Effect of Location Coordinates on RTR Risk Results

Anne Pope, Dr. Michael Stewart, Brian Stitt, Ketan Patel, and Colin Boswell
U.S. Environmental Protection Agency, Research Triangle Park, NC 27711
pope.anne@epa.gov, stewart.michael@epa.gov, stitt.brian@epa.gov
patel.ketan@epa.gov, boswell.colin@epa.gov,
Stacie Enoch
Eastern Research Group, Inc., 1600 Perimeter Park, Morrisville, NC 27560Stacie.Enoch@erg.com

ABSTRACT

The Risk and Technology Review (RTR) is a combined effort to evaluate both risk and technology after the application of maximum achievable control technology (MACT) standards, as required by the 1990 Clean Air Act (CAA) Amendments. The RTR evaluates the effectiveness of technology-based standards, using cancer and noncancer risk as metrics, and determines the need for implementing additional control requirements on specific source categories to reduce cancer and noncancer risk as well as to address additional operations not covered by the current MACT standards. RTR data are modeled using the United States Environmental Protection Agency (EPA)'s Human Exposure Model – American Meteorological Society (AMS)/EPA Regulatory Model (HEM-AERMOD). HEM-AERMOD results indicate that location coordinates of individual stack and fugitive emission releases within facilities can significantly influence RTR risk results. The Sector Policies and Programs Division (SPPD) and the Health and Environmental Impacts Division (HEID) within EPA's Office of Air Quality Planning and Standards (OAQPS) have developed quality assurance (QA) procedures and tools to review and correct coordinates, fenceline maps, and fugitive release parameters of width, length and angle. The data sources of RTR location coordinates, fenceline maps, and fugitive parameters in addition to the National Emission Inventory (NEI) can include information collection request (ICR) data collected under CAA Section 114 authority, performance test data, industry data, and permit data. Significant time and resources have been expended by industry and SPPD staff to improve location data. In order to improve the NEI for use in future regulatory and modeling applications, it is critical that data providers improve the data quality of location coordinates of individual release points within facilities and fugitive release parameters and include accurate up-to-date fenceline maps in their Emission Inventory System (EIS) submittals.

The purposes of this paper are two-fold: (1) to illustrate the impact of improving location coordinates and fugitive parameters on RTR risk results along with the receipt of quality assured fenceline maps, and (2) to summarize SPPD procedures for QA of coordinates, fugitive release parameters, and fenceline maps.

INTRODUCTION

The Risk and Technology Review (RTR) is an effort to conduct residual risk assessment and technology review under Clean Air Act (CAA) Section 112(f) and 112(d)(6), respectively. Section 112(f)(2) requires the United States Environmental Protection Agency (EPA) to conduct risk assessments on the source categories subject to maximum achievable control technology (MACT) standards and to determine if additional standards are necessary to reduce the residual risk. Section 112(d)(6) requires EPA to review and revise MACT standards as necessary, taking into account developments in practices, processes, and control technologies. Where there are advances in controls, the EPA will consider costs, potential emissions reductions, and health and environmental risks in determining what further controls are necessary.

The approach for developing RTR rules includes three phases. In phase one, the EPA collects data to support the proposed rule. In phase two, the EPA prepares a model input file using the data collected in phase one and conducts the residual risk assessment. During phase two, EPA also conducts its technology review and proposes a rule which may include additional standards based on the results of the risk assessment and/or the technology review. In phase three, EPA addresses public comments on the proposal, revises the proposal modeling input file based on public comments if appropriate, and creates a final, promulgation modeling input file. In addition, the EPA revises the risk assessment and technology review if necessary, and promulgates standards.

For the RTR Program, the EPA predicts inhalation risks using the Human Exposure Model (HEM) in combination with the American Meteorological Society (AMS)/EPA Regulatory Model (AERMOD) dispersion modeling system. HEM-AERMOD performs three main operations: atmospheric dispersion modeling, estimation of individual human exposures and health risks, and estimation of population risks. HEM-AERMOD completes these operations using the following inputs: the emissions modeling file, 2010 Census block data (about 10 households are in each census block), terrain elevation data, meteorological data, chemistry information, exposure data (e.g., activity patterns) and health benchmarks data. AERMOD is a state-of-the-science plume dispersion model that is preferred by EPA for modeling point, area, and volume sources of continuous air emissions from facility applications. The basis for AERMOD is a Gaussian plume equation (shown below) that simulates the growth and dispersion of a plume as a function of the source-release characteristics, meteorological conditions, terrain, and receptor characteristics.

$$C = \frac{Q}{2\pi\sigma_y(x)\sigma_z(x)u} e^{\frac{-y^2}{2\sigma_y(x)^2}} \left[e^{\frac{-(z-h)^2}{2\sigma_z(x)^2}} + e^{\frac{-(z+h)^2}{2\sigma_z(x)^2}} \right]$$

According to this equation, the ambient concentration (C) at ground level is inversely proportional to the distance from the source (x) and the plume height (h). Thus, ground-level concentration decreases with increasing distance and with increasing plume height. The plume height is a function of the actual physical release height (stack height) and the plume’s rise due to buoyancy and momentum. In turn, plume rise is a function of the plume’s exit velocity, volumetric flow, and release temperature.

RTR inhalation risk outputs include: chronic cancer, chronic noncancer and acute noncancer estimates of risk. Chronic (long term) inhalation cancer risks are expressed as Maximum Individual Risk (MIR). MIR is the highest cancer risk (in a million) at a location where people live (census block centroid or nearest residence). Chronic inhalation noncancer risks are expressed as Hazard Index (HI). HI is a noncancer risk at a location where people live. Acute (short term) inhalation noncancer risks are expressed as a Hazard Quotient (HQ) and provide a measure of the maximum off-site impact for the highest 1-hour exposure to a specific pollutant at any location outside the facility fenceline. In addition to assessing inhalation human health risks from RTR categories, the EPA determines if there are potential health effects resulting from exposures to persistent and bioaccumulative hazardous air pollutants (HAPs) via non-inhalation pathways, primarily the ingestion pathway.

To perform RTR risk assessments, the Sector Policies and Programs Division (SPPD) prepares source category modeling files that contain actual annual, allowable annual, and maximum hourly emission estimates and operating parameters. The SPPD conducts the following steps to develop RTR proposal modeling files.

- Compile SPPD Master Facility List
- Collect available data from existing EPA Data sources: National Air Toxics Assessment (NATA), NEI, Emission Inventory System (EIS), Toxic Release inventory (TRI), Air Facility System (AFS)
- Conduct quality assurance (QA) of available data
- Identify missing and poor quality data
- Collect data needed to develop modeling files from: available test data, information collection requests (ICRs), Section 114 letters, required new source testing, compliance test data, voluntary surveys, site visits, stakeholder meetings, trade associations, permits, EPA Regional Offices, state and local agencies, and tribes
- Extract data from all data sources into RTR modeling file format
- Select data to use in modeling file
- Identify and populate missing data
- Assign Emission Process Groups to MACT category records (Emission Process Groups are groups of processes within a MACT category that are assigned by the SPPD project lead in order to review risk results and to evaluate control options)
- Prepare draft fenceline maps in KMZ format
- Conduct QA of draft modeling files and draft fenceline maps
- Prepare final modeling files in RTR format and fenceline maps in KMZ format
- Prepare technical support memo that documents modeling file and map preparation

RTR risk results are greatly impacted by pollutant emissions, geographical data fields, stack parameters and meteorological conditions. Three key geographical modeling file components that impact risk modeling include:

- Latitudes and longitudes of individual stack and fugitive emission release points;
- Fugitive release parameters of length, width, and angle; and
- Fenceline maps of facilities.

More details on each of these components, the QA procedures that the SPPD employs, and the impact of these components on risk assessment results follow.

LATITUDE AND LONGITUDE OF INDIVIDUAL STACK AND FUGITIVE EMISSION RELEASE POINTS

The SPPD plots all coordinates, conducts QA, and revises coordinates prior to sending modeling files to the Health and Environmental Impacts Division (HEID). Because latitude and longitude are key components of risk modeling, coordinates of individual stack and fugitive releases need to be as accurate as possible. Latitudes and longitudes are reported for each emission release point in RTR modeling files. In order to get as accurate risk results as possible, individual release point coordinates are preferred in RTR modeling files rather than a single site latitude and longitude. The RTR data field, Emission Release Point Type Code, identifies releases as stack or fugitive. Stack releases are modeled as a single point with latitude and longitude. Fugitive releases are modeled either as a single point with a latitude and longitude in the center of the source or as a rectangle with latitude and longitude reported at the SW corner of the release. Latitudes and longitudes are reported in decimal degrees to the fifth decimal place (i.e. 0.0000X) at a minimum in RTR modeling files. The fifth decimal place corresponds to approximately 1.0-1.5 meters of accuracy. Negative signs for longitudes are also required in RTR modeling files.

Figure 1 represents typical downwind ground-level concentrations for plumes released at different elevations and distances. As shown in Figure 1, the greatest change in ambient concentrations, especially from a low level release, occurs within the first few hundred meters downwind from the source.

Figure 2 compares coordinates for a refinery (Sunoco Marcus Hook, REF, PA) reported in the 2008 EIS and coordinates collected for the RTR modeling file. The EIS file contained 8 unique pairs of latitude and longitude, and the RTR modeling file, based on ICR data collected for calendar year 2010, contained 118 unique pairs of latitude and longitude. All of the RTR coordinates are reported to a minimum of 5 decimal places. Twenty-five percent of the EIS pairs of coordinates are reported to 5 decimal places, and the remaining EIS pairs of coordinates are reported to 2 decimal places. The cancer risk for this facility is located in the residential area to the southeast of the plant driven by a combination of release points within the facility on the east side and by the predominant NW flow of air in this area of the country.

Figure 3 illustrates how important it is to correct coordinates for risk modeling. Figure 3 provides an example for a Publicly Owned Treatment Works (POTW) facility, Ward's Island Water Pollution Control Plant, in New York City. The facility originally had coordinates reported in 2005 NEI that were defaulted to the center of the zip code (see A in Figure 3). These coordinates appear to be in a residential area, and the MIR was estimated as 100 in 1 million. However, the actual facility location that was identified by using Google Earth maps was several thousand meters to the southeast (see B in Figure 3). When the revised coordinates were used to model this facility, the estimated cancer risk fell to approximately 5 in 1 million.

The SPPD conducts QA and revises coordinates prior to sending files to the HEID for modeling. The HEID then performs a second review of coordinates and census block centroid receptor locations. The SPPD uses ArcGIS, Google Earth, or Bing to plot coordinates of all releases. The SPPD includes the following data fields in its QA of latitude and longitude:

- Facility ID,
- Facility Name,
- State/County FIPS Code, State, County,
- Tribal Code and Description,
- Location Address, City, Zip Code,
- Emission Unit ID, Process ID, Emission Release Point ID,
- SCC and Description,
- Emission Unit Description,
- MACT or EIS Regulatory Code and MACT Code Description,
- Emission Process Group,
- Emission Release Point Type Code and Description,
- Longitude, Latitude, and
- Location Default Flag and Description.

The SPPD performs the following QA steps for all coordinates.

- Convert coordinates that are not reported in decimal degrees to decimal degrees
- Correct any longitudes missing the negative sign

- Identify records with site coordinates
- Identify records with coordinates that are reported to less than the 5th decimal place
- Identify records with defaulted coordinates
- Plot all coordinates using Bing, Google Earth, or ArcGIS and identify coordinates that need to be revised.
  - ❖ Address of facility may help locate the facility if the entire facility is not plotted correctly
  - ❖ Emission Unit Descriptions, SCCs and Descriptions, MACT Codes and Descriptions, Emission Process Groups, and Emission Process Descriptions also help to determine if coordinates are correct for individual emission release points within facilities

After QA is completed, then the SPPD revises coordinates that are incorrect. The SPPD performs the following augmentation steps to revise coordinates.

- Revise coordinates using the following hierarchy of data sources.
  - ❖ Contact facility to obtain site specific data
  - ❖ If site specific data are unavailable, use a combination of the following data sources
    - ▪ ArcGIS, Google Earth, or Bing maps
    - ▪ Company websites
    - ▪ EPA websites and databases
- Report coordinates in decimal degrees to the 5th decimal place and include negative sign for longitudes
- Document the source of data for the revision (e.g., Google Earth or ArcGIS, EPA websites, company web site, etc.).
- Populate Location Default Flag and Location Default Description data fields to identify records with coordinates that have been revised and the method used to revise coordinates

FUGITIVE PARAMETERS

In preparing modeling files, valid parameters for the physical characteristics of each emission release point are necessary to correctly place those release points and their associated emissions. Gaussian dispersion models, such as AERMOD, use stack and fugitive parameters to characterize the plume. Fugitive releases are typically modeled as ground releases with no velocity or buoyancy. The first step in QA of fugitive parameters is to review the emission release point type. HEID modelers use the emission release point type to determine how to model the release. If the emission release point type is incorrect, it can greatly affect the results of the risk assessment.

The SPPD includes the following data fields in its QA of fugitive release data fields:

- Facility ID,
- Facility Name,
- State/County FIPS Code, State, County,
- Tribal Code and Description,
- Emission Unit ID, Process ID, Emission Release Point ID,
- SCC and Description,
- Emission Unit Description,
- MACT or EIS Regulatory Code and MACT Code Description,
- Emission Process Group,
- Emission Release Point Type Code and Description,
- Stack Height (ft), Stack Diameter (ft), Exit Gas Temperature (F), Exit Gas Velocity (ft/sec), Exit Gas Flow Rate, (cu ft/sec),

- Fugitive Length Sigma X (ft), Fugitive Width Sigma Y (ft), Fugitive Angle (degrees), and
- Stack Default Flag and Description.

The SPPD first reviews and corrects the emission release point type for all emission release points. The SPPD staff use SCCs, emission unit descriptions, and their knowledge of the category to perform QA of emission release point type. To revise emission release point type, the SPPD first contacts the facility. If site specific data are unavailable, then the SPPD defaults the emission release point type based on data reported by other facilities in the category or on knowledge of the category.

Then the SPPD determines if a fugitive release is being modeled as a point or as an area source. If the fugitive release is modeled as a point, the fugitive length, width, and angle are not populated. For fugitive releases modeled as area sources, length and width must be greater than 0 and fugitive angles must have a value between 0 and 180 degrees.

Area sources are represented in modeling files as rectangles or squares. Figure 4 shows examples of how fugitive area source rectangles are created. The red dashed lines represent the coordinate plane with north towards the top. The purple SW points to the southwest corner to show correct location of fugitive coordinates. The X and Y represent fugitive length and width, and the rotation of each angle is also shown in Figure 4.

The QA of fugitive area sources is very important because the dimensions directly affect RTR risk results. Figures 5 and 6, Google Earth maps of a primary aluminum facility, provide an example of why SPPD maps all fugitive area sources prior to RTR modeling. Figure 5 shows the coordinates and fugitive parameters for data originally provided in the ICR. Figure 6 shows the revised data modeled in the proposal. The red Xs depict stack releases, and the red rectangles represent the areas of the fugitive releases (pot lines). The green Xs identify the model receptors (census block centroids). Figure 5 shows that if data were modeled without revisions, the pot line emission releases would be in residences and not within the site boundary. Figure 5 also indicates that latitudes and longitudes are not correctly located at the southwest corner for fugitive area releases and that coordinates for some of the stack releases are incorrect**.** When the coordinates and fugitive parameters were revised, the original cancer risk of 40 in 1 million decreased to 20 in 1 million.

To perform QA of fugitive area sources, the SPPD first identifies records that have null values or values of 0 reported for width or length and records that have angles reported as null or greater than 180 degrees. Then SPPD plots latitudes, longitudes, and fugitive dimension parameters for all fugitive sources using Bing, Google Earth, or ArcGIS. From the maps, the SPPD identifies records that have incorrect coordinates, dimensions, or angles. To revise fugitive area parameters, the SPPD uses the following hierarchy.

- Contact facility to obtain fugitive parameters
- If site specific data are unavailable, revise fugitive length, width and angle using one of the following methods
    - ❖ Use maps to revise length, width, and angle
    - ❖ Revise angle based on maps, and default length and width using:
        - Median values of existing non-0 values for SCC, MACT category, or Emission Process Group
        - Knowledge of the industry
    - ❖ Revise length, width and angle using national NATA default of 32.8 ft for length and width and 0 for angle

FENCELINE MAPS OF FACILITIES

Detailed maps with plant boundaries improve the results of RTR risk assessments, especially for facilities with large fugitive sources or facilities that encompass large geographic areas. Although fenceline maps have not been available for many of the RTR categories to date, the SPPD and the HEID encourage project leads to provide fenceline maps in order to obtain better HEM results. The SPPD prepares fenceline maps by drawing in plant boundaries on Google Earth, Bing or ArcGIS maps and then saves the maps to a KMZ format that are submitted with final modeling files to the HEID. Only contiguous areas are modeled for RTR.

Figure 7 depicts an aerial photo of the only primary lead processing facility in the U.S., Doe Run Herculaneum. The blue outline label, MO DNR Doe Run Boundary, was used in modeling for the proposal. The red outline label, Doe Run's Property Map, was provided by the facility in proposal comments submitted to the docket. The tan shaded area is the property that was modeled for promulgation. The remodeled area included property that the facility had recently purchased. Risks for the facility are driven primarily by fugitive dust sources. Promulgation risks declined 98% from proposal risks (proposal risks were 50 times the NAAQS and promulgation risks were equal to the NAAQS). The majority of the decline in risk values was due to the revised plant boundary. Risks also declined to a lesser amount as a result of a decrease in fugitive emissions from 2.5 tpy in the proposal modeling file to 1 tpy in the promulgation modeling file.

To perform QA of fenceline maps, the SPPD reviews fenceline maps to make sure that plant boundaries encompass all operations. Maps are reviewed using Google Earth, Bing, or ArcGIS. To revise fenceline maps, the SPPD first contacts facilities and provides draft fenceline maps in KMZ format to facilities for their review and revision of plant boundaries. If site specific maps from facilities are unavailable, then the SPPD uses the following hierarchy to revise fenceline maps.

- Review permits to obtain maps
- Contact state and local agencies and tribes or EPA Regional Offices to obtain available site maps
- Use Google Earth, Bing, or ArcGIS to redraw plant boundaries

CONCLUSIONS

The RTR process has made significant contributions towards improving the accuracy of modeling files. More accurate risk estimates lead to more reasoned and defensible rule proposals. In order for the NEI to be used in future regulatory and modeling applications, it is critical that data providers improve the data quality of location coordinates of individual release points within facilities and fugitive release parameters and include accurate up-to-date fenceline maps in their EIS submittals. The SPPD and the HEID recommend that EIS data submitters:

- Provide coordinates for individual emission release points in addition to site coordinates;
- Provide coordinates in decimal degrees to the 5th decimal place;
- Provide fenceline maps for RTR facilities;
- Provide fugitive dimensions and angles for fugitive area sources;
- Incorporate the QA methodology described in this paper into preparation of EIS files; and
- Use RTR data for facility configurations in EIS.

Improvements in the quality of location and fugitive release data will help to reduce the uncertainty in RTR risk assessment results that are the basis for RTR rules.

Figure 1. Plume Concentration as a Function of Release Height and Downwind Distance

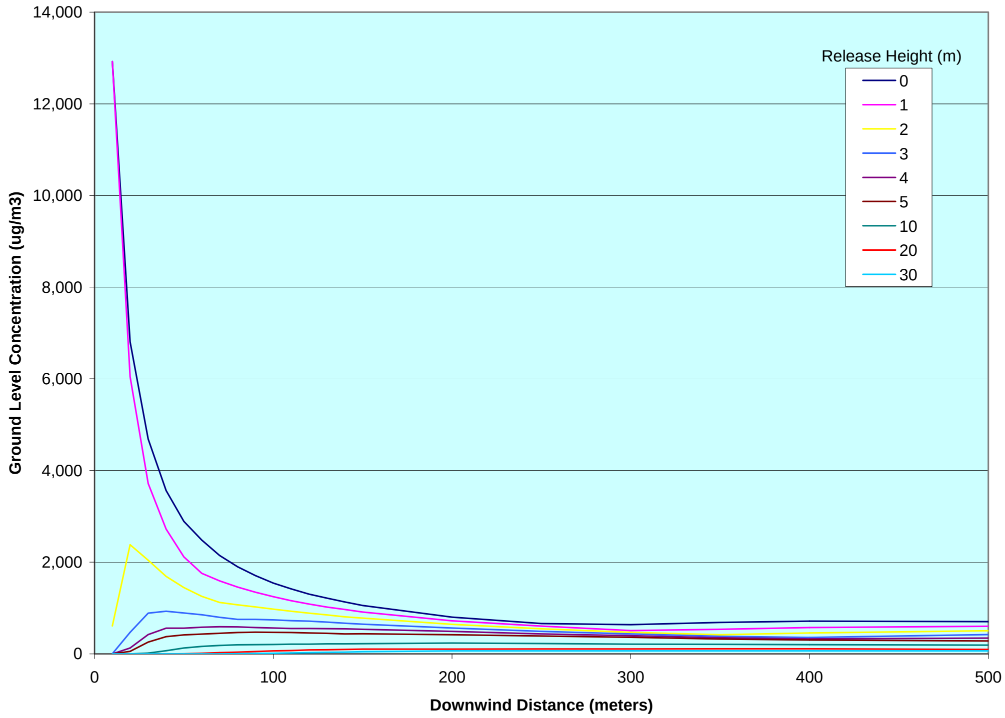


Figure 2. Comparison of Coordinates in 2008 EIS and 2010 Base Year RTR for a Refinery

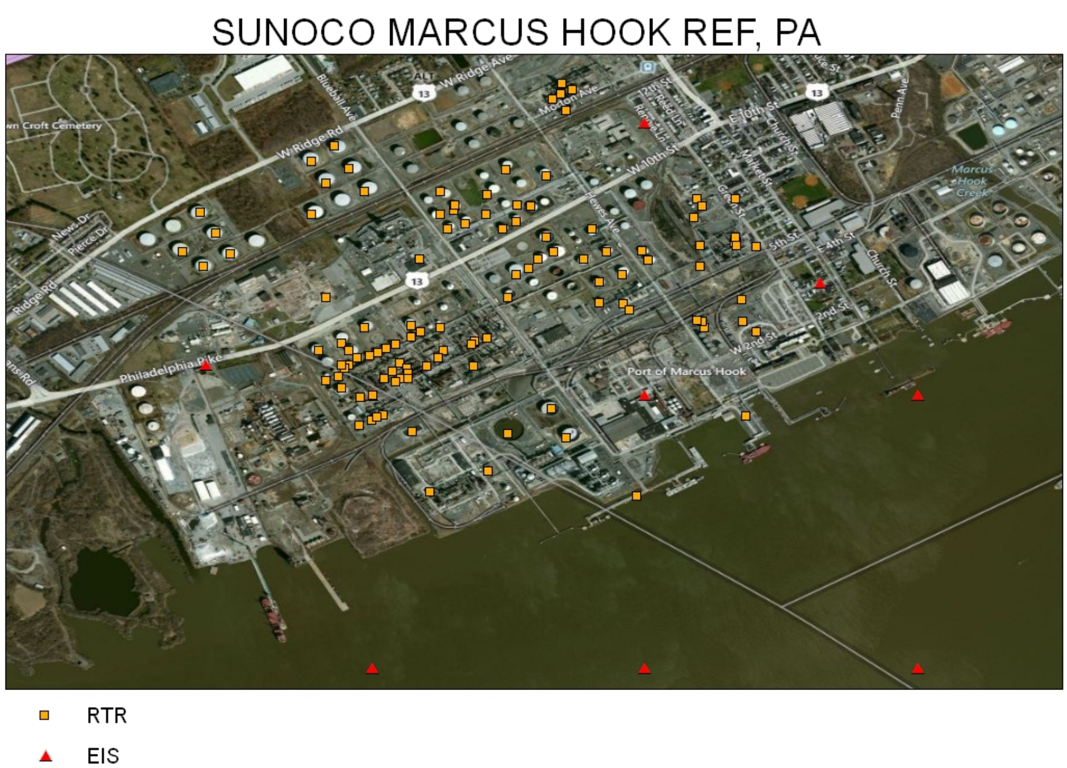


Figure 3. Revised Emissions Point Locations for a POTW

Figure 4. Depiction of Fugitive Area Source Parameters

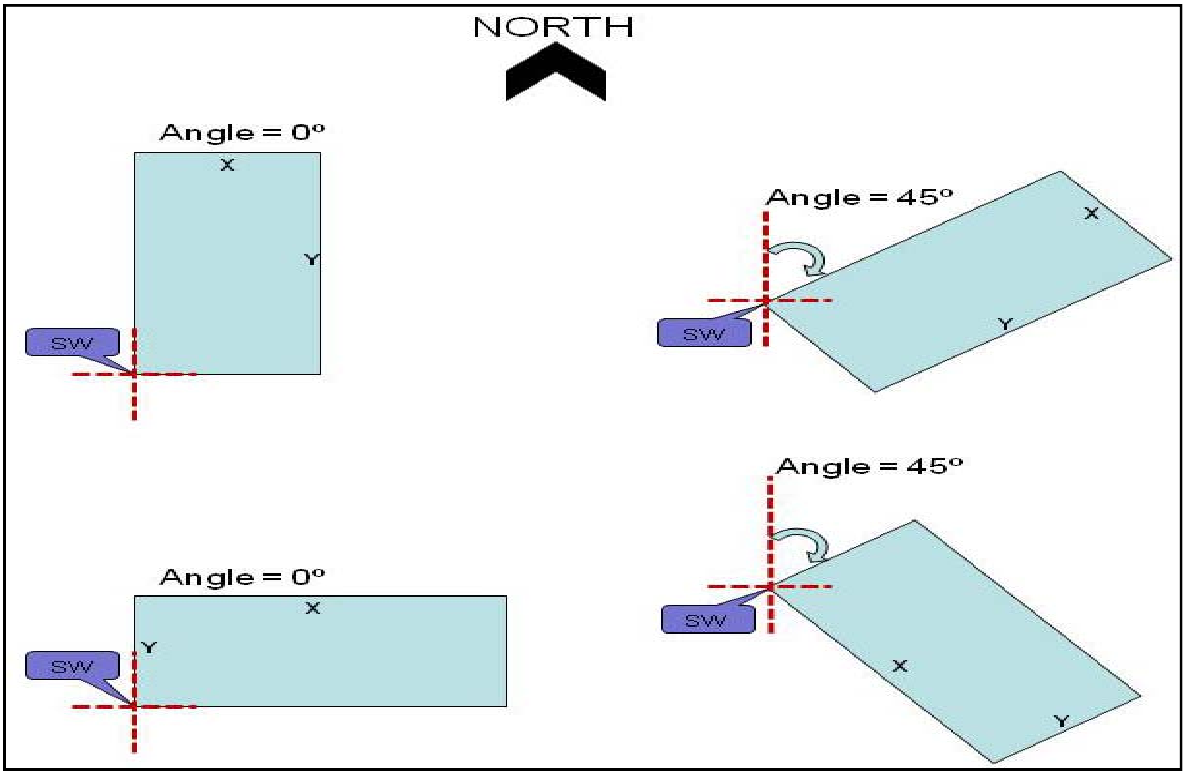


Figure 5. Mapping of Draft Emission Release Points at a TN Primary Al Facility

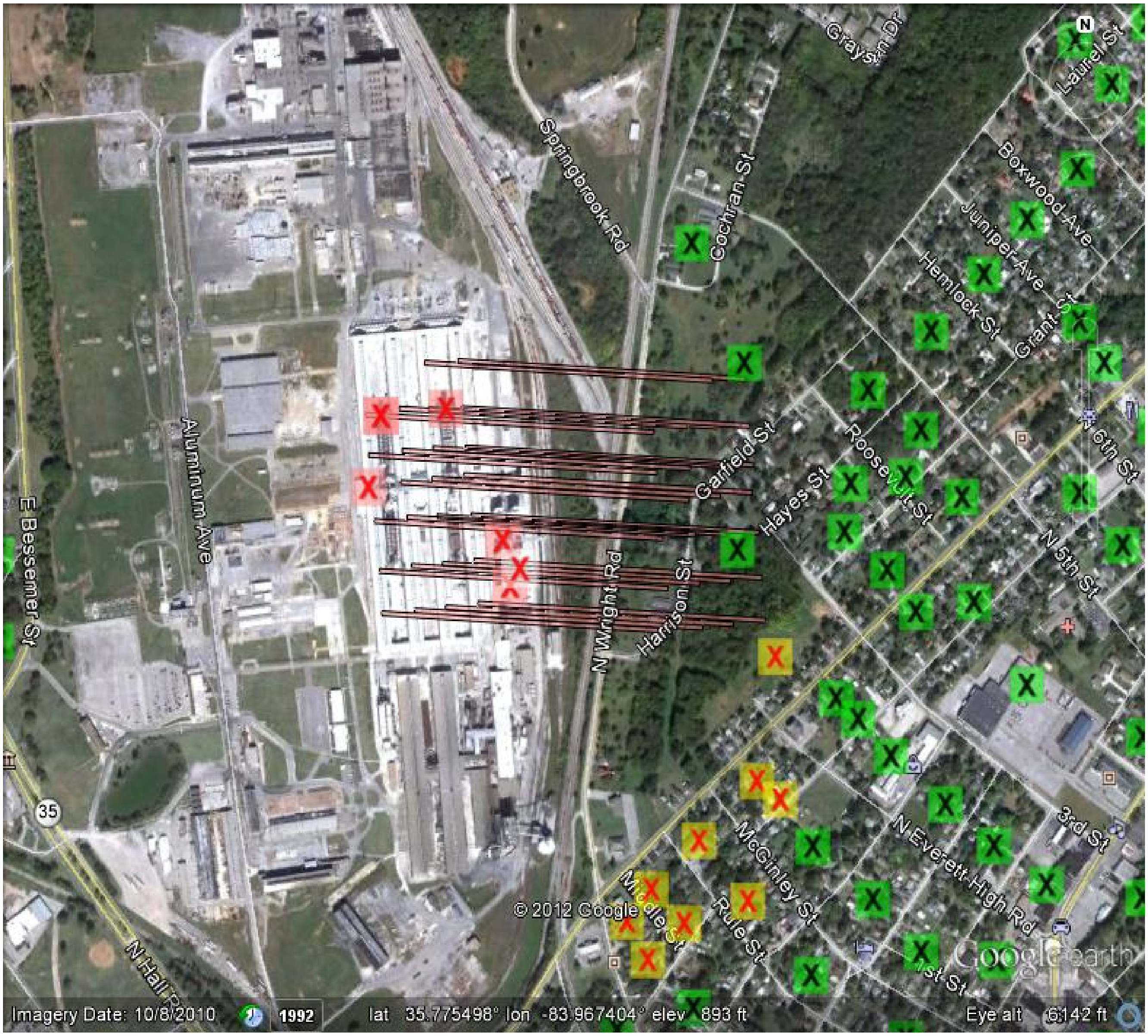


Figure 6. Revised Mapping of Emission Release Points at a TN Primary Al Facility

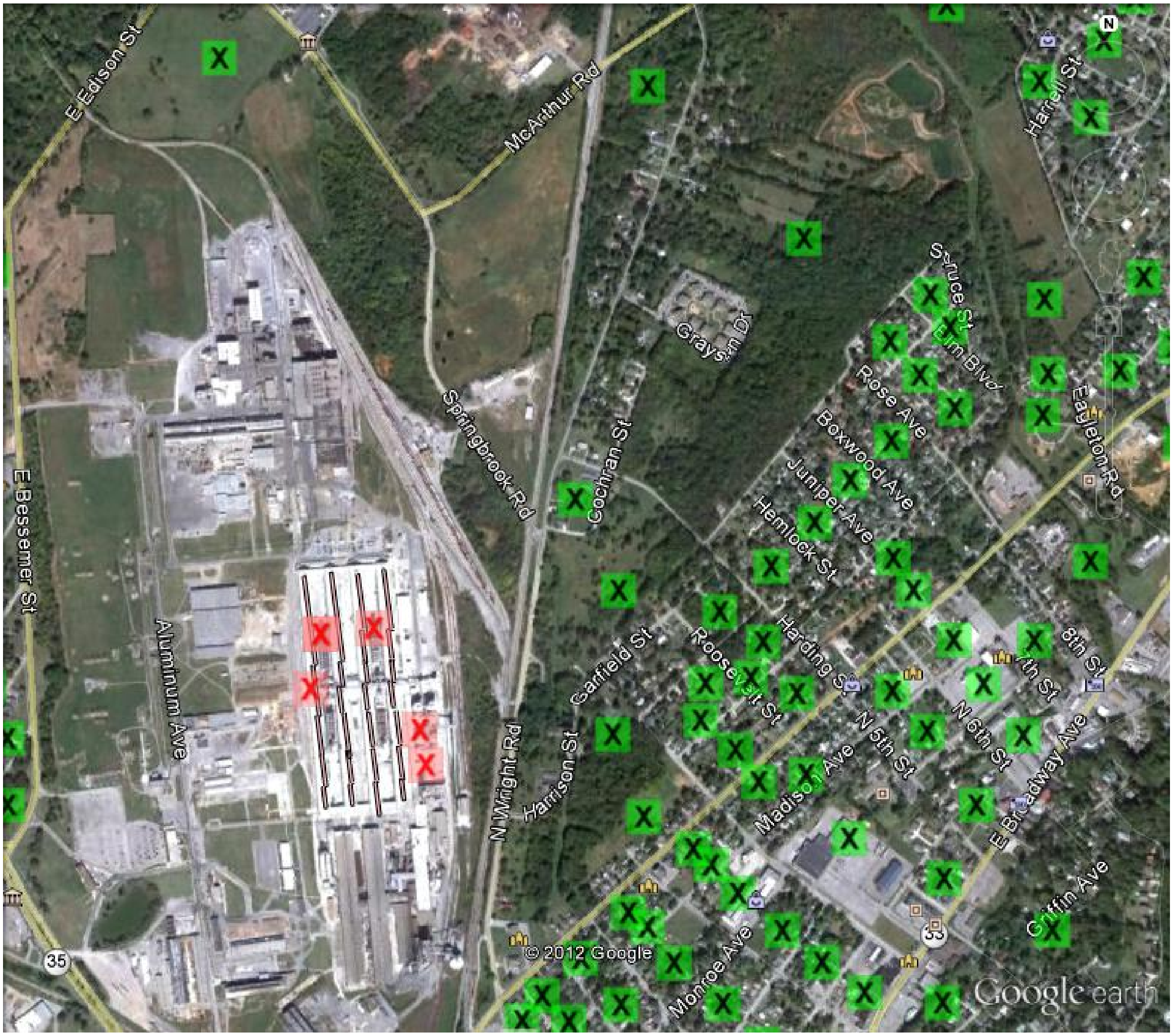
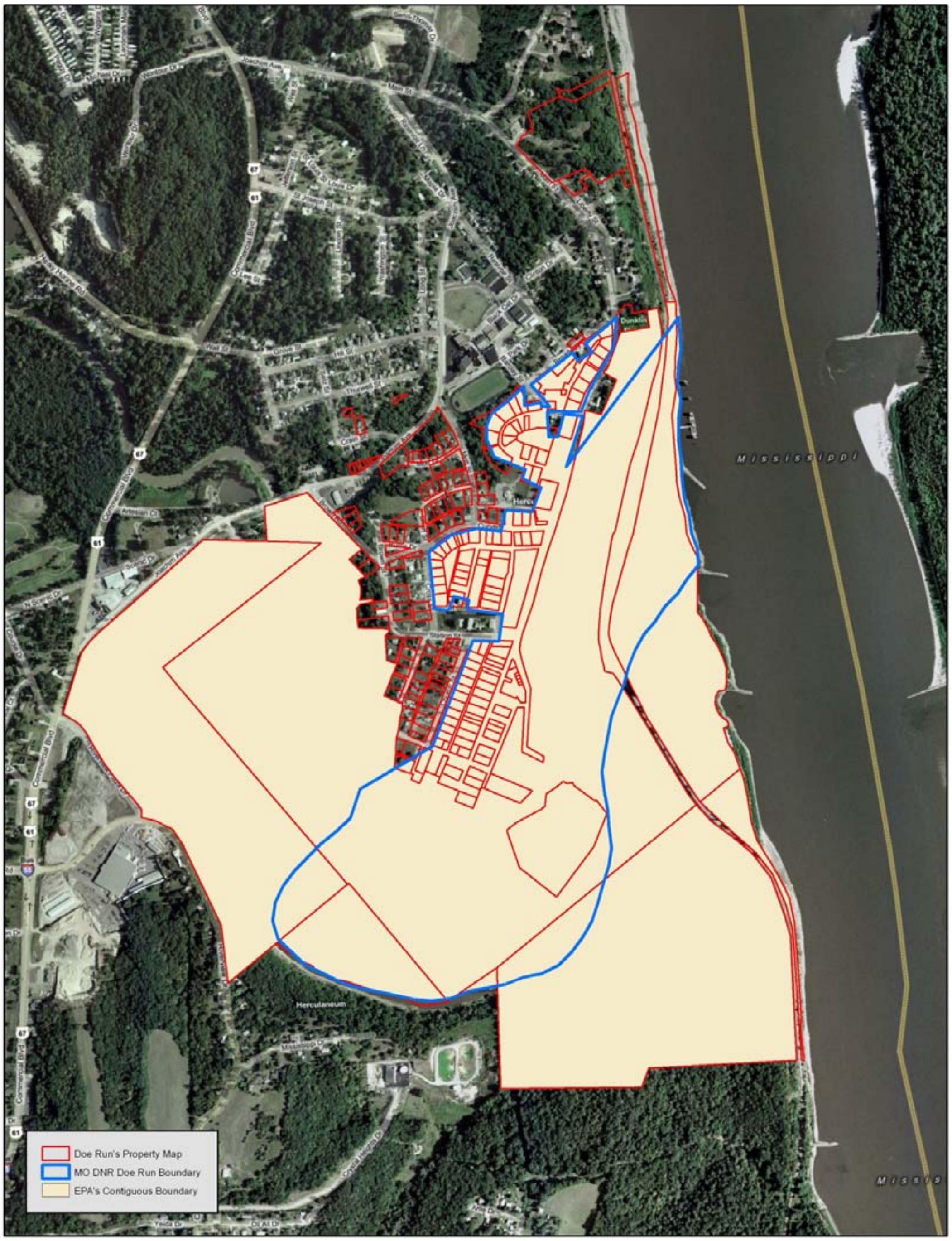


Figure 7. Revision of Primary Lead Processing Fenceline (Plant Boundary)



KEY WORDS

RTR
Risk Assessment Modeling
QA
Latitude and Longitude
Fugitive Modeling Parameters
Fenceline Maps