EXECUTIVE SUMMARY

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was requested by Environmental Impact Management Services to carry out a soil, land use and land capability survey for the proposed Paardeplaats coal mining project, near Belfast in Mpumalanga Province.

The soils of an area of 1 462 ha were investigated using a 150 x 150 m grid, controlled by GPS and samples were collected for analysis at 19 sites.

Several soil map units were identified, following the field survey phase, carried out using a soil auger. A description of the most important soil characteristics of each unit, such as the dominant soil form and family, soil depth, topsoil texture and underlying material, is given in the soil legend.

In general, the soils are yellow-brown or red, and range from shallow through moderately deep to deep, with significant areas of surface rock outcrops.

The soils are of light texture, slightly sandy loam to loamy soils, are highly weathered, slightly to strongly acidic, with low to moderate organic carbon. The P and K levels are very low. The map units with the highest agricultural potential are the **dHu** and **dCv** map units. The other map units have moderate to very low agricultural potential.

Three alternatives were assessed. For the “No-go” alternative, the significance of impact will be low, while for the “Portion 30” and “Entire Study Area” alternatives, it will be high and very high respectively.

Mitigation measures will include a comprehensive soil utilization plan, whereby all available soil is removed, stockpiled, replaced, loosened, re-vegetated and monitored to try and ensure that the post-mining soil quality is as high as possible.

CONTENTS

1 INTRODUCTION

1.1 Terms of Reference

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was requested by Environmental Impact Management Services to carry out a soil, land use and land capabiity survey for the Paardeplaats coal mining project near Belfast, Mpumalanga Province, proposed by Exxaro. The aim of the survey was:

- A detailed impact assessment on the above aspects (Soils, Land Use and Land Capability) as a result of the proposed activities;
- Identification of potential impacts (cumulative, direct and indirect),quantified where possible and fully described for each feasible alternative;
- Evaluation of potential impacts in accordance with the agreed methodology to determine significance.
- Comparative assessment of the identified alternatives;
- Recommended mitigation / management measures, including a detailed description of implementation and means of measuring their success.
- Evaluation of residual impacts after mitigation such that actual implemented results can be measured against those predicted;
- Preparation of a detailed, site-specific EMP relating to the specific field of expertise and impacts identified, based on the mitigation and management measures identified;
- Site sensitivities, if any;
- Site constraints, if any;
- Recommendations to be undertaken;

2 STUDY AREA

2.1 Location

The study area occupies Portion 28, 29, 30 and 40 of the farm Paardeplaats 380 JT; Portion 2 of the farm Paardeplaats 425JS and Portion 13 of Paardeplaats 380 JT; and is located approximately 3 km south-west of the town of Belfast. The area (shown in green) lies between latitudes 25^o 42’ and 25^o 46’ S and between longitudes 29^o 57’ and 30^o 1’ E (Figure 1).

The area is bounded on the south by the N4 tarred road and a railway line. The existing Glisa coal mine adjoins the area to the north. The site is approximately 1 462 ha in extent (areas determined by the GIS mapping exercise).

The land use comprises a mixture of grassland areas, some previously cultivates pasture areas and some areas of intensive cultivation (Hadeco property), along with smaller zones of forestry, farm buildings and farm residential areas (Figure 2).

2.2 Terrain

The area lies between 1 840 and 1 880 metres above sea level, with the highest point occurring in the southern part of the area. The terrain is comprised of undulating plains, with slopes of between 3% and 8%. The site is has relatively steeply-incised streams and rivers in various sections of the area that drain into water catchment dams/ponds within the area. All catchment dams/ponds, streams and wetland areas have been mapped (see map in the appendix).

2.3 Parent Material

The geology of the study area consists of shale, sandstone and grit of the Ecca Group, of the Karoo Sequence (Geological Survey, 1986).

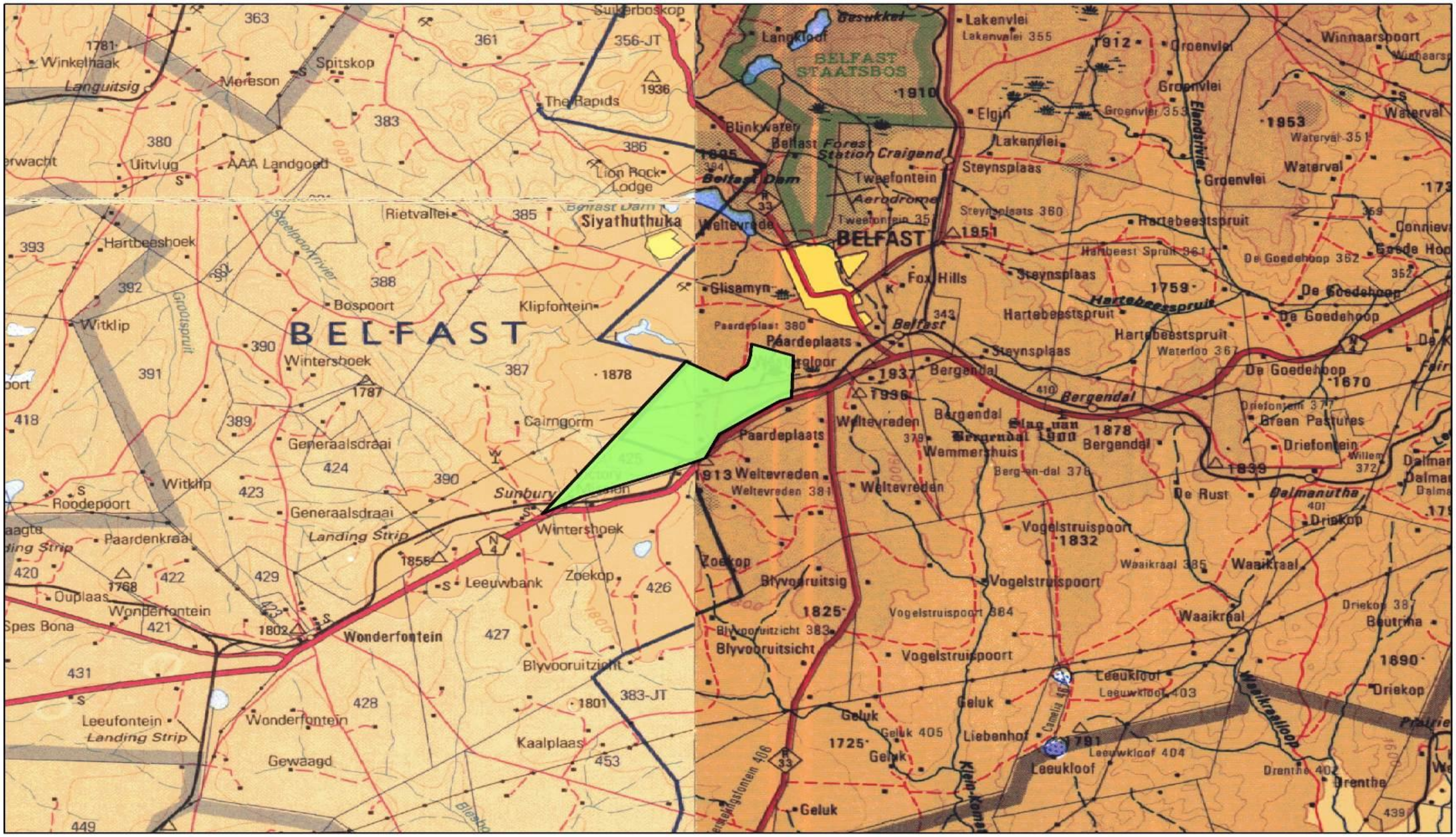


Figure 1 Location map

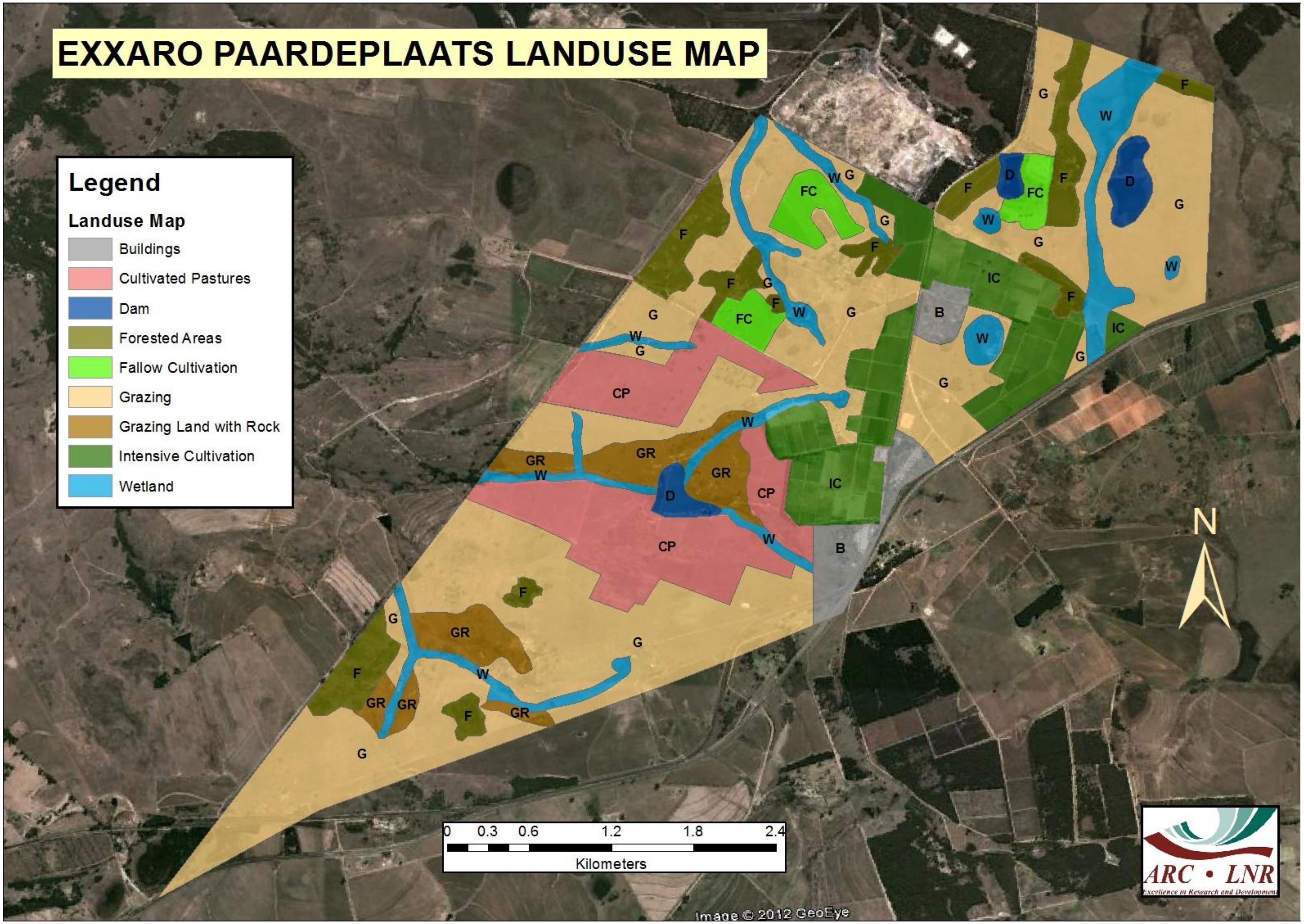


Figure 2 Land use map

2.4 Climate

Climate data was obtained from the national Land Type Survey (Koch, 1987).

The climate has warm, moist summers with cool, dry winters. On average, 84% of the annual average rainfall of 720 mm falls in the growing season (October to March). Frost, often severe, occurs in winter. The extreme maximum temperature is 35.6^{o}C and the extreme minimum -11.1^{o}C

The climatic data is given in Table 1 below.

Table 1 Climate data for Belfast area

Month	Rainfall (mm)	Min. Temp (^{o}C)	Max. Temp (^{o}C)	Average frost dates
Jan	125.6	12.5	25.0	Start date: 11/05
Feb	89.9	12.1	24.6	End date: 01/09
Mar	78.8	10.9	23.6	Days with frost: <u>+25</u>
Apr	40.7	7.7	21.8	
May	17.2	3.6	19.3	
Jun	6.8	0.4	16.4	
Jul	8.7	0.2	16.7	**Heat units (hrs > 10^{o}C)**
Aug	9.6	2.8	19.6	Summer (Oct-Mar): 1432
Sep	26.7	6.4	22.4	
Oct	76.3	9.4	24.0	Winter (Apr-Sept): 364
Nov	121.9	10.8	24.0	
Dec	118.3	12.0	24.9	
Year	**720.3**	**(Average) 14.6^{o}C**		

3 METHODOLOGY

The soils were investigated using a hand-held soil auger to a maximum depth of 1 200 mm, on a grid of 150 x 150 metres, which was established using a GPS. All the relevant soil properties (horizons, colour, structure, texture, calcareousness, drainage, etc) at each observation point were noted and the soils were classified according to the South African Soil Classification System (Soil Classification Working Group, 1991). Similar soils were grouped together into mapping units. During this phase, the areas of wetlands, with their distinct soil patterns, were delineated. The soil mapping units, as well as the wetland areas, are shown on the soil map in the Appendix.

Following the delineation of the soil map units, each unit can then be allocated to a class of agricultural potential, as well as pre-mining land capability.

Representative topsoil and subsoil (where present) samples were also collected.

The samples were analyzed for particle size, pH, cation exchange capacity (CEC) and exchangeable cations, organic carbon and P according to the standard prescribed methods (Non-Affiliated Soil Analysis Work Committee, 1990).

In addition, during the soil survey phase, current land use was noted in order that a map of the distribution of the various land use types could be prepared.

4 RESULTS

4.1 Soils

Several soil map units were identified. A description of the most important soil characteristics of each unit, such as the dominant soil form and family, soil depth, topsoil texture and underlying material, is given in the soil legend shown in Table 2.

In general, the greater part of the area contains deep soils intermixed in certain areas with soils of varying depths from shallow to moderate; with predominantly yellow-brown and red (occasionally reddish-brown) colors. The soils are weakly structured to structureless across the entire area, with rock outcrops and surface stones in places. The south western portion of the site is dominated by shallower soils mixed with some moderately deep soils.

Wetland areas (including streams and dams) occur in the lower-lying positions in various portions of the site.

4.2 Soil Analysis Results

Samples of topsoil and subsoil were collected at 19 localities (S1 to S19). These points are marked on the soil map. The analysis results are shown in Table 3.

Table 2 Soil map legend

Map Unit (+ area)	Depth (mm)	Dominant Soil Form(s)	Sub-dominant Soil Form(s)	General description of soils occurring	Agric. Pot.
Deep structureless soils					
dCv (286.52 ha)	800-1200	Clovelly 1200	Clovelly 1100, Avalon 1200 Longlands 2000	Brown, apedal, loamy sand to sandy loam topsoil on yellow-brown (occasionally grey), apedal, loamy sand to sandy loam subsoil, occasionally on mottled soft plinthite or weathering rock.	Very high
dHu (93.78 ha)	800-1200	Hutton 1200	Hutton 1100, Clovelly 1200, Bainsvlei 1200	Reddish-brown, apedal, loamy sand to sandy loam topsoil on red (occasionally yellow-brown), apedal, loamy sand to sandy loam subsoil, occasionally on mottled soft plinthiteor weathering rock.	Very high
dHu/Cv (41.81 ha)	800-1200	Hutton 1200, Clovelly 1200	Hutton 1100, Clovelly 1100	Brown to reddish-brown, apedal, loamy sand to sandy loam topsoil on yellow-brown to red, apedal, loamy sand to sandy loam subsoil, on weathering rock.	Very high
dAv (24.63 ha)	800-1200	Avalon 1200	Avalon 1100, Glencoe 1200	Brown, apedal, loamy sand to sandy loam topsoil on yellow-brown, apedal, loamy sand to sandy loam subsoil, on a periodical wetting zone with mottled soil colors, occasionally cemented.	Very high
Moderately deep structureless soils					
mdCv (186.07 ha)	450-800	Clovelly 1200	Clovelly 1100, Avalon 1200	Reddish-brown, apedal, loamy sand to sandy loam topsoil on red, apedal, loamy sand to sandy loam subsoil (often with concretions) on weathering rock.	Moderate
mdHu (20.59 ha)	450-800	Hutton 1200	Hutton 1100, Clovelly 1200	Brown, apedal, loamy sand to sandy loam topsoil on yellow-brown, apedal, loamy sand to sandy loam subsoil (often with concretions) on weathering rock.	Moderate
mdAv (66.94 ha)	450-800	Avalon 1200	Avalon 1100, Glencoe 1200	Brown, apedal, loamy sand to sandy loam topsoil on yellow-brown, apedal, loamy sand to sandy loam subsoil, on a periodical wetting zone with mottled soil colors.	Moderate
mdAv/Cv (80.16 ha)	450-800	Avalon 1200, Clovelly 1200	Avalon 1100, Glencoe 1200	Brown, apedal, loamy sand to sandy loam topsoil on yellow-brown, apedal, loamy sand to sandy loam subsoil, on weathering rock or mottled soft plinthite.	Moderate
mdCv/Lo (6.85 ha)	450-700	Clovelly 1200, Longlands 2000	-	Brown to greyish-brown, apedal, loamy sand to sandy loam topsoil on yellow-brown, apedal, loamy sand to sandy loam subsoil on weathering rock. In lower landscape positions,	Moderate to low

				grey, loamy sand subsoils on mottled soft plinthite occur.	
mdKd (6.79 ha)	450-700	Kroonstad 2000	-	Dark brown, weakly structured, sandy clay loam topsoil on grey, mottled, weakly developed structured, sandy clay subsoil with signs of wetness. The lower horizon is saturated with water for long periods unless drained.	Very low
				Shallow soils	
sDr (392.77 ha)	200-400	Dresden 1100	Mispah 1000, Clovelly 1200, Hutton 1200	Brown to greyish-brown, apedal, loamy sand to sandy loam topsoil on cemented ferricrete or hard (occasionally weathering) rock. Yellow-brown and red topsoils also occur. Rock outcrops occur occasionally.	Very low
sDr/R (85.11 ha)	50-250	Dresden 1100	Mispah 1000, Rock	Brown to greyish-brown, apedal, loamy sand to sandy loam topsoil on cemented ferricrete or hard (occasionally weathering) rock. Rock outcrops occur throughout the map unit.	Very low
				Wetlands	
W (118.75 ha)	0-200	Katspruit 2000	Sepane 1110	Dark grey to dark brown, structureless to weakly structured, sandy loam to sandy clay loam topsoils, on dark brown to black, mottled, structured sandy clay to clay subsoils, often wet. Occur in low-lying areas such as stream beds and valley bottoms. Soils are saturated with water year-round.	None
Dam (28.77 ha)	-	Dam		Water catchment areas.	None
				Miscellaneous areas	
B (22.32 ha)	-	Buildings		Built up areas.	None
TOTAL AREA: 1 461.86 ha					

Table 3 Soil analysis results

Sample Site No.	S1			S2			S3	S4		S5	
	0-300 mm	300-800 mm	800+ mm	0-300 mm	300-800 mm	800+ mm	0-300 mm	0-300 mm	300-1200 mm	0-300 mm	300-950 mm
Co-ordinates	25° 45’ 34.83” S 29° 58’ 10.61” E			25° 45’ 5.58” S 29° 58’ 15.99” E			25° 44’ 46.09” S 29° 58’ 37.53” E	25° 44’ 41.21” S 29° 58’ 59.06” E		25° 45’ 0.72” S 29° 59’ 25.97” E	
Soil Form	Av			Av			Dr	Cv		Gc	
Map Unit	mdAv/Cv			mdAv/Cv			sDr	dCv		dAv	
Sand (%)	78.0	72.0	72.0	64.0	66.0	66.0	68.0	68.0	64.0	74.0	78.0
Silt (%)	6.0	8.0	6.0	8.0	6.0	8.0	8.0	6.0	4.0	10.0	4.0
Clay (%)	16.0	20.0	22.0	28.0	28.0	26.0	24.0	26.0	32.0	16.0	18.0
Na (cmol (+) kg^{-1})	0.037	0.041	0.035	0.030	0.044	0.052	0.056	0.042	0.039	0.046	0.074
K (cmol (+) kg^{-1})	0.102	0.086	0.080	0.195	0.101	0.081	0.095	0.191	0.115	0.124	0.067
Ca (cmol (+) kg^{-1})	0.179	0.187	0.547	0.575	0.152	0.094	0.118	1.088	0.644	1.164	0.283
Mg (cmol (+) kg^{-1})	0.129	0.141	0.417	0.353	0.661	0.615	0.179	0.596	0.263	0.559	0.283
CEC* (cmol (+) kg^{-1})	7.905	7.355	8.232	11.227	3.724	5.230	4.761	4.991	4.954	6.928	2.986
$P^{\#}$ (ppm)	3.31	1.26	0.83	2.71	1.25	0.65	2.51	4.30	0.68	1.43	1.01
pH_{WATER}	4.89	5.07	5.72	5.15	5.31	5.78	5.26	5.40	5.39	5.40	5.38
Org. Carbon %	1.13	0.82	0.40	1.05	0.58	0.39	1.16	0.95	0.47	2.56	0.40

Table 3 Soil analysis results (continued….)

Sample Site No.	S6		S7		S8			S9		S10	
	0-300 mm	300-900 mm	0-350 mm	350-800 mm	0-200 mm	200-650 mm	650+ mm	0-350 mm	350-1200 mm	0-300 mm	300-1000 mm
Co-ordinates	25° 44' 26.59" S 29° 59' 4.45" E		25° 44' 36.34" S 29° 59' 25.97" E		25° 46' 58.85" S 30° 0' 9.03" E			25° 43' 52.47" S 29° 59' 42.12" E		25° 44' 32.98" S 29° 59' 25.98" E	
Soil Form	Cv		Lo		Av			Hu		Cv	
Map Unit	dCv		dCv		mdAv			dCv		mCv	
Sand (%)	70.0	60.0	64.0	62.0	78.0	68.0	64.0	72.0	68.0	78.0	74.0
Silt (%)	6.0	8.0	10.0	6.0	4.0	6.0	10.0	4.0	4.0	2.0	6.0
Clay (%)	24.0	32.0	26.0	32.0	18.0	26.0	26.0	24.0	28.0	20.0	20.0
Na (cmol (+) kg^{-1})	0.026	0.033	0.031	0.030	0.031	0.033	0.050	0.026	0.029	0.040	0.030
K (cmol (+) kg^{-1})	0.209	0.156	0.290	0.095	0.418	0.471	0.550	0.172	0.100	0.088	0.066
Ca (cmol (+) kg^{-1})	0.311	0.285	1.076	0.423	2.030	0.846	1.216	0.322	0.089	0.113	0.054
Mg (cmol (+) kg^{-1})	0.183	0.177	0.439	0.337	0.634	0.398	0.565	0.179	0.085	0.160	0.156
CEC* (cmol (+) kg^{-1})	4.804	3.828	8.435	2.556	4.284	3.828	2.847	3.948	5.751	3.883	2.883
$P^{\#}$ (ppm)	1.21	0.66	2.51	0.89	7.80	2.61	1.01	2.25	0.47	3.02	1.08
pH_{WATER}	5.22	5.30	5.27	5.58	6.00	5.25	5.35	5.36	5.07	4.88	4.99
Org. Carbon %	1.68	0.53	2.68	0.35	0.74	0.47	0.31	1.47	0.59	0.52	1.60

Table 3 Soil analysis results (continued….)

Sample Site No.	S11		S12		S13		S14		S15	
	0-200 mm	200-900 mm	0-300 mm	300-1000 mm	0-300 mm	300-1000 mm	0-300 mm	300-1200 mm	0-300 mm	300-1200 mm
Co-ordinates	25° 43' 8.6" S 29° 59' 42.65" E		25° 43'23.23" S 30° 0' 30.55" E		25° 44' 2.22" S 30° 0' 35.94" E		25° 43' 42.72" S 30° 1' 2.84" E		25° 43' 32.97" S 30° 1' 35.13" E	
Soil Form	Cv		Hu		Cv		Hu		Hu	
Map Unit	dCv		dHu		dHu/Cv		dHu/Cv		dHu	
Sand (%)	70.0	72.0	84.0	70.0	72.0	68.0	62.0	54.0	54.0	48.0
Silt (%)	10.0	4.0	4.0	6.0	10.0	6.0	14.0	10.0	12.0	28.0
Clay (%)	20.0	24.0	12.0	24.0	18.0	26.0	24.0	36.0	34.0	24.0
Na (cmol (+) kg^{-1})	0.033	0.025	0.026	0.027	0.029	0.038	0.047	0.039	0.049	0.129
K (cmol (+) kg^{-1})	0.157	0.080	0.252	0.193	0.109	0.083	0.405	0.143	0.125	0.075
Ca (cmol (+) kg^{-1})	5.414	0.539	1.817	0.795	0.827	0.294	2.639	1.301	0.417	0.169
Mg (cmol (+) kg^{-1})	1.377	0.307	0.517	0.339	0.570	0.510	1.213	0.777	0.267	0.121
CEC* (cmol (+) kg^{-1})	10.245	4.639	2.556	7.902	7.860	3.174	9.197	10.482	0.858	9.979
$P^{\#}$ (ppm)	2.10	0.73	8.56	2.81	3.33	1.43	4.23	1.60	2.26	0.78
pH_{WATER}	6.25	5.35	6.80	5.30	5.40	5.37	5.65	5.90	4.70	5.05
Org. Carbon %	0.48	0.67	0.45	0.43	1.91	0.64	2.55	0.92	2.37	0.86

Table 3 Soil analysis results (continued….)

Sample Site No.	S16		S17		S18			S19	
	0-250 mm	250-650 mm	0-300 mm	300-1200 mm	0-350 mm	350-700 mm	700-1200 mm	0-300 mm	300-600 mm
Co-ordinates	25° 43' 23.22" S 30° 1' 8.22" E		25° 42' 58.85" S 30° 1' 24.36" E		25° 42' 58.86" S 30° 0' 57.46" E			25° 42' 39.36" S 30° 0' 57.45" E	
Soil Form	Hu		Hu		Hu			Hu	
Map Unit	mdHu		dHu		dHu			dHu	
Sand (%)	62.0	54.0	58.0	64.0	66.0	58.0	54.0	64.0	66.0
Silt (%)	8.0	8.0	20.0	8.0	10.0	12.0	6.0	10.0	8.0
Clay (%)	30.0	38.0	22.0	28.0	24.0	30.0	40.0	26.0	26.0
Na (cmol (+) kg^{-1})	0.107	0.134	0.102	0.110	0.100	0.111	0.103	0.096	0.124
K (cmol (+) kg^{-1})	0.075	0.050	0.229	0.067	0.357	0.071	0.105	0.199	0.170
Ca (cmol (+) kg^{-1})	0.293	0.032	0.970	0.295	1.366	0.079	0.052	0.760	0.799
Mg (cmol (+) kg^{-1})	0.309	0.166	0.828	0.553	0.745	0.504	0.341	0.595	0.928
CEC* (cmol (+) kg^{-1})	10.020	14.552	12.357	6.088	7.957	6.872	7.915	8.173	8.727
$P^{\#}$ (ppm)	3.45	1.62	6.21	3.48	6.53	2.20	0.95	2.38	0.83
pH_{WATER}	4.94	5.28	5.33	5.74	5.52	5.38	5.44	5.30	5.41
Org. Carbon %	1.48	0.40	2.01	0.94	1.90	1.00	0.63	1.87	1.85

The analyses show the soil textures are loamy sand to sandy clay loam for the topsoils, usually becoming sandy loam to sandy clay loam in the subsoils. Generally, all of the soils are dystrophic (highly leached) with very low CEC values. Only samples S8, S14 and S19 are slightly above the dystrophic threshold. Generally the pH values are low, also indicating acidic conditions.

On average, the soils have very low P levels due to the low acidity of the soils, which in turn causes P to be fixed in the soil and thus render it unavailable for plant uptake. In addition, most the soils have not been previously/ and or recently cultivated which will also contribute to the low P levels. The K levels are also extremely low for cultivation of crops, especially vegetables.

Organic carbon levels are low to moderate, slightly higher in grassland areas that have not been recently cultivated, and lower in the cultivated areas.

4.3 Agricultural Potential

The general agricultural potential of each map unit, and the main limiting factors, are given in Table 4 below. The area in hectares is given, with the percentage of the total survey area in red.

More than half the area comprises soils with moderate to high potential for agriculture. In addition, approximately 10% of the area comprises a wetland system (with associated dams) and these occur throughout the area.

For the areas that are best suited for grazing, the prevailing climatic and other conditions in the area mean that the approximate grazing capacity is around 7-8 ha/LSU (ARC-ISCW, 2004).

Table 4 Agricultural Potential

Agricultural Potential	Map unit	Area (ha) + %	Limitations
Very high	**dHu, dCv, dAv, dHu/Cv**	446.74 (30.56%)	Few to none
Moderate	**mdHu, mdCv, mdAv, mAv/Cv**	353.76 (24.20%)	Somewhat restricted depth in places, otherwise favourable
Moderate to low	**mdCv/Lo**	6.85 (0.47%)	Restricted depth and lower fertility of soils (Lo)
Very low	**mdKd, sDr, sDr/R**	484.67 (33.15%)	• Shallow soil depth with some rockiness (sDr, sDr/R). • High clay content and signs of wetness in subsoils (mdKd)
None	**W, Dams, B**	169.84 (11.62%)	Usually no soil available for use
	Total	**1 461.86 (100%)**	

4.5 Pre-mining land capability

The soil mapping units were also allocated to a class of pre-mining land capability (Chamber of Mines/Coaltech, 2007), as indicated in Table 5. While only one class of arable capability is suggested, the variation in soil characteristics (mainly depth, texture and structure) at virtually every mining site makes it desirable to divide this class into more than one sub-class.

Table 5 Pre-mining land capability

Capability Class	Map unit	Area (ha) + %
Arable, high	**dHu, dCv, dAv, dHu/Cv**	446.74 (30.56%)
Arable, moderate	**mdHu, mdCv, mdAv, mAv/Cv**	353.76 (24.20%)
Grazing	**mdCv/Lo, sDr**	392.77 (26.87%)
Wilderness	**sDr/R**	85.11 (5.82%)
Wetland	**mdKd, W, Dam**	154.31 (10.56%)
Other	**B**	22.32 (1.53%)
	Total	**1 461.86** (100%)

The distribution of the land capability classes is shown in the map in the Appendix.

4.6 Soil volumes for rehabilitation

The average depth (m) of ***non-plinthic*** soil in each map unit was combined with the area of the map unit to calculate the volumes of soil available for post-mining rehabilitation. Within the study area, most of the soils have a small increase in clay content from the topsoil to the subsoil horizon (Table 3), but some have little or no increase. In addition, the soil structure is similar and no duplex soils occur. It can therefore be stated that the entire soil volume, down to any limiting layer such as rock, clay or plinthite) will be available for rehabilitation.

The volumes calculated are as follows:

Table 6 Available soil volumes

Map Unit	Average Depth (m)	Area (ha)	Volume (m^3)
dCv	1.0	286.52	2 865 200
dHu	1.0	93.78	937 800
dCv/Hu	1.0	41.81	418 100
dAv	1.0	24.63	246 300
mdCv	0.625	186.07	1 162 937
mdHu	0.625	20.59	128 687
mdAv	0.625	66.94	418 375
mdAv/Cv	0.625	80.16	501 000
mdCv/Lo	0.575	6.85	39 387
mdKd	0.575	6.79	39 042
sDr	0.30	392.77	1 178 310
sDr/R	0.15	118.75	178 125

5. IMPACT ASSESSMENT

The impacts of open-cast coal mining on the soil resource, and the availability of that resource for agriculture, are usually long-lasting and severe. Even when soils are stockpiled then replaced, there are usually problems such as compaction, acidification, impeded drainage and insufficient soil depth after rehabilitation, all of which are likely to lower the prevailing land capability class.

For this reason, it is desirable to avoid, wherever possible, both high potential agricultural land and wetland areas in the mining process. A buffer distance of at least 250 m around wetland and high potential agricultural land would help to ensure that effects of mining, such as subsurface seepage of water, coal dust contamination of topsoils are minimized as far as possible.

Three alternative scenarios have been proposed for consideration of impact assessments, namely:

- **"No-go" Alternative –** no mining to take place at all;
- **Portion 30 Alternative** – mining activities to be confined to Portion 30 of Paardeplaats 380JT (the red outline in Figure 2);
- **Entire Study Area Alternative –** mining activities may take place throughout the entire study area (the black outline in Figure 3).

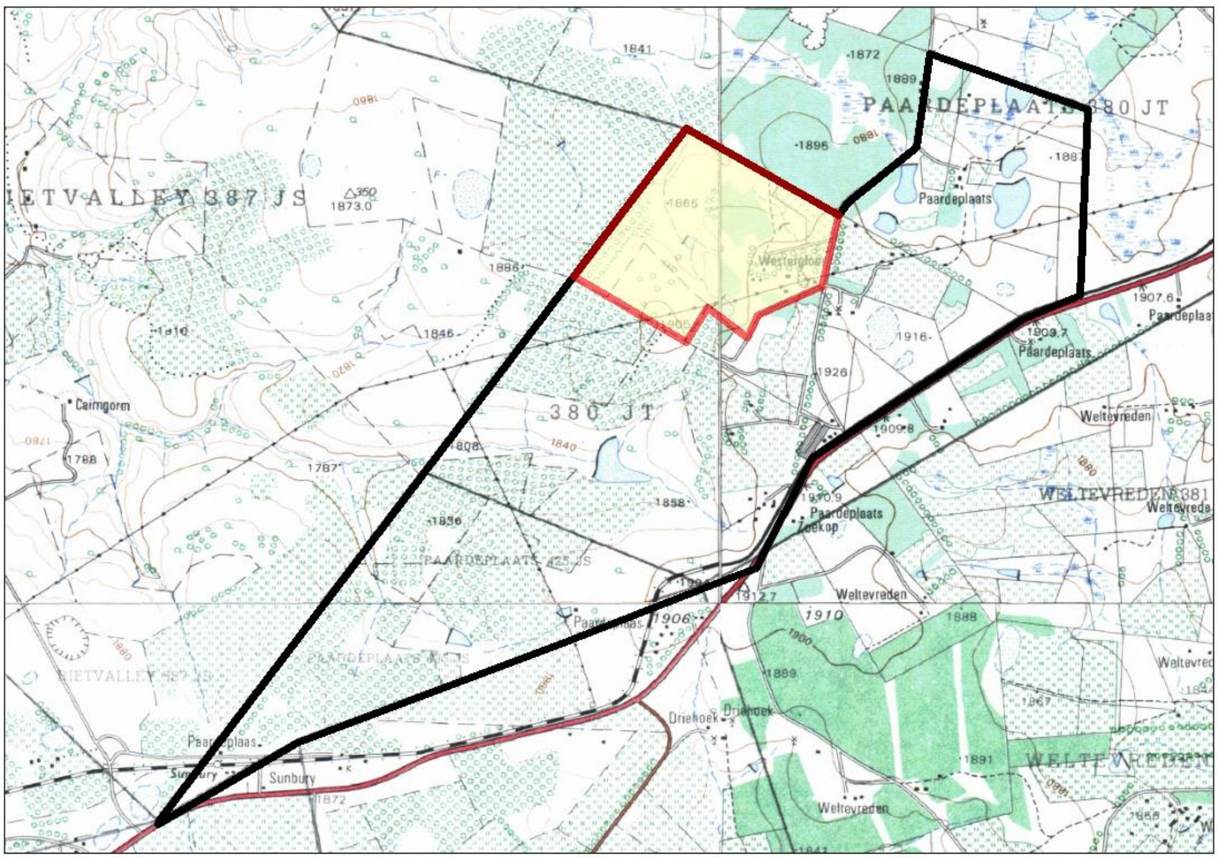


Figure 3 Paardeplaats study area, with Portion 30 Alternative in yellow

If the land capability map in the Appendix is consulted, it is clear that the distribution and proportion of the various classes within Portion 30 is very similar to that of the study area as a whole. If that alternative is utilised, despite the reduced spatial extent, there will still be a significant proportion of moderate and high potential arable soils that will be disturbed, as well as two wetlands. However, the fact that the two wetlands in question flow into the already mined Glisa area, where deterioration has taken place.

If the fact that Portion 30 is already bounded on the north by the Glisa mine is also taken into consideration, it should mean that by restricting mining to this area, more widespread impacts associated with commencing activities in an otherwise more pristine area would be reduced. Furthermore, the study done on sensitive receptors in the area (GSC, 2011) has shown that the water sources in the area (streams, dams, pans) are of excellent quality and may well be interlinked. They should therefore be disturbed as little as possible.

5.1 Impact Methodology

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations. The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E+D+M+R)}{4} \times N$$

If any soil that is removed is stockpiled and then replaced, then there will not be a “loss of soil resource” as such, but the impacts assessed will be a combination of reduction in land capability, loss of productivity and general deterioration of the pre-mining soil profile.

Table 7 Environmental Risk for "No-go" Alternative

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENV. SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENV. SIGNIFICANCE AFTER MITIGATION						
		E	D	M	R	C	P	ER		E	D	M	R	C	P	ER
Issues related to soils, Land Use and Land Capability																
Construction Phase: Footprint Clearance																
Loss of soil fertility	Vegetation removal	1	1	1	1	1	1	**1**	Retain maximum surface vegetation cover	1	1	1	1	1	1	**1**
Soil erosion hazard	Vegetation removal	1	1	1	1	1	1	**1**	Retain maximum surface vegetation cover	1	1	1	1	1	1	**1**
Soil compaction	Vehicles on surface	1	1	1	1	1	1	**1**	Reduce footprint areas to minimum	1	1	1	1	1	1	**1**
Construction Phase: Establishment of Infrastructure																
Loss of soil fertility	Construction of infrastructure	1	1	1	1	1	1	**1**	Retain maximum surface vegetation cover	1	1	1	1	1	1	**1**
Soil erosion hazard	Vegetation removal	1	1	1	1	1	1	**1**	Reduce footprint areas to minimum	1	1	1	1	1	1	**1**
Soil compaction	Construction of infrastructure	1	1	1	1	1	1	**1**	Reduce footprint areas to minimum	1	1	1	1	1	1	**1**
Chemical pollution	Spillage and seepage	1	1	1	1	1	1	**1**	Correct water and drainage control	1	1	1	1	1	1	**1**
Change in natural landscape	Landscaping and levelling	1	1	1	1	1	1	**1**	Reduce footprint areas to minimum	1	1	1	1	1	1	**1**
Operational Phase: Mining of Coal (Opencast)																
Reduction of agricultural potential	Removal of soil profile	1	1	1	1	1	1	**1**	Storage of all removed soil	1	1	1	1	1	1	**1**
Loss of soil fertility	Removal of soil profile	1	1	1	1	1	1	**1**	Correct stockpiling procedure	1	1	1	1	1	1	**1**
Soil erosion hazard	Removal of soil profile	1	1	1	1	1	1	**1**	Correct stockpiling procedure	1	1	1	1	1	1	**1**
Soil compaction	Removal of soil profile	1	1	1	1	1	1	**1**	Correct stockpiling procedure	1	1	1	1	1	1	**1**
Chemical pollution	Spillage and seepage	1	1	1	1	1	1	**1**	Drainage control around pit and stockpile(s)	1	1	1	1	1	1	**1**
Change in natural landscape	Removal of soil profile	1	1	1	1	1	1	**1**	Reduce footprint areas to minimum	1	1	1	1	1	1	**1**
Decommission Phase: Replacement of soil profile																
Reduction of agricultural potential	Replacement of stored soil	1	1	1	1	1	1	**1**	Replace soil to optimum depth	1	1	1	1	1	1	**1**
Soil compaction	Replacement of stored soil	1	1	1	1	1	1	**1**	Loosen soil after replacement	1	1	1	1	1	1	**1**
Change in natural landscape	Replacement of stored soil	1	1	1	1	1	1	**1**	Refer to original contour plan	1	1	1	1	1	1	**1**
Reduction of soil fertility	Replacement of stored soil	1	1	1	1	1	1	**1**	Re-vegetate, lime and fertilize	1	1	1	1	1	1	**1**
Soil erosion hazard	Replacement of stored soil	1	1	1	1	1	1	**1**	Re-vegetate as soon as possible	1	1	1	1	1	1	**1**
Decommission Phase: Removal of Infrastructure																
Reduction of agricultural potential	Replacement of removed soil	1	1	1	1	1	1	**1**	Replace soil to optimum depth	1	1	1	1	1	1	**1**
Soil compaction	Replacement of removed soil	1	1	1	1	1	1	**1**	Loosen soil after infrastructure removal	1	1	1	1	1	1	**1**
Soil erosion hazard	Replacement of removed soil	1	1	1	1	1	1	**1**	Re-vegetate as soon as possible	1	1	1	1	1	1	**1**

Table 8: Impacts for "Sensitivity Planning" Approach (Portion 30 Option)

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENV. SIGNIFICANCE BEFORE MITIGATION*							RECOMMENDED MITIGATION MEASURES	ENV. SIGNIFICANCE AFTER MITIGATION*						
		E	D	M	R	C	P	ER		E	D	M	R	C	P	ER
Issues related to soils, Land Use and Land Capability																
Construction Phase: Footprint Clearance																
Loss of soil fertility	Vegetation removal	1	2	3	2	-2	5	**-10**	Retain maximum surface vegetation cover	1	2	2	2	-1.75	3	**-5.25**
Soil erosion hazard	Vegetation removal	1	2	3	2	-2	4	**-8**	Retain maximum surface vegetation cover	1	2	2	2	-1.75	3	**-5.25**
Soil compaction	Vehicles on surface	1	2	2	2	-1.75	4	**-7**	Reduce footprint areas to minimum	1	2	2	2	-1.75	3	**-5.25**
Construction Phase: Establishment of Infrastructure																
Loss of soil fertility	Construction of infrastructure	2	4	4	3	-3,25	5	**-16.2**	Retain maximum surface vegetation cover	2	4	3	3	-3	4	**-12**
Soil erosion hazard	Vegetation removal	2	4	3	3	-3	4	**-12**	Reduce footprint areas to minimum	1	4	3	3	-2.75	4	**-11**
Soil compaction	Construction of infrastructure	2	4	4	3	-3.25	4	**-13**	Reduce footprint areas to minimum	2	4	3	3	-3	4	**-12**
Chemical pollution	Spillage and seepage	3	4	4	3	-3.5	5	**-17.5**	Correct water and drainage control	3	4	3	3	-3.5	4	**-14**
Change in natural landscape	Landscaping and levelling	2	4	3	3	-3	4	**-12**	Reduce footprint areas to minimum	2	4	3	3	-3	4	**-12**
Operational Phase: Mining of Coal (Opencast)																
Reduction of agricultural potential	Removal of soil profile	2	4	5	3	-3.5	5	**-17.5**	Storage of all removed soil	2	4	5	3	-3.5	4	**-14**
Loss of soil fertility	Removal of soil profile	2	4	5	3	-3.5	5	**-17.5**	Correct stockpiling procedure	2	4	5	3	-3.5	4	**-14**
Soil erosion hazard	Removal of soil profile	2	4	5	3	-3.5	4	**-14**	Correct stockpiling procedure	2	4	5	3	-3.5	4	**-14**
Soil compaction	Removal of soil profile	2	4	5	3	-3.5	5	**-17.5**	Correct stockpiling procedure	2	4	5	3	-3.5	5	**-17.5**
Chemical pollution	Spillage and seepage	3	4	5	3	-4	5	**-20**	Drainage control (pit) and stockpile(s)	3	4	5	3	-4	4	**-16**
Change in natural landscape	Removal of soil profile	2	4	5	3	-3.5	5	**-17.5**	Reduce footprint areas to minimum	2	4	5	3	-3.5	5	**-17.5**
Decommission Phase: Replacement of soil profile																
Reduction of agricultural potential	Replacement of stored soil	2	4	5	3	-3.5	5	**-17.5**	Replace soil to optimum depth	2	4	5	3	-3.5	4	**-14**
Soil compaction	Replacement of stored soil	2	4	5	3	-3.5	5	**-17.5**	Loosen soil after replacement	2	4	5	3	-3.5	5	**-17.5**
Change in natural landscape	Replacement of stored soil	2	4	5	3	-3.5	5	**-17.5**	Refer to original contour plan	2	4	5	3	-3.5	4	**-14**
Reduction of soil fertility	Replacement of stored soil	2	4	5	3	-3.5	5	**-17.5**	Re-vegetate, lime and fertilize	2	4	4	3	-3.5	4	**-14**
Soil erosion hazard	Replacement of stored soil	2	4	5	3	-3.5	5	**-17.5**	Re-vegetate as soon as possible	2	4	4	3	-3.5	4	**-14**
Decommission Phase: Removal of Infrastructure																
Reduction of agricultural potential	Replacement of removed soil	2	4	4	3	-3.25	4	**-14**	Replace soil to optimum depth	2	4	4	3	-3.25	4	**-14**
Soil compaction	Replacement of removed soil	2	4	4	3	-3.25	4	**-14**	Loosen soil after infrastructure removal	2	4	4	3	-3.25	4	**-14**
Soil erosion hazard	Replacement of removed soil	2	4	4	3	-3.25	4	**-14**	Re-vegetate as soon as possible	2	4	4	3	-3.25	4	**-14**

- **All values under "Nature of Impact" will be negative, so that all final values are also negative.**

Table 9: Impacts for Maximum Mine Production Alternative (Full Study Area)

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENV. SIGNIFICANCE BEFORE MITIGATION*							RECOMMENDED MITIGATION MEASURES	ENV. SIGNIFICANCE AFTER MITIGATION*						
		E	D	M	R	C	P	ER		E	D	M	R	C	P	ER
Issues related to soils, Land Use and Land Capability																
Construction Phase: Footprint Clearance																
Loss of soil fertility	Vegetation removal	2	2	3	2	-2.25	5	**-11.2**	Retain maximum surface vegetation cover	2	2	2	2	-2	3	**-6**
Soil erosion hazard	Vegetation removal	2	2	3	2	-2.25	4	**-9**	Retain maximum surface vegetation cover	2	2	2	2	-2	3	**-6**
Soil compaction	Vehicles on surface	2	2	2	2	-2.25	4	**-9**	Reduce footprint areas to minimum	2	2	2	2	-2	3	**-6**
Construction Phase: Establishment of Infrastructure																
Loss of soil fertility	Construction of infrastructure	2	4	4	3	-3,25	5	**-16.2**	Retain maximum surface vegetation cover	2	4	3	3	-3	4	**-12**
Soil erosion hazard	Vegetation removal	2	4	3	3	-3	4	**-12**	Reduce footprint areas to minimum	1	4	3	3	-2.75	4	**-11**
Soil compaction	Construction of infrastructure	2	4	4	3	-3.25	4	**-13**	Reduce footprint areas to minimum	2	4	3	3	-3	4	**-12**
Chemical pollution	Spillage and seepage	3	4	4	3	-3.5	5	**-17.5**	Correct water and drainage control	3	4	3	3	-3.5	4	**-14**
Change in natural landscape	Landscaping and levelling	2	4	3	3	-3	4	**-12**	Reduce footprint areas to minimum	2	4	3	3	-3	4	**-12**
Operational Phase: Mining of Coal (Opencast)																
Reduction of agricultural potential	Removal of soil profile	2	4	5	4	-3.75	5	**-18.7**	Storage of all removed soil	2	4	5	3	-3.5	4	**-14**
Loss of soil fertility	Removal of soil profile	2	4	5	4	-3.75	5	**-18.7**	Correct stockpiling procedure	2	4	5	3	-3.5	4	**-14**
Soil erosion hazard	Removal of soil profile	2	4	4	4	-3.5	4	**-16**	Correct stockpiling procedure	2	4	5	3	-3.5	4	**-14**
Soil compaction	Removal of soil profile	2	4	5	4	-3.75	5	**-18.7**	Correct stockpiling procedure	2	4	5	3	-3.5	5	**-17.5**
Chemical pollution	Spillage and seepage	3	4	5	4	-4	5	**-20**	Drainage control (pit) and stockpile(s)	3	4	5	3	-4	4	**-16**
Change in natural landscape	Removal of soil profile	2	4	5	4	-3.75	5	**-18.7**	Reduce footprint areas to minimum	2	4	5	3	-3.5	5	**-17.5**
Decommission Phase: Replacement of soil profile																
Reduction of agricultural potential	Replacement of stored soil	2	4	5	4	-3.75	5	**-18.7**	Replace soil to optimum depth	2	4	5	3	-3.5	4	**-14**
Soil compaction	Replacement of stored soil	2	4	5	4	-3.75	5	**-18.7**	Loosen soil after replacement	2	4	5	3	-3.5	5	**-17.5**
Change in natural landscape	Replacement of stored soil	2	4	5	4	-3.75	5	**-18.7**	Refer to original contour plan	2	4	5	3	-3.5	4	**-14**
Reduction of soil fertility	Replacement of stored soil	2	4	5	4	-3.75	5	**-18.7**	Re-vegetate, lime and fertilize	2	4	4	3	-3.5	4	**-14**
Soil erosion hazard	Replacement of stored soil	2	4	5	4	-3.75	5	**-18.7**	Re-vegetate as soon as possible	2	4	4	3	-3.5	4	**-14**
Decommission Phase: Removal of Infrastructure																
Reduction of agricultural potential	Replacement of removed soil	2	4	4	3	-3.25	4	**-14**	Replace soil to optimum depth	2	4	4	3	-3.25	4	**-14**
Soil compaction	Replacement of removed soil	2	4	4	3	-3.25	4	**-14**	Loosen soil after infrastructure removal	2	4	4	3	-3.25	4	**-14**
Soil erosion hazard	Replacement of removed soil	2	4	4	3	-3.25	4	**-14**	Re-vegetate as soon as possible	2	4	4	3	-3.25	4	**-14**

All values under "Nature of Impact" will be negative, so that all final values are also negative.

5.2 Mitigation measures

Recommended mitigation measures regarding the loss of high potential soil can be equated to the implementation of a comprehensive soil utilization and rehabilitation plan. The measures are standard recommended practice within the coal mining industry (Chamber of Mines/Coaltech, 2007).

Such measures include:

- ***Avoid all wetland areas***, with a buffer zone of at least 250 m;
- ***Strip the existing non-plinthic soil*** material to the maximum depth possible per soil mapping unit (see Table 6);
- ***Create stockpiles*** to store these stripped soils for later use. These should be kept to a maximum height of ±5 m, if possible, and placed on convenient freely-drained areas of low potential soils, wherever possible;
- Use continuous "cut and cover" excavation techniques to ensure that the stockpiled soils are stored for the ***shortest possible time*** before being re-utilized;
- Once mining has been completed, ***replace the spoil*** and other rock material to the approximate contours of the pre-mining landscape, ensuring the minimum occurrence of holes, voids or other inconsistencies in the material.
- ***Replace the stockpiled soil*** on top, ensuring the closest possible adherence to the pre-mining soil depth. If heavy machinery is used for landscape shaping, the soils should be ripped or otherwise loosened before being re-vegetated;
- ***Determine the characteristics*** of the replaced soil. The soils in the study area will have a medium to high buffer capacity (due to the pH and clay content), meaning that lime will be required to raise the pH post-rehabilitation. The amount of lime required will depend on many factors, including the duration of stockpiling, so it is not feasible to determine potential liming requirement at this stage.
- ***Re-vegetate*** with a suitable grass/fertilizer mixture (obtain specialist advice) at the beginning of the rainy season. ***Monitor the rehabilitated soil*** (by visual inspection of growth patterns and by periodic soil sampling) for post-rehab compaction and other problems.

5.3 Costs of rehabilitation

Based on information received from elsewhere in the coal mining industry (G. Le Roux, Kleinkopje Colliery, personal communication), **approximate** rehabilitation costs vary from around **R96 000/ha** (0.3 m of soil; ***grazing*** land capability) to **R230 000/ha** (0.6 m of soil; ***arable*** land capability), including all stripping, stockpiling and replacement costs, to which specific fertilizer, liming, seeding and soil monitoring costs. However, these figures were applicable in 2010, so allowance for inflation must be done to obtain approximately comparable costs at the present time or into the future.

5.4 Post-Mining Land Use

The envisaged post-mining land use must be agreed upon. There is sufficient soil available to return the mined areas to arable capability (at least 0.6 m of soil, preferably at least 0.75 m), but compaction, fertility and other rehabilitation issues usually mean that arable production is not physically or economically feasible. ***However, that does not mean that this should not be the aim at all.***

If reasonable mitigation measures are put in place, it should be possible to obtain post-mining grazing capacity levels approximately equivalent to the prevailing levels in the area, of around 7-8 ha/LSU. If specialist advice on grass species and re-vegetation techniques is obtained, it should be a realistic aim.

REFERENCES

ARC-ISCW, 2004. Overview of the status of the agricultural natural resources of South Africa (First Edition). ARC-Institute for Soil, Climate and Water, Pretoria.

Chamber of Mines/Coaltech, 2007. Guidelines for the rehabilitation of mined land. Coaltech Research Association, Johannesburg.

GCS, 2011. Paardeplaats sensitive receptor study. Project Number GCS 11-087. Groundwater Consulting Services, Rivonia, Johannesburg.

Geological Survey, 1986. 1:250 000 scale Geological Map of 2528 Pretoria. Department of Mineral and Energy Affairs, Pretoria.

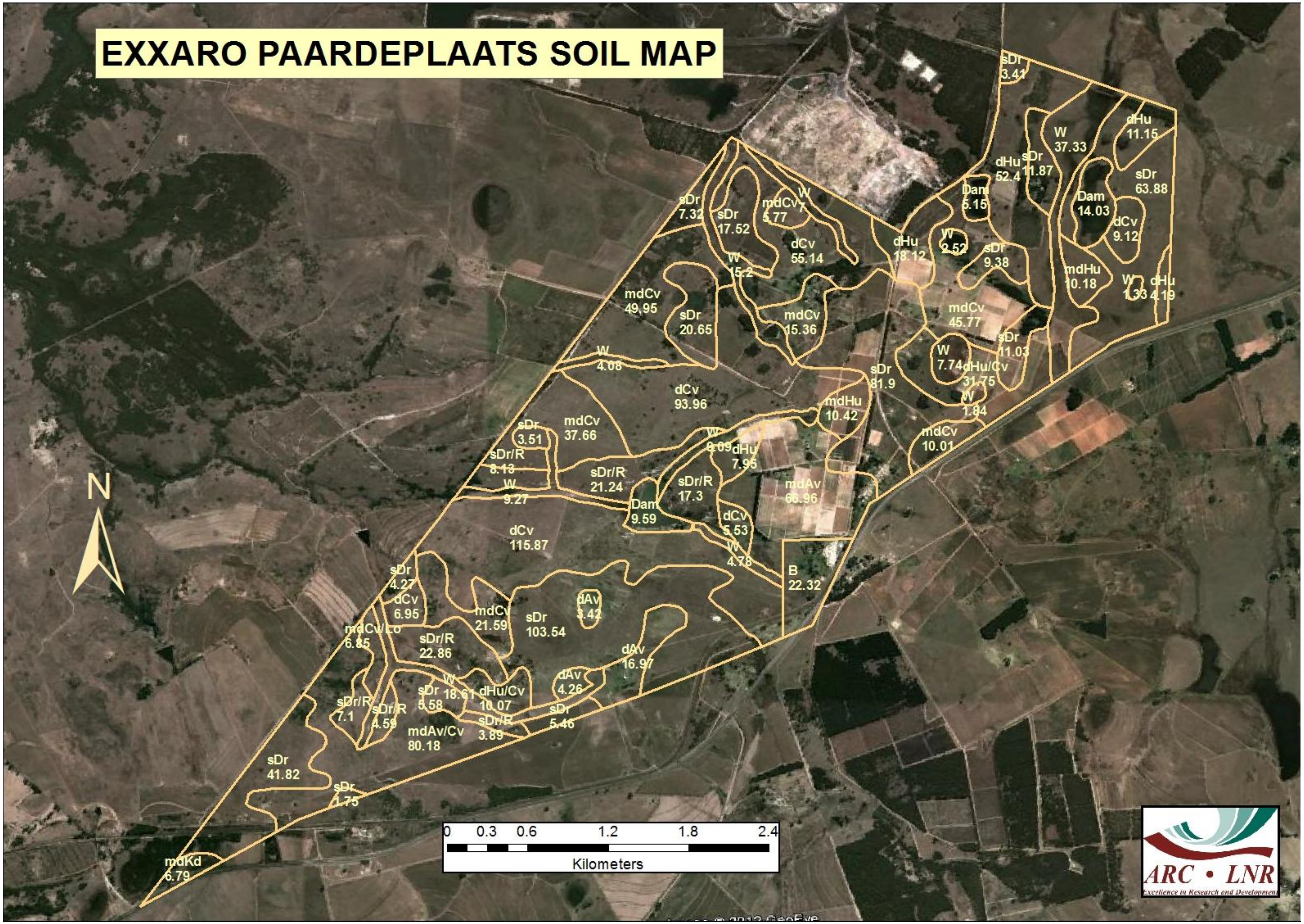
Koch, F.G.L., 1987. Climate data. In: Land types of the maps 2526 Rustenburg and 2528 Pretoria. *Mem. Agric. nat. Res .S. Afr*. No.8. Department of Agriculture, Pretoria.

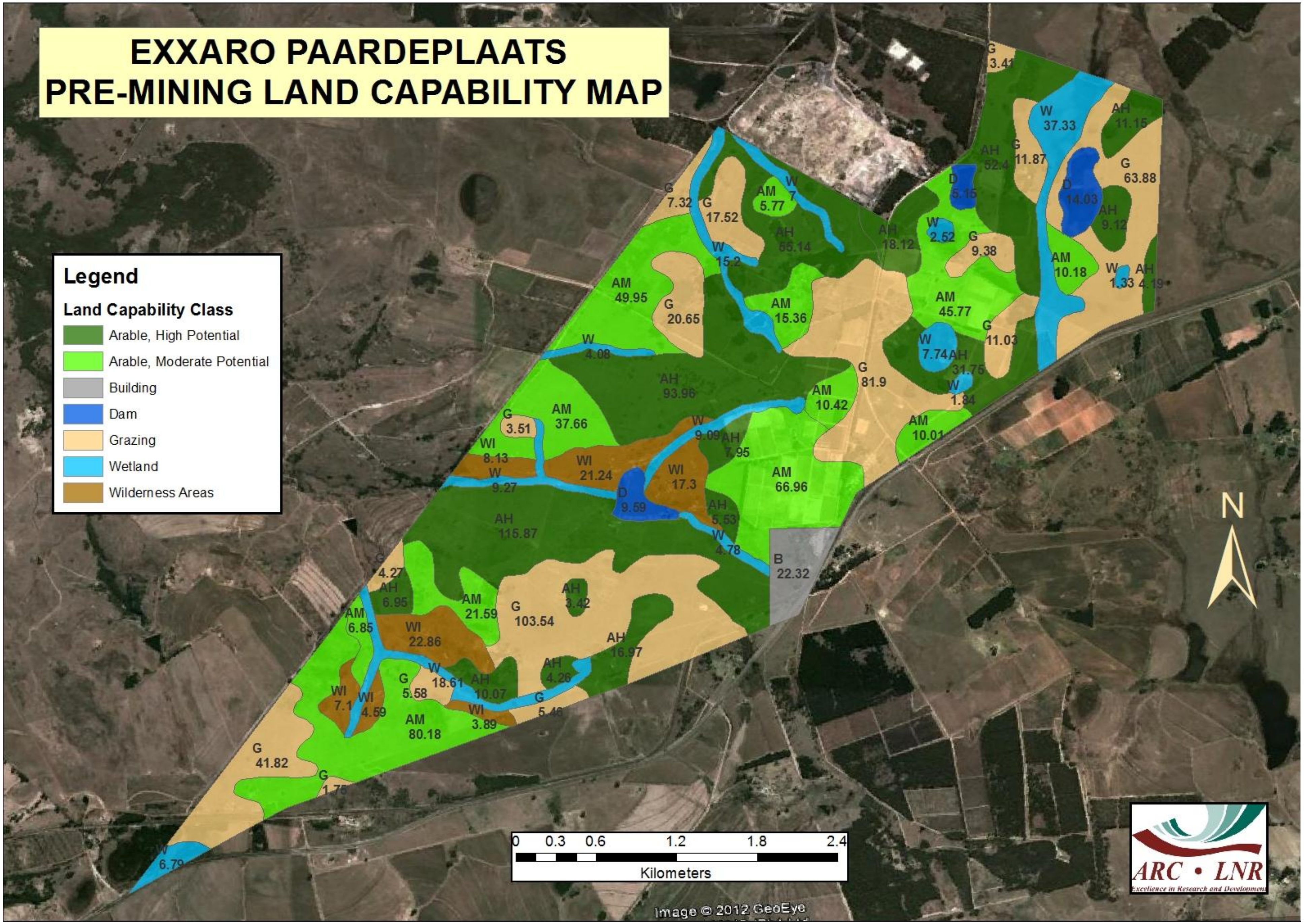
Non – Affiliated Soil Analysis Work Committee, 1990. Handbook of standard soil testing methods for advisory purposes. Soil Science Society of South Africa, Pretoria.

Soil Classification Working Group, 1991. Soil classification. A taxonomic system for South Africa. Institute for Soil, Climate & Water, Pretoria.

Appendix:

Soil Map
Pre-Mining Land Capability Map


EXXARO PAARDEPLAATS SOIL MAP
N
sDr 3.41
W 37.33
dHu 11.15
dHu 52.4
sDr 11.87
sDr 63.88
Dam 5.15
Dam 14.03
dCv 9.12
sDr 7.32
sDr 17.52
mdCv 5.77
W 7
dCv 55.14
dHu 18.12
W 2.52
sDr 9.38
mdHu 10.18
W 1.33
dHu 4.19
W 15.2
mdCv 49.95
sDr 20.65
mdCv 15.36
mdCv 45.77
sDr 11.03
W 7.74
dHu/Cv 31.75
W 4.08
dCv 93.96
sDr 81.9
W 1.84
mdHu 10.42
mdCv 10.01
sDr 3.51
mdCv 37.66
W 9.09
dHu 7.95
sDr/R 8.13
sDr/R 21.24
sDr/R 17.3
mdAv 66.96
W 9.27
Dam 9.59
dCv 5.53
W 4.78
dCv 115.87
B 22.32
sDr 4.27
dCv 6.95
mdCv 21.59
sDr 103.54
dAv 3.42
mdCv/Lo 6.85
sDr/R 22.86
dAv 16.97
W 18.61
dHu/Cv 10.07
dAv 4.26
sDr/R 7.1
sDr/R 4.59
sDr 5.58
sDr/R 3.89
sDr 5.46
mdAv/Cv 80.18
sDr 41.82
sDr 1.75
mdKd 6.79
0 0.3 0.6 1.2 1.8 2.4
Kilometers
ARC • LNR
Excellence in Research and Development


EXXARO PAARDEPLAATS
PRE-MINING LAND CAPABILITY MAP
Legend
Land Capability Class
Arable, High Potential
Arable, Moderate Potential
Building
Dam
Grazing
Wetland
Wilderness Areas
0 0.3 0.6 1.2 1.8 2.4
Kilometers
N
ARC • LNR
Image © 2012 GeoEye

1. REHABILITATION OBJECTIVES

1.1 Objectives

Before any rehabilitation measures are implemented, it is of vital importance to define objectives for the rehabilitation procedures. These objectives should address:

- Define an end-use for the area. This should be established as soon as possible.
- Define and agree upon end-goals for the rehabilitation process, such as land use, rehabilitation objectives, areas to be rehabilitated, etc.
- Ascertain whether the proposed end-use is compatible with the land capability of the area.
- Minimise visual impacts of rehabilitated areas by recreating natural landforms and ensuring that reshaped areas are visually compatible with surrounding landscapes.
- Restore natural landforms such as drainage lines, undulating areas and ridges (which may have been damaged during activities).
- Quantify, restrict and remediate chemical environmental pollution of water and soil as a result of the various mining activities.
- Ensure post-mining soil integrity. This is the most important aspect of rehabilitation as it forms the base from which rehabilitation proceeds. If soils are not correctly prepared, suitable conditions for re-vegetation will not be achieved.
- Monitor and combat alien floral invasion, as this also poses a threat both during and post-rehabilitation activities. Adequate alien and invasive species control measures must be applied.

Identification and recording of soil and terrain units prior to disturbance is an essential part of the planning process. These units must then, as far as possible, be re-instated during rehabilitation to maintain habitat diversity and consequently biodiversity. These units were defined in the soil and land capability study by the method of soil classification and allocating soil form units into land capability classes.

Four land capability classes (along with two sub-classes) were identified and rehabilitation should aim to restore these classes once mining activities have ceased.

2. SOIL MANAGEMENT PLAN

2.1 The impact of environmental disturbance on soil quality

Soil degradation includes **physical** (compaction, crusting, structural deterioration, erosion, desertification), **chemical** (acidification, salinisation, sodicity and alkalization, nutrient depletion, pollution, toxicity) and **biological** (decline in Soil Organic Matter (SOM), loss of biodiversity, and soil sterility) aspects. As degradation occurs, some soil properties change, particularly soil structure and microbial activity, which is fundamental in the maintenance of soil quality.

2.2 Topsoil Stripping

Topsoil stripping is a key rehabilitation activity because soil, once lost, takes many years to regenerate. As part of the planning phase of the construction and rehabilitation activities, a detailed soil survey was conducted for all the areas that may potentially be subjected to disturbance and a soil inventory was produced as part of the results.

Availability of soil materials is the key to successful rehabilitation. The surface layer ("topsoil") that contains the inherent fertility and seed bank should ideally be stripped and stored separately. The broad soil stripping process should remove all materials that are suitable for supporting plant growth. In practice, the thickness of usable soil materials varies considerably. Across the coal mining zone of the Highveld, this is normally less than one meter but, on occasions, may be as much as 3-5 m thick and, in others, less than 0.15 m. The pre-mining soil survey identified those horizons that will support plant growth and those that will be unsuitable.

Soils of significantly different soil groups (based on characteristics like clay content) should be stockpiled separately. This is to ensure that their characteristics are suitable for the prevailing landscape and drainage conditions once replaced. Soils should be separated into categories based on clay content, and into topsoil and subsoil horizons. The soil utilization (stripping) guidelines below indicate how soils of the Paardeplaats study area should be stripped.

3. SOIL UTILIZATION (STRIPPING) GUIDE

During the construction phase (or as the facilities expand and mining commences), the available 'topsoil' reserves must be stripped separately (different soil groups should be stockpiled separately). The map summarises the soil forms into four broad soil groups based on the average usable depth of each group. The broad soil groups indicated on the soil utilization (stripping) guide include soils with high potential for stripping purposes, soil forms with low potential, shallow, rocky soils and soils with no potential that should not be disturbed at all. This map was used to determine a topsoil volume budget for rehabilitation purposes.

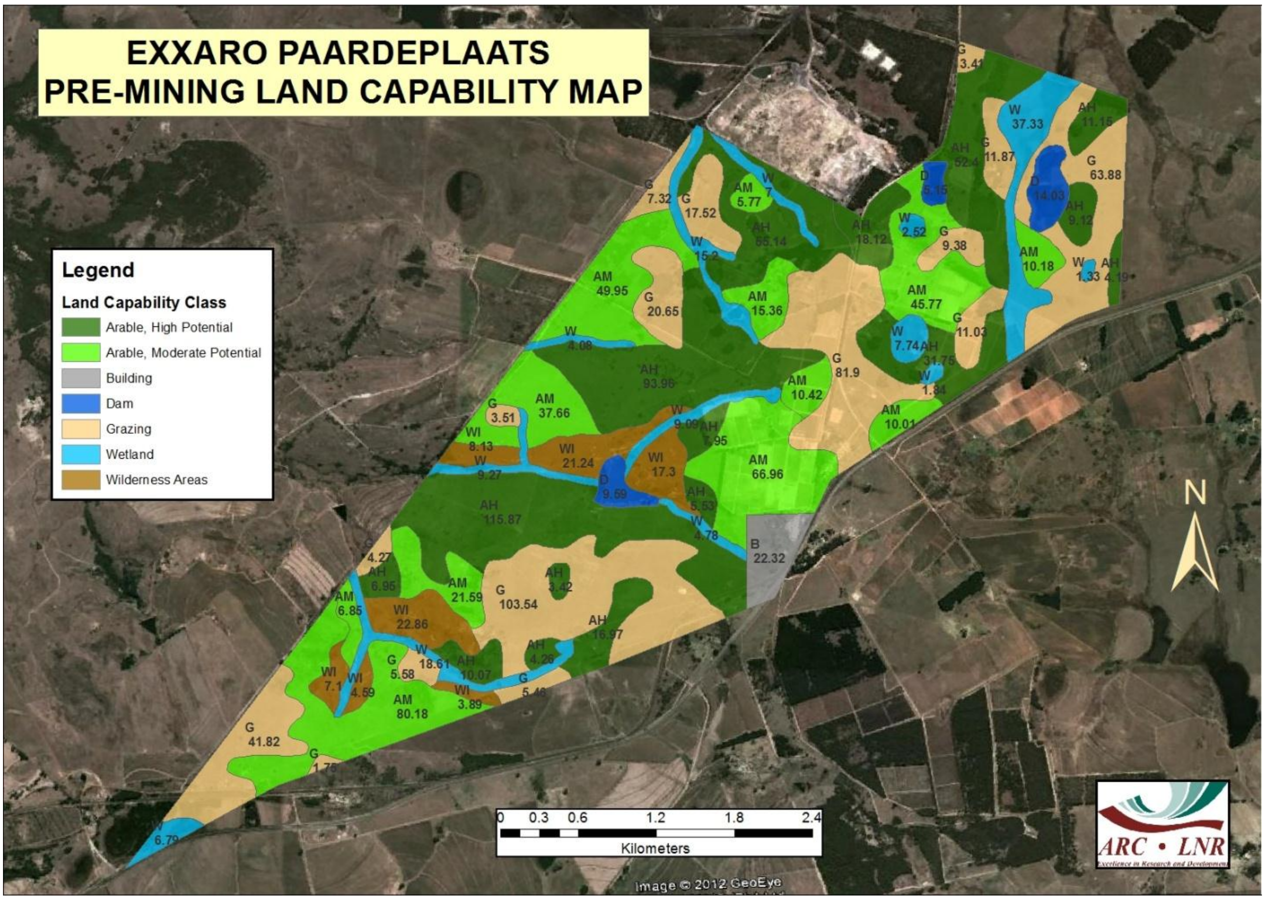


Figure 1 Land Capability Map

Table 1 shows that almost 4.5 M m³ of soil is available within the high potential arable areas to be stripped and stockpiled for mining purposes, with a further 2.25 M m^3 available in the moderate potential arable areas. The soil most suitable for this is soil forms with red and yellow-brown apedal B1 horizons that have an average topsoil stripping depth of 1.0 and 0.625 m respectively. The soil stripping groups must be stripped, stockpiled and utilized separately to prevent mixing with soil of the less suitable types.

Table 1 Available soil volumes

Land Capability Class	Map Unit	Average Depth (m)	Area (ha)	Volume (m^3)	
Arable, High	**dCv**	1.0	286.52	2 865 200	4 467 400
	dHu		93.78	937 800	
	dCv/Hu		41.81	418 100	
	dAv		24.63	246 300	
Arable, Moderate	**mdCv**	0.625	186.07	1 162 937	2 250 386
	mdHu		20.59	128 687	
	mdAv		66.94	418 375	
	mdAv/Cv		80.16	501 000	
	mdCv/Lo	0.575	6.85	39 387	
Wetland	**mdKd**		6.79	39 042	39 042
Grazing	**sDr**	0.30	392.77	1 178 310	1 178 310
Wilderness	**sDr/R**	0.15	118.75	178 125	178 125
				Total	**8 113 263**

Soils should be stripped by horizon. The perfect situation would be to strip soils in at least two layers:

- Firstly, the surface soil horizons, which contain the seed bank, would be removed. This layer would be about 150-300 mm thick. The soil survey showed that this is the average depth of the topsoil.
- Secondly, the usable non-plinthic "B" horizon materials would be removed. These materials are physically suitable for rehabilitation but contain limited organic matter and, accordingly, will not immediately supply planted crops or grasses with nutrients if used as topsoil.

Unfortunately, it is rare for reshaped areas of the correct form to be available and ready for topsoiling at the same time as soil stripping from the mined area becomes necessary. This is when topsoil stockpiling is required. Guidance for soil stockpiling is given in the next section.

4. STOCKPILING RECOMMENDATIONS

4.1 Strip a suitable distance ahead of the construction (disturbance) at all times, to avoid loss and contamination

Do not strip too large an area ahead of construction, because this exposes the stripped surface to the risk of water and wind erosion, with the associated dust and water sediment pollution problems. However, if the stripping face is too close to the construction activity, it will result in the loss of valuable soil material. Contamination by overburden materials as well as chemical soil pollution may well occur.

4.2 Supervise stripping to ensure soils are not mixed

Close supervision and monitoring of the stripping process is required to ensure that soils are stripped correctly. Common failings in this process are stripping too little or too much. When too little, valuable rehabilitation materials are lost and when too much, good quality soil is contaminated with poorer quality and unsuitable underlying materials which are frequently highly compactable and tend to crust when exposed at surface. Risks of soil loss or contamination are particularly high when soil stripping contracts are purely issued on volume stripped, rather than on volume and quality. Monitoring requires assessment of the depth stripped, the degree of mixing of soil materials and the volumes of material replaced directly or placed on stockpiles.

4.3 Strip soils only when moisture content will minimize compaction risk

Most soils are highly susceptible to compaction. Compaction is usually greatest when soils are moist or wet, so soils should be stripped when moisture content is as low as possible. Stripping and replacement of soil should be done during the dry winter when rainfall is at its lowest and soils are driest. When not practical, every effort must be made to minimize compaction by the methods used for soil stripping, stockpiling and replacement.

4.4 Strip and replace in one action wherever possible

Wherever possible, stripping and replacing of soils should be done in a single action. This is both to reduce compaction and also to increase the viability of the seed bank contained in the stripped surface soil horizons. Stockpiling both increases compaction and decreases the viability of the seed bank, and should only be done when no areas of reshaped impacted land are available for direct placement.

4.5 Use shovel and truck in preference to bowl scraper

The use of bowl scrapers is not ideal for stripping and replacing soils with a minimum of compaction. When used, their compacting effect can be reduced to some extent by only stripping and replacing soils when dry, maximizing the thickness of soil layers placed per run, and running along the same wheel tracks. Wherever possible, soils should be stripped and replaced using shovel (backhoe) and truck equipment. Compaction is the single biggest limitation to the re-establishment of land use capability of rehabilitated land.

5. TOPSOIL MANAGEMENT

During and after topsoil stripping, prudent topsoil, and more specifically, stockpile management will ensure efficient rehabilitation. These measures are discussed below.

5.1 Locate soil stockpiles so that re-handling of soil is minimized

Soil stockpiles should not be moved after initial stripping unless the soil is being replaced in its final location in the rehabilitated profile. This is because each re-handling damages soil structure and increases compaction. In addition, soil losses occur with each re-handling and there is considerable additional cost. While it may cost more initially, it is better to place stockpiles in areas where they will not have to be moved. There will always be some soil that has to be stripped before any rehabilitated areas are available for direct placement (for example, soils stripped for roads infrastructure and box-cut development during construction), but these materials should be stockpiled as close as possible to where they are going to be ultimately used.

5.2 Ensure free draining location

Placing soil stockpiles in drainage lines has two major harmful effects: the soils become waterlogged and lose desirable physical and chemical characteristics and the risk of loss of soil materials due to erosion is increased. Ideally, stockpiles should be placed on a topographical crest which provides free drainage in all directions. Alternatively, a side-slope location with suitable cut-off berm construction upslope is acceptable.

5.3 Minimize compaction during stockpile creation

Soils should be stockpiled loosely. The degree to which soils become compacted during stripping is largely dependent on the equipment used. If shovel and truck are used, the ideal practice is for soils to be dumped in a single lift. The use of heavy equipment over soil piles results in soil structure damage. If direct dumped soil piles are too low, then it is possible to increase stockpile height using a bulldozer blade or back-actor bucket to raise the materials.

Running trucks over the piles or using bowl scrapers or graders to level and shape stockpiles, is not recommended. When the only alternative to losing soil material is the use of unsatisfactory (i.e. bowl scraper) equipment, compaction damage can be reduced to some extent by stripping as thick a cut as possible and by dumping it as thickly as possible. In addition, deposition in a single track line may reduce to some extent the overall compaction of the dumped or replaced soil through the minimization of the footprint area of disturbance.

6. SEEDING METHODS

Seeding can be undertaken by a variety of methods, including, but not limited to the following:

- Manual seeding;
- Mechanical seeding and
- Hydro-seeding.

6.1 Manual seeding

Manual seeding should be undertaken by site personnel trained in seeding methods. The advantage of this method is that it is often the most cost-effective method, as it requires only rudimentary training and can then be overseen and monitored by a seeding specialist in order to determine efficacy. It is also labour-intensive and leads to job creation, albeit over a limited period of time.

6.2 Mechanical seeding

Mechanical seeding is undertaken utilising methods commonly associated with agricultural practices. This method necessitates mechanical equipment and is therefore more costly, but can be more effective, especially if associated with large areas where manual seeding may prove time-consuming or require an excessive number of labourers.

6.3 Hydro-seeding

Hydro-seeding is an effective method of seeding, especially in areas that are hard to reach for manual or mechanical treatment. It must be performed by a specialist contractor to ensure efficacy, but may save time and costs if performed in areas where seed propagation is proving testing or in areas such as steep slopes and gullies, where the binding agents often associated with hydro-seeding mulch will ensure that seeds are not eroded and that the seed mixture reaches all areas necessary for effective re-vegetation.

6.4 Soil Preparation Prior To Re-vegetation

Prior to planting or seeding, the site should be prepared to ensure that appropriate conditions for plant growth are provided. Site preparation should involve:

- Retaining and re-spreading soils so that their natural order is reflected (i.e. subsoils at the bottom and topsoils at the top);
- Raking the surface so that big clods are broken up, the surface is even and the soil is easy to handle during planting.
- Ensuring that soil is not overly dry and powdery. It should be slightly damp but not sodden and muddy or the soil structure will be damaged. If it is very dry, watering it the day before planting is recommended.

The lack of available weed and pathogen-free soil material is a common limiting factor to restoration and re-vegetation works in disturbed areas. A minimum depth of 200 mm of soil material is generally required to sustain plant growth for most species. As a result, protection of the existing soil material on and around work sites is essential for successful restoration works.

6.5 Composted exotic vegetation

Several areas of the undisturbed fields within the Paardeplaats area are covered by exotic trees and shrubs, of which some species are alien invasive plants. During pre-construction and construction phases, ground clearing will be one of the main activities that will remove all the *Eucalyptus spp.* trees that are currently growing on site.

Composting of these trees and plant material is an effective method of managing the organic material removed from the soil that will be stripped and stockpiled. Rather than burning the wood (that will result in the production of additional carbon dioxide), the wood can be processed by putting it through a wood chipper and composting it in a designated area.

The resulting compost can be beneficially re-used to improve land condition in already degraded areas that require urgent rehabilitation. The micro-organisms that will establish themselves in the compost will be beneficial for re-vegetation of rehabilitated areas.

6.2 Chemical Fertilizers

Chemical fertilizers should only be considered as a last resort or supplementary measures to organic fertilizers. A single large application of chemical fertilizer is usually insufficient to restore the nutrient capital of a degraded soil. If soil organic matter has been displaced or destroyed, and if only limited vegetation cover is present, most of the nutrients added in a large application may be lost from the site. Instead, fertilization should be used primarily to enhance the early establishment and growth of vegetation, which will help to restore soil structure and organic matter content. Modest repeat applications may be needed until the internal nutrient cycle of the site is re-established and can meet the needs of the vegetation, but a site would not be considered adequately rehabilitated if the survival of the vegetative cover depends on continued fertilization.

While natural environments commonly respond to nitrogen fertilization and only rarely to phosphorus, potassium or sulphur, any of these nutrients may be deficient in disturbed and rehabilitated soils. Soil samples should be taken for chemical analysis before any rehabilitation starts on site and be compared to the soil samples analysed for the purpose of the soil study to evaluate changes in soil chemical composition that occurred because of the disturbance. Fertilizer tends to be a small portion of total rehabilitation costs, so if nutrient deficiencies are anticipated, complete formulations should be used at rates that approach safe maximums.

Maximum fertilizer rates are set and should be applied to reduce the risks of damaging vegetation from over-fertilization and losing fertilizer through runoff or leaching. Damage to young seedlings has been reported at application rates around 100 kg N/ha. The risk of fertilizer damage increases greatly with decreasing moisture and increasing temperature, so that higher fertilization rates can be used without damaging seedlings in climates with higher precipitation. However, in wet environments, large amounts of fertilizer can be lost from recently disturbed sites that are low in organic matter and have limited vegetation cover.

Fertilizers can be broadcast on the surface, included in a hydroseeding slurry, or incorporated if shallow mixing (<20 cm) is part of the rehabilitation plan. Fertilizer is usually applied at the time of seeding, ideally immediately after the seedbed is prepared. Higher losses of seed and fertilizer occur after the freshly prepared surface has been subjected to rainfall. Where vegetation is already established, apply fertilizer when growth is most rapid (usually in spring and early summer).

The following issues are important to remember for the use of fertilizer in rehabilitation:

- To avoid burning seed, do not mix seed and fertilizer together in the same bin for dry seed application.
- Where a large amount of a nutrient-poor material such as wood chips or compost has been applied to increase organic carbon content of soil, extra nitrogen will be needed to counteract the nitrogen-immobilizing tendency of the added organic material. Consult with a soil expert to determine rates. Urea is suitable for use in combination with nitrogen-poor amendments.
- Where there is a risk of drought, reduce single application rates or incorporate the fertilizer.
- If fertilizer supplies are limited, apply the fertilizer to critical locations such as large fills and cut banks.
- Schedule a second fertilizer application within three to five years after seeding to maintain the vigour of grasses and legumes at critical erosion control locations, and for severely degraded soils.
- Slow-release fertilizers like sulphur-coated urea should not be applied within 3 m of watercourses.

7. CONCLUSION

Soil management and rehabilitation should be a top priority during mining activity phases as well as during and after decommissioning. Over and above the guidelines for successful rehabilitation specified above, a specialist should be consulted during all the phases of rehabilitation to improvise and monitor progress as the project continues. Any rehabilitation measures and methods should be planned based on the intended end land use. Once this decision has been made, rehabilitation guidelines and plans should be adjusted in order to achieve the planned post-mining land use.

EIMS (Pty) Ltd

Proposed Mining Rights Application, Paardeplaats Farm, Belfast, Mpumalanga

Environmental Traffic Impact Assessment

219268

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Executive Summary

The Paardeplaats Project area is located within the Witbank Coalfield and is very close to the north-eastern edge of the main Karoo basin located north-west of Belfast.

The Mining Works Programme (Exxaro, 2011) estimated that the Paardeplaats project will have a production rate of 4.2 to 4.4 million tonnes per annum (mtpa). With a reserve of approximately 79.65 million tonnes it relates to approximately 20 years of coal production.

Of the 4.4 mtpa, 2.4 mtpa will be power station coal and the remaining will be a mix of A-Grade Export and P58-Grade Export. The raw coal will be transported to the existing Glisa Coal Processing Plant.

Located next to the Paardeplaats mine is the existing Glisa Mine, also operated by Exarro. Production at the Glisa mine is currently being increased from the current 3.5mtpa to 4.5mtpa, based on information from the Traffic Impact Study Glisa Mine (ITS (Pty) Ltd, 2011).

Therefore this assessment will also consider the additional traffic generated by the increase in production of the Glisa Mine as this will be additional traffic on the surrounding road network and not collected in the traffic counts.

Although two access points to the site are possible, it is recommended that the existing entrance for the Glisa mine is utilised.

An examination of the traffic counts carried out show that the number of vehicles travelling on the surrounding road is low in comparison to their designed capacity. Using the information from the Traffic Impact Assessment Glisa Mine (ITS (Pty) Ltd, 2011) a number of assumptions were made with regards to the number of vehicle trips that would be generated from the Paardeplaats Project.

When these were combined with those from the Traffic Impact Assessment Glisa Mine (ITS (Pty) LTD, 2011) it was seen that the number of additional vehicles would be less than 100 from both developments. When this is added to the background traffic the number of vehicles is still low in comparison to its design capacity.

As a result of this the decision was made not to carry out any intersection analysis as the traffic flows were low enough to ensure that the intersections are operating within capacity. Of more importance would be the geometry of the intersections and the link capacity to ensure that are suited to accommodate the size and number of vehicles.

Upgrades to the intersections and links may be required to ensure the safety of other vehicles on the road and that the links remain in a safe condition for the vehicles.

The assessment of the impact of the mine traffic and mitigation strategy shows that the impact on the intersections and links will remain low, the water course / culvert impact will remain medium and the community impact will remain high. As outlined in the traffic impact scoping report.

1 Introduction

Arup Transport Planning was appointed by EIMS (Pty) Ltd to undertake a traffic impact study for the proposed development of a 1 415 hectare coal mine on the Remainder of Portion 13 of the Farm Paardeplaats 380 JT, Portion 28, 29, 30 and Portion 40 of the Farm Paardeplaats 380 JT and the Remainder of Portion 2 of the Farm Paardeplaats 425 JS.

The site is located approximately 6 km southwest of eMakhazeni (Belfast) and is within the Witbank Coalfield close to the north-eastern edge of the main Karoo basing located north-west of Belfast.

The site location is shown on the locality plan and the aerial photograph, see Figures 1 and 2.

Located next to the Paardeplaats mine is the existing Glisa Mine operation, also operated by Exxaro. This currently produces 3.5 million tonnes per annum (mtpa) of coal and based on information from the Traffic Impact Assessment Glisa Mine (ITS (Pty) Ltd, 2011) is currently undergoing an increase in production to 4.5 mtpa.

The Glisa mine expansion is not operational yet and therefore the traffic expected to be generated by the expansion of the Glisa Mine is not represented in the traffic counts undertaken as part of the study. Therefore the Glisa Mine expansion traffic will be included as latent traffic.

From information contained in the Mining Works Programme (Exxaro, 2011) it is estimated that the Paardeplaats Project will have a production rate of 4.2 to 4.4 mtpa and with a reserve of approximately 79.65 million tonnes it relates to approximately 20 years of coal production.

Of the 4.4 mtpa, 2.4 mtpa will be power station coal and the remaining will be a mix of A-Grade Export and P58-Grade Export. The raw coal will be transported to the existing Glisa Coal Processing Plant.

2 Background

2.1 Background Information

The main information required for the transport assessment are traffic counts from the intersections of interest. Refer to the scoping report for the intersections likely to be affected.

Traffic counts were carried out over a three hour period on 22 February 2012 during the AM and PM peak periods at the following intersections:

- Vermooten Street (R33) and Spitskop Road;
- Spitskop Road and Van Kraayenburg Street; and
- Spitskop Road and Site Access.

Only peak hour counts were undertaken as this represents the worst case scenario in terms of a combination of background and development traffic.

The peak hour traffic volumes for 2012 are summarised in Figure 3 for the AM peak and Figure 4 for the PM peak. The main route to the site is Spitkskop Road and the results from the traffic counts can be summarised as follows:

- During the AM peak hour approximately 114 vehicles are travelling on the road to the east and 70 to the west of the site;
- Of the 114 vehicles to the east, 40% are heavy vehicles and this decreases to 18% west of the site;
- During the PM peak hour approximately 78 vehicles are travelling to the east of the site and 41 vehicles to the west; and
- Approximately 41% are heavy vehicles.

The major road in the area is Vermooten Street (R33) and traffic flows on this road can be summarised as follows:

- Approximately 400 vehicles travel on this road during the AM peak hour in both directions with the flow evenly split between northbound and southbound traffic;
- In the PM peak hour approximately 530 vehicles travel in both directions with the heaviest flow being northbound.

The N4 Road carries approximately 1 060 vph during the AM peak hour in both directions of which the majority is eastbound. During the afternoon peak, the N4 Road carries approximately 1 020 vph in both directions. The peak direction in the afternoon is in a westerly direction.

2.2 Haul Routes

As stated in the Mining Works Programme (Exxaro, 2011) the coal will be transported to the existing Glisa coal processing plant and then delivered to the clients using the existing infrastructure and logistics used for delivering the Glisa mine coal.

Due to the proximity of the rail sidings at Belfast and that the majority of the coal will be used at power stations the haul route to be assessed will be from the mine to the rail sidings.

2.3 Site Visit

As part of the study a site visit was carried out in February 2012. This site visit was focused concentrated on the surrounding road network and associated infrastructure. During the site visit a number of photos of the road network were taken to help illustrate the road network.

N4 at the Intersection with Sunbury

The N4 is a single lane per direction national route, with localized widening at intersections to accommodate turning movements.

Paardeplaats Road looking North Towards Belfast

Paardeplaats Road is a gravel local access road.

Photograph 3: Spitskop Road

Spitskop Road is a single lane per direction local road.

3 Methodology

In order to carry out the traffic assessment and determine the impact that the mine will have on the road network and the environment it is necessary to calculate the amount of traffic generated by the mine and the future background traffic in the assessment year.

The future background traffic takes latent and growth rate into account. The trip rate has been based on the information from existing mining operations.

3.1 Future Background Traffic Volumes

The Manual for Traffic Impact Studies (Department of Transport, 1995) suggests a five year design horizon is used i.e. 2017. But, at this point in time the mine will not be fully operational so the decision has been made to use 2022 (10 year design horizon) as the design horizon. The predicted future (2022) traffic flows have been determined by using the growth method.

The growth method is the simplest form of increasing the traffic between the base year and the year in which the traffic counts were conducted, to the assessment year. The growth method assumes that the current traffic growth rate will continue on a year by year basis until the assessment year.

There are two main reasons for traffic growth to occur. The first is economic prosperity and an increase in car ownership. The second is that between the time the assessment is carried out and the opening of the development a number of developments may have been constructed in the area that would generate and attract additional vehicles.

The predicted future (2022) traffic flows have been determined by using the growth method. A growth rate of 2% per annum has been applied to the existing traffic volumes over a 10 year period.

The future 2022 background traffic volumes are shown in Figures 5 and 6 for the AM and PM peak hours.

Due to the close proximity of the Glisa mine the decision has been taken to include the additional traffic generated by this mine as latent traffic when assessing the potential impact of the Paardeplaats mine.

The additional estimated traffic generated by the expansion of Glisa mine is shown on Figures 7 and 8. This will then be added combined to the background traffic from Figures 5 and 6.

3.2 Development Traffic

3.2.1 Trip Generation

The South African Trip Generation Manual (Department of Transport, 1995) does not provide a guideline for mining activities. Therefore, a combination of information from the Glisa Mine Traffic Impact Assessment and existing counts was used to determine the trip generation for the proposed Paardeplaats Project.

The information from Glisa mine has been used to calculate the number of heavy vehicle trips generated by the mine. Based on information from the Mining Works Programme (Exxaro, 2011), the Glisa Mine management team will be responsible for support services and line management of the Paardeplaats Project.

In light of the mine being operated by the same company and certain activities being overseen by the Glisa mine management team, then there will be similarities in terms of activities and therefore it is acceptable to apply the same traffic patterns.

3.2.2 Additional Glisa Mine Trips

The Traffic Impact Assessment (ITS (Pty) Ltd, 2011) provides the number of heavy vehicle trips for the existing production of 3.5 mtpa and from this the number of heavy trips required for the increase in production of the mine to 4.5mtpa can be estimated. Table 1 below shows the heavy vehicle trips generated in the present and future horizon year scenarios.

Table 1: Heavy Vehicle Trips Generated from Existing Glisa Mine

Scenario 1: 2010 Operational phase	Quantities	Unit	Comment
Amount of tons produced per year	3,500,000	Tons per annum	
Amount of tons transported a day	12,000	Tons/day	0.0035% of the yearly production
Truck capacity	50	Tons/trip	
Total number of trucks generated	240	Trucks	
AM peak hour counted volumes	44	Trucks	18.27% of the daily truck trips
PM peak hour counted volumes	48	Truck	19.87% of the daily truck trips

Scenario 2: 2018 operational phase	Quantities	Unit	Comment
Amount of tons produced per year	4,500,000	Tons per annum	
Amount of tons transported a day	15,600	Tons/day	
Truck capacity	50	Tons/trip	
Total number of trucks generated	312	Trucks	
AM peak hour volumes	57	Trucks	
PM peak hour volumes	62	Trucks	

Based on the above it is expected that the increase in production of coal at the Glisa Mine will result in an additional 13 heavy vehicles during the AM peak and 14 additional heavy vehicles during the PM peak.

3.2.3 Paardeplaats Mine Trips

3.2.3.1 Heavy Vehicle Trips

Using the information from Table 1 above it is possible to approximate the expected number of heavy vehicle trips that will be generated by the Paardeplaats Project. The maximum productivity of the mine will be 4.4 mtpa.

The heavy vehicle trip rate as observed from the Glisa mine was applied to the expected production of the proposed Paardeplaats Project to determine the number of heavy vehicle trips during peak hour periods.

Table 2 below shows the number of heavy vehicle trips generated by the project.

Table 2: Heavy Vehicle Trip Generation for Paardeplaats Project

	Quantities	Unit
Amount of tons produced per year	4,400,000	Tons per annum
Amount of tons transported a day	15,253	Tons/day
Truck capacity	50	Tons/trip
Total number of trucks generated	305	Trucks
AM peak hour volumes	56	Trucks
PM peak hour volumes	61	Trucks
Inter peak hour volumes	188	Trucks

3.2.3.2 Light Vehicle Trips

For the Traffic Impact Assessment Glisa Mine (ITS (Pty) Lts, 2011) no trips for light vehicles were calculated. Although no reason is provided in the TIA it is possible that there would have been no increase in the number of staff using vehicles to travel to and from work.

For Paardeplaats Project there has to be an assumption that some of the staff will travel by light vehicles, including mini-bus taxi and private vehicles. To determine the light vehicle trip generation for the Paardeplaats Project, traffic counts were carried out at the access point to the Glisa mine to estimate the expected number of light vehicles to be generated by the Paardeplaats Project.

Table 3 shows the number of light vehicles entering and leaving the site during the AM and PM peak.

Table 3: Light Vehicle Trip Generation from Glisa Mine

Time Period	Inbound		Outbound		Total
	Number	Percentage	Number	Percentage	
AM	31	65%	17	35%	48
PM	8	22%	29	78%	37

The assumption can be made that this is the number of light vehicles that are required to operate a mine that has a coal production of 3.5mtpa. From this it is possible to calculate the number of light vehicles for a mine with a coal production of 4.4mtpa by extrapolating from the Glisa mine information.

Table 4 below shows the estimated number of light vehicles for Paardeplaats Project during peak hour periods.

Table 4: Light Vehicle Trip Generation for Paardeplaats Mine

Time Period	Inbound		Outbound		Total
	Number	Percentage	Number	Percentage	
AM	39	65%	21	35%	60
PM	10	22%	35	78%	47

3.2.4 Trip Assignment and Trip Distribution

Two trip generation patterns have been used, one for heavy vehicles and one for light vehicles. These two have been chosen as the Mining Works Programme (Exxaro, 2011) states “After processing, the existing infrastructure and logistics will be used to deliver Coal to the Client. The existing siding at Belfast will be used to send produce to Eskom via rail”. This would indicate that heavy vehicles will have their own trip distribution different to that of light vehicles.

The trip distribution for heavy vehicles assumes that heavy vehicles will travel towards Belfast avoiding sensitive areas, such as residential. Figures 9 and 10 show the trip distribution for the heavy and light vehicles respectively. The assumption is made that the AM and PM peak hours have the same trip distribution.

The expected assignment of the development traffic onto the local road network is indicated on Figures 11 and 12 for the heavy vehicles (AM and PM) and Figures 13 and 14 for light vehicles (AM and PM). Figures 15 and 16 show the total traffic generated by the mine for the AM and PM peaks.

This is combined with the 2022 background traffic and depicted in Figures 7 and 8 (AM and PM). When added to the 2022 background traffic the forecasted traffic volumes are depicted in Figures 17 and 18 (AM and PM).

4 Site Sensitivities

The site sensitivity has been calculated using the significance methodology and this looks at the impact, the mitigation measures proposed and the duration of the impact. The result from this is a significance rating that can ultimately be classified as low, medium and high. The definition of the impacts is as follows:

- **Low** – The impact would not have a direct influence of the decision to develop in the area;
- **Medium** – Where the impact could influence the decision to develop in the area); and
- **High** – Where the impact must have an influence on the decision process to develop the area.

The scoping study showed that the intersections and links, where they do not intersect with water courses, have a low impact, there is a medium sensitivity at culverts and bridges and a high sensitivity with regard to the communities.

4.1 Links and Intersection Impact

During the operational stage of the mine it is expected that the impact on the links and intersections outside of the site will remain low as there are no issues with regards to capacity at these intersections.

Any mitigation undertaken at these intersections is purely to provide an intersection that the heavy vehicles can safely manoeuvre round without running over the pavement edges and causing damage. The mitigation measures will be of benefit to all users in the long term as the intersections would be safer, especially for those wishing to turn right at the intersections.

4.2 Water Courses/Culverts and Bridges

The impact on the water courses would remain at a medium level as the impact from the additional vehicles will be minimal and any mitigation measures that need to be applied to the culverts should have a minimal impact on the water courses.

With regards to the underpasses it is expected that no mitigation measures would be required and so the impact would remain at the medium level.

4.3 Community

During the operational stage of the mine the impact on the local communities would remain at a high level due to the nature of the impact on the communities.

The main mitigation strategy for the communities affected is to ensure that the heavy vehicles avoid travelling through communities and instead remain on roads that travel around the communities, where possible. The impact will remain high on communities due to the nature of these impacts, these namely being noise, vibration and air pollution.

To mitigate the impact it is recommended that a travel management plan be developed to ensure that heavy vehicle have little impact on communities.

4.4 Summary

As stated above the significance methodology was used to determine the impact that the additional traffic would have on the aspects listed above. Table 5 below provides a summary of the impacts for each of the above with the final score. For the complete calculation for each aspect, refer to Appendix B.

Table 5: Summary from the Significance Methodology Calculations

Impact Name	Final Significance	Impact Level
Impact of heavy vehicles at intersections	-5.5	Low
Impact on water courses / culverts	2.5	Low
Impact on community	-6.0	Medium

The following comments are made in relation to the above:

1. The impact on the adjacent road network is considered low, as the traffic will be added to existing roads network, which is already carrying traffic through the area. The roads are existing infrastructure and therefore from an environmental perspective the environmental damage has already been done, when the road was constructed.

2. The impact on rivers and watercourses has been assessed as low. Similar to the roads the damage has already been done from an environmental perspective during the road construction. The additional impact that may occur during the life cycle of mine will be the increased number of heavy vehicles on the road, which may damage the culverts and bridges.

3. The increase in heavy vehicles passing through a community / urban area has been assessed as medium.

4.5 Mitigation Measures

The following mitigation measures are proposed:

1. Prior to the implementation of the mine a condition survey of the existing bridges and culverts on the road network in the vicinity of the mine be undertaken by the appropriate specialist (structural engineer) and any remedial measures taken to address any problems identified.

2. To minimise the impact on the adjacent communities a traffic management plan be should be prepared, which would identify appropriate routes for heavy vehicles to avoid communities and limit time of operation.

4.6 Conclusion

If the mining activity does not proceed the status quo will remain and no new traffic will be added to the surrounding road network and therefore there will be no additional impact on the surrounding environment..

Should the mining activity proceed on any portion of the property the impact will be the same as outlined above as the impact will be on the existing infrastructure.

5 Site Constraints

Within the site itself attention needs to be paid to the water courses and ponds. There are a number of these within the site boundary of which these all are of a sensitive nature. Any intrusion into these areas should be avoided, where possible. If this is not possible then a scheme for offsetting the impact of the roads should be put in place to ensure that these sensitive areas are conserved where possible.

The latest information regarding the mine suggests that mining activity may be restricted to Portion 30 of the mine, as this the is least environmentally sensitive area, and the rest of the site could be used as offsets. This should reduce the impact that the haul roads will have on the wetlands.

The latest plan of the mine shows that the Paardeplaats Road will be used to haul the coal from the pit to the processing facilities at the Glisa mine. Using this existing road should reduce the impact of hauling coal.

The latest plan shows the diversion of Paardeplaats Road so that it follows the mining rights border and then cuts across the site at the northern end of the site. It is recommended that the road be fenced off from the mining area.

6 Impact Assessment

The impact assessment has been based on the operational stage of the mine, as this stage will be a worst case scenario from a traffic engineering perspective. During the operational phase of the mine the traffic generated will be at its highest on a daily basis and it is during this period that the impact will be the highest.

The impact on the roads is measured in terms of performance (Level of Service), which is the accepted methodology. The level is service is based on a scale of A to F, with A been the best case and F the worst case and any performance better than D is acceptable.

6.1 Link Capacity Analyses

A link capacity analysis was carried out on the roads surrounding the site. Figure 19 shows these links graphically. This link capacity analysis was carried out in line with the Highways Capacity Manual.

As stated earlier the decision was made to carry out a link analysis instead of an intersection analysis. The reason for this is that the low base traffic flow and the relatively low numbers from the Glisa mine and the Paardeplaats Project would not require intersection analysis and that link analysis would be more appropriate.

6.1.1 Link Analysis – AM Peak

Table 5 below shows the Level of Service for each of the links for each scenario in the AM Peak, these can also be seen graphically in Figures 20, 21 and 22.

Table 5: Level of Service for Each Scenario for the AM Peak

Link	Background 2022	Background 2022 + Glisa Expansion	Background 2022 + Glisa + Paardeplaats
1	C	C	C
2	B	B	B
3	A	A	A
4	A	A	A
5	A	A	A
6	A	A	A
7	A	A	A

As can be seen from the analysis in Table 5 there is no change in the Level of Service on any of the links between the three scenarios. This shows that the additional vehicles, in particular the heavy vehicles, has not had any effect on the road to result in a change in the LOS.

6.2 Link Analysis – PM Peak

Table 6 below shows the Level of Service for each of the links for each scenario in the AM Peak, these can also be seen graphically in Figures 23, 24 and 25.

Table 6: Level of Service for Each Scenario for the PM Peak

Link	Background 2022	Background 2022 + Glisa Expansion	Background 2022 + Glisa + Paardeplaats
1	C	C	C
2	C	C	C
3	A	A	A
4	A	A	A
5	A	A	A
6	A	A	A
7	A	A	A

The analysis in Table 6 shows there is no change in the Level of Service on any of the links between the three scenarios. This shows that the additional vehicles, in particular the heavy vehicles, is not a significant number of vehicles to result in a change in the LOS.

6.2.1 Discussion of the Results

The LOS (Level of Service) is a scale from A to F that indicates the effectiveness of the road in ensuring that traffic is flowing freely. A LOS A indicates that the road is operating in free flow conditions with vehicles travelling at or above the posted speed limit.

A LOS F indicates that the vehicular flow has broken down and that vehicles are frequently slowing and stopping, technically a road in constant jam would be at level F. Ideally a road should operate between LOS A and D, if a road operates at LOS E or F then it would indicate that upgrades are required in order for the road to operate at an acceptable LOS.

The results from the analysis carried out show that for the AM and PM peak the roads all operate at a LOS C or better and that there is no change in the LOS as additional traffic is added due to the mining activities. This indicates that the additional traffic has no discernable impact on the operation of the links assessed.

Therefore no road upgrades are required on the links to accommodate the additional traffic generated by the Glisa Mine and Paardeplaats Mine.

6.3 Intersection Impacts

No intersection analysis has been carried out due to existing low traffic flows and little risk of intersections operating near capacity. A link analysis for the AM and PM peak hour (Tables 5 and 6) shows that the additional traffic from the Glisa Mine and Paardeplaats Project will result in no change to the LOS for the various links.

The additional development traffic is expected not to cause capacity issues. No road upgrades are therefore proposed to increase road capacity. However, road upgrades should be considered to accommodate access for the heavy vehicles, in particular the abnormal loads that may be required during construction.

Upgrades that may be considered for the heavy vehicles could be as follows:

- Minimum width of 4m for all lanes on approach to intersection;
- Increasing the corner radii to 20m to ensure abnormal roads do not run over the pavement edges;

Right turn refuges at all intersections that are able to accommodate two heavy vehicles without impeding the through traffic on the links.

6.4 Bridges / Culverts

For the bridges and culverts the main issue will be as with the haul route to the Belfast sidings the bridges are avoided were possible. The bridges that are in the vicinity of the site pass over the roads. The two main bridges in the area are over the R33 and these should have been designed with the correct height clearance that the heavy vehicles can pass under with no restrictions. Prior to the use of this route to haul coal from the mine to the siding the height clearance should be checked and verified.

The few culverts that are on the haul route may require upgrades to ensure that they capable of withstanding the load, but, this will require a structural assessment which is outside the remit of this assessment.

With regards to the internal workings of the mine culverts maybe required due to the number of ponds that are located within the site boundary and these should be designed to a standard that will meet the demands during the operational life span of the mine.

6.5 Community

There are a number of impacts that the transportation of the coal will have on the communities and these are listed below:

- Possible congestion if a haul routes passes through the centre of the community;
- Noise pollution;
- Vibration pollution; and
- Air pollution.

The impact from the noise, vibration and air are being dealt with by other specialists.

With regards to the congestion the issue is the lack of maneuverability of the heavy vehicles used for hauling coal between the mine and the rail sidings. These large vehicles generally require two lanes to carry out some maneuvers, a larger gap than normal vehicles and their length requires a long queuing area at any intersections.

6.6 Environmental Impacts

6.6.1 Wetlands

The Baseline Wetlands Assessment – Paardeplaats Portions 1, 2, 13, 24, 28, 29 and 30 (Wetland Consulting Services, 2011) carried out a number of assessments to determine the condition of the wetlands in the Paardeplaats Project area.

From this a wetland risk assessment scale was developed that would indicate the suitability of an area to the proposed mining activity. The risk assessment was on a scale of 1 to 9, with a value of 1 indicating an area highly suitable for the mining activity and 9 indicating a restricted area.

The result from the wetlands risk assessment showed that there are a number of areas that had a risk assessment value of 9 indicating a restricted area. These are located mainly on the northern boundary and western boundary of the site.

As a result of this it would be recommended that these areas should be avoided in terms of haul road routes where possible.

6.6.2 Ecological

From the Informative / Scoping Level Report Ecological Assessment of the Proposed Paardeplaats Mining Area, Belfast, Mpumalanga, EkoInfo CC and Associates 2011 a study into the ecology of the Paardeplaats Project site was undertaken.

Following on from the individual ecological studies carried out a total ecological sensitivity map was produced. The scale for this operates 1 to 8 with 8 being the most ecologically sensitive.

From the map it can be seen that the most sensitive areas are located in the north-eastern and south western sections of the site. There is also a band across the site in the middle as well. It is recommended that these areas are avoided with regards to transport.

7 Mitigation Measures

7.1 Intersection and Link Mitigation Measures

With regards to the intersections it is felt no mitigation measures will be required in terms of capacity as the additional development traffic will have a minimal impact at the intersections.

However, in terms of the geometry mitigation measures should be considered at the following intersections to accommodate the heavy vehicles, in particular interlink vehicles for hauling coal, particularly from a maneuverability perspective:

- Mine access / Spitskop Road;
- Spitskop Road / R33; and
- R33 / Access to rail sidings.

The mitigation measures suggested are as follows:

- Minimum width of 4m for all lanes on approach to intersection;
- Increasing the corner radii to 20m to ensure abnormal roads do not run over the pavement;
- Right turn refuges at all intersections that are able to accommodate two heavy vehicles without restricting the flow of traffic;

These mitigation measures are suggested in order to ensure that the heavy vehicles are able to successfully negotiate these intersections without running onto the pavement edges and causing damage and that they are safe for all users.

With regards to the links themselves the analysis shows that none of the links require upgrades in terms of capacity, but as with the intersections, mitigation measures may be required in order to ensure the roads stay in a condition fit for their purpose.

- **Site Access Road** – It is assumed that the access to the mine will be via the existing access to ensure the minimum access on Spitskop Road. Currently the access road is not paved and it is be recommended that it is in the future. The reason for paving this road is to reduce the amount of gravel surfacing been dislodged and dragged / spread on to the Spitskop Road. It is recommended that the section of road to be paved, as a minimum, 50m from the intersection with Spitskop Road. The road should be a minimum width of 4m per lane;
- **Spitskop Road** – Spitskop Road is currently in a good condition and at present requires no upgrades. It is recommended that the condition of the road is monitored during the lifespan of the mine and be maintained as and when required;
- **R33** – Some widening is required along the section of the R33 used by heavy vehicles. The widening should be carried out to specification in line with the

expected vehicle loading in the future and to the relevant local authority standards and requirements.

- **Internal Haul Roads** – As part of the workings a number of haul roads will be constructed within the mine to carry the coal between the pit and the processing plant. The width of these roads will vary between 10m and 22m, depending on their purpose and final destination. These should be designed as gravel roads with the required layer works to ensure that they are fit for their purpose.

7.2 Public Transport

Current public transport facilities on Spitskop Road are limited and it is recommended that a lay by be provided on Spitksop Road westbound, downstream of the Spitskop Road / Access intersection.

This is suggested as the nearest lay by is currently located on the R33 and constructing a lay by in close proximity to the access road will reduce the distance that employees have to walk.

7.3 Water Courses / Culverts

As stated in the Scoping Report, there are relatively few water courses / culverts that intersect with the existing road network, but within the site there are a number of ponds and streams that have important, sensitive eco-systems associated with them.

The most appropriate mitigation strategy would be to avoid these environmentally sensitive areas, where possible, by designing the mine layout in such a way that the routes between the pit and the processing plant and other areas are the shortest possible, but avoid these sensitive areas as much as possible.

If it is not possible to avoid these areas, then the culverts should be designed to have the minimum impact on the environment as possible and should be temporary structures that can be removed as soon as that section of the road is not required.

For the external road network the impact will be determined following a structural assessment of the culverts themselves. This is required in order to determine the structural condition of these culverts. Once this has been carried out it will be possible to determine if these culverts have the structural integrity to cope with the expected loadings during the operational lifespan of the mine.

If mitigation measures are required then it is recommended that they are designed to have as little impact as possible and should be designed in such a way that they can be removed at a later stage, if required.

8 Conclusion and Recommendations

8.1 Conclusion

The Exxaro Paardeplaats Project will be developed adjacent to the Spitskop Road in the eMakhazeni area. The access will be from the existing mine access off Spitskop Road.

Based on the information from the Glisa Mine TIA it has been estimated that the Paardeplaats Project could generate the following trips:

- 60 light vehicle trips in the AM peak (39 inbound, 21 outbound);
- 47 light vehicle trips in the PM peak (10 inbound, 36 outbound);
- 55 heavy vehicle trips in the AM peak (30 inbound, 25 outbound); and
- 60 heavy vehicle trips in the PM peak (25 inbound, 35 outbound).

It should be noted that the calculation for the number of trips generated by the proposed Paardeplaats Project has been based on the Transport Impact Assessment for the neighbouring Glisa Mine.

The analysis indicates that the addition of the additional traffic will have no impact on the adjacent road network. The link based analysis shows that each link will operate at LOS C or better, which is acceptable from a traffic engineering perspective.

The access to the site will be provided at the existing access off Spitskop Road. The following recommendations are made in relation to the access:

- The access consist of one inbound and one outbound lane and this will be adequate for the future development.
- The stacking area between the gate and the main road is constructed to provide space for vehicles to wait while being processed in and out of the gate;
- It is recommended that one of the access lanes must be at least 4.5m wide to allow for emergency and service vehicle entry. Vertical clearance to any overhead structures should be at least 4.2m.

It is recommended that a lay-by for public transport be provided on Spitskop Road eastbound, downstream of the intersection Spitskop Road / Access to mining area.

With regards to the significance methodology the transportation of coal will have the following impacts:

- Intersections and links - Low impact;
- Water Courses / Culverts and Underpasses – Medium impact; and
- Communities – High impact.

The study addresses the impact on the existing infrastructure in the vicinity of the mine and the impact can be summarised as follows:

1. Should the mine not proceed the status quo remains as is on the adjacent road network as no new traffic will be added to the network.
2. If mining activity proceeds on one or all the portions of the farm the impact remains as above. The traffic will be added to the existing infrastructure, the roads and bridges / culverts are all in place and therefore the environmental damage has already been done.

8.2 Recommendations

Having completed this study the following recommendations are made:

- That the intersections on the haul route are upgraded to ensure that the heavy vehicles can manoeuvre safely;
- A pavement assessment of the haul route is undertaken to determine the existing condition of the route;
- Upgrades to the haul route, in terms of pavement surface, are planned if the pavement surface shows that resurfacing is required;
- A structural assessment of all culverts on the haul route is undertaken to determine their current condition and if upgrades are required then these are designed to have the minimum impact on the environment;
- To minimise the impact on the adjacent communities a traffic management plan be should be prepared, which would identify appropriate routes for heavy vehicles to avoid communities and limit time of operation.
- Any culverts required within the site are designed to have minimum impact on the environment and can be removed when no longer required;
- The internal roads are positioned to ensure minimum impact on the sensitive wetland eco-systems, as the current plan indicates;
- Existing roads within the site are used where possible to minimise the impact; and
- The diverted Paardeplaats Road is fenced to ensure members of the public cannot gain access to the mine.

Figures

A4

Legend

Site

P1	01-02-08	MM	RM	EP
Issue	Date	By	Chkd	Appd

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Metres
0 1,850 3,700 7,400

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www.arup.com

Client
Environmental Impact Management Services

Job Title
Exarro Paardeplaats

Locality Plan

Scale at A4
1:150,000

Job No
219268

Drawing Status
Preliminary

Drawing No
Figure 1

Issue
P1

MXD Location

A4

Legend

Site

P1	01-02-08	MM	RM	EP
Issue	Date	By	Chkd	Appd

Metres
0 1,850 3,700 7,400

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Client
Environmental Impact Management Services

Job Title
Exarro Paardeplaats

Aerial Plan

Scale at A4
1:150,000

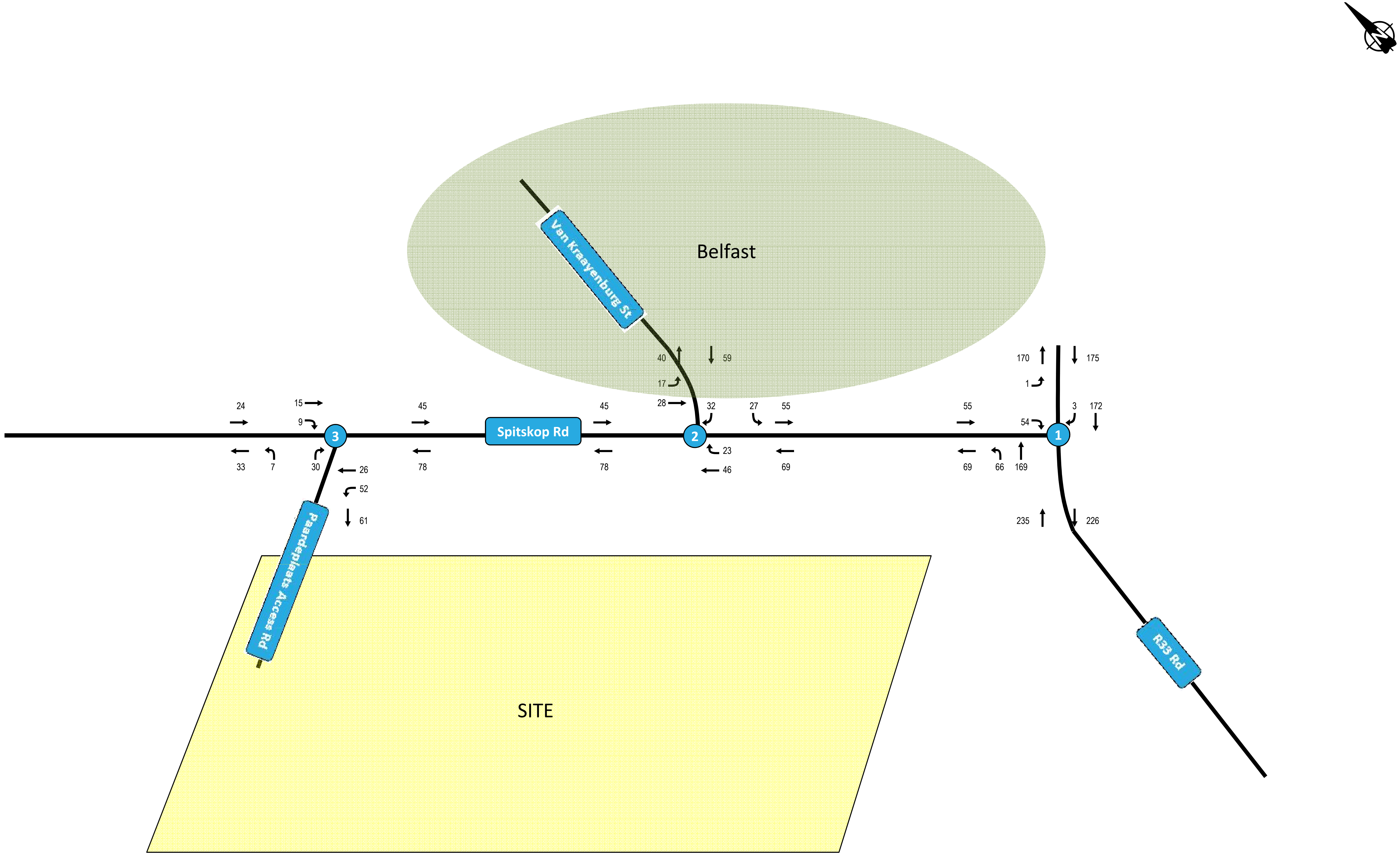
Job No
219268

Drawing Status
Preliminary

Drawing No
Figure 2

Issue
P1

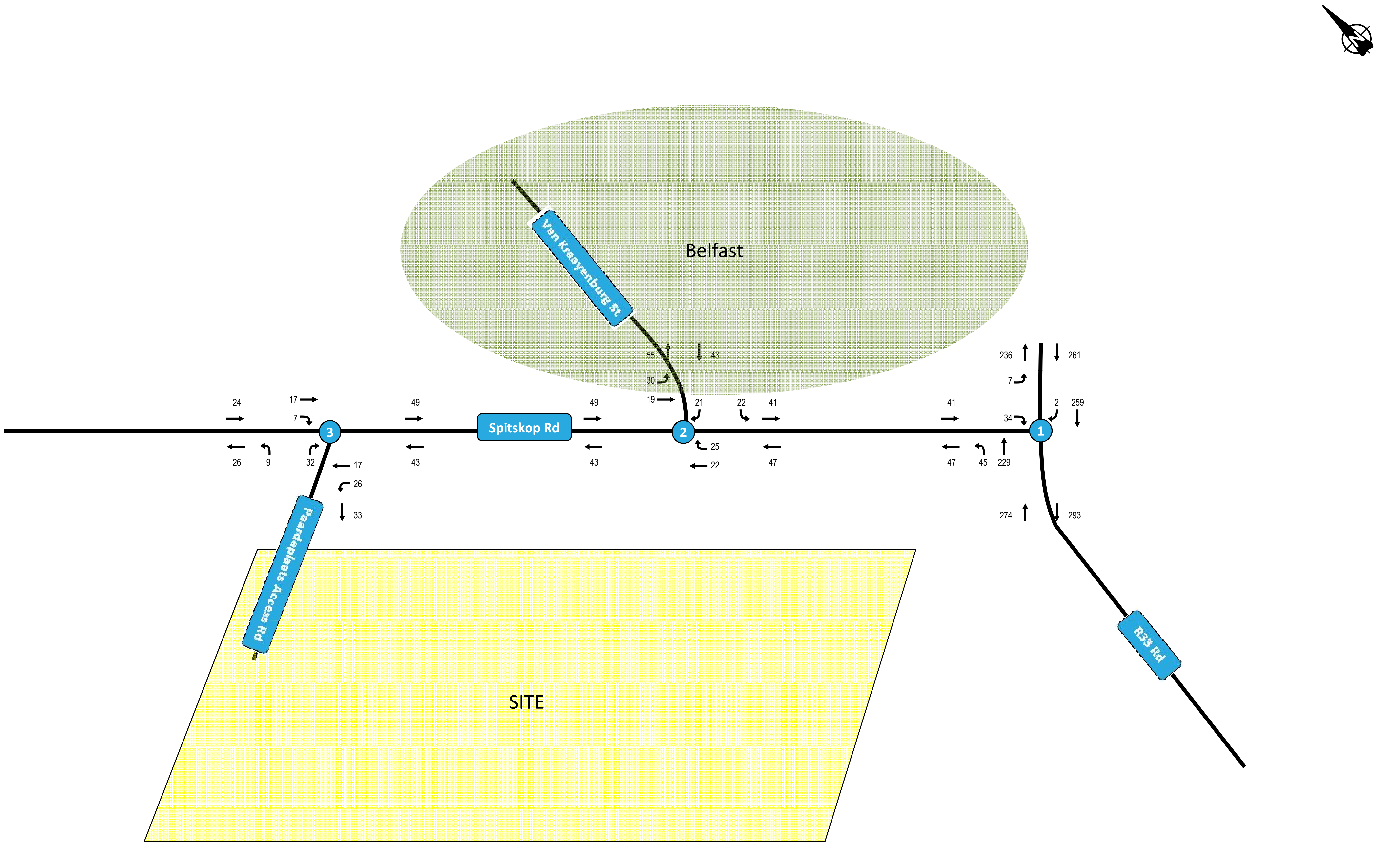
MXD Location



WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Present Traffic Demand (2012)	Fig: **3**



WEEKDAY PM PEAK HOUR

Schematic

ARUP TransportPlanning

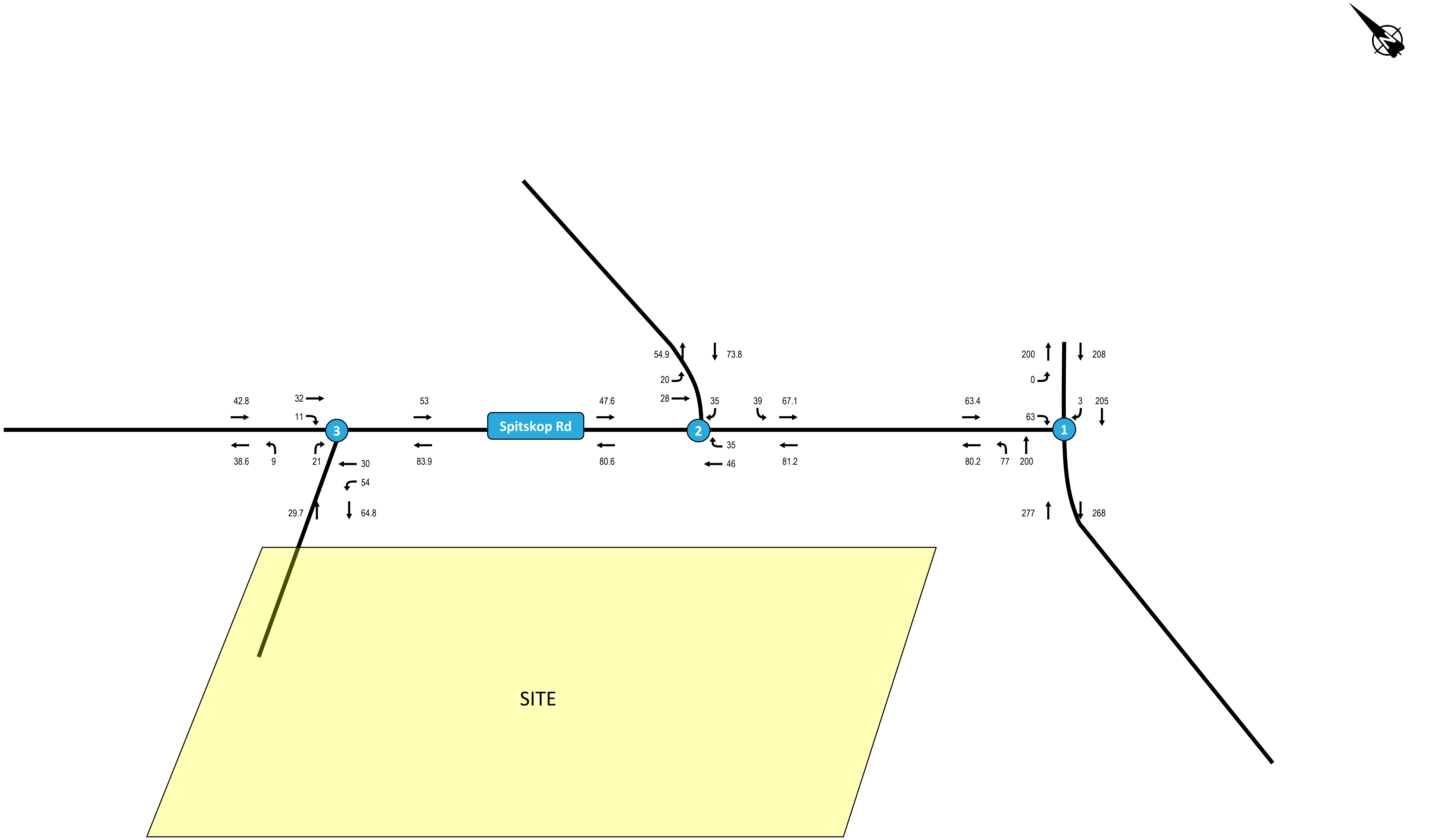
Paardeplaats Exxaro Colliery

Present Traffic Demand (2012)

Job Ref No: 219268

Fig: 4

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

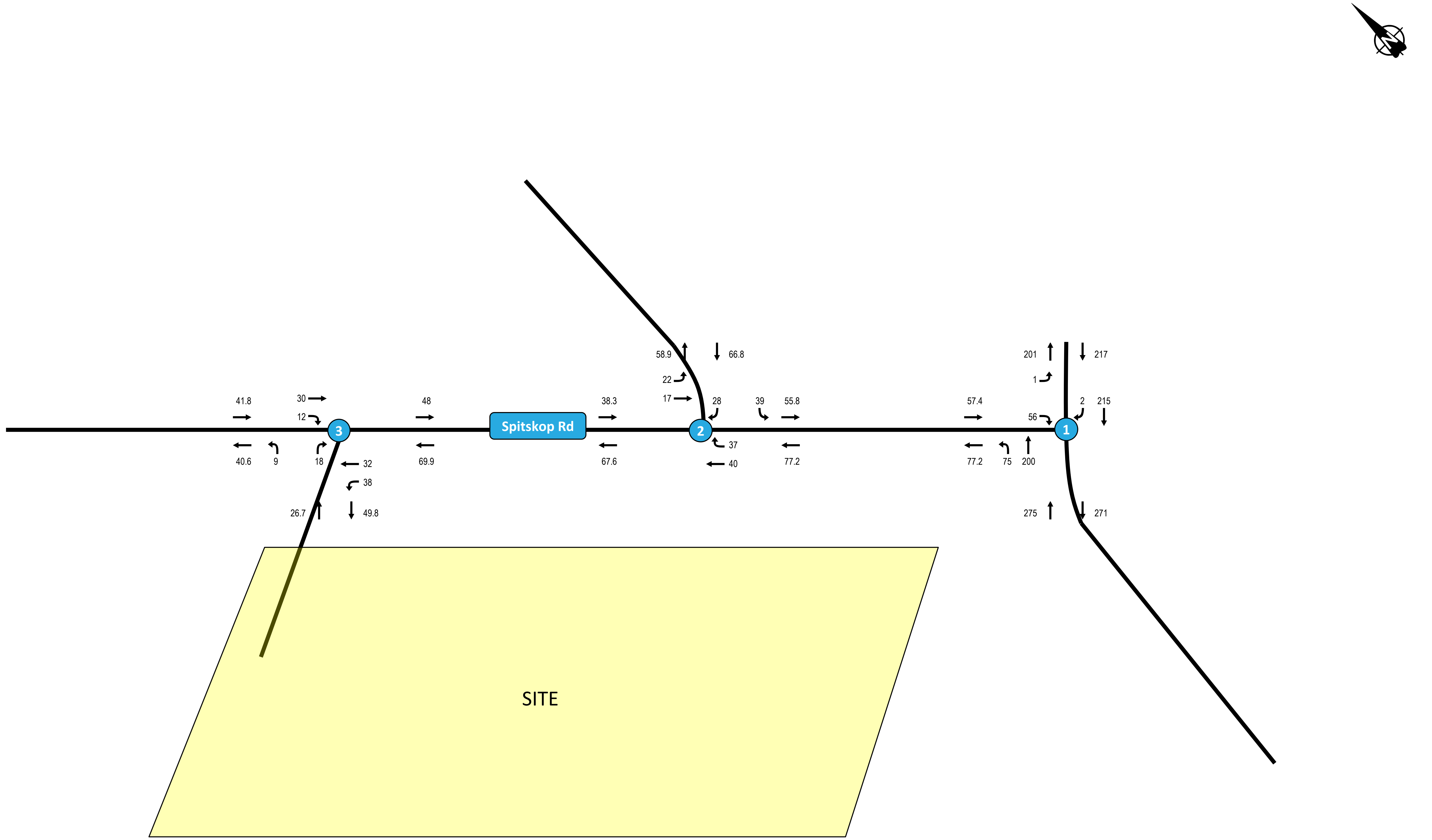


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Background 2022 Traffic - AM Peak	Fig: **5**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

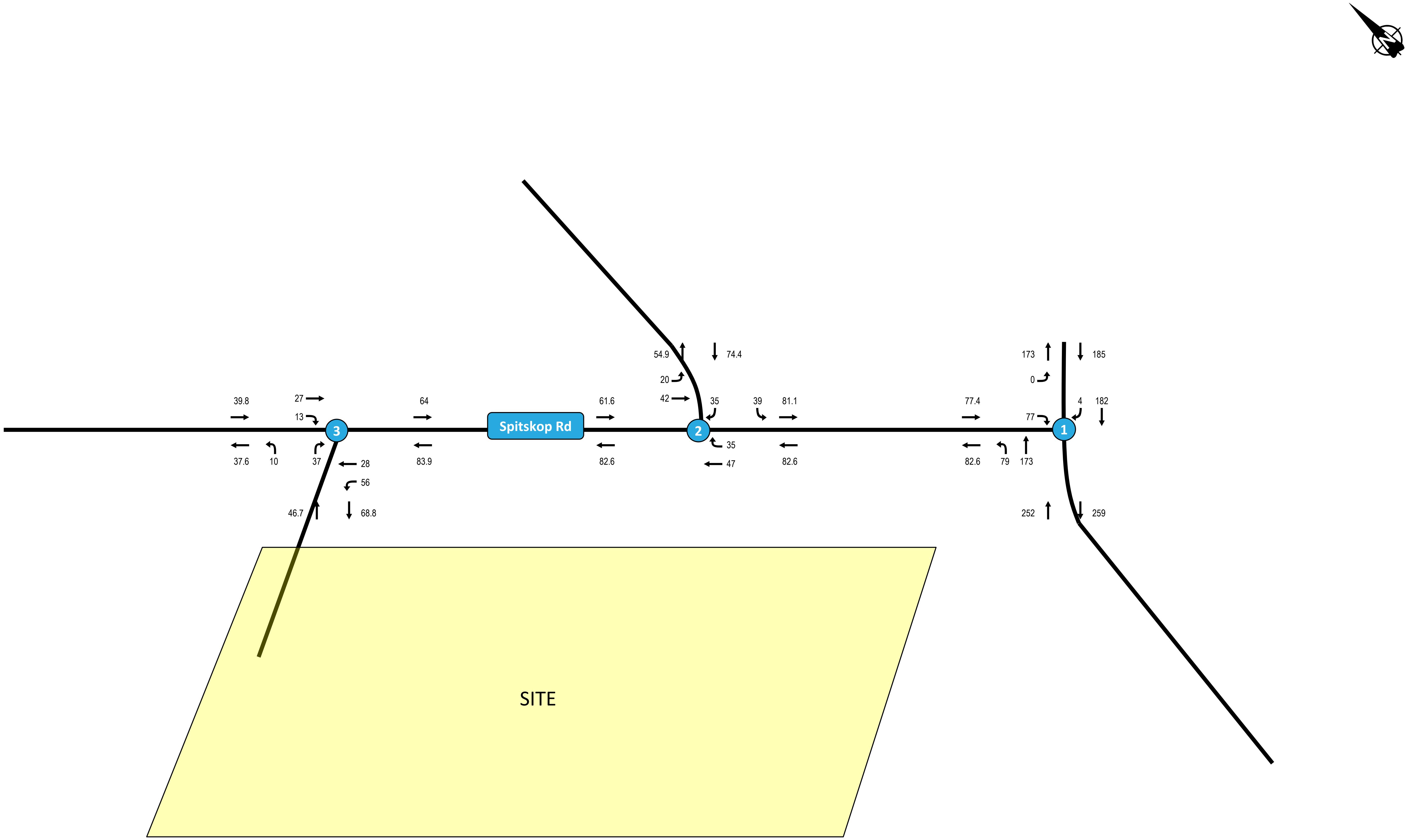


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Background 2022 Traffic - PM Peak	Fig: **6**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

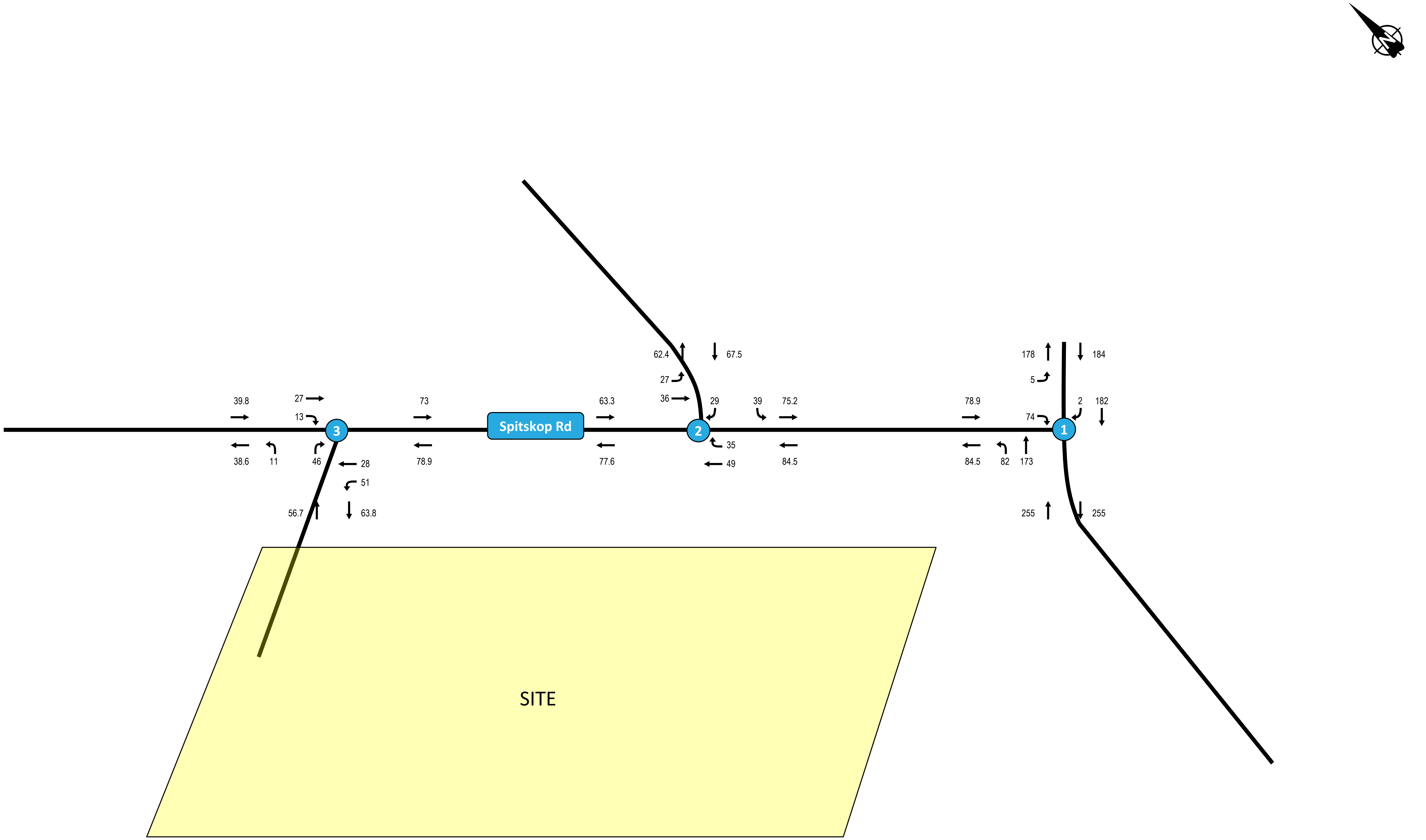


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Background 2022 and Glisa Mine Traffic - AM Peak	Fig: **7**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

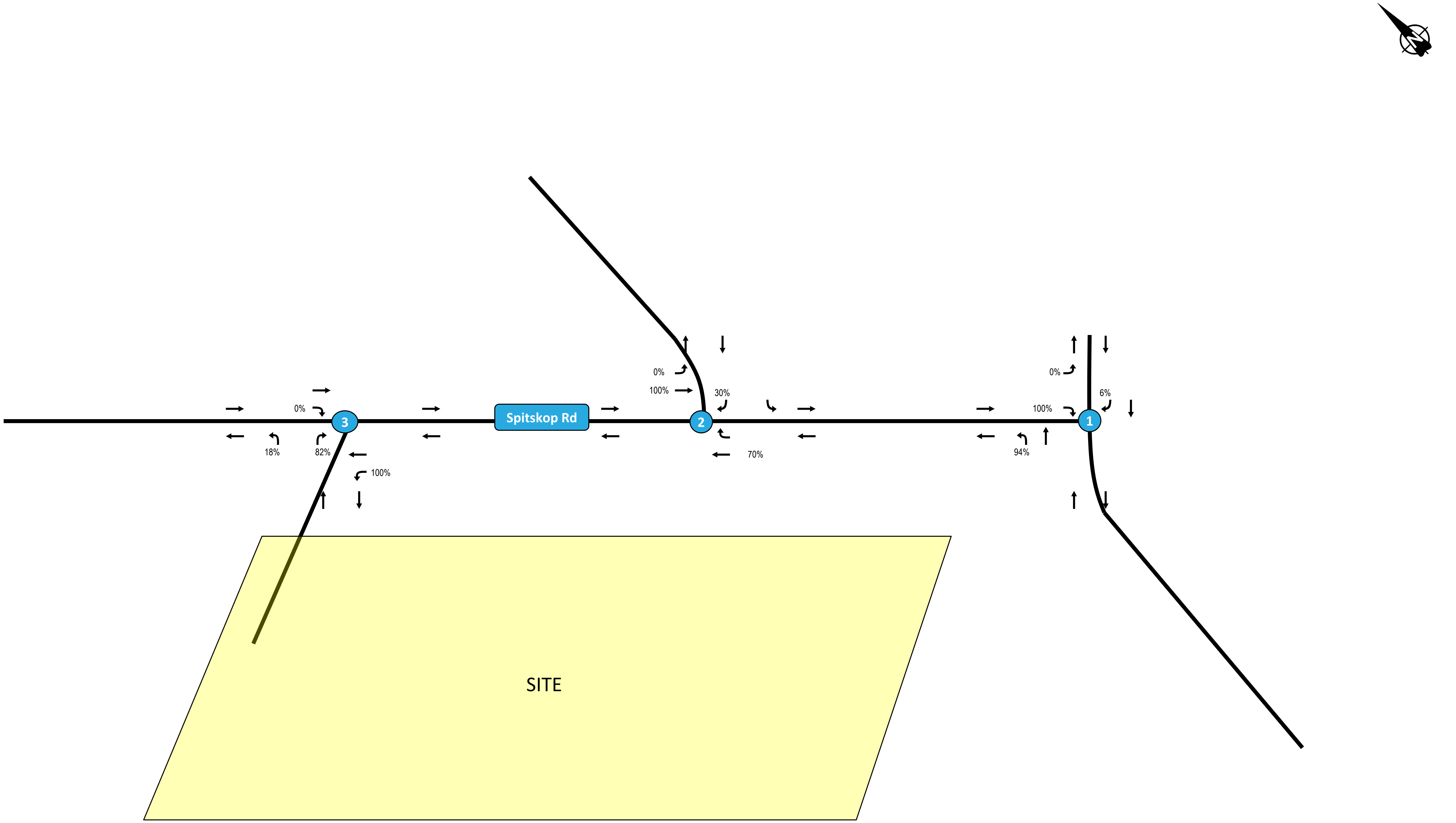


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Background 2022 and Glisa Mine Traffic - PM Peak	Fig: **8**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

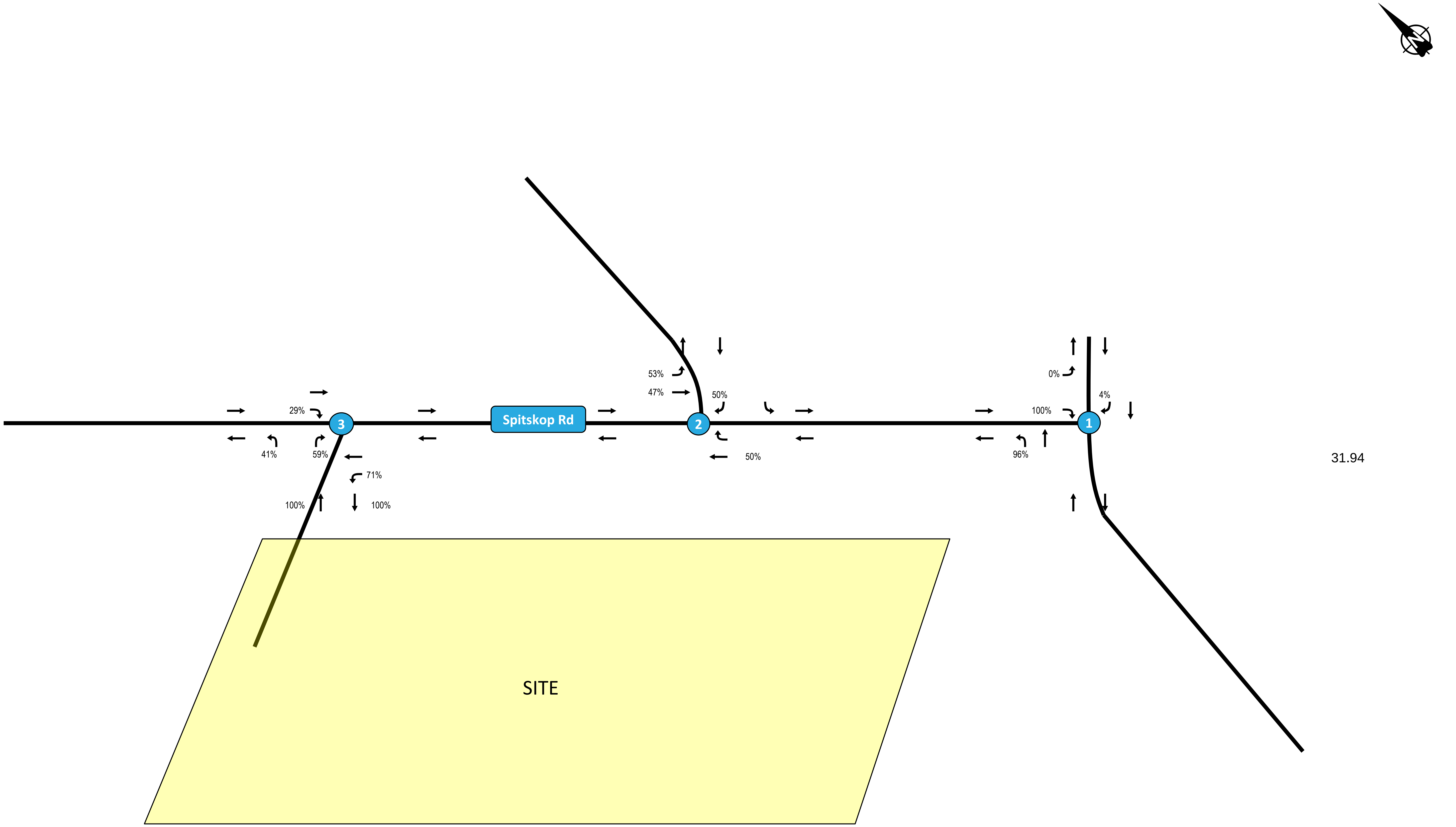


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Heavy Vehicle Trip Distribution	Fig: **9**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

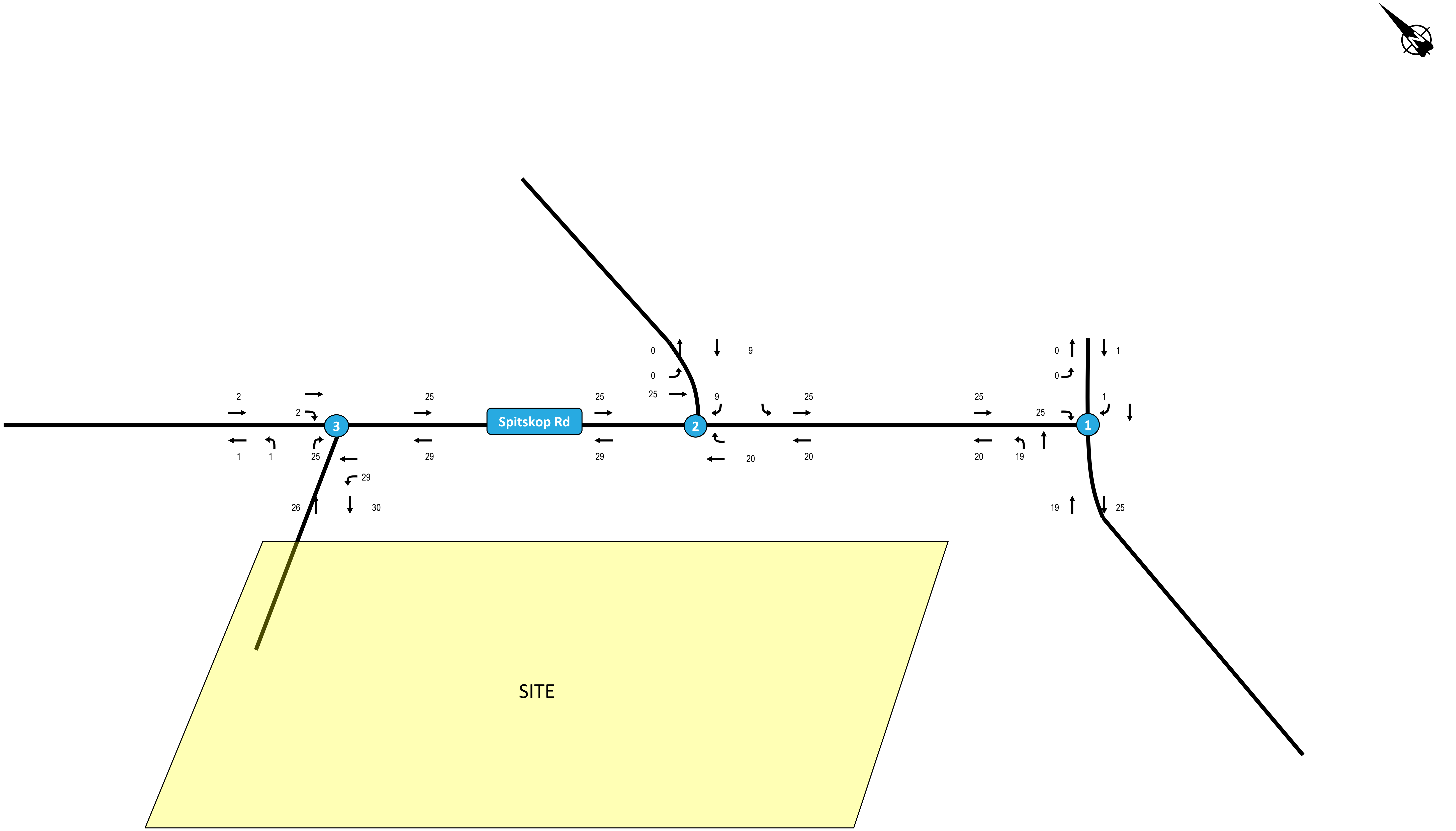


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Light Vehicle Trip Distribution	Fig: **10**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

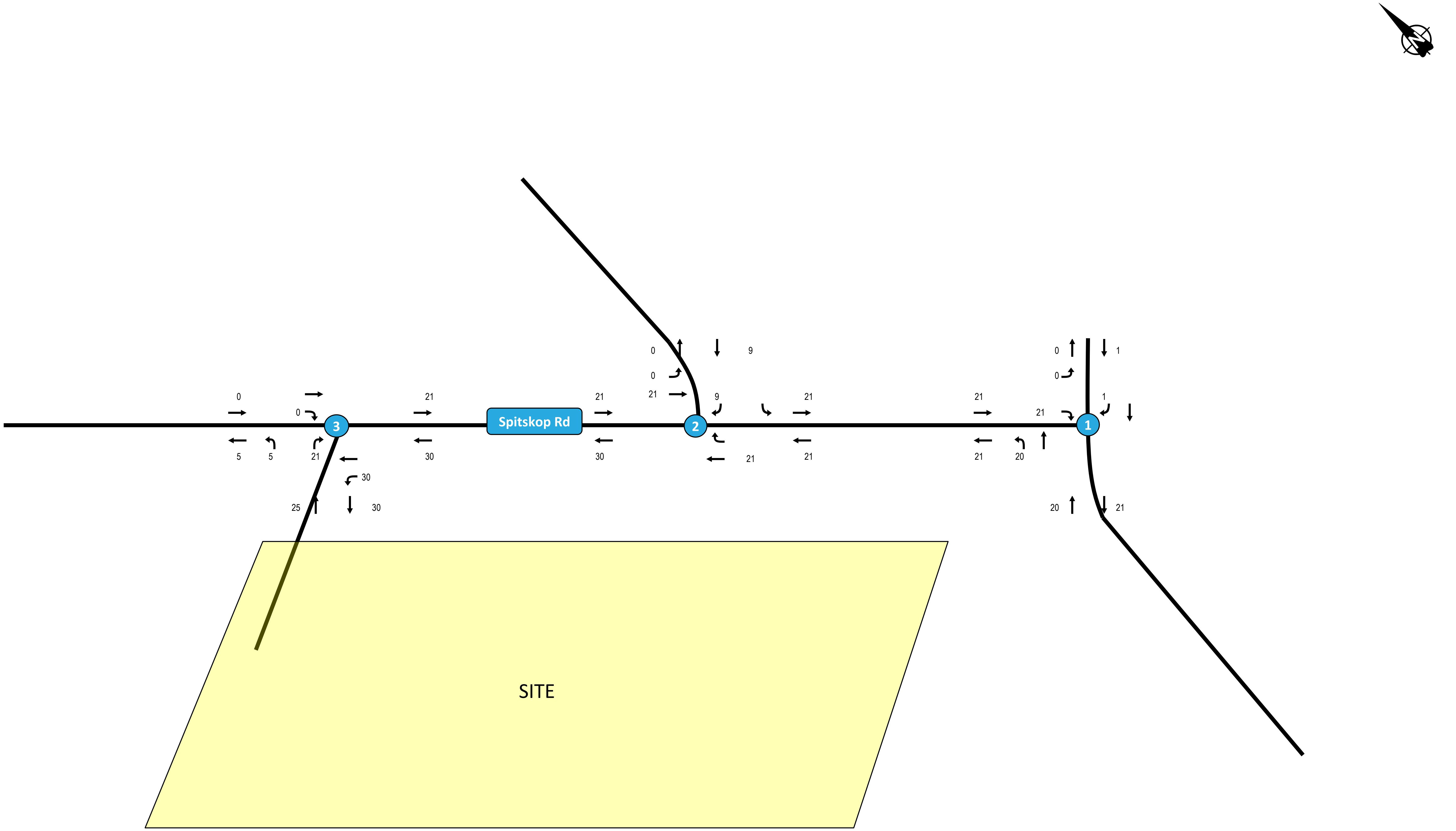


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Glisa Mine Heavy Vehicle Trip Assignment - AM Peak	Fig: **11**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

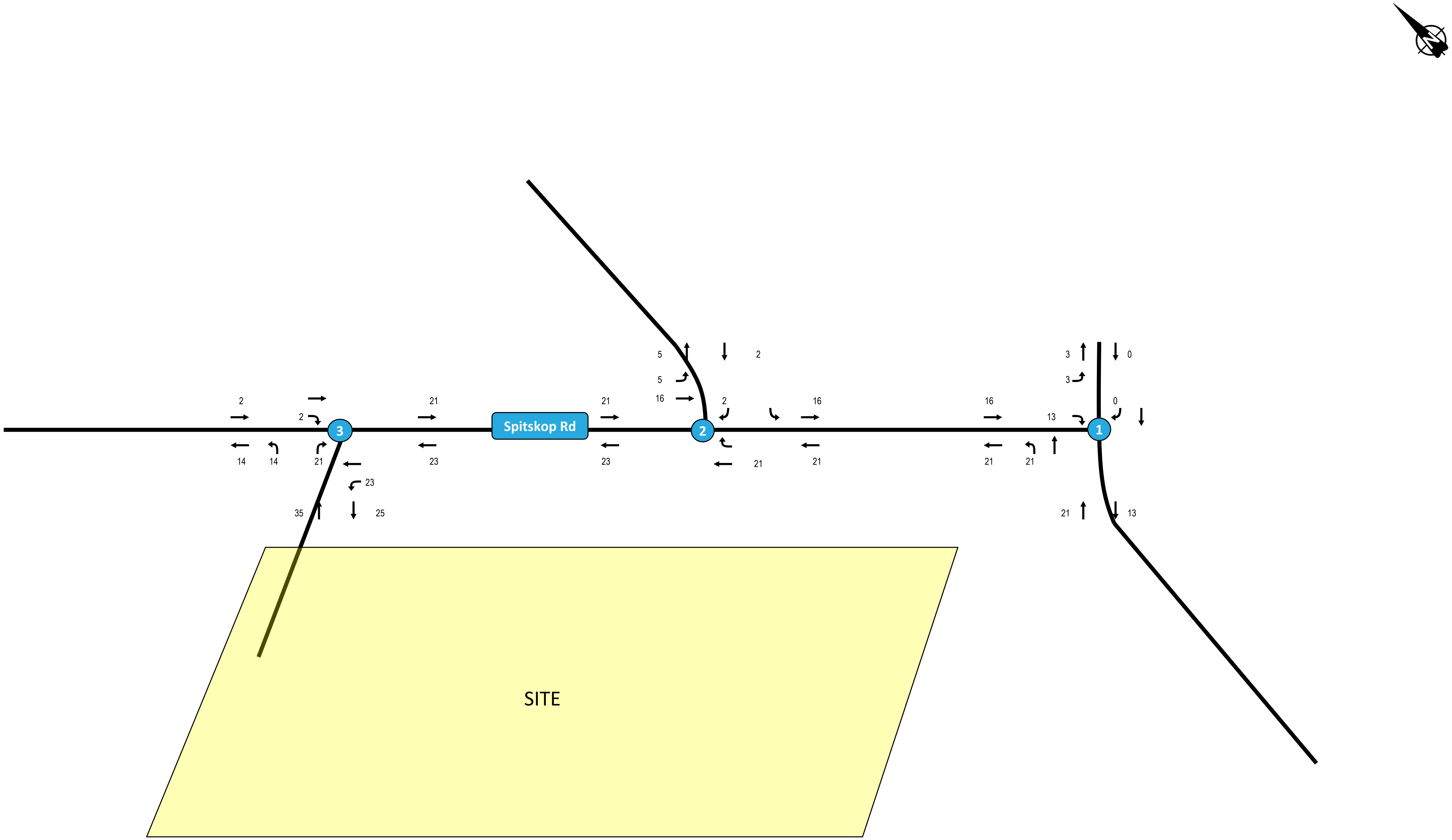


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Heavy Vehicle Trip Assignment - AM Peak	Fig: **11**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

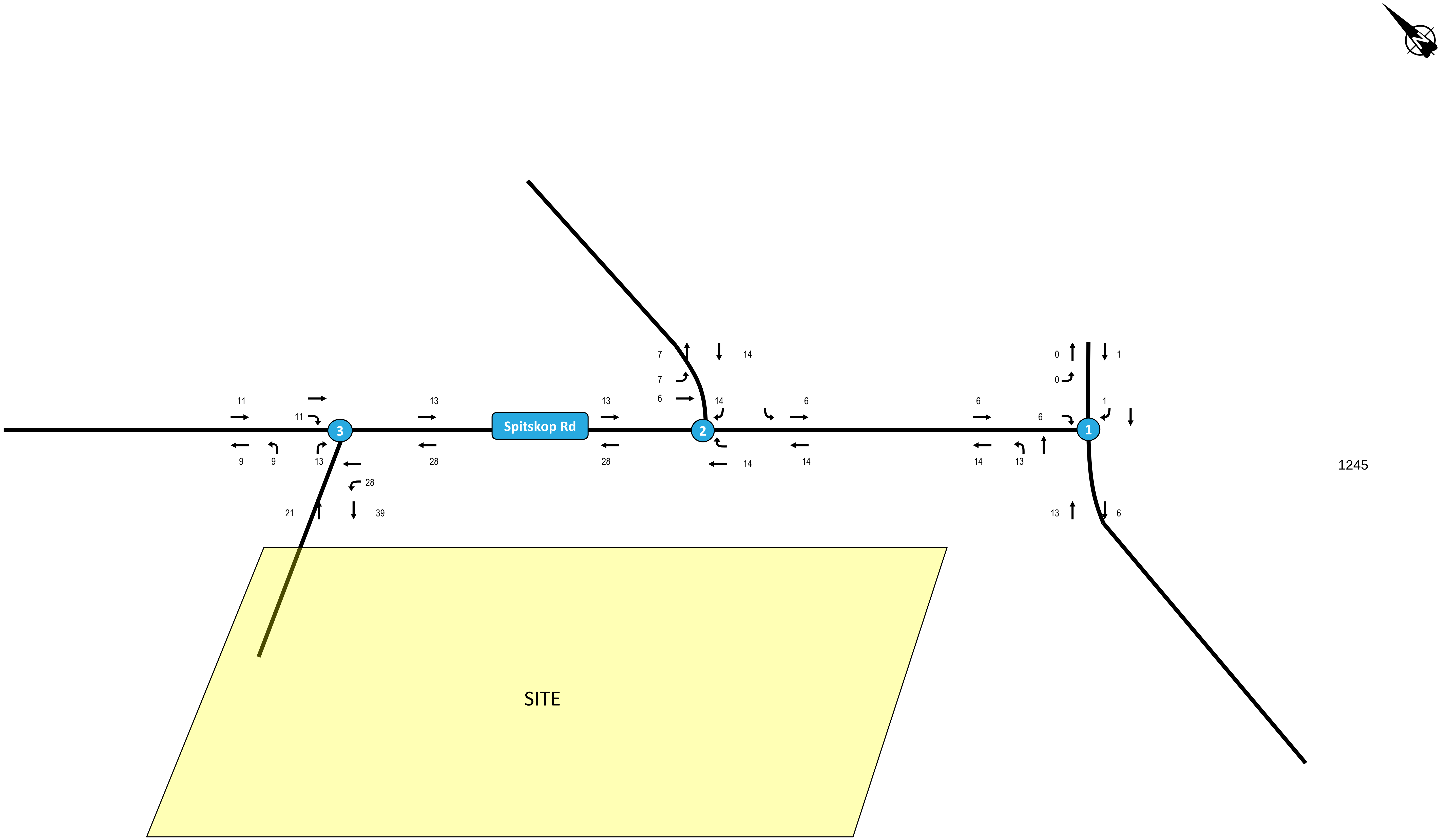


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Heavy Vehicle Trip Assignment - PM Peak	Fig: **12**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

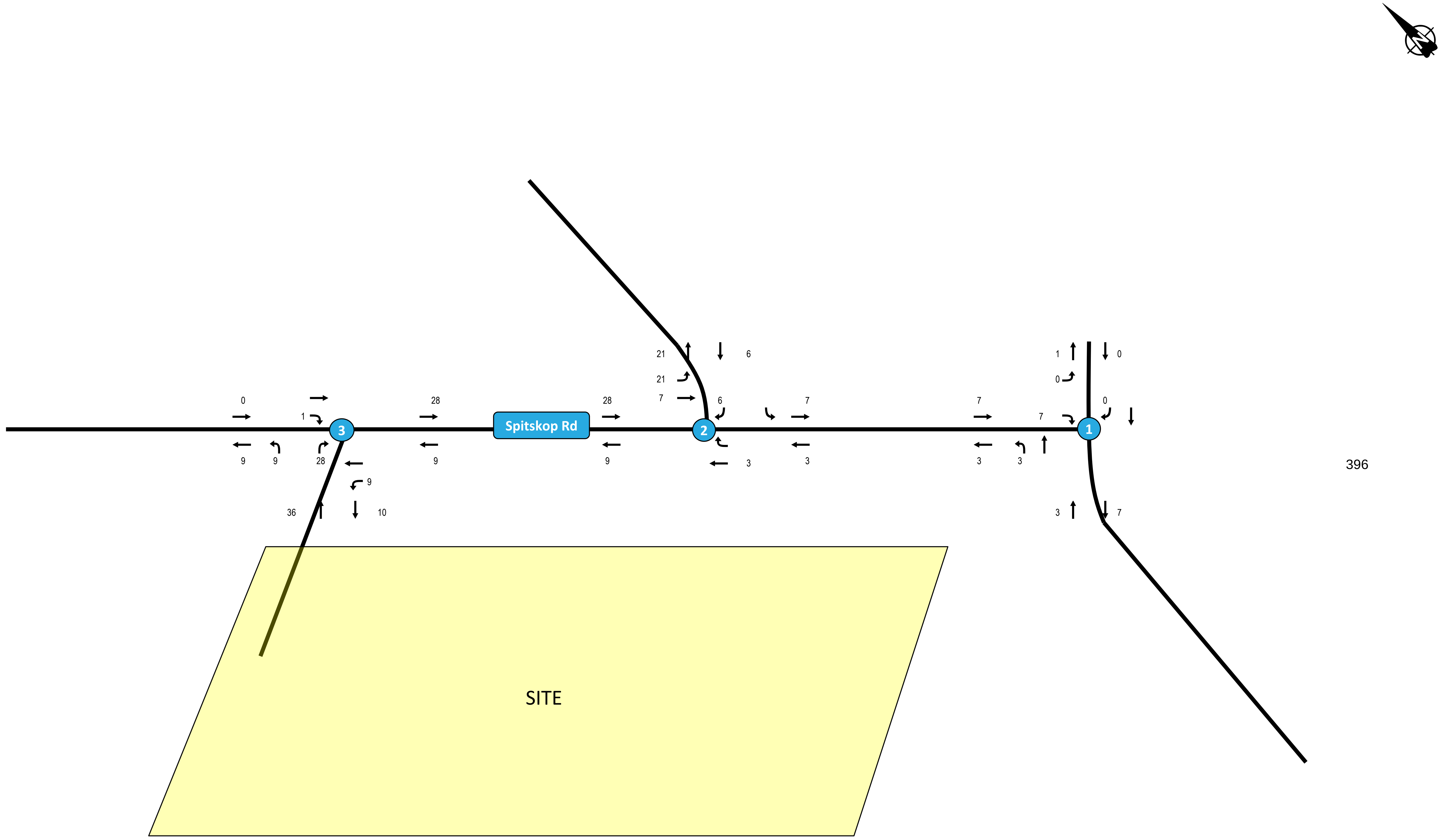


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Light Vehicle Trip Assignment - AM Peak	Fig: **13**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1



WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning

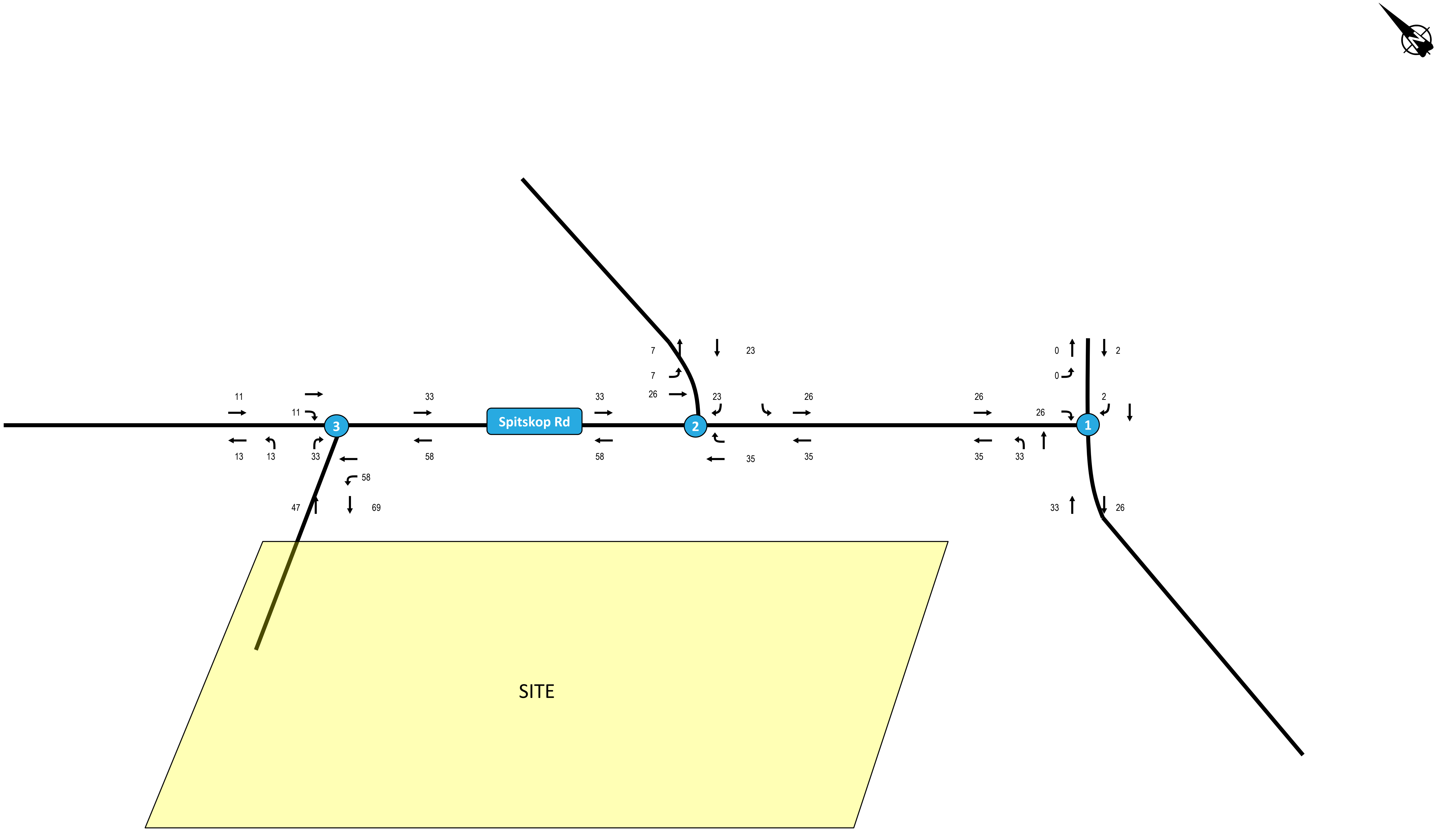
Paardeplaats Exxaro Colliery

Light Vehicle Trip Assignment - PM Peak

Job Ref No: **219268**

Fig: **14**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

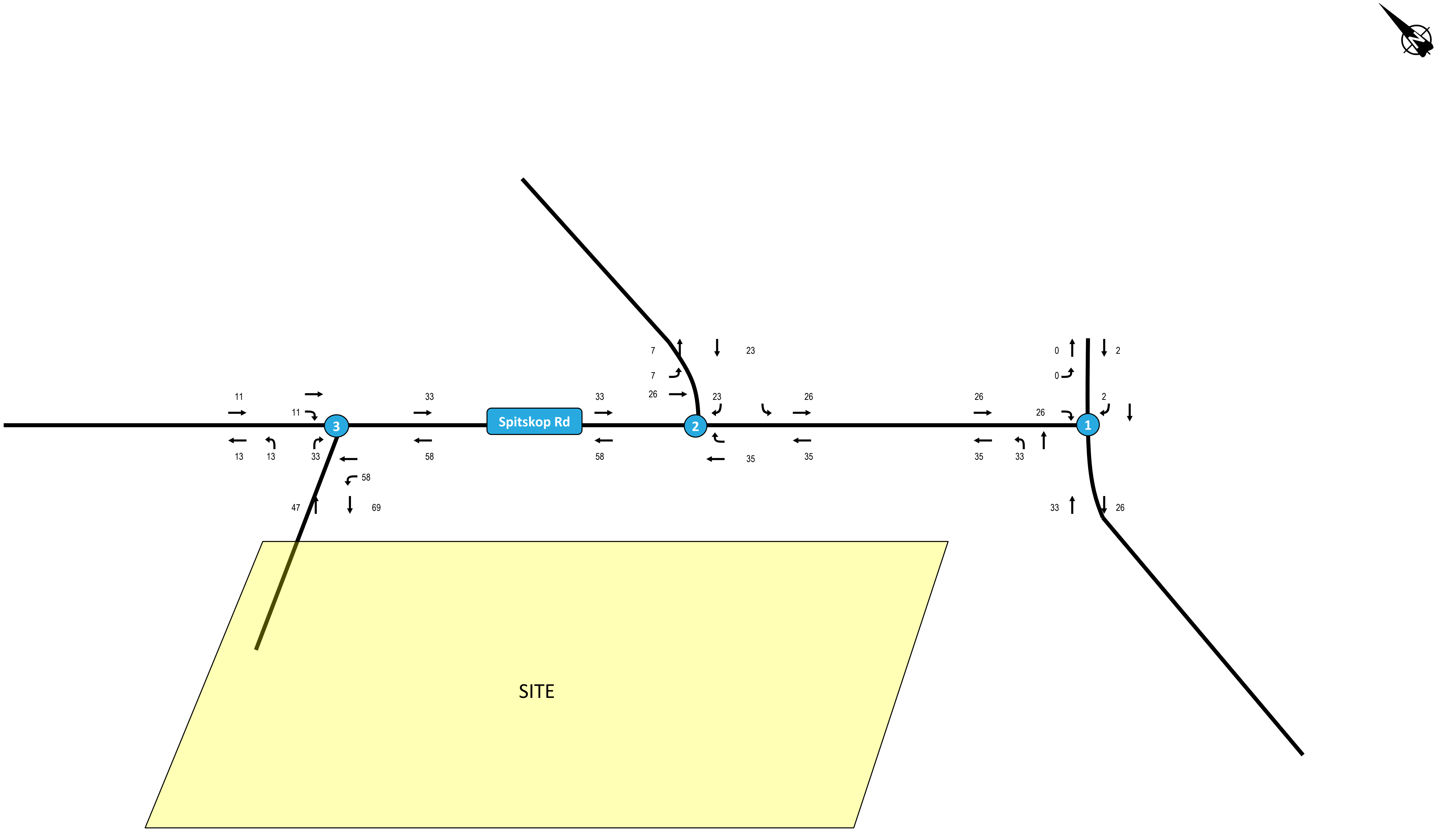


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Paardeplaats Mine Traffic - AM Peak	Fig: 15

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

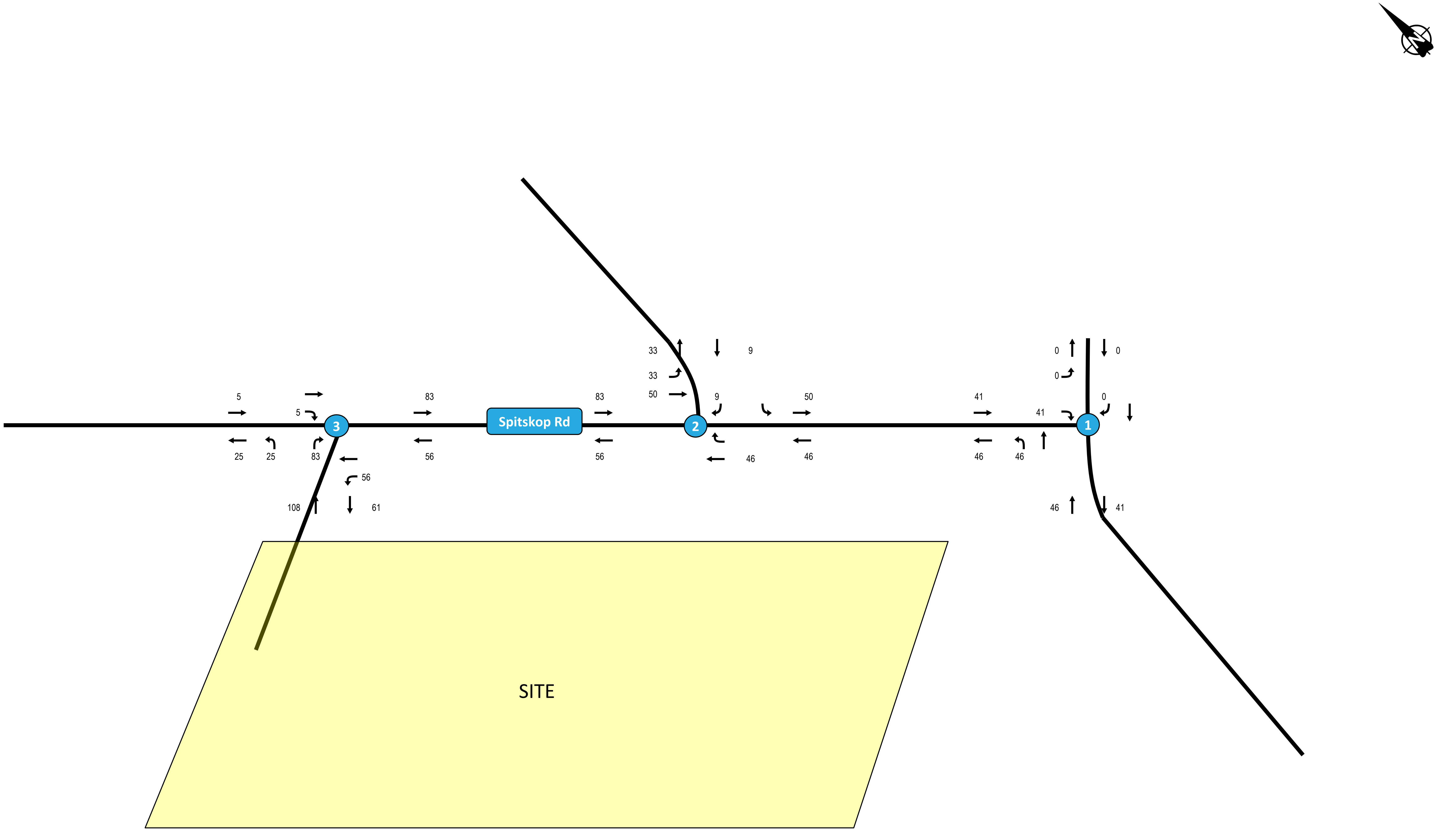


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Paardeplaats Mine Traffic - AM Peak	Fig: **15**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1



WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning

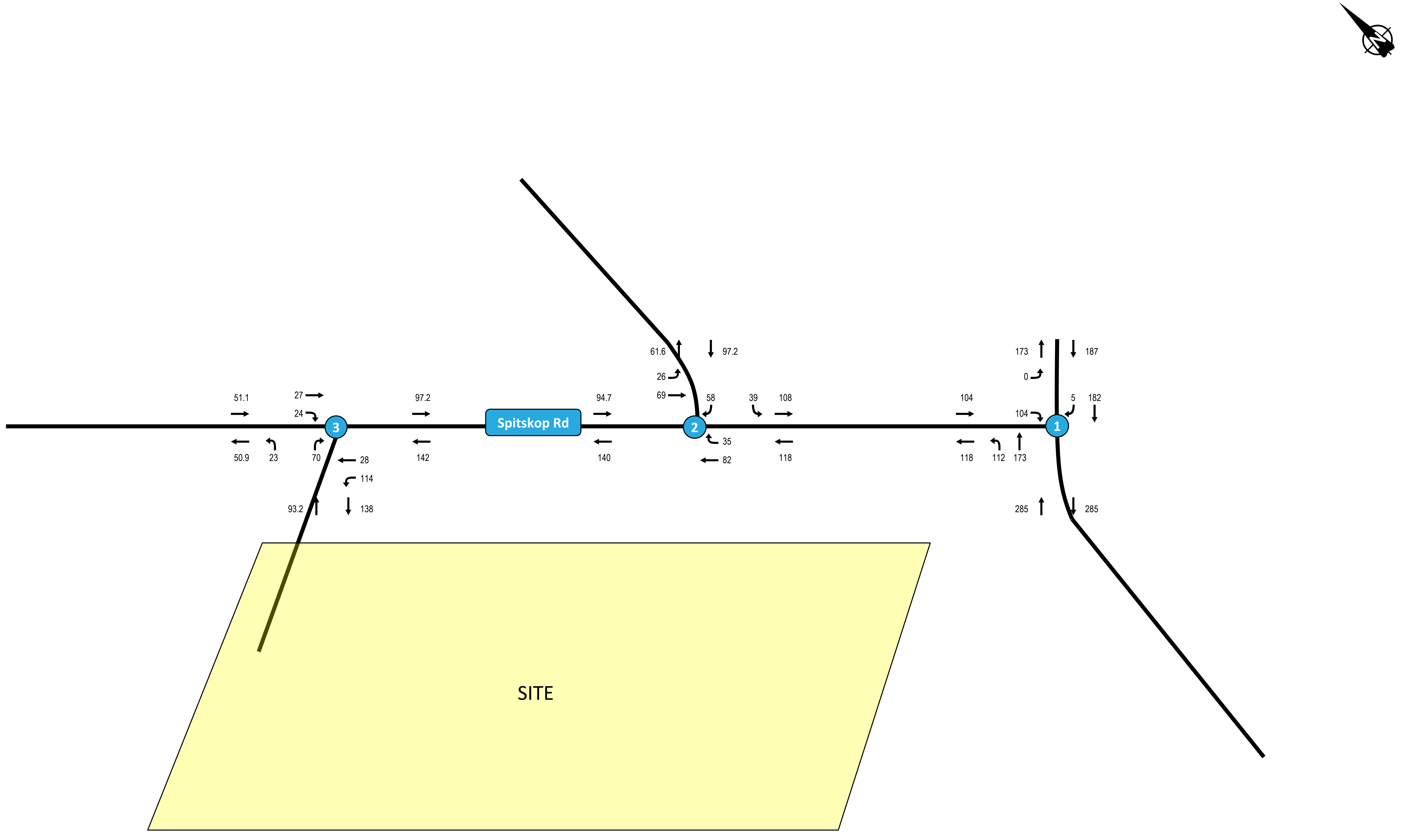
Paardeplaats Exxaro Colliery

Paardeplaats Mine Traffic - PM Peak

Job Ref No: **219268**

Fig: **16**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

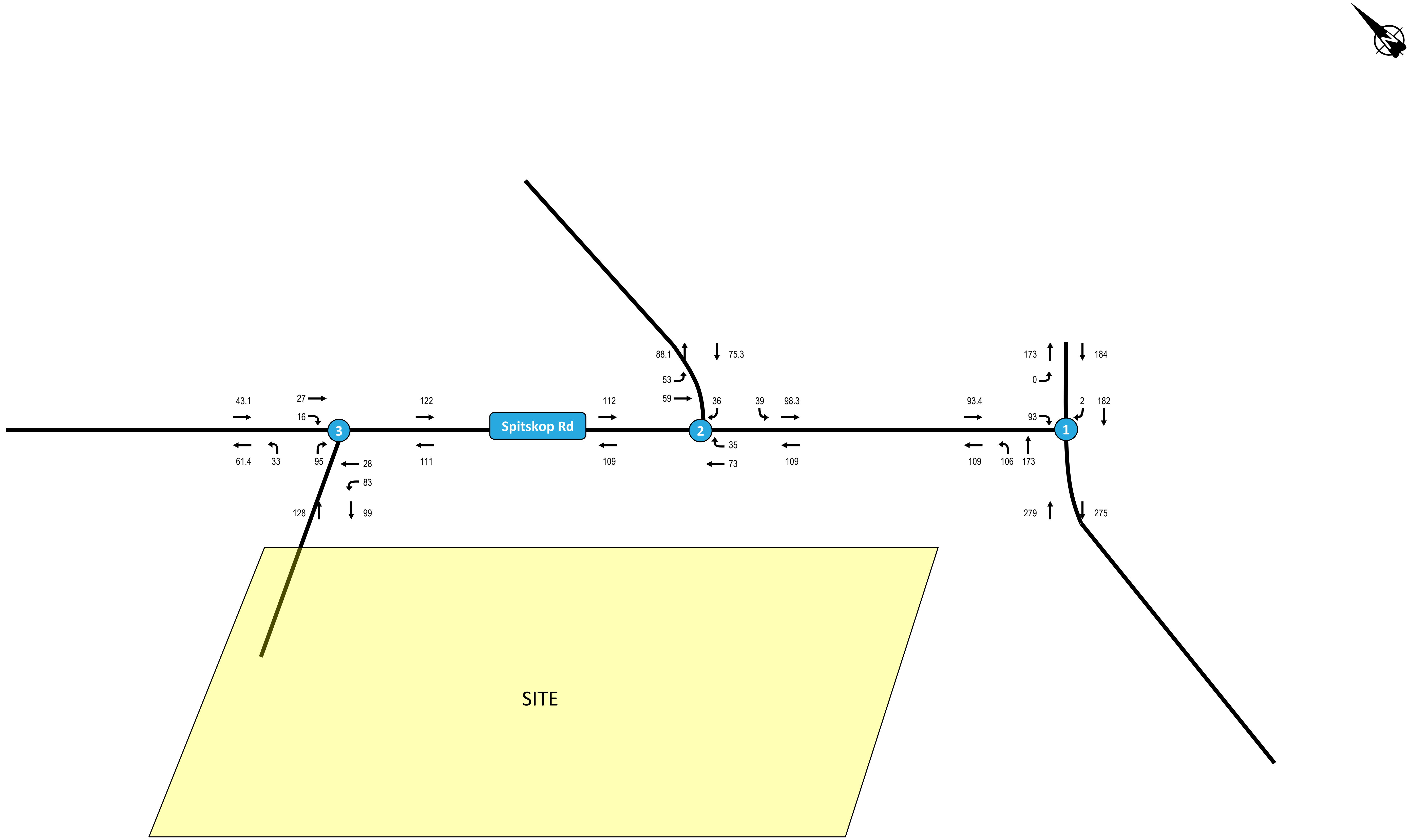


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Total 2022 Traffic - AM Peak	Fig: **17**

TISA FIGURE SHEET:
A3 LANDSCAPE - ROAD NETWORK 1

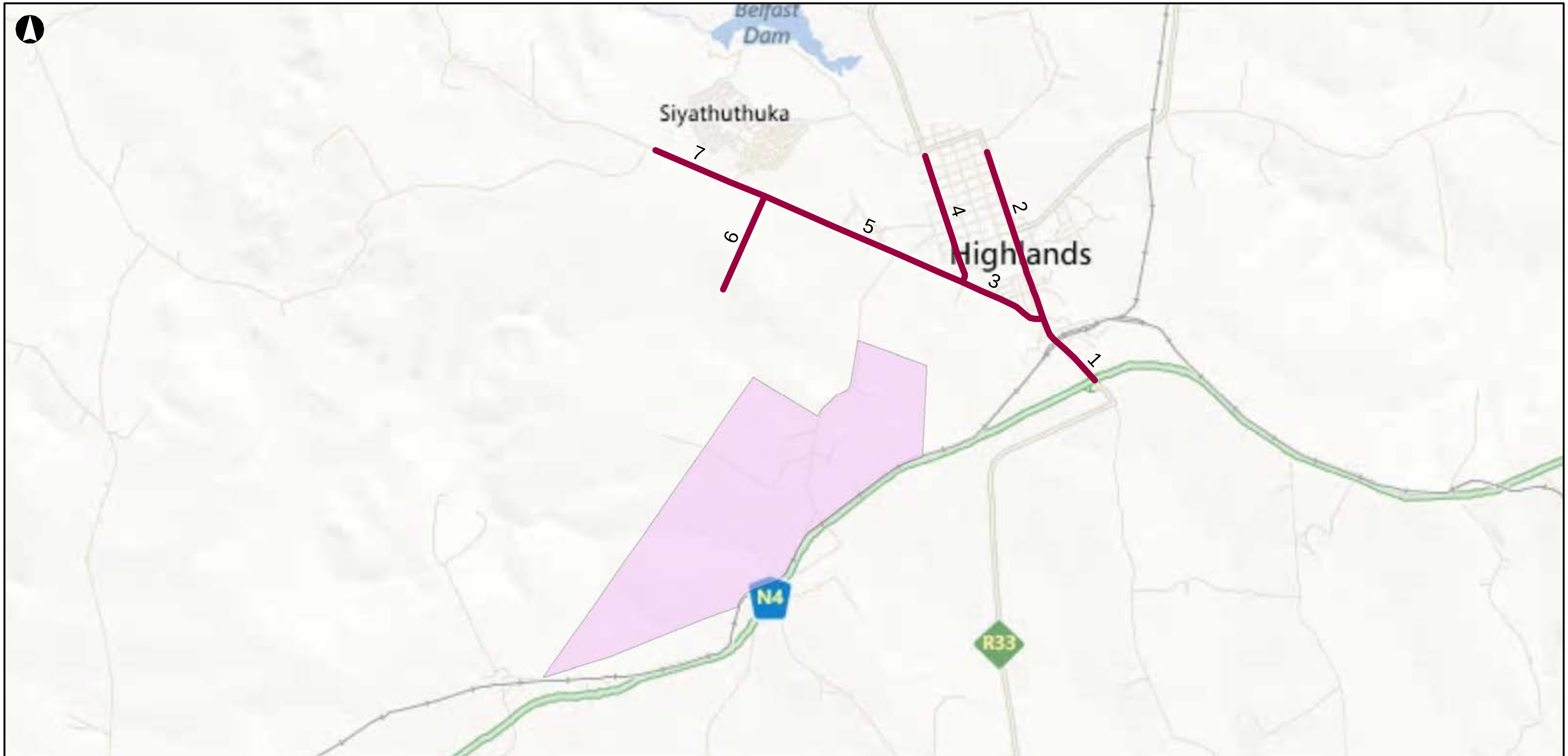


WEEKDAY AM PEAK HOUR

Schematic

ARUP TransportPlanning	Paardeplaats Exxaro Colliery	Job Ref No: 219268
	Total Traffic 2022 - PM Peak	Fig: **18**

A4



Legend

Links

Site

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P1	01-02-08	MM	RM	EP
Issue	Date	By	Chkd	Appd

Metres
0 1,350 2,700 5,400

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Client
Environmental Impact Management Services

Job Title
Exarro Paardeplaats

Links for the Link Analysis

Scale at A4
1:109,388

Job No **219268** | Drawing Status **Preliminary**

Drawing No **Figure 19** | Issue **P1**

MXD Location

Appendix A

Sensitivity Map

Legend

Sensitivity

- Low (Intersections)
- Medium (Bridges and Culverts)
- High (Town/Communities)
- Low (Roads)

Issue	Date	By	Chkd	Appd
P0	2012-10-25	P.S	V.N	A.D

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Client
Exxaro

Job Title
Proposed Mining Application, Paardeplaats Farm, Belfast, Mpumalanga

Sensitivity Map

Scale at A3
1:30 000

Discipline
GIS

Job No
R002

Drawing Status
Preliminary

Drawing No
Plan 1

Issue
P0

Appendix B

Significance Methodology Results

Nature	-1	Negative		
	1	Positive		
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)	CONSEQUENCE	ENVIRONMENTAL RISK
	2	Site (i.e. within the development property boundary),		
	3	Local (i.e. the area within 5 km of the site),		
	4	Regional (i.e. extrends between 5 and 50 km from the site		
	5	Provincial / National (i.e. extends beyond 50 km from the site)		
Duration	1	Immediate (<1 year)		
	2	Short term (1-5 years),		
	3	Medium term (6-15 years),		
	4	Long term (the impact will cease after the operational life span of the project),		
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).		
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),		
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),		
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),		
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or		
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).		
Reversibility	1	Impact is reversible without any time and cost.		
	2	Impact is reversible without incurring significant time and cost.		
	3	Impact is reversible only by incurring significant time and cost.		
	4	Impact is reversible only by incurring prohibitively high time and cost.		
	5	Irreversible Impact		
Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),	PROBABILITY	
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),		
	3	Medium probability (the impact may occur; >50% and <75%),		
	4	High probability (it is most likely that the impact will occur- > 75% probability), or		
	5	Definite (the impact will occur),		
Public feedback	1	Low: issues raised in < 30% of responses	PRIORITISATION FACTOR	
	2	Medium: issue raised in >30% and < 60% of responses		
	3	High: issues raised in >60%		
Cumulative Impact	1	Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikley that the impact will result in spatial and temporal cummulative change.		
	2	Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cummulative change.		
	3	High: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cummulative change.		
Irreplaceble loss of resources	1	Low: Where the impact is unlikely to result in irreplaceable loss of resources.		
	2	Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or subsitituted) of resources but the value (services and/or functions) of these resources is limited.		
	3	High: Where the impact may result in the irreplacable loss of resources of high value (services and/or functions).		
Degree of Confidence	Low	> 60% certain of impact prediction		
	Medium	>30 and < 60% certain of impact prediction		
	High	< 30% certain of impact prediction		

Impact name:	*Impact on Adjacent Road Network*				
Alternative:	*All scenarios, ecxcluding the No-Go, as No-Go means that no additional traffic will be added*				
Description of impact:	*There will be an increase in heavy vehicle traffic on the adjacent road roads*				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	2	2
Extent of Impact	3	3	Reversibility of Impact	1	2
Duration of Impact	4	4	Probability	2	2
Environmental Risk (Pre-mitigation)					**-5**
Environmental Risk (Post-mitigation)					**5.5**
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					1
EIMS WILL COMPLETE					
Cumulative Impacts					1
From a traffic engineering perspective the impact is low. The traffic will added to the existing road network. The environmental damage has already been done with the construction of the road within an existing road reserve, which may also include services and stormwater drainage. The mitigation measure may include road upgrades at the					
Degree of potential irreplaceable loss of resources					1
The loss of resources is negligible as the road network is existing.					
Prioritisation Factor					1
Final Significance					**5.5**

Impact name:	*Impact on Bridges and Culverts*				
Alternative:	*All Scenarios, excluding No-Go as this means that no new traffic will be added to the*				
Description of impact:	*please provide a written description of the impact.*				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	1	Magnitude of Impact	2	2
Extent of Impact	3	3	Reversibility of Impact	1	1
Duration of Impact	2	4	Probability	1	1
Environmental Risk (Pre-mitigation)					**-2**
Environmental Risk (Post-mitigation)					**2.5**
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
EIMS WILL COMPLETE					
Cumulative Impacts					1
The cumulative impact on the bridges and culverts on the adjacent road network will be low. All these are existing structures and should have been design to the correct standards to accommodate heavy vehicles. The report recommended that all culverts and bridges on possible heavy vehicle routes be assessed by a structural engineer and					
Degree of potential irreplaceable loss of resources					1
The impact on resources will be negligible as the culverts and bridges are on existing roads. Therefore any environmental damage has occurred during the construction of the bridges and culverts. There may be some additional impact should remedial works be required to repair or upgrade any bridges and culverts.					
Prioritisation Factor					1
Final Significance					**2.5**

Impact name:	*Impact on Communities*				
Alternative:	*All scenarios, excluding No-Go as this means that no additional traffic will be added to the*				
Description of impact:	*Additional heavy vehicles travelling through communitities or urban areas*				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	3
Extent of Impact	3	3	Reversibility of Impact	2	2
Duration of Impact	4	4	Probability	2	2
Environmental Risk (Pre-mitigation)					**-6**
Environmental Risk (Post-mitigation)					**-6**
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
EIMS WILL COMPLETE					
Cumulative Impacts					1
The addition of heavy vehicle on the road network that pass through local communities and urban areas will have some impact. Many of the these routes all already experience heavy vehicles operating on them. However this impact can be mitigated by the implementation of travel management plan. This will identify appropriate routes that					
Degree of potential irreplaceable loss of resources					1
There will be no loss of resources as the additional heavy vehicles will be operating on existing roads.					
Prioritisation Factor					1
Final Significance					**-6**