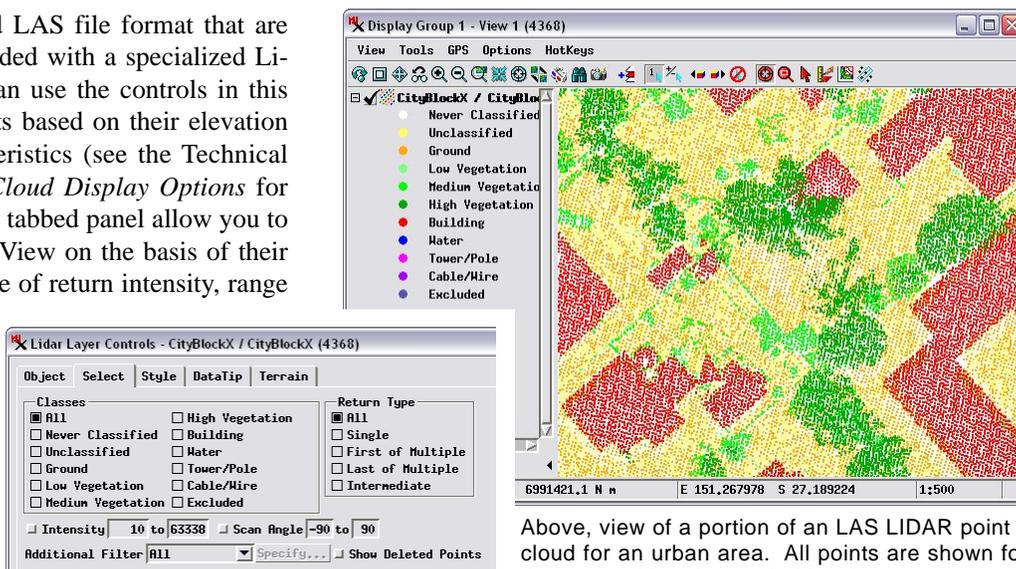


# Select Points by Class, Return Type, Intensity

LIDAR point clouds in the standard LAS file format that are displayed in TNTmips Pro are provided with a specialized Lidar Layer Controls window. You can use the controls in this window to select and style the points based on their elevation or their LIDAR acquisition characteristics (see the Technical Guide entitled *LIDAR: LAS Point Cloud Display Options* for an overview). Controls on the Select tabbed panel allow you to choose which points to show in the View on the basis of their LIDAR point class, return type, range of return intensity, range of scan angle, or any combination of these characteristics.

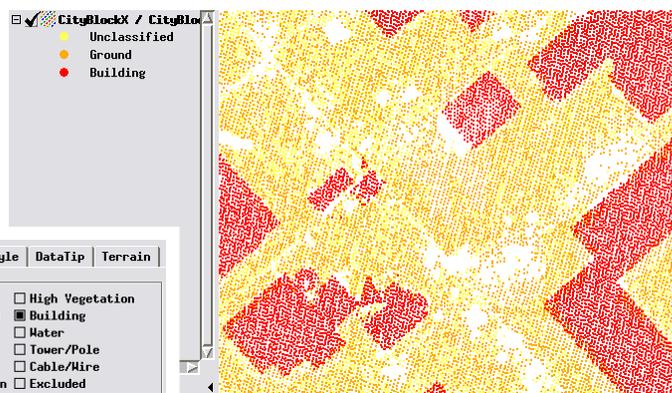
The Select panel on the Lidar Layer Controls window allows you to choose points based on class, return type, return intensity, or scan angle. The illustration to the right shows these controls set to show all points, as in the View to the right.



Above, view of a portion of an LAS LIDAR point cloud for an urban area. All points are shown for the area, with points styled by class.

## Select by Class

LAS points that you display may have been previously classified using automated and/or manual procedures. The LAS format provides for a standard set of material classes, including ground, vegetation (low, medium, and high), building, and so on. When you first use an LAS file in TNTmips, you can also define your own additional material classes by assigning names to unused classes in the LAS structure. The Classes list on the Select tabbed panel of the Lidar Layer Controls shows the standard LAS classes and any additional class names you have specified, each with a toggle button. You can choose to show any individual point class or combination of classes, or toggle on the box for All.



In this view only points in the Unclassified, Ground, and Building classes shown. When points are also styled by class, as in this example, the point legend in LegendView automatically adjusts to show only the classes chosen for display.

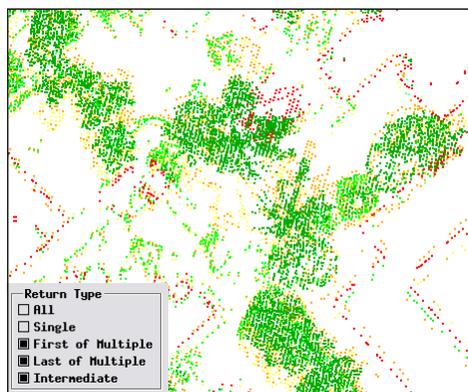
## Select by Return Type

Each LIDAR laser pulse illuminates a finite area that may include objects at various heights above the ground, each of which can yield a return pulse that reaches the sensor at a different

time. LIDAR systems can typically record up to 3 to 5 return pulses per emitted pulse. Each of these return pulses results in a separate 3D point in the point cloud with an associated number of returns and return number.



Single-return points styled by class. Most are returns from hard surfaces (ground and buildings) or from the tops of dense clusters of vegetation.



Multiple-return points (first, last, intermediate) styled by class. These include vegetation points and multiple returns around the edges of buildings.

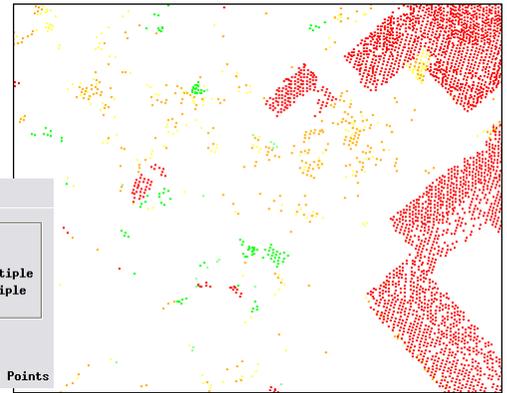
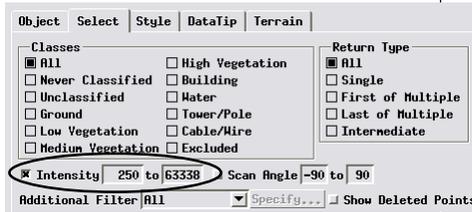
Expansive solid surfaces such as the ground and building roofs typically create single returns. Multiple returns are most often generated by vegetation, where portions of the LIDAR pulse penetrate deeper through gaps in the canopy, reflecting off branches and leaves at various heights, or from the ground. A LIDAR pulse straddling the edge of a building also generates multiple returns. The Return Type toggle buttons allow you to display all returns, single returns, and several categories of multiple returns: first, last, and intermediate.

(over)

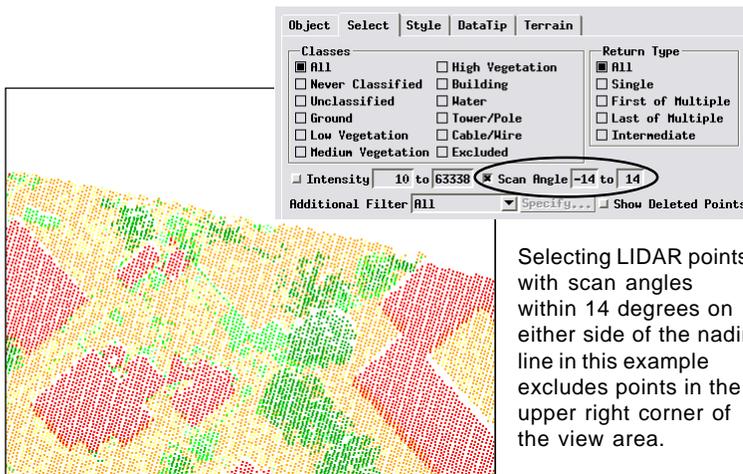
## Select by Intensity

Intensity is the relative strength of the return pulse measured by the LIDAR sensor. Characteristics of the reflecting objects that affect return intensity include the reflectivity of the material at the LIDAR wavelength, how smooth or rough the surface is, and the orientation of the surface relative to the sensor. Highest return intensities are associated with smooth, highly reflective surfaces, such as bright building roofs, that face the sensor (surface perpendicular to the direction of the laser beam). Darker surfaces absorb more of the laser energy while rougher surfaces scatter some of the energy away from the sensor, each resulting in lower return intensities. A smooth reflective surface may nevertheless produce lower intensity returns if it is tilted away from the direction of the incoming light pulse and thus reflects most of the energy away from the sensor.

The numerical values recorded for intensity vary with the acquisition system, and so should be used only in the relative sense. To use return intensity to choose points for display, turn on the Intensity checkbox and set minimum and/or maximum values in the adjacent numeric fields. These fields initially show the actual range of intensity values of the points in the LAS file.



LIDAR points with return intensity values greater than 250, styled by class. The clusters of red points on the right side of the area are smooth, light-colored building roofs that efficiently reflected the laser energy back to the sensor. A scattered set of points classified as ground and low vegetation also fall within this intensity range.



Selecting LIDAR points with scan angles within 14 degrees on either side of the nadir line in this example excludes points in the upper right corner of the view area.

## Select by Scan Angle

Airborne LIDAR systems scan the emitted laser pulses rapidly from side to side perpendicular to the aircraft track. The scan angle is the angle of the laser beam outward from a straight-down direction (0 degrees at nadir), including the roll of the aircraft. Scan angle can theoretically range from -90 degrees to the left of the aircraft to +90 to the right, though in practice points are typically recorded within about 30 degrees on either side of the nadir line. At higher scan angles the shape of the laser beam “footprint” can become highly distorted, reducing accuracy.

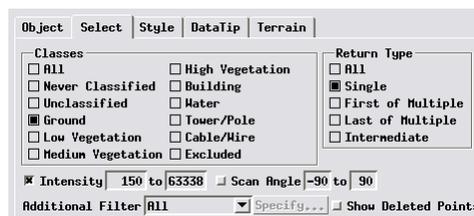
To select points by scan angle, turn on the Scan Angle checkbox and set minimum and maximum scan angle values in the adjacent numerical fields.

## Combine Selection Criteria

The different groups of selection controls on the Select tabbed panel are not mutually exclusive, so you can set selection criteria in multiple categories at the same time, as shown in the illustrations to the right.

## Additional Filter

Using the specific selection controls described above and on the reverse, you can readily select LAS points for display based on their standard LIDAR attributes. The Additional Filter menu at the bottom of the Select tabbed panel (illustrated to the right) presents the general selection options for elements in geometric objects (shape, vector, or CAD): All, By Attribute, By Map Scale, and By Query. These options are most useful for LIDAR point selection if you have assigned additional attributes of your own to the points, in which case you can add your own custom selection criterion to the criteria set using the standard LIDAR selection controls.



LIDAR points selected for display based on multiple criteria: Ground class, single return only, with return intensity greater than 150.



The Additional Filter menu presents general selection options common to all geometric objects.

Spurious LIDAR points are never actually deleted from an LAS file, just marked as “deleted” if they are to be ignored during processing. You can elect to show such points by turning on the Show Deleted Points toggle button.