

**EXPOSURE EVALUATION FOR NEW PROCESS AT
FAYETTEVILLE SITE**

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Executive Summary

This exposure assessment was performed to compare modeled concentrations of APFO in air, water and fish to the Community Exposure Guidelines for this compound.

An air exposure analysis was performed by comparing the maximum annual ambient air concentrations (determined through modeling) with a laboratory derived Community Exposure Guideline for air (CEG_a). For APFO, the chronic CEG_a is $0.3 \mu\text{g}/\text{m}^3$. This CEG_a is based on exposure to APFO for 7 days a week, 24 hours per day over a 70 year lifetime. The maximum predicted annual ambient air concentration was determined to be $0.0191 \mu\text{g}/\text{m}^3$. Predicted concentrations were 15 times below the CEG_a .

A water exposure analysis was performed by comparing modeled concentrations in the river with a laboratory derived Community Exposure Guideline for water (CEG_w). For APFO, the chronic CEG_w is $1 \mu\text{g}/\text{L}$. This CEG_w is based on ingestion of 2 liters per day of drinking water over a 70 year lifetime. The estimated annual average concentration in the river from storm water runoff was determined to be $0.004 \mu\text{g}/\text{L}$. Estimated concentrations were 250 times below the CEG_w .

A fish ingestion analysis was performed by comparing estimated concentrations in fish with a business-supplied exposure guideline of $730 \mu\text{g}/\text{yr}$. The estimated fish concentration was $1.3 \mu\text{g}/\text{yr}$. The estimated intake of APFO from fish is 500 times below the guideline.

1. Introduction

This report summarizes the results of a screening level exposure assessment for a new process planned for installation at the Fayetteville, NC site. The assessment was undertaken to ensure that exposure to emissions from the new process will be within acceptable Community Exposure Guideline levels for air and water.

2. Emission Source

2.1 Compound of Concern (COPC)

The COPC modeled in this assessment was Ammonium Perfluorooctanoate (APFO). This compound is nonvolatile, with a vapor pressure of 10mm mercury at 20° C.

2.2 Stack Parameters

The new process will be the only source of APFO emissions on the site. This process will have one stack emission source of APFO. This was the only source included in the modeling. The stack parameters used for this source are as follows:

Location: 697638E, 3857918N
Height = 55 ft (16.8 m)
Temperature = 77°F (298 K)
Velocity = 100 ft/s (30.5 m/s)
Diameter = 1 ft (0.305 m)
Flow Rate = 4,710 scfm
Emission Rate = 0.03 g/s

Note: Several months after the completion of this report, the writers were informed by the project team that two of the original stack parameters had changed. The stack height was increased from 55 to 85 feet and the flow rate was increased from 4,710 to 12,500 scfm. Since both of these changes will improve dispersion, resulting in lower ground level concentrations and lower deposition rates, it was decided that there is no need to rerun the model and revise this report for the new stack parameters.

3. Dispersion Modeling and Calculations

3.1 Dispersion Modeling for Air Exposure

3.1.1 Model Description

An air dispersion analysis was performed to provide input to the screening level assessment for air emissions. Results were in the form of annual average ambient air concentrations.

Dispersion modeling was performed using EPA's Industrial Source Complex Short Term 3 Model (ISCST3) provided by Lakes Environmental. All modeling was done in accordance with the procedures in EPA's Guideline on Air Quality Models (40 CFR Part 51, Appendix W). The EPA regulatory default options and the rural dispersion coefficient were used in the model.

3.1.2 Methodology and Assumptions

The process stack was evaluated for downwash effects from surrounding buildings. The Lakes Environmental BPIP View model was used to provide wind direction specific building parameters. All buildings on the site were evaluated to determine if they could potentially impact the stack by causing building down-wash effects. With the exception of the new process building, all other buildings were determined not to be in the zone of influence for the stack. Therefore, the new process building was the only building included in the model. A plot plan showing the location of the building and the emission source and the site boundary is shown in Figure 1.

A receptor grid with 100-meter spacing extending out 2000 meters from the property line was used. Receptors were also placed on the property line at 25 meter intervals. No receptors were placed inside the plant property line. The model was run with the elevated terrain height option. Terrain elevations were imported from digital elevation map (DEM) files provided by the USGS.

Five years of meteorological data (1995-1999) were analyzed to determine the maximum annual average concentration. The model-ready meteorological files were obtained from the Trinity Consultants. The surface station data is from the Pope Air Force Base in Fayetteville, NC and the upper air data is from Greensboro, NC. An anemometer height of 10 meters was used.

3.1.3 Air Dispersion Modeling Results

An averaging time of one year was used to determine the location of the receptor with the highest predicted ambient concentration. The modeling results for each year are shown in Table 1. The highest predicted annual average concentration occurred for the 1997 meteorological data set. Figure 2 shows a contour plot of the predicted annual average concentrations for the 1997 data.

Table 1 Predicted Annual Average Ambient Air Concentrations		
Year	Maximum Concentration ($\mu\text{g}/\text{m}^3$)	Location
1995	0.0143	698367E, 3858657N
1996	0.0177	698386E, 3858611N

1997	0.0191	698386E, 3858611N
1998	0.0171	698386E, 3858611N
1999	0.0172	698386E, 3858611N

3.2 Deposition Modeling for Water Exposure

3.2.1 Model Description

The water exposure assessment was performed by conservatively assuming that all particles deposited in the watershed from the new process stack would be carried into the nearby Cape Fear River as storm-water runoff. As a first step in this assessment, modeling was performed to determine the highest annual deposition flux over a five-year period. Deposition modeling was performed using two models provided by Lakes Environmental Software:

- EPA's Industrial Source Complex Short Term 3 Model (ISCST3)
- Industrial Risk Assessment Program for Human Health (IRAP-h)

The ISCST3 model provided wet and dry particle deposition information. The IRAP-h model processed the deposition information along with site-specific watershed information to determine the total mass of particles deposited over the identified watershed area.

3.2.2 Methodology and Assumptions

The ISCST3 model was run using a receptor grid with 100-meter spacing extending 10,000 meters from the source. The model was run to calculate annual dry and wet deposition fluxes, including dry and wet depletion of the plume. The following particle information was used in the model:

- The particle size was assumed to be 3 μm for all particles.
- A particle density of 0.7 g/cm^3 was used.
- A liquid scavenging coefficient of 0.0001 ($10^{-4} \text{ s}^{-1}/\text{mm-hr}^{-1}$) was used.
- A frozen scavenging coefficient of 0.0001 ($10^{-4} \text{ s}^{-1}/\text{mm-hr}^{-1}$) was used.

3.2.3 Deposition Modeling Results

Output from the ISCST3 model consisted of an annual deposition rate for each receptor per unit of surface area per year. The ISCST3 output files were imported into the IRAP-h model and the model was run to determine the average annual particle deposition rate over the watershed area of interest. This information was multiplied by the total watershed size to determine the total mass loading from the designated watershed to the Cape Fear River. A watershed size of 20 kilometers by 20 kilometers was selected for this assessment. This watershed area encompasses points upstream and downstream of the Cape Fear River, land on either side of the river, a large number of tributaries draining into the river, and an area stretching 10 kilometers in all directions from the new process stack. Calculations and results for 20 kilometer by 20 kilometer square watershed are presented below.

Total Deposition from Watershed

- IRAP-h calculated an average particle deposition rate over the watershed area of 0.00154 g/m^2 per year.
- The average wet deposition from the vapor phase was not included due to the involatile nature of the compound.
- The deposition rate calculated in the IRAP-h model was based on an emission rate of 1 g/s. To determine the actual deposition rate, this rate must be multiplied by the actual emission rate of 0.03 g/s:

$$\text{Actual Deposition Rate} = 0.00154 \frac{\text{g}}{\text{m}^2 \cdot \text{yr}} \times 0.03 = 4.62 \times 10^{-5} \frac{\text{g}}{\text{m}^2 \cdot \text{yr}}$$

Mass Loading to the River

- The load to river is assumed to be equal to the deposition rate multiplied by the watershed area:

$$\text{Load} = 4.62 \times 10^{-5} \frac{\text{g}}{\text{m}^2 \cdot \text{yr}} \times 413.4 \times 10^6 \text{ m}^2 = 19,100 \frac{\text{g}}{\text{yr}}$$

Concentration in the River

- The mean flow of the Cape Fear river is 1.25×10^4 million liters per day.
- The concentration in the river is assumed to be equal to the load to the river divided by the mean flow:

$$\frac{19,100 \text{ g}}{\text{yr}} \times \frac{\text{day}}{1.25 \times 10^{10} \text{ L}} \times \frac{\text{yr}}{365 \text{ days}} \times \frac{10^6 \mu\text{g}}{\text{g}} \approx 0.004 \frac{\mu\text{g}}{\text{L}}$$

4. Air Exposure Assessment

The exposure pathway explored in the air exposure scenario is one that assumes that residents in the surrounding area will be inhaling air contaminated with APFO emissions from the process stack. The exposure analysis was performed by comparing the maximum predicted annual average ambient air concentration (determined through modeling) with a laboratory derived Community Exposure Guideline for air (CEG_a). For APFO the chronic CEG_a is $0.3 \mu\text{g}/\text{m}^3$. The CEG_a is based on exposure to APFO for 7 days a week, 24 hours per day over a 70 year lifetime. The maximum predicted annual average ambient air concentration was determined to be $0.0191 \mu\text{g}/\text{m}^3$. Predicted concentrations were 15 times below the CEG_a .

5. Water Exposure Assessment

The exposure pathway explored in the water exposure scenario is one that assumes that humans may ingest water from the Cape Fear River, which is adjacent to the Fayetteville facility. This scenario assumes all the stormwater from the watershed

enters the Cape Fear River at a single point of discharge and is immediately completely mixed with the flow of the river.

The water exposure analysis was performed by comparing concentrations in the river with a laboratory derived Community Exposure Guideline for water (CEG_w). For APFO, the chronic CEG_w is 1 µg/L. This CEG_w is based on ingestion of 2 liters per day of drinking water over a 70 year lifetime. The estimated concentration in the river from storm water runoff was determined to be 0.004 µg/L. Estimated concentrations were 250 times below the CEG_w.

6. Fish Ingestion Exposure Assessment

The exposure pathway explored in the fish ingestion exposure scenario is one that assumes that humans eat fish from the Cape Fear river. Calculations of the estimated daily intake from fish ingestion are presented below.

Daily Intake from Fish Ingestion

- The concentration of APFO in the river is assumed to be 0.004 µg/L (calculated in the previous section).
- The bioconcentration factor (BCF) for APFO is assumed to be 10 Liters per kilogram.
- The Ingestion rate of fish for adults is assumed to be 0.00117 kg/kg per day (as per EPA's Environmental Factors Handbook).
- It is assumed that the average adult weighs 70 kilograms.

$$\text{Daily Intake} = \frac{0.004 \mu\text{g APFO}}{\text{L}} \times \frac{0.00117 \text{ kg fish}}{\text{kg} \cdot \text{day}} \times \frac{10 \text{ L}}{\text{kg fish}} \times 70 \text{ kg} \times \frac{365 \text{ days}}{\text{yr}} = 1.2 \frac{\mu\text{g}}{\text{yr}}$$

Given a fish ingestion guideline of 730 µg/yr (as supplied by the business), the estimated intake of APFO from fish is 500 times less than the guideline.

Figure 1
Site Boundary and Source Location

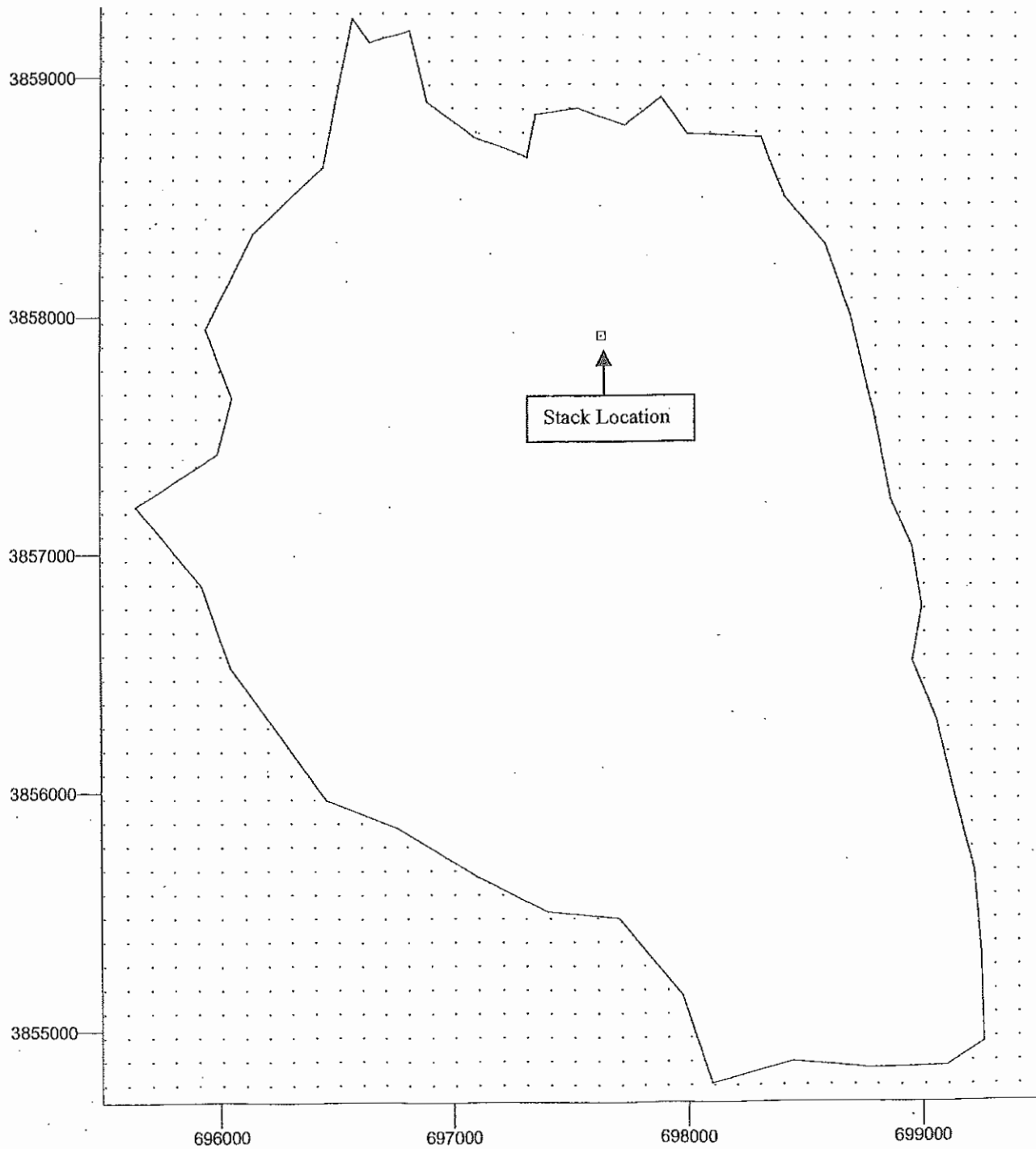


Figure 1

Figure 2
Predicted Annual Average
Ambient Air Concentrations
1997 Met Data

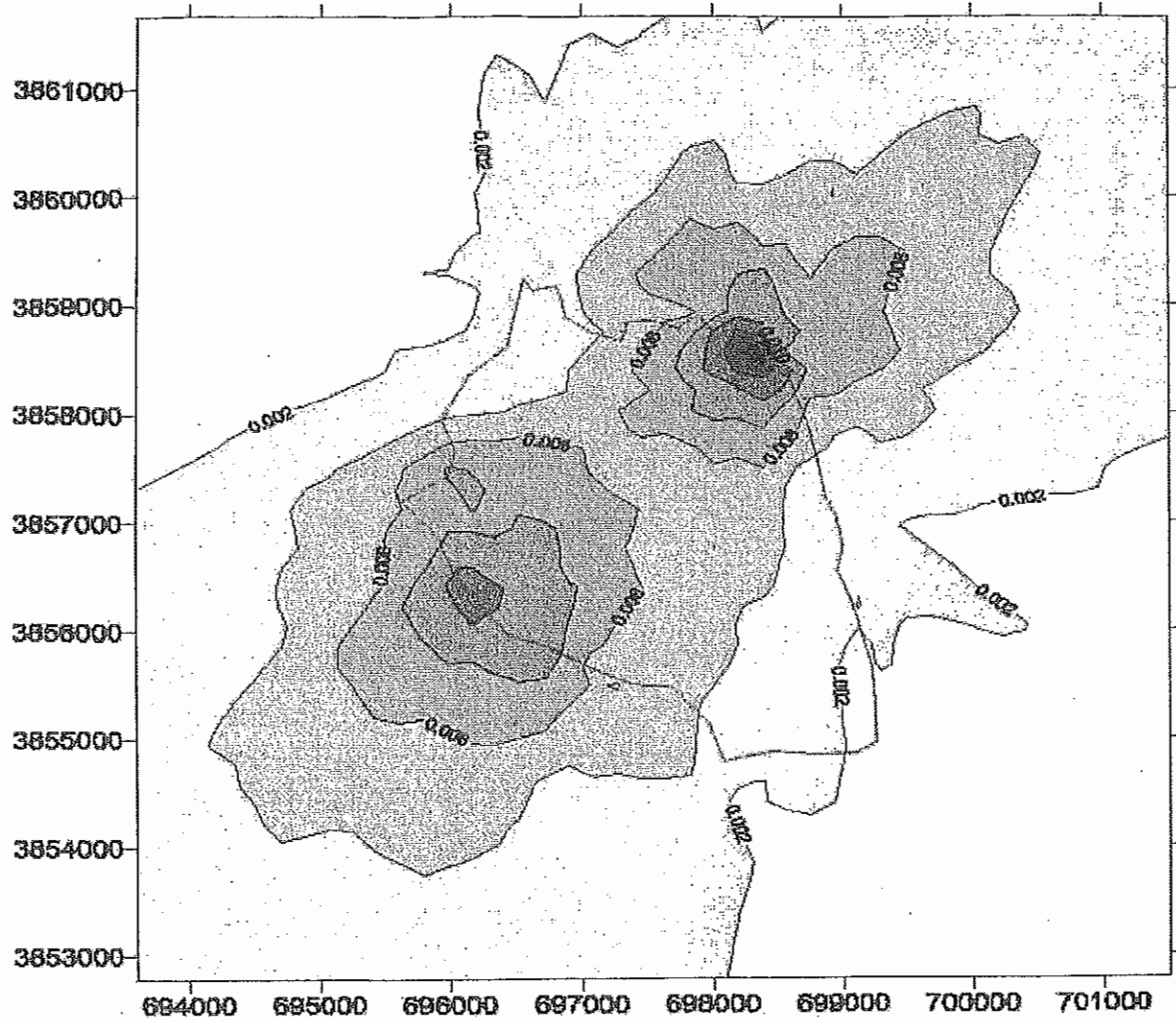


Figure 2