

Letter Health Consultation

Evaluation of the Potential Public Health Implications of Ambient Air Exposures
to Manganese in the Vicinity of a Steel Mill

EVRAZ ROCKY MOUNTAIN STEEL MILL
PUEBLO, PUEBLO COUNTY, COLORADO

Prepared by
Colorado Department of Public Health and Environment

AUGUST 14, 2013

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
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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LETTER HEALTH CONSULTATION

TO: Nancy Chick, Ambient Air Monitoring Specialist, APCD/CDPHE

FROM: Thomas Simmons, Health Assessor, CCPEHA/DCEED/CDPHE

SUBJECT: Evaluation of the Potential Public Health Implications of Ambient Air Exposures in the Vicinity of a Steel Mill (ERMS Site)

CC: Gordon Pierce, APCD/CDPHE and Raj Goyal, Ph.D, Principal Investigator, CCPEHA/DCEED/CDPHE

DATE: 8/15/2013

Purpose

The purpose of this follow-up letter health consultation is to determine the potential for public health impacts of manganese inhalation by reviewing the new ambient air PM₁₀ data in the vicinity of the Evraz Rocky Mountain Steel mill (ERMS). If necessary, the Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) will also recommend actions to reduce exposure.

Background

Based on the data that were available at the time of the previous health consultation in 2009, CCPEHA concluded that it could not be determined if the ambient air adjacent to the ERMS could harm residents' health (ATSDR 2010). This conclusion was reached because the available ambient air data only included total suspended particulate (TSP) data. To fill this data gap, CCPEHA made a recommendation to collect PM₁₀ (particulate matter less than 10 micrometers in diameter) ambient air data for manganese. Additional ambient air data have been collected since the time of the initial health consultation, including the PM₁₀ fraction.

Site Description

ERMS currently operates a steel mini-mill at 1612 East Abriendo Avenue in Pueblo, Colorado (Figure 1). The site is located in a mixed residential and industrial/commercial area. Plant operations include melting steel scrap with additives to produce molten steel, casting molten steel, and producing forms such as rails (ARS 2012). The additives depend upon the product and quality specifications, but typically include carbon (from coal), limestone, fluxing agents, and oxygen. Manganese is used to improve the hardness, stiffness, and strength of steel (ATSDR 2012). The melting operation is a batch process that uses materials specific for the type of steel being produced. Currently, ERMS produces over 150 different grades of steel (Burns and McDonnell 2008).

ERMS is a regulated facility under the federal Clean Air Act, which is administered by the CDPHE under the authorization of the U.S. Environmental Protection Agency (EPA). An air monitoring program began at the mill on September 1, 2002. Prior to March 2006, the mill modified their two-electric arc furnace steel melting operations to a single modern furnace with a dual fabric filter control system (4th hole and canopy controls). This was designed to be New Source Performance Standards (NSPS) compliant. From March 1, 2008 through February 28, 2009, Air Resource Specialists, Inc. (ARS) of Fort Collins, Colorado executed the Phase II post-construction monitoring program of oxides of nitrogen, meteorological, and particulate/metals parameters. However, TSP was the only data available for metals. From September 1, 2009 and March 1, 2012, Air Resource Specialists continued the monitoring program, but modified the sampling to include the PM₁₀ fraction.

ERMS Air Sampling Data

Currently, PM₁₀ samples are collected with a Hi-Vol PM₁₀ sampler once every three days over a period of 24 hours from midnight-to-midnight from the monitoring station located on the north end of the ERMS facility (Figures 1 and 2). Between September 1, 2009 and March 1, 2012, 293 air samples were collected from the monitoring station located on the north end of the ERMS facility (Figures 1 and 2) (ARS 2010a to d; 2011a to d; 2012).

The summary statistics for the manganese concentration in the PM₁₀ fraction are shown below in Table 1. The 24-hour minimum and maximum detected concentrations of manganese were 0.0028 µg/m³ and 1.32 µg/m³, respectively with an overall average concentration of 0.126 µg/m³. To screen the data for potential health concerns, the maximum detected manganese concentration was compared with the ATSDR's Chronic Environmental Media Evaluation Guide of 0.3 µg/m³ (ATSDR 2013a). The maximum concentration of manganese exceeds the screening value, which requires further evaluation to determine if there is a potential public health concern.

Table 1. Summary Statistics of Ambient Air Concentration of Manganese (PM₁₀); Data collected by ARS (2009-2012)

Minimum Detected 24-hour Average Concentration (in µg/m ³)	Maximum Detected 24hour Average Concentration (in µg/m ³)	Overall Average Concentration (in µg/m ³)	Median Concentration (in µg/m ³)	Number of Samples
0.0028	1.32	0.126	0.087	293

NOTE: µg/m³: micrograms per cubic meter of air

As shown in the Figures 1 and 2, the monitoring station is located on the northern end of EMRS property, which is also just south (across the street) from a residential neighborhood. If health effects are not expected to occur from residential exposure, it is unlikely that health effects would occur for any other group of individuals (e.g. off-site workers, recreational users, etc.)

because the residents are conservatively assumed to be exposed the ambient air on a nearly constant basis. In addition, the area surrounding the mill in all other directions is best described as industrial and/or open space, so there is limited exposure to air contaminants by other receptor populations. The location of the monitoring station is appropriate for evaluating residential exposures. In fact, the purpose of the monitoring site was to capture pollutant impacts that are representative of the concentration level of various pollutants in “ambient air” that travel northward from the plant, into a nearby residential area. It should be noted that the primary wind direction is out of the northwest to the southeast (i.e. away from the neighborhood) as shown in the 3-year wind rose (Figure 3). Since the exact location(s) of the source(s) of manganese that may be impacting the monitor are not well understood, it is unknown if the monitored concentrations levels are representative of a “highest exposure.” This is noted as a potential limitation in the data.

Evaluation of Potential Health Risks

Standardized protocols established by the ATSDR and EPA were used to evaluate the potential public health implications of residential exposure to manganese in ambient air (ATSDR 2005 and EPA 2009). The method used is based on a calculated air concentration of manganese for residential exposures. The calculated air concentration is then compared to health-based guidelines such as ATSDR’s Minimal Risk Level (MRL) and EPA’s Inhalation Reference Concentration (RfC). If the calculated exposure concentration exceeds the health-based guidelines, a more detailed analysis is conducted. This includes an evaluation of the calculated air concentration in relation to known adverse effect levels documented in scientific literature.

For this evaluation, it was assumed that residential exposure to manganese in air occurs 24 hours per day, 350 days per year over a period of 30 years. The residential default values are sufficiently protective of child and adult residents living near the ERMS site. It should also be noted that the estimated exposure concentration was not adjusted to account for the relative difference between outdoor ambient air and indoor air. However, it is reasonable to assume, for the sake of this evaluation that the levels of manganese in the available outdoor air data is equal to the levels that would be found in indoor air of residential properties surrounding the mill.

To estimate the long-term average exposure concentration, the ambient 24-hour average PM_{10} data samples collected from September 2009 through March 2012 were used. Based on EPA’s statistical software called ProUCL (latest version 4.1.00), the 95% H-statistic Upper Confidence Limit (UCL) of the mean concentration ($0.15 \mu g/m^3$) was used in this health evaluation.

The most common health problems associated with exposure to high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that may become slow and clumsy. This combination of symptoms when sufficiently severe is referred to as “manganism”. Other less severe nervous system effects such as slowed hand movements have been observed in some workers exposed to

lower concentrations in the work place. Manganese is not a known or suspected carcinogen since very little evidence exists at this time to suggest that exposure to manganese results in cancer.

In comparison to health-based guidelines, the estimated exposure concentration of $0.15 \mu\text{g}/\text{m}^3$ for manganese was 3.0 times higher than EPA's RfC of $0.05 \mu\text{g}/\text{m}^3$. However, when the estimated exposure concentration was compared to observed health effect levels used to derive EPA's RfC, the estimated concentration of manganese for residents in the vicinity of ERMS is well below the observed values (Table 2). In addition, the ATSDR recently revised the Minimal Risk Level (MRL) for manganese particles in air from $0.04 \mu\text{g}/\text{m}^3$ to $0.3 \mu\text{g}/\text{m}^3$ (ATSDR 2012). The estimated exposure concentration of manganese in this evaluation is lower than the revised MRL. The Benchmark Dose Level associated with a 10% response rate (BMDL_{10}) was derived from an occupational cohort study of 92 male workers from a dry alkaline battery plant that were exposed to manganese in respirable dust. The workers performance on a battery of neurobehavioral tests was compared with an unexposed control group of 101 age and area matched workers that were not occupationally exposed to manganese. It was determined that the worker group's performance was significantly worse than the control group's, particularly in the measures of simple reaction time, hand-eye coordination, and hand steadiness. The exposure concentration at the plant was measured using personal samplers on the workers, and a BMDL_{10} of $74 \mu\text{g}/\text{m}^3$ for manganese was derived using a benchmark dose analysis. The BMDL_{10} of $74 \mu\text{g}/\text{m}^3$ is expected to result in a 10% response rate on neurobehavioral testing and is considered an acceptable surrogate for a NOAEL (ATSDR 2012). Therefore, the estimated residential exposure concentration of $0.15 \mu\text{g}/\text{m}^3$ is approximately 500 times lower than the surrogate No Observable Adverse Effect Level (NOAEL) identified in the studies and 1,000 times lower than the level that adverse health effects were observed, which includes subtle neurological changes in workers. This information, along with the conservative assumptions utilized in this evaluation, indicates that adverse health effects are not likely to occur in the residential area surrounding ERMS if the exposure assumptions used in this evaluation are representative of residential exposures. However, to be prudent of public health, reasonable actions should be taken to lower the concentration of manganese, preferably to levels lower than the EPA Reference Concentration of $0.05 \mu\text{g}/\text{m}^3$.

Table 2. Comparison of the Estimated Inhalation Exposure Concentration of Manganese and Non-cancer Toxicity Values

Estimated Exposure Concentration $\mu\text{g}/\text{m}^3$	ATSDR Minimal Risk Level in $\mu\text{g}/\text{m}^3$		Manganese Benchmark Dose Level with 10% Response $\mu\text{g}/\text{m}^3$	Manganese Lowest Observed Adverse Effect Level $\mu\text{g}/\text{m}^3$
0.146	0.3	0.05	74	150
Hazard Quotients	$0.146/0.3 = 0.5$	$0.146/0.05 = 3.0$	N/a	N/a

NOTE: - $\mu\text{g}/\text{m}^3$: micrograms per cubic meter of air

- Hazard Quotient is equal to the estimated exposure concentration divided by the non-cancer toxicity values.

Uncertainties and Limitations

In general, any risk evaluation is likely to over- or underestimate environmental exposures and the associated health risks because of the uncertainty associated with various exposure assumptions and toxicity values. This section of the discussion is not intended to be an in-depth description of all the uncertainties associated with this evaluation. Rather, the focus is to highlight the major assumptions and limitations that are specific to this evaluation and result in uncertainty.

- The estimated residential exposure concentration of manganese in ambient air is based on data collected at a single monitoring site between September 1, 2009 and March 1, 2012. Potential health impacts based on the concentrations found during this period could over- or under-estimate the true long-term risk since they may not reflect the actual long-term residential exposure concentration.
- Various sources of manganese in the vicinity of ERMS are not known. Therefore, the estimated risk in this evaluation may over- or under-represent possible contributions from the steel mill.
- Short-term acute and intermediate exposures to manganese cannot be evaluated because no health guidelines are available. However, the available evidence suggests that the concentration of manganese would have to be much higher to experience acute health effects.
- The available PM_{10} ambient air data is limited to manganese data. Therefore, exposure to other metals in the PM_{10} fraction and the potential health effects of cumulative exposures could not be evaluated.

Conclusion

Based on a thorough review of the current ambient air monitoring data in the vicinity of the ERMS mill in Pueblo, Colorado, CCPEHA has reached one conclusion in regards to residential exposures. It should be noted that this conclusion is relevant only for residential exposure to the PM₁₀ data collected from the northern monitoring station. If additional environmental data or an alternative land-use/exposure scenario is identified in the future, the findings of this health consultation should be reconsidered.

Exposure to ambient air in the vicinity of the Evraz Rocky Mountain Steel Mill is not expected to harm current or future residents' health based on the currently available air monitoring data. This conclusion was reached because the estimated residential exposure concentration of manganese in ambient air near the steel mill is well below levels of manganese found to be associated with harmful health effects in human exposure studies. For example, the estimated residential exposure concentration of manganese is approximately 500 times lower than the surrogate No Observable Adverse Effect Level (NOAEL) and approximately 1,000 times lower than the Lowest Observable Adverse Effect Level (LOAEL). In addition, the ATSDR recently revised the Minimal Risk Level (MRL) for manganese particles in air from 0.04 µg /m³ to 0.3 µg/m³ (ATSDR 2012). The estimated exposure concentration of manganese in this evaluation is lower than the revised MRL. This provides further evidence that adverse health effects are not likely to occur from exposure to manganese in air surrounding ERMS. It should be noted, however, that this conclusion is associated with some uncertainty because the exposure point concentration of 0.146µg /m³ for manganese in ambient air near the mill is 3 times greater than EPA Reference Concentration for manganese (i.e., above the acceptable level of Hazard Quotient of one).

Recommendations

- CDPHE's APCD should continue to require ambient air monitoring data for manganese and ERMS should take all reasonable action to reduce the levels of manganese emitted from the facility.
- APCD should request that ERMS continue its efforts to identify sources of manganese emissions within their property boundary. Once there is a better understanding of the origin of the manganese emissions that affect the monitoring site, APCD should determine if additional monitoring is warranted at another location if there is reason to believe the current monitoring site is not representative of the highest exposure in residential areas.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by CCPEHA and other governmental agencies at the site. The purpose of the public health action plan is to ensure that this public health consultation both identifies public health

hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from breathing, drinking, eating, or touching hazardous substances in the environment. Included is a commitment on the part of CCPEHA to follow up on this plan to be sure that it is implemented.

Public health actions that will be implemented include:

- CDPHE's APCD should continue PM₁₀ monitoring at the facility.
- Upon request, CCPEHA will review and evaluate any future air data.
- CCPEHA will make the findings of this evaluation available to the public and stakeholders.

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Report Preparation

This Letter Health Consultation was prepared by the Colorado Department of Public Health and Environment (CDPHE) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved agency methodology and procedures existing at the time the letter health consultation was initiated. Editorial review was completed by the cooperative agreement partner. The Agency for Toxic Substances and Disease Registry has reviewed this health consultation and concurs with its findings based on the information presented in this report. ATSDR's approval of this document has been captured in an electronic database, and the approving reviewers are listed below.

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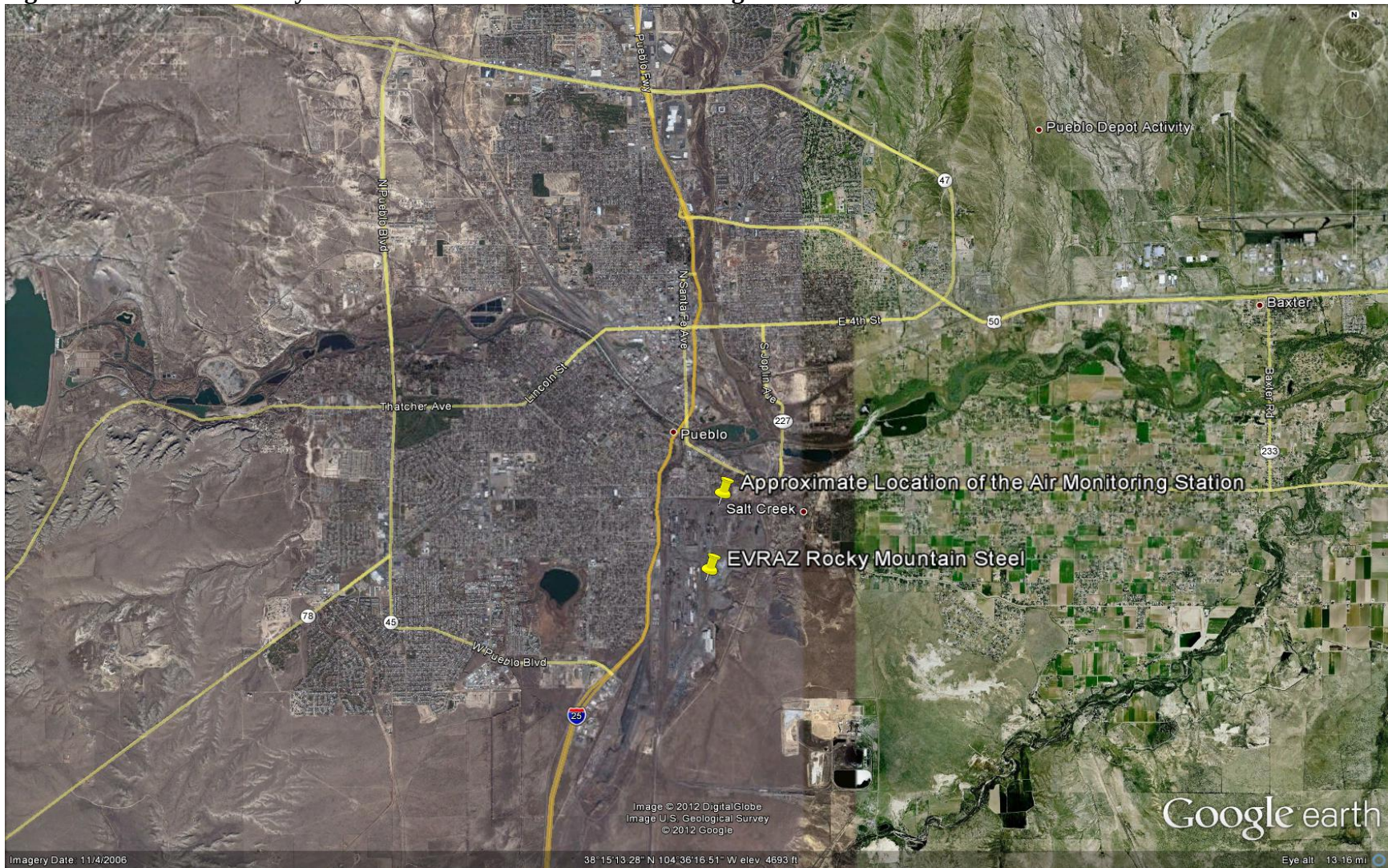
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Figure 1. Location of Rocky Mountain Steel and the Air Monitoring Station



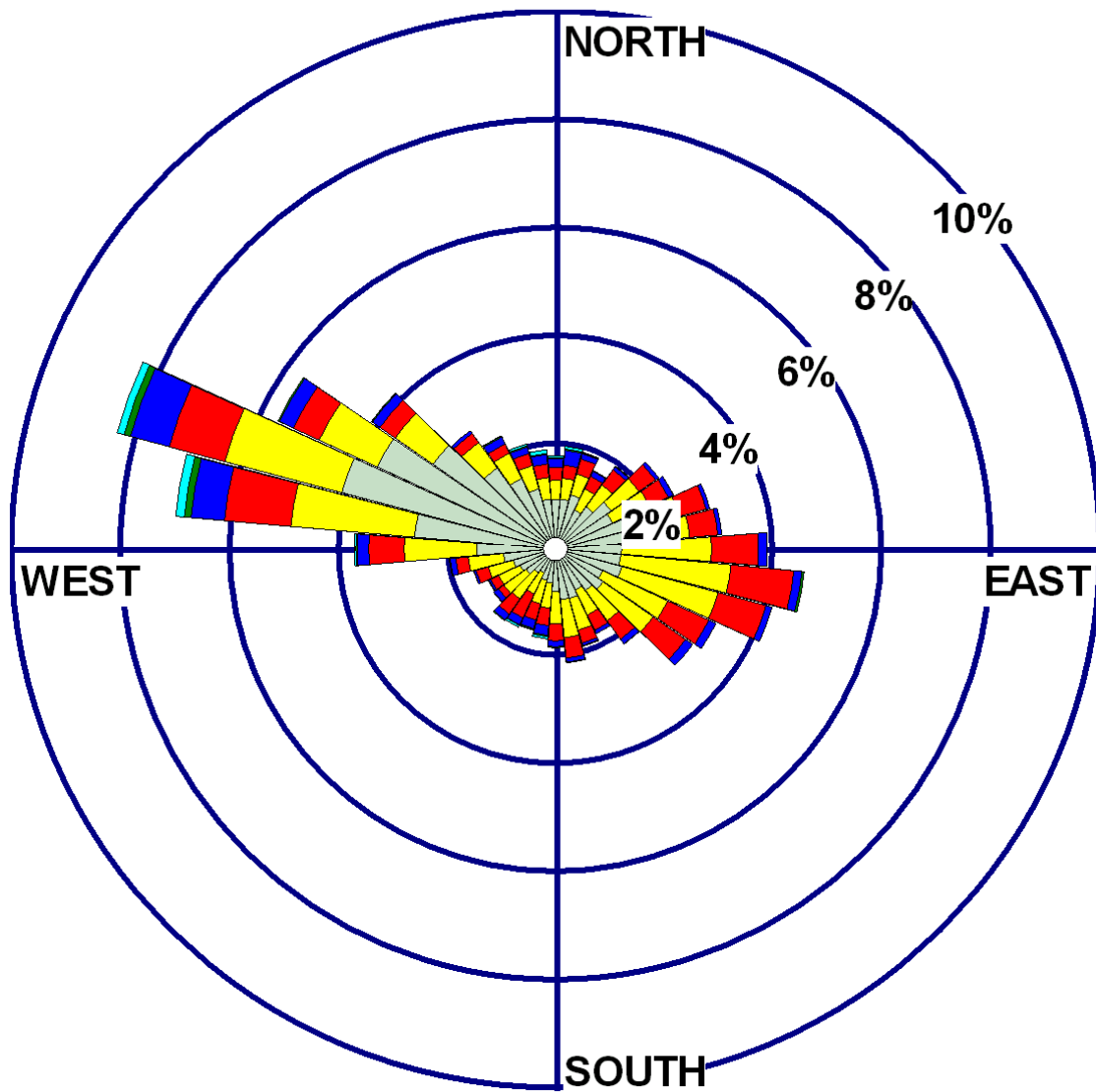
SOURCE: Google Earth 2012

Figure 2. Air Monitoring Station used to Collect Ambient Air Data



SOURCE: Air Resource Specialists 2012 (Quarterly Monitoring Report)

Figure 3. Annual Wind Rose in the Vicinity of the Evraz Rocky Mountain Steel Mill



SOURCE: Developed by the Air Pollution Control Division of the Colorado Department of Public Health and Environment based on data from Air Resources Specialists