

HISTORICAL GIS RESEARCH IN CANADA

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Mapping the Welland Canals and the St. Lawrence Seaway with Google Earth

Colleen Beard, Daniel Macfarlane, and Jim Clifford

INTRODUCTION

Google Earth is a desktop virtual globe and mapping application that utilizes geospatial data held on the web to visualize the earth in three dimensions. Google Earth also allows users to document, incorporate, and map out their own data and other information onto the virtual globe.

For researchers and local history enthusiasts, the ability to incorporate historical documents into a digital geographic interface is especially compelling. Moreover, this easy-to-use free software considerably decreases the obstacles that might prevent a researcher from employing GIS.

The process of creating custom maps in Google Maps and Google Earth uses many of the same methods as more advanced researchers use with GIS software. It provides the option to create custom lines, polygons, and points. By consulting historical maps, we can add lines representing roads or railways, polygons for the outlines of building or agricultural fields, and points to identify particular places or to locate events. Google Earth also allows users to attach descriptions

(using text and HTML code) to these lines, polygons, and points. Although Google Earth cannot link data to an attribute table or query a database in the same manner as GIS, the user can incorporate dates and build a basic spatially referenced digital historic map of a landscape.

Google is now constantly adding historical imagery to their web application, a development that will be well received by environmental historians and geographers. For example, aerial photographs are available for London, England, from 1945 on, along with the more recent series of satellite imagery. However, this information is more limited for Canada, and in the case of the St. Lawrence Valley the images only go back to 1995. The situation is better in the Niagara Region, in part because of aerial photographs uploaded to Google Earth by Sharon Janzen and Colleen Beard, one of the co-authors of this paper. Hopefully this example will lead other map librarians, geographers, and historians to share historical imagery through Google Earth. The “Layers” icon in Google Earth provides access to another huge collection of data, including features such as labels, places, roads, and pictures, but also third-party data from organizations such as NASA and National Geographic. These layers are provided by Google and partner organizations.

Among the layers currently available, the most useful for historical research and teaching is the David Rumsey Historical Maps collection (found under the gallery tab), which includes dozens of historical maps “pinned” or georeferenced onto their location on the digital globe. Working with layers approximates one of the central methods in HGIS, where researchers create and analyze layers of scanned and georeferenced historical maps. While there

are a great number of georeferenced maps for the United States, fewer exist for Canada. It is possible, though not particularly advisable, to add more layers of historical imagery, found for example on the Library and Archives Canada website or from a university map library. The georeferencing tool provides a very basic method for comparing layers of historical maps with more recent satellite images. It should be noted, however, that the georeferencing functions in GIS software are considerably more functional than in Google Earth, and if you find yourself with a collection of scanned historical maps, it is probably best to invest the time and learn the more complicated GIS software.

Even after a researcher learns to work with Quantum GIS or ArcGIS, these Google products remain valuable for presenting digital maps. Many GIS programs allow researchers to export their layers as Google Earth files, making them accessible to collaborators and the public. Moreover, the Movie Maker function allows researchers to create dynamic presentations using Google satellite imagery. This free software and the associated web-based Google Maps is an essential digital mapping tool for learning, presenting, and teaching. University academics have free access to the Pro version of Google Earth, which expands the capacity to work with GIS files and provides higher resolution images for presentations, making it even more useful for historical researchers and teachers. Whether one uses Google Earth in conjunction with GIS software or on its own, it provides a low-budget and easily mastered option for including and presenting digital mapping in historical research. After starting digital mapping education on Google Earth, researchers are well prepared to then learn how

to use ArcGIS; Google Earth is an extremely useful stepping stone.

The remainder of this chapter brings together two projects that have used Google Earth to explore the spatial history of the Welland Canals and the St. Lawrence Seaway. Historian Daniel Macfarlane works with Google Maps and Google Earth to facilitate his research on the history of the St. Lawrence Seaway and Power Project, with assistance from Jim Clifford. Brock University Map Librarian Colleen Beard sets her focus on local landscape change, employing Google Earth to explore the three historic Welland Canals that traversed St. Catharines, Ontario, in the nineteenth century.

1. MAPPING THE ST. LAWRENCE SEAWAY AND POWER PROJECT¹

The St. Lawrence Seaway and Power Project, built between 1954 and 1959, combined a major hydroelectric development in conjunction with a deep water navigation scheme. It was one of the greatest megaprojects of the twentieth century and is now the second largest transborder water control endeavour of its kind. The construction entailed a massive reshaping of the St. Lawrence environment. Over 40,000 acres of land were flooded to create Lake St. Lawrence, which served as the power pool for the international hydro dam between Cornwall and Massena. Since the St. Lawrence River forms the border between Ontario and New York (and the United States and Canada) before flowing through Quebec and emptying

into the Atlantic Ocean, modifications of river water levels necessitated bilateral cooperation between Canada and the United States. Half a century of complicated negotiations and failed compacts passed before the two countries reached a final agreement in the 1950s, a process that was extremely revealing for not only the history of Canadian–American relations and nationalisms but also North American environmental and technological history.

Over the course of my doctoral research on the Seaway, I encountered a great number of maps and other geographically referenced documents concerning the St. Lawrence project. These included blueprints and engineering plans ranging from the late nineteenth century to the early Cold War, from hand-drawn schemes to precise engineering documents. Blueprints of the International Rapids Section of the St. Lawrence River (Fig. 2.1), which was turned into a lake, were particularly fascinating because they showed the ways that the St. Lawrence landscape had been imagined in numbers and measurements. One of my major interests is the ways that North American societies, states, and experts in the mid-third of the twentieth century conceived of the engineering possibilities of riverine environments. This wealth of inherently spatial information presented opportunities to enrich my analysis.

Like many people, I had experience with Google Maps for generic purposes and had even made a few custom maps, but I wasn't sure that the type of multilayered and interactive mapping I envisioned was within my capabilities. Given my lack of time and skills, taking on a large GIS project seemed impossible, but after I had completed my dissertation and started turning it into a book, Google Earth provided a free and accessible alternative that

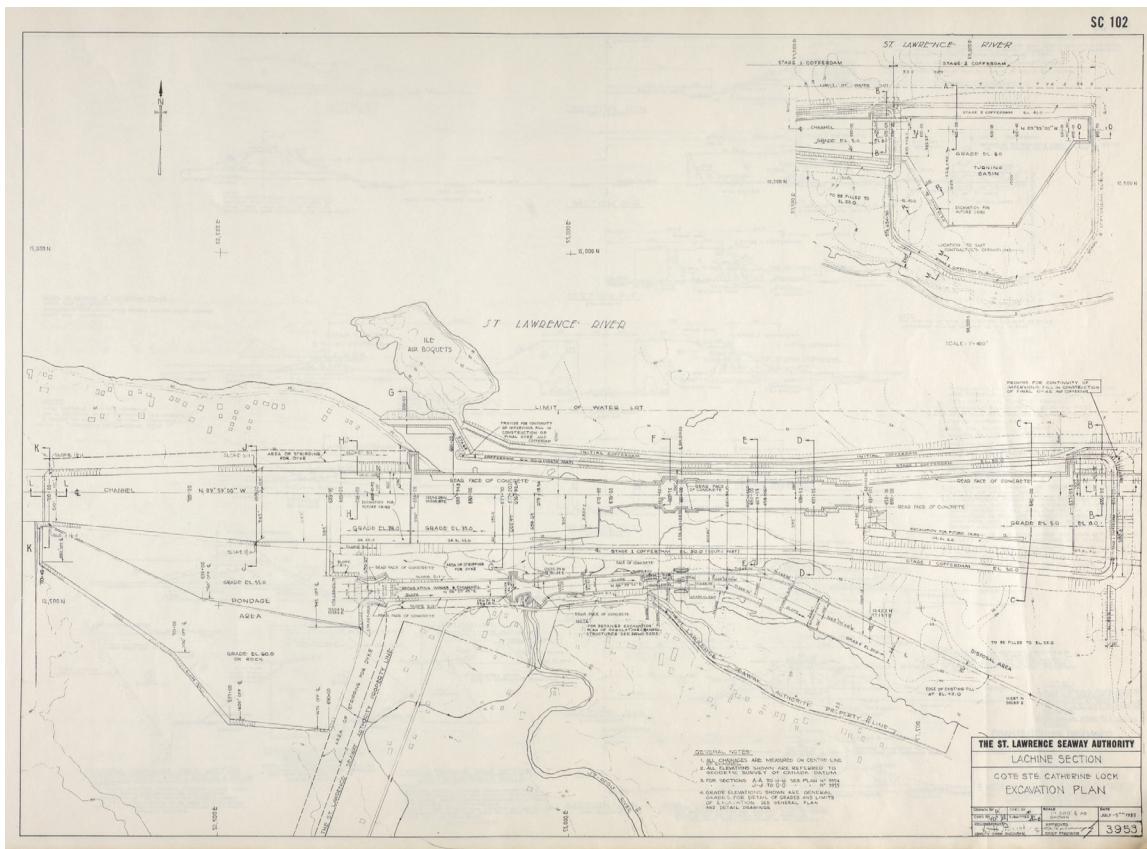


Fig. 2.1. St. Lawrence Seaway Authority blueprint of Lachine section of St. Lawrence Seaway at Montreal © Government of Canada. Reproduced with the permission of the Minister of Public Works and Government Services Canada (2012). (Source: Library and Archives Canada/Department of Transport fonds/RG 12/vol. 5565/Mikan 1254527.)

could be mastered relatively quickly. I sought out further training and education,² and began exploring the custom maps feature of Google Maps. Soon I had marked off the main Seaway channel and found that I could use anchors and signs to designate key points of interest and different features. Based on other maps and blueprints, I began adding text, maps, and pictures to the various points of interest, then started tracking the lines of the older canals that the Seaway had replaced. In just a few combined hours, I had essentially produced the map displayed in this chapter. While this did

not result in a comprehensive HGIS database, it did create a digital map with layers of spatial and descriptive information. This sparked my interest in digital mapping and started me on a path towards learning GIS. It also provided me with a map that could be exported into Google Earth, which uses technology that is closely related to GIS.³

Google Earth is a virtual globe that allows one to view the earth in three dimensions. For example, the tilt function can be used to look at the earth from an angle, rather than from straight above (this is similar to Google Maps,



Fig. 2.2. Map of St. Lawrence Seaway route. (Created in Google Earth. © 2012 Google; © 2012 TerraMetrics.)

where the “Street View” option simulates the map’s appearance from the perspective of someone standing in front of a landmark, or even adjusts for time of day). This was a particularly effective way of following the Seaway route, as it permitted me to start at one end and track along. Using another option on the same tool bar, a custom tour can be recorded for easy playback.

I used Google Earth to highlight the navigation path of the actual Seaway, as well as ports and features of interest (Fig. 2.2). This provided a useful and potentially powerful visual and geographic representation for future readers but also allowed me to undertake spatial analysis in

a way I could not have otherwise. Using the overlay feature, which will be explained in more detail below, I compared the map of the flooded International Rapids section of the St. Lawrence project (from approximately Prescott to Cornwall) with a historical picture to better understand how much land was flooded and where. The Seaway was digitally viewable from alternative angles, heights, and directions, providing unique perspectives on the subject.

Google Earth also allowed me to map the previous canal systems that predated the Seaway, including the Welland Canal. By adding points, lines, and polygons, I was able to create a custom map of the previous canal routes and



Fig. 2.3. Overlay of village of Aultsville. (Created in Google Earth. © 2012 Google; © 2012 USDA Farm Service Agency.)

the contemporary St. Lawrence Seaway, using satellite imagery to isolate and highlight the features that were pertinent to my research.

The flooding in the International Rapids sections of the St. Lawrence power project required the relocation of a number of riverine communities – the Lost Villages. Archival records, maps, and photographs indicate the placement of individual properties in the various Lost Villages. This information can be represented in Google Earth to reconstruct the layout of the village and, using different features, can be analyzed in order to determine patterns. For example, I was interested in showing how the government hoped to re-orient the newly created communities towards

the freeway rather than the river by comparing the distance distribution of residential areas in relation to schools, business centres and other amenities, the river, and the highway.

Even though the historical satellite imagery function of Google Earth does not yet permit me to view images from the time period before the St. Lawrence project was constructed, the fact that it did allow me to go back a decade was nonetheless helpful. The water clarity of the St. Lawrence has varied over the years due to different factors and the sliding historical imagery timeline enabled me to select images from years when the water (and the images themselves) was comparatively clear. Under such conditions, one can view the foundations

and remains of many parts of the Lost Villages and transportation networks, even though they are under water, and trace the route of the now-inundated Highway 2. Combining the remains of infrastructure viewable in Google Earth with sufficient archival information makes it possible to create a map showing land covered by water before and after the flooding. To achieve this in Google Earth, I did an image overlay, putting a digitized version of an old map of the flooded village of Aultsville over top of a Google Earth satellite image of its present location (Fig. 2.3).

This was a relatively simple operation. Using the Google Earth overlay function only requires hitting the button along the top border, and selecting the file one wants to upload. Opaqueness – the amount one can see through the image being overlaid – is a key attribute of overlays and can easily be controlled. Using the lines of the main north–south street and old east–west Highway 2 as reference points, I lined up the old maps and the Google Earth image – a simplified form of the more sophisticated georeferencing that can be done with more advanced GIS software.

With this Aultsville overlay, the portions of the area and infrastructure that were submerged, as well as those that remained dry, are obvious. Images such as this have allowed me to discover and explore (if done with remote sensing technology, this would be called “groundtruthing”) the actual area depicted on the satellite imagery; this can also be used as a pedagogical tool, as I have taken several classes on field trips to this site. Because the water is relatively shallow here, one can walk the former streets of the town and find building foundations. In fact, when the water is low, one can walk close to the old river shoreline. One

can easily count the number of properties that existed (and were flooded) and discover geographical features that influenced the pattern of the flooding. For example, the main streets and highways remain visible, while flooding was more prominent along the watersheds of tributary creeks and streams. Aided by other information, such as property registries or interviews with former residents, the spatial aspects of the community can be recovered.

2. VISUALIZING THE HISTORIC WELLAND CANALS

In 2010, Brock University Map Librarian Colleen Beard set out to create an interactive visualization tool, or “mashup,” to explore the spatial history of the three historic Welland Canals. Inspired by the interest that was generated by the Welland Canal Summit, a public meeting held in 2009 by the Niagara regional government to discuss the heritage designation of the historic canal corridor, the Historic Welland Canals project aimed to increase awareness of the region’s canal heritage while showcasing the rich collections of the Brock University Map Library and other local collections. The project brought together hundreds of historic air photos, maps, plans, photographs, and audio interviews held at Brock University and other local collections. These documents were then scanned and embedded into the Google Earth framework to provide a geographic reference for exploring the many features of the three canals.

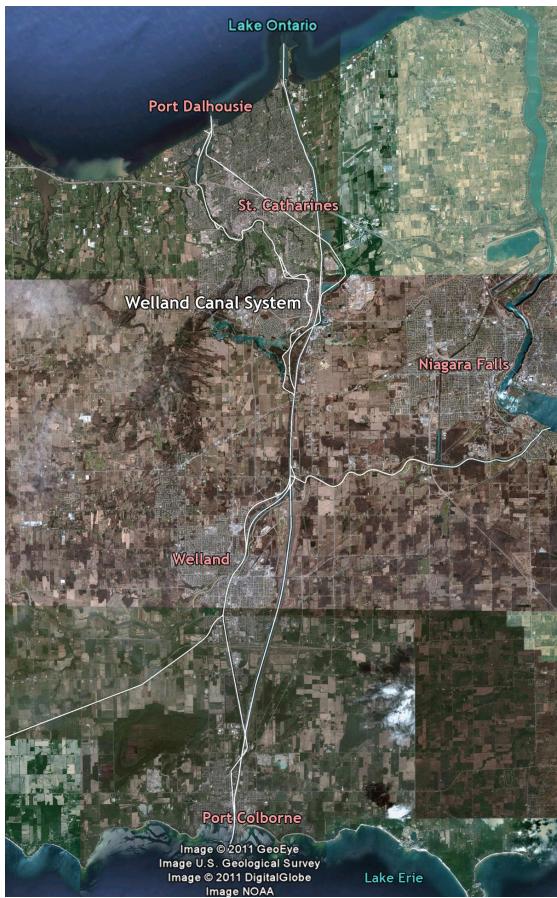


Fig. 2.4. The Welland Canal System within the Niagara Region. (Created in Google Earth Pro, 2011.)

The Welland Canal is a major route for ships navigating between Lake Ontario and Lake Erie to circumvent Niagara Falls (Fig. 2.4). The canal was first established in 1829 by local businessmen to stimulate local and regional trade, but the government of Upper Canada soon saw its potential as a crucial artery for British North American trade. Over a period of one hundred years, the canal was rebuilt three times. All three routes used Port Dalhousie

as the access point to the canals, with slight variations. The canals climbed the escarpment at Thorold, and then progressed to Lake Erie. The first and second canals had similar routes, each of which followed natural waterways through what is now downtown St. Catharines. The third canal, completed in 1881, deviated from Port Dalhousie and cut a straight diagonal path bypassing St. Catharines. It survives as a scar in the landscape visible primarily from the air. Some of its twenty-six stone-cut locks are still intact and visible where the canal intersects the current fourth canal at its eastern extent.

This project aims to increase the awareness and importance of the canals among the general public and government authorities, particularly within the context of the regional government's application to Parks Canada for historic site designation. It will also serve as a significant resource for planners in making informed decisions associated with cultural, tourism, and environmental planning. For example, historical air photos are currently being used to examine the area where the fourth canal, currently in operation, intersects with the historic third canal, in order to determine zones of concern where tourism may interfere with the daily operation of the canal. Figure 2.5 illustrates the extent of the project content, where each point symbol on the map represents the location of a canal lock, feature, or a point of interest. Each placemark links to photographs, maps, or air photos that annotate and illustrate its history. Navigating the resources using Google Earth provides a virtual tour of canal history.⁴

Historical maps and air photos provide useful sources for exploring and documenting features and landscape change along the historic canal routes. When converted to a



Fig. 2.5. A sample of the project placemarks within the Google Earth framework, displaying the Port Dalhousie area and north terminus of the historic Welland canals. (Created in Google Earth Pro, 2011.)

digital format, these images can be imported into Google Earth and georectified, or adjusted to overlay and match the underlying Google Earth imagery. This technology can reveal some startling landscape changes over time. Geotagging historical photographs to their exact location, for example, allows viewers with handheld devices to stand in the same location as the photo was taken and “look back in time.” Audio interviews with employees of shipyards and local businesses, as well as local residents from the time period, provide first-hand accounts and stories of canal life. These historic documents, when placed in a geographic

context, provide a powerful means of relating little-known discoveries about the canals.

Canal Discoveries

The Piers of Old Lock One

The location of the submerged wooden piers of the very first canal in 1829 has been a subject of great interest for local canal enthusiasts. Many area residents were unaware that the north access to the first canal at Lake Ontario cut a path through what is now popular Lakeside Park in Port Dalhousie. The 1855 Welland



Fig. 2.6. Top: Welland Canal 1855 survey map, showing the location of the piers and Lock 1 of the first canal, overlaid in Google Earth shown faintly underneath. (Digital image: Brock University Archives, St. Lawrence Seaway Authority [Canada] Fonds, Second Welland Canal Survey Map 1, ca. 1855; reproduced in Google Earth Pro, 2011.) Bottom: 1934 air photo showing the submerged shadows of the piers. (Digital image reproduction: Brock University Map Library; NAPL photo A4700 #33.)

Canal Survey (Fig. 2.6) illustrates the position of these piers that extend beyond Lock One into Lake Ontario.

By overlaying this digital image over the Google Earth imagery, I was able to determine the exact geographical location of the piers in today's landscape. Google Earth provides a tool that displays an overlay at gradual transparency levels. As the top layer becomes transparent, it reveals the underlying current imagery. The shoreline of the Lakeside Park area, for example, reveals especially dramatic landscape changes. The shadows of the submerged pier remains, clearly visible from the 1934 air photo taken one hundred years after the canal was in operation, provided another exciting discovery. These shadows are also discernible on the current imagery in Google Earth. Such discoveries are not merely academic; they are of great interest to community members and canal enthusiasts as well. For example, when these shadows were revealed in a community publication,⁵ an advocate for the canals hopped in his kayak, equipped with snorkel and mask, determined to locate the underwater remains (unfortunately with little success)!

The 1855 survey map, the 1934 air photo, and one other 1839 map of Port Dalhousie provided the geographical information for accurately locating the buried Lock One for a recent excavation.⁶ In 2008, an archaeological assessment was initiated by the City of St. Catharines to determine the significance of buried canal features within the north entrance channel. The study established with certainty the precise location of these features within Lakeside Park, and determined that much of Lock One's wooden structure remained intact.

Shipwreck at Lock 21

This area of the third canal is currently used as a reservoir for regulating water for the Thorold flight locks 4, 5, and 6 of the fourth and current canal. When drained in the winter, the skeletal remains of a sunken vessel can be seen outside the north gate at Lock 21. Although many are aware of these remains, their history is a mystery. Amazingly, the digitized 1934 air photo, when viewed at a zoomed level, shows this vessel in nearly the same position, but afloat (Fig. 2.7).⁷ This boat is very difficult to detect from the original air photo print. Not until this image was enhanced through digital processes was it noticeable. These enhancements offer a few more details that can help unravel the mystery. For example, the boat would have had to have been abandoned sometime after 1932 when the canal was no longer in use, since it obstructs the entrance to the lock. Although the boat's mast is not visible, the details in the shadow cast by the mast indicate a vessel larger than a tug boat, as some residents suspect. A 1948 air photo of the same area from the Map Library collection shows no evidence of the boat. It must, therefore, have sunk before then. The history of the ship remains a mystery, but the evidence that the 1934 digital imagery provides has inspired great curiosity among canal enthusiasts and Seaway personnel.

The Railway Tunnel Entrance

A final story unravels the mystery of the railroad tunnel. Not far from Lock 21 on the third canal, between Lock 18 and 19, is the Grand Trunk Railway tunnel. Built in 1887, the tunnel redirected trains under the canal instead of having them pause at the surface rail bridge to make way for ship traffic. Only 220 yards in



Fig. 2.7. This 1934 air photo shows a boat afloat outside Lock 21 of the third canal. The 1934 imagery is also accessible through the Google Earth Historical Imagery option. (Digital image: Brock University Map Library; NAPL photo A4873 #28.)

length, it is locally known as the Blue Ghost Tunnel due to its spine-chilling effect for those that dare to explore – with a good flashlight and companions in tow! The tunnel is accessible on foot from the west entrance. However, the last thirty yards through to the opposite end are impassable (without hip waders and a hard hat) due to the deterioration of the railroad and ceiling. Although the opening is visible and seems within reach, it is nowhere in sight from the road above. Previous searches for the eastern entrance by canal hikers had met with no success.

A closer look at the 1934 air photo of the area clearly shows the path of the tunnel with both the west and east entrances visible. When overlayed onto the Google Earth framework (Fig. 2.8), the precise latitude and longitude of the east entrance was recorded. We entered these coordinates into a Global Positioning System unit and set out on foot.



Fig. 2.8. Google Earth is used with a 1934 photo overlay to determine the exact position of the east entrance of the Grant Trunk Railroad tunnel under the third canal. (Created in Google Earth Pro, 2011.)

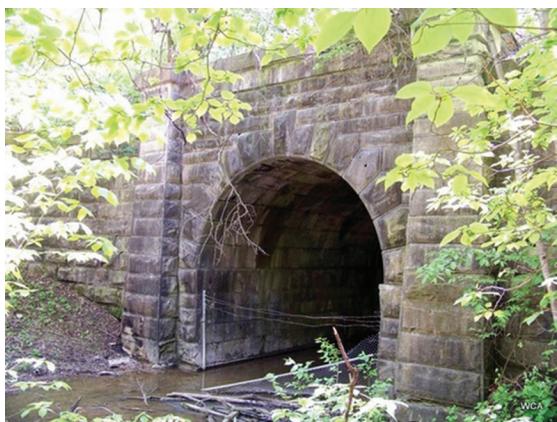


Fig. 2.9. East entrance of the Grand Trunk Railroad tunnel. (Photo: Rene Ressler, May 2009.)

The east side of the canal bank in this area is not easily accessible. After a half-hour trek through deep mud and dense brush, with weak GPS signals, the GPS finally beeped, warning us that we were within a few metres. Several steps further into the dense brush, and there it was – a large concrete ledge. A short descent down the bank revealed the tunnel entrance. To our delight, the concrete structure was still in excellent condition. Protected by underbrush, it had been spared the popularity of the graffiti-covered and garbage-strewn western entrance (see Fig. 2.9).

The Talking Map

Alex Bennett was a pipefitter for Muir Bros Drydock Company in Port Dalhousie during the 1940s (Fig. 2.10). Although the northern terminus of the canal had moved east to Port Weller in 1932, the Drydock Company continued to operate as an important shipyard industry for the region. An audio clip of Bennett's interview with two local historians can be heard from a link within the project's web application.⁸ The project can also be accessed on a mobile device, thus making possible a walking tour of the historic canal area. While standing at the location of Muir Bros, now Rennie Park, one can link to the audio and listen to details describing Alex's working experience, at the same time viewing accompanying historical photographs. This application is also referred to as a "talking map." Bennett speaks passionately about coming over from Scotland and being down to his last twenty dollars and about his experience working on a ship called the *Makewelli*. He describes the layout of the Muir building almost to the point where one could recreate the design. Although the Muir Bros Drydock Company had no monopoly over the shipbuilding industry, it managed to operate longer than its competitors, until 1954. This area became the site of the Canadian Canal Society in 1982.



Fig. 2.10. Muir Bros Drydock Company, 1882. (Photo: Brock University Special Collections and Archives.)

The Power of Photography

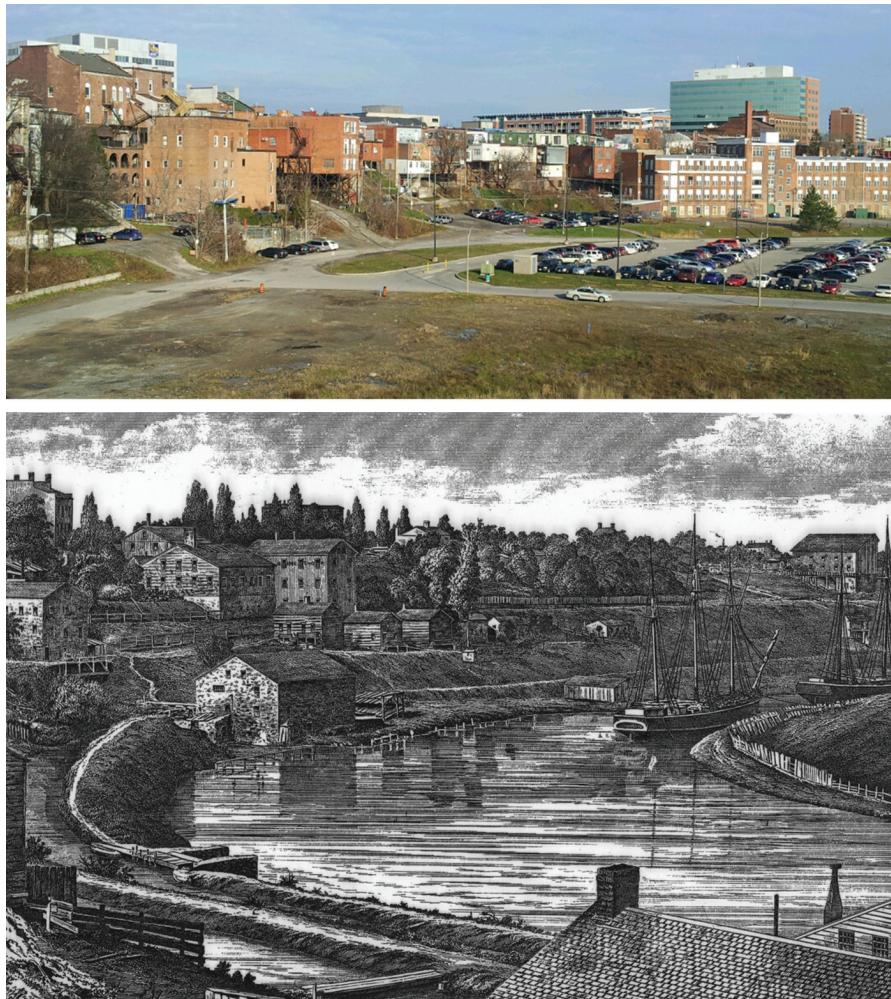
There are numerous photographs and sketches of the canals. Displaying photographs in the Google Earth framework, however, provides an exciting enhancement to the canal experience. Several books provide historical accounts of the canal with photographs and maps but lack geographic context. To date, 175 photographs or sketches have been added to the project and “geotagged” with their geographical identification. This is a simple, but very effective, procedure. Using photographs in this way can help to reconstruct the historical landscape. Historical maps are used first to identify the names and locations of buildings, lock features, or industries. Once these maps are converted to a digital form and georectified in Google Earth, they become important resources in identifying locations in today’s landscape. Photographs of these features are geotagged to the location they once occupied. Several industries along the canal corridor were identified using this method.

Adding old photos of the landscape in the Google Earth context is a very effective method of placing one at the scene. A geotagged

photograph can include annotation about a building or historic event to augment the experience of “being there.” For example, atop the Glenridge bridge near the corner of St. Paul Street and Westchester in downtown St. Catharines, a current view reveals a neglected landscape – the backend of a series of rundown buildings on St. Paul Street. Standing near this spot in 1871, the view would have been much different! Figure 2.11 illustrates this striking comparison. The 1871 sketch shows a view of the same area where the second canal, now a parking lot and future site of a sports complex, meandered through quite a different landscape. Historical maps were used to identify some of the industry that lined the shores during this time.

Another interesting use of geotagged photos is to document the history and progressive use of buildings over time. The Beaver Cotton Mills, located in Merritton by Lock 16 of the second canal, is documented chronologically in this project through several photos. The mill was situated at the base of the escarpment to take advantage of the water power associated with the series of locks that carried ships up

Fig. 2.11. Top: A current view of the area once occupied by the second canal, downtown St. Catharines. December 2011. (Photo: Brock University Map Library.) Bottom: a sketch-up view of the area in 1871 showing the second canal and surrounding landscape. (Photo: Canadian Illustrated News.)



the steep incline, also referred to as “Neptune’s staircase” – one of the few spots along the corridor that is currently designated as a local historic site. Early sketches of the mill illustrate a flurry of activity in the years before its demise. Current photos offer a good example of a historic mill site repurposed as a restaurant.

Libraries and Digitization

To date, this project has generated interest from the Region of Niagara, as they continue

to pursue a heritage designation for the canals. Teachers have expressed interest in using the project as a learning tool by imbedding it into their local history curriculum. It is currently part of the focus for a university geography assignment in a course titled “Digital Cities.” The discoveries that have been unveiled through historical maps have sparked the curiosity of local historians and canal enthusiasts and have led to further exploration.

A number of years ago, Brock’s Map Library staff embarked on their first digitization project of several hundred 1934 air photos. The

enhancements were remarkable: detail could be seen that wasn't apparent from the contact printed version. Since then, digitizing our collections to make them more widely accessible to our researchers has become a priority. Google Earth has provided us with a virtual stage to showcase our digital collections. The Brock Map Library is one of few university libraries to have partnered with Google to have their digital imagery actually incorporated into their Historical Imagery database. By connecting historical documents with geographic locations in the present, it provides a sense of "place" with which we can describe and display the region's history – something that books and other printed materials cannot alone achieve. It is time for librarians and archivists to dust off their historical collections and bring them back to life. Historical GIS has provided many exciting ways to do this. Freely accessible and easily mastered, Google Earth is a good place to start.

CONCLUSION

These two projects each worked with Google Earth in different ways to document and display different aspects of Great Lakes-St. Lawrence canal infrastructure. Both present Google Earth as a flexible, accessible, and

readily mastered technology for getting started with historical GIS, or for sharing the results of more comprehensive spatial history projects with a wider audience. Through these examples, we have introduced readers to methods of locating information, building a basic spatially referenced digital historic map, and presenting the results. For example, we have shown how aerial photography, specifically, can be used and georeferenced within Google Earth to generate new information. In doing so, we have demonstrated that Google Earth can benefit those looking to utilize digital mapping technology, be they professional academics, public historians, researchers, librarians, archivists, or public history enthusiasts. Google Earth also provides an ideal platform for teaching historical digital mapping and introducing the basic approaches of HGIS at the undergraduate level.

We have shown how digital technologies have allowed libraries to easily transform their valued historical collections from traditional print format to digital spatial information that reveals new knowledge. The enhancements achieved through digital processes, coupled with the viewing technologies that Google Earth provides, unleash a wealth of information about the history of Canadian landscapes and do so in a way that can be easily presented, disseminated, and absorbed by both academic researchers and the public.

NOTES

- 1 Daniel Macfarlane, "To the Heart of the Continent: Canada and the Negotiation of the St. Lawrence Seaway and Power Project, 1921–1954," PhD dissertation, University of Ottawa, 2010. An expanded version of this dissertation will be published as a monograph with UBC Press in 2014. For a shorter summary see: Daniel Macfarlane, "Rapid Changes: Canada and the St. Lawrence and Seaway Project," Research Paper, Program on Water Issues (POWI), Munk School of Global Affairs (University of Toronto), 2010, <http://www.powi.ca/pdfs/other/Macfarlane-POWI%20paper.pdf>.
- 2 This included a series of blog posts on HGIS for beginners on the NiCHE website: <http://niche-canada.org/taxonomy/term/772>. Daniel is especially grateful to Jim Clifford for his tutelage in developing GIS skills.
- 3 Converting a custom Google Map to Google Earth is very easy: on the top of a custom map, just click on "View in Google Earth." A prompt will ask whether you want to open or download the file. Unlike a custom map, which remains stored and saved online, a Google Earth map can be downloaded to your desktop (download a free copy of Google Earth first). Alternatively, you can start directly with Google Earth and skip Maps.
- 4 This project is accessible from the Brock University Map Library website: <http://www.brocku.ca/library/collections/maplibrary>. The kml files can be saved and opened in Google Earth.
- 5 Colleen Beard, "The Three 'Old' Lock Ones – A history in maps," *Dalhousie Peer – Port Dalhousie's Community News Magazine* 10 (2000): 6–8.
- 6 J. K. Jouppien, "The Location of the North Entrance Channel of the 1st Welland Canal, 1824–1829 and a Stage 1-3 Archaeological Assessment of Select Areas at Lakeside Park, City of St. Catharines, Regional Municipality of Niagara, AhGt-20 CIF/PIF #P119-001-2008" (Niagara Falls, ON: J. K. Jouppien Heritage Resource Consultant Inc., 2008).
- 7 The entire 1934 air photo imagery of the Niagara area has been digitized by Map Library staff and recently donated to Google. It is now included in the Google Earth Historical Imagery database.
- 8 The audio interview with Alex Bennett was conducted by Christine Robertson and David Serafino, 2000. http://www.brocku.ca/maplibrary/WellandCanal/Bennett_audio.mp3