



Managing Culverts and Other Stormwater Infrastructure Using Free Spatial and Geo-Location Technology

Introduction

The changing climate is forcing many local communities to adapt their stormwater infrastructure to the threats of extreme storms and their increase in frequency and intensity. However, it is nearly impossible to adapt culverts and other stormwater infrastructure without knowing important information about these assets, such as their: location, dimensions, material and condition. While some communities are starting to take stock in their stormwater infrastructure assets, many have not.

The Environmental Systems Research Institute (ESRI) is one of the best known suppliers of geographical information systems (GIS) software and mobile application tools in the world. It uses proprietary models and calculations to help users analyze many types of spatial information, including those involving hydrology and stormwater infrastructure. However, the learning curve for ESRI's ArcGIS is rather steep and requires someone who is proficient in many different applications to warrant spending money on the annual licenses to acquire and use it. While many communities cannot afford these costs, or the personnel to run the software, there are free and user-friendly options available.

The following is a guide for public works, road commissioners or any other community official who wants to monitor and more efficiently manage and prioritize their stormwater assets (culverts) for long-term climate adaptation and budgetary purposes.

Step 1 - Create a Spreadsheet to Organize Culvert Information

First, it is important to determine the information you want to record. The immediate categories would be the: location (using latitude and longitude coordinates), type (cross culvert, driveway culvert, state road culvert), dimensions (diameter and length), material (steel, high density polyurethane, concrete, etc.) and condition of the culvert. The condition could be on a scale from 1 (poor) to 10 (excellent) based on whether it can accommodate enough water or is in a dilapidated state. Since ranking is somewhat subjective, photos should also be taken using a digital camera or smartphone to document the inlet and outlet so there is visual evidence to justify each condition ranking. There should also be a category used to document any additional information, such as: replacement dates, resident complaints or anecdotal flooding history.

Set up your spreadsheet so that each culvert has a name that is unique from all the others. The example below uses a combination of the road name and distance in feet from a starting point. Some communities

Name	Latitude	Longitude	Type	Diameter (in)	Length (ft)	Condition	Additional
Egypt 750	44.032726	-69.470202	Cross culvert	15	47	10	
Egypt 1188	44.03331	-69.468657	Cross culvert	18	72	5	Under Rocky Run apron
Egypt 1412	44.033832	-69.468208	Cross culvert	18	50	10	

may want to use additional categories to help with future hydraulic modeling, like headwater depth and culvert slope, however this may require a professional engineer. The categories in the spreadsheet above are certainly enough to get you started.

Step 2 - Download a GIS Location Application for Your Smartphone

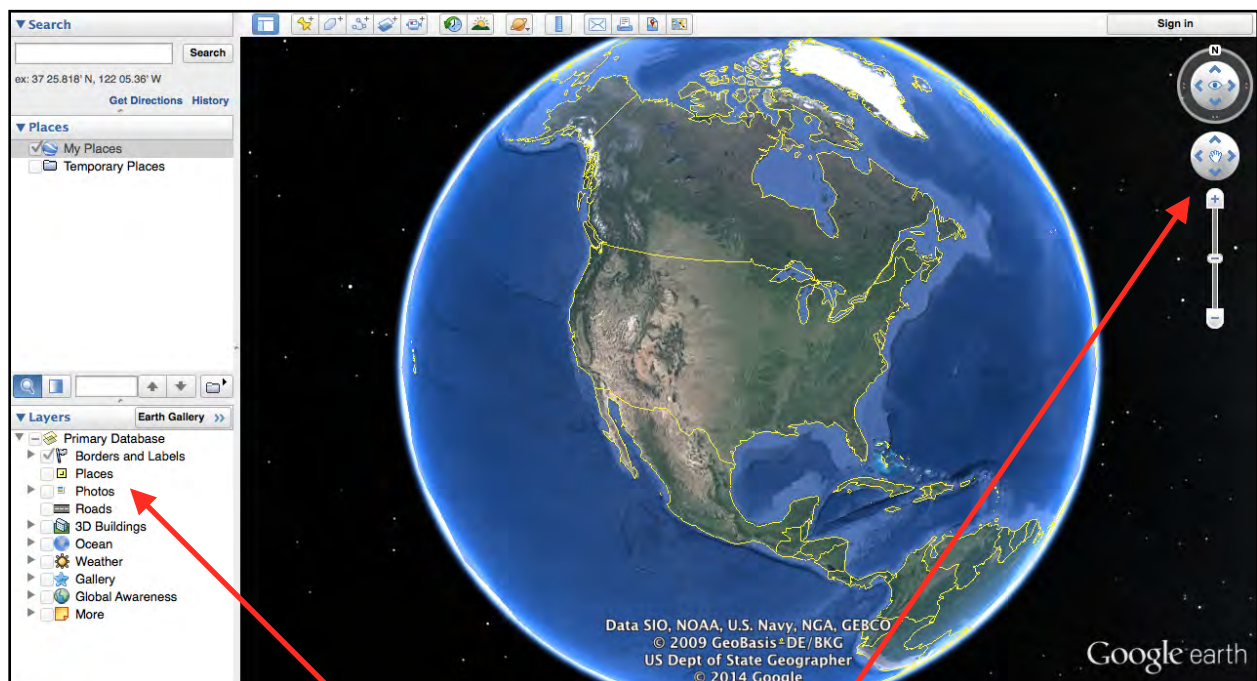
There are many free options available. Choose one that is easy to use and at the minimum will calculate your location in latitude and longitude. Some applications have options for calculating locations in Degrees/Minutes/Seconds and Decimal Degrees. Each will work for future use, but Decimal Degrees are easier for notation and copy/paste purposes.

Step 3 - Enter Information into Spreadsheet

This can be an ongoing process. Print out a blank spreadsheet (with only the categories at the top) and keep it with you as you are out in the field. Fill in the spreadsheet at your own pace, using the GIS Location Application to find your coordinates and appropriate measuring tools for the culvert dimensions. Fill out the rest of the columns in the spreadsheet and take photos with a digital camera or smartphone. Make sure to keep track of which photos you're taking at each culvert by writing the image numbers in the 'Additional' field of the spreadsheet. Then at a later time, rewrite this information into your spreadsheet on the computer. Remember to save your work each time you add a new culvert to your database. Your eventual goal is to have all culvert locations, dimensions, materials, conditions and additional information in a master list on your computer.

Step 4 - Download Google Earth

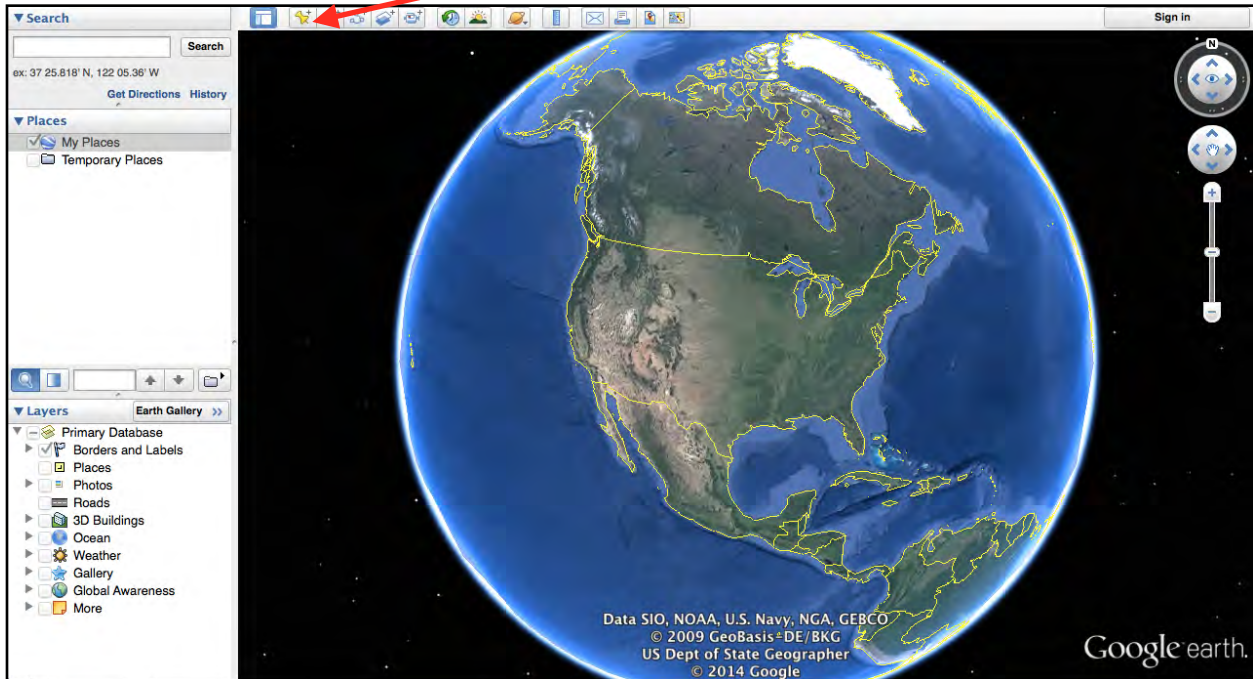
Google Earth is a free tool that will help you visualize and monitor your culverts as you add them to your master list. Start by downloading the free desktop version [here](#). When you first open Google Earth you will see a 3-D image of the world (below).



The layers in the lower lefthand side of the Google Earth can be selected to display additional information, like road names and places or interest. You can zoom in and out, rotate your viewing angle and move right and left with the tools in the upper righthand side.

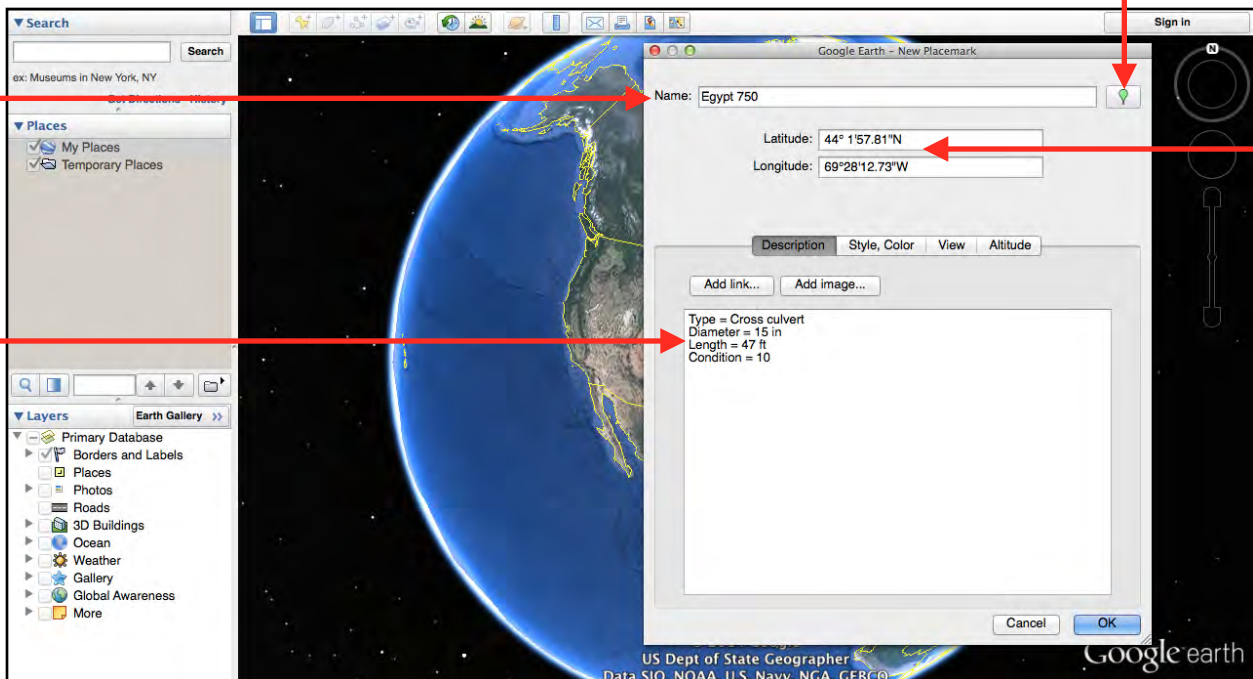
Step 5 - Create 'Placemarks' in Google Earth

In this step you will add the information from your master list excel spreadsheet to create individual points for each culvert. Start by clicking the yellow 'pushpin' button at the top of the menu bar.

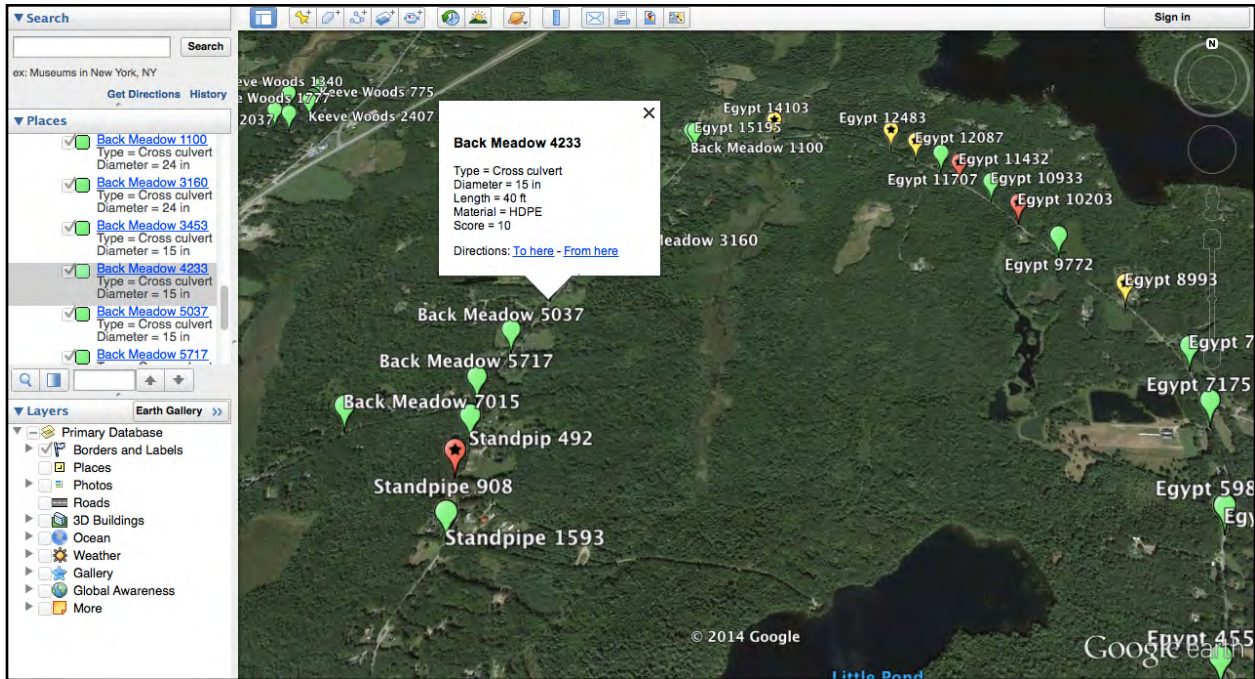


Next, enter the name or ID of the first culvert where it says 'Name'.

Next copy the latitude from the master excel file and paste it directly where it says 'Latitude' (it will automatically switch from Decimal Degrees to Degree/Minutes/Seconds once you tab down to 'Longitude'). Copy and paste the longitude from the master Excel list as well and then tab down to the 'Description' box. Enter the dimension and condition information, then select a color balloon that represents a condition of 10 (I chose green here).



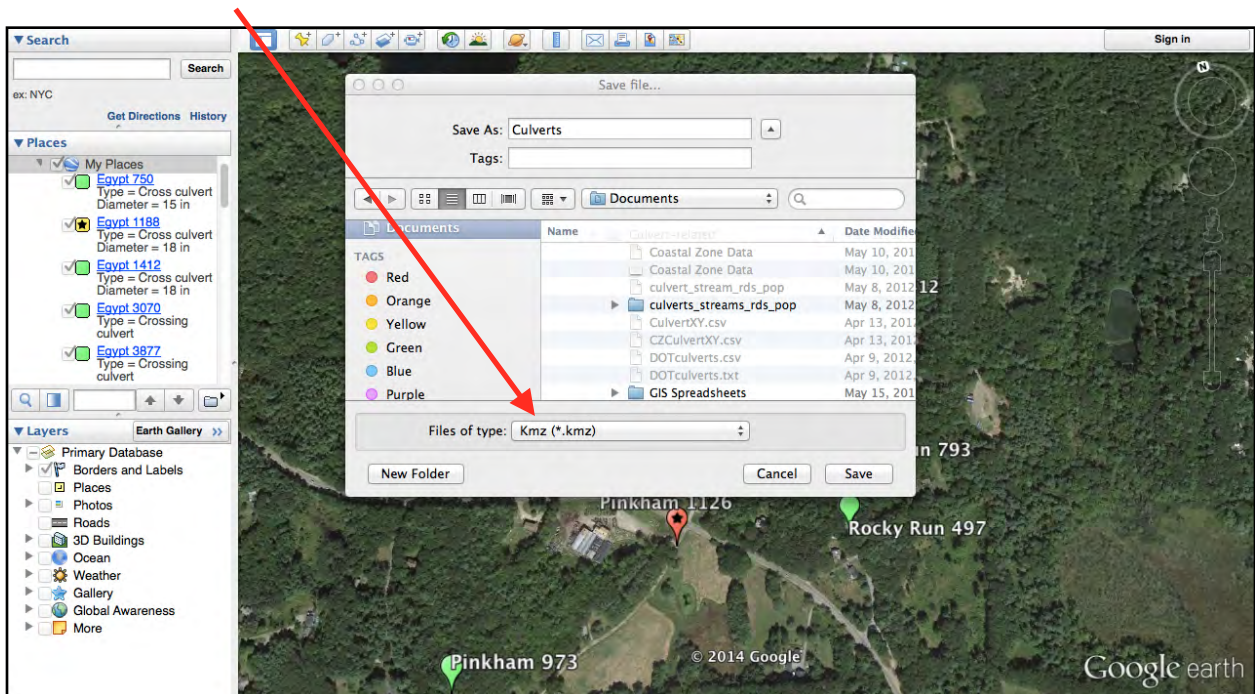
Click 'OK' when finished. Continue these steps for the remainder of the culverts on the Excel master list. Change the color of the placemark balloons to represent different culvert conditions. Your final product should show all the culverts on the Excel master list, with selectable balloons that display the information you just entered; like in the example below.



All the culverts you just entered are also listed on the lefthand side of the screen and can be edited by right clicking on them or by right clicking on the individual balloon and selecting 'Edit' or 'Get Info'

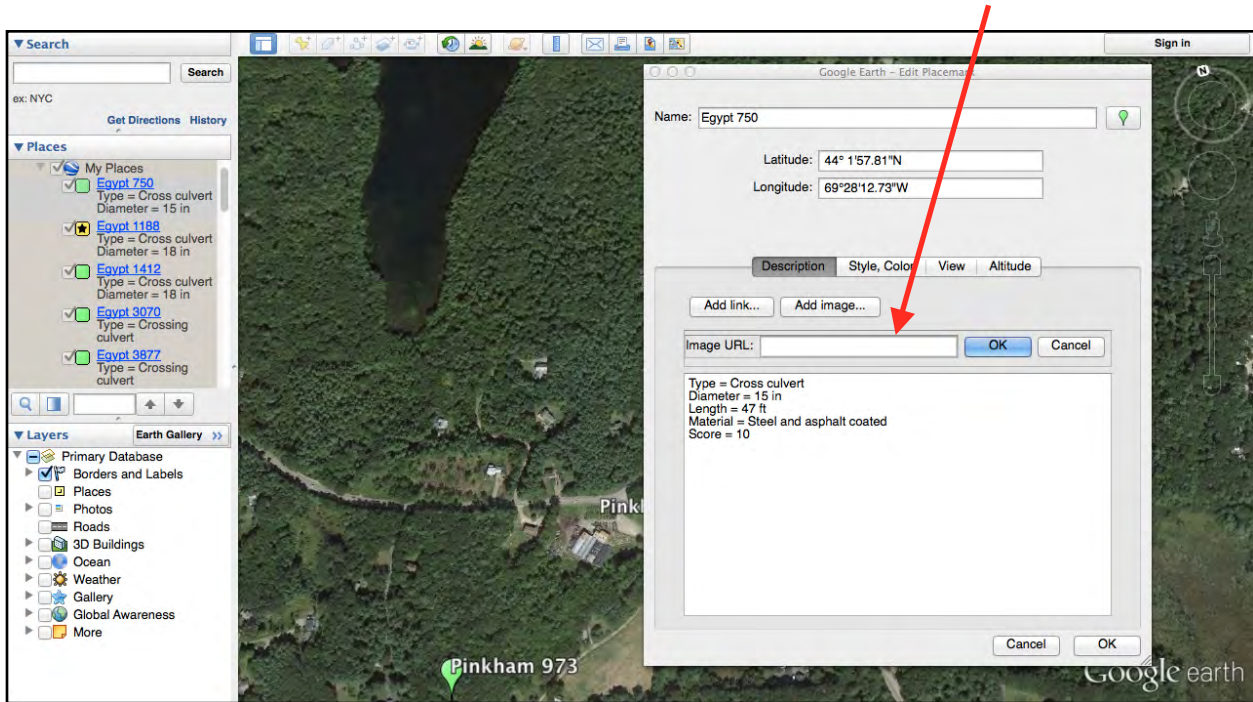
Step 6 - Save Your Work

You should continually save your work as you input new culvert placemarks. Simply click 'File' then select 'Save Place As...'. Enter a name for the list of placemarks you just created and make sure the file type is a 'Kml (*.kml)'.

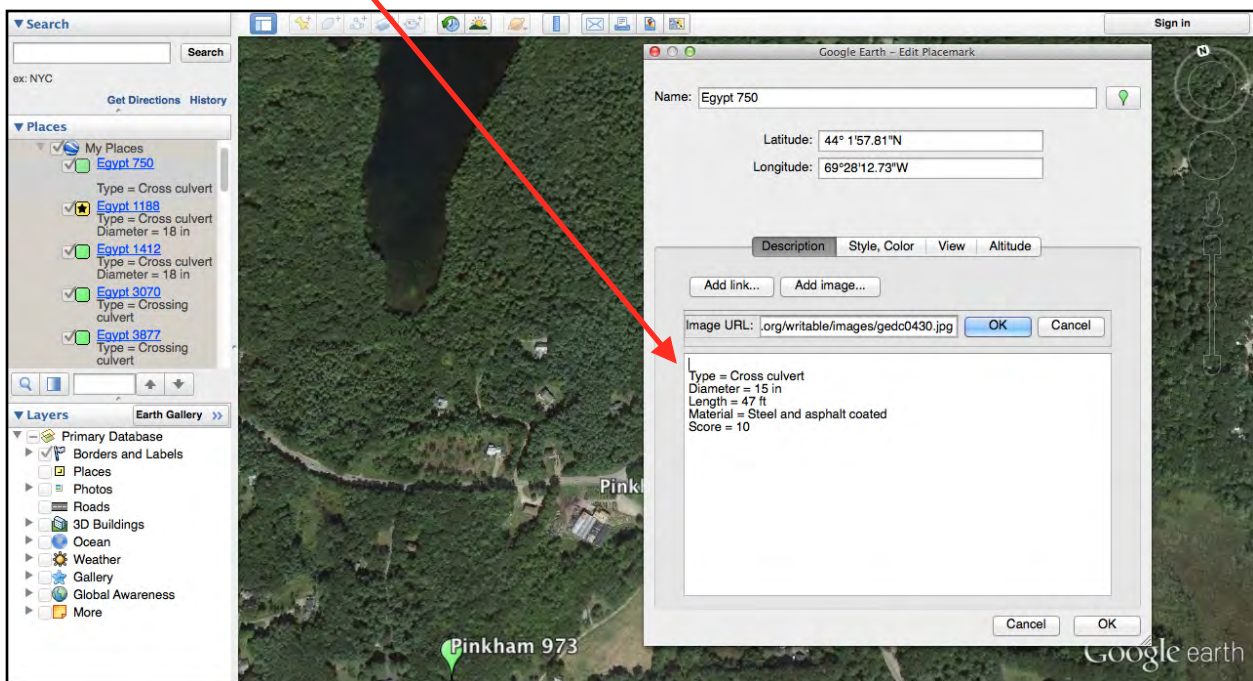


Step 7 - Adding Photos to Your Work

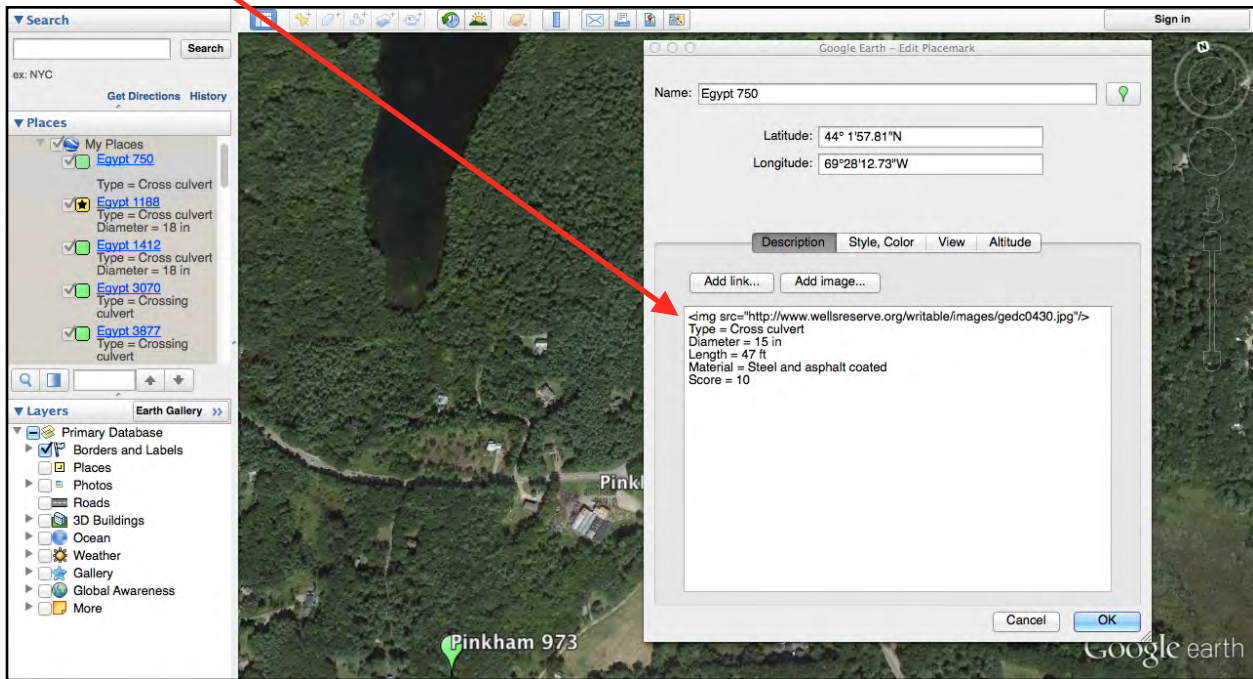
The easiest option that requires no HTML coding is to upload your culvert photos using the program (PC) or application (Mac) Picasa. It is free and can be downloaded at picasa.google.com. This program/application allows you to take photos from your computer or camera and upload them to the internet so that a photo's web address can be used to add to the culvert's placemark as you add information. Click 'Add image...' and a box will appear where you can paste the web address of your culvert inlet photo.



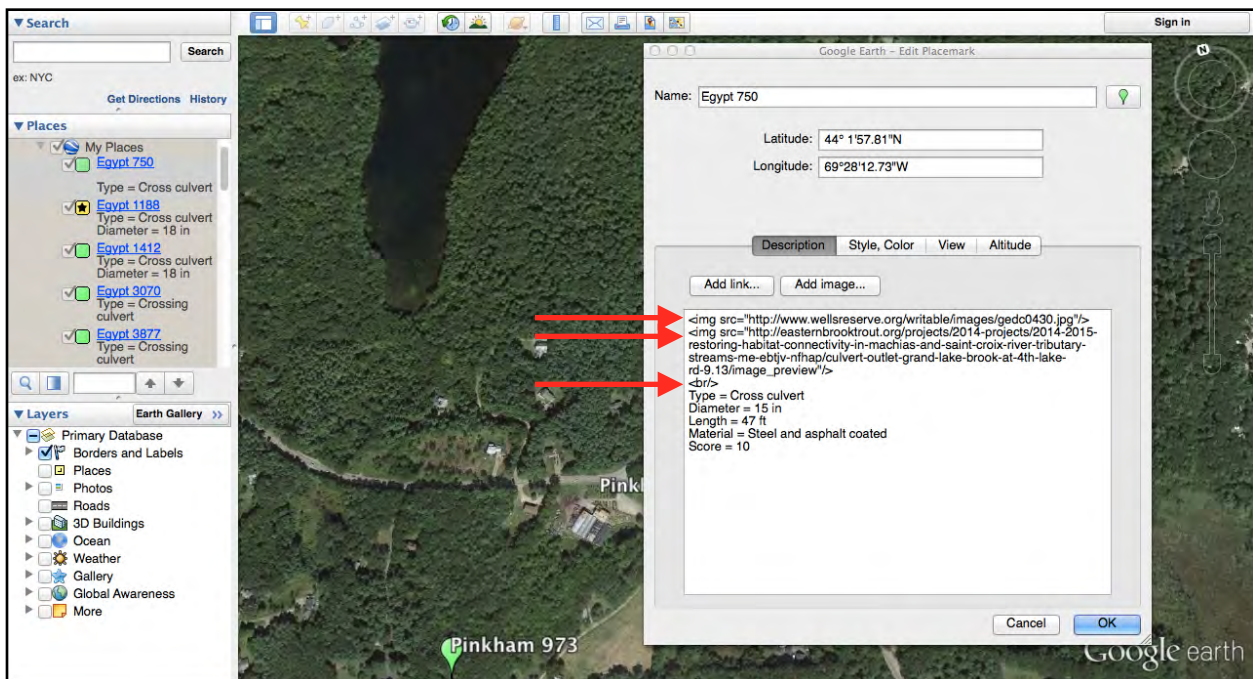
Before you click 'OK' make sure the image will appear on top of the culvert's information by clicking in the 'Description' box and giving yourself a line of space before the list of information. Then click the empty line so that the blinking cursor appears in this line, like in the example below.



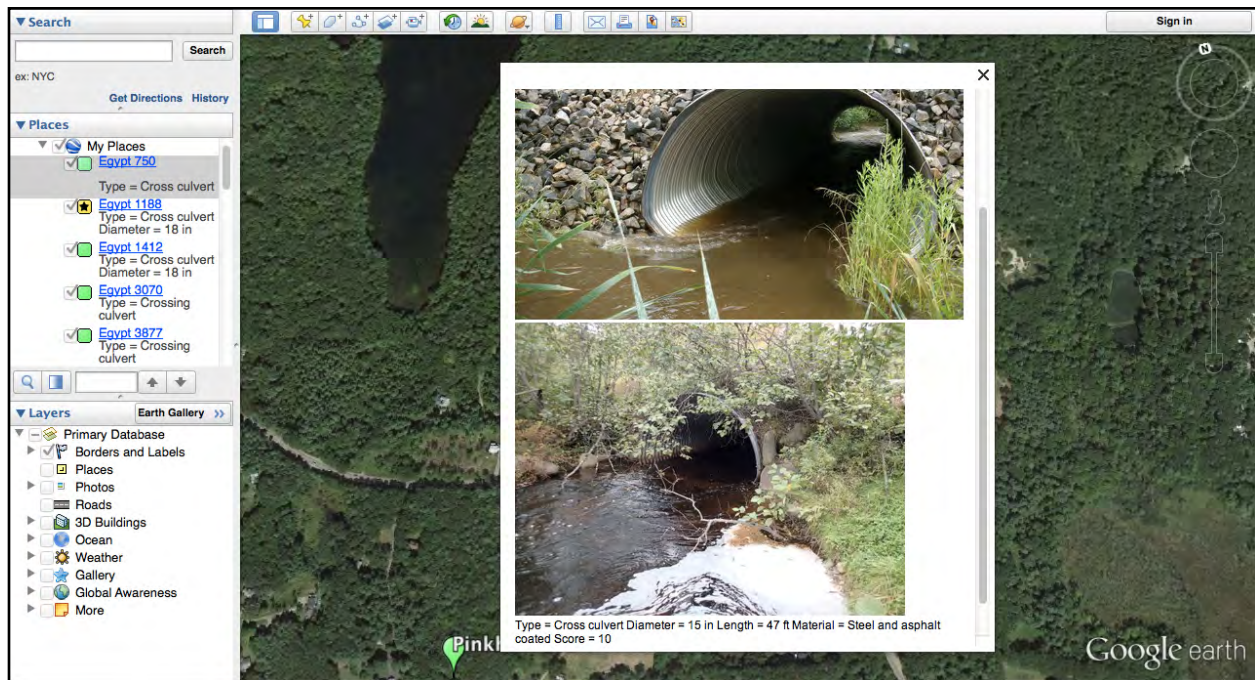
Once you click 'Ok' beside the 'Image URL:' you'll see the image HTML code above the culvert information.



Next, create another blank line above the culvert information (and below your inlet photo HTML code) like you just did and put the cursor in the blank line again. Now click 'Add image...' to add the URL of the culvert outlet photo. Click 'OK' next to the 'Image URL:' and you should see both image HTML codes above the culvert information. Then, create one last line above the culvert information and type `
`. This will give a space between your photos and the culvert information when you click on the individual placemarks.



Click 'OK' in the bottom right of the 'Description' box. Now click the placemark to which you just added the photos. You should now see both the inlet and outlet photos, as well as the original culvert information, like in the example below.



Continue this process for the rest of your culvert placemarks and always remember to save your work as you go. Using a photo sharing program/application like Picasa with Google Earth allows you to share the photos of each placemark when you share your .kmz file. Send your file to an engineer when you have a location-specific question to ask, or send it to a colleague to share a success story or management advice.

Conclusion

The purpose of this document is to give people like road commissioners and public works personnel free and user-friendly tools to begin keeping track of their stormwater assets. Over time, asset information should be updated, in both the master Excel file and the Google Earth .kmz file. The objective is to begin creating data that will make it easier to:

- Understand the location of vulnerable assets and their proximity to important social services facilities (hospitals, schools, police, fire rescue, etc.)
- Prioritize asset upgrades, replacements or short-term fixes based on asset condition and other variables your municipality may consider (e.g., proximity to important social services facilities, traffic re-routing, populated areas of town, etc.)
- Develop a stormwater maintenance schedule and have places to store important information (Excel master list and Google Earth .kmz file) as you inspect your infrastructure
- Transition to a more sophisticated GIS or asset management software program when appropriate

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This project was funded by the University of Maine's Sustainability Solutions Initiative and NOAA's National Sea Grant Network

