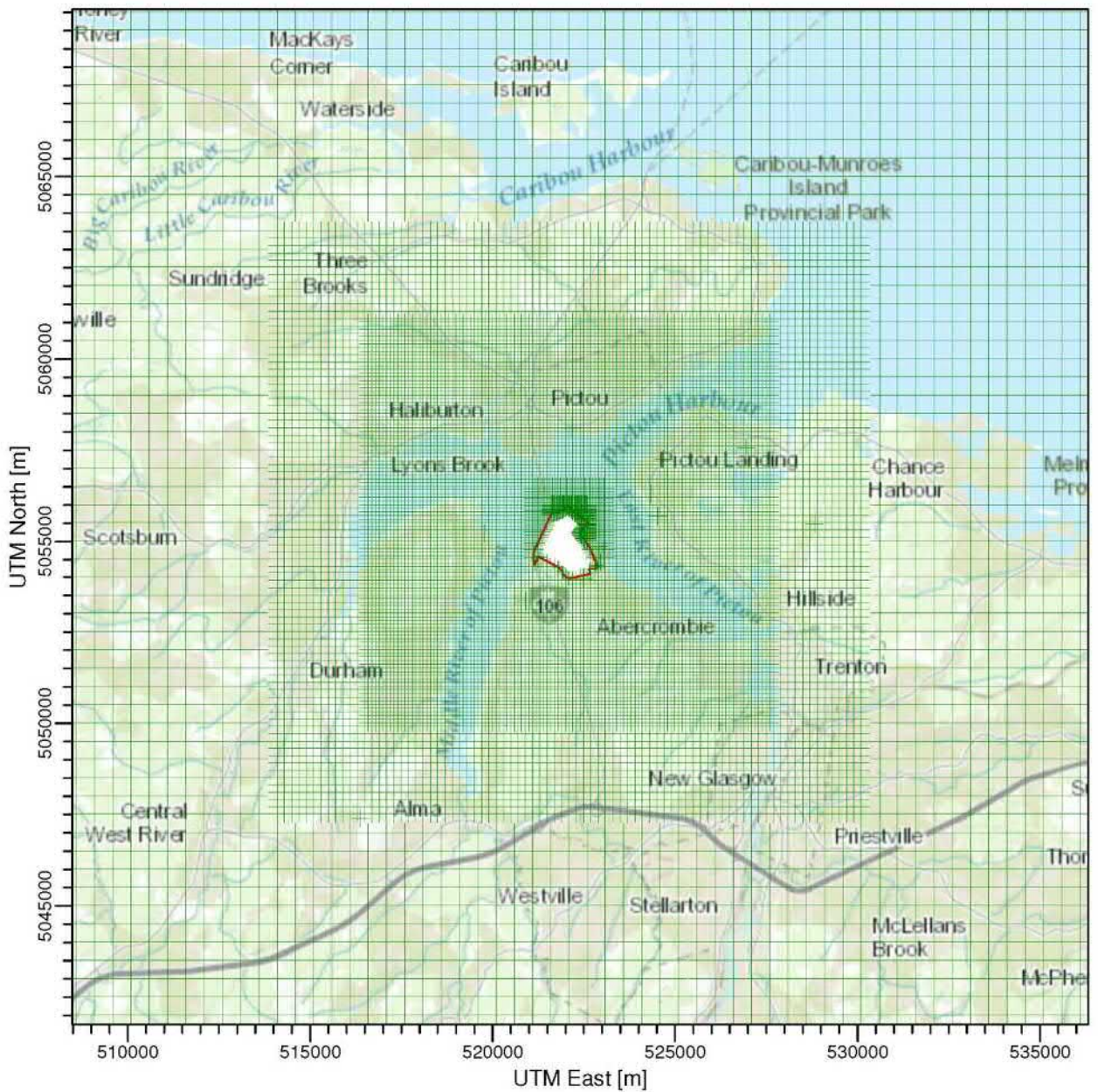


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Figure 5.4 Receptor Grid, Modelling Scenario 2



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Ten discrete receptors were also included in each modelling computation. These represent nearby residential areas. The locations of these receptors and a brief description are provided in Table 5.1 and illustrated on Figure 5.5 by the blue dots on the map.

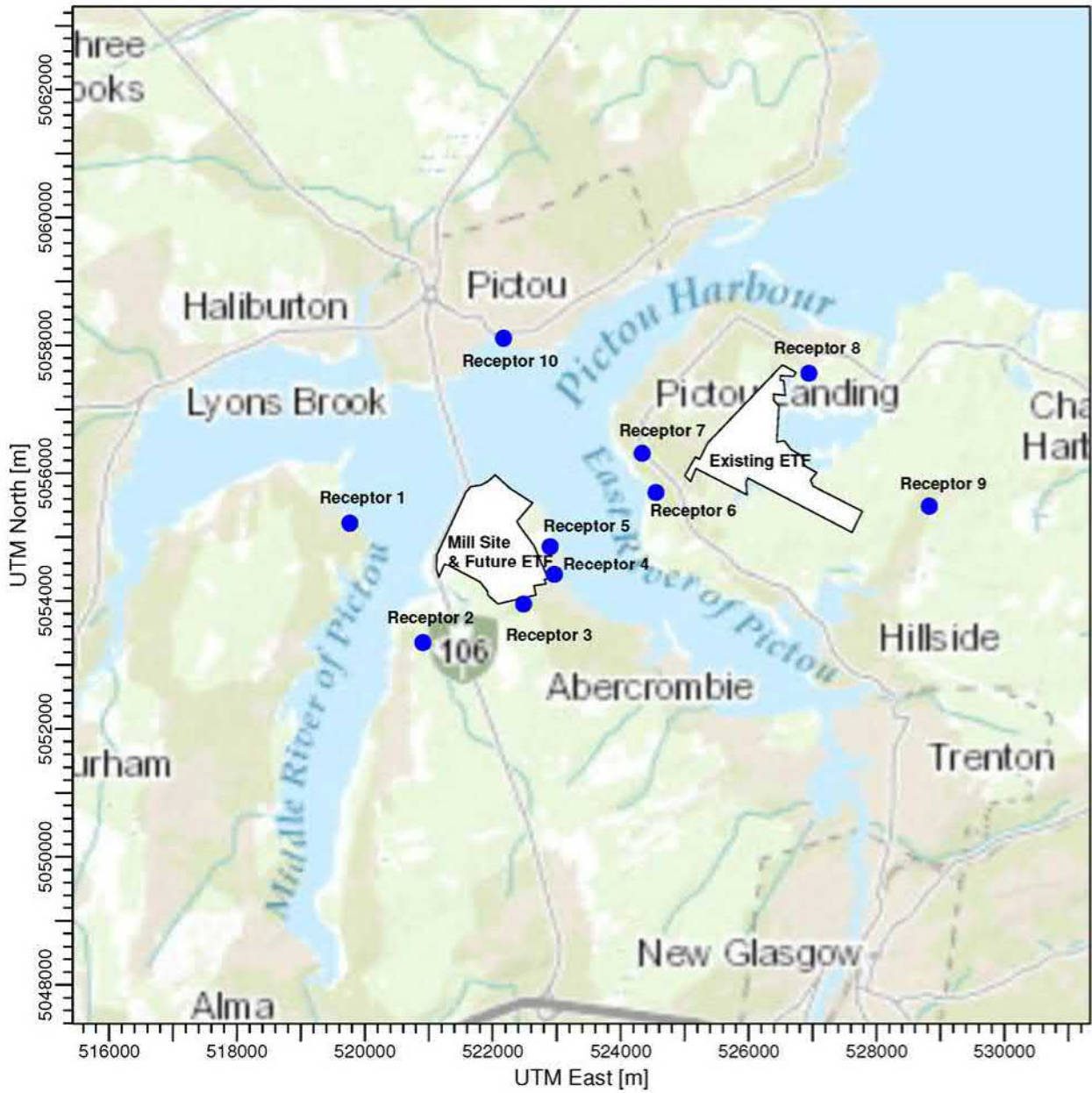
Table 5.1 Discrete Receptors Used in Dispersion Modelling

Receptor ID	UTM Coordinates (Zone 20)		Description
	Easting (m)	Northing (m)	
1	519768	5055219	Residential area
2	520907	5053346	Residential area
3	522480	5053951	Residential area
4	522963	5054415	Residential area
5	522899	5054854	Residential area
6	524552	5055699	Residential area
7	524337	5056312	Residential area
8	526942	5057565	Residential area
9	528826	5055486	Residential area
10	522169	5058110	Residential area



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Figure 5.5 Discrete Receptors



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5.8 SOURCE INFORMATION

The sources of emissions at the Facility can be categorized as either a point source or an area source, based on structural and physical properties of the source and how air contaminants are released. A point source is simply a single location where the exhaust is released to the atmosphere, e.g., an exhaust stack. An area source is typically a single location with air contaminants being released over the area at or near ground level (such as a water treatment lagoon). These groupings are further described below.

5.8.1 Point Sources

The five major point sources of emissions incorporated into the modelling study, along with the source characteristics, are presented in Table 5.2. Emissions information for each of these sources are presented in Section 4. The point sources of emissions listed in Table 5.2 are located within the property boundaries of the existing Mill site.

Table 5.2 Point Emission Sources and Stack Parameters

Point Sources	UTM Coordinates		Stack Parameters					
	Easting (m)	Northing (m)	Base Elevation (m)	Release Height (m)	Stack Diameter (m)	Gas Exit Flow Rate (m ³ /s)	Gas Exit Velocity (m/s)	Gas Exit Temp. (°C)
Power Boiler Scrubber Stack	522111	5055475	10.0	50.6	1.93	25.4	14.4	58
Other Mill Point Source	522098	5055487	10.0	69.2	3.51	121	12.5	66
Other Mill Point Source	522187	5055397	10.0	37.0	1.07	11.4	12.7	73
Other Mill Point Source	522105	5055482	10.0	50.6	1.22	8.85	7.57	88
Other Mill Point Source	522077	5055507	10.0	65.4	1.83	49.3	18.8	60

5.8.2 Area Sources

For modelling Scenario 1, the effluent treatment lagoon ponds located at Boat Harbour (i.e. the existing ETF) were modelled as area emission sources. The source metrics for the existing ETF are presented in Table 5.3. The UTM coordinates provided in Table 5.3 represent approximately the center of the area source. The area sources of emissions listed in Table 5.3 are located within the property boundaries of the existing ETF site.



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Table 5.3 Area Emission Sources and Source Metrics – Existing ETF

Area Sources	UTM Coordinates (Zone 20)		Base Elevation (m)	Area of the Release Surface (m ²)	Assumed Release Height (m)
	Easting (m)	Northing (m)			
Settling Pond	525,538	5,056,417	10.4	14,984	0.5
Cell 1	526,110	5,056,477	5.97	39,002	0.5
Cell 2	526,155	5,056,343	3.89	31,627	0.5
Cell 3	526,331	5,056,197	5.12	58,599	0.5
Cell 4	526,484	5,056,121	5.29	48,369	0.5

Note: Terrain information acquired from GOTOP030

For modelling Scenario 2, the individual components of the Activated Sludge Treatment (AST) system were modelled as area emission sources. The sources parameters for the replacement ETF, including the area of each component, is presented in Table 5.4. The UTM coordinates provided in Table 5.4 represent approximately the center of the area source. The area sources of emissions listed in the table are located within the property boundaries of the existing Mill site.

Table 5.4 Area Emission Sources and Source Parameters – Replacement ETF

Area Sources	UTM Coordinates (Zone 20)		Base Elevation (m)	Area of the Release Surface (m ²)	Release Height above Ground Level (m)
	Easting (m)	Northing (m)			
Primary Clarifier	522199	5055159	22.5	2,462	4.3
Aeration Basin	522589	5055145	17.5	4,183	8.2
Secondary Clarifier No.1	522333	5055211	21.0	2,462	3.7
Secondary Clarifier No.2	522312	5055277	20.2	2,462	3.7

Note: Terrain information acquired from GOTOP030

5.9 NO_x TO NO₂ CONVERSION

Oxides of nitrogen (NO_x) comprise nitric oxide (NO) and nitrogen dioxide (NO₂). Most combustion sources emit primarily NO that can react with ambient ozone (O₃) to produce NO₂. The concentration of NO₂ in the atmosphere then becomes a function of the available O₃ in the atmosphere during the release and mixing in the atmosphere as it travels downwind.

Only ground-level concentrations of NO₂ are regulated in Nova Scotia, therefore a method is needed to determine the amount of NO_x emitted from the stack that ends up as NO₂. For this assessment, the Plume Volume Molar Ratio Method (PVMRM) was used.



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The PVMRM in AERMOD is used to determine the conversion rate of NO_x to NO₂ based on a calculation of the moles of NO_x emitted into the plume and the amount of O₃ moles contained within the volume of the plume between the source and receptor (US EPA 2002).

The in-stack and equilibrium NO₂/NO_x ratios and ambient concentrations of O₃ are required for input to the AERMOD-PVMRM model. Since the actual values for the NO₂/NO_x ratios are not known, the US EPA AERMOD default values for the in-stack and equilibrium ratios of 0.1 and 0.9 were used in the assessment. The ambient concentration of O₃ included in the AERMOD-PVMRM model was acquired from data collected by ECCC in Pictou, NS through the National Air Pollutant Surveillance (NAPS) monitoring program. The annual average of O₃ (46 µg/m³) was estimated by averaging the 98th percentile of the maximum 1-hour concentrations for 2014, 2015 and 2016, as collected at the in Pictou, NS monitoring station (ECCC 2017).

6.0 AIR DISPERSION MODELLING RESULTS

A summary of the dispersion modelling results for each modelling scenario is provided in the following subsections.

In Nova Scotia, the *Air Quality Regulations* stipulate a permissible ground level concentration limit and the averaging time for the criterion of each contaminant of concern (refer to Section 3.1) except that the Canadian Ambient Air Quality Standards is used for PM_{2.5} compliance evaluation.

The results presented below include the highest predicted ground level concentrations at each of the 10 discrete receptors included in the model (refer to Section 5.7). Concentration plots at the modelling domain for each of the air contaminants of concern and time averaging periods, have been included in **Appendix A**.

6.1 EXISTING OPERATIONS

Carbon Monoxide

The maximum predicted ground level concentrations for carbon monoxide (CO) at each discrete receptor are presented in Table 6.1. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for CO.



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Table 6.1 Maximum Predicted Ground Level Concentrations (GLC) for CO - Existing

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	8-hour (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	34,600	12,700
1	519768	5055219	170	48.8
2	520907	5053346	158	45.2
3	522480	5053951	304	89.4
4	522963	5054415	233	128
5	522899	5054854	340	200
6	524552	5055699	68	40.8
7	524337	5056312	179	44.5
8	526942	5057565	127	28.2
9	528826	5055486	49	20.3
10	522169	5058110	69	40.2

Sulphur Dioxide

The maximum predicted ground level concentrations for sulphur dioxide (SO₂) at each discrete receptor are presented in Table 6.2. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for SO₂.

Table 6.2 Maximum Predicted Ground Level Concentrations (GLC) for SO₂ – Existing

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	24-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)			
Regulatory Limit	-	-	900	300	60
1	519768	5055219	15.6	1.98	0.06
2	520907	5053346	26.8	4.26	0.13
3	522480	5053951	33.7	6.67	0.24
4	522963	5054415	42.8	8.10	0.38
5	522899	5054854	57.3	11.1	0.68
6	524552	5055699	9.56	1.12	0.12
7	524337	5056312	16.2	3.60	0.23
8	526942	5057565	8.76	1.60	0.09
9	528826	5055486	1.87	0.41	0.03
10	522169	5058110	5.03	0.90	0.08



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Nitrogen Dioxide

The maximum predicted ground level concentrations for nitrogen dioxide (NO₂) at each discrete receptor are presented in Table 6.3. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for NO₂.

Table 6.3 Maximum Predicted Ground Level Concentrations (GLC) for NO₂ – Existing

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	400	100
1	519768	5055219	22.0	0.08
2	520907	5053346	18.1	0.18
3	522480	5053951	26.2	0.38
4	522963	5054415	24.7	0.54
5	522899	5054854	25.5	0.78
6	524552	5055699	10.4	0.49
7	524337	5056312	29.0	0.41
8	526942	5057565	19.6	0.16
9	528826	5055486	7.2	0.15
10	522169	5058110	10.5	0.34

Total Suspended Particulate

The maximum predicted ground level concentrations for total suspended particulate (TSP) at each discrete receptor are presented in Table 6.4. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for TSP.

Table 6.4 Maximum Predicted Ground Level Concentrations (GLC) for TSP – Existing

Receptor ID/Regulatory Limit	UTM Coordinates		24-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	120	70
1	519768	5055219	6.34	0.23
2	520907	5053346	15.0	0.49
3	522480	5053951	31.6	1.18
4	522963	5054415	39.3	1.89
5	522899	5054854	51.1	3.35
6	524552	5055699	6.11	0.67
7	524337	5056312	9.38	0.89
8	526942	5057565	4.43	0.34
9	528826	5055486	2.42	0.17
10	522169	5058110	5.00	0.43



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Hydrogen Sulphide

The maximum predicted ground level concentrations for hydrogen sulphide (H₂S) at each discrete receptor are presented in Table 6.5.

Table 6.5 Maximum Predicted Ground Level Concentrations (GLC) for H₂S – Existing

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	24-hour (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	42	8
1	519768	5055219	20.4	0.86
2	520907	5053346	18.1	1.16
3	522480	5053951	7.69	0.77
4	522963	5054415	40.5	2.69
5	522899	5054854	37.0	2.55
6	524552	5055699	96.6	4.90
7	524337	5056312	34.8	2.21
8	526942	5057565	15.4	1.46
9	528826	5055486	2.52	0.24
10	522169	5058110	2.21	0.58

Bold – indicates an exceedance

Exceedances of the Nova Scotia maximum permissible ground level concentration limit for H₂S for the 1-hour averaging period were predicted at discrete receptor 6. The source contributing to the exceedance at discrete receptor 6 is the existing ETF. There were no exceedances of the 24-hour maximum permissible ground level concentration limit.

Further analysis of the above modelling results, including a exceedance frequency analysis at receptor 6, are discussed in Section 7 below.

Fine Particulate (PM_{2.5})

The maximum predicted ground level concentrations for particulate matter less than 2.5 microns in diameter (PM_{2.5}) at each discrete receptor are presented in Table 6.6. The ambient concentration of PM_{2.5} is not currently regulated by the Province of Nova Scotia but is regulated under Northern Pulp’s Industrial Approval (2011-076657-A01) and through the Canadian Ambient Air Quality Standards. No exceedances of the Canadian Ambient Air Quality Standards were predicted for PM_{2.5}.



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Table 6.6 Maximum Predicted Ground Level Concentrations (GLC) for PM_{2.5} – Existing

Receptor ID/Regulatory Limit	UTM Coordinates		24-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)		
AAQS	-	-	27	10
1	519768	5055219	1.21	0.04
2	520907	5053346	2.88	0.09
3	522480	5053951	6.37	0.24
4	522963	5054415	7.92	0.38
5	522899	5054854	10.5	0.68
6	524552	5055699	1.26	0.13
7	524337	5056312	1.53	0.16
8	526942	5057565	0.82	0.07
9	528826	5055486	0.48	0.03
10	522169	5058110	1.02	0.09

6.2 FUTURE OPERATIONS

Carbon Monoxide

The maximum predicted ground level concentrations for carbon monoxide (CO) at each discrete receptor are presented in Table 6.7. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for CO.

Table 6.7 Maximum Predicted Ground Level Concentrations (GLC) for CO - Future

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	8-hour (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	34,600	12,700
1	519768	5055219	148.4	43.4
2	520907	5053346	136.5	36.6
3	522480	5053951	252.4	55.1
4	522963	5054415	171.8	105.3
5	522899	5054854	209.2	160.5
6	524552	5055699	59.5	35.8
7	524337	5056312	146.0	38.3
8	526942	5057565	109.9	24.0
9	528826	5055486	43.4	16.7
10	522169	5058110	60.4	35.8



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Sulphur Dioxide

The maximum predicted ground level concentrations for sulphur dioxide (SO₂) at each discrete receptor are presented in Table 6.8. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for SO₂.

Table 6.8 Maximum Predicted Ground Level Concentrations (GLC) for SO₂ - Future

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	24-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)			
Regulatory Limit	-	-	900	300	60
1	519768	5055219	17.1	2.23	0.07
2	520907	5053346	29.4	4.81	0.14
3	522480	5053951	39.7	7.86	0.29
4	522963	5054415	50.0	9.56	0.45
5	522899	5054854	67.4	13.2	0.82
6	524552	5055699	10.6	1.31	0.15
7	524337	5056312	17.1	3.79	0.26
8	526942	5057565	9.20	1.70	0.10
9	528826	5055486	2.21	0.48	0.04
10	522169	5058110	5.54	1.09	0.09

Nitrogen Dioxide

The maximum predicted ground level concentrations for nitrogen dioxide (NO₂) at each discrete receptor are presented in Table 6.9. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for NO₂.

Table 6.9 Maximum Predicted Ground Level Concentrations (GLC) for NO₂ - Future

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	400	100
1	519768	5055219	25.7	0.11
2	520907	5053346	25.3	0.24
3	522480	5053951	38.7	0.47
4	522963	5054415	25.	0.68
5	522899	5054854	28.9	0.92



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Table 6.9 Maximum Predicted Ground Level Concentrations (GLC) for NO₂ - Future

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)		
6	524552	5055699	15.3	0.69
7	524337	5056312	37.7	0.56
8	526942	5057565	27.4	0.22
9	528826	5055486	9.95	0.20
10	522169	5058110	16.8	0.48

bold – indicates an exceedance

Total Suspended Particulate

The maximum predicted ground level concentrations for total suspended particulate (TSP) at each discrete receptor are presented in Table 6.10. No exceedances of the Nova Scotia maximum permissible ground level concentration limits were predicted for TSP.

Table 6.10 Maximum Predicted Ground Level Concentrations (GLC) for TSP - Future

Receptor ID/Regulatory Limit	UTM Coordinates		24-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	120	70
1	519768	5055219	5.65	0.21
2	520907	5053346	13.3	0.44
3	522480	5053951	28.1	1.05
4	522963	5054415	34.9	1.68
5	522899	5054854	44.8	2.96
6	524552	5055699	5.42	0.60
7	524337	5056312	8.83	0.82
8	526942	5057565	4.07	0.31
9	528826	5055486	2.19	0.16
10	522169	5058110	4.44	0.38

Hydrogen Sulphide

The maximum predicted ground level concentrations for hydrogen sulphide (H₂S) at each discrete receptor are presented in Table 6.11. No exceedances of the Nova Scotia maximum 1-hour permissible ground level concentration limits were predicted for H₂S. For the 24-hour time averaging period, the maximum predicted concentration of H₂S at Receptor 5 was slightly above the maximum permissible ground level concentration limit.



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Table 6.11 Maximum Predicted Ground Level Concentrations (GLC) for H₂S - Future

Receptor ID/Regulatory Limit	UTM Coordinates		1-hour (µg/m ³)	24-hour (µg/m ³)
	Easting (m)	Northing (m)		
Regulatory Limit	-	-	42	8
1	519768	5055219	9.46	1.89
2	520907	5053346	10.4	2.01
3	522480	5053951	12.2	2.66
4	522963	5054415	18.0	4.40
5	522899	5054854	21.3	8.52
6	524552	5055699	2.15	0.75
7	524337	5056312	10.6	2.50
8	526942	5057565	7.21	1.14
9	528826	5055486	1.08	0.23
10	522169	5058110	1.59	0.61

Bold – indicates an exceedance

Further analysis of the above modelling results is presented in Section 7 below.

Fine Particulate (PM_{2.5})

The maximum predicted ground level concentrations for particulate matter less than 2.5 microns in diameters (PM_{2.5}) at each discrete receptor are presented in Table 6.12. No exceedances of the Canadian Ambient Air Quality Standards were identified for PM_{2.5}.

Table 6.12 Maximum Predicted Ground Level Concentrations (GLC) for PM_{2.5} - Future

Receptor ID/Regulatory Limit	UTM Coordinates		24-hour (µg/m ³)	Annual (µg/m ³)
	Easting (m)	Northing (m)		
AAQS	-	-	27	10
1	519768	5055219	0.87	0.03
2	520907	5053346	2.06	0.07
3	522480	5053951	4.59	0.17
4	522963	5054415	5.73	0.28
5	522899	5054854	7.38	0.49
6	524552	5055699	0.91	0.10
7	524337	5056312	1.25	0.13
8	526942	5057565	0.61	0.05
9	528826	5055486	0.37	0.03
10	522169	5058110	0.75	0.06



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Concentration plots for a select number of air contaminants and averaging time periods have been included in **Appendix A**.

7.0 DISCUSSION AND CONCLUSION

A discussion of the air dispersion modelling results, for both existing and future operation of the Northern Pulp kraft pulp mill, is provided in the following subsections.

7.1 EXISTING OPERATIONS

7.1.1 Emission Summary

A summary table of impacts for the selected representative discrete receptors for the existing operating conditions (Scenario 1) is presented below.

Table 7.1 Emission Impact Summary Table - Existing Operation

Contaminant	Maximum Predicted Concentration at Nearby Specific Receptors (ug/m ³)	Averaging Period	Reference Criteria* (ug/m ³)	Percentage of Criteria (%)
Carbon monoxide (CO)	340	1-hour	34,600	1%
	200	8-hour	12,700	2%
Hydrogen sulphide (H ₂ S)	96.6	1-hour	42	230%
	4.9	24-hour	8	61%
Nitrogen dioxide (NO ₂)	29	1 hour	400	7%
	0.78	Annual	100	1%
Sulphur dioxide (SO ₂)	57.3	1 hour	900	6%
	11.1	24 hour	300	4%
	0.68	Annual	60	1%
Total suspended particulate (TSP)	51.1	24-hour	120	43%
	3.35	Annual	70	5%
PM _{2.5}	7.92	24-hour	28	28%
	0.68	Annual	10	7%

*The criteria for the listed contaminants are Maximum Permissible Ground Level Concentration Limits specified in the Nova Scotia Air Quality Regulations except for PM_{2.5}, which criteria are Canadian Ambient Air Quality Standards.

As presented above, the maximum predicted ground level concentrations of contaminants of concern at these off-property discrete receptors during the operation of the kraft pulp mill (the Facility) and the existing Effluent Treatment Facility (ETF) are below the respective criteria for carbon monoxide (CO), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), total suspended particulate (TSP) and PM_{2.5}. One



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exception is H₂S, which peak hourly concentration is predicted to be greater than the hourly limit (230% of the limit). This exceedance was predicted at Receptor 6 as shown in above Table 6.5. The maximum hourly H₂S concentration at other receptors and the 24-hour maximum concentrations at each discrete receptor are predicted to be below the criteria.

Exceedance frequencies and highest concentration values following the removal of data anomalies are discussed in the following sub-sections. Also, a generic comparison of the modelling results with actual ambient monitoring data at Northern Pulp's ambient air monitoring station along Pictou Landing Road, is conducted and discussed.

7.1.2 Frequency of Exceedance

The maximum predicted 1-hour ground level concentration of H₂S exceeded the reference standard at Receptor 6. To determine how often the predicted ground level concentrations of H₂S exceeded the NS maximum permissible ground level concentration of 42 µg/m³, a frequency of the exceedance was analyzed for the 5-year data set at this particular receptor.

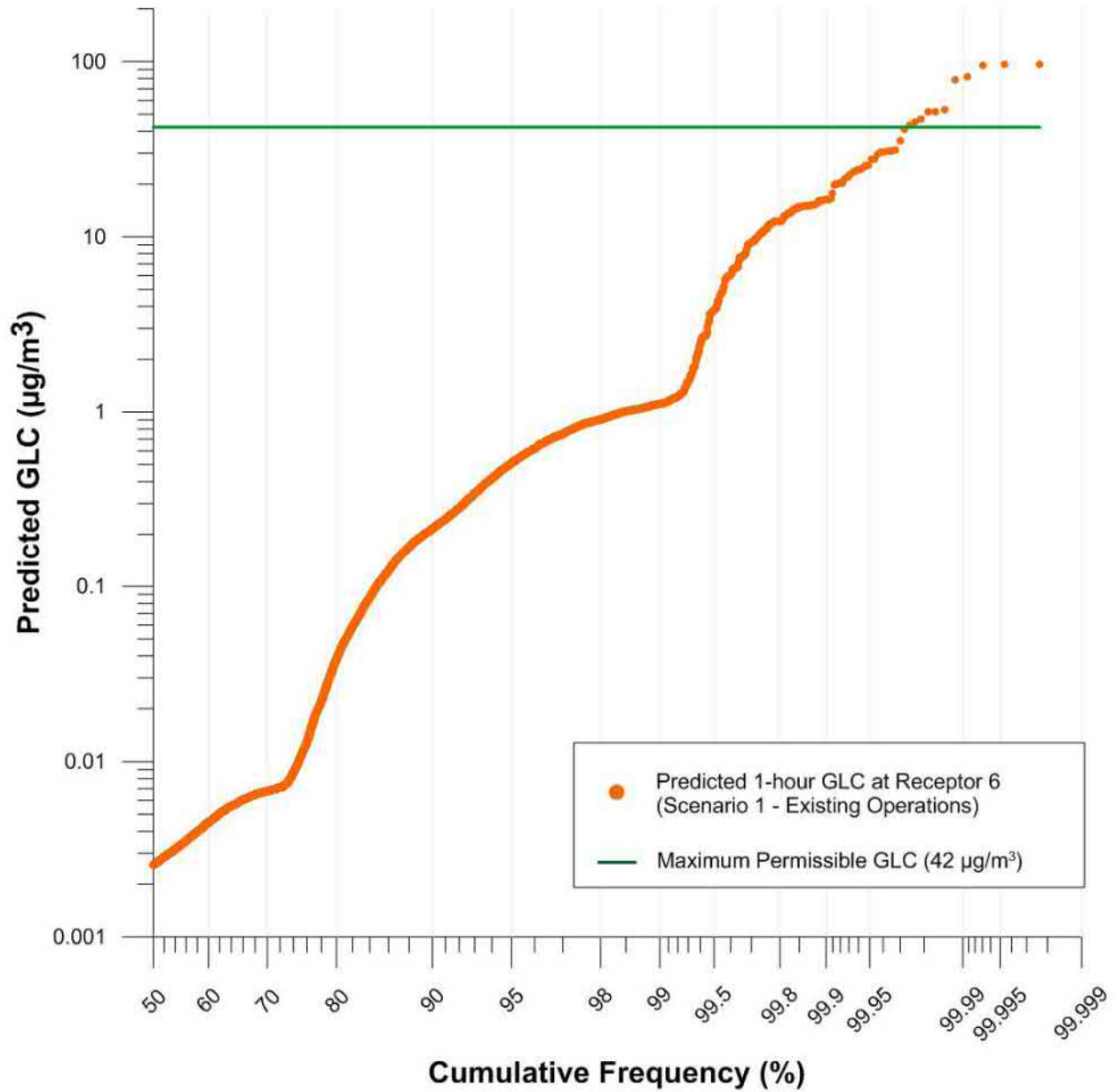
In the 5-year (2013-2017) meteorological data set used in the modelling, a total of 43,109 hourly concentration levels were obtained for Receptor 6. The receptor's H₂S hourly concentrations in 11 hours out of the 43,109 hours were predicted to be over the 42 ug/m³ limit, with the highest concentration of 96.6 ug/m³, as shown in Table 7.1. The exceedance frequency for the hourly concentrations is therefore 0.03% (11/43109), which is not considered significant.

An hourly concentration and frequency distribution graph is shown in Figure 7.1 for this receptor. This figure illustrates that during the operation of the Facility and existing ETF, the maximum predicted ground level concentrations of H₂S are below the NS maximum permissible ground level concentration limit of 42 µg/m³ for 99.97% of the time during the 5-year period modelled.



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Figure 7.1 Frequency Distribution for Hydrogen Sulphide at Receptor 6 (Modelling Scenario 1 – Existing Operations)



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7.1.3 Maximum Concentration Levels with Elimination of Meteorological Anomalies

Since there is no available air dispersion modelling analysis guideline in Nova Scotia, the related reference from Ontario is used for the data analysis, which has been previously accepted by NSE.

In modelling applications using regional or local meteorological data sets, certain extreme, rare and transient meteorological conditions may be present in the data sets that may be considered outliers. As such, for assessments of 24-hour concentrations, the second highest 24-hour average predicted concentration in each single meteorological year is considered the preferred metric; for 1-hour concentrations, the 9th highest 1-hour average predicted concentration in each single meteorological year is considered the preferred metric. For compliance assessment the highest concentration after consideration of the preferred metrics over the five-year period from the modelling results can be used as the maximum modelling results to be compared with associated regulatory limits (Ontario Ministry of the Environment, Conservation and Parks, 2017).

The maximum hourly concentration at Receptor 6 using the preferred metric values (as per the above) is presented in Table 7.2. It is shown that this maximum concentration level is below the Nova Scotia maximum permissible ground level concentration limit for H₂S.

Table 7.2 Maximum Hourly Concentration Compliance

Contaminant	Maximum Predicted Concentration at Receptor 6* (ug/m ³)	Averaging Period	Reference Criteria (ug/m ³)	Percentage of Criteria (%)
Hydrogen sulphide (H ₂ S)	25.6	1-hour	42	61%
*The maximum 9th highest hourly concentration in each of the modelling years is listed after removing the meteorological anomalies.				

7.1.4 Comparison of Modelling Outputs with Actual Ambient Monitoring Data

Ambient air monitoring for TRS is conducted at the Pictou Landing Ambient Air Monitoring Station. The H₂S emissions from the existing Facility operation (including the mill and existing ETF) are expected to contribute to this ambient data. In order to evaluate the conservatism of the dispersion modelling, AERMOD modelling was conducted at the same location as the Pictou Landing Ambient Air Monitoring Station for one full year (from January 1 to December 31, 2017), and compared to the monitored data for the same time period. The comparison of the monitoring data and the modelling results are summarized in Table 7.3.



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Table 7.3 Monitoring and Modelled Data Summary, 2017

Monitoring and Modelled Receptor	Pictou Landing Ambient Air Monitoring Station (UTM East-522080, North-5055503)					
Monitoring and Modelled Period	January 1, 2017 - December 31, 2017					
Total number of hours	8760					
Total number of days	365					
Target Contaminant	TRS monitored; H ₂ S modelled					
Concentrations	Monitored Data*		Modelled Data		Percentage of Monitored/Model Data	
	1-hour	24-hour	1-hour	24-hour	1-hour	24-hour
Maximum Concentration (ug/m ³)	5.423	0.556	6.13	1.04	88%	53%
2nd highest Concentration (ug/m ³)	3.894	0.556	6.04	0.81	64%	69%
3rd highest Concentration (ug/m ³)	3.198	0.556	5.82	0.79	55%	70%
9th highest Concentration (ug/m ³)	1.530	0.556	5.41	0.56	28%	99%
Average Concentration (ug/m³)	0.025	0.019	0.10	0.10	25%	19%

*Quarterly calibration data in the annual monitored dataset were removed from the analysis.

It is indicated that the concentration outputs of the dispersion modelling are generally greater than the actual ambient air monitoring data. The average hourly and daily (24-hour) monitoring concentrations during 2017 are about 25% and 19% of the modelling results at the same location.

Note that there are always biases between monitored and modelled data due to, but not limited to, the following factors:

- Discrepancies in the meteorological data between the meteorological tower site (used for modelling) and the facility (i.e. winds may be in a different direction at the site than what was modelled). Values measured on calm days might be difficult to model. The meteorological data may show a fairly constant direction at 1 m/s when in actuality the wind was varying in direction and lower in speed.
- Accuracy of the dispersion modelling software
- Discrepancies in the source emission rates that were modelled. The emission rates used in the model should be representative of the actual facility operating conditions that occurred during the monitoring period and should not be the worst-case maximum emission rates that the source is capable of.
- Potential uncertainties occurring during the sample collection.
- The distance that the monitor is located from the sources of interest. Most ambient air quality stations have been located to measure representative air quality levels in the communities surrounding industrial facilities and as such are not positioned to capture a specific source(s) of air contaminants.

Air dispersion modelling is generally required to be used to demonstrate the compliance with required limits for air contaminants of concern. Due to the spatial limitations of monitoring, monitoring results alone cannot be used to demonstrate compliance. Monitored concentrations below a limit at discrete locations



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do not guarantee that the concentrations are below the limit at other off-site locations that are not monitored.

However, based on the findings from Table 7.3 and the following facts, it is likely that the modelled results were conservative (overestimation).

- The target contaminant of the monitoring program is TRS, which includes H₂S and a number of other sulphur compounds. The actual contribution of H₂S to the monitored data should be even less.
- The location of the sampling station is about 1.2 km from the existing ETF. It is reasonably expected that the monitored ambient data include the emission contribution from the pulp mill and ETF facility as well as other additional sources in the area.

7.1.5 Conclusion

Based on the modelling results, frequency of exceedances, maximum concentrations using the preferred metrics, and the discussion of the actual monitoring data at the nearest station, the predicted concentrations of air contaminants of concern (i.e., CO, NO₂, SO₂, TSP, PM_{2.5} and H₂S) from the operation of the existing mill and existing ETF are expected to be in compliance with the reference criteria at the representative off-property discrete receptors.

7.2 FUTURE OPERATIONS

7.2.1 Emission Summary

A summary table of impacts for the selected representative discrete receptors for the future operating conditions (Scenario 2) is presented in Table 7.4 below.

Table 7.4 Emission Impact Summary Table - Future Operation

Contaminant	Maximum Predicted Concentration at Nearby Specific Receptors (ug/m ³)	Averaging Period	Reference Criteria* (ug/m ³)	Percentage of Criteria (%)
Carbon monoxide (CO)	252.4	1-hour	34,600	1%
	160.5	8-hour	12,700	1%
Hydrogen sulphide (H ₂ S)	21.3	1-hour	42	51%
	8.5	24-hour-	8	106%
Nitrogen dioxide (NO ₂)	38.7	1-hour	400	10%
	0.92	Annual	100	1%
Sulphur dioxide (SO ₂)	67.4	1-hour	900	7%
	9.56	24-hour	300	3%
	0.82	Annual	60	1%
Total suspended particulate (TSP)	44.8	24-hour	120	37%
	2.96	Annual	70	4%
PM _{2.5}	7.38	24-hour	28	26%
	0.49	Annual	10	5%

*The criteria for the listed contaminants are Maximum Permissible Ground Level Concentration Limits specified in Nova Scotia Air Quality Regulations except for PM_{2.5}, which criteria are Canadian Ambient Air Quality Standards.



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Table 7.4 Emission Impact Summary Table - Future Operation

Contaminant	Maximum Predicted Concentration at Nearby Specific Receptors (ug/m ³)	Averaging Period	Reference Criteria* (ug/m ³)	Percentage of Criteria (%)
bold – indicates an exceedance				

As presented above, the maximum predicted ground level concentrations during the future operation of the kraft pulp mill (the Facility) and the replacement Effluent Treatment Facility (ETF) are were below the Nova Scotia *Air Quality Regulations* for carbon monoxide (CO), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), and total suspended particulate (TSP) and the Canadian Ambient Air Quality Standard for fine particulate matter (PM_{2.5}).

The modelling conducted for the future operation of the Facility and the replacement ETF, however, shows a slight exceedance of the provincial maximum permissible ground level concentration limit for hydrogen sulphide (H₂S) over the 24-hour averaging period at Receptor 5, as shown in Table 6.11.

Exceedance frequencies and highest concentration values following the removal of data anomalies are discussed in the following sub-sections.

7.2.2 Frequency of Exceedance

The maximum predicted 24-hour ground level concentration of H₂S exceeded the Nova Scotia maximum permissible ground level concentration of H₂S at Receptor 5 by 10%. To determine how often the predicted ground level concentration of H₂S exceeded the Nova Scotia limit of 8 ug/m³, a frequency of the exceedance was analyzed at this particular receptor for the 5-year data set.

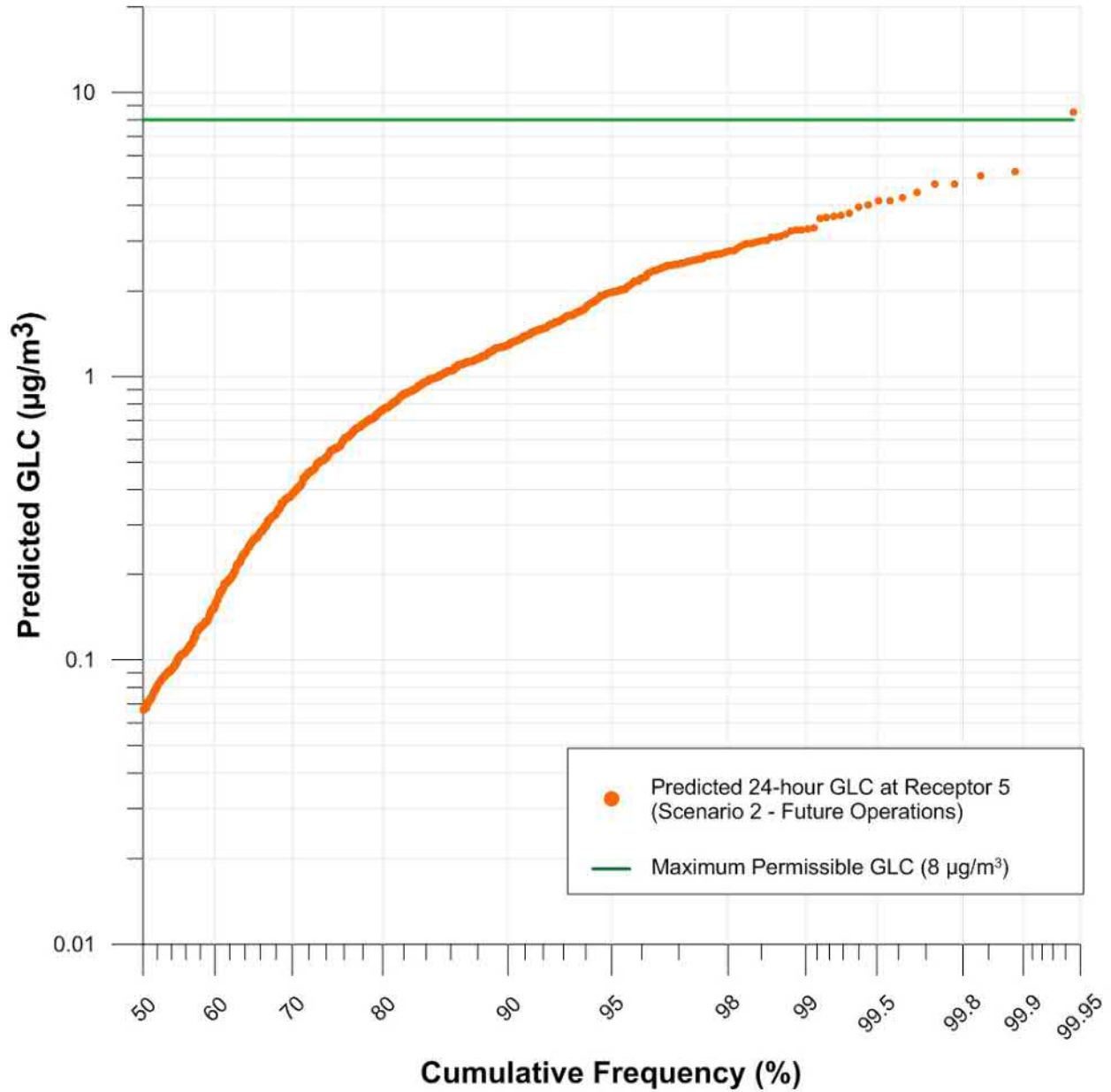
In the 5-year (2013-2017) meteorological data set used in the modelling, a total of 1,826 daily concentration levels were obtained for Receptor 5. The receptor's H₂S daily concentrations in 1 day out of the 1,826 days were predicted to be over the 8 ug/m³ limit, with the highest concentration of 8.8 ug/m³, as shown in Table 7.4. The exceedance frequency for the daily concentrations is therefore 0.05% (1/1,826), which is not considered significant.

A daily concentration and frequency distribution graph is shown in Figure 7.2 for this receptor. This figure illustrates that during the operation of the Facility and replacement ETF, the maximum daily predicted ground level concentrations of H₂S are below the Nova Scotia maximum permissible ground level concentration limit of 8 ug/m³ for 99.95% of the time during the 5-year period modelled.



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Figure 7.2 Frequency Distribution for Hydrogen Sulphide at Receptor 5 (Modelling Scenario 2 – Future Operations)



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7.2.3 Maximum Concentration Levels with Elimination of Meteorological Anomalies

The maximum daily concentration at Receptor 5 after consideration of the preferred metric (refer to Section 7.1.3) is presented in Table 7.5. It is shown that this maximum concentration level is below the Nova Scotia maximum permissible daily ground level concentration limit for H₂S.

Table 7.5 Maximum Daily Concentration Compliance

Contaminant	Maximum Predicted Concentration at Receptor 5* (ug/m ³)	Averaging Period	Reference Criteria (ug/m ³)	Percentage of Criteria (%)
Hydrogen sulphide (H ₂ S)	4.74	24-hour	8	57%

*The maximum 2nd highest daily concentration in each of the modelling years is listed after removing the meteorological anomalies.

7.2.4 Conclusion

Based on the modelling results, frequency of exceedances, and maximum concentration after using the preferred metrics, the predicted concentrations of the air contaminants of concern (i.e., CO, NO₂, SO₂, TSP, PM_{2.5} and H₂S) from the operation of the existing mill and the future mill (with replacement ETF) are both expected to be in compliance with the reference criteria at the representative off-property discrete receptors.

It is recommended that once the replacement ETF is operational a combination of source emissions testing (and subsequent air dispersion modelling) and ambient air monitoring be conducted to assess compliance with the applicable ambient air quality criteria for H₂S.



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8.0 REFERENCES

Crawford, R.J., Crapo, A.M. and Ashok K. Jain. 2009. Reduced Sulphur Compound Emissions from Kraft Pulp and Paper Mill Wastewater Treatment Plants, Water Practice, Volume 3, No.1.

Department of Municipal Affairs and Environment. 2012. Determination of Compliance with the Ambient Air Quality Standards.

Environment and Climate Change Canada (ECCC). 2016. Guide for Reporting to the National Pollutant Release Inventory (NPRI) 2016 and 2017.

Environment and Climate Change Canada (ECCC).2017. National Air Pollutant Surveillance Data from Pictou, NS (Station ID 30901), for January 2014 through to December 2016.

Guy Martin, KSH, Personal Communication, May 4, 2018.

Lakes Environmental Software. 2018. Surface and Upper Air Met Data AEMET/AERMOD Preprocessed from MM5 Data (2013-2017).

National Council for Air and Stream Improvement (NCASI). 2007. NPRI Handbook for Pulp and Paper Mills.

Ontario Ministry of the Environment, Conservation and Parks. 2018. Procedure for Preparing an Emissions Study Modelling Report.

Ontario Ministry of the Environment, Conservation and Parks. 2017. Air Dispersion Modelling Guideline for Ontario.

Stantec Consulting Ltd. 2013. Final Air Dispersion Modelling Study.

United States Environmental Protection Agency (US EPA). 1995. Chapter 2.2, Sewage Sludge Incineration

United States Environmental Protection Agency (US EPA). 2010. Chapter 1.3, Fuel Oil Combustion

United States Environmental Protection Agency (US EPA). 2002. Addendum AERMOD: Model Formulation Document. Online

Source: http://www.epa.gov/scram001/7thconf/aermod/aermod_mfd_addm_rev.pdf



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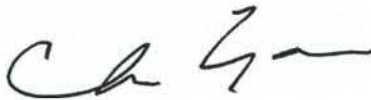
9.0 CLOSING

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APPENDIX A

Air Dispersion Modelling Results – Concentration Contours

Figure A1 Highest Predicted 24-Hour Ground Level Concentration of Total Suspended Particulate (TSP) – Existing

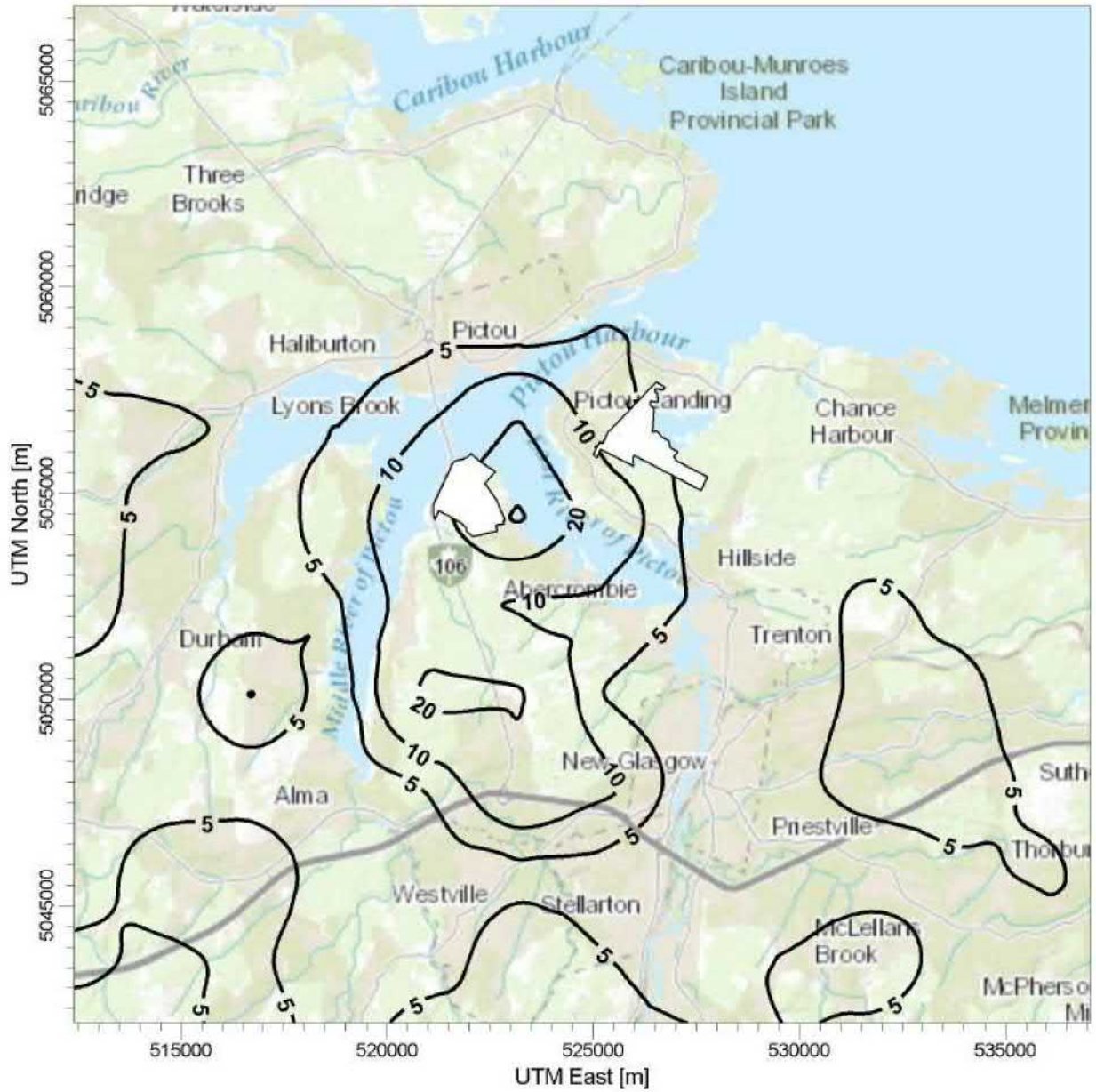


Figure A2 Highest Predicted 1-Hour Ground Level Concentration of Nitrogen Dioxide (NO₂) – Existing

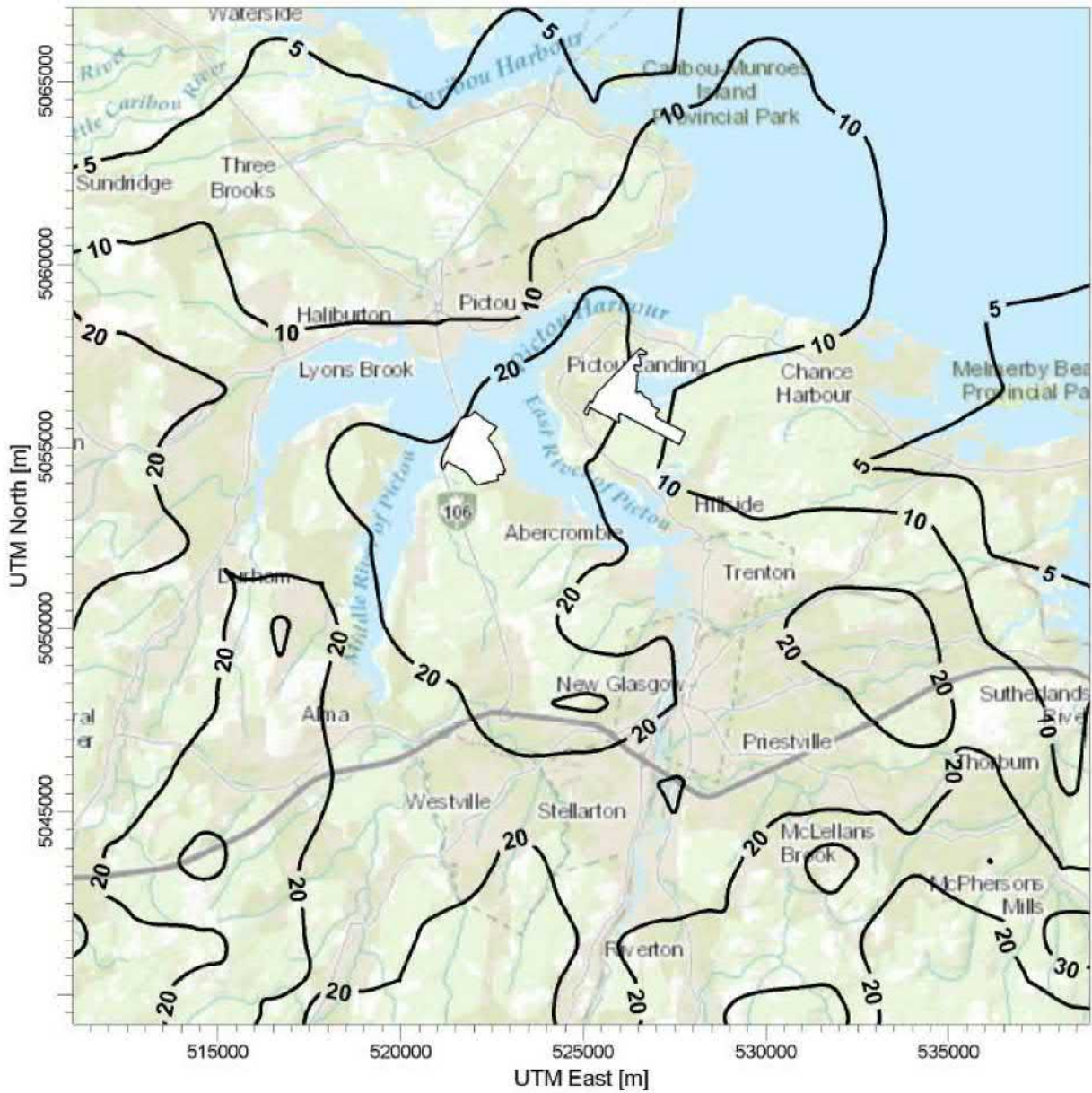


Figure A3 Highest Predicted 1-Hour Ground Level Concentration of Hydrogen Sulphide (H₂S) – Existing

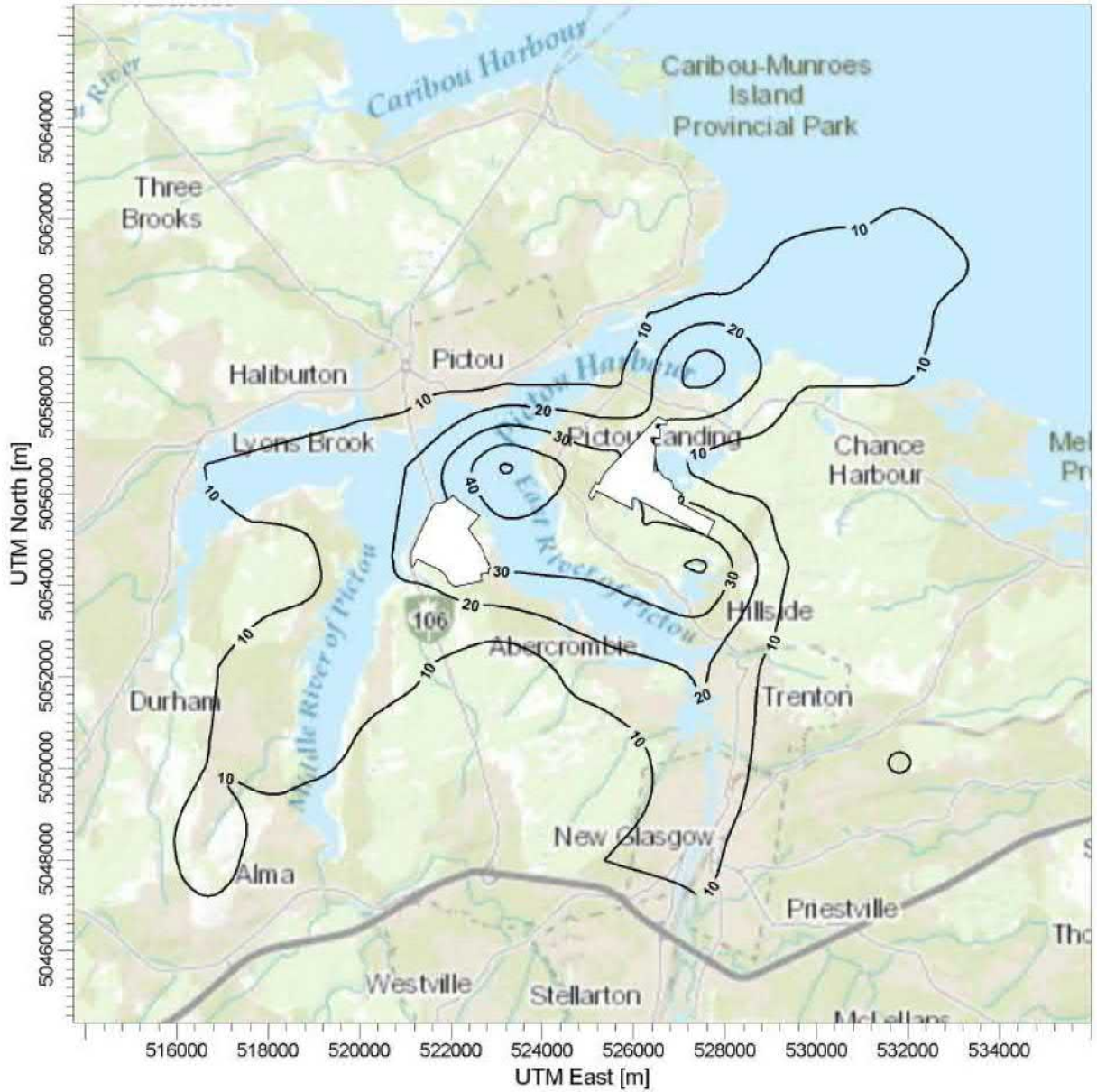


Figure A4 Highest Predicted 24-Hour Ground Level Concentration of Total Suspended Particulate (TSP) – Future

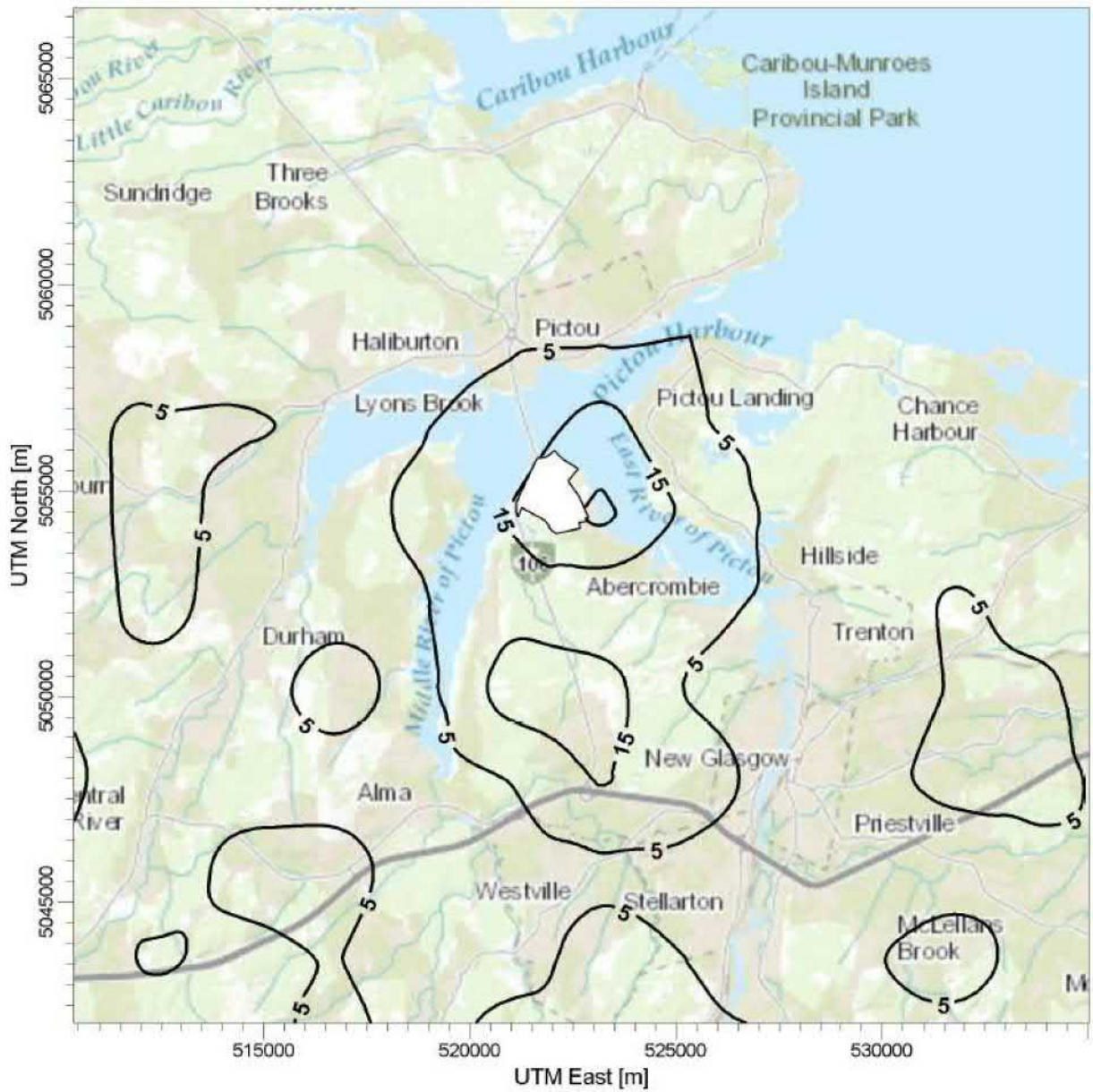


Figure A5 Highest Predicted 1-Hour Ground Level Concentration of Nitrogen Dioxide (NO₂) – Future

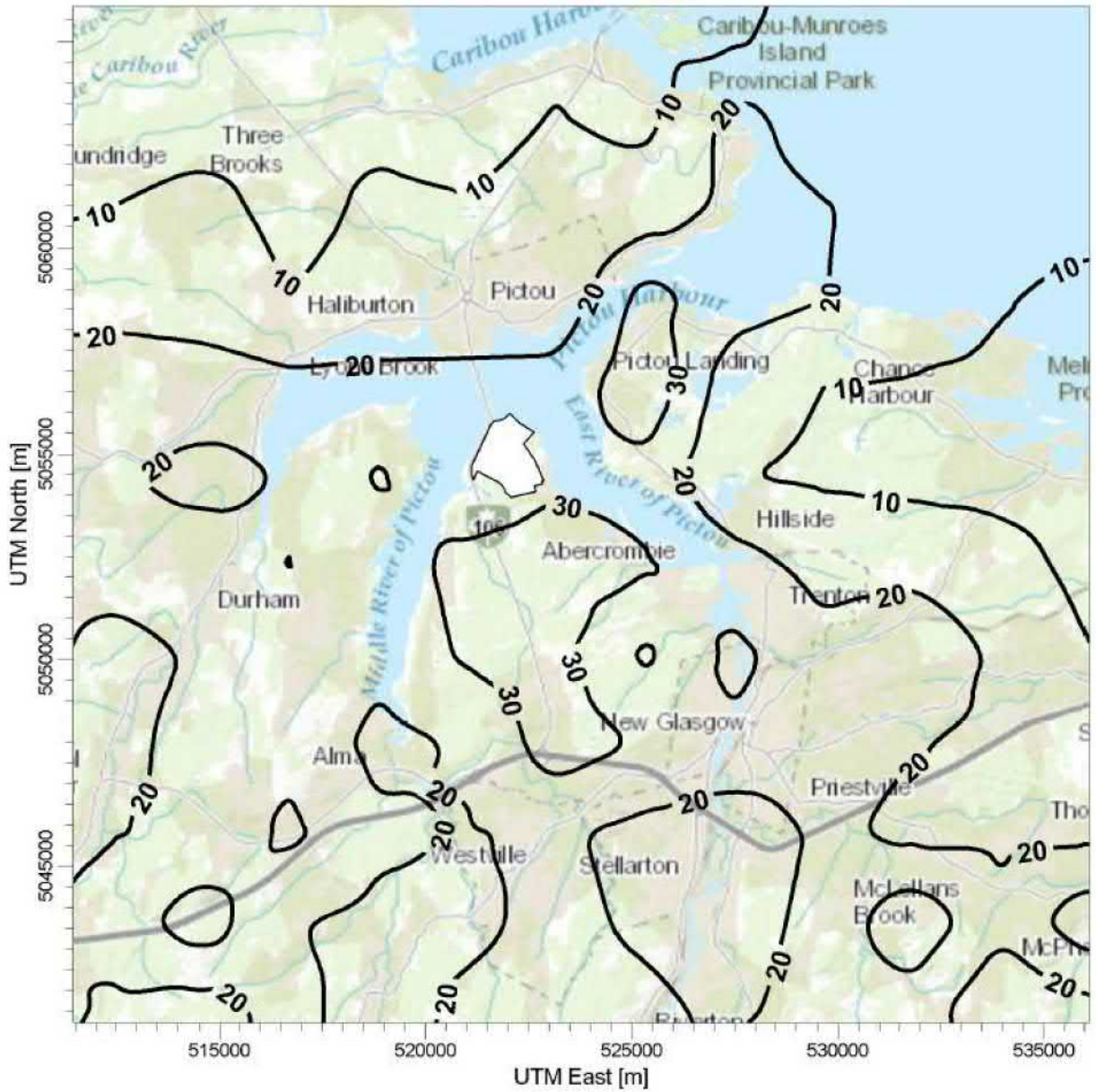
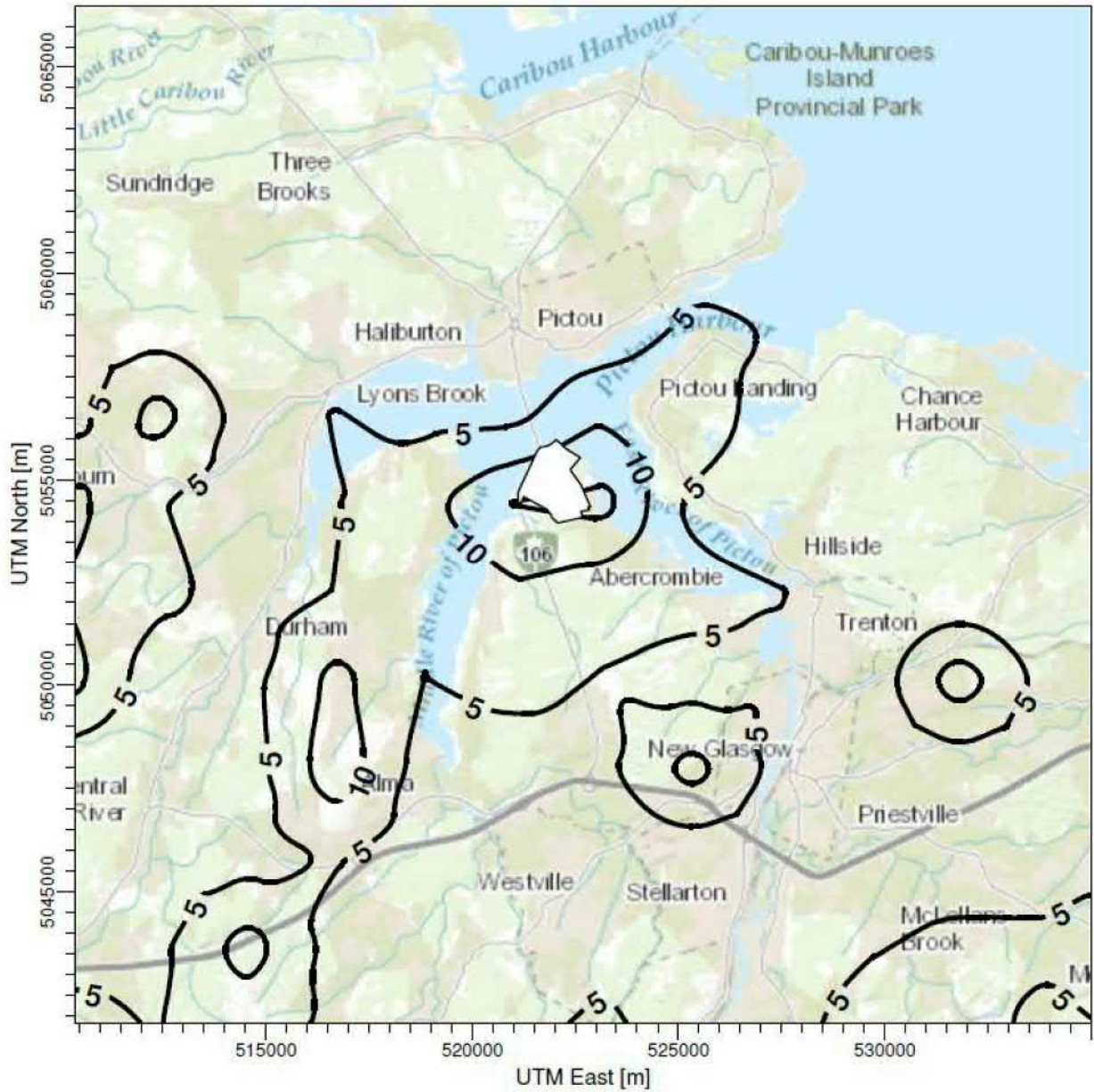


Figure A6 Highest Predicted 1-Hour Ground Level Concentration of Hydrogen Sulphide (H₂S) – Future



Appendix K2

Stantec Memo re Hoffman Report

To:	Mike Wilson	From:	Tania Noble and Mike Murphy
	Northern Pulp		Fredericton, NB and Charlottetown, PE
File:	121415558	Date:	June 15, 2018

Reference: **Comments on Paper - Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia by Hoffman et al. (2017a,b)**

As requested, we reviewed the above-noted paper and the supplementary supporting material and offer the following.

Summary

The authors state that the main objective of their study was to determine whether wind direction correlated with prioritized air toxic ambient VOC concentrations at a NAPS site (Granton) nearby to the Northern Pulp Mill in Pictou, NS. To do this, they compared concentrations of VOCs measured at Granton NAPS site when the prevailing wind direction (PW) is from the northeast (representing winds from the mill towards the NAPS site), to concentrations of VOCs measured during all other wind directions (AOWD). Although two parameters (24-h measured concentrations of 1,3-butadiene and tetrachloroethylene) were statistically higher on days when prevailing winds were from the northeast for at least one hour, the authors acknowledge that the origin(s) of the VOCs are inconclusive. Further, the authors note that scatter plots suggest that there is no correlation ($R^2 = \sim 0$) between increasing proportions of time with PW from the selected range that blew toward the Granton NAPS site and VOC concentrations; therefore, the hypothesis is not supported in this regard. They conclude that “The results highlight associations with wind direction and the Granton NAPS site’s ambient VOC concentrations in relation to location of the pulp mill... suggesting that the mill is likely a contributor to increased concentrations.” Given the lack of correlation and no clear source of the VOCs, this conclusion does not appear to be supported by the data presented.

The authors also state that the aim of this pilot study was to assess levels of community exposures to VOC air toxics emissions from 2006 to 2013, and to evaluate these data in relation to potential risks suggested by EPA air toxic guidelines. Only three VOCs (1,3-butadiene, benzene and carbon tetrachloride) were present at concentrations that are higher than the “cancer risk thresholds” used for comparison. The cancer risk thresholds presented are based on a *1 in a million* probability of contracting cancer if exposed to a substance *at the threshold concentration* every day over the course of a lifetime (italicized text added by reviewer). As such, comparison of individual 24-h sample results to the threshold as an indicator of health risk is a mis-application. As the median concentration of 1,3 butadiene is less than the cancer risk threshold, health risks are considered negligible. Benzene and carbon tetrachloride concentrations are consistently above the chronic cancer targets used; however, overall, these parameters do not differ significantly by wind direction and are similar to concentrations observed at the other NAPS stations across Canada (Galarneau et al. 2016).

Additional comments

Of the three “air toxics of primary concern” identified by the authors (1,3-butadiene, benzene, and carbon tetrachloride), only 1,3-butadiene was (statistically) significantly higher when PW were from the northeast towards the NAPS station. Specifically, the authors state:

Reference: Comments on Paper - Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia by Hoffman et al. (2017a,b)

“1,3-Butadiene and tetrachloroethylene were significantly higher ($p < 0.05$) when prevailing wind direction blew from the northeast and the mill towards the NAPS site.”

While there is a substantive analysis of wind direction presented in the paper, there is very little emphasis on the fact that the wind frequency blowing from the northeast, from the mill toward the NAPS station is quite low. This is a very important point that deserves far more weight in forming conclusions about observations at the monitoring station.

In the context of the statement on 1,3-butadiene, it is implied that the source of the emissions is the pulp mill. Yet, it is also stated in the paper:

“The largest point source emitter within this range is likely the mill; however, the origin(s) of VOCs are inconclusive.”

And further in the paper,

“Direct links between 1,3-butadiene and vinyl chloride with P&P industries were not found in the literature.”

There are other industrial sources in the area (such as the tire manufacturing facility and the coal-fired thermal generating station), and there is some consideration of these sources; however, there is no valid assessment of the effects of emissions from other sources and how these emissions influence the observed values at the Granton NAPS monitoring station. Instead, it is stated in the paper:

“Boat Harbour (the mill's effluent treatment facility) may therefore contribute to ambient concentrations of VOCs. Collectively, these emissions may have contributed to the ambient atmospheric levels of VOCs measured at the Granton NAPS site.”

In the paper, the phrase “... may have contributed” is used frequently. Most of the time, the evidence is either weak or simply not presented to substantiate these statements. Further, the authors then make the leap from “... may have contributed” in Results and Discussion to “...likely a contributor” in Conclusions.

In other instances, the authors have presented only partial information. Examples include the presentation of cancer risk thresholds without providing the basis of that risk (i.e., 1 in a million increase in probability), or focusing on the potential for mixtures to have synergistic health effects, without also considering the potential for mixtures to be non-interactive, or have antagonistic effects. This is outside the norms for an objective scientific study.

Overall Conclusions

The approach used in the wind analysis as presented in this paper is weak. Claims that the investigation documented elevated concentrations of certain VOCs air toxics to be associated with pulp and paper emissions are not supported by the data, and contradict the authors' statistical findings and acknowledged lack of direct links between the VOCs and pulp and paper industries. The authors' presentation of speculation without foundation limits the usefulness of this paper as a scientific study.

Reference: **Comments on Paper - Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia by Hoffman et al. (2017a,b)**

References

- Galarneau E., Wang D., Dabek-Zlotorzynska E., Siu M., Celo V., Tardif M., Harnish D. and Jiang Y. 2016. Air toxics in Canada measured by the National Air Pollution Surveillance (NAPS) program and their relation to ambient air quality guidelines. *J Air Waste Manage Assoc* 66:184–200. DOI 10.1080/10962247.2015.1096863
- Hoffman E., Guernsey, J.R., Walker, T., Kim, J.S., Sherren, K. and P. Andreou. 2017a. Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia. *Environ Sci Pollut Res*, DOI 10.1007/c11356-017-9719-5, Research Article published online: 15 July 2017, Springer-Verlag GmbH Germany, 14 p.
- Hoffman E., Guernsey, J.R., Walker, T., Kim, J.S., Sherren, K. and P. Andreou. 2017b. Supplementary Material - Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia. 22 pages including analysis, 5 Figures and 3 Tables, pages S1-S23.