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LiDAR Surface Topography of Whiteside County, Illinois

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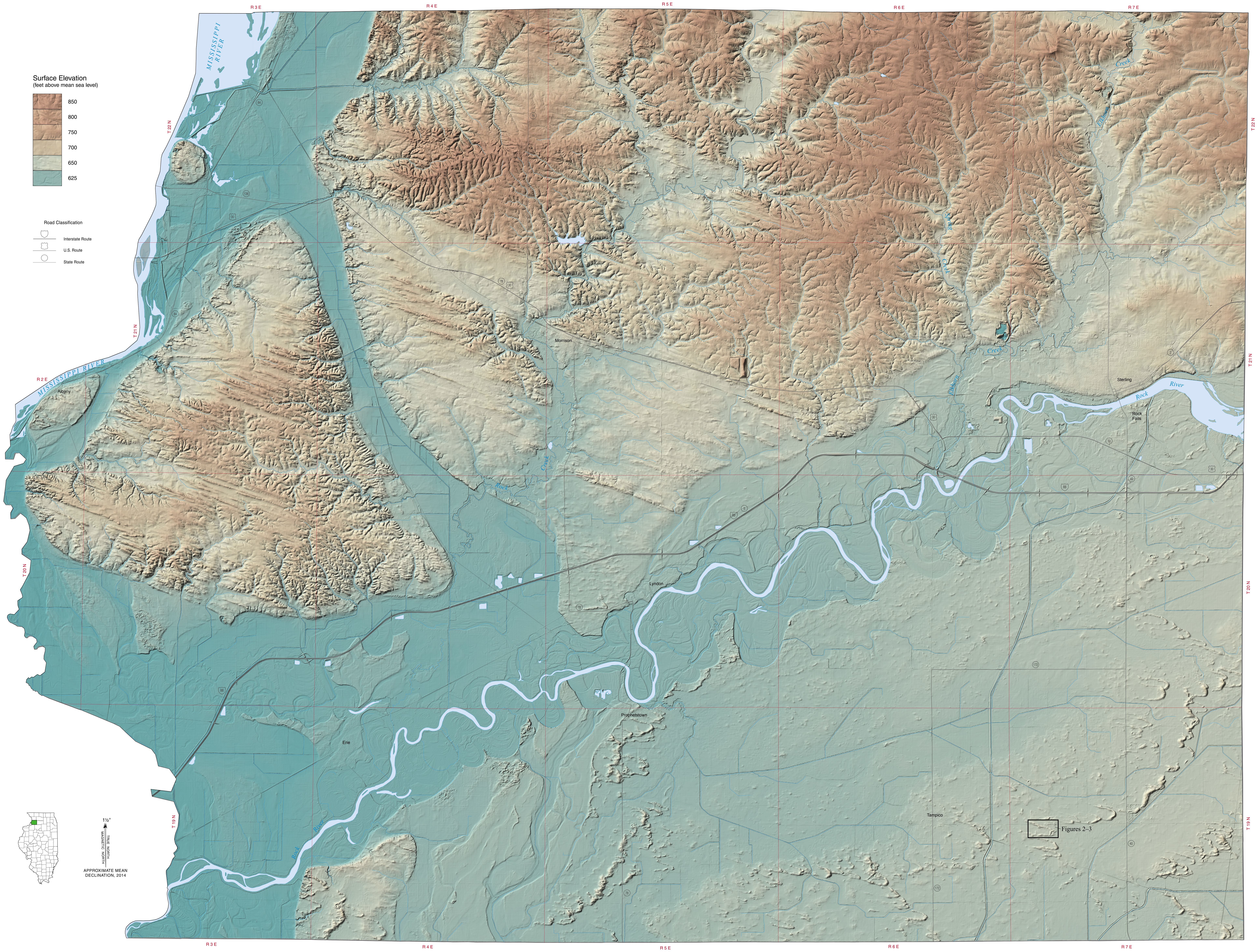
2014

Surface Elevation
(feet above mean sea level)

850
800
750
700
650
625

Road Classification
Interstate Route
U.S. Route
State Route



APPROXIMATE MEAN DECLINATION, 2014

SCALE 1:62,500
1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 KILOMETERS

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.

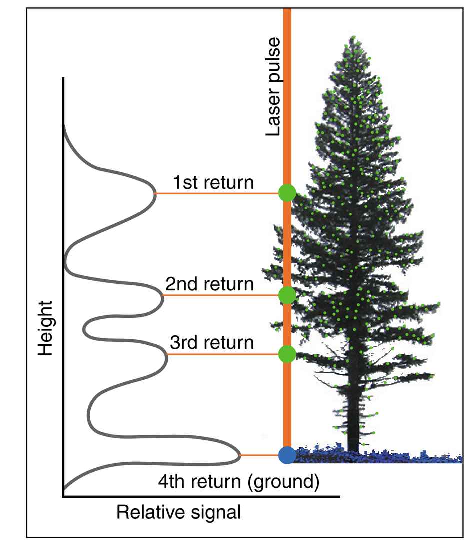


Figure 1 Simplified illustration of a single laser pulse interacting with a soft target (the tree). A maximum of four returns are possible from each pulse, and current airborne systems can emit more than 150,000 pulses per second. The waveform data collected from the target are processed into a LiDAR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

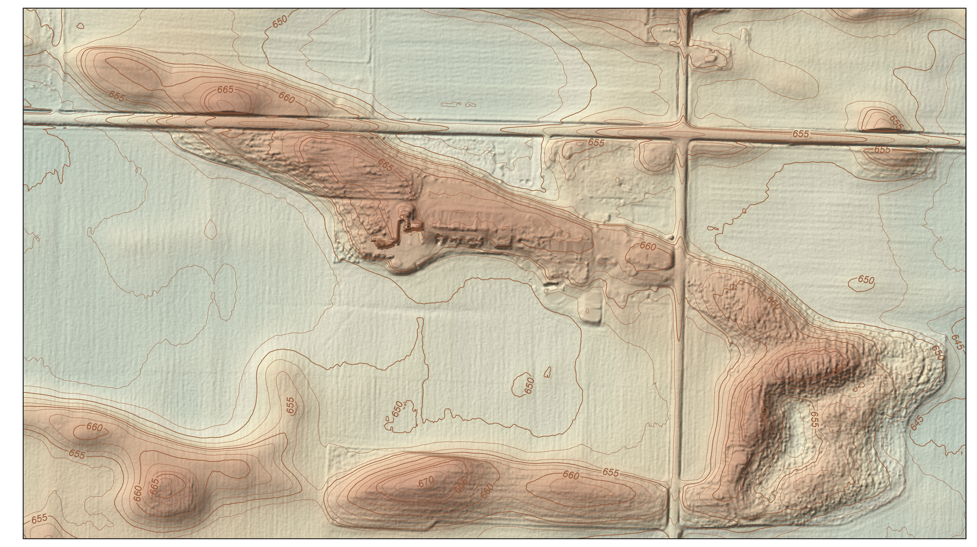


Figure 2 LiDAR digital terrain model (DTM) showing exceptional feature detail of an isolated sand dune measuring 4,500 feet (0.85 mi) in length and standing 23 feet in height above the local terrain (T19N, R7E). A DTM represents only the ground surface and is extracted from airborne LiDAR data using automated filtering methods to produce what is commonly referred to as a "bare-earth" point cloud. Dunes are a prominent landform feature within the Green River Lowland in northwestern Illinois, and several dune fields are present in Whiteside County. Created by wind action, major dune construction in this region occurred approximately 17,000 to 18,000 years ago, and these relict dunes, now stabilized by vegetation cover, exhibit parabolic or compound parabolic forms. Dune orientation indicates that winds from the northwest and west were responsible for dune construction, similar to the current prevailing wind direction in this region (Miao 2009). Contours are shown at 2- and 5-foot intervals. Scale is 1:6,000 (1 in. = 500 ft).

Figure 3 LiDAR-based digital surface model (DSM) of the same dune feature. In contrast to a DTM, which represents only ground features, a DSM portrays all aboveground features. Compare the landscape features observable on the DSM with the features visible on this DTM. For example, note the farmstead structures situated atop the dune at (a) and the farmstead house situated at the base of the dune, surrounded by trees (b). Scale is 1:6,000 (1 in. = 500 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 Whiteside County, Illinois*. The extraordinary feature detail contained in the DTM is illustrated in the 1:6,000-scale enlargement of the parabolic dune feature in Figure 2. 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. 3). Wooded areas, buildings, and other structures associated with the farmsteads that can been seen on Figure 3 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 Whiteside 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. 2).

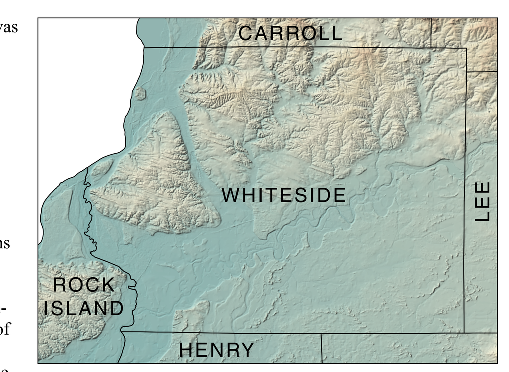


Figure 4 Generalized surface topography for a portion of northwestern Illinois produced from the U.S. Geological Survey, one-third arc second resolution National Elevation Dataset (U.S. Geological Survey 2014).

References

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).

Miao, X., 2009, Distribution of surfical eolian and outwash sand deposits, Bureau County, Illinois: Illinois State Geological Survey, Illinois County Geologic Map, ICGM Bureau County-SS, 1:100,000.

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2009 LiDAR data for Whiteside County, Illinois, made available through 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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