

**Tracking a Potential Mercury Emissions Source –
Measurements in the
Vicinity of the LCP Chemicals, Inc. Superfund Site in Linden, NJ**



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Executive Summary

An internal NJDEP Office of Science research project was initiated to follow up on the results from a Rutgers University study on an apparent source of elevated ambient mercury concentrations near Linden, New Jersey. Office of Science researchers were tasked with conducting mercury monitoring in a large area with a state-of-the-art portable low level gaseous elemental mercury (Hg) analyzer. To perform the monitoring, the mercury analyzer was deployed in a state vehicle which allowed the coverage of not only the likely source of the Hg emissions, but also those potentially impacted residential areas that were downwind and adjacent to the source. The study was focused on Hg monitoring in the vicinity of the LCP Chemicals, Inc. (LCP) Superfund site, a known source of air pollution in the area. The National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) air transport model was used prior to each sampling event. Forward trajectories were calculated, and locations where the emissions from the LCP site could be monitored from the vehicle were identified. In every case, the Hg analyzer showed a corresponding increase in Hg concentration prior to and when passing through the trajectory projection from the transport model, followed by a decrease in Hg concentrations. LCP site-related mercury concentrations ranged from 10 to 500 ng/m³ in the areas downwind of the LCP site. However, elevated concentrations above 40 ng/m³ were measured only in close proximity to the LCP Superfund site (<2 km). The monitored mercury data were compared with the results of the HYSPLIT dispersion modeling, and good agreement was achieved. It was confirmed that the Linden LCP superfund site is a source of Hg emissions in the vicinity of the site. It was found that the HYSPLIT models represent a useful tool for mercury air pollution monitoring.

Background

NJDEP Ambient Air Monitoring network for atmospheric mercury in northeastern New Jersey showed that gaseous elemental mercury (Hg) concentrations episodically exceed the background level of 2 ng/m³ (Goodrow et al., 2005; Aucott et al., 2009). In order to identify a corresponding mercury emissions source in northeastern New Jersey, a NJDEP/Rutgers University study was undertaken in 2011-2013 (Reinfelder and Wallace, 2013). Mercury concentrations at a location to the east of the potential emissions source on Staten Island, New York were measured and analyzed with those collected by the NJDEP at the air monitoring site in Elizabeth, New Jersey. The study delineated geographic areas in which this source may be located (Reinfelder and Wallace, 2013).

Directional analysis of the number, frequency and concentration-weighted distributions of Hg peaks with concentrations >4 ng/m³ at the Elizabeth monitoring site revealed a single source direction just east of south (bearing 173.4°). Similar analysis of Hg results for the Staten Island site determined two source directions, one to the west (bearing 280.5°) and a second to the southwest (bearing 213.8°) (Fig. 13 of Reinfelder and Wallace, 2013). The intersections of the two Staten Island trajectories with the Elizabeth site trajectory delineated two possible mercury source areas. The first was centered in Rossville, NY on Staten Island (40.5514 N, 74.1947 W) and the second near Pralls Island in the Arthur Kill along the eastern border of Linden, NJ (40.6119 N, 74.2039 W). It was also found that the number and intensity of Hg peaks at the Elizabeth and Staten Island sites was highest on Sunday through Wednesday, but decreased from Wednesday to Saturday (Fig. 11 of Reinfelder and Wallace, 2013).

The goal of the current follow up monitoring study was performing additional measurements to:

1. Identify the likely Hg source within the Linden area as delineated by the Rutgers study;
2. Measure Hg concentrations downwind and in close proximity to the LCP site and for potentially impacted residential communities in the area;
3. Determine if the water treatment facility near the LCP site represents a source of Hg;
4. Perform HYSPLIT modeling and evaluate the HYSPLIT trajectory and dispersion calculations for each sampling event and compare results with obtained data.

Measurement Strategy

Gaseous elemental mercury concentrations in the Linden area were measured using a RA-915+ LUMEX Mercury Analyzer (Fig. 1) (Ohio Lumex, 2014). The RA-915+ Mercury Analyzer is a portable continuous atomic absorption spectrometer with Zeeman background correction, which eliminates the effect of potential interferences. The instrument performs real time monitoring of vapor phase mercury with the detection limit of 2 ng/m³. The inlet line for the Hg analyzer (¼" Teflon tubing) was attached to a car window (Fig. 2), and the analyzer was installed inside the vehicle to efficiently facilitate the monitoring of the entire area rather than walking the portable unit around the site as was done in previous studies. Attempts were made to utilize the vendor supplied data acquisition and control system, but it was not reliable enough to document the preliminary results and control the portable unit, so all values in addition to Global Positioning System (GPS) coordinates were recorded manually during the study.

The study was focused on measurements in the vicinity of the LCP Chemicals, Inc. (LCP) superfund site, a well-known source of Hg and other contaminants in the Linden area (Fig. 3 and 4) (EPA, 2014). High levels of mercury and other contaminants had been documented in samples of soil, surface water, sediment, and groundwater at this site (ISP Environmental Services, Inc. 2013). The 26-acre LCP site is located in an industrial zone on the Tremley Point peninsula adjacent to the Arthur Kill, in Linden, Union County, New Jersey. The site is situated in the area determined by the Rutgers study as the source area for the elevated Hg concentrations, observed on Staten Island and in Elizabeth (Fig. 13 of Reinfelder and Wallace, 2013).

Hg concentrations in the LCP site area were measured during 10 intermittent days of monitoring from July to October of 2013. Measurements at the GAF Corporation water treatment plant, located northwest of the LCP site on the adjacent property, were also performed (Fig. 3). This facility is a pump and treat plant designed to collect water from the contaminated soil plots that surround the facility. Since meteorological conditions could affect evaporation and transport of gaseous mercury, measurements were performed at different times of day and during different meteorological conditions, such as temperature, wind direction, presence of temperature inversions, etc. Prior to each air sampling campaign, the LCP site coordinates were input into the HYSPLIT (NOAA/Air Resources Laboratory, 2014) model which calculated

forward wind trajectories to determine potential measurement locations downwind of the site. The HYSPLIT model is a complete system for calculating air parcel single or multiple trajectories to complex dispersion and deposition simulations. Archive meteorological data sets and source coordinates were used for the trajectory calculations. The Global Positioning System (GPS) and the HYSPLIT trajectory plots were used for downwind measurements both in close proximity of the LCP site (10-100 m, 11-109 yd.) and in areas further away from the site (1-20 km, 0.6-12.4 mi).

Results and Discussion

Mercury concentrations downwind of the LCP site of 10-500 ng/m³ were measured in the vicinity of the LCP site. However, Hg concentrations above 40 ng/m³ were not observed in residential areas >2 km from the LCP site. Observed maximum daily concentrations ranged from 40 to 2200 ng/m³. Table 1 shows values of maximum daily gaseous mercury concentrations in the atmosphere along with the dates, time, and coordinates of the measurement locations. Very high concentrations of 1660-2200 ng/m³, shown at the bottom of the table, were likely related to the localized mercury soil concentrations (i.e., hot spots) on Staten Island (Aug 20 and 26, 2013) and at the water treatment facility (Aug 13, 2013) (Fig. 3) near a converted storage garage that was partially washed away during super storm Sandy. The location was backfilled with gravel on subsequent visits. High levels of Hg on Staten Island were observed on two separate days in August 2013 at almost exactly the same location (Table 1). Since high readings were observed in a very small (a few square meters) area close to the ground at the same location on two different days, it is unlikely that they were caused by the transport of Hg from the LCP site. Most likely, they were caused by Hg hot spots on the ground.

On August 13th, 2013, extensive measurements of mercury were performed in close proximity to the water treatment plant and inside of the plant during the sludge removal process. No elevated levels of mercury were observed related to this process. Only a few local Hg hot spots on the ground at the water treatment plant were identified. Thus, it is unlikely that the water treatment facility represents a source of gaseous mercury emissions in the area.

Meteorological analysis of backward HYSPLIT trajectories showed that most of the time elevated mercury concentrations are related to air transport from the LCP site. HYSPLIT trajectories and corresponding maximum mercury concentrations for each day of measurements

are shown in Figure 5. It can be seen that maximum values of mercury concentration in most cases are associated with LCP related trajectories. Only one maximum concentration on August 13th was related to western wind not from the LCP site but the wind on that day was not stable, and this trajectory most likely was not accurate.

In addition to forward trajectory calculations, HYSPLIT dispersion modeling was performed. The results for two days of measurements are shown in Figures 6 and 7. It can be seen that the measurement data agree well with the results of the dispersion modeling: elevated Hg concentrations are observed only in close proximity of the LCP site (<2 km). Dispersion model predicts much lower concentrations a few kilometers away from the site depending on the wind speed, and the Hg monitoring data confirm this result (Fig. 6 and 7).

Summary and Conclusions

An internal NJDEP Office of Science research project was initiated following a report from a Rutgers University study on mercury emissions near Linden, New Jersey. The study was focused on measurements in the vicinity of the LCP Chemicals, Inc. (LCP) Superfund site. In addition, measurements at the GAF water treatment facility, located northwest of the LCP site on the adjacent property, were also performed. It was found that most likely the water treatment facility does not represent a source of gaseous mercury emissions in the area. Mercury concentrations ranged from 10 to 500 ng/m³ in the areas downwind of the LCP site. However, most of the time, concentrations above 40 ng/m³ were measured only in close proximity of the site (<2 km). HYSPLIT forward trajectory and dispersion modeling for the LCP site as the potential Hg source site was performed. Field measurement results agree with the model calculations. It is concluded that the LCP Superfund site is a source of Hg emissions in the vicinity of the site. Most likely, the Hg peaks in Staten Island and Elizabeth, episodically observed earlier (Goodrow et al., 2005; Aucott et al., 2009; Reinfelder and Wallace, 2013) are related to Hg transport from the LCP site. However, according to our knowledge, currently and in 2011-2012, when the Rutgers study was conducted, there was no activity on the LCP site. Therefore, the day of week Hg peak frequency distributions (peaks occur more often on Mon-Wed), observed during the Rutgers study (Reinfelder and Wallace, 2013), cannot be explained by the observed emissions from the LCP site.

The Hg vapor concentration measured in the residential areas was less than 40 ng/m³. This concentration is below the USEPA Reference Concentration (RfC) of 300 ng/m³. The RfC is a concentration that will not result in significant adverse effects over a lifetime of exposure to the most sensitive groups in the population. Recently, USEPA finalized a cleanup plan for the LCP Chemicals, Inc. Superfund site in Linden, NJ. The planned \$36.5 million cleanup at the site will protect the community from mercury and other contaminants (EPA, 2014).

Table 1. Maximum concentrations, observed during the monitoring study for each day of measurements. High values shown at the bottom, measured downwind of the LCP site, are believed to be related to hot spots on the ground rather than transport from the LCP site.

Date	Time	Latitude deg. N	Longitude deg. W	Maximum Hg concentration for each day of measurements, ng/m ³
<i>Likely LCP related measurements</i>				
31-Jul-13	16:00	40.60952	74.21238	240
7-Aug-13	14:13	40.6092	74.21189	258
13-Aug-13	15:42	40.60795	74.21438	159
26-Aug-13	14:09	40.60863	74.21011	492
27-Aug-13	15:11	40.60621	74.21184	414
9-Sep-13	8:22	40.60694	74.2119	363
18-Sep-13	22:31	40.61291	74.20654	66
26-Sep-13	9:20	40.60692	74.21179	216
16-Oct-13	16:49	40.61418	74.21907	40
<i>Likely hot spot Hg measurements</i>				
13-Aug-13	12:30	40.60996	74.20618	2200
20-Aug-13	14:41	40.61805	74.17841	2200
26-Aug-13	15:57	40.61812	74.17841	1660

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Figure 1. RA-915 light mercury analyzer



Figure 2. Air inlet of the RA-915 light mercury analyzer in the surveillance vehicle



Figure 3. Aerial view of the LCP Chemicals, Inc. (LCP) Superfund site and water treatment plant (arrow). The Arthur Kill is in the right corner of the picture.



Figure 4. View of the LCP Chemicals, Inc. (LCP) Superfund site

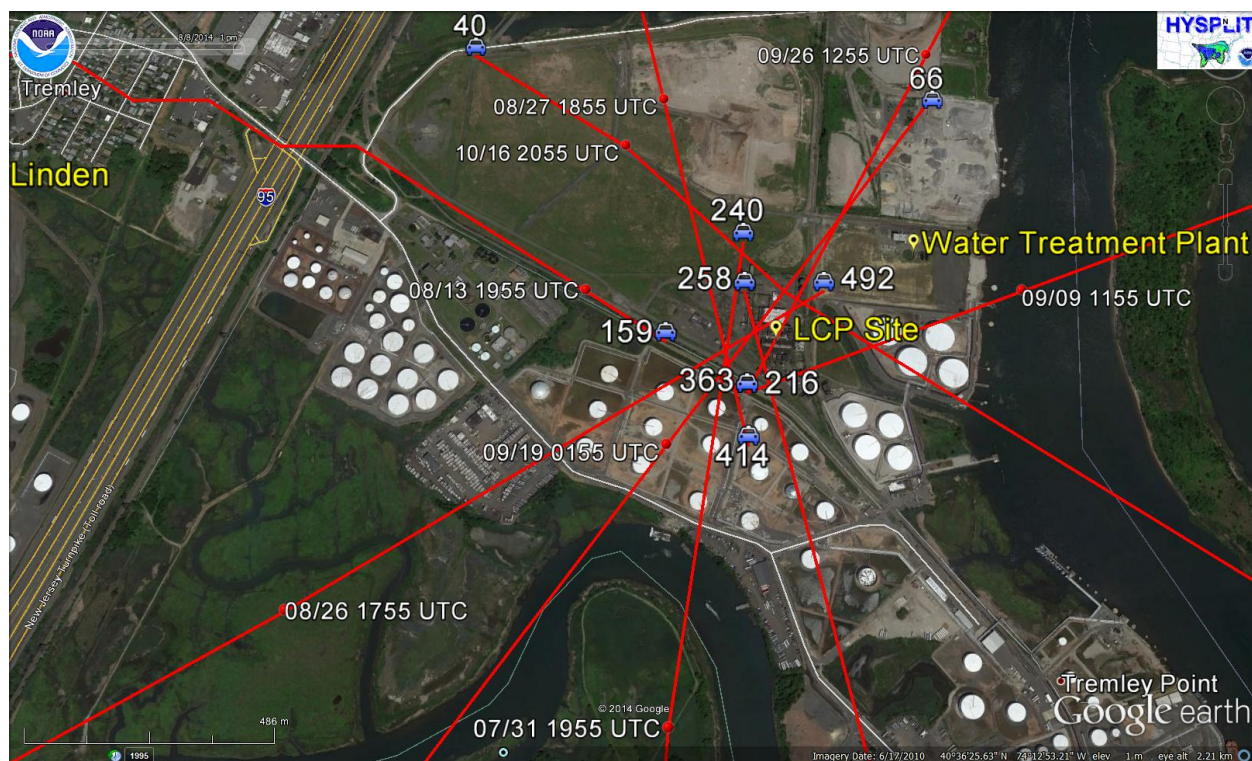


Figure 5. Backward trajectories for measured maximum concentrations for each day of measurements and corresponding values of Hg concentrations in ng/m^3

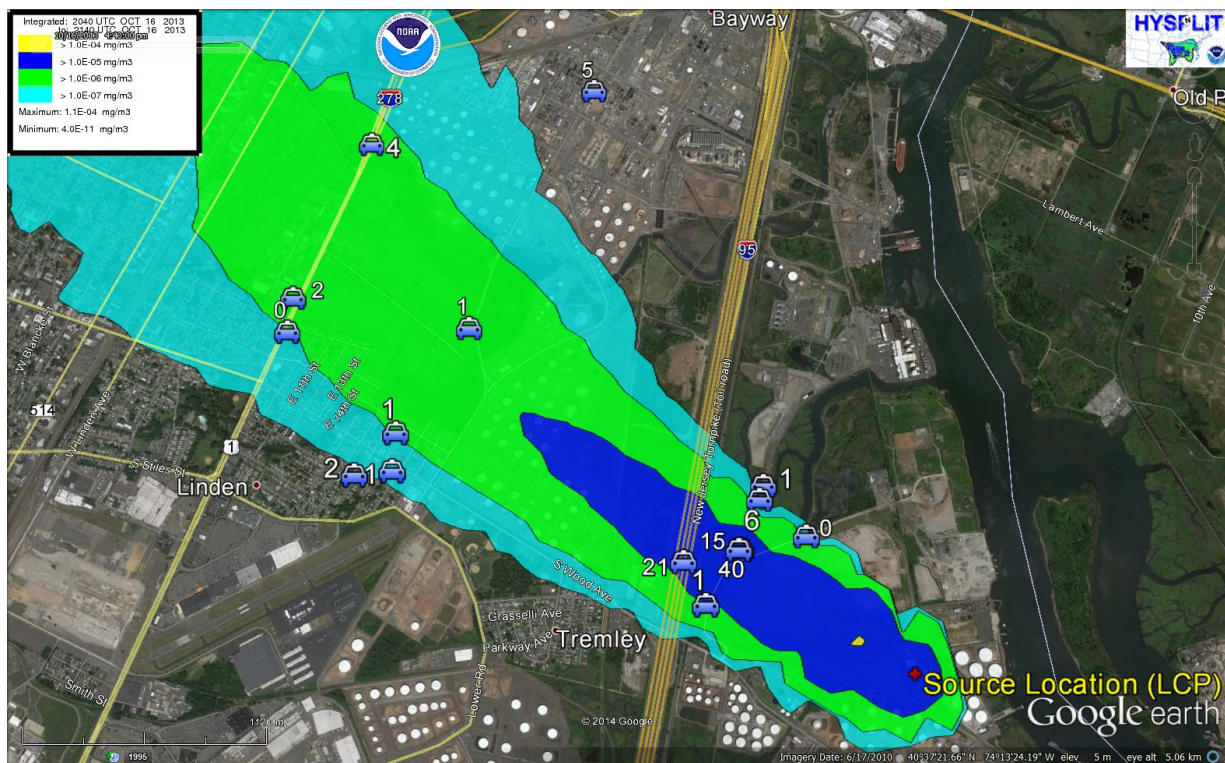


Figure 6. HYSPLIT dispersion modeling result along with measured concentrations in ng/m^3 for October 16th, 2014

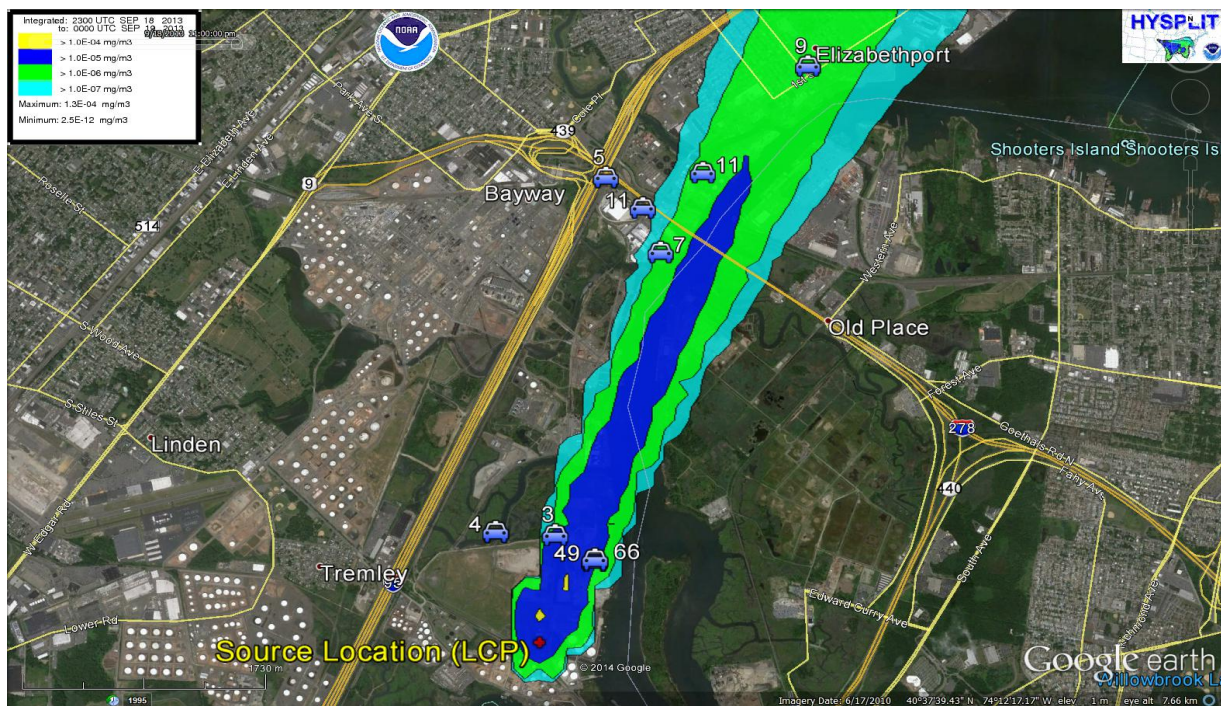


Figure 7. HYSPLIT dispersion modeling result along with measured concentrations in ng/m^3 for September 18th, 2014