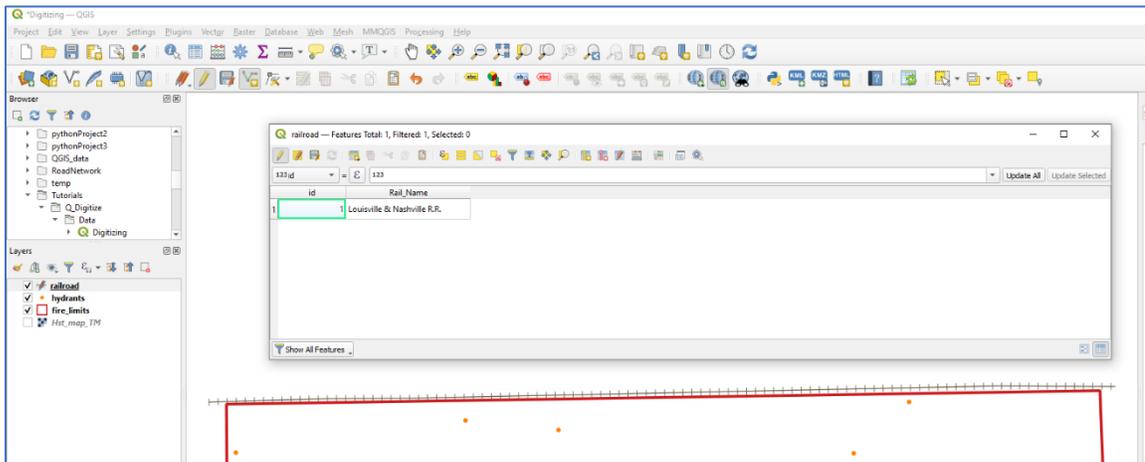
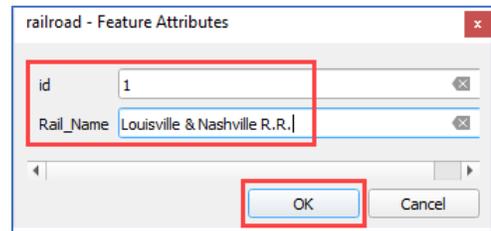
- C. Begin editing by clicking on the *Toggle Editing* button and zooming into a northern boundary of the *fire limits* zone as shown below.



- D. Click on the *Add Line Feature* button to start digitizing the railroad. Note that this time, line digitizing tools were activated to allow editing line vertices.

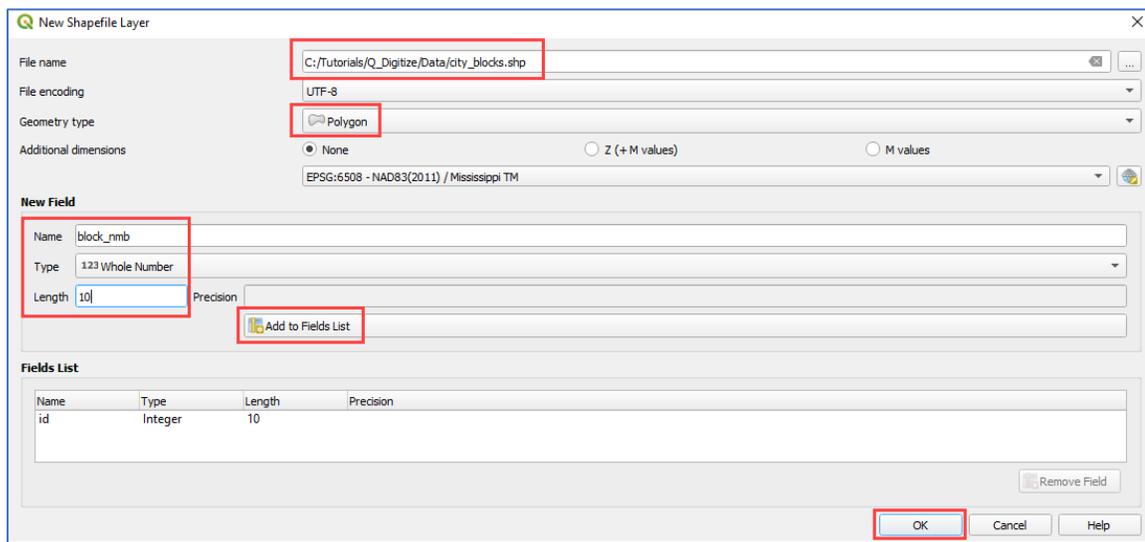


- E. Similarly to the point digitizing, the mouse cursor changes to a crosshair symbol indicating a digitizing mode. To help you move around the area that needs digitizing, use the mouse wheel to zoom in and out. Begin by clicking on the black rail line east of the northeast corner of the *fire limits* zone and finish the line at the northwest corner. This segment of the railroad is relatively short and straight, so you do not need a lot of vertices to accurately digitize it. Click 5 to 7 times to trace the railroad. Each time you click, make sure that your newly created line does not intersect with the *fire limits* zone. Right-click to finish the line feature.
- F. The *Feature Attributes* window will automatically appear. Type *1* into the *id* line and *Louisville & Nashville R.R.* into the *Rail\_Name* line. Click *OK*. This will create the first and, in this case, only line feature.
- G. Save the edits and view the results. Open the attribute table and turn off the *Hst\_map\_TM* layer to better see the created line feature.

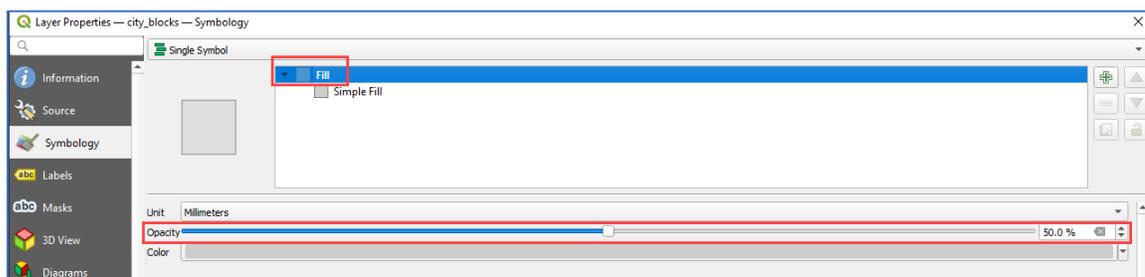


## STEP 5. CREATE A NEW POLYGON LAYER AND DIGITIZE CITY BLOCKS

- A. In this step, you will digitize city blocks located within the *fire limits* zone. In this case, polygons are the most appropriate geometry type to be used. Turn the *Hst\_map\_TM* layer back on and then create a polygon shapefile (*Layer > Create Layer > New Shapefile Layer...*) called **city\_blocks.shp**. This time choose *Polygon* as the *Geometry Type*, create an additional numeric field called *block\_nmb* (*Whole Number* field type, length 10), click the *Add to Fields List* button to add this field to the list, and then *OK* to create the layer.



- B. The *city\_blocks* layer will be loaded into the *Layers* panel. Drag it, to place it below the hydrants layer. Note a small square symbol next to the layer's name, indicating a polygon geometry type. Click on it to activate the layer.
- C. Change the symbology of the *city\_blocks* layer (*Properties > Symbology*). Select your favorite fill color and change the opacity to 50%. This way you will be able to clearly see segments that need tracing.



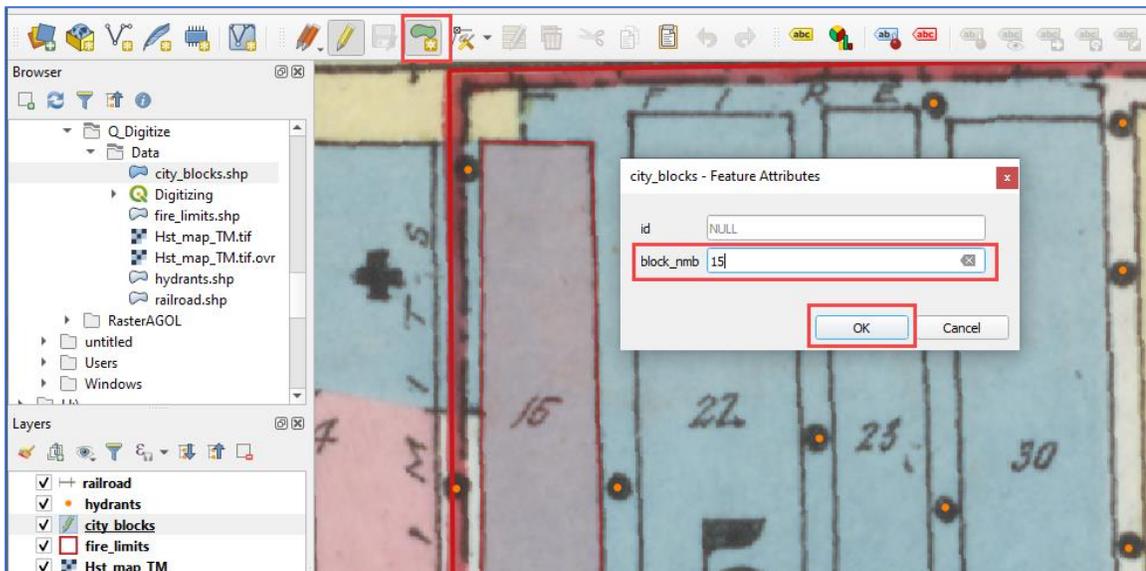
- H. The digitizing process for lines and polygons is very similar. Both feature types have vertices representing turns and corners and both require you to right-click to end tracing. The key difference is that lines are open (the first and last pairs of coordinates are different), while polygons are closed (the first and last pairs of coordinates are the same). Occasionally this creates problems while tracing polygons, especially when the digitized shapes are complex, as they may cover up sections that still need to be digitized. Begin editing by clicking on the *Toggle Editing*

button and zooming in to the northeastern corner of the *fire limits* zone, specifically focusing on *city block number 15*.

I.

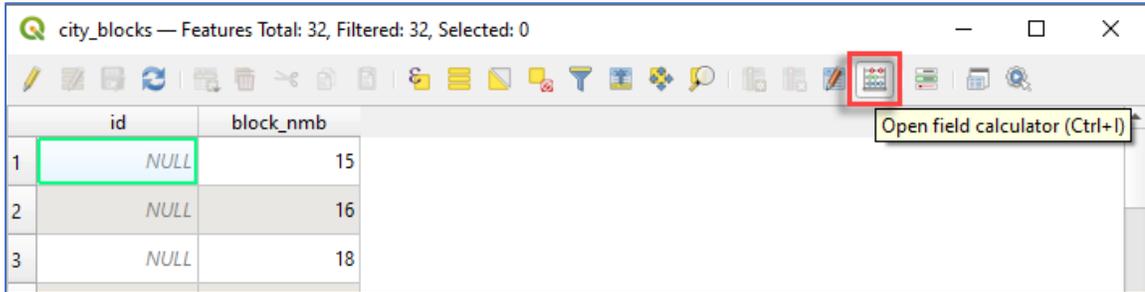


- D. Select the *Add Polygon* tool. Click on one of the corners of the *city block 15* and start tracing. After you trace all four corners, right-click to create the polygon. To avoid confusion, enter only the block number, listed on the historic map, in this case *15*. Do not enter the *id* number at this time, keep it *NULL*.

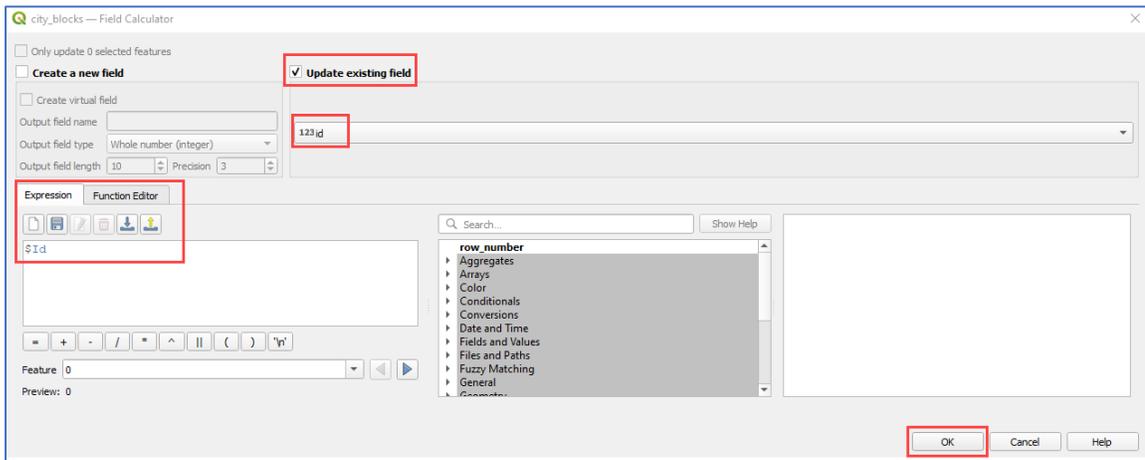


- E. Continue digitizing the remaining city blocks. The order of tracing is not important, but it might be a good idea to trace the city blocks in the order they are numbered on the historic map. This way you will lower your chances of entering a wrong block number into the attribute table. Save edits periodically .
- F. Once the city blocks are digitized you should have 32 polygons created. Turn off the *Hst\_map\_TM* layer to better see the results. When you are satisfied with your work, save edits, and click on the pencil button (*Toggle Editing*) to close the editing session.
- G. An important part of digitizing is working with attribute tables and populating existing fields. Review the attribute table of the *city\_blocks* layer. Right-click on the *city\_blocks* layer and select

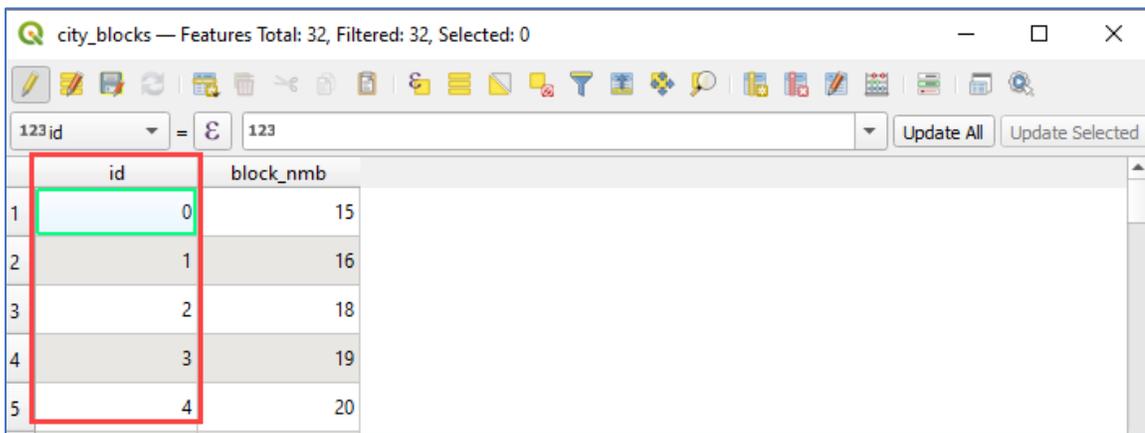
*Open Attribute Table.* Note that the polygon *id* field is listing only NULL values when it should list consecutive ID numbers. You can enter these numbers manually, but this is not a very efficient approach. Instead, you can correct this issue in one easy step, by using the field calculator.



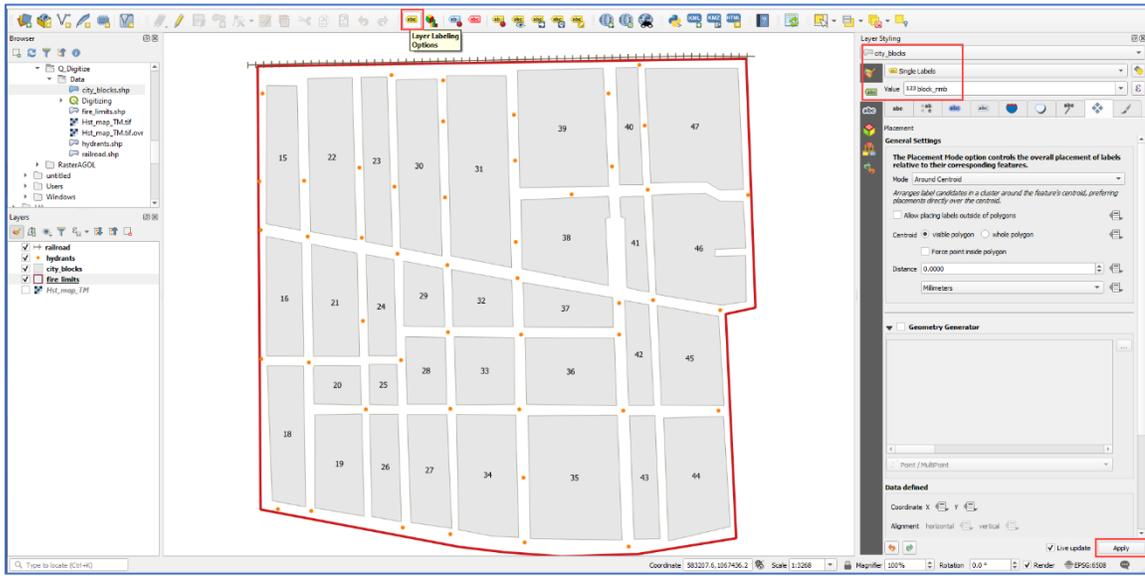
- H. Click on the *Open field calculator button* and check the *Update existing field* box. From the dropdown menu select the *id* field. In the expression box, type in:  $\$id$  and click *OK* to execute the expression.



- I. The field calculator expression will add unique numbers to the *id* field. This method is significantly more efficient than entering consecutive numbers for each digitized polygon manually.



- J. To complete the digitizing process, you should always review your work. Make sure that all your digitized layers are visible. Look for potential mistakes or misplaced features. At this stage, you can easily edit all layers, by enabling editing for each and making final adjustments.
- K. As a last touch, it might be a good idea to label the *city\_blocks* layer. Click on the *Layer Labeling Options* button. In the *Layer Styling* panel, select Single Labels' type, *city\_blocks* layer, and *block\_nmb* as the *Value* field. Click *Apply* to generate labels. Note that the labeling options can also be accessed by double-clicking the layer to open the properties window.



- L. Save the **Digitizing.qgz** project and exit QGIS.

This concludes our GEO Tutorial. The point, line, and polygon features have been successfully digitized based on the historic fire insurance map. The created vector layers can be used to analyze the distribution of historic features, create professional maps, or generate spatial overlays for use in more complex geospatial workflows. In a nutshell, the key benefit of on-screen digitizing is the ease of creating new datasets fitted specifically to the requirements of your geospatial project.