

Subsidence at the Fairport Harbor Water Level Gauge

NGS, the NSRS, and CO-OPS

NOAA's National Geodetic Survey (NGS) defines and maintains the National Spatial Reference System (NSRS). The NSRS includes a network of permanently marked points; a consistent, accurate, and up-to-date national shoreline; a network of Continuously Operating Reference Stations (CORS) which supports three-dimensional positioning activities; and a set of accurate models describing dynamic, geophysical processes that affect spatial measurements. The NSRS provides the spatial reference foundation for transportation, mapping, charting and a multitude of scientific and engineering applications.

NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) is responsible for monitoring tides and water levels. They maintain a network of water level gauges throughout the Great Lakes and tide gauges on the ocean coast. They are responsible for determining heights associated with the International Great Lakes Datum (IGLD), which they do in cooperation with NGS.

Cleveland Water Level Gauge and GPS CORS



Figure 1

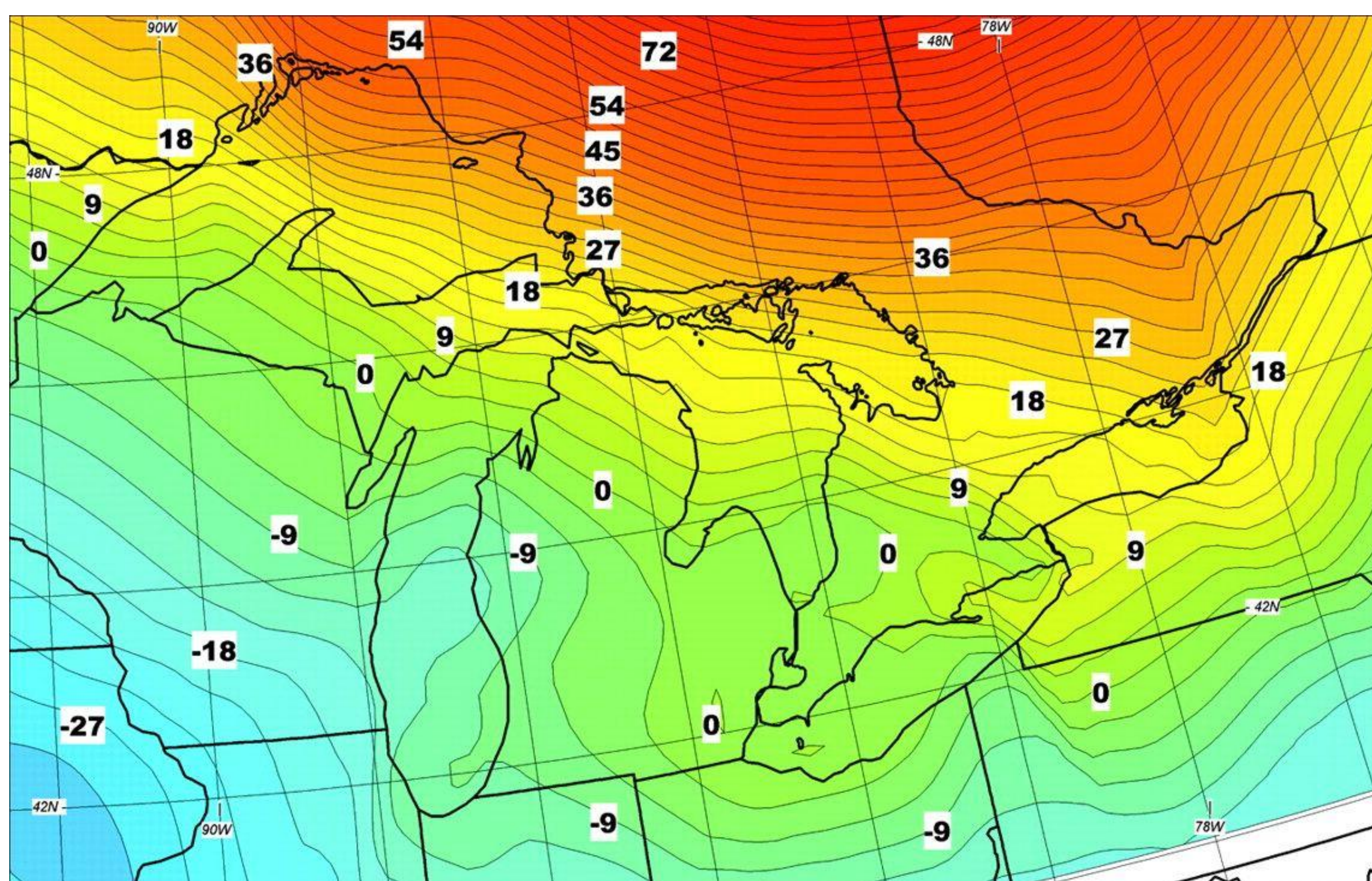
Fundamental elements of geodetic infrastructure include:

- GPS CORS (3-D)
- Water level and tide gauges (height)
- A system of vertical bench marks (height)

When two or more of these elements converge at a water level gauge they may provide an independent determination of position and stability.

International Great Lakes Datum (IGLD)

- The Great Lakes are a vast hydraulic system with water levels and flows influenced by engineered channels and control structures.
- The entire Great Lakes basin is tilting due to glacial isostatic adjustment (GIA, aka post-glacial rebound) caused by melting of glaciers at the end of the last ice age 10,000 years ago (Figure 2).
- The IGLD represents a fixed frame of reference used to measure water levels in the Great Lakes in both the US and Canada. It is revised about every 30 years to remove the effects of GIA
- Establishment of the IGLD is governed by International treaty between the US and Canada.



Source: "Present-day tilting of the Great Lakes Region Based on Water Level Gauges", André Mainville, Michael R. Craymer, 2005

Figure 2 - Vertical Movement due to GIA, derived from water level gauges
Contour interval: 3 cm/century

Subsidence at the Fairport Harbor, OH Water Level Gauge

Analysis of GPS, leveling and water level data reveal that this gauge is subsiding at about 2-3 mm/year, independent of the effects of GIA.



Figure 3



Figure 4

Salt Mining Activity Nearby

A long history of salt mine activity in the area is well known to the ODNR's Division of Geological Survey (OGS), Figures 5 and 6. And it is well known to geologists that salt mining always causes subsidence in the vicinity. But the realization that this activity was taking place so close to a water level gauge came as an unwelcome surprise to scientists.

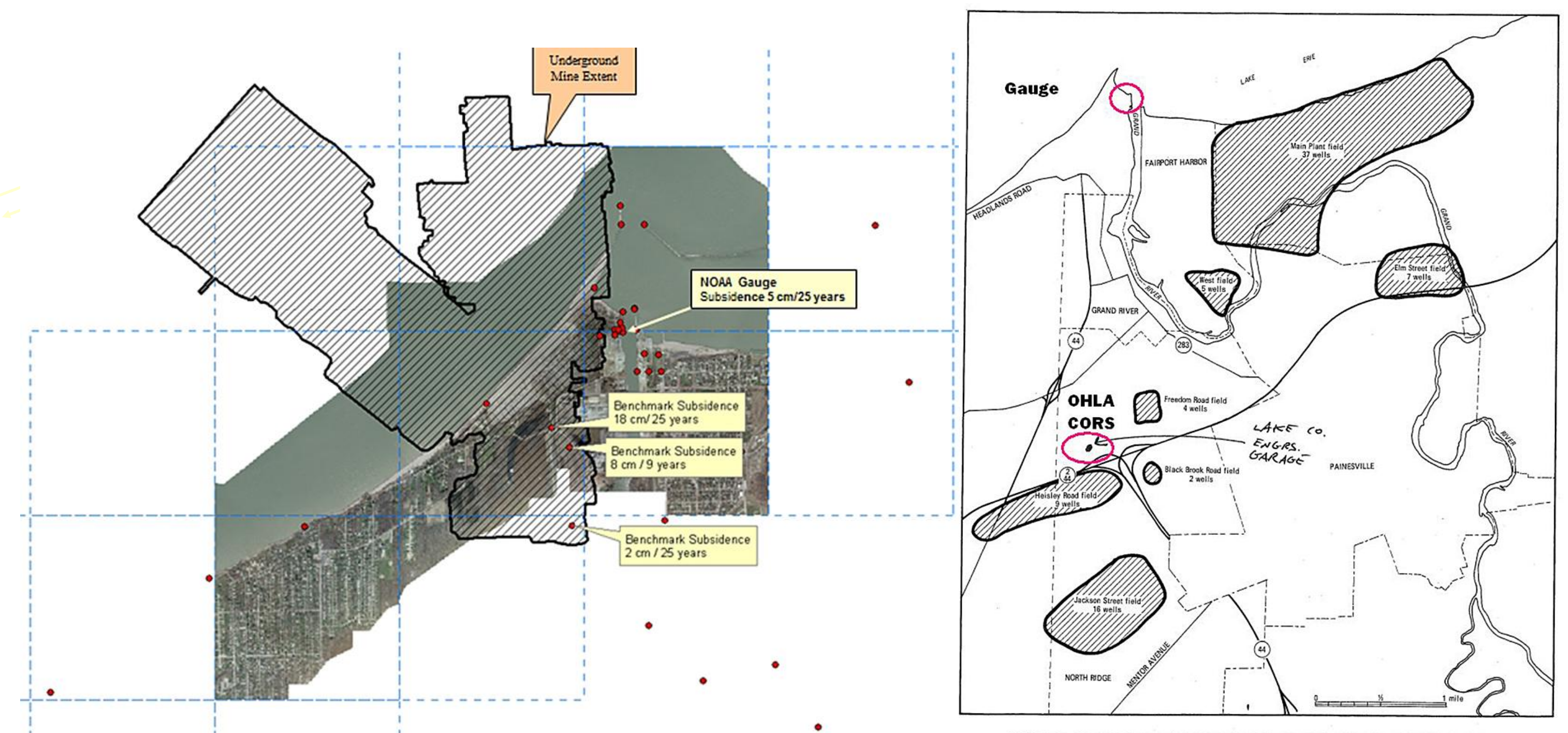


Figure 5

Figure 6

Figure 5 shows the extent of an underground rock salt mine and its relationship to the water level gauge. Nearby brine fields (a type of salt mine) in the vicinity of the gauge are shown in Figure 6. Analysis of data from the nearby OHLA GPS CORS shows it subsiding at about 4 mm/yr, four times faster than expected due to GIA alone.

More Salt Mine Activity

A major salt mine is also located near another NOAA water level gauge at Cleveland (Figure 7). The bed of salt being mined at the two Ohio locations, the Salina Group, extends for hundreds of miles across the region, and there are numerous other locations where it is being mined, with subsequent subsidence. (Figure 8).

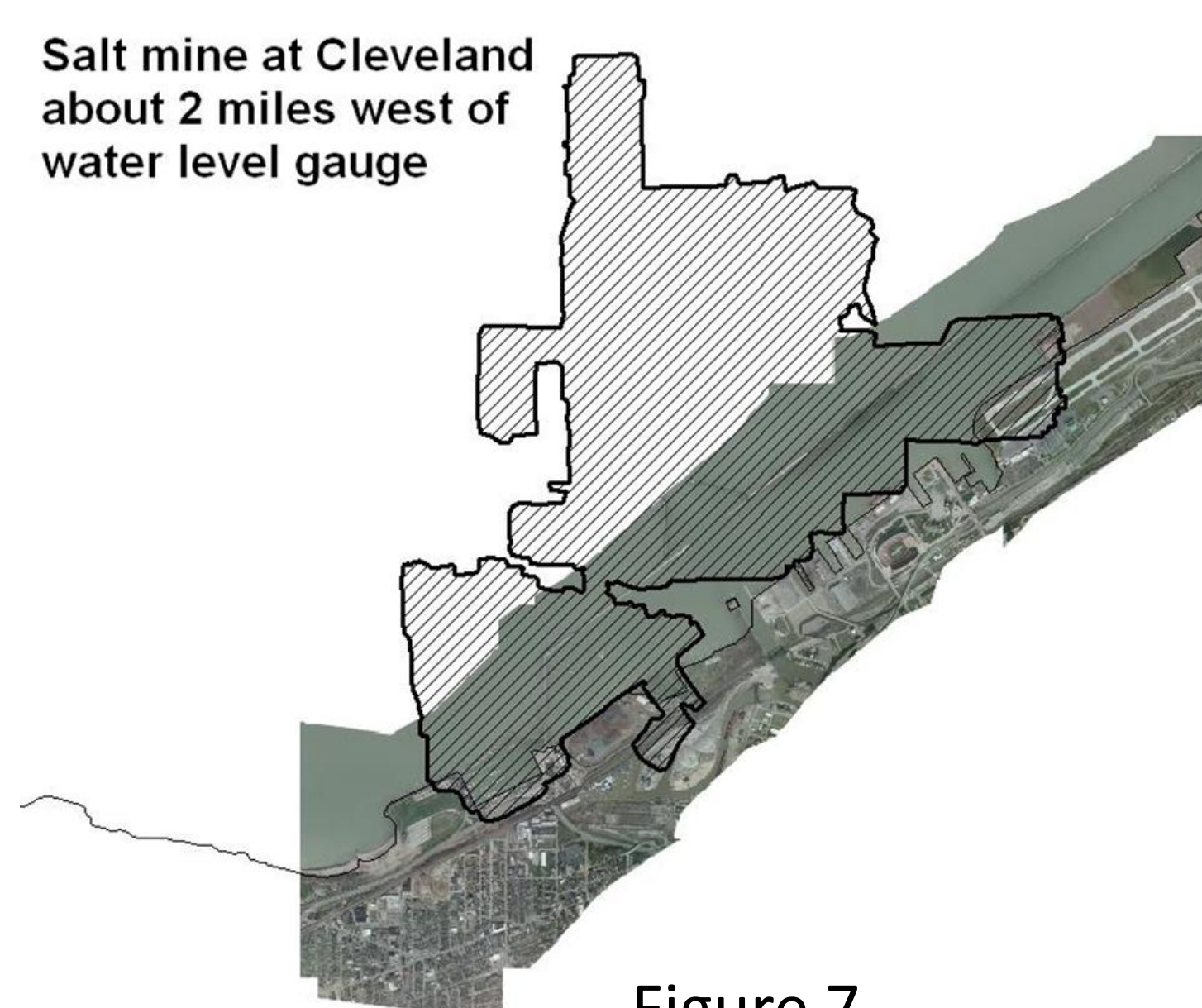


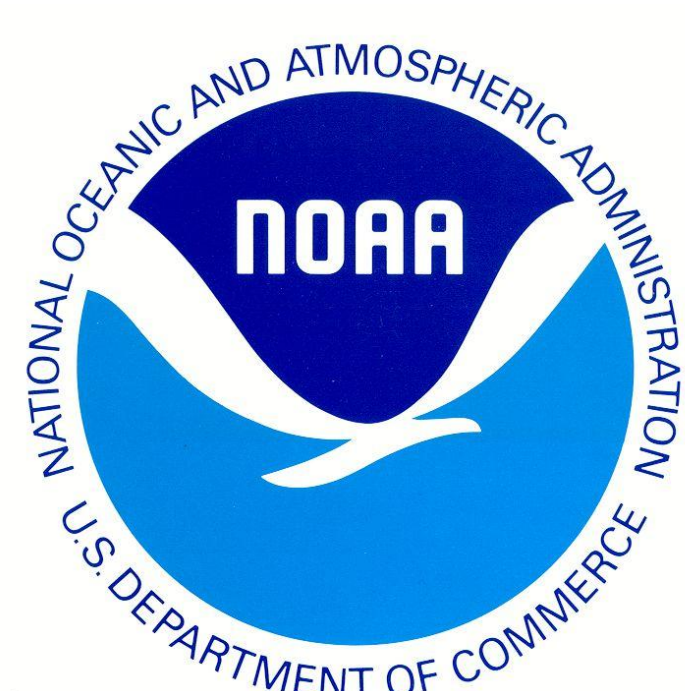
Figure 7



Figure 8. Extent of the Salt-Bearing Salina Group

Plans for the Future

A long term subsidence monitoring plan was recently adopted by OGS and the mining company at Fairport Harbor, in cooperation with NGS and CO-OPS. The plan includes installation of a GPS CORS at the gauge, a network of monitoring points which will be surveyed on an annual basis, and annual reports to OGS, nearly all paid for by the mining company. An effort will be made to find a stable location and funding for a replacement water level gauge. The Perry Nuclear Power Plant, several miles East of Fairport Harbor (visible in Figure 4), is one possible location. Another subsidence monitoring plan was recently adopted at Cleveland, similar to the Fairport Harbor plan.



National Geodetic Survey
National Ocean Service
National Oceanic and Atmospheric Administration
United States Department of Commerce

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