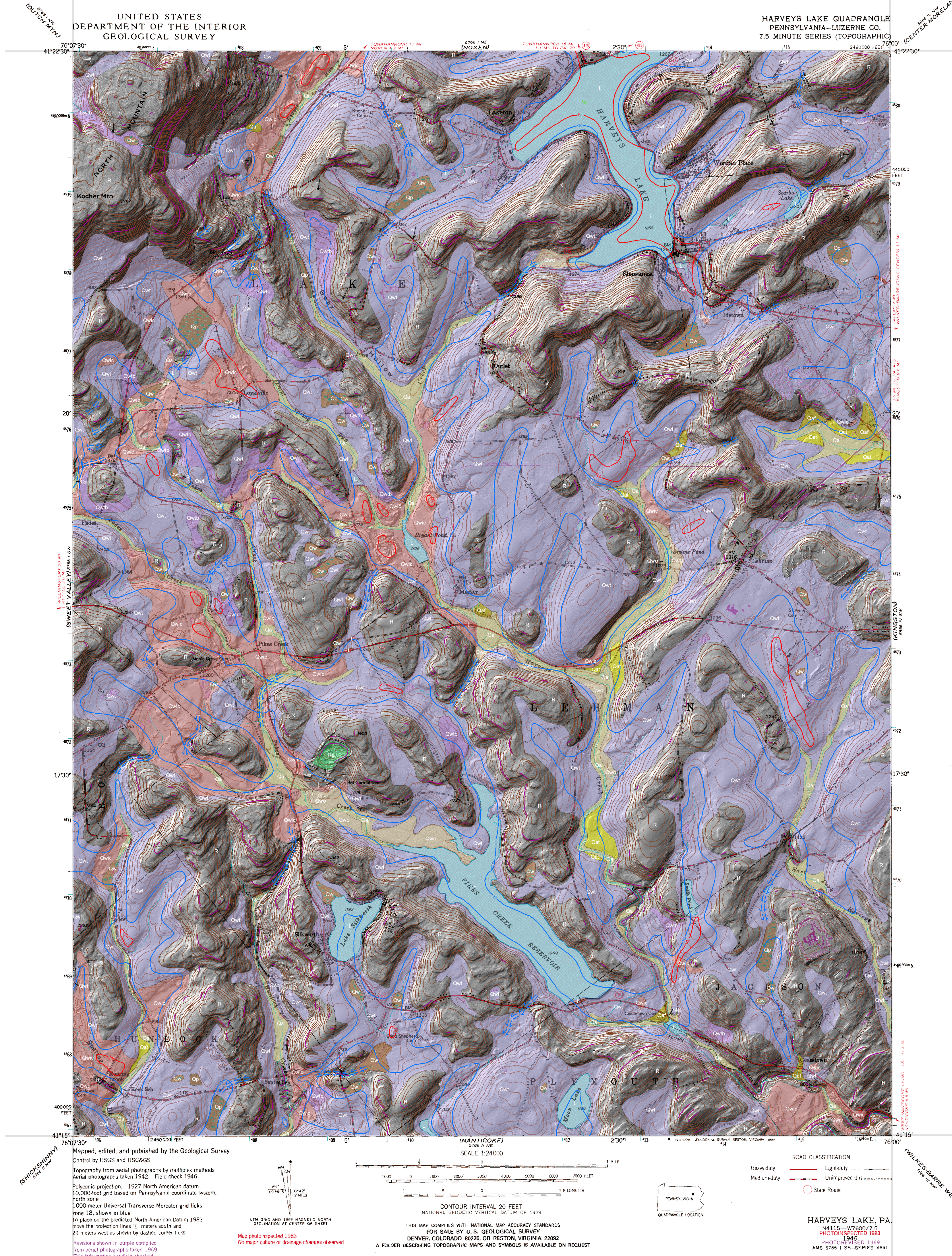


Open File Report OFSM 07-08.0

Description of Map Units

f — **Fill**
Rock fragments and/or soil material; typically in road, railroad, or dam embankments; up to several tens of feet thick.

Rp — **Rock Quarry Pit**
Quarry pits typically have steep to vertical sides and are tens of feet deep. Active pits produce aggregate for construction activity.

U — **Urban Land**
Cut and fill disturbing more than 50 percent of the ground surface; includes most areas with homes on one-half acre or smaller lots, commercial sites, and industrial sites.

L — **Lake**

Qa — **Alluvium**
Stratified silt, sand, and gravel, with some boulders; subrounded to rounded clasts; contains localized lenses of silty or sandy clay; more bouldery in upstream reaches, usually is underlain by other unconsolidated material (glacial deposits); 6 feet (2 meters) thick in headward tributary valleys, 10 feet (3 meters) or more thick in Harveys Creek and Pikes Creek valleys.

Qat — **Alluvial Terrace**
Stratified silt, sand, and gravel with some boulders; subrounded to rounded clasts; the deposits form benches running parallel to and a few feet above the present floodplain; usually is underlain by other unconsolidated material (glacial deposits); 6 feet (2 meters) or more thick. Mapped only in the Harveys Creek valley.

Qaf — **Alluvial Fan**
Stratified silt, sand, and gravel, with some boulders; subrounded to rounded clasts; having a fan-shaped landform; usually is underlain by other unconsolidated material (glacial deposits); 6 feet (2 meters) or more thick. Some fans have a series of levels with younger, lower, less steeply sloped segments inset in older, higher, steeper segments.

Qp — **Peat Bog**
Wetland underlain by peat, thickness variable, usually less than 6 feet (2 meters) thick in localized upland sites and up to 30 feet (10 meters) thick in valley floor settings; usually is underlain by other unconsolidated material (glacial deposits).

Qw — **Wetland**
Area with standing water for part of each year; usually underlain by peat, clay, silt, sand, or some combination of those materials beneath which is other unconsolidated material (glacial deposits); thickness of peat usually less than 1.5 feet (0.5 meter), overall thickness of unconsolidated material is usually greater than 6 feet (2 meters).

Qwo — **Wisconsinan Outwash**
Stratified sand and gravel that forms terraces along the flanks of Harveys, Hunlock, and Pikes Creek valleys. The overall stratification is horizontal with individual strata showing cross-beds, ripples, clast-imbrication, and/or cut-fill features. Thickness is 6 (2 meters) to more than 30 feet (10 meters) in places.

Qwic — **Wisconsinan Ice-Conract Stratified Drift**
Stratified sand and gravel with some boulders; often chaotic stratification; some internal slump structures; gently sloping upper surfaces with a few closed depressions; generally not more than 30 feet (10 meters) thick; typically deposited in valley side kames; often underlain by till.

Qwt — **Wisconsinan Till**
Glacial or resedimented till; texturally a diamict, a nonsorted or poorly sorted, unconsolidated deposit that contains a wide range of particle sizes, commonly from clay to cobble- or boulder-size, and rounded and/or angular fragments with a clayey, silty, or sandy matrix depending on the local source bedrock; poor to multimodal sorting; unstratified to crudely stratified with a clast fabric; striated cobble and boulder clasts are common; typically occurs as a fairly smooth landform with a bouldery surface and little distinct constructional (knob and kettle) topography on hillslopes; upper 3 feet (1 meter) is often colluviated, displaying a downslope-oriented fabric; thickness is greater than 6 feet (2 meters), is typically 15 feet (5 meters), and can be greater than 100 feet (30 meters) in buried to partly in-filled valleys. Locally areas mapped as till may have a thickness of less than 6 feet (2 meters) on hilltops or where there are cliff top edges in the till mantled cliff and bench bedrock topography. It is expected that in more than 90 percent of the area mapped as till, the till has a thickness of more than 6 feet (2 meters). Large areas of the mountain slopes are covered by boulder colluvium derived from rock ledges high on the mountain side that extends down over till lower on the slopes. Generally the till is considerably thicker than the boulder colluvium and those areas have been mapped as till.

Qwtb — **Wisconsinan Bouldery Till**
Glacial or resedimented till with a boulder-mantled surface (more than 50 per cent of ground surface boulder-covered); texturally a diamict; poor to multimodal sorting; unstratified to crudely stratified with a clast fabric; striated cobble and boulder clasts are common; typically occurs in the lee of bedrock knobs as a fairly smooth landform but sometimes shows a distinct constructional (knob and kettle) topography on hillslopes; upper 3 feet (1 meter) is often colluviated, displaying a downslope-oriented fabric; thickness is greater than 6 feet (2 meters), is typically 15 feet (5 meters), and can be greater than 100 feet (30 meters) in buried to partly in-filled valleys.

R — **Sandstone and Shale Bedrock**
Bedrock outcrops or clast-rich diamict of glacial, residual and/or colluvial material overlying bedrock of interbedded red and gray sandstone and shale; often forming a cliff and bench topography. The diamict is reddish brown to yellowish brown and has clayey silt to sandy silt matrix. Clasts are typically matrix-supported with lenses of clast-supported material with or without matrix. Tabular clasts generally exhibit a down slope directed orientation within the upper 1.5 to 3 feet (0.5 to 1 meter) of the diamict. On greater than 25 percent slopes, typically less than 3 feet (1 meter) of diamict overlies bedrock. Locally on broad hilltops and benches the diamict is thicker than 6 feet (2 meters).

Symbols

Contours of Total Thickness of Surficial Deposits in Feet (100, 30)
Isochore lines sometimes pass over more than one surficial deposit, indicating total thickness of all deposits encountered.

Striations (2)
Site number above arrow. Location and striation orientation in Table 2, listed by site number. Arrow point marks site location.

Bedrock Ledge Outcrops

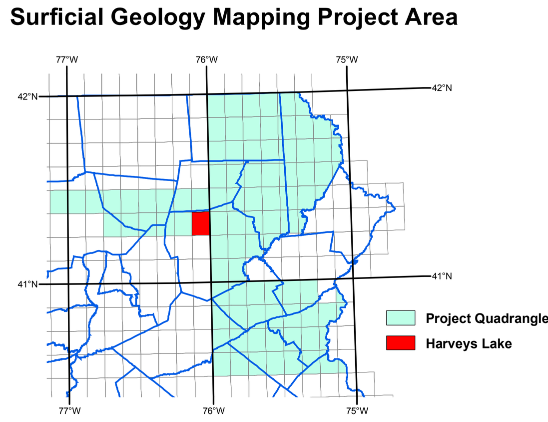
Glacial Meltwater Sluiceway
An abandoned glacial meltwater channel cut into bedrock and/or glacial deposits.

Surficial Geology of the Harveys Lake 7.5-minute Quadrangle Luzerne County, Pennsylvania

Geologic Mapping by
Duane D. Braun, Bloomsburg University, 2007

Digital Map Production by
Thomas G. Whitfield
Bureau of Topographic and Geologic Survey, 2007

Surficial Geology Mapping Project Area



This report has not been reviewed for conformity with the publication standards of the Bureau of Topographic and Geologic Survey.

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Bureau of Topographic and Geologic Survey
and
Bloomsburg University

2007

Old Mapping and New LiDAR........a Reality Check

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Pennsylvania Geological Survey

Digital Mapping Techniques 2007
May 20 - 23, 2007
Columbia, South Carolina

Introduction:

The Commonwealth of Pennsylvania has begun a state-wide mapping program called PAMAP. PAMAP will be a new digital map of Pennsylvania, available as a seamless, consistent, high resolution set of digital, geospatial data products. PAMAP data is being compiled from new, high-resolution aerial orthoimagery, LiDAR elevation data, and existing digital map data developed by state and federal agencies, counties, regional agencies, and municipalities. PAMAP is part of The National Map, a cooperative effort of the USGS and the Commonwealth of Pennsylvania.

Part of the Commonwealth's efforts in this project is to fly high resolution, 1:2400, color orthoimagery on a four year cycle. More recently, LiDAR was added to the over-flight contracts.

As part of the flight program in 2006, several counties were flown for LiDAR as a test. One of the counties, Luzerne, also had an ongoing STATEMAP mapping project. The surficial geology of the Harveys Lake 7.5-minute quadrangle had just been compiled using traditional mapping methods by a very experienced author, Dr. Duane D. Braun, professor of Geology at Bloomsburg University of Pennsylvania.

The Pennsylvania Geological Survey (PAGS) obtained a pre-release version of the Luzerne County LiDAR DEMs. These DEMs have not completed the Q/A process and may have some extraneous errors. We decided to compile and print a hillshade of the Harveys Lake quad and compare it to the surficial geology recently compiled. It had also crossed our minds to compare the hillshade data-set to the bedrock geology, but this quad has only three formations identified, 95% of which is the Catskill Formation (Dck), so the resulting comparison would be rather boring.

In mapping the Harveys Lake quadrangle, Dr. Braun used a variety of sources and methods. Soils maps, aerial photography, previously published and unpublished mapping efforts, and good old fashioned field work were his main sources of data. Combinations of digital and analog methods were used to compile the digital data-sets in ESRI geodatabases. The hillshade data-set was made using ArcGIS by PAGS.

Observations:

The map to the left, is a de-constructed map of surficial geology that is part of the PAGS Open File Series of Surficial Materials (OFSM). This map is still under review and has not been released as of date of this poster. Normally, the surficial geology and supporting Digital Raster Graphic (DRG) files are printed on the map area. For the purposes of this demonstration, we printed the hillshade of the quad on the paper map and then printed the surficial geology and DRG on clear film to act as an overlay. Colors for the mapped Bedrock (R) and Urban (U) areas were dropped from the film overlay to primarily show the glacial deposits and some obvious man-made disturbances.

Our initial comparisons were done on a light table. We plotted the hillshade of the quad on our HP 5500 UV plotter on photopaper. We then laid a clear film plot of the surficial geology on top. The 3-D looking results were stunning. The hilltops literally shot up through the glacial deposits. This poster's attempt to illustrate that 3-D effect is fair to good, but nothing like the backlighting of a light table.

At first glance, Dr. Braun did an excellent job mapping the surficial geology. The last advances of the Wisconsinan ice sheet were from the NNE with glacial striations ranging from S 05°W to S 30°W. Many of the preglacial valleys oriented parallel to ice flow are significantly scoured while valleys oriented perpendicular to ice flow would have the least scour and be the most back-filled, sometimes becoming completely buried. The overall glacial deposit pattern is one of ridges with a thin, discontinuous till mantle rising above valleys partly filled with 30 to more than 100 feet of glacial till. The many lakes, wetlands, and peat bogs are naturally formed by glacial activity, with many of the lakes dammed by piles of glacial till. As the glacial ice retreated to the northwest, drainage channels (sluiceways) from the ice margins opened up through the ridge tops. These sluiceway channels tend to follow the southwesterly curve of the Allegheny Front. Periglacial activity is also observed in the quad including frost-shattering of the bedrock ridges and mobilization of some of the glacial deposits by gelifluction. Modern day deposits of alluvium, alluvial fans and terraces are also influenced by the previous glacial activity.

Looking carefully, the observer can see where the till deposits have run up the valleys. And how the topography influenced how other deposits were placed. In the northeastern corner (Fig. 1) of the quad, one can see just how a meltwater sluiceway sliced through the ridge top. Just to the north and west, the LiDAR hillshade shows another "gap" in a ridge top indicating another possible, but not mapped, sluiceway. Also notice how the bedrock outcrop ridges follow the ridge contours. The rock pit (Rp) quarry in the southwest part of the quad (Fig. 2) is pretty accurately placed, despite the lack of identifiable features on the original topographic map. One can also see some glacial outwash (Qwo) against the ridge on the southwest shore of Harveys Lake (Fig. 3). In the northwestern corner of the quad (Fig. 4), on the eastern slope of Kocher Mountain, multiple level sluiceway benches can be observed descending east into the valley to the floor. A till shadow on the opposite side of the valley remains where the glacier dropped its load on the lee side of the mountain. LiDAR bears each of these examples out.

Conclusions:

Overall, the LiDAR hillshade rendering and the traditional surficial geologic mapping of the Harveys Lake quad indicate that Dr. Braun did an excellent job of mapping the area. In fact, Dr. Braun was given a copy of the data presented here. He said he wished it was available before. The LiDAR hillshade has given him more incite not only to what glacial processes were involved in creating the Harveys Lake geomorphology, but more of the regional processes involved. Dr. Braun is currently analyzing this LiDAR data-set and in all probability, will be making revisions and refinements to this map. If I may quote him, "There are so many things I missed." Fortunately, GIS data is easily revised when an author changes interpretations.

Even in this very limited experiment, LiDAR has proven its worth as another a valuable tool in a geologist's arsenal.

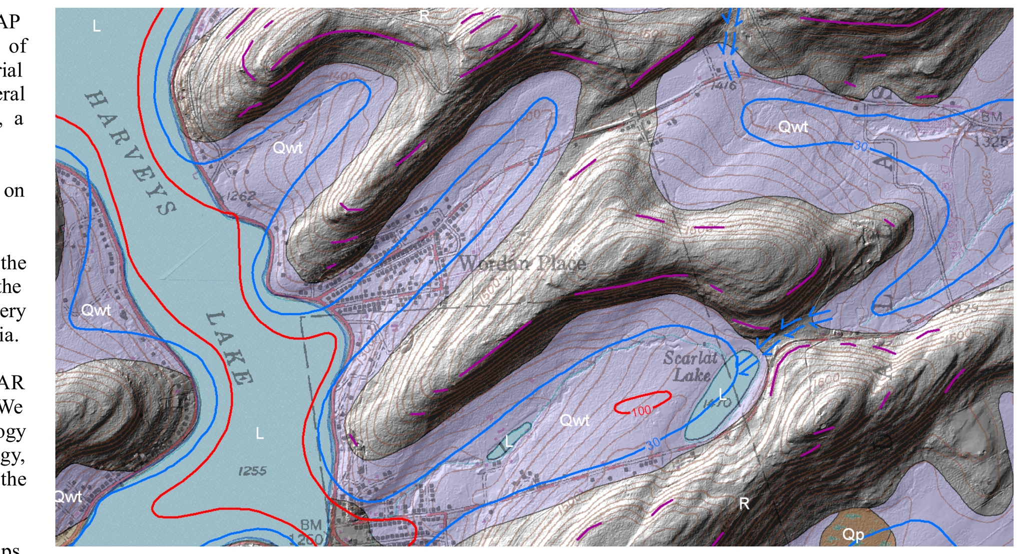

Figure 1 – Just east of Harveys Lake, a glacial meltwater sluiceway slices through a bedrock ridge. To the west and north, a higher elevation gap in the bedrock is exposed that could also be an unmapped, higher elevation sluiceway. Note another sluiceway just north and east.

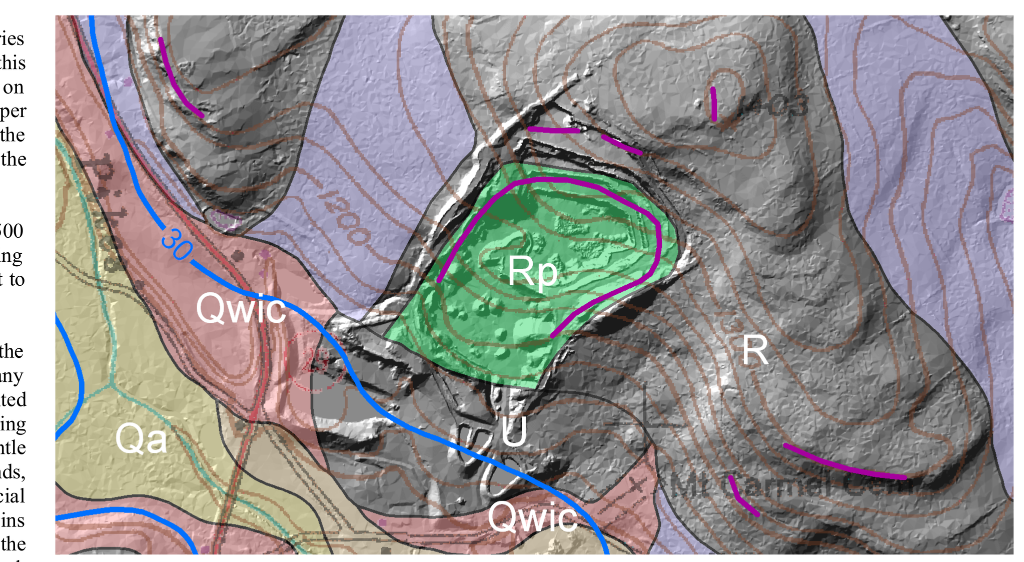

Figure 2 – In the southwest part of the quad is a mapped rock pit (Rp) quarry. It was accurately placed despite the lack of identifiable landmarks on the topographic map. Note the highwall mapped as a bedrock outcrop ledge. Settling ponds and possible associated possessing equipment areas are adjacent (SSW) to the quarry and mapped as Urban lands (U).

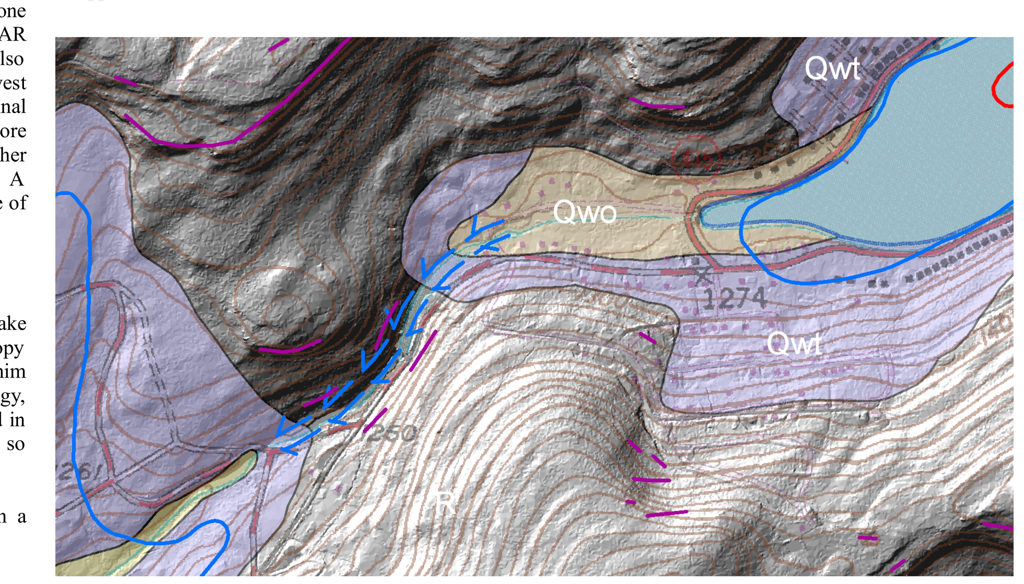

Figure 3 – On a southwestern section of Harveys Lake, glacial water outflow left outwash (Qwo) over till (Qwt) before plunging through the gap into the next valley. Note the absence of till in the gap.

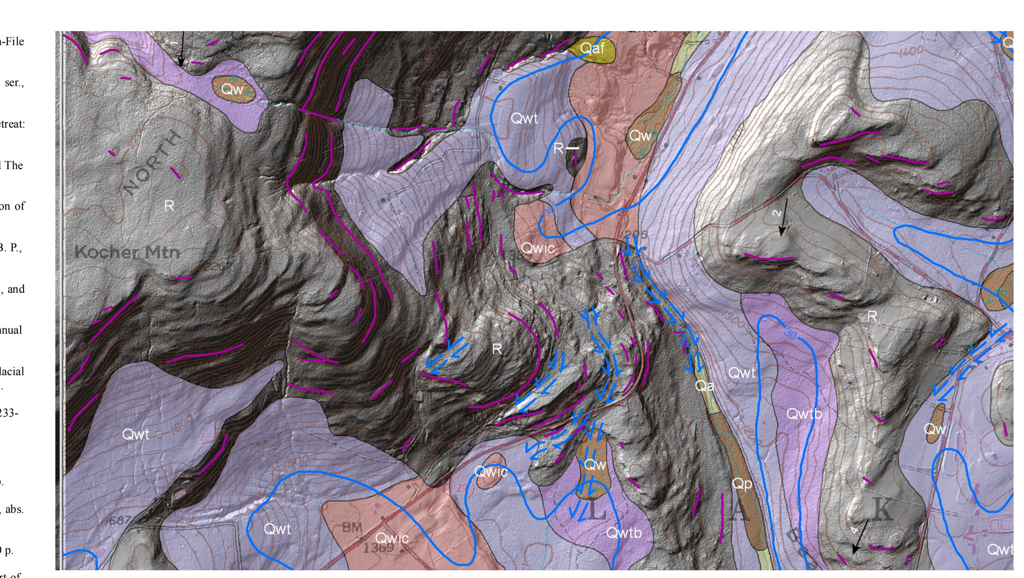

Figure 4 – In the northwest area of the quad, on the eastern slope of Kocher Mountain, there are multiple level sluiceway benches descending east into the valley to the floor. As the glacial meltwater levels decreased, new sluiceway paths was carved into the bedrock. On the opposite side of the valley (east), a till shadow exists. As glacial ice moved SW over the mountain, as indicated by striation station number 2 on top of the mountain, the glacier drops its load on the lee side of the mountain, while scouring the western (opposite) side of the valley. Kocher Mountain also has till shadows on its SSW slope.

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