APPENDICES

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APPENDIX A

Validation of the TAPM Model and Background PM_{10} Procedure

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A1 VALIDATION OF THE TAPM MODEL

A1.1 Introduction

This appendix clarifies the use of The Air Pollution Model (TAPM) in the generation of site-specific meteorological data.

A1.2 Meteorology and Dispersion Modelling

Air pollutant dispersion models, such as the Ausplume Gaussian Plume Dispersion Model software developed by EPA Victoria, require meteorological data inputs to simulate the potential impacts of pollutants on the nearest receptors. In the past, this has been achieved using observations from the nearest meteorological monitoring station and converting these into a format suitable for dispersion modelling (Martin & Cook, 2002).

However, there are a number of problems inherent in this approach. Upper air parameters such as mixing height are often inaccurately estimated due to the small number of upper air stations in Australia (Martin & Cook, 2002). Additionally, there is often a significant geographical separation between study areas and the nearest meteorological stations, particularly in rural areas.

The Air Pollution Model (TAPM) software, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), is often used simulate the meteorology of an area where insufficient on-site meteorological data is available. TAPM is a prognostic model which may be used to predict three-dimensional meteorological data, with no local data inputs required.

The model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations. TAPM is often used to drive the regulatory Ausplume model where insufficient on-site meteorology data is available.

The TAPM model also allows for the assimilation of wind observations to be optionally included in a model simulation. The wind speed and direction observations are used to “nudge” the predicted solution towards the observation values.

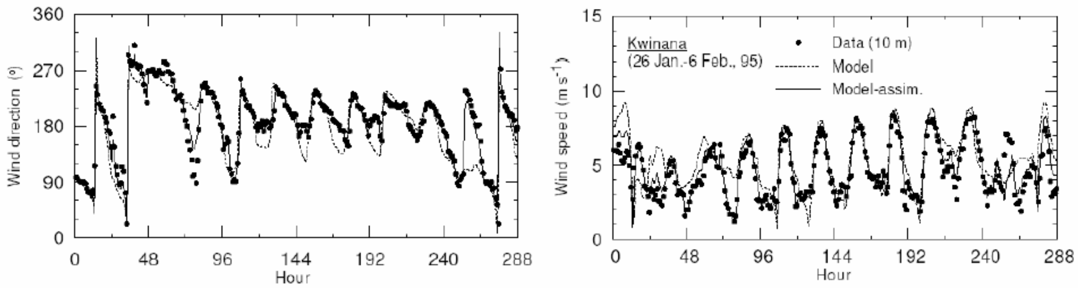
A1.3 TAPM Verification Studies

There exists a number of studies that investigate the effectiveness of the TAPM software in simulating site-specific meteorological data. These verification studies demonstrate that TAPM performs well in a variety of regions throughout Australia and for a range of important phenomena such as convective dispersion (Hurley *et al.*, 2002). A select number of these studies are detailed below:

- The TAPM software was used to simulate the meteorology in Melbourne for winter (July 1998) and summer (December 1998). These predictions were compared with observational data measured as part of the EPA Victoria air quality monitoring. The results of this comparison indicate that TAPM predicts both winds and temperature very well, with no significant biases (Hurley *et al.*, 2002).

- The effectiveness of TAPM in estimating annual urban meteorology was assessed by comparing a TAPM-simulated data set for Perth with meteorological observations. An analysis of ambient temperature, wind speed and wind direction demonstrates that the meteorology of Perth was well-simulated by the TAPM software throughout the year (Hurley *et al*., 2002).
- A comparison of observed and predicted meteorology was undertaken for Kwinana, a coastal industrial region south of Perth, Western Australia. A comparison of these data sets indicates that TAPM simulates the meteorology of the area well, particularly with respect to wind speed and wind direction (Luhar & Hurley, 2002). **Figure A** demonstrates the comparison of observed results with TAPM predictions for these parameters.

Figure A1 Hourly Average Wind Speed and Wind Direction (Observed and TAPM-Generated) at Kwinana, WA (Source: Luhar & Hurley, 2002)



- TAPM predictions of wind speed, wind direction, temperature and relative humidity were compared with observational data for the Pilbara region, WA. The comparison indicates that there is a strong correlation between predicted and observed results at this site, demonstrating that TAPM-generated meteorology is a useful tool in dispersion modelling (Hurley *et al.,* 2003).

A1.4 References

- Hurley P.J., Physick W.L. & Luhar A.K. (2002) *The Air Pollution Model (TAPM) Version 2. Part 2: Summary of Some Verification Studies.* CSIRO Atmospheric Research Technical Paper No.57.
- Hurley P.J., Physick W.L., Cope M., Borgas M. & Brace P. (2003) An evaluation of TAPM for photochemical smog applications in the Pilbara region of WA. *17th International Clean Air and Environment Conference of the Clean Air Society of Australia & New Zealand, 23 - 27 November 2003, Conference Proceedings.*
- Luhar A.K. & Hurley P.J. (2002) Evaluation of TAPM using the Indianapolis (urban) and Kwinana (coastal) field data sets. 16th International Clean Air and Environment Conference of the Clean Air Society of Australia & New Zealand, 19 - 22 August 2002, Conference Proceedings.
- Martin A.P. & Cook B.J. (2002) Modelling of meteorological events using observations, TAPM and CALMET. 16th International Clean Air and Environment Conference of the Clean Air Society of Australia & New Zealand, 19 - 22 August 2002, Conference Proceedings.

A2 BACKGROUND PM_{10} PROCEDURE

A2.1 Introduction

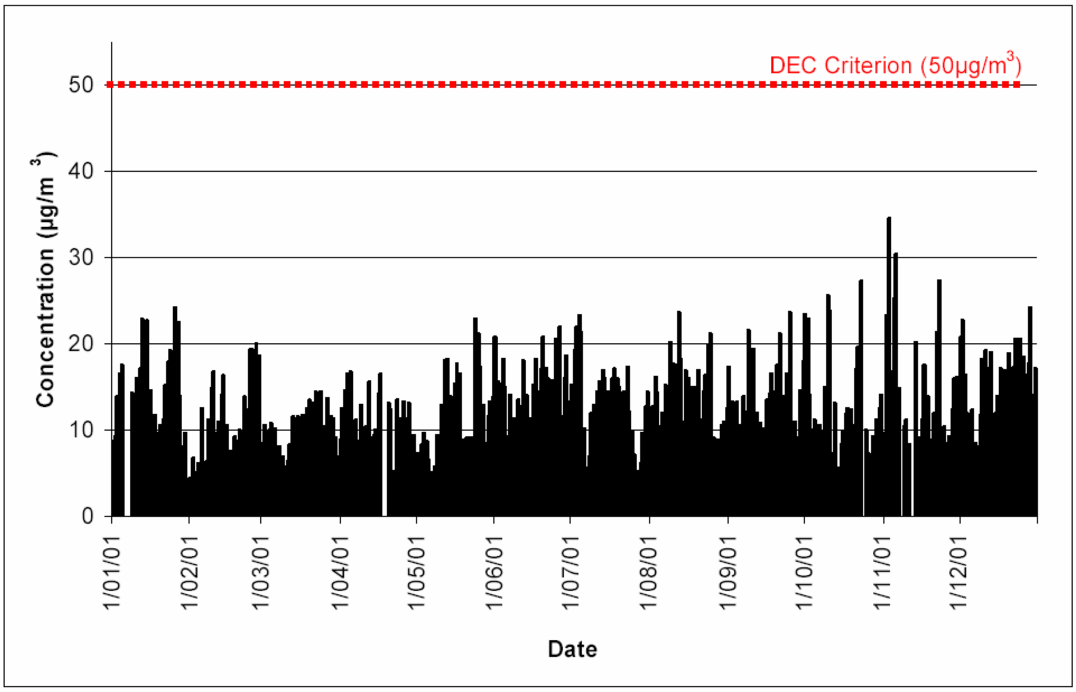
The following explanation is intended to clarify the application of 24-hour average PM_{10} data within the Ausplume atmospheric dispersion modelling presented within this assessment.

All modelling within the assessment has been conducted in accordance with the NSW DEC document *"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW"* ("the DEC Approved Methods").

A2.2 Background PM_{10} for Modelling Purposes

Ambient concentrations of PM_{10} were assessed using DEC air quality monitoring data. An example of a verified data set showing 24-hour average PM_{10} concentrations at a DEC monitoring site is presented in **Figure A2**.

Figure A2 Example of DEC PM_{10} (24-hour average) Monitoring Results



Section 5.2 of the DEC Approved Methods states that for Level 2 assessments, ambient monitoring data for at least one year of continuous measurements contemporaneous with the meteorological data should be used in dispersion modelling. This has been achieved by using daily varying background data, coupled with a meteorological input file for the same period.

A2.3 24-Hour Average PM_{10} Ausplume Predictions

The protocol contained within Section 5.2 of the DEC Approved Methods, prescribes the following for Level 2 Assessments.

> *At the maximum exposed off-site receptor, add the maximum background concentration and the 100th percentile dispersion model prediction to obtain the total impact, for each averaging period.*

PM_{10} concentrations (background + increment) recorded at a given residence for all 24-hour periods over a calendar year are presented in **Figure A3** and **Figure A4**. These figures present the results from two example operational scenarios. Background concentrations are taken directly from those displayed in **Figure A2** above.

Figure A3 Example of Background + Incremental PM_{10} (24-hour average) Concentrations at a Given Residence - Operational Scenario A

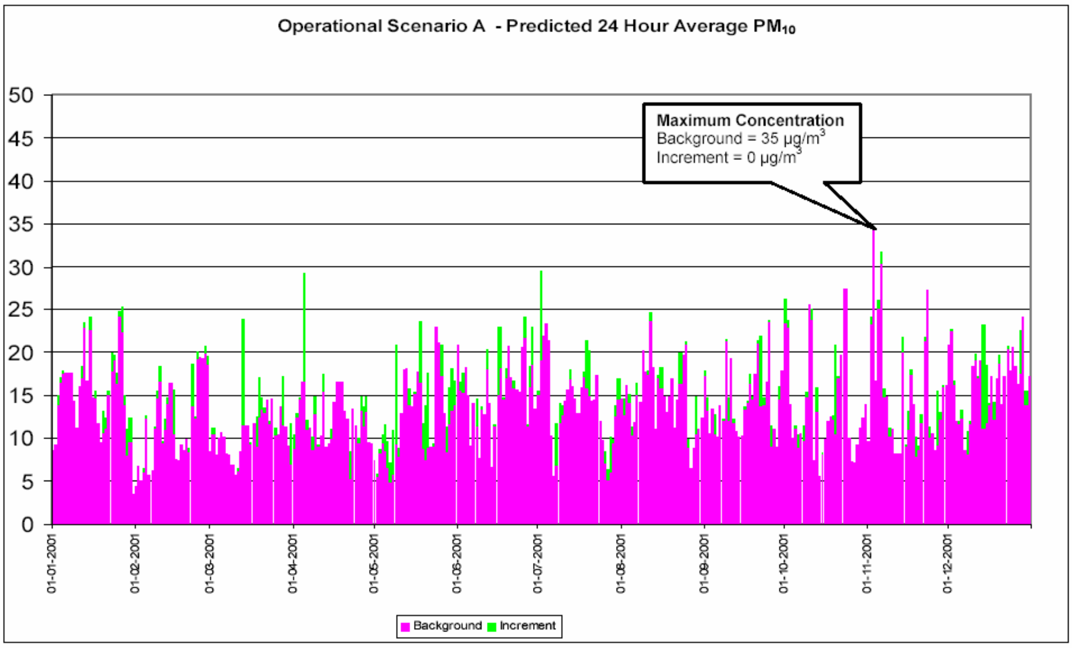


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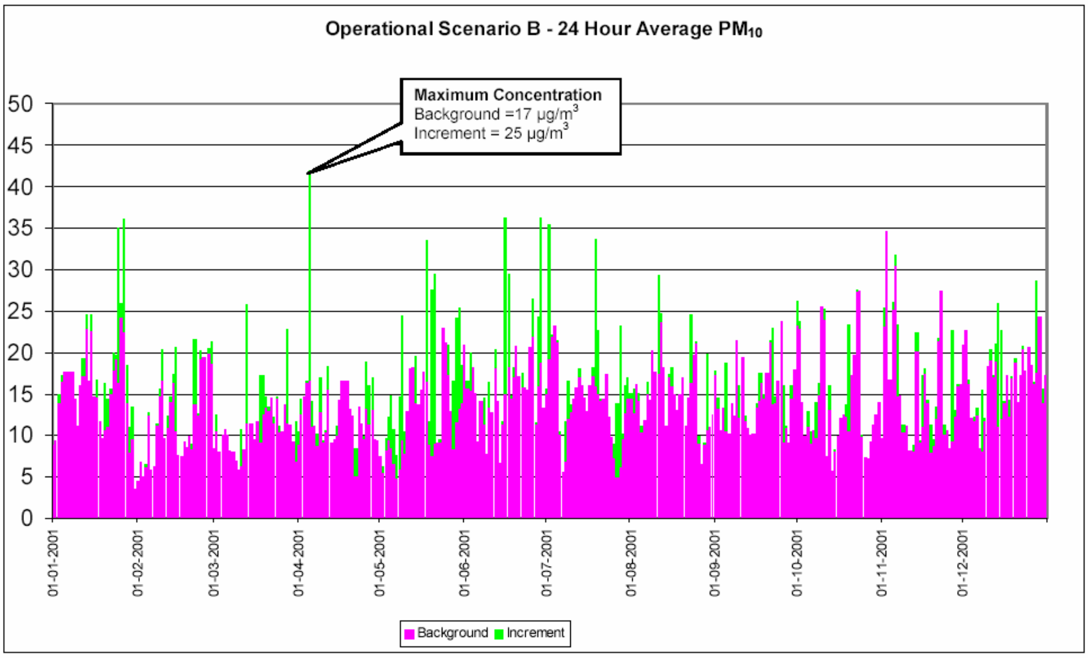
Figure A4 Example of Background + Incremental PM_{10} (24-hour average) Concentrations at a Given Residence – Operational Scenario B



It can be seen from the above Figures that the maximum predicted 24-hour concentration at a given residence (Background + Increment) for Operational Scenario A occurs when the background is 35µg/m^3, and the increment is 0µg/m^3.

The maximum predicted 24-hour concentration at the same residence (Background + Increment) for Operational Scenario B occurs when the background is 17µg/m^3, and the increment is 25µg/m^3.

It is noted that in Operational Scenario B, on the 3rd November, the PM_{10} concentration (at the nominated residence) produces a background of 35µg/m^3, and an increment of 0µg/m^3, as per the Operational Scenario A maximum value. However, as this is below the maximum predicted 24-hour concentration (Background + Increment) for the scenario year, it is not recorded as the maximum.

The implication, therefore, is that the meteorology on 3rd November was not conducive to high incremental PM_{10} concentrations recorded at surrounding residences.

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APPENDIX B

Annual and Seasonal Wind Roses for the Project Site

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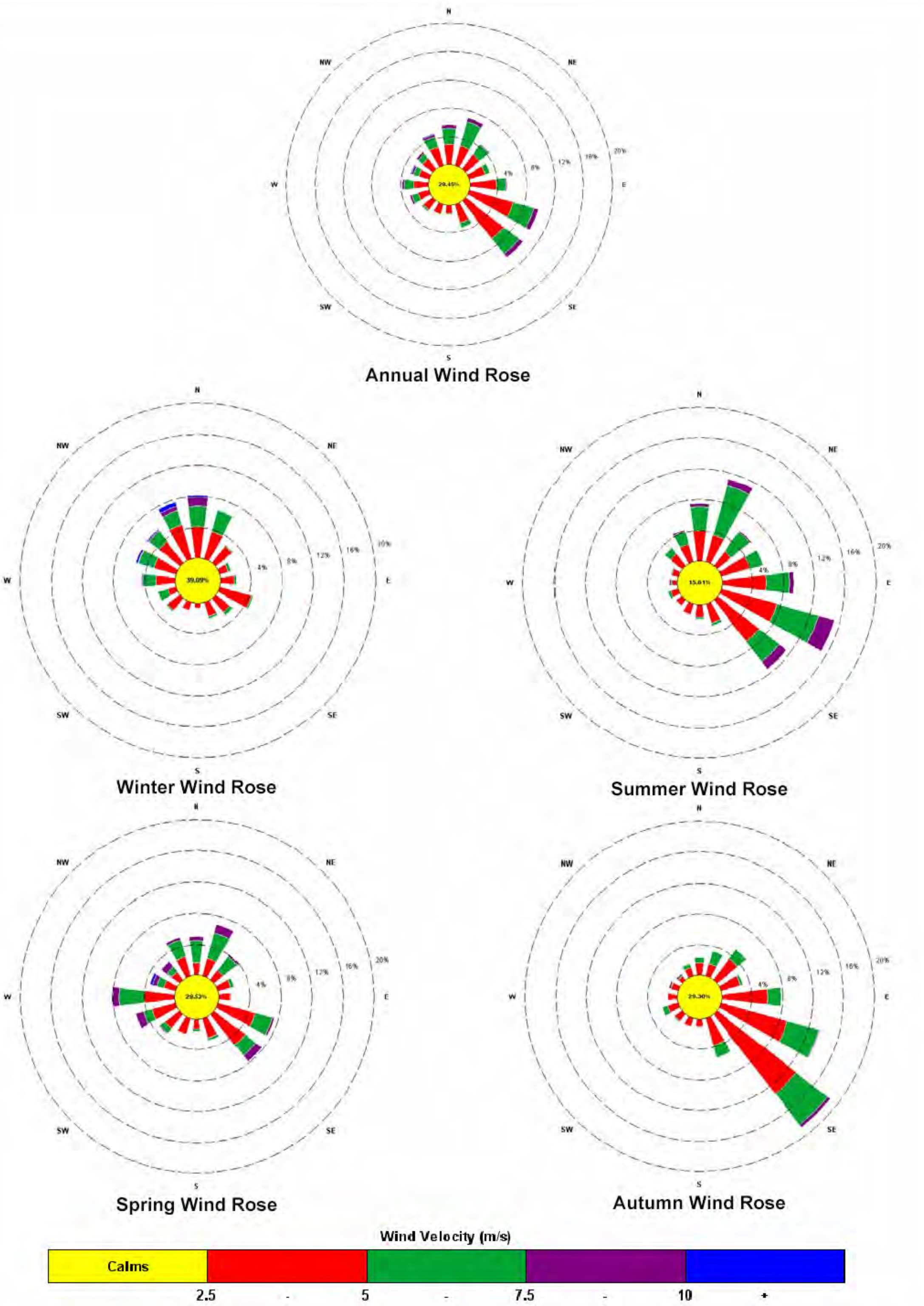

Richard Heggie Associates Pty Ltd Consulting Engineers Level 2, 2 Lincoln Street Lane Cove NSW 2066 Australia PO Box 176 Lane Cove NSW 1595 Telephone +612 9427 8100 Facsimile +612 9427 8200 Email Sydney@heggies.com.au	Designed by DP	Checked by DR	Approved by - date DR – 07/07/05	Filename 10-3655R2	Dated 07/07/05	Quality System Quality Endorsed Company ISO 9001 Lic 3236 Standards Australia
	Title Appendix B – Seasonal Wind Roses for the Proposed East Boggabri Coal Mine Project Site					

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APPENDIX C

Seasonal Stability Classes for the Project Site

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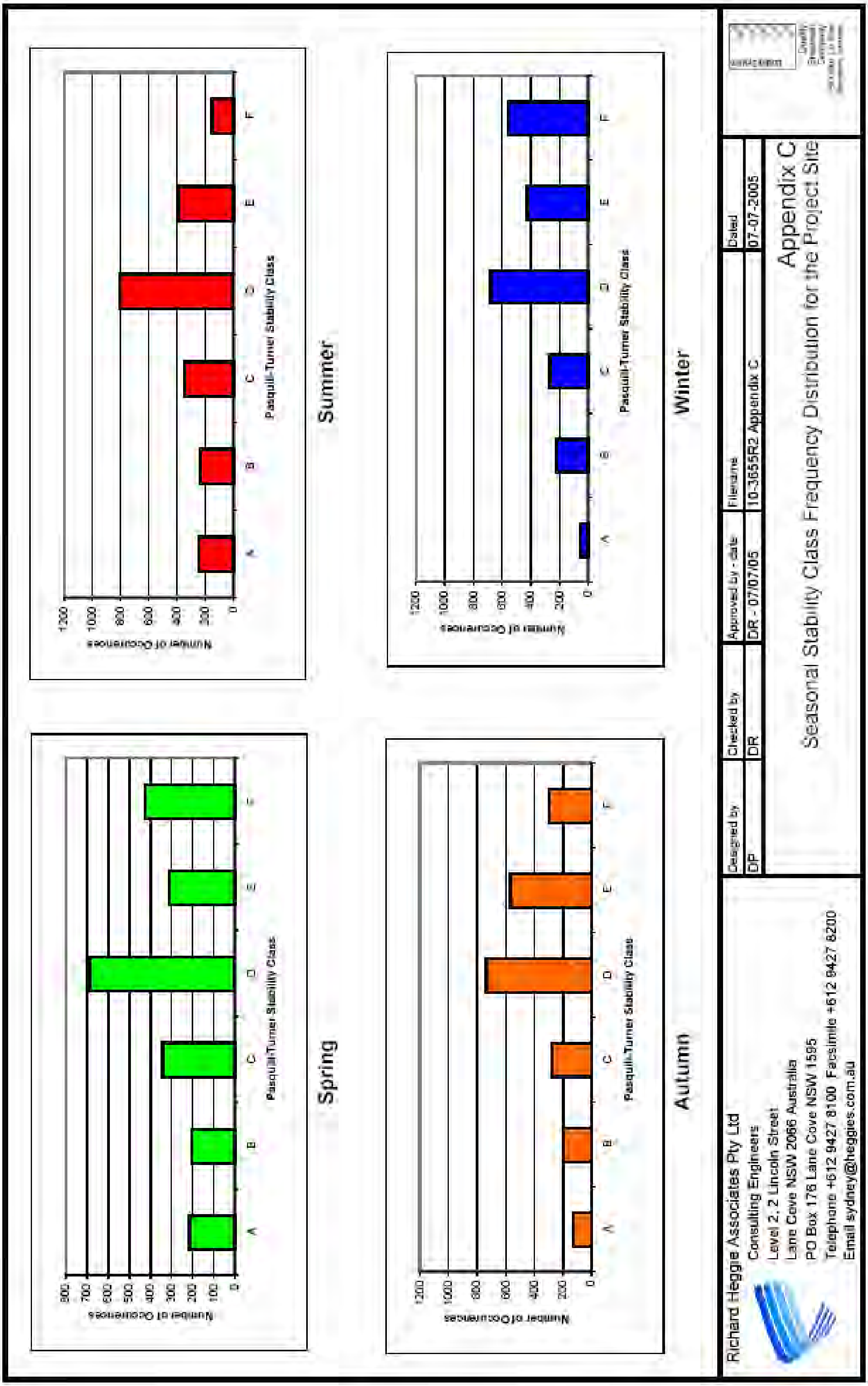
Summer
Winter
Spring
Autumn
Number of Occurrences
Pasquill-Turner Stability Class
A
B
C
D
E
F
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Approved by - date
DR - 07/07/05
Filename
10-3655R2 Appendix C
Dated
07-07-2005
Appendix C
Seasonal Stability Class Frequency Distribution for the Project Site

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APPENDIX D

Atmospheric Emissions Inventory

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Proposed East Boggabri Coal Mine - Year 2	Total Particulate Emission Factor	PM_{10} Emission Factor	Emission Factor Units	Throughput (tonnes per hour)	Number of Hectares of stockpile	Average number of kilometres per return trip	Working days available	Working Hours Per Day	Total Particulate Emission Rate (mg/s)	PM_{10} Emission Rate (mg/s)	Total Particulate Emission Flux (mg/s/m²)	PM_{10} Emission Flux (mg/s/m²)	Easting	Northing	width	length	height
1. Excavation																	
Blasting	102.1	53.1	kg/blast	N/A	N/A	N/A	72	1	2797	14011	0.466	2.3352	228001	6607679	50	120	-25
Excavator A - Hitachi EX3600 (overburden / interburden)	0.000	0.00014	kg/t	3949.45	N/A	N/A	275	24	120	143	N/A	N/A	228058	6607848	3	5	4
Excavator B - Hitachi EX1900 (coal excavation)	0.030	0.0098	kg/t	244	N/A	N/A	275	24	769	620	N/A	N/A	227942	6607649	3	5	4
Dozer A - Cat D11R (prime overburden movement, ancillaries)	0.55	0.09	kg/hr	N/A	N/A	N/A	275	24	58	23	N/A	N/A	227988	6607836	4	4	2
Dozer B - Cat D11R (prime overburden movement, ancillaries)	0.55	0.09	kg/hr	N/A	N/A	N/A	275	24	58	23	N/A	N/A	228031	6607808	4	4	2
Dozer C - Cat D10R (ancillaries)	0.55	0.09	kg/hr	N/A	N/A	N/A	275	16	77	24	N/A	N/A	227877	6607690	4	4	2
Grader - Cat 16H (ancillaries)	0.524	0.191	kg/VKT	N/A	N/A	7.5	275	14	480	379	N/A	N/A	227874	6607528	3	10	1
Scraper A (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	228140	6607854	6	10	1
Scraper B (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	228088	6608029	6	10	1
Scraper C (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	227741	6607722	6	10	1
Scraper D (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	228129	6607400	6	10	1
Open Pit Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	23.27	N/A	N/A	N/A	N/A	N/A	0.0028	0.0026	227958	6607497	420	550	40
Topsoil Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.43	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227467	6607108	50	86	3
Subsoil Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.77	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	226952	6607381	77	100	3
Northern Out-of-pit Emplacement Area Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	3.58	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227393	6607453	200	179	60
Northern Out-of-pit Overburden Emplacement	0.0003	0.0001	kg/t	418	N/A	N/A	275	24	25	16	N/A	N/A	227288	6608219	2	4	4
In-pit Overburden Emplacement	0.0003	0.0001	kg/t	2979	N/A	N/A	275	24	84	108	N/A	N/A	227946	6607845	2	4	4

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Appendix D. Atmospheric Emissions Inventory

Proposed East Boggabri Coal Mine - Year 2 (Cont.)	Total Particulate Emission Factor	PM_{10} Emission Factor	Emission Factor Units	Throughput (tonnes per hour)	Number of Hectares of stockpile	Average number of kilometres per return trip	Working days available	Working Hours Per Day	Total Particulate Emission Rate (mg/s)	PM_{10} Emission Rate (mg/s)	Total Particulate Emission Flux (mg/s/m²)	PM_{10} Emission Flux (mg/s/m²)	Easting	Northing	width	length	height
1. Excavation (Cont.)																	
Haul Truck Generated Wheel Dust A (open pit area to northern out-of-pit emplacement area)	0.623	0.172	kg/VKT	N/A	N/A	23.7	275	24	773	270	N/A	N/A	227584	6607747	2	4	4
Haul Truck Generated Wheel Dust B (open pit area to in-pit emplacement area)	0.623	0.172	kg/VKT	N/A	N/A	18.0	275	24	586	205	N/A	N/A	227935	6607776	2	4	4
Haul Truck Generated Wheel Dust C (open pit to ROM processing area)	0.623	0.172	kg/VKT	N/A	N/A	10.5	275	24	343	120	N/A	N/A	227774	6607456	2	4	4
Drill (overburden / interburden drilling)	0.59	0.31	kg/hole	N/A	N/A	N/A	275	14	144	N/A	N/A	N/A	227968	6607709	2	4	2
2. Crushing / Processing / Dispatch																	
ROM Coal Emplacement by Trucks	0.010	0.0042	kg/t	390	N/A	N/A	275	15	817	137	N/A	N/A	227551	6607397	2	4	4
ROM Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	1.26	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227499	6607380	126	100	5
Front end loader loading coal into feeder	0.030	0.0096	kg/t	390	N/A	N/A	275	15	2460	1045	N/A	N/A	227575	6607398	2	4	2
Primary crusher - Stamler MVT 800-1500	0.010	0.0040	kg/t	390	N/A	N/A	275	15	817	217	N/A	N/A	227648	6607372	1	1	6
Secondary Crusher - Stamler MVT 600-1500	0.030	0.0120	kg/t	254	N/A	N/A	275	15	1593	423	N/A	N/A	227670	6607353	2	2	4
Handling,transfer and conveying	0.0005	0.0002	kg/t	390	N/A	N/A	275	15	39	2	N/A	N/A	227680	6607343	3	85	8
Clean Bypass Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.36	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227741	6607331	34	34	5
Dirty Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.36	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227741	6607287	34	34	5
Dirty, Dirty Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.36	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227692	6607277	34	34	5
Product Bin loading to trucks	0.0004	0.00017	kg/t	390	N/A	N/A	275	15	33	2	N/A	N/A	227714	6607308	7	7	26

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Appendix D. Atmospheric Emissions Inventory

Proposed East Boggabri Coal Mine - Year 8	Total Particulate Emission Factor	PM_{10} Emission Factor	Emission Factor Units	Throughput (tonnes per hour)	Number of Hectares of stockpile	Average number of kilometres per return trip	Working days available	Working Hours Per Day	Total Particulate Emission Rate (mg/s)	PM_{10} Emission Rate (mg/s)	Total Particulate Emission Flux ($mg/s/m^2$)	PM_{10} Emission Flux ($mg/s/m^2$)	Easting	Northing	width	length	height
1. Excavation																	
Blasting	102.1	53.1	kg/blast	N/A	N/A	N/A	72	1	2797	14011	0.4662	2.3352	229119	6607098	50	120	-25
Excavator A - Hitachi EX3600 (overburden/interburden excavation)	0.000	0.00014	kg/t	4302.18	N/A	N/A	275	24	131	156	N/A	N/A	229054	6607266	3	5	4
Excavator B - Hitachi EX1900 (coal excavation)	0.030	0.0096	kg/t	238	N/A	N/A	275	24	751	607	N/A	N/A	229242	6607059	3	5	4
Dozer A - Cat D11R (prime overburden movement, ancillaries)	0.55	0.09	kg/hr	N/A	N/A	N/A	275	24	58	23	N/A	N/A	228986	6607264	4	4	2
Dozer B - Cat D11R (prime overburden movement, ancillaries)	0.55	0.09	kg/hr	N/A	N/A	N/A	275	24	58	23	N/A	N/A	229088	6607202	4	4	2
Dozer C - Cat D10R (ancillaries)	0.55	0.09	kg/hr	N/A	N/A	N/A	275	16	77	24	N/A	N/A	229230	6606996	4	4	2
Grader - Cat 16H (ancillaries)	0.524	0.191	kg/VKT	N/A	N/A	7.5	275	14	480	379	N/A	N/A	228859	6606928	3	10	1
Scraper A (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	228889	6607279	6	10	1
Scraper B (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	229144	6607286	6	10	1
Scraper C (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	229116	6607022	6	10	1
Scraper D (topsoil and subsoil clearing)	0.302	0.084	kg/VKT	N/A	N/A	7.5	275	14	277	175	N/A	N/A	229305	6607077	6	10	1
Open Pit Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	17.51	N/A	N/A	N/A	N/A	N/A	0.0028	0.0026	229223	6607056	438	400	100
Topsoil Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.30	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	228452	6606124	46	65	3
Subsoil Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.60	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	229314	6606058	80	75	3
Southern Out-of-pit Emplacement Area Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	5.66	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	229381	6606347	250	200	60
Southern Out-of-pit Overburden Emplacement	0.0003	0.0001	kg/t	681	N/A	N/A	275	24	41	26	N/A	N/A	228438	6606882	2	4	4
In-pit Overburden Emplacement	0.0003	0.0001	kg/t	3019	N/A	N/A	275	24	85	109	N/A	N/A	229123	6607247	2	4	4

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Appendix D. Atmospheric Emissions Inventory

Proposed East Boggabri Coal Mine - Year 8 (Cont.)	Total Particulate Emission Factor	PM_{10} Emission Factor	Emission Factor Units	Throughput (tonnes per hour)	Number of Hectares of stockpile	Average number of kilometres per return trip	Working days available	Working Hours Per Day	Total Particulate Emission Rate (mg/s)	PM_{10} Emission Rate (mg/s)	Total Particulate Emission Flux (mg/s/m²)	PM_{10} Emission Flux (mg/s/m²)	Easting	Northing	width	length	height
1. Excavation (Cont.)																	
Haul Truck Generated Wheel Dust A (open pit area to southern out-of-pit emplacement area)	0.623	0.172	kg/VKT	N/A	N/A	26.4	275	24	860	300	N/A	N/A	228770	6606867	2	4	4
Haul Truck Generated Wheel Dust B (open pit area to in-pit emplacement area)	0.623	0.172	kg/VKT	N/A	N/A	13.6	275	24	442	154	N/A	N/A	229117	6607195	2	4	4
Haul Truck Generated Wheel Dust C (open pit to ROM processing area) A	0.623	0.172	kg/VKT	N/A	N/A	12.0	275	24	196	137	N/A	N/A	228619	6606925	2	4	4
Haul Truck Generated Wheel Dust D (open pit to ROM processing area) B	0.623	0.172	kg/VKT	N/A	N/A	24.0	275	24	392	137	N/A	N/A	228056	6607204	2	4	4
Drill (overburden/interburden drilling)	0.59	0.31	kg/hole	N/A	N/A	N/A	275	14	144	N/A	N/A	N/A	229058	6607152	2	4	2
2. Crushing / Processing / Dispatch																	
ROM Coal Emplacement by Trucks	0.010	0.0042	kg/t	382	N/A	N/A	275	15	799	134	N/A	N/A	227551	6607397	2	4	4
ROM Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	1.26	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227499	6607380	126	100	5
Front end loader loading coal into feeder	0.030	0.0096	kg/t	382	N/A	N/A	275	15	2405	1022	N/A	N/A	227575	6607398	2	4	2
Primary crusher - Stamler MVT 800-1500	0.010	0.0040	kg/t	382	N/A	N/A	275	15	799	212	N/A	N/A	227648	6607372	1	1	6
Secondary Crusher - Stamler MVT 600-1500	0.030	0.0120	kg/t	248	N/A	N/A	275	15	1557	413	N/A	N/A	227670	6607353	2	2	4
Handling,transfer and conveying	0.0005	0.0002	kg/t	382	N/A	N/A	275	15	38	2	N/A	N/A	227680	6607343	3	85	8
Clean Bypass Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.36	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227741	6607331	34	34	5
Dirty Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.36	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227741	6607287	34	34	5
Dirty, Dirty Coal Stockpile Wind Erosion	0.40	0.2000	kg/ha/hr	N/A	0.36	N/A	N/A	N/A	N/A	N/A	0.0056	0.0028	227692	6607277	34	34	5
Product Bin loading to trucks	0.0004	0.00017	kg/t	382	N/A	N/A	275	15	32	2	N/A	N/A	227714	6607308	7	7	26

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Designed by: DP | Checked by: DR | Approved by – date: 07/07/05 | Filename: 10-3565R2 Appendix D | Dated: 07/07/05

Appendix D. Atmospheric Emissions Inventory

APPENDIX E

Predicted Average Monthly Dust Deposition Contours

(No. of pages excluding this page = 2)

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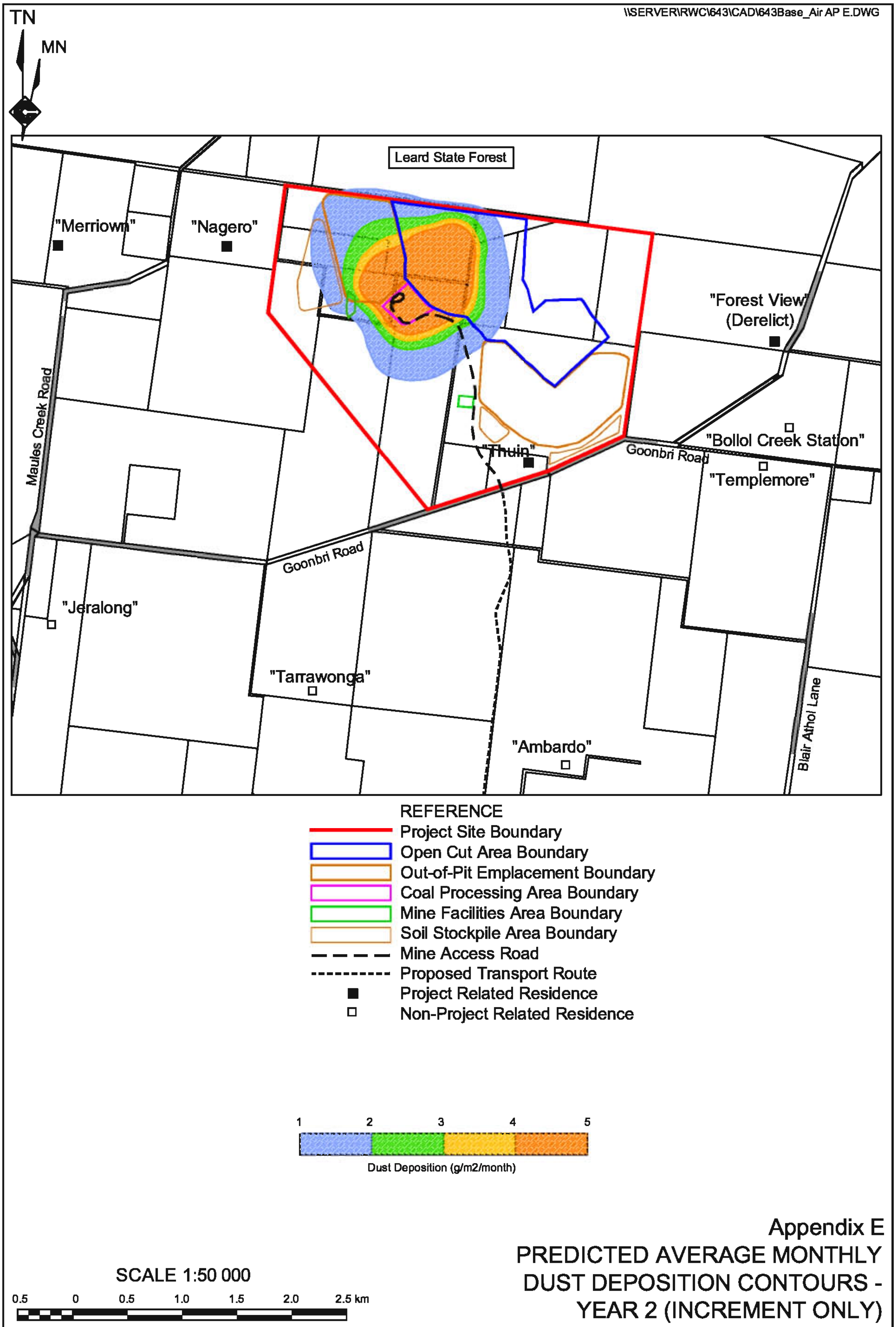
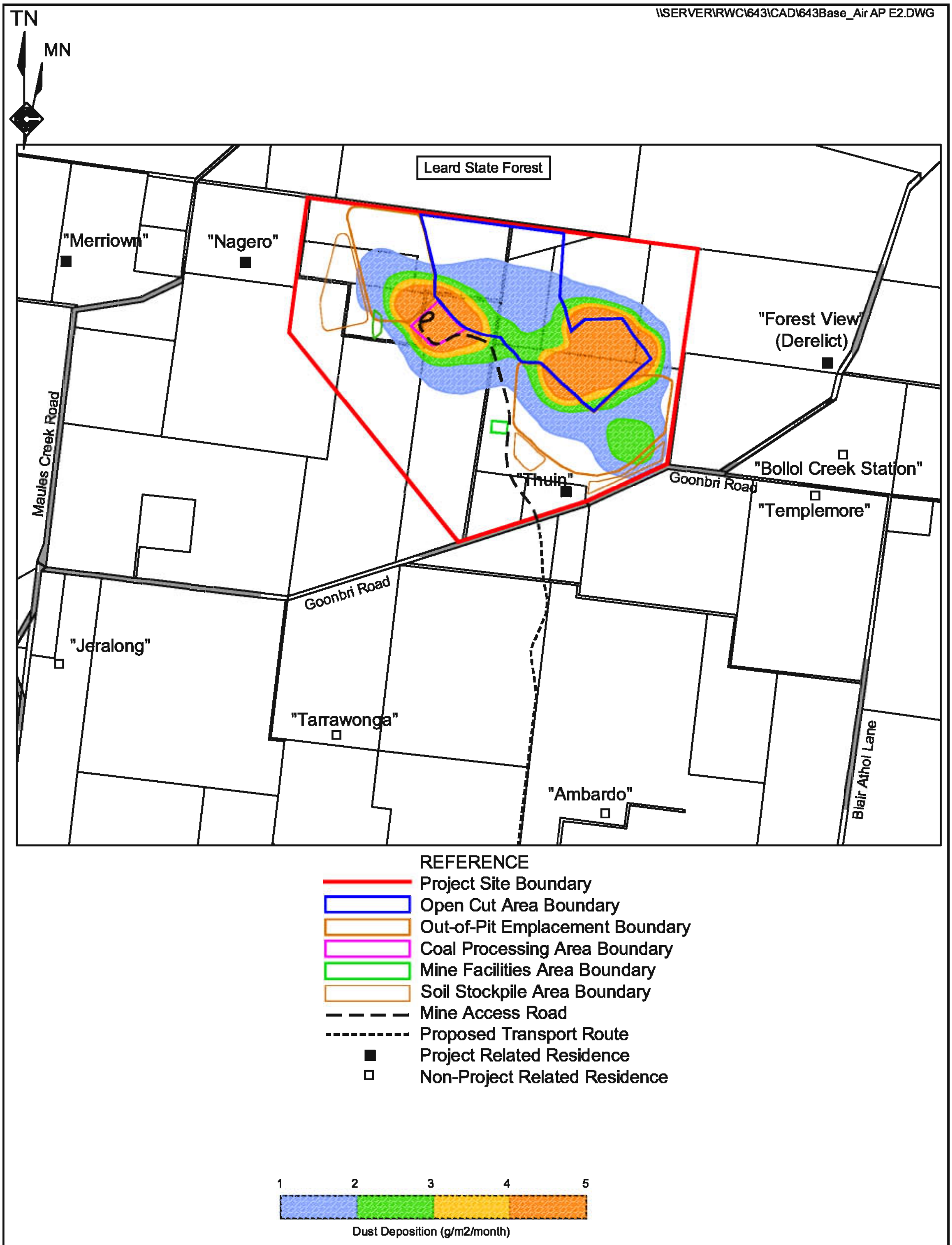


Appendix E
PREDICTED AVERAGE MONTHLY DUST DEPOSITION CONTOURS - YEAR 2 (INCREMENT ONLY)



SCALE 1:50 000

0.5 0 0.5 1.0 1.5 2.0 2.5 km

Appendix E
PREDICTED AVERAGE MONTHLY
DUST DEPOSITION CONTOURS -
YEAR 8 (INCREMENT ONLY)

APPENDIX F

Predicted 24-Hour Average PM_{10} Contours

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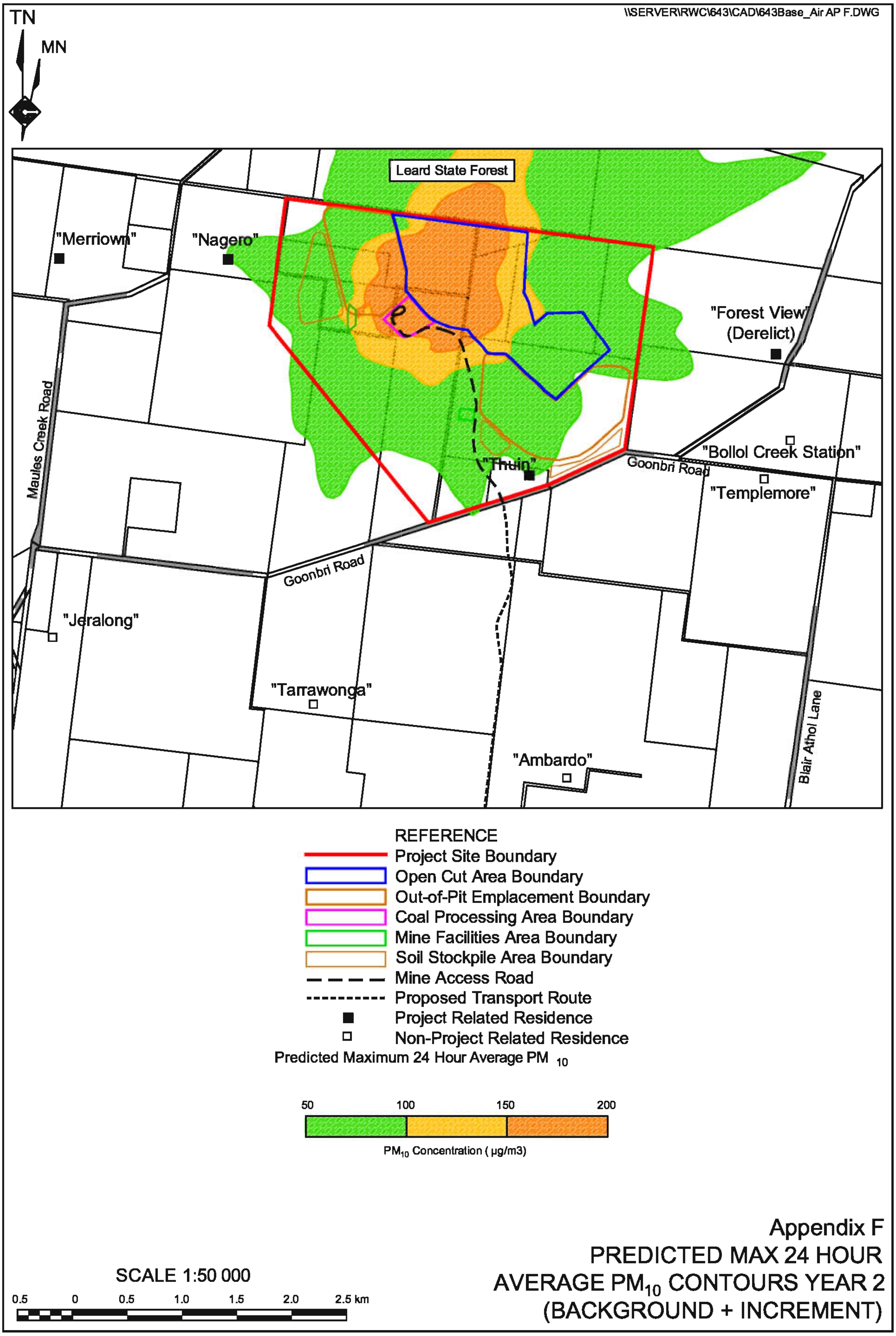
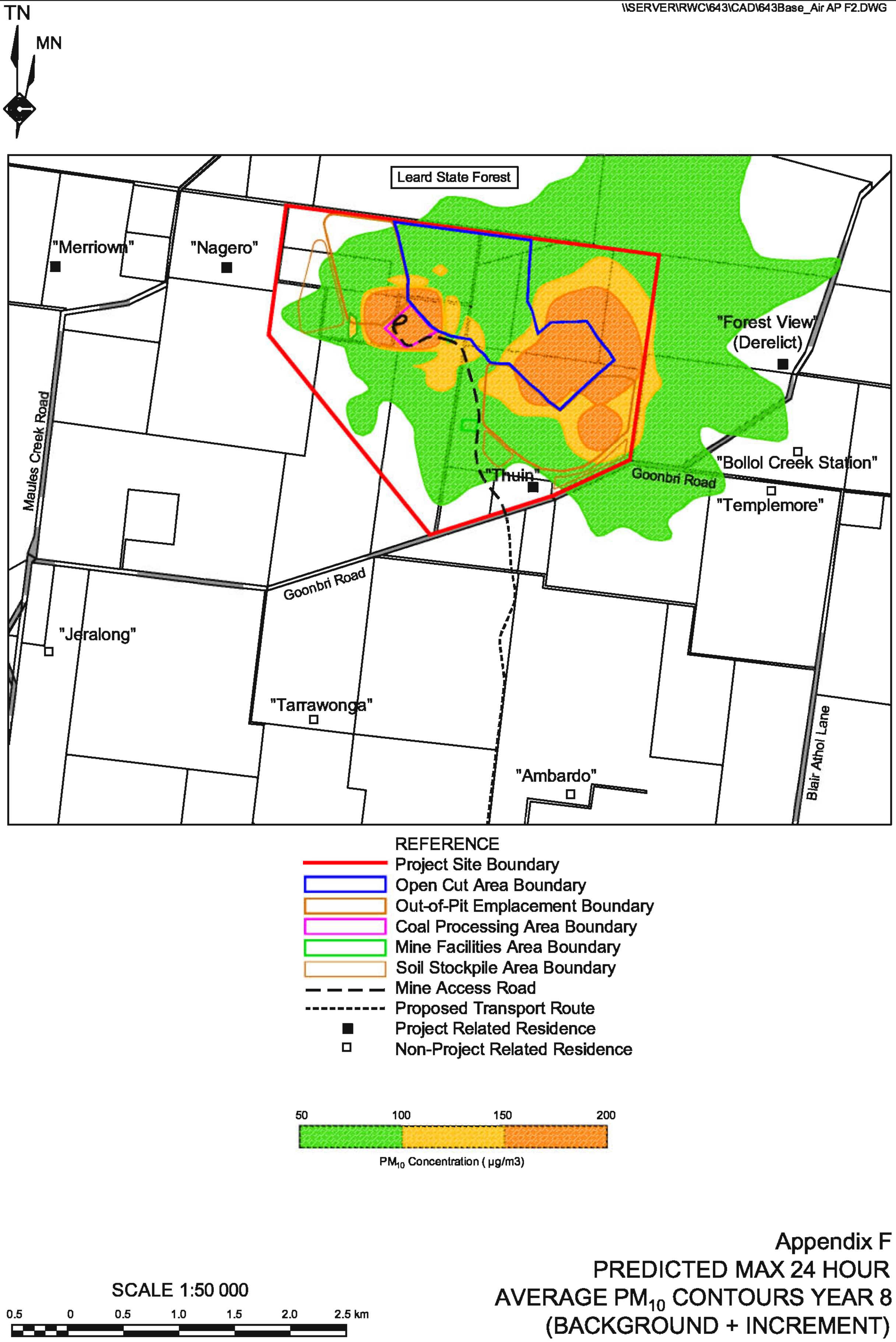


Appendix F
PREDICTED MAX 24 HOUR AVERAGE PM_{10} CONTOURS YEAR 2 (BACKGROUND + INCREMENT)



Appendix F
PREDICTED MAX 24 HOUR AVERAGE PM_{10} CONTOURS YEAR 8 (BACKGROUND + INCREMENT)

APPENDIX G

Predicted Annual Average PM_{10} Contours

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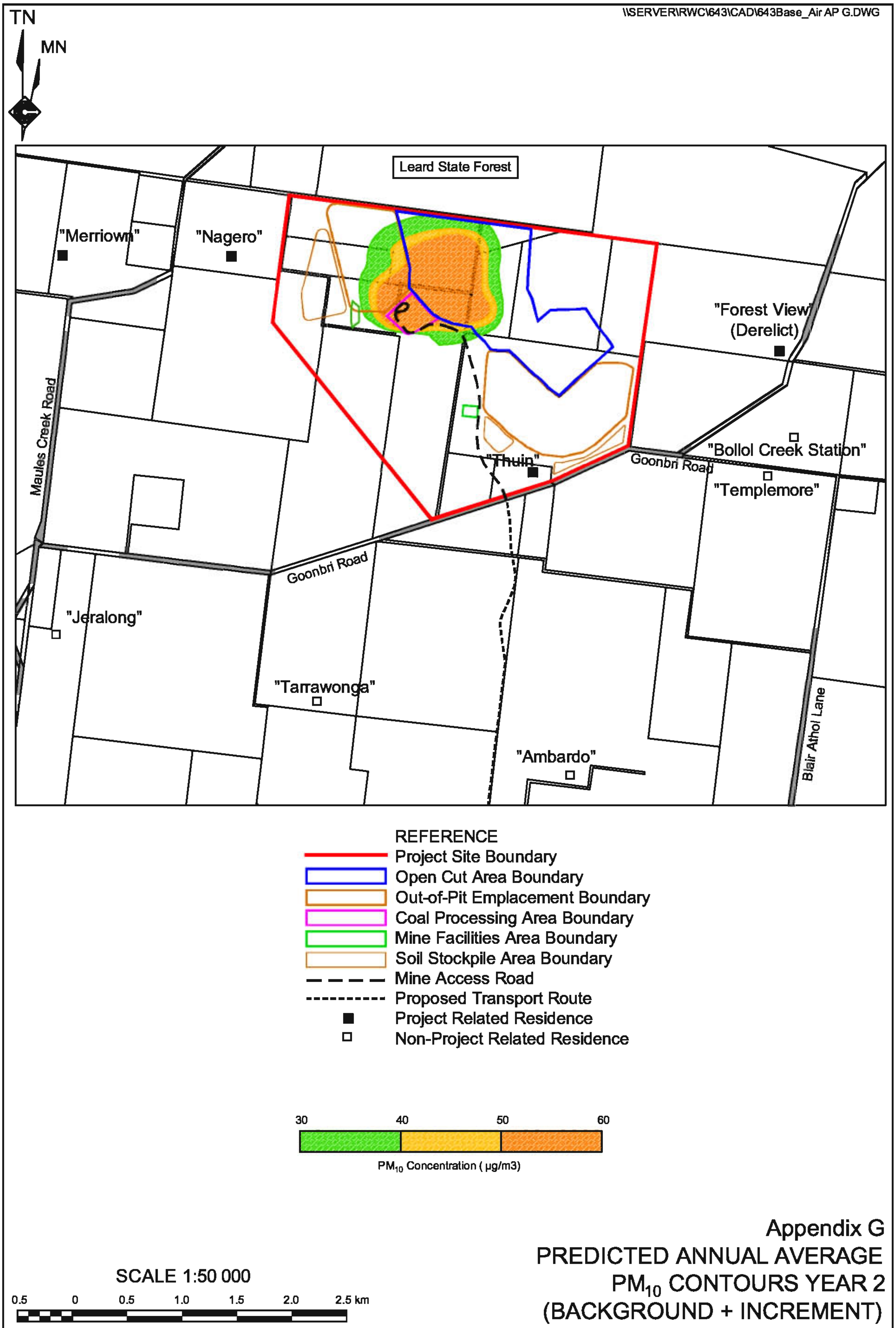
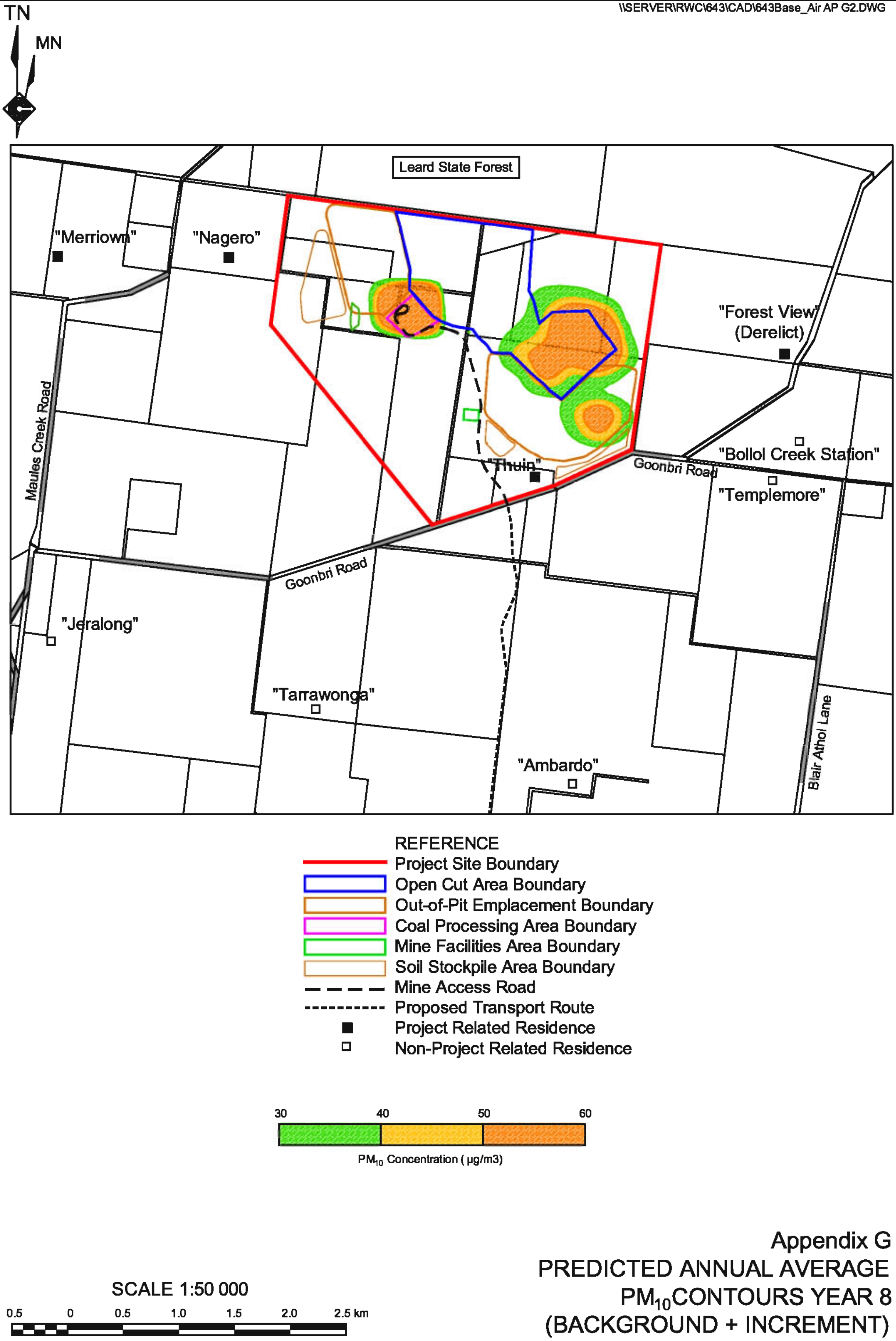


Appendix G
PREDICTED ANNUAL AVERAGE
PM_{10} CONTOURS YEAR 2
(BACKGROUND + INCREMENT)



Appendix G
PREDICTED ANNUAL AVERAGE
PM_{10} CONTOURS YEAR 8
(BACKGROUND + INCREMENT)