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# LiDAR Surface Topography of McHenry County, Illinois

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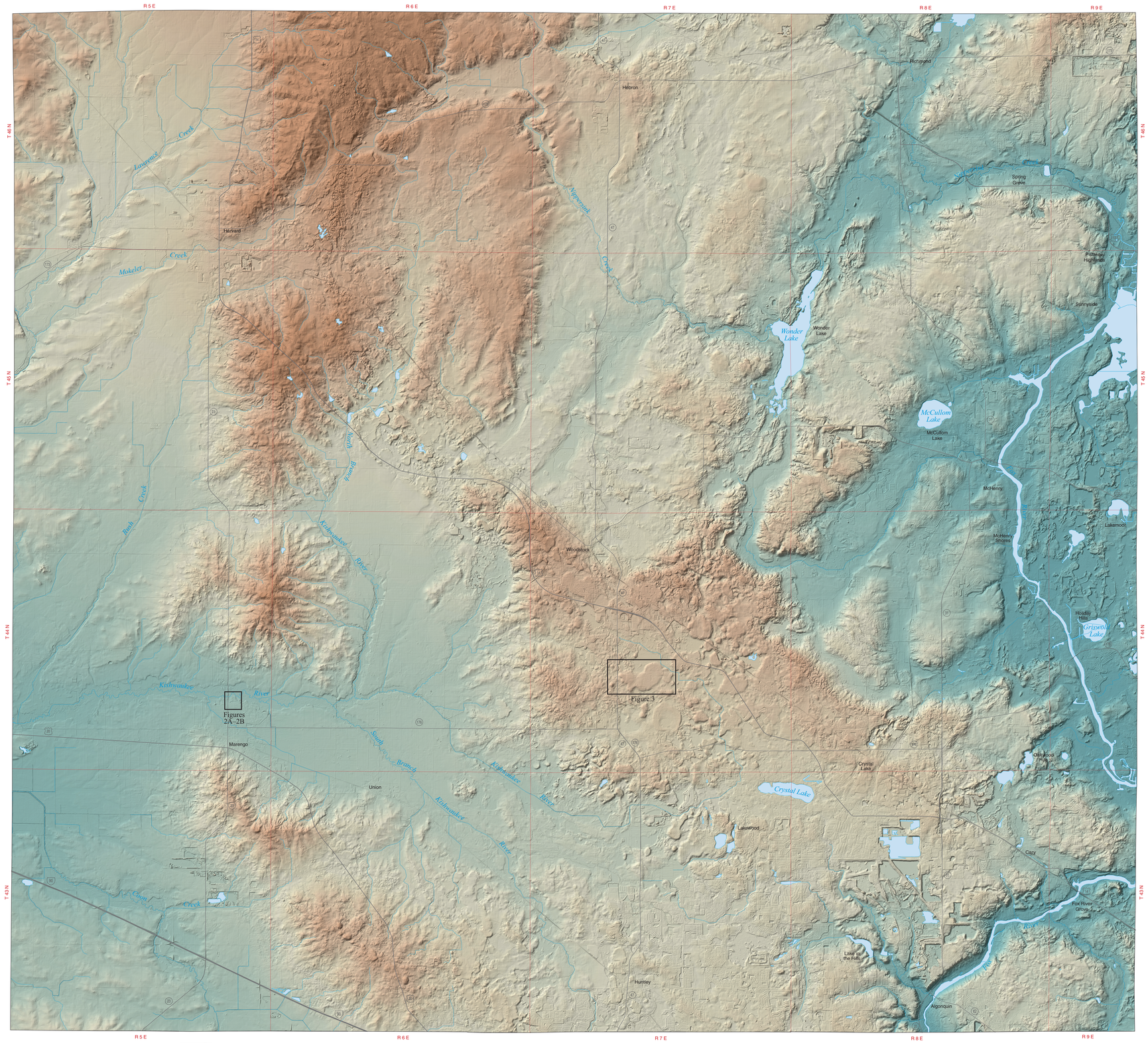
2014

Illinois County Geologic Map
ICGM McHenry-ST




ICGM McHenry-ST



## LiDAR Elevation Data

This surface topography map was created from enhanced elevation data acquired using airborne LiDAR (light detection and ranging) technology. This active remote sensing technique uses a pulsating laser sensor to scan the Earth's surface, and the intended application determines the sensitivity of the laser sensor used for data acquisition. For terrestrial applications such as topographic mapping, the principal wavelength selected for most airborne laser sensors is 1,064 nm, which is within the near-infrared band of the electromagnetic spectrum.

The first object contacted by a laser pulse and reflected back to the sensor is designated as a "first return," which may be a hard target, such as a building rooftop or the ground surface, or a soft target, such as vegetation. When a laser pulse encounters a soft target, e.g., a tree, a portion of the laser beam continues downward and reflects from the underlying branches and trunk, providing additional returns recorded by the laser sensor (Fig. 1). The reflected light pulses are detected by instruments that record the accurate location of each return pulse in three dimensions—(x) and (y) horizontal coordinates and (z) elevation values. The processed returns, which number in the billions for a typical county area, are termed a "point cloud."

A portion of the processed returns represent the ground surface and are referred to as the "bare-earth" point cloud. To maximize the probability of acquiring sufficient ground returns in vegetated terrain, LiDAR is collected in the Midwest during the leaf-off portion of the year when deciduous tree canopies are barren, crops are absent, and most other vegetation types are dormant. However, wherever filtered daylight can pass through vegetated canopy, a portion of the laser pulses reach the surface and produce ground returns.

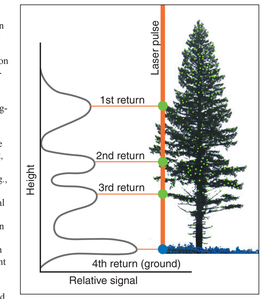



**Figure 1** Simplified illustration of a single laser pulse interacting with a soft target (the tree). A maximum of four returns are possible from each pulse, and current airborne systems can emit more than 150,000 pulses per second. The waveform data collected from the target are processed into a LiDAR point cloud (colored dots), which is used to generate a three-dimensional representation of the target (revised from Mangold and Van Sickle 2008).

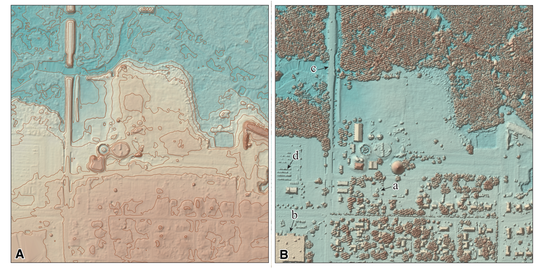



**Figure 2** Figure 2A is a LiDAR digital terrain model (DTM) of a 0.15-square-mile area situated along the Kishwaukee River in western McHenry County (T44N, R5E). A portion of the town of Marengo is at the lower right. A DTM characterizes only the ground surface and results from filtering all aboveground features to produce a "bare-earth" point cloud. In contrast, a digital surface model (DSM) as shown in Figure 2B, portrays all aboveground features. For example, dense woodland cover (a), buildings and other structures (b), a bridge crossing the Kishwaukee River (c), and cars in a parking lot (d), all classified as aboveground features and easily discernible on the DSM, have been removed on the DTM. Contours are shown at 2- and 5-foot intervals. Scale is 1:6,000 (1 in. = 500

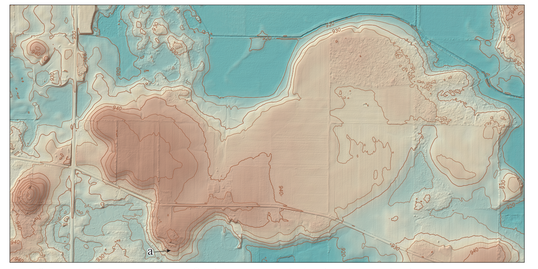



**Figure 3** The surface topography of McHenry County has largely resulted from the action of continental glaciers and glacial meltwaters. The prominent feature shown on this DTM (T44N, R7E) is an ice-walled lake plain that formed on the glacier surface approximately 8,300 to 14,400 $^{14}C$ years BP (before present; Curry et al. 2014). Measuring approximately 1.25 × 0.6 square miles, this particular ice-walled lake plain exhibits a noticeable raised outer rim (a) that stands 25 feet above the surrounding land surface. Although ice-walled lake plains are subtle landforms when viewed at the ground level, LiDAR DTMs have shown them to be a conspicuous landscape feature in McHenry County, and many other such features can be seen on the main map. Contour interval is 5 feet. Scale is 1:12,000 (1 in. = 1,000 ft).

The bare-earth point cloud, comprising only ground returns, was processed to create a digital terrain model (DTM), which was used to produce the *LiDAR Surface Topography of McHenry County, Illinois*. The extraordinary feature detail contained in LiDAR DTMs is illustrated in the enlargements shown in Figures 2A and 3. In contrast, processing all the returns in the LiDAR point cloud produces a digital surface model (DSM) that characterizes the remaining landscape features for the same area (Fig. 2B). Wooded areas, buildings, and other structures associated with the town of Marengo and the Kishwaukee River lowland are all apparent on the DSM. The returns representing these aboveground features are filtered from the all-returns point cloud to create a DTM. The airborne LiDAR data collected for McHenry County and the surrounding counties (Fig. 4) average at least one return for each square meter of land surface. This point density, coupled with the exceptional vertical accuracy of LiDAR enhanced elevation data, meets the National Standard for Spatial Data Accuracy for the creation of 2-foot contours (Fig. 2A).

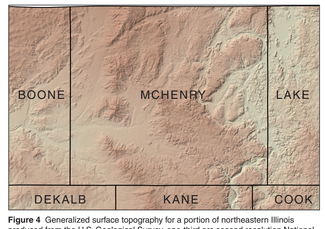



**Figure 4** Generalized surface topography for a portion of northeastern Illinois produced from the U.S. Geological Survey, one-third arc second resolution National Elevation Dataset (U.S. Geological Survey 2014).

## References

Curry, B., E. Hajic, K. Befus, J. Clark, J. Carrell, and S. Brown, 2014, The Kankakee Torrent and other large meltwater flooding events during the last deglaciation, Illinois, USA: Quaternary Science Reviews, v. 90, p. 22–36.

Mangold, R., and J. Van Sickle, 2008, Points of light, *in* Point of beginning, February 1, 2008, http://www.pobonline.com/articles/91662-points-of-light (accessed March 30, 2014).

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Surface Elevation
(feet above mean sea level)

1150
1100
1050
1000
950
900
850
800
750

Road Classification
Interstate Route
U.S. Route
State Route

2008 LiDAR data for McHenry County, Illinois, made available through the U.S. Geological Survey, the McHenry County GIS Department, and the Illinois Height Modernization Program (http://www.isgs.illinois.edu/nsdihome/webdocs/ilhmp/). Universal Transverse Mercator, zone 16. North American Datum of 1983 (NSRS2007), North American Vertical Datum of 1988. Vector base data from 2013 TIGER/Line Shapefiles provided by the United States Census Bureau.

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