

Surficial Geology of Joiner Brook and Winooski River Valleys: Bolton, Vermont

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Introduction:

The town of Bolton is located in eastern Chittenden County in Northwestern Vermont. It is bordered by Waterbury to east, Stowe and Underhill to the north, Richmond to the west, and Huntington to the south. The Green Mountains run north to south through the town and the Winooski River flows west to east through the southern portion of the town. Research for this project focused on the area of Joiner Brook and adjacent areas of the Winooski River valley. The town of Bolton is underlain primarily by schists and some quartzite. These rocks were metamorphosed during the Taconic Orogeny and Acadian Orogeny between 440 and 375 million years ago (Ratcliffe et al., 2011). Most of the surficial materials in the area were deposited as the Laurentide Ice Sheet retreated from the area around 13,900 years ago (Ridge et al., 2012). As the ice sheet retreated to the northwest, it left behind glacial till (a mixture of boulders, pebbles, sand, and silt). These materials have been redistributed by surficial processes in the form of landslides, stream erosion, and alluvial fans. The retreat of the ice sheet also blocked the flow of the westward flowing Winooski River. This allowed for a series of proglacial lakes (Glacial Lake Winooski, Glacial Lake Mansfield, Glacial Lake Vermont) to develop, and for sediments to be deposited in these valleys in a lacustrine environment (Larsen, 1987).

Field Methods:

The main objective of this project was to map the distribution of surficial materials in the Joiner Brook valley and adjacent parts of the Winooski River valley. The geologic mapping of this area was conducted during July and August of 2017. Field observations were recorded using the Fulcrum Mapping Application. The surficial geology was observed and mapped at approximately 800 field locations. Geologic contacts between different surficial materials were drawn on the surficial geologic map using a combination of field observations and LIDAR imagery. Bedrock outcrops represented on the map are the digitized version of the mapping done by Thompson and Thompson (1992) and were downloaded through the Vermont Open Geodata Portal. Upland areas that were not surveyed were presumed to be composed primarily of glacial till.

The Geologic Map:

The Laurentide ice sheet retreated from higher elevation regions surrounding Joiner Brook prior to retreating west of Bolton. However, an arm of the ice sheet remained within the Joiner Brook valley preventing the flow of the brook. This damming of Joiner Brook created a high elevation proglacial lake which is evidenced by lacustrine and gravel sediments seen at about 1,300 feet on both the western and eastern sides of the modern-day channel of Joiner Brook (Geologic Map, Fig. 3).

As the ice sheet was retreating across the Bolton area about 13,900 years ago, gravel was deposited in and at the mouth of subglacial tunnels. These esker deposits occur as gravel deposits in the Winooski River valley (Fig. 1). These deposits were later buried under Lacustrine sediments as the mouth of the esker moved and the state of the lake calmed. These sediments have since been heavily excavated and sourced for construction material.

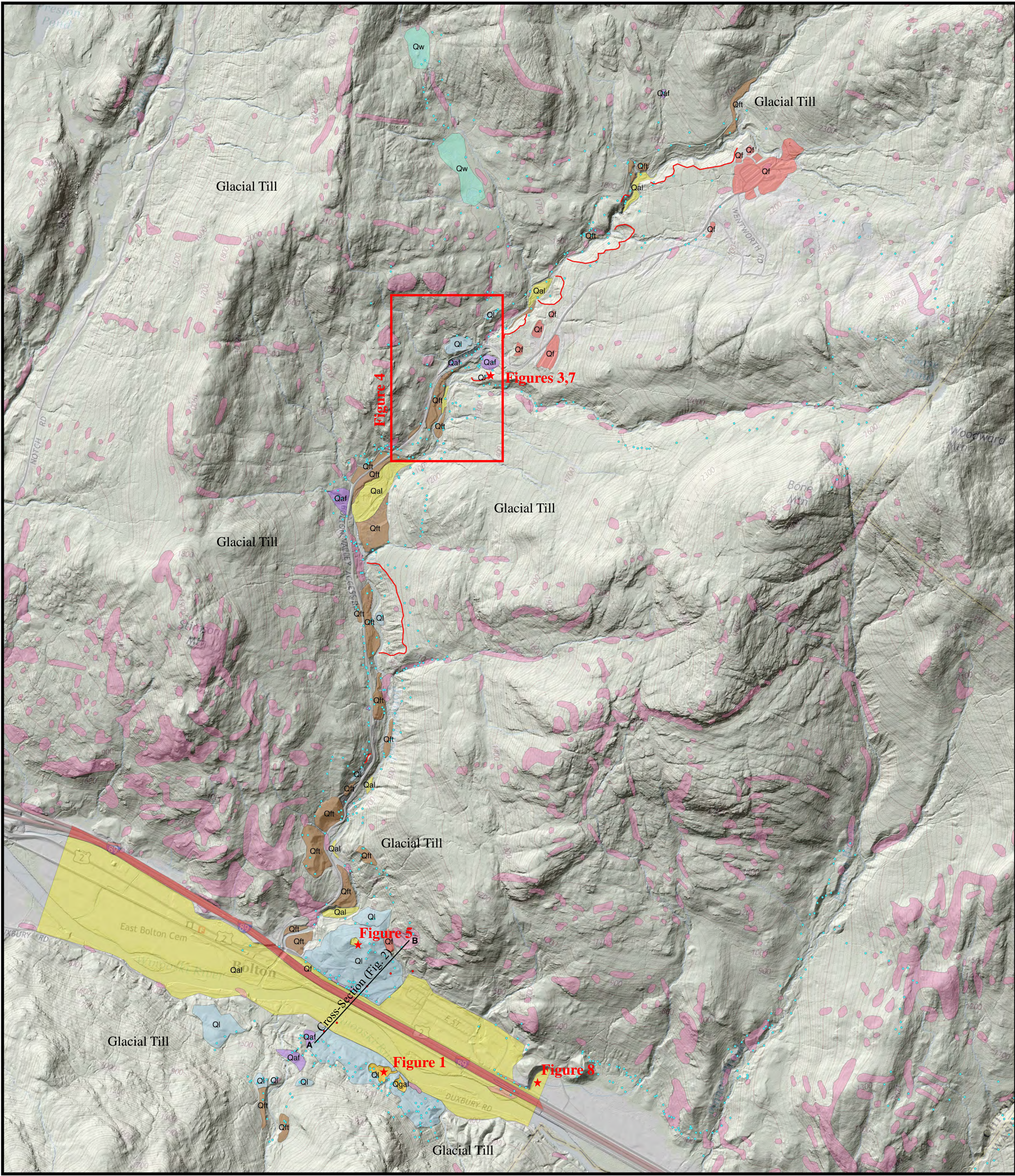
Lacustrine sediments, deposited within the glacial lakes that followed the retreat of the ice sheet, were seen throughout the Winooski River valley (Geologic Cross-Section). These finer sand, silt, and clay deposits were generally found at elevations of less than 600 ft. In some cases, these sediments overlie esker gravel deposits (Fig. 1) and in many places are themselves overlain by modern-day alluvium deposited by the Winooski River (Fig. 5). Lacustrine sediments within the Joiner Brook valley are rare. It is likely lacustrine sediments from Glacial Lake Winooski and the subsequent glacial lakes that occupied the Winooski Valley were once found within Joiner Brook valley. However, today they are difficult to find due to their erosion by Joiner Brook and the deposition of modern-day alluvium on top of the remnants of these lacustrine sediments.

Fluvial terraces found above the current stream channel of Joiner Brook are the result of the brook eroding sediments left behind after the retreat of the ice sheet. The retreat of the ice sheet and the drainage of the subsequent proglacial lakes, left the Winooski River and Joiner Brook valleys partially filled with glacial till and lacustrine sediments (gravel, sand, silt, and clay) (Geologic Map). Over the last several thousand years, Joiner Brook has meandered across the landscape, transporting and depositing this glacial till and lacustrine sediment. As Joiner Brook continued to cut down through the landscape, these sediments were left behind on fluvial terraces above the modern-day stream channel.

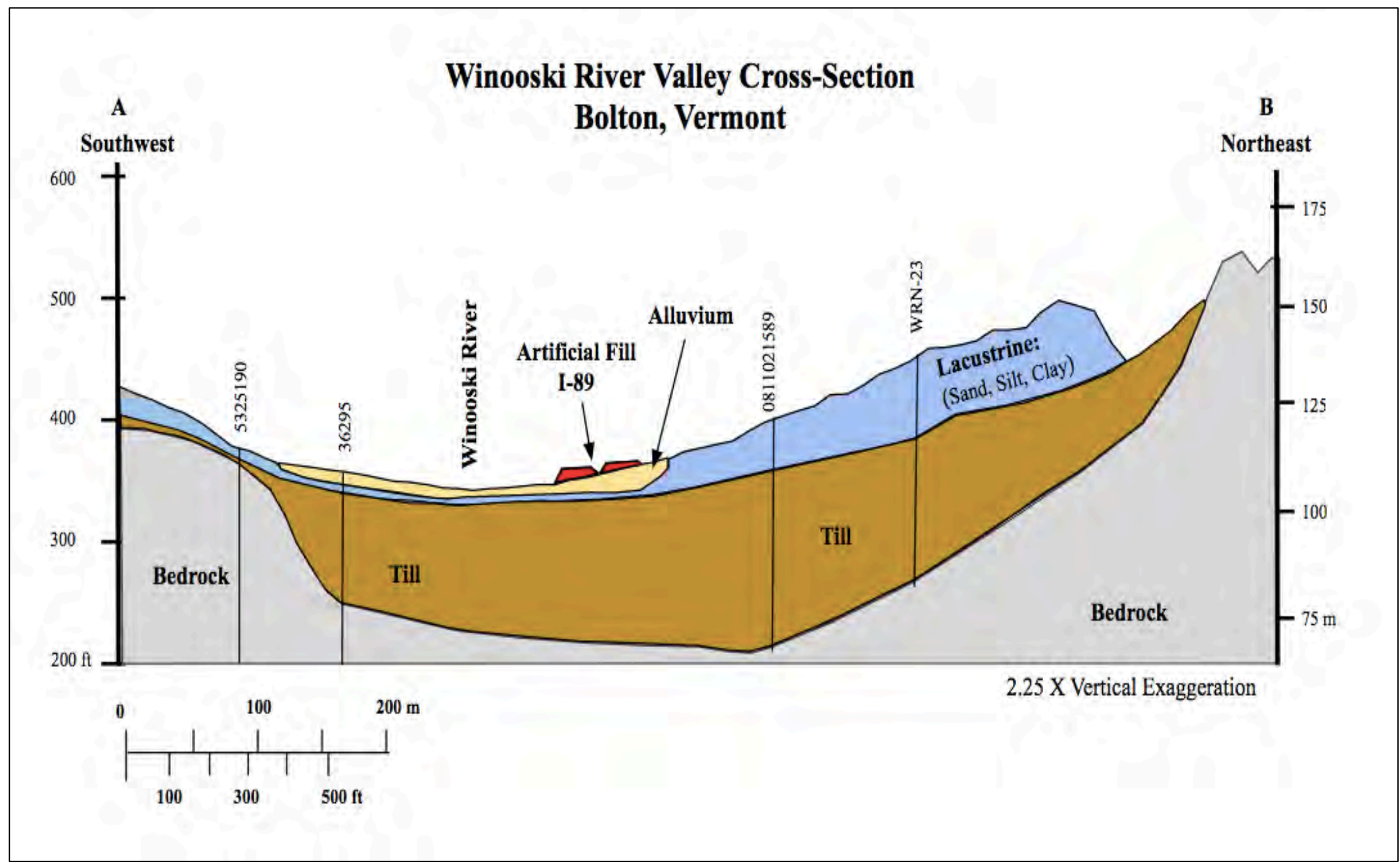
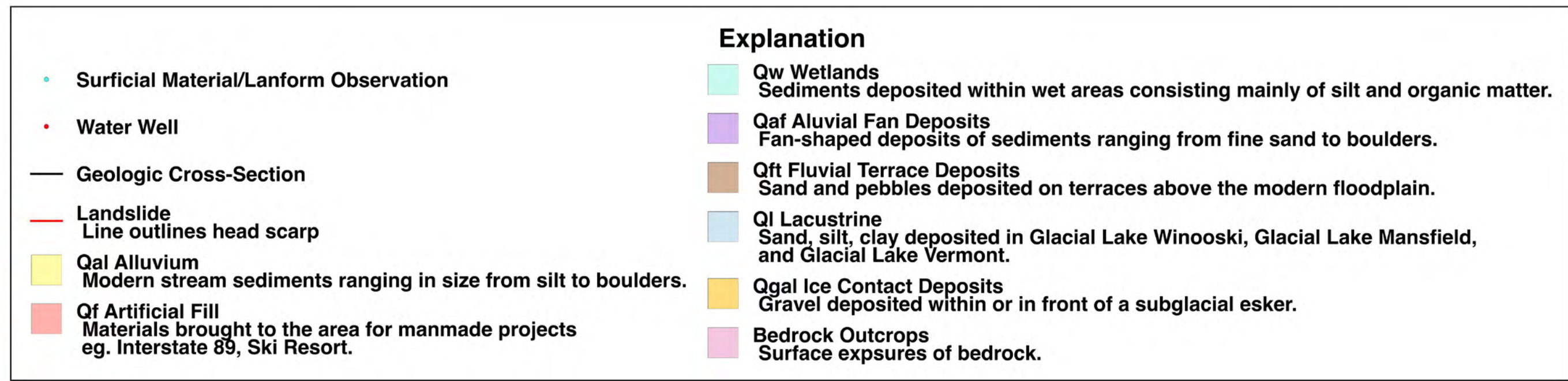
The most modern surficial features observed were landslides (Fig. 7) caused by the undercutting of banks along Joiner Brook and alluvial floodplains (Fig. 8) created alongside the modern channel of the Winooski River (Geologic Map). Joiner Brook and additional Winooski River tributaries carry these sediments into the Winooski River where they are deposited onto these floodplains during high water events.



Figure 1: Ice contact deposits and lacustrine sediments from a gravel pit in the Winooski River valley at an elevation of 450 ft. (A) The contact between a gravel layer overlain by a layer of very fine sand and clay. The coarser layer may have been deposited by an esker depositing sediment into a glacial lake. As the ice retreated the esker deposited coarse sediments elsewhere allowing the finer silt and sand particles to be deposited. (B) A closer view of the deformed silt and very fine sand layers. These layers may have undergone slumping causing them to become disturbed. Several dropstones (small pebbles) are present.



Surficial Geologic Map, Bolton, Vermont



Cross-section of the Winooski River Valley in Bolton, VT.

Figure 2: Geologic cross-section across the Winooski River valley. Cross-section AB transects a variety of surficial materials, including bedrock, glacial till. Lacustrine sediments, modern alluvium, and artificial fill. Subsurface information was gathered from groundwater well logs from four private wells located near the cross-section. The depth to bedrock information in this well data was deemed accurate. However, the accuracy of the intermediate materials was questionable. These layers were determined by utilizing field observations of surficial materials.

Note:

1. Bedrock valley bottom is well below modern river level.
2. Bedrock is overlain by thick sections of till and lacustrine sediments.
3. Veneer of modern alluvium exists adjacent to the Winooski River
4. Well logs do not indicate any esker sediments.

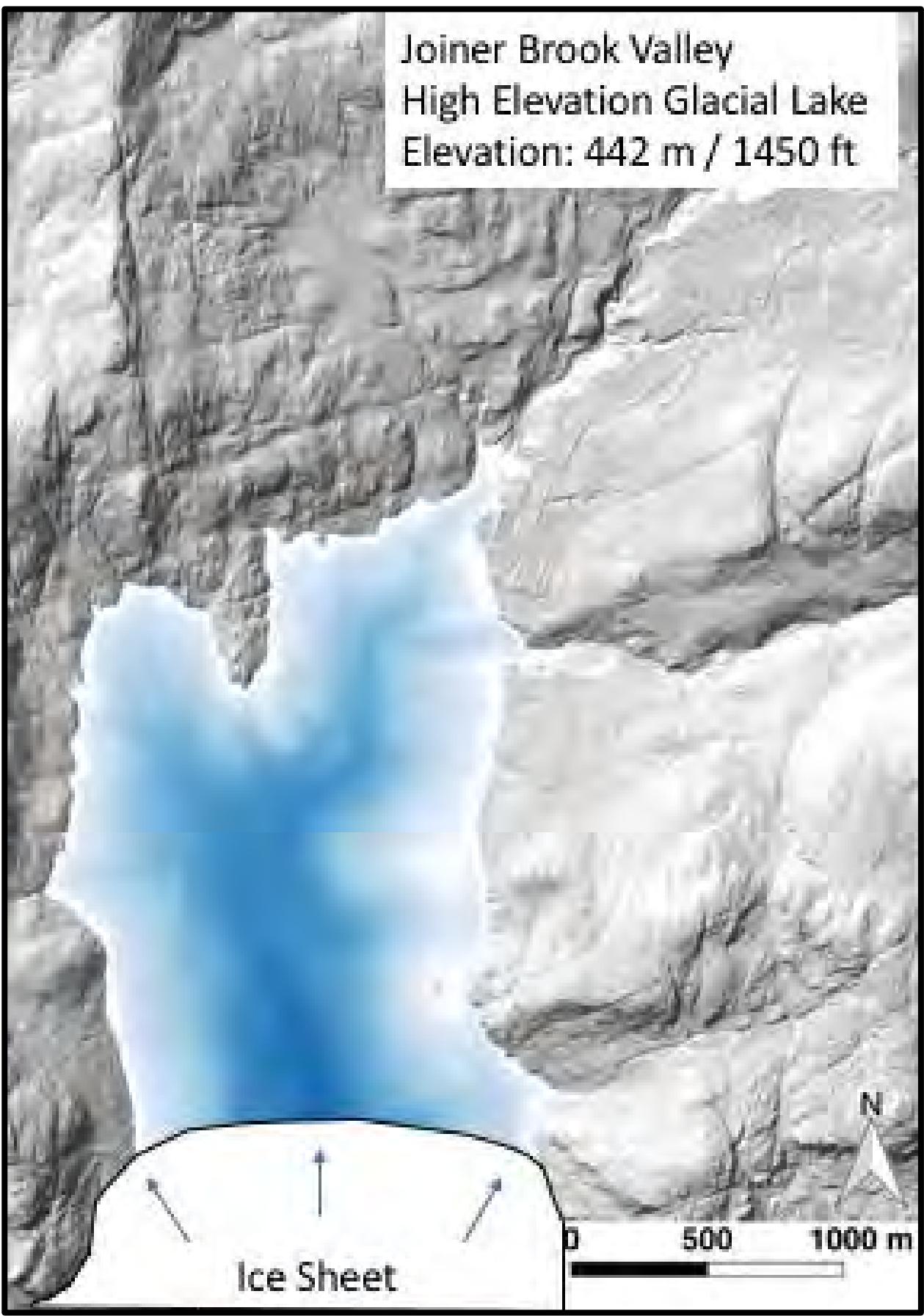


Figure 3: Layered lacustrine sediments exposed in a landslide at about 1300 ft. elevation (Fig. 7).

Figure 4: Prior to completely retreating west of Bolton, the Laurentide ice sheet retreated from higher elevation regions surrounding Joiner Brook. As it did so, an arm of the ice sheet remained within the Joiner Brook valley damming Joiner Brook. This created a high elevation proglacial lake which is evidenced by lacustrine (sand and silt) deposits and gravel deposits seen at about 1,300 feet on both the western and eastern sides of the modern-day channel of Joiner Brook (Geologic Map). The sand and silt observed in this area was layered (Fig. 3). It is likely these layers were created during seasonal changes. The sand was deposited during warmer months and the silt was deposited during colder months when the small proglacial lake became ice covered.

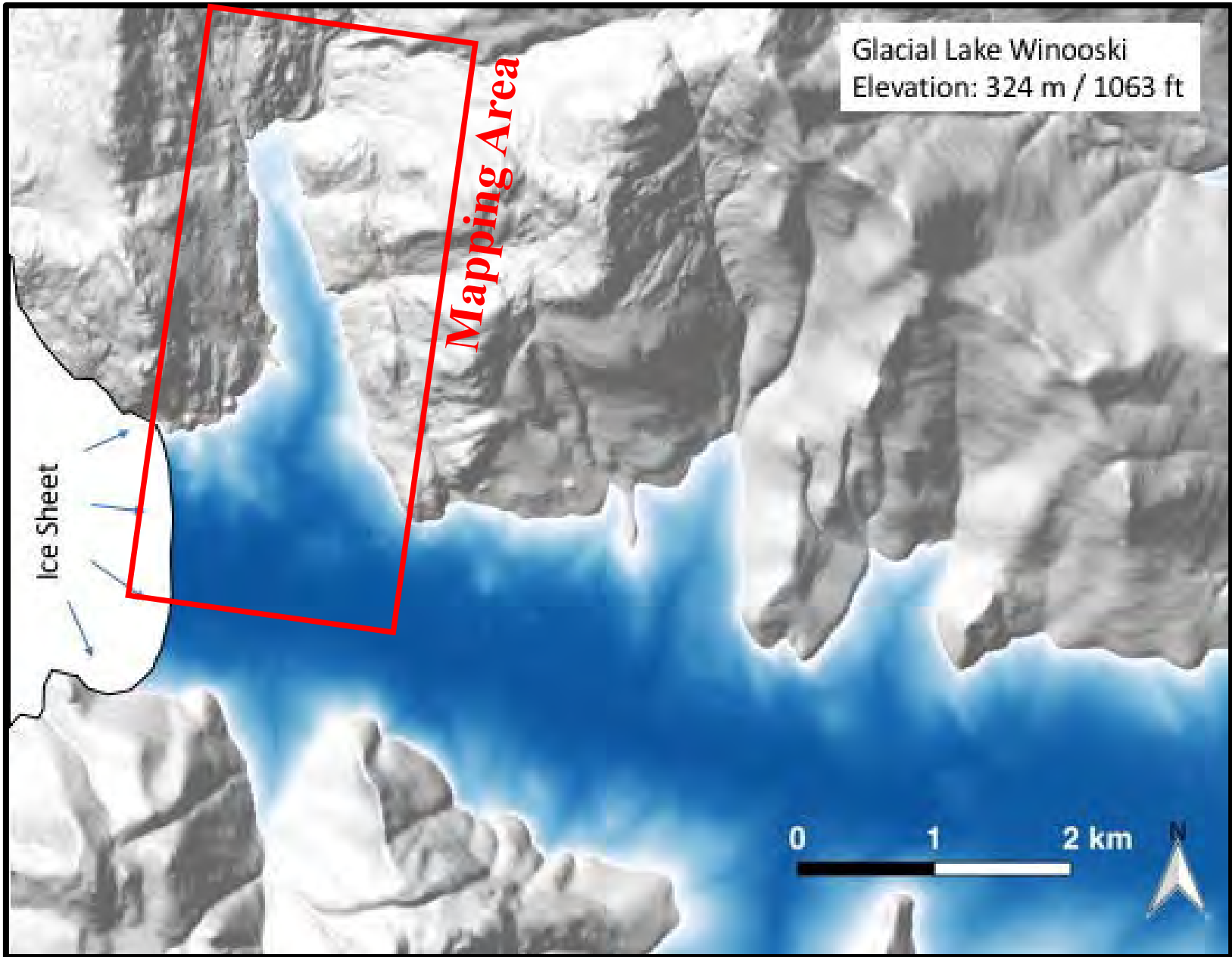


Figure 5: Glacial Lake Winooski lacustrine sediments overlain by coarser alluvial sediments at about 600 ft. elevation.

Figure 6: As the Laurentian Ice Sheet retreated west of Bolton, the westward flow of the Winooski River and meltwater was dammed by the ice sheet causing water to backup and form a lake. Several iterations of proglacial lakes existed in the Winooski River valley as the ice sheet retreated northwest and the outflows of these lakes changed (Larsen, 1987). The first of a series of proglacial lakes to exist in this area was Glacial Lake Winooski. Glacial Lake Winooski resided in the region for at least 312 years (Larsen et al., 2003). Lacustrine sediments were found throughout the Winooski River valley, generally at elevations below 600 ft. In the areas closest to the current Winooski River channel these sediments are overlain by modern alluvium (Fig. 5).



Figure 7: Head scarp of a recent landslide at about 1330 ft. elevation.



Figure 8: Winooski River Alluvial Floodplain.

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