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Risk Assessment Based on Review of Fenceline Monitoring Data from Integrated Iron and Steel Manufacturing Facilities

Prepared by American Iron and Steel Institute and U. S. Steel Corporation with the assistance of AECOM

Executive Summary

Fenceline air monitoring for chromium, arsenic and lead was conducted at four integrated iron and steel (II&S) facilities as part of a 2022 Information Collection Request (ICR) to support the National Emission Standards for Hazardous Air Pollutants (NESHAP) for II&S Manufacturing Facilities (40 C.F.R. Part 63 Subpart FFFFF) as part of the Risk and Technology Review (RTR) process. We have reviewed the fenceline air monitoring data that has been collected at these facilities, other available ambient monitoring data, and data from a prior 2011 II&S ICR that also was collected in support of the RTR process. Applying a hexavalent chromium to total chromium ratio based on data from a representative ambient air monitoring site and using the inhalable portion of particulate matter in the risk calculation results in acceptable risk at all monitor locations. The risk is less than 22 in a million at monitor locations closest to sensitive receptors, as shown in Table ES-1 below. The primary risk driver for the overall cancer risks shown in the table is arsenic, which is consistent with the modeling published by EPA in support of the RTR.

Table ES 1 Summary of Estimated Cancer Risks within/at the Fenceline and Nearest Sensitive Receptors at Each Monitor

Facility	Monitor	Overall Cancer Risk[1]	Nearest Sensitive Receptor
Gary Works	ST1-North	59	> 2.4km away to the S, SW & E
Gary Works	ST2-East	10	> 1.1km away to S, SE and E
Gary Works	**ST3-South**	**21***	**600-700m to the S, SW & SE, across I-90**
Gary Works	ST4-West	9	> 2.5km away to S and W
Granite City	ST1-North	9	~100m to the N and E
Granite City	**ST2-LeeAve**	**14***	**50-75m to the NW and NE**
Granite City	ST3-South	22	~450m to the SW
Granite City	**ST4-West**	**10***	**50-75m to the S, SW and W**
Granite City	ST5-Central	29	~850m to the SW, N & NE
Burns Harbor	BH1	18	> 2km to the E
Burns Harbor	BH2	4	~500m to the SE/S
Burns Harbor	**BH3**	**5***	**~350m to the E**
Burns Harbor	BH4	8	~2.8km to the W
Cleveland Works	CLE S1	15	~ 350m to the E/SE, across HWY 77
Cleveland Works	**CLE S2**	**6***	**30-50m to the E/SE/S**
Cleveland Works	CLE S3	5	300m to the E/SE/S
Cleveland Works	CLE S4	4	500m to the N

* Each facility's risk nearest to sensitive receptors. Note that the facility contribution to the nearest sensitive receptor would be expected to be less than the monitored concentrations due to distance.

[1] The overall cancer risk shown in Table ES 1 uses the hexavalent chromium to total chromium ratio of 0.97% (the highest ratio from the representative monitor in Dearborn, MI after implementation of the NESHAP) and the PM_{10} fraction of TSP. It does not reflect reduction for non-II&S source category or off-site contributions to measurements at the fenceline monitors.

Introduction

Fenceline air monitoring data were collected at four II&S facilities from May to November of 2022 for arsenic, total chromium, lead and total suspended particulates (TSP) in support of the NESHAP RTR process. In addition, two facilities collected data for particulate matter 10 microns or less (PM_{10}).

The following subsections discuss the basis of our risk assessment, including key factors and observations considered when evaluating the data collected and calculating estimated cancer risk. Specifically, we found:

1. Actual ambient data (8+ years) provide a hexavalent to total chromium ratio of 0.68% - 0.97%, which is supported by slag testing data.
2. For particulate metals, the inhalable portion of particulate matter (PM_{10}) should be used to assess risks; the use of TSP rather than PM_{10} would overestimate inhalation risk.
3. Monitors that are close to sensitive receptors (*e.g.*, residences, etc.) show lower estimated risks; monitors with higher measured concentrations are not representative of risk at sensitive receptors.
4. Potential offsite contributions to these monitors have been identified, which would result in an overestimation of the risk attributable to II&S facilities.

In each subsection below, we discuss areas which would overestimate risk. It should be noted that EPA typically uses values that are one half of the detection limit for developing emissions used in risk assessment modeling;[2] however, the ratios calculated as part of this study apply more conservative modeling assumptions through the use of the detection limit when calculating the average monitored concentrations and associated cancer risks over the six-month monitoring period.

Hexavalent Chromium to Total Chromium Ratio

Estimation of Hexavalent Chromium

The fenceline outdoor air sampling conducted under the 2022 ICR monitored total chromium in order to help determine potential emissions from nonpoint sources at II&S facilities as part of the RTR process. In order to estimate speciated chromium emissions of chromium VI (hexavalent chromium) from this data, a hexavalent chromium to total chromium ratio is applied to the chromium concentrations collected. We have reviewed the fenceline monitoring data that has been collected at these facilities. We have also reviewed available data collected at a representative ambient air monitoring site for both hexavalent chromium and total chromium. As shown in Table 2, applying a hexavalent chromium to total chromium ratio derived from that ambient monitoring data and accounting for the PM_{10} fraction of TSP results in an estimated overall risk assessment for hexavalent chromium of less than 22 in a million as derived from monitors closest to residences and other sensitive receptors.

We note that, as part of a prior 2011 II&S ICR, the primary and secondary basic oxygen process furnaces (BOPF), blast furnace (BF), and BF stoves at II&S facilities tested for hexavalent chromium in addition to

[2] EPA, *Guidelines for Human Exposure Assessment*, EPA/100/B-19/001, at 75 (Oct. 2019), https://www.epa.gov/sites/production/files/2020-01/documents/guidelines_for_human_exposure_assessment_final2019.pdf

total chromium. EPA used the 2011 ICR stack testing data as part of its 2019 RTR process. The average hexavalent to total chromium ratio developed by EPA from BOPF primary unit stack tests was 0.39 and the ratio from the BOPF secondary unit stack tests was 0.10.[3] At the time, the 10% and 39% hexavalent to total chromium ratios were applied to total chromium data for other point source emissions units at II&S facilities (ladle metallurgy, sinter plants, etc.) that had not tested for hexavalent chromium in order to estimate hexavalent chromium emissions from those units across the industry. Application of such ratios to the fenceline data that has been collected as part of the 2022 ICR would raise several areas of concern as a methodology that would rely on assumptions that are not representative of actual hexavalent chromium concentrations at the fenceline nor of such concentrations that could potentially be attributable to nonpoint sources. Our evaluation relies on actual ambient monitoring data and slag testing data to estimate speciated chromium emissions at the fenceline, as discussed below.

In addition, as previously commented upon by AISI,[4] the 10% and 39% hexavalent to total chromium ratios developed by EPA in 2019 were based on total chromium concentrations measured using EPA Method 29 and hexavalent chromium concentrations measured using EPA Method 0061. Method 0061 is susceptible to interferences that can result in an overestimation of hexavalent chromium emissions. This resulted in some facilities showing hexavalent to total chromium ratios greater than 100%, which is not physically possible.[5] These flawed higher values were used by EPA to estimate industry-wide hexavalent to total chromium ratios for emissions in 2019, nevertheless resulting in acceptable risk. Yet, usage of those hexavalent to total chromium ratios can result in overestimation of hexavalent chromium emissions.

Overestimates of total chromium emissions would also result from attributing all of the total chromium measured at the fenceline monitors to the II&S source category because it does not account for contributions of total chromium from other sources that are also measured by fenceline monitors, such as nearby industrial operations, storage piles, and on- and off-site roadways. These other sources would have different hexavalent chromium to total chromium ratios. Application of a hexavalent to total chromium ratio to the total chromium measured by fenceline monitors would not account for total chromium from non-II&S source category sources, thereby skewing the concentrations at the fenceline monitors. To avoid this overestimation of total chromium from the II&S source category and therefore of risk, total chromium measurements determined to be susceptible to non-source category contribution should be corrected when calculating hexavalent chromium estimates. The results in Table ES-1 do not include this correction and are therefore conservative estimates of risk.

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[3] *See* Mem. of Donna L. Jones to II&S RTR Project File on Source Data Summary, EPA-HQ-OAR-2002-0083-0955, at 11 (May 1, 2019), https://www.regulations.gov/document/EPA-HQ-OAR-2002-0083-0955 ; *see* Mem. from Donna L. Jones to II&S RTR Project File on Summary of Integrated Iron and Steel Point Source Emissions Estimates for Risk and Technology Review, EPA-HQ-OAR-2002-0083-0960, at 11, Table 6 (May 1, 2019), https://www.regulations.gov/document/EPA-HQ-OAR-2002-0083-0960 (explaining that the hexavalent to total chromium ratios were calculated using 2011 ICR stack test data collected as part of the II&S RTR process from the basic oxygen furnace (BOF) primary furnaces, ladles / hot metal transfers, desulfurization, and skimming (HMTDS) process units which had industry-wide ratios of 39% and 10%, respectively).

[4] *See* AISI, *Comments on EPA December 12, 2014 Integrated Iron and Steel Risk and Technology Review Modeling Data File*, at 5 (Mar. 13, 2015), https://www.regulations.gov/document/EPA-HQ-OAR-2002-0083-0711.

[5] *See* EPA Point Source Data Summary Mem., *supra* note 3, at 11.

Review of Available Hexavalent and Total Chromium Ambient Monitoring Data

A review of available monitoring data was conducted to assess whether there is coinciding hexavalent and total chromium ambient measurements that are representative of concentrations downwind of II&S facilities. EPA's air toxics database includes nearly nine years of ambient hexavalent chromium and total chromium monitoring data near the fenceline downwind of the II&S facility in Dearborn, MI. This data helps inform the hexavalent to total chromium ratio that would be expected from II&S facility emissions. As detailed below, it shows the ratios of hexavalent chromium to total chromium ranged from 0.68% to 0.97% after the implementation of the II&S NESHAP, showing no support for applying the 10% to 39% hexavalent chromium to total chromium ratios derived from the 2011 ICR stack testing to total chromium values generated at the fenceline monitors.

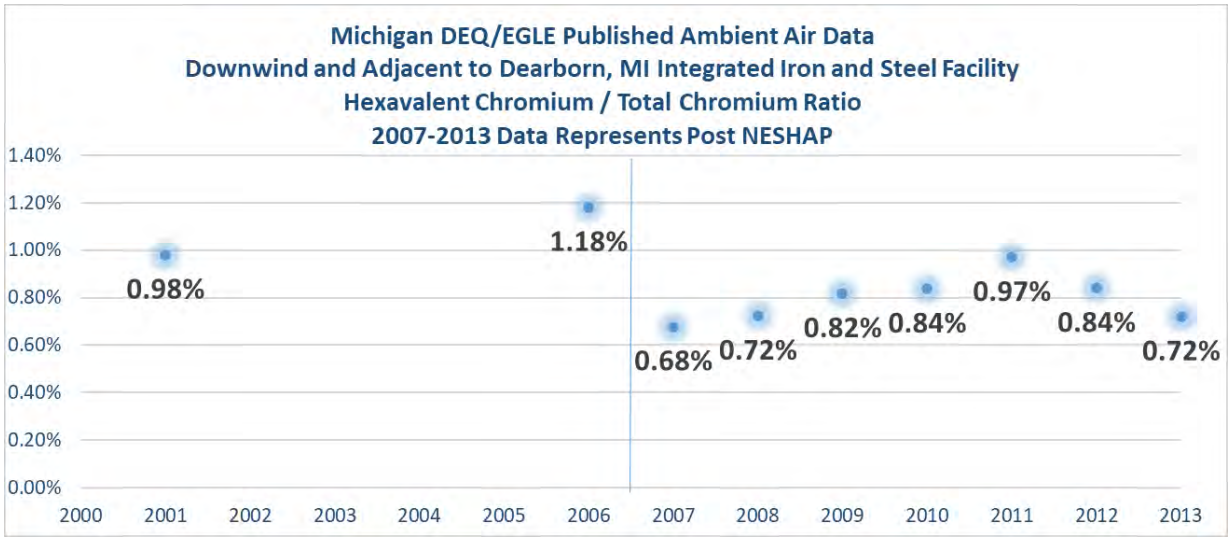
Figure 1 depicts average hexavalent chromium to total chromium ratios for the years 2001, 2006, and 2007 to 2013 derived from the Dearborn monitor data that was determined to be representative of II&S facilities. As shown in Figure 1, hexavalent chromium and total chromium ratios range from 0.68% to 1.18%, with post-II&S NESHAP data from EPA's AirData demonstrating a hexavalent chromium and total chromium range of 0.68% to 0.97% (calculations attached in Appendix A). The ratios in Figure 1 are derived from:

1) available ambient air monitoring annual data from the Dearborn monitor that measured both hexavalent chromium and total chromium, and
2) reported hexavalent chromium to total chromium ratios from the Detroit Air Toxics Initiative (DATI) project conducted by the Michigan Department of Environmental Quality (DEQ) (now known as the Department of Environment, Great Lakes, and Energy (EGLE)).

The summaries that follow describe in more detail the underlying data and information utilized in calculating the ratios.

Notably, the Dearborn monitoring data includes the year 2012, when stack testing was conducted at the Dearborn II&S facility for the 2011 ICR. The data show no contemporaneous relationship between the stack test data (where hexavalent chromium to total chromium ratios were greater than or equal to 10%, as developed under EPA's approach to 2011 ICR II&S stack testing data) and ambient air concentrations, which furthers the point that there is no support for applying hexavalent chromium to total chromium ratios from stack testing in 2012 to total chromium values generated at fenceline ambient air monitors at II&S facilities.

Figure 1 Hexavalent Chromium to Total Chromium Ratios for the Dearborn Ambient Air Monitor



Note: 2013 data are a partial year (January to June). The average of the 2007 through 2012 annual data was 0.81%.

Measurements of Hexavalent and Total Chromium Ambient Monitoring Data from the Dearborn Ambient Monitor

Using the EPA AirData website,[6] the ambient air monitoring annual summary data files were obtained to identify any available monitors that have or had measured both hexavalent chromium and total chromium data.[7] Once available monitors were identified, their locations relative to the II&S facilities were assessed. A timeframe of calendar years 2007-2013 was chosen to assess representative emissions after implementation of the NESHAP. The Dearborn monitor (Site ID 26-163-0033) was identified as having both hexavalent and total chromium ambient measurements and is located within 250 meters of the fenceline of the Dearborn Works II&S facility in Dearborn, Michigan. Figure 2 shows the location of the Dearborn monitor in relation to the Dearborn II&S facility, along with a 5-year average wind rose demonstrating that monitor concentrations are expected to be downwind and highly representative of facility emissions.

The Dearborn monitor had measurements available for full years 2007 to 2012, post II&S NESHAP compliance. The Dearborn cancer risk results associated with hexavalent chromium showed less than 1 in

[6] EPA, *Pre-Generated Data Files*, https://aqs.epa.gov/aqsweb/airdata/download_files.html (including: https://aqs.epa.gov/aqsweb/airdata/annual_conc_by_monitor_2007.zip; https://aqs.epa.gov/aqsweb/airdata/annual_conc_by_monitor_2008.zip; https://aqs.epa.gov/aqsweb/airdata/annual_conc_by_monitor_2009.zip; https://aqs.epa.gov/aqsweb/airdata/annual_conc_by_monitor_2010.zip; https://aqs.epa.gov/aqsweb/airdata/annual_conc_by_monitor_2011.zip; and https://aqs.epa.gov/aqsweb/airdata/annual_conc_by_monitor_2012.zip; https://aqs.epa.gov/aqsweb/airdata/daily_HAPS_2013.zip.

[7] Note that the EPA AirData database only covers air monitors that report their data to EPA. State or local agencies may maintain measurements from monitors operated at times for special purposes that are not reported to EPA.

a million.[8] This finding contributed to hexavalent chromium monitoring being discontinued in 2013; however, 2013 partial year data from January to June was available. This information was used to develop average hexavalent chromium to total chromium ratios for the years 2007 to 2013. This data is summarized in Figure 1 above.

Figure 2 The Dearborn Ambient Monitor Location in Relation to the Dearborn II&S Facility[9]

[8] *See, e.g.*, Michigan Department of Natural Resources, *Detroit Air Toxics Initiative: Risk Assessment Update*, at, ES-11 (Dec. 22, 2010), https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Reports/AQD/toxics/presentation-2010-12-22-detroit-air-toxics-initiative-update.pdf.

[9] The red line in Figure 2 represents an approximation of the steel mill boundary line.

Michigan Department of Environmental Quality 2005 and 2010 Detroit Air Toxics Initiative: Risk Assessment Updates

In addition to this data, MDEQ published two reports[10] that include hexavalent chromium to total chromium ratios for the Dearborn monitor. This study was conducted as part of the DATI project to understand urban area health risks and help reduce any potential exposure.

Hexavalent chromium was chosen in addition to total chromium for measurement because MDEQ wanted to determine the hexavalent chromium to total chromium ratio in the Detroit area. The DATI study ran from April 2001 to April 2002 and again from February 28, 2006 to March 28, 2007. Measurements were taken every six days for total chromium and every 12 days for hexavalent chromium. The reported hexavalent to total chromium ratios from the DATI project are also summarized in Figure 1. The ambient monitoring data collected at Dearborn show very low hexavalent chromium to total chromium ratios.

Facility Slag Hexavalent and Total Chromium Test Data

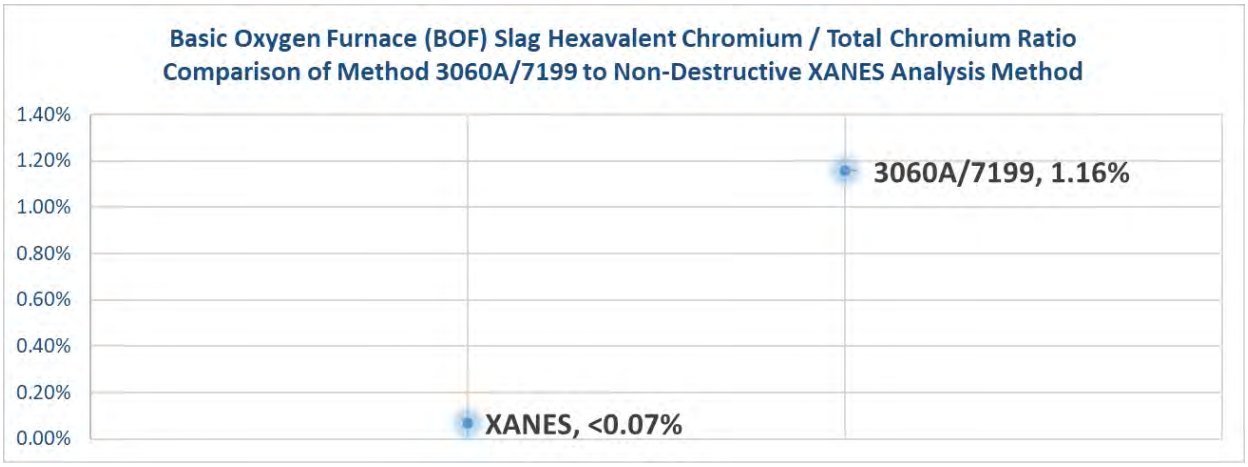
The ratios from the Dearborn ambient monitoring data align with the sampling that was conducted for cooled/solidified slag. Testing conducted in 2019 on BF and BOF slag using analysis Method 3060A/7199 showed very low hexavalent to total chromium ratios of 1.06% and 0.58%, respectively. The slag testing results support very low hexavalent chromium to total chromium ratios even though the test method used, Method 3060A/7199, yields higher hexavalent to total chromium results than other available test methods as described below.

A 2022 study by Rock Vitale of Environmental Standards[11] was conducted to compare the methodology and achieved results between Method 3060A/7199 and the new X-Ray Adsorption Near Edge Structure (XANES) method. The XANES method is a non-destructive direct analysis method that uses a high-resolution laser. This is contrasted with Method 3060A/7199 which requires a pH adjustment, digestion and mass spectrometry for analysis that potentially results in a bias of the hexavalent chromium measurements. The results from the comparison of Method 3060A/7199 to the non-destructive XANES analysis method for BOF slag are shown in Figure 3 below. Compared to Method 3060A/7199, which showed a hexavalent to total chromium ratio of 1.16% for BOF slag in the 2022 study, the XANES method shows even lower hexavalent to total chromium ratios for BOF slag, with hexavalent chromium below the detection limit of 2 mg/kg, resulting in a ratio of <0.07% hexavalent chromium to total chromium. Additional details of the testing methodology and results are located in Appendix B.

[10] The 2005 report is available at: https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Reports/AQD/toxics/presentation-2005-11-09-detroit-air-toxics-initiative.pdf. The 2010 report is available at: https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Reports/AQD/toxics/presentation-2010-12-22-detroit-air-toxics-initiative-update.pdf.

[11] Rock J. Vitale, Presentation on Chromium Chemistry with Focus on Measurement in Slag Material (Sept. 20, 2022) https://nationalslag.org/wp-content/uploads/2022/09/Rock-Vitale-Chromium-Chemistry-with-Focus-on-Measurement-in-Slag-Material.pdf.

Figure 3 2022 BOF Slag Hexavalent Chromium to Total Chromium Ratio Comparison of Method 3060A/7199 to XANES Method



Use of the Hexavalent to Total Chromium Ratio from Available Ambient Monitoring Data

Figure 1 shows that the annual average hexavalent to total chromium ratios at the highly representative Dearborn monitor ranged from 0.68% to 0.97% post compliance with the NESHAP, with an average of the 2007-2013 annual data of 0.80%.[12] In addition, facility test data indicate that the hexavalent chromium content in slag ranges from <0.07% to 1.16%, depending on the analysis method used. This information indicates that the ratio of hexavalent chromium to total chromium is likely substantially lower than the 10% to 39% ratios developed by EPA from the 2011 ICR II&S stack testing of point sources. The actual Dearborn monitor hexavalent to total chromium ratio is much lower, showing correlation between the Dearborn hexavalent chromium to total chromium ratio and the slag hexavalent chromium to total chromium ratio.

Table 1 shows the estimated inhalation-related cancer risks based on the TSP fractions associated with hexavalent chromium at a 0.97% ratio (the highest estimated annual ratio from the Dearborn monitoring data post-NESHAP). Using the highest annual ratio is conservative, as the average hexavalent to total chromium ratio during the 2007-2013 monitoring period is 0.80%, which would reduce the cancer risk from hexavalent chromium by an additional 18%. It also shows the overall cancer risk from arsenic and chromium using a 0.97% hexavalent chromium to total chromium ratio. When using the hexavalent chromium to total chromium ratio from the Dearborn monitor, the primary risk driver for the cancer risks shown in the table is arsenic, which is consistent with the modeling published by EPA in support of the RTR.

[12] Note: 2013 data are a partial year (January to June). The average of the 2007 through 2012 annual data was 0.81%.

Table 1 Reconsideration of the Hexavalent to Total Chromium Ratio Used to Estimate Risk Based on TSP

Facility	Monitor	Chromium VI Cancer Risk at 0.97% Ratio – TSP Fraction	Overall Cancer Risk at 0.97% Ratio – TSP Fraction
Gary Works	ST1-North	18	72
Gary Works	ST2-East	1	11
Gary Works	ST3-South	4	25
Gary Works	ST4-West	1	10
Granite City	ST1-North	1	11
Granite City	ST2-LeeAve	1	16
Granite City	ST3-South	7	27
Granite City	ST4-West	1	11
Granite City	ST5-Central	10	36
Burns Harbor	BH1	3	23
Burns Harbor	BH2	0.3	4
Burns Harbor	BH3	0.5	6
Burns Harbor	BH4	3	15
Cleveland Works	CLE S1	9	24
Cleveland Works	CLE S2	1	8
Cleveland Works	CLE S3	2	8
Cleveland Works	CLE S4	1	5

Using the Inhalable Portion of Particulate Matter to Assess Potential Risks

The Cleveland Works and Burns Harbor facilities monitored for both TSP and PM_{10} concentrations during the fenceline monitoring collection period from May to November of 2022. For particulate metals, only PM_{10} is inhalable into the lungs and potentially induces adverse health effects. As shown by EPA's reference concentrations and unit risk factors to estimate human health risks that were developed specifically in consideration of inhalation-related risks,[13] it is appropriate to assess health risks against the PM_{10} portion of metal concentrations for arsenic and hexavalent chromium.[14]

Table 2 compares what inhalation-related cancer risks for arsenic and chromium would result when using the TSP fraction measured at the Burns Harbor and Cleveland Works facilities to what results when using the PM_{10} fraction measured at the two facilities. The cancer risks in Table 2 for the Gary Works and Granite City facilities were estimated by applying the average ratio of 61% PM_{10} to TSP for chromium and 89% PM_{10} to TSP for arsenic that was derived from data from the Dearborn monitor, which collected data for TSP and PM_{10} for chromium and arsenic (Calculations provided in Appendix A). The annual average chromium and arsenic PM_{10} to TSP ratios at the Dearborn monitor for 2007-2021 are shown in Figure 4 and Figure 5, respectively.

[13] *See* EPA, *Integrated Risk Information System (IRIS): Chromium (VI); CASRN 18540-29-9*, at 1-33, https://iris.epa.gov/static/pdfs/0144_summary.pdf (for hexavalent chromium); EPA, *IRIS Arsenic, inorganic; CASRN 7440-38-2*, at 1-27, https://iris.epa.gov/static/pdfs/0278_summary.pdf (for arsenic).

[14] Because the lead NAAQS was developed in consideration of both ingestion risks and inhalation risks, it appropriate to use TSP for lead.

As shown in Table 2, estimated cancer risks using measured PM_{10} concentrations for Cleveland Works and Burns Harbor are considerably lower, often showing cancer risks 20-40% lower than those that would be estimated using the TSP fraction. The ratios of PM_{10} to TSP during the years 2007 through 2021 from the Dearborn monitoring data similarly show that the chromium and arsenic PM_{10} monitored concentrations are approximately 39% lower and 11% lower, respectively, than measured TSP concentrations, which corresponds to an average PM_{10} to TSP ratio of approximately of 61% and 89%, respectively, for chromium and arsenic (calculations provided in Appendix A).

Data are available on the average national background concentrations for arsenic. EPA's 2015 Report on the Environment Ambient Concentrations of Selected Air Toxics[15] shows that ambient arsenic concentrations at 23 monitoring sites in industrial and non-industrial locations nationwide exhibit annual average arsenic concentrations in the same time period ranging from ~0.0005 µg/m³ at the 10th percentile to 0.0015 µg/m³ at the 90th percentile. The arsenic data in this report is based on sampling of PM_{10} at monitoring sites where data were consistently collected between 2003 and 2013. The monitors are part of the National Air Toxics Trends Station (NATTS) Network and the Urban Air Toxics Monitoring Program and are supplemented by other locally maintained monitoring sites.[16] Should the average ambient background value (~ 0.001 µg/m³) be subtracted from the arsenic fenceline monitoring concentrations, it would further reduce the estimated cancer risk by approximately 4 in a million.

[15] EPA, *Ambient Concentrations of Selected Air Toxics*, at Ex. 8, https://cfpub.epa.gov/roe/indicator.cfm?i=90#8 (last updated Sept. 18, 2018).
[16] EPA, *ROE – Arsenic Data*, https://cfpub.epa.gov/roe/documents/ROE-Arsenic-Data-(2-14-2015).xlsx.

Figure 4 Chromium PM_{10} to Chromium TSP Ratios for the Dearborn Ambient Air Monitor, 2007-2021

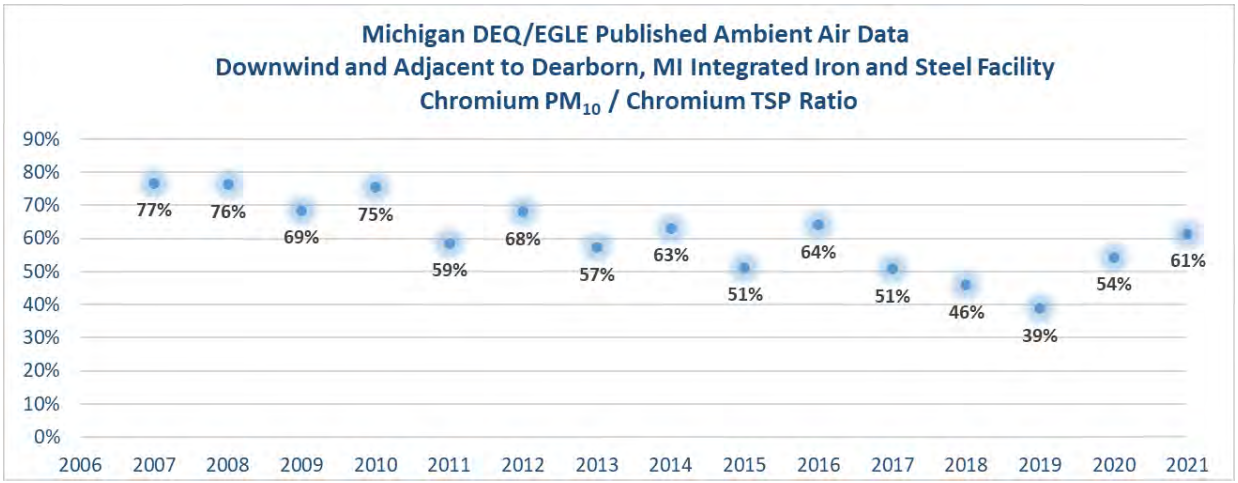


Figure 5 Arsenic PM_{10} to Arsenic TSP Ratios for the Dearborn Ambient Air Monitor, 2007 – 2021

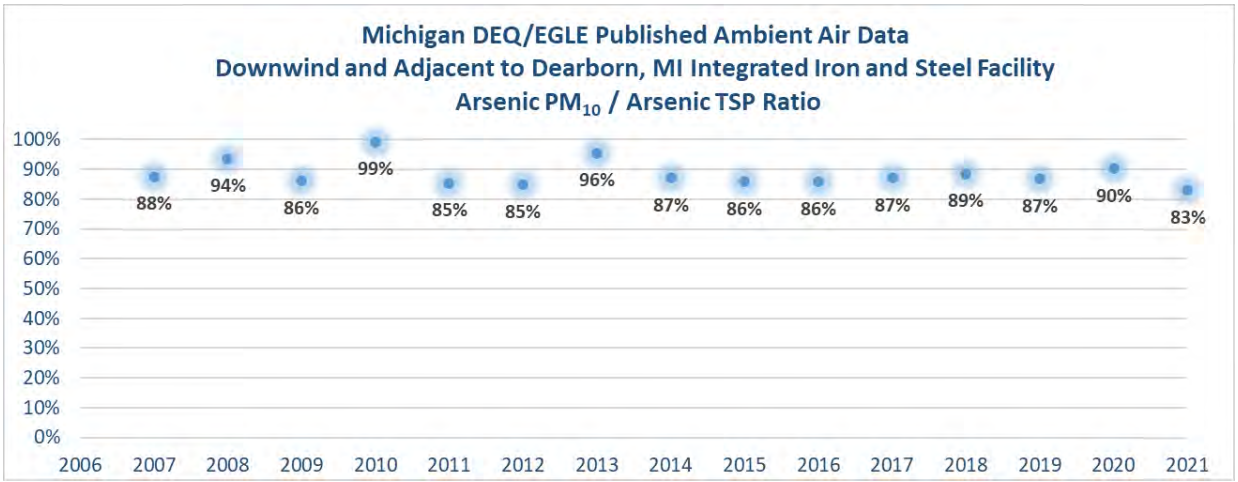


Table 2 Comparison of Estimated Cancer Risks Using TSP Fractions and PM_{10} Fractions[17]

Facility	Monitor	Overall Cancer Risk at 0.97% Ratio – TSP Fraction	Overall Cancer Risk at 0.97% Ratio – PM_{10} Fraction
Burns Harbor	BH1	23	18
Burns Harbor	BH2	4	4
Burns Harbor	BH3	6	5
Burns Harbor	BH4	15	8
Cleveland Works	CLE S1	24	15
Cleveland Works	CLE S2	8	6
Cleveland Works	CLE S3	8	5
Cleveland Works	CLE S4	5	4
Gary Works	ST1-North	72	59
Gary Works	ST2-East	11	10
Gary Works	ST3-South	25	21
Gary Works	ST4-West	10	9
Granite City	ST1-North	11	9
Granite City	ST2-LeeAve	16	14
Granite City	ST3-South	27	22
Granite City	ST4-West	11	10
Granite City	ST5-Central	36	29

[17] For the purposes of this comparison, results are shown applying the conservative 0.97% hexavalent to total chromium ratio, which is the maximum ratio observed at the Dearborn monitor after implementation of the II&S NESHAP. Burns Harbor and Cleveland Works cancer risk estimates using the PM_{10} fraction are from fenceline monitoring. Gary Works and Granite City estimates using the PM_{10} fraction are based on applying the average PM_{10} to TSP ratios for chromium and arsenic from the Dearborn monitor during 2007-2021.

Nearest Sensitive Receptors in Relation to Fenceline Monitors

Sensitive receptors, or areas in close proximity to the sensitive receptors, are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants. Sensitive receptors are most commonly residences (such as the census block receptors used in the HEM4 modeling program[18] developed by EPA to estimate inhalation risks for the RTR), but schools and daycares can also be considered sensitive receptors. The following sections demonstrate that the monitors with higher measured total chromium concentrations are farther away from nearby sensitive receptors, while monitors showing lower cancer risk, as detailed in Table 3, are generally closer to sensitive receptors. Therefore, monitors with lower concentrations are more representative of health risks at sensitive receptor locations, noting that the cancer risk at the nearest sensitive receptor locations would still be lower than the cancer risk estimated at the closest monitor, depending on the distance from the monitor. The monitors with the higher concentrations are not representative of cancer risk at sensitive receptor locations. Table 3 reiterates the overall cancer risk from arsenic and chromium using a conservative 0.97% hexavalent to total chromium ratio and summarizes the distance and direction to the nearest sensitive receptor for each of the fenceline monitors.

Table 3 Summary of Estimated Cancer Risks and Nearest Sensitive Receptors at Each Monitor

Facility	Monitor	Overall Cancer Risk at 0.97% Ratio – PM_{10} Fraction[19]	Nearest Sensitive Receptor
Gary Works	ST1-North	59	> 2.4km away to the S, SW & E
Gary Works	ST2-East	10	> 1.1km away to S, SE and E
Gary Works	**ST3-South**	**21***	**600-700m to the S, SW & SE, across I-90**
Gary Works	ST4-West	9	> 2.5km away to S and W
Granite City	ST1-North	9	~100m to the N and E
Granite City	**ST2-LeeAve**	**14***	**50-75m to the NW and NE**
Granite City	ST3-South	22	~450m to the SW
Granite City	**ST4-West**	**10***	**50-75m to the S, SW and W**
Granite City	ST5-Central	29	~850m to the SW, N & NE
Burns Harbor	BH1	18	> 2km to the E
Burns Harbor	BH2	4	~500m to the SE/S
Burns Harbor	**BH3**	**5***	**~350m to the E**
Burns Harbor	BH4	8	~2.8km to the W
Cleveland Works	CLE S1	15	~ 350m to the E/SE, across HWY 77
Cleveland Works	**CLE S2**	**6***	**30-50m to the E/SE/S**
Cleveland Works	CLE S3	5	300m to the E/SE/S
Cleveland Works	CLE S4	4	500m to the N

*Each facility's risk nearest sensitive receptors. Note that the facility contribution to the nearest sensitive receptor would be expected to be less than the monitored concentrations due to distance.

[19] The overall cancer risk in Table 3 does not include reduction for non-II&S or off-site contributions to fenceline monitors.

Nearest Sensitive Receptors to the Gary Works Facility

The four fenceline monitors installed at the Gary Works Facility are shown in Figure 6. As summarized in Table 3, the Gary North monitor with the highest cancer risk is located more than 2.4 kilometers away from any sensitive receptor. All of the monitors at the facility are located over 600 to over 2,500 meters away from any sensitive receptor. The Gary South monitor, which has the second highest cancer risk (approximately one-third the risk of the north monitor) is located 600 to 700 meters away from any sensitive receptor. The East and West monitors, which showed the lowest risks, are located more than 1,100 and 2,500 meters away from any sensitive receptor, respectively.

Figure 6 Gary Works Fenceline Monitor and Sensitive Receptor Locations

Nearest Sensitive Receptors to the Granite City Works Facility

The five fenceline monitors installed at the Granite City Works Facility are shown in Figure 7. As summarized in Table 3, the Granite City Central and South monitors, which have the highest and second highest cancer risks are located approximately 850 and 450 meters away from any sensitive receptor, respectively. The Lee Avenue, West and North monitors, which showed the lowest risks (approximately one third to two thirds of the risks at the South and Central monitors), are all 100 meters or less from sensitive receptors.

Figure 7 Granite City Works Fenceline Monitor and Sensitive Receptor Locations

Nearest Sensitive Receptors to the Burns Harbor Facility

The four fenceline monitors installed at the Burns Harbor Facility are shown in Figure 8. As summarized in Table 3, the BH1 and BH4 monitors, which have the highest and second highest cancer risks are located more than 2 and approximately 2.8 kilometers away from any sensitive receptor, respectively. The BH2 and BH3 monitors, which showed the lowest risks with arsenic concentrations similar to the EPA published background concentration discussed on page 10, are 500 and 350 meters from sensitive receptors, respectively.

Figure 8 Burns Harbor Fenceline Monitor and Sensitive Receptor Locations

Nearest Sensitive Receptors to the Cleveland Works Facility

The four fenceline monitors installed at the Cleveland Works Facility are shown in Figure 9. As summarized in Table 3, the S2 monitor, which is the closest of all four monitors to sensitive receptors showed, lower risk and is approximately 50 meters from sensitive receptors. In comparison, the S1 and S3[20] monitors which have the highest and second highest cancer risks are located approximately 350 and 300 meters away from any sensitive receptor, respectively. The S4 monitor, which showed the lowest risk is 500 meters from sensitive receptors. The S2, S3 and S4 monitors showed lower risks, with arsenic concentrations similar to the EPA published background concentration of approximately 4 in a million (discussed on page 10).

Figure 9 Cleveland Works Fenceline Monitor and Sensitive Receptor Locations

[20] Over 39,000 pounds of chromium emissions reported in 2021 by offsite sources may account for the higher measurements at the S3 monitor. This potential for offsite contribution is discussed below.

Potential Offsite Contribution to Monitor Concentrations

EPA's methodology attributes all of the total chromium measured at the fenceline monitors to the II&S source category when other sources, such as nearby industrial operations, storage piles, and on- and off-site roadways, are also measured by fenceline monitors. Potential contributions from non-II&S sources have been identified using:

1) 5-year average and daily wind roses from representative meteorological stations;
    a. 5-year average wind roses were used to identify longer term wind patterns, to help assess the potential for chronic exposure at sensitive receptors
    b. Daily wind roses were used to help identify acute influences on days with higher monitor concentrations
2) The most recent available reported chromium emissions (years 2019-2021) obtained using the Toxics Release Inventory (TRI) Program Toxics Tracker;[21] and
3) Google Maps satellite layer map details.

The wind roses were overlaid onto fenceline monitor locations with higher concentrations. Daily wind roses corresponding to each 24-hour monitoring period referenced below are provided in Appendix C and show the wind direction and potential contributing sources. The potential offsite contributions to monitored concentrations were assessed based on wind direction, historically reported chromium emissions, and satellite imagery to determine whether upwind sources reported chromium emissions. The review focused on chromium as it is the primary pollutant contributing to the cancer risks estimated by EPA; however, there may be additional contributions to TSP measurements at fenceline monitors. Other sources that are not required to report to the TRI program[22] may also be contributing to measurements at fenceline monitors. The potential for offsite contribution to monitors with higher concentrations at each facility is discussed below.

Gary Works

The 5-year average wind rose is shown overlaid on the North and South monitors in Figure 10 below.

Gary North

For the Gary North monitor, there are a fair amount of winds from the north-northeast, which likely brings contribution from offsite marine vessels as they sail by the facility, hotel offshore or sail into port[23] in relatively close proximity to the monitor. Marine vessels continue to emit air contaminants when hoteling because they are using auxiliary marine diesel-fired boilers and engines. The Ventura County Air Pollution Control District speciates diesel fuel from marine engines into metal and volatile organic components, including arsenic, chromium and lead.[24] The highest monitored chromium concentration occurred on July

[21] The EPA TRI Toxics Tracker is available at: https://edap.epa.gov/public/extensions/TRIToxicsTracker/TRIToxicsTracker.html#continue.
[22] Information on which facilities are required to report to the TRI Program can be found here: https://www.epa.gov/toxics-release-inventory-tri-program/reporting-tri-facilities#q1.
[23] Port location and any active vessels can be located here: https://www.marinetraffic.com/en/ais/home/centerx:-87.323/centery:41.645/zoom:13.
[24] *See* Ventura County Air Pollution Control District, *AB 2588 Combustion Emission Factors* (May 2001) http://www.vcapcd.org/pubs/Engineering/AirToxics/combem.pdf.

1st, 2022. On that date, as shown in Figure 11 below, the wind direction was predominantly from the north-northeast, indicating contribution to the monitor from marine vessels. Another non-II&S contributor derived from the use of wind roses is the co-located facility, TMS International Corporation, which reported 2,741 pounds of chromium emissions in 2021.

Gary South

The contributions from winds from north-northeast as discussed above also likely contribute to the Gary South monitored concentrations, which may include those from facility sources. There are substantial periods of winds from the southwest-south-southeast as shown in Figure 11, which would indicate offsite contributions. Given that the area to the south of the South monitor is largely residential, and the well-established high levels of emissions from high traffic roadways,[25,26,27,28] there is likely a considerable contribution to the South monitor's concentrations from Interstate 90 (I-90), which is approximately 275 meters away from the South monitor.

[25] *See* Doug Brugge, Near-highway pollutants in motor vehicle exhaust: A review of epidemiologic evidence of cardiac and pulmonary health risks, 6 ENVTL HEALTH 23 (Aug. 9, 2007), https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-6-23.

[26] *See* California Office of Environmental health Hazard Assessment, *Health Studies of Traffic Exposure*, https://oehha.ca.gov/air/residential-traffic-studies.

[27] *See* American Lung Association, *Living Near Highways and Air Pollution*, https://www.lung.org/clean-air/outdoors/who-is-at-risk/highways.

[28] *See* Population Reference Bureau, *The Health Costs and Benefits of Living Near Roads, Highways, and Light Rail*, https://www.prb.org/resources/the-health-costs-and-benefits-of-living-near-roads-highways-and-light-rail/.

Figure 10 Gary Works 5-Year Average Wind Rose Overlaid on the North and South Monitors

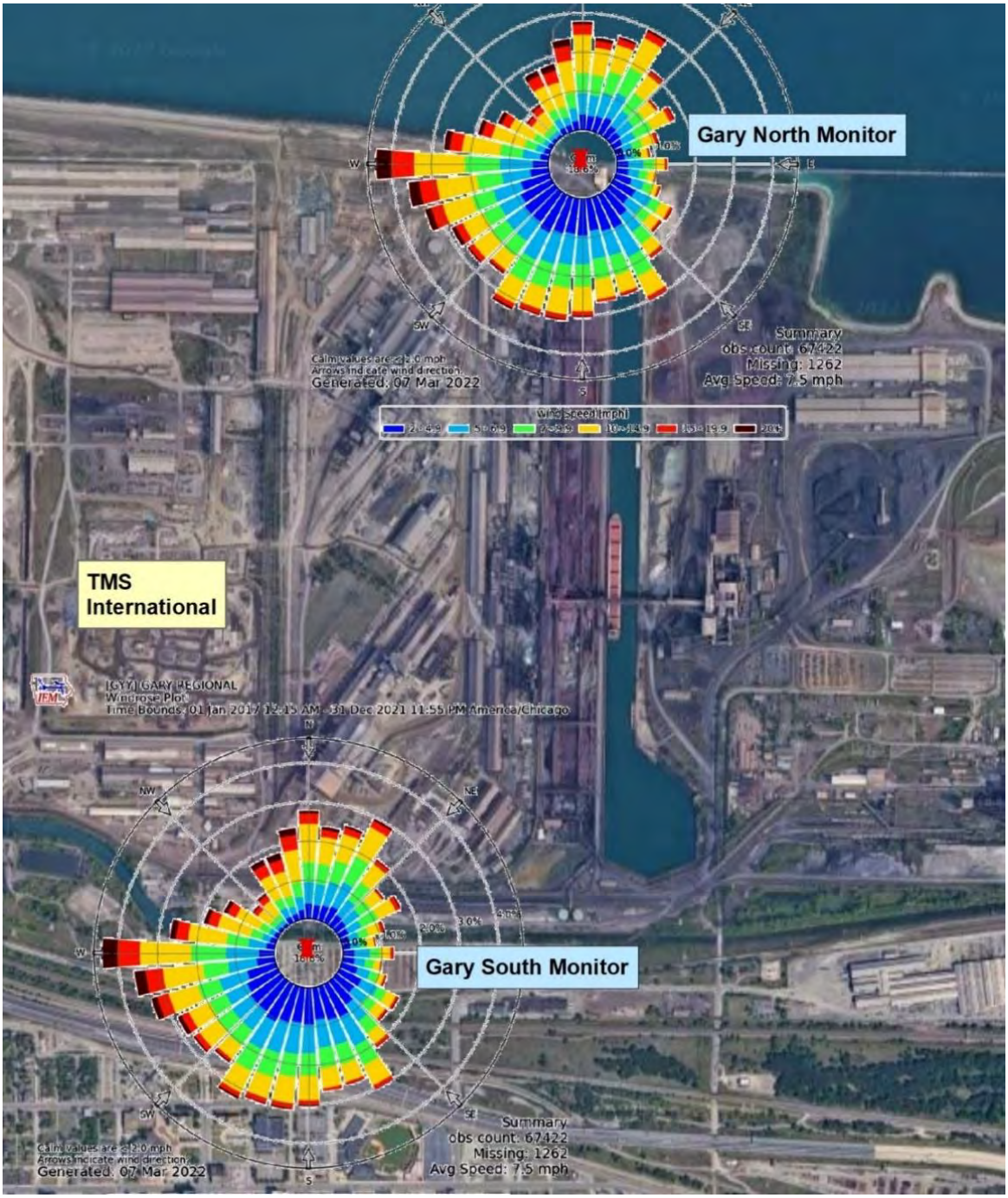


Figure 11 Gary Works Daily Wind Rose for July 1st, 2022 Overlaid on the North and South Monitors

Granite City

The 5-year average wind rose is shown overlaid on the Granite City South monitor in Figure 12 below. As the Central and South monitors are close together on the figure, the wind rose was overlaid on the South monitor only.

There are predominant winds from the south-southeast, which would indicate likely offsite contribution to monitor concentrations. There are several industrial sources to the south of the South monitor, including Mid-Continent Coal & Coke Co, Lapham-Hickey Steel, Allied Crawford Steel and Granite City Slag. No nearby facilities reported chromium emissions to the TRI Program in 2019-2021; therefore, it is not fully clear to what extent these facilities may have chromium emissions or emissions of other toxic air contaminants. Yet, the highest monitored chromium concentration occurred on June 14th, 2022, with, as shown in Figure 13 below, the wind direction predominantly from the south-southwest, indicating offsite contributions to the monitored concentration from the areas of several of the other industrial sources mentioned. The second highest through fifth highest monitored chromium concentrations at the south monitor also occur on days when the wind directly was predominantly from the south-southwest.

Approximately 30% of the winds are from the northwest-north-northeast, indicating possible contribution at the Central monitor from SunCoke Energy to the northeast. EPA's preliminary RTR modeling for the coke industry indicates there are chromium emissions emitted by SunCoke. At the Central monitor, the four highest monitored chromium concentrations occur when the winds are from the north-northeast, indicating offsite contributions from SunCoke Energy.

Figure 12 Granite City 5-Year Average Wind Rose Overlaid on the South Monitor

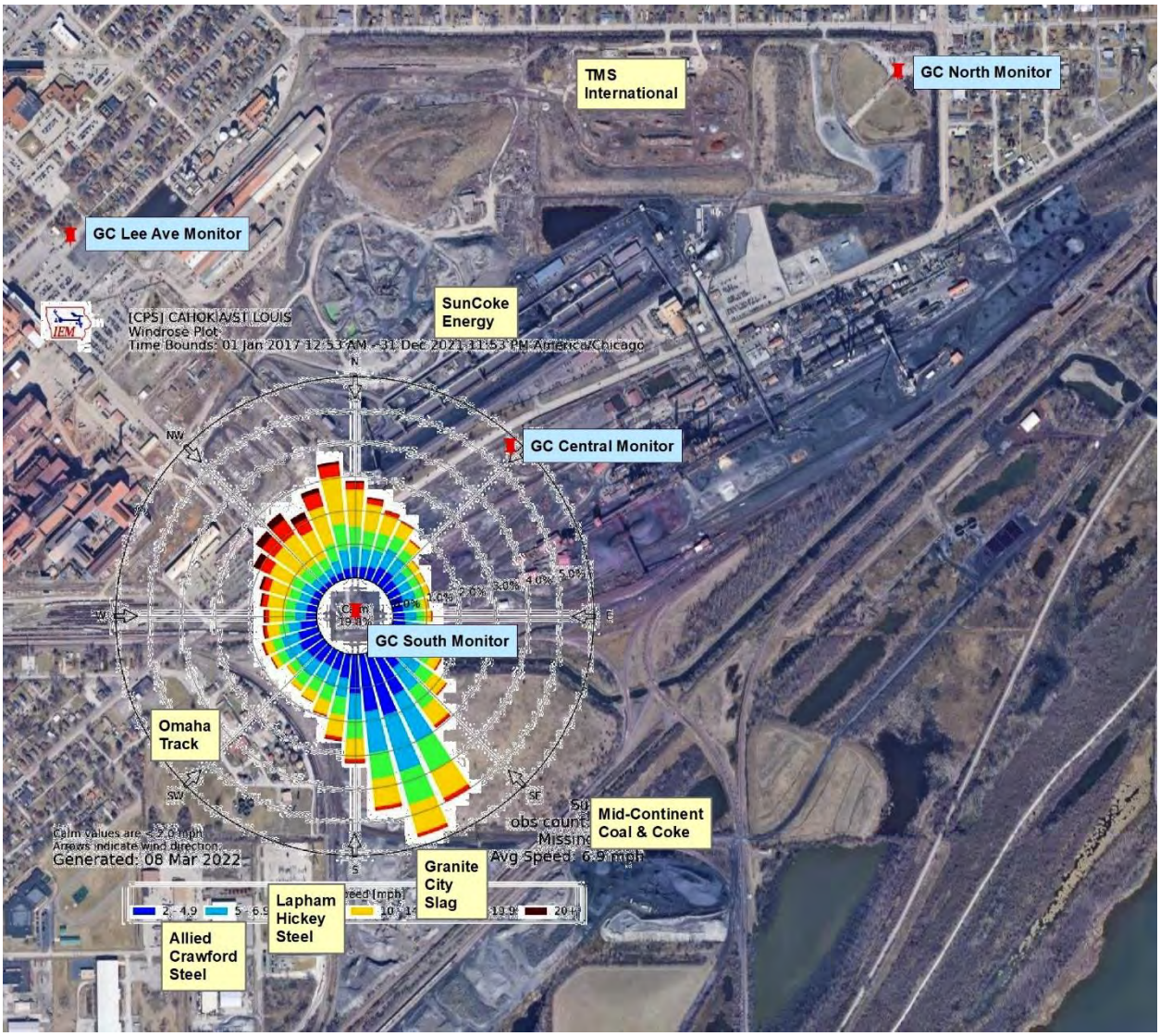


Figure 13 Granite City Works Daily Wind Rose for June 14th, 2022 Overlaid on the South Monitor

Cleveland Works

CLE S1 Monitor

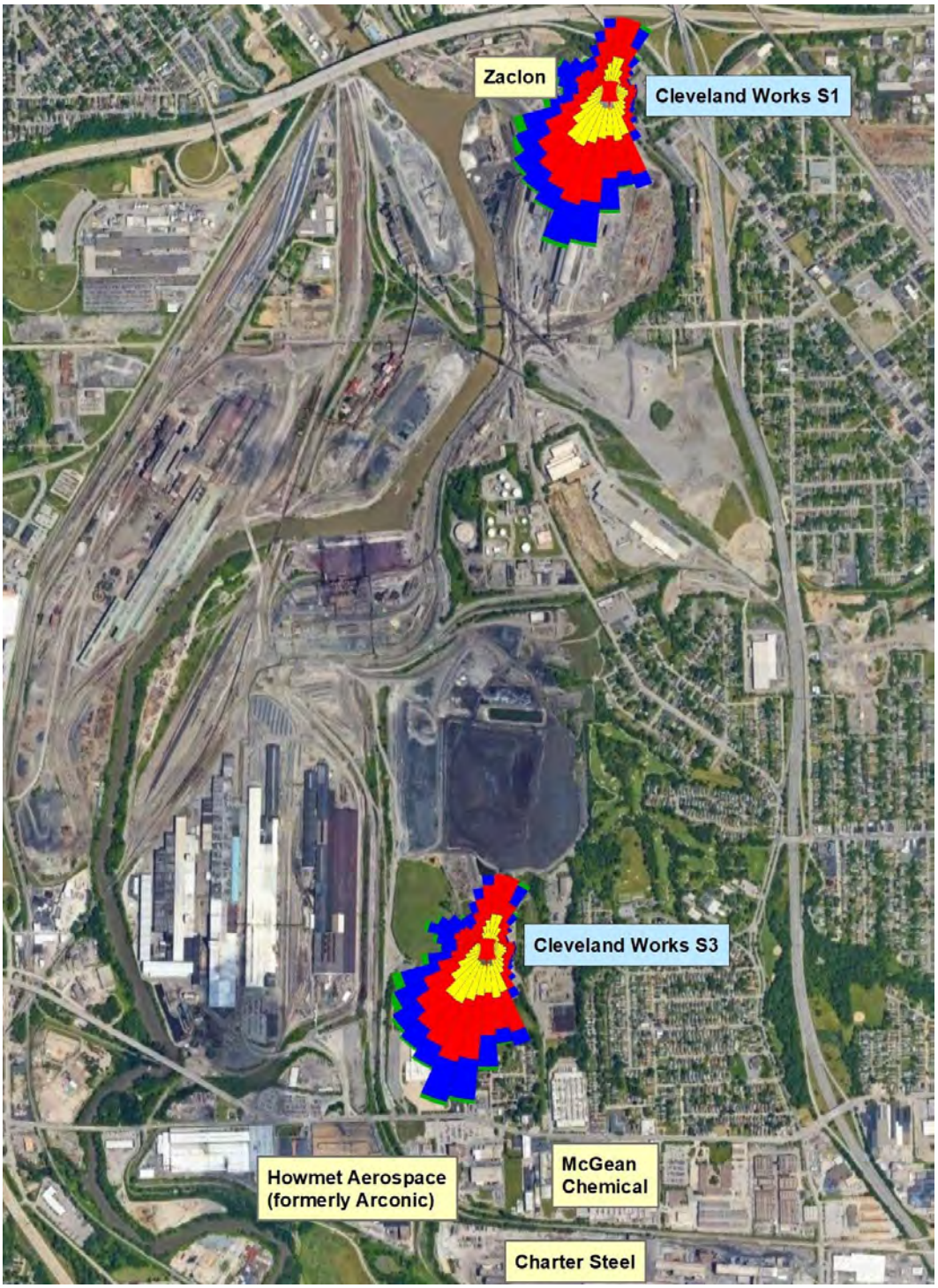
The 5-year average wind rose is shown overlaid on the CLE S1 and S3 monitors in Figure 14 below.

The S1 monitor is situated in "Industrial Valley" in Cleveland at the north end of the Cleveland Works facility. Predominant winds are from the south-southwest-west. However, on the two days of highest monitored chromium at S1, winds from off-property indicate possible offsite contribution from Zaclon LLC, located within a few meters of the CLE S1 monitor, which reported 89 pounds of chromium emissions in 2019. There are also some winds from the northeast, which, based on the well-established high levels of emissions from high traffic roadways discussed above for the Gary South monitor, indicate likely contribution from I-490 and I-77, which are 200-350 meters away from the monitor. The two highest monitored chromium concentrations at the S1 monitor occurred on June 22nd, 2022 and August 9th, 2022, when the wind direction was predominantly from the north-west and north, respectively indicating contributions from offsite sources.

CLE S3 Monitor

The predominant winds at the CLE S3 monitor are from the south-southwest which would likely show substantial offsite contribution to monitor concentrations. Howmet Aerospace (formerly Arconic Inc. and Alcoa), which is located approximately 700 meters to the southwest, reported 178 pounds of chromium emissions in 2021. McGean Chemical Company, located 600 meters to the south of the CLE S3 monitor, reported 7,425 pounds of chromium emissions in 2021. Charter Steel, which is 1 kilometer to the south-southeast of the monitor, reported 31,763 pounds of chromium in 2021.

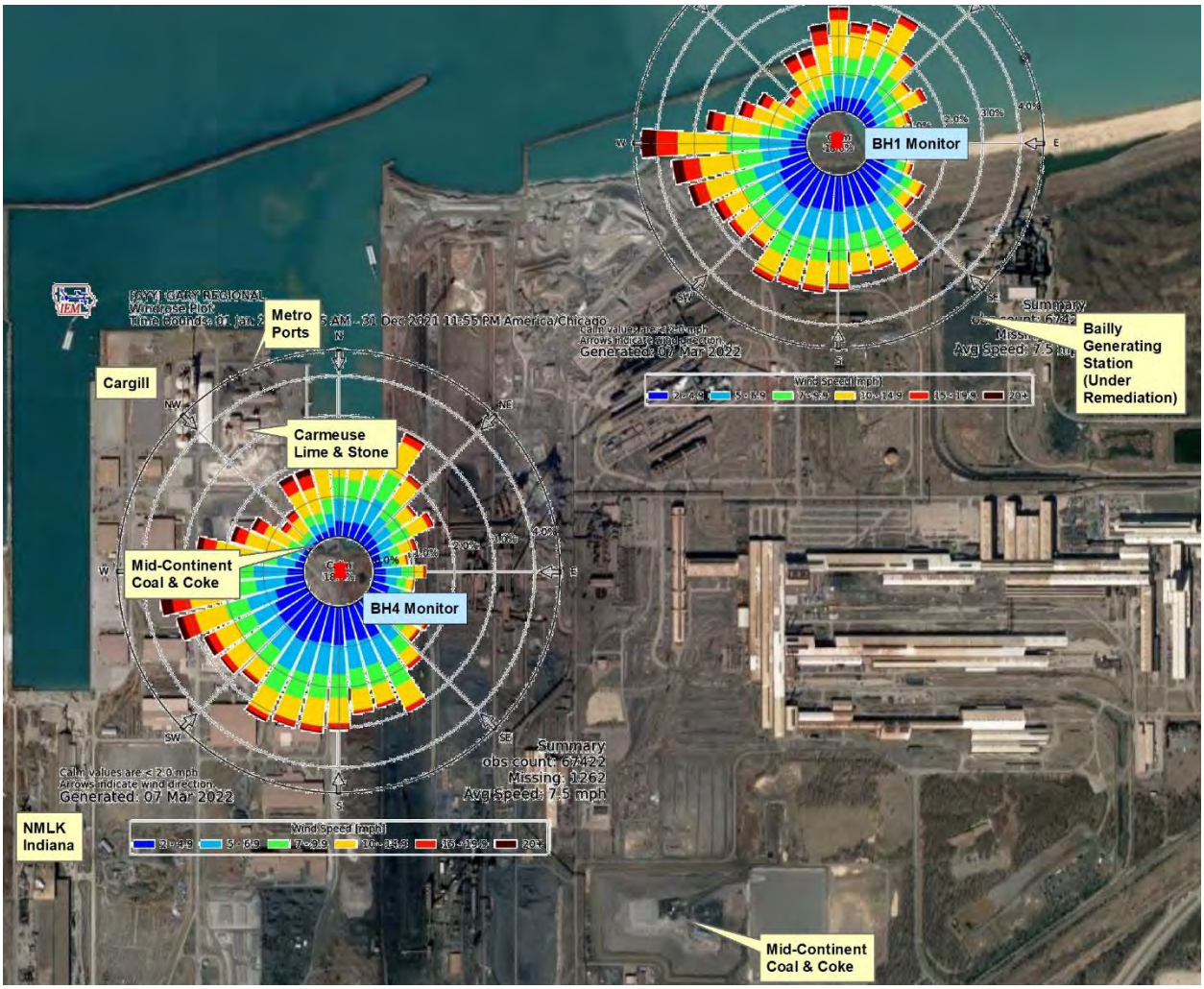
Figure 14 Cleveland Works 5-Year Average Wind Rose Overlaid on the CLE S1 and S3 Monitors



Burns Harbor

The 5-year average wind rose is shown overlaid on the BH1 and BH4 monitors in Figure 15 below.

Figure 15 Burns Harbor 5-Year Average Wind Rose Overlaid on the BH1 and BH4 Monitors



BH1 Monitor

There are predominant winds from the west-southwest-south, showing likely contribution from onsite storage piles. Winds from the southeast show some potential contribution from the Bailly Generating Station. This coal-fired power plant ceased operation in 2018. Only the natural gas peaker plant remains; however, remediation of this site is still in progress.[29] It is possible that fugitive dust emissions from the former coal plant could be contributing to monitor concentrations as well.

[29] *See* EPA, *Hazardous Waste Cleanup: Northern Indiana Public Service Company (NIPSCO) Bailly Generating Station - Chesterton, Indiana*, https://www.epa.gov/hwcorrectiveactioncleanups/hazardous-waste-cleanup-northern-indiana-public-service-company-nipsco.

BH4 Monitor

There are predominant winds from the west-southwest-south, showing likely contribution from offsite sources to monitor concentrations. The NMLK Indiana facility, located 400 meters to the southwest, reported 12,762 pounds of chromium in 2021. There are additional sources to the west-southwest of the BH4 monitor, including Mid-Continent Coal and Coke Company, Carmeuse Lime and Stone, and Cargill. None of the aforementioned sources reported emissions in 2019-2021 to the TRI Program but may have had emissions of toxic air contaminants. Winds from the north-northeast indicate potential contribution from marine vessel hoteling from the nearby port[30] and/or from fugitive dust from storage piles.

[30] Port location and any active vessels can be located here: https://www.marinetraffic.com/en/ais/home/portid:673/zoom:15.