2.3 Ambient Air Quality Objectives for Volatile Organic Compounds

Unlike criteria air pollutants, emissions of VOCs are not governed by federal ambient air quality objectives to determine acceptable air quality.

AENV (2008) has established hourly average guideline values for a limited number of VOC emissions. For other non-criteria substances, acceptable ambient levels may be generally determined using the effects screening levels (ESL) as recommended by the TCEQ.

Table 4 lists potentially significant VOCs associated with operations of the Spy Hill Asphalt Plant as measured by Protocol2 Air Services Inc. (Protocol2) (2008) with accompanying ESL values. The ESLs are based on data concerning health effects, odour nuisance potential, vegetation effects, and corrosion effects. If predicted or measured airborne levels of a constituent do not exceed the screening level, adverse health or environmental effects are not expected to result. Ambient levels of constituents in the air exceeding the screening level do not necessarily indicate a problem, but rather that a more in-depth review is required.

Of the air emissions shown in Table 4, AENV has ambient air quality objectives for only the three substances presented in Table 5.

Table 4: Effects Screening Levels (ESL) for the Indicated VOC

VOC	Short Term ESL[1] (µg/m³)	Long Term ESL[2] (µg/m³)	VOC	Short Term ESL[1] (µg/m³)	Long Term ESL[2] (µg/m³)
Benzene	170	4.5	2-Methylpentane	290	29
Butane	19000	1900	3-Methyl-1-butene	125	12.5
Cyclohexane	1400	140	3-Methylheptane	3500	350
Cyclopentane	3400	340	3-Methylhexane	3070	307
Cyclopentene	8100	810	3-Methylpentane	3500	350
2,3-Dimethylpentane	3500	350	4-Methyl-1-pentene	70	7
Ethylene	1400	34	Nonane	2000	200
Ethyl benzene	2000	200	Octane	3500	350
Heptane	3500	350	Pentane	3500	350
Hexane	5300	200	cis-2-Pentene	7500	odour
cis-2-Hexene	70	7	trans-2-Pentene	7500	odour
Trans-2-Hexene	70	7	Propane	18000	1800
Isopentane	3500	350	n-Propylbenzene	1250	125
Isopropylbenzene	3300	330	Toluene	640	1200
2-Methyl-2-butene	n/a	n/a	1,2,4-Trimethylbenzene	1250	125
Methylcyclohexane	16100	1610	1,3,5-Trimethylbenzene	1250	125
Methylcyclopentane	2600	260	m,p-Xylene	2080	208
2-Methylheptane	3500	350	o-Xylene	3700	370
2-Methylhexane	3070	307			

NOTES:
n/a not available
[1] Short term indicates a 1-hour averaging period.
[2] Long term indicates an annual averaging period.

Table 5: Alberta's Ambient Air Quality Objectives for Indicated VOC

VOC	Hourly Average ($\mu g.m^{-3}$)	Daily Average ($\mu g.m^{-3}$)
Benzene	30	not available
Toluene	1,880	400
Xylenes	2,300	700

3.0 DESCRIPTION OF SITE AND ASPHALT PLANT

The location of the Asphalt Plant within the Spy Hill area is shown in Figure 1. It was situated in the southeast portion of BLV Group's present sand and gravel excavation area as outlined in yellow.

The Asphalt Plant operates with a production rate of about 320 t/h. It has a diesel oil-fired dryer equipped with a bag house. Its stack emission parameters were measured on September 04, 05, 2008 during three tests conducted by personnel from Protocol2 Air Services Inc. (2008).

3.1 Stack Parameters and Pollutant Concentrations

Results of the Protocol2 survey for stack exit temperatures and exit velocity are presented in Table 6. The Table also shows stack concentrations for Particulate matter (PM) , VOCs and CO. All measured stack concentrations of pollutants are less than regulatory standards except for CO.

Table 6: Emission Parameters Associated with the Spy Hill Asphalt Plant as Reported by Protocol2

Parameter	Value	
	Protocol2	Regulatory Limit
Stack Height (m)	11.0	not available
Effective Stack Diameter (m)	1.74	not available
Stack Exit Temperature (^oC)	143	not available
Stack Exit Velocity ($m\ s^{-1}$)	10.8	not available
Stack Effluent Rate (m^3/s)*	16.2	not available
Stack Effluent Rate (kg/s)	24.4	not available
PM Concentration (g/kg)	0.16	0.20**
VOCs Concentration (g/m^3)*	0.012	0.06***
CO concentration (g/m^3)*	0.92	0.50***

NOTES:
*dry, 16% O_2, 20 ^oC, 760 mm Hg,
** ANEV Code of Practice,
*** B C Environment Regulation

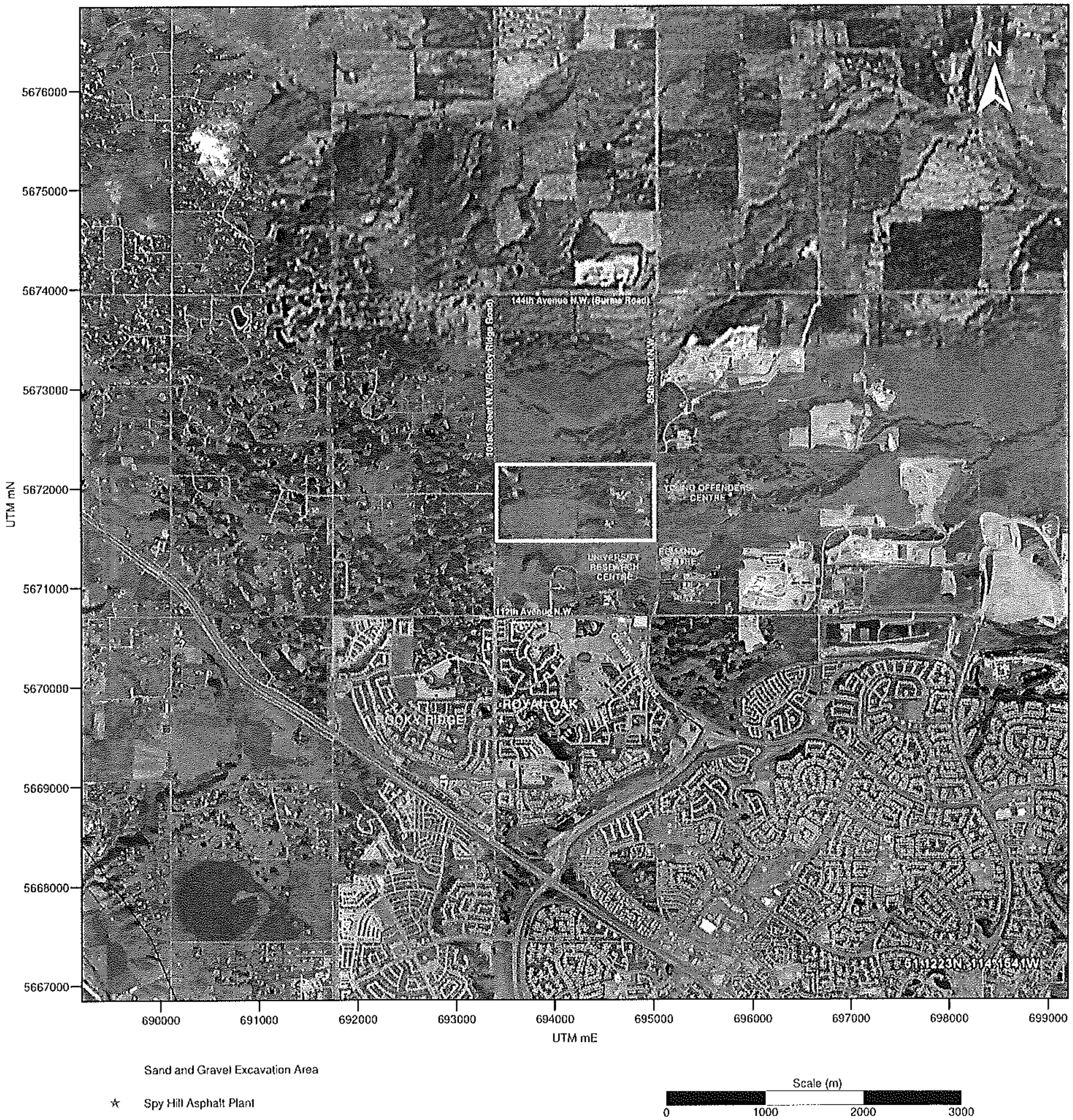

Figure 1: Aerial Photograph of the Area Surrounding the Spy Hill Asphalt Plant.

3.2 Air Emissions

Measurements of air emissions reported by Protocol2 covered a wide range of air emissions.

Table 2 shows average air emissions from the Spy Hill Asphalt Plant as measured by Protocol2. It shows results for both criteria pollutants and volatile organic compounds. Measured emissions of SO_2 are small while those for CO are comparatively large.

Ground-level concentrations of the four criteria pollutants (CO, NO_x, SO_2 and fine particulates, $PM_{2.5}$) are governed by nation-wide objectives. Fine particulates, which have diameters equal to or less than 2.5 microns, were assumed to be equal to 21 % of measured total particulate matter (PM) emissions (USEPA 2004). Of the 88 VOCs reported by Protocol2 only the 38 shown in Table 2 were at emission levels greater than one gram/second. All measured speciated VOC emissions were very low with only those for butane and nonane exceeding 100 g/h.

Table 7: Average Air Emissions from the Spy Hill Asphalt Plant as Measured by Protocol2

Air Emission	Measured Emission Rate (g/h)	Air Emission	Measured Emission Rate (g/h)
Criteria Pollutants			
CO	53,700	$PM_{2.5}$	2,060
NO_x	5,030	SO_2	968
CO	698		
Volatile Organic Compounds			
Benzene	18.4	2-Methylpentane	8.09
Butane	129	3-Methyl-1-butene	1.2
Cyclohexane	6.7	3-Methylheptane	11.3
Cyclopentane	1.3	3-Methylhexane	9.52
Cyclopentene	1.97	3-Methylpentane	4.0
2,3-Dimethylpentane	1.76	4-Methyl-1-pentene	1.86
Ethylene	43.6	Nonane	120.7
Ethyl benzene	11.2	Octane	36.0
Heptane	22.7	Pentane	25.0
Hexane	15.1	cis-2-Pentene	1.48
cis-2-Hexene	3.59	trans-2-Pentene	3.7
trans—2-Hexene	1.36	Propane	12.7
Isopentane	6.7	n-Propylbenzene	8.78
Isopropylbenzene	4.2	Toluene	32.1
2-Methyl-2-butene	2.1	1,2,4-trimethylbenzene	29.1
Methylcyclohexane	29.2	1,3,5-Trimethylbenzene	12.1
Methylcyclopentane	3.66	m,p-Xylene	38.2
2-Methylheptane	22.8	o-Xylene	15.2
2-Methylhexane	5.37		

4.0 PLUME DISPERSION MODELING APPROACH TO PREDICTING AIR QUALITY CHANGES

Plume dispersion model calculations were performed in order to estimate ground-level air quality changes that might be attributable to emissions associated with operation of the Spy Hill Asphalt Plant.

Ground-level concentrations of air emissions from this source, were estimated through use of the ISCPRIME plume dispersion model which was developed for the U.S. EPA (1995) on the assumption that the Plant operates continuously from May to October inclusive. Recommended by AENV, the ISCPRIME model is universally known, widely accepted, and well documented. The same model was applied in a previous assessment of dust emissions associated with Spy Hill Sand and Gravel Operations (DM Leahey & Associates Limited and Jacques Whitford Environment Limited 2003).

For plume dispersion modeling, AENV (2003) allows calculated pollutant concentrations that exceed ambient air quality objectives provided the predicted exceedances do not occur more than 0.10% of the time. This means that the eight highest hourly average concentrations could be rejected annually. The rejections are allowed because various approximations applied to develop the meteorological dataset used for plume dispersion predictions occasionally result in unrepresentative situations. Therefore, maximum predicted hourly average concentrations of air emissions presented in this study will pertain to the 99.9% value.

A regularly spaced, nested Cartesian receptor grid was created for the ISCPRIME model to determine the maximum ground-level concentration resulting from the Asphalt Plant stack emissions. The receptor grid was more densely spaced nearer the Plant where maximum impacts are expected. The receptor spacing followed the guidance of AENV (2003):

- 10 km by 10 km with 1000 m receptor spacing;
- 6.5 km by 6 km with 500 m receptor spacing;
- 5.0 km By 3.5 km With 250 M Receptor Spacing;
- 2.9 km by 2.0 km with 50 m receptor spacing; and
- 20 m receptor spacing in areas of maximum impact and along the property boundary.

The nested grid included 3086 receptor locations. The grid is modelled using discrete receptor locations. The Asphalt Plant is situated in an area on Spy Hill where the slope of the land is in a west-south-westerly direction. Elevations at the grid locations were determined from a topographical map of the Spy Hill region. Effects of the topographical features are incorporated into the ISCPRIME model through assumed decreases in plume rise and wind sector homogeneity with respect to plume spreads.

Dispersion meteorology data relating to wind speeds, wind directions, atmospheric stability, and mixing heights were needed to estimate hourly average concentrations of the particulate emissions. The area surrounding the Asphalt Plant was assumed to be characterized by a roughness length of 0.30 m with Monin-Obukhov lengths being dependent on Pasquill stability classes in the manner proposed by Golden (Seinfeld and Pandis 1998). Five years of meteorological data obtained from the Calgary International Airport and Stony Plain were used to predict maximum daily concentration averages. More details pertaining to assumptions regarding atmospheric stability conditions, and mixing height distributions may be found in a previous report relating to air quality in the Spy Hill area (DM Leahey & Associates Limited and Jacques Whitford Environment Limited 2003).

5.0 ASSESSMENT RESULTS

The ISCPRIME plume dispersion model was applied with the air emission parameters as measured by Protocol2 to estimate maximum ground-level concentrations of criteria pollutants and VOCs which might result from emissions of the Spy Hill Asphalt Plant. In the calculations, it was conservatively assumed that all NO_x was in the form of NO_2.

Results of plume dispersion calculations for maximum ground-level concentrations of criteria pollutants are presented in Table 8 and those for VOCs are presented in Tables 9 and 10. All Tables show the relevant regulatory values.

An examination of Tables 8, 9 and 10 shows that, all pollutant concentrations are much less than maximum values allowed under regulatory guidelines. This is especially true of the speciated VOCs which are of negligible value. The maximum predicted daily average value for $PM_{2.5}$ is 4 $\mu g/m^3$. The 98 percentile value will be appreciably less in value and thus well within the limit of 30 $\mu g/m^3$ denoted by the CWS.

Table 8: Maximum Predicted Ground-level Concentrations of Criteria Air Pollutants Associated with Air Emissions from the Spy Hill Asphalt Plant. Relevant AAAQO Values are also Shown

Pollutant	Averaging Time	Maximum Predicted Value (µg/s)	AAAQO (µg/s)
CO	1-hour	220	15,000
	8-hour	149	6,000
NO_2	1-hour	21	400
	24-hour	9	200
	Annual	0.3	60
SO_2	1-hour	4	450
	24-hour	2	150
	Annual	0.05	30
$PM_{2.5}$	24-hour (98^{th} percentile)	4	30*

NOTES:
* Canada-Wide Standard

DML

Jacques Whitford AXYS

Table 9: Maximum Predicted Ground-Level Concentrations of VOCs Associated with Air Emissions from the Spy Hill Asphalt Plant. Relevant ESL Values are also Shown

VOC	Maximum Estimated Hourly Average Concentration (μg/m³)	Short Term ESL[1] (μg/m³)	Maximum Estimated Annual Average Concentration (μg/m³)	Long Term ESL[2] (μg/m³)
Benzene	0.075	170	0.0010	4.5
Butane	0.527	19000	0.0069	1900
Cyclohexane	0.027	1400	0.0004	140
Cyclopentane	0.005	3400	0.0001	340
Cyclopentene	0.008	8100	0.0001	810
2,3-Dimethylpentane	0.007	3500	0.0001	350
Ethylene	0.178	1400	0.0026	34
Ethyl benzene	0.046	2000	0.0006	200
Heptane	0.093	3500	0.0012	350
Hexane	0.062	5300	0.0008	200
cis-2-Hexene	0.015	70	0.0002	7
Trans-2-Hexene	0.006	70	0.0001	7
Isopentane	0.027	3500	0.0004	350
Isopropylbenzene	0.017	3300	0.0002	330
2-Methyl-2-butene	0.009	n/a	0.0001	n/a
Methylcyclohexane	0.119	16100	0.0016	1610
Methylcyclopentane	0.015	2600	0.0002	260
2-Methylheptane	0.093	3500	0.0012	350
2-Methylhexane	0.022	3070	0.0003	307
2-Methylpentane	0.033	290	0.0004	29
3-Methyl-1-butene	0.005	125	0.0001	12.5
3-Methylheptane	0.046	3500	0.0006	350
3-Methylhexane	0.039	3070	0.0005	307
3-Methylpentane	0.016	3500	0.0002	350
4-Methyl-1-pentene	0.008	70	0.0001	7
Nonane	0.493	2000	0.0065	200
Octane	0.147	3500	0.0019	350
Pentane	0.102	3500	0.0013	350
cis-2-Pentene	0.006	7500	0.0001	odour
trans-2-Pentene	0.015	7500	0.0002	Odour
Propane	0.052	18000	0.0007	1800
n-Propylbenzene	0.036	1250	0.0005	125
Toluene	0.131	640	0.0017	1200
1,2,4-Trimethylbenzene	0.119	1250	0.0016	125
1,3,5-Trimethylbenzene	0.049	1250	0.0007	125
m,p-Xylene	0.156	2080	0.0021	208
o-Xylene	0.062	3700	0.0008	370

NOTES:
n/a – not available
[1] Short term indicates a 1-hour averaging period.
[2] Long term indicates an annual averaging period.

Table 10: Maximum Predicted Ground-Level Concentrations of VOCs Associated with Air Emissions from the Spy Hill Asphalt Plant as Measured by AGAT. Relevant AAAQO Values are also Shown

VOC	Maximum Estimated Hourly Average Concentration (μg/m^3)	AAAQO (μg/m^3)	Maximum Estimated Daily Average Concentration (μg/m^3)	AAAQO (μg/m^3)
Benzene	0.075	30	0.033	not available
Toluene	0.131	1,880	0.058	400
Xylenes	0.156	2,300	0.069	700

Figure 2 shows isopleths of maximum predicted hourly average concentrations of benzene. The highest predicted concentration of 0.075 μg m^{-3} occurs about 600 m south-southeast of the Asphalt Plant. The largest concentration predicted within the sub-divisions of Rock Ridge and Royal Oak is about 0.03 μg/m^3.

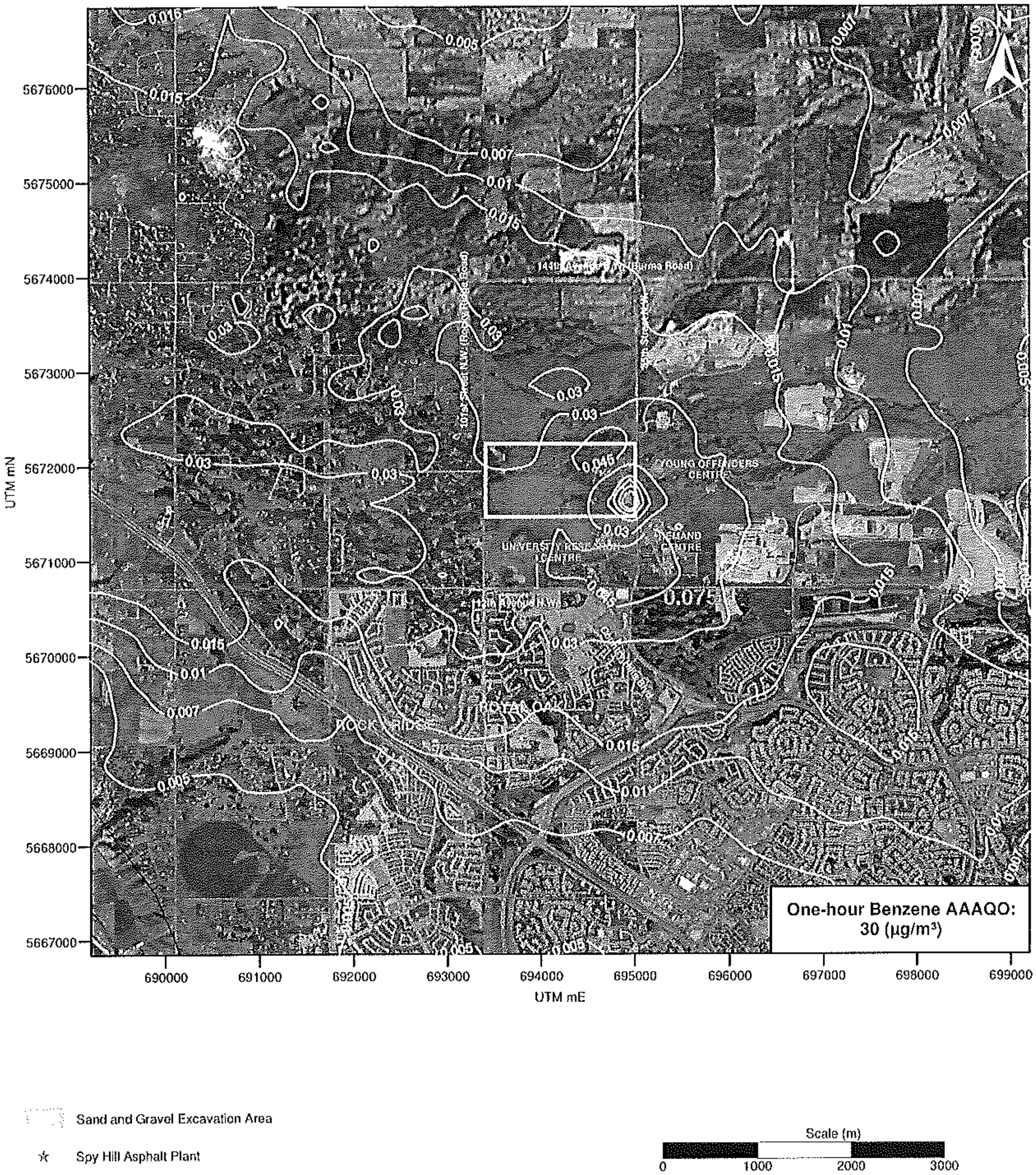

Figure 2: Isopleths of Maximum Predicted Hourly Average Ground-Level Benzene Concentrations (µg/m³) Associated with Emissions from the Spy Hill Asphalt Plant as Measured by Maxxam.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The Spy Hill Asphalt Plant is a source of a wide range of air emissions of criteria and volatile organic compounds.

In-stack measurements showed PM concentrations to be less than the maximum values stipulated in Alberta's Code of Practice for Asphalt Paving Plants. Stack concentration measurements of CO exceeded British Columbia's Ministry of Environment's standard of 0.5 g/m^3. But estimated ground-level concentrations of CO are nonetheless much lower than the AAAQOs and should therefore not have any adverse environmental implications.

An assessment of the ground-level air quality impacts of all other observed air emissions has demonstrated that they should also have no adverse environmental effects.

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