New York State Museum
Mark Schaming, Director

New York State Geological Survey

BEDROCK TOPOGRAPHY OF CAYUGA COUNTY, NEW YORK

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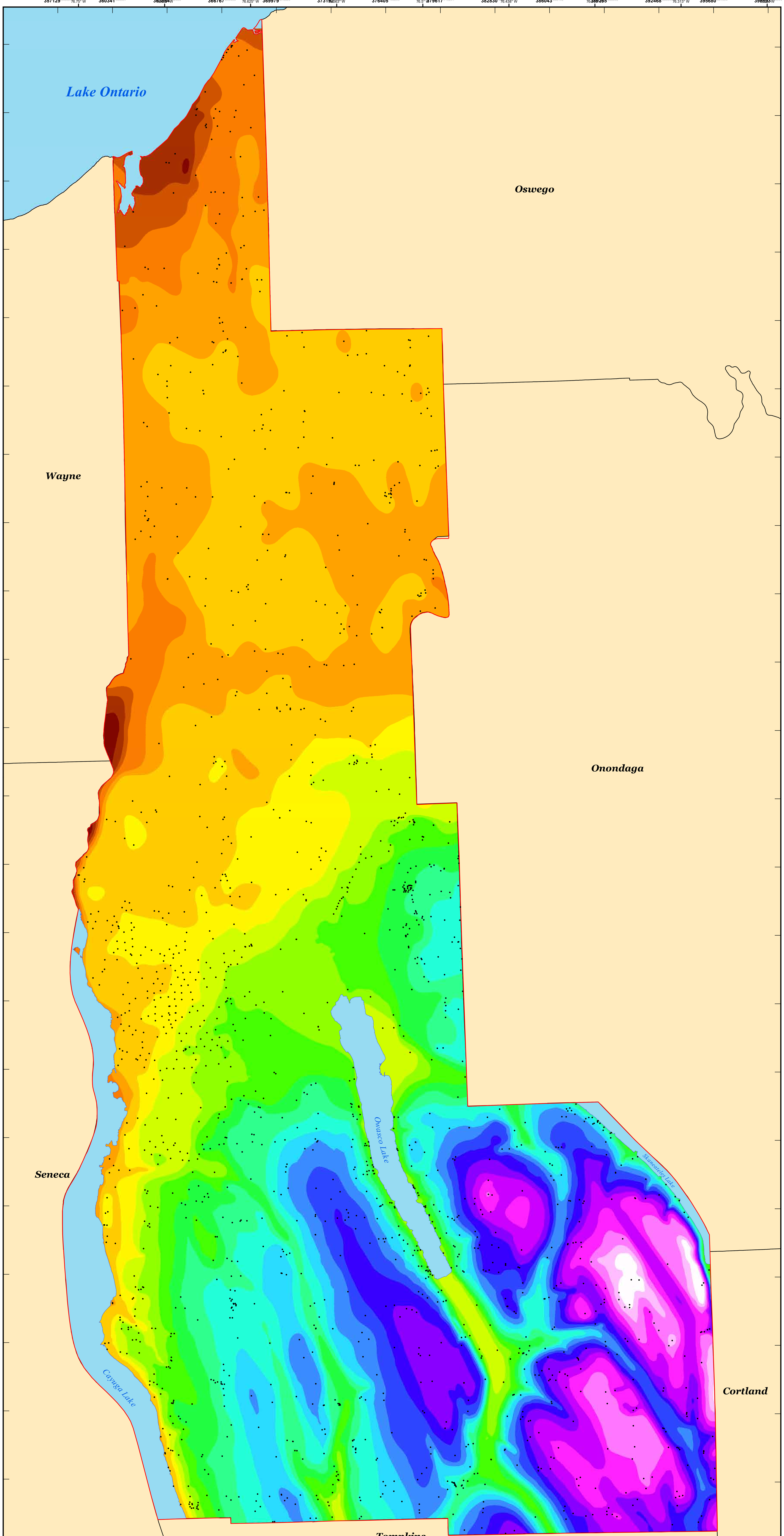
2022



Digital data and cartography, K. Backhaus and B. Bird, 2016-19.

Introduction

Throughout the nine years of geologic mapping in Cayuga County (2010-2019), the end goal was to create a three-dimensional map of the geology of the county. Three-dimensional maps consist of up four maps: Surficial Geology (underlain by elevation data), Bedrock Geology, Bedrock Topography and Drift Thickness. Prior to beginning the geologic mapping of Cayuga County, the geology was relatively unknown aside from the 1:250,000 scale Bedrock and Surficial Geologic maps of New York State (Rickard and Fisher, 1970; Muller and Cadwell, 1986). The geologic mapping that occurred in Cayuga County from 2009-2018 was focused on its surficial geology. This involved determining the extent and character of the surficial geology, or drift within the county. Drift is unconsolidated sediment that was either directly deposited by glacial, fluvial or aeolian processes.

Upon completion of the geologic mapping in 2018, fourteen quadrangles (Map and Chart Series #: 60, 65, 76, 77, 82-86, 88-90, 96-97, and 107), one interpretive publication (Map and Chart Series #105) and the Surficial Geologic Map of Cayuga County (Map and Chart Series #104) were made and published by the New York State Museum/Geological Survey. Work simultaneously began on delineating the bedrock surface to determine the topography of the Paleozoic bedrock, ultimately to determine the drift thickness present within the county (Backhaus, Bird and Kozlowski,2019). Detailed mapping of Cayuga County's bedrock topography may be particularly informative in the discovery and description of freshwater aquifers, as well as more rigorous modeling of contaminant movement through groundwater. It also provides an important context for understanding the natural history of the county and where possible aggregate resources might be located.

Methods

To create the drift thickness map of the county, a total of 1,725 bedrock control points were compiled to delineate the bedrock topographic surface. These points consist of 1,186 water wells, 262 oil and gas wells, 57 engineering boreholes, 18 exploratory boreholes, 93 sampling stops, and 109 known bedrock outcrops. From these points, using their latitude and longitude, the surface elevation was extracted from the 2018 Cayuga/Oswego 1-meter lidar DEM and the depth to bedrock was subtracted. This elevation is the true bedrock surface elevation. These data were entered ESRI's ArcMap 10.6 program and using the "Contours" tool, 50ft contours were generated (see inset map to the bottom right). Using the bedrock surface elevation from each point and knowing the surface elevation in the county, the contours were adjusted manually through a multi-review process to fix any errors created by the tool. The contours, after being adjusted, were then converted into a 10-meter raster using the "Topo to Raster" tool and excluded the Finger Lakes within the county as bedrock depth is unknown, or poorly constrained within the lakes themselves. The raster generated from the contours is then resized to a 1-meter resolution using the "Resampling" tool. This map construction technique is performed to heighten the resolution of the raster and match that of the DEM that it is subtracted from.

Discussion

Upon completion of the Bedrock Topography of Cayuga County map, the bedrock topography was found to range from one hundred to over 1,820 feet in elevation above mean sea level. The lowest elevations were found to be along the shoreline of Lake Ontario in the Town of Sterling and Fairhaven, and also along the shoreline of Cayuga Lake. The highest elevation is around the highlands within the Bear Swamp State Forest Park in Moravia, New York. The finger lake basins are analogous to fjords found in Sweden and Norway and as such these narrow, deep valleys have been infilled with sediments either deposited or eroded by glacial and fluvial processes and freshwater since their formation. The actual bedrock topography beneath the lake is relatively unknown due to the lack of bedrock control points as no water wells, exploratory borings or engineering borings have been completed directly in the basins to bedrock. The bedrock topography within the Owasco Inlet is thought to be deeper than suggested by Mullins and others (1996). In 2022, the New York State Geological Survey completed borehole 2225 at the Town of Moravia Highway Garage and hit bedrock at 125 feet below the surface which also agreed with the prior Drift Thickness Map of Cayuga County (Backhaus, Bird and Kozlowski, 2019). Along with BH2225, boreholes 2219 and 2220 were conducted north of Owasco Lake with bedrock hit 170 and 125 feet below the surface, respectively. BH2220's depth to rock of 125 feet was accurately predicted by Backhaus, Bird and Kozlowski (2019), however BH2219 showed bedrock being considerably deeper than expected.

One area of extremely variable bedrock topography is already known as the Great Gully Buried Valley system to the south and east of the Town of Union Springs (Kozlowski, et. al., 2016; Kozlowski, et. al., 2018). This NNW-SSE trending valley extends through the Great Gully to the Little Salmon Creek valley. With the completion of the map, another fork of the Great Gully Buried Valley system became apparent that has a more northward trend and aligns with the Big Salmon Creek valley in Genoa. The confluence of the Big and Little Salmon Creeks also contains a deep, incised valleys of Devonian age Levanna shales (Rickard and Fisher, 1970). These valleys were likely pre-glacial streams channels that were then exploited by the onset of glacial advances through the area during the Quaternary. The lower elevations of bedrock along Lake Ontario and in the Montezuma National Wildlife Refuge are likely related to the erosion of the Queenston and Camillus Shales by repeated glacial advances, forming the U-shaped fjord that now contains Cayuga Lake.

Lastly, the City of Auburn, Town of Weedsport and Town of Montezuma lie atop the Onondaga Escarpment. This is seen on the map as the transition from yellows to the greens. South of this escarpment there is little to no change due to the resistive nature of the limestone until the clastic rocks of the Ithaca Formation of the Genesee Group to the south and southeast (Rickard and Fisher, 1970). The Owasco Lake valley is the biggest cut into these rock layers aside from Cayuga Lake and the Great Gully Valley System.

Error Analysis

The most problematic error during the creation of the map was caused by the rugged and irregular surface within the county. Common errors were caused by the lack of bedrock control points in many areas of the county, which made correlating the bedrock surface difficult. Key locations needing additional subsurface data include: the finger lake basins, the City of Auburn, state forest lands and areas north of the Montezuma Wetlands Complex. Other errors are associated with the lack of control points, in some areas the bedrock surface that protrudes above the true surface of the county. This error was corrected in most areas, but some regions do not have enough elevation control points. The valley walls of the lake basins largely had this issue as a lack of data density resulting from minimal well control, thus the uncertainty of the bedrock surface/drift thickness is higher in these regions. An additional factor to consider when evaluating potential error within the scope of this product is that the majority of data points originated as water well records. Considering the vast range of interpretations by well drilling companies, there is always the possibility that bedrock was incorrectly interpreted. On numerous occasions, authors on this project have discovered or suspected bedrock as being mis-reported on these logs.

Conclusions

With the rugged and irregular terrain, the many glacial episodes and various bedrock lithologies within the county, the bedrock topography varies greatly near the north and south of each Finger Lake Basin. Aside from these areas, the bedrock topography is similar to a staircase with the treads made up of more resistive rock layers while the risers are comprised of less resistive and rocks that are more prone to weathering. The work completed by the New York State Museum/Geological Survey has created the first high-resolution Bedrock Topography Map for Cayuga County. The areas of higher variation in bedrock topography within the county can now be investigated further to determine the reasoning for their variation and map the bedrock layers throughout the County.

References

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Explanation

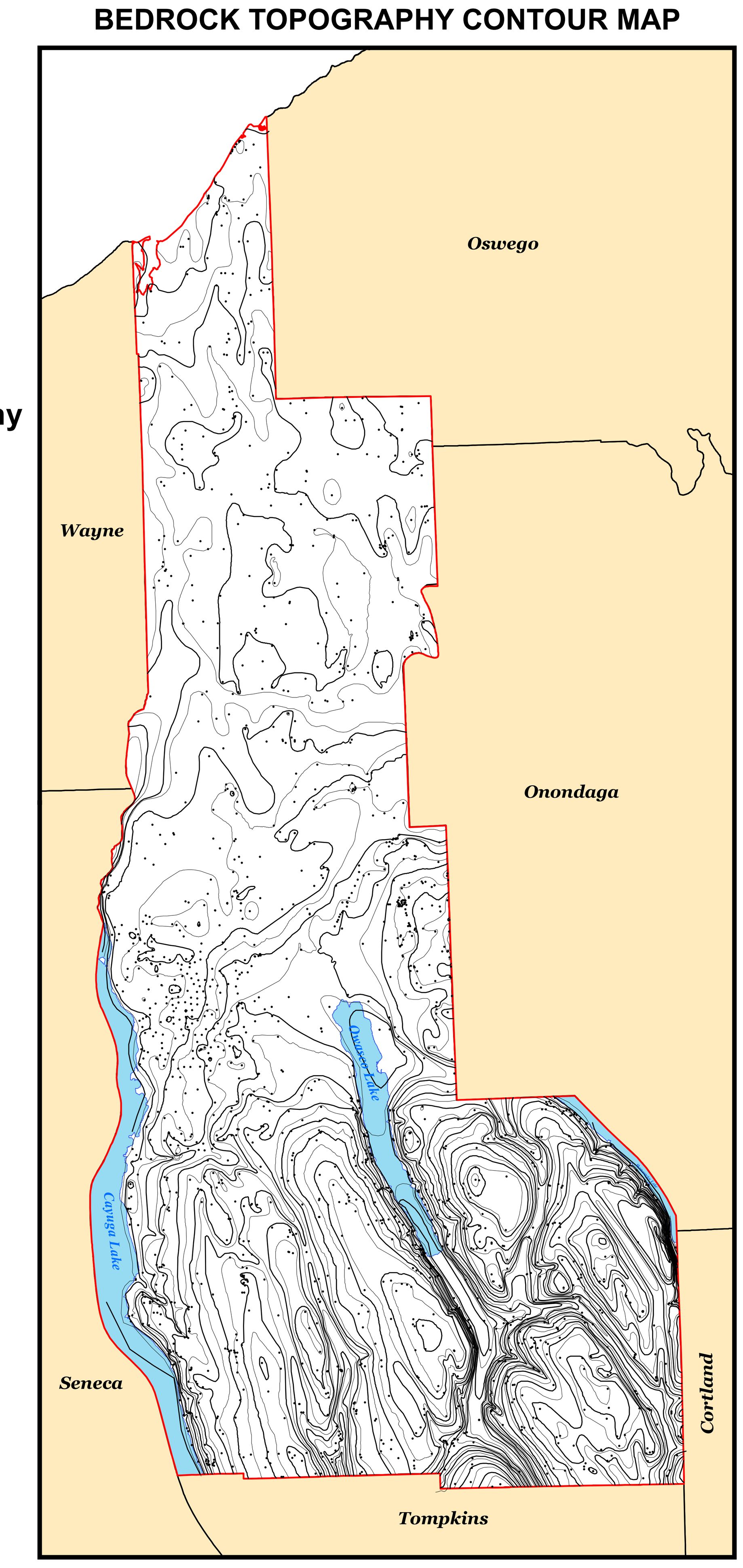
- Reference Points
- 50-foot Contour
- 100-foot Contour
- Water Bodies
- Surrounding Counties
- Cayuga County Line

Bedrock Topography

Feet-amsl

- 100- 140
- 140 - 180
- 180 - 220
- 220 - 300
- 300 - 380
- 380 - 460
- 460 - 540
- 540 - 620
- 620 - 700
- 700 - 780
- 780 - 860
- 860 - 940
- 940 - 1,020
- 1,020 - 1,100
- 1,100 - 1,180
- 1,180 - 1,260
- 1,260 - 1,340
- 1,340 - 1,420
- 1,420 - 1,500
- 1,500 - 1,580
- 1,580 - 1,660
- 1,660 - 1,740
- 1,740 - 1,820

BEDROCK TOPOGRAPHY CONTOUR MAP



Digital Data and Cartography by K. Backhaus, 2019-2022.

Universal Transverse Mercator, Zone 18 N North American Datum of 1983

Geographic and hydrograpghy data
obtained from the NYSGIS Clearinghouse
(https://gis.ny.gov/)

Shaded relief from Cayuga and Oswego Counties 1-meter Lidar data sets by NYSGPO
(http://gis.ny.gov/elevation/index.cfm)

SCALE1:100,000

Kilometers: 0, 2.5, 5, 10, 15, 20
Meters: 0, 10,000, 20,000
Miles: 0, 1.25, 2.5, 5, 7.5, 10
Feet: 0, 6,250, 12,500, 25,000, 37,500, 50,000

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