Health Consultation

111-Trichoroethane Modeling Report

Chrome Plating Facility
REMCO HYDRAULICS SITE

WILLITS, CALIFORNIA

APRIL 27, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

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Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) and the California Department of Health Services (CDHS) were asked by concerned citizens if their exposures to air emissions from the Remco Hydraulics Site in Willits (REMCO), Mendocino County, posed a public health hazard. Since no ambient air samples were available, ATSDR and CDHS collected available data emissions data to reconstruct the possible chemical release rates and determine their transport and fate into the community. The previous report summarizes the procedures used in determining the fate and transport of Hexavalent Chromium (Cr_6). This report describes the fate and transport of 1,1,1-trichoroethane (111-TCA). These results will be used by CDHS to assess the health impact of the site.

The Atmospheric dispersion modeling was performed using the Industrial Source Complex Short Term (ISCST3) dispersion model in conjunction with representative surface and upper air meteorological data.

Site Background

REMCO began manufacturing hydraulic cylinders at the site around 1959 with chrome plating of the cylinders commencing around 1963 and ceasing in 1995. Although there were varied plating operations occurring at the site, chromium plating was the primary operation. Seven chrome plating tanks were in use during peak periods. At times the sources released through a common vent.

ATSDR and CDHS have conducted numerous documents associated with the site, including air dispersion modeling of specific scenarios and a site health assessment that found that the airborne emission of hexavalent chromium posted a public health hazard.

Objective

The objective of this modeling exercise is to estimate the potential average annual air concentrations for two scenarios representing the 111-TCA emissions for two years 1987 and 1990. Shorter averages were not considered as there were many sources of uncertainty for daily emissions rates [ATSDR 2004].

The concentration contours will represent average annual concentrations. The contours and information of this report will be included in a comprehensive exposure assessment completed by CDHS. An electronic file of the latitude, longitude and annual concentration will be transmitted along with the document.

Methodology

The ISCST3 model was used as the local terrain was simple (no drastic changes in elevation) and most buildings are low rise buildings. The model was run using elevated terrain height to allow for any changes to local terrain. The weather data had some complications, as the wind speed had a low bias after May of 1998. However, the data

used was collected nearby on top of a long low rise building that has many similarities with the long low rise REMCO facility (from 1997-2000).

Meteorological data was collected, analyzed, and evaluated and a single year of meteorological was derived to represent typical conditions (without the low wind speed bias). Then, emissions and operations data were collected analyzed and evaluated and a single set of emissions data were developed. Except for emission rates, the model set up was identical to that in the previous ATSDR Remco Modeling report [ATSDR 2005]. Pertinent information required for health assessors is provided in Appendix A.

For this surveillance guidance document, two scenarios were developed that represent specific release characteristics from two years at the site. They are:

1987 Emission Data Provided	**Data Entered**
Stack = 32,175 lbs Fugitive = 32,175 lbs 111-TCA	Source 1 = 0.9754 g/s, 16hrs/day, 5 days/week, 52 weeks/yr No atmospheric decay 11.7 m/s from 5 m height Source 2 = 0.975 g/s, 16hrs/day 5 days/week, 52 weeks/yr Length = 100 m Lateral dispersion = 23.26 m Vertical dispersion = 0.85 m No atmospheric decay

1990 Emission Data Provided	**Data Entered**
Stack = 71,000 lbs Fugitive = 71,000 lbs 111-TCA	Source 1 = 2.18 g/sec, 16hrs/day, 5 days/week, 52 weeks/yr No atmospheric decay 11.7 m/s from 5 m height Source 2 = 2.18 g/s, 16hrs/day 5 days/week, 52 weeks/yr Length = 100 m Lateral dispersion = 23.26 m Vertical dispersion = 0.85 m No atmospheric decay

The emission data were obtained from the US Environmental Protection Agency (USEPA) Toxic Release Inventory data and provided by CDHS. Concentrations are calculated at 1.5 meters (breathing height).

Meteorological Data

An ISCST3 modeling study requires weather observations at both the surface and aloft. Due to the rural location of the REMCO facility, no nearby hourly airport or twice-daily upper air weather observations commonly distributed by the National Weather Service

(NWS) were available as input for dispersion modeling. Therefore, data was gathered from a variety of sources and locations in order to best represent the climate of Willits, CA.

Surface Data - A complete set of hourly temperature, wind speed, and wind direction data from 1997-2000 was provided by the Mendocino County Air Quality Management District (MCAQMD). The weather station providing this data was located on the roof of the Safeway Supermarket located across the street from the Remco Site at 845 South Main St., Willits, CA.

It was important to have data so close to the city because it is important to account for the local effects when evaluating the likely transport for public health purposes. While the effects of local buildings may interfere with the applicability of wind for modeling regionally, locally collected data is ideal to evaluate near-field site-specific transport.

Time series analysis of this data suggests that the wind directions were reliable for fate and transport calculations and approximately 1.5 years of the wind speed was of good quality. The wind direction data was stable and repeatable throughout the period, with the exception of two continuous events that occurred in the beginning of 1997. The "typical" produced results were similar to actual data through comparative model runs. The wind speeds measured after May 20, 1998 began to decline due to (expected) machine wear of the anemometer. Since the remaining meteorological data showed good repeatability and predictability, the wind speed data from 1997 was chosen to represent the entire period.

Upper Air Data - Twice daily data recorded at 0z and 12z was obtained via the internet from the Forecast Systems Laboratory (FSL) in Boulder, CO (now called the Earth Systems Research Laboratory) [NOAA 2006]. This data includes wind speed, wind direction, air temperature, and dew point temperature from various heights above ground level. Geographically, upper air data is not as widely recorded as surface data and this is exemplified by the fact that there are only twelve such stations across the entire state of California. For this modeling study, Oakland, CA was chosen as the upper air station and data from 1997-2000 was obtained. The upper air data will have little effect on the dispersion at the surface and there is little difference from one upper air station to the next.

Cloud Cover/Cloud Height Data - Complete NWS observations include air temperature, dew point temperature, barometric pressure, relative humidity, wind speed, wind direction, cloud height, and cloud cover. Since surface observations were obtained from a small weather station located in Willits, cloud information was unavailable. The closest NWS airport that could provide this data was Ukiah, CA. Hourly readings of cloud cover and cloud height for the years 1997-2000 were acquired electronically from the Western Regional Climate Center in Reno, NV. This data, like the upper air data will impact the regional transport more than the local transport because cloud cover is used to determine the highest altitude under which the air will mix.

Replacement of Missing and Incomplete Data

The EPA document Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models (Atkinson & Lee, July 1992) was used as the guide for this modeling project. Hourly weather data provided by the MCAQMD was a complete set and did not need any substituted values [MCAQMD 2004]. However, both the NWS cloud cover and cloud height data and the FSL upper air data required substitute data to replace missing values. In all cases, the regulatory procedures were followed. The document is attached as Appendix A.

Procedures for Developing a Complete Data Set

Estimates of hourly mixing heights are required in applications of the ISCST3 dispersion model. To produce these estimates, hourly wind speed and wind direction data from Willits, CA were combined with cloud height and cloud cover data from Ukiah, CA and placed in yearly files in Hourly United States Weather Observations (HUSWO) format. The complete HUSWO files were combined with upper air files from FSL and run through a mixing height program. This program produced hourly mixing heights which are required for a successful ISCST3 run. The procedures are outlined in Computing Twice-Daily Mixing Heights from Upper Air Soundings and Hourly Temperatures [EPA 1995].

The final step in producing a viable data set for ISCST3 is to combine the hourly mixing height file with the HUSWO hourly data set. Procedures for this step are covered in PCRAMMET User's Guide, June 1999. This preprocessor generates data files that contain the correct parameters in the proper format to be read by the ISCST3 dispersion model. This is done for the model to run. However the actual temperature, mixing height and upper air soundings have little or no impact on local dispersion. The dispersion equation for fate and transport has no temperature term. However the data needs to be complete for the model to run.

Source Characterization

After an hourly data set was completed, the Remco site was characterized so that it could be used for input in ISCST3. Parameters used as input to the model are as follows:

Yearly concentration averaging periods were used along with shorter intervals of 8 and 24 hours.

ISCST3 was run in the Elevated Terrain mode which allows for the calculation of ground level concentrations at locations higher than the source. Higher than source concentrations are completed using the COMPLEX1 algorithm within the ISCST3 model.

The exact source location was acquired by importing an electronic United States Geological Survey (USGS) quadrangle map for the Willits area and importing the map file into the ArcView mapping program. The source location, in Universe Transverse Mercator Unit (UTMs), was determined to be 469630N and 4361525E at an elevation of 423 meters. Modeling was done to mark the source locations to ensure that map and

contour coordinates matched.

A stack gas exit temperature of 295^{o}K was used for the stack emissions. Fugitive emissions have neutral buoyancy and therefore, no gas exit temperature.

Exit velocities and stack diameters for each tank were calculated from data recorded in an October 1983 operating permit from the County of Mendocino Air Pollution Control District. Flow rates in cubic feet per minute (CFM) were recorded for each tank and this data was converted into units of meters/second (m/s) needed by the ISCST3 model. This information was also used for the earlier time periods. Area measurements for each tank in square feet (ft^2) shown in the operating permit were converted to stack diameters in units of meters (m) that could be used by the model. Uncertainty: the uncertainty of using the measured rather than design flow rates may create a low bias if the measured values were only temporary as the design rates were higher than those measured [EPA, 1992].

Emissions were restricted to the hours of 7 AM through 11 PM five days per week. This operation schedule is noted in a March 1983 application permit to the County of Mendocino Air Pollution Control District.

A Digital Elevation Model (DEM) file with 1 m resolution was obtained from the US Geological Service. The DEM was imported into the ISCST3 model and elevations were inserted for each source and receptor point.

A discrete Cartesian grid centered on the source and extending outward five kilometers in all directions in conjunction with corresponding elevations was used in the modeling study. Ground level concentrations in micrograms per cubic meters (ug/m3) were generated for each discrete location.

Results

For both scenarios, ISCST3 was run with the "typical year" of meteorological data. A summary of the model results for the "index" case for each of the scenarios is provided below.

Summary of Predicted Level 111-TCA Concentrations (at 1.5 m -breathing height)

Scenario	Max Annual Concentration ($\mu g/m^3$)*
1987	539
1990	1206

***Off-site on residential property to the east of source**

The uncertainty was not calculated for these 111-TCA scenarios, but uncertainty was calculated previously for chromium emissions [ATSDR 2004].

These maximum concentrations were not calculated at any residences. The average 111-TCA concentration near homes was above 50 ug/m3 and for some as high as 500 ug/m3. Concentration contours are provided in Appendix B for the 1987 scenario (in Figure 1) and the 1990 scenario (in Figure 2).

Short-term (daily) concentrations can not be calculated due to the variability of the daily emissions and daily meteorology as well as the uncertainty with the short term meteorological data.

Discussion

The average annual concentrations predicted at residential locations are between 50 and 200 $\mu g/m^3$ and are well above the range of normal outdoor levels.

The ambient air in the United States usually contains about 0.1-1.0 parts per billion (0.546-5.46 $\mu g/m^3$). [ATSDR 2005]. Typical outdoor levels are lower than indoor levels, as 111-TCA used to be used in household products and may still be present in older household materials [ATSDR 2005].

The half life of 111-TCA in air is approximately 6 years [ATSDR 2005], so the mitigating factor for removal of 111-TCA from the resident's air would be wind.

Limitations

The estimated concentrations do not represent the reconstructed values for those two years (1987 and 1990), because the meteorological data was constructed to represent a typical year. However, they are expected to be a reasonable approximation. Since the actual meteorological measurements had errors, a single file of a typical year was constructed [ATSDR 2004]. Some studies found less than eight percent variation in dispersion from year to year due to annual variations in meteorology [Zarus 1992, Zarus 1993]. ATSDR found that one (1997) of the four years (1997-2000) analyzed for modeling, had markedly varied wind directions measured during the spring months [ATSDR 2004, Zarus 2003, Zarus 2004]. Time series plots for two similar years are provided in Appendix C.

Conclusion

Maximum annual concentrations of 111-TCA are predicted to the east and the east-southeast of the facility. The maximum annual concentration predicted was 1206 $\mu g/m^3$.

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GM Zarus 2003: “Weather is predictable,” email revealing correlations of meteorological data from different years or sites in close proximity. Mar 13, 2003. (Histogram from email provided in Appendix C).

GM Zarus 2004: “Assessment of meteorological data for modeling dispersion from the Remco Hydraulics Facility” email revealing correlations of meteorological data from different years or sites in close proximity. Jan 27, 2004. (Histogram from email provided in Appendix C).

Appendix A
Health Assessor Requirements for Health Consultations.

In December 2004, the Division of Health Assessment and Consultation (DHAC) prepared a guidance document outlining the "Use of Environmental Fate and Transport Models in Public Health Assessment and Health Consultations." This document lists five items that must be addressed in the appendix. Those items are listed below:

1) **Model Used and Rationale:** The Atmospheric dispersion modeling was performed using the Industrial Source Complex Short Term (ISCST3) dispersion model in conjunction with representative surface and upper air meteorological data. ISCST3 is a Gaussian dispersion model that is appropriate for simple terrain. The ISCST3 model was used as the local terrain was simple (simple means no drastic changes in elevation) and most buildings are low rise buildings. The model was run using elevated terrain height to allow for any changes to local terrain. The weather data had some complications. However, it was collected nearby on top of a long low rise building that has many similarities with the long low rise REMCO facility.

2) **Input Parameters**

Scenario 1: No atmospheric decay

Source 1 = 0.9754 g/s, 16hrs/day, 5 days/week, 52 weeks/yr
11.7 m/s from 5 m height

Source 2 = 0.975 g/s, 16hrs/day, 5 days/week, 52 weeks/yr
Length = 100 m; Lateral dispersion = 23.26 m
Vertical dispersion = 0.85 m

Scenario 2: No atmospheric decay

Source 1 = 2.18 g/sec, 16hrs/day, 5 days/week, 52 weeks/yr
11.7 m/s from 5 m height

Source 2 = 2.18 g/s, 16hrs/day 5 days/week, 52 weeks/yr
Length = 100 m; Lateral dispersion = 23.26 m
Vertical dispersion = 0.85 m

Source: CTEH provided the reported emissions for the facility in 1989 and 1990.

Meteorological data Used: Surface Data - A complete set of hourly temperature, wind speed, and wind direction data from 1997-2000 was provided by the MCAQMD. The weather station providing this data was located on the roof of the Safeway Supermarket located across the street from the Remco Site at 845 South Main St., Willits, CA. (see methodology section)

3) **Source Data:** The input emission rates are reported as actual annual and the output value are average annual. Since annual data was available for emissions, annual average calculations were appropriate. The modeled source was "turned

on" for 16 hours per day as reported and therefore, the concentrations represent, averages including "on" and "off" hours.

4) **The Duration of Predicted Exposures:** The duration of these exposures is likely to be several years. Average annual concentrations are appropriate to calculate as the daily uncertainty of the emission rates and the daily variability of meteorology are minimized by time averaging.

5) **Uncertainty:** The uncertainty is discussed in ATSDR 2004. Since the ISCST3 model conserves mass, the larges source of error becomes the source term when calculating annual averages within entire communities. The source term was provided by CTEH, and represents emissions calculated using mass balance and reported usage of 111-TCA. The source emission term provided was a factor of 2 (or 100%) different. Year to year variability may be more.

   The wind directions were similar for all but one of the five years. In that one year, direction varied for only a number of days within the year; general trends for the years are shown in Appendix C. Wind speeds varied from year to year. We expect that the anemometer under reported as time progressed; so, therefore, the earliest (highest year) was used. This may under estimate potential exposures slightly. Specifically, if wind speed was underestimated by as much as 40% (a high value), then the concentrations would be over predicted by 40%. Having thrown out the lower wind speeds, we may have underestimated concentration for any specific year; however, over many years those exposures will "average out" to be lower.

Appendix B: Modeled Contours of 111-TCA

Figure 1: Contours of Predicted 111-Trichoroethane Concentrations for 1987

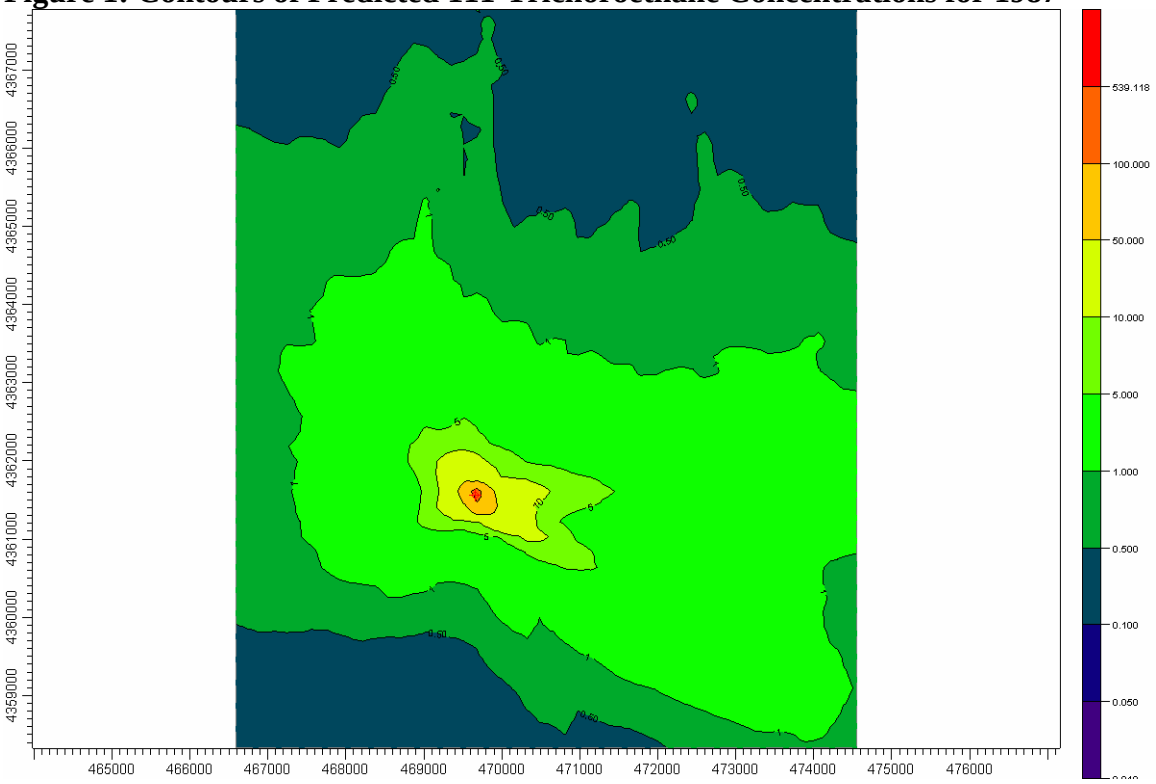


Figure 2 Contours of Predicted 111-Trichoroethane Concentrations for 1990

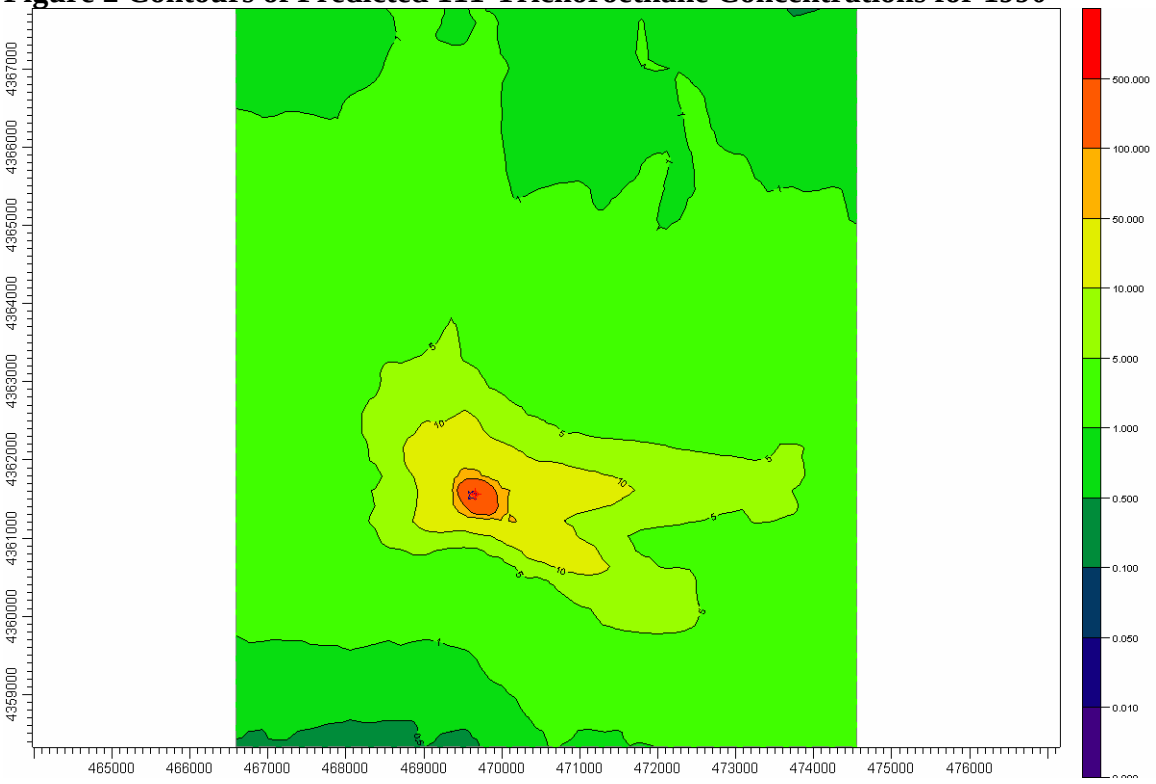


Figure 3: Contours of Predicted 111-Trichoroethane Concentrations for 1987 (for a focused area of 20KM^2)

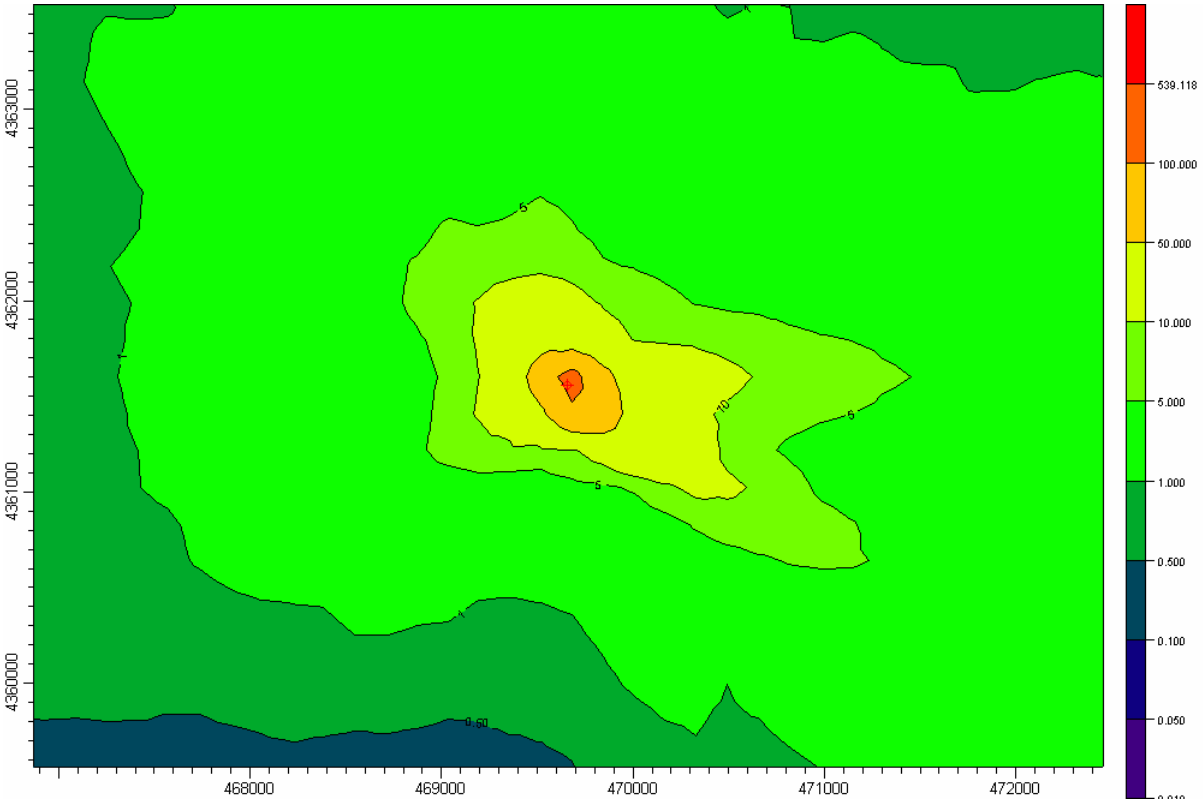
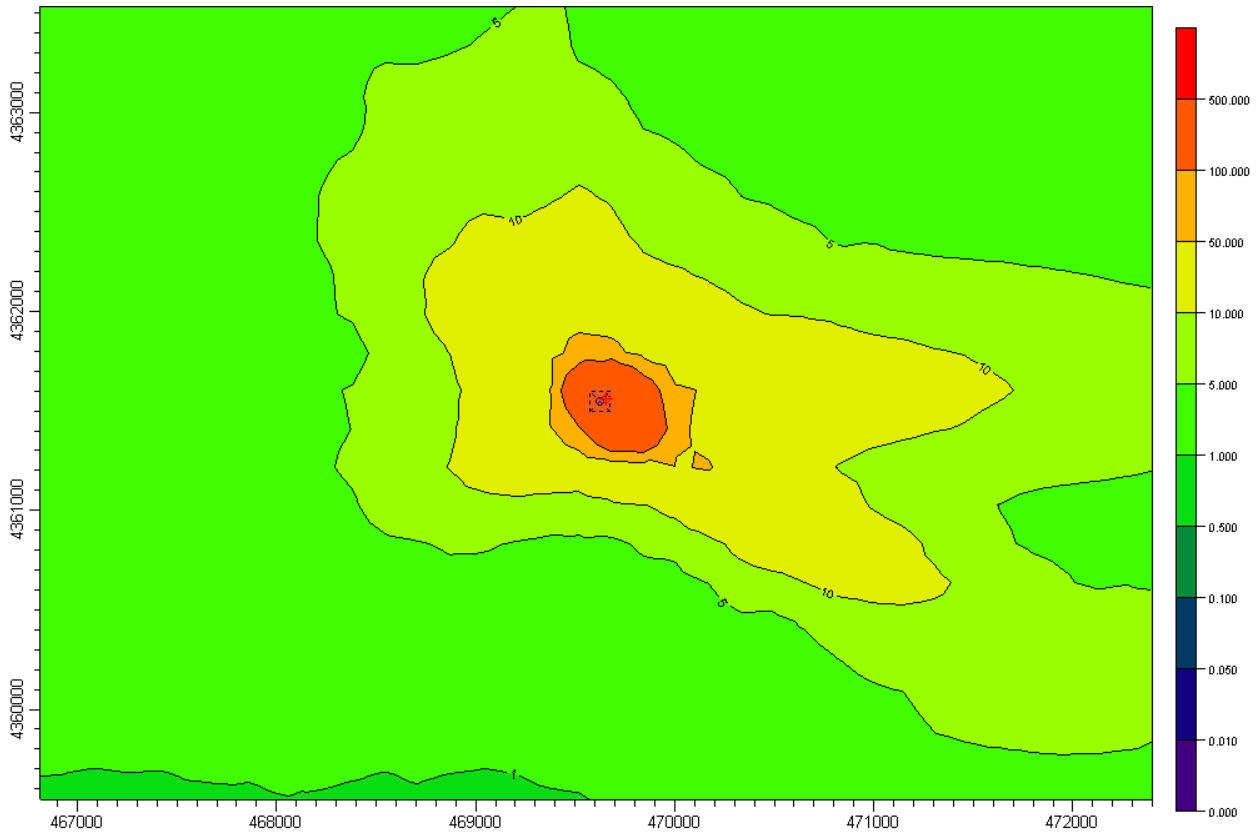


Figure 4 Contours of Predicted 111-Trichoroethane Concentrations for 1990 (for a focused area of 20KM^2)



Appendix C: Similarities in Annual Wind Direction

These figures represent the raw data collected in Willits, CA in 1998 and 1999, respectively. The red line indicates the daily averages and the yellow line is a linear trend line.

Figure 5: Hourly Wind Direction Histogram for 1997 (On the vertical axis, north is 0 º or 360 º, east is 90 º, south is 180 º, and west is 270 º –representing compass degrees).

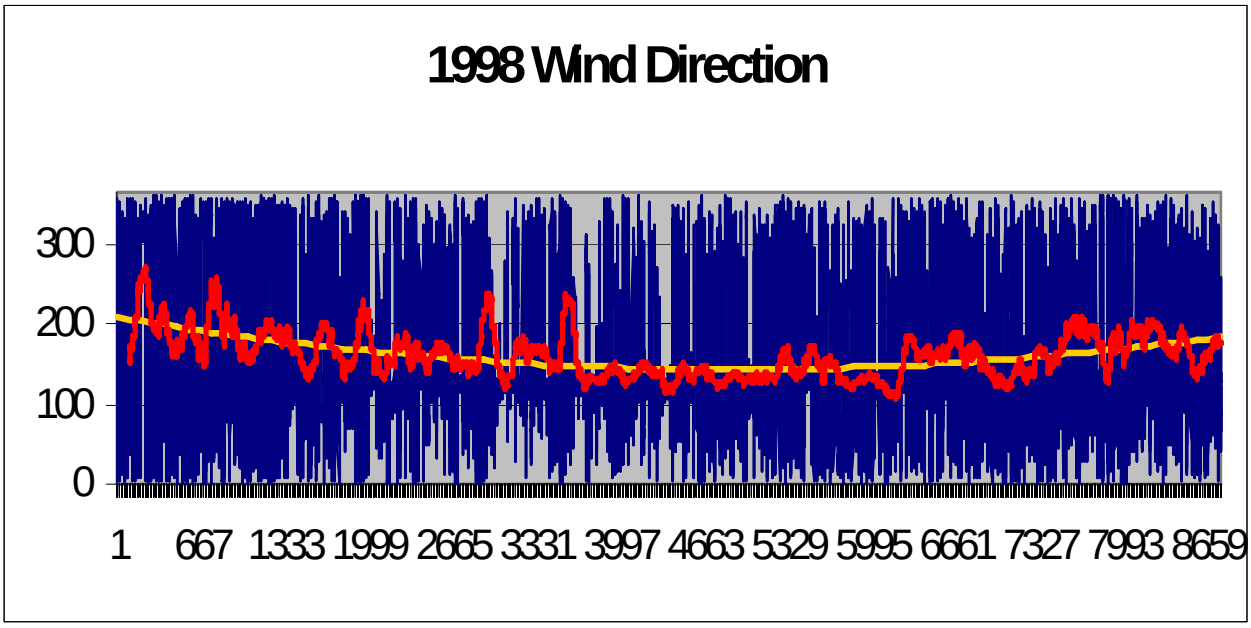


Figure 6: Hourly Wind Direction Histogram for 1999 (On the vertical axis, north is 0 º or 360 º, east is 90, south is 180 º, and west is 270º –representing compass degrees).