APPENDIX F – SUPPLEMENTARY EMF ASSESSMENT

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11 November 2010

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Dear Deborah

North Sydney Zone Substation: EMF Assessment

The purpose of this letter is to provide supplementary advice in relation to our report *North Sydney 132kV Zone Substation EMF Assessment* dated 19th August 2010.

1. Background

The subject project is currently undergoing assessment under Part 3A of the *Environmental Planning and Assessment Act 1979* and an Environmental Assessment (EA) has been undertaken. Aurecon's August, 2010 EMF assessment report was submitted as part of the EA. As a result of the Department of Planning's examination of the EA and consideration of submissions thereto, the proponent has modified the design of the proposed substation and, accordingly has instructed Aurecon to review the impact of the design changes on the earlier EMF assessment.

2. Principal Design Changes

In the context of EMF, the principal design changes are:

- the relocation of 10x11kV feeder cables from Riser 1 to Risers 2 and 3, both of which are further from the eastern boundary than Riser 1;
- consequential changes associated with the abovementioned cable relocations; and
- the revision of the switchboard arrangement from double bus to single bus.

3. Alternative Development Proposal 136-140 Walker Street

At the time of our August 2010 EMF assessment, we were advised of a combined commercial and residential development (the Castle Constructions development) proposed for an adjoining property (136-140 Walker Street) and this was specifically considered in the assessment. We have since become aware of an alternative development proposal (the Winten Property Group development) for the same site and have been instructed to consider this development also in this supplementary advice. We have also been asked to consider the field reduction which could be achieved by the provision of 1 metre separation between the residential floors and the substation.

4. Approach

In preparing this supplementary advice we have:

- Obtained details of the proposed modified cable routes from Energy2U Alliance.
- Modified our model of the substation to reflect the modified cable routes, where a material impact on the magnetic fields at and beyond the substation boundary is predicted.
- Re-run the model to produce revised field contour maps and profiles.
- Calculated the magnetic fields at the relevant floor levels of the two alternative developments proposed for 136-140 Walker Street.
- Compared the predicted field levels associated with the revised design with those contained in our EMF report dated 19th August 2010.

5. Findings

The results of our calculations are set out in a supplementary report, a copy of which is attached. In summary, the proposed design modifications will have the following effect on the predicted magnetic fields:

- There will be a 46% reduction in the magnetic field peaks adjacent to Riser No.1 on the eastern boundary of the site.
- The predicted peak field level at a commercial floor of the proposed Castle Constructions development will be reduced by approximately 12% to 15mG. The levels now predicted at the commercial floors are shown in Figures 2.9 to 2.11 of our supplementary report.
- The predicted peak field level at a residential floor of the proposed Castle Constructions development (Level 5) will be reduced by approximately 5% to 8.5mG. The levels now predicted at the lowest residential floor are shown in Figure 2.12 of our supplementary report.
- The predicted field levels at the various levels of the proposed Winten Property Group development are shown in Figures 2.14 to 2.20 of our supplementary report.

6. Conclusions

- The highest magnetic fields at the eastern boundary of the proposed North Sydney Zone Substation have been reduced by the proposed design modifications. The design modifications made are consistent with the principles of Prudent Avoidance.
- The highest magnetic fields at the proposed Castle Constructions development are predicted to occur at Level 2 and will now range from 11 to 15 mG (under the ultimate loading condition) at the outer wall nearest the substation. From the peak of 15mG, the magnetic field level will decrease to 7mG within 10 metres of the outer wall. The fields at other levels will be less than those for Level 2.
- The highest magnetic fields at the proposed Winten Property Group development are predicted to occur at the ground floor and will range from 11 to 15 mG (under the ultimate loading condition) at the inner wall nearest the substation. From the peak of approximately 15mG, the magnetic field level will decrease to 6mG within 10 metres of the inner wall. The fields at other levels will be less than those for the ground floor.

- In regard to the residential floors, the highest magnetic fields are predicted to occur at Level 5 for the proposed Castle Constructions development and Level 2 for the proposed Winten Property Group development. The peak magnetic field level at a residential floor is predicted to be 8.5mG for the Castle Constructions development and 15mG for the Winten Properties Group development. Within 10 metres of the wall, these peak field levels will decrease to 5mG and 7mG respectively.

- If a 1 metre separation were to be provided between the residential floors of the Winten Property Group development and the substation, the peak field level at a residential floor (Level 2) would be reduced by approximately 13%.

Yours faithfully

Paul Flanagan /CB

Principal Engineer

North Sydney 132kV Zone Substation
EMF Assessment – Supplementary Report
Energy2UAlliance

11 November 2010

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Document control

Rev No	Date	Revision details	Typist	Author	Verifier	Approver
0	11 November 2010	Final Supplementary Report	CB	CB	PF	BK

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1. Introduction

1.1 Background

EnergyAustralia is seeking planning approval under Part 3A of the *Environmental Planning and Assesment Act 1979*for the establishment of a 132kV Zone Substation (ZS) at North Sydney. In connection with the project, Aurecon has previously undertaken an EMF assessment which is documented in our report *North Sydney 132kV Zone Substation EMF Assessment* dated 19th August 2010. It is understood that Aurecon's August, 2010 EMF assessment report was submitted to the Department of Planning as part of the overall Environmental Assessment (EA) for the project.

It is further understood that, as a result of the Department of Planning's examination of the EA and consideration of submissions thereto, the proponent has modified the design of the proposed substation and, accordingly has instructed Aurecon to review the impact of the design changes on the earlier EMF assessment. The information contained within this report will be used to inform a Preferred Project Report.

1.2 Principal Design Changes

In the context of EMF, the principal design changes are:

- the relocation of 10x11kV feeder cables from Riser 1 to Risers 2 and 3, both of which are further from the eastern boundary than Riser 1;
- consequential changes associated with the abovementioned cable relocations; and
- the revised switchboard arrangement from double bus to single bus.

1.3 Alternative Development Proposal 136-140 Walker Street

At the time of our August 2010 EMF assessment, we were advised of a proposed combined commercial and residential development (the Castle Constructions development) proposed for an adjoining property (136-140 Walker Street) and this was specifically considered in the assessment. We have since become aware of an alternative development proposal (the Winten Property Group development) for the same site and have been instructed to consider this development also in this supplementary advice.

1.4 Approach

In preparing this supplementary advice we have:

- Obtained details of the proposed modified cable routes from Energy2U Alliance.
- Modified our model of the substation to reflect the modified cable routes, where a material impact on the magnetic fields at and beyond the substation boundary is predicted.
- Re-run the model to produce revised field contour maps and profiles, with particular emphasis on the eastern boundary.
- Calculated the magnetic fields at the relevant floor levels of the two alternative developments proposed for 136-140 Walker Street.
- Compared the predicted field levels associated with the revised design with those contained in our EMF report dated 19th August 2010.

2. Field Characterisation

2.1 Modelling of the magnetic field contribution of the proposed ZS

Based on the available revised design and loading information, provided by Energy2U Alliance, the magnetic field contribution expected from the proposed ZS and adjacent underground feeders has been modelled using the CDEGS software package.

CDEGS is an internationally recognised software package pioneered by Safe Engineering Services & Technologies (SES) to provide grounding and electromagnetic and conductive interference analysis involving electrical networks. The software has undergone extensive scientific validation using field tests and comparisons with analytical or published results for over twenty years.

As noted in our previous assessment, the magnetic fields from substation equipment depend on the loadings at that particular time. Accordingly, in characterising the magnetic fields, it is necessary to make practical assumptions regarding the substation and feeder loadings.

During a typical day, the amount of load current passing through a substation will vary substantially between a daily minimum, generally in the early hours of the morning and a daily maximum at times of peak demand. Loadings also vary seasonally during the year, generally reaching a peak in either summer or winter. An example of a summer weekday load profile for the existing North Sydney ZS is shown in Figure 2.1. It can be seen that the night-time load (and hence magnetic field) is less than half the day-time load.

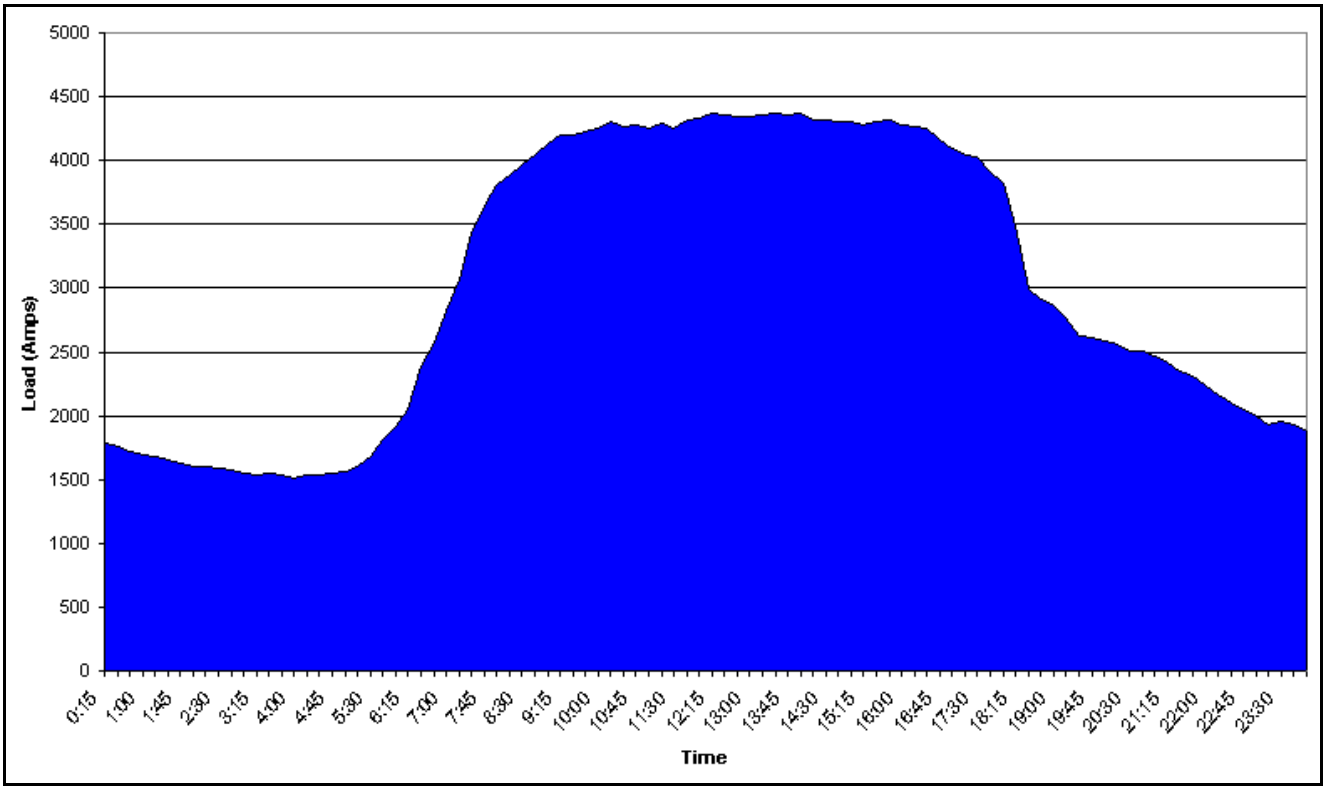

Figure 2.1 – Summer weekday load profile for North Sydney zone (Feb 4th 2010)

As in our previous assessment, the magnetic field levels have been modelled with the substation loading conservatively assumed to be the 85th percentile of the forecast initial and ultimate load levels respectively, provided by Energy2U Alliance. It should be noted that, following completion of the proposed works, the magnetic fields would be dependent on the actual loading rather than that used for calculation purposes. Nevertheless, the actual loading would be expected to be less than that modelled for 85% of the time.

Fields have been calculated at a height of 1 metre above street level in accordance with international practice. Two sets of contours were calculated for the substation, one related to Ward Street level and one related to Harnett Street level which is approximately 3 metres lower than Ward Street.

2.1.1 Proposed ZS

Plan and elevation screenshots of the CDEGS model of the proposed ZS are shown in Figure 2.2 below.

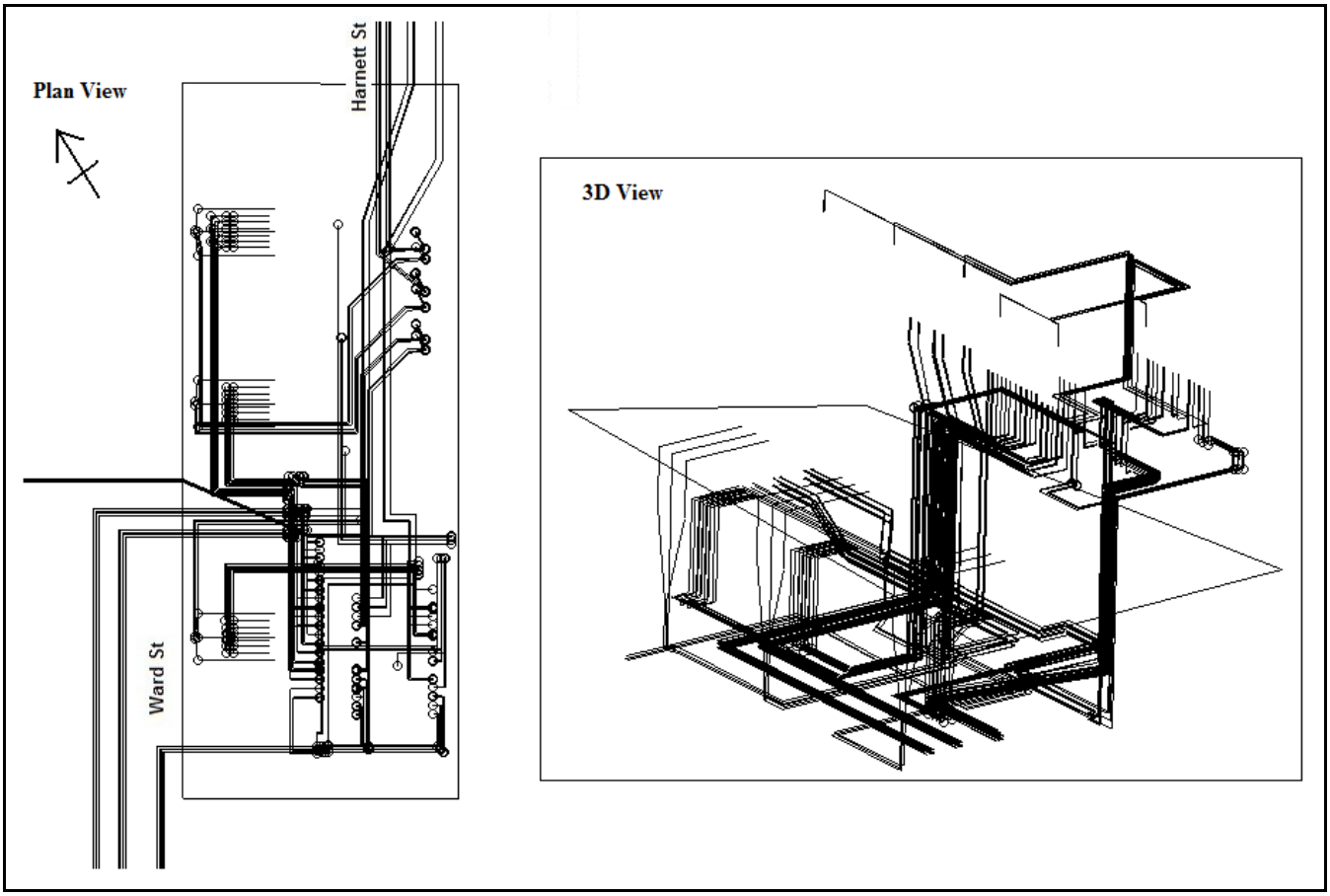

Figure 2.2 – CDEGS Model of proposed ZS (ultimate configuration)

The results obtained from the magnetic field modelling are shown below in the form of surface contour plots for the whole site and profiles along the boundaries. Figures 2.3a and 2.3b show surface contour plots of the magnetic field levels calculated within and around the proposed ZS, both under the initial condition (shortly after commissioning) and under the ultimate loading condition. These contour plots were calculated at 1m above the street level for Harnett Street and Ward Street levels respectively.

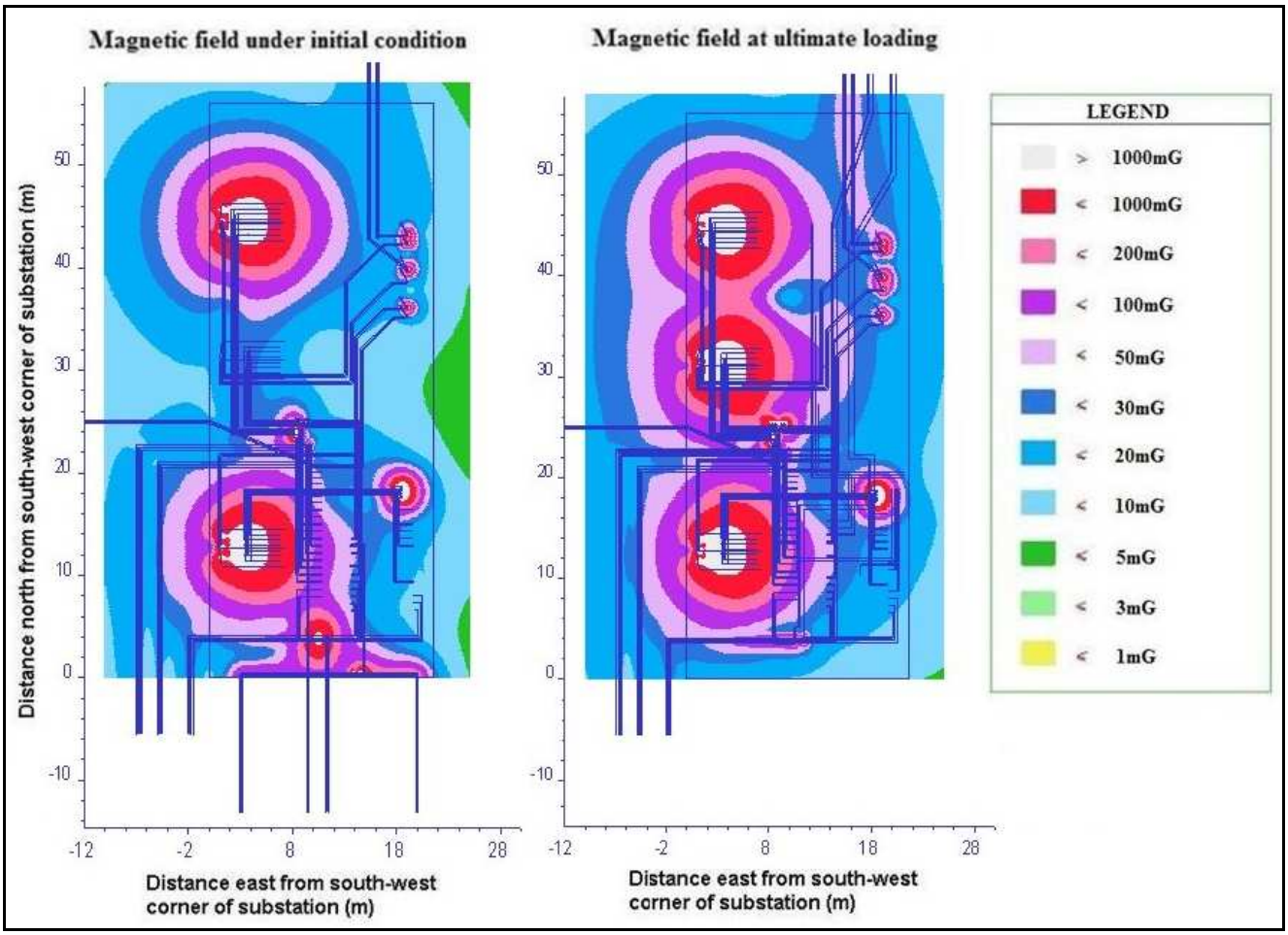

Figure 2.3a – Predicted magnetic field contribution associated with the proposed ZS at 1m above Harnett Street level

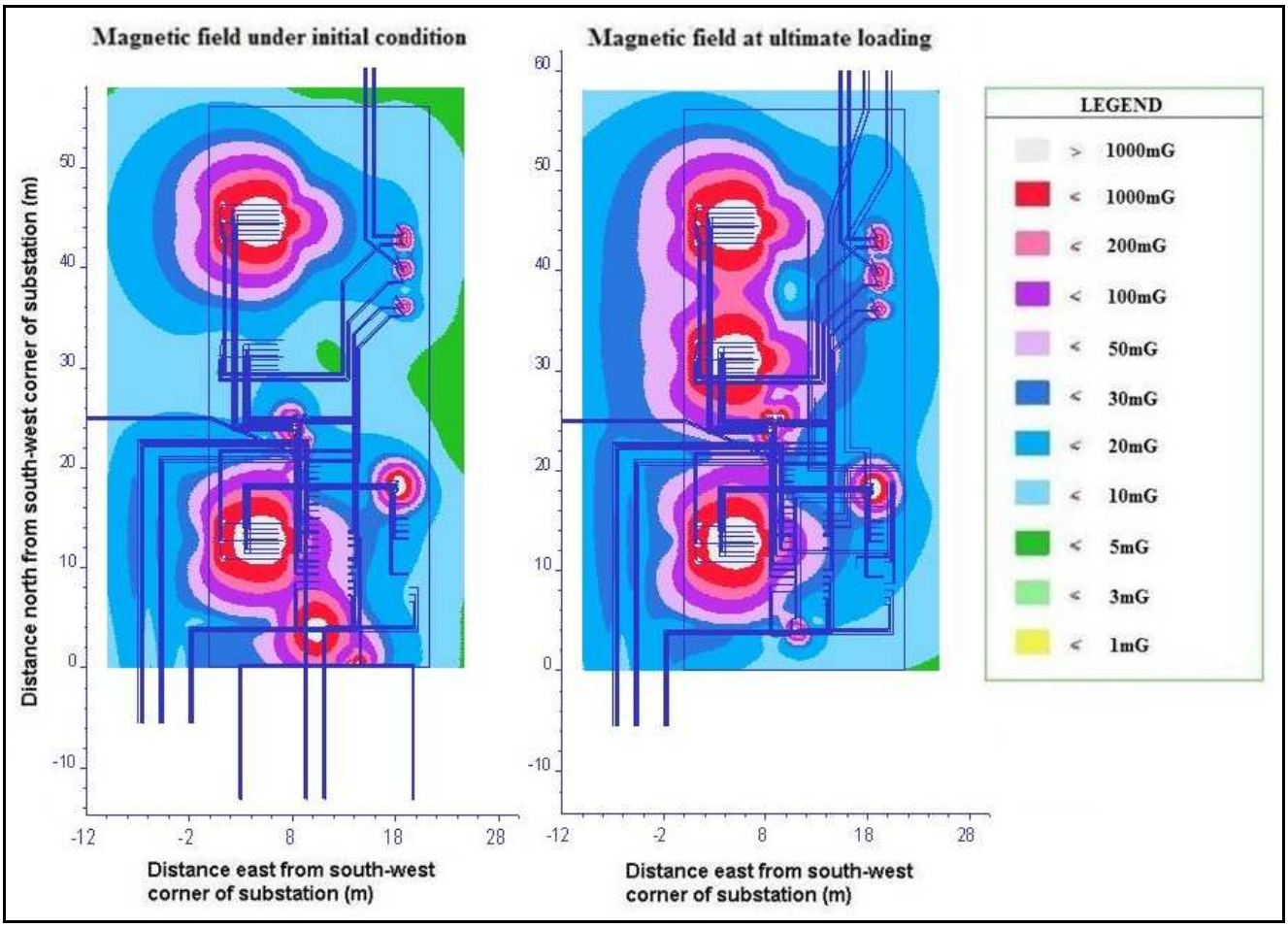

Figure 2.3b - Predicted magnetic field contribution associated with the proposed ZS at 1m above Ward Street level

The expected magnetic field contributions of the proposed ZS along the northern (Harnett Street and carpark), eastern (mixed use development), southern (existing ZS) and western (Ward Street) boundaries are shown in Figures 2.4 to 2.7.

In calculating the magnetic fields along the boundaries, it is necessary to select an appropriate height at which to perform these calculations. Accordingly, the magnetic field profiles along the northern and eastern boundaries were calculated at approximately 1m above Harnett Street level (RL66.1) and the magnetic field profiles along the western and southern boundaries were calculated at approximately 1m above Ward Street (RL68.8).

It is noted that the magnetic field contributions along the western boundary and southern boundary have not changed.

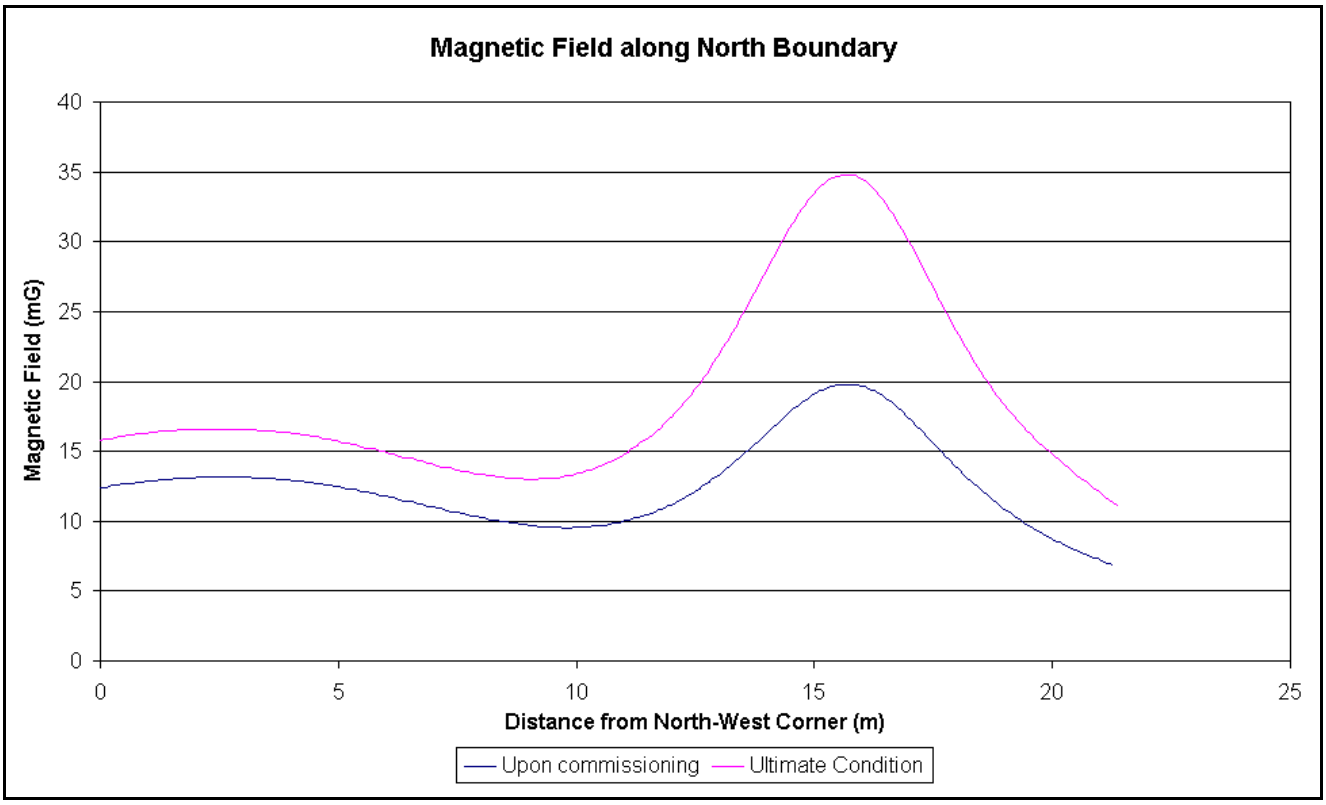

Figure 2.4 – Magnetic Field contribution along northern boundary (Harnett Street and carpark)

The proposed ZS's contribution to the magnetic field levels along its northern boundary is predicted to be in the range of 7 – 20 mG upon commissioning and 11 – 35 mG under ultimate conditions. The peaks along the northern boundary are due to the underground 132kV feeders where they cross it.

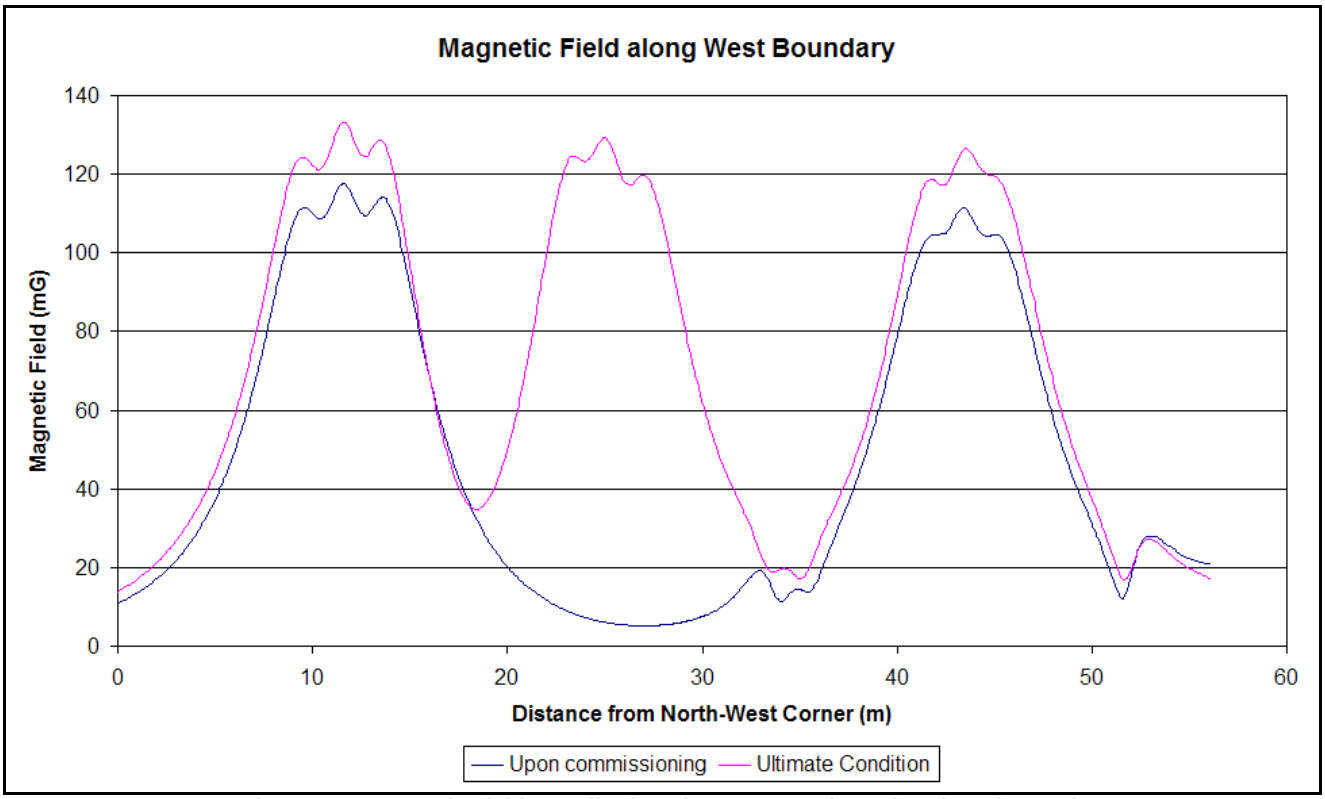

Figure 2.5– Magnetic Field contribution along western boundary (Ward Street)

The proposed ZS's contribution to the magnetic field levels along its western boundary is predicted to be generally in the range of 20 – 70 mG, with two substantial peaks of up to 120mG upon commissioning and three peaks of up to 130mG under the ultimate loading condition. The predicted peaks along the western ZS boundary appear to be primarily due to the transformer connections.

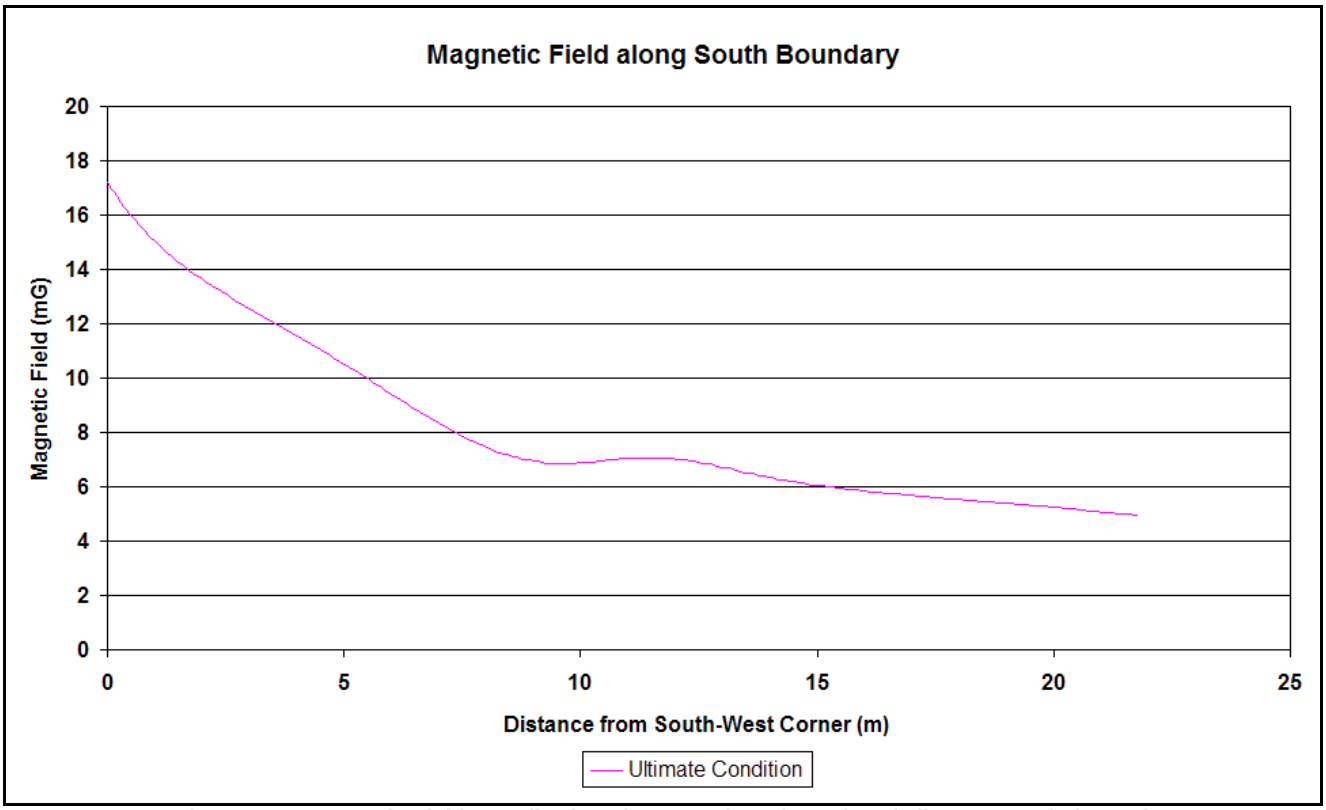

Figure 2.6 – Magnetic Field contribution along southern boundary (adjacent to existing ZS)

The proposed ZS's contribution to the magnetic field levels along its southern boundary under the ultimate loading condition, at which time the existing ZS would be fully decommissioned is predicted to be in the range of 5 - 17 mG. For the initial condition, the southern boundary of the proposed ZS is directly adjacent to the northern boundary of the existing ZS and is not accessible to the general public. As such, the magnetic fields along the southern boundary were not assessed under the initial loading condition.

Under the ultimate loading condition, the magnetic field levels are highest on the western side, decreasing progressively across the boundary towards the eastern side. The higher magnetic fields along the western side of the boundary, seen in the above figure at the ultimate loading condition, appear to be due to the transformer connections. There is also a slight increase in magnetic field levels midway along the southern boundary, compared to the results shown in the August 2010 report, due to the 11kV feeders being moved from riser 1 to risers 2 & 3.

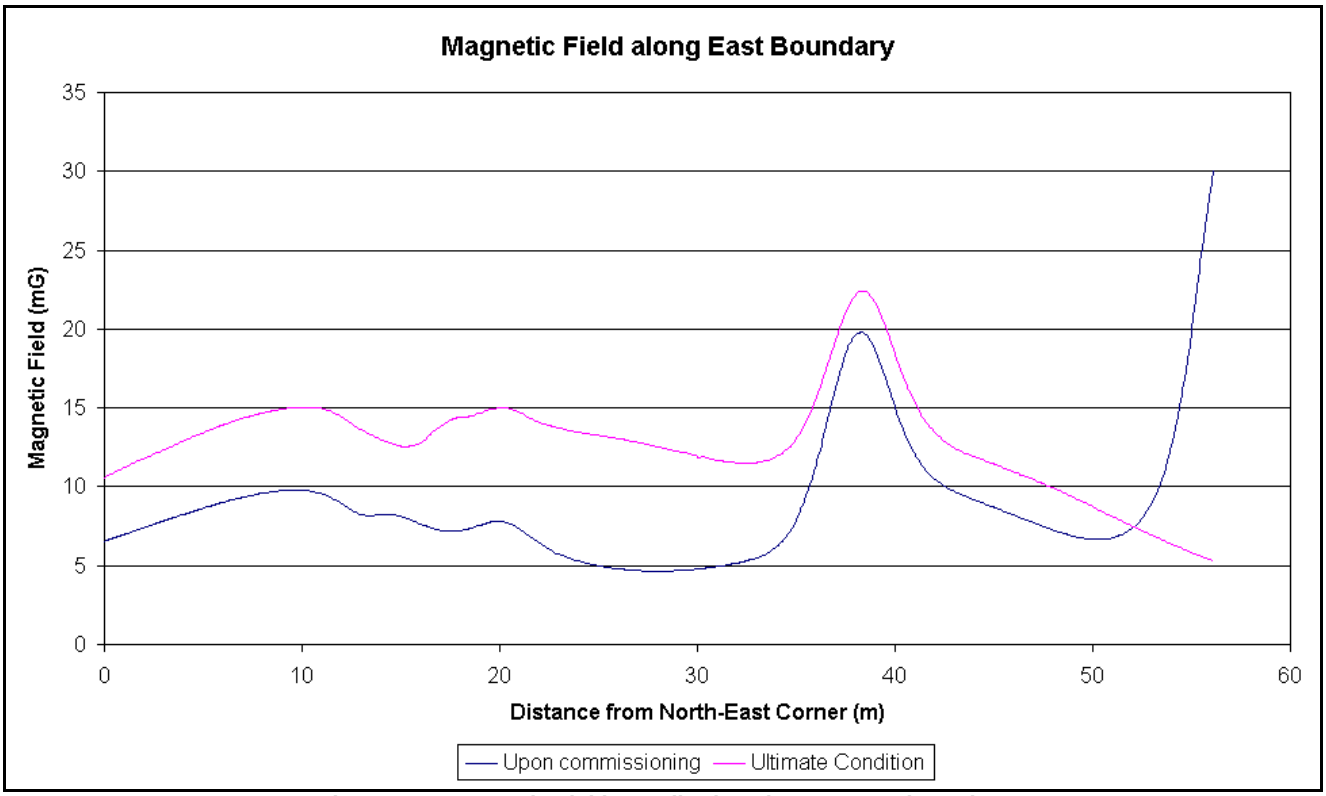

Figure 2.7 – Magnetic Field contribution along eastern boundary

The proposed ZS's contribution to the magnetic field levels along its eastern boundary is now predicted to be generally in the range of 5 - 10 mG upon commissioning and 10 - 15 mG under ultimate conditions. There is also predicted to be a peak, of up to 20mG under the initial loading condition and 22mG at the ultimate loading condition. This peak appears to be due to the eastern cable riser and drops off rapidly with distance outside the boundary. For the initial condition only (prior to the full commissioning of the ZS at 132kV), there is also predicted to be a peak of around 30mG near the southern end of this boundary, due to the temporary 11kV cables.

The following observations are made with regard to the forecast magnetic field contribution from the proposed ZS:

- Within the ZS, the highest magnetic fields, which appear to be strongly influenced by the transformer connections, are expected to be in excess of 1000mG[2] but would reduce to less than 100mG within 5 metres of the connections.
- The fields across the bulk of the remainder of the ZS itself would be less than 50 mG, except for the areas in proximity to the transformer connections and those areas directly above or beside underground cables or cable risers.
- Upon commissioning, the ZS' contribution to the external magnetic fields would be less than 10mG for approximately half the length of its boundaries, with much of the remainder being less than 30mG. There would also be a number of localised peaks ranging up to 120mG.
- In the ultimate condition, the ZS' contribution to the external magnetic fields would be less than 20mG for approximately half the length of its boundaries, with much of the remainder being less than 60mG. There would also be a number of peaks ranging up to 130mG.

[2] The relevant occupational exposure limit, which applies within the substation, is 5000mG.

- The highest magnetic field levels at and beyond the ZS boundary are predicted to occur along the western boundary. The peaks along the western boundary, near each of the transformer connections, were calculated at approximately 120mG under the initial condition and 130mG at the ultimate loading condition.

- The principal effect of the relocation of the 10 x 11kV feeder cables from Riser 1 to Risers 2 and 3, both of which are further from the eastern boundary than Riser 1, is a 46% reduction compared to the August 2010 report, in the magnetic field peak on the eastern boundary, from 41mG to 22mG.

2.1.2 Properties and Proposed Developments in the Vicinity of the ZS

It is understood that approval has been granted for a new development at 144-150 Walker Street, a short distance north of the proposed ZS. Our modelling indicates that the dominant influence on the magnetic field environment of this site will be the incoming 132kV cables which are not part of this project and will be subject to their own assessment. The proposed ZS itself will have little contribution and its influence on this property is not further assessed.

Part of the property at 142 Walker Street backs onto the eastern boundary of the proposed ZS near the north-eastern corner. Our modelling indicates that the magnetic field environment of this site will also be influenced by the incoming 132kV cables, both in Harnett Street and within the ZS. Under the ultimate loading condition, the magnetic field will be approximately 12 mG at the property boundary and a few mG at the existing building at 142 Walker Street.

As noted in Section 1.3, there are two alternative proposed developments for the site at 136 – 140 Walker Street, both requiring assessment.

The first of these proposals, which was assessed as part of our August 2010 assessment, is for a 22 storey mixed use commercial and residential development by Castle Constructions. An elevation of this development is shown in Figure 2.8.

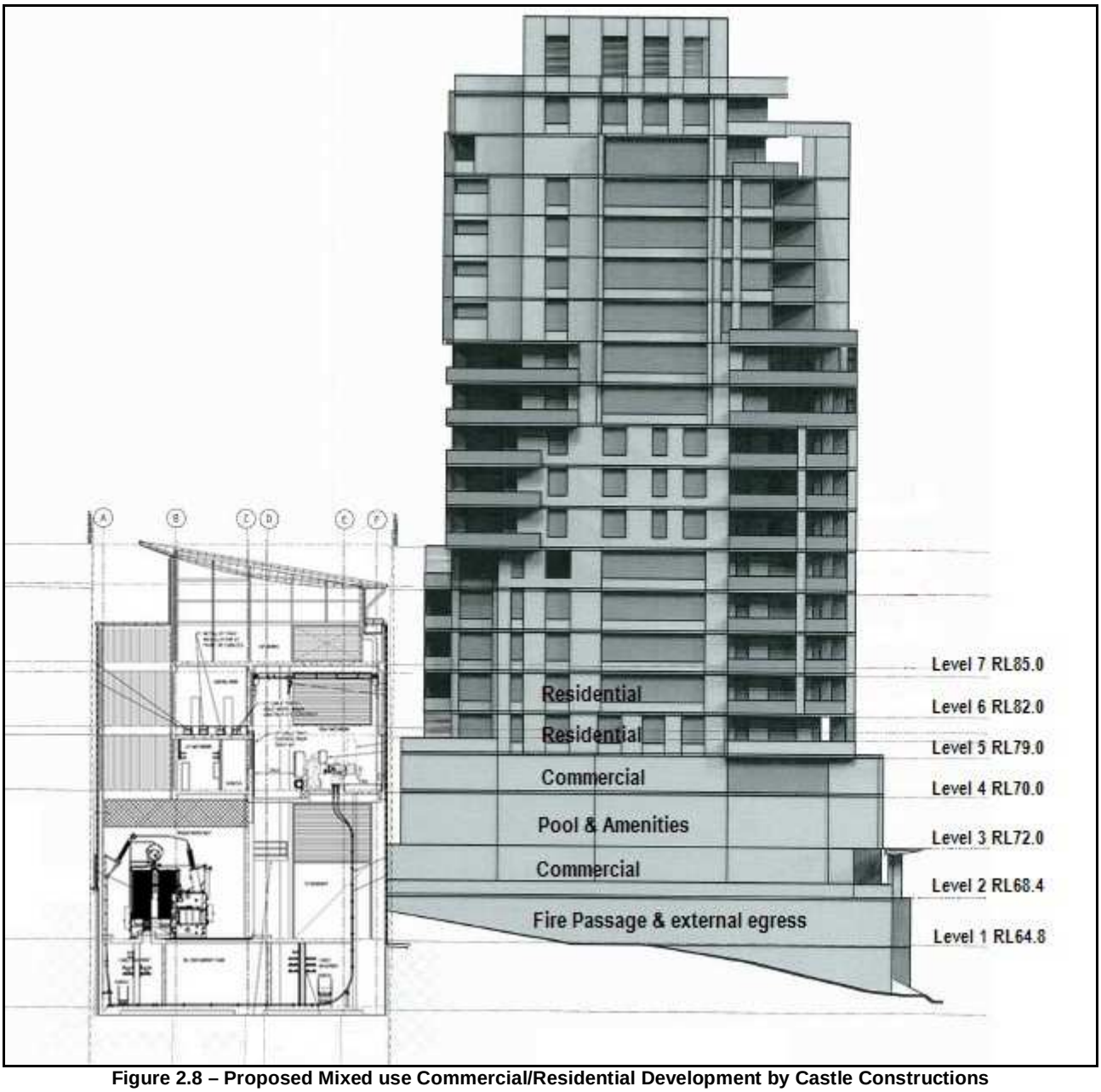

Figure 2.8 – Proposed Mixed use Commercial/Residential Development by Castle Constructions

Magnetic field profiles along the external surfaces of the western walls of the proposed Castle Constructions development have been calculated as follows:

- One metre above floor level on Level 2 (Commercial), (Figure 2.9);
- One metre above floor level on Level 3 (Pool and Amenities), (Figure 2.10);
- One metre above floor level on Level 4 (Commercial) (Figure 2.11);and
- One metre above floor level on Level 5 (Residential). (Figure 2.12).

Profiles have not been calculated for the residential levels above Level 5 as the magnetic field would be lower than that on Level 5.

To give an indication of the rate at which the magnetic fields are predicted to decrease inside the proposed Castle Constructions development at 136 – 140 Walker Street, we have also calculated profiles at right angles from the eastern boundary of the ZS at the points corresponding to the highest fields at each level.

The expected contribution of the proposed ZS to the magnetic field levels at and beyond the outer western wall of the proposed Castle Constructions development are shown in Figures 2.9 to 2.12. In each of these figures, the right hand plot shows the decrease in the magnetic field with increasing distance inside the mixed use development from the peak on the western wall shown in the left hand plot. Note that the magnetic field levels have been calculated at 1m above the RLs shown in Figure 2.8.

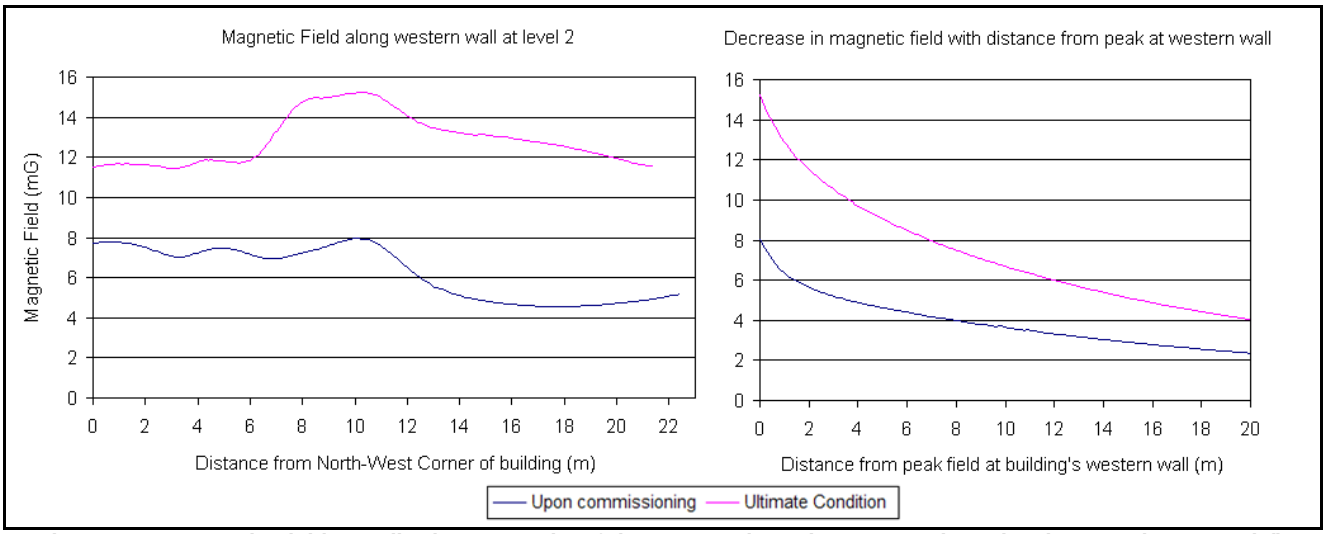

Figure 2.9 – Magnetic Field contribution at Level 2 of the proposed Castle Constructions development (Commercial)

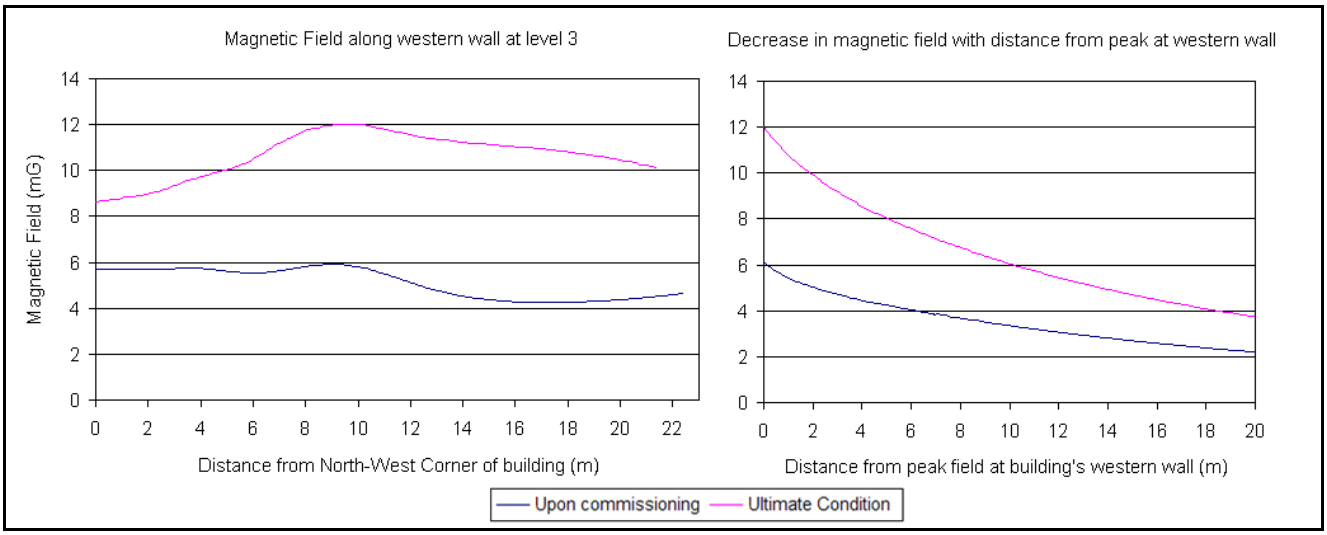

Figure 2.10 – Magnetic Field contribution at Level 3 of the proposed Castle Constructions development (Pool & Amenities)

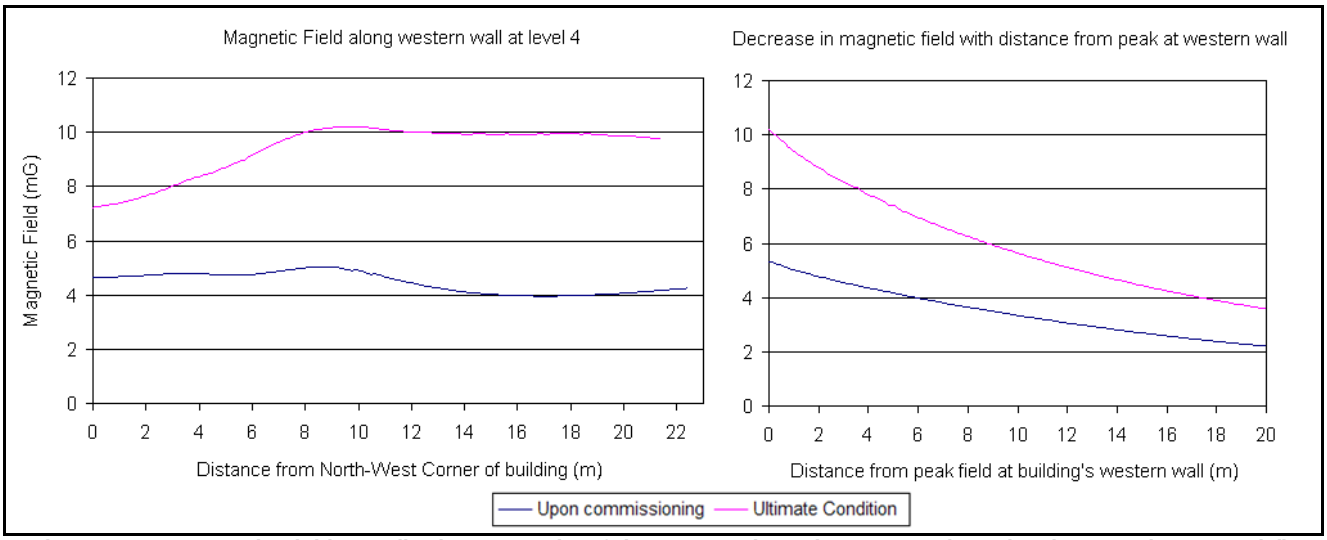

Figure 2.11 – Magnetic Field contribution at Level 4 of the proposed Castle Constructions development (Commercial)

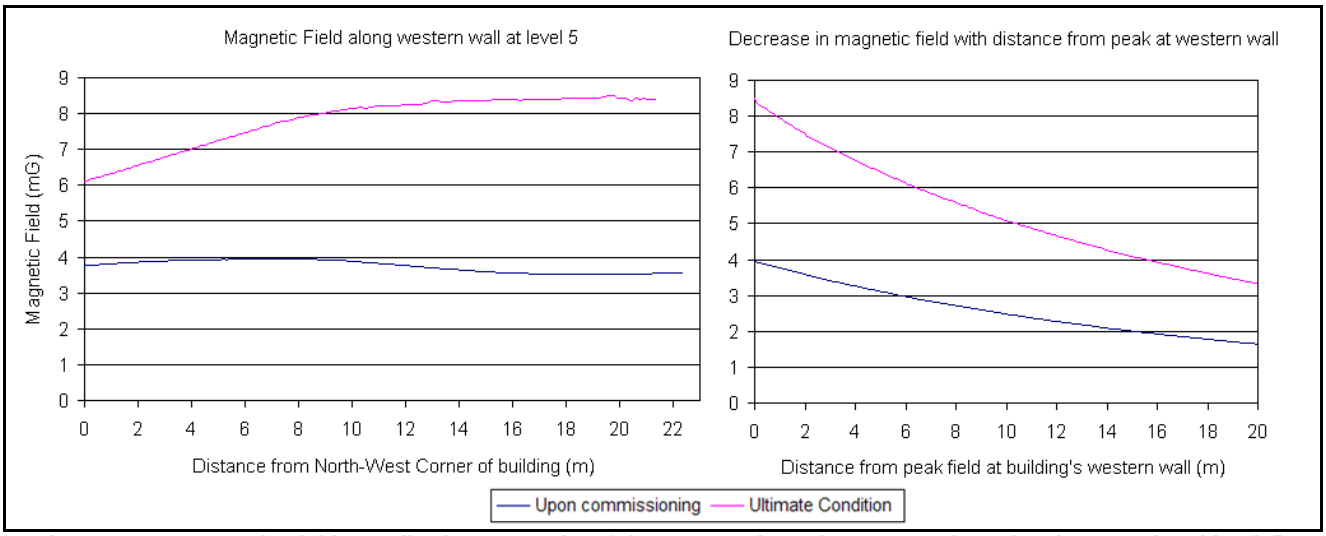

Figure 2.12 – Magnetic Field contribution at Level 5 of the proposed Castle Constructions development (Residential)

The following observations are made with regard to the forecast magnetic field contribution from the proposed ZS to the magnetic fields at and beyond the western wall of the proposed Castle Constructions development at 136 - 140 Walker Street:

- The highest magnetic fields in the mixed use development are predicted to occur at Level 2 (commercial use). At this level, along the outer western wall of this building the magnetic fields are predicted to be in the range of 5mG to 8mG under the initial condition and between 11mG and 15mG under the ultimate loading condition. The predicted peak magnetic field level at Level 2 will be reduced by approximately 12% when compared with the EMF assessment undertaken in August 2010.

- The contribution of the ZS to the magnetic fields at the residential levels is predicted to be highest at Level 5. At 1m above this level, the magnetic fields are predicted to be in the range of 3mG to 4mG under the initial condition and between 6mG and 8.5mG under the ultimate loading condition. The predicted peak magnetic field level at Level 5 will be reduced by approximately 5% when compared with the EMF assessment undertaken in August 2010.

- The contribution of the ZS to the magnetic fields beyond the outer western wall of the Castle Constructions development would reduce with distance from the wall. At 10m from the western wall on Level 2, the peak magnetic field is predicted to be less than 4mG under the initial condition and less

than 7mG under the ultimate loading condition. At 10m from the western wall on Level 5 the peak magnetic field is predicted to be less than 3mG under the initial condition and less than 5mG under the ultimate loading condition.

- The principal effect of the relocation of the 10 x 11kV feeder cables from Riser 1 to Risers 2 and 3, both of which are further from the Castle Constructions development than Riser 1, is an approximate 12% reduction in the peak magnetic field at a commercial floor (Level 2) and a 5% reduction at a residential floor (Level 5).

The alternative proposal for 136 – 140 Walker Street is a 23 storey mixed use development by Winten Property Group. An elevation of this development is shown in Figure 2.13. Note that, for this development, in contrast to the Castle Constructions model, the fields at the internal surface of the western wall were modelled as the wall thickness was known.

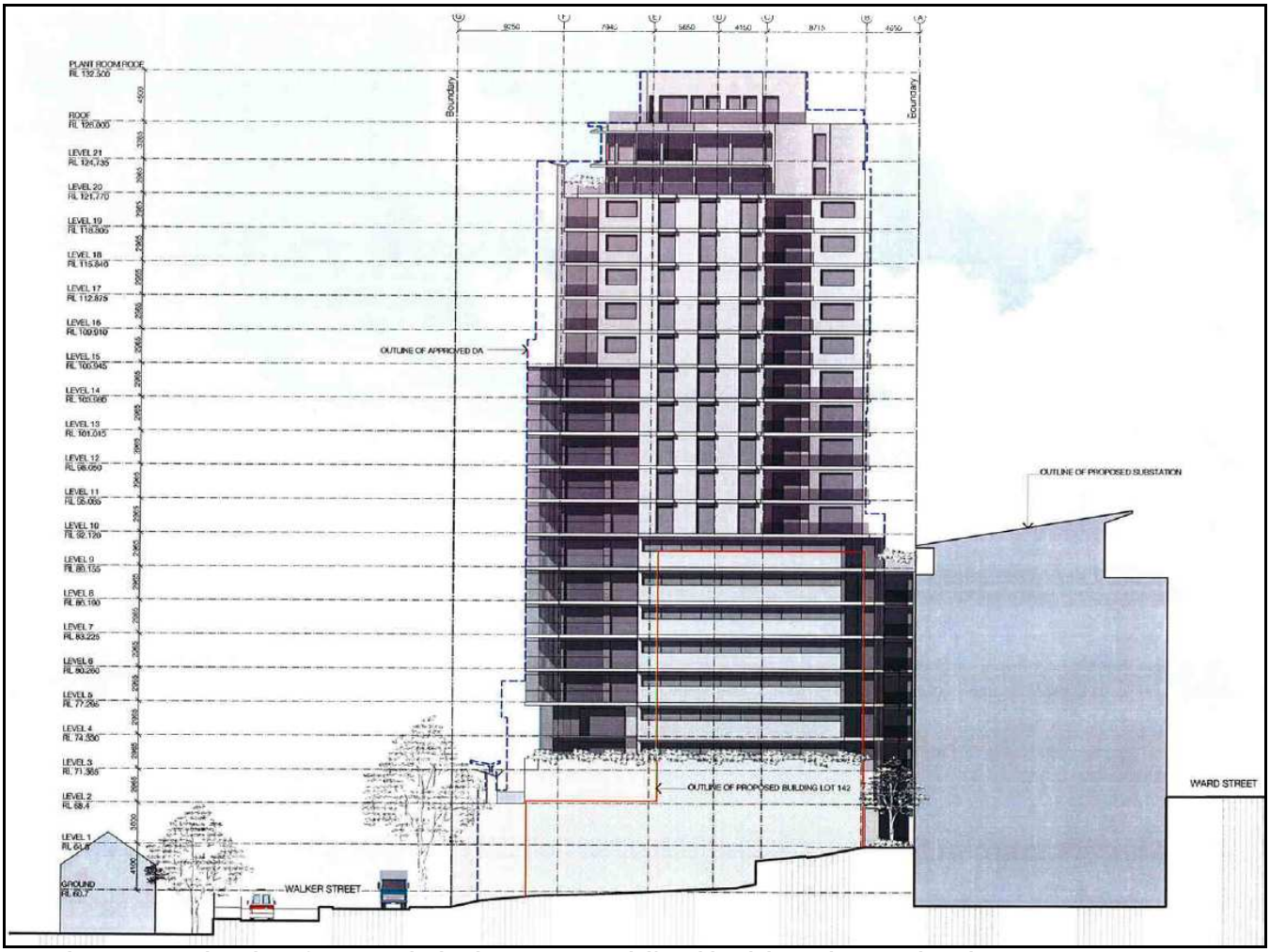

Figure 2.13 – Elevation of Proposed Mixed use Commercial/Residential Development by Winten Property Group.

Magnetic field profiles along the internal surfaces of the western walls of the proposed Winten Property Group development have been calculated as follows:

- One metre above ground floor level (Commercial), (Figure 2.14);
- One metre above floor level on Level 1 (Commercial), (Figure 2.15);
- One metre above floor level on Level 2 (Residential), (Figure 2.16);
- One metre above floor level on Level 3 (Residential), (Figure 2.17);
- One metre above floor level on Level 4 (Residential), (Figure 2.18);
- One metre above floor level on Level 5 (Residential), (Figure 2.19);
- One metre above floor level on Level 6 (Residential), (Figure 2.20);

Profiles have not been calculated for the residential levels above Level 6 as the magnetic field would be lower than that on Level 6.

To give an indication of the rate at which the magnetic fields are predicted to decrease inside the Winten Property Group development at 136 – 140 Walker Street, we have also calculated profiles at right angles to the eastern boundary of the ZS at the points corresponding to the highest fields at each level.

The expected contribution of the proposed ZS to the magnetic field levels at and beyond the inner surface of the western wall of the proposed Winten Property Group development are shown in Figures 2.14 to 2.20. In each of these figures, the right hand plot shows the decrease in the magnetic field with increasing distance inside the building from the peak on the western wall shown in the left hand plot. Note that the magnetic field levels have been calculated at 1m above the RLs shown in Figure 2.13.

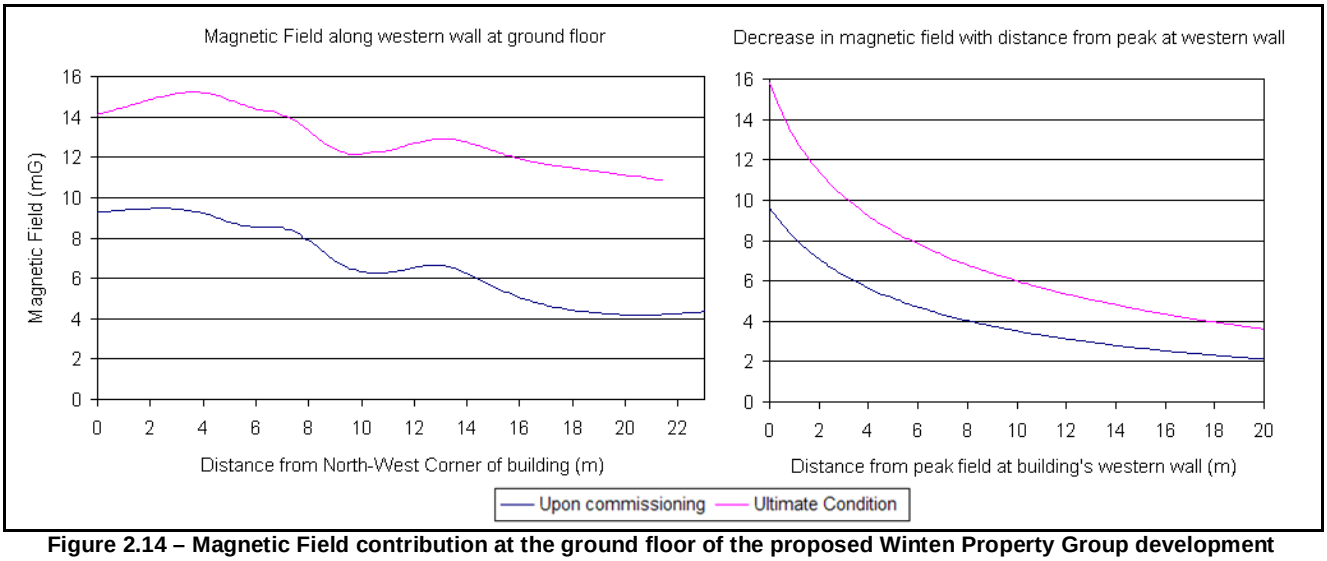

Figure 2.14 – Magnetic Field contribution at the ground floor of the proposed Winten Property Group development (Commercial)

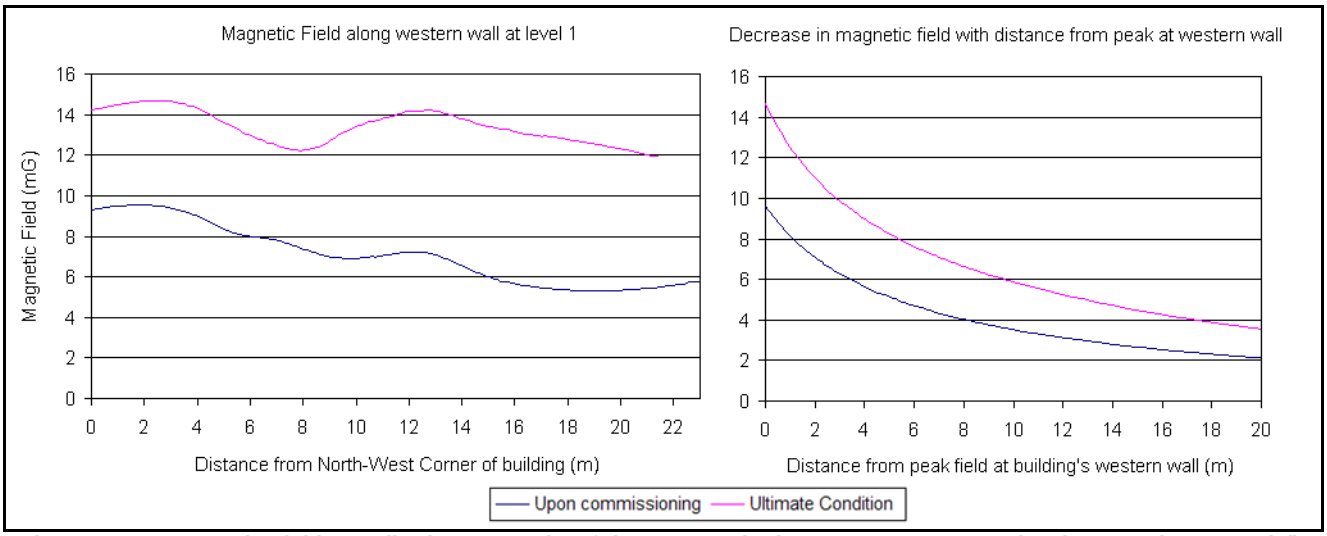

Figure 2.15 – Magnetic Field contribution at Level 1 of the proposed Winten Property Group development (Commercial)

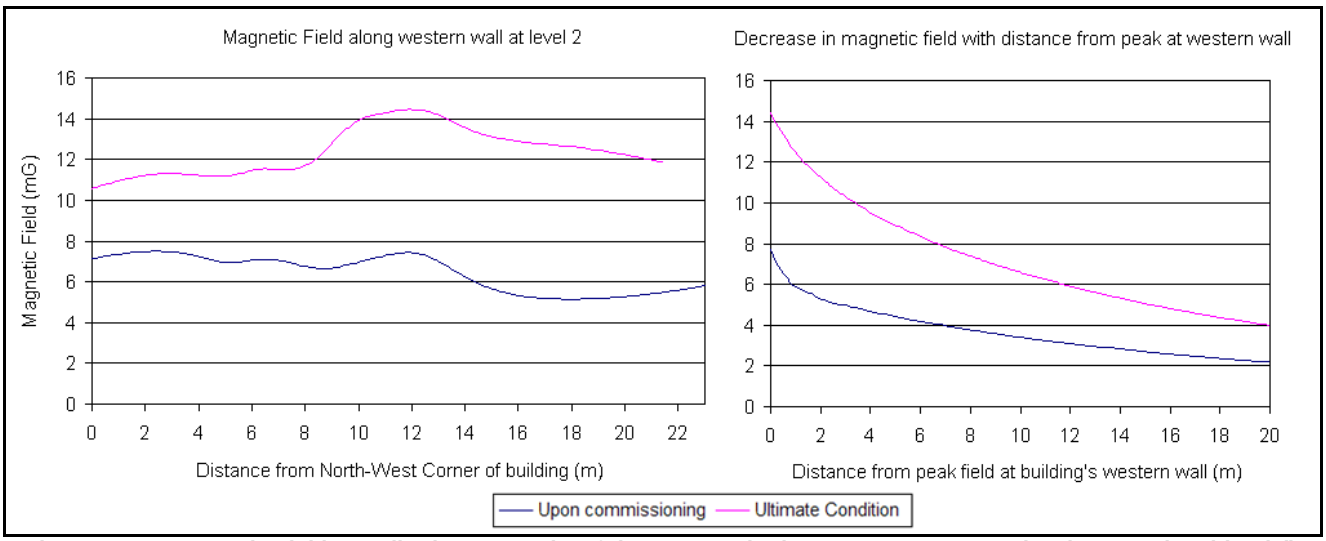

Figure 2.16 – Magnetic Field contribution at Level 2 of the proposed Winten Property Group development (Residential)

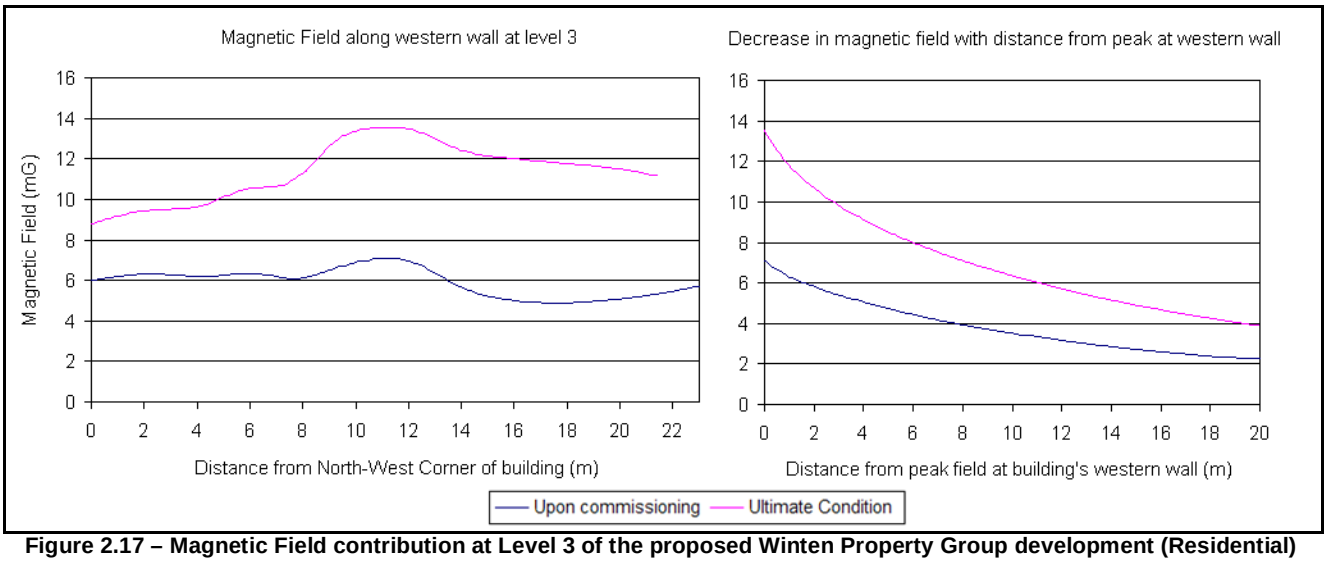

Figure 2.17 – Magnetic Field contribution at Level 3 of the proposed Winten Property Group development (Residential)

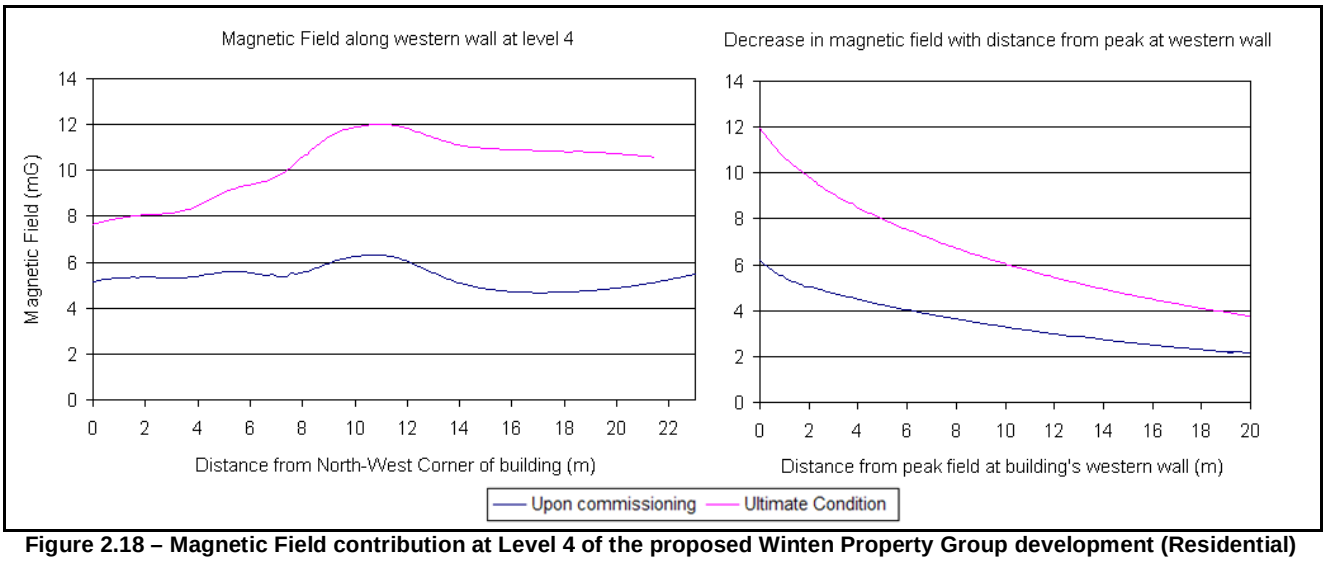

Figure 2.18 – Magnetic Field contribution at Level 4 of the proposed Winten Property Group development (Residential)

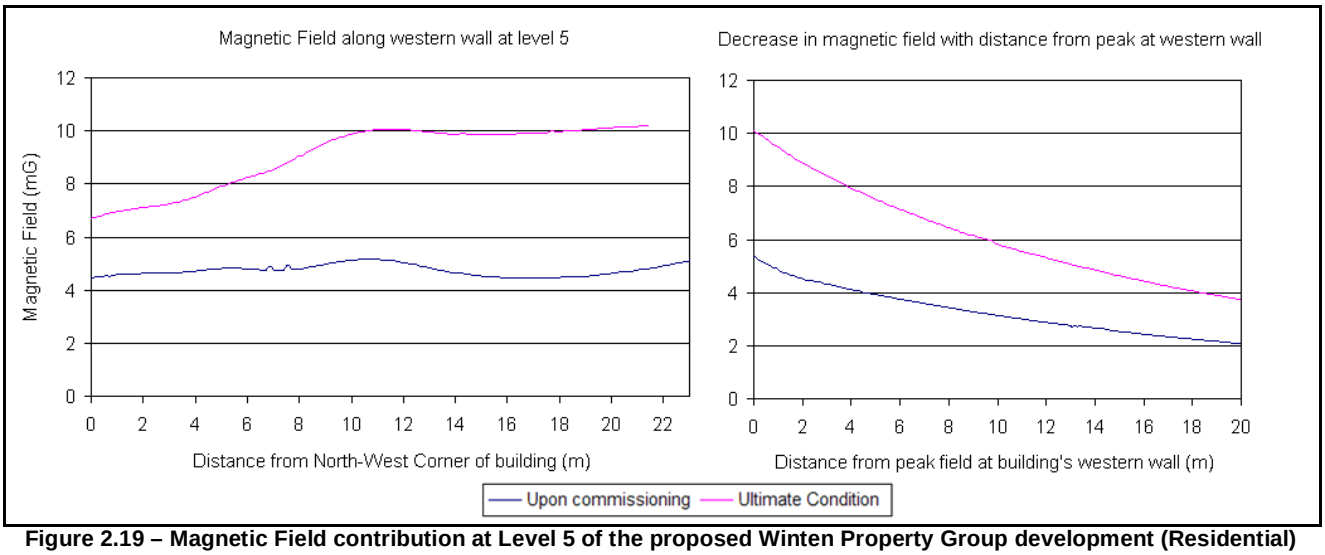

Figure 2.19 – Magnetic Field contribution at Level 5 of the proposed Winten Property Group development (Residential)

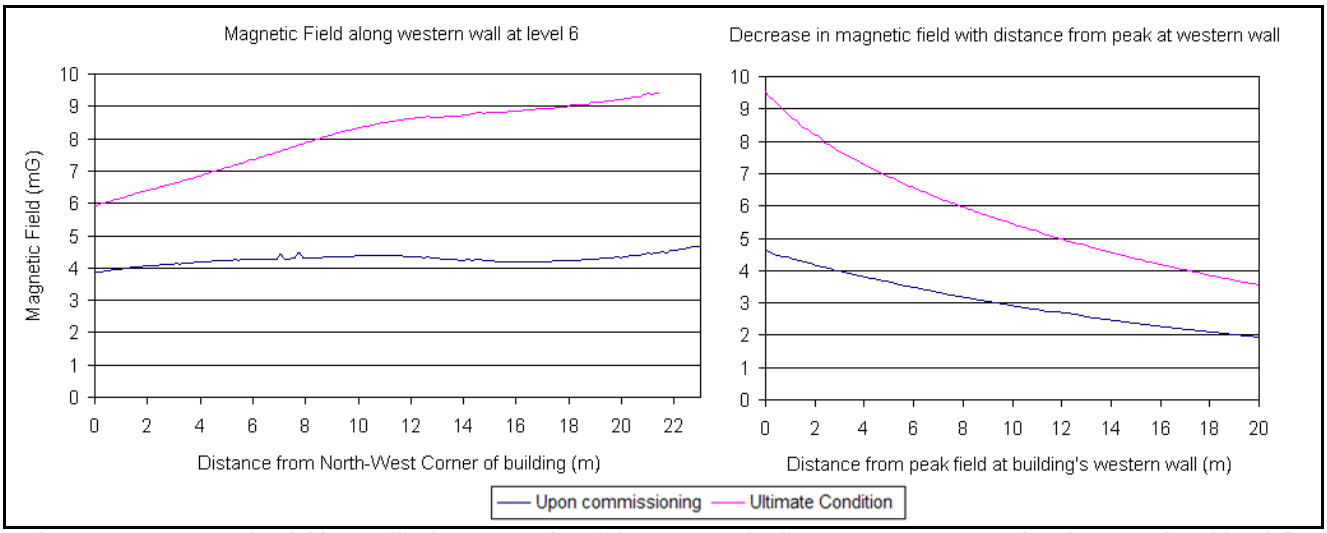

Figure 2.20 – Magnetic Field contribution at Level 6 of the proposed Winten Property Group development (Residential)

The following observations are made with regard to the forecast magnetic field contribution from the proposed ZS to the magnetic fields at and beyond the western wall of the proposed Winten Property Group development at 136-140 Walker Street:

- The highest magnetic fields in the Winten Property Group development are predicted to occur at the ground floor (commercial use). At this level, along the inner western wall of this building the magnetic fields are predicted to be in the range of 4mG to 10mG under the initial condition and between 11mG and 15mG under the ultimate loading condition.

- The contribution of the ZS to the magnetic fields at the residential levels is predicted to be highest at level 2. At 1m above this level, the magnetic fields are predicted to be in the range of 5mG to 8mG under the initial condition and between 11mG and 15mG under the ultimate loading condition.

- The contribution of the ZS to the magnetic fields beyond the inner western wall of the development would reduce with distance from the wall. At 10m from the inner western wall on the ground floor the peak magnetic field is predicted to be less than 4mG under the initial condition and approximately 6mG under the ultimate loading condition. At 10m from the inner western wall on level 2 the peak magnetic

field is predicted to be less than 4mG under the initial condition and less than 7mG under the ultimate loading condition.

2.1.3 Possible Adjustment to Winten Property Group Development

We have been advised by Energy2U Alliance that the possibility that the proposed Winten Property Group development could be stepped back 1m from Level 2 upwards (residential levels) has been raised. Accordingly, this alternative arrangement for the development has also been modelled. The following observations are made regarding the magnetic field profile of this alternative arrangement, in comparison to the arrangement currently proposed:

- The contribution of the ZS to the magnetic fields at the residential levels is still predicted to be highest at Level 2 but would be reduced compared to the levels predicted under the arrangement currently proposed. At 1m above this level, the magnetic fields are predicted to be in the range of 5mG to 7mG under the initial condition and between 10mG and 13mG under the ultimate loading condition.

- The contribution of the ZS to the magnetic fields at Level 3 would be reduced and is predicted to be in the range of 5mG to 6mG under the initial condition and between 8mG and 12mG under the ultimate loading condition.

- The contribution of the ZS to the magnetic fields at Level 4 would be reduced and is predicted to be in the range of 4mG to 6mG under the initial condition and between 7mG and 11mG under the ultimate loading condition.

- The contribution of the ZS to the magnetic fields at Level 5 would be reduced and is predicted to be in the range of 4mG to 5mG under the initial condition and between 6mG and 10mG under the ultimate loading condition.

- The contribution of the ZS to the magnetic fields at Level 6 would be reduced and is predicted to be in the range of 3mG to 5mG under the initial condition and between 6mG and 9mG under the ultimate loading condition.

- The principal effect of the alternative design would be that the peak field level at a residential floor of the proposed Winten Property Group development (Level 2) would be reduced by approximately 13% from 14.5mG to 12.5mG.