# Informational Memorandum

**Date:** **May 19, 2009**

**Subject:** **North Carolina Toxic Air Pollutants Program and an evaluation of the May 6, 2009 Blue Ridge Environmental Defense League Technical Report "Poultry Manure Incineration Toxic Air Pollution Impacts"**

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## CONCLUSIONS

Blue Ridge Environmental Defense League's ("BREDL") May 6 2009 report "Poultry Manure Incineration Toxic Air Pollution Impacts" was studied carefully to understand how it was put together and the basis behind it. What we learned in this review is that BREDL, if they had actually provided the results of their conservative SCREEN3 air-dispersion modeling, successfully demonstrated that the proposed Surry County plant would easily meet all of the evaluated toxic air pollutant levels established by the North Carolina Department of Environment and Natural Resources ("DENR"). Furthermore, we also determined that BREDL used a second misleading and factually incorrect "worst-case spreadsheet" model in their report that can not legitimately be used to evaluate the proposed Fibrowatt Surry County plant.

Fibrowatt has also provided, along with this review, information on recent metals emissions testing in March 2009 at the Fibrominn Biomass Power Plant in Benson, Minnesota. Using this data, showing actual emissions anywhere from 5 to 200 times lower than the data used in the BREDL analysis, indicates that BREDL's own air dispersion modeling would demonstrate that results would be roughly 59 to 183,000 times below the North Carolina acceptable ambient levels. Based on information from Fibrowatt's biomass plant in Minnesota and BREDL's SCREEN3 air-dispersion modeling approach, it is obvious that a Fibrowatt plant will be very protective of the local population.

As should be apparent with this review, a proper and factually complete analysis of the impacts of a proposed plant in Surry County provides results that are far different than the way it was portrayed by BREDL in their report. Perhaps this difference is a result of BREDL's inexperience in performing complex air dispersion modeling and analysis. Or maybe BREDL manipulated the presentation of its findings to justify its opposition to Fibrowatt. Either way, the overall portrayal of Fibrowatt's air quality impacts is simply wrong.

We have offered to meet representatives of BREDL to show them where their conclusions are unsupported by the facts. They have not responded. When we attempted to explain these inaccuracies at BREDL's public meetings on May 11th & 12th and June 2nd, 2009, we were not allowed to speak. It is this reticence on the part of BREDL to respond to a factual review of their study that has led us to distribute this comprehensive review of their report. Fibrowatt is willing to be judged on the facts by fair-minded people; however, without Fibrowatt addressing BREDL's flawed facts and conclusions – we feel that the general public is being needlessly misled toward the wrong conclusions. For all of the people in North Carolina that will benefit from the development of Fibrowatt biomass power plants, allowing BREDL's errors to go unchecked would be a real disservice to the economic and environmental future of this fine state.

## SUMMARY POINTS

- North Carolina has a comprehensive program to protect the health of even the most sensitive individuals from the effects of potentially toxic air pollutants. This program is based on meeting "acceptable ambient levels" ("AALs") and these levels are set based on health-risk criteria and include significant margins of safety. According to the North Carolina Department of Environment and Natural Resources, AALs are set so that they are "*below the concentration that would produce adverse health effects in sensitive subgroups of the general population.*"
- BREDL has used a very conservative (i.e. showing higher impacts than would actually be demonstrated) air-dispersion model referred to as the USEPA SCREEN3 model in their report "Poultry Manure Incineration Toxic Air Pollution Impacts" (May 6, 2009). The results of BREDL's conservative modeling actually demonstrate that a Fibrowatt plant, using Minnesota permit emissions data and size, would have met all of the selected North Carolina acceptable ambient levels – though BREDL never included these results in the report.
- An important factor overlooked in the BREDL analysis is Fibrowatt's previously stated intention to build a smaller plant in Surry County, currently envisioned as a 40 mega-watt plant. BREDL's analysis assumes a 55 mega-watt plant; therefore, the impacts of the Surry Plant actually are expected to be significantly lower than indicated throughout BREDL's comparative analysis.
- Results of the BREDL SCREEN3 model demonstrate that a Fibrowatt plant, using conservative emissions data from the 2001 Minnesota permit application, would have been anywhere from 1.7 to 5,177 times lower than North Carolina's acceptable ambient levels.
- BREDL's conclusions regarding chromium are incorrect as they failed to note that the North Carolina acceptable ambient level is for chromium(VI) a small part of total chromium emissions. Using an appropriate and conservative chromium(VI) assumption for Minnesota permit levels indicate that the plant would have easily met the North Carolina AALs.
- A comparison of the BREDL SCREEN3 results and refined air-dispersion modeling, as used for the Minnesota plant and as will also be required for North Carolina modeling, indicate that the Minnesota modeling results for annual ambient levels were actually 13 times lower than the conservative BREDL SCREEN3 results. For regulatory purposes, refined modeling is the required approach, suggesting that actual annual results for a Surry plant would potentially be 13 times lower than the levels calculated (but not presented) by BREDL.
- Since the Minnesota plant began operation in 2007, stack tests have been undertaken for metals emissions. These 2009 results indicate actual emission levels are anywhere from 6 to 211 times lower than the emissions estimates used during Minnesota permitting and used by BREDL for a comparison. Metals evaluated using the BREDL SCREEN3 technique and current 2009 metals testing results indicate that the impacts for emissions would be roughly 59 to 183,000 times below the North Carolina acceptable ambient levels.
- Based on the 2009 Minnesota metals emissions results and the more appropriate 2001 refined modeling approach as used in the Minnesota permit (13 times lower for annual results than BREDL's approach), indicate that the impacts for metals emissions could be more than 750 times lower that the applicable North Carolina acceptable ambient levels.
- Based on information from Fibrowatt's biomass plant in Minnesota and BREDL's SCREEN3 air-dispersion modeling approach, it is obvious that a Fibrowatt plant will be very protective of the local population.

- BREDL's second air-dispersion model, a so-called "worst-case spreadsheet", gives results that are baseless and are in no way applicable for evaluating the Fibrowatt plant planned for Surry County, North Carolina. The validity and details for this model were not even documented or explained in the report.
- The "worst-case spreadsheet" model appears to be intended for ground-level discharges (likely for accidental release evaluation) and therefore can not be used for evaluating emissions from a stack. BREDL can not legitimately use the "worst-case spreadsheet" for evaluating a Fibrowatt plant as our plants are not designed with a mechanism that would result in direct emissions at ground-level. The only route for flue gas emissions from our combustion process is through the air pollution control system and exiting through the top of the stack. Flue gas emissions released from the top of a stack will ensure that, by the time these emissions reach the ground, the few pollutants that reach the top of the stack disperse in the atmosphere and are therefore found at negligible concentrations.
- The conclusions provided on Table 2 of the BREDL report are meaningless as the last column ("Distance Meters") has nothing to do with the emission rate (grams/sec.). All of the spreadsheet model spreadsheets in Attachment 3 are invalid and BREDL needs to remove all reference to findings associated with the "worst-case spreadsheet" from this report. To not remove this information would be misleading and suggests that BREDL was purposefully using invalid methods to support unsubstantiated findings and conclusions.

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**OTHER IMPORTANT POINTS**

- A permit application has not been submitted for a planned facility in Surry County; therefore, it is only possible at this point to make theoretical conclusions on potential toxic air pollutants from the proposed Surry County facility.
- Fibrowatt completed an air toxics evaluation much like what is utilized by North Carolina and was able to demonstrate compliance with this evaluation – and Fibrowatt is certain that we will be able to likewise meet North Carolina's strict requirements.
- Results of the Minnesota air toxics evaluation, using stack testing data for metals obtained in March 2009 and refined air-dispersion modeling techniques, indicate that the Fibrominn plant would be anywhere from 780 to 7,000,000 times below the Minnesota air toxics levels, results that are similarly expected for the North Carolina plants.
- BREDL has incorrectly used the word "incinerator" to define a Fibrowatt plant. This use is likely intentional and meant to elicit a negative connotation with this study. Such a characterization is wrong as Fibrowatt plants are defined as biomass power plants – permitting designation has specifically confirmed that Fibrowatt plants are biomass power plants. Furthermore, poultry litter is not a waste as it is never disposed of. Poultry litter is always beneficially used, either as a low-grade fertilizer/soil amendment or in Minnesota as a renewable fuel. Incinerators are used for the destruction of wastes and volume reduction for eventual disposal in a landfill. <u>No Waste – No Incinerator.</u>

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For further information on the Fibrowatt's review of the BREDL report, please contact Terry Walmsley at (267) 352-6589 or terry.walmsley@fibrowattusa.com.

On May 6, 2009 the Blue Ridge Environmental Defense League ("BREDL") released a technical report, which was intended to address the issue of toxic air emissions, using information from (a) the Fibrominn Biomass Power Plant permitting process in Minnesota in 2001-2004, (b) process data from recent Fibrominn stack testing in September 2008, and (c) a few details about the site chosen by Surry County and Fibrowatt for the company's proposed FibroHills Biomass Power Plant near Elkin, North Carolina. Since Fibrowatt has not submitted an air permit application for the FibroHills project at this time, BREDL's assessment is based almost entirely on data and assumptions for the Fibrominn Biomass Power Plant in Benson, MN.

## North Carolina Air Toxics Program

In North Carolina, the Department of Environment and Natural Resources ("DENR") utilizes a state Toxic Air Pollutant program (http://daq.state.nc.us/toxics/intro.shtml), a "risk-based" regulatory program, designed to protect the public health by limiting emissions of toxic air pollutants from man-made sources. As stated by DENR:

*The North Carolina Division of Air Quality's air toxics program is a "risk-based" regulatory program designed to protect the public health by limiting emissions of toxic air pollutants from man-made sources. It established airborne concentrations of chemicals "above which the substance may be considered to have an adverse effect on human health." The chemicals became known as toxic air pollutants or TAPs and the concentrations became known as acceptable ambient levels or AALs. "Acceptable" in this context is intended to be a level "below the concentration that would produce adverse health effects in sensitive subgroups of the general population." AALs are expressed in weight per unit volume, most often as milligrams per cubic meter of air (mg/m3). North Carolina has developed AALs for 97 toxic air pollutants. By their nature, AALs are intrinsically different from measured air concentrations, and an understanding of this distinction is necessary to prevent misunderstanding and misapplication of AALs.*

*Regulated pollution sources are asked to reduce their emissions below those levels that are predicted to exceed the AAL beyond their fenceline. The toxics program uses computer-based dispersion models to compare the impact of pollution from a smokestack to the appropriate AAL.*

*Determining what exposure level is acceptable can be very challenging. The standard approach is to study very closely everything that is known about a pollutant in order to determine the lowest level known to cause harm to people. Then beginning from this starting point, several safety factors are used to reduce that level even further. Safety factors may be used to protect sensitive people such as asthmatics or to take into consideration other possible adverse effects that have not been studied. In some cases, safety factors may be used if a chemical is known to interact with other chemicals to produce greater toxicity. In general, larger safety factors are used when less is known about a chemical. This approach defaults to the protection of public health.*

*The approach described above applies to chemicals that have AALs based on non-cancer health effects such as airway irritation or liver damage. They are believed to be without significant risk because they are set far below exposures associated with toxic effects. In the case of carcinogenic (cancer-causing) agents, risk assessment methods assume by default that no exposure is without at least some risk. In these cases, AALs are set at levels that represent extremely low incidence levels. For example, AAL guidelines for known carcinogens represent "one in a million" cancer risk. Using the assumptions outlined above, if one million persons were exposed to this level continuously, one person would develop cancer as a result of exposure to that chemical*

*Some chemicals are known to cause multiple health effects in humans. For example, many solvents will cause lightheadedness following short-term (acute), high level exposures and organ damage following longer-term (chronic) exposure to lower levels. In these cases, multiple AAL guidelines may exist for the same chemical to control both acute and chronic exposures. When this is the case, short-term AALs act to "smooth out" emissions spikes while also regulating the total amount emitted over a longer period of time. It is also worth noting that many of the long-term cancer based AALs are set at levels so low that they also become effective* *at reducing short-term exposures. This is especially true for manufacturing processes that tend to operate on a continuous basis.*

The acceptable ambient levels ("AAL") are established according to the type of risk that they pose. The AALs are evaluated according to whether they pose a (a) long-term risk (evaluated based on an annual ambient average level), (b) a chronic risk (evaluated based on a 24-hr ambient average level), (c) an acute short-term risk (evaluated based on a 1-hour ambient average level), and (d) an acute short-term irritation risk (evaluated based on a 1-hour ambient average level). To evaluate these risks, as mentioned earlier, computer-based air-dispersion models developed by the United States Environmental Protection Agency ("USEPA") are used. These models utilize source-specific data from a source of emissions (e.g. stack height, stack diameter, flue-gas exit velocity, flue-gas temperature) along with the emission rate (generally in grams/sec) released from the emission source. This source specific information is used along with information on the local topography (i.e ground elevation around the plant) and a 5-year dataset of actual weather data around the area to identify the predicted maximum ambient average level for the particular emissions. It is these predicted maximum ambient average levels that are compared with the AALs to determine if the levels of emissions of toxic air pollutants are acceptably low so as to protect the health of even the most sensitive recipient.

Within DENR's list of 97 Toxic Air Pollutants ("TAPs"), BREDL provided information for 10 different pollutant types. The AALs for the selected toxic air pollutants can be found in Table 1. DENR presents the AALs in units of milligrams per cubic-meter ("$mg/m^3$") but in general emissions are evaluated in units of micrograms per cubic-meter ("$\mu g/m^3$"). There are 1,000 micrograms in a milligram.

<u>BREDL's SCREEN3 Air Dispersion Modeling</u>

As the starting point for BREDL's analysis, they utilized a simple USEPA computer-driven air-dispersion modeling program referred to as the SCREEN3 dispersion model, which has been around since the 1980's. The SCREEN3 model is typically used as a preliminary evaluation model to help determine the need for further more refined air-dispersion modeling. The SCREEN3 model is a conservative model as it has several simple assumptions (standard set of weather conditions, atmospheric stability, wind speeds, flat topography) that generally results in higher ground-level concentrations than would be found with the more refined models that are used to determine regulatory compliance. If results from SCREEN3 modeling demonstrate compliance with a standard, it may not be necessary to complete more refined air-dispersion modeling.

The SCREEN3 model, based on the standard assumptions, is used to determine short-term impacts (1-hr) and is not designed for providing accuracy with longer averaging periods like 24-hr concentrations and annual concentrations. The 24-hr and annual concentrations are dependant on actual weather conditions and local topography, data not accurately addressed in the SCREEN3 model. BREDL has used the SCREEN3 model for determining the longer timeframe estimates using a simple scaling conversion. To obtain 24-hr and annual results, they have multiplied the results of the SCREEN3 model 1-hr results by 0.4 for 24-hr results and multiplied by 0.08 to convert to annual averages. While this is an acceptable methodology, it often provides very conservative (i.e. higher results) for the annual evaluation.

Table 1

## North Carolina Toxic Air Pollutants Program

### Acceptable Ambient Levels (AAL) for Select Pollutants (1)

| Pollutant | Note | AAL (mg/m$^3$) | AAL (µg/m$^3$) | Basis for AAL Toxic |
|---|---|---|---|---|
| Ammonia | (2) | 2.70E+00 | 2.70E+03 | 1-Hour Average (Irritant) |
| Arsenic | (3) | 2.30E-07 | 2.30E-04 | Annual Average |
| Beryllium | (4) | 4.10E-06 | 4.10E-03 | Annual Average |
| Cadmium | (5) | 5.50E-06 | 5.50E-03 | Annual Average |
| Chromium | (6) | 8.30E-08 | 8.30E-05 | Annual Average |
| Hydrogen Chloride | (7) | 7.00E-01 | 7.00E+02 | 1-Hour Average (Irritant) |
| Manganese | (8) | 3.10E-02 | 3.10E+01 | 24-Hour Average |
| Mercury | (9) | 6.00E-04 | 6.00E-01 | 24-Hour Average |
| Nickel | (10) | 6.00E-04 | 6.00E-01 | 24-Hour Average |
| Sulfuric Acid | (11) | 1.20E-02 | 1.20E+01 | 24-Hour Average |
| | (12) | 1.00E-01 | 1.00E+02 | 1-Hour Average |

Notes

The AAL within the NC Toxic Air Pollutant Program is reported in units of mg/m$^3$

AALs presented in scientific notation. (Ex. 0.002 mg/m$^3$ = 2.00x10$^{-3}$ mg/m$^3$ = 2.00E-3 mg/m$^3$)

(1) AALs as found at http://daq.state.nc.us/toxics/haps-taps/haps-taps-lookup.shtml

(2) Ammonia identified by CAS# (7664-41-7)

(3) Arsenic identified by CAS# (7440-38-2)

(4) Beryllium identified by CAS# (7440-41-7)

(5) Cadmium identified by CAS# (7440-43-9)

(6) The AAL for Chromium is not for total chromium, rather it is for Chromium (VI), a subspecies of total chromium

(7) Hydrogen chloride identified by CAS# (7647-01-0)

(8) Manganese identified as manganese and compounds

(9) Mercury identified by Mercury, aryl and inorganic compounds

(10) Nickel identified by Nickel, soluble compounds, as nickel

(11) Sulfuric Acid identified by CAS# (7664-93-9) - 24-Hour average

(12) Sulfuric Acid identified by CAS# (7664-93-9) - 1-Hour average

## BREDL Air Dispersion Modeling Results

For purposes of Fibrowatt's review of the BREDL report, we have not attempted to replicate the results with our own SCREEN3 analysis; rather, we have taken BREDL's SCREEN3 model results as an accurate representation of their stated modeling and drawn conclusions based on the BREDL results. Fibrowatt, as part of its permitting efforts, will ultimately perform more complex and refined modeling for the proposed Surry plant and this modeling will ultimately be used to assess general regulatory compliance including demonstrating compliance with the NC Toxic Air Pollutants program.

On page 4 of the BREDL Report, they refer to Table A: Stack Parameters for the Fibrominn plant. While these stack parameters are accurate variables in Minnesota, they may not be accurate for the FibroHills plant as the Surry County design anticipates a smaller plant, currently planned to be 40 MW as compared to 55 MW as for the Fibrominn plant in Minnesota. Likewise, the Surry County project modeling will use the actual terrain for the area rather than a standard assumed terrain. In BREDL's analysis, they assumed that all land around the site will be elevated 65.6 feet above the base elevation of the stack. In this way, BREDL has assumed that modeling is being done as if the proposed plant sits in a 65 foot hole or as if it has a 234.4 ft. stack. Furthermore, they also added to this an assumption that a 6'5" person was standing at the peak location (receptor height). Both assumptions are a conservative approach to modeling at this stage and not accurate for permitting purposes.

BREDL used the following Minnesota data to perform their analysis:

**Table 2**
**SCREEN3 Modeling Parameters Used by BREDL**

| Parameter | Variable |
|---|---|
| Stack Height | 300 ft. (91.4 meters) |
| Stack Diameter | 9 ft. (2.7 meters) |
| Stack Exit Velocity | 84.3 ft./sec. (25.7 m/sec) |
| Stack Exit Temperature | 298 °F (421 °K) |
| Ambient Air Temperature | 68 °F (293 °K) |
| Terrain Elevation | 65.6 ft. (20 meters) |
| Receptor Height | 6.5 ft. (2 meters) |

With this data, BREDL then ran the SCREEN3 model using what they referred to as a "generic concentration factor" defined in their model as 0.126 g/sec. (i.e. 1 lb/hr). The generic concentration factor gave a maximum 1-hr. concentration of 0.2317 $\mu g/m^3$ and identified this maximum location as 3,189 ft. (972 m) from the stack. Locations closer to the plant and farther from the plant would have lower impacts according to the model, for example at 985 ft. (300 m) from the stack, the emissions concentration was 0.000007 $\mu g/m^3$ or more than 3,000 times lower than this maximum. This lower concentration near the stack is typical for stack emissions and is an important point to note as compared to some of the results BREDL reports within their study.

This maximum concentration of 0.2317 $\mu g/m^3$ at 0.126 gram/sec was then compared to the estimated emission rates utilized in the Fibrominn Air Permit Application of August 28, 2001. The formula, as stated in the BREDL report is as follows:

$$\text{Ambient Level } (C_m) = C_g * E_p * \text{Conversion Factor}$$

Where:

$C_g$ = the generic concentration factor (BREDL = 0.2317 $\mu g/m^3$ per lb/hr)
Cg is divided by 0.126 g/sec /lb/hr to utilize the Minnesota emissions data in g/sec.
$E_p$ = 2001 Permit Estimate in g/sec
Conv. Factor = 1.0 for 1-hr, 0.4 for 24-hr, 0.08 for annual

An example of this calculation can be seen for arsenic (an annual AAL) as:

$C_m$ = $C_g$ * $E_p$ * Conversion Factor
= (0.2317 $\mu g/m^3$ per lb/hr) / (0.126 g/sec per lb/hr) * (9.17E-04 g/sec) * (0.08)
= (1.839 $\mu g/m^3$ / g/sec) * (9.17E-04 g/sec) * (0.08)
= 1.35E-04 $\mu g/m^3$

**According to this approach, the Fibrowatt project in Surry County, if designed according to the same standards as the Minnesota plant (i.e 55 MW plant), would meet each of the AALs being analyzed despite the very conservative nature of the SCREEN3 air-dispersion modeling**. The BREDL analysis, as provided in Table 3, indicates that the modeled results would be anywhere from 1.7 times lower (arsenic) to 5,177 times lower (manganese) than the NC AAL standards.

Table 3

## BREDL Maximum Impacts versus NC AAL

Based on 2001 Estimates Presented in the Fibrominn Biomass Power Plant Permit Application

| Emission (1) | 2001 Permit Estimate (g/sec) (2) | NC AAL Levels ($\mu g/m^3$) (3) | NC AAL Analysis Basis (4) | BREDL Modeling ($\mu g/m^3$) (5) | Comparative Ratio of AAL v. 2001 Permit (6) | Percent of AAL (7) |
|---|---|---|---|---|---|---|
| **Ammonia** | 1.60E+00 | **2.70E+03** | 1-hour | **2.94E+00** | 917.7 | 0.11% |
| **Arsenic** | 9.17E-04 | **2.30E-04** | Annual | **1.35E-04** | 1.7 | 58.65% |
| **Beryllium** | 3.90E-04 | **4.10E-03** | Annual | **5.74E-05** | 71.5 | 1.40% |
| **Cadmium** | 2.25E-04 | **5.50E-03** | Annual | **3.31E-05** | 166.2 | 0.60% |
| **Chromium** | 1.51E-03 | **No AAL** | | | | |
| **Chromium (VI) *** | *1.51E-04* | **8.30E-05** | Annual | ***2.22E-05*** | 3.7 | 26.76% |
| **Hydrogen Chloride** | 3.39E+00 | **7.00E+02** | 1-hour | **6.23E+00** | 112.3 | 0.89% |
| **Manganese** | 8.14E-03 | **3.10E+01** | 24-hour | **5.99E-03** | 5,177.5 | 0.02% |
| **Mercury** | 8.10E-04 | **6.00E-01** | 24-hour | **5.96E-04** | 1,007.0 | 0.10% |
| **Nickel** | 5.49E-03 | **6.00E-01** | 24-hour | **4.04E-03** | 148.6 | 0.67% |
| **Sulfuric Acid** | 5.59E+00 | **1.20E+01** | 24-hour | **4.11E+00** | 2.9 | 34.26% |
| | | **1.00E+02** | 1-hour | **1.03E+01** | 9.7 | 10.28% |

* **The NC Acceptable Ambient Level (AAL) for chromium is for chromium (VI) not total chromium. Since the Fibrominn permit application data only provides information for total chromium, we have made a conservative assumption that 10% of the total chromium is in the form of chromium (VI). Historical data for combustion sources generally suggests that 1% - 3% of total chromium might be in the form of chromium (VI).**

**AALs presented in scientific notation. (Ex. 0.00023 $\mu g/m^3$ = $2.30 \times 10^{-4}$ $\mu g/m^3$ = 2.30E-4 $\mu g/m^3$)**

(1) The list of 10 Hazardous Air Pollutants that were analyzed by BREDL includes 7 metals (Ar, Be, Cd, Cr, Mn, Hg, Ni) and 3 inorganic emissions (ammonia, HCl, Sulfuric Acid)
(2) Emission estimates as presented in the Fibrominn Biomass Power Plant permit application dated August 2001. These estimates, based on stack testing in the UK, were presented in Section 10, Volume 3 of 3. The estimates presented here are values based on the average for all of the Thetford UK stack tests where emissions were detected. If no emissions were detected, the emission level is 1/2 of the average of the detection limit.
(3) The NC AALs are converted from $mg/m^3$, as stated in the NC Toxic Air Pollutants Program, to $\mu g/m^3$ by multiply by 1,000 µg/mg.
(4) The basis for the AALs is important as the calculation of impacts in $\mu g/m^3$ will differ if the AAL is based on a 1-hr, 24-hr, or annual basis.
(5) The BREDL modeling impacts are calculated based on (emission rate g/sec) / (0.126 g/sec) * (0.2317 $\mu g/m^3$) * (conversion factor) where the conversion factor is 1.0 if the AAL is a 1-hr standard, 0.4 if the AAL is a 24-hr standard, or 0.08 if the AAL is an annual standard.
(6) The comparative ratio is how many times lower the calculated rate is versus the NC AAL.
(7) This is the alternative of the comparative ratio representing what level the ambient impact will be at versus the AAL.

As a point of reference, Fibrowatt has compared the results of the original complex refined air dispersion modeling in Minnesota and the results of the BREDL SCREEN3 analysis. The annual ground-level impacts for the refined modeling in Minnesota were 13 times lower than was predicted using the BREDL SCREEN3 approach for the same emission rate (i.e. grams/second - "g/sec"). This difference would be due to, in some degree, the standard model assumption BREDL used - that the average ground-level around the facility would be equal to 72.2 feet above the bottom of the stack – but a large part of the difference is the comparison of the use of a conservative screening analysis (SCREEN3) versus a refined model. The conservative nature of the SCREEN3 analysis, looking at annual impacts, can be seen in Table 4. As is indicated in the results for the 1-hr comparison, the BREDL analysis, even at BREDL's higher assumed ground elevation, is fairly similar with the results obtained for permitting the Fibrominn project in 2001; however, the annual values for Minnesota, like arsenic, are 13 times lower than the BREDL model predicted. Since the emissions that are close to the AALs according to the BREDL analysis are annual standards, it is important that proper, refined modeling is used to assess these impacts. In this way, BREDL has not drawn proper conclusions regarding the potential impact of a Fibrowatt plant based on their use of a simple screening analysis that overstates annual impacts.

Table 4

## BREDL Maximum Impacts versus Minnesota Modeling

**Based on 2001 Estimates Presented in the Fibrominn Biomass Power Plant Permit Application**

| Emission (1) | 2001 Permit Estimate (g/sec) (2) | NC AAL Levels ($\mu g/m^3$) (3) | BREDL Modeling ($\mu g/m^3$) (4) | Fibrominn Modeling ($\mu g/m^3$) (5) | Comparative Ratio of MN v. BREDL (6) | Comparative Ratio of MN v. NC AAL (7) |
|---|---|---|---|---|---|---|
| Ammonia | 1.60E+00 | 2.70E+03 | **2.94E+00** | **2.75E+00** | 1.1 | 981.8 |
| Arsenic | 9.17E-04 | 2.30E-04 | **1.35E-04** | **1.01E-05** | 13.4 | 22.8 |
| Beryllium | 3.90E-04 | 4.10E-03 | **5.74E-05** | **4.29E-06** | 13.4 | 955.7 |
| Cadmium | 2.25E-04 | 5.50E-03 | **3.31E-05** | **2.48E-06** | 13.3 | 2,217.7 |
| Chromium | 1.51E-03 | No AAL | | | | |
| Chromium (VI) * | *1.51E-04* | 8.30E-05 | ***2.22E-05*** | ***1.66E-06*** | 13.4 | 50.0 |
| Hydrogen Chloride | 3.39E+00 | 7.00E+02 | **6.23E+00** | **5.82E+00** | 1.1 | 120.3 |
| Manganese | 8.14E-03 | 3.10E+01 | **5.99E-03** | 24-hr concentration not modeled in MN | | |
| Mercury | 8.10E-04 | 6.00E-01 | **5.96E-04** | 24-hr concentration not modeled in MN | | |
| Nickel | 5.49E-03 | 6.00E-01 | **4.04E-03** | 24-hr concentration not modeled in MN | | |
| Sulfuric Acid | 5.59E+00 | 1.20E+01 | **4.11E+00** | 24-hr concentration not modeled in MN | | |
| | | 1.00E+02 | **1.03E+01** | **9.61E+00** | 1.1 | 10.4 |

* **The NC Acceptable Ambient Level (AAL) for chromium is for chromium (VI) not total chromium. Since the Fibrominn permit application data only provides information for total chromium, we have made a conservative assumption that 10% of the total chromium is in the form of chromium (VI). Historical data for combustion sources generally suggests that 1% - 3% of total chromium might be in the form of chromium (VI).**

**AALs presented in scientific notation. (Ex. 0.00023 $\mu g/m^3$ = $2.30 \times 10^{-4}$ $\mu g/m^3$ = 2.30E-4 $\mu g/m^3$)**

(1) The list of 10 Hazardous Air Pollutants that were analyzed by BREDL includes 7 metals (Ar, Be, Cd, Cr, Mn, Hg, Ni) and 3 inorganic emissions (ammonia, HCl, Sulfuric Acid)

(2) Emission estimates as presented in the Fibrominn Biomass Power Plant permit application dated August 2001. These estimates, based on stack testing in the UK, were presented in Section 10, Volume 3 of 3. The estimates presented here are values based on the average for all of the Thetford UK stack tests where emissions were detected. If no emissions were detected, the emission level is 1/2 of the average of the detection limit.

(3) The NC AALs are converted from $mg/m^3$, as stated in the NC Toxic Air Pollutants Program, to $\mu g/m^3$ by multiply by 1,000 µg/mg.

(4) The BREDL modeling impacts are calculated based on (emission rate g/sec) / (0.126 g/sec) * (0.2317 $\mu g/m^3$) * (conversion factor) where the conversion factor is 1.0 if the AAL is a 1-hr standard, 0.4 if the AAL is a 24-hr standard, or 0.08 if the AAL is an annual standard.

(5) Air-dispersion modeling results as presented in the Fibrominn Biomass Power Plant permit application dated August 2001. These estimates, based on stack testing in the UK, were presented in Section 10, Volume 3 of 3. The estimates presented here are values based on the average for all of the Thetford UK stack tests where emissions were detected. If no emissions were detected, the emission level is 1/2 of the average of the detection limits. These results were then evaluated based on ISCST3 modeling using actual local topography, 5-years of weather data.

(6) The comparative ratio is how many times lower the Minnesota modeling results were versus the BREDL results.

(7) The comparative ratio is how many times lower the Minnesota modeling results were versus the NC AAL limits.

As seen in Table 4, looking at the Minnesota testing results and comparing these to the NC AALs shows that a refined air-dispersion model would have demonstrated compliance with all of the NC AALs, being anywhere from 10 to 2,200 times lower than the AALs.

<u>Fibrominn Metals Testing Results</u>

In March 2009, as part of its normal air emissions compliance testing for PM-10 and HCl, Fibrominn completed stack testing of emissions to determine the level of metals emissions from the plant. These results were subsequently reported to the Minnesota Pollution Control Agency within the compliance stack testing report. Based on the type of emission control system utilized at the Minnesota plant, metals testing is not a normal requirement within the plant permit. This testing was performed for what is identified as the USEPA multi-metals test, which includes analysis for 15 metals. This testing data, as presented in Table 5, can be used for comparison with the metals emissions estimates that were used in BREDL's analysis. As seen in this data, actual testing data in Minnesota indicated results that were anywhere from 6 to 211 times lower than the emissions estimates used during Minnesota permitting and used by BREDL for a comparison.

Table 5

# Fibrominn Emissions Testing Comparison - Metals

## Comparison of 2001 Estimates Presented in the Permit Application with Actual March 2009 Stack Testing Results

| Metal (1) | 2001 Estimates (lb/mmBtu) (2) | % data above detect (3) | 2009 Testing (lb/mmBtu) (4) | % data above detect (5) | 2001 Estimates gram/sec (6) | 2001 Estimates lb/hr (7) | 2009 Testing gram/sec (8) | 2009 Testing lb/hr (9) | Reduction Ratio 2001 v. 2009 (10) | Proportion 2009 as a % of 2001 (11) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Antimony** | 7.760E-06 | 33.3% | 4.621E-07 | 83.3% | 7.750E-04 | 6.151E-03 | 4.611E-05 | 3.660E-04 | **16.8** | 5.95% |
| **Arsenic** | 9.190E-06 | 20.0% | 2.668E-07 | 50.0% | 9.170E-04 | 7.278E-03 | 2.662E-05 | 2.113E-04 | **34.4** | 2.90% |
| **Barium** | *Not Tested* | | 3.532E-06 | 100.0% | | | 3.525E-04 | 2.797E-03 | | |
| **Beryllium** | 3.910E-06 | 0.0% | 1.272E-07 | 66.7% | 3.900E-04 | 3.095E-03 | 1.269E-05 | 1.007E-04 | **30.7** | 3.25% |
| **Boron** | 4.470E-04 | 100.0% | *Not Tested* | | 4.460E-02 | 3.540E-01 | | | | |
| **Cadmium** | 2.250E-06 | 0.0% | 2.330E-07 | 83.3% | 2.250E-04 | 1.786E-03 | 2.325E-05 | 1.845E-04 | **9.7** | 10.33% |
| **Chromium** | 1.510E-05 | 60.0% | 9.315E-07 | 100.0% | 1.510E-03 | 1.198E-02 | 9.296E-05 | 7.377E-04 | **16.2** | 6.16% |
| **Cobalt** | 4.270E-06 | 50.0% | 2.312E-08 | 0.0% | 4.260E-04 | 3.381E-03 | 2.307E-06 | 1.831E-05 | **184.6** | 0.54% |
| **Copper** | 1.110E-05 | 90.0% | 1.977E-06 | 100.0% | 1.110E-03 | 8.810E-03 | 1.973E-04 | 1.566E-03 | **5.6** | 17.77% |
| **Lead** | 7.820E-06 | 66.7% | 9.128E-07 | 100.0% | 7.810E-04 | 6.198E-03 | 9.109E-05 | 7.229E-04 | **8.6** | 11.66% |
| **Manganese** | 8.160E-05 | 100.0% | 2.307E-06 | 100.0% | 8.140E-03 | 6.460E-02 | 2.302E-04 | 1.827E-03 | **35.4** | 2.83% |
| **Mercury** | 8.120E-06 | 20.0% | 8.852E-08 | | 8.100E-04 | 6.429E-03 | 8.834E-06 | 7.011E-05 | **91.7** | 1.09% |
| **Nickel** | 5.500E-05 | 90.0% | 9.418E-07 | 100.0% | 5.490E-03 | 4.357E-02 | 9.398E-05 | 7.459E-04 | **58.4** | 1.71% |
| **Selenium** | 3.910E-06 | 0.0% | 2.581E-07 | 16.7% | 3.900E-04 | 3.095E-03 | 2.576E-05 | 2.044E-04 | **15.1** | 6.60% |
| **Silver** | *Not Tested* | | 7.926E-08 | 0.0% | | | | | | |
| **Thallium** | 6.280E-06 | 50.0% | 2.972E-08 | 0.0% | 6.270E-04 | 4.976E-03 | 2.966E-06 | 2.354E-05 | **211.4** | 0.47% |
| **Tin** | 2.280E-05 | 100.0% | *Not Tested* | | 2.270E-03 | 1.802E-02 | | | | |
| **Vanadium** | 2.130E-06 | 0.0% | *Not Tested* | | 2.130E-04 | 1.690E-03 | | | | |
| **Zinc** | 2.310E-04 | 100.0% | 9.242E-06 | 100.0% | 2.310E-02 | 1.833E-01 | 9.223E-04 | 7.320E-03 | **25.0** | 3.99% |

(1) Metals as presented in this analysis are total metals. Note that chromium as presented is for total chromium, not just chromium (VI)

(2) Emission estimates as presented in the Fibrominn Biomass Power Plant permit application dated August 2001. These estimates, based on stack testing in the UK, were presented in Section 10, Volume 3 of 3. The estimates presented here are values based on the average for all of the Thetford UK stack tests where emissions were detected. If no emissions were detected, the emission level is 1/2 of the average of the detection limit.

(3) Percent of the stack tests that were above the detection limit for an individual stack test

(4) Emissions data from the March 24-26, 2009 testing performed by Eagle Mountain Scientific. In addition to multi-metals testing, report includes compliance testing for PM-10 and HCl

(5) Emissions data is the average of three testing runs. Test methods evaluated both filterable and condensable values. As such, the representation of data above detection levels is based on a detectable value for the filterable and a detectable value for the condensable fraction of the test results.

(6) Emission estimates in grams/sec. as presented in the Fibrominn Biomass Power Plant permit application dated August 2001.

(7) 2001 emission estimates in lb/hr based on the grams/sec. estimates divided by 0.126 g/sec per lb/hr.

(8) 2009 testing data in lb/mmBtu is converted to gram/sec based on formula of (lb/mmBtu) * (792 mmBtu/hr) / (60 min/hr) /(60 sec/min) * (453.6 g/lb). 792 mmBtu is the design thermal rate used to normalize the results used in the original 2001 emissions estimates.

(9) 2009 emission estimates in lb/hr based on the grams/sec. estimates divided by 0.126 g/sec per lb/hr.

(10) The comparative ratio is how many times lower the Minnesota 2009 stack testing results were than the Minnesota 2001 emissions estimates used in the BREDL evaluation

(11) This is the alternative of the comparative ratio representing what level the 2009 results are of the 2001 emissions estimate

The 2009 metals data, unlike the 2001 data, used the detection level as the level for reporting emissions if a test result was below the detection level. Since the results for the 2001 testing utilized data at ½ the detection level for tests where data was below the detection level, in some cases the proportional difference between the 2001 emissions estimates and the 2009 stack testing data would be even more pronounced. If the same methods were used for detection limits in both the 2001 and 2009 analysis, it is expected that materials like arsenic, beryllium, cadmium, chromium, and mercury would have had a greater proportional difference – meaning they would have been a greater number of times lower than the projected Minnesota results used in the permit application.

Finally, based on the results of the March 2009 stack testing, it is possible the utilize the BREDL modeling approach using SCREEN3 and the stack testing results for metals in 2009 to further show that actual emissions results are significantly below the NC AALs. This comparison can be seen in Table 6.

Table 6
**Minnesota Metals Testing Data Ambient Impacts versus NC AAL**
Based on March 2009 Metals Testing Data

| Emission (1) | 2009 Testing Data (g/sec) (2) | NC AAL Levels (μg/m³) (3) | NC AAL Analysis Basis (4) | BREDL Original Modeling (μg/m³) (5) | BREDL Modeling 2009 Data (μg/m³) (6) | Comparative Ratio of AAL v. 2009 Data (7) | 2009 Data Percent of AAL (8) |
|---|---|---|---|---|---|---|---|
| **Arsenic** | 2.66E-05 | **2.30E-04** | Annual | **1.35E-04** | **3.92E-06** | 59 | 1.70% |
| **Beryllium** | 1.27E-05 | **4.10E-03** | Annual | **5.74E-05** | **1.87E-06** | 2,196 | 0.05% |
| **Cadmium** | 2.33E-05 | **5.50E-03** | Annual | **3.31E-05** | **3.42E-06** | 1,608 | 0.06% |
| **Chromium** | 9.30E-05 | **No AAL** | | | | | |
| **Chromium (VI)** * | *9.30E-06* | **8.30E-05** | Annual | ***2.22E-05*** | ***1.37E-06*** | 61 | 1.65% |
| **Manganese** | 2.30E-04 | **3.10E+01** | 24-hour | **5.99E-03** | **1.69E-04** | 183,064 | 0.00% |
| **Mercury** | 8.83E-06 | **6.00E-01** | 24-hour | **5.96E-04** | **6.50E-06** | 92,342 | 0.00% |
| **Nickel** | 9.40E-05 | **6.00E-01** | 24-hour | **4.04E-03** | **6.91E-05** | 8,679 | 0.01% |

* The NC Acceptable Ambient Level (AAL) for chromium is for chromium (VI) not total chromium. Since the Fibrominn permit application data only provides information for total chromium, we have made a conservative assumption that 10% of the total chromium is in the form of chromium (VI). Historical data for combustion sources generally suggests that 1% - 3% of total chromium might be in the form of chromium (VI).

Results presented in scientific notation. (Ex. 0.00023 μg/m³ = $2.30\times10^{-4}$ μg/m³ = 2.30E-4 μg/m³)

(1) Metals as presented in this analysis are total metals. Note that chromium as presented is for total chromium, not just chromium (VI)
(2) For proper comparison, the March 2009 testing results in gram/sec are reported here based on the design capacity of the plant rather than the actual g/sec emissions based on the operating conditions at the time of testing. Actual g/sec were slightly lower. Furthermore, data is reported at the detection level for several metals.
(3) The NC AALs are converted from mg/m³, as stated in the NC Toxic Air Pollutants Program, to μg/m³ by multiply by 1,000 μg/mg.
(4) The basis for the AALs is important as the calculation of impacts in μg/m³ will differ if the AAL is based on a 1-hr, 24-hr, or annual basis.
(5) The BREDL modeling impacts using the 2001 permit metals levels are calculated based on (emission rate g/sec) / (0.126 g/sec) * (0.2317 μg/m ³) * (conversion factor) where the conversion factor is 1.0 if the AAL is a 1-hr standard, 0.4 if the AAL is a 24-hr standard, or 0.08 if the AAL is an annual standard.
(6) The results using the BREDL modeling approach uses the results reported in the previous column (BREDL Original Results) times the proportion of 2001 results versus the 2009 testing results, reported in the final column of Table 5. Example Ar = (1.35E-04) * (2.90%) = 3.92E-06
(7) The comparative ratio is how many times lower the Minnesota modeling results are, using 2009 tesing results, than the NC AAL levels using the BREDL SCREEN3 modeling parameters.
(8) This is the alternative of the comparative ratio representing what level the modeling using 2009 actual results are versus the NC AAL

As seen in Table 6, all of the metals evaluated using the BREDL SCREEN3 technique and current 2009 metals testing results for the Minnesota plant indicate that the impacts for metals emissions would be roughly 60 times or more below the North Carolina AAL. Furthermore, as indicated in Table 4, using refined modeling as required for regulatory evaluation of the proposed FibroHills plant in Surry County, annual evaluations of arsenic and chromium (VI) might be as much as 13 times lower (based on $2^{nd}$ last column in Table 4) than BREDL assumes, suggesting that the refined modeling using actual 2009 metals emission results could be roughly 750 times or more lower than the NC AAL levels.

As shown using the BREDL SCREEN3 modeling approach and actual 2009 stack testing data from Minnesota, BREDL has in fact demonstrated that a Fibrowatt plant will be very protective of public health, even for the most sensitive individual.

## Worst-Case Source Analysis

Within BREDL's report, they briefly refer to their use of what they identify as a "worst-case spreadsheet" but provide no further information on the background or validity of this tool. We were unable to find reference to this method of analysis for emissions from a stack and were unable to even identify such a model on the USEPA website. Because BREDL has provided no information on this evaluation tool, it is impossible to check the validity of any aspect of this model. Looking further at this data, however, we are able to show that the conclusions they draw from this analysis go counter to the actual SCREEN3 results BREDL presented earlier in their report and the "worst-case spreadsheet" results are in fact plainly wrong and misleading.

To demonstrate this, we have looked at the Attachment 3 information from the BREDL report. Looking at the results, a few points stick out that help demonstrate that this BREDL "worst-case spreadsheet" analysis is inaccurate and inapplicable for evaluating a Fibrowatt plant.

As indicated on page 5 of the BREDL report (based on their SCREEN3 results on page 8), BREDL states that the maximum 1-hr concentration was found at 3,189 ft. (972 m) from the stack. For a facility with a stack, it is normal for the maximum ground-level concentration to be found at a point far away from the stack location. As such, there is a significant reduction in the concentration of the emission by the time it reaches the ground. However, looking at BREDL's "worst-case spreadsheet" results for arsenic on page 13 of the BREDL report (as well as other results pages), it can be seen that BREDL here claims that the worst-case concentration takes place at 10 meters, not between 900-1,000 meters as previously suggested in the SCREEN3 results. Comparing the BREDL SCREEN3 results with BREDL's unsubstantiated worst-case spreadsheet analysis shows that BREDL is not being consistent in the way they analyze emissions from the plant.

Furthermore, as stated in the table, BREDL claims to be using a peak 30-min emission rate (0.00091 g/sec) but then they compare the spreadsheet results with an annual AAL (of 2E-04 $\mu g/m^3$). As seen in Table 1, there is no short-term AAL (there is no 1-hr or 30-min AAL) for arsenic or for any of the metals. As such, regardless of what model is used, it is plainly wrong for BREDL to make a comparison between a short-term ground-level release (30-min) and an annual AAL standard.

While it is not possible to determine for sure, as BREDL has provided no support documentation for their "worst-case spreadsheet" model, it appears that this model is some form of a ground-level release model, a model that might be used as part of an analysis of an accidental ground-level release – not stack emissions. However, no mention is given in the report about how this model is used and there is no suggestion in the report that the "worst-case spreadsheet" is a ground-level release model. If BREDL is attempting to draw significant conclusions from this model, they need to provide far more detail on the origin of this model and how such a model is intended to be used.

Since a Fibrowatt plant will always discharge from the top of the stack (there is no ground-level release or emergency by-pass duct) – in using the "worst-case spreadsheet" model, BREDL has used a model that has no validity for evaluating a project proposed in Surry County, North Carolina. On this basis, the "worst-case spreadsheet" results, presented on page 6 of their report in "Table 2 Worst-case Pollution Impacts", are baseless and should in no way be quoted as applicable for evaluating the Fibrowatt plant planned for Surry County, North Carolina. The last column of Table 2 that suggests that high levels of pollution extend out as far as 10,000 meters or more is wrong.

As shown above, while it was inappropriate for BREDL to use this model, what is more troubling is the way BREDL has presented this model information in the report. As suggested on page 5, the "worst-case spreadsheet" analysis "is based on the SCREEN3 and ISCST3 models." While the "worst-case spreadsheet" model may have been originally developed based on a SCREEN3 "Gaussian plume dispersion model" there is no relationship between the BREDL SCREEN3 analysis presented in their report and the "worst-case spreadsheet" model. Despite this fact, it appears that the BREDL study was written in such a way as to imply a relationship between BREDL's SCREEN3 analysis and the inappropriate "worst-case spreadsheet" model.

While only BREDL can answer this question, it is our suggestion that BREDL has either inadvertently or intentionally used an invalid model in the form of the "worst-case spreadsheet" and has drawn misleading conclusions that have no validity for a planned Fibrowatt plant in Surry County. We think it is crucial that, before BREDL makes such unsubstantiated claims as to the risk of a Fibrowatt plant that they (a) support the validity of the "worst-case spreadsheet" model, (b) state that this is not a stack emission model, (c) make it clear that their results in no way correlate with their SCREEN3 modeling, and that (d) there are no short-term acceptable ambient levels to compare to for such an analysis. To not go on record in this regard is blatantly dishonest.

# ATTACHMENT A

## Blue Ridge Environmental Defense League Report
## "Poultry Manure Incineration Toxic Air Pollution Impacts"
## May 6, 2009

# Poultry Manure Incineration Toxic Air Pollution Impacts

A Technical Report

Louis A. Zeller

May 6, 2009

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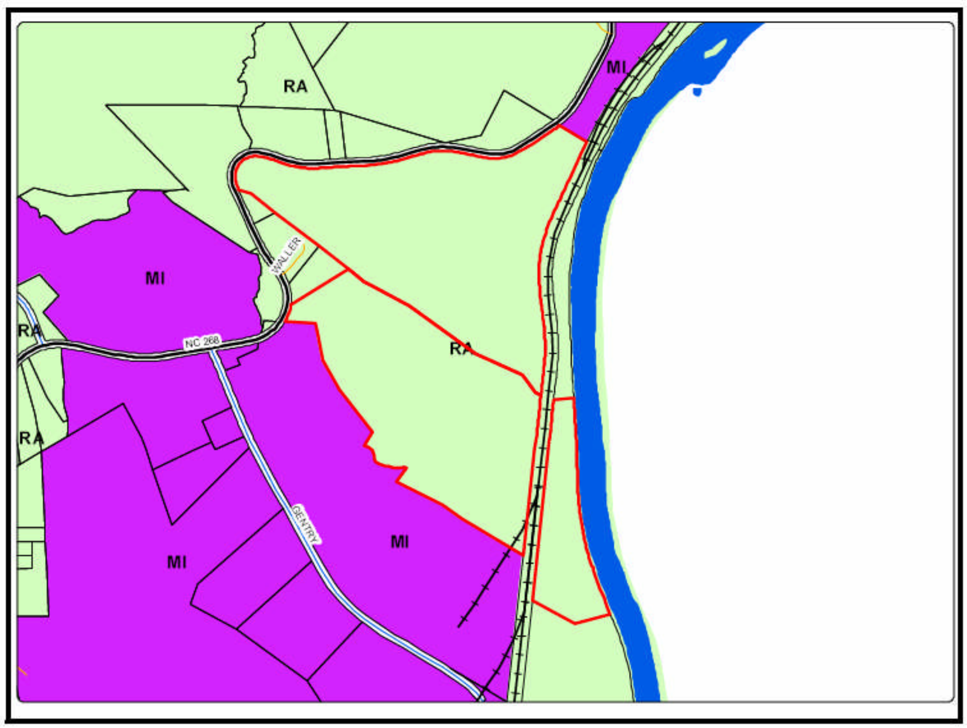
**Background: Fibrowatt Picks Surry County; Surry County Approves Zoning**

In June 2008, Surry County was selected by Fibrowatt LLC, as the site for a proposed poultry manure-burning power plant. The site is located along the Yadkin River east of Interstate 77 and near NC Highway 268. In February 2009, Surry County officials approved the rezoning of the site to accommodate the proposed plant. Figure A illustrates the site of the zoning change.

**Figure A: Surry County Planning and Development Map[1]**




The map indicates the two parcels included in the site of the re-zoning outlined in red.

**BREDL Air Pollution Modeling of the Proposed Site**

The facility which Blue Ridge Environmental Defense League used for the basis of this report was the Fibrominn Biomass Power Plant is located in Benson, Minnesota. The Fibrominn plant utilizes a single boiler burning primarily poultry litter for fuel. The plant has a nominal capacity of 50 megawatts of electricity, or MWe, a peak electrical capacity of 55 MW.

[1] Zoning Amendment Staff Report, Re-zoning Case No. ZCR1039, Applicant: Surry County, Tax Parcel ID Nos. 4972-00-31-8317 and 4972-00-30-8546

Pollution controls installed at the Fibrominn incinerator include a spray dryer absorber and a fabric filter baghouse to limit particulate pollution and selective non-catalytic reduction to reduce nitrogen oxides. Other major pollutants emitted by the plant include carbon monoxide, volatile organic compounds, sulfur dioxide, sulfuric acid mist, hydrogen chloride and carbon dioxide.

In addition to the major criteria pollutants, many other air pollutants designated by the federal Clean Air Act as "hazardous" are emitted by the Fibrominn plant. In North Carolina, many of these pollutants would be regulated by the state Toxic Air Pollutant program under 15A NCAC 02D .1100. North Carolina's Toxic Air Pollutant program has come under assault during the last decade, but the TAP law remains our best means for the reduction of hazardous/toxic air pollution. In this analysis, we have applied the NC TAP limits to a hypothetical poultry manure incinerating plant on the banks of the Yadkin River in Surry County plant identical to the one in Benson, Minnesota: that is, a 50 megawatt poultry manure incinerator with a 715 million BTU/hour heat input and a 300 foot tall smokestack. Figure B illustrates the site of the proposed Surry County poultry manure incinerator. Note NC Highway 268 and the Yadkin River.

**Figure B: Aerial map of the proposed site east of Elkin, North Carolina.**


We analyzed the proposed site using Google topographic map software. The terrain is rolling countryside.

In our analysis we employed a standard Gaussian dispersion model, the SCREEN3 to provide a generic concentration factor based on the physical characteristics of the plant smokestack. Attachment 1 contains the detailed computer readout and Attachment 2 explains the modeling protocol. Table A lists the parameters used in the model.

**Table A: Stack Parameters**[2]

| | |
|---|---|
| Emission Rate | 0.126 grams/second (1 pound/hour) |
| Stack height | 91.4 meters (300 feet) |
| Stack diameter: | 2.7 meters(9 feet) |
| Stack exit velocity | 25.7 m/s (84.3 ft/sec) |
| Stack exit temperature | 421 degrees-K, (298 degrees-F) |
| Ambient air temperature | 293 degrees-K (default 68 degrees-F) |

Modeled ambient level of a given pollutant is product of:

$$C_g \text{ x } E_p \text{ x Conversion Factor} = C_m$$

Where:

$C_g$ = generic concentration factor (μg/m3/lb/hr) from SCREEN3
$E_p$ = pollutant emission rate (lb./hour) from permit application data
$C_m$ = modeled pollutant concentration (μg/m3).

Conversion Factors for hourly, daily and annual pollution limits:

Hourly concentration = $C_m$ x 1.0
24-hour concentration = $C_m$ x .4
Annual concentration = $C_m$ x 0.08

Solving the equation:

0.2317 x 0.012 x 0.08 = 0.00022 micrograms/cubic meter (2.2E-04 μg/$m^3$)

Finally, the modeled pollutant concentration was compared to the state ambient limits to determine if the pollution source would be in compliance with state regulations.

**<u>Computer Modeling Results for the Surry County Site</u>**

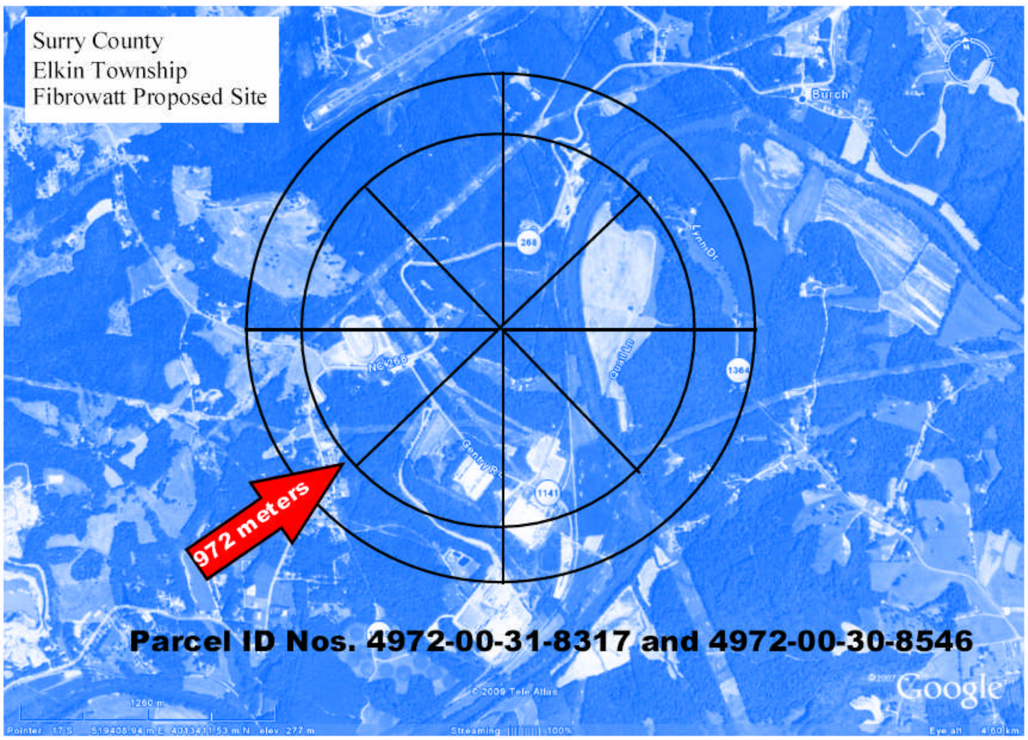
Our computer modeling predicts that a Fibrominn-type plant would exceed North Carolina toxic air pollutant limits for chromium. We calculated that chromium emissions would be 265% of the allowable NC limit. Figure C shows the extent of the pollution outside of the boundary of the re-zoned property, with the highest impacts located more than a half-mile from the proposed plant. This area would encompass many private homes and businesses surrounding the site on both sides of the river.

The modeled pollutant concentration of chromium is 0.00022 micrograms per cubic meter (2.2E-04 μg/$m^3$). North Carolina's highest acceptable ambient limit for chromium

[2] Stack data from Fibrominn Biomass Power Plant, Application for Re-issuance of Part 70 Permit, Eagle Mountain Scientific, Inc. Report No. 902487Hg, Table 2.1, September 3-4, 2008

is 0.000083 micrograms per cubic meter (8.3E-05 $\mu g/m^3$). The computer model indicates that the pollution leaving the smoke stack would create rising pollution levels at ground level as the poisons move downwind. The highest ambient level would be well outside property boundary at 972 meters, or six-tenths of a mile from the plant stack. It appears that the plant could not be placed within the designated property without exceeding the toxic air pollutant limit.

**Figure C: Impact Zone of Toxic Air Pollutants**




The North Carolina Division of Air Quality did an analysis of poultry litter incinerators and found that a Fibrominn-type plant would have trouble meeting state limits for arsenic. In fact, the DAQ's analysis revealed an annual ambient concentration of arsenic 277% of the acceptable ambient limit.[3] Both chromium and arsenic are toxic heavy metals. Both would be emitted from the smoke stack burning poultry litter.

**Worst-Case Source Analysis**

In addition to the SCREEN3 model, we applied the US EPA's Worst-case Spreadsheet to Fibrominn data on toxic air pollutants emissions. The worst-case method was developed by the US Environmental Protection Agency and is based upon the SCREEN3 and ISCST3 models.

[3] "NC Toxics Emissions Evaluation from Poultry/Turkey Litter," NC Environmental Management Commission Air Quality Committee, Agenda Item 13, March 11, 2009

Table 2 details the results of the worst-case analysis for each pollutant: Ammonia, Arsenic, Beryllium, Cadmium, Chromium, Hydrogen Chloride, Manganese, Mercury, Nickel and Sulfuric Acid.

**Table 2: Worst-case Pollution Impacts**

| **Toxic Air Pollutant** | Molecular Weight | AAL[4] mg/m3 | AAL[5] ppm | Emission rate[6] grams/sec. | **Distance Meters** |
|---|---|---|---|---|---|
| **Ammonia** | 17.02 | 2.7 | 3.88 | 1.6 | **500** |
| **Arsenic** | 74.92 | 2.3E-07 | 7.5E-08 | 9.17E-04 | **>10,000** |
| **Beryllium** | 9.01 | 4.1E-06 | 1.1E-05 | 3.9E-04 | **>10,000** |
| **Cadmium** | 112.41 | 5.5E-06 | 1.2E-06 | 2.25E-04 | **>10,000** |
| **Chromium** | 51.99 | 8.3E-08 | 3.9E-08 | 1.51E-03 | **>10,000** |
| **Hydrogen Chloride (1)** | 36.47 | 0.7 | 0.469 | 3.39 | **2,300** |
| ***Hydrogen Chloride(2)*** | 17.02 | 0.7 | 0.469 | *1.23* | **1,100** |
| **Manganese** | 54.94 | 0.031 | 1.37E-02 | 8.14E-03 | **300** |
| **Mercury** | 200.59 | 0.0006 | 7.3E-05 | 8.10E-04 | **900** |
| **Nickel** | 58.69 | 0.006 | 2.5E-03 | 5.49E-03 | **700** |
| **Sulfuric Acid** | 98.08 | 0.012 | 2.99E-03 | 5.59 | **>10,000** |

The worst-case model predicts high levels of pollution extending up to 10 kilometers from the poultry manure incinerator. Attachment 3 contains all spreadsheets used in the worst-case analysis. Attachment 4 lists health impacts of the toxic air pollutants.

May 6, 2009

Louis A. Zeller
Science Director

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[4] North Carolina Toxic Air Pollutant Guidelines, 15A NCAC 02D .1104
[5] Milligrams per cubic meter divided by molecular weight times 24.45 = parts per million (ppm)
[6] Emissions Data from: Application for PSD Permit to Construct and Federal Part 70 Permit to Operate for the Fibrominn Biomass Power Plant, Benson, MN, August 28, 2001

**ATTACHMENT 1**

****** SCREEN3 MODEL ******
**** VERSION DATED 95250 ****

ENTER TITLE FOR THIS RUN (UP TO 79 CHARACTERS):
Surry Fibrowatt 090430A

ENTER SOURCE TYPE: P FOR POINT
F FOR FLARE
A FOR AREA
V FOR VOLUME
p
ENTER EMISSION RATE (G/S):
0.126
ENTER STACK HEIGHT (M):
91.4
ENTER STACK INSIDE DIAMETER (M):
2.7
ENTER STACK GAS EXIT VELOCITY OR FLOW RATE:
OPTION 1 : EXIT VELOCITY (M/S):
DEFAULT - ENTER NUMBER ONLY
OPTION 2 : VOLUME FLOW RATE (M**3/S):
EXAMPLE "VM=20.00"
OPTION 3 : VOLUME FLOW RATE (ACFM):
EXAMPLE "VF=1000.00"
25.7
ENTER STACK GAS EXIT TEMPERATURE (K):
421
ENTER AMBIENT AIR TEMPERATURE (USE 293 FOR DEFAULT) (K):
293
ENTER RECEPTOR HEIGHT ABOVE GROUND (FOR FLAGPOLE RECEPTOR) (M):
2
ENTER URBAN/RURAL OPTION (U=URBAN, R=RURAL):
r
CONSIDER BUILDING DOWNWASH IN CALCS? ENTER Y OR N:
n
USE COMPLEX TERRAIN SCREEN FOR TERRAIN ABOVE STACK HEIGHT?
ENTER Y OR N:
n
USE SIMPLE TERRAIN SCREEN WITH TERRAIN ABOVE STACK BASE?
ENTER Y OR N:
y
ENTER CHOICE OF METEOROLOGY;

1 - FULL METEOROLOGY (ALL STABILITIES & WIND SPEEDS)
2 - INPUT SINGLE STABILITY CLASS
3 - INPUT SINGLE STABILITY CLASS AND WIND SPEED
1
USE AUTOMATED DISTANCE ARRAY? ENTER Y OR N:
y
ENTER TERRAIN HEIGHT ABOVE STACK BASE (M):
20
ENTER MIN AND MAX DISTANCES TO USE (M):
300
1260
**********************************

*** TERRAIN HEIGHT OF 20. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

| DIST (M) | CONC (UG/M**3) | STAB | U10M (M/S) | USTK (M/S) | MIX HT (M) | PLUME HT (M) | SIGMA Y (M) | SIGMA Z (M) | DWASH |
|---|---|---|---|---|---|---|---|---|---|
| 300. | .7006E-05 | 1 | 3.0 | 3.5 | 960.0 | 285.42 | 77.92 | 56.32 | NO |
| 400. | .2516E-02 | 1 | 3.0 | 3.5 | 960.0 | 285.42 | 99.73 | 80.10 | NO |
| 500. | .3458E-01 | 1 | 3.0 | 3.5 | 960.0 | 285.42 | 120.82 | 113.01 | NO |
| 600. | .1050 | 1 | 3.0 | 3.5 | 960.0 | 285.42 | 141.34 | 161.30 | NO |
| 700. | .1390 | 1 | 3.0 | 3.5 | 960.0 | 285.42 | 161.39 | 219.91 | NO |
| 800. | .1897 | 1 | 1.5 | 1.8 | 500.4 | 499.44 | 207.36 | 306.12 | NO |
| 900. | .2256 | 1 | 1.5 | 1.8 | 500.4 | 499.44 | 226.11 | 383.17 | NO |
| 1000. | .2310 | 1 | 1.5 | 1.8 | 500.4 | 499.44 | 241.90 | 470.04 | NO |
| 1100. | .2217 | 1 | 1.5 | 1.8 | 500.4 | 499.44 | 257.84 | 568.60 | NO |
| 1200. | .2094 | 1 | 1.5 | 1.8 | 500.4 | 499.44 | 273.88 | 678.70 | NO |

ITERATING TO FIND MAXIMUM CONCENTRATION . . .

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 300. M:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 972. | .2317 | 1 | 1.5 | 1.8 | 500.4 | 499.44 | 237.62 | 445.42 | NO |

CONTINUE SIMPLE TERRAIN AUTOMATED CALCS WITH NEW TERRAIN HEIGHT?
ENTER Y OR N:
n

USE DISCRETE DISTANCES? ENTER Y OR N:
n

DO YOU WISH TO MAKE A FUMIGATION CALCULATION? ENTER Y OR N:
n

***************************************
*** SUMMARY OF SCREEN MODEL RESULTS ***
***************************************

| CALCULATION PROCEDURE | MAX CONC (UG/M**3) | DIST TO MAX (M) | TERRAIN HT (M) |
|---|---|---|---|
| SIMPLE TERRAIN | .2317 | 972. | 20. |

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************

DO YOU WANT TO PRINT A HARDCOPY OF THE RESULTS?  ENTER Y OR N:

**ATTACHMENT 2**

AIR MODELING PROTOCOL FOR THIS REPORT

We utilized the US Environmental Protection Agency's SCREEN3 Model in our calculations. The model estimates pollution concentrations from air pollution sources under a wide range of meteorological conditions. SCREEN is a Gaussian plume dispersion model which takes into account the physical factors of each particular air pollution source including emission rate, stack height and diameter, and gas exit velocity and temperature. The model can calculate pollution concentrations from a particular source at discrete distances downwind from an emission point. The EPA Technology Transfer Network Support Center for Regulatory Atmospheric Modeling states:

> Dispersion modeling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source. Based on emissions and meteorological inputs, a dispersion model can be used to predict concentrations at selected downwind receptor locations. These air quality models are used to determine compliance with National Ambient Air Quality Standards (NAAQS), and other regulatory requirements such as New Source Review (NSR) and Prevention of Significant Deterioration (PSD) regulations. These models are addressed in Appendix A of EPA's *Guideline on Air Quality Models* (also published as Appendix W of 40 CFR Part 51), which was originally published in April 1978 to provide consistency and equity in the use of modeling within the U.S. air quality management system.

The SCREEN3 equation for determining ground-level pollution concentration is:

$$X = Q/(2u_s yz)\ \{\exp[-½((z_r - h_e)/z)^2] + \exp[-½((z_r + h_e)/z)^2]$$

$$+ \sum_{N=1}^{k} [\exp[-½((z_r - h_e - 2Nz_i)/z)^2]$$

$$+ \exp[-½((z_r + h_e - 2Nz_i)/z)^2]$$

$$+ \exp[-½((z_r - h_e + 2Nz_i)/z)^2]$$

$$+ \exp[-½((z_r + h_e + 2Nz_i)/z)^2]\ ]\ \}$$

Where:

X = concentration
Q = emission rate
$u_s$ = wind speed at stack height
y = lateral dispersion parameter
z = vertical dispersion parameter
$z_r$ = receptor height
$h_e$ = height of plume centerline above ground
$z_i$ = mixing height

k = summation level for multiple reflections of plume off of the ground and elevated inversion, usually ?4.

SCREEN3 uses all stabilities and wind speeds in an iterative process to determine a range of ambient pollution levels downwind of an air emission point.

We have largely adopted a regulatory agency methodology (ref: North Carolina DENR Air Quality Analysis Branch) in developing the protocol used for our assessment.

SCREEN3 inputs are specific for each stack and site location. Most are simple parameters based on physical measurements: source type, stack height and inside diameter, etc. Also, the model asks the user to enter a value for the emission rate in grams per second. For this report, we used the value of 0.126 g/s which corresponds to 1 pound per hour. With this value entered, the SCREEN3 calculates a *generic concentration factor* for the main stack which facilitates the use of the pounds per hour data for each air pollutant. This calculation is explained further below.

There are user options which allow SCREEN3 to adjust to local conditions. Model options selected for this investigation are:

Stack exit velocity: For vertical stacks, the exit velocity is entered. For horizontal stacks or those with rain caps or other deflectors, the formula is $v_i = v_r \sin(\alpha)$ where $v_i$ is velocity to input into the model, $v_r$ is the reported exit velocity, and $\alpha$ is the angle of the stack from horizontal. The minimum recommended input value is 0.01 meters/second.

Ambient air temperature: We used the regulatory default of 293 degrees-K, which is 68 degrees-F.

Receptor height: We used 2 meters to determine ambient pollution at nose level for children and adults.

Urban/rural option: Rural option selected throughout based on land use and population density within SRS and the surrounding areas.

Complex terrain analysis: This option is required when the local topography rises above the top of a 50 meter stack within 20 kilometers. The complex terrain option is also required for shorter stacks where the terrain exceeds stack height within 5 kilometers. Therefore, the complex terrain analysis was not selected.

Building downwash: Used to determine cavitation effects, elevated pollution concentrations caused by structures downwind of stack emissions. Not enough information was available regarding height, width and orientation of local structures to allow us to make determinations for building downwash. The most severe impacts of building downwash pollution would be on receptors within the plant site; i.e., employees and visitors. Subsequent studies will be necessary to measure these impacts.

Using the SCREEN3 model (Version 95250), we calculated a *generic concentration factor* ($C_g$) at the property line and/or in nearby population centers for each air pollution source. Next, we multiplied the generic concentration factor by the source's *pollutant emission rate* ($E_p$) to find the *modeled pollutant concentration* ($C_m$) for each toxic chemical.

The formula for the modeled pollutant concentration is:

$$C_g \times E_p = C_m$$

Where:

$C_g$ = generic concentration factor (µg/m3/lb/hr)
$E_p$ = pollutant emission rate (lb./hour)
$C_m$ = modeled pollutant concentration (µg/m3)

The following conversion factors are used as needed:

Hourly concentration = $C_m$ x 1.0
24-hour concentration = $C_m$ x .4
Annual concentration = $C_m$ x 0.08

The generic concentration factor was computed using stack parameters we obtained from Fibrominn's Application for Re-issuance of Part 70 Permit, *Results of Speciated Mercury Testing*, Eagle Mountain Scientific, Inc., Report No. 902487Hg, Table 2.1, September 3-4, 2008.

We obtained pollutant emission rates from the Application for PSD Permit to Construct and Federal Part 70 Permit to Operate for the Fibrominn Biomass Power Plant, Benson, MN, August 28, 2001

We obtained physical stack data from Fibrominn Biomass Power Plant Application for Re-issuance of Part 70 Permit, Eagle Mountain Scientific, Inc. Report No. 902487Hg, Table 2.1, September 3-4, 2008

<u>Conversion Factors</u>
Feet to Meters: 0.3048
Fahrenheit to Kelvin: 0.55555 (F-32) + 273
tons/year to pounds/hour: 1 ton/year x 2000 lbs/ton ÷8760 hours/year = 0.2283

## ATTACHMENT 3

On the following pages are US EPA Worst-case Spreadsheet data for toxic air pollutants from a 50 Megawatt poultry manure incinerator. Each toxic pollutant is presented in a separate table: Ammonia, Arsenic, Beryllium, Cadmium, Chromium, Hydrogen Chloride, Manganese, Mercury, Nickel and Sulfuric Acid.

**ARSENIC**

**Enter the peak emission rate of the contaminent of concern**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | | | **0.00091** | **g/s** | **0.032** | **tons/yr** |
| **MW=** | | | **74.92** | | | |
| **Concern level** | | | **0.000000075** | **ppm** | **2E-04** | **ug/m3** |
| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | | **Recommendation** |
| **10** | 1.17E+01 | 1.56E+02 | 1.56E+01 | **1.56E+02** | | reduce emissions |
| **100** | 6.71E-01 | 2.15E+01 | 7.01E+00 | **2.15E+01** | | reduce emissions |
| **200** | 3.66E-01 | 8.51E+00 | 3.89E+00 | **8.51E+00** | | reduce emissions |
| **300** | 2.52E-01 | 4.61E+00 | 2.50E+00 | **4.61E+00** | | reduce emissions |
| **400** | 1.93E-01 | 2.92E+00 | 1.76E+00 | **2.92E+00** | | reduce emissions |
| **500** | 1.57E-01 | 2.04E+00 | 1.32E+00 | **2.04E+00** | | reduce emissions |
| **600** | 1.33E-01 | 1.51E+00 | 1.06E+00 | **1.51E+00** | | reduce emissions |
| **700** | 1.13E-01 | 1.17E+00 | 8.58E-01 | **1.17E+00** | | reduce emissions |
| **800** | 9.81E-02 | 9.49E-01 | 7.13E-01 | **9.49E-01** | | reduce emissions |
| **900** | 9.85E-02 | 7.89E-01 | 6.11E-01 | **7.89E-01** | | reduce emissions |
| **1000** | 9.87E-02 | 6.68E-01 | 5.28E-01 | **6.68E-01** | | reduce emissions |
| **1100** | 9.73E-02 | 5.78E-01 | 4.62E-01 | **5.78E-01** | | reduce emissions |
| **1200** | 9.74E-02 | 5.06E-01 | 4.08E-01 | **5.06E-01** | | reduce emissions |
| **1300** | 9.72E-02 | 4.48E-01 | 3.64E-01 | **4.48E-01** | | reduce emissions |
| **1400** | 9.64E-02 | 4.00E-01 | 3.28E-01 | **4.00E-01** | | reduce emissions |
| **1500** | 9.51E-02 | 3.60E-01 | 2.97E-01 | **3.60E-01** | | reduce emissions |
| **1600** | 9.35E-02 | 3.26E-01 | 2.70E-01 | **3.26E-01** | | reduce emissions |
| **1700** | 9.15E-02 | 2.97E-01 | 2.48E-01 | **2.97E-01** | | reduce emissions |
| **1800** | 8.95E-02 | 2.72E-01 | 2.28E-01 | **2.72E-01** | | reduce emissions |
| **1900** | 8.73E-02 | 2.51E-01 | 2.10E-01 | **2.51E-01** | | reduce emissions |
| **2000** | 8.51E-02 | 2.32E-01 | 1.98E-01 | **2.32E-01** | | reduce emissions |
| **2100** | 8.26E-02 | 2.16E-01 | 1.85E-01 | **2.16E-01** | | reduce emissions |
| **2200** | 8.02E-02 | 2.02E-01 | 1.73E-01 | **2.02E-01** | | reduce emissions |
| **2300** | 7.79E-02 | 1.89E-01 | 1.63E-01 | **1.89E-01** | | reduce emissions |
| **2400** | 7.56E-02 | 1.78E-01 | 1.53E-01 | **1.78E-01** | | reduce emissions |
| **2500** | 7.34E-02 | 1.68E-01 | 1.45E-01 | **1.68E-01** | | reduce emissions |
| **2600** | 7.13E-02 | 1.59E-01 | 1.37E-01 | **1.59E-01** | | reduce emissions |
| **2700** | 6.93E-02 | 1.50E-01 | 1.30E-01 | **1.50E-01** | | reduce emissions |
| **2800** | 6.73E-02 | 1.42E-01 | 1.24E-01 | **1.42E-01** | | reduce emissions |
| **2900** | 6.54E-02 | 1.35E-01 | 1.18E-01 | **1.35E-01** | | reduce emissions |
| **3000** | 6.36E-02 | 1.29E-01 | 1.13E-01 | **1.29E-01** | | reduce emissions |
| **3500** | 5.56E-02 | 1.04E-01 | 9.17E-02 | **1.04E-01** | | reduce emissions |
| **4000** | 4.91E-02 | 8.71E-02 | 7.67E-02 | **8.71E-02** | | reduce emissions |
| **4500** | 4.38E-02 | 7.42E-02 | 6.55E-02 | **7.42E-02** | | reduce emissions |

| | | | | | |
|---|---|---|---|---|---|
| **5000** | 3.94E-02 | 6.43E-02 | 5.69E-02 | **6.43E-02** | reduce emissions |
| **5500** | 3.57E-02 | 5.64E-02 | 5.01E-02 | **5.64E-02** | reduce emissions |
| **6000** | 3.26E-02 | 5.01E-02 | 4.45E-02 | **5.01E-02** | reduce emissions |
| **6500** | 2.99E-02 | 4.50E-02 | 4.00E-02 | **4.50E-02** | reduce emissions |
| **7000** | 2.75E-02 | 4.07E-02 | 3.62E-02 | **4.07E-02** | reduce emissions |
| **7500** | 2.56E-02 | 3.72E-02 | 3.31E-02 | **3.72E-02** | reduce emissions |
| **8000** | 2.38E-02 | 3.42E-02 | 3.05E-02 | **3.42E-02** | reduce emissions |
| **8500** | 2.23E-02 | 3.16E-02 | 2.82E-02 | **3.16E-02** | reduce emissions |
| **9000** | 2.09E-02 | 2.93E-02 | 2.62E-02 | **2.93E-02** | reduce emissions |
| **9500** | 1.97E-02 | 2.73E-02 | 2.44E-02 | **2.73E-02** | reduce emissions |
| **10000** | 1.86E-02 | 2.55E-02 | 2.28E-02 | **2.55E-02** | reduce emissions |

**BERYLLIUM**

**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | **0.00039** | **g/s** | **0.014** | **tons/yr** |
| **MW=** | **9.01** | | | |
| **Concern level** | **0.000011** | **ppm** | **0.004** | **ug/m3** |

| Distance (M) | Point | Area | Volume | Worst | Recommendation |
|---|---|---|---|---|---|
| **10** | 5.00E+00 | 6.70E+01 | 6.67E+00 | **6.70E+01** | reduce emissions |
| **100** | 2.87E-01 | 9.21E+00 | 3.00E+00 | **9.21E+00** | reduce emissions |
| **200** | 1.57E-01 | 3.65E+00 | 1.67E+00 | **3.65E+00** | reduce emissions |
| **300** | 1.08E-01 | 1.98E+00 | 1.07E+00 | **1.98E+00** | reduce emissions |
| **400** | 8.29E-02 | 1.25E+00 | 7.56E-01 | **1.25E+00** | reduce emissions |
| **500** | 6.74E-02 | 8.73E-01 | 5.64E-01 | **8.73E-01** | reduce emissions |
| **600** | 5.70E-02 | 6.47E-01 | 4.53E-01 | **6.47E-01** | reduce emissions |
| **700** | 4.82E-02 | 5.02E-01 | 3.68E-01 | **5.02E-01** | reduce emissions |
| **800** | 4.20E-02 | 4.07E-01 | 3.06E-01 | **4.07E-01** | reduce emissions |
| **900** | 4.22E-02 | 3.38E-01 | 2.62E-01 | **3.38E-01** | reduce emissions |
| **1000** | 4.23E-02 | 2.86E-01 | 2.26E-01 | **2.86E-01** | reduce emissions |
| **1100** | 4.17E-02 | 2.48E-01 | 1.98E-01 | **2.48E-01** | reduce emissions |
| **1200** | 4.17E-02 | 2.17E-01 | 1.75E-01 | **2.17E-01** | reduce emissions |
| **1300** | 4.17E-02 | 1.92E-01 | 1.56E-01 | **1.92E-01** | reduce emissions |
| **1400** | 4.13E-02 | 1.71E-01 | 1.40E-01 | **1.71E-01** | reduce emissions |
| **1500** | 4.08E-02 | 1.54E-01 | 1.27E-01 | **1.54E-01** | reduce emissions |
| **1600** | 4.01E-02 | 1.40E-01 | 1.16E-01 | **1.40E-01** | reduce emissions |
| **1700** | 3.92E-02 | 1.27E-01 | 1.06E-01 | **1.27E-01** | reduce emissions |
| **1800** | 3.83E-02 | 1.17E-01 | 9.76E-02 | **1.17E-01** | reduce emissions |
| **1900** | 3.74E-02 | 1.07E-01 | 9.02E-02 | **1.07E-01** | reduce emissions |
| **2000** | 3.65E-02 | 9.93E-02 | 8.47E-02 | **9.93E-02** | reduce emissions |
| **2100** | 3.54E-02 | 9.25E-02 | 7.92E-02 | **9.25E-02** | reduce emissions |
| **2200** | 3.44E-02 | 8.65E-02 | 7.42E-02 | **8.65E-02** | reduce emissions |
| **2300** | 3.34E-02 | 8.11E-02 | 6.98E-02 | **8.11E-02** | reduce emissions |
| **2400** | 3.24E-02 | 7.63E-02 | 6.57E-02 | **7.63E-02** | reduce emissions |
| **2500** | 3.15E-02 | 7.19E-02 | 6.21E-02 | **7.19E-02** | reduce emissions |
| **2600** | 3.06E-02 | 6.79E-02 | 5.87E-02 | **6.79E-02** | reduce emissions |
| **2700** | 2.97E-02 | 6.44E-02 | 5.57E-02 | **6.44E-02** | reduce emissions |
| **2800** | 2.89E-02 | 6.10E-02 | 5.30E-02 | **6.10E-02** | reduce emissions |
| **2900** | 2.80E-02 | 5.80E-02 | 5.04E-02 | **5.80E-02** | reduce emissions |

| | | | | | |
|---|---|---|---|---|---|
| **3000** | 2.73E-02 | 5.53E-02 | 4.83E-02 | **5.53E-02** | reduce emissions |
| **3500** | 2.38E-02 | 4.48E-02 | 3.93E-02 | **4.48E-02** | reduce emissions |
| **4000** | 2.10E-02 | 3.73E-02 | 3.29E-02 | **3.73E-02** | reduce emissions |
| **4500** | 1.88E-02 | 3.18E-02 | 2.81E-02 | **3.18E-02** | reduce emissions |
| **5000** | 1.69E-02 | 2.75E-02 | 2.44E-02 | **2.75E-02** | reduce emissions |
| **5500** | 1.53E-02 | 2.42E-02 | 2.15E-02 | **2.42E-02** | reduce emissions |
| **6000** | 1.40E-02 | 2.15E-02 | 1.91E-02 | **2.15E-02** | reduce emissions |
| **6500** | 1.28E-02 | 1.93E-02 | 1.71E-02 | **1.93E-02** | reduce emissions |
| **7000** | 1.18E-02 | 1.74E-02 | 1.55E-02 | **1.74E-02** | reduce emissions |
| **7500** | 1.10E-02 | 1.59E-02 | 1.42E-02 | **1.59E-02** | reduce emissions |
| **8000** | 1.02E-02 | 1.46E-02 | 1.31E-02 | **1.46E-02** | reduce emissions |
| **8500** | 9.54E-03 | 1.35E-02 | 1.21E-02 | **1.35E-02** | reduce emissions |
| **9000** | 8.95E-03 | 1.26E-02 | 1.12E-02 | **1.26E-02** | reduce emissions |
| **9500** | 8.43E-03 | 1.17E-02 | 1.05E-02 | **1.17E-02** | reduce emissions |
| **10000** | 7.96E-03 | 1.09E-02 | 9.78E-03 | **1.09E-02** | reduce emissions |

**CADMIUM**

**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | **0.00023** | **g/s** | **0.008** | **tons/yr** |
| **MW=** | **112.41** | | | |
| **Concern level** | **0.0000012** | **ppm** | **0.006** | **ug/m3** |

| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | **Recommendation** |
|---|---|---|---|---|---|
| **10** | 2.89E+00 | 3.87E+01 | 3.85E+00 | **3.87E+01** | reduce emissions |
| **100** | 1.66E-01 | 5.31E+00 | 1.73E+00 | **5.31E+00** | reduce emissions |
| **200** | 9.05E-02 | 2.10E+00 | 9.61E-01 | **2.10E+00** | reduce emissions |
| **300** | 6.23E-02 | 1.14E+00 | 6.19E-01 | **1.14E+00** | reduce emissions |
| **400** | 4.78E-02 | 7.23E-01 | 4.36E-01 | **7.23E-01** | reduce emissions |
| **500** | 3.89E-02 | 5.04E-01 | 3.26E-01 | **5.04E-01** | reduce emissions |
| **600** | 3.29E-02 | 3.74E-01 | 2.61E-01 | **3.74E-01** | reduce emissions |
| **700** | 2.78E-02 | 2.89E-01 | 2.12E-01 | **2.89E-01** | reduce emissions |
| **800** | 2.43E-02 | 2.35E-01 | 1.76E-01 | **2.35E-01** | reduce emissions |
| **900** | 2.43E-02 | 1.95E-01 | 1.51E-01 | **1.95E-01** | reduce emissions |
| **1000** | 2.44E-02 | 1.65E-01 | 1.30E-01 | **1.65E-01** | reduce emissions |
| **1100** | 2.41E-02 | 1.43E-01 | 1.14E-01 | **1.43E-01** | reduce emissions |
| **1200** | 2.41E-02 | 1.25E-01 | 1.01E-01 | **1.25E-01** | reduce emissions |
| **1300** | 2.40E-02 | 1.11E-01 | 9.01E-02 | **1.11E-01** | reduce emissions |
| **1400** | 2.38E-02 | 9.88E-02 | 8.10E-02 | **9.88E-02** | reduce emissions |
| **1500** | 2.35E-02 | 8.89E-02 | 7.34E-02 | **8.89E-02** | reduce emissions |
| **1600** | 2.31E-02 | 8.06E-02 | 6.68E-02 | **8.06E-02** | reduce emissions |
| **1700** | 2.26E-02 | 7.34E-02 | 6.12E-02 | **7.34E-02** | reduce emissions |
| **1800** | 2.21E-02 | 6.73E-02 | 5.63E-02 | **6.73E-02** | reduce emissions |
| **1900** | 2.16E-02 | 6.19E-02 | 5.20E-02 | **6.19E-02** | reduce emissions |
| **2000** | 2.10E-02 | 5.73E-02 | 4.89E-02 | **5.73E-02** | reduce emissions |
| **2100** | 2.04E-02 | 5.34E-02 | 4.57E-02 | **5.34E-02** | reduce emissions |
| **2200** | 1.98E-02 | 4.99E-02 | 4.28E-02 | **4.99E-02** | reduce emissions |
| **2300** | 1.93E-02 | 4.68E-02 | 4.03E-02 | **4.68E-02** | reduce emissions |
| **2400** | 1.87E-02 | 4.40E-02 | 3.79E-02 | **4.40E-02** | reduce emissions |
| **2500** | 1.82E-02 | 4.15E-02 | 3.58E-02 | **4.15E-02** | reduce emissions |
| **2600** | 1.76E-02 | 3.92E-02 | 3.39E-02 | **3.92E-02** | reduce emissions |

| | | | | | |
|---|---|---|---|---|---|
| **2700** | 1.71E-02 | 3.71E-02 | 3.22E-02 | **3.71E-02** | reduce emissions |
| **2800** | 1.66E-02 | 3.52E-02 | 3.06E-02 | **3.52E-02** | reduce emissions |
| **2900** | 1.62E-02 | 3.35E-02 | 2.91E-02 | **3.35E-02** | reduce emissions |
| **3000** | 1.57E-02 | 3.19E-02 | 2.79E-02 | **3.19E-02** | reduce emissions |
| **3500** | 1.37E-02 | 2.58E-02 | 2.27E-02 | **2.58E-02** | reduce emissions |
| **4000** | 1.21E-02 | 2.15E-02 | 1.90E-02 | **2.15E-02** | reduce emissions |
| **4500** | 1.08E-02 | 1.83E-02 | 1.62E-02 | **1.83E-02** | reduce emissions |
| **5000** | 9.74E-03 | 1.59E-02 | 1.41E-02 | **1.59E-02** | reduce emissions |
| **5500** | 8.82E-03 | 1.40E-02 | 1.24E-02 | **1.40E-02** | reduce emissions |
| **6000** | 8.05E-03 | 1.24E-02 | 1.10E-02 | **1.24E-02** | reduce emissions |
| **6500** | 7.38E-03 | 1.11E-02 | 9.89E-03 | **1.11E-02** | reduce emissions |
| **7000** | 6.81E-03 | 1.01E-02 | 8.96E-03 | **1.01E-02** | reduce emissions |
| **7500** | 6.32E-03 | 9.19E-03 | 8.19E-03 | **9.19E-03** | reduce emissions |
| **8000** | 5.89E-03 | 8.44E-03 | 7.53E-03 | **8.44E-03** | reduce emissions |
| **8500** | 5.51E-03 | 7.80E-03 | 6.96E-03 | **7.80E-03** | reduce emissions |
| **9000** | 5.17E-03 | 7.24E-03 | 6.47E-03 | **7.24E-03** | reduce emissions |
| **9500** | 4.86E-03 | 6.75E-03 | 6.03E-03 | **6.75E-03** | reduce emissions |
| **10000** | 4.59E-03 | 6.31E-03 | 5.64E-03 | **6.31E-03** | reduce emissions |

**CHROMIUM**

**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | **0.00151** | **g/s** | **0.052** | **tons/yr** |
| **MW=** | **51.99** | | | |
| **Concern level** | **0.000000039** | **ppm** | **8E-05** | **ug/m3** |

| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | **Recommendation** |
|---|---|---|---|---|---|
| **10** | 1.94E+01 | 2.59E+02 | 2.58E+01 | **2.59E+02** | reduce emissions |
| **100** | 1.11E+00 | 3.57E+01 | 1.16E+01 | **3.57E+01** | reduce emissions |
| **200** | 6.07E-01 | 1.41E+01 | 6.45E+00 | **1.41E+01** | reduce emissions |
| **300** | 4.18E-01 | 7.66E+00 | 4.16E+00 | **7.66E+00** | reduce emissions |
| **400** | 3.21E-01 | 4.85E+00 | 2.93E+00 | **4.85E+00** | reduce emissions |
| **500** | 2.61E-01 | 3.38E+00 | 2.18E+00 | **3.38E+00** | reduce emissions |
| **600** | 2.21E-01 | 2.51E+00 | 1.75E+00 | **2.51E+00** | reduce emissions |
| **700** | 1.87E-01 | 1.94E+00 | 1.42E+00 | **1.94E+00** | reduce emissions |
| **800** | 1.63E-01 | 1.57E+00 | 1.18E+00 | **1.57E+00** | reduce emissions |
| **900** | 1.63E-01 | 1.31E+00 | 1.01E+00 | **1.31E+00** | reduce emissions |
| **1000** | 1.64E-01 | 1.11E+00 | 8.76E-01 | **1.11E+00** | reduce emissions |
| **1100** | 1.61E-01 | 9.59E-01 | 7.66E-01 | **9.59E-01** | reduce emissions |
| **1200** | 1.62E-01 | 8.40E-01 | 6.77E-01 | **8.40E-01** | reduce emissions |
| **1300** | 1.61E-01 | 7.43E-01 | 6.04E-01 | **7.43E-01** | reduce emissions |
| **1400** | 1.60E-01 | 6.63E-01 | 5.44E-01 | **6.63E-01** | reduce emissions |
| **1500** | 1.58E-01 | 5.97E-01 | 4.92E-01 | **5.97E-01** | reduce emissions |
| **1600** | 1.55E-01 | 5.41E-01 | 4.48E-01 | **5.41E-01** | reduce emissions |
| **1700** | 1.52E-01 | 4.93E-01 | 4.11E-01 | **4.93E-01** | reduce emissions |
| **1800** | 1.48E-01 | 4.51E-01 | 3.78E-01 | **4.51E-01** | reduce emissions |
| **1900** | 1.45E-01 | 4.16E-01 | 3.49E-01 | **4.16E-01** | reduce emissions |
| **2000** | 1.41E-01 | 3.84E-01 | 3.28E-01 | **3.84E-01** | reduce emissions |
| **2100** | 1.37E-01 | 3.58E-01 | 3.07E-01 | **3.58E-01** | reduce emissions |
| **2200** | 1.33E-01 | 3.35E-01 | 2.87E-01 | **3.35E-01** | reduce emissions |

| | | | | | |
|---|---|---|---|---|---|
| **2300** | 1.29E-01 | 3.14E-01 | 2.70E-01 | **3.14E-01** | reduce emissions |
| **2400** | 1.25E-01 | 2.95E-01 | 2.54E-01 | **2.95E-01** | reduce emissions |
| **2500** | 1.22E-01 | 2.78E-01 | 2.40E-01 | **2.78E-01** | reduce emissions |
| **2600** | 1.18E-01 | 2.63E-01 | 2.27E-01 | **2.63E-01** | reduce emissions |
| **2700** | 1.15E-01 | 2.49E-01 | 2.16E-01 | **2.49E-01** | reduce emissions |
| **2800** | 1.12E-01 | 2.36E-01 | 2.05E-01 | **2.36E-01** | reduce emissions |
| **2900** | 1.09E-01 | 2.25E-01 | 1.95E-01 | **2.25E-01** | reduce emissions |
| **3000** | 1.06E-01 | 2.14E-01 | 1.87E-01 | **2.14E-01** | reduce emissions |
| **3500** | 9.22E-02 | 1.73E-01 | 1.52E-01 | **1.73E-01** | reduce emissions |
| **4000** | 8.14E-02 | 1.44E-01 | 1.27E-01 | **1.44E-01** | reduce emissions |
| **4500** | 7.26E-02 | 1.23E-01 | 1.09E-01 | **1.23E-01** | reduce emissions |
| **5000** | 6.54E-02 | 1.07E-01 | 9.44E-02 | **1.07E-01** | reduce emissions |
| **5500** | 5.92E-02 | 9.37E-02 | 8.31E-02 | **9.37E-02** | reduce emissions |
| **6000** | 5.40E-02 | 8.32E-02 | 7.39E-02 | **8.32E-02** | reduce emissions |
| **6500** | 4.96E-02 | 7.46E-02 | 6.64E-02 | **7.46E-02** | reduce emissions |
| **7000** | 4.57E-02 | 6.75E-02 | 6.01E-02 | **6.75E-02** | reduce emissions |
| **7500** | 4.24E-02 | 6.17E-02 | 5.50E-02 | **6.17E-02** | reduce emissions |
| **8000** | 3.95E-02 | 5.67E-02 | 5.06E-02 | **5.67E-02** | reduce emissions |
| **8500** | 3.69E-02 | 5.24E-02 | 4.67E-02 | **5.24E-02** | reduce emissions |
| **9000** | 3.47E-02 | 4.86E-02 | 4.34E-02 | **4.86E-02** | reduce emissions |
| **9500** | 3.26E-02 | 4.53E-02 | 4.05E-02 | **4.53E-02** | reduce emissions |
| **10000** | 3.08E-02 | 4.24E-02 | 3.79E-02 | **4.24E-02** | reduce emissions |

**MANGANESE**
**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | **0.00814** | **g/s** | **0.283** | **tons/yr** |
| **MW=** | **54.94** | | | |
| **Concern level** | **0.0137** | **ppm** | **30.78** | **ug/m3** |

| Distance (M) | Point | Area | Volume | Worst | Recommendation |
|---|---|---|---|---|---|
| **10** | 1.04E+02 | 1.40E+03 | 1.39E+02 | **1.40E+03** | reduce emissions |
| **100** | 6.00E+00 | 1.92E+02 | 6.27E+01 | **1.92E+02** | reduce emissions |
| **200** | 3.27E+00 | 7.61E+01 | 3.48E+01 | **7.61E+01** | reduce emissions |
| **300** | 2.25E+00 | 4.13E+01 | 2.24E+01 | **4.13E+01** | reduce emissions |
| **400** | 1.73E+00 | 2.62E+01 | 1.58E+01 | **2.62E+01** | its OK |
| **500** | 1.41E+00 | 1.82E+01 | 1.18E+01 | **1.82E+01** | its OK |
| **600** | 1.19E+00 | 1.35E+01 | 9.45E+00 | **1.35E+01** | its OK |
| **700** | 1.01E+00 | 1.05E+01 | 7.67E+00 | **1.05E+01** | its OK |
| **800** | 8.77E-01 | 8.49E+00 | 6.38E+00 | **8.49E+00** | its OK |
| **900** | 8.81E-01 | 7.06E+00 | 5.47E+00 | **7.06E+00** | its OK |
| **1000** | 8.83E-01 | 5.98E+00 | 4.72E+00 | **5.98E+00** | its OK |
| **1100** | 8.70E-01 | 5.17E+00 | 4.13E+00 | **5.17E+00** | its OK |
| **1200** | 8.71E-01 | 4.53E+00 | 3.65E+00 | **4.53E+00** | its OK |
| **1300** | 8.69E-01 | 4.00E+00 | 3.26E+00 | **4.00E+00** | its OK |
| **1400** | 8.62E-01 | 3.58E+00 | 2.93E+00 | **3.58E+00** | its OK |
| **1500** | 8.51E-01 | 3.22E+00 | 2.65E+00 | **3.22E+00** | its OK |
| **1600** | 8.36E-01 | 2.91E+00 | 2.42E+00 | **2.91E+00** | its OK |

| | | | | | |
|---|---|---|---|---|---|
| **1700** | 8.19E-01 | 2.66E+00 | 2.21E+00 | **2.66E+00** | its OK |
| **1800** | 8.00E-01 | 2.43E+00 | 2.04E+00 | **2.43E+00** | its OK |
| **1900** | 7.81E-01 | 2.24E+00 | 1.88E+00 | **2.24E+00** | its OK |
| **2000** | 7.61E-01 | 2.07E+00 | 1.77E+00 | **2.07E+00** | its OK |
| **2100** | 7.39E-01 | 1.93E+00 | 1.65E+00 | **1.93E+00** | its OK |
| **2200** | 7.18E-01 | 1.81E+00 | 1.55E+00 | **1.81E+00** | its OK |
| **2300** | 6.97E-01 | 1.69E+00 | 1.46E+00 | **1.69E+00** | its OK |
| **2400** | 6.76E-01 | 1.59E+00 | 1.37E+00 | **1.59E+00** | its OK |
| **2500** | 6.57E-01 | 1.50E+00 | 1.30E+00 | **1.50E+00** | its OK |
| **2600** | 6.38E-01 | 1.42E+00 | 1.23E+00 | **1.42E+00** | its OK |
| **2700** | 6.20E-01 | 1.34E+00 | 1.16E+00 | **1.34E+00** | its OK |
| **2800** | 6.02E-01 | 1.27E+00 | 1.11E+00 | **1.27E+00** | its OK |
| **2900** | 5.85E-01 | 1.21E+00 | 1.05E+00 | **1.21E+00** | its OK |
| **3000** | 5.69E-01 | 1.15E+00 | 1.01E+00 | **1.15E+00** | its OK |
| **3500** | 4.97E-01 | 9.34E-01 | 8.21E-01 | **9.34E-01** | its OK |
| **4000** | 4.39E-01 | 7.79E-01 | 6.86E-01 | **7.79E-01** | its OK |
| **4500** | 3.92E-01 | 6.63E-01 | 5.86E-01 | **6.63E-01** | its OK |
| **5000** | 3.52E-01 | 5.75E-01 | 5.09E-01 | **5.75E-01** | its OK |
| **5500** | 3.19E-01 | 5.05E-01 | 4.48E-01 | **5.05E-01** | its OK |
| **6000** | 2.91E-01 | 4.49E-01 | 3.98E-01 | **4.49E-01** | its OK |
| **6500** | 2.67E-01 | 4.02E-01 | 3.58E-01 | **4.02E-01** | its OK |
| **7000** | 2.46E-01 | 3.64E-01 | 3.24E-01 | **3.64E-01** | its OK |
| **7500** | 2.29E-01 | 3.32E-01 | 2.96E-01 | **3.32E-01** | its OK |
| **8000** | 2.13E-01 | 3.05E-01 | 2.73E-01 | **3.05E-01** | its OK |
| **8500** | 1.99E-01 | 2.82E-01 | 2.52E-01 | **2.82E-01** | its OK |
| **9000** | 1.87E-01 | 2.62E-01 | 2.34E-01 | **2.62E-01** | its OK |
| **9500** | 1.76E-01 | 2.44E-01 | 2.18E-01 | **2.44E-01** | its OK |
| **10000** | 1.66E-01 | 2.28E-01 | 2.04E-01 | **2.28E-01** | its OK |

**MERCURY**

**Enter the peak emission rate of the contaminent of concern**

| | | | | | |
|---|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | | **0.00081** | **g/s** | **0.028** | **tons/yr** |
| **MW=** | | **200.59** | | | |
| **Concern level** | | **0.000073** | **ppm** | **0.599** | **ug/m3** |

| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | **Recommendation** |
|---|---|---|---|---|---|
| **10** | 1.04E+01 | 1.39E+02 | 1.39E+01 | **1.39E+02** | reduce emissions |
| **100** | 5.97E-01 | 1.91E+01 | 6.24E+00 | **1.91E+01** | reduce emissions |
| **200** | 3.26E-01 | 7.57E+00 | 3.46E+00 | **7.57E+00** | reduce emissions |
| **300** | 2.24E-01 | 4.11E+00 | 2.23E+00 | **4.11E+00** | reduce emissions |
| **400** | 1.72E-01 | 2.60E+00 | 1.57E+00 | **2.60E+00** | reduce emissions |
| **500** | 1.40E-01 | 1.81E+00 | 1.17E+00 | **1.81E+00** | reduce emissions |
| **600** | 1.18E-01 | 1.34E+00 | 9.40E-01 | **1.34E+00** | reduce emissions |
| **700** | 1.00E-01 | 1.04E+00 | 7.63E-01 | **1.04E+00** | reduce emissions |
| **800** | 8.73E-02 | 8.45E-01 | 6.35E-01 | **8.45E-01** | reduce emissions |
| **900** | 8.76E-02 | 7.02E-01 | 5.44E-01 | **7.02E-01** | reduce emissions |
| **1000** | 8.79E-02 | 5.95E-01 | 4.70E-01 | **5.95E-01** | its OK |
| **1100** | 8.66E-02 | 5.14E-01 | 4.11E-01 | **5.14E-01** | its OK |
| **1200** | 8.67E-02 | 4.50E-01 | 3.63E-01 | **4.50E-01** | its OK |

| | | | | | |
|---|---|---|---|---|---|
| **1300** | 8.65E-02 | 3.99E-01 | 3.24E-01 | **3.99E-01** | its OK |
| **1400** | 8.58E-02 | 3.56E-01 | 2.92E-01 | **3.56E-01** | its OK |
| **1500** | 8.46E-02 | 3.20E-01 | 2.64E-01 | **3.20E-01** | its OK |
| **1600** | 8.32E-02 | 2.90E-01 | 2.41E-01 | **2.90E-01** | its OK |
| **1700** | 8.15E-02 | 2.64E-01 | 2.20E-01 | **2.64E-01** | its OK |
| **1800** | 7.96E-02 | 2.42E-01 | 2.03E-01 | **2.42E-01** | its OK |
| **1900** | 7.77E-02 | 2.23E-01 | 1.87E-01 | **2.23E-01** | its OK |
| **2000** | 7.57E-02 | 2.06E-01 | 1.76E-01 | **2.06E-01** | its OK |
| **2100** | 7.35E-02 | 1.92E-01 | 1.65E-01 | **1.92E-01** | its OK |
| **2200** | 7.14E-02 | 1.80E-01 | 1.54E-01 | **1.80E-01** | its OK |
| **2300** | 6.93E-02 | 1.68E-01 | 1.45E-01 | **1.68E-01** | its OK |
| **2400** | 6.73E-02 | 1.58E-01 | 1.36E-01 | **1.58E-01** | its OK |
| **2500** | 6.54E-02 | 1.49E-01 | 1.29E-01 | **1.49E-01** | its OK |
| **2600** | 6.35E-02 | 1.41E-01 | 1.22E-01 | **1.41E-01** | its OK |
| **2700** | 6.17E-02 | 1.34E-01 | 1.16E-01 | **1.34E-01** | its OK |
| **2800** | 5.99E-02 | 1.27E-01 | 1.10E-01 | **1.27E-01** | its OK |
| **2900** | 5.82E-02 | 1.21E-01 | 1.05E-01 | **1.21E-01** | its OK |
| **3000** | 5.66E-02 | 1.15E-01 | 1.00E-01 | **1.15E-01** | its OK |
| **3500** | 4.95E-02 | 9.30E-02 | 8.16E-02 | **9.30E-02** | its OK |
| **4000** | 4.37E-02 | 7.75E-02 | 6.83E-02 | **7.75E-02** | its OK |
| **4500** | 3.90E-02 | 6.60E-02 | 5.83E-02 | **6.60E-02** | its OK |
| **5000** | 3.51E-02 | 5.72E-02 | 5.06E-02 | **5.72E-02** | its OK |
| **5500** | 3.18E-02 | 5.02E-02 | 4.46E-02 | **5.02E-02** | its OK |
| **6000** | 2.90E-02 | 4.46E-02 | 3.96E-02 | **4.46E-02** | its OK |
| **6500** | 2.66E-02 | 4.00E-02 | 3.56E-02 | **4.00E-02** | its OK |
| **7000** | 2.45E-02 | 3.62E-02 | 3.22E-02 | **3.62E-02** | its OK |
| **7500** | 2.27E-02 | 3.31E-02 | 2.95E-02 | **3.31E-02** | its OK |
| **8000** | 2.12E-02 | 3.04E-02 | 2.71E-02 | **3.04E-02** | its OK |
| **8500** | 1.98E-02 | 2.81E-02 | 2.51E-02 | **2.81E-02** | its OK |
| **9000** | 1.86E-02 | 2.61E-02 | 2.33E-02 | **2.61E-02** | its OK |
| **9500** | 1.75E-02 | 2.43E-02 | 2.17E-02 | **2.43E-02** | its OK |
| **10000** | 1.65E-02 | 2.27E-02 | 2.03E-02 | **2.27E-02** | its OK |

**NICKEL**

**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | **0.00549** | **g/s** | **0.191** | **tons/yr** |
| **MW=** | **58.69** | | | |
| **Concern level** | **0.0025** | **ppm** | **6.001** | **ug/m3** |

| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | **Recommendation** |
|---|---|---|---|---|---|
| **10** | 7.04E+01 | 9.43E+02 | 9.39E+01 | **9.43E+02** | reduce emissions |
| **100** | 4.05E+00 | 1.30E+02 | 4.23E+01 | **1.30E+02** | reduce emissions |
| **200** | 2.21E+00 | 5.13E+01 | 2.35E+01 | **5.13E+01** | reduce emissions |
| **300** | 1.52E+00 | 2.78E+01 | 1.51E+01 | **2.78E+01** | reduce emissions |
| **400** | 1.17E+00 | 1.76E+01 | 1.06E+01 | **1.76E+01** | reduce emissions |
| **500** | 9.49E-01 | 1.23E+01 | 7.94E+00 | **1.23E+01** | reduce emissions |
| **600** | 8.03E-01 | 9.11E+00 | 6.37E+00 | **9.11E+00** | reduce emissions |
| **700** | 6.79E-01 | 7.06E+00 | 5.17E+00 | **7.06E+00** | reduce emissions |
| **800** | 5.92E-01 | 5.73E+00 | 4.30E+00 | **5.73E+00** | its OK |

| | | | | | |
|---|---|---|---|---|---|
| **900** | 5.94E-01 | 4.76E+00 | 3.69E+00 | **4.76E+00** | its OK |
| **1000** | 5.96E-01 | 4.03E+00 | 3.18E+00 | **4.03E+00** | its OK |
| **1100** | 5.87E-01 | 3.49E+00 | 2.79E+00 | **3.49E+00** | its OK |
| **1200** | 5.87E-01 | 3.05E+00 | 2.46E+00 | **3.05E+00** | its OK |
| **1300** | 5.86E-01 | 2.70E+00 | 2.20E+00 | **2.70E+00** | its OK |
| **1400** | 5.81E-01 | 2.41E+00 | 1.98E+00 | **2.41E+00** | its OK |
| **1500** | 5.74E-01 | 2.17E+00 | 1.79E+00 | **2.17E+00** | its OK |
| **1600** | 5.64E-01 | 1.97E+00 | 1.63E+00 | **1.97E+00** | its OK |
| **1700** | 5.52E-01 | 1.79E+00 | 1.49E+00 | **1.79E+00** | its OK |
| **1800** | 5.40E-01 | 1.64E+00 | 1.37E+00 | **1.64E+00** | its OK |
| **1900** | 5.27E-01 | 1.51E+00 | 1.27E+00 | **1.51E+00** | its OK |
| **2000** | 5.13E-01 | 1.40E+00 | 1.19E+00 | **1.40E+00** | its OK |
| **2100** | 4.98E-01 | 1.30E+00 | 1.12E+00 | **1.30E+00** | its OK |
| **2200** | 4.84E-01 | 1.22E+00 | 1.04E+00 | **1.22E+00** | its OK |
| **2300** | 4.70E-01 | 1.14E+00 | 9.82E-01 | **1.14E+00** | its OK |
| **2400** | 4.56E-01 | 1.07E+00 | 9.25E-01 | **1.07E+00** | its OK |
| **2500** | 4.43E-01 | 1.01E+00 | 8.74E-01 | **1.01E+00** | its OK |
| **2600** | 4.30E-01 | 9.56E-01 | 8.27E-01 | **9.56E-01** | its OK |
| **2700** | 4.18E-01 | 9.06E-01 | 7.85E-01 | **9.06E-01** | its OK |
| **2800** | 4.06E-01 | 8.59E-01 | 7.46E-01 | **8.59E-01** | its OK |
| **2900** | 3.95E-01 | 8.17E-01 | 7.09E-01 | **8.17E-01** | its OK |
| **3000** | 3.84E-01 | 7.78E-01 | 6.80E-01 | **7.78E-01** | its OK |
| **3500** | 3.35E-01 | 6.30E-01 | 5.53E-01 | **6.30E-01** | its OK |
| **4000** | 2.96E-01 | 5.25E-01 | 4.63E-01 | **5.25E-01** | its OK |
| **4500** | 2.64E-01 | 4.47E-01 | 3.95E-01 | **4.47E-01** | its OK |
| **5000** | 2.38E-01 | 3.88E-01 | 3.43E-01 | **3.88E-01** | its OK |
| **5500** | 2.15E-01 | 3.41E-01 | 3.02E-01 | **3.41E-01** | its OK |
| **6000** | 1.96E-01 | 3.02E-01 | 2.69E-01 | **3.02E-01** | its OK |
| **6500** | 1.80E-01 | 2.71E-01 | 2.41E-01 | **2.71E-01** | its OK |
| **7000** | 1.66E-01 | 2.45E-01 | 2.19E-01 | **2.45E-01** | its OK |
| **7500** | 1.54E-01 | 2.24E-01 | 2.00E-01 | **2.24E-01** | its OK |
| **8000** | 1.44E-01 | 2.06E-01 | 1.84E-01 | **2.06E-01** | its OK |
| **8500** | 1.34E-01 | 1.90E-01 | 1.70E-01 | **1.90E-01** | its OK |
| **9000** | 1.26E-01 | 1.77E-01 | 1.58E-01 | **1.77E-01** | its OK |
| **9500** | 1.19E-01 | 1.65E-01 | 1.47E-01 | **1.65E-01** | its OK |
| **10000** | 1.12E-01 | 1.54E-01 | 1.38E-01 | **1.54E-01** | its OK |

**HYDROGEN CHLORIDE**

**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | 3.39 | g/s | **117.7** | **tons/yr** |
| **MW=** | 36.47 | | | |
| **Concern level** | 0.469 | **ppm** | **699.6** | **ug/m3** |

| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | **Recommendation** |
|---|---|---|---|---|---|
| **10** | 4.35E+04 | 5.82E+05 | 5.80E+04 | **5.82E+05** | reduce emissions |
| **100** | 2.50E+03 | 8.00E+04 | 2.61E+04 | **8.00E+04** | reduce emissions |
| **200** | 1.36E+03 | 3.17E+04 | 1.45E+04 | **3.17E+04** | reduce emissions |

| | | | | | |
|---|---|---|---|---|---|
| **300** | 9.38E+02 | 1.72E+04 | 9.33E+03 | **1.72E+04** | reduce emissions |
| **400** | 7.21E+02 | 1.09E+04 | 6.57E+03 | **1.09E+04** | reduce emissions |
| **500** | 5.86E+02 | 7.59E+03 | 4.91E+03 | **7.59E+03** | reduce emissions |
| **600** | 4.96E+02 | 5.63E+03 | 3.94E+03 | **5.63E+03** | reduce emissions |
| **700** | 4.19E+02 | 4.36E+03 | 3.19E+03 | **4.36E+03** | reduce emissions |
| **800** | 3.65E+02 | 3.54E+03 | 2.66E+03 | **3.54E+03** | reduce emissions |
| **900** | 3.67E+02 | 2.94E+03 | 2.28E+03 | **2.94E+03** | reduce emissions |
| **1000** | 3.68E+02 | 2.49E+03 | 1.97E+03 | **2.49E+03** | reduce emissions |
| **1100** | 3.62E+02 | 2.15E+03 | 1.72E+03 | **2.15E+03** | reduce emissions |
| **1200** | 3.63E+02 | 1.88E+03 | 1.52E+03 | **1.88E+03** | reduce emissions |
| **1300** | 3.62E+02 | 1.67E+03 | 1.36E+03 | **1.67E+03** | reduce emissions |
| **1400** | 3.59E+02 | 1.49E+03 | 1.22E+03 | **1.49E+03** | reduce emissions |
| **1500** | 3.54E+02 | 1.34E+03 | 1.11E+03 | **1.34E+03** | reduce emissions |
| **1600** | 3.48E+02 | 1.21E+03 | 1.01E+03 | **1.21E+03** | reduce emissions |
| **1700** | 3.41E+02 | 1.11E+03 | 9.22E+02 | **1.11E+03** | reduce emissions |
| **1800** | 3.33E+02 | 1.01E+03 | 8.49E+02 | **1.01E+03** | reduce emissions |
| **1900** | 3.25E+02 | 9.33E+02 | 7.84E+02 | **9.33E+02** | reduce emissions |
| **2000** | 3.17E+02 | 8.63E+02 | 7.37E+02 | **8.63E+02** | reduce emissions |
| **2100** | 3.08E+02 | 8.04E+02 | 6.89E+02 | **8.04E+02** | reduce emissions |
| **2200** | 2.99E+02 | 7.52E+02 | 6.45E+02 | **7.52E+02** | reduce emissions |
| **2300** | 2.90E+02 | 7.05E+02 | 6.06E+02 | **7.05E+02** | reduce emissions |
| **2400** | 2.82E+02 | 6.63E+02 | 5.71E+02 | **6.63E+02** | its OK |
| **2500** | 2.74E+02 | 6.25E+02 | 5.40E+02 | **6.25E+02** | its OK |
| **2600** | 2.66E+02 | 5.91E+02 | 5.11E+02 | **5.91E+02** | its OK |
| **2700** | 2.58E+02 | 5.59E+02 | 4.84E+02 | **5.59E+02** | its OK |
| **2800** | 2.51E+02 | 5.31E+02 | 4.60E+02 | **5.31E+02** | its OK |
| **2900** | 2.44E+02 | 5.04E+02 | 4.38E+02 | **5.04E+02** | its OK |
| **3000** | 2.37E+02 | 4.80E+02 | 4.20E+02 | **4.80E+02** | its OK |
| **3500** | 2.07E+02 | 3.89E+02 | 3.42E+02 | **3.89E+02** | its OK |
| **4000** | 1.83E+02 | 3.24E+02 | 2.86E+02 | **3.24E+02** | its OK |
| **4500** | 1.63E+02 | 2.76E+02 | 2.44E+02 | **2.76E+02** | its OK |
| **5000** | 1.47E+02 | 2.39E+02 | 2.12E+02 | **2.39E+02** | its OK |
| **5500** | 1.33E+02 | 2.10E+02 | 1.86E+02 | **2.10E+02** | its OK |
| **6000** | 1.21E+02 | 1.87E+02 | 1.66E+02 | **1.87E+02** | its OK |
| **6500** | 1.11E+02 | 1.68E+02 | 1.49E+02 | **1.68E+02** | its OK |
| **7000** | 1.03E+02 | 1.52E+02 | 1.35E+02 | **1.52E+02** | its OK |
| **7500** | 9.52E+01 | 1.38E+02 | 1.23E+02 | **1.38E+02** | its OK |
| **8000** | 8.87E+01 | 1.27E+02 | 1.13E+02 | **1.27E+02** | its OK |
| **8500** | 8.30E+01 | 1.18E+02 | 1.05E+02 | **1.18E+02** | its OK |
| **9000** | 7.78E+01 | 1.09E+02 | 9.74E+01 | **1.09E+02** | its OK |
| **9500** | 7.33E+01 | 1.02E+02 | 9.09E+01 | **1.02E+02** | its OK |
| **10000** | 6.92E+01 | 9.51E+01 | 8.50E+01 | **9.51E+01** | its OK |

**SULFURIC ACID**
**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | 5.59 | **g/s** | **194.1** | **tons/yr** |
| **MW=** | **98.08** | | | |
| **Concern level** | **0.00299** | **ppm** | **11.99** | **ug/m3** |

| Distance (M) | Point | Area | Volume | Worst | Recommendation |
|---|---|---|---|---|---|
| **10** | 7.17E+04 | 9.60E+05 | 9.56E+04 | **9.60E+05** | reduce emissions |
| **100** | 4.12E+03 | 1.32E+05 | 4.30E+04 | **1.32E+05** | reduce emissions |
| **200** | 2.25E+03 | 5.22E+04 | 2.39E+04 | **5.22E+04** | reduce emissions |
| **300** | 1.55E+03 | 2.83E+04 | 1.54E+04 | **2.83E+04** | reduce emissions |
| **400** | 1.19E+03 | 1.80E+04 | 1.08E+04 | **1.80E+04** | reduce emissions |
| **500** | 9.66E+02 | 1.25E+04 | 8.09E+03 | **1.25E+04** | reduce emissions |
| **600** | 8.17E+02 | 9.28E+03 | 6.49E+03 | **9.28E+03** | reduce emissions |
| **700** | 6.91E+02 | 7.19E+03 | 5.27E+03 | **7.19E+03** | reduce emissions |
| **800** | 6.03E+02 | 5.83E+03 | 4.38E+03 | **5.83E+03** | reduce emissions |
| **900** | 6.05E+02 | 4.85E+03 | 3.75E+03 | **4.85E+03** | reduce emissions |
| **1000** | 6.07E+02 | 4.11E+03 | 3.24E+03 | **4.11E+03** | reduce emissions |
| **1100** | 5.98E+02 | 3.55E+03 | 2.84E+03 | **3.55E+03** | reduce emissions |
| **1200** | 5.98E+02 | 3.11E+03 | 2.51E+03 | **3.11E+03** | reduce emissions |
| **1300** | 5.97E+02 | 2.75E+03 | 2.24E+03 | **2.75E+03** | reduce emissions |
| **1400** | 5.92E+02 | 2.46E+03 | 2.01E+03 | **2.46E+03** | reduce emissions |
| **1500** | 5.84E+02 | 2.21E+03 | 1.82E+03 | **2.21E+03** | reduce emissions |
| **1600** | 5.74E+02 | 2.00E+03 | 1.66E+03 | **2.00E+03** | reduce emissions |
| **1700** | 5.62E+02 | 1.82E+03 | 1.52E+03 | **1.82E+03** | reduce emissions |
| **1800** | 5.50E+02 | 1.67E+03 | 1.40E+03 | **1.67E+03** | reduce emissions |
| **1900** | 5.36E+02 | 1.54E+03 | 1.29E+03 | **1.54E+03** | reduce emissions |
| **2000** | 5.23E+02 | 1.42E+03 | 1.21E+03 | **1.42E+03** | reduce emissions |
| **2100** | 5.07E+02 | 1.33E+03 | 1.14E+03 | **1.33E+03** | reduce emissions |
| **2200** | 4.93E+02 | 1.24E+03 | 1.06E+03 | **1.24E+03** | reduce emissions |
| **2300** | 4.78E+02 | 1.16E+03 | 1.00E+03 | **1.16E+03** | reduce emissions |
| **2400** | 4.65E+02 | 1.09E+03 | 9.42E+02 | **1.09E+03** | reduce emissions |
| **2500** | 4.51E+02 | 1.03E+03 | 8.90E+02 | **1.03E+03** | reduce emissions |
| **2600** | 4.38E+02 | 9.74E+02 | 8.42E+02 | **9.74E+02** | reduce emissions |
| **2700** | 4.26E+02 | 9.22E+02 | 7.99E+02 | **9.22E+02** | reduce emissions |
| **2800** | 4.14E+02 | 8.75E+02 | 7.59E+02 | **8.75E+02** | reduce emissions |
| **2900** | 4.02E+02 | 8.32E+02 | 7.22E+02 | **8.32E+02** | reduce emissions |
| **3000** | 3.91E+02 | 7.92E+02 | 6.93E+02 | **7.92E+02** | reduce emissions |
| **3500** | 3.41E+02 | 6.42E+02 | 5.63E+02 | **6.42E+02** | reduce emissions |
| **4000** | 3.02E+02 | 5.35E+02 | 4.71E+02 | **5.35E+02** | reduce emissions |
| **4500** | 2.69E+02 | 4.56E+02 | 4.03E+02 | **4.56E+02** | reduce emissions |
| **5000** | 2.42E+02 | 3.95E+02 | 3.49E+02 | **3.95E+02** | reduce emissions |
| **5500** | 2.19E+02 | 3.47E+02 | 3.08E+02 | **3.47E+02** | reduce emissions |
| **6000** | 2.00E+02 | 3.08E+02 | 2.74E+02 | **3.08E+02** | reduce emissions |
| **6500** | 1.83E+02 | 2.76E+02 | 2.46E+02 | **2.76E+02** | reduce emissions |
| **7000** | 1.69E+02 | 2.50E+02 | 2.23E+02 | **2.50E+02** | reduce emissions |
| **7500** | 1.57E+02 | 2.28E+02 | 2.04E+02 | **2.28E+02** | reduce emissions |
| **8000** | 1.46E+02 | 2.10E+02 | 1.87E+02 | **2.10E+02** | reduce emissions |
| **8500** | 1.37E+02 | 1.94E+02 | 1.73E+02 | **1.94E+02** | reduce emissions |
| **9000** | 1.28E+02 | 1.80E+02 | 1.61E+02 | **1.80E+02** | reduce emissions |
| **9500** | 1.21E+02 | 1.68E+02 | 1.50E+02 | **1.68E+02** | reduce emissions |
| **10000** | 1.14E+02 | 1.57E+02 | 1.40E+02 | **1.57E+02** | reduce emissions |

**AMMONIA**

**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | 1.6 | **g/s** | **55.57** | **tons/yr** |
| **MW=** | 17.02 | | | |
| **Concern level** | 3.88 | **ppm** | **2701** | **ug/m3** |

| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | **Recommendation** |
|---|---|---|---|---|---|
| **10** | 2.05E+04 | 2.75E+05 | 2.74E+04 | **2.75E+05** | reduce emissions |
| **100** | 1.18E+03 | 3.78E+04 | 1.23E+04 | **3.78E+04** | reduce emissions |
| **200** | 6.43E+02 | 1.50E+04 | 6.84E+03 | **1.50E+04** | reduce emissions |
| **300** | 4.43E+02 | 8.11E+03 | 4.40E+03 | **8.11E+03** | reduce emissions |
| **400** | 3.40E+02 | 5.14E+03 | 3.10E+03 | **5.14E+03** | reduce emissions |
| **500** | 2.76E+02 | 3.58E+03 | 2.32E+03 | **3.58E+03** | reduce emissions |
| **600** | 2.34E+02 | 2.66E+03 | 1.86E+03 | **2.66E+03** | its OK |
| **700** | 1.98E+02 | 2.06E+03 | 1.51E+03 | **2.06E+03** | its OK |
| **800** | 1.72E+02 | 1.67E+03 | 1.25E+03 | **1.67E+03** | its OK |
| **900** | 1.73E+02 | 1.39E+03 | 1.07E+03 | **1.39E+03** | its OK |
| **1000** | 1.74E+02 | 1.18E+03 | 9.28E+02 | **1.18E+03** | its OK |
| **1100** | 1.71E+02 | 1.02E+03 | 8.12E+02 | **1.02E+03** | its OK |
| **1200** | 1.71E+02 | 8.90E+02 | 7.18E+02 | **8.90E+02** | its OK |
| **1300** | 1.71E+02 | 7.87E+02 | 6.40E+02 | **7.87E+02** | its OK |
| **1400** | 1.69E+02 | 7.03E+02 | 5.76E+02 | **7.03E+02** | its OK |
| **1500** | 1.67E+02 | 6.32E+02 | 5.22E+02 | **6.32E+02** | its OK |
| **1600** | 1.64E+02 | 5.73E+02 | 4.75E+02 | **5.73E+02** | its OK |
| **1700** | 1.61E+02 | 5.22E+02 | 4.35E+02 | **5.22E+02** | its OK |
| **1800** | 1.57E+02 | 4.78E+02 | 4.00E+02 | **4.78E+02** | its OK |
| **1900** | 1.54E+02 | 4.40E+02 | 3.70E+02 | **4.40E+02** | its OK |
| **2000** | 1.50E+02 | 4.07E+02 | 3.48E+02 | **4.07E+02** | its OK |
| **2100** | 1.45E+02 | 3.80E+02 | 3.25E+02 | **3.80E+02** | its OK |
| **2200** | 1.41E+02 | 3.55E+02 | 3.04E+02 | **3.55E+02** | its OK |
| **2300** | 1.37E+02 | 3.33E+02 | 2.86E+02 | **3.33E+02** | its OK |
| **2400** | 1.33E+02 | 3.13E+02 | 2.70E+02 | **3.13E+02** | its OK |
| **2500** | 1.29E+02 | 2.95E+02 | 2.55E+02 | **2.95E+02** | its OK |
| **2600** | 1.25E+02 | 2.79E+02 | 2.41E+02 | **2.79E+02** | its OK |
| **2700** | 1.22E+02 | 2.64E+02 | 2.29E+02 | **2.64E+02** | its OK |
| **2800** | 1.18E+02 | 2.50E+02 | 2.17E+02 | **2.50E+02** | its OK |
| **2900** | 1.15E+02 | 2.38E+02 | 2.07E+02 | **2.38E+02** | its OK |
| **3000** | 1.12E+02 | 2.27E+02 | 1.98E+02 | **2.27E+02** | its OK |
| **3500** | 9.77E+01 | 1.84E+02 | 1.61E+02 | **1.84E+02** | its OK |
| **4000** | 8.63E+01 | 1.53E+02 | 1.35E+02 | **1.53E+02** | its OK |
| **4500** | 7.70E+01 | 1.30E+02 | 1.15E+02 | **1.30E+02** | its OK |
| **5000** | 6.92E+01 | 1.13E+02 | 1.00E+02 | **1.13E+02** | its OK |
| **5500** | 6.28E+01 | 9.92E+01 | 8.80E+01 | **9.92E+01** | its OK |
| **6000** | 5.72E+01 | 8.82E+01 | 7.83E+01 | **8.82E+01** | its OK |
| **6500** | 5.25E+01 | 7.91E+01 | 7.03E+01 | **7.91E+01** | its OK |
| **7000** | 4.84E+01 | 7.15E+01 | 6.37E+01 | **7.15E+01** | its OK |
| **7500** | 4.49E+01 | 6.53E+01 | 5.83E+01 | **6.53E+01** | its OK |
| **8000** | 4.19E+01 | 6.00E+01 | 5.36E+01 | **6.00E+01** | its OK |
| **8500** | 3.92E+01 | 5.55E+01 | 4.95E+01 | **5.55E+01** | its OK |
| **9000** | 3.67E+01 | 5.15E+01 | 4.60E+01 | **5.15E+01** | its OK |
| **9500** | 3.46E+01 | 4.80E+01 | 4.29E+01 | **4.80E+01** | its OK |

| | | | | | |
|---|---|---|---|---|---|
| **10000** | 3.26E+01 | 4.49E+01 | 4.01E+01 | **4.49E+01** | its OK |

**HYDROGEN CHLORIDE(2)**

**Enter the peak emission rate of the contaminent of concern**

| | | | | |
|---|---|---|---|---|
| **Peak (30 min) Emission Rate =** | 1.23 | **g/s** | **42.72** | **tons/yr** |
| **MW=** | **36.47** | | | |
| **Concern level** | **0.469** | **ppm** | **699.6** | **ug/m3** |

| **Distance (M)** | **Point** | **Area** | **Volume** | **Worst** | **Recommendation** |
|---|---|---|---|---|---|
| **10** | 1.58E+04 | 2.11E+05 | 2.10E+04 | **2.11E+05** | reduce emissions |
| **100** | 9.07E+02 | 2.90E+04 | 9.47E+03 | **2.90E+04** | reduce emissions |
| **200** | 4.95E+02 | 1.15E+04 | 5.25E+03 | **1.15E+04** | reduce emissions |
| **300** | 3.40E+02 | 6.24E+03 | 3.38E+03 | **6.24E+03** | reduce emissions |
| **400** | 2.61E+02 | 3.95E+03 | 2.38E+03 | **3.95E+03** | reduce emissions |
| **500** | 2.13E+02 | 2.75E+03 | 1.78E+03 | **2.75E+03** | reduce emissions |
| **600** | 1.80E+02 | 2.04E+03 | 1.43E+03 | **2.04E+03** | reduce emissions |
| **700** | 1.52E+02 | 1.58E+03 | 1.16E+03 | **1.58E+03** | reduce emissions |
| **800** | 1.33E+02 | 1.28E+03 | 9.64E+02 | **1.28E+03** | reduce emissions |
| **900** | 1.33E+02 | 1.07E+03 | 8.26E+02 | **1.07E+03** | reduce emissions |
| **1000** | 1.33E+02 | 9.03E+02 | 7.13E+02 | **9.03E+02** | reduce emissions |
| **1100** | 1.31E+02 | 7.81E+02 | 6.24E+02 | **7.81E+02** | reduce emissions |
| **1200** | 1.32E+02 | 6.84E+02 | 5.52E+02 | **6.84E+02** | its OK |
| **1300** | 1.31E+02 | 6.05E+02 | 4.92E+02 | **6.05E+02** | its OK |
| **1400** | 1.30E+02 | 5.40E+02 | 4.43E+02 | **5.40E+02** | its OK |
| **1500** | 1.29E+02 | 4.86E+02 | 4.01E+02 | **4.86E+02** | its OK |
| **1600** | 1.26E+02 | 4.40E+02 | 3.65E+02 | **4.40E+02** | its OK |
| **1700** | 1.24E+02 | 4.01E+02 | 3.35E+02 | **4.01E+02** | its OK |
| **1800** | 1.21E+02 | 3.68E+02 | 3.08E+02 | **3.68E+02** | its OK |
| **1900** | 1.18E+02 | 3.39E+02 | 2.84E+02 | **3.39E+02** | its OK |
| **2000** | 1.15E+02 | 3.13E+02 | 2.67E+02 | **3.13E+02** | its OK |
| **2100** | 1.12E+02 | 2.92E+02 | 2.50E+02 | **2.92E+02** | its OK |
| **2200** | 1.08E+02 | 2.73E+02 | 2.34E+02 | **2.73E+02** | its OK |
| **2300** | 1.05E+02 | 2.56E+02 | 2.20E+02 | **2.56E+02** | its OK |
| **2400** | 1.02E+02 | 2.41E+02 | 2.07E+02 | **2.41E+02** | its OK |
| **2500** | 9.93E+01 | 2.27E+02 | 1.96E+02 | **2.27E+02** | its OK |
| **2600** | 9.64E+01 | 2.14E+02 | 1.85E+02 | **2.14E+02** | its OK |
| **2700** | 9.37E+01 | 2.03E+02 | 1.76E+02 | **2.03E+02** | its OK |
| **2800** | 9.10E+01 | 1.92E+02 | 1.67E+02 | **1.92E+02** | its OK |
| **2900** | 8.84E+01 | 1.83E+02 | 1.59E+02 | **1.83E+02** | its OK |
| **3000** | 8.60E+01 | 1.74E+02 | 1.52E+02 | **1.74E+02** | its OK |
| **3500** | 7.51E+01 | 1.41E+02 | 1.24E+02 | **1.41E+02** | its OK |
| **4000** | 6.63E+01 | 1.18E+02 | 1.04E+02 | **1.18E+02** | its OK |
| **4500** | 5.92E+01 | 1.00E+02 | 8.86E+01 | **1.00E+02** | its OK |
| **5000** | 5.32E+01 | 8.69E+01 | 7.69E+01 | **8.69E+01** | its OK |
| **5500** | 4.82E+01 | 7.63E+01 | 6.77E+01 | **7.63E+01** | its OK |
| **6000** | 4.40E+01 | 6.78E+01 | 6.02E+01 | **6.78E+01** | its OK |
| **6500** | 4.04E+01 | 6.08E+01 | 5.41E+01 | **6.08E+01** | its OK |
| **7000** | 3.72E+01 | 5.50E+01 | 4.90E+01 | **5.50E+01** | its OK |
| **7500** | 3.45E+01 | 5.02E+01 | 4.48E+01 | **5.02E+01** | its OK |
| **8000** | 3.22E+01 | 4.62E+01 | 4.12E+01 | **4.62E+01** | its OK |

| | | | | | |
|---|---|---|---|---|---|
| **8500** | 3.01E+01 | 4.27E+01 | 3.81E+01 | **4.27E+01** | its OK |
| **9000** | 2.82E+01 | 3.96E+01 | 3.54E+01 | **3.96E+01** | its OK |
| **9500** | 2.66E+01 | 3.69E+01 | 3.30E+01 | **3.69E+01** | its OK |
| **10000** | 2.51E+01 | 3.45E+01 | 3.08E+01 | **3.45E+01** | its OK |

**Attachment 4**

# PUBLIC HEALTH IMPACT DATA

Ammonia ($NH_3$) caustic and hazardous

Arsenic (As) The IARC lists element as Group 1, carcinogenic to humans
European Union directive 67/548/EEC, The International Agency for Research on Cancer (IARC)

Nickel (Ni) Nickel fume and dust is believed to be carcinogenic
KS Kasprzak, FW Sunderman Jr, K Salnikow. Nickel carcinogenesis. Mutation Research. 2003 Dec 10;533(1-2):67-97. PubMed

JK Dunnick, MR Elwell, AE Radovsky, JM Benson, FF Hahn, KJ Nikula, EB Barr, CH Hobbs. Comparative Carcinogenic Effects of Nickel Subsulfide, Nickel Oxide, or Nickel Sulfate Hexahydrate Chronic Exposures in the Lung. Cancer Research. 1995 Nov 15;55(22):5251-6. PubMed

Cadmium (Cd) Cadmium and several cadmium-containing compounds are known carcinogens and can induce many types of cancer.

"11th Report on Carcinogens" National Toxicology Program. http://ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932.

Chromium (Cr) when ingested, damages the kidneys, the liver and blood cells and is carcinogenic.

Dayan, A. D.; Paine, A. J. (2001). "Mechanisms of chromium toxicity, carcinogenicity and allergenicity: Review of the literature from 1985 to 2000". Human & Experimental Toxicology 20 (9): 439–451.

Newman, D. (1890). "A case of adeno-carcinoma of the left inferior turbinated body, and perforation of the nasal septum, in the person of a worker in chrome pigments". Glasgow Med J 33: 469–470.

Langard, Sverre (1990). "One Hundred Years of Chromium and Cancer: A Review of Epidemiological Evidence and Selected Case Reports". American Journal of Industrial Medicine 17: 189–215..

Manganese (Mn) poisoning has been linked to impaired motor skills and cognitive disorders

[Risk Assessment Information System Toxicity Summary for MANGANESE". Oak Ridge National Laboratory. http://rais.ornl.gov/tox/profiles/mn.shtml.]

Mercury (Hg) Mercury and most of its compounds are extremely toxic. effects include damage to the brain, kidney, and lungs

Clifton JC 2nd (2007). "Mercury exposure and public health". *Pediatr Clin North Am* 54 (2): 237–69, viii.

Hydrogen chloride (HCl) forms corrosive hydrochloric acid on contact with water found in body tissue. Inhalation of the fumes can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory system failure, and death

*Public health and reference data from Wikipedia*