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MBS Environmental

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MRP Technical Consulting Pty Ltd prepared this report in accordance with the scope of work as outlined in our proposal to Martinick Bosch Sell Pty Ltd dated 16 May 2025 and in accordance with our understanding and interpretation of current regulatory standards.

The conclusions presented in this report represent MRP's professional judgement based on information made available during the course of this assignment and are true and correct to the best of MRP's knowledge as at the date of the assessment.

MRP did not independently verify all of the written or oral information provided during the course of this investigation. While MRP has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to MRP was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

This report has been prepared for MBS Environmental and may not be relied upon by any other person or entity without MRP's express written permission.

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1 Introduction

Zenith Energy Pty Ltd (Zenith) is working with Northern Star Resources (Northern Star) to develop additional power supply sources for the Kalgoorlie Consolidated Gold Mines (KCGM) operations which are located in Kalgoorlie in Western Australia, approximately 600 km east of Perth. Additional power supply is required to meet increasing power demands for the operation as a direct result of significant expansion of ore processing throughput rates at the Fimiston Gold Plant.

Zenith and Northern Star have identified supplementing the existing aging 110 MW natural gas thermal power supply at Parkeston with a new thermal power generation facility with a capacity of circa 140 MW. The new power station would provide the additional power required for increased ore processing. Construction and operation of the new facility would be targeted at providing power supply for KCGM by late 2027 to match scheduled completion of the Fimiston Gold Plant expansion at KCGM. Thermal power is anticipated to provide the full KCGM power needs for a period of 12–24 months with decreasing reliance over time as other alternative energy supply options are assessed and ultimately constructed and become available. Zenith and Northern Star are planning to construct the new 140 MW power station to the northwest of the existing Parkeston Power Station. The power station will comprise two engine halls, each with 6 engines and associated stacks. The two clusters of stacks will have a separation distance of approximately 68 m. The assessment considered the following potential air pollutants from the power station: oxides of nitrogen (NOx), particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2), carbon monoxide (CO) and formaldehyde (CH_2O).

Martinick Bosch Sell Pty Ltd (hereafter “MBS Environmental” or the “Client”) requested that MRP Technical Consulting Pty Ltd (MRP) undertake an air quality assessment in support of relevant environmental approvals and licenses associated with the proposed power station.

2 Methodology

2.1 Air dispersion model

The CALPUFF modelling system was utilised to undertake air dispersion modelling. CALPUFF is a multi-layer, multi-species, non-steady-state puff dispersion model. It utilises three-dimensional wind fields to simulate the effects of the temporal and spatial meteorological conditions on pollutant transport, transformation and removal. CALPUFF also allows for three-dimensional characterisation of land use and surface characteristics such as height and density of vegetation. CALPUFF was selected for this assessment to account for impacts on meteorology associated with the complex terrain at the nearby Fimiston Open Pit.

The following model set-up options within CALPUFF were used:

- Meteorological grid of 15.75 km by 13.5 km;
- Meteorological grid spacings of 0.15 km
- Sampling grid of 6 km by 6 km and 50 m spacing; and

- No chemical transformation.

In addition to the gridded receptors for CALPUFF, a number of discrete receptors were selected throughout the modelled domain representing nearby residential dwellings and recreational locations to provide a quantitative assessment of ground level concentrations (GLCs) in sensitive areas of interest. These discrete receptors are summarised in Table 2-1 and are also highlighted in Figure 2-1.

Table 2-1: Discrete receptor locations

Receptor	Easting (UTM Zone 51) (m)	Northing (UTM Zone 51) (m)	Distance to Project (km)
Ninga Mia East	355,791	6,599,225	0.7
Ninga Mia West	355,425	6,599,071	0.8
Kalgoorlie North 3	352,284	6,599,815	3.3
Kalgoorlie North 2	353,019	6,599,803	2.5
Kalgoorlie North 1	353,861	6,598,719	2.1
Kalgoorlie Central	354,090	6,598,599	2.0
Kalgoorlie South 1	354,275	6,598,022	2.3
Kalgoorlie South 2	354,328	6,597,706	2.5
Kalgoorlie South 3	354,479	6,597,413	2.7
Williamstown North	354,902	6,598,222	1.8
Williamstown Central East	354,903	6,597,876	2.1
Williamstown Central West	354,706	6,597,872	2.2
Williamstown South	355,020	6,597,400	2.6

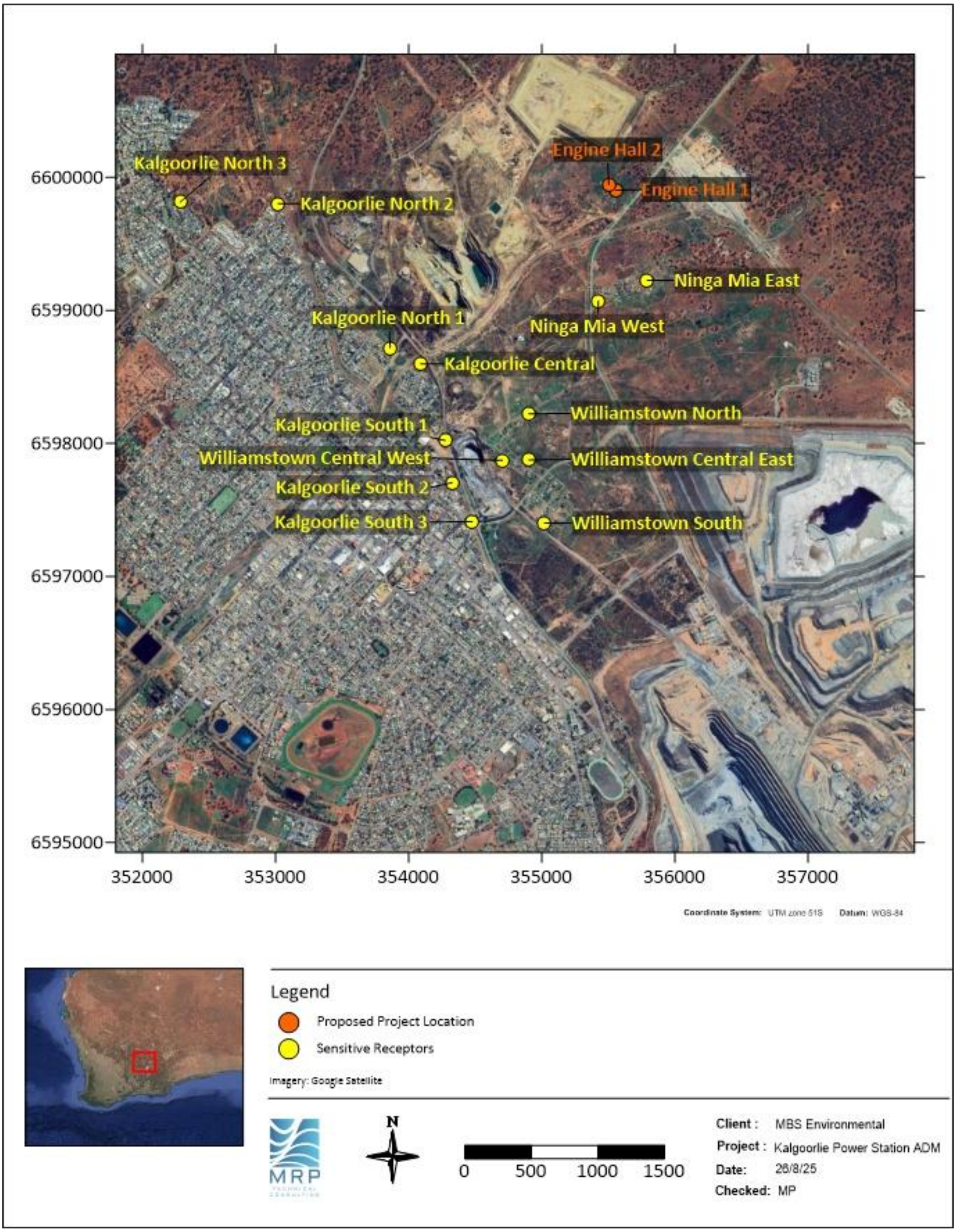

Figure 2-1 :Kalgoorlie power station project location and nominated sensitive receptors

2.2 Meteorological data

The meteorology of the required site was simulated using the Weather Research and Forecasting Model (Michalakes et al. 2001), subsequently referred to as "WRF". This is a state-of-the-art numerical model, which uses the basic laws of physics and thermodynamics to calculate the evolution of a region's meteorology in time and space. While originally released in 2001, it has been continuously updated since that date. Version 4.6 has been used in this assessment.

It represents the interactions of many variables, including wind velocity, air pressure, temperature and humidity, cloud, rain, snow, plus surface characteristics like soil moisture, land use type, vegetation structure, ground roughness and water surface temperature. These are represented on a set of three-dimensional grids, covering the full depth of the atmosphere and a horizontal region that may be only a few kilometres wide, or cover the whole globe. Normally it is used in "nested" mode, in which the broader scales surrounding a region of particular interest are represented at coarse resolution, while those centred on that region are represented on a fine scale.

2.2.1 Meteorological model configuration

The model run used five nests, with south-north resolution 81000, 27000, 9000, 3000 and 1000 metres, and west-east resolution approximately 85% of these values.

The centre of the modelling region was set at 32.683°S, 21.496°E. A polar grid setup was used. The innermost four nested grids were of size 31 by 31 cells, with the outermost 25 by 19. The innermost two were each centred within the next largest, with the third and fourth displaced northward within the next outermost (Figure 2-2). This arrangement was chosen to ensure that the transport of moisture, and so rainfall, from the ocean, and effects of winds from the southern coast, were adequately represented.

The run simulated the period 1 January to 31 December 2020. This period was preceded by a single day's "run up", provided to permit model parameters to stabilise. Experience has shown that since the model was initialised using high-resolution measured data, a good match between modelled and measured values developed within a few hours.

Input boundary and initial conditions for the model were obtained using the ERA5 reanalyses (Herzbach et al. 2023). The data used comprised a subset of the global data set, at 1° horizontal resolution with 16 levels from the surface to 50 hPa, covering the region from 90° to 165°E and 65° to 0°S.

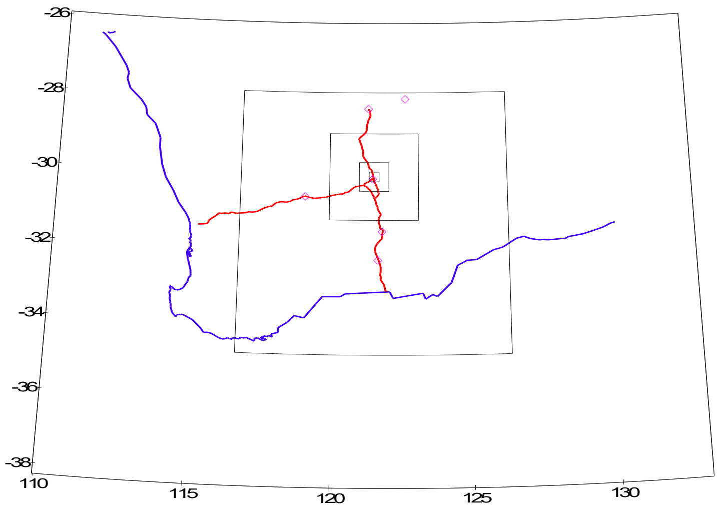

Figure 2-2: Boundaries of the five nested grids used for modelling, with an outline of the Western Australian coastline (blue) and major roads (red) for reference.

Other important configuration choices comprised:

- Providing for time-varying sea surface temperatures, based on global data records;
- Output of model results at hourly intervals for the two innermost grids, three-hourly intervals for the next two and six-hourly for the outermost;
- Lateral boundary conditions for the outermost nest provided by global measured data, with two-way transfer of boundary data at the edges of inner nests;
- Adaptive time steps, to speed execution. Experience has shown that while there are small differences between model results for fixed and adaptive time steps, both approaches give similar accuracy;
- 28 model layers, with interfaces between near-surface layers at heights of about 20, 50, 90, 160, 250, 360, 550 and 760 m;
- Microphysics using the WRF Single-Moment 6-class scheme (option 6), cumulus physics using the newer Tiedeke scheme (option 16), longwave radiation using the Rapid Radiative Transfer Model (option 4), shortwave radiation using the Dudhia scheme (option 1), surface layer using the revised MM5 surface layer scheme (option 1). These were found not to be crucial options, all reasonable choices giving similar results;
- Surface physics using the Noah Land Surface Model;
- Surface heights obtained for the Geoscience Australia 9-second data set;
- 4 soil layers;
- Boundary layer physics using the YSU scheme. This choice has been found to give reliable results, and also permits the use of the topographic wind adjustment scheme. The topographic wind adjustment factor ("topo_wind") was set to zero, this being appropriate for the low topography of the Kalgoorlie region. However, it was found to have negligible effect in this case;
- Non-hydrostatic modelling for all nests; and
- Nested boundary relaxation width of 4 cells;

Land use classes employed in the model were based on the MODIFIED_IGBP_MODIS_NOAH 30 second data set, with the exception that the urban area of Kalgoorlie was adjusted to match satellite imagery, and the area of Kalgoorlie Airport was set to the “barren ground” classification. Brief checks showed that these alterations had little effect on model results.

For the model run which is the focus of this report, WRF was run using only the standard initial and boundary condition inputs:

- Site measurements were not included, because it was desired to be able to compare model estimates with measurements. Should data from measurement sites have been incorporated in the model run, this would not have been feasible, since the validation process would have involved comparison of measurements with a derivative of those measurements; and
- Nudging of model calculations towards the ongoing values in the ERA5 analyses (using the “grid nudging” approach) was not used, since previous work had shown little effect on model results.

The CALMET meteorology files were generated for the period 31 December 2018 to 31 December 2019 (noting that the initial day was a run-up period for WRF) with a grid size of 105 points west-east and 90 points south-north, and 14 levels corresponding to the lowest 14 levels used by WRF. The southwest grid origin was located at UTM zone 51, 348125 m east and 6588250 m north, using grid intervals of 50 m. This grid was located well within innermost WRF modelling grid.

2.2.2 Analysis of the meteorological model results

The sole nearby site for which validation data were available was the Bureau of Meteorology station at Kalgoorlie Airport (located 30.7844°S, 121.4542°E). This is located on open ground, with the nearest buildings 50 m to the west and 70 m to the north west.

The modeled region was relatively flat, with only small, broad rises in topography. Corresponding modeled wind field variations were therefore relatively gradual (Figure 2-3).

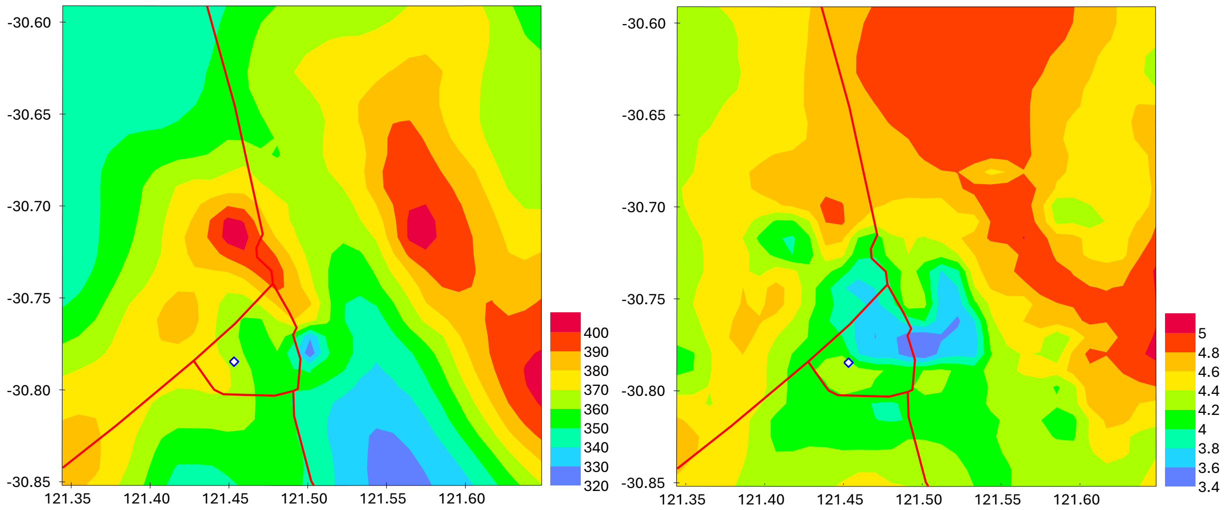

Figure 2-3: Surface heights (m) (Left) and modelled mean wind speeds (m/s) for the innermost model grid (Right). Red lines indicate major roads and the diamond shows the location of the Kalgoorlie Airport measurement site.

The model simulation showed reasonable performance at the Kalgoorlie Airport site. Sample plots of wind speed and direction are shown in Figure 2-4 and Figure 2-5, and statistics relating to the validation quality for wind speed, wind direction and air temperature are shown in Table 2-2.

Total modeled rainfall at Kalgoorlie Airport was 172.0 mm, while the measured total was 163.6. Figure 2-6 shows the trends of measured and modeled rainfall. It can be seen that there are some rainfall events in which modeled rainfall was heavier, others in which measured rainfall was heavier. This is a normal occurrence, particularly when modeling rainfall in semi-arid areas. As found by Rye (2021), matching of the time of rainfall events is the more important objective.

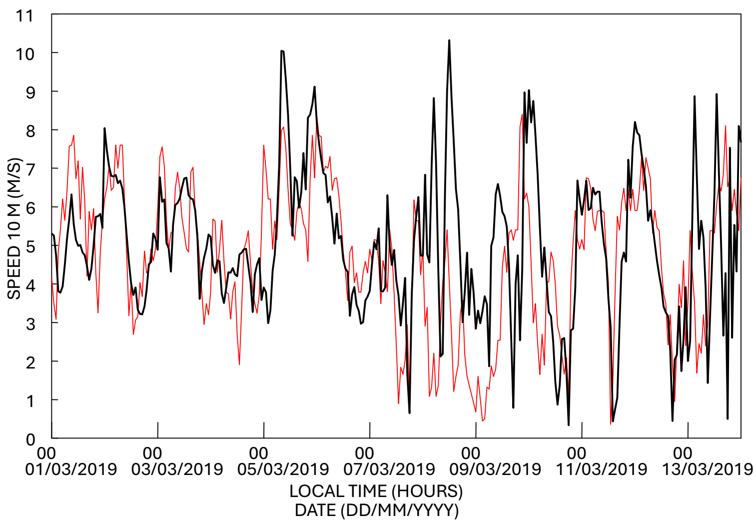

Figure 2-4: Sample plot comparing modeled (black line) and measured (red line) wind speeds at Kalgoorlie Airport

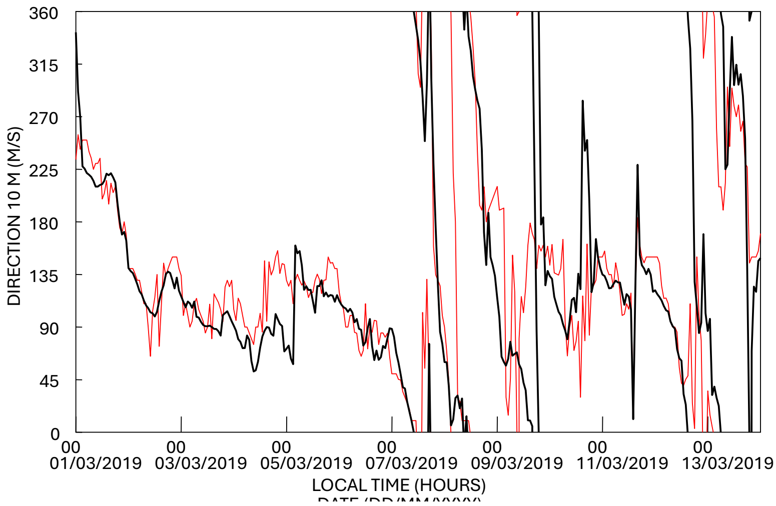

Figure 2-5: Sample plot comparing modeled (black line) and measured (red line) wind directions at Kalgoorlie Airport

Table 2-2: Model validation statistics for Kalgoorlie Airport

Variable	Wind Speed 10m	Wind Direction 10m	Air Temperature 2m
Gross Error	1.10 m/s	26.45º	2.04ºC
Index of Agreement	0.836	N/A	0.9794
Linear Fit Slope	1.025	0.985	1.046
Linear Fit Constant	-0.106 m/s	-1.633º	-2.421ºC
Standard Deviation	1.381 m/s	39.974º	1.976ºC
Correlation coefficient (r)	0.836	0.959	0.988

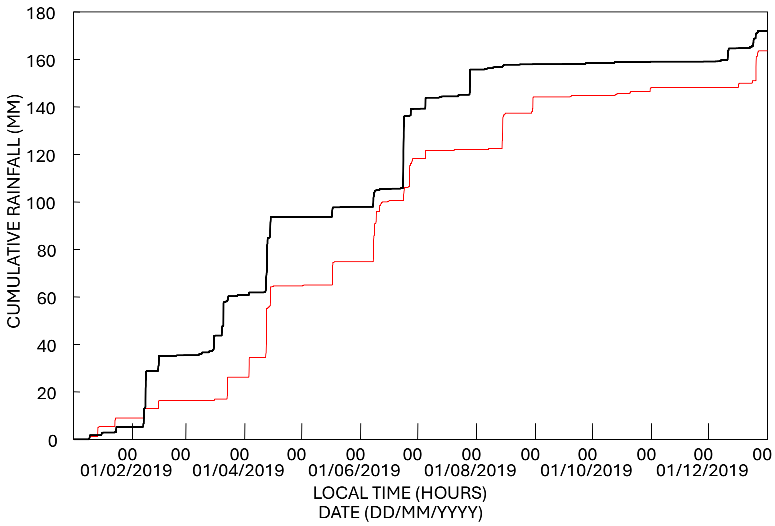

Figure 2-6: Comparison of modeled (black line) and measured (red line) cumulative rainfall at Kalgoorlie Airport.

Table 2-3 and Figure 2-7 show model estimates the occurrence of stability classes A-F, using the scheme of Golder (1972). While no validation of these estimates is possible, the greater relative frequency of high stability (class F) for wind direction sectors from north to east might be noted.

Table 2-3: Stability class distribution changes with wind direction.

Direction Sector	Stability Class					
	A	B	C	D	E	F
N	17	41	62	46	34	136
NE	38	72	81	24	52	213
E	71	141	146	169	134	219
SE	65	110	149	255	179	130
S	48	42	59	111	103	67
SW	29	57	91	48	151	109
W	22	42	105	127	107	72
NW	28	23	54	78	69	67
Totals	318	528	747	858	829	1013

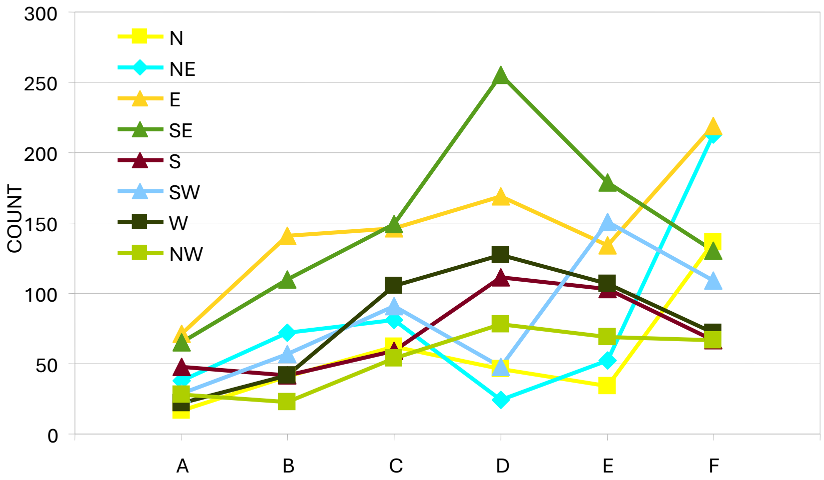

Figure 2-7: Stability class distribution changes with wind direction.

2.2.3 Buoyancy enhancement

Combined plume rise or plume rise enhancement is often used to account for the effect that nearby plumes will tend to merge and increase the overall plume rise of each individual plume. Plume rise enhancement was used in the model validations for the Karratha Gas Plant by Physick and Blockley (2001) who argued it was required to explain the observed concentrations, and also in the later model validation by Pitts et al (2011).

To better represent the effective plume rise from the proposed stack configuration at the Kalgoorlie Power Station, a buoyancy enhancement factor was applied in this assessment. The enhancement is based on work previously undertaken by Briggs (Briggs, 1975; 1984) and was later described by CSIRO (Manins et al., 1992). The approach defines a buoyancy enhancement factor (NE) as follows:

Equation 2-1

$$NE = \left[\frac{[n+S]}{[1+S]}\right]^{1/3}$$

Where *n* is the number of stacks and *S* is the dimensionless separation factor, defined as:

Equation 2-2

$$S = 6 * \left[\frac{(n-1)\Delta s}{n^{1/3}\Delta z}\right]^{3/2}$$

Where Δ*s* is the stack separation and Δ*z* is the rise of an individual plume above the top of the stack (i.e. for a single stack in isolation). The relevant Δ*z* was estimated for a single stack in isolation, whilst Δ*s* was based on the stack separation. The separation factor and buoyancy enhancement factor were then estimated in accordance with Equation 1 and Equation 2. The CALPUFF model was then re-run to provide hourly plume rise profiles incorporating buoyancy enhancement. The buoyancy enhancement factor was applied to separate clusters of six proposed stacks.

An equivalent diameter of 3.68 m was adopted in the modelling, based on an original stack diameter of 1.4 m, to reflect this enhancement. This adjustment is intended to provide a more realistic representation of plume behaviour under operational conditions and improve the accuracy of predicted ground level concentrations.

2.3 Particulate emissions

In this assessment, whilst emissions of total particulates have been modelled, the results have only been compared against the $PM_{2.5}$ (particulate matter ≤2.5 µm in diameter) guideline. The $PM_{2.5}$ criteria is more conservative than the PM_{10} criteria and $PM_{2.5}$ is widely recognised as posing a greater risk to human health than PM_{10}, due to its ability to penetrate deeper into the respiratory system and enter the bloodstream (DEC, 2011). As such, this guideline has been adopted as the primary indicator for assessing potential health impacts from airborne particulates.

2.4 Background concentrations

The Department of Water and Environmental Regulation (DWER) collects air quality data in Western Australia from a number of monitoring stations throughout the Perth, Kwinana, Southwest, Kalgoorlie and Midwest regions of the state. No specific guidance for selection of an appropriate background level is provided in Western Australia. Accordingly, in Victoria, the State Environment Protection Policy (Ambient Air Quality) (SEPP (AQM)) (EPA Victoria, 2001) states that the 70th percentile concentration (concentration which is exceeded by 30% of concentrations for that averaging period) should be adopted as the background level. DWER reports annually the 75th percentile for NO_2, $PM_{2.5}$, SO_2, and CO short-term averages at its monitoring stations in Western Australia. Hence, in the absence of reported 70th percentile values, the highest recorded 75th percentile for short-term averages and the annual average concentrations measured at any of the DWER monitoring stations for the most recent published monitoring period (2022) were utilised in this study to represent the ambient background concentrations (Table 2-4) of the pollutants of concern. Where there was 75th percentile and annual average monitoring data available for the Kalgoorlie region, that data takes precedence.

In the absence of monitoring data in the DWER document (2022), regional concentrations were adapted from the Copernicus Atmosphere Monitoring Service (CAMS) global reanalysis dataset (Copernicus, 2024) (Table 2-5).

Table 2-4: DWER monitored ambient background concentrations

Pollutant	Averaging period	Concentration (µg/m³)[1]	Monitoring station
NO_2	75th percentile 1-hour	35.7	Duncraig & South Lake
	Annual	11.3	South Lake
$PM_{2.5}$	75th percentile 24-hour	4.7	Kalgoorlie
	Annual	4.2	Kalgoorlie
SO_2	75th percentile 1-hour	13.1	Kalgoorlie
	75th percentile 24-hour	5.2	Kalgoorlie
CO	75th percentile 8-hour	343.5	Duncraig & South Lake

Notes
1. Referenced to 25ºC, and 101.3 kPa

Table 2-5: CAMS monitored background concentrations

Pollutant	Averaging Period	Concentration (µg/m³)[1]
SO_2	Annual	0.098
CO	70th percentile 1-hour	84
CH_2O	70th percentile 1-hour	2.0
	70th percentile 24-hour	2.1

Notes
1. Referenced to 25ºC, and 101.3 kPa

2.5 Treatment of oxides of nitrogen

A key element in assessing the potential environmental impacts from ground level NO_2 concentrations is estimating NO_2 concentrations from modelled NO_x emissions. The final NO_2 concentration is a combination of the NO emitted as NO_2 from the source stacks and the amount of NO that is converted to NO_2 by oxidation in the plume after release.

Generally, after the NO_x is emitted from the stack, additional NO_2 is formed as the plume mixes and reacts with the surrounding air. There are several reactions that both form and destroy NO_2, but the primary reaction is oxidation with ozone according to the following reaction (Calvert et al, 2015):

$$NO + O_3 \rightarrow NO_2 + O_2$$

This reaction is essentially instantaneous as the plume entrains the surrounding air. It is limited by the amount of ozone available and by how quickly the plume mixes with the surrounding air. Thus, the ratio of NO_2 to NO_x increases as the plume disperses downwind. After release, the NO is converted to NO_2 by chemical reactions, primarily involving ozone in the presence of sunlight and to a lesser extent due to other reactive gases.

MRP has applied the Ozone Limiting Method (OLM) to predict ground level concentrations of NO_2 as specified by the USEPA (see Cole and Summerhays 1979; Tikvart 1996) and NSW Environment Protection Authority (NSW EPA, 2016). This method assumes that all the available ozone in the atmosphere will react with nitrogen oxide (NO) in the plume until either all the available ozone or all the NO is used up. This approach is conservative in that it assumes that the atmospheric reaction is instant when in reality, the reaction takes place over a number of hours.

In the absence of ozone monitoring data in the Kalgoorlie region, regional 3-hourly ozone concentrations were adapted from the Copernicus Atmosphere Monitoring Service (CAMS) global reanalysis dataset (Copernicus, 2024) and utilised in this assessment.

2.6 Scenarios

A number of scenarios representing potential future operations under normal operating conditions were modelled as part of the assessment. It is noted that the power station is typically expected to operate in gas mode (Scenario #1 and #2). The power station will operate in liquid fuel (LFO) mode only in the event that natural gas is unavailable. An investigation into the frequency of historic gas supply interruptions was undertaken. Northern Star Resources has verbally communicated that the gas supply has not been interrupted during normal operation conditions in the previous ten (10) years and that the Parkeston facility has not previously experienced any interruptions to their gas supply. An overview of the scenarios modelled as part of this assessment is provided below.

Scenario #1: Gas mode - in isolation

- 12 stacks from 2 engine halls (6 stacks for each engine hall) operating in gas mode
  - 370 mg/m^3 NOx emissions, dry at 15% O_2
  - 220 mg/m^3 carbon monoxide emissions, dry at 15% O_2
  - 14 mg/m^3 sulphur dioxide emissions, dry at 15% O_2
  - 7 mg/m^3 particulate matter as $PM_{2.5}$ emissions, dry at 15% O_2
  - 30 mg/m^3 formaldehyde emissions, dry at 15% O_2

Scenario #2: Gas mode - cumulative

- Scenario #1 emissions with background concentrations.

Scenario #3: LFO mode - in isolation

- 12 stacks from 2 engine halls (6 stacks for each engine hall) operating in LFO mode

- 1700 mg/m^3 NOx emissions, dry at 15% O_2
- 30 mg/m^3 carbon monoxide emissions, dry at 15% O_2
- 70 mg/m^3 sulphur dioxide emissions, dry at 15% O_2
- 25 mg/m^3 particulate matter as $PM_{2.5}$ emissions, dry at 15% O_2

Scenario #4: LFO mode - cumulative.

- Scenario #3 emissions with background concentrations.

In terms of potential upset conditions, Zenith Energy indicated that emissions from startup and shutdown operations will not significantly differ from normal operations (per comms: 9th & 10th August 2025). Startup operations occur for short duration with a maximum startup time of 5 minutes where the overall concentration of pollutants within the emissions stream is similar to normal operations (as represented in scenarios #1 & #4).

2.7 Stack parameters and emissions estimates

Table 2-6 presents the emissions estimates and stack parameters from the operation of the power station using gas fuel and diesel (Gas mode and LFO mode) respectively used in the air dispersion modelling. Table 2-5 displays the coordinates of the stacks based on the information provided by Zenith.

Table 2-6: Summary of estimated emissions per engine

Parameter	Units	Gas mode	LFO mode
Height	**m**	30	30
Diameter	**m**	1.4 (3.68)[1]	1.4 (3.68)[1]
Temp	**K**	610	553
Exit velocity	**m/s**	22.4	22.7
Emission estimates			
Oxide of nitrogen (NOx)	**g/s**	7.8	38.6
PM_{25}	**g/s**	0.1	0.6
Sulphur dioxide (SO_2)	**g/s**	0.3	1.6
Carbon monoxide (CO)	**g/s**	4.6	0.7
Formaldehyde (CH_2O)	**g/s**	0.6	NE

Notes

1. The value in brackets is an equivalent diameter calculated using the buoyancy enhancement factor as outlined in Section 2.2.3.
2. NE = Negligible emissions

Table 2-7: Stack locations

Stack description	Easting (UTM zone 51) (m)	Northing (UTM zone 51) (m)
Engine hall 1-1	355,559	6,599,905
Engine hall 1-2	355,557	6,599,903
Engine hall 1-3	355,555	6,599,900
Engine hall 1-4	355,552	6,599,902

Stack description	Easting (UTM zone 51) (m)	Northing (UTM zone 51) (m)
Engine hall 1-5	355,554	6,599,905
Engine hall 1-6	355,556	6,599,907
Engine hall 2-1	355,507	6,599,948
Engine hall 2-2	355,504	6,599,946
Engine hall 2-3	355,502	6,599,943
Engine hall 2-4	355,499	6,599,945
Engine hall 2-5	355,502	6,599,948
Engine hall 2-6	355,504	6,599,951

3 Air quality criteria

Ambient air quality standards are generally designed to protect human health, with an adequate margin of safety, including sensitive populations such as children, the elderly, and individuals suffering from respiratory diseases. They are generally applied at residential areas or places where people may congregate in public areas, such as beaches or picnic areas. In this instance, nearby residences would be the nearest sensitive receptors where ambient air quality standards would apply.

The Department of Water and Environmental Regulation (DWER) published the Guidance Statement for Risk Assessments in February 2017 (DWER, 2017) and the draft Guideline: Air Emissions in October 2019 (DWER, 2019), which refer to air quality criteria that may be considered in determining public health and environment impacts. The publications containing air quality criteria relevant to this assessment include:

- National Environment Protection (Ambient Air Quality) Measure (NEPM) (NEPC, 2021), noting that a proposed variation to the $PM_{2.5}$ and SO_2 standards have recently come into effect as of January 2025;
- NEPM (Air Toxics) (NEPC, 2011); and
- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (AMMAAP) (NSW EPA, 2022).

Table 3-1 displays standards for pollutants relevant to this assessment. Where there is available framework in both the NEPM (NEPC, 2021) and the DWER guideline (2019), the NEPM criteria is used.

Table 3-1: Relevant air quality criteria

Compound	Averaging period	Concentration (µg/m³)[1]	Source
NO_2	1-hour	151	(NEPC, 2021)
	Annual	28	
$PM_{2.5}$	24-hour	18	(NEPC, 2021)
	Annual	6.4	
SO_2	1-hour	196	(NEPC, 2021)
	24-hour	52	
	Annual	52	(DWER, 2019)
CO	1-hour	30,000	(DWER, 2019)
	8-hour	10,000	(NEPC, 2021)
CH_2O	1-hour	20	(DWER, 2019)
	24-hour[2]	49	(NEPC, 2011)

Notes

1. Referenced to 25ºC, and 101.3 kPa
2. This is a monitoring investigation level. As defined in the NEPM (AT) (NEPC, 2011), monitoring investigation levels are established for use in assessing the significance of the monitored levels of air toxics with respect to protection of human health. If the monitoring investigation level is exceeded then some form of further investigation by the relevant jurisdiction of the cause of the exceedance is appropriate.

4 Modelling results

4.1 Nitrogen dioxide

Contour plots showing predicted concentrations of NO_2 can be found in Figure 4-1 to Figure 4-8 below, with relevant air quality criteria displayed as a red contour line. Table 4-1presents the predicted GLCs at nearby sensitive receptors in the region.

Results of the modelling indicated that for the normal operations scenario, no exceedances of relevant 1-hour maximum or annual average ambient guideline values (AGVs) for NO_2 were predicted at any nearby sensitive receptors. Concentrations of NO_2 are predicted to meet and/or exceed the 1-hour NO_2 AGV at the sensitive receptors: Ninga Mia East and Kalgoorlie North 2, with predicted values of 104% and 100% respectively for scenario 4 (LFO mode – cumulative). It is noted that Northern Star Resources has verbally communicated that the gas supply has not been interrupted during normal operation conditions in the previous ten (10) years and that the Parkeston facility has not previously experienced any interruptions to their gas supply. Given the low likelihood of the gas supply being interrupted and the low probability that it would occur under worst case meteorological conditions, the likelihood of an exceedance occurring would be considered negligible. When considered in isolation, the same receptors reach 80% and 77% of the 1-hour AGVs respectively.

Table 4-1: Summary of predicted NO_2 concentrations at the closest sensitive receptors

1-hour maximum NO_2 ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East				53	35%	89	59%	121	80%	157	104%
Rec_002	Ninga Mia West				60	40%	96	64%	91	61%	127	84%
Rec_003	Kalgoorlie North 3				54	36%	90	59%	100	66%	136	90%
Rec_004	Kalgoorlie North 2				54	36%	90	60%	116	77%	151	100%
Rec_005	Kalgoorlie North 1				52	35%	88	58%	96	64%	132	87%
Rec_006	Kalgoorlie Central				55	36%	91	60%	93	62%	129	86%
Rec_007	Kalgoorlie South 1	151	35.7	24%	54	36%	90	59%	90	60%	126	84%
Rec_008	Kalgoorlie South 2				57	38%	93	62%	85	56%	121	80%
Rec_009	Kalgoorlie South 3				38	25%	76	50%	71	47%	107	71%
Rec_010	Williamstown North				46	30%	85	56%	79	52%	118	78%
Rec_011	Williamstown Central East				45	30%	81	53%	85	56%	122	81%
Rec_012	Williamstown Central West				46	30%	82	54%	75	50%	111	73%
Rec_013	Williamstown South				44	29%	80	53%	76	51%	112	74%
Annual average NO_2 ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East				0.7	3%	12.1	43%	1.7	6%	13.1	47%
Rec_002	Ninga Mia West				0.7	3%	12.1	43%	1.8	6%	13.1	47%
Rec_003	Kalgoorlie North 3				1.3	5%	12.7	45%	3.4	12%	14.8	53%
Rec_004	Kalgoorlie North 2				1.5	5%	12.9	46%	3.7	13%	15.1	54%
Rec_005	Kalgoorlie North 1				0.8	3%	12.3	44%	2.3	8%	13.8	49%
Rec_006	Kalgoorlie Central				0.8	3%	12.3	44%	2.1	8%	13.6	49%
Rec_007	Kalgoorlie South 1	28	11.3	40%	0.6	2%	12.8	46%	1.7	6%	13.9	50%
Rec_008	Kalgoorlie South 2				0.6	2%	12.2	44%	1.6	6%	13.2	47%
Rec_009	Kalgoorlie South 3				0.5	2%	12.0	43%	1.5	5%	13.0	46%
Rec_010	Williamstown North				0.6	2%	12.2	44%	1.6	6%	13.2	47%
Rec_011	Williamstown Central East				0.6	2%	12.2	44%	1.6	6%	13.2	47%
Rec_012	Williamstown Central West				0.6	2%	12.2	44%	1.6	6%	13.2	47%
Rec_013	Williamstown South				0.5	2%	12.2	43%	1.4	5%	13.1	47%

Notes

1. Referenced to 25ºC, and 101.3 kPa

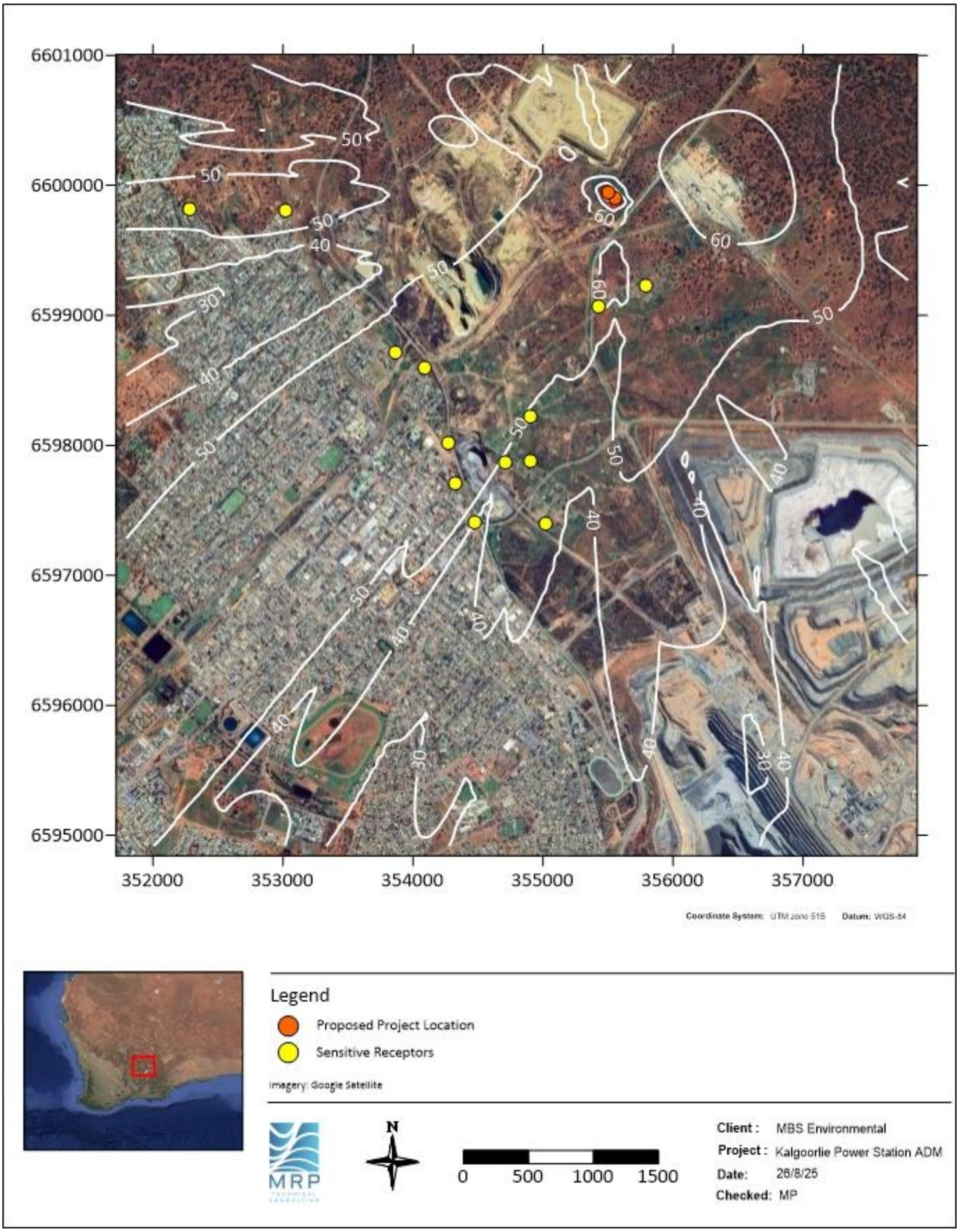

Figure 4-1: Predicted 1-hour maximum GLCs of NO_2 (µg/m³) in isolation – gas mode (Scenario 1)

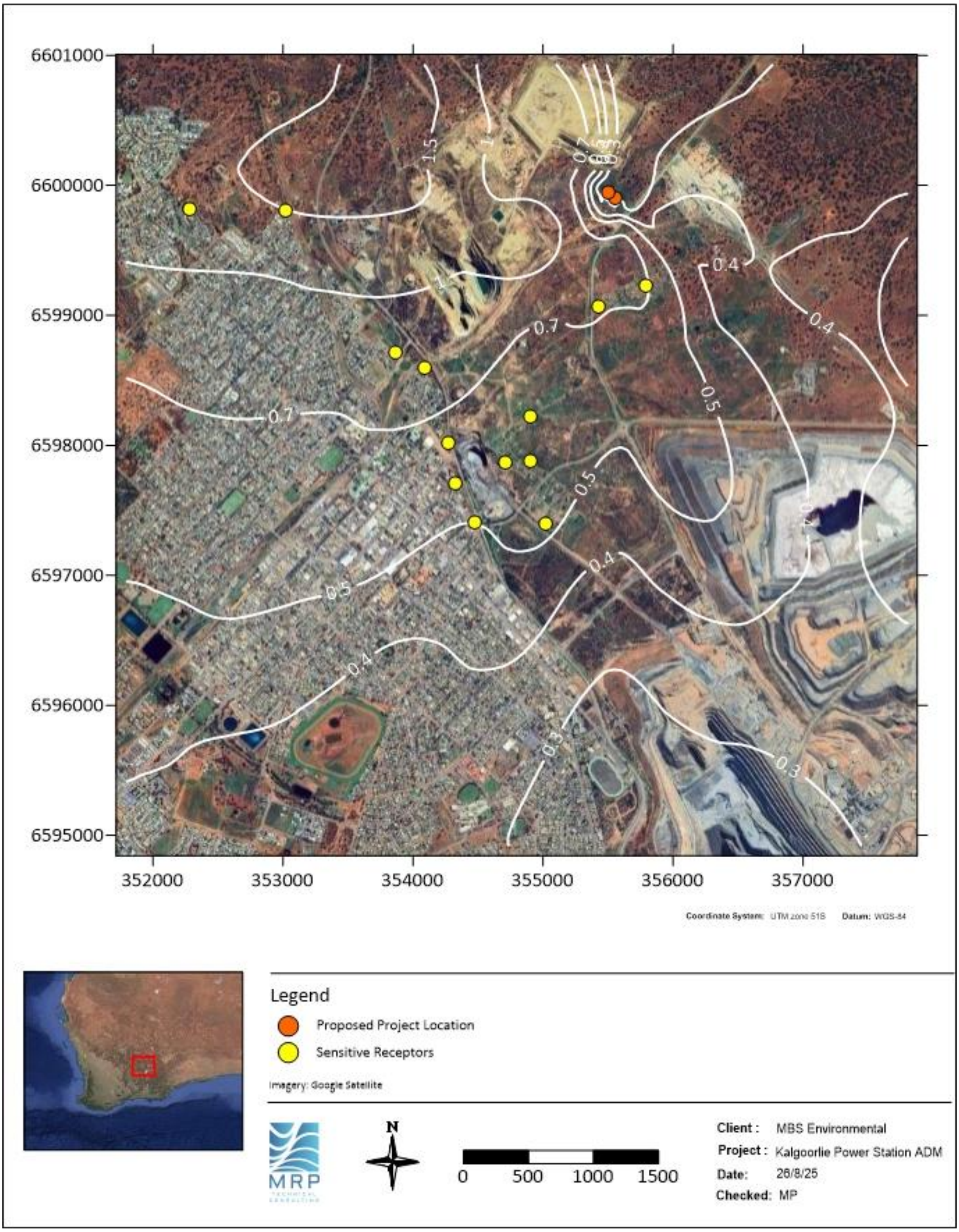

Figure 4-2: Predicted annual average GLCs of NO_2 ($\mu g/m^3$) in isolation – gas mode (Scenario 1)

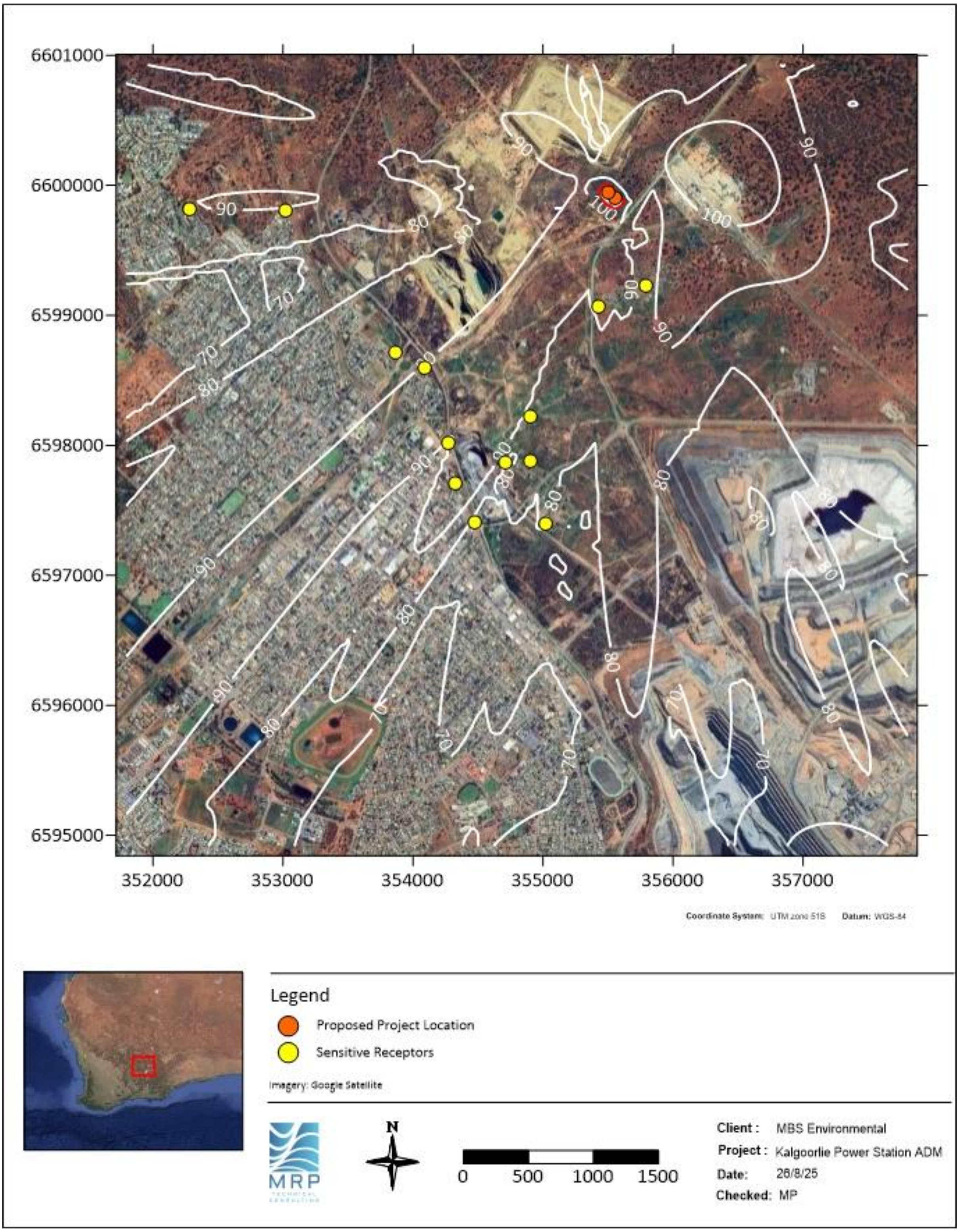

Figure 4-3: Predicted cumulative 1-hour maximum GLCs of NO_2 (µg/m³) – gas mode (Scenario 2)

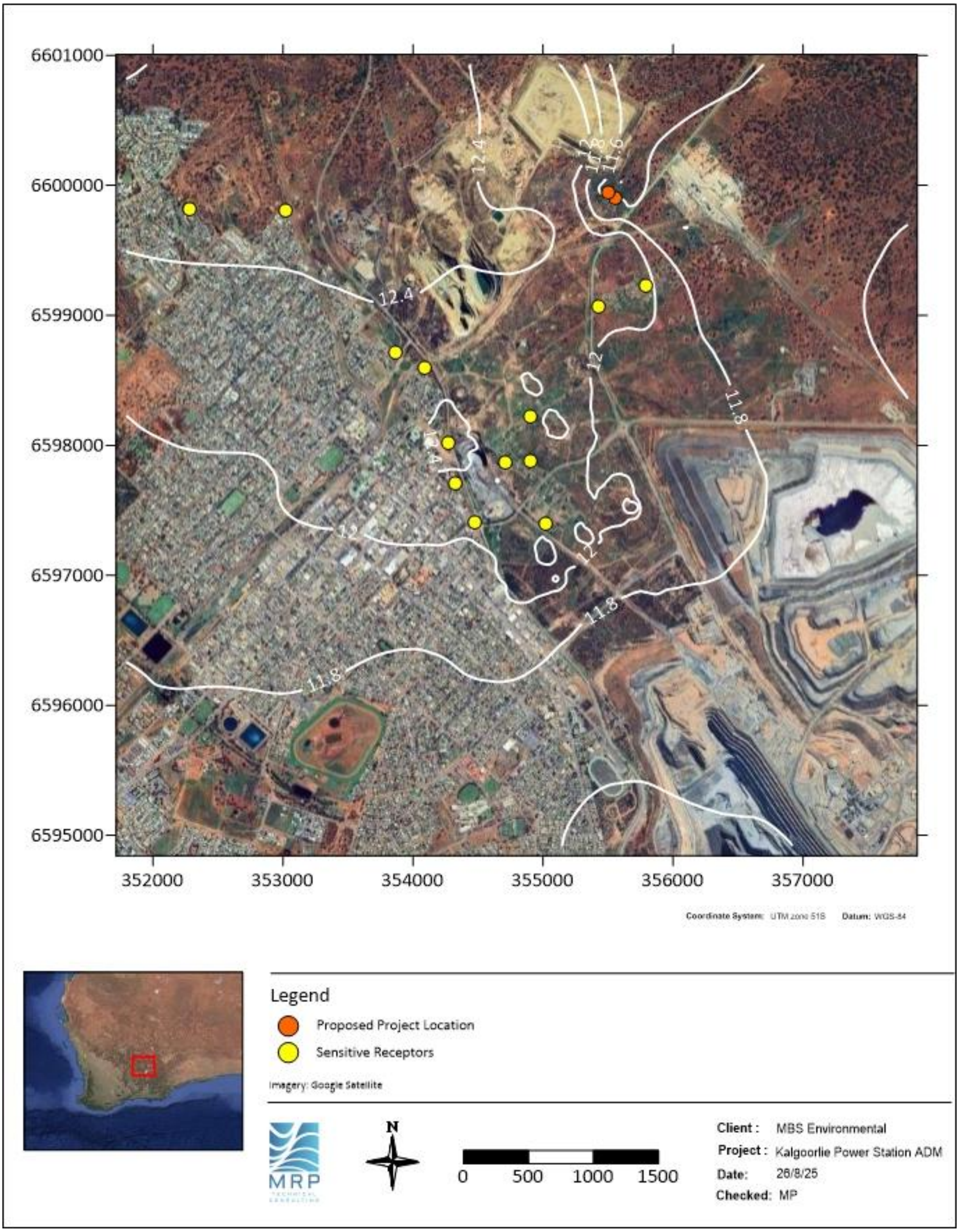

Figure 4-4: Predicted cumulative annual average GLCs of NO_2 (μg/m³) – gas mode (Scenario 2)

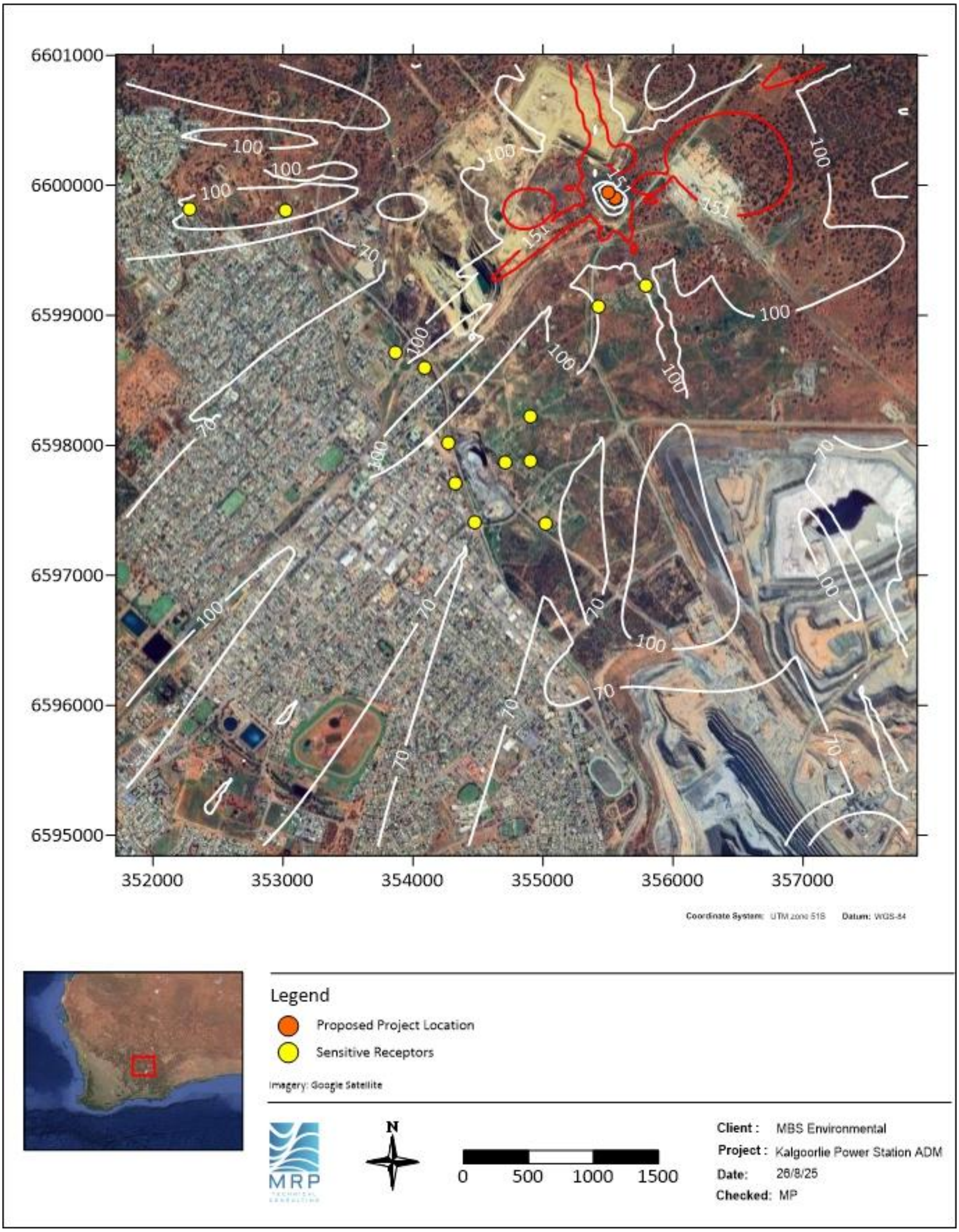

Figure 4-5: Predicted 1-hour maximum GLCs of NO_2 (µg/m³) in isolation – LFO mode (Scenario 3)

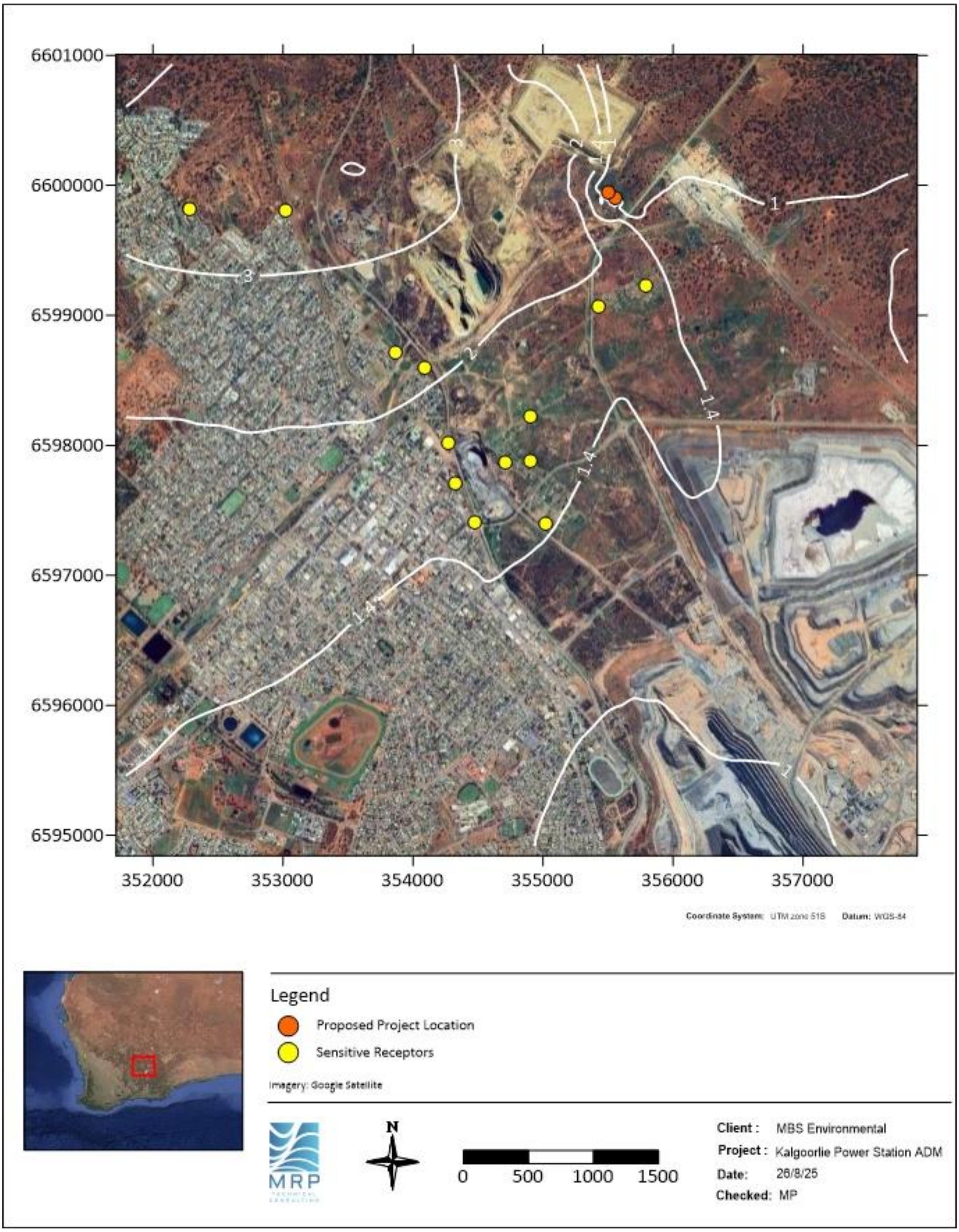

Figure 4-6: Predicted annual average GLCs of NO_2 (μg/m^3) in isolation – LFO mode (Scenario 3)

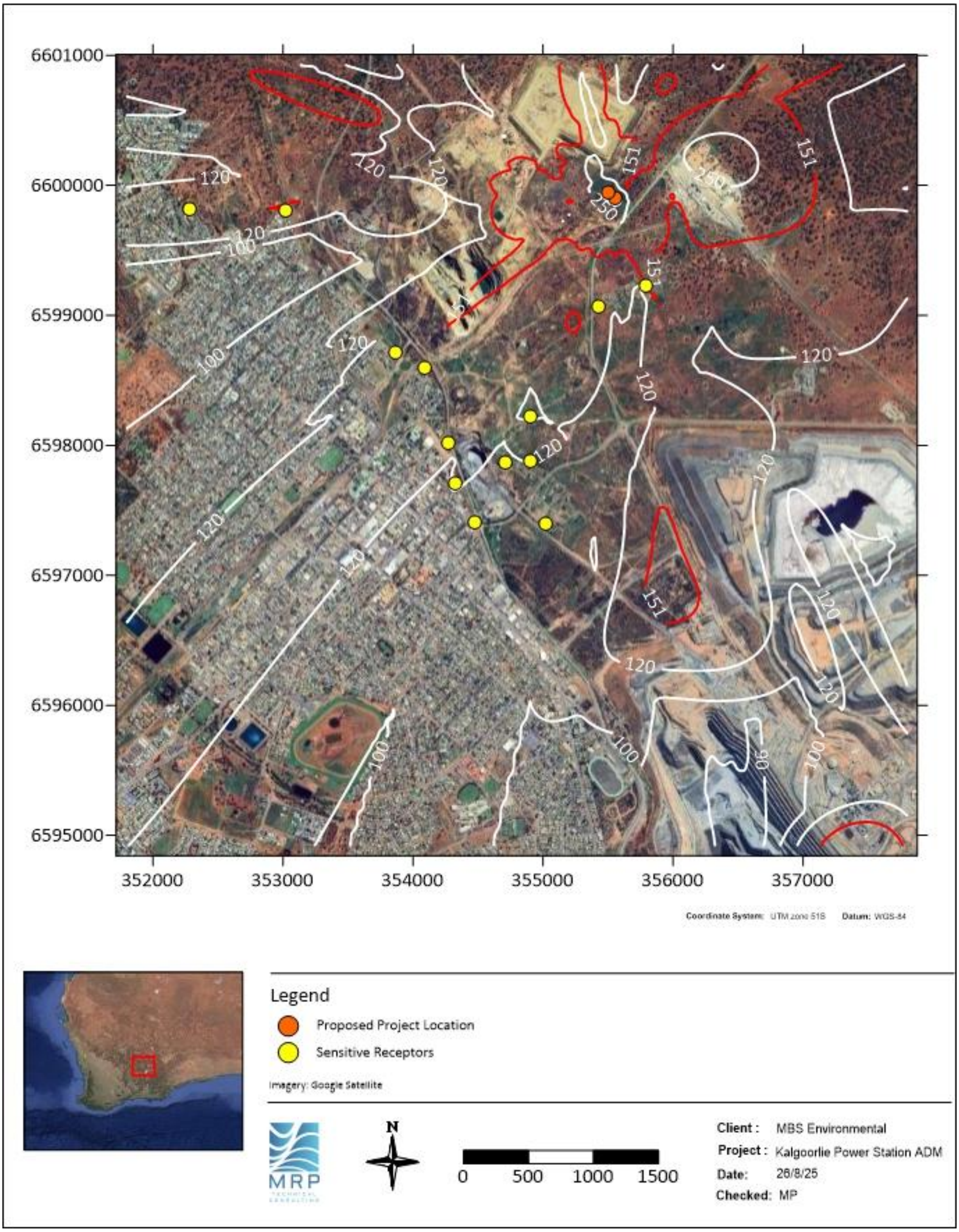

Figure 4-7: Predicted cumulative 1-hour maximum GLCs of NO_2 ($\mu g/m^3$) – LFO mode (Scenario 4)

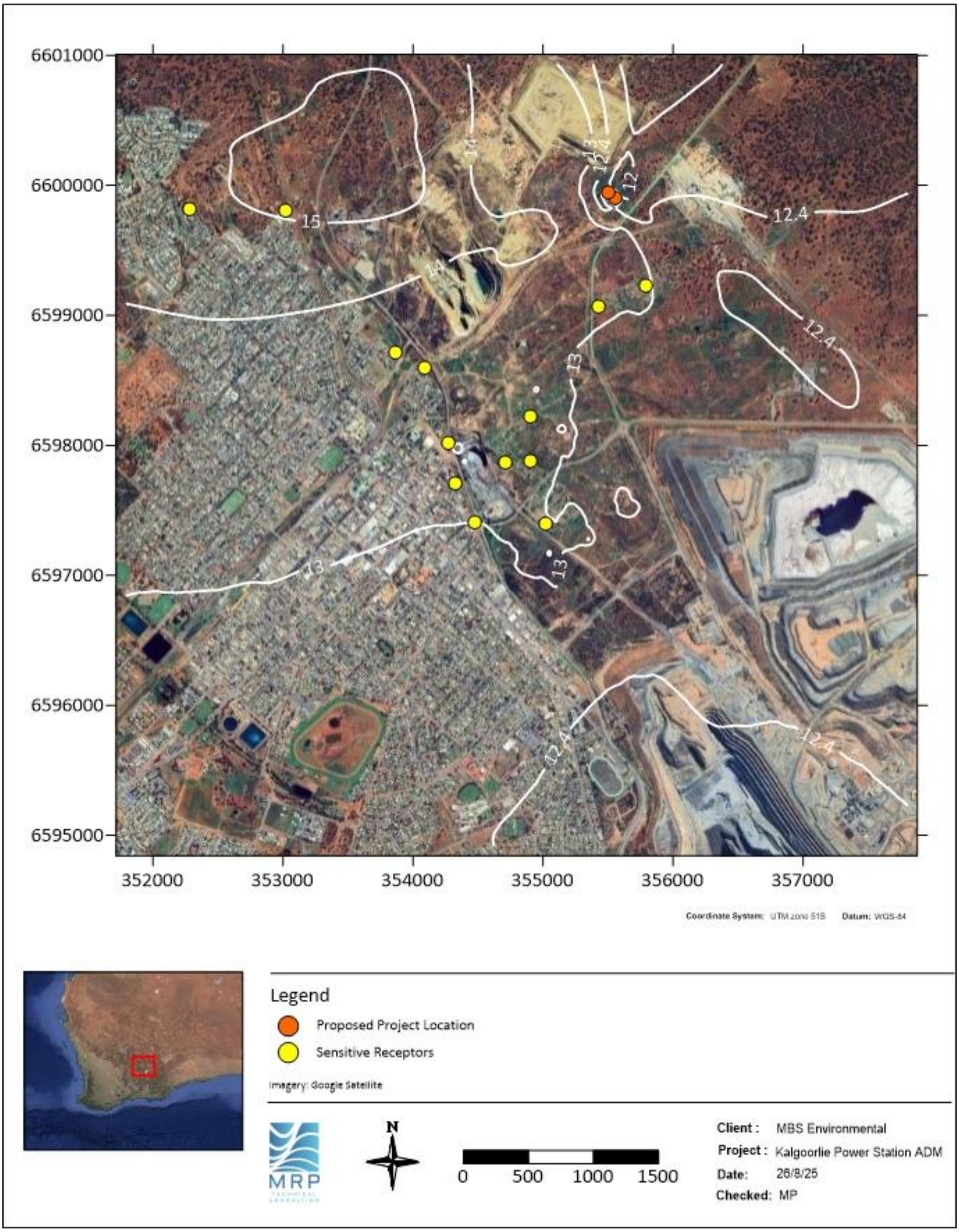

Figure 4-8: Predicted cumulative annual average GLCs of NO_2 (µg/m^3) – LFO mode (Scenario 4)

4.2 Particulate matter ($PM_{2.5}$)

Contour plots showing predicted concentrations of $PM_{2.5}$ can be found in Figure 4-9 to Figure 4-16 below, with relevant air quality criteria displayed as a red contour line. Table 4-2 presents the predicted GLCs at nearby sensitive receptors in the region.

Results of the modelling indicated that there were no exceedances of the relevant 24-hour maximum or annual average AGVs for $PM_{2.5}$ predicted at any of the nearby sensitive receptors for any of the modelled scenarios.

Table 4-2: Summary of predicted $PM_{2.5}$ concentrations at the closest sensitive receptors

24-hour maximum $PM_{2.5}$ ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East	18	4.7	26%	0.35	2%	5.05	28%	1.34	7%	6.04	34%
Rec_002	Ninga Mia West				0.31	2%	5.01	28%	1.29	7%	5.99	33%
Rec_003	Kalgoorlie North 3				0.29	2%	4.99	28%	1.16	6%	5.86	33%
Rec_004	Kalgoorlie North 2				0.35	2%	5.05	28%	1.35	8%	6.05	34%
Rec_005	Kalgoorlie North 1				0.25	1%	5.01	28%	1.07	6%	5.77	32%
Rec_006	Kalgoorlie Central				0.23	1%	5.05	28%	1.04	6%	5.74	32%
Rec_007	Kalgoorlie South 1				0.21	1%	5.18	29%	0.87	5%	5.60	31%
Rec_008	Kalgoorlie South 2				0.15	1%	5.00	28%	0.60	3%	5.42	30%
Rec_009	Kalgoorlie South 3				0.15	1%	4.92	27%	0.67	4%	5.39	30%
Rec_010	Williamstown North				0.16	1%	4.93	27%	0.70	4%	5.44	30%
Rec_011	Williamstown Central East				0.16	1%	4.89	27%	0.64	4%	5.38	30%
Rec_012	Williamstown Central West				0.16	1%	4.94	27%	0.71	4%	5.45	30%
Rec_013	Williamstown South				0.16	1%	4.95	28%	0.65	4%	5.39	30%
Annual average $PM_{2.5}$ ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East	6.4	4.2	66%	0.019	0.3%	4.22	66%	0.075	1.2%	4.28	67%
Rec_002	Ninga Mia West				0.020	0.3%	4.22	66%	0.082	1.3%	4.29	67%
Rec_003	Kalgoorlie North 3				0.032	0.5%	4.24	66%	0.129	2.0%	4.33	68%
Rec_004	Kalgoorlie North 2				0.038	0.6%	4.24	66%	0.152	2.4%	4.36	68%
Rec_005	Kalgoorlie North 1				0.020	0.3%	4.23	66%	0.082	1.3%	4.29	67%
Rec_006	Kalgoorlie Central				0.018	0.3%	4.23	66%	0.077	1.2%	4.29	67%
Rec_007	Kalgoorlie South 1				0.014	0.2%	4.29	67%	0.061	1.0%	4.33	68%
Rec_008	Kalgoorlie South 2				0.012	0.2%	4.24	66%	0.052	0.8%	4.28	67%
Rec_009	Kalgoorlie South 3				0.011	0.2%	4.23	66%	0.045	0.7%	4.27	67%
Rec_010	Williamstown North				0.013	0.2%	4.24	66%	0.057	0.9%	4.28	67%
Rec_011	Williamstown Central East				0.013	0.2%	4.24	66%	0.054	0.8%	4.28	67%
Rec_012	Williamstown Central West				0.012	0.2%	4.24	66%	0.053	0.8%	4.28	67%
Rec_013	Williamstown South				0.012	0.2%	4.24	66%	0.047	0.7%	4.27	67%

Notes
1. Referenced to 25ºC, and 101.3 kPa

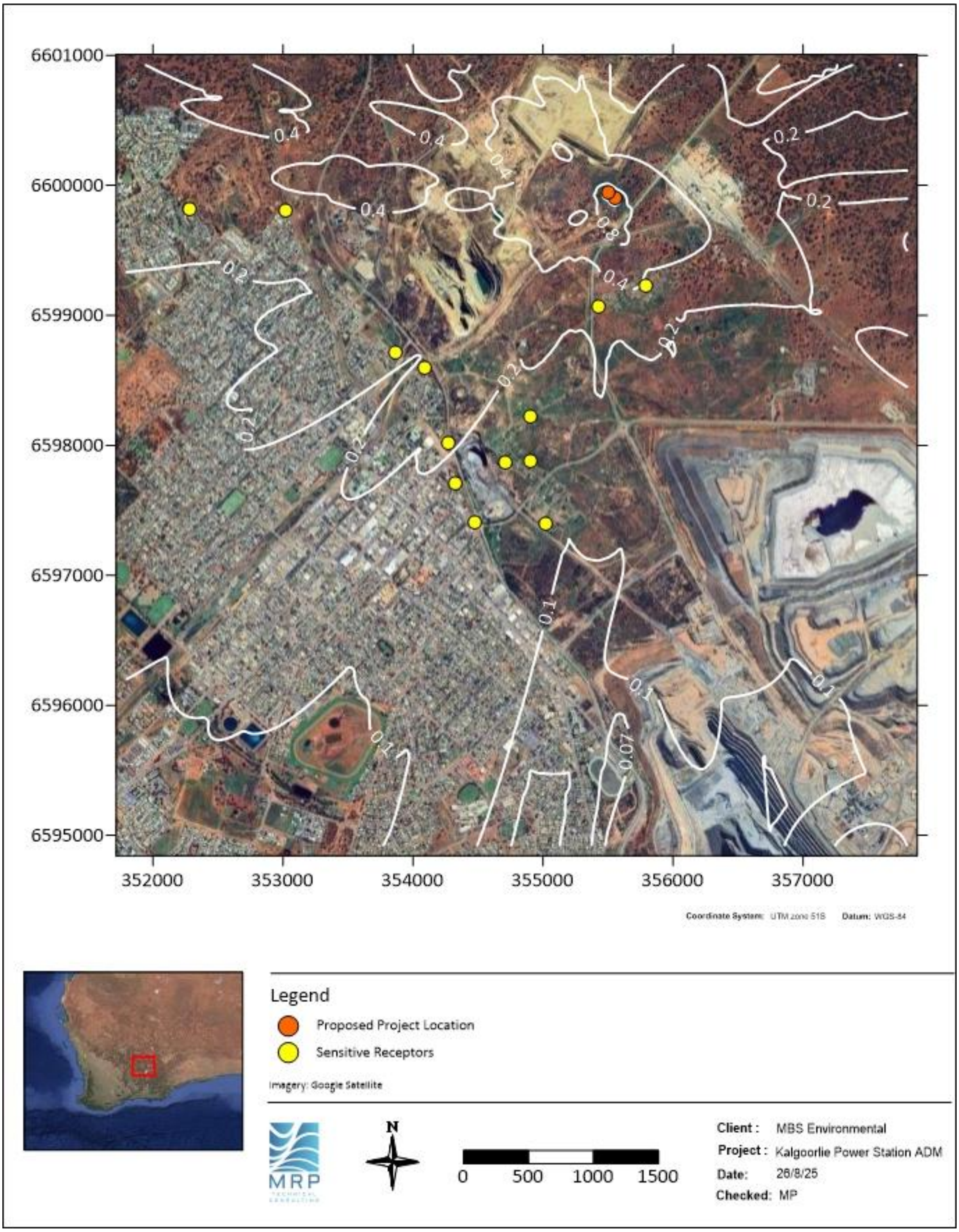

Figure 4-9: Predicted 24-hour maximum GLCs of $PM_{2.5}$ (µg/m³) in isolation – gas mode (Scenario 1)

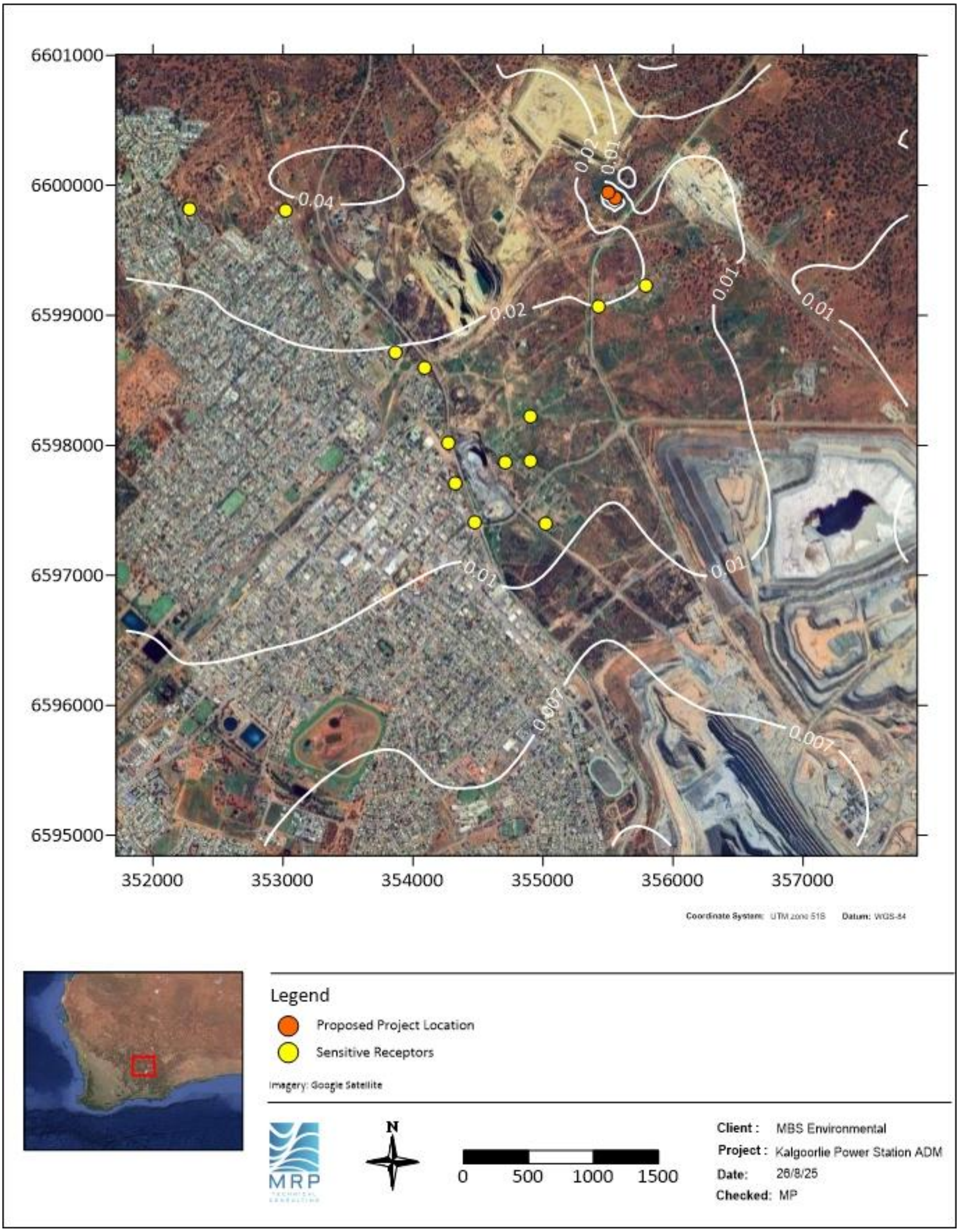

Figure 4-10: Predicted annual average GLCs of $PM_{2.5}$ ($\mu g/m^3$) in isolation – gas mode (Scenario 1)

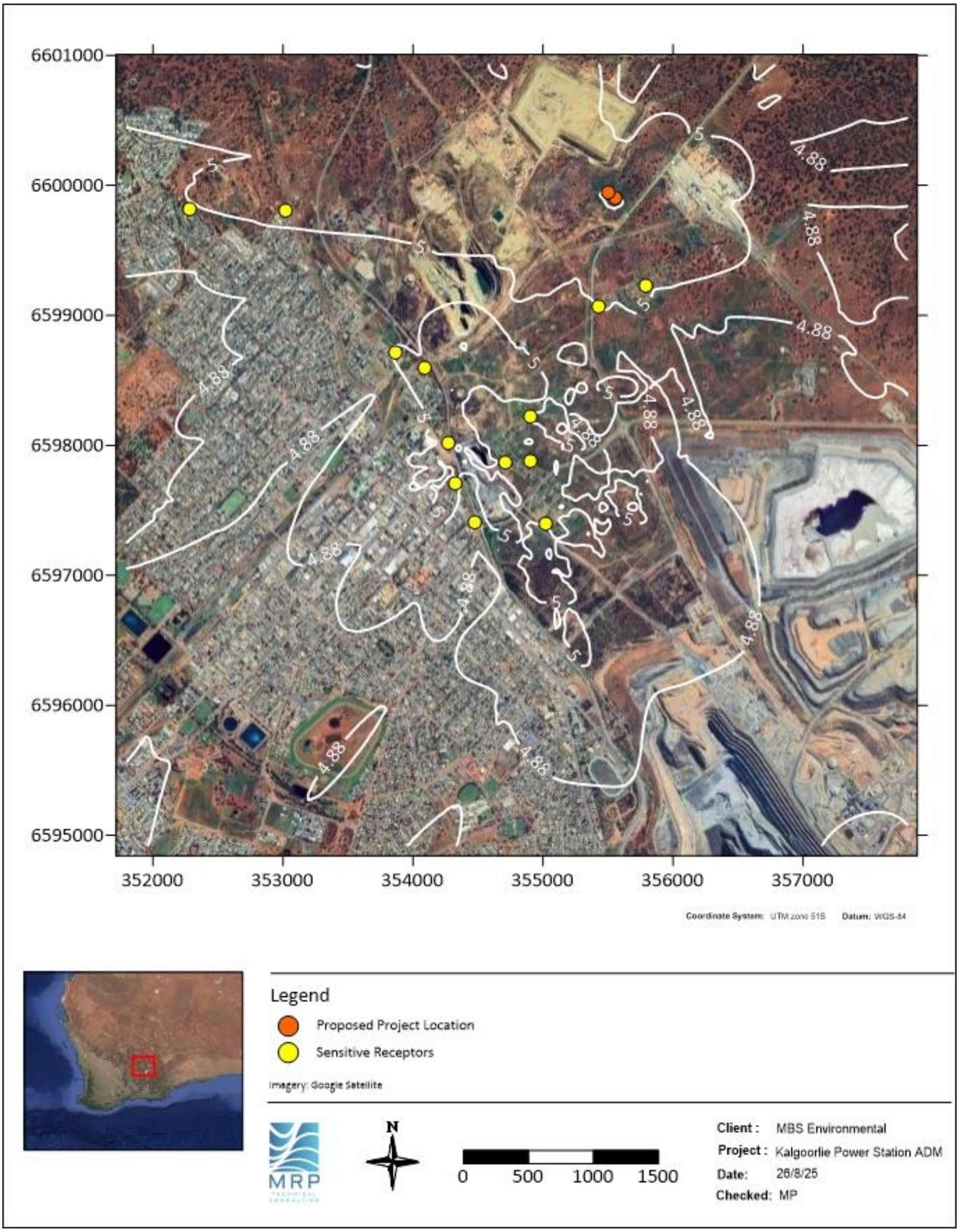

Figure 4-11: Predicted cumulative 24-hour maximum GLCs of $PM_{2.5}$ ($\mu g/m^3$) – gas mode (Scenario 2)

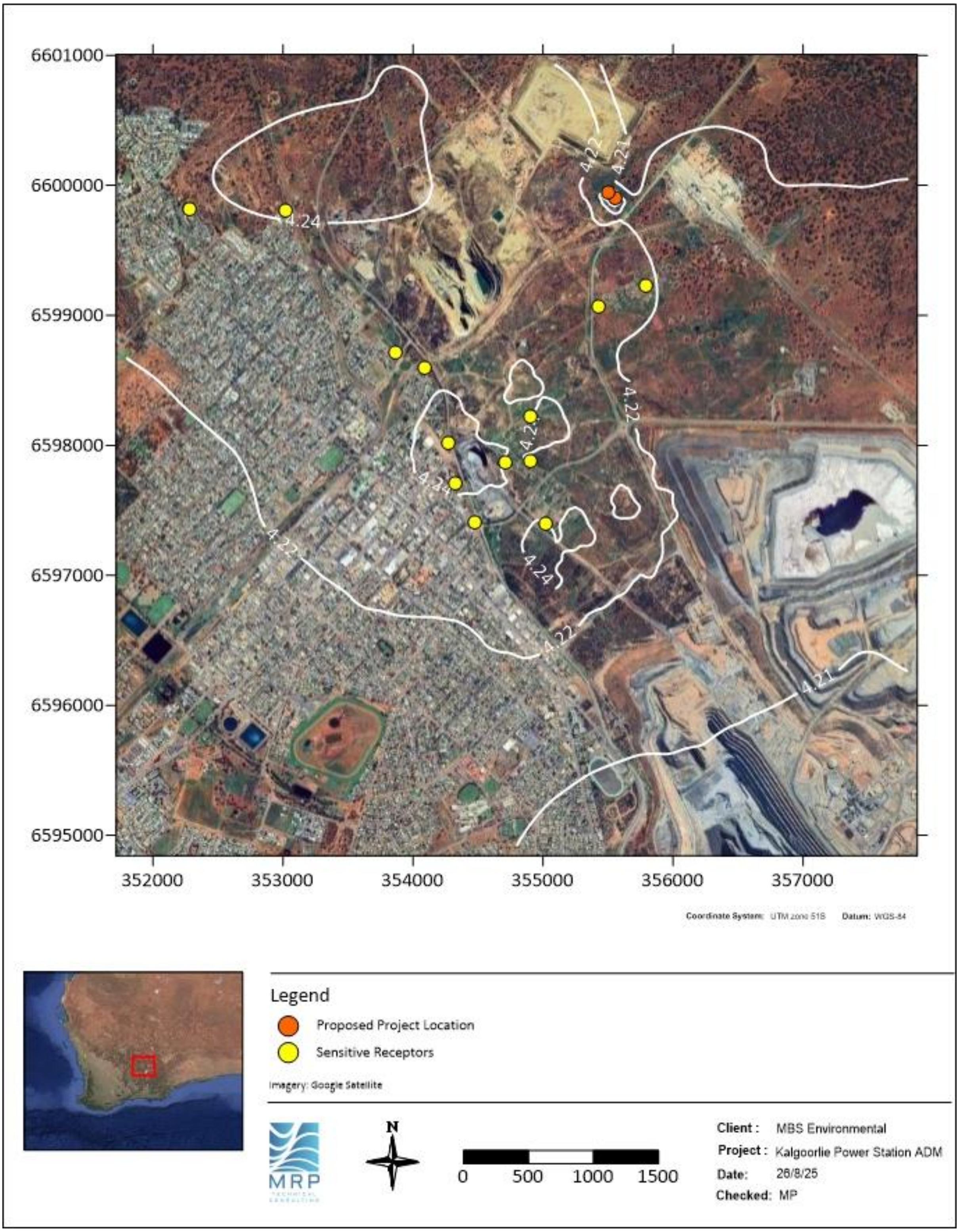

Figure 4-12:Predicted cumulative annual average GLCs of $PM_{2.5}$ ($\mu g/m^3$) – gas mode (Scenario 2)

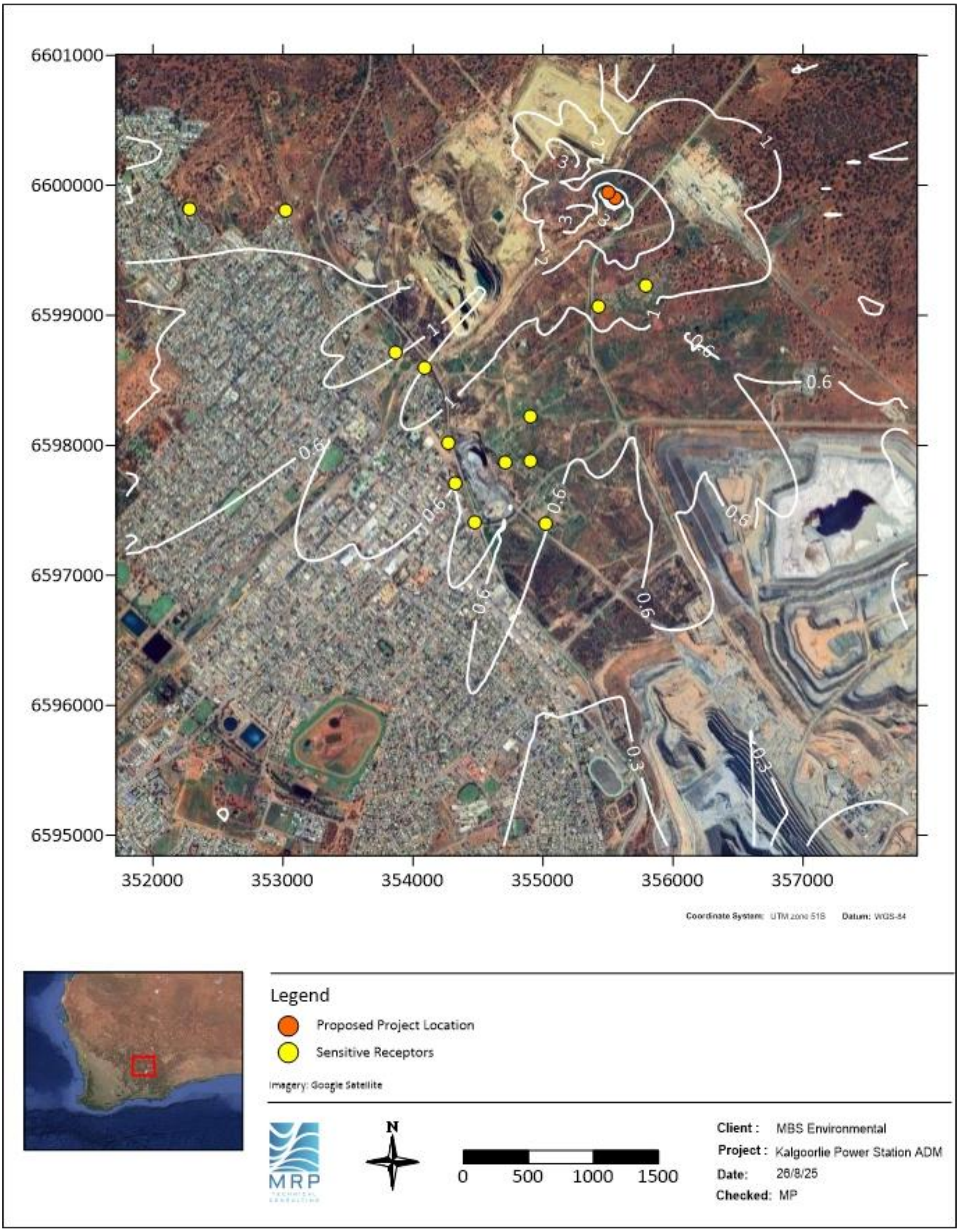

Figure 4-13: Predicted 24-hour maximum GLCs of $PM_{2.5}$ ($\mu g/m^3$) in isolation – LFO mode (Scenario 3)

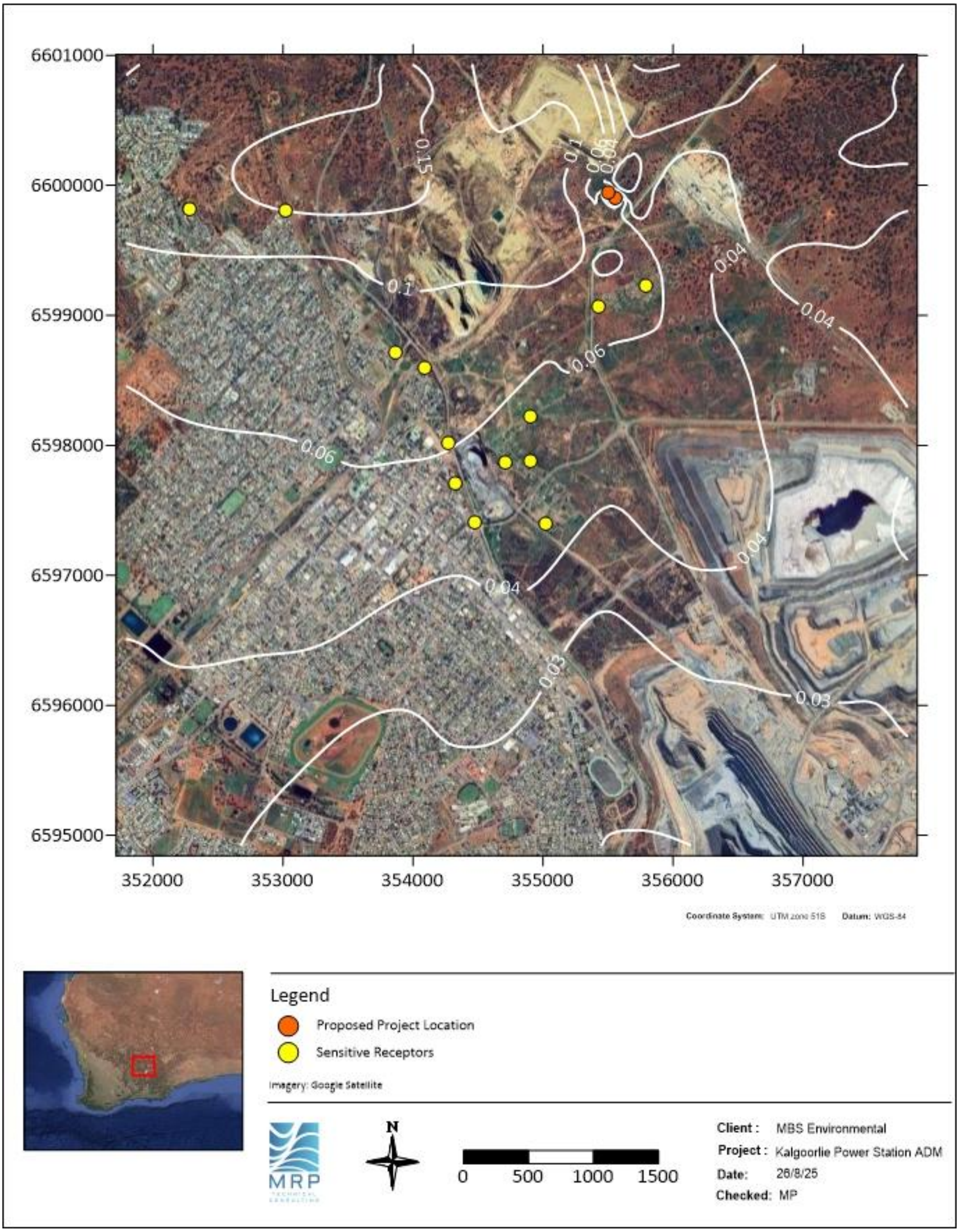

Figure 4-14: Predicted annual average GLCs of $PM_{2.5}$ (µg/m^3) in isolation – LFO mode (Scenario 3)

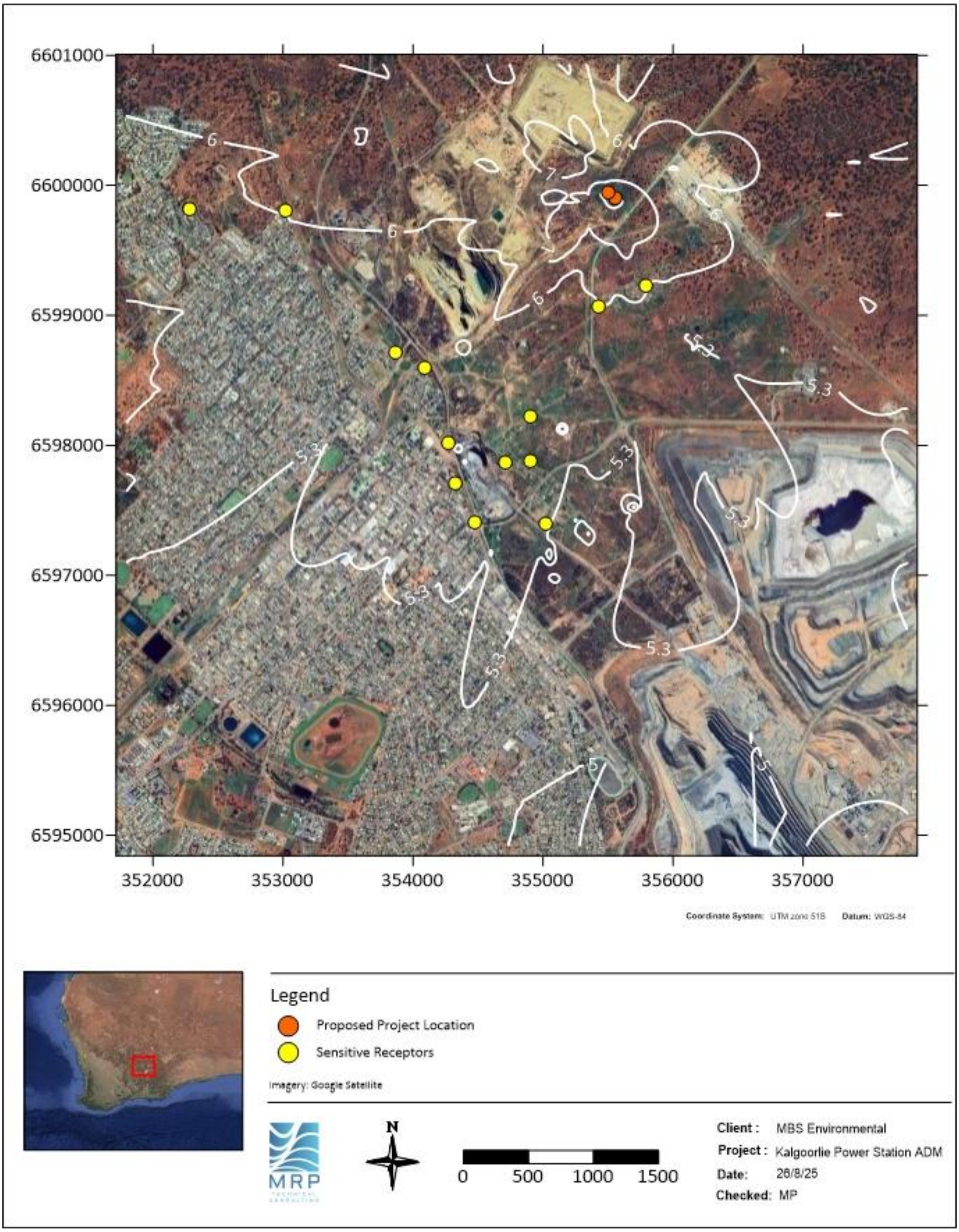

Figure 4-15: Predicted cumulative 24-hour maximum GLCs of $PM_{2.5}$ ($\mu g/m^3$) – LFO mode (Scenario 4)

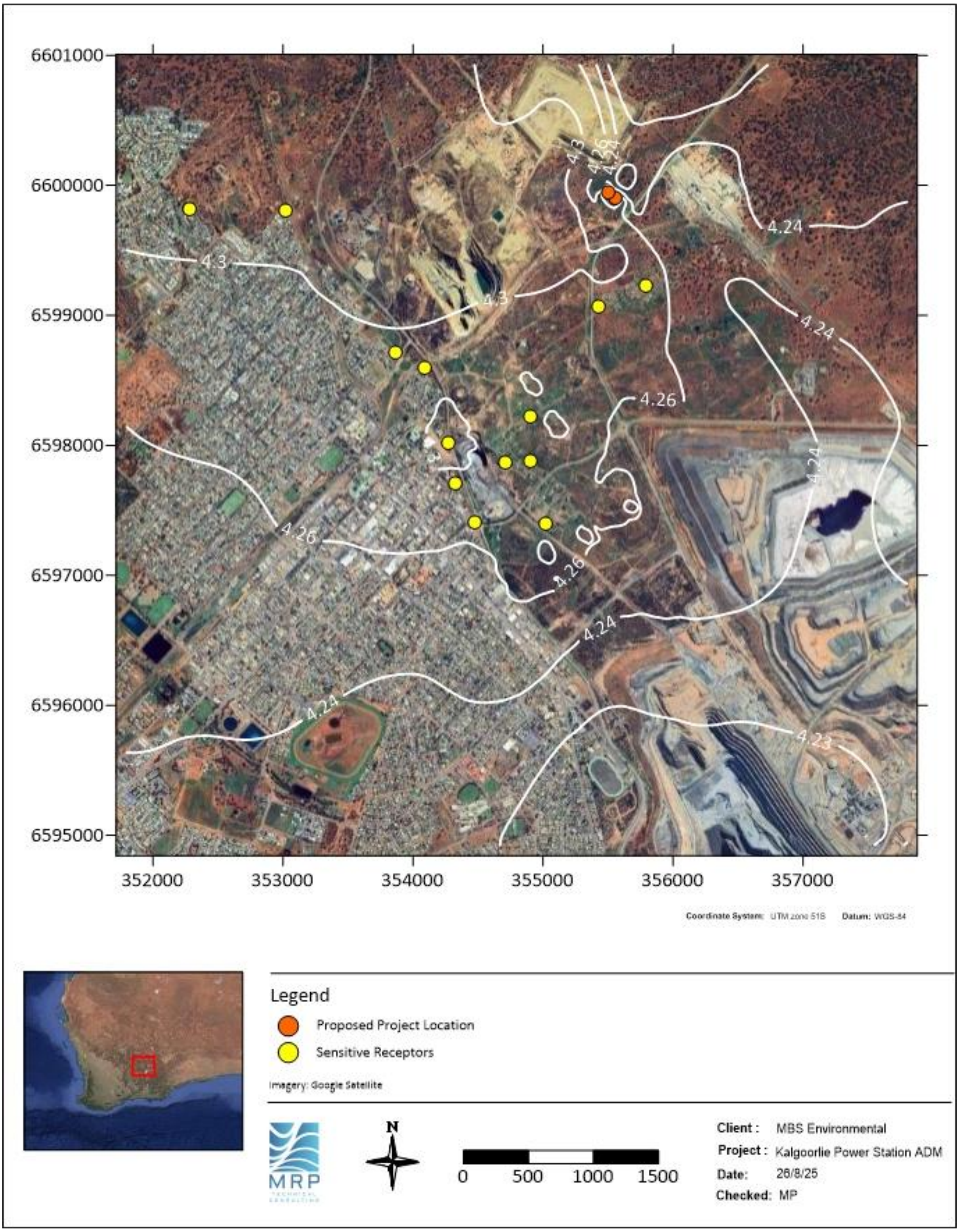

Figure 4-16: Predicted cumulative annual average GLCs of $PM_{2.5}$ (μg/m^3) – LFO mode (Scenario 4)

4.3 Sulphur dioxide

Contour plots showing predicted concentrations of SO_2 can be found in Figure 4-17 to Figure 4-28 below, with relevant air quality criteria displayed as a red contour line. Table 4-3 presents the predicted GLCs at nearby sensitive receptors in the region.

Results of the modelling indicated that there were no exceedances of the relevant 1-hour or 24-hour maximum or annual average AGVs for SO_2 predicted at any of the nearby sensitive receptors for any of the modelled scenarios.

Table 4-3: Summary of predicted SO_2 concentrations at the closest sensitive receptors

1-hour maximum SO_2 ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		($\mu g/m^3$)[1]	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline
Rec_001	Ninga Mia East				5.0	2.5%	18	9%	36	18%	49	25%
Rec_002	Ninga Mia West				4.0	2.1%	17	9%	22	11%	35	18%
Rec_003	Kalgoorlie North 3				4.2	2.1%	17	9%	24	12%	37	19%
Rec_004	Kalgoorlie North 2				4.4	2.3%	18	9%	31	16%	44	23%
Rec_005	Kalgoorlie North 1				5.7	2.9%	19	10%	30	15%	43	22%
Rec_006	Kalgoorlie Central				4.2	2.2%	17	9%	24	12%	37	19%
Rec_007	Kalgoorlie South 1	196	13	7%	3.3	1.7%	16	8%	19	9%	32	16%
Rec_008	Kalgoorlie South 2				2.7	1.4%	16	8%	17	9%	30	15%
Rec_009	Kalgoorlie South 3				2.0	1.0%	15	8%	15	7%	28	14%
Rec_010	Williamstown North				2.8	1.4%	16	8%	26	13%	39	20%
Rec_011	Williamstown Central East				2.4	1.2%	16	8%	28	14%	41	21%
Rec_012	Williamstown Central West				2.5	1.3%	16	8%	24	12%	37	19%
Rec_013	Williamstown South				2.3	1.2%	15	8%	16	8%	29	15%
24-hour maximum SO_2 ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		($\mu g/m^3$)[1]	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline	($\mu g/m^3$)[1]	% Guideline
Rec_001	Ninga Mia East				0.71	1.4%	5.91	11.3%	3.74	7.1%	8.94	17%
Rec_002	Ninga Mia West				0.62	1.2%	5.82	11.1%	3.61	6.9%	8.81	17%
Rec_003	Kalgoorlie North 3				0.59	1.1%	5.79	11.0%	3.24	6.2%	8.44	16%
Rec_004	Kalgoorlie North 2				0.70	1.3%	5.90	11.3%	3.79	7.2%	8.99	17%
Rec_005	Kalgoorlie North 1				0.51	1.0%	5.71	10.9%	2.99	5.7%	8.19	16%
Rec_006	Kalgoorlie Central				0.46	0.9%	5.66	10.8%	2.90	5.5%	8.10	15%
Rec_007	Kalgoorlie South 1	52	5.2	10%	0.42	0.8%	5.62	10.7%	2.44	4.7%	7.64	15%
Rec_008	Kalgoorlie South 2				0.29	0.6%	5.49	10.5%	1.69	3.2%	6.89	13%
Rec_009	Kalgoorlie South 3				0.31	0.6%	5.51	10.5%	1.87	3.6%	7.07	13%
Rec_010	Williamstown North				0.31	0.6%	5.51	10.5%	1.95	3.7%	7.15	14%
Rec_011	Williamstown Central East				0.32	0.6%	5.52	10.5%	1.81	3.4%	7.01	13%
Rec_012	Williamstown Central West				0.32	0.6%	5.52	10.5%	1.99	3.8%	7.19	14%
Rec_013	Williamstown South				0.32	0.6%	5.52	10.5%	1.81	3.5%	7.01	13%

Notes

1. Referenced to 25ºC, and 101.3 kPa

Annual average SO_2 ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		(µg/m^3)[1]	(µg/m^3)[1]	% Guideline	(µg/m^3)[1]	% Guideline	(µg/m^3)[1]	% Guideline	(µg/m^3)[1]	% Guideline	(µg/m^3)[1]	% Guideline
Rec_001	Ninga Mia East				0.037	0.072%	0.135	0.26%	0.209	0.40%	0.307	0.59%
Rec_002	Ninga Mia West				0.040	0.077%	0.138	0.26%	0.229	0.44%	0.327	0.63%
Rec_003	Kalgoorlie North 3				0.064	0.123%	0.162	0.31%	0.362	0.70%	0.460	0.89%
Rec_004	Kalgoorlie North 2				0.075	0.144%	0.173	0.33%	0.425	0.82%	0.523	1.01%
Rec_005	Kalgoorlie North 1				0.039	0.076%	0.137	0.26%	0.230	0.44%	0.328	0.63%
Rec_006	Kalgoorlie Central				0.036	0.070%	0.134	0.26%	0.216	0.42%	0.314	0.60%
Rec_007	Kalgoorlie South 1	52	0.098	0.2%	0.029	0.055%	0.127	0.24%	0.171	0.33%	0.269	0.52%
Rec_008	Kalgoorlie South 2				0.025	0.048%	0.123	0.24%	0.147	0.28%	0.245	0.47%
Rec_009	Kalgoorlie South 3				0.022	0.042%	0.120	0.23%	0.127	0.24%	0.225	0.43%
Rec_010	Williamstown North				0.027	0.052%	0.125	0.24%	0.159	0.31%	0.257	0.49%
Rec_011	Williamstown Central East				0.026	0.049%	0.124	0.24%	0.151	0.29%	0.249	0.48%
Rec_012	Williamstown Central West				0.025	0.048%	0.123	0.24%	0.147	0.28%	0.245	0.47%
Rec_013	Williamstown South				0.023	0.045%	0.121	0.23%	0.132	0.25%	0.230	0.44%

Notes

1. Referenced to 25ºC, and 101.3 kPa

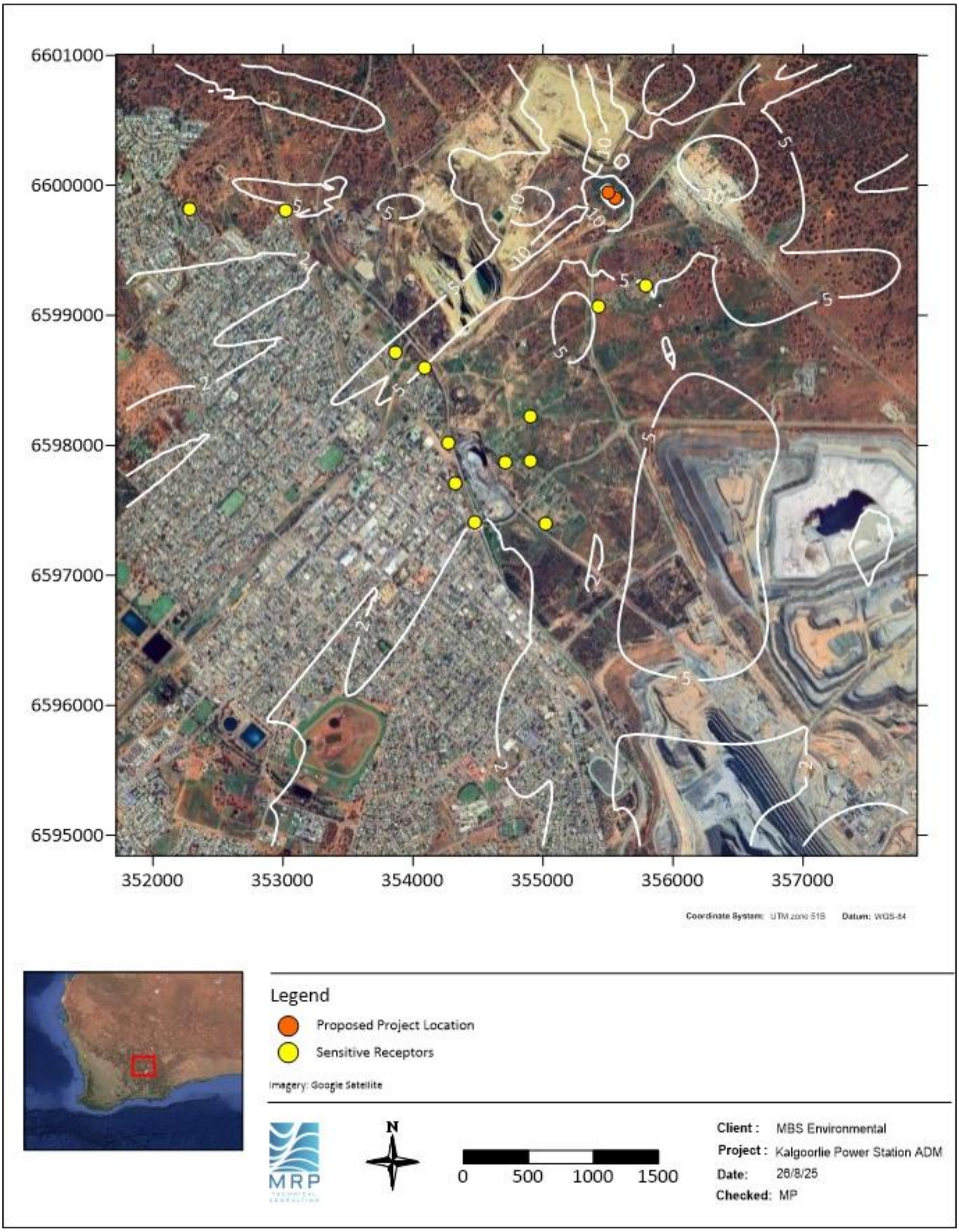

Figure 4-17: Predicted 1-hour maximum GLCs of SO_2 (µg/m^3) in isolation – gas mode (Scenario 1)

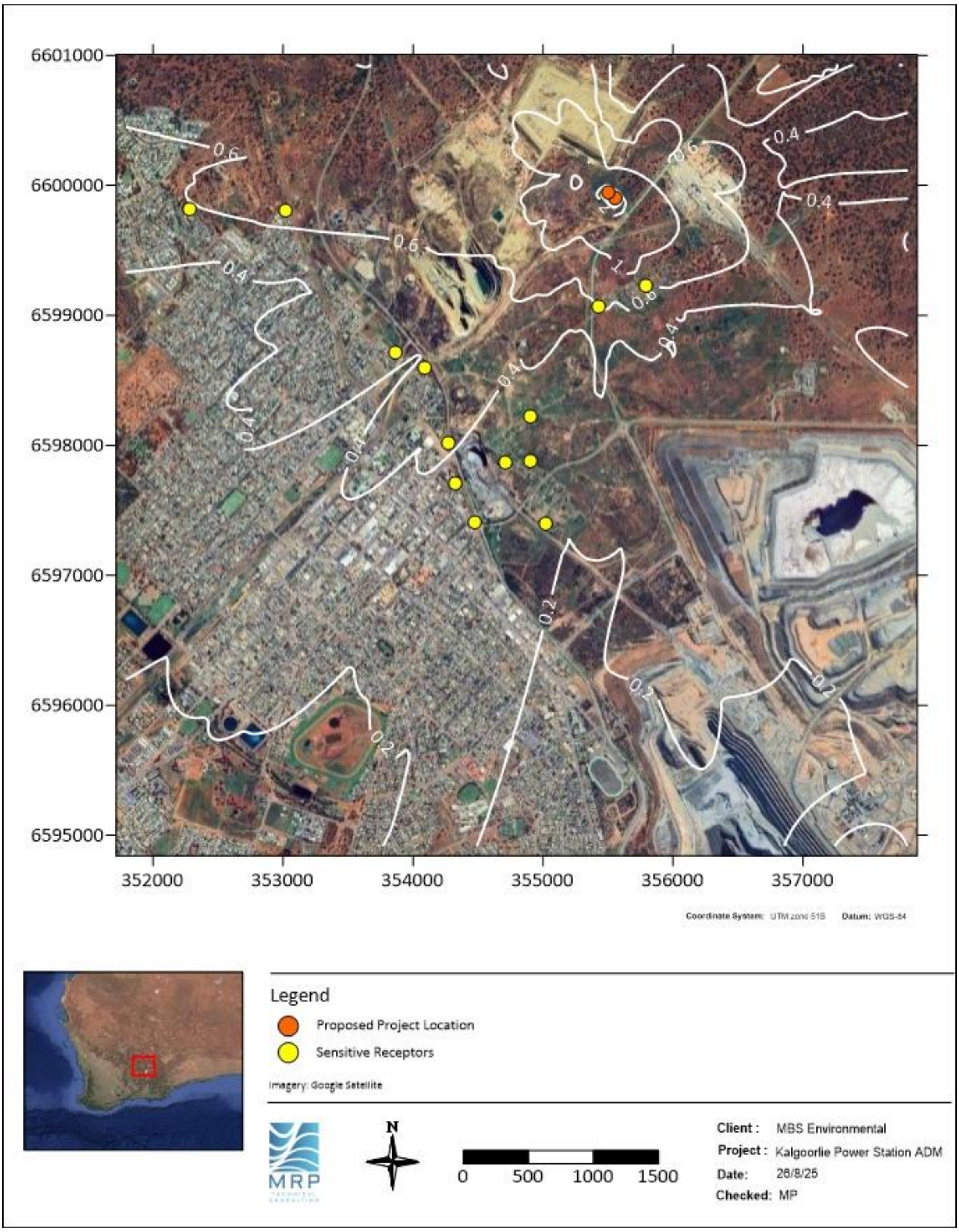

Figure 4-18: Predicted 24-hour maximum GLCs of SO_2 (µg/m^3) in isolation – gas mode (Scenario 1)

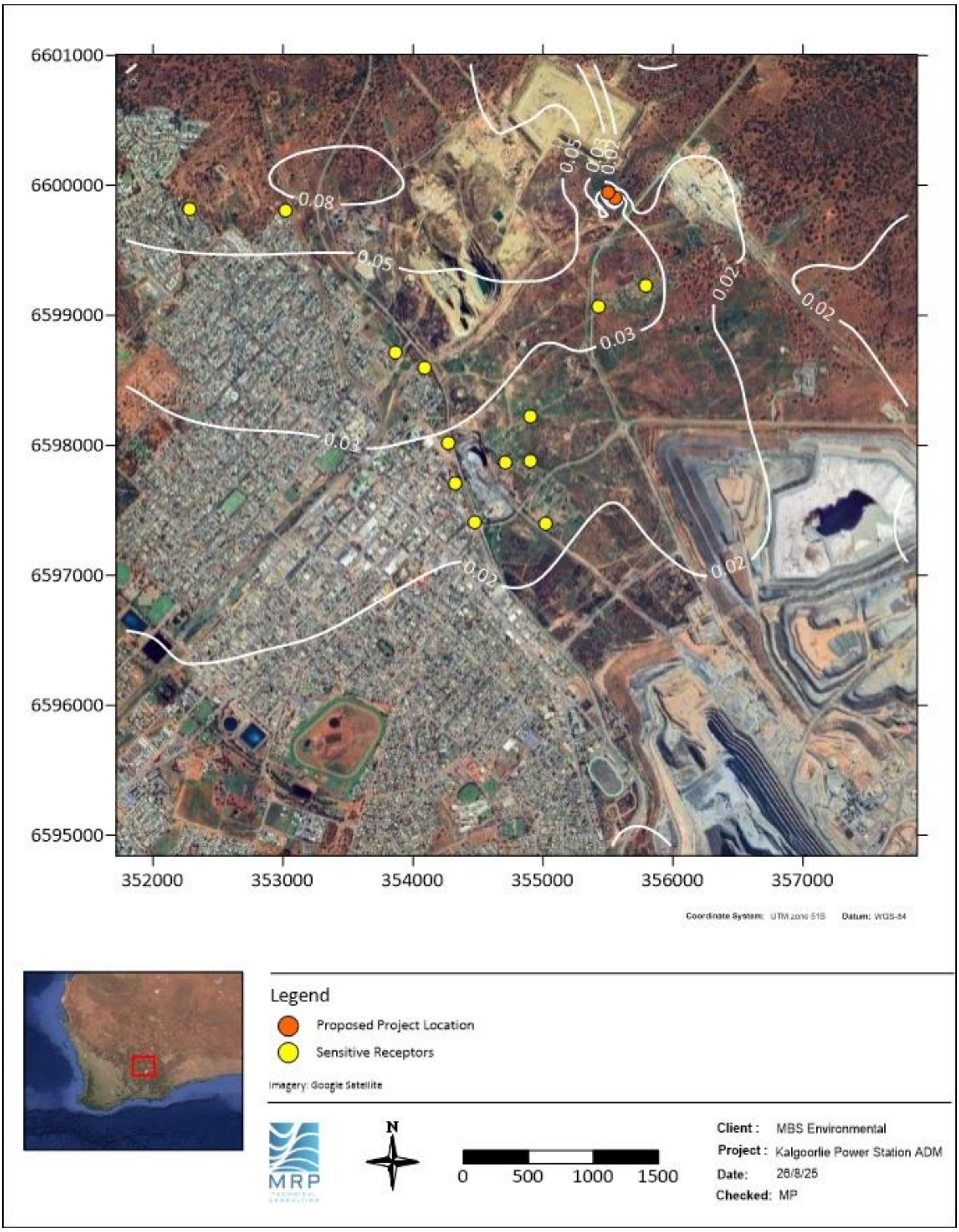

Figure 4-19: Predicted annual average GLCs of SO_2 ($\mu g/m^3$) in isolation – gas mode (Scenario 1)

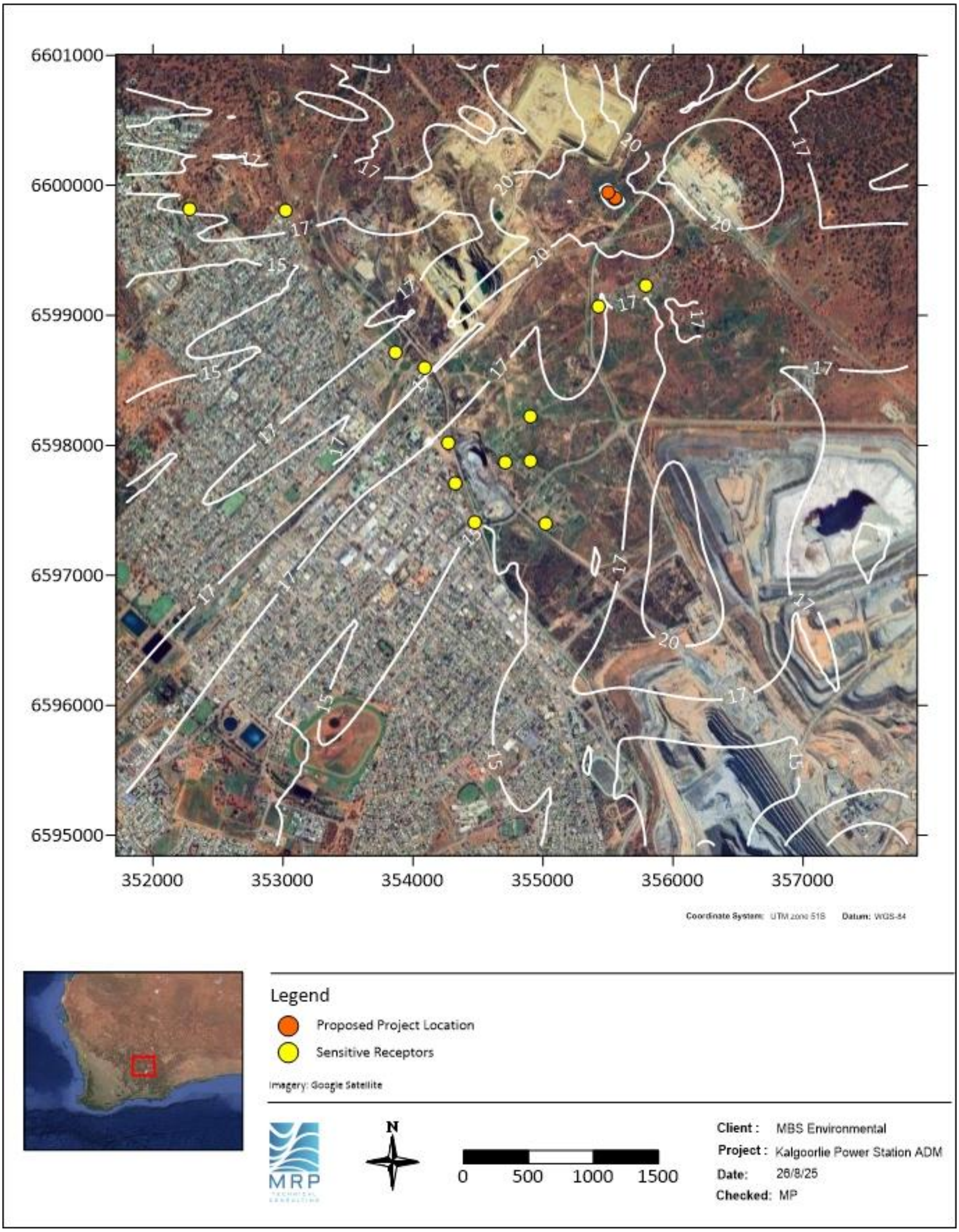

Figure 4-20: Predicted cumulative 1-hour maximum GLCs of SO_2 (µg/m³) – gas mode (Scenario 2)

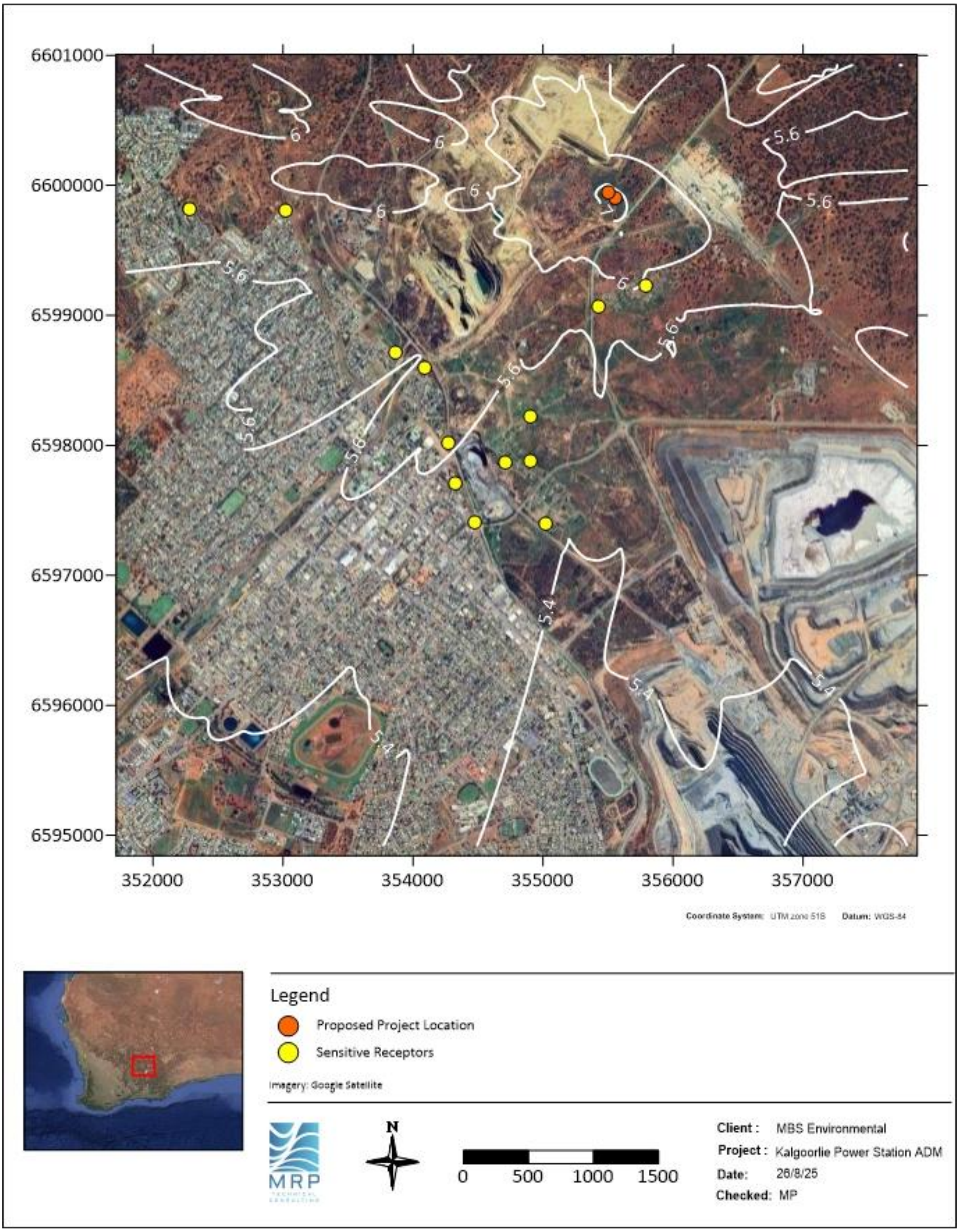

Figure 4-21: Predicted cumulative 24-hour maximum GLCs of SO_2 (μg/m^3) – gas mode (Scenario 2)

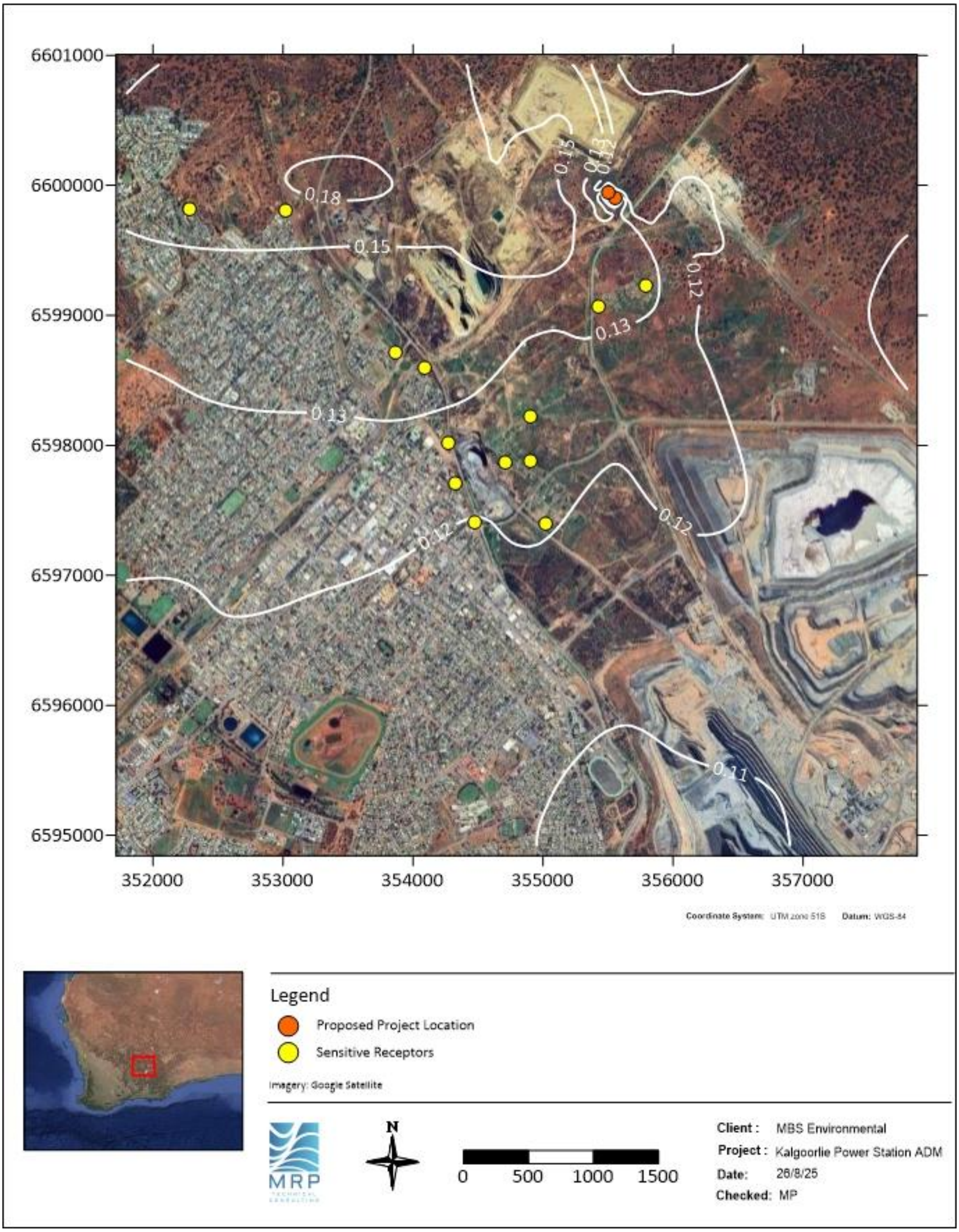

Figure 4-22: Predicted cumulative annual average GLCs of SO_2 (µg/m³) – gas mode (Scenario 2)

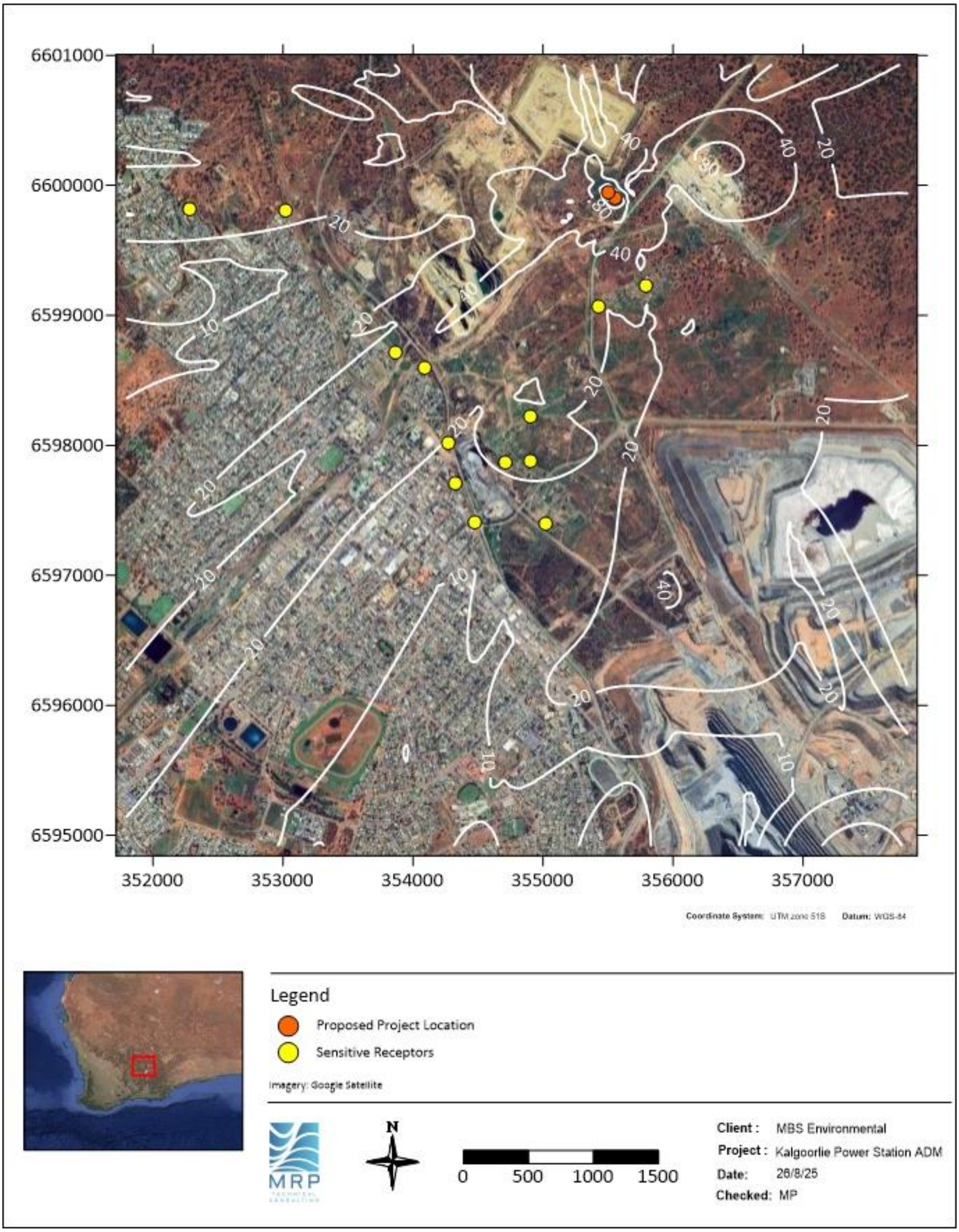

Figure 4-23: Predicted 1-hour maximum GLCs of SO_2 (µg/m^3) in isolation – LFO mode (Scenario 3)

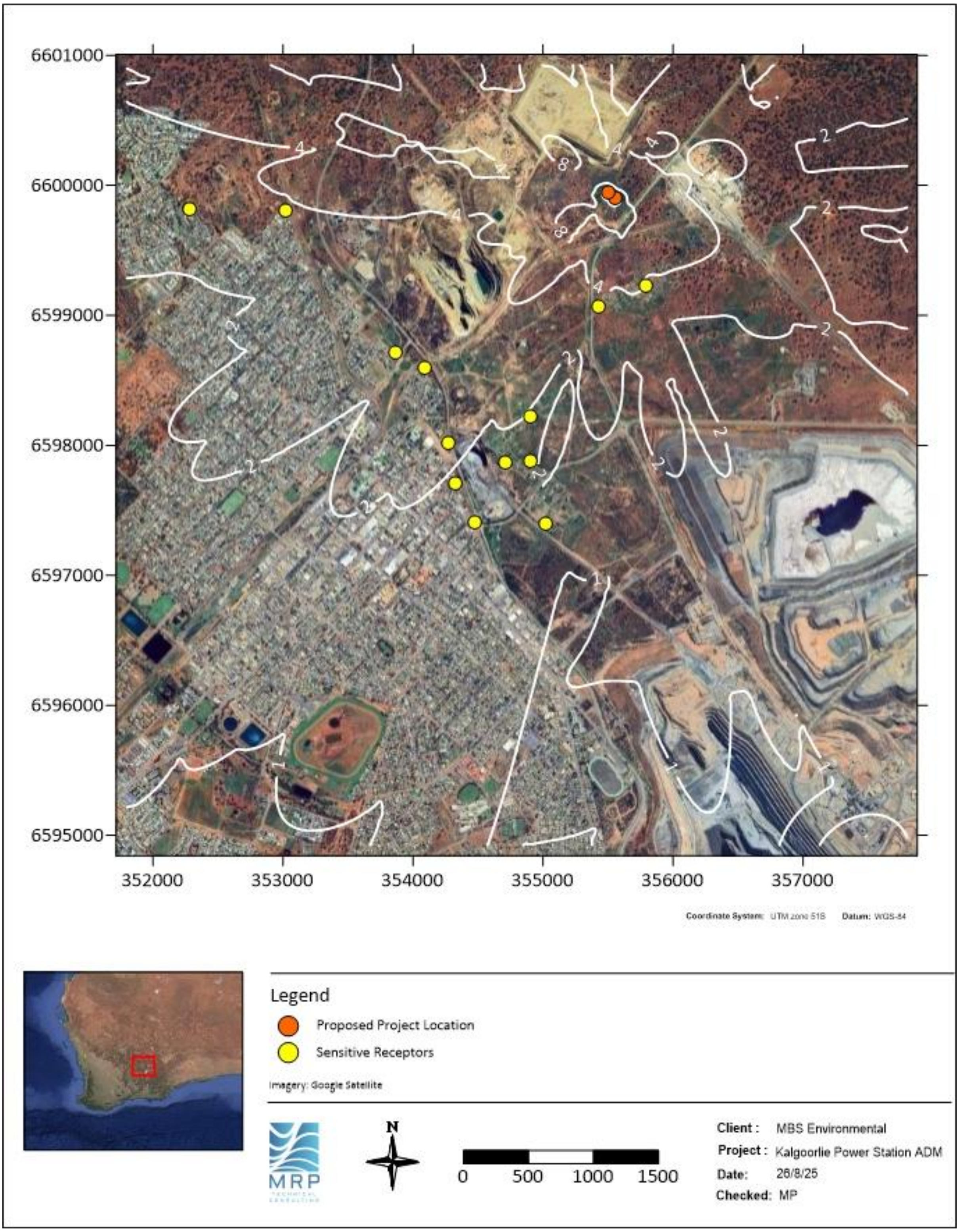

Figure 4-24: Predicted 24-hour maximum GLCs of SO_2 (µg/m^3) in isolation – LFO mode (Scenario 3)

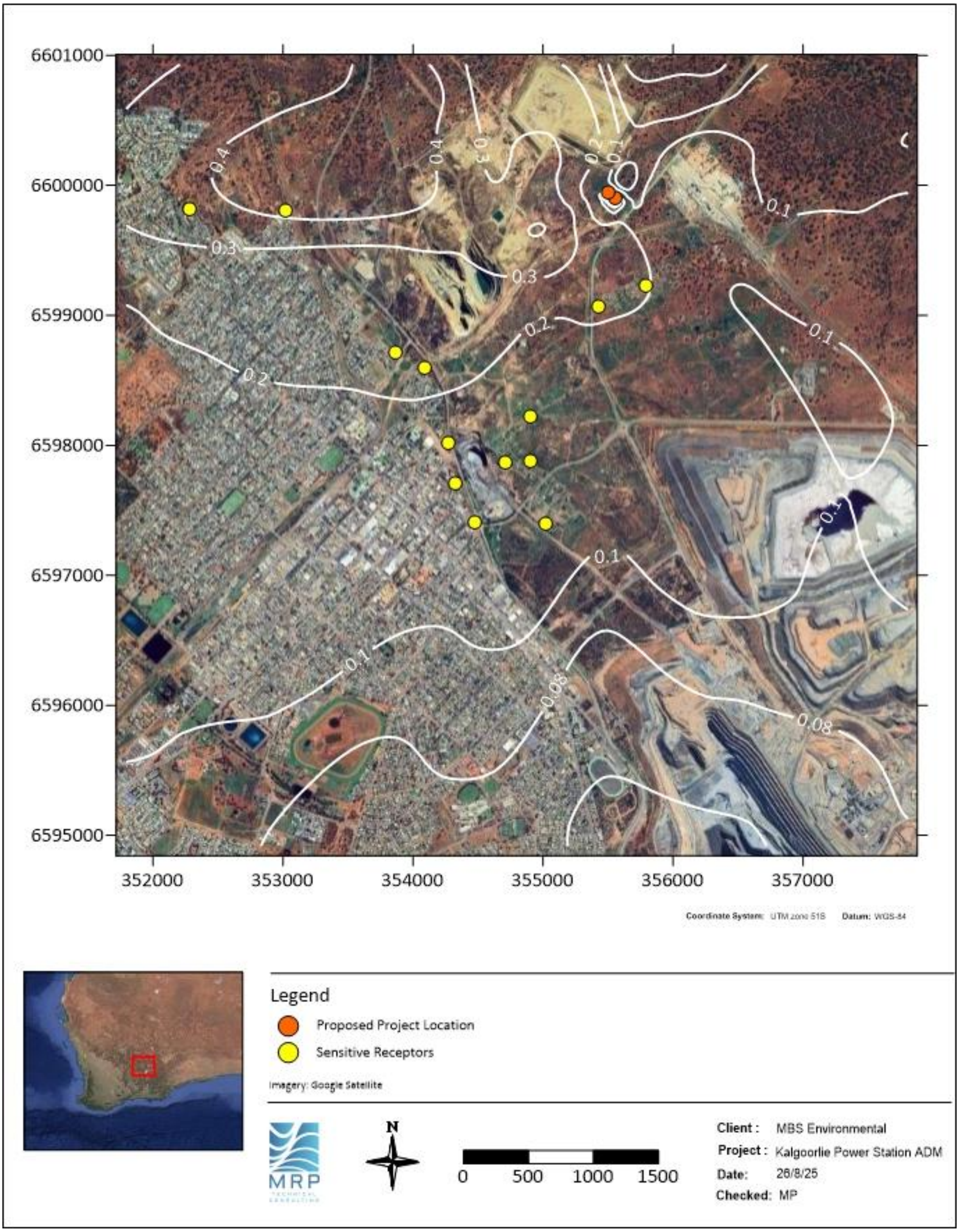

Figure 4-25: Predicted annual average GLCs of SO_2 (µg/m³) in isolation – LFO mode (Scenario 3)

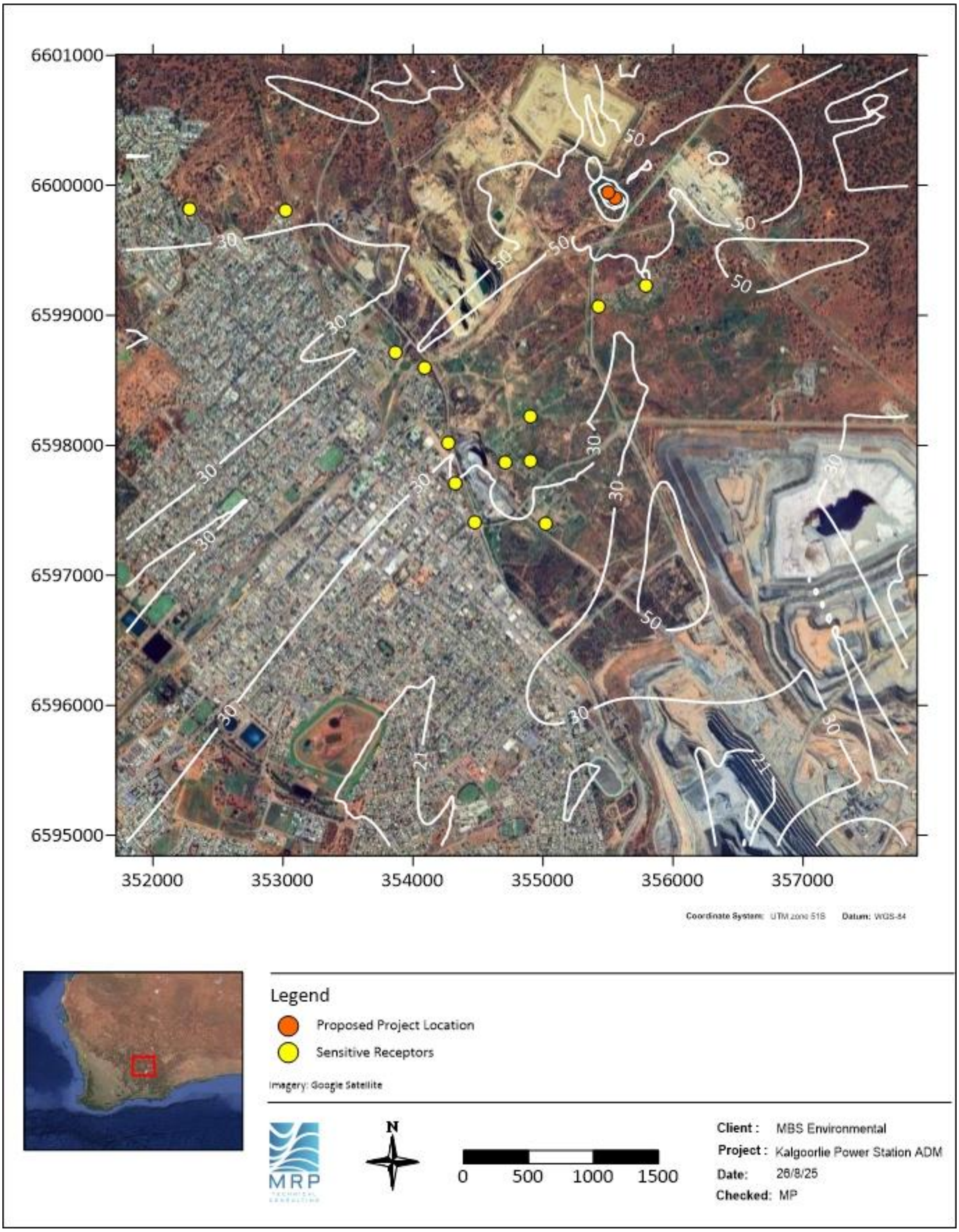

Figure 4-26: Predicted cumulative 1-hour maximum GLCs of NO_2 (µg/m³) – LFO mode (Scenario 4)

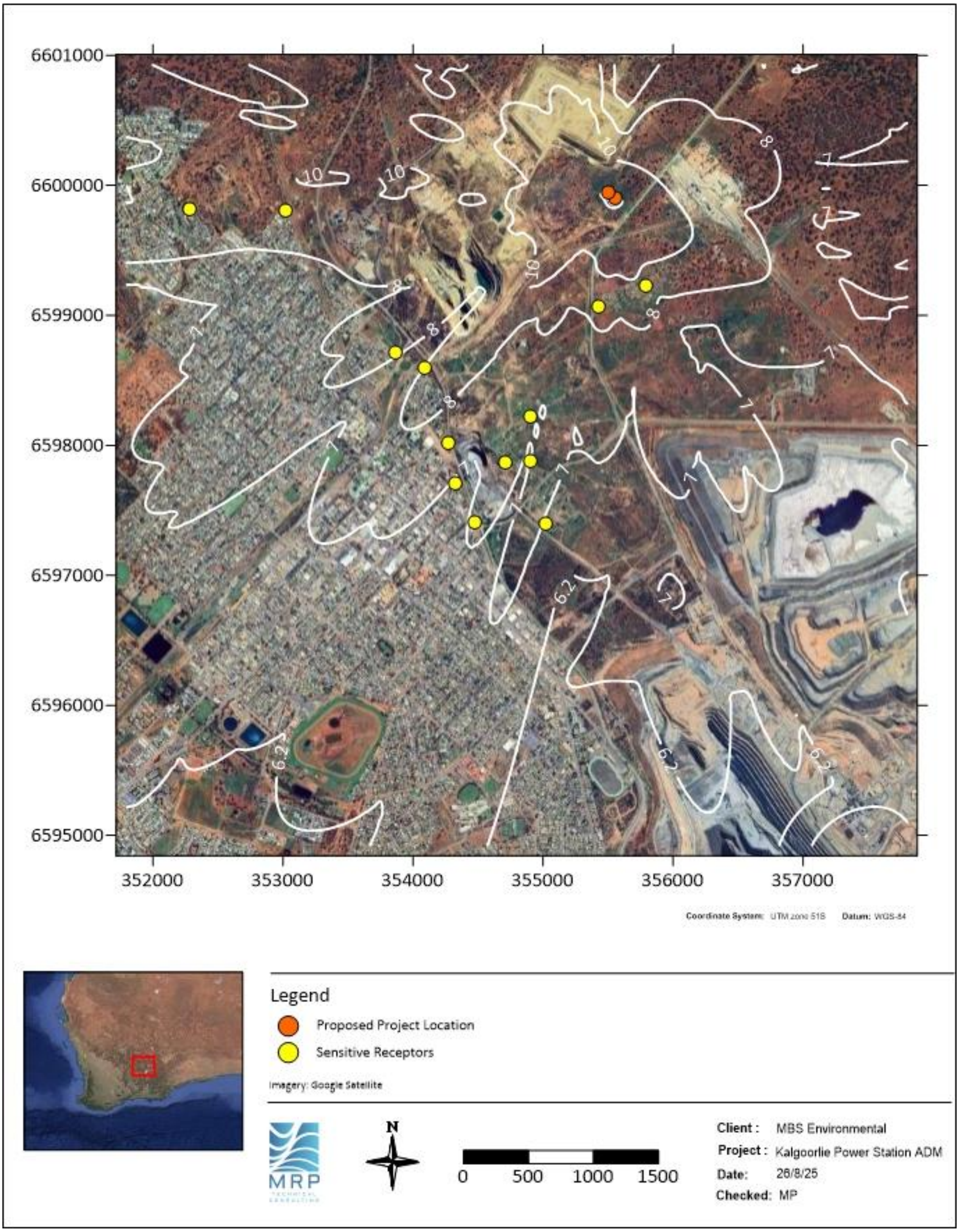

Figure 4-27: Predicted cumulative 24-hour maximum GLCs of SO_2 ($\mu g/m^3$) – LFO mode (Scenario 4)

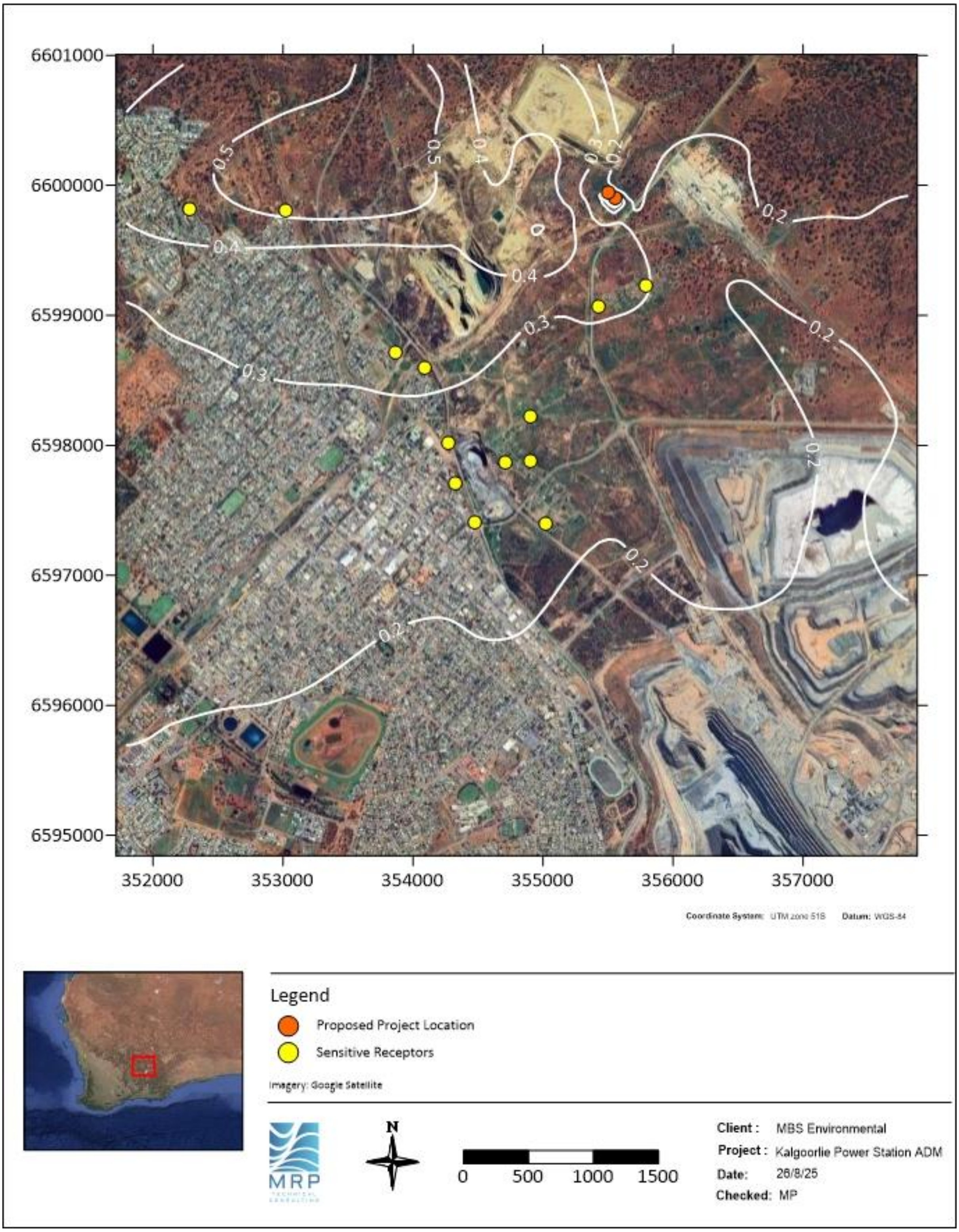

Figure 4-28: Predicted cumulative annual average GLCs of SO_2 (µg/m^3) – LFO mode (Scenario 4)

4.4 Carbon monoxide

Contour plots showing predicted concentrations of CO can be found in Figure 4-29 to Figure 4-36 below, with relevant air quality criteria displayed as a red contour line. Table 4-4 presents the predicted GLCs at nearby sensitive receptors in the region.

Results of the modelling indicated that there were no exceedances of the relevant 1-hour or 8-hour maximum AGVs for CO predicted at any of the nearby sensitive receptors for any of the modelled scenarios.

Table 4-4: Summary of predicted CO concentrations at the closest sensitive receptors

1-hour maximum CO ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East	30,000	84	0.28%	78	0.26%	162	0.54%	15	0.051%	99	0.33%
Rec_002	Ninga Mia West				63	0.21%	148	0.49%	9	0.031%	94	0.31%
Rec_003	Kalgoorlie North 3				65	0.22%	149	0.50%	10	0.034%	95	0.32%
Rec_004	Kalgoorlie North 2				69	0.23%	154	0.51%	13	0.045%	98	0.33%
Rec_005	Kalgoorlie North 1				90	0.30%	174	0.58%	13	0.043%	97	0.32%
Rec_006	Kalgoorlie Central				66	0.22%	150	0.50%	10	0.034%	95	0.32%
Rec_007	Kalgoorlie South 1				52	0.17%	136	0.45%	8	0.027%	92	0.31%
Rec_008	Kalgoorlie South 2				42	0.14%	126	0.42%	7	0.024%	91	0.30%
Rec_009	Kalgoorlie South 3				31	0.10%	115	0.38%	6	0.021%	91	0.30%
Rec_010	Williamstown North				45	0.15%	129	0.43%	11	0.037%	95	0.32%
Rec_011	Williamstown Central East				38	0.13%	122	0.41%	12	0.040%	96	0.32%
Rec_012	Williamstown Central West				39	0.13%	123	0.41%	10	0.034%	94	0.31%
Rec_013	Williamstown South				36	0.12%	120	0.40%	7	0.023%	91	0.30%
8-hour maximum CO ground level concentrations												
Receptor		Criteria	Background		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
					Gas mode - isolation		Gas mode - cumulative		LFO mode - isolation		LFO mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East	10,000	344	3.4%	33	0.33%	376	3.8%	5	0.047%	348	3.5%
Rec_002	Ninga Mia West				27	0.27%	370	3.7%	4	0.042%	348	3.5%
Rec_003	Kalgoorlie North 3				19	0.19%	363	3.6%	3	0.030%	346	3.5%
Rec_004	Kalgoorlie North 2				22	0.22%	365	3.7%	3	0.034%	347	3.5%
Rec_005	Kalgoorlie North 1				21	0.21%	365	3.6%	3	0.034%	347	3.5%
Rec_006	Kalgoorlie Central				16	0.16%	360	3.6%	3	0.026%	346	3.5%
Rec_007	Kalgoorlie South 1				19	0.19%	363	3.6%	3	0.031%	347	3.5%
Rec_008	Kalgoorlie South 2				13	0.13%	357	3.6%	2	0.022%	346	3.5%
Rec_009	Kalgoorlie South 3				15	0.15%	358	3.6%	2	0.024%	346	3.5%
Rec_010	Williamstown North				15	0.15%	358	3.6%	2	0.025%	346	3.5%
Rec_011	Williamstown Central East				13	0.13%	356	3.6%	2	0.021%	346	3.5%
Rec_012	Williamstown Central West				15	0.15%	359	3.6%	3	0.025%	346	3.5%
Rec_013	Williamstown South				14	0.14%	357	3.6%	2	0.021%	346	3.5%

Notes

1. Referenced to 25ºC, and 101.3 kPa

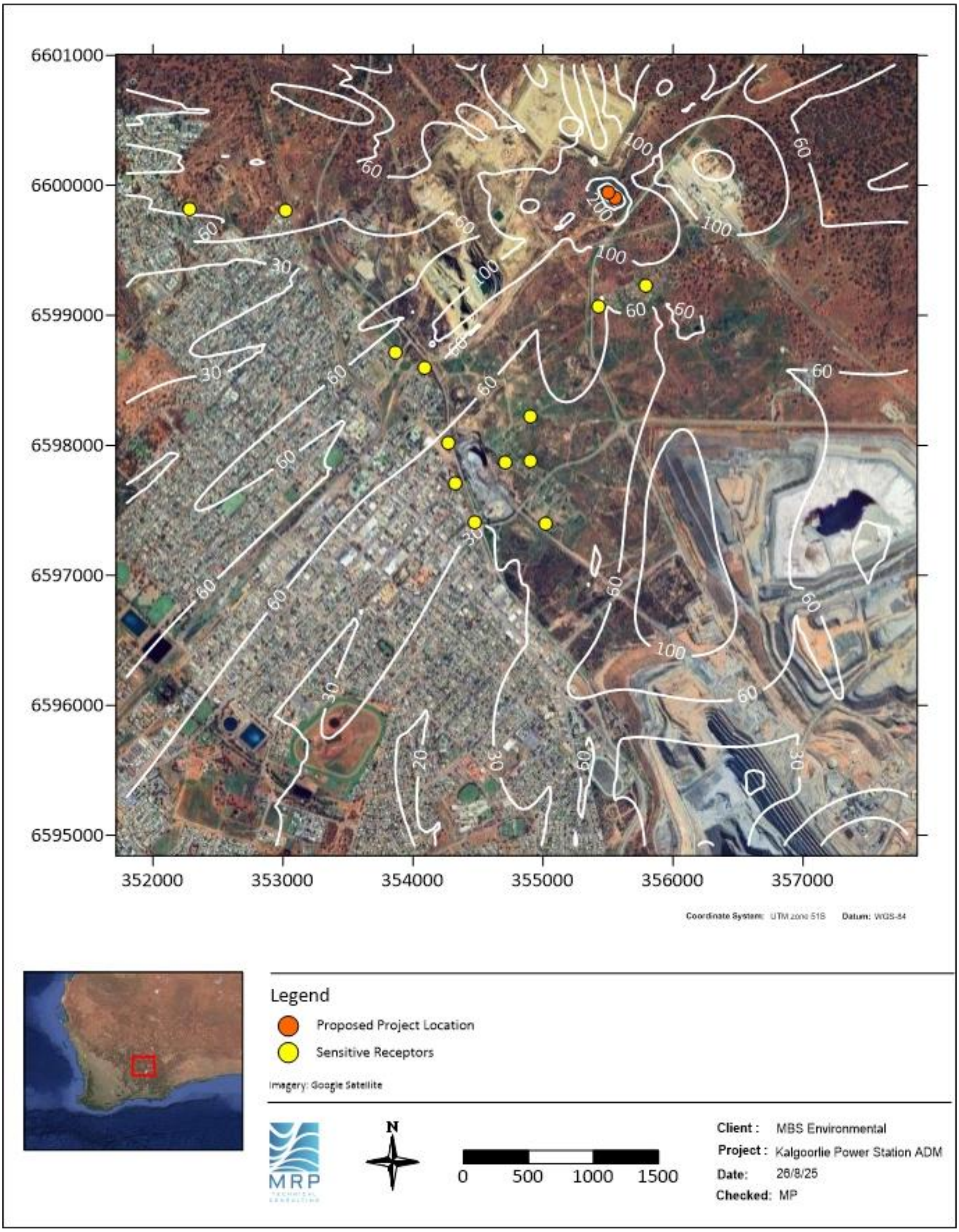

Figure 4-29: Predicted 1-hour maximum GLCs of CO (µg/m³) in isolation – gas mode (Scenario 1)

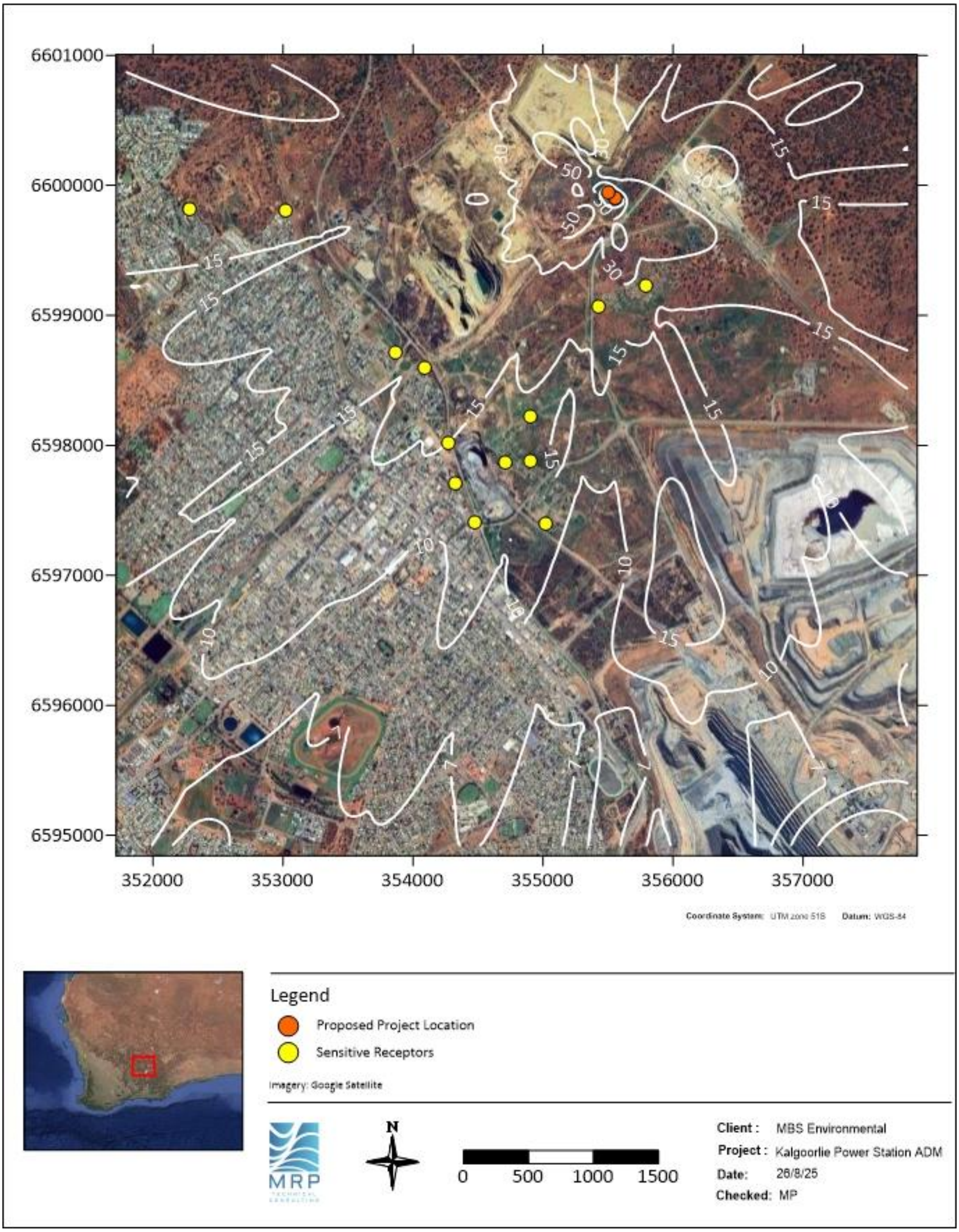

Figure 4-30: Predicted 8-hour maximum GLCs of CO (μg/m³) in isolation – gas mode (Scenario 1)

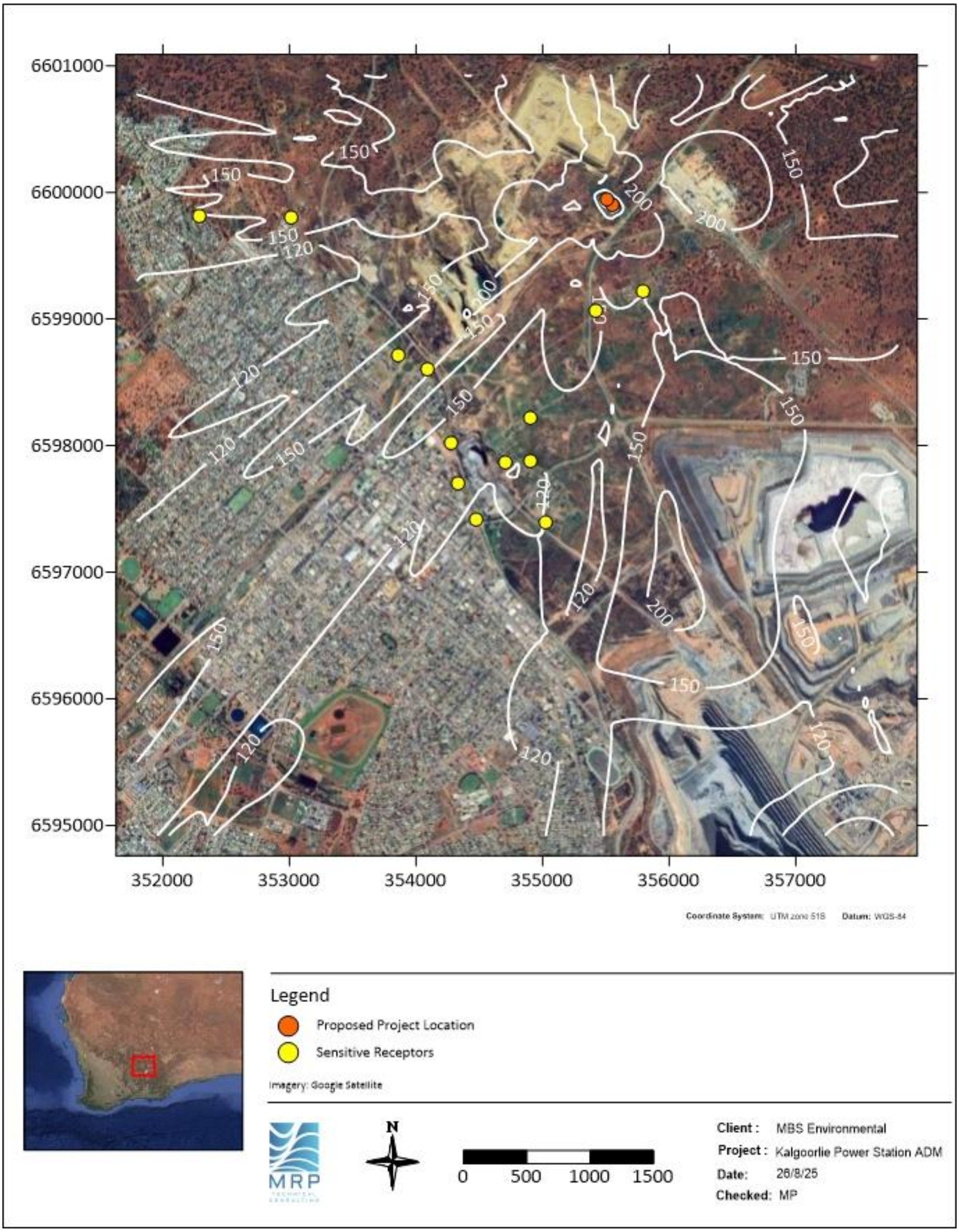

Figure 4-31: Predicted cumulative 1-hour maximum GLCs of CO (µg/m³) – gas mode (Scenario 2)

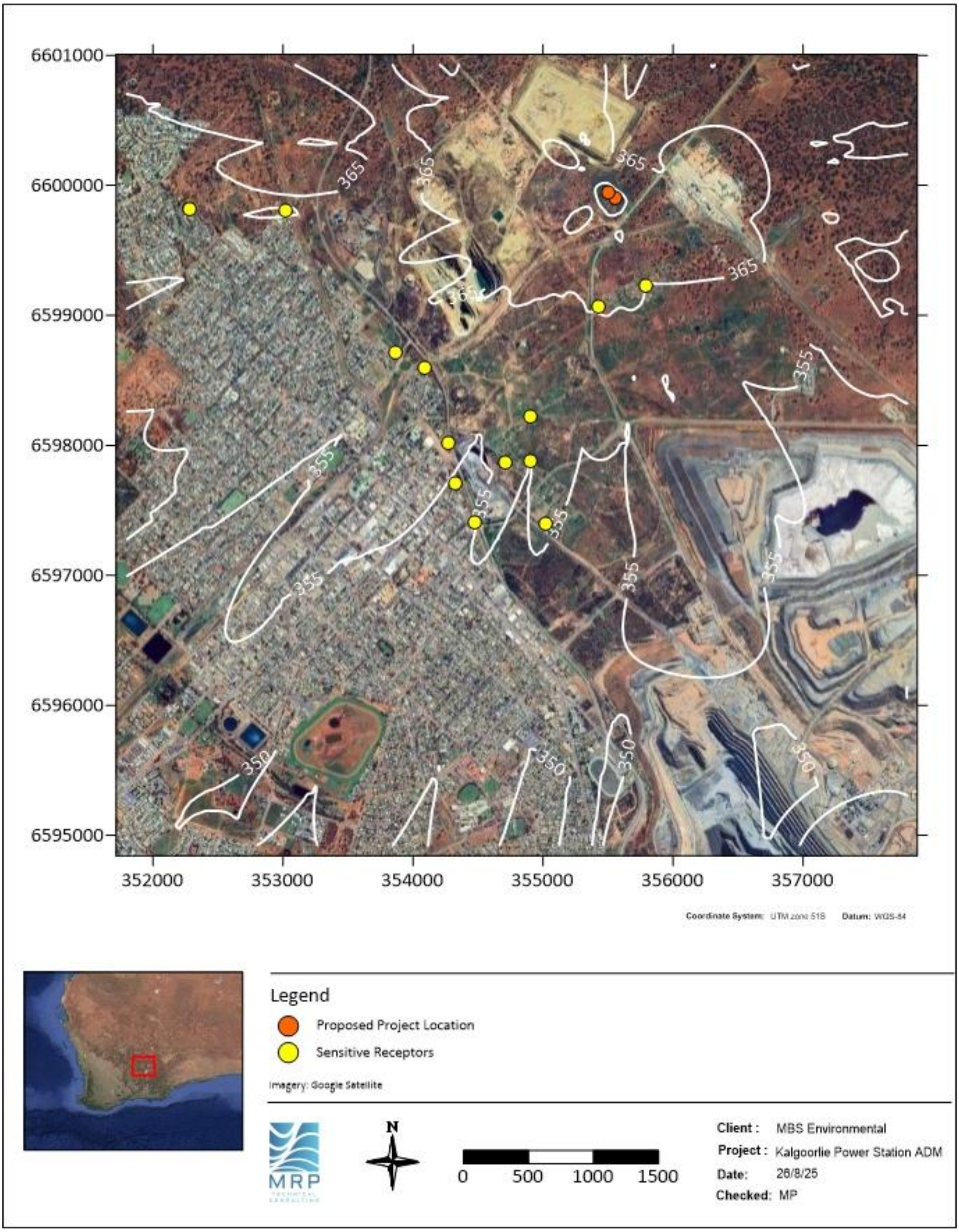

Figure 4-32: Predicted cumulative 8-hour maximum GLCs of CO (μg/m^3) – gas mode (Scenario 2)

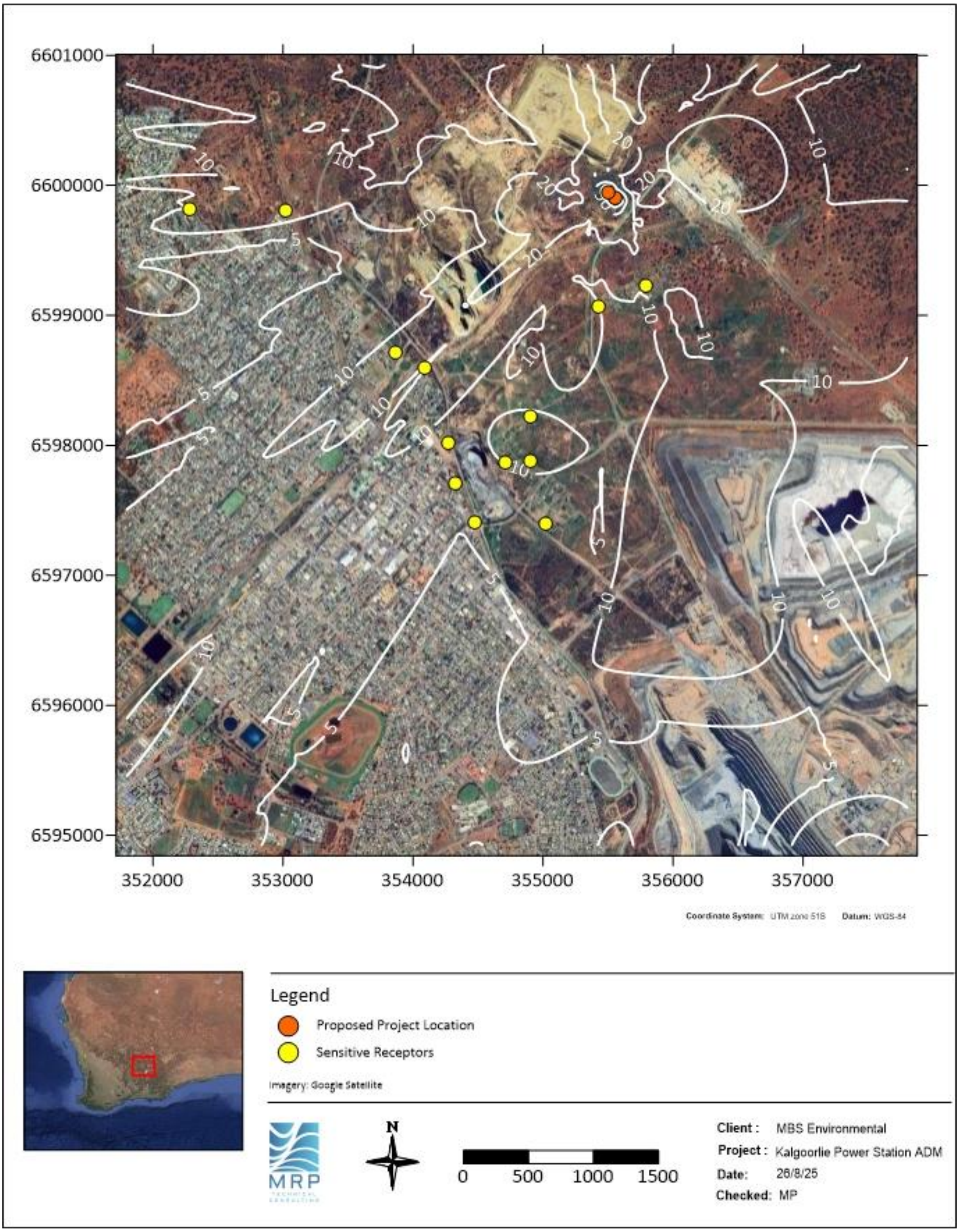

Figure 4-33: Predicted 1-hour maximum GLCs of CO (μg/m³) in isolation – LFO mode (Scenario 3)

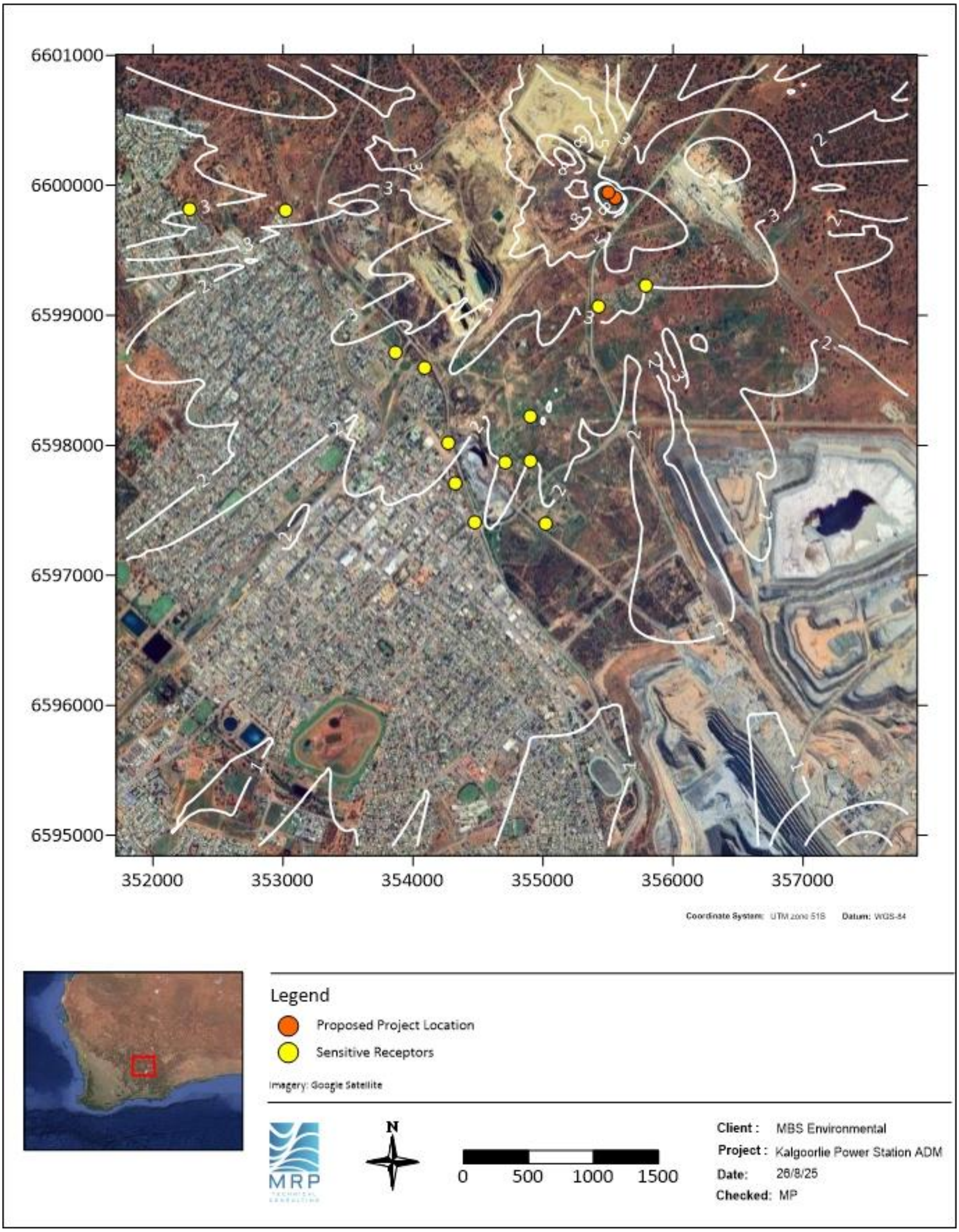

Figure 4-34: Predicted 8-hour maximum GLCs of CO (μg/m³) in isolation – LFO mode (Scenario 3)

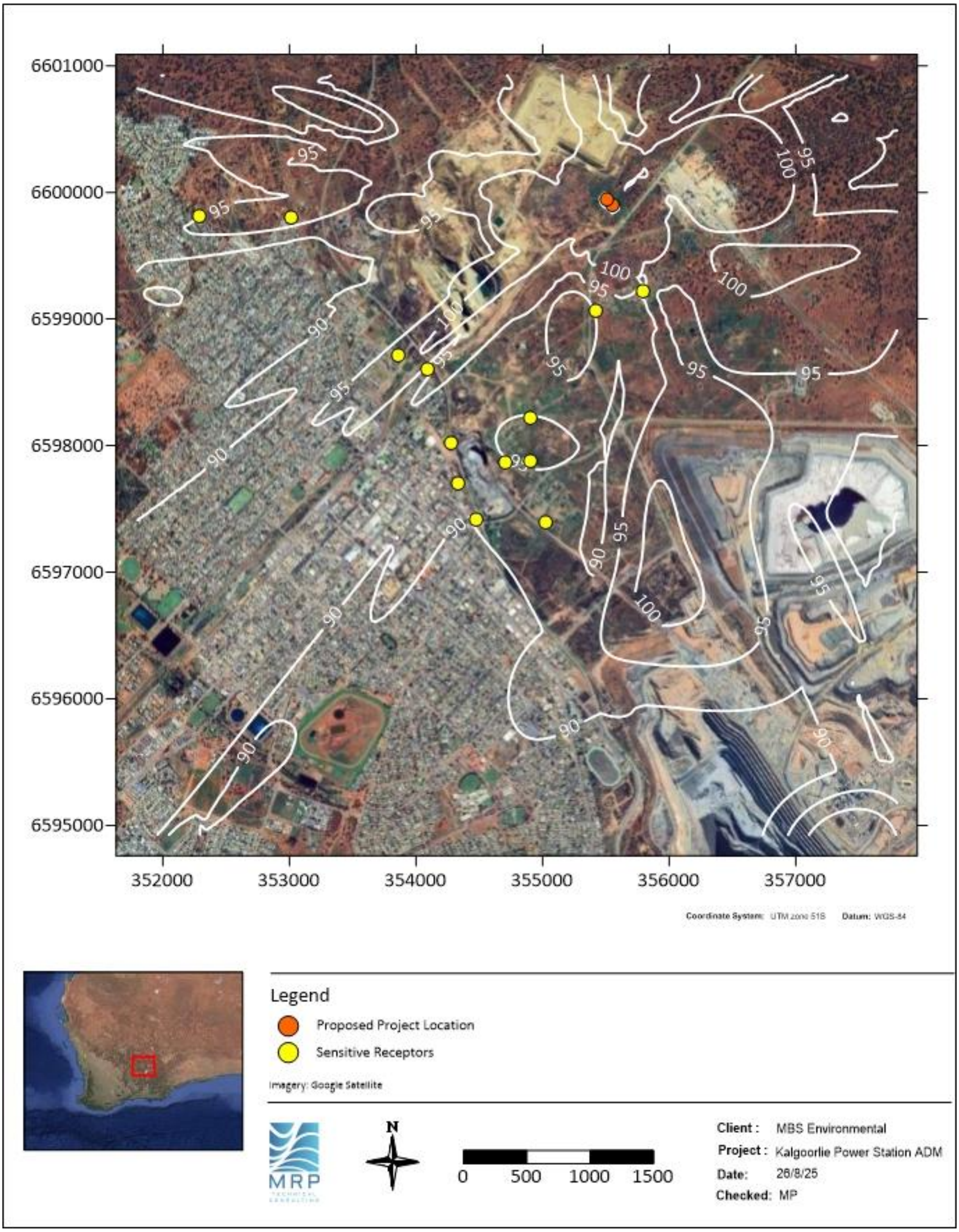

Figure 4-35: Predicted cumulative 1-hour maximum GLCs of CO (µg/m^3) – LFO mode (Scenario 4)

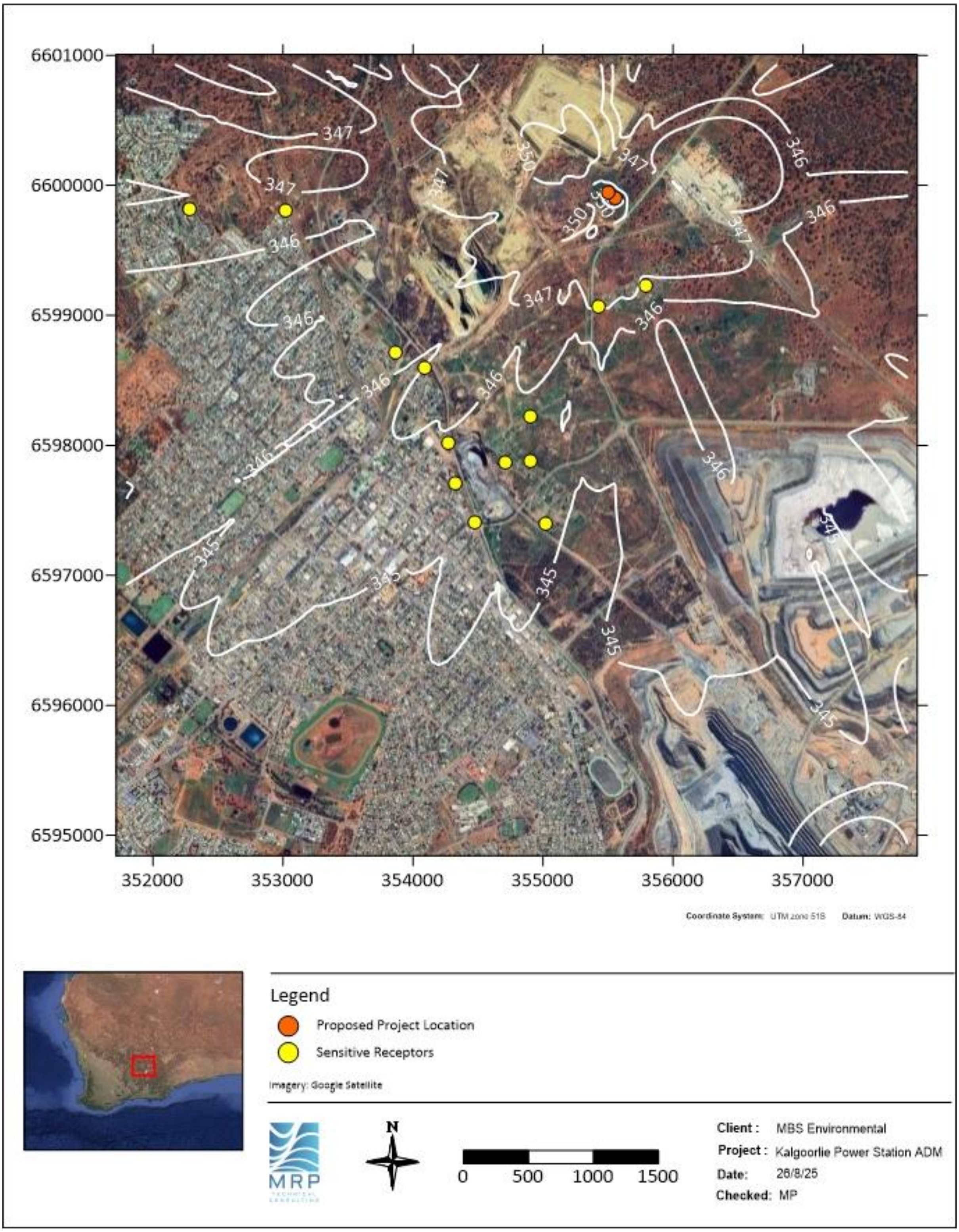

Figure 4-36: Predicted cumulative 8-hour maximum GLCs of CO (μg/m³) – LFO mode (Scenario 4)

4.5 Formaldehyde

Contour plots showing predicted concentrations of CH_2O can be found in Figure 4-37 to Figure 4-40 below, with relevant air quality criteria displayed as a red contour line. Table 4-5 presents the predicted GLCs at nearby sensitive receptors in the region.

Results of the modelling indicated that there were no exceedances of the relevant 1-hour or 24-hour maximum AGVs for CH_2O predicted at any of the nearby sensitive receptors or outside of the facility boundary for any of the modelled scenarios.

Table 4-5: Summary of predicted CH_2O concentrations at the closest sensitive receptors

1-hour maximum CH_2O ground level concentrations								
Receptor		Criteria	Background		Scenario 1 Gas mode - isolation		Scenario 2 Gas mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East	20	1.96	10%	10.76	54%	12.71	64%
Rec_002	Ninga Mia West				8.71	44%	10.66	53%
Rec_003	Kalgoorlie North 3				8.97	45%	10.93	55%
Rec_004	Kalgoorlie North 2				9.53	48%	11.49	57%
Rec_005	Kalgoorlie North 1				12.32	62%	14.28	71%
Rec_006	Kalgoorlie Central				9.11	46%	11.07	55%
Rec_007	Kalgoorlie South 1				7.10	35%	9.06	45%
Rec_008	Kalgoorlie South 2				5.78	29%	7.73	39%
Rec_009	Kalgoorlie South 3				4.29	21%	6.24	31%
Rec_010	Williamstown North				6.13	31%	8.09	40%
Rec_011	Williamstown Central East				5.19	26%	7.14	36%
Rec_012	Williamstown Central West				5.33	27%	7.29	36%
Rec_013	Williamstown South				4.90	25%	6.86	34%
1-hour 99.9th Percentile CH_2O ground level concentrations								
Facility Boundary		20	1.96	10%	13.20	66%	15.15	76%

Notes

1. Referenced to 25ºC, and 101.3 kPa

24-hour maximum CH_2O ground level concentrations								
Receptor		Criteria	Background		Scenario 1 Gas mode - isolation		Scenario 2 Gas mode - cumulative	
		(µg/m³)[1]	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline	(µg/m³)[1]	% Guideline
Rec_001	Ninga Mia East	49	2.10	4%	1.53	8%	3.63	18%
Rec_002	Ninga Mia West				1.34	7%	3.44	17%
Rec_003	Kalgoorlie North 3				1.27	6%	3.36	17%
Rec_004	Kalgoorlie North 2				1.52	8%	3.61	18%
Rec_005	Kalgoorlie North 1				1.09	5%	3.19	16%
Rec_006	Kalgoorlie Central				0.99	5%	3.09	15%
Rec_007	Kalgoorlie South 1				0.91	5%	3.01	15%
Rec_008	Kalgoorlie South 2				0.63	3%	2.72	14%
Rec_009	Kalgoorlie South 3				0.67	3%	2.76	14%
Rec_010	Williamstown North				0.68	3%	2.77	14%
Rec_011	Williamstown Central East				0.69	3%	2.79	14%
Rec_012	Williamstown Central West				0.69	3%	2.79	14%
Rec_013	Williamstown South				0.70	3%	2.80	14%

Notes

1. Referenced to 25ºC, and 101.3 kPa

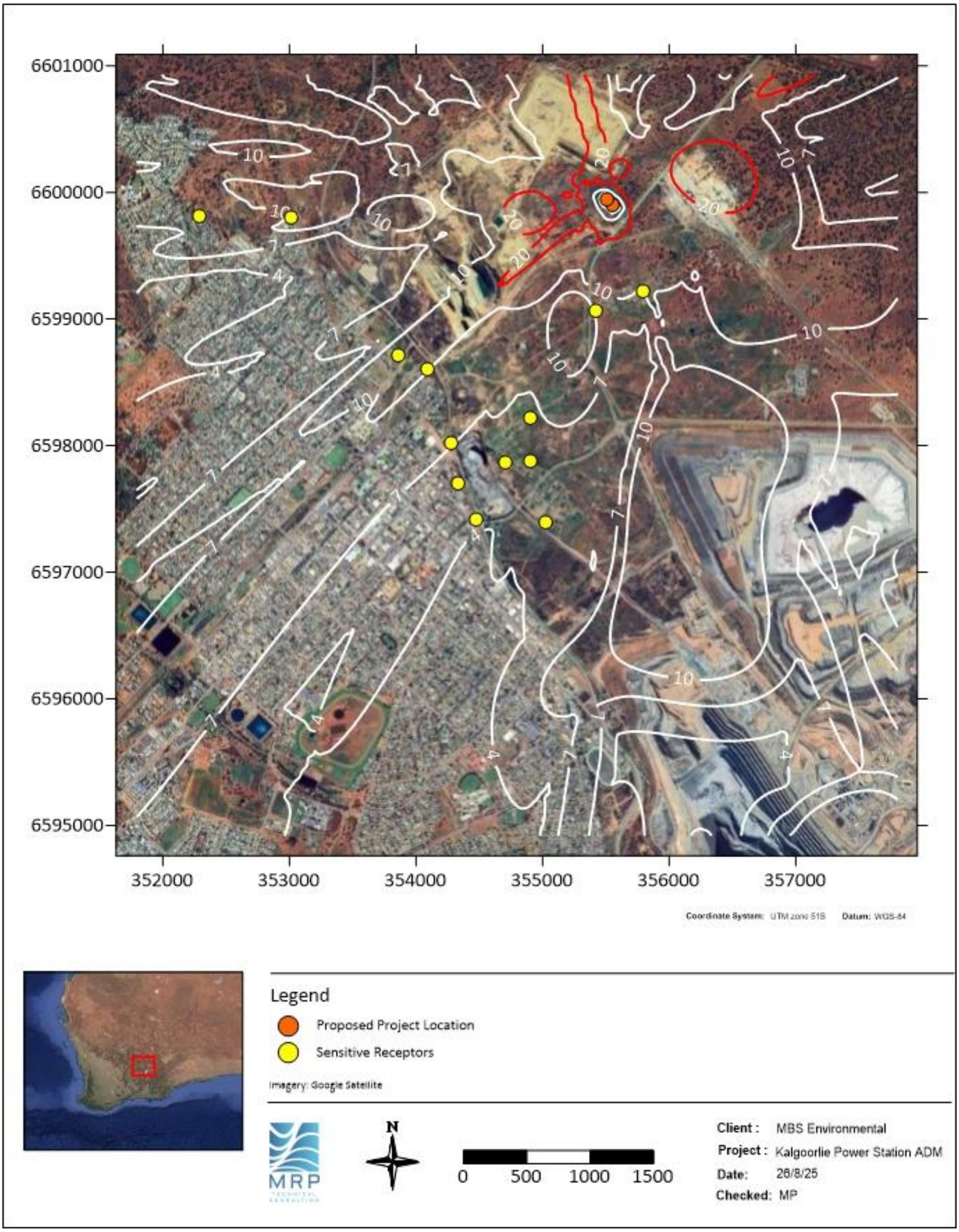

Figure 4-37: Predicted 1-hour maximum GLCs of CH_2O (μg/m^3) in isolation – gas mode (Scenario 1)

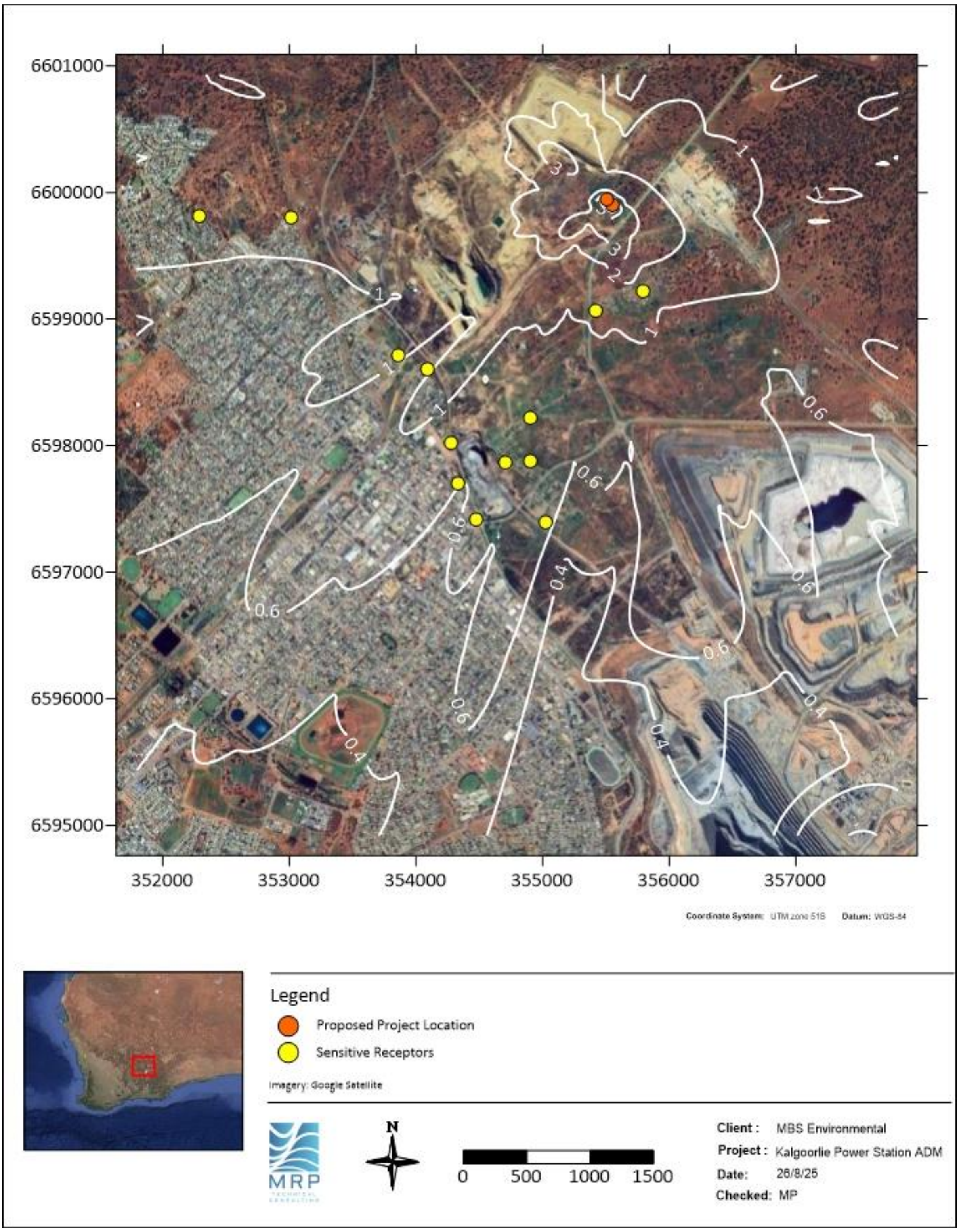

Figure 4-38: Predicted 24-hour maximum GLCs of CH_2O (µg/m^3) in isolation – gas mode (Scenario 1)

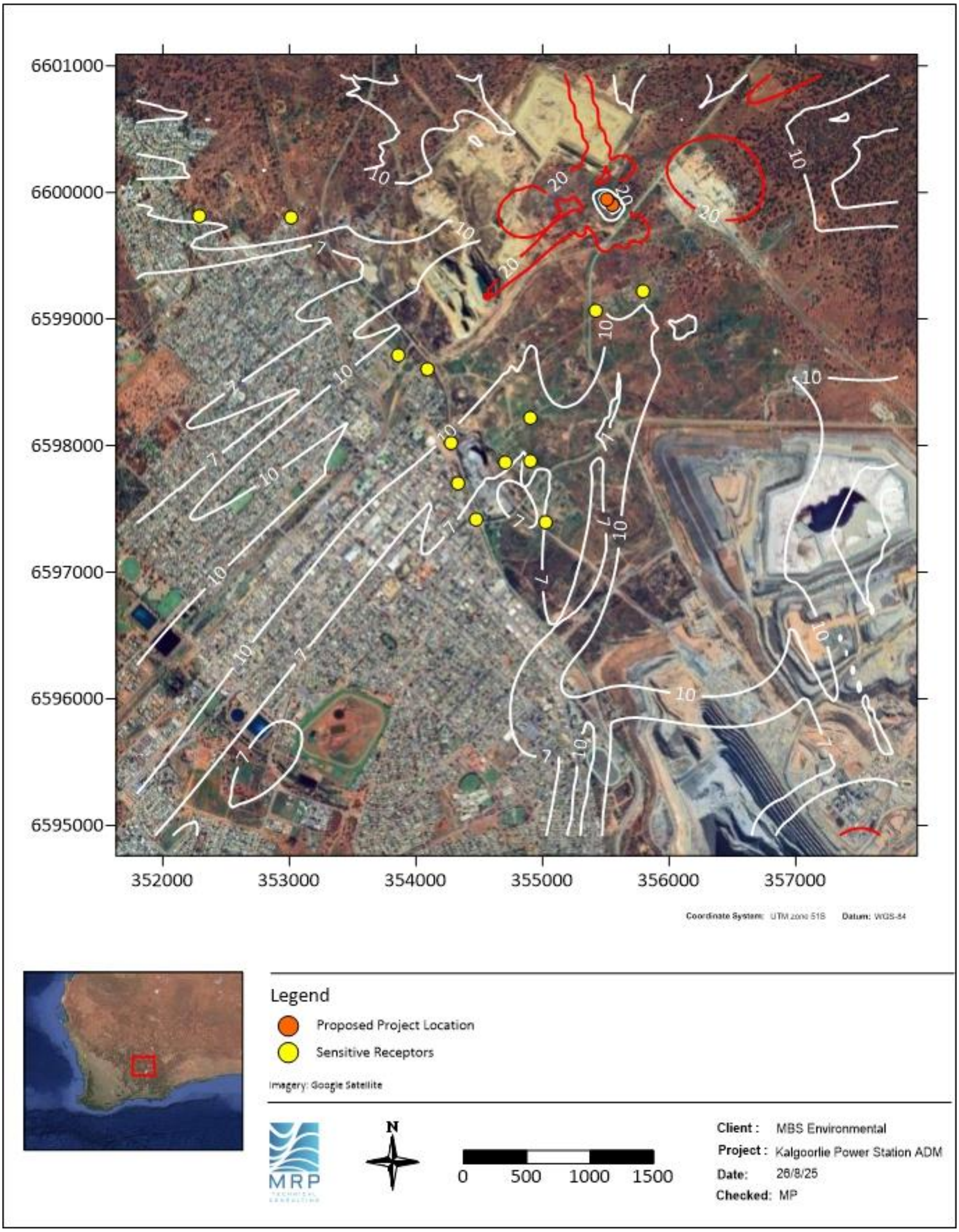

Figure 4-39: Predicted cumulative 1-hour maximum GLCs of CH_2O (µg/m^3) – gas mode (Scenario 2)

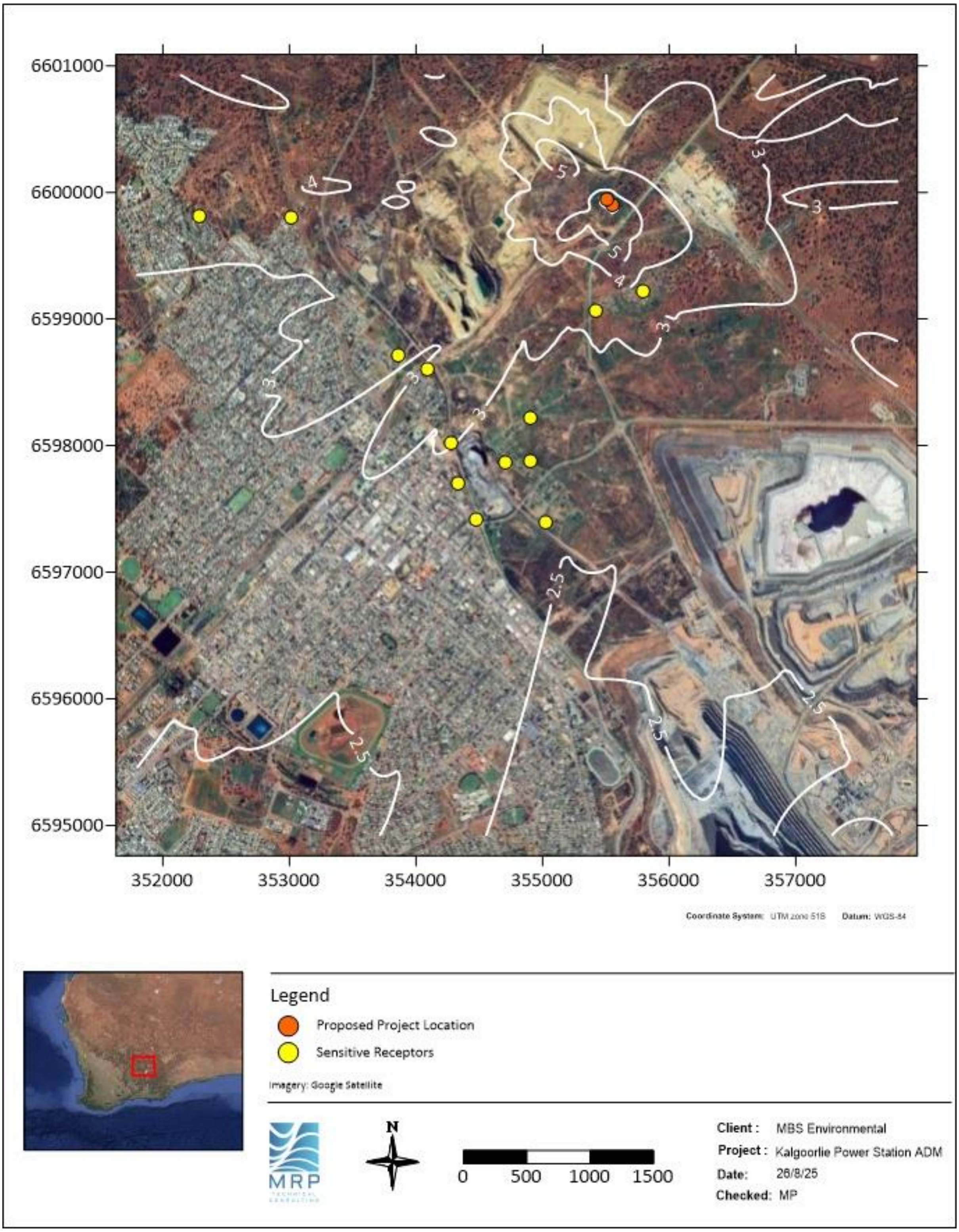

Figure 4-40: Predicted cumulative 24-hour maximum GLCs of CH_2O (µg/m^3) – gas mode (Scenario 2)

5 Conclusion

Zenith is working with Northern Star to develop additional power supply sources for the KCGM operations which are located in Kalgoorlie in Western Australia, approximately 600 km east of Perth. Additional power supply is required to meet increasing power demands for the operation as a direct result of significant expansion of ore processing throughput rates at the Fimiston Gold Plant from 13.4 to about 20 Mtpa.

Zenith and Northern Star have identified supplementing the existing aging 110 MW natural gas thermal power supply at Parkeston with a new thermal power generation facility with a capacity of circa 140 MW. The new power station would provide the additional power required for increased ore processing. Construction and operation of the new facility would be targeted at providing power supply for KCGM by late 2027 to match scheduled completion of the Fimiston Gold Plant expansion at KCGM. Thermal power is anticipated to provide the full KCGM power needs for a period of 12–24 months with decreasing reliance over time as other alternative energy supply options are assessed and ultimately constructed and become available. Zenith and Northern Star are planning to construct the new 140 MW power station northwest of the existing Parkeston Power Station. The assessment considered the following potential air pollutants from the power station: NOx, $PM_{2.5}$, SO_2, CO and CH_2O.

Air dispersion modelling was conducted to assess the proposed operations of the thermal power generation facility. The air dispersion modelling did not predict exceedances of $PM_{2.5}$, SO_2, CO or CH_2O at any of the sensitive receptor locations for any scenario or averaging period.

Exceedances of the 1-hour average ambient air quality criterion for NO_2 were predicted at two nearby sensitive receptors (Ninga Mia East and Kalgoorlie North 2) for operations in the LFO mode (no exceedances were predicted for gas mode) when considered cumulatively with background concentrations (Scenario #4). The predicted values at the receptors were 104% and 100% of the 1-hour AGV. When considered in isolation (Scenario #3), no exceedance was predicted for the 1-hour criterion was predicted for NO_2. It is noted that the magnitude and the frequency of predicted exceedances of the 1-hour AGV for NO_2 (assuming continuous operations in LFO mode) is low. The plant is not expected to operate in LFO mode unless natural gas is unavailable. The probability that potential worst case meteorological conditions would occur at the same time as potential times where the plant may be required to operate in LFO mode is low. Given the above, the risk to human health at nearby receptors associated with the proposed operational profile of the power station in LFO mode is considered low.

Scenarios #3 and #4 are considered representative of startup and shutdown conditions and are expected to occur infrequently and for short durations (5 minutes). Northern Star Resources has verbally communicated that the gas supply has not been interrupted during normal operation conditions in the previous ten (10) years and that the Parkeston facility has not previously experienced any interruptions to their gas supply.

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