AIR DISPERSION MODEL REPORT FOR WINDALCO PROPOSED MINING OF SPECIAL EXCLUSIVE PROSPECTIVE LICENSE (SEPL) 524 AREA, ST. ANN. IN FULFILLMENT OF REQUIREMENTS OF AN ENVIRONMENTAL IMPACT ASSESSMENT

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Executive Summary

The air dispersion modelling exercise was conducted in order to estimate the impact of air emissions from the proposed mining of Special Exclusive License Area (SEPL) 524 on the ambient air quality. This assessment, done in partial fulfilment of the requirements of an Environmental Impact Assessment of the proposed mining activities in the area, was done using AERMOD version 9.6.1. The Mines are located on approximately 6900 hectares of land in St. Ann. Approximately 470 hectares of this land is proposed to be mined. The assessment was done in accordance with the Natural Resources Conservation Authority Ambient Air Guidelines 2006 and the USEPA Guidelines on Air Quality Modelling. The latest version of the AERMOD/AERMET air dispersion model was used to determine the pollutant fallout concentrations using input files created by EPES limited.

Emission rate input files for sources at the Mines were determined using data collected from proposed mining locations (proposed Pits and load out areas), WINDALCO methodologies used in mining activities, terrain data and onsite information gathered from assessment conducted by EPES engineers in the proposed mining Area. Meteorological Data used to input into AERMET files was gathered from MM5 pre-processed modelling data for a 5 year period provided by Lakes Environmental. Lakes Environmental offers a service providing **modeled meteorological data** for any location in the world. Lakes Environmental obtain this data by running the NCAR MM5 (visit this website for more information on NCAR; http://www.mmm.ucar.edu/mm5/mm5-home.html) (5th-generation Mesoscale Model) prognostic meteorological model for a specified location and site domain.

Once the MM5 preprocessing has been completed, the MM5 output file is converted into a format recognized by the **AERMET model** (meteorological preprocessor for the AERMOD model). The final output is generated by creating a pseudo met-station at the specified site location.

A receptor grid was determined for the purpose of completing the model, in essence, creating the modelling domain. A uniform cartesian grid receptor system using a 1000-meter grid spacing from the centre point of SEPL 524, to a distance of 20km in radius was employed. Sensitive receptors around SEPL 524 within the modelling domain were identified and modelled as special receptors The report provides the details on the input files mentioned above for the model and provides the model runs for the identified pollutant PM10. It clearly provides the scenarios showing the impact that the current Mining areas air pollutants operating at its maximum capacity will have on its surroundings. It provides maximum concentrations for the pollutants, the coordinates at which they fall and uses the land use categories. The summary of the result is presented in Table 1 and show that fallout concentration for the pollutant modelled from the mining activities in SEPL 524 plus the background concentration will be in compliance with the Jamaica Ambient Air Quality Standards JAAQS and guideline concentration for PM10. The report concludes that WINDALCO SEPL 524 is predicted to be in full compliance with the Jamaica Ambient Air Quality Standard (JAAQS) for PM10.

Table 1: Showing Maximum predicted concentrations for all pollutants modelled

					COORDINATES	
Pollutant	AVG. TIME	Background Conc. (ug/m3)	JNAAQS	MAX MODEL PREDICTED CONC (ug/m3)	UTMN	UTME
Particulate Matter (PM10)	24 hr	20	150	108.64	267155.65	2022050.9
	Annual	4	50	15.35	267155.65	2022050.9

1.0 Introduction

WINDALCO Special Exclusive License Area (SEPL) 524, are a series of proposed Bauxite Mining pits, to be mined by WINDALCO, providing the Bauxite ore for the WINDALCO Alumina Works, As part of a requirement of an Environmental Impact Assessment (EIA), WINDALCO is required to provide air dispersion modeling studies of emissions in accordance with the Natural Resources Conservation Authority (Air Quality) Regulations 2006 for the proposed mining areas. WINDALCO requested the services of Environmental and Process Engineering Services Limited to perform an air quality assessment on the proposed Mines using the regulatory approved AERMOD air dispersion model.

This report describes the dispersion modeling for particulate matter less than 10 microns in diameter (PM10) emissions from the Mining Pits and Haul Roads. The model predictions are compared with Jamaican Ambient Air Quality Standards (JAAQS). Section 2 of this report describes the processes in which pollutants modeled may be emitted into the atmosphere. The methodology used for the air dispersion modeling is described in Section 3. The results and the air quality assessment are presented in Section 4.

2.0 DISPERSION MODELING ASSESSMENT METHODOLOGY

The assessment methodology for the air dispersion modeling exercise follows the guidelines specified in the Natural Resources Conservation Authority (NRCA) Ambient Air Quality Guideline Document 2006.

The detailed model recommended in the Ambient Air Quality Guideline Document is the AMS/EPA Regulatory Model AERMOD. The model selected was the ISC-AERMOD View dispersion model, developed by Lakes Environmental. This model is used extensively to assess pollution concentration and deposition from a wide variety of sources. ISC-AERMOD View is a, Microsoft Windows application. AERMOD is a regulatory steady-state plume modeling system with three separate components:

- AERMOD (AERMIC Dispersion Model),
- AERMAP (AERMOD Terrain Preprocessor)
- AERMET (AERMOD Meteorological Preprocessor).

The AERMOD model includes a wide range of options for modeling air quality impacts of pollution sources, making it a popular choice among the modeling community for a variety of applications. Some of the modeling capabilities of AERMOD include the following:

- AERMOD model may be used to model primary pollutants and continuous releases of toxic and hazardous waste pollutants.
- Source emission rates can be treated as constant or may be varied by month, season, hour-of-day, or other optional periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources. On this project all emission rates were treated as constant.
- The model can account for the effects of aerodynamic downwash due to nearby buildings on point source emissions. PRIME building downwash algorithms based on the ISCPRIME model has been added to the model.
- Receptor locations can be specified as grid and/or discrete receptors in a Cartesian or polar coordinate system. A new type of receptor was included, the discrete Cartesian receptors that allows for grouping of receptors.
- For applications involving elevated terrain, the user must also input a hill height scale along with the receptor elevation. The U.S. EPA AERMAP terrain preprocessing program was used to generate hill height scales as well as terrain elevations for all receptor locations.
- The model contains algorithms for modeling the effects of settling and removal (through dry deposition) of large particulates and for modeling the effects of precipitation scavenging for gases or particulates.
- AERMOD requires two types of meteorological data files, a file containing surface scalar parameters and a file containing vertical profiles. These two files are provided by the U.S. EPA AERMET meteorological preprocessor program.

Figure 1 displays the location of all emission sources that were modeled for the mining area. Table 2 and 3 contains the location data for all sources that were modeled. The location data included emission source coordinates, source heights, and base elevations for the sources identified. These data were obtained from plant data, topographic maps supplied by Google Earth and the use of Jamaica Metric Grid 1:50,000 map.

Meteorological information was provided using MM5 pre-processed modelling data for a 5 year period (2016-2020) provided by Lakes Environmental. Lakes Environmental offers a service providing **modeled meteorological data** for any location in the world. Lakes Environmental obtain this data by running the NCAR MM5 (visit this website for more information on NCAR;

http://www.mmm.ucar.edu/mm5/mm5-home.html) (5th-generation Mesoscale Model) prognostic meteorological model for a specified location and site domain.

Once the MM5 preprocessing has been completed, the MM5 output file is converted into a format recognized by the **AERMET model** (meteorological preprocessor for the AERMOD model). The final output is generated by creating a pseudo met-station at the specified site location.

Figure 1: Showing extent of model domain. – Yellow line represents boundary of SEPL524

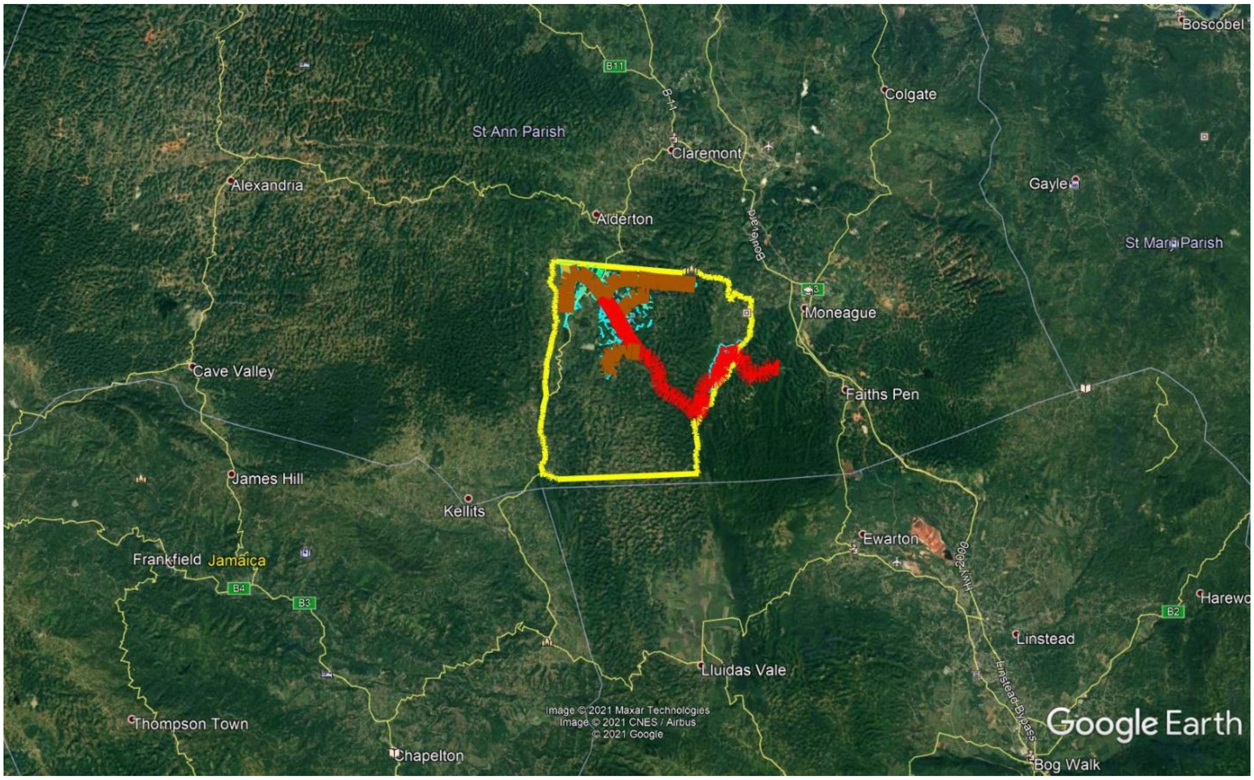
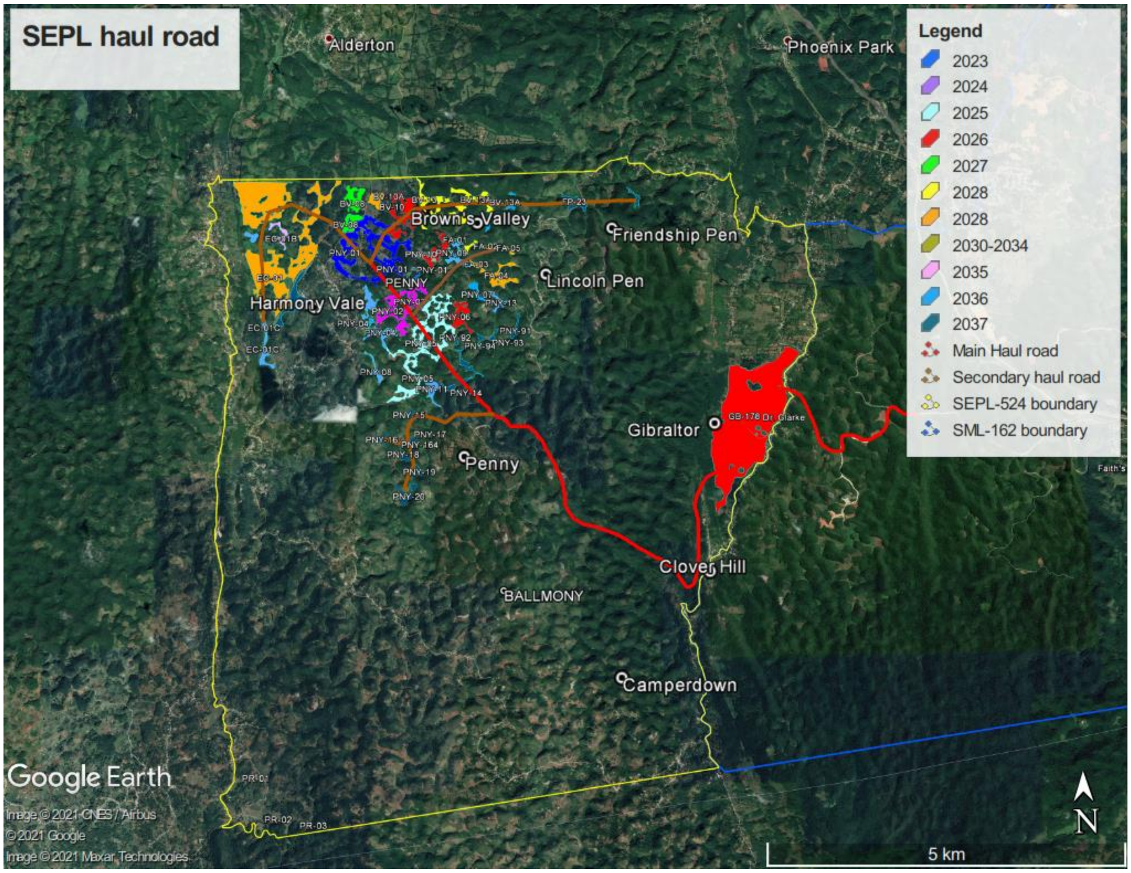


Figure 1a: Showing emission sources (mining pits) proposed in SEPL 524



2.1 PROCESS DESCRIPTION AND SOURCES OF AIRBORNE POLLUTANTS

The airborne pollutants are described below in table 2:

Table 2 Description of Pollutant Sources

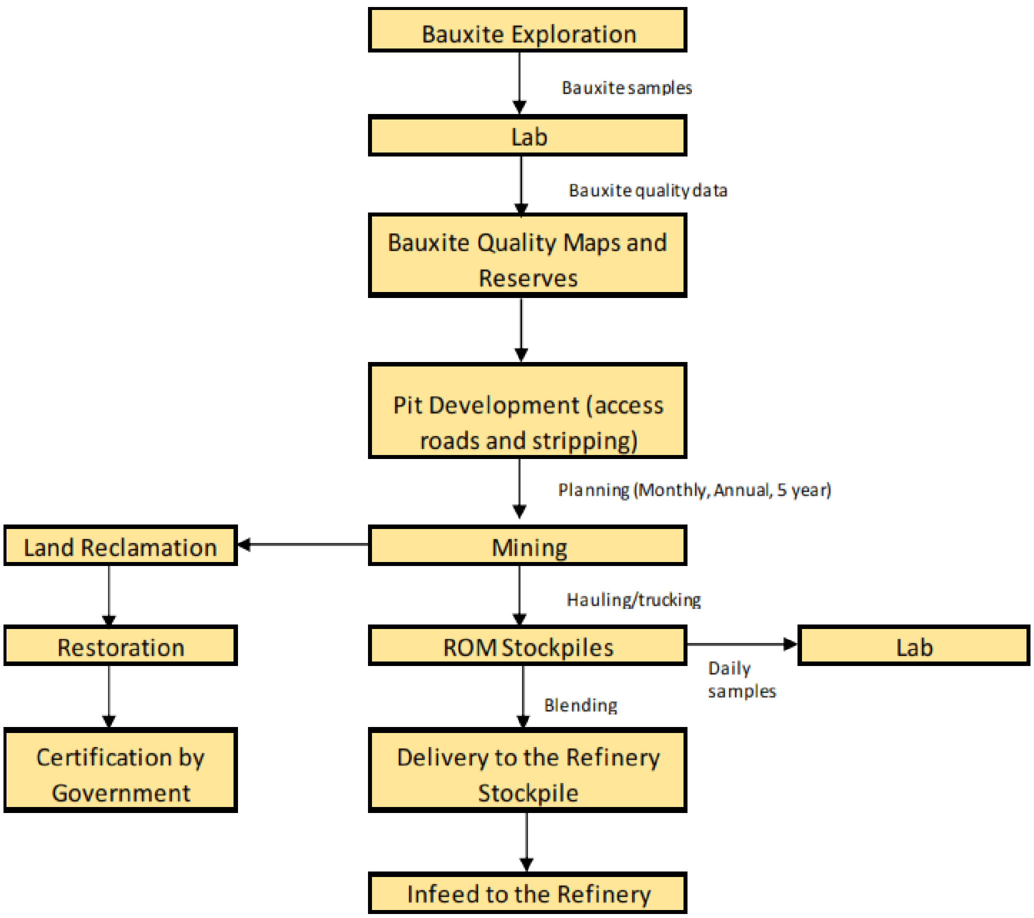
Sources	Pollutants
• Excavation of Mining Pits to extract ore from the Earth. • Loading and unloading of Bauxite Ore for transport to the Ewarton Alumina Works	Particulate matter (PM)

• Distance travelled by Trucks on Haul Road to and from the mining pit to the Load and off load mined ore	

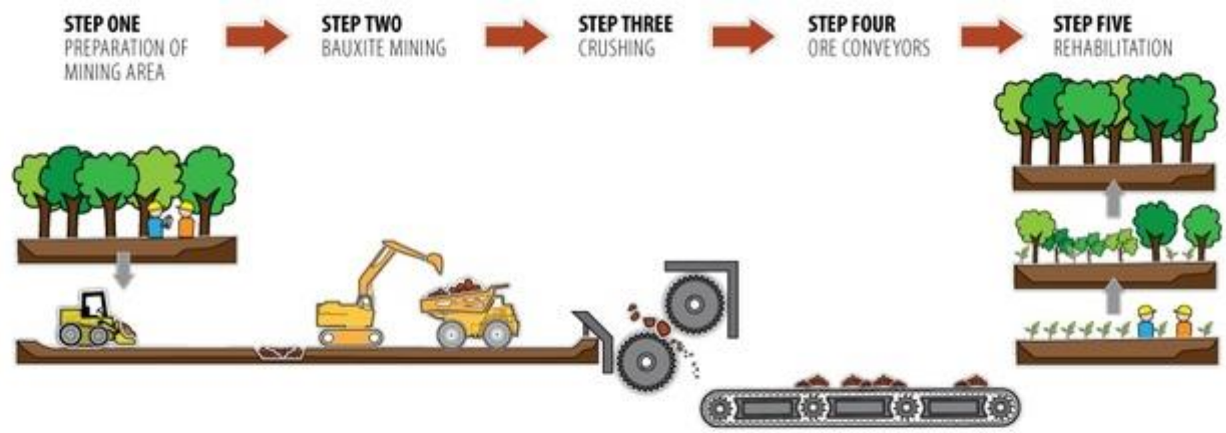
These processes at the various locations where these operations occur are described in the following section

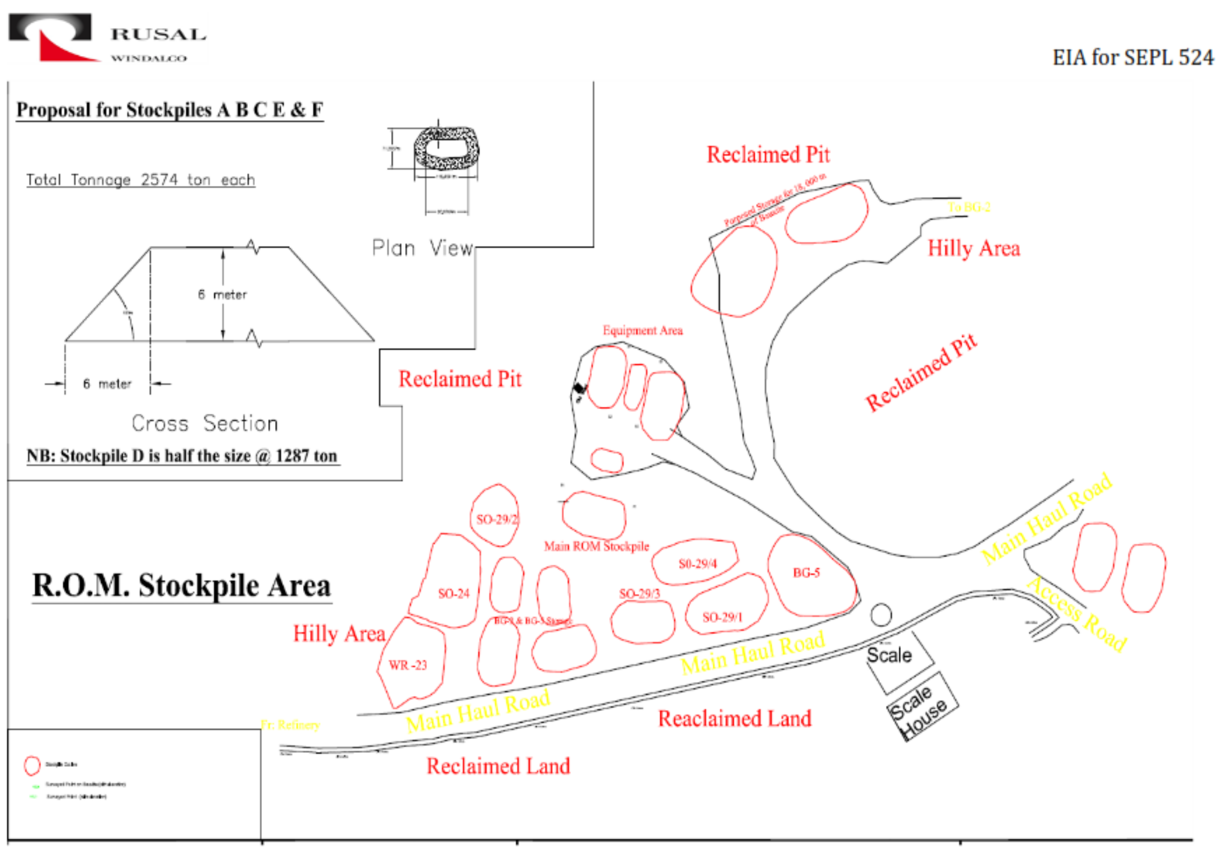
2.2 PROCESSES AT FACILITY

Figure 2 Showing Process Flow Diagram



A FLOW CHART ILLUSTRATING THE MINES OPERATIONS





3.0 MODELING METHODOLOGY

The model approach used was to compare the model predictions plus the relevant background concentrations with Jamaica Ambient Air Quality Standards (JAAQS) - see Table 3. The USEPA AERMOD model was used to predict the worst-case concentrations for the combined releases from the mining pits for averaging periods that correspond to the averaging times for the JAAQS. As required in the *Guideline Document* model predictions were based on worst-case emissions for all sources. These emission rates are higher than the actual emission rates. Model predictions were made using meteorological data for a 5 year period (2016-2020). Predictions were made at a number of points (hereafter called receptors) that comprised grids developed relative to the entire domain and the property boundary or fence line with a discrete spacing as well as at special receptors where there is likely to be population exposure (schools, churches, hospitals and health centers). Model predictions also considered the complex terrain around the plant by using terrain heights for all receptors. Digital elevation data were obtained from www.webgis.com

Table 3 Jamaican National Ambient Air Quality Standards (JNAAQS)

Pollutant	Averaging time	Standard Maximum concentrationµg/m3
PM_{10}	Annual 24 h	50 150

b) PM_{10} refers to particles with an aerodynamic diameter of 10 micrometers or less as measured by the PM_{10} sampler.

3.1 INPUTS

3.1.1 Pollutants

The pollutant modeled is PM10. The Estimate of the rates of emission are presented in Table 4.

Table 4: Emission rates for the pollutant sources (proposed mining pits) modelled

Type	ID	Desc	Base_Elev	Height	Emission Rates
			[m]	[m]	[g/s]
AREA_POLY	PNY_03	MINING PIT PNY3	517.03	3.4	4.83283E-06
AREA_POLY	PNY_01	MINING PIT PNY1	498.56	3.4	4.4896E-06
AREA_POLY	PNY_05	MINING PIT PNY5	528.75	3.4	2.70078E-06
AREA_POLY	PNY_06	MINING PIT PNY6	532.85	3.4	3.14498E-05
AREA_POLY	PNY_10	MINING PITPNY10	515.51	3.4	7.42043E-06
LINE_VOLUME	SLINE2	ROAD2			0.0347
LINE_VOLUME	SLINE2				
LINE_VOLUME	SLINE2				
LINE_VOLUME	SLINE3	ROAD3			0.0347
LINE_VOLUME	SLINE3				
LINE_VOLUME	SLINE3				
LINE_VOLUME	SLINE4	ROAD4			0.0347
LINE_VOLUME	SLINE4				
LINE_VOLUME	SLINE4				
LINE_VOLUME	SLINE1	ROAD1			0.0347
LINE_VOLUME	SLINE1				
LINE_VOLUME	SLINE1				
LINE_VOLUME	SLINE6	ROAD6			0.0347
LINE_VOLUME	SLINE6				
LINE_VOLUME	SLINE6				
AREA_POLY	GB178A	GBY SET	371.66	3.4	1.60914E-06

3.1.2 Meteorological Data

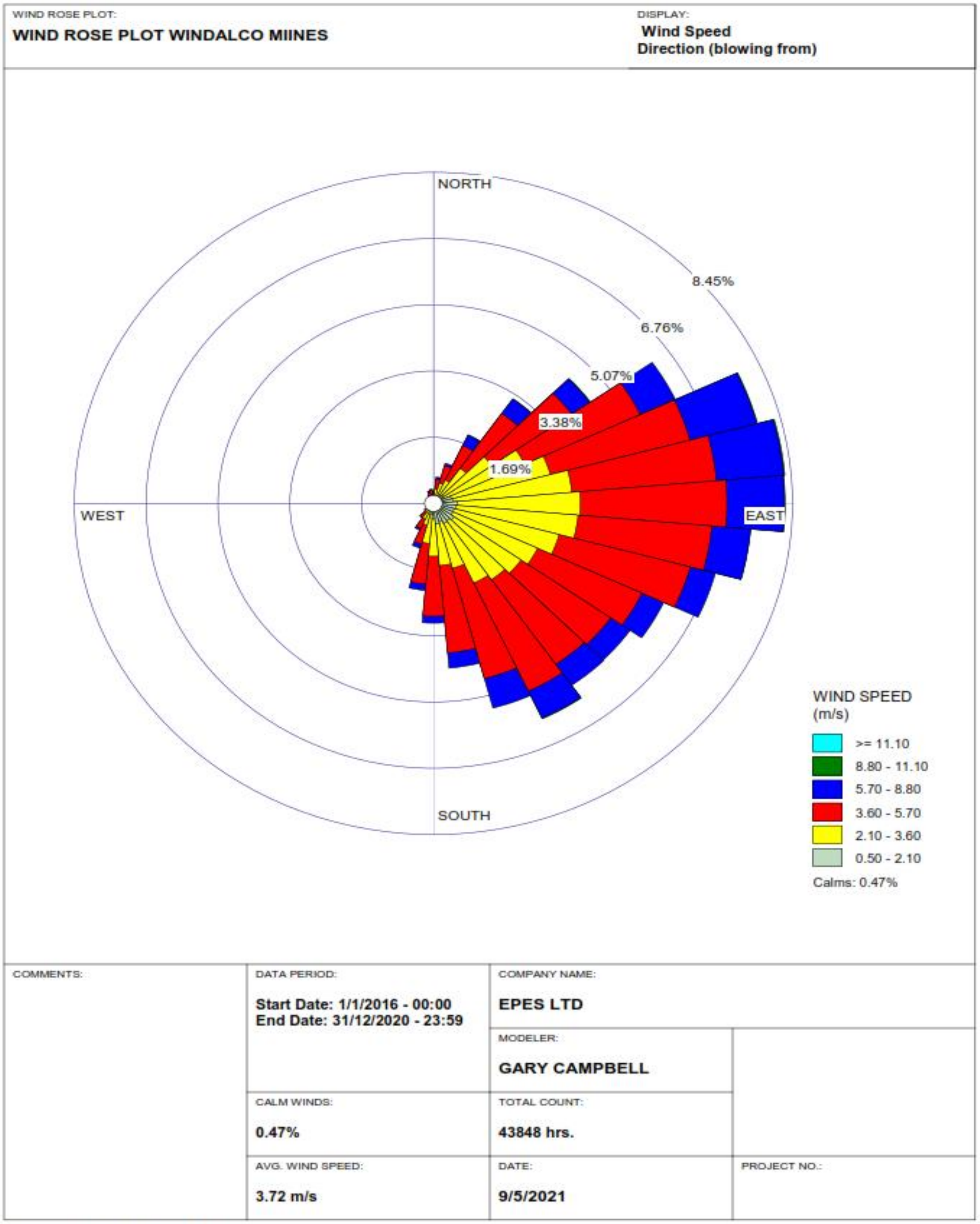
The AERMOD model requires hourly surface data values for wind speed, wind direction, temperature, total or opaque cloud cover, cloud ceiling height and at least once daily mixing height data at 1200 UTC. Hourly surface data for 2016-2020 were obtained from the MM5 data mentioned previously, which also provided surface wind speed, wind direction, relative humidity, solar radiation, temperature, ceiling height and cloud cover. The wind rose for the onsite Pseudo Met station is shown in Figure 3-1.

3.1.3 Model Domain, Grids and Receptors

The model domain selected was 20 km (east-west) by 20 km (north-south) with an origin at 268715m E, 2018192 m N in UTM coordinates. All UTM distances are in meters (m) and the notation m will be omitted hence forth.

Estimates of ground level concentrations were calculated at the intersection of the following grids and along the fence line for a total of up to 441 receptors. A uniform cartesian grid system was used. Boundary receptor grid, as well as the fence line grid receptor network was used.

Figure 3-1 Wind Rose at on-site Pseudo Meteorological Station – St. Ann



WRPLOT View - Lakes Environmental Software

Figure 3-1a Location of Pseudo met station

Calculated Pseudo Met Station Parameters:

Anemometer Height:	14 m
Station Base Elevation:	554 m
Upper Air Adjustment:	+5 hour(s)

Digital elevation data with 1Km spacing were obtained for the study area from www.WEBGIS.com. The elevation data were used to construct digital elevation model (DEM) files which are required for use in the model.

WINDALCO provided drawings of proposed mining pits, haul roads and load out areas. These drawings together with additional data gathered by EPES personnel were used to determine the model boundary, and the dimensions of the sources. Figure 3-2 illustrates the model domain, the regular Cartesian grid and terrain contours. Figure 3-3 shows the location of the special receptors placed in the model.. The special receptors were selected to coincide with sites in populated areas (schools, health centers, hospitals and community centers).

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Figure 3-2: Showing Receptor Grid Spacing and terrain contours

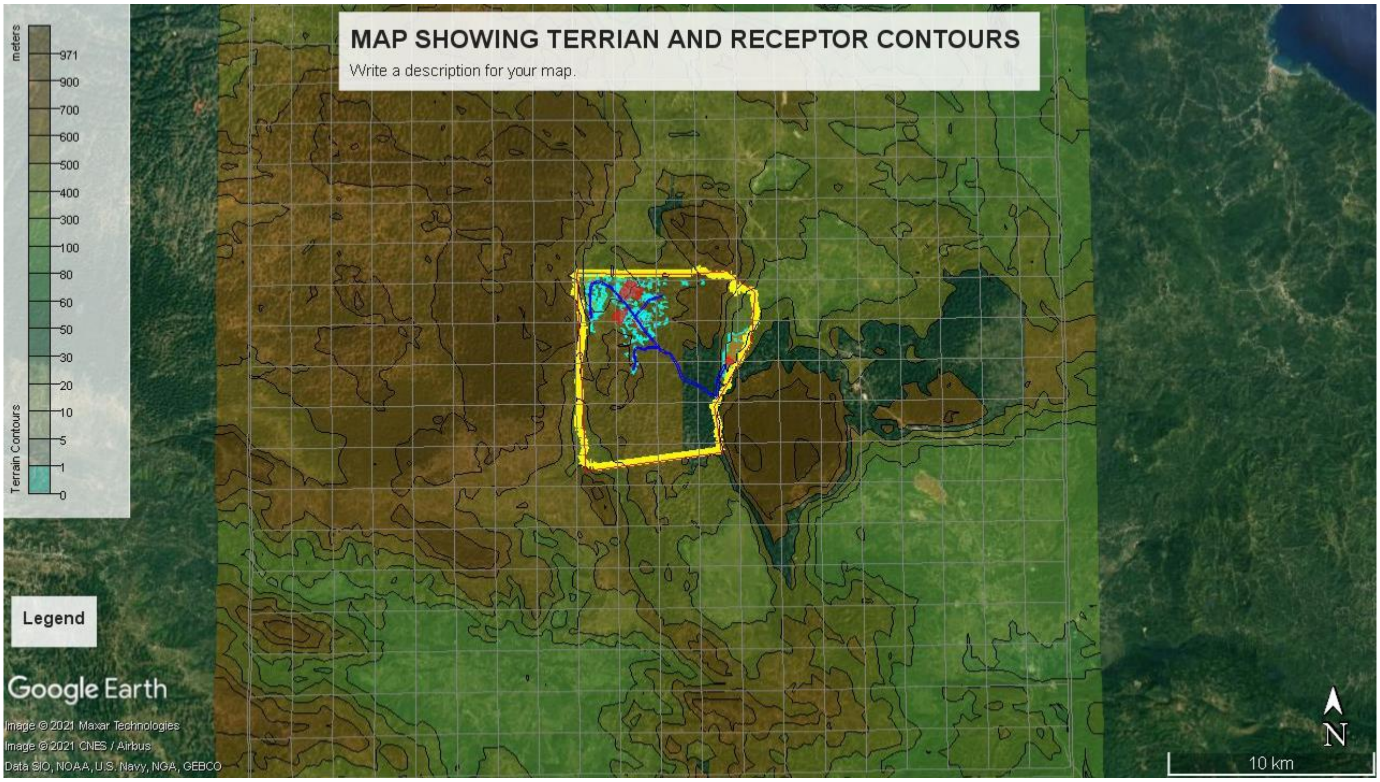
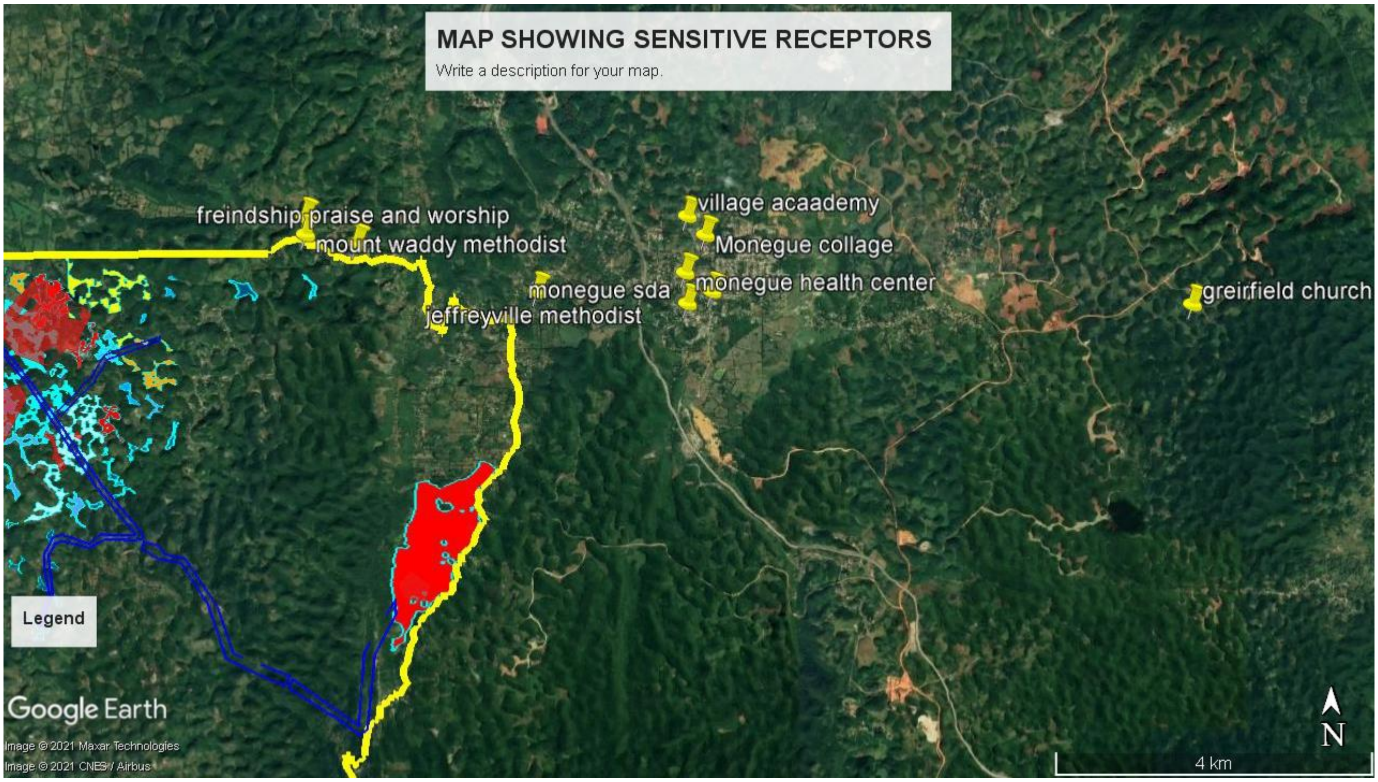


Figure 3-3: Showing special receptor locations



3.2 SOURCE INFORMATION

The location and area of the proposed mining pits, stockpiles, load out areas and haul roads were used to create the source files for the model. Using the proposed schedule for mining of each identified mining pit, a "worst case" scenario was created for the model. This was done by assuming that all the mining pit areas to be mined in a year was operating all at the same time. Although this scenario is unlikely, it is a good measure of what is a possible outcome that would create the most fugitive emissions.

The locations of schools and other community sites used as special receptors were obtained from a listing published by the Ministry of Education and were verified based on local knowledge and examination of Google Earth.

4.0 RESULTS OF DISPERSION MODEL EXERCISE

4.1 Discussion

The Input files created by auxiliary programs were used to perform runs for Particulate Matter less than 10 Microns (PM10). The results are illustrated in Figures 4-1 and 4-2. A summary of the maximum average concentrations at the averaging periods related to the JAAQS is shown in Table 5. Table 6 Shows the highest predicted concentrations at the special receptors. All runs were conducted using the averaging times that correspond to the JAAQS.

Table 5 Showing Summary of highest predicted concentration fallout from Mines and all Sources

					COORDINATES	
Pollutant	AVG. TIME	Background Conc. (ug/m3)	JNAAQS	MAX MODEL PREDICTED CONC (ug/m3)	UTMN	UTME
Particulate Matter (PM10)	24 hr	20	150	108.64	267155.65	2022050.9
	Annual	4	50	15.35	267155.65	2022050.9

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Table 6 Showing Summary of highest predicted concentration fallout from Mines and all Sources at the special receptors.

PM10 - Concentration - Source Group: ALL										
Averaging Period	**Rank**	**Peak**	**Units**	**Receptor ID**	**X (m)**	**Y (m)**	**ZELEV (m)**	**ZFLAG (m)**	**ZHILL (m)**	**Peak Date, Start Hour**
24-HR	1ST	5.27304	ug/m^3	JMC	274261.73	2021684.35	370.77	0.00	786.00	28/1/2020, 24
24-HR	1ST	0.86761	ug/m^3	FPWC	271977.20	2022295.53	649.25	0.00	761.00	28/1/2020, 24
24-HR	1ST	1.12455	ug/m^3	FSDA	271305.54	2022641.79	614.71	0.00	786.00	28/1/2020, 24
24-HR	1ST	1.41390	ug/m^3	MWMC	271302.99	2022426.53	598.97	0.00	786.00	28/1/2020, 24
24-HR	1ST	3.41257	ug/m^3	MSDA	276228.22	2021507.69	337.32	0.00	751.00	28/1/2020, 24
24-HR	1ST	3.44380	ug/m^3	STMC	276553.14	2021657.69	334.66	0.00	731.00	28/1/2020, 24
24-HR	1ST	3.69578	ug/m^3	MHC	276203.47	2021907.78	343.65	0.00	761.00	28/1/2020, 24
24-HR	1ST	3.21447	ug/m^3	MC	276473.56	2022396.72	353.44	0.00	731.00	25/1/2020, 24
24-HR	1ST	3.72883	ug/m^3	VAAC	276241.40	2022645.44	356.00	0.00	752.00	25/1/2020, 24
24-HR	2ND	2.93650	ug/m^3	JMC	274261.73	2021684.35	370.77	0.00	786.00	25/1/2020, 24
24-HR	2ND	0.58150	ug/m^3	FPWC	271977.20	2022295.53	649.25	0.00	761.00	29/1/2020, 24
24-HR	2ND	0.80365	ug/m^3	FSDA	271305.54	2022641.79	614.71	0.00	786.00	16/9/2020, 24
24-HR	2ND	1.06450	ug/m^3	MWMC	271302.99	2022426.53	598.97	0.00	786.00	16/9/2020, 24
24-HR	2ND	1.82631	ug/m^3	MSDA	276228.22	2021507.69	337.32	0.00	751.00	25/1/2020, 24
24-HR	2ND	1.96931	ug/m^3	STMC	276553.14	2021657.69	334.66	0.00	731.00	25/1/2020, 24
24-HR	2ND	2.46840	ug/m^3	MHC	276203.47	2021907.78	343.65	0.00	761.00	25/1/2020, 24
24-HR	2ND	2.88130	ug/m^3	MC	276473.56	2022396.72	353.44	0.00	731.00	9/9/2020, 24
24-HR	2ND	3.50390	ug/m^3	VAAC	276241.40	2022645.44	356.00	0.00	752.00	9/9/2020, 24
24-HR	3RD	2.75410	ug/m^3	JMC	274261.73	2021684.35	370.77	0.00	786.00	9/9/2020, 24
24-HR	3RD	0.45722	ug/m^3	FPWC	271977.20	2022295.53	649.25	0.00	761.00	2/4/2020, 24

Figure 4-1: Showing Dispersion Fallout Concentration Plot for 24Hr PM_{10}

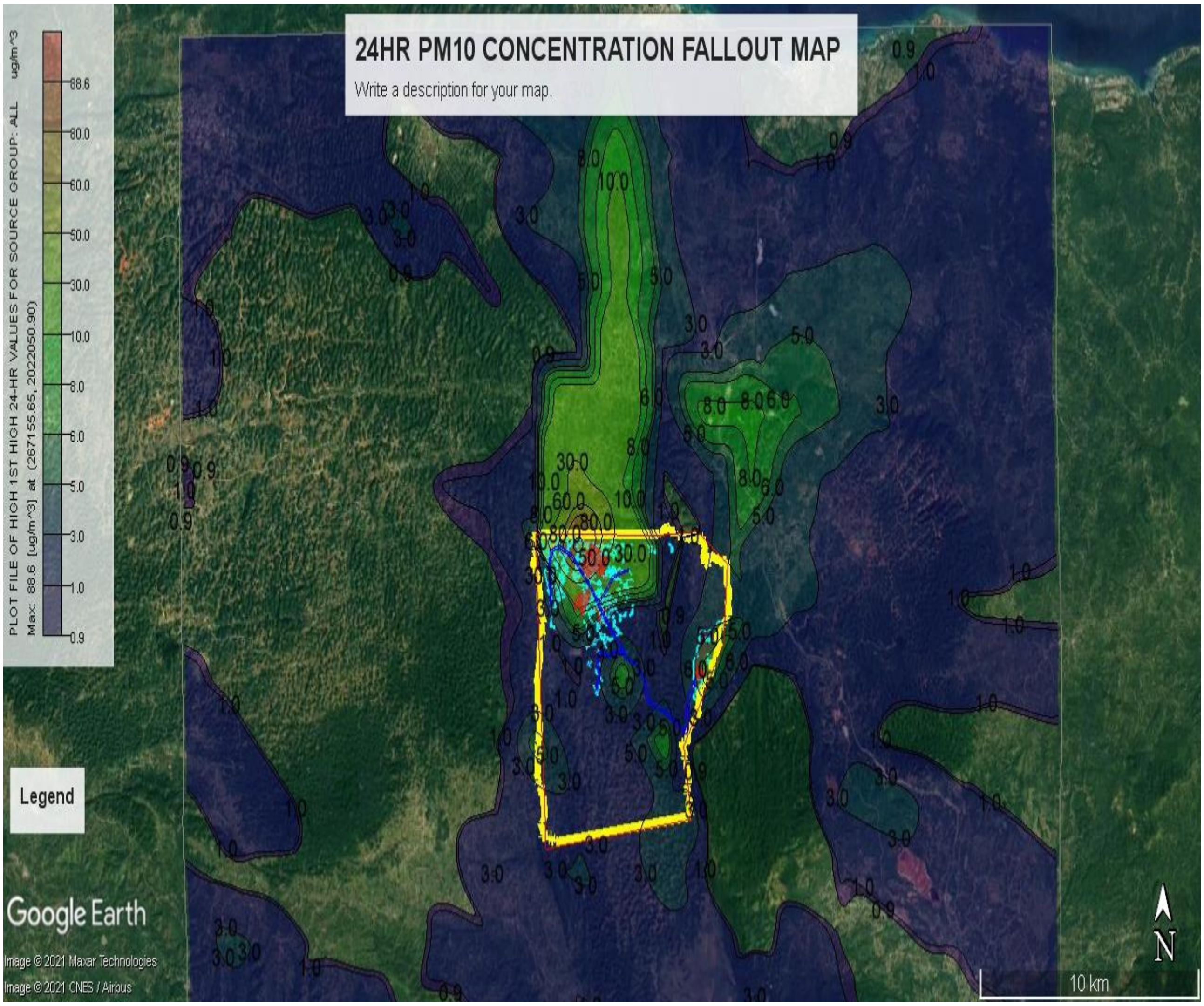
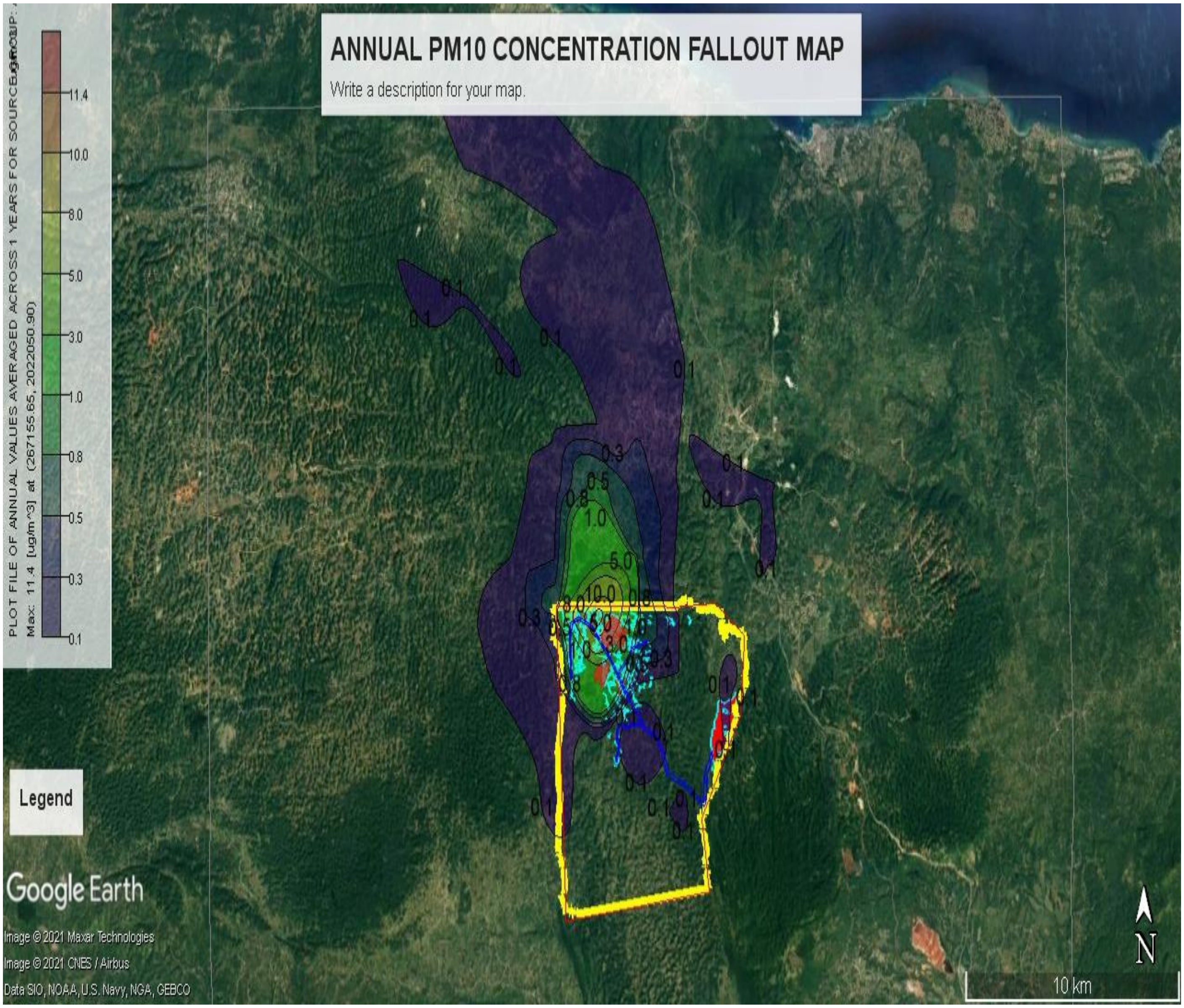


Figure 4-2: Showing Dispersion Fallout Concentration Plot for Annual PM_{10}



5.0 CONCLUSION

Based on the results of this exercise, ambient concentrations for the pollutants modelled from the proposed WINDALCO SEPL 524 Mines plus the background concentration is predicted to be incompliance with the Jamaica National Ambient Air Quality Standards JNAAQS and guideline concentration. The report concludes that WINDALCO proposed mining activities in SEPL524 is predicted to be in full compliance with the ambient standards for PM10.