METROPOLITAN COAL LONGWALLS 305-307

BUILT FEATURES MANAGEMENT PLAN

   

Peabody

METROPOLITAN COAL

LONGWALLS 305-307

BUILT FEATURES MANAGEMENT PLAN

TRANSGRID

ME-TSE-MNP-0092

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPIE Approval Date
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October 2019

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1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Longwalls 305-307 are situated to the west of Longwall 304, and define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – TransGrid (BFMP-TRA) has been developed to manage the potential consequences of longwall extraction on the TransGrid assets.

The relationship of this BFMP-TRA to the Metropolitan Coal Environmental Management Structure and to the Metropolitan Coal Longwalls 305-307 Extraction Plan is shown on Figure 4.

This BFMP-TRA includes post-mining monitoring and management of TransGrid assets subject to the previously approved Metropolitan Coal Longwall 304 Extraction Plan.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-TRA, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Secretary of the Department of Planning (DP&E) (now the NSW Department of Planning, Industry and Environment [DPIE]). This BFMP-TRA has been prepared in consultation with TransGrid, including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-TRA

The remainder of the BFMP-TRA is structured as follows:

Section 2: Describes the review and update of the BFMP-TRA.

Section 3: Outlines the statutory requirements applicable to the BFMP-TRA.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 305-307.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

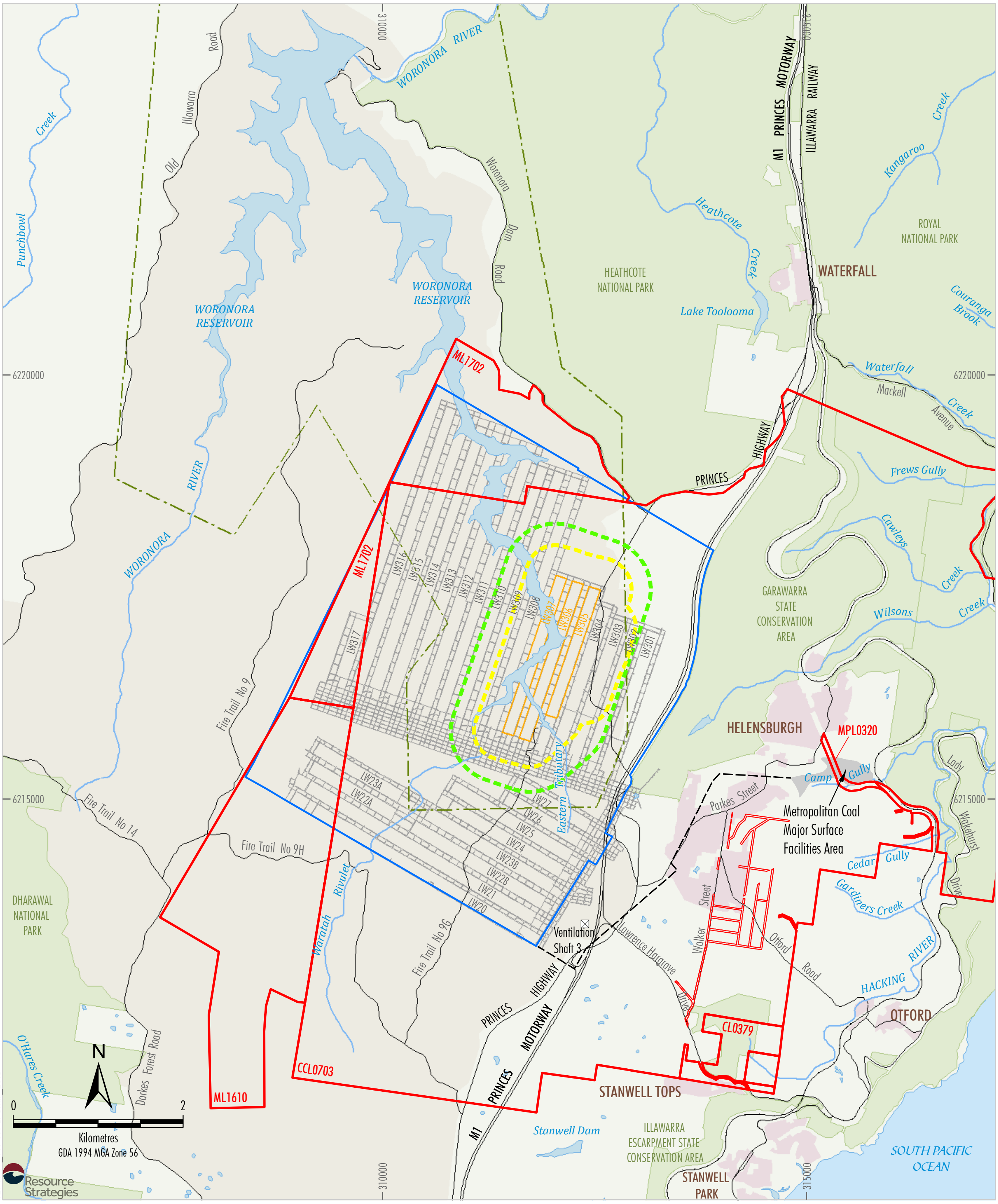
Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwalls 305-307 Secondary Extraction
- Longwalls 305-307 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Longwalls 305-307 Secondary Extraction
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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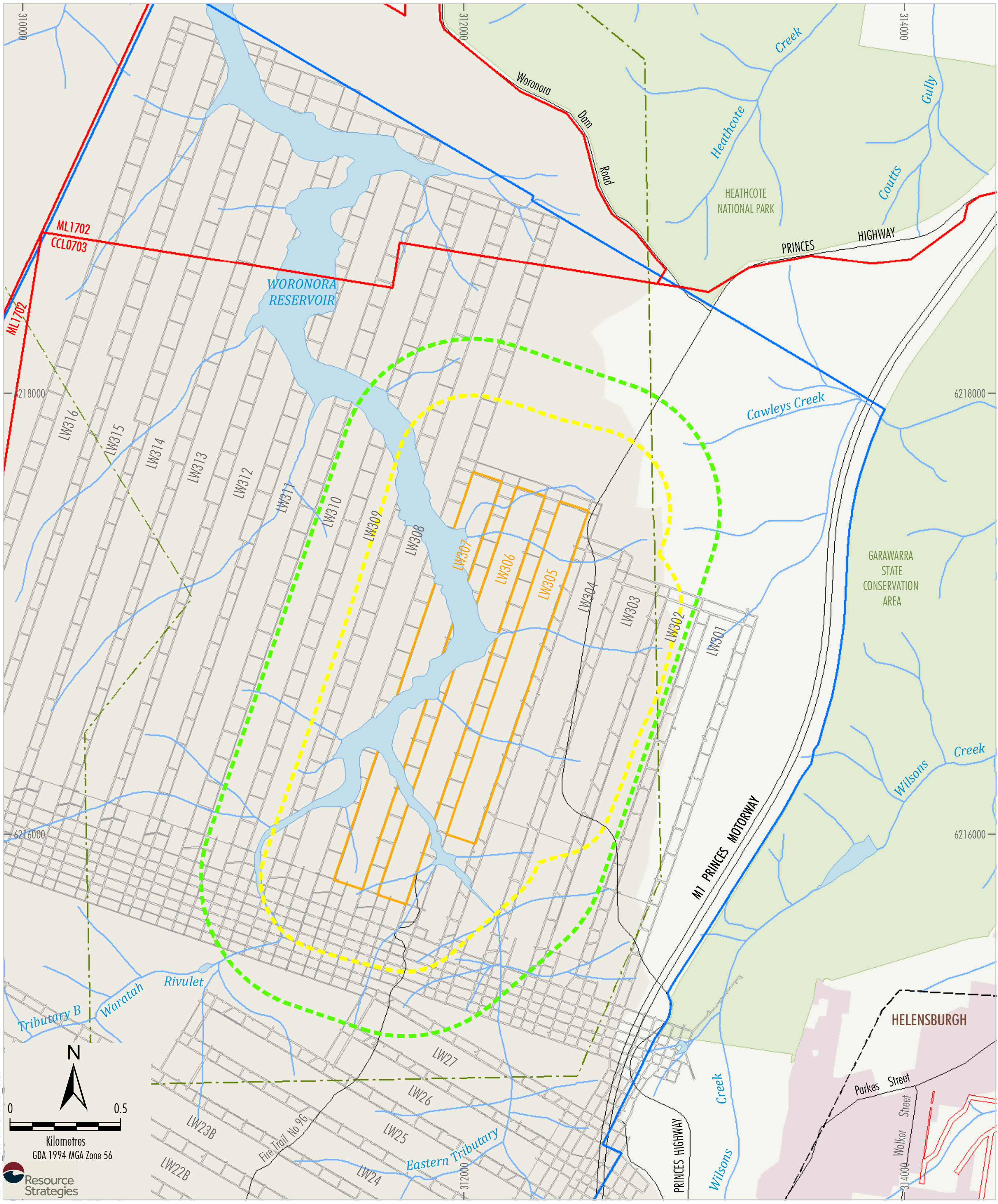
Longwalls 305-307 and Project Underground Mining Area

Figure 1



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Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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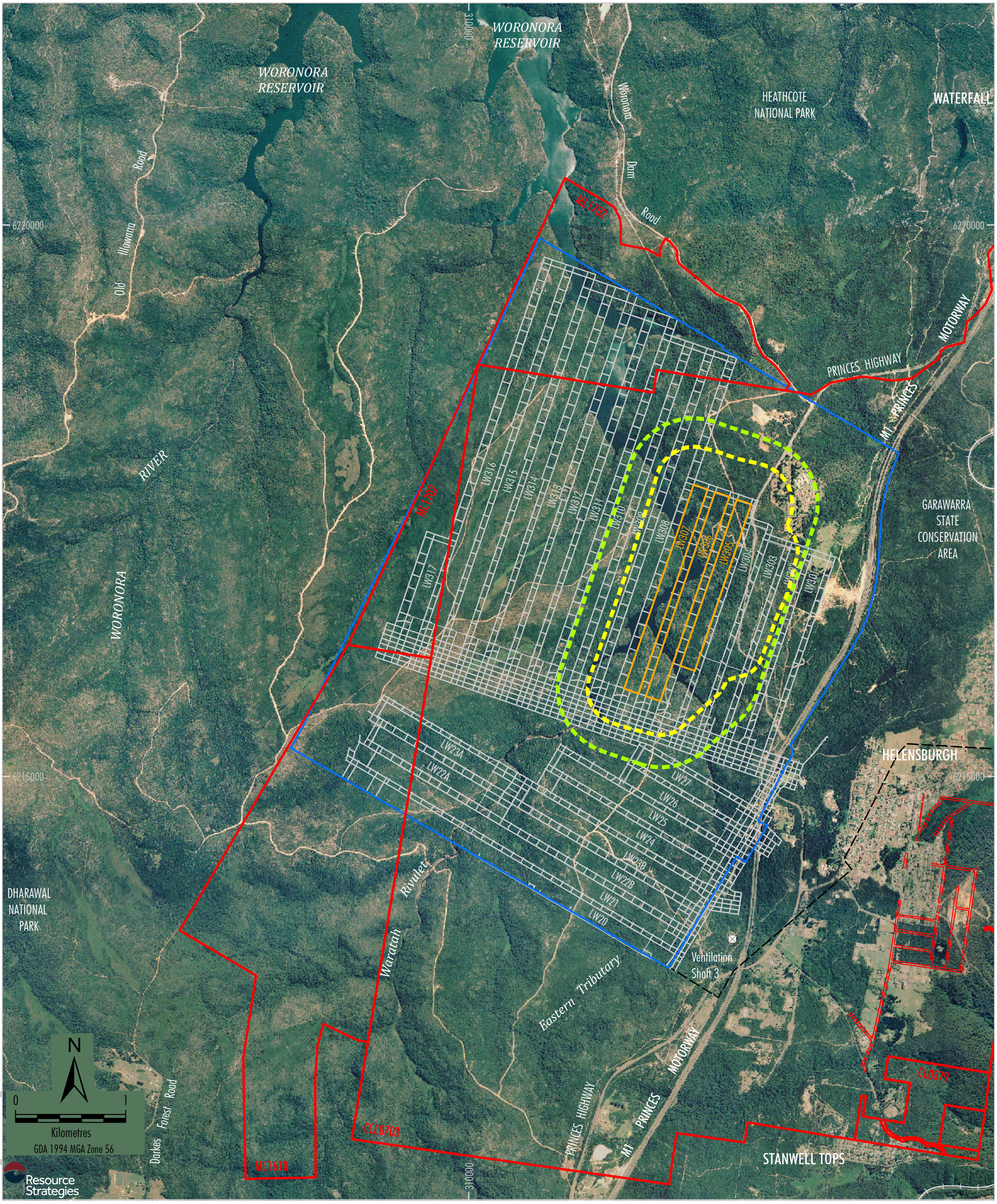
Longwalls 305-307 Layout

Figure 2



LEGEND

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- 600 m from Longwalls 305-307 Secondary Extraction
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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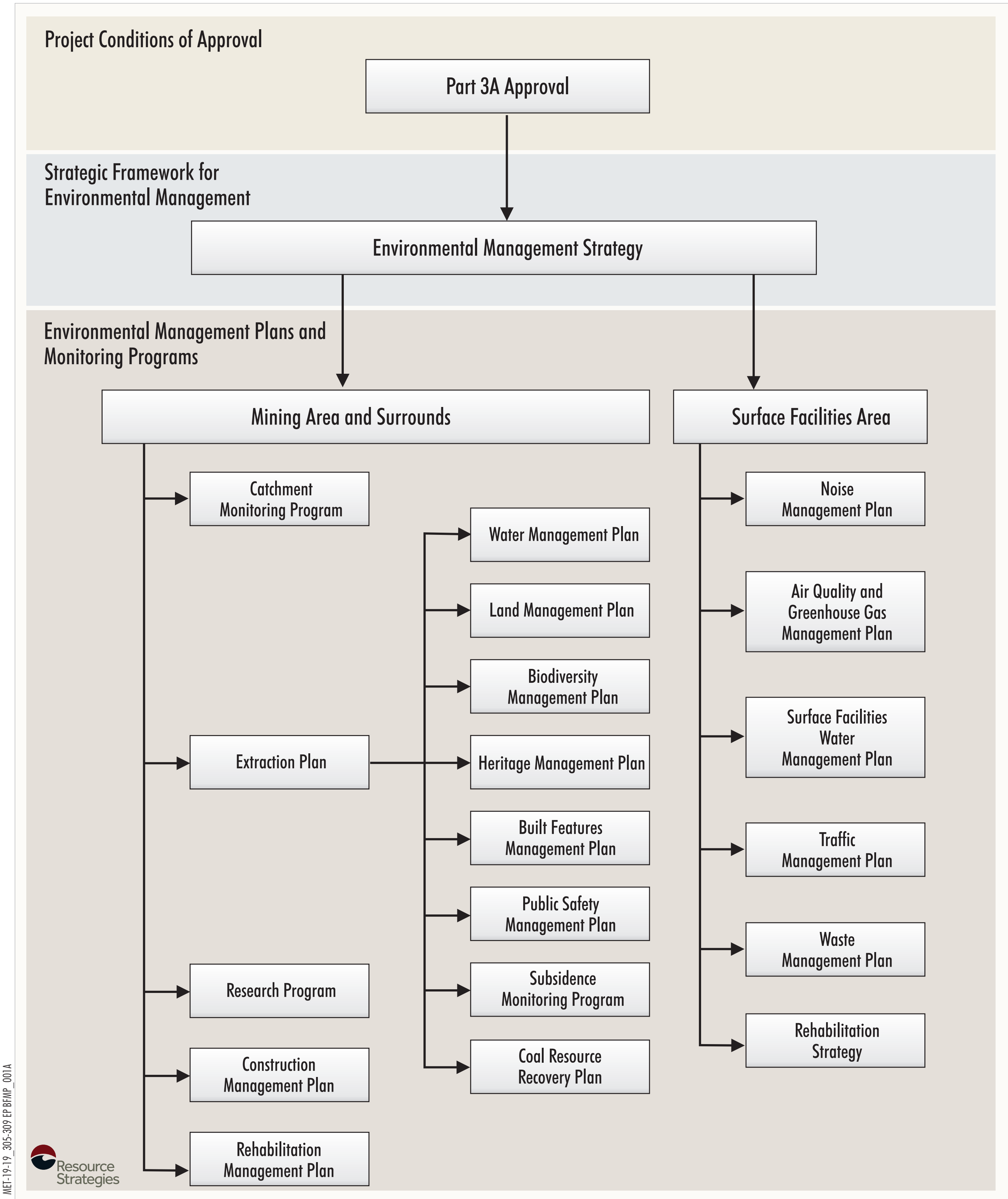
Longwalls 305-307 and Project Underground Mining Area- Aerial Photograph

Figure 3



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Environmental Management Structure

Figure 4

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-TRA.

2 BFMP-TRA REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, the BFMP-TRA will be reviewed within three months of the submission of:

- an audit under Condition 8, Schedule 7;
- an incident report under Condition 6, Schedule 7;
- an annual review under Condition 3, Schedule 7; and

if necessary, revised to the satisfaction of the Secretary of the DPIE, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DPIE.

The revision status of this plan is indicated on the title page of each copy of the BFMP-TRA. The distribution register for controlled copies of the BFMP-TRA is described in Section 2.1.

Revisions to any documents listed within this BFMP-TRA will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the BFMP-TRA publicly available on the Peabody website. A hard copy of the BFMP-TRA will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-TRA, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-TRA on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-TRA. Table 1 indicates where each component of the conditions is addressed within this BFMP-TRA.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-TRA Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 5
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 5
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 5

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the Department of Industry – Water (now the DPIE - Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*

1 The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 305-307 and the area of land within 600 metres (m) of Longwalls 305-307 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The Longwall 305 layout includes a 138 m panel width (void), a 45 m tailgate pillar width and a 70 m maingate pillar width. The layout of Longwalls 306 and 307 includes 138 m panel widths (void) and 70 m pillar widths (solid).

The provisional extraction schedule for Longwalls 305-307 is provided in Table 2.

Table 2
Provisional Extraction Schedule

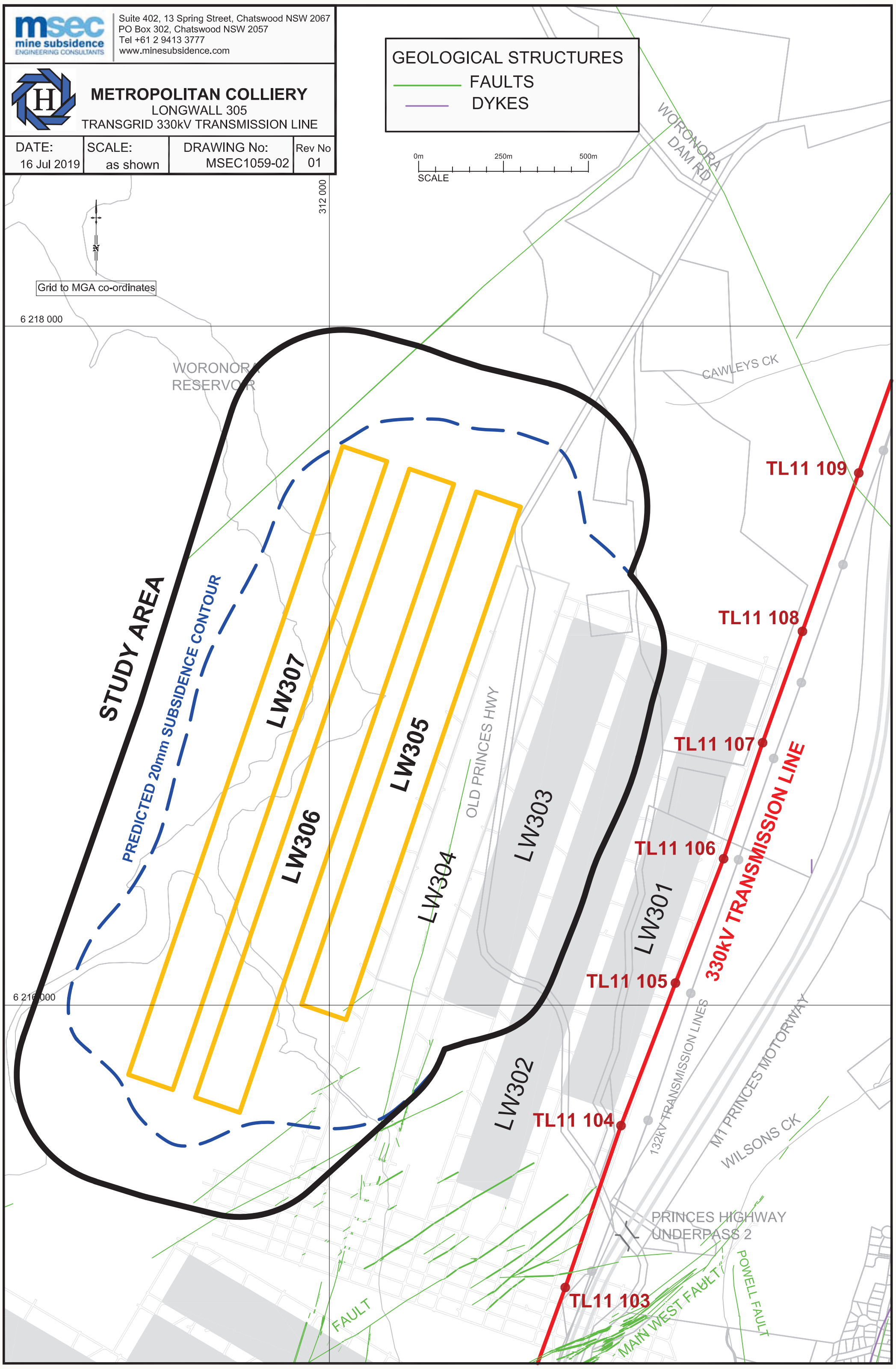
Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
Longwall 305	March 2020	7 Months	October 2020
Longwall 306	November 2020	8 Months	July 2021
Longwall 307	August 2021	8 Months	April 2022

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 TransGrid Assets

Figure 5 illustrates the TransGrid 330 kilovolt (kV) transmission line and towers. The 330 kV transmission line is composed of:

- Transmission (suspension) towers (field numbers TL11-104 to TL11-108) located to the east of the Study Area for Longwalls 305-307; and
- Dapto to Sydney South 330 kV Transmission Line (Feeder number 11).



MET-19-19_305-309 EP BFMP_006A

Source: MSEC (2019)

There are no tension towers within the Study Area for Longwalls 305-307.

The 330 kV transmission line and towers are located to the east of Longwalls 301-307 and the longwalls will not pass beneath these electrical services. The transmission line is located approximately 870 m from the nearest longwall (Longwall 305) with longwall mining progressing further to the west.

There are five towers located near the 35 degree angle of draw and/or predicted 20 mm subsidence line around Longwalls 305-307 as shown on Drawing No. MSEC1013-02 (Figure 5). The distances from the towers to the nearest longwalls are summarised in Table 3 below.

Table 3
Transmission Towers Distance to Longwalls 301-307

Tower Number	Tower Type	Approximate Distance to Longwall 301 (m)	Approximate Distance to Longwall 305[1] (m)
TL11-104	Suspension	50	870
TL11-105	Suspension	50	870
TL11-106	Suspension	70	870
TL11-107	Suspension	70	880
TL11-108	Suspension	195	890

[1] The closest longwall to the transmission towers for the Extraction Plan is Longwall 305.

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the TransGrid assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 on TransGrid assets were conducted by MSEC (MSEC, 2016; 2019a). For completeness, the maximum predicted total systematic subsidence parameters in relation to the transmission lines and transmission towers for the extraction of Longwalls 303-307 are shown in Tables 4 and 5, respectively.

Table 4
Total Subsidence Predictions for the Transmission Line After Longwalls 303-307

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt along Alignment (mm/m)	Maximum Predicted Total Tilt across Alignment (mm/m)
After LW303	140	0.5	1.0
After LW304	140	0.5	1.0
After LW307	140	0.5	1.0

Source: Table 3 in MSEC (2016) (Appendix 1) and MSEC (2019a).
Mm = millimetres.
Mm/m = millimetres per metre.

Table 5
Total Subsidence Predictions for the Towers After Longwalls 303-307

Field Tower	Maximum Predicted Total Subsidence (mm)			Maximum Predicted Total Tilt Along Alignment at Base of the Tower (mm/m) [+ve north; -ve south]	Maximum Predicted Total Tilt Across Alignment at Base of the Tower (mm/m) [+ve east; -ve west]
	After LW303	After LW304	After LW307		
TL11-104	50	50	50	<± 0.5	<± 0.5
TL11-105	125	125	125	<± 0.5	- 1.0
TL11-106	100	100	100	<± 0.5	- 0.5
TL11-107	100	100	100	<± 0.5	- 0.5
TL11-108	50	50	50	<± 0.5	<± 0.5

Source: Tables 4 and 5 in MSEC (2016) (Appendix 1) and MSEC (2019a).

As longwall mining moves further to the west, the predictions at the transmission line and transmission towers show that after Longwall 303, there is no increase in the predicted total subsidence parameters due to the extraction of Longwall 304. The transmission line and transmission towers are not predicted to experience further measurable conventional subsidence, tilts or curvatures due to the extraction Longwalls 305-307.

The maximum predicted subsidence of 125 mm and total tilt of 1.0 mm/m were both predicted to occur at Tower TL11-105 after the extraction of Longwall 303. The maximum predicted horizontal movement at the top of the towers (i.e. T11-105) was predicted to be -60 mm orientated to the west (towards the longwalls) and is not expected to increase as longwall mining moves further to the west for Longwalls 305-307.

Revised subsidence and impact predictions for the extraction of Longwalls 305-307 on TransGrid assets were conducted by MSEC and reported in MSEC (2019b) (Appendix 3).

- The transmission line is located at distances of 870 m or more from the nearest longwall (Longwall 305) and is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwalls 305-307.
- The transmission towers could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.
- It is considered unlikely that the transmission lines would experience adverse impacts as a result of predicted movements due to the extraction of Longwalls 305-307.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting for Longwalls 301-303 was held on 26 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, TransGrid, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- preliminary identification of TransGrid assets;
- review of the revised subsidence predictions and potential impacts on TransGrid assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified and implemented during the risk assessment which considered the extraction of coal beneath the land within the Study Area and in proximity to the TransGrid assets.

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 were reviewed and continued for the extraction of Longwall 304. On 13 September 2019 a review of the risk control measures was held with representatives of TransGrid, Metropolitan Coal and MSEC. The efficacy of the transmission line monitoring was reviewed and for Longwalls 305-307 will be discontinued. The monitoring system will primarily be continued directly at towers for differential leg movement and absolute tower movement. The transmission line is not predicted to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwalls 305-307. The frequency of monitoring at towers will be progressively reduced during the extraction of Longwalls 305-307 in line with increasing distance and based upon continued relative measurements below TARP’s and at limits of survey accuracy.

4.2.3 TransGrid Impact Assessment

TransGrid carried out an assessment of the impacts of the predicted subsidence on the 330 kV transmission line and towers based on MSEC (2016) predictions. In summary:

- Cruciforms are not necessary.
- Conductor sheaves are not necessary.
- Earthwire sheaves are not necessary.
- Survey monitoring is necessary for towers legs.

TransGrid will inform Metropolitan Coal if any maintenance activities and/or capital works are scheduled for the towers within the Study Area.

4.3 UNDERGROUND BLAST VIBRATION IMPACTS

Use of explosives is not required for existing or proposed general underground coal mining. Occasionally, geological structures (e.g. dykes) may be encountered underground that have to be broken up using very low mass explosives. This underground blasting would be undertaken at significant depth (e.g. greater than 400 m below the surface).

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria ensures that the potential to cause structural damage is minimal. Based on the assessment results presented in the Metropolitan Coal Project Noise Impact Assessment (Heggies, 2008), ground vibration levels are predicted to meet the most stringent night-time criteria of 1 mm/s at a distance of 500 m from the blast site. As blasting is conducted at least 400 m below the surface, vibration impacts are likely to be minimal (which is consistent with the existing Metropolitan Colliery blasting practices and experience).

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- the structural integrity of the transmission line and towers is maintained;
- the electrical clearance from vegetation is maintained; and
- the serviceability of the access roads/tracks is maintained.

Section 7 of this BFMP-TRA describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-TRA provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

A photograph of a 330 kV transmission tower is shown in Plate 1.

Plate 1 – 330 kV Transmission Tower (Source: MSEC, 2019b)

A site inspection of the 330 kV line was conducted prior to commencement of secondary extraction of Longwall 301 to establish the condition of the line. The inspection included:

- recording of existing structure conditions;

- two dimensional image records of the affected structures; and
- condition of the access road/tracks with specific attention to surface cracks.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and TransGrid during the development and implementation of this BFMP are provided in Table 6.

Table 6
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Technical Services Manager Jon Degotardi	Metropolitan 24hr Control Room 02 4294 7333
TransGrid	Proposal Manager John Psarologos	Transgrid 24hr Contact 1800 027 253 Transgrid General Enquiry 02 9284 3000

If an emergency situation arises and alternative supply is required, the following TransGrid stakeholders would be notified:

- TransGrid System Operation
  - phone: 02 9620 0102;
  - email: system.operator@transgrid.com.au
- TransGrid Maintenance Group
  - phone: 02 9620 0350;
  - email: TransmissionLinesandEasementsMaintenance@transgrid.com.au

7 MONITORING

A monitoring program has been implemented to monitor the impacts of the Project on the 330 kV transmission line and access roads/tracks as determined in consultation with TransGrid. Table 7 summarises the BFMP-TRA monitoring components.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

TransGrid or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany TransGrid or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-TRA.

Table 7
BFMP-TRA Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Towers (TL11-104 to TL11-108)	Relative Survey	4 x ground points outside each leg for each tower	Establish base conditions	Prior to Longwall 305	Complete
			4 x tower leg mounted prisms for each tower	Establish base condition	Prior to Longwall 305	Complete
		Condition Report (recording of existing structure conditions and two-dimensional image records of structures)		Establish base condition	Prior to Longwall 305	Complete
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwall 301 and 304 extraction	Complete
During Mining	Towers (TL11-104 to TL11-108)	Relative Survey	4 x Ground points outside each leg for each tower	Monitor subsidence effects during mining (tilt, strain)	Specifically LW305	Measurement at intervals of 2 months during extraction
					Within 3 months of the completion of Longwalls 305, 306 and 307	Once per longwall
			4 x tower leg mounted prisms for each tower	Monitor subsidence effects during mining (differential leg movement)	Specifically LW305	Measurement at intervals of 2 months during extraction
					Within 3 months of the completion of Longwalls 305, 306 and 307	Once per longwall
		Visual inspection	Field notes and observations recorded by surveyors	Monitor for evidence of subsidence effects on Towers including any observable surface deformations (e.g. degradation of foundations/ footings) or other subsidence related effects (noted quantitatively in regards width, length, orientation)	Whenever scheduled survey occurs	At relative survey frequencies
		Visual inspection (TransGrid)	Visual check by TransGrid of earth wire/ optical ground wire (OPGW), and for any conductor movement or impact on integrity and function of support clamps.		At any time in case of fault or emergency	

Table 7 (Continued)
BFMP-TRA Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining (Cont.)	Access roads/tracks	Visual inspection	Field notes on general condition of access roads/tracks by surveyors	Monitor for surface cracks, buckling and general safety	At the completion of each longwall	Once per Longwall
					As per Longwalls 305-307LMP	
Post Mining	Towers (TL11-104 to TL11-108)	Survey	4 x ground points outside each leg for each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwall 307	Once
			4 x tower leg mounted prisms for each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwall 307	Once
		Condition Inspection (Review any change in structure and two-dimensional image records of structures)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwall 307	Once
		Visual inspection (TransGrid)	Ground inspection	Validation	Next scheduled post mining	Once
			Climbing inspection	Validation	Next scheduled post mining	Once
	Access roads/tracks	Visual inspection	Field notes on general condition of access roads/tracks by surveyors	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwall 307	Once

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwalls 305-307 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the TransGrid 330 kV Transmission Line will be measured by a relative survey of each tower (Towers TL11-104 to TL11-108), and by absolute GNSS monitoring stations installed at certain towers to record continuous absolute movements.

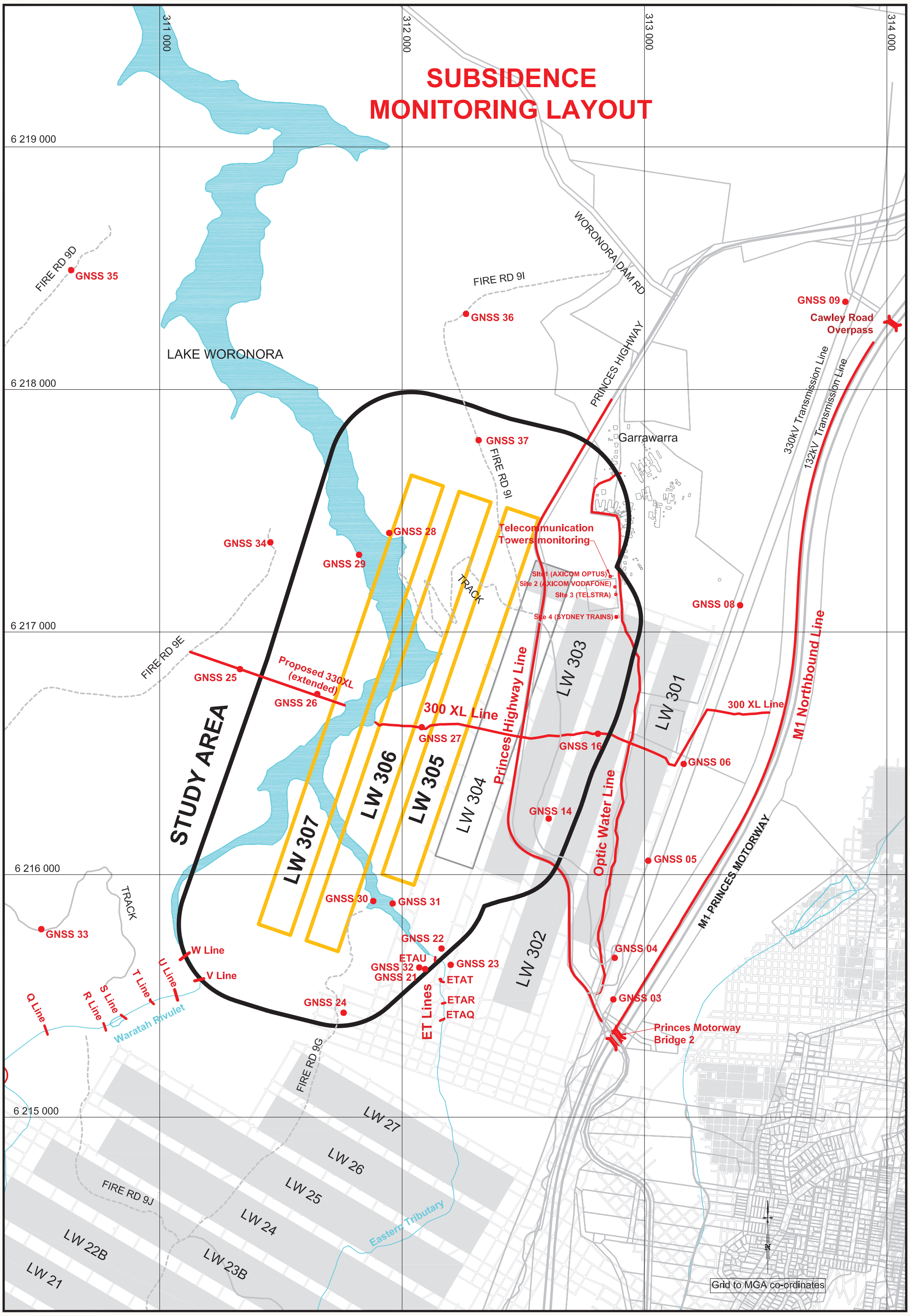
7.2 SUBSIDENCE IMPACTS

7.2.1 Towers and Transmission Line

Visual inspections will be conducted of the towers and transmission line between Tower TL11-104 to TL11-108 inclusive in accordance with the TransGrid inspection program. This generally includes:

- annual inspection of the structure integrity sites from the ground;
- annual inspection of vegetation growth and electrical clearances from the air;
- six yearly climbing inspection; and
- fault and emergency patrols from either the air or ground at any time.

Audit / baseline inspections occurred prior to commencement of Longwall 301. Survey inspections will be conducted during extraction of Longwall 305 at 2 monthly frequency. Additional observations of subsidence impacts will be conducted during routine works and recorded by surveyors during tower monitoring survey.



Source: MSEC (2019)

MET-19-19_305-309 EP BFMP_017A

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 2) and reported in accordance with the Project Approval conditions.

7.2.2 Access Roads/Tracks

Visual inspection of the access roads/tracks to the TransGrid assets was undertaken prior to the commencement of Longwall 301, and will be conducted following extraction of each longwall panel (i.e. Longwalls 305-307).

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwalls 305-307 secondary extraction as described in the Metropolitan Coal Longwalls 305-307 Land Management Plan (Longwalls 305-307 LMP).
Specific details that will be noted and/or photographed that are relevant to the TransGrid access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to the access road/track to the TransGrid asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwalls 305-307 LMP, initiation of the Contingency Plan as outlined in the Longwalls 305-307 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwalls 305-307 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwalls 305-307 LMP) and to identify required management measures. Management measures are discussed in the Longwalls 305-307 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwalls 305-307 Public Safety Management Plan.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and TransGrid will compare the results of the subsidence impact monitoring against the built features performance measure and indicators. In the event the observed subsidence impacts exceed the performance measure or indicators, Metropolitan Coal and TransGrid will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to towers and transmission lines are considered to be applicable. These include:

- alteration of conductor tensions;
- install temporary structures;
- modification to attachment points such as placement of stringing sheaves to earth wires and/or phase conductors; and
- strengthening of tower structures (e.g. through installation of cruciform footings).

The requirement for these management measures will be determined by TransGrid (Section 4.2.3) and if required, constructed prior to mining within 600 m of the towers. It is noted that Longwalls 305-307 are located greater than 600 m from the transmission towers and located at increasing distances to TransGrid infrastructure.

Where significant subsidence impacts on access roads/tracks are detected (e.g. those that affect the serviceability) or at any time Metropolitan Coal, TransGrid or the landholder considers that the integrity of the access roads/tracks may be compromised, the following management measures would be applied. Where significant cracks are detected, the cracks would be repaired as soon as practicable in consultation with the landholder. This may include the use of earthmoving equipment if considered the most appropriate means of repair. Appropriate sedimentation controls will be implemented during repair works. Management measures for access roads/tracks will be implemented in accordance with the Longwalls 305-307 Land Management Plan.

Metropolitan Coal will assess the potential impacts to public safety and where appropriate, implement measures in accordance with the Longwalls 305-307 Public Safety Management Plan.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP-TRA, Metropolitan Coal will implement the following Contingency Plan (Appendix 5):

- The observation will be reported to the Metropolitan Coal Technical Services Manager within 24 hours.

- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 4) consistent with the monitoring program described in Section 7 of this BFMP-TRA.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal Longwalls 305-307 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DPIE and TransGrid as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwalls 305-307 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.
- Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DPIE for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DPIE.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Secretary of DPIE if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Secretary determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-307.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

TransGrid designs its network with full redundancy provision (i.e. n-1 capability). In the unlikely event that TL11 became unserviceable due to a subsidence impact, TransGrid can potentially switch around TL11 for a period of time to effect emergency works, continuing to provide power to its customers (unless there are planned outages/faults in other connected parts of the transmission network).

Contingency measures that could be considered in the event the performance measure for the towers and transmission line is exceeded are summarised in Table 8. The decision tree for the contingency measures is shown in Appendix 3.

Preliminary design works for contingency measures (e.g. temporary structures for use in an emergency) has been completed in consultation with TransGrid, including identifying locations for temporary pole towers.

Table 8
Contingency Measures – Towers and Transmission Lines

Environmental Consequence	Contingency Measures	
	Measure	**Description**
Impact on Towers	Temporary replacement	• Temporary switching of power to alternate transmission lines to effect repairs to TL11. • Installation of temporary emergency tower structures as designed by TransGrid. • Emergency structures can be deployed to re-establish line operations within 72hrs (depending on the amount of towers requiring replacement).
	Rebuilding	• Construction of new tower(s) while temporary towers are in operation.
Impact on Transmission Wires	Stabilisation techniques	• Sheaving of conductors and/or earth wires.
	Rebuilding	• Construction of new transmission lines.

In the event that contingency measures in Table 8 are still expected to exceed performance measures, adaptive management will be implemented. This includes:

- reduction in extraction height; or
- modification to longwall layout.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-TRA are summarised in the BFMP-TRA TARP shown in Table 9. The BFMP-TRA TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 9
BFMP-TRA Trigger Action Response Plan

<table>
<tr><td colspan="3">TRANSGRID – Towers (T11-104 to T11-108)</td></tr>
<tr><td rowspan="8">TRANSGRID Towers</td><td colspan="2">Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.</td></tr>
<tr><td>TRIGGER LEVEL</td><td>RESPONSE</td></tr>
<tr><td colspan="2">Level 1 – Normal - Expected tower leg service condittion</td></tr>
<tr><td>Differential tower leg movements;
• less than 4.0 mm
No observable surface deformations at a tower;</td><td><u>Normal Operations</u>
• Towers are safe and serviceable.
• Negligible impact to towers.</td></tr>
<tr><td colspan="2">Level 2 – Monitor - Tower leg service condition elevating</td></tr>
<tr><td>Differential tower leg movements;
• between 4.0 and 8.0 mm
No observable surface deformations at a tower;</td><td>• Towers are safe and serviceable.
<u>Metropolitan Coal</u>
• Resurvey tower leg mounted prisms in affected area to confirm results.
• Engage subsidence expert to assess results.
• Inform and report to TransGrid and NSW Principal Subsidence Engineer of results (notify within 24 hours of trigger).
• Collaboratively share information with TransGrid to monitor situation.
<u>TransGrid</u>
• Assess information provided by Metropolitan Coal.</td></tr>
<tr><td colspan="2">Level 3 – Cautionary - Anomalous differential leg movement</td></tr>
<tr><td>Observable subsidence ground deformations at a tower and/or
Differential tower leg movements;
• greater than 8.0 mm</td><td><u>Investigate & Resolve</u>
• Towers are safe and serviceable, however indication of impact to towers
<u>Metropolitan Coal</u>
• Steps as per Level 2 event, plus:
– Inform TransGrid and NSW Principal Subsidence Engineer (immediately following awareness of trigger).
– Increase frequency of monitoring to weekly in affected area (if not already).
– Report monitoring data to NSW Principal Subsidence Engineer within 48hrs following collection of data.
– Request TransGrid assess tower condition and/or conductor performance.
– Review the subsidence monitoring program and update the program where appropriate.
– Provide report on issue to both TransGrid and DPIE.
<u>TransGrid</u>
• In conjunction with Metropolitan Coal identify impact location, inspect tower, assess condition and determine appropriate response. (e.g. greater monitoring data or frequency, or schedule maintenance on the structure).
• Make determination if other measures necessary to avoid further impact (e.g. deployment of emergency structures).</td></tr>
</table>

Table 9 (Continued)
BFMP-TRA Trigger Action Response Plan

TRANSGRID – Towers (T11-104 to T11-108)		
TRANSGRID Towers	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 4 – Restoration **Evidence of structural impact at tower or transmission line fault occurs**	
	Fault Occurs	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** • As per Level 3 event, plus: – General Manager to be involved in all decision-making processes. – Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwalls 305-307 Public Safety Management Plan. – Report exceedance of the performance measure or indicators to the DPIE and TransGrid as soon as practicable. – Update the 'Built Features Management Plan – Subsidence Impact Register'. – Investigate circumstances of the fault and determine requirement for adaptive management of mining operations prior to future operations in vicinity of the towers and transmission lines. **TransGrid** • As per Level 3 event, plus: – For fault - TransGrid to enact fault / emergency response measures including switching around TL11 while service is restored. – For greater than 8.0 mm differential leg movement - TransGrid to determine timing of emergency restoration measure. – Complete restoration works. – Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 308 on). The baseline (and post-mining) data collected for Longwalls 301-307 will be used as baseline for Longwalls 308 onward as longwall mining progressively moves further away from the TransGrid assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-TRA will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Secretary of DPIE and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Secretary of DPIE and any relevant agencies with a detailed report on the incident.

TransGrid will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Technical Services Manager and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Secretary of the DPIE and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Secretary of the DPIE and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Secretary of the DPIE and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary of the DPIE.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Heggies (2008) *Metropolitan Coal Project Noise Impact Assessment.* Appendix J in the Metropolitan Coal Project Environmental Assessment.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301-303 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line, dated 7 September 2016.*

Mine Subsidence Engineering Consultants (2019a) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line.*

Mine Subsidence Engineering Consultants (2019b) *Metropolitan Colliery – Proposed Longwalls 305-307 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE TRANSGRID 330 KV TRANSMISSION LINE, DATED 7 SEPTEMBER 2016

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7th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-02

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the TransGrid 330 kV transmission line resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the 330 kV transmission line and the proposed longwalls are shown in the attached Drawing No. MSEC844-02. The transmission line is located to the east of Longwalls 301 to 303 and therefore is not proposed to be directly mined beneath.

The transmission towers and reference numbers are also shown in Drawing No. MSEC844-02. There are six towers that are located within or immediately adjacent to the Study Area for Longwalls 301 to 303. The distances of these towers from the nearest longwall, being Longwall 301, are summarised in Table 1.

Table 1 Distances of the 330 kV Transmission Towers from Longwalls 301 to 303

Tower Number	Tower Type	Distance of the Transmission Towers Centrelines from the Longwalls (m)
TL11 103	Suspension	310
TL11 104	Suspension	50
TL11 105	Suspension	50
TL11 106	Suspension	70
TL11 107	Suspension	70
TL11 108	Suspension	110

The transmission towers that are located within the Study Area are all suspension towers. The changes in alignment at the transmission towers are in the order of 1 to 3 degrees.

A photograph of one of the 330 kV transmission towers is provided in Figure 1.

Figure 1 Photograph of a 330 kV Transmission Tower

The predictions and impact assessments for the 330 kV transmission line are provided in the following sections.

Predictions of Conventional Subsidence Parameters

The following provides summaries of the maximum predicted conventional movements for the 330 kV transmission line resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in the following section.

The predicted profiles of transient subsidence, tilt along and tilt across the alignment of the 330 kV transmission line, during the extraction of Longwall 301, are shown in the attached Fig. A.1. The profiles have been shown based on 50 metre advances of the longwall extraction face. The transmission line will initially experience subsidence adjacent to the northern end of Longwall 301 and then subsidence will progressively develop towards the southern end of the longwall during mining.

The predicted profiles of incremental and total conventional subsidence, tilt along and tilt across the alignment of the 330 kV transmission line, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Fig. A.2. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall.

A summary of the maximum predicted values of incremental subsidence, tilt along and tilt across the alignment of the 330 kV transmission line, due to the extraction of each of the Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere along the transmission line (i.e. not necessarily at the tower locations).

Table 2 Maximum Predicted Incremental Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt Along Alignment (mm/m)	Maximum Predicted Incremental Tilt Across Alignment (mm/m)
Due To LW301	40	< 0.5	< 0.5
Due To LW302	80	< 0.5	0.5
Due To LW303	30	< 0.5	< 0.5

The maximum predicted incremental subsidence for the 330 kV transmission line, due to the extraction of each of the Longwalls 301 to 303, varies between 30 mm and 80 mm. It is noted, that the maximum predicted incremental subsidence due to Longwall 302 is greater than that due Longwall 301, as it is a second panel in the series and therefore results in higher magnitudes of subsidence above and outside of the mining area. The maximum predicted incremental tilt due to each of the longwalls is 0.5 mm/m (i.e. 0.05 %, or 1 in 2,000) across the alignment.

A summary of the maximum predicted values of total subsidence, tilt along the alignment and tilt across the alignment, resulting from the extraction of Longwalls 301 to 303, is provided in Table 3. The values are the maxima anywhere along the transmission line (i.e. not necessarily at the tower locations).

Table 3 Maximum Predicted Total Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt Along Alignment (mm/m)	Maximum Predicted Total Tilt Across Alignment (mm/m)
After LW301	60	< 0.5	0.5
After LW302	110	0.5	1.0
After LW303	140	0.5	1.0

The maximum predicted total subsidence for the 330 kV transmission line, resulting from the extraction of Longwalls 301 to 303, is 140 mm. The greatest subsidence occurs adjacent to the southern end of Longwall 301. The maximum predicted conventional tilt is 1.0 mm/m (i.e. 0.1 %, or 1 in 1,000) and is orientated across the alignment of the transmission line. The maximum predicted conventional tilt along the alignment of the transmission line is 0.5 mm/m (i.e. 0.05 %, or 1 in 2,000).

There are six transmission towers that are located within or immediately adjacent to the Study Area, being Towers TL11 103 to TL11 108. A summary of the predicted values of total subsidence in the locations of the transmission towers, resulting from the extraction of Longwalls 301 to 303, is provided in Table 4.

Table 4 Predicted Total Subsidence in the Locations of the Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Tower	Maximum Predicted Total Subsidence after LW301 (mm)	Maximum Predicted Total Subsidence after LW302 (mm)	Maximum Predicted Total Subsidence after LW303 (mm)
TL11 103	< 20	< 20	< 20
TL11 104	< 20	40	50
TL11 105	40	100	125
TL11 106	30	90	100
TL11 107	30	80	100
TL11 108	< 20	< 20	<20

The transmission towers are predicted to experience vertical subsidence up to 125 mm resulting from the extraction of Longwalls 301 to 303. The highest subsidence is predicted to occur at Tower TL11 105.

A summary of the maximum predicted values of total tilt at the bases of the transmission towers and total horizontal movements at the tops of the towers, resulting from the extraction of Longwalls 301 to 303, is provided in Table 5. The values are the maxima that occur at any time during or after the extraction of these longwalls. The horizontal movements have been based on an overall tower height of 50 metres.

Table 5 Maximum Predicted Total Tilts and Horizontal Movements at the Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Tower	Maximum Predicted Total Tilt Along Alignment at the Base of the Tower (mm, +ve towards north and -ve towards south)	Maximum Predicted Total Tilt Across Alignment at the Base of the Tower (mm, +ve towards east and -ve towards west)	Maximum Predicted Total Horizontal Movement Along Alignment at the Top of Tower (mm, +ve towards north and -ve towards south)	Maximum Predicted Total Horizontal Movement Across Alignment at the Top of the Tower (mm, +ve towards east and -ve towards west)
TL11 103	< ±0.5	< ±0.5	< ±20	< ±20
TL11 104	< ±0.5	< ±0.5	< ±20	< ±20
TL11 105	< ±0.5	-1.0	< ±20	-60
TL11 106	< ±0.5	-0.5	< ±20	-50
TL11 107	< ±0.5	-0.5	< ±20	-50
TL11 108	< ±0.5	< ±0.5	< ±20	< ±20

The maximum predicted conventional tilt in the locations of the transmission towers is -1.0 mm/m (i.e. 0.1 %, or 1 in 1,000). The maximum predicted horizontal movement at the tops of the towers is -60 mm. The maximum tilt and horizontal movement both occur at Tower TL11 105 and are orientated towards the west (i.e. towards the longwalls).

A summary of the maximum predicted values of total opening and closure between the tops of the transmission towers, resulting from predicted conventional subsidence movements due to the extraction of Longwalls 301 to 303, is provided in Table 6. The values are the maxima that occur at any time during or after the extraction of these longwalls.

Table 6 Maximum Predicted Total Opening and Total Closure between Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Span	Maximum Predicted Opening due to LW301 to LW303 (mm)	Maximum Predicted Closure due to LW301 to LW303 (mm)	Final Predicted Opening (+ve) or Closure (-ve) after LW303 (mm)
TL11 103 to TL11 104	< 20	< 20	< ±20
TL11 104 to TL11 105	< 20	< 20	< ±20
TL11 105 to TL11 106	< 20	< 20	< ±20
TL11 106 to TL11 107	< 20	< 20	< ±20
TL11 107 to TL11 108	< 20	< 20	< ±20

The maximum predicted closure and opening between the tops of the transmission towers due to conventional subsidence movement is less than 20 mm.

The 330 kV transmission line is also likely to experience far-field horizontal movements orientated towards the mining area. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

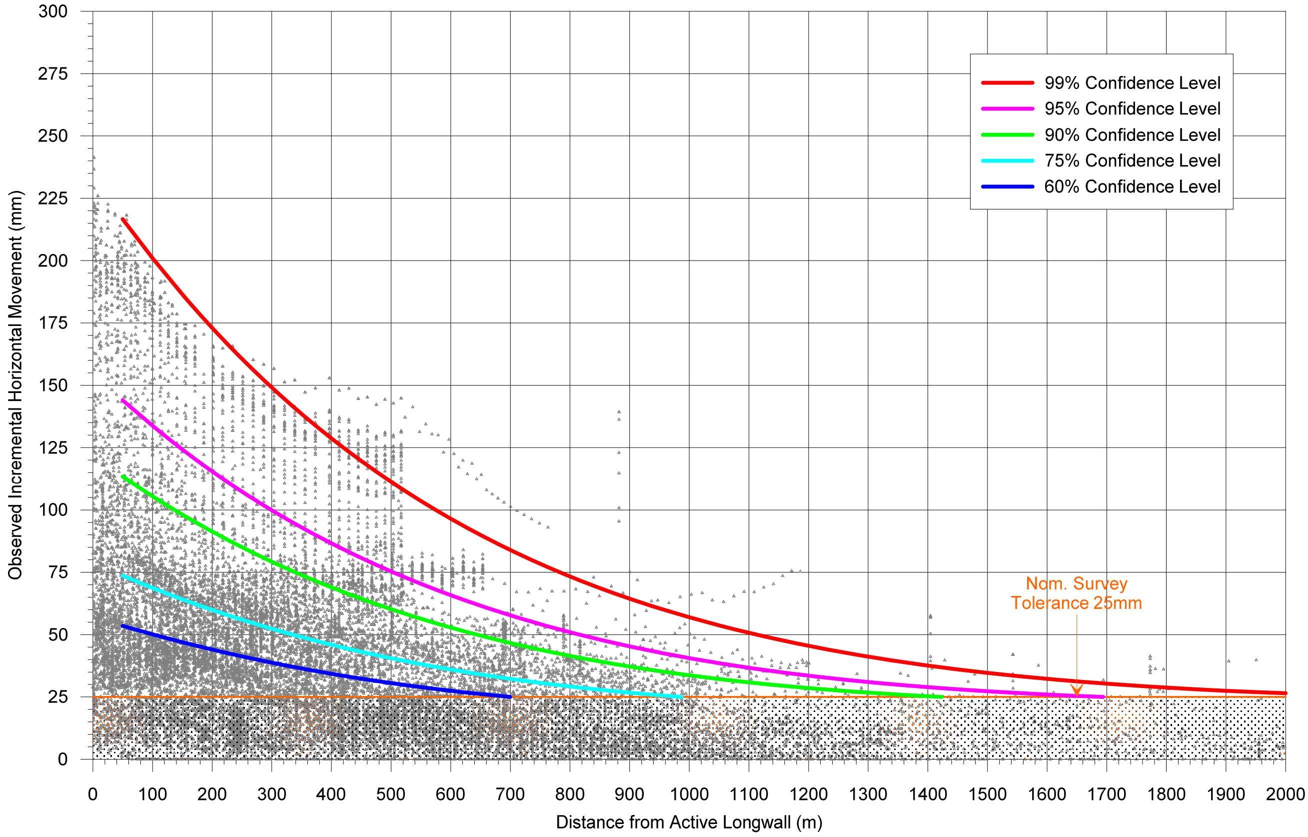

Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The transmission towers are located at distances between 50 and 310 metres from Longwalls 301 to 303. At these distances, the towers could experience absolute horizontal movements in the order of 100 mm to 140 mm based on the 95 % confidence level.

Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The potential for impacts does not result from these absolute horizontal movements, but rather the differential horizontal movements.

These absolute far-field horizontal movements could result in small changes in the distances between the towers since the directions of these far-field horizontal movements are generally expected to be towards the extracted longwalls and the 330 kV transmission line is oriented approximately perpendicular to the longwalls. The greatest differences would therefore be expected to occur between towers that are located close to the longwalls and those located further from the longwalls, such as towers TL11 103 to TL11 104 and towers TL11 108 to TL11 109. A calculation of relative far field movements between towers based on potential far-field horizontal movements from Figure 2, for the 95% confidence level, indicates a potential maximum closure movement of less than 50 mm between the towers. With increasing distance from the extracted longwalls, the potential relative far-field movement between towers could result in an opening of less than 50 mm.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. The reason for this is that strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, in cases where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the average relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values.

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones.

At a point however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the 330 kV transmission line has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements. The strains resulting from damaged or disturbed survey marks have also been excluded.

The transmission towers are located at distances of 50 metres or greater from the proposed longwalls. The database has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside between zero and 100 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

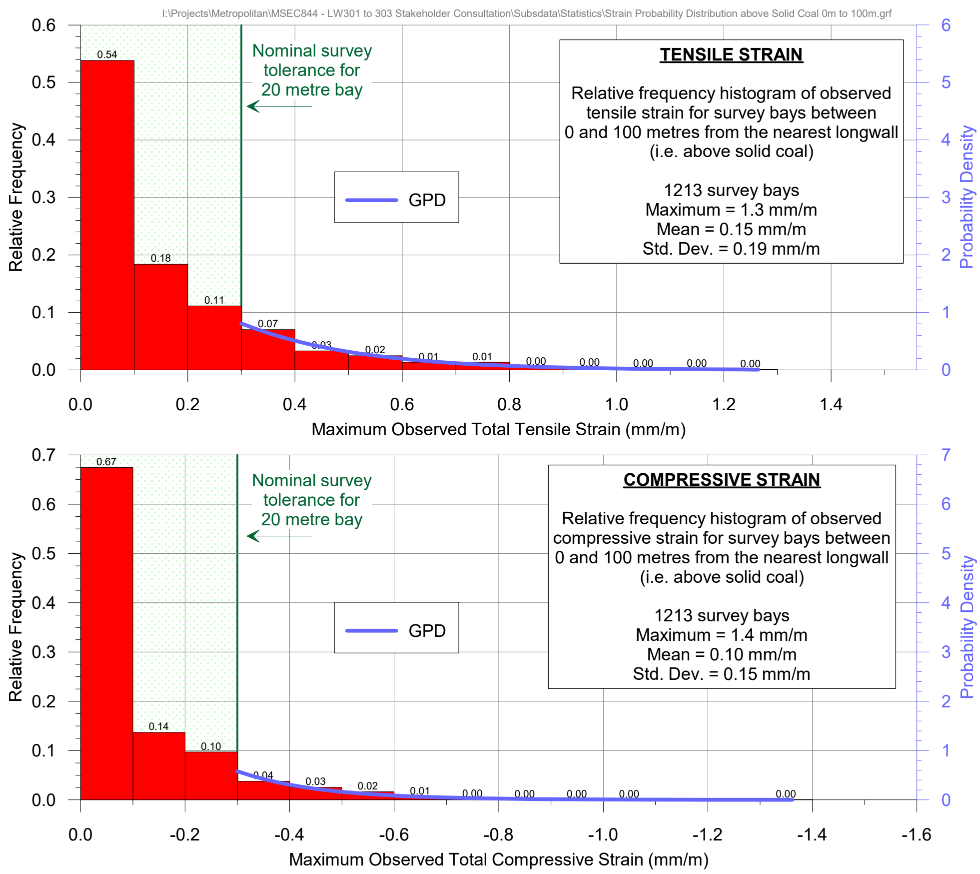

Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (0 to 100 metres)

Confidence intervals have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based on the fitted GPDs, is provided in Table 7.

Table 7 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-1.5	1 in 3,100
	-1.0	1 in 630
	-0.5	1 in 40
	-0.3	1 in 10
Tension	+0.3	1 in 6
	+0.5	1 in 15
	+1.0	1 in 250
	+1.5	1 in 2,200

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.5 mm/m tensile and 0.4 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.8 mm/m tensile and 0.7 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures are shown in Drawing No. MSEC844-02. The Metropolitan Fault has a north west to south east strike and dips to the north east. This fault crosses the alignment of the 330 kV transmission line outside of the Study Area, in close proximity to Tower TL11 109, at a distance of 0.5 kilometres north of Longwall 301. Faults also cross the alignment of the transmission line in the southern part of the Study Area, in close proximity to Tower TL11 103.

If these faults extend from the seam up to the surface, then localised and elevated compressive strains could develop at their surface expressions. It is also possible that localised and elevated strains could occur elsewhere due to unknown geological structures (i.e. anomalies).

If the surface expressions of the faults are located between the towers, then the predicted parameters for the towers do not change from those summarised in Table 4 to Table 7. However, if the surface expression of a fault is coincident with a tower, then it could experience a compressive strain greater than that predicted based on conventional ground movements.

It is difficult to predict the magnitudes of the non-conventional movements at known geological structures, especially in locations outside of mining. Experience from previous mining in close proximity of known geological structures can be used to provide a guide to the potential ground movements.

The greatest strain that has been measured at a known geological structure that was located outside of mining in the Southern Coalfield occurred in Appin Area 4. The surface expression of a low angle thrust fault was located at a distance of 190 metres from Longwall 407. The measured compressive strain at the surface expression due to mining of this longwall was 3.5 mm/m. The development of compressive strain versus the longwall face advance is illustrated in Figure 4. The rate of change of compressive strain per 10 metre longwall face advance is shown in Figure 5.

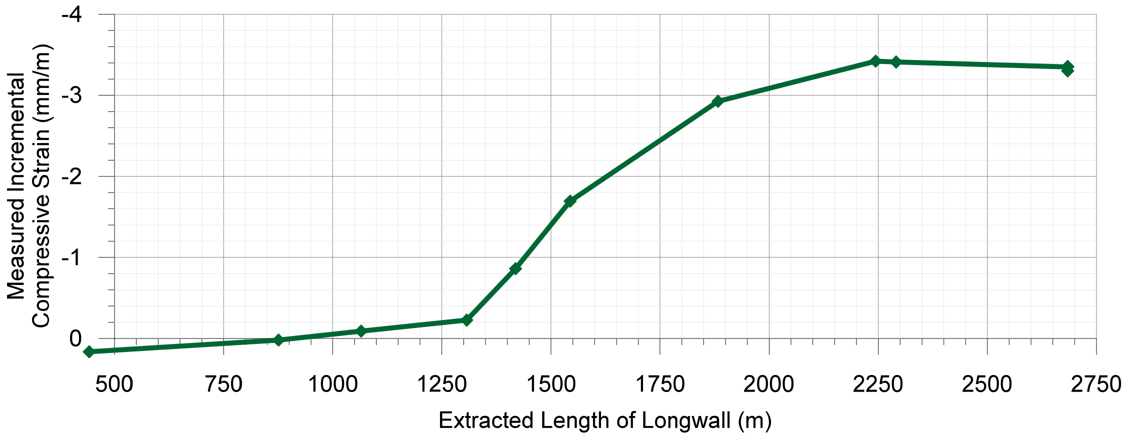

Figure 4 Development of Compressive Strain at the Surface Expression of the Low Angle Thrust Fault due to the Extraction of Appin Longwall 407

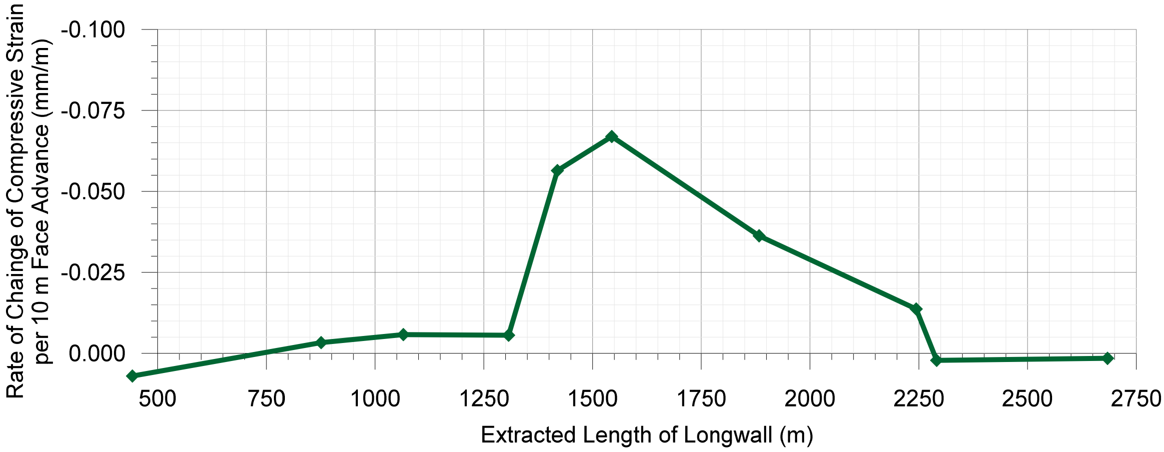

Figure 5 Rate of Change of Compressive Strain at the Surface Expression of the Low Angle Thrust Fault due to the Extraction of Appin Longwall 407

The maximum rate of change of compressive strain was 0.076 mm/m per 10 metre longwall face advance. Based on an average extraction rate of 50 metres per week, this equates to a maximum rate of 0.4 mm/m per week. The compressive strain developed over the period when the longwall had an extracted length between 1,300 and 2,200 metres. This equates to a period of approximately 18 weeks based on an average extraction rate of 50 metres per week.

The localised movements that developed at the surface expression of the low angled thrust fault in Appin Area 4 are an extreme case and greater than other known and measured cases in the Southern Coalfield. This case is likely to provide a conservative indication of potential non-conventional movements at surface expressions of geological structures outside of mining.

There are no major streams that cross the alignment of the 330 kV transmission line adjacent to Longwalls 301 to 303. The are some small tributaries along the alignment of the transmission line, which can be seen from the surface profile shown in Figs. A.1 and A.2. Localised and elevated compressive strains could develop in the bases of these small tributaries due to valley closure effects. However, the towers are located away from the bases of these small tributaries and, therefore, are unlikely to experience these valley closure strains.

Impact Assessments for the 330 kV Transmission Line

The cables along the 330 kV transmission line are not directly affected by ground strains, as they are supported by the towers above ground level. The cables can, however, be affected by the changes in bay lengths, i.e. the distances between the towers at the level of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the towers due to differential tilting of the towers. The stability of the transmission towers can be affected by the mining induced tilts, curvatures and ground strains at the tower locations and by changes in the catenary profiles of the cables.

Potential Impacts due to the Predicted Conventional Movements

The transmission towers are predicted to experience vertical subsidence up to 125 mm resulting from the extraction of Longwalls 301 to 303. The transmission line is orientated parallel to the longwalls and therefore the low level vertical subsidence is predicted to be reasonably uniform along its alignment. It is unlikely, therefore, that these magnitudes of vertical subsidence would result in adverse impacts on the cable ground clearances.

The maximum predicted conventional tilt in the locations of the transmission towers is 1.0 mm/m (i.e. 0.1 %, or 1 in 1,000) orientated across the alignment. The predicted mining induced tilts are very small and generally similar to the order of survey tolerance. The mining induced tilts and horizontal movements along the alignment of the transmission line are predicted to result in opening and closure of less than 20 mm between adjacent towers. It is unlikely, therefore, that the conventional movements would result in adverse impacts on the transmission line.

Far-field horizontal movements could result in small changes in the distances between the towers, particularly those located near the ends of the longwalls. Potential maximum predicted shortening movement of 50 mm between the towers and opening of less than 50 mm could occur between towers, due to far-field horizontal movements.

The predicted strains at the locations of the transmission towers are 0.5 mm/m tensile and 0.4 mm/m compressive based on the 95 % confidence level and are 0.8 mm/m tensile and 0.7 mm/m compressive based on the 99 % confidence level. It is recommended that TransGrid review the structural integrity of the towers based on changes in the tower leg spacings (i.e. k-point distances) resulting from the predicted strains.

Potential Impacts due to Possible Non-Conventional Movements

Localised and elevated compressive strains can develop due to the presence of geological structures or valley related effects. There are no significant streams in the locations of the transmission towers and, therefore, it is unlikely that they will be adversely impacted by valley closure effects.

It is possible that the transmission towers could experience compressive strains greater than those predicted based on conventional movements if they were coincident with the surface expression of a fault. The potential for non-conventional movements in the locations of the towers is very low, due to their distances from the longwalls, however, the potential for these irregular movements cannot be discounted.

It is recommended that strategies are developed, in consultation with TransGrid, to manage the potential for non-conventional movements at the transmission tower locations. The strategies should consider the magnitudes and rates of development of strain in locations of known geological structures adjacent to previous longwall mining. The observation at a low angled thrust fault in Appin Area 4 (refer to Figure 4 and Figure 5) is an extreme case and greater than other known and measured cases in the Southern Coalfield. This case is likely to provide a conservative indication of potential non-conventional movements at surface expressions of geological structures outside of mining.

The management strategies should include monitoring of the transmission towers during active subsidence to identify the early development of non-conventional ground movements. It is understood that survey marks have been installed on each of the transmission tower legs and in the ground.

It is recommended that a Trigger Action Response Plan (TARP) is developed outlining the actions required if non-conventional movements were identified at the transmission tower locations. The triggers and actions should be developed and agreed between TransGrid and Peabody Energy.

It is also recommended that preventive measures are developed in case non-conventional movements are identified. The preventive measures could include: installation of timber poles to support the existing tower and/or the conductors; installation of additional bracing and/or strengthening members to the existing frame; or installation of a prefabricated steel frame to support the tower base.

The appropriate monitoring, management, preventive and remedial measures should be developed in consultation between TransGrid and Peabody Energy.

Summary

The 330 kV transmission line is located to the east of the proposed Longwalls 301 to 303. The transmission towers are located at distances between 50 metres and 310 metres from the longwalls. At these distances, the transmission towers are predicted to experience low levels of vertical subsidence up to 125 mm. The predicted conventional tilts and differential horizontal movements between the towers are very small and unlikely to result in adverse impacts.

However, it is possible that the transmission towers could experience localised and elevated compressive strains due to the presence of geological structures (known or unknown), if the surface expressions of these features are coincident with them. It is recommended that monitoring, management, preventive and remedial measures are developed, in consultation between TransGrid and Peabody Energy, to manage the potential for these irregular movements.

Yours sincerely

Peter DeBono
Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC844-02 – Longwalls 301 to 303 – TransGrid 330 kV Transmission Line

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line during the Mining of Longwall 301

Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line due to LW301 to LW303

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METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
TRANSGRID 330kV TRANSMISSION LINE

DATE:	SCALE:	DRAWING No:	Rev No
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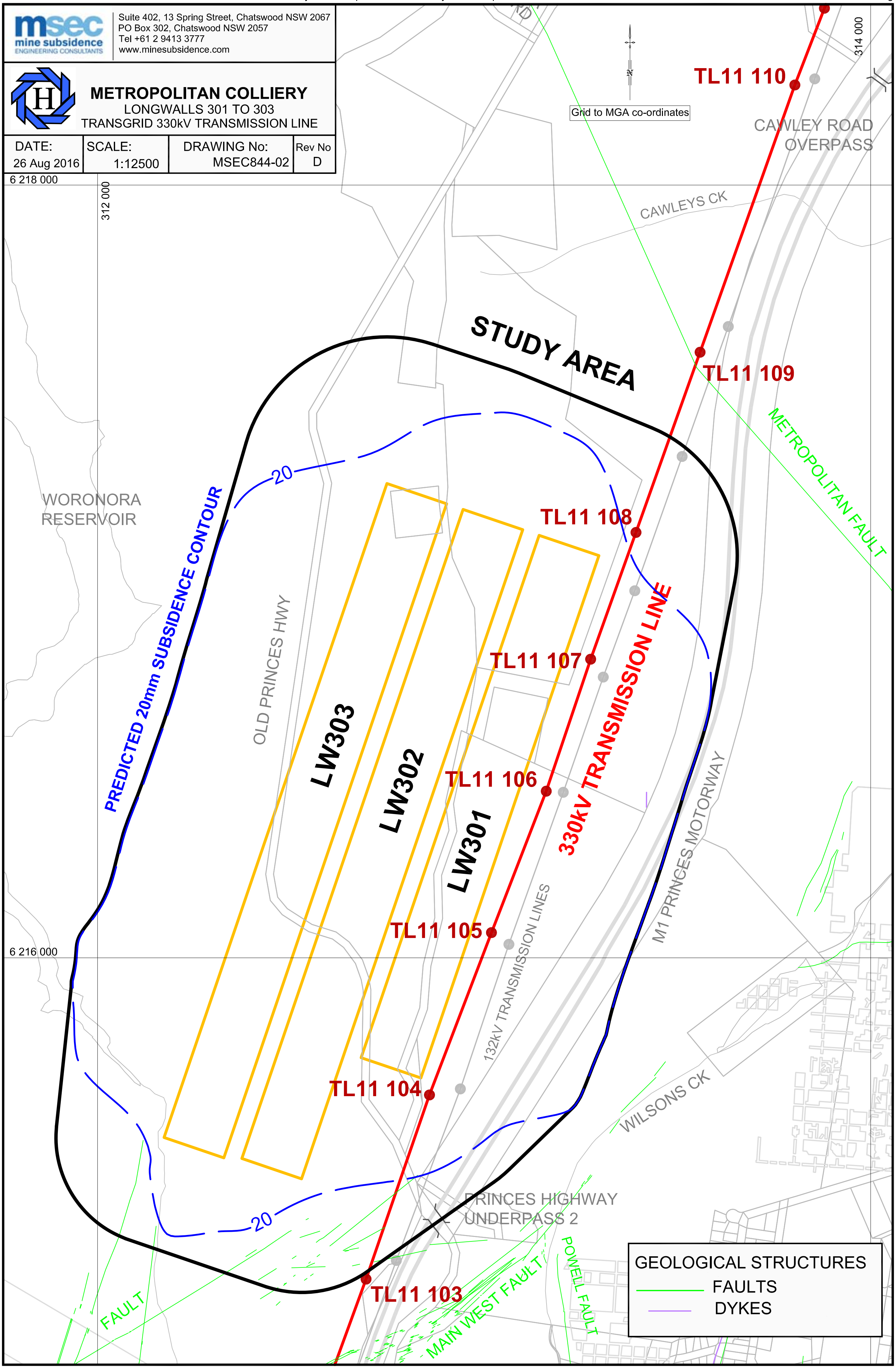

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line during the Mining of LW301

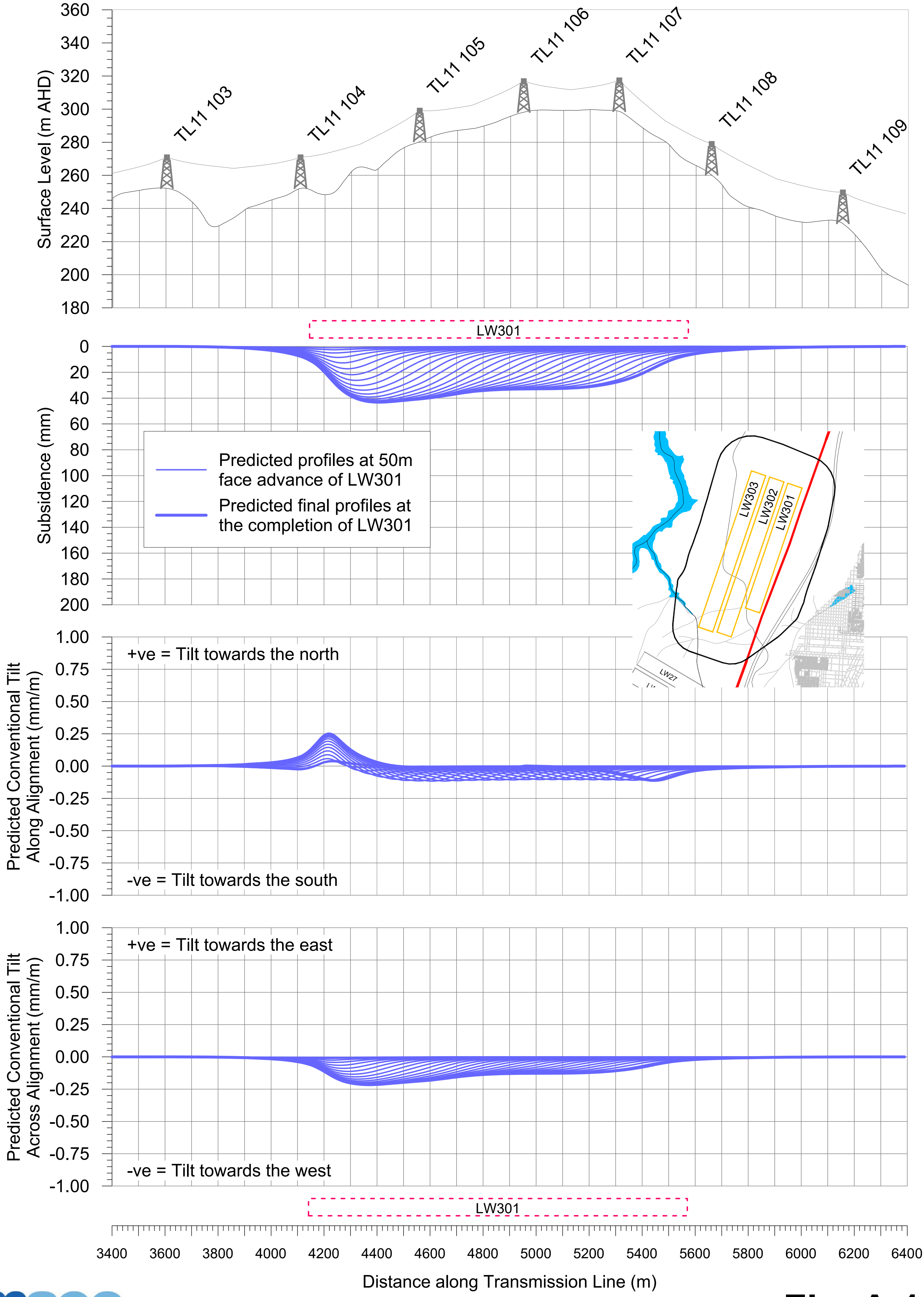

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Fig. A.1

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line due to LW301 to LW303

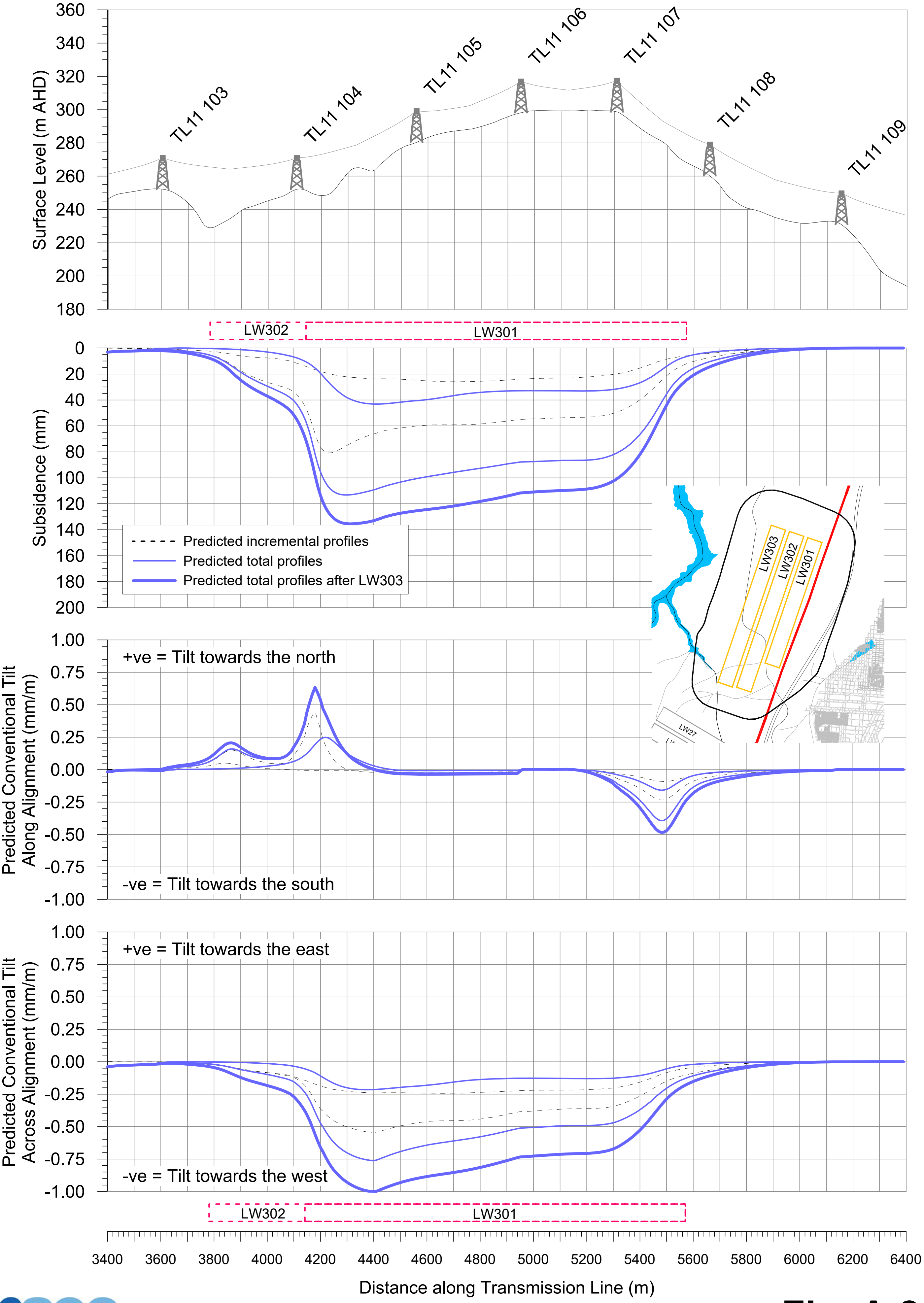

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Fig. A.2

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE TRANSGRID 330 KV TRANSMISSION LINE

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16th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-03

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Garrawarra Complex

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the built features of the Garrawarra Complex resulting from the extraction of the proposed Longwalls 304 at Metropolitan Colliery. Several services within the Garrawarra Complex are owned by other stakeholders and will be assessed and managed as necessary, through consultation with the relevant owners.

The locations of the Garrawarra Complex and the proposed longwalls are shown in the attached Drawing No. MSEC1013-03a, 03b and 03c. A Study Area is shown in the drawings and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304.

The type and size of the building structures are shown in the attached Table A.1 at the end of this letter report. There are a total of 86 building structures on the complex, comprising 57 residential or hospital buildings and 29 ancillary structures. All residential and hospital buildings are located outside the footprint of the proposed longwalls. There are also nine water storage tanks and a number of telecommunications towers located within the complex.

The *hospital* building structures are Refs. A01a to A01k and B03a to B03l. These structures are located outside the extents of the longwalls at a minimum distance of 470 m from Longwall 304. The buildings are not currently in use and have been fenced off. Photographs of the main hospital building structures are provided in Figure 1 and Figure 2.

Figure 1 Hospital Building Structure (Ref. A01a)

Figure 2 Hospital Building Structure (Ref. B03a)

The main *aged care* building structures are Refs. B01a to B01j and B02a to B02h. The other buildings associated with the aged care are Refs. B01k to B01q, B02i and B02j.

Structure Refs. B01a to B01d are located over 250 m to the north of Longwall 304. These buildings comprise single storey structures founded on a combination of ground slabs, strip footings and pad footings. The external walls are brick-veneer and the internal walls are of lightweight construction. The roofs are steel framed with metal sheeting. The roofs are steel framed with metal sheeting. Photographs of these structures are provided in Figure 3.

Figure 3 Aged Care Building Structure Refs. B01a to B01d

Structure Ref. B01e is located 350 m to the north of Longwall 304. This building is a double storey brick structure founded on a ground slab with a tiled roof. Photographs of this structure are provided in Figure 4.

Figure 4 Aged Care Building Structure Ref. B01e

Structure Refs. B02a to B02h are located outside the Study Area. These buildings comprise one and two storey structures founded on strip footings and ground slabs. The perimeter walls are double brick, but in some cases the upper levels have timber framed walls. The suspended floors are timber framed and in some cases are supported on steel frames. The tiled roofs are supported by timber frames. Photographs of two of these structures are provided in Figure 5.

Figure 5   Aged Care Building Structure Refs. B02a and B02b

The *houses* are Refs. A01m, A02a to A09a and B04a to B09a. The other buildings associated with the houses are Refs. A01l, A02b, A03b to A03d, A06b, and A08b to A08f.

Structure Refs. A01m, A02a to A09a are located outside the Study Area. Only Structure Ref. A09a is located within the Study Area boundary. This building is a two storey double brick structure on strip footings with timber floor and a tiled roof. Photographs of this house and the associated structure are provided in Figure 6.

Figure 6   House Structure Ref. A09a (left side) and A09b (right side)

Structure Refs. B04a to B09a are located 200 m to 240 m to the north east of Longwall 304. These houses are one storey structures founded on brick piers and low level perimeter brickwalls with timber floors, fibro walls and tiled roofs. Photographs of two of these houses are provided in Figure 7. The houses are currently vacant and have been fenced off in preparation for demolition.

Figure 7 Houses Structure Refs. B06a (left side) and B08a (right side)

The other main structures on the complex include water storage tanks (Refs. B14t01, B14t02, B16t01 to B16t03, B17t01, and B18t01), above ground gas storage tank (Ref. B01t03), and trickle filter tank B15t01. Photographs of these features are provided in Figure 8 to Figure 11.

Figure 8 Water Storage Tanks Refs. B14t01 and B14t02 (left side) and Refs. B16t01 to B16t03 (right side)

Figure 9 Water Storage Tanks Refs. B17t01 (poly tank) and B18t01 (steel tank)

Figure 10 Gas Storage Tank B01t03

Figure 11 Trickle Filter Tank B15t01

Other built features on the complex include telecommunications towers and compounds (Refs. B06b and B10a to B12a), potable water and sewer pipelines, powerlines and telecommunications cables.

The predictions and impact assessments for the built features in the Garrawarra Complex are provided in the following sections.

Conventional Subsidence Parameters for the Built Features

The following provides summaries of the maximum predicted conventional movements for the built features resulting from the extraction of Longwalls 304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The maximum predicted subsidence, tilt and curvature for each of the building structures and tanks, after the extraction of Longwall 303 and after the extraction of Longwall 304, are provided in Table A.1 at the end of this letter report. The values are the maxima within a distance of 20 metres from the mapped extents of these features.

Summaries of the maximum predicted values of total subsidence, tilt and curvature are provided in: Table 1 for the hospital building structures; Table 2 for the aged care building structures; Table 3 and Table 4 for the houses; Table 5 for the water storage tanks; and Table 6 for the above ground gas storage tank.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Hospital Building Structures (Refs. A01a to A01k and B03a to B03l)

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for the Aged Care Building Structures (Refs. B01a to B01q, and B02a to B02j)

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for the Northern Houses (Refs. A01m and A02a to A09a)

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

Table 4 Maximum Predicted Total Subsidence, Tilt and Curvature for the Southern Houses (Refs. B04a to B09a)

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
After LW303	50	< 0.5	< 0.01	< 0.01
After LW304	90	0.5	< 0.01	< 0.01

Table 5 Maximum Predicted Total Subsidence, Tilt and Curvature for the Water Tanks and Trickle Filter Tank (Refs. B14t01, B14t02, B15t01, B16t01 to B16t03, B17t01 B18t01)

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
After LW303	70	0.5	< 0.01	< 0.01
After LW304	125	1.0	0.01	< 0.01

Table 6 Maximum Predicted Total Subsidence, Tilt and Curvature for the Gas Storage Tank (Ref. B01t03)

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

A large proportion of the building structures are located outside or close to the Study Area boundary and are not expected to experience measurable conventional vertical subsidence, tilts or curvatures.

The private roads and the services directly associated with the hospital and residential building structures are located outside the footprint of Longwall 304 and are therefore expected to experience low levels of predicted movements, consistent with the above tables. A summary of the maximum predicted subsidence, tilt and curvature for the private roads and services, resulting from the extraction of Longwall 303 and 304, is provided in Table 7.

Table 7 Maximum Predicted Total Subsidence, Tilt and Curvature for the Private Roads and Services on the Garrawarra Complex

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
After LW303	200	2.0	0.03	< 0.01
After LW304	300	3.0	0.03	< 0.01

The maximum predicted total subsidence for the private roads and services is 300 mm. The maximum predicted conventional tilt is 3.0 mm/m (i.e. 0.3 %, or 1 in 330). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and < 0.01 sagging, which equate to minimum radii of curvature of 33 km and 100 km respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. The reason for this is that strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, in cases where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the average relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values.

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones.

At a point however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the built features has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements. The strains resulting from damaged or disturbed survey marks have also been excluded.

Where features are located outside the proposed longwalls, as is the case for the structures at the Garrawarra complex, the database has been analysed to extract the maximum tensile and compressive strains outside the longwalls, referred to as '*above solid coal'.* The majority of building structures are greater than 100 metres from the longwalls and, therefore, the database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 metres to 250 metres of the nearest longwall goaf edge.

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 12. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

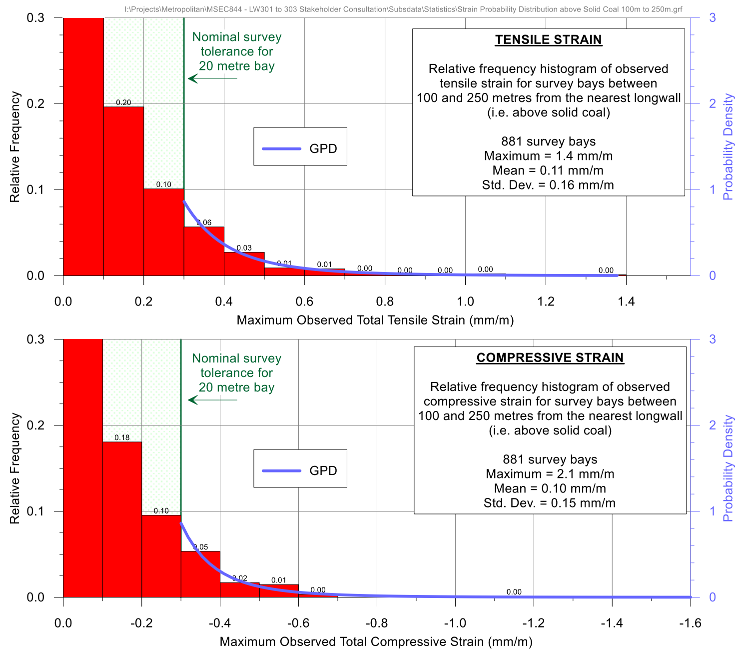

Figure 12 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 metres)

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal (100 to 250 metres) experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-03a. There are no mapped faults located within the Study Area that extend beneath the Garrawarra Complex. It is possible that structures could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302 and part extraction of Longwall 303. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

There are no major streams located within the complex. The built features, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Building Structures

Longwall layouts have been modified in order to minimise predicted subsidence movements at the Garrawarra building structures B01a to B01e, which house aged care patients and administrative support.

A structural assessment of the building structures within the Garrawarra Complex was undertaken by John Matheson and Associates Pty Ltd (JMA 2016). A summary of the results of the structural inspection is provided in Table 3 of JMA (2016). The assessment is based on predicted subsidence parameters for Longwall 301 to 303 and indicates that the likelihood of greater than negligible damage developing in the building structures is low, with an assessed probability of exceedance for Category 1 damage (i.e. fine cracks of less than 1mm) of 1% or less for all buildings with the exception of Building B02c. The abandoned building B02c has a probability of exceedance of 10% for Category 1 damage and a probability of exceedance of 1% for a 2 mm crack in Category 2. The assessed probability exceedance of 1% is generally associated with large masonry structures. The assessed probability exceedance for the smaller building structures is generally unlikely to remote. A detailed discussion of the structural assessments is provided in the report by JMA (2016). Since the preparation of the structural assessment report, the Longwalls 301 to 303 were shortened by 90 m. The predicted subsidence parameters for the structures after Longwall 304 are generally unchanged or similar to those assessed in the report by JMA (2016) and the resulting assessments for the structures do not change. The buildings are expected to remain safe and serviceable and potential impacts could be repaired using normal building maintenance techniques.

A detailed discussion of the structural assessments is provided in the report by JMA (2016).

Impact Assessments for the Water Tanks and Trickle Filter Tank

The maximum predicted tilt for the water tanks and trickle filter tank is 1.0 mm/m (i.e. 0.1 %, or 1 in 1000). The magnitude of tilt is very small (i.e. less than 1 %) and therefore unlikely to adversely impact on these structures. Tilt can potentially affect the stored water levels within these tanks. It is recommended that infrastructure owner reviews the potential changes in freeboard resulting from the mining induced tilt.

The maximum predicted conventional curvatures are 0.01 km^{-1} hogging and less than 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 km and greater than 100 km, respectively.

The tanks are located at distances of 200 m or greater from Longwall 304. The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

As assessment of the tanks was undertaken by John Matheson and Associates Pty Ltd (JMA 2016). A summary of the results of the structural inspection is provided in Table 3 of JMA (2016). The assessment is based on predicted subsidence parameters for Longwall 301 to 303 and indicates that the likelihood of greater than negligible damage developing in the water storage tanks is 20% for Category 1 damage (i.e. fine cracks of less than 1mm) of 1% or less. Since the preparation of the structural assessment report, the Longwalls 301 to 303 were shortened by 90 m. The predicted subsidence parameters for the structures after Longwall 304 are unchanged or less than those assessed in the report by JMA (2016) and the resulting assessments for the structures therefore do not change. The tanks are expected to remain safe and serviceable and potential impacts could be repaired using normal building maintenance techniques.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301-303 are updated, in consultation with the infrastructure owner, to manage the potential impacts on the water storage tanks and trickle filter tank. It is expected that these tanks can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Gas Storage Tank

The gas storage tank is located more than 330 m from Longwall 304. The maximum predicted subsidence parameters are negligible and therefore unlikely to adversely impact on this tank.

The maximum predicted conventional curvatures are less than 0.01 km^{-1} for both hogging and sagging curvature, which equate to minimum radii of curvature of greater than 100 km. The predicted strains are less than 0.5 mm/m tensile and compressive based on the 95 % confidence level.

The gas storage tank is supported on a concrete slab above the ground and therefore is unlikely to experience the mining induced curvatures and strains.

At this distance, it is unlikely that the storage tank and pipework would experience adverse impacts as a result of the extraction of Longwall 304.

Impact Assessments for the Private Roads and Services

The private roads in the complex with bitumen seals and private services within the complex are located outside Longwall 304. Experience from the Southern Coalfield indicates that the impacts on these roads and services are unlikely.

Short lengths of road comprising chip seal or gravel surface are located above Longwall 302. The roads are not well maintained. Potential impacts to these roads may include minor and isolated cracks. The impacts can be managed using monitoring (visual or ground survey lines) during active subsidence and remediation of impacts using normal road maintenance techniques.

It is expected that the private roads and service can be maintained in safe and serviceable conditions with the development of the appropriate monitoring and management plans.

Summary

The building structures and services associated with the Garrawarra Complex are located to the north east of Longwall 304. The main patient wards are located more than 250 metres from Longwall 304. Assessments of the building structures were carried out by JMA (2016) and indicate that the structures can be maintained in a safe and serviceable condition.

It is expected that the potential impacts on the building structures and services could be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:
Drawing No. MSEC1013-03a – Longwall 304 – Location Plan
Drawing No. MSEC1013-03b – Longwall 304 – Buildings and Structures
Drawing No. MSEC1013-03c – Longwall 304 – Services

Table A.1 Predicted Subsidence, Tilt and Curvature for the Building Structures

References:

John Matheson and Associates (JMA 2016), Garrawarra:R0295-Rev 3 *Preliminary Structural Inspection Report.* 10 October 2016

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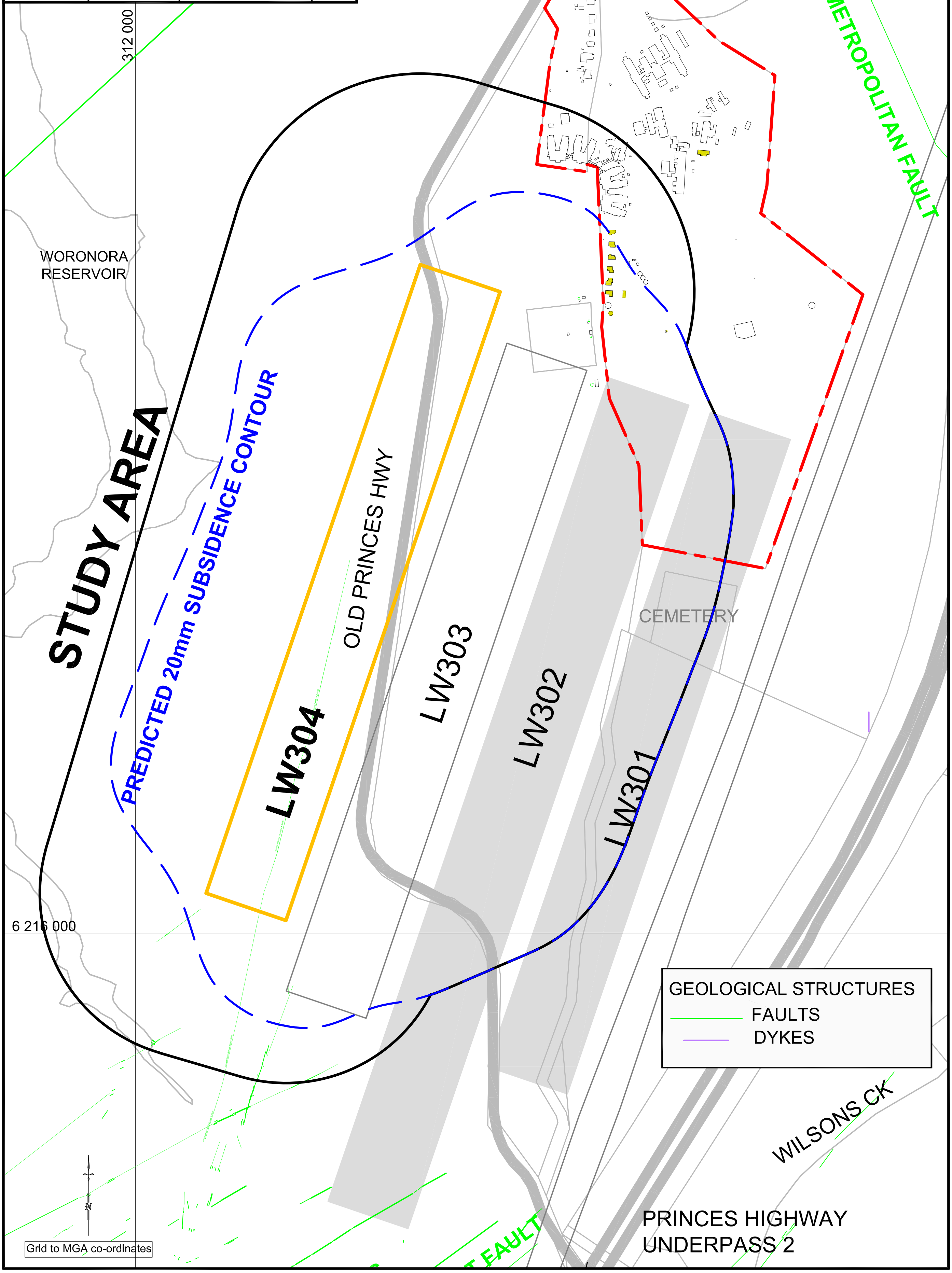
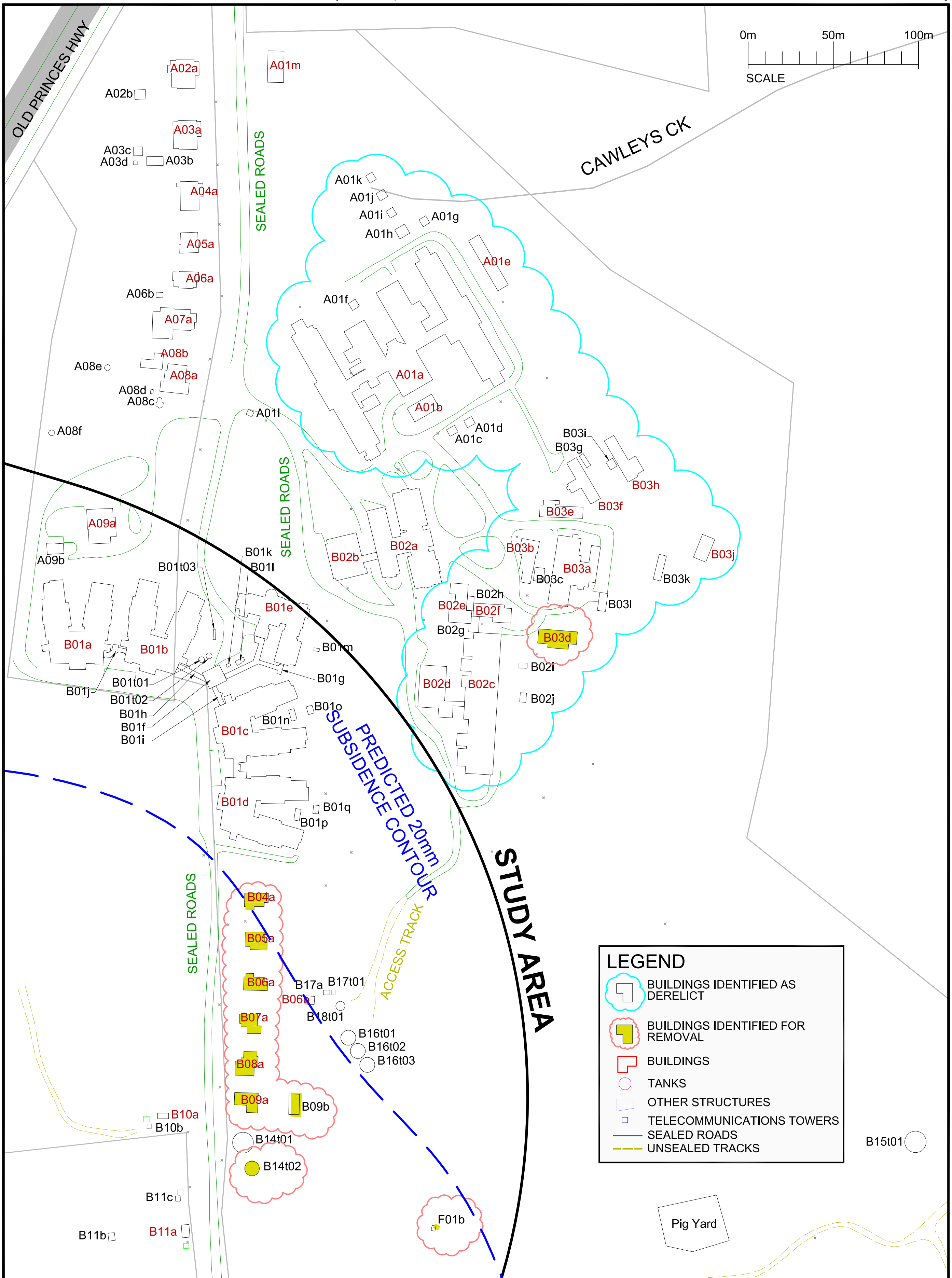
METROPOLITAN COLLIERY
LONGWALL 304
GARRAWARRA CENTRE SESLHD
LOCATION PLAN

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-03a	02





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LONGWALL 304
GARRAWARRA CENTRE SESLHD
BUILDING & STRUCTURES

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	as shown	MSEC1013-03b	02

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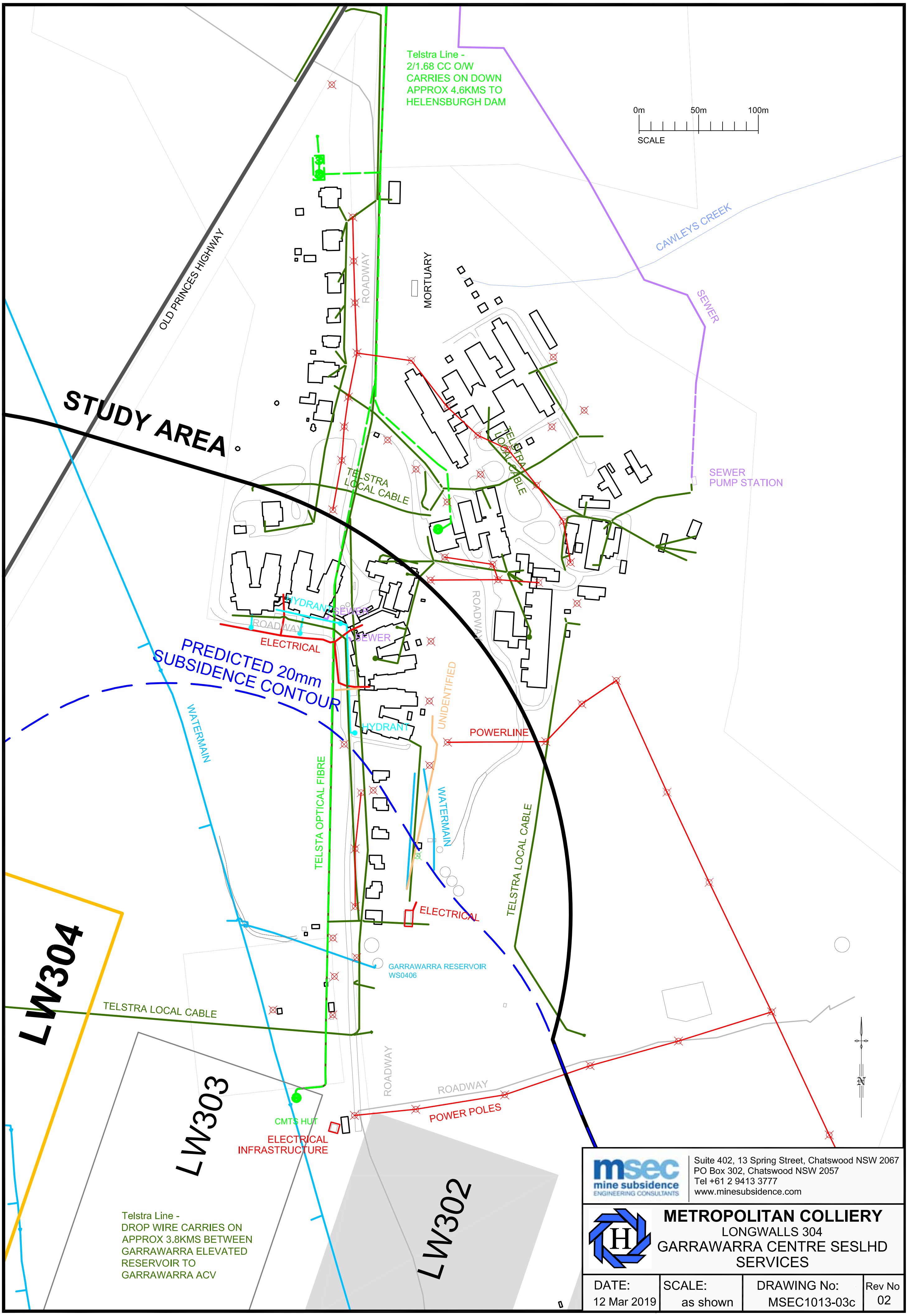

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METROPOLITAN COLLIERY
LONGWALLS 304
GARRAWARRA CENTRE SESLHD
SERVICES

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	as shown	MSEC1013-03c	02

Table A.01 - Maximum Predicted Subsidence Parameters for the Building Structures

Ref.	Description	Maximum Dimension (m)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW303 (mm)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW304 (mm)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW303 (mm/m)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW304 (mm/m)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW304 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW304 (1/km)
A01a	Hospital	38	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01b	Hospital	17	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01c	Hospital	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01d	Hospital	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01e	Hospital	34	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01f	Hospital	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01g	Hospital	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01h	Hospital	7	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01i	Hospital	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01j	Hospital	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01k	Hospital	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01l	Shed	4	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01m	House	18	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A02a	House	11	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A02b	Shed	6	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03a	House	16	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03b	Shed	10	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03c	Shed	5	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03d	Shed	2	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A04a	House	14	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A05a	House	12	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A06a	House	11	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A06b	Shed	4	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A07a	House	16	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08a	House	17	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08b	Shed	13	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08c	Shed	3	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08d	Shed	3	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08e	Shed	2	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08f	Shed	2	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A09a	House	15	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A09b	Shed	10	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01a	Retirement Home	14	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01b	Retirement Home	14	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01c	Retirement Home	14	< 20	20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01d	Retirement Home	15	< 20	30	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01e	Retirement Home	19	< 20	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01

Table A.01 - Maximum Predicted Subsidence Parameters for the Building Structures

Ref.	Description	Maximum Dimension (m)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW303 (mm)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW304 (mm)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW303 (mm/m)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW304 (mm/m)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW304 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW304 (1/km)
B01f	Retirement Home	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01g	Retirement Home	21	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01h	Retirement Home	19	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01i	Retirement Home	12	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01j	Retirement Home	6	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01k	Shed	3	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01l	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01m	Shed	3	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01n	Shed	7	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01o	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01p	Shed	7	*< 20*	30	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01q	Shed	5	*< 20*	20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01t01	Tank	4	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01t02	Tank	4	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01t03	Tank	6	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02a	Retirement Home	40	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02b	Retirement Home	21	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02c	Retirement Home	83	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02d	Retirement Home	25	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02e	Retirement Home	15	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02f	Retirement Home	18	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02g	Retirement Home	9	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02h	Retirement Home	8	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02i	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02j	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03a	Hospital	41	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03b	Hospital	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03c	Hospital	8	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03d	Hospital	23	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03e	Hospital	25	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03f	Hospital	28	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03g	Hospital	8	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03h	Hospital	28	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03i	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03j	Hospital	14	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03k	Hospital	15	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03l	Hospital	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B04a	House	14	*< 20*	40	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01

Table A.01 - Maximum Predicted Subsidence Parameters for the Building Structures

Ref.	Description	Maximum Dimension (m)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW303 (mm)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW304 (mm)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW303 (mm/m)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW304 (mm/m)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW304 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW304 (1/km)
B05a	House	11	*20*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B06a	House	14	*30*	60	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B06b	Shed	5	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B07a	House	11	*30*	70	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B08a	House	11	*40*	80	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B09a	House	14	*50*	90	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B09b	Shed	14	*50*	90	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B10a	Shed	6	*50*	125	< 0.5	1.0	< 0.01	0.01	< 0.01	< 0.01
B10b	Shed	3	*50*	125	< 0.5	1.0	< 0.01	0.01	< 0.01	< 0.01
B11a	Shed	7	*90*	175	1.0	2.0	< 0.01	0.02	< 0.01	< 0.01
B11b	Shed	5	*90*	225	1.0	2.5	< 0.01	0.03	< 0.01	< 0.01
B11c	Shed	3	*80*	150	0.5	1.5	< 0.01	0.02	< 0.01	< 0.01
B12a	Shed	14	*250*	400	3.0	3.5	0.03	0.03	< 0.01	< 0.01
B14t01	Reservoir	12	*60*	100	0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01
B14t02	Reservoir	8	*70*	125	0.5	1.0	< 0.01	0.01	< 0.01	< 0.01
B15t01	Tank	13	*< 20*	20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B16t01	Tank	9	*40*	60	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B16t02	Tank	9	*40*	60	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B16t03	Tank	9	*40*	60	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B17a	Pump house	4	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B17t01	Fire water tank	3	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B18t01	Tank	5	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
F01b	Kiln	3	*80*	100	0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01

APPENDIX 3

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 305-307 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE TRANSGRID 330 KV TRANSMISSION LINE

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22nd July 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
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Helensburgh NSW 2508

Ref: MSEC1059-02

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the TransGrid 330 kV transmission line resulting from the extraction of the proposed Longwall 305 to 307 at Metropolitan Colliery.

The locations of the 330 kV transmission line and the proposed longwall are shown in the attached Drawing No. MSEC1059-02.

A Study Area is shown in Drawing No. MSEC1059-02 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwalls 305 to 307.

The 330kV transmission line is located is outside the Study Area for Longwalls 305 to 307 and is 870 m from the nearest longwall (LW305). Predictions and impact assessments for the TransGrid 330 kV transmission line are provided below.

The transmission towers and reference numbers along the alignment of the TransGrid 330 kV transmission line are shown in Drawing No. MSEC1059-02. There are five suspension towers that are located to the east of the 300 series of longwalls that have been monitored since the commencement of Longwall 301 (i.e. Towers TL11 104 to TL11 108). The changes in alignment at the transmission towers are in the order of 1 to 3 degrees. A photograph of one of the 330 kV transmission towers is provided in Figure 1.

Figure 1 Photograph of a 330 kV Transmission Tower

Predictions of Conventional Subsidence Parameters

The 330 kV transmission line is located 870 m from Longwall 305. At this distance, the transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwalls 305 to 307. The transmission towers could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.

It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in the following section.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

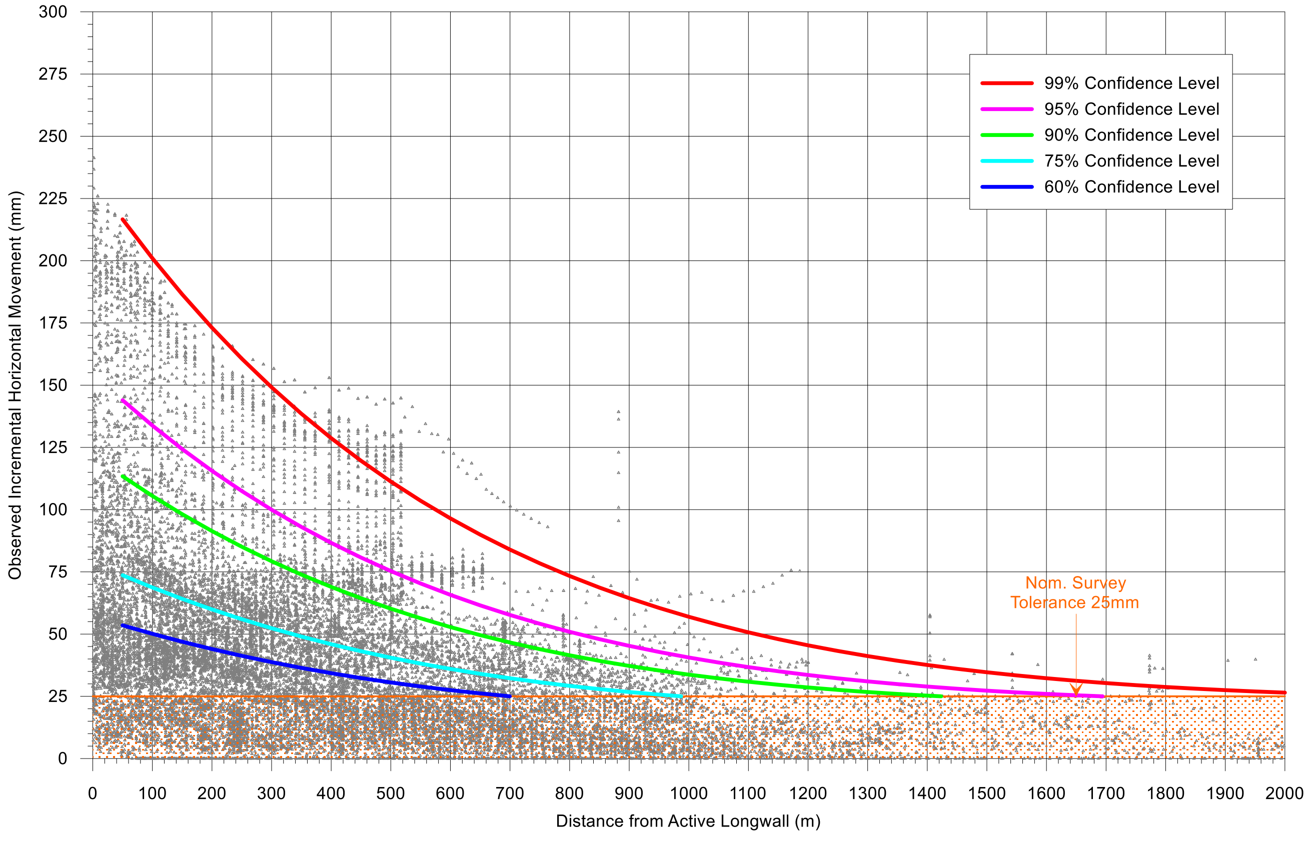

Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute incremental horizontal movements measured at distances greater than 870 m from mining are in the order of 45 mm based on the 95% confidence level. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable. The absolute far-field horizontal movements could result in minor changes in the distances between the towers since the directions of these far-field horizontal movements are generally expected to be towards the extracted longwalls.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1059-02. There are no mapped faults located within the Study Area that extend beneath the 330 kV transmission line. It is possible that the transmission line could experience localised and elevated strains due to unknown geological structures (i.e. anomalies).

Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 to 303. The range of strains provided in previous assessments (0.5 mm/m tensile and 0.4 mm/m compressive based on the 95% confidence interval) include those resulting from irregular anomalous movements.

The transmission line does not cross any major streams near the Study Area and, therefore, is not expected to experience any measurable valley closure effects.

Monitoring Data

Extensive monitoring of the transmission line and towers has been undertaken since the commencement of Longwall 301. A summary of the monitoring is provided below.

Transmission Line

A survey line (the Transmission Line) comprising ground survey pegs at nominal 20 m spacings has been monitored since the commencement of Longwall 301. Monitoring of the Transmission Line was initially carried out on a weekly basis during Longwalls 301 and 302. Monitoring of the Transmission Line encountered problems due disturbance of marks and peg stability. With the availability of accurate continuous GNSS monitoring stations at the towers and relative monitoring of the tower legs, the monitoring frequency of the Transmission Line was revised to end of panel only after the completion of Longwall 302.

A summary of the Total observed subsidence, tilt and strain along the Transmission Line after the completion of Longwall 303 is shown in the attached Fig. 01. It can be seen in this figure that maximum vertical subsidence is approximately 110mm between towers 106 and 107. Ground strains along the Transmission Line are predominantly within levels of survey accuracy of ±0.5mm. The maximum observed total subsidence at the GNSS monitoring stations are also shown in Fig. 01. The maximum incremental subsidence during the extraction of Longwall 303 was approximately 20mm.

GNSS Monitoring Stations

Continuous GNSS monitoring stations are located at the towers 104 to 108. GNSS Site 07, adjacent to tower 107 was vandalised soon after installation. The profiles of the development of vertical subsidence with time at the GNSS sites are shown in attached Fig. 02. It can be seen from this figure that the maximum vertical subsidence was measured at Sites 05 and 06 with minor subsidence at Site 04.

Horizontal movement at the GNSS sites is shown in Fig. 03. The maximum horizontal movement occurred at Site 06, with approximately 60mm observed during Longwall 303. The horizontal movements observed during the longwall extraction are consistent with the horizontal movement data in Figure 2.

The observed relative opening and closing between GNSS sites is shown in Fig. 04. In the absence of observed data for Site 07, relative opening and closure is measured between Sites 06 and 08. It can be seen from this figure that maximum relative opening or closing between the towers is approximately 25mm, which is consistent with expected movements.

Tower Tilt

Tower tilt has been monitoring using changes in relative height of leg mounted prisms. The observed tilts for Towers 104 to 108 are shown in Fig. 05. Maximum observed tilt occurs at Towers 105 and 106 with an observed tilt of 1.5mm/m (0.09 degrees). The maximum observed tilt is slightly higher than predicted tilt of 1.0 mm/m.

It can be seen from Fig. 05 that the majority of the observed tilt developed during the extraction of Longwalls 301 and 302, with minor tilt observed during Longwall 303.

Differential movement between tower legs

The change in distance between tower legs has been monitored during the extraction of Longwalls 301 to 303. Monitoring was revised from weekly to monthly after the completion of Longwall 302. The observed change in distance between tower legs and average strain for Towers 104 to 108 are shown in Fig. 06 to 10 respectively.

It can be seen from Fig. 06 to 10 that the variation in magnitude of differential movement for Towers 104 to 108 varies from 3 mm opening to 2 mm closing. The variation during the extraction of Longwall 303 varied from approximately 1mm opening to 1mm closing. This range of differential movement is predominantly generated by limits of survey accuracy and is within the range of ±4 mm outlined in the Trigger Action Response Plan for Longwalls 301 to 303.

Impact Assessments and Recommendations for the 330 kV Transmission Line

The cables along the 330 kV transmission line are not directly affected by ground strains, as they are supported by the towers above ground level. The cables can, however, be affected by the changes in bay lengths, i.e. the distances between the towers at the level of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the towers due to differential tilting of the towers. The stability of the transmission towers can be affected by the mining induced tilts, curvatures and ground strains at the tower locations and by changes in the catenary profiles of the cables.

Whilst the 330 kV transmission line could experience low level far-field horizontal movements, the associated tilts, curvatures or strains are not expected to be measurable. It is unlikely that the transmission lines would experience adverse impacts as a result of conventional subsidence movements due to the extraction of Longwalls 305 o 307.

Far-field horizontal movements could result in small changes in the distances between the towers, particularly those located near the ends of the longwalls. Differential far-field horizontal movements between the transmission towers due to the extraction of Longwall 305 to 307 are expected to be less than 20 mm and are not expected to result in adverse impacts to the transmission line.

Localised and elevated ground strains can develop due to the presence of geological structures. It is possible that the transmission towers could experience ground strains greater than those predicted based on conventional movements if they were coincident with the surface expression of a fault. The potential for non-conventional movements in the locations of the towers is very low, due to their distances from the longwalls and observations to date, however, the potential for these irregular movements cannot be discounted.

A monitoring program, including a trigger action response plan, has been in place since the commencement of Longwall 301. Observed subsidence parameters have been within expected levels with no identified non-conventional movements. Based on these results the likelihood of non-conventional movements occurring as a result of the extraction of Longwall 304 is considered to be very low.

It is considered that monitoring and management strategies developed for the extraction of Longwalls 301 to 304 could be relaxed for the extraction of Longwalls 305 to 307. In consultation with Endeavour Energy, monitoring and management strategies could be revised to manage the transmission line for potential non-conventional ground movements. Given the increased distance to the Transmission Line and the minor movements observed during Longwall 303 it considered that survey frequency could be reduced to end of panel surveys only. In addition, with real time GNSS monitoring stations in place and continuation of tower leg monitoring, consideration could be given to cessation of monitoring of the Transmission Line ground pegs during Longwalls 305 to 307.

Summary

The 330 kV transmission line is located to the east of the proposed Longwalls 305 to 307 and is located outside the Study Area at distances of 870 m or more from Longwall 305. At this distance, the transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwalls 305 to 307. The transmission towers could experience low level far-field horizontal movement. It is considered unlikely that the transmission lines would experience adverse impacts as a result of predicted movements due to the extraction of Longwalls 305 to 307.

It is possible that the transmission towers could experience localised and elevated strains due to the presence of geological structures (known or unknown), if the surface expressions of these features are coincident with them. Non-conventional subsidence movements have not been observed during the extraction of Longwalls 301 to 303 and the likelihood of non-conventional subsidence movements at the transmission towers due to Longwalls 305 to 307 is considered to be very low.

Based on monitoring data observed during Longwalls 301 to 303 and the increased distance to the transmission towers, a revision of the monitoring and management strategies is recommended in consultation with TransGrid with a view to reducing the frequency of monitoring. It is expected that the potential impacts on the TransGrid infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono
Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC1059-02 – Longwall 305 to 307 – TransGrid 330 kV Transmission Line

Fig. 01 Profiles of total subsidence, tilt and strain along the transmission line due to LW301 to 303

Fig. 02 Observed total subsidence at GNSS monitoring stations

Fig. 03 GNSS stations total horizontal movement due to Longwall 301 to 303

Fig. 04 Observed opening and closure between GNSS monitoring stations

Fig. 05 Total observed tilt at TransGrid 330kV towers due to Longwalls 301 to 303

Fig. 06 Observed differential leg movements and strain at tower 104 due to LW301 to 303

Fig. 07 Observed differential leg movements and strain at tower 105 due to LW301 to 303

Fig. 08 Observed differential leg movements and strain at tower 106 due to LW301 to 303

Fig. 09 Observed differential leg movements and strain at tower 107 due to LW301 to 303

Fig. 10 Observed differential leg movements and strain at tower 108 due to LW301 to 303

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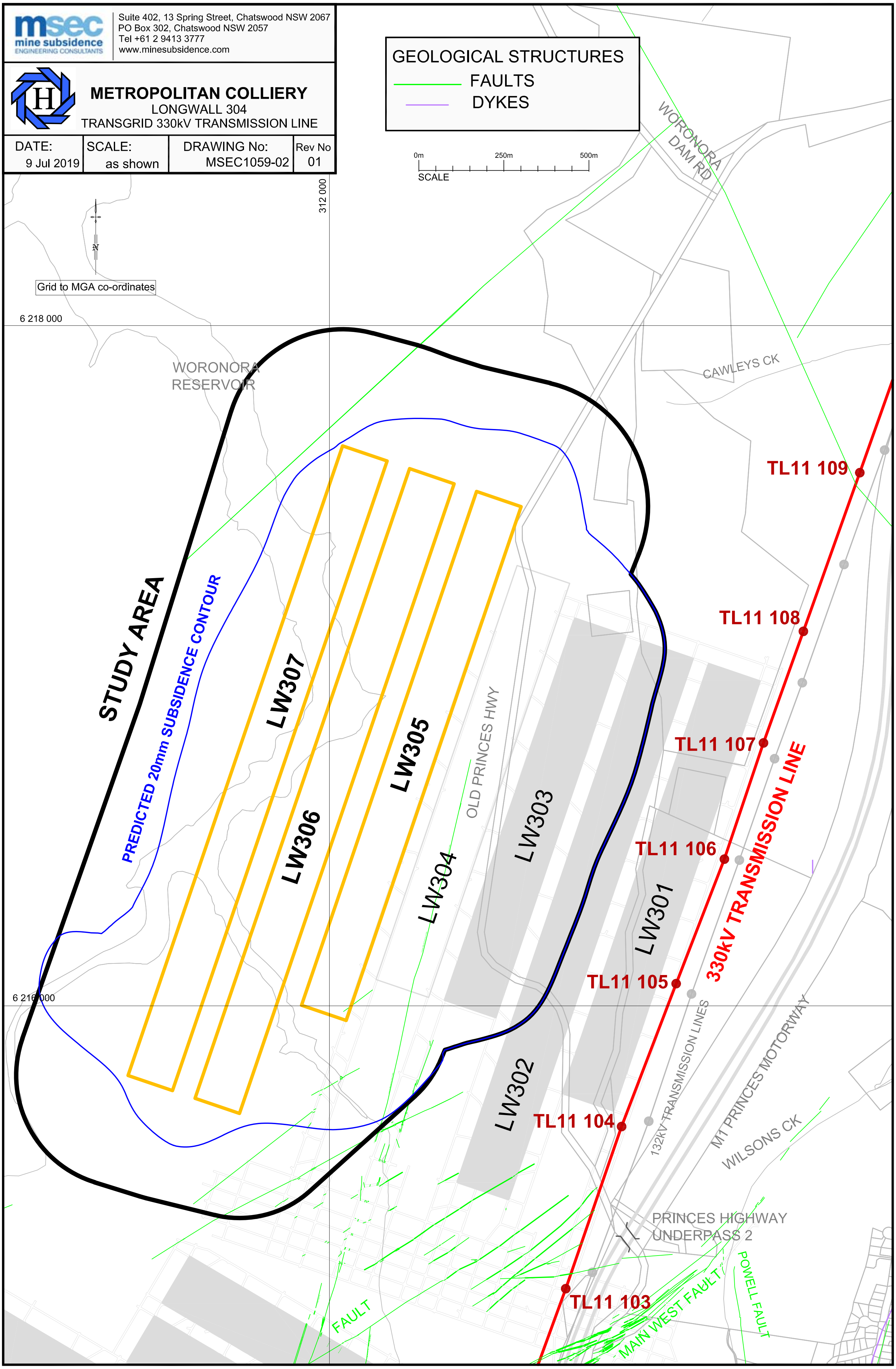
METROPOLITAN COLLIERY
LONGWALL 304
TRANSGRID 330kV TRANSMISSION LINE

DATE:	SCALE:	DRAWING No:	Rev No
9 Jul 2019	as shown	MSEC1059-02	01



Profiles of Total Subsidence, Tilt and Strain along the Transmission Line due to LW301 to LW303

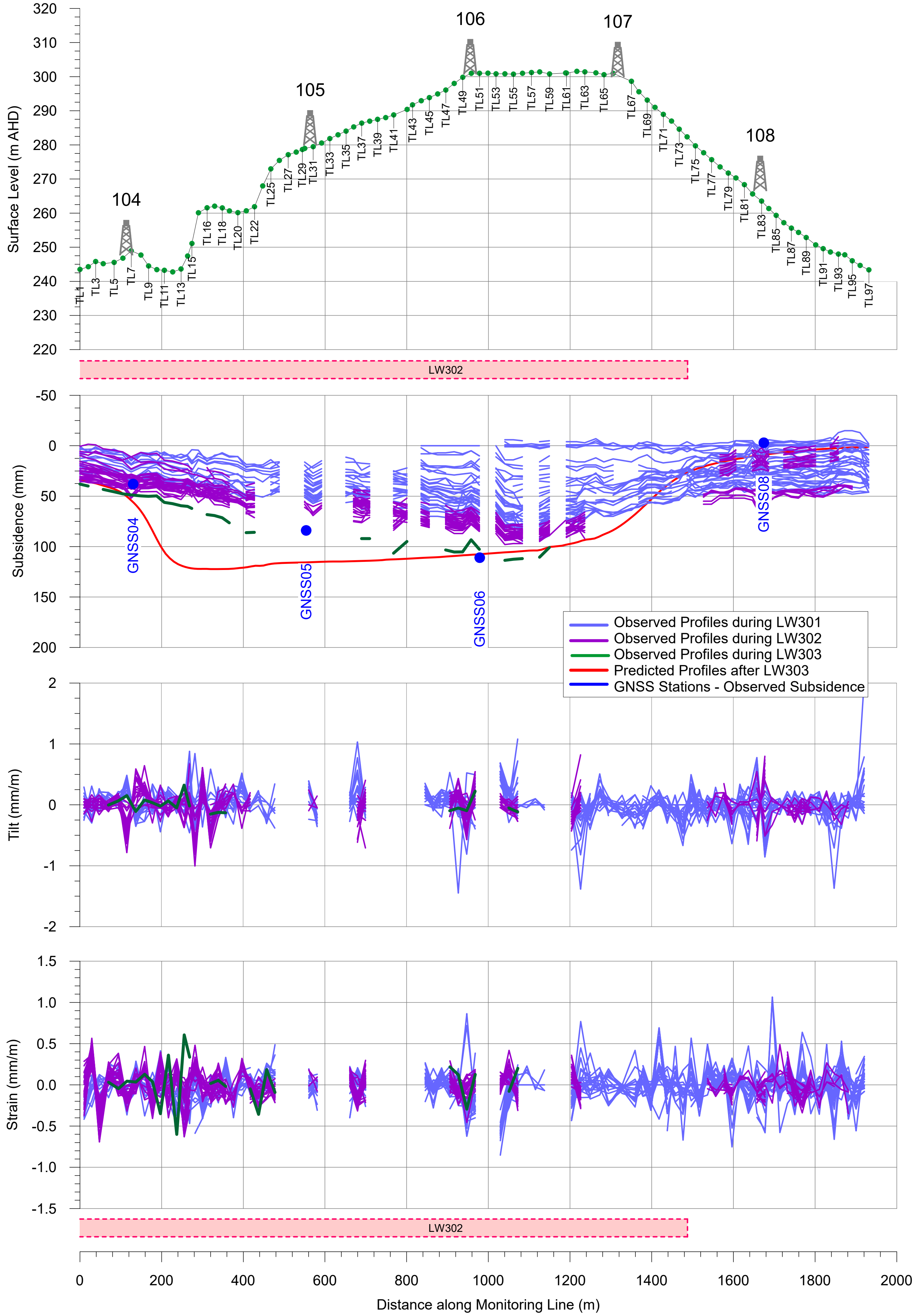


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Fig. 01

Observed Total Subsidence at GNSS Monitoring Stations

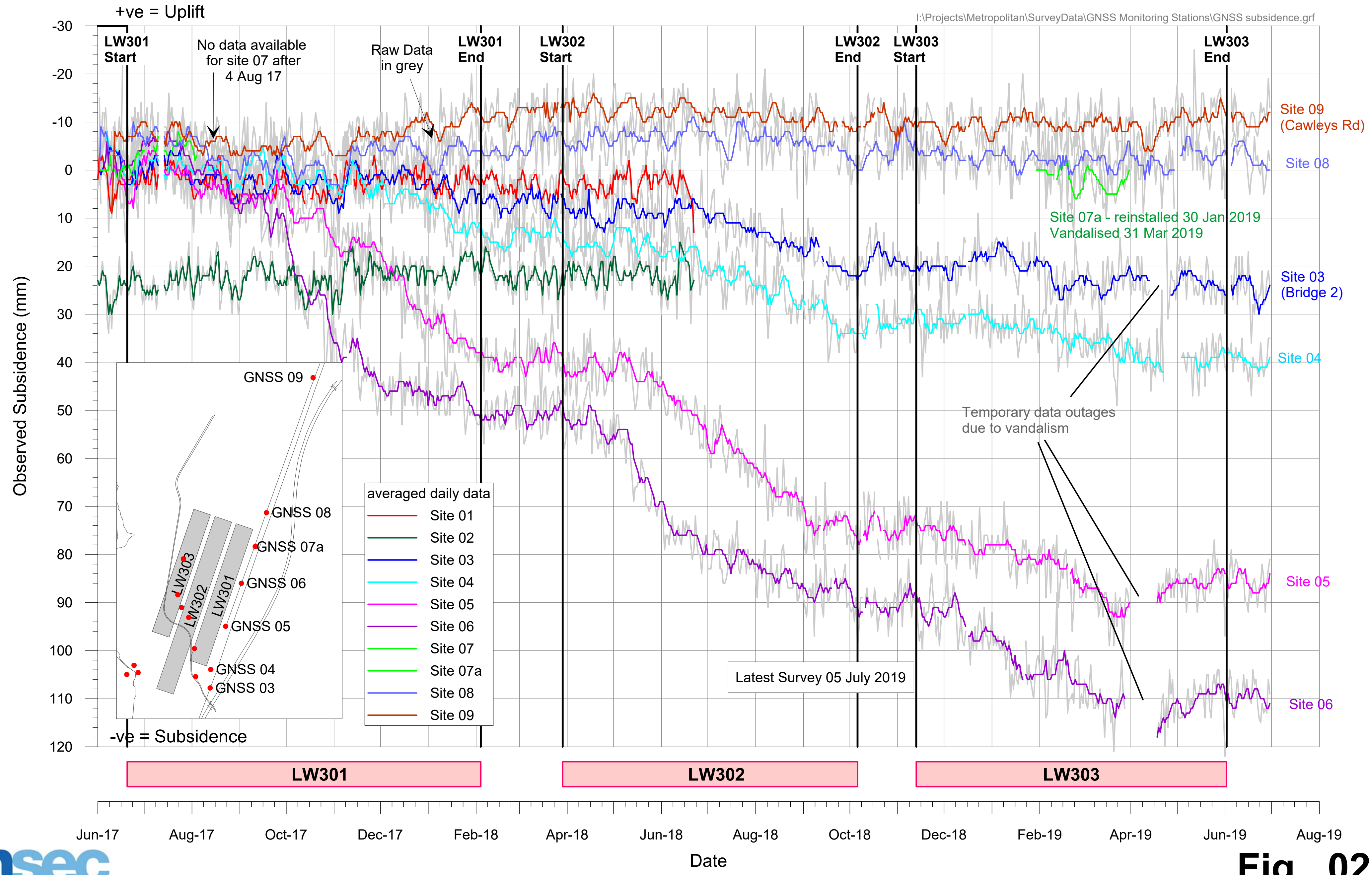

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Fig. 02

GNSS Stations Total Horizontal Movement due to Longwall 301 to 303

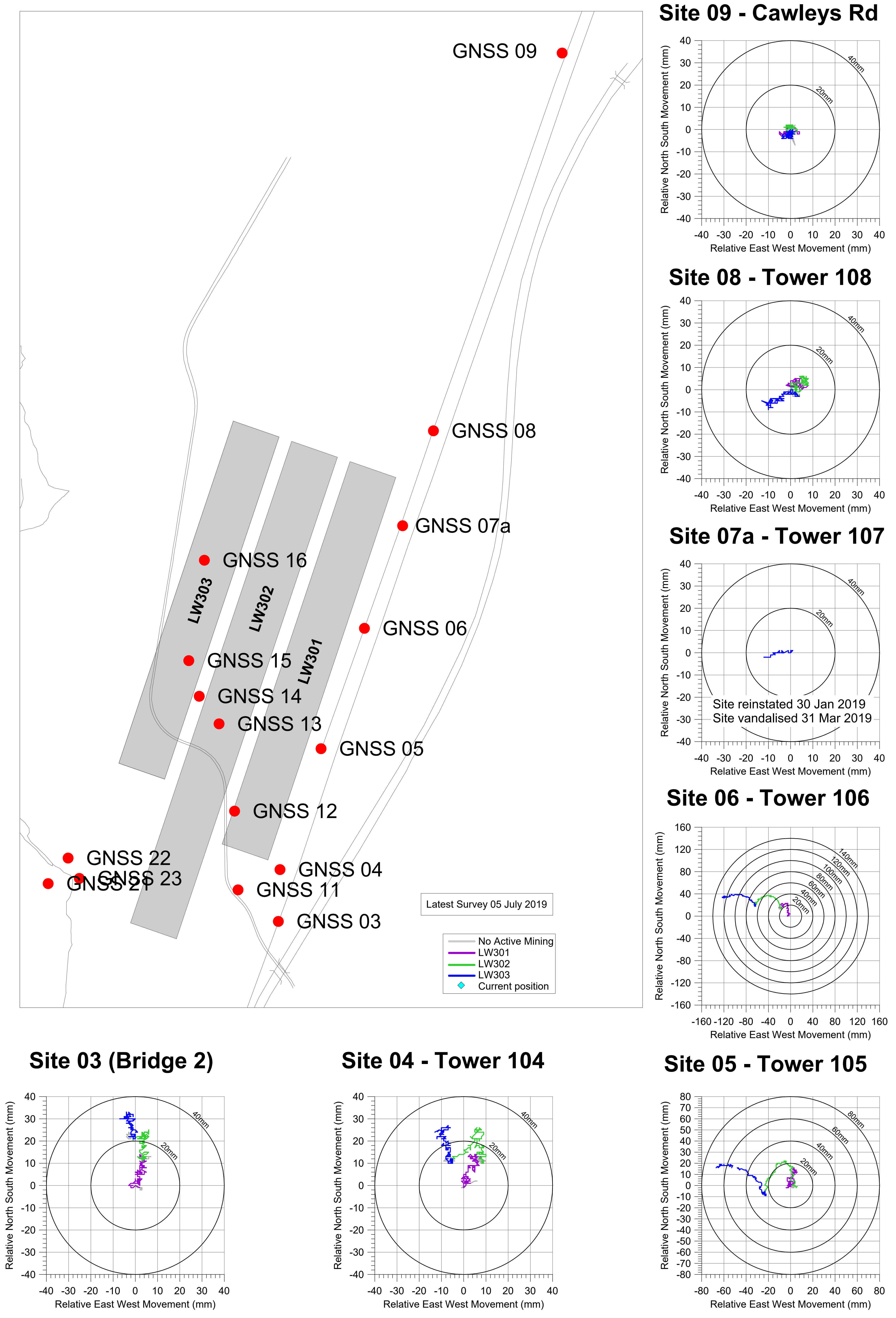
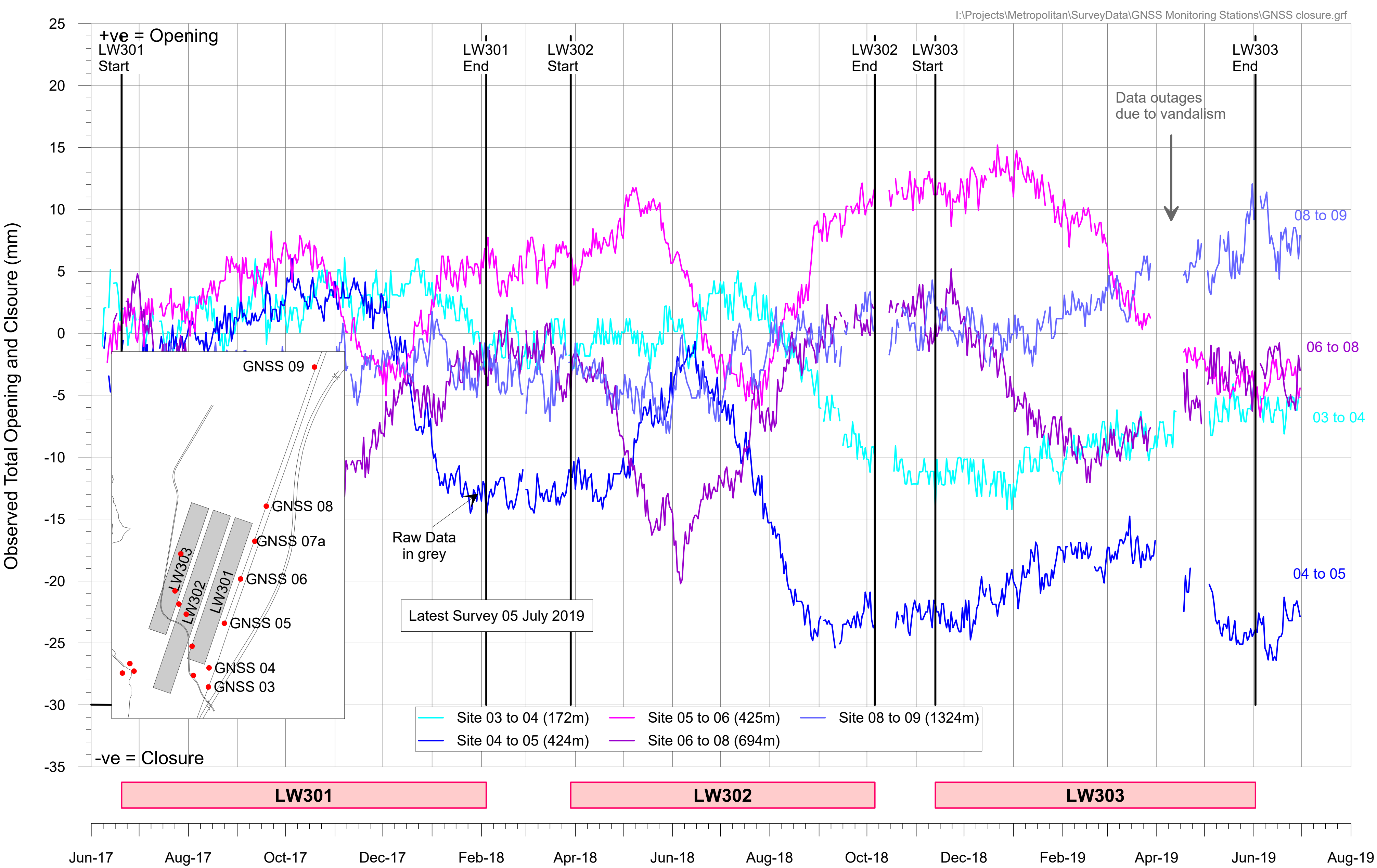


Fig. 03

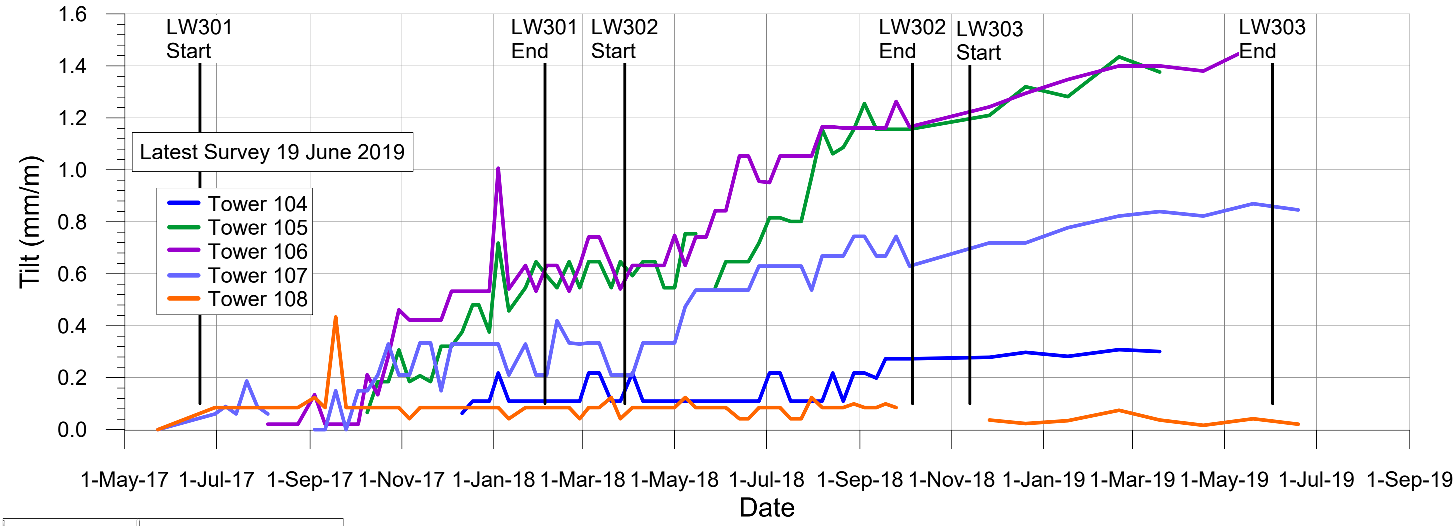
Observed Opening and Closure between GNSS Monitoring Stations

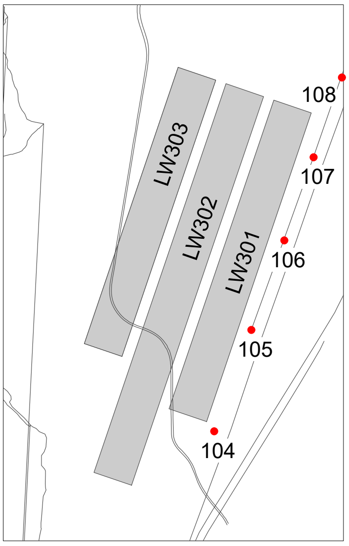


msec

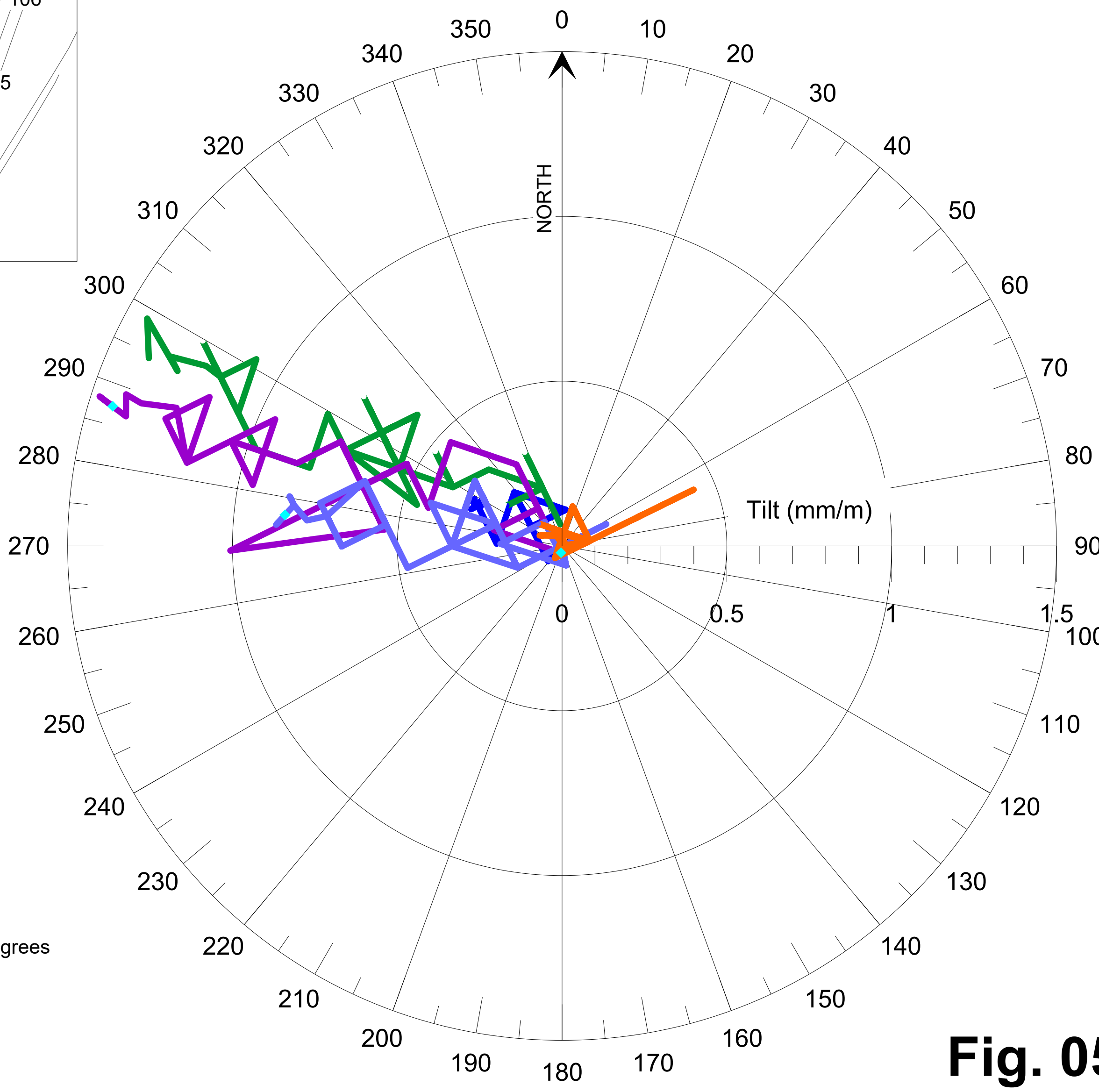
Fig. 04

Total Observed Tilt at TransGrid 330kV Towers
Due to Longwalls 301 to 303





Polar Plot of TransGrid 330kV Towers
Total Tilt due to Longwalls 301 to 303

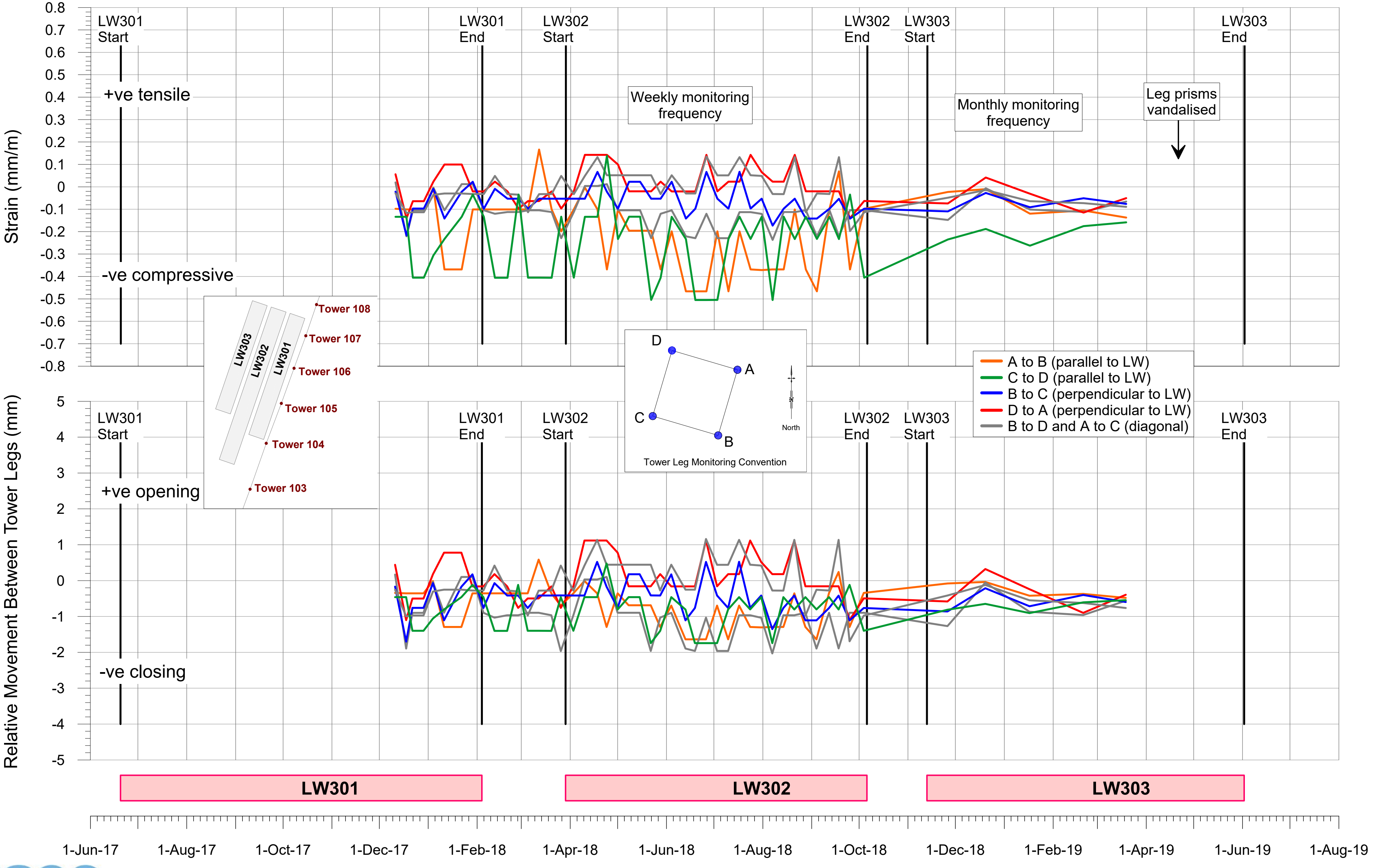


Note
1.5mm/m tilt = 0.09 degrees

msec

Fig. 05

Observed Differential Leg Movements and Strain at Tower 104 due to LW301 to 303



msec

Fig. 06

Observed Differential Leg Movements and Strain at Tower 105 due to LW301 to 303

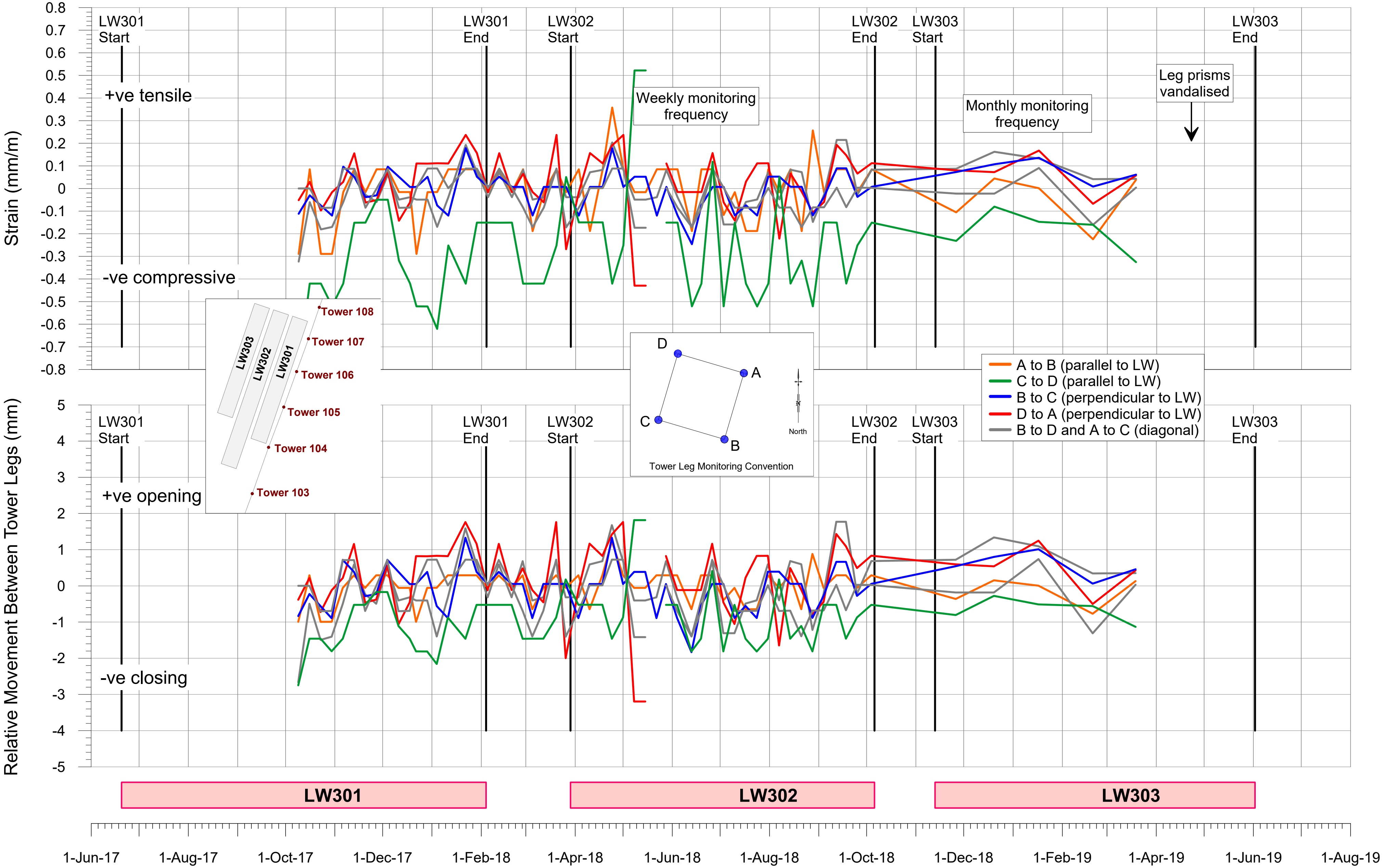


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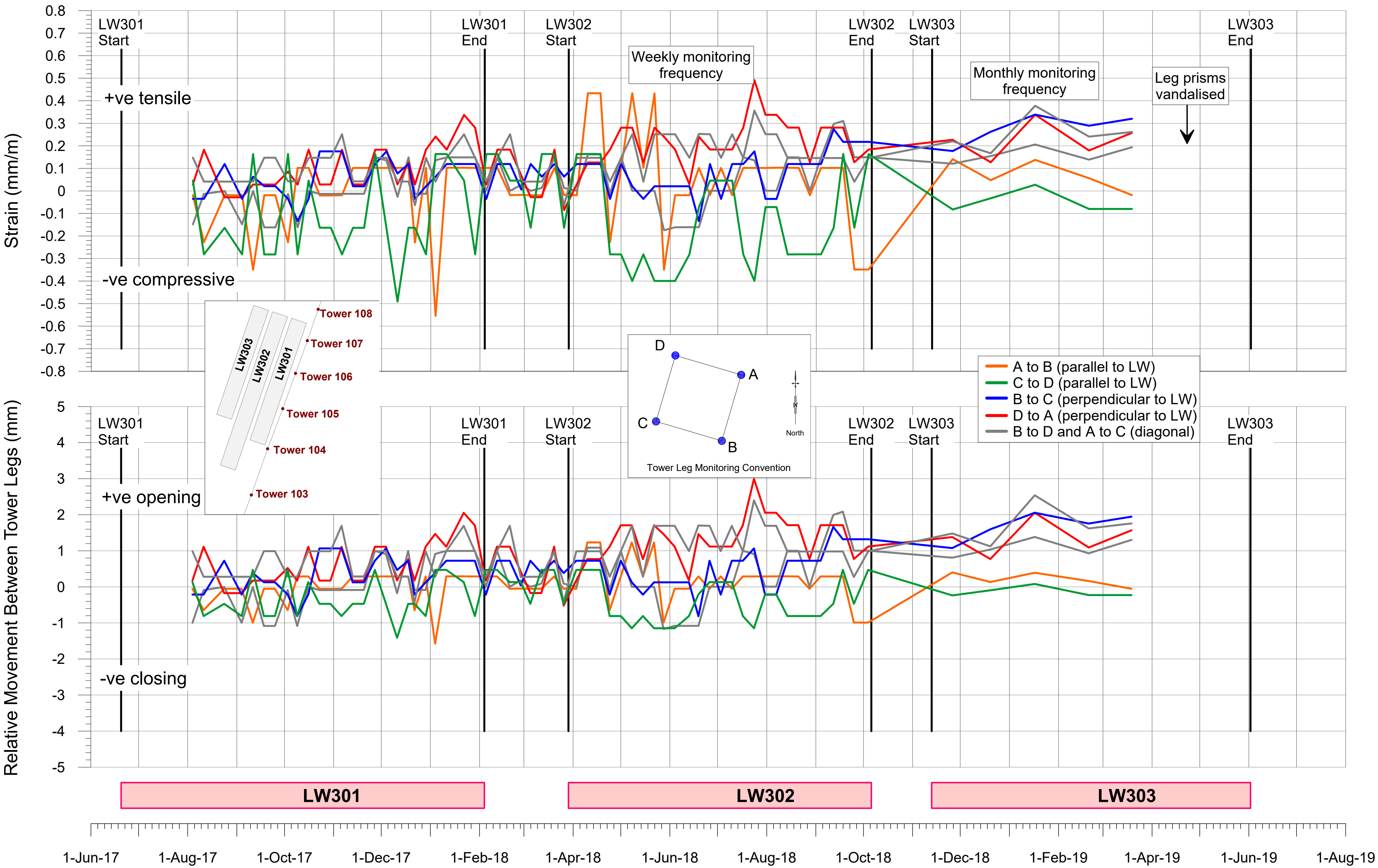
Fig. 07

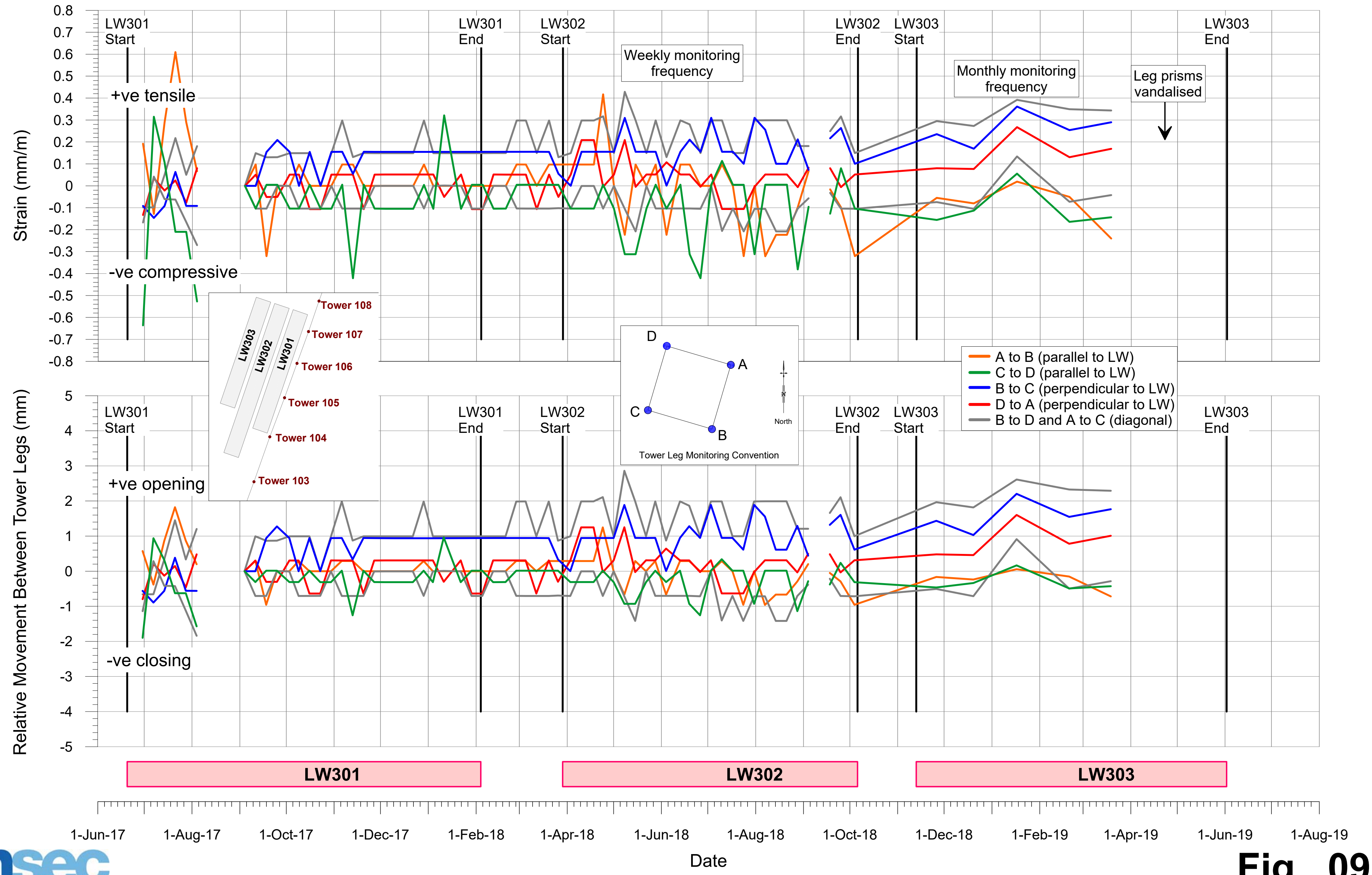
Observed Differential Leg Movements and Strain at Tower 106 due to LW301 to 303



msec

Fig. 08

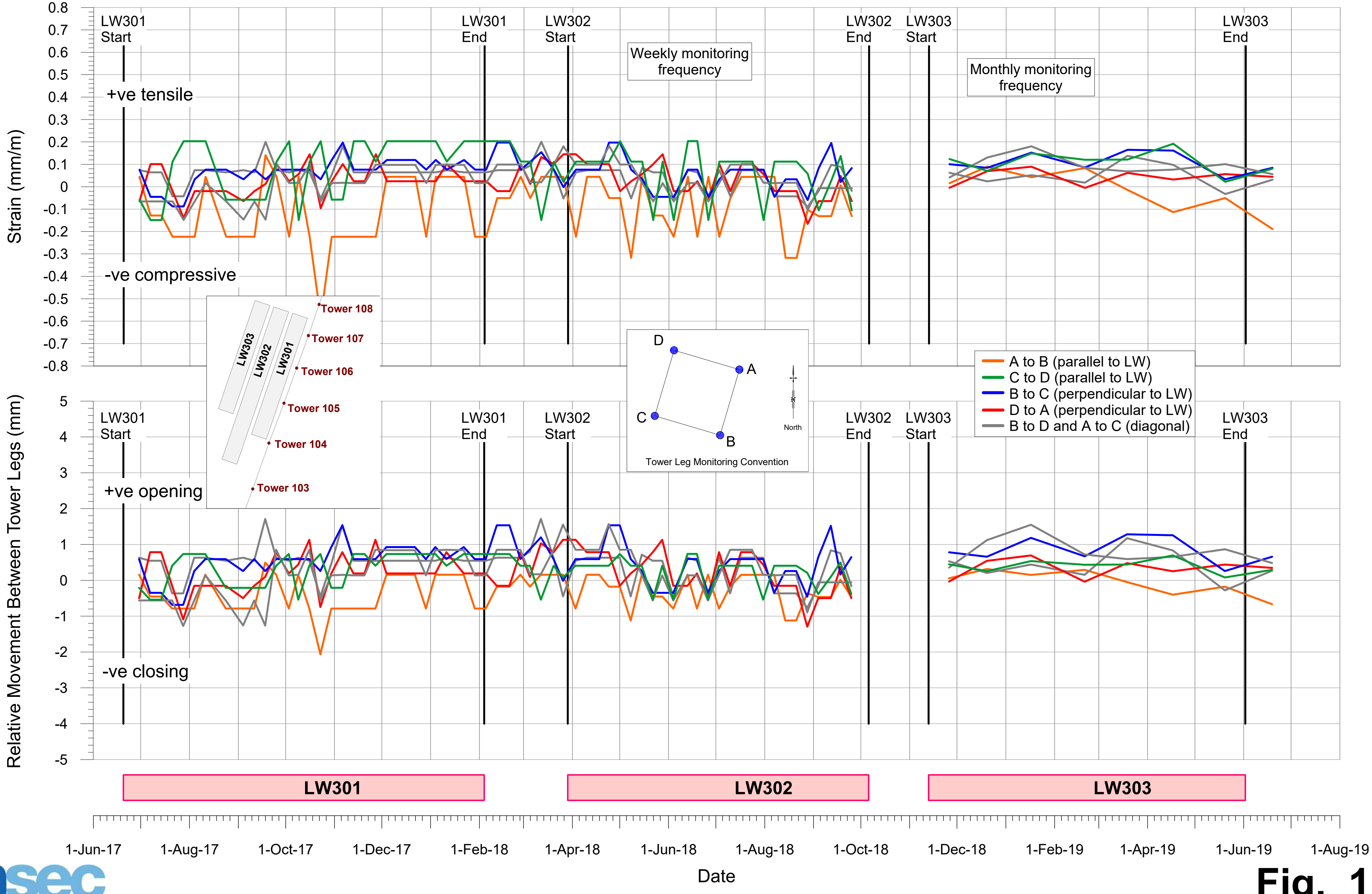
Observed Differential Leg Movements and Strain at Tower 107 due to LW301 to 303



msec

Fig. 09

Observed Differential Leg Movements and Strain at Tower 108 due to LW301 to 303



msec

Fig. 10

APPENDIX 4

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. transmission line, tower, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of tower, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

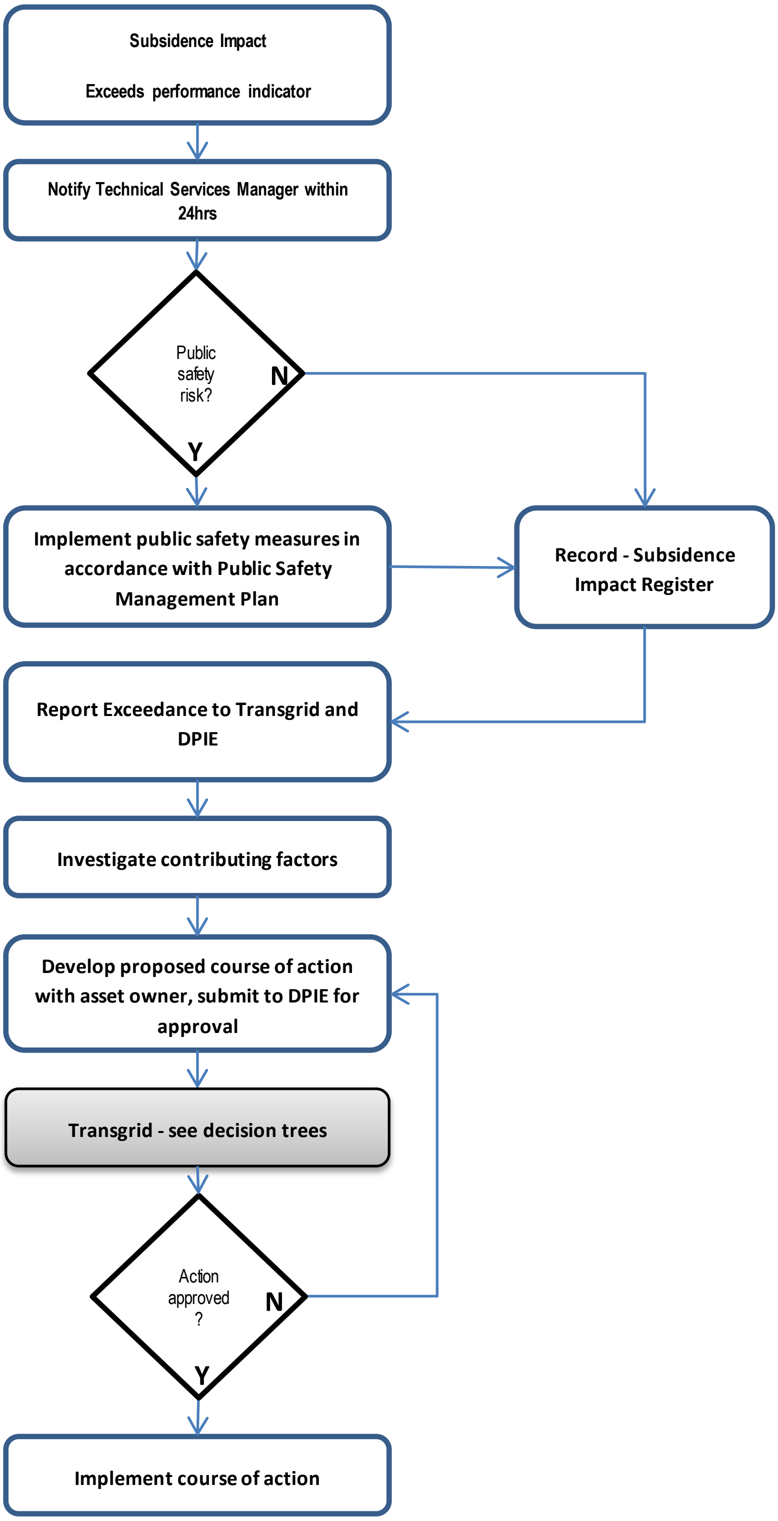
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

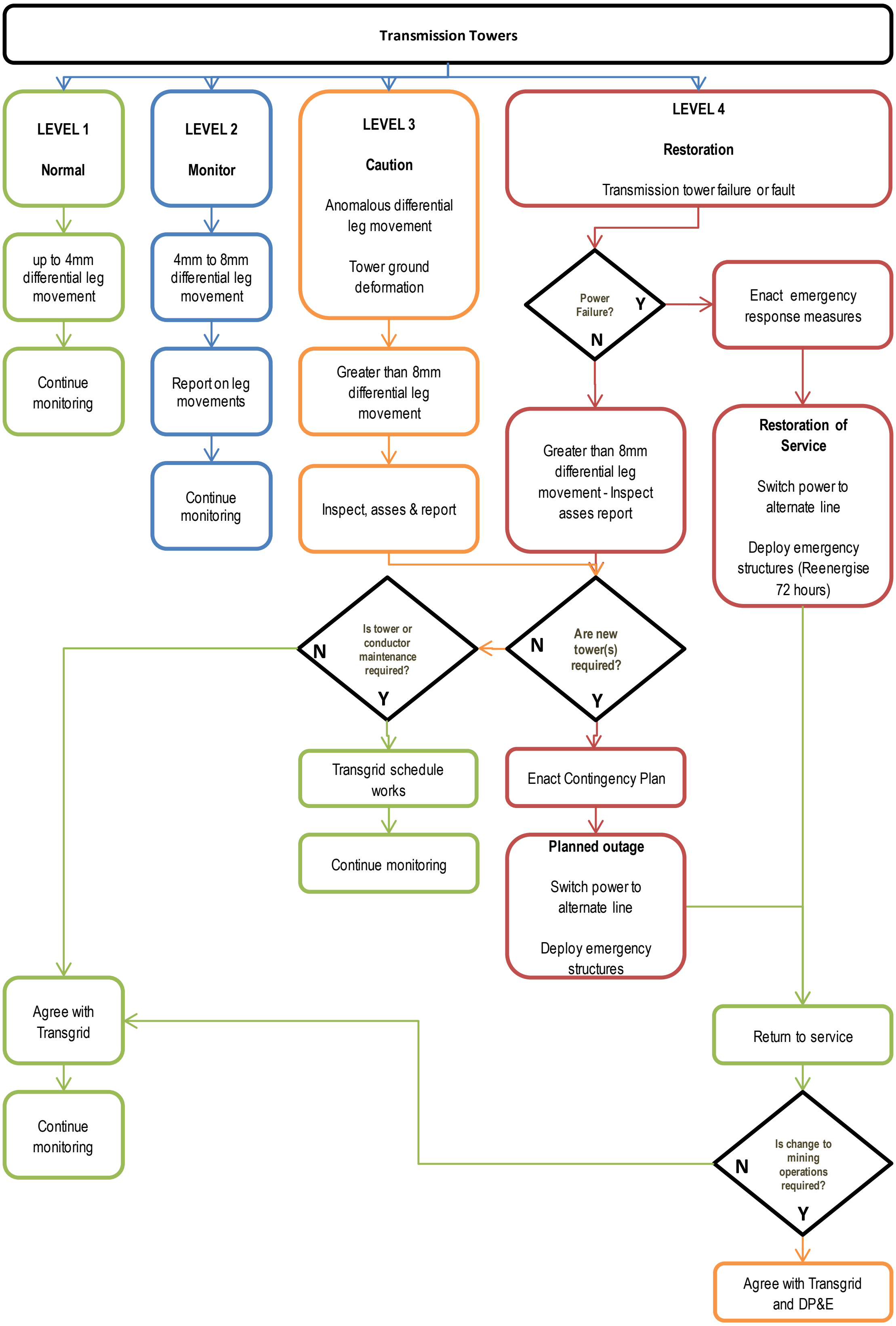
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 5

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Transgrid and DPIE
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DPIE for approval
Transgrid - see decision trees
Action approved ?
N
Y
Implement course of action


Transmission Towers
LEVEL 1
Normal
up to 4mm differential leg movement
Continue monitoring
LEVEL 2
Monitor
4mm to 8mm differential leg movement
Report on leg movements
Continue monitoring
LEVEL 3
Caution
Anomalous differential leg movement
Tower ground deformation
Greater than 8mm differential leg movement
Inspect, asses & report
LEVEL 4
Restoration
Transmission tower failure or fault
Power Failure?
Y
N
Enact emergency response measures
Restoration of Service
Switch power to alternate line
Deploy emergency structures (Reenergise 72 hours)
Greater than 8mm differential leg movement - Inspect asses report
Are new tower(s) required?
N
Y
Is tower or conductor maintenance required?
N
Y
Transgrid schedule works
Continue monitoring
Enact Contingency Plan
Planned outage
Switch power to alternate line
Deploy emergency structures
Agree with Transgrid
Continue monitoring
Return to service
Is change to mining operations required?
N
Y
Agree with Transgrid and DP&E