

Concept Development Application and First Stage Development 65 Glendale Road, Glendale

Mine Subsidence Assessment Report

Transport for NSW



Reference: 754-NTLGE320046-AC.Rev4

25 June 2024

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EXECUTIVE SUMMARY¹

This report is submitted to Lake Macquarie City Council in support of a Concept Development Application (DA) and first stage of development relating to 65 Glendale Drive, Glendale. The subject site is legally described as **Lot 1 in DP 1286424** and has a total site area of **35.85 hectares**. The site is zoned MU1, E2 and C2, located northeast of the Stockland Shopping Centre and has frontages to Glendale Drive and Stockland Drive, with Main Road bounding the site to the north.

The Concept DA will facilitate the future development of the site, generally in line with Lake Macquarie Council's Development Control Plan for the Glendale Town Centre through definition of development parcels and associated uses that will support the delivery of Council's North West Growth Strategy. The first stage of development includes a subdivision that will establish the greater lots, to be further subdivided in the future in accordance with the Concept DA. The first stage of development also includes site works that facilitate the subdivision.

The subject site and general area around the site are known to be located over abandoned mine workings within the Dudley Seam by the Gretley Colliery.

Using depth marks on the mine plans the workings are understood to be at a depth of 70m to 90m. The workings are described as mini-wall mine panels meaning the mine workings were generally much narrower than then depth of workings. During the mining of the Dudley Seam, subsidence monitoring was completed with subsidence generally being within expected values.

With reference to the NSW Planning Portal surrounding properties are designated Guideline 3A which refers to Historical mine workings – low subsidence risk. This low risk refers to the mine workings being generally 'squat' with width to height ratio greater than 5, with the majority of coal extracted beneath the site by mini-wall panels.

The risk of subsidence was assessed in general accordance with SA NSW policies including:

- Development Application – Subdivision Assessment Policy Version 2 5 April 2023.
- Development Application – Merit Assessment Policy Version 2 5 April 2023.

Using these policy documents the site has a 'Moderate' uncertainty factor. Although with a factor of safety greater than 2.1 would normally mean buildings require to be designed for 'Safety', due to the proposed mechanism, SA NSW have requested building be designed for 'Serviceability' for the proposed movements.

Potential subsidence was assessed based on the mined mini-wall panel plus roadway less previous subsidence that generally occurred in the area using empirical charts (Holla, 1987). The assessed maximum potential subsidence values are:

- Maximum subsidence 80mm.
- Maximum tensile strains 1mm/m.
- Maximum compressive strains 3mm/m, over a length of 20m, reducing to 1mm/m for the outer 10m for each panel.
- Maximum tilts 1.2mm/m.
- Maximum curvature:
 - 10km concave down.
 - 3.5km concave up.

These subsidence values have been reviewed by Northrop Consulting Engineers (Project no NL221237_E01), who have confirmed buildings can be designed to accommodate the parameters and remain safe.

¹ This executive summary must be read in the context of the full report and the attached limitations.

Based on the above advice and previous experience, the development of buildings up to four (4) storeys in height with basement parking generally as shown in the Concept DA master plan can be achieved, subject to appropriate structural detailing in the design of buildings and services at the site.

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
BGL	Below Ground Level
DA	Development Application
Is ₅₀	Point Load index normalised to a cylindrical width of 50mm
OCAL	Oceanic Coal Australia Limited
SA NSW	Subsidence Advisory NSW
TAHE	Transport Asset Holding Entity
Tetra Tech	Tetra Tech Coffey Pty Ltd
Transport	Transport for NSW
UCS	Unconfined Compressive Strength

GLOSSARY

Term	Definition
Angle of draw	The angle made by the zone of trough subsidence beyond the limit of mining. Usually adopted as 26.5° to vertical (1H:2V) in the Newcastle area
Crush	Used to describe the effect of pillar failure in a mine
Cut throughs	The tunnel cut at the ends of pillars, typically perpendicular to the bords
Face cleat	A well defined near vertical joint / cleavage plane within coal, typically smooth and shiny
Overburden	The mass of the unit / strata above mine workings
Panel	The plan area of extraction
Pillar	A column of coal left to hold the roof during mining
Roadway	The more modern name used for the mined tunnel used to transport coal back to the shaft/s or drifts
Roof fall	Material that has caved into a mined area also known as cave in, typically forms an arching of the roof
Strata	The formation of a multiple layers of rock and/or soil
Subcritical Longwall Panel	Refers to longwall panels which are narrower than the thickness of overburden
Supercritical Longwall Panel	Refers to longwall panels which are wider than the thickness of overburden
Tributary area	Defines the area of influence above a pillar, typically taken as the area of the pillar plus half the width of neighbouring bords and cut throughs.
Trough subsidence	Broad, shallow depressions that result from the failure of one or more pillars

1. INTRODUCTION

Transport for NSW (Transport) commissioned Tetra Tech Coffey (Tetra Tech) to carry out a mine subsidence desktop study for the Concept Development Application and first Stage Development - 65 Glendale Road, Glendale.

This report addresses the scope of works from Tetra Tech proposal 754-NTLGE320046-AA.Rev2 dated 17 July 2023. It is submitted to Lake Macquarie City Council in support of a Concept Development Application (DA) relating to 65 Glendale Drive, Glendale. The subject site is legally described as Lot 1 in DP 1286424 and has a total site area of 35.85 hectares.

The subject site (shown in Figure 1 below) is owned by the Transport Asset Holding Entity (TAHE). The site is largely vacant, except for a small portion of land to the south, which is being used by Sydney Trains for project operations and will be retained for this purpose. It is legally described as Lot 1, DP 1286424 and is currently zoned as E2 commercial centre, MU1 mixed use, C2 environmental conservation land uses.



Figure 1: Aerial view of the site.

1.1 PROPOSAL

The proposed development comprises the following elements:

- A Concept DA under s4.22 of the EP&A Act with proposed arrangement comprising:
 - Internal vehicular and active transport network.
 - Connections and alterations to the adjacent street network.
 - Civil and stormwater arrangement.
 - Bulk earthworks arrangement.

- Landscaped and public open space areas.
- Bush fire management arrangement.
- Ecological management arrangement.
- Heritage management arrangement.
- Future development parcels.
- Land use and development envelope associated with each parcel.
- A first stage of development, which includes subdivision comprising two phases:
 - Phase 1: Three (3) lots (north and south of Glendale Drive).
 - Phase 2: Subdivision of Lot 3 created at Phase 1 into seven (7) lots, including one (1) proposed road reserve lot. Works to facilitate the second subdivision phase, including (but not limited to):
 - Bulk earthworks.
 - Civil (stormwater and road) infrastructure.
 - Servicing infrastructure.

The Concept DA proposes the following uses for each lot:

- Lot 1 (north of Glendale Drive):
 - Development parcels comprising:
 - Mixed use buildings.
 - Residential flat buildings.
 - Multi dwelling housing.
 - Commercial.
 - Public open space.
- Lot 2 (north of Winding Creek and east of Glendale Drive):
 - A development parcel comprising residential flat buildings.
- Lot 3 (south of Glendale Drive):
 - Subdivision at Stage 2 into seven lots comprising:
 - Three lots with a permissible use (Lot 31, Lot 32, and Lot 33).
 - Three lots to be retained by TAHE for existing transport operational purposes (Lot 34, Lot 35, and Lot 36).
 - One lot for dedication as road reserve (Lot 37).

Further information may be found in Appendix C.

1.2 BACKGROUND

The site and general area around the site are known to be located over abandoned mine workings within the Dudley Seam by the Gretley Colliery. This seam is also referred to as the Young Wallsend Seam when combined with the Nobbys Seam with both names used within the mine Record Tracing RT574. As Dudley Seam is shown on the individual sheets (U5450-52, U5450-61, and U5450-62) and a separation to other nearby seams, this seam name will be utilised. Using depth marks on the mine plans the workings are understood to be at a depth of 70m to 90m. The workings are described as mini-wall mine panels meaning the mine workings were generally much narrower than then depth of workings.

With reference to the NSW Planning Portal surrounding properties are designated Guideline 3A which refers to Historical mine workings – low subsidence risk.

The following report presents the steps followed in the desktop study analysis of the mine workings, the data used in this assessment, and the resultant findings and recommendations for design. This report does not include assessment of potential movements from the construction of the building/s (i.e. consolidation of soil layers) and does not address footing design parameters.

2. SCOPE OF WORK UNDERTAKEN

This mine subsidence assessment has included:

- A review of previous reports in the area including:
 - N09235/01-AG dated 6 July 2006 Railcorp Land at Glendale.
 - GEOTWARA22620AA-AB dated 16 December 2015.
- A review of Record Tracing and mine survey plans within the Young Wallsend Seam / Dudley Seam supplied by Department of Primary Industries – Mineral Resources including:
 - RT574 Gretley Colliery workings Dudley Seam (sheets U5450-52, U5450-61, and U5450-62).
- 1:100,000 Scale Newcastle Coalfield Regional Geology Sheet.
- SA NSW Merit Policy document 2023.
- Assessment of coal pillars stability using rectangular pillar theories, incorporated in the Modified UNSW Power Law strength equation as presented in (Galvin & University of New South Wales. School of Mining En, 1998).
- Assessment of subsidence using empirical charts (Holla, 1987).

2.1 MINE SUBSIDENCE

Mine subsidence refers to the downward movement of the ground surface due to the failure of support at mine level. Subsidence can take the form of sinkholes or troughs. Sinkholes (potholes) are usually circular collapse depressions with sides that can be steep and abrupt or gently sloping towards the centre. Sinkhole formation is controlled by the thickness of the rock overburden, jointing of the rock, mining conditions, and bulking of the roof fall material.

For this reason, sinkholes are generally limited to mining within 25m of the surface with diameters usually less than 5m in diameter. However, a general rule of thumb is pothole subsidence can exist where the depth of cover is less than 10x the thickness mined.

Troughs are broad, shallow depressions that result from the failure of one or more pillars or in the case of workings beneath the site, failure of mini-wall or longwall panels (refer to Figure 2). Pillars can fail by several ways including crushing, punching into the roof or the floor, roof failure exposing soil strength material to tributary loading. Long wall mining will have generally an immediate response to the ground surface during mining, with less potential for ongoing settlement.

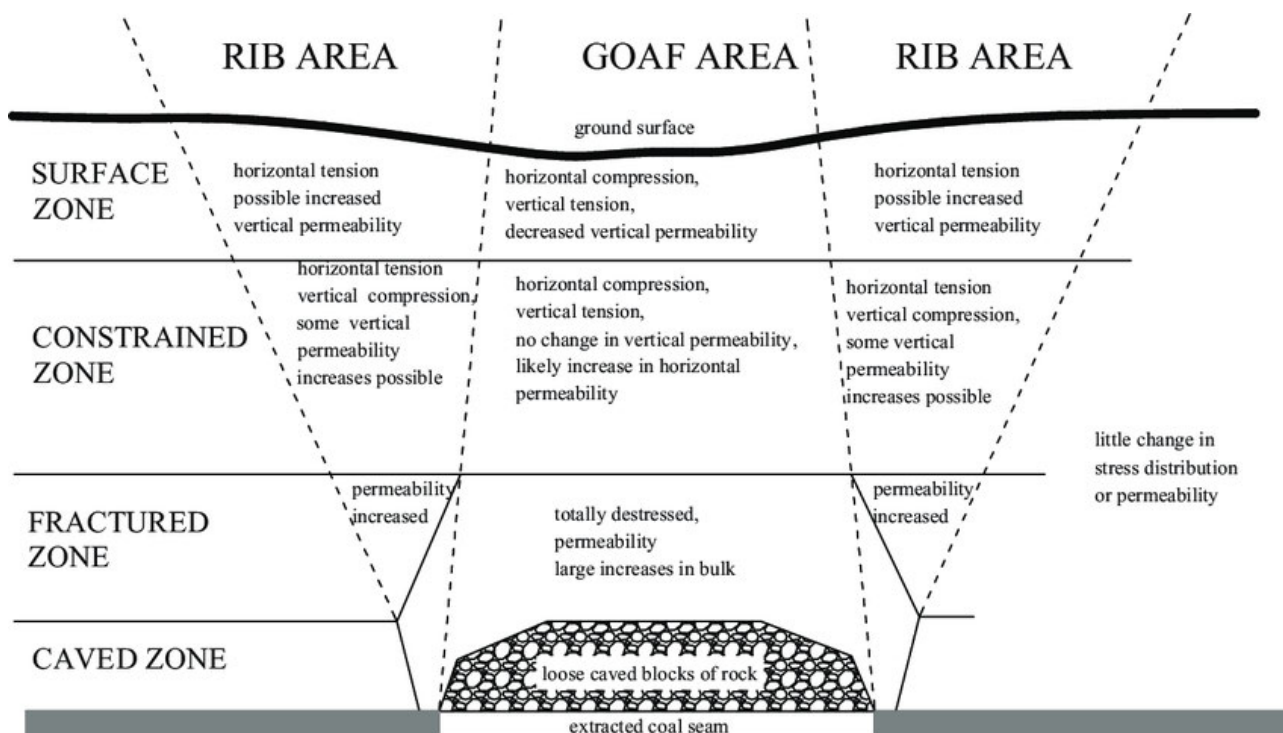


Figure 2: A hydrogeological model proposed for the Central Coast (Forster & Enever, 1992)

The trough size and deformations depend on the mined width, mined height, thickness and hardness of overburden rocks, and pillar stability. Deformations from trough subsidence can extend beyond the limits of mining. The zone beyond the limit of mining that is impacted by trough subsidence is determined by the angle of draw. Within the Newcastle Coal Measures an angle of draw of 26.5° to the vertical is generally adopted. This angle translates to one horizontal for every two vertical. That is, with workings at approximately 70m below the surface, pillars beyond a horizontal distance of 35m would not be expected to affect the building.

3. SITE CONDITIONS

3.1 SURFACE CONDITIONS

The site is Lot 1 in DP 1286424 and has a total site area of 35.85 hectares. The site extends from Lake Road to the west, Main Road to the North, rear of Cedar Street residential lots to the east and a combination of the Hunter Sports Stadium and Great North Railway to the south.

Topographically, the site is situated within a relatively low-lying area associated with Winding Creek. Ground surface reduced levels vary from approximately 17m AHD in the south of the site down to 7m AHD along Winding Creek and approximately 2.5m to 3.5m AHD in the creek bed. Winding Creek passes through the site from west to east dividing it in two. On either side, the ground slopes gently down toward the creek, generally at approximately 0° to 5° to the horizontal.

Except for a few small, cleared areas (like the former George Durie Field) much of the current surface is covered in well-established bushland.

3.2 SUBSURFACE CONDITIONS

With reference to the NSW government MinView Website, the site is generally underlain by alluvial flood plain associated with Winding Creek. Along Main Road the subsurface rocks belong to the Adamstown Subgroup of the Newcastle Coal Measures, particularly the Glebe Formation. To the south of Winding Creek, the surface is shown to be raised by Fill and in turn underlain by the Tickhole Formation.

A section of strata shown on the mine plan for borehole DDH2 (RT574 aka sheet U5450-61) indicates that the sequence of strata from the surface to the Dudley Seam (aka Young Wallsend Seam) includes the unmined Fern Valley Seam, Victoria Tunnel Seam, and Nobby's Seam. Sections of strata for boreholes DDH2 and DDH25 (sheets U5450-52, 61) indicate that the Dudley Seam thickness in this area is between approximately 2.0m and 2.1m thick.

Contours of the seam floor are shown on the mine plans. These indicate the Dudley Seam dip to be approximately 4° toward the southwest and the seam floor to be at approximately RL -65m AHD giving cover depths in the ranges of approximately 70m to 80m in Lot 1 and 78m to 85m in Lot 2 and 3a to 3f.

The locations of various geological dykes (near vertical igneous intrusions) and faults are shown on the mine plans (sheets U5450-52, 61) and geological maps and have been reproduced on the attached Drawing 4. The indicated position of these features is at the Dudley Seam level and their surface position is likely to be in significantly different. The dip angle of the faults and dykes are not indicated in the available plans. Fault throw (vertical displacement) and dyke thickness are shown for some locations, and these have also been reproduced in Drawing 4. The type of fault (normal or reverse) is indicated as is the down/upside across the faults.

The faults and dykes of the area generally trend in a north-west, southeast direction, which is typical for the Newcastle / Lake Macquarie area as shown in Drawing 9. Fault throws of between 0.5m and 2m and dyke thickness of 1m are indicated. The site is situated between two normal fault / dyke systems that both have the down throw toward the site, suggesting previous tension on a regional scale. A system of thrust faults on a more local scale pass through the southern portion of the site and are indicative of horizontal compression. These thrust faults have been observed within the mine workings as “pop-up structures” (Lohe & Dean-Jones, 1995)

A feature of the normal faults are sub-horizontal slickensides indicating some reactivation of the faults by strike-slip motion, probably during the compressional deformation that generated thrust faults.

The thrust faults in the mini-wall MW 7 and MW 8 areas are reported to have created problems of roof stability for considerable distances along the drives. The faults are low-angled (less than 45°) with deformation commonly around a claystone marker bed within the Dudley Seam. The total amount of shortening / over thrusting is understood to have been estimated by the Gretley Colliery to be up to 12m to 15m which has been accommodated by both thrusting and folding.

The northwest trending normal fault encountered in mini-wall MW 8 (dip 75° NE, strike 310°) displaces an earlier thrust fault but is itself displaced by a later thrust fault.

3.3 SUBSURFACE CONDITIONS

The overburden units at the site based on DDH2 (refer to Drawing 7 with the location as shown on Drawing 3) are shown in Table 1.

Table 1: Summary of Geotechnical Units

Stratum	Thickness of Unit	Approximate depth to base of unit below ground level (m)
Surface RL	NA	8.9m
Soils	3.05	3.05
Tingira Conglomerate	3.3	6.35
Fern Valley Tuff	16.4	22.75
Fern Valley Seam Upper	5.04	27.79
Fern Valley Split Tuff	2.89	30.68
Fern Valley Seam Lower	2.71	33.39
Kotara Formation	14.92	48.31
Victoria Tunnel Seam	2.93	51.24
Nobby's Tuff	4.9	56.14
Nobby's Seam	1.01	57.15
Signal Hill Conglomerate	8.76	65.91
Remainder of Bar Beach Formation	5.61	71.52
Dudley Seam	2.09	73.61
Bogey Hill Formation	12.4	86.01
Yard Seam	1.32	87.33
Tighes Hill Formation	4.32	91.65
Borehole Seam	1.94	93.59
Waratah Sandstone	3.32	96.91

Additional boreholes CG1 and CG2 have previously been attempted (Coffey Geosciences Pty Ltd, 2006) although they only reached depths of 52.1m and 45.6m respectively before being terminated due to gas build-up within the broken overburden. CG1 was reported to have some fracturing throughout the overburden. This may have been partly due to faulting in the area. For the other borehole CG2, it encountered tool drops of 200mm and 450mm at a depth of 44m. This means that at least some bedding separations i.e. the 'Fractured Zone' (Refer to Figure 2), has occurred up to 27m above the mine workings in some areas.

Since this previous investigation, the pumps of the Glencore West Wallsend Coal mine (operated by Oceanic Coal Australia Limited (OCAL) have been turned off since approximately 2018. This has allowed the head of water within the Gretley Colliery to rise. The water level within the connected Borehole Seam workings was observed at approximately -14m AHD in August 2023 (754-NTLGE321729-AC). This means the head of water within the mine workings and water level within the fractured overburden level is expected to be approximately 23m below ground surface.

4. INFORMATION ON MINE WORKINGS

The mine workings beneath the site were completed by the Newcastle Wallsend Coal Company from their Gretley Colliery between 1987 and 1991. These workings are at a depth of between 70m and 90m. The workings are shown on 1:2000 scale RT574 (U5450 sheets 52, 61 and 62).

The method of extraction was blind ended mini-wall panels separated either by chain pillars or barrier pillars with ventilation passing along the extracted panel to the development and main headings. Difficulties were encountered with mini-wall MW 8 due to geological faults and the panel was not extracted for a length of approximately 250m beneath the Railway Workshops refer to Drawing 3 and Drawing 4.

These mini-wall panels range in width from 24m up to 34.4m (plus 5m for the roadway) and generally increase in width towards the south. These walls were separated by either 19m to 24m wide barriers or chain pillars with 19m to 24.5m width by approximately 45m long (although some pillars are up to 180m in length). At the western end of the site, more square shaped pillars were completed with widths and lengths ranging from 19m up to 24.5m.

The height of these workings for each area is shown as a seam section on each sheet. These seam sections range in height from 1.7m up to 2.0m (refer to Drawing 7). The height of seam from the borehole log DDH2 was 2.1m.

On the 14 the November 1996 in the process of developing a roadway, the continuous miner connected with former workings by the Young Wallsend Colliery causing a sudden inrush of water. This roadway is more than 2.5km to the west of the site.

During later inspections of the mine workings near the site in 2001, the mine workings were found to be closed off with the rock above the mini-walls generally not caved, at least in visible area (Coffey Geosciences Pty Ltd, 2006).

It is understood the colliery later became known as the New Wallsend No. 2 Colliery. The workings were closed with shafts remediated in 2003. Although closed, the mine workings remained dewatered by activities of the Glencore West Wallsend Coal mine (operated by Oceanic Coal Australia Limited (OCAL). The pumps for this area were turned off in approximately 2018, allowing the Gretley Colliery mine workings to fill with water.

4.1 PREVIOUS SUBSIDENCE PREDICTIONS

It is understood based on previous communications with Brian McCowan from McCowan Consulting (Coffey Geosciences Pty Ltd, 2006) the subsidence predictions for the mining was completed in the 1980's with the workings designed for:

- Long term stability.
- Mini-wall panels to not cave during mining.
- Subcritical mini-wall panels.
- Additional 20mm to 30mm of elastic compression of coal pillars and barriers.

4.2 PREVIOUS SURVEY MONITORING

Within the previous report several survey lines were monitored (Coffey Geosciences Pty Ltd, 2006). Available data includes:

- Subsidence survey line down Stephens Ave, Glendale including surface subsidence and strain survey data from 18/09/92, 15/10/92, 26/11/92.
- Subsidence survey line down Lake Road, Glendale including surface subsidence data from 18/10/90, 6/2/91, 25/3/91, 8/5/91, 26/7/91, 19/2/92.
- Subsidence survey line down Glendale Drive, Glendale including surface subsidence and strain data from 18/10/90, 3/12/90, 6/2/91, 20/3/91, 8/5/91, 26/7/91, 19/2/92.
- Subsidence survey line down Bruce Street, Glendale including surface subsidence and strain data from 18/10/90, 8/5/91, 26/7/91, 19/2/92.

- Nine subsidence survey lines in the area around the Railway Workshops including surface subsidence data during and post mining from March 1989 to April 1991.

The survey line locations are shown in the attached Drawing 4 with magnitudes at the site shown on Drawing 5.

A summary of data from the various survey lines, refer to Drawing 4 located north of the subject site is presented in Table 2.

Table 2: Summary of survey data during mining

Survey Line	Subsidence Range (mm)	Strain Range (mm)
Stephens Avenue	0 to 22	-0.5 to 0.78
Lake Road	-11 to 13	Not measured
Glendale Drive	0 to 28	-0.3 to 0.6
Bruce Street	-22 to 24	-1.2 to 0.9

Subsidence data from the nine survey lines around the Railway Workshops (Lines 6, 7, 8, and 9) is presented graphically Drawing 5. The presented values of subsidence are the maximum recorded and most recent measurements. For survey lines 7, 8 and 9, maximum subsidence was less than 50mm with the exception of one point on line 7 representing 53mm. This is within generally acceptable levels and would not usually be considered anomalous. The additional 20mm to 30mm of subsidence compared to the surveyed areas north of the site (Table 2) is expected to be due to caving above the mini-wall panels.

Further to the west around the proposed development Lot 3a and 3d, line 6 provides data for mini-wall 7. Subsidence was less than 50mm with the exception of three points above mini-wall 7 where 52mm, 59mm and 79mm of subsidence were recorded.

Further to the west again, in the area occupied by the Stockland Super Centre and the Hunter Sports Centre (outside the limits of the subject site), lines 1, 2, 3, 4 and 5 indicate anomalous levels of subsidence. In the northern portion of line 2, subsidence of up to 184mm was recorded. To the south, along lines 4 and 5 above a thrust fault, maximum subsidence was consistently above 125mm and up to 277mm on the eastern end of line 5. It should be noted that the area described on Drawing 5 is based on the available subsidence data and it is possible that other areas of anomalous subsidence exist. The larger settlements as well as additional survey lines corresponds to locations where faulting has been noted on the mine plans.

4.3 POSITION OF THE MINE WORKINGS

The mine workings are from the modern era, being completed between 1987 and 1991. As such the position of mine workings relative to the surface is understood to be known quite accurately.

5. DISCUSSION

The mine workings beneath the site have the following features:

- Thirteen mini-walls.
- Six barrier pillars.
- Seven rows of chain pillars.
- Several unmined zone due to the presence of faulting near the southern end of the site.

5.1 PILLAR STABILITY ASSESSMENT

5.1.1 Pillar Factor of Safety Methodology

In order to quantify pillar stability, a factor of safety (FOS) is used. The FOS of an individual pillar is the ratio of pillar strength to pillar load. There are many published methods in practice around the world to estimate pillar strength. All are simplifications and, thus have limitations. In Australia, the UNSW Pillar Design method (Galvin & University of New South Wales. School of Mining En, 1998) is commonly used. This approach is based on semi-empirical relationships, derived from a database of failed and un-failed pillars. It is only valid where roof and floor conditions are good and where full pillar yield does not exist. In general, as discussed above based on core drilling of the seam, this appears to be the case in this area.

The strength of the pillars with a width to height ratio <5 (S_p in MPa) can be estimated using Equation 2.

$$S_p = \frac{8.6(Q \times w)^{0.51}}{h^{0.84}} \quad (2)$$

Where:

- w = width of pillar (m).
- h = height of pillar (m).

Where the width to height ratio is >5 , the equation is modified to Equation 3.

$$S_p = \frac{27.63(Q)^{0.51}}{w^{0.22}h^{0.11}} \left\{ 0.29 \left[\left(\frac{w}{5h} \right)^{2.5} - 1 \right] + 1 \right\} \quad (3)$$

Where: Q = shape factor:

- For width to height ratio 'R' greater than 6: $Q = \frac{2L}{L+w}$ (4)

- For width to height ratio between 3 and 6: $Q = \left(\frac{2L}{L+w} \right)^{\frac{R-3}{3}}$ (5)

- For width to height ratio less than 3: $Q = 1$ (6)

Where: R = width/height

The assessed load applied to the coal pillars is obtained by the weight of all the overburden layers within the tributary area, expressed as a vertical pressure on the top of the pillar. The tributary area is typically taken the midway along bords and cut throughs surrounding a pillar, as shown in Figure 3.

Where: 'TW' is the tributary width and 'TL' is the tributary length.

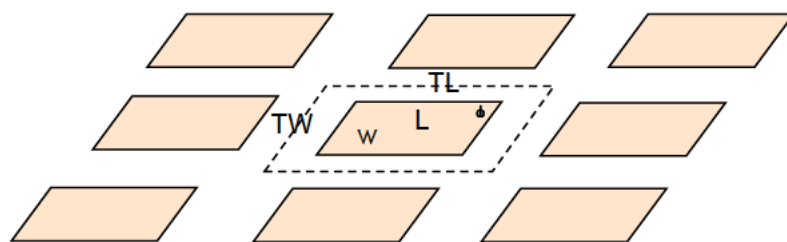


Figure 3: Tributary model

In the case of the site, since the mini-walls were designed to span between the barriers and chain pillars, the mined width is taken as full width of the mini-walls plus the width of roadways.

5.1.2 Pillar Stability Calculations

The following section describes a pillar stability based on pillars around the site. Due to the regular size of pillars, the factor of safety is assessed for representative pillars only. Dimensions used in this assessment include:

- For height two values were adopted:
 - 2.1m being the height from borehole log DDH2.
 - 3.1m allowing for an additional 1m off roof collapse.
- For the width of pillars two values were adopted:
 - As drawn widths from RT574.
 - As drawn widths from RT574 less 0.5m.
- For the overburden we have assumed two cover depths
 - 70m being the minimum cover depth.
 - 90m being the maximum cover depth.

The pillar stability calculations are summarised in Table 3.

Table 3: Summary of Pillar Stability Calculations

Pillar	Width (m)	Length (m)	Scaled Tributary Width (m)	Scaled Tributary Length (m)	Width to Height Ratio		Factor of Safety			
Cover Depth (m)							70		90	
Height (m)					2.1	3.1	2.1	3.1	2.1	3.1
Pillar 1	18.8	21.8	24.8	27.8	9.0	6.1	9.4	5.5	7.3	4.2
	18.3				8.7	5.9	8.9	5.3	6.9	4.1
Pillar 2	24.4	24.5	30.4	30.5	11.6	7.9	14.7	7.4	11.4	5.7
	23.9				11.4	7.7	14.0	7.1	10.8	5.5
Pillar 3	20.1	545	36.8	551	9.6	6.5	12.7	7.1	9.8	5.5
	19.6				9.3	6.3	11.9	6.8	9.2	5.3
Pillar 4	18.8	37.4	36.0	43.4	9.0	6.1	7.9	4.6	6.1	3.6
	18.3				8.7	5.9	7.5	4.4	5.8	3.4
Pillar 5	20.3	125.5	38.8	131.5	9.7	6.5	11.2	6.3	8.7	4.8
	19.8				9.4	6.4	10.5	6.0	8.2	4.6
Pillar 6	22.7	378	41.7	384	10.8	7.3	15.0	7.9	11.6	6.1
	22.2				10.6	7.2	14.1	7.5	10.9	5.8

5.2 REFERENCE TO SA NSW MERIT ASSESSMENT POLICIES

5.2.1 Subdivision

For subdivisions, the SA NSW have developed the policy “*Development Application – Subdivision Assessment Policy Version 2 5 April 2023*”. The objective of the policy is to:

- Communicate to applicants the requirement for approval given the number of derivative lots and location of the subdivision.
- Provide a clear framework for assessing applications for land subdivisions.
- Ensure conditions of approval for the proposed subdivision are commensurate (in proportion) with subsidence risks.
- Provide clear timeframes for the assessment of subdivisions.

The uncertainty factor is used by SA NSW to determine the levels of conservatism and allowed assumptions required when assessing the likelihood of a trough subsidence event. The level of geotechnical uncertainty is categorised as low, medium or high based on the level of confidence and understanding of the:

- Geological environment (R1)
- Level of geotechnical investigation (R2)
- Type of coal mine plans and records (R3)
- Method used to assess stability and impact (R4)

The weighting applied to each factor is:

- R1 = 3
- R2 = 2
- R3 = 3
- R4 = 3

An uncertainty value of either ranging from 1 to 3 is assigned for each category (R1 to R4) based on the descriptions in Table C2 of Attachment C of the SA NSW Merit Assessment Policy. The uncertainty values (U) are:

- Low uncertainty = 1
- Moderate uncertainty = 2
- High uncertainty = 3 (or 5 for R3)

Once these have been determined, the Uncertainty Factor can be determined by applying the following formula:

$$\text{Uncertainty Factor (UF)} = (R1 \times U) + (R2 \times U) + (R3 \times U) + (R4 \times U) \quad (10)$$

The Uncertainty Factor is used to rate project uncertainty for a project is rated as low, medium or high uncertainty based on the following values:

- Low uncertainty – UF <= 16
- Moderate uncertainty – UF > 17 and <=22
- High uncertainty – UF >23

A summary of uncertainty factors for the subject site is provided below in Table 4.

Table 4: Summary of uncertainty factors

Item	Weighting	Uncertainty Value	Uncertainty Factor	Comments
Geological Environment (R1)	2	3	6	Dykes and multiple faults are present within the site boundary
Level of geotechnical Investigation (R2)	2	3	6	No site-specific boreholes after mining, however boreholes were completed during mining.
Coal Mine Plans and Records (R3)	3	1	3	Mostly mini-wall mining with width to height ratios greater than 5 even allowing for some roof fall.
Method used to assess stability and impact (R4)	3	2	6	Single method used, looking at whole coal pillars all values clearly outlined, less 0.5m with various heights assessed. Increased pillar heights.
Uncertainty Factor (UF)			21	

Based on the above the site would have a medium uncertainty.

Although the current subdivision is for a small number of lots, due to the number of proposed townhouses, the subdivision will be likely considered to be a large-scale subdivision (i.e. >20 lots). To proceed with “no design requirements”, in accordance with Table B2, the required factor of safety would need to be greater than 2.1 which is present (Table 3).

5.2.2 Buildings

With reference to the NSW Planning Portal surrounding properties are designated Guideline 3A which refers to “*Historical mine workings – low subsidence risk*”. For sites with this guideline, SA NSW permits up to two complying developments that conform with the following:

Up to two storey brick veneer developments or up to three storey lightweight clad frame developments erected on reinforced concrete footings/slab to comply with AS 2870-2011. These improvements are limited to a maximum length of 36 metres and maximum footprint size of 600m².

For buildings over standard guidelines, the SA NSW have developed the policy “*Development Application – Merit Assessment Policy Version 2 5 April 2023*”.

The objective of the policy is to:

- Communicate to applicants the requirement for approval given the size and location of a development proposal.
- Provide a clear framework for assessing applications for proposed development that do not comply with a property’s guideline.
- Ensure conditions of approval for the proposed development are commensurate (in proportion) with subsidence risks.
- Provide clear timeframes for the assessment of developments that do not comply with a property’s guideline.

To assess the geotechnical uncertainty factor, the same process is utilised as above in Section 5.2.1. As such a medium risk is likely appropriate for the site.

The proposed developments would likely fit within the 'B3' category, with a value over \$7.5M, even if it was divided into several development applications.

In accordance with Table C2, B3 structures with moderate uncertainty factor require minimum factor of safety of 2.1, which is present. However, as the current mechanism for subsidence envisioned for the site is potential future creep of mini-wall panels SA NSW have requested the proposed parameters be used for 'Serviceability' design.

5.3 SUBSIDENCE ASSESSMENT

The pillars beneath the site have width to height ratios greater than 5 and factor of safety greater than 2.1. As the pillars beneath the site meet the above, then design for failure of pillars is not required. The more likely event is failure of the mini-wall roof in locations than currently remain standing.

To estimate the surface subsidence resulting from caving of the strata above mini-wall panels, empirical charts developed over long wall panel is utilised (Holla, 1987). The mini-wall panel widths, including roadway, range from:

- 34.5m in the north where the cover is likely close to 70m thick.
- 40m in the south where the cover increases to 80m.

Using these charts, the maximum subsidence parameters, assuming no subsidence had already occurred, would likely be in the order of:

- Maximum subsidence 100mm
- Maximum tensile strains 2mm/m.
- Maximum compressive strains 4.5mm/m.
- Maximum tilts 2mm/m.
- Maximum curvature:
 - 5km concave down.
 - 2km concave up.

However, as described in Section 4.2, previous subsidence values within and round the site of approximately 20mm to 50mm was observed away from fault areas, with 50mm to 277mm around fault areas, during previous settlement monitoring. Therefore, allowing for settlement that has already been documented, the maximum values reduce to:

- Maximum subsidence 80mm.
- Maximum tensile strains 1mm/m.
- Maximum compressive strains 3mm/m.
- Maximum tilts 1.2mm/m.
- Maximum curvature:
 - 10km concave down.
 - 3.5km concave up.

These values are based on the curve provided on Figure 7. It is noted the data suggests a s_{max}/T ratio of 0.04 where the mini-wall has a width to height ratio of 0.5. This would have the effect of reducing the above subsidence values to 60mm. It is noted that this is very conservative given over 90% is likely to have occurred in the first 12 months, with the remainder usually occurring within the next 2 to 5 years (Galvin J. M., 2016).

The above maximum subsidence parameters would generally be applicable in a north south alignment (across the mini-walls) and only over the mini-wall panels for a length of 20m. For the full panel width of 40m this would reduce 80mm of compression (i.e. 3mm/m for 20m and 1mm/m for 20m). Along the mini-wall panels, the rates of curvature are likely to be much more gradual. With reference to empirical charts (Holla, 1987) the strains in relation to the maximum subsidence are predicted to be more than 3 times greater for panels with a width to height ratio of 0.5 versus a width to height ratio of 1. As such, it is likely the compressive strains along the mini-walls will be less than 1mm/m with curvature values of 10km concave up.

The above analysis ignores the effect of faulting on the subsidence. Although offsite areas with faulting present have already undergone a greater degree of settlement, the above subsidence parameters are likely appropriate for the remainder of the site.

It is noted the tensile zone is likely to be outside the panel that fails. As such within mini-wall panels the strains could be either tensile or compressive while outside the mini-wall panel the strains can only be tensile. This is shown on Drawing 6 and Drawing 8 with the proposed development.

As the mine workings have already filled with water, designing for uplift due to the increase in pore pressure, is not considered appropriate.

6. CLOSING REMARKS

The site at Main Road Glendale is underlain by mine workings within the Dudley Seam by the Gretley Colliery. These workings are relatively modern with squat pillars (pillars with width to height ratio greater than 5) with much of the workings comprised of mini-wall panels. Although the panels showed some relaxation during mining, full roof fall is understood to have not occurred over 10 years later in some areas, before the closure in 2003.

It is recommended some residual subsidence be allowed for in the area over mini-wall panels. A subsidence value of 80mm is recommended based on the difference between potential subsidence of 100mm using empirical design charts (Holla, 1987) and the at least 20mm that had already been observed in the area.

The mine workings within the current site were assessed to have a moderate geotechnical risk factor. However given the proposed mechanism is creep of collapsed workings, it will be necessary to design the building for 'Serviceability' for possible mine subsidence movements as below:

- Maximum subsidence 80mm.
- Maximum tensile strains 1mm/m.
- Maximum compressive strains 3mm/m.
- Maximum tilts 1.2mm/m.
- Maximum curvature:
 - 10km concave down.
 - 3.5km concave up.

The mine subsidence assessment undertaken for this concept DA and first stage of development demonstrate compliance with relevant State and Local Government policies including SA NSW Merit Assessment Policy 2023, subject to future stage development applications satisfactorily addressing the potential subsidence parameters provided above. Based on the advice from Northrop (NL221237_E01.NP) and previous experience, the development of buildings up to four (4) storeys in height with basement parking generally as shown in the Concept DA master plan can be achieved, subject to appropriate structural detailing in the design of buildings and services at the site.

Further advice on the uses and limitations of this report is presented in the attached document, Important Information about your Tetra Tech Coffey Report which forms and integral part of this report.

Signature:	
Full name:	Simon Baker
Title:	Senior Geotechnical Engineer
Date:	25 June 2024

7. BIBLIOGRAPHY

- Coffey Geosciences Pty Ltd. (2006). *Railcorp Land at Glendale - Mine Subsidence Assessment*.
- Forster, I., & Enever, J. (1992). *Hydrogeological response of overburden strata to underground mining, Central Coast, New South Wales*.
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APPENDIX A: LIMITATIONS

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

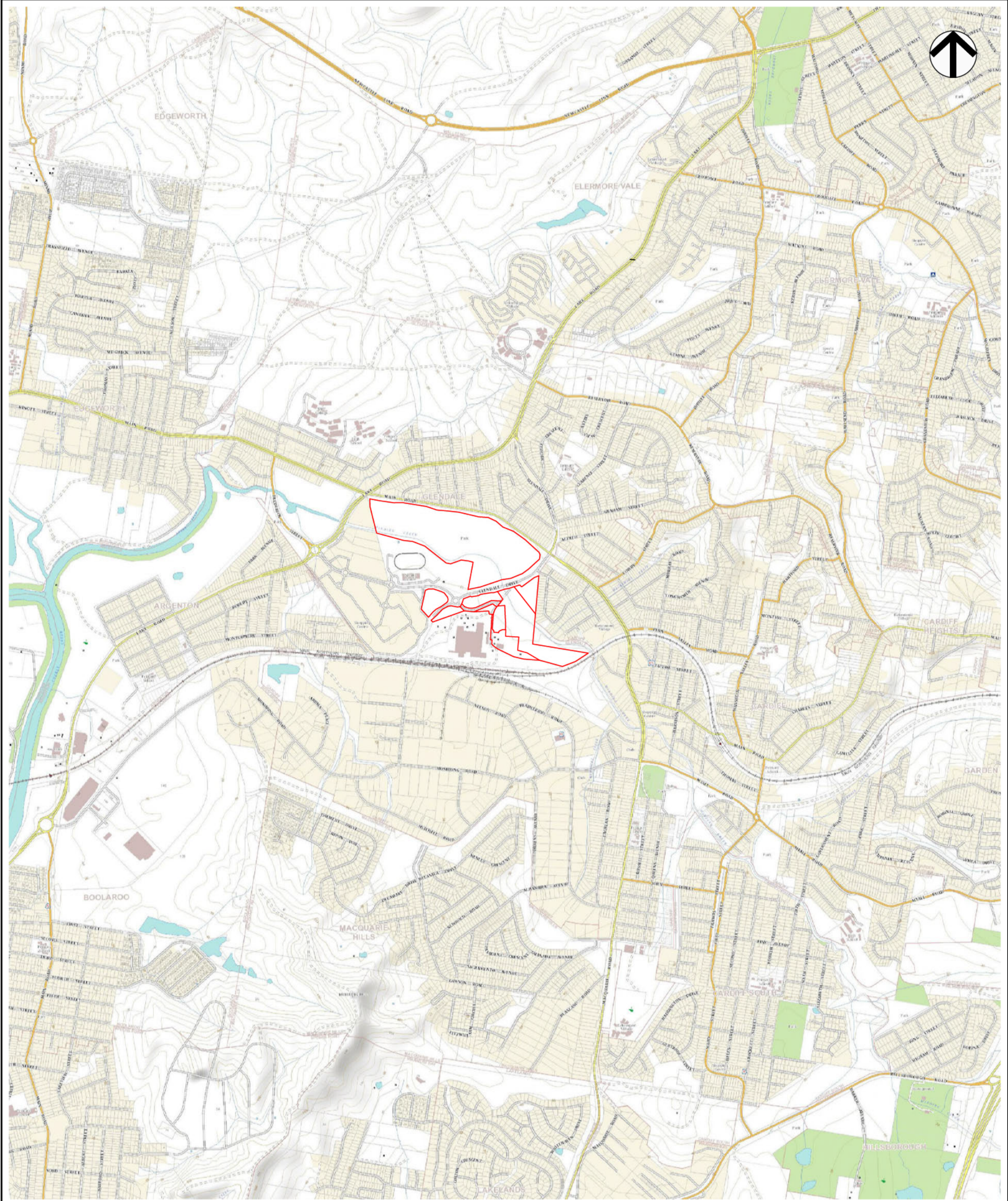
Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.

APPENDIX B: DRAWINGS



revision	no.	description	drawn	approved	date	LEGEND SITE BOUNDARY						
MAP PROJECTION: GDA1994 MGA ZONE 56 200 0 200 600 1000 Scale (metres) 1:20000 AERIAL IMAGERY COPYRIGHT: ©Land and Property Information (2018) SOURCED FROM WEBSITE: http://www.lpi.nsw.gov.au/mapping_and_imagery/lpi_web_services LICENSED UNDER CC BY 3.0 AU (https://creativecommons.org/licenses/by/3.0/au/legalcode)						drawn	SJB		Tt TETRA TECH COFFEY	client:TRANSPORT FOR NSW		
approved	JD		project:CONCEPT DEVELOPMENT APPLICATION AND FIRST STAGE DEVELOPMENT MAIN ROAD GLENDALE MINE SUBSIDENCE ASSESSMENT									
date	20-02-2024		title:SITE LOCATION PLAN									
scale	AS SHOWN		project no: 754-NTLGE320046drawing no: DRAWING 1rev: A									
original size	A3											

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LEGEND

SITE BOUNDARY

APPROXIMATE BOREHOLE LOCATION GRETLEY / NEW WALLSEND

APPROXIMATE BOREHOLE LOCATION N9235-01-AG 2006

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	-	-	-

MAP PROJECTION: GDA1984 MGA ZONE 56

50

0

50

100

150

200

Scale (metres) 1:4000

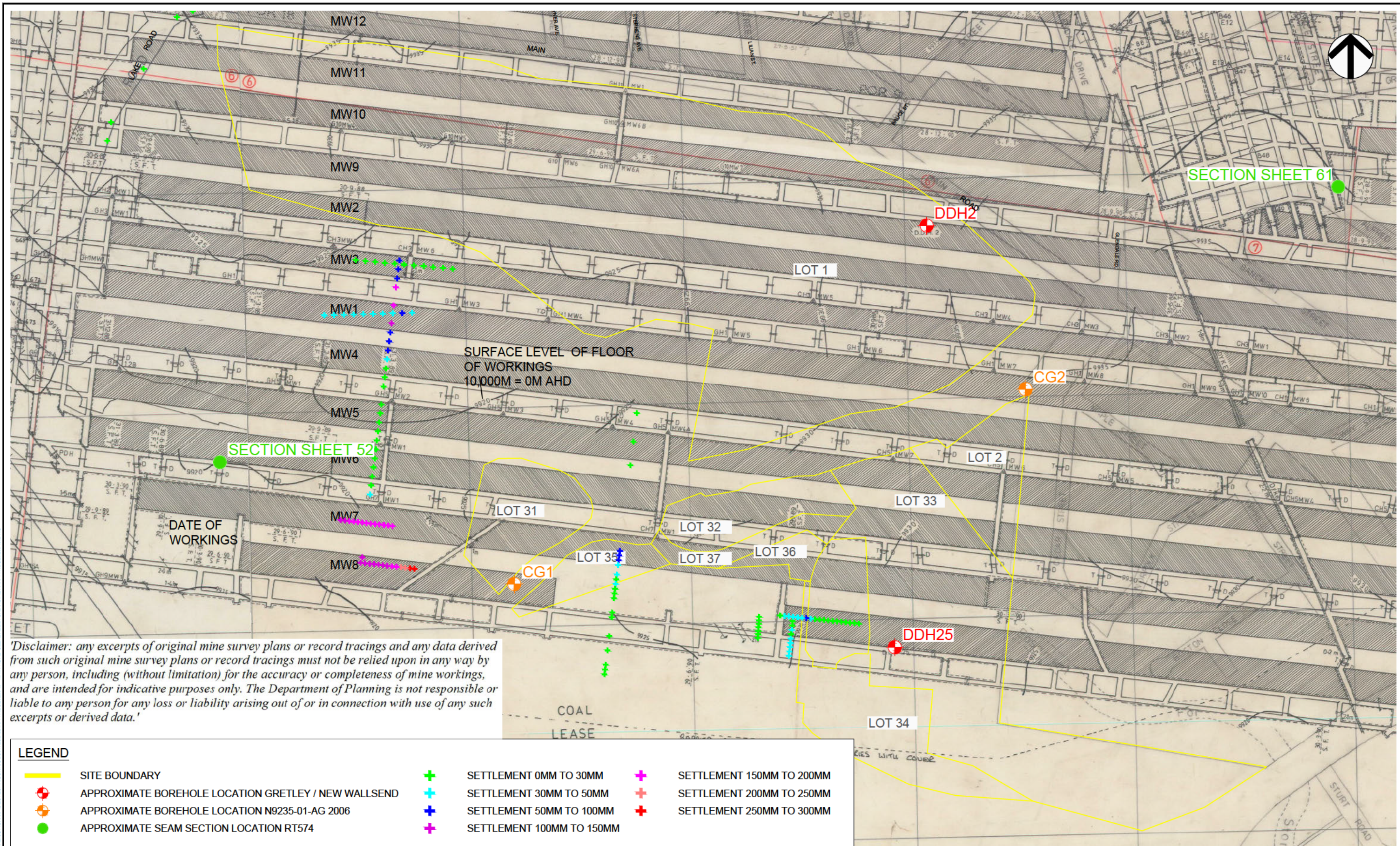
AERIAL IMAGERY COPYRIGHT: ©Land and Property Information (2018)
SOURCED FROM WEBSITE: http://www.lpi.nsw.gov.au/mapping_and_imagery/lpi_web_services
LICENSED UNDER CC BY 3.0 AU (<https://creativecommons.org/licenses/by/3.0/au/legalcode>)

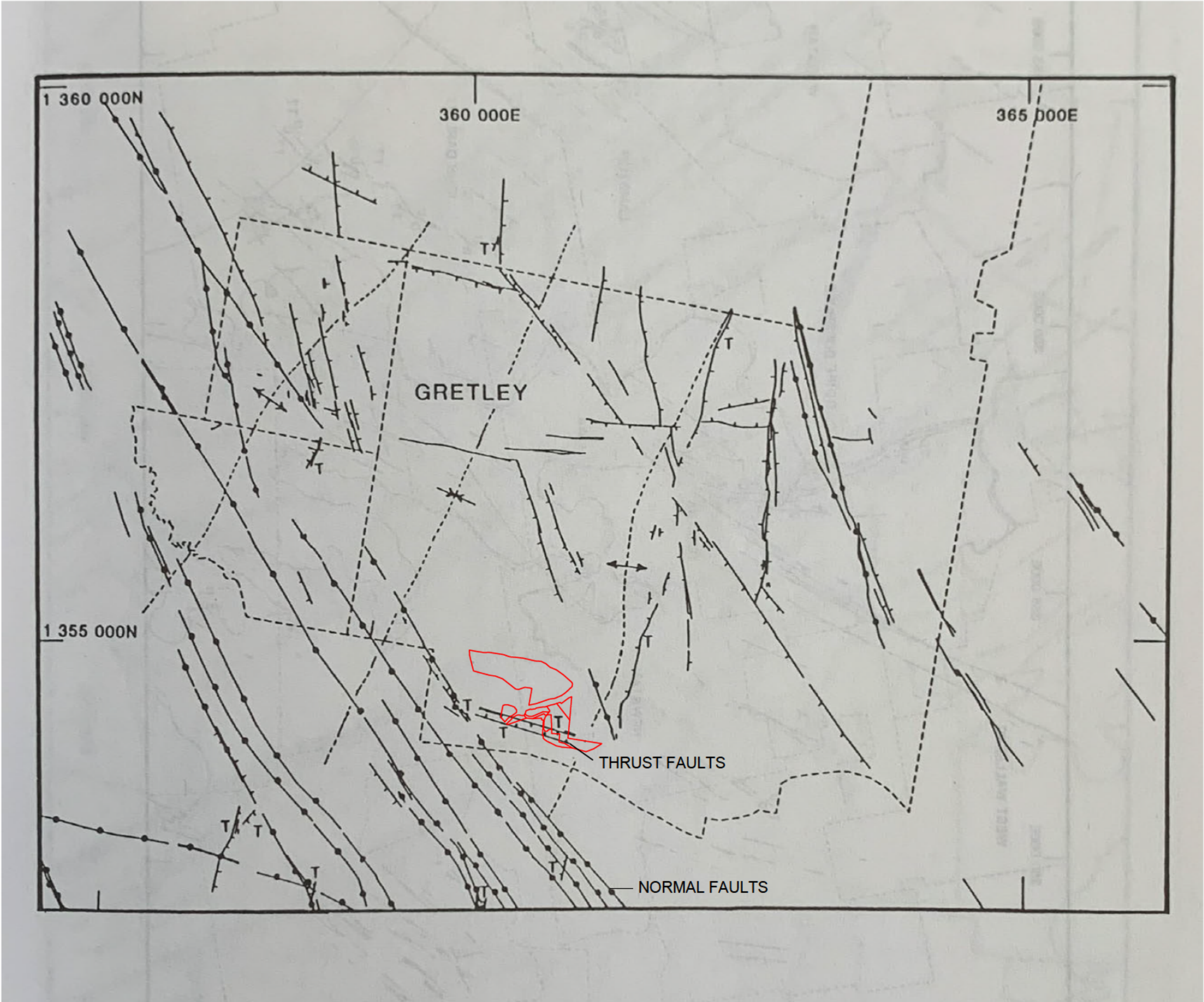
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approved	JD
date	20-02-2024
scale	AS SHOWN
original size	A3

Tt

TETRA TECH
COFFEY

client:	TRANSPORT FOR NSW		
project:	CONCEPT DEVELOPMENT APPLICATION AND FIRST STAGE DEVELOPMENT MAIN ROAD GLENDALE MINE SUBSIDENCE ASSESSMENT		
title:	CURRENT SITE CONDITIONS WITH PROPOSED		
project no:	754-NTLGE320046	drawing no:	DRAWING 2
		rev:	A





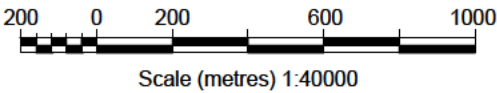
revision	no.	description	drawn	approved	date

LEGEND

— SITE BOUNDARY

REPRODUCED FROM LOHE, E.M. & DEAN-JONES, G.L. 1995

MAP PROJECTION: GDA1994 MGA ZONE 56

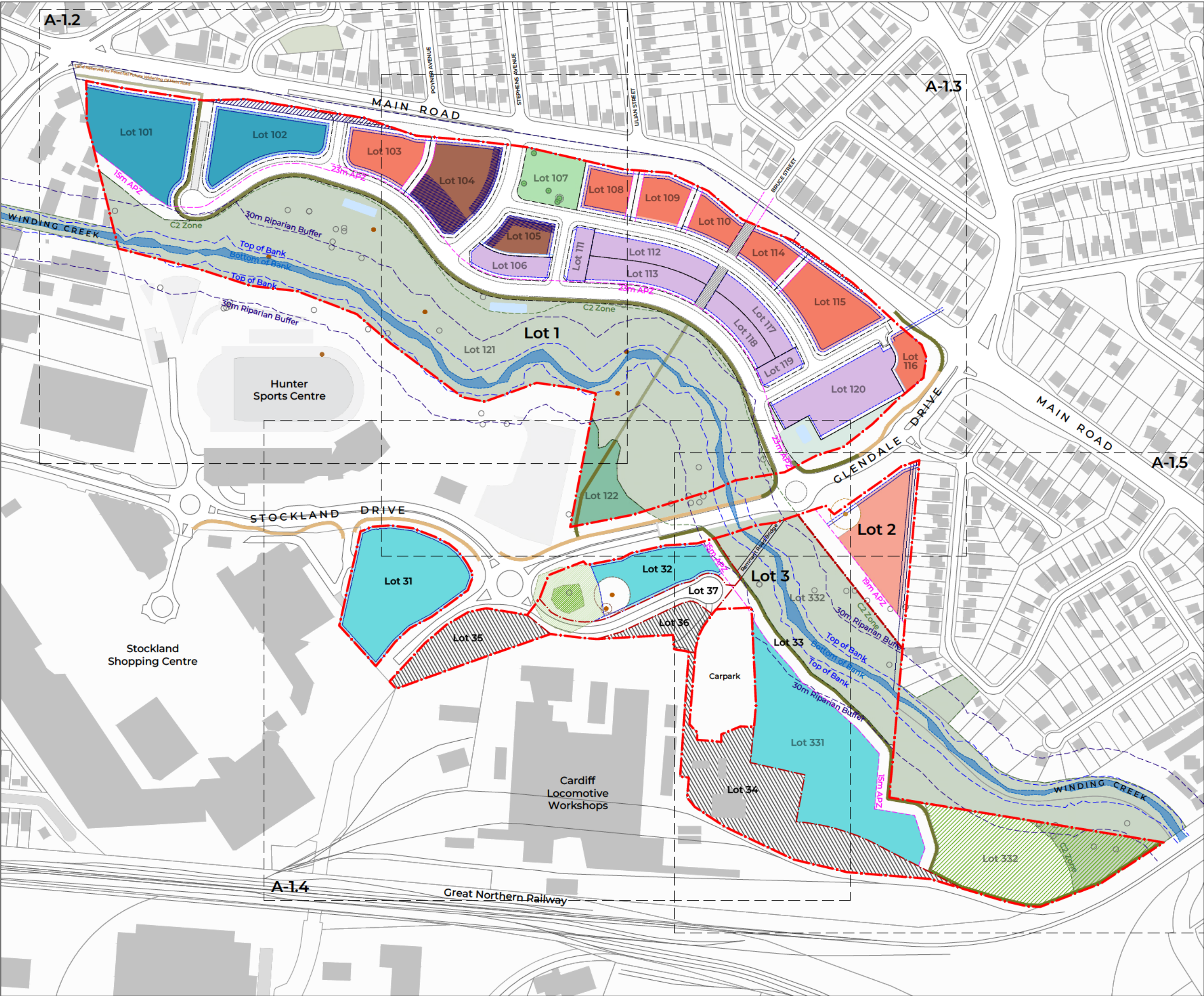


drawn	SJB
approved	JD
date	20-02-2024
scale	AS SHOWN
original size	A3



client:	TRANSPORT FOR NSW		
project:	CONCEPT DEVELOPMENT APPLICATION AND FIRST STAGE DEVELOPMENT MAIN ROAD GLENDALE MINE SUBSIDENCE ASSESSMENT		
title:	GRETLEY COLLIERY FAULTS AND DYKES		
project no:	754-NTLGE320046	drawing no:	DRAWING 9
		rev:	A

APPENDIX C: GLENDALE MASTER PLAN



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FOR LODGEMENT

ISSUE				
ISSUE	DATE	REVISION	REVISION BY	APPROVED BY
P1	14.09.23	Coordination Issue 1	CT	IIP
P2	23.10.23	Coordination Issue 2	CT	IIP
P3	11.12.23	Final Draft	CT	IIP
A	19.02.24	For Lodgement	CT	IIP

LEGEND

- Subject Site

SixMap Cadastre

Context Buildings

Existing Kerbs

Existing Cycle Path / Shared Space

Potential Future Road Widening (DCP)

Potential Land Resumption Subject to confirmation with TfNSW

Proposed Subdivision Boundary

Proposed Stage 1 Subdivision Boundary

Proposed Stage 2 Subdivision Boundary

Future Development Lots (Subject to Future Subdivision DA)

Lots to be Retained by TAHE

Lot xx

Stage 1 Subdivision Lot Identification Numbers

Stage 2 Subdivision Lot Identification Numbers

Future Subdivision Lot Identification Numbers

Planning Controls (DCP & ADG)

DCP Street Setback

DCP Side Setback

DCP Upper Level Setback

DCP Setback to Residential Zone

ADG Building Separation

Bushfire Asset Protection Zone

Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space

C2 Zone (Lake Macquarie LEP 2014)

Proposed Winding Creek Riparian Corridor

Winding Creek

Winding Creek Bottom of Bank

Winding Creek Top of Bank

30m Vegetated Riparian Zone

Existing Site Element to be Retained

Existing Vegetation on Site to be Retained

Existing Hollow Bearing Trees (HBT) and E-robusta (ER) to be Retained (Proposed Local Park)

Existing Nest Tree to be Retained

Tree Protection Zone for Nest Tree

Reassessed AHIMS Sites

Tree Protection Zone for Culturally Modified Trees

Proposed Land Use Envelope

Commercial Premise (Max 2 Storey)

Commercial Premise (Max 4 Storey)

Residential Flat Building (Max 2 Storey)

Residential Flat Building (Max 4 Storey)

Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

Retail on Ground Level

Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)

NOTES

* Area identified for potential future land resumption along Main Road has been provided by Northrop and is indicative only. Actual size and location of land to be acquired for the purpose of road widening is subject to future detail design by Transport for New South Wales.



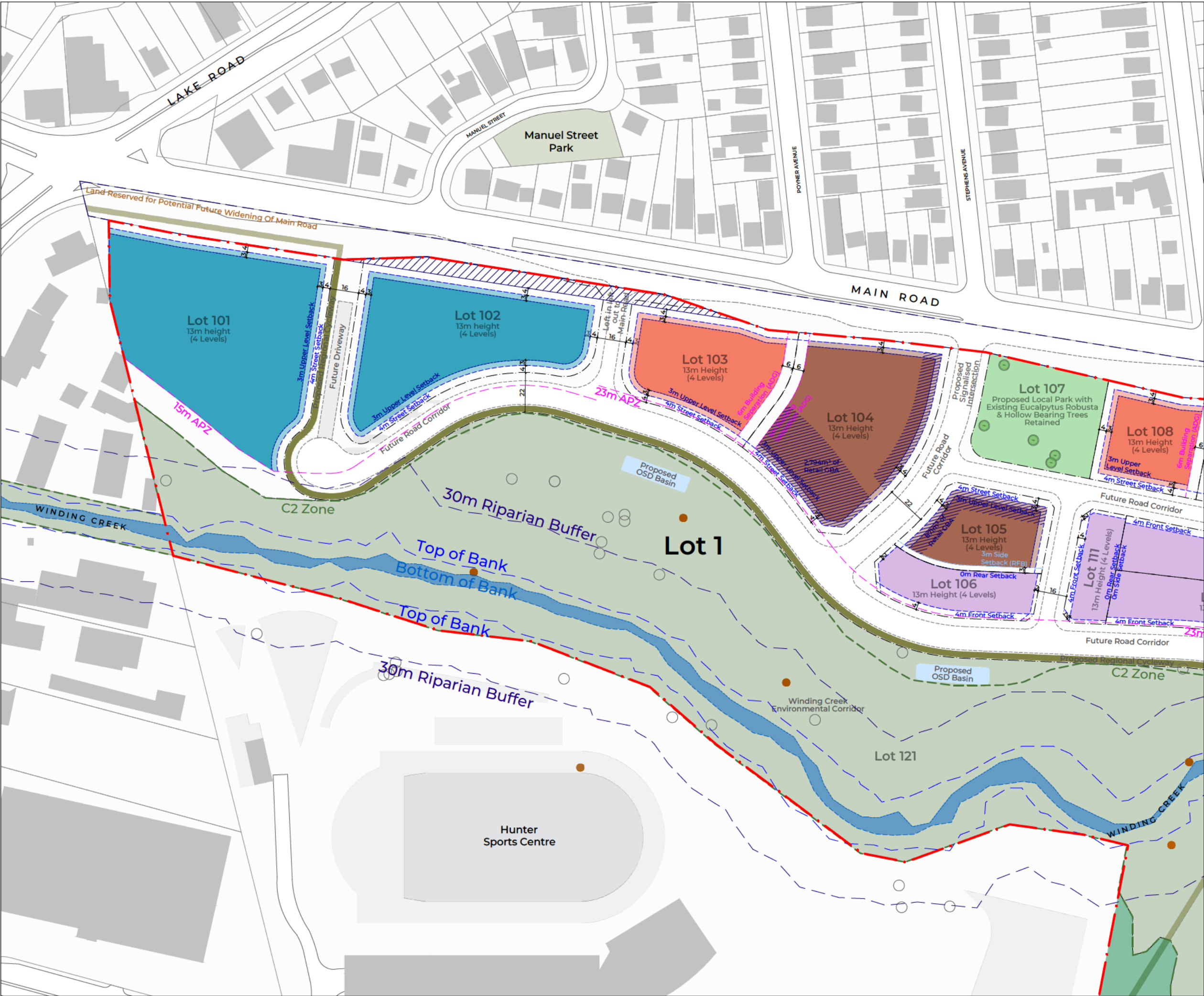
DRAWING

A-1.1 /A Glendale Concept DA Overall Envelope Plan

JOB NO.	DWG NO.	ISSUE	DATE	DRAWN BY
2210945	A-1.1	A	19.02.24	CT

PROJECT

Concept Development Application and First Stage of Development at 65 Glendale Road, Glendale



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ISSUE	DATE	REVISION	REVISION BY	APPROVED BY
P1	14.09.23	Coordination Issue 1	CT	IIP
P2	23.10.23	Coordination Issue 2	CT	IIP
P3	11.12.23	Final Draft	CT	IIP
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LEGEND

- Subject Site

SixMap Cadastre

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Existing Kerbs

Existing Cycle Path / Shared Space

Potential Future Road Widening (DCP)

Potential Land Resumption Subject to confirmation with TfNSW

Proposed Subdivision Boundary

Proposed Stage 1 Subdivision Boundary

Proposed Stage 2 Subdivision Boundary

Future Development Lots (Subject to Future Subdivision DA)

Lots to be Retained by TAHE

Lot xx

Stage 1 Subdivision Lot Identification Numbers

Stage 2 Subdivision Lot Identification Numbers

Future Subdivision Lot Identification Numbers

Planning Controls (DCP & ADG)

DCP Street Setback

DCP Side Setback

DCP Upper Level Setback

DCP Setback to Residential Zone

ADG Building Separation

Bushfire Asset Protection Zone

Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space

C2 Zone (Lake Macquarie LEP 2014)

Proposed Winding Creek Riparian Corridor

Winding Creek

Winding Creek Bottom of Bank

Winding Creek Top of Bank

30m Vegetated Riparian Zone

Existing Site Element to be Retained

Existing Vegetation on Site to be Retained

Existing Hollow Bearing Trees (HBT) and E. Robusta (ER)

Existing HBT and ER to be retained (Proposed Local Park)

Existing Nest Tree to be Retained

Tree Protection Zone for Nest Tree

Reassessed AHIMS Sites

Tree Protection Zone for Culturally Modified Trees

Proposed Land Use Envelope

Commercial Premise (Max 2 Storey)

Commercial Premise (Max 4 Storey)

Residential Flat Building (Max 2 Storey)

Residential Flat Building (Max 4 Storey)

Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

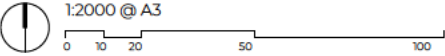
Retail on Ground Level

Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)

NOTES

* Area identified for potential future land resumption along Main Road has been provided by Northrop and is indicative only. Actual size and location of land to be acquired for the purpose of road widening is subject to future detail design by Transport for New South Wales.



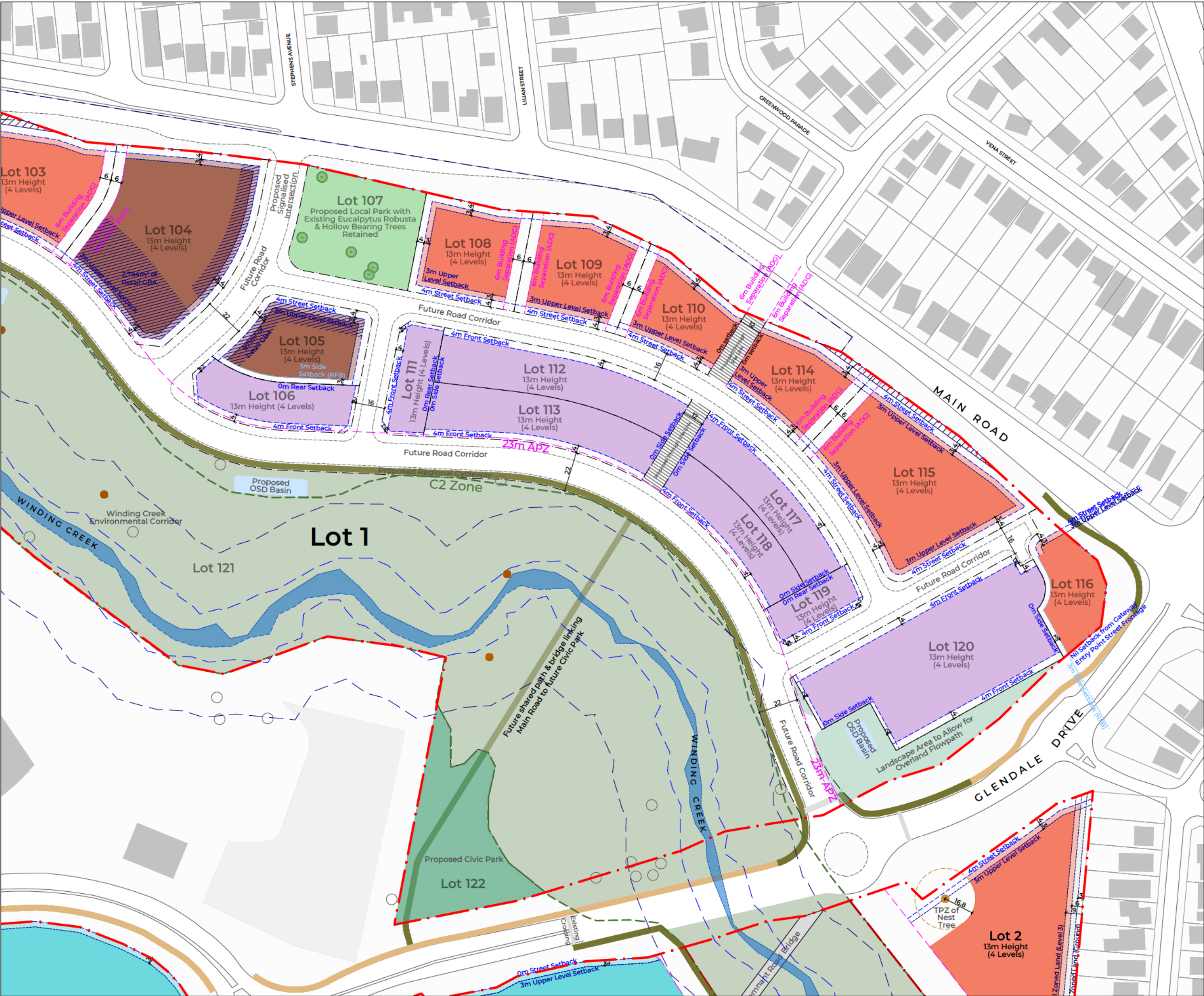
DRAWING

A-1.2
/A Glendale Concept DA
Envelope Plan - Lot 1 West

JOB NO.	DWG NO.	ISSUE	DATE	DRAWN BY
2210945	A-1.2	A	19.02.24	CT

PROJECT

Concept Development
Application and First
Stage of Development at
65 Glendale Road, Glendale



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ISSUE				
ISSUE	DATE	REVISION	REVISION BY	APPROVED BY
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P2	23.10.23	Coordination Issue 2	CT	IIP
P3	11.12.23	Final Draft	CT	IIP
A	19.02.24	For Lodgement	CT	IIP

LEGEND

- Subject Site

SixMap Cadastre

Context Buildings

Existing Kerbs

Existing Cycle Path / Shared Space

Potential Future Road Widening (DCP)

Potential Land Resumption Subject to confirmation with TNSW

Proposed Subdivision Boundary

Proposed Stage 1 Subdivision Boundary

Proposed Stage 2 Subdivision Boundary

Future Development Lots (Subject to Future Subdivision DA)

Lots to be Retained by TAHE

Lot xx

Lot xx

Lot xx

Planning Controls (DCP & ADG)

DCP Street Setback

DCP Side Setback

DCP Upper Level Setback

DCP Setback to Residential Zone

ADG Building Separation

Bushfire Asset Protection Zone

Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space

C2 Zone (Lake Macquarie LEP 2014)

Proposed Winding Creek Riparian Corridor

Winding Creek

Winding Creek Bottom of Bank

Winding Creek Top of Bank

30m Vegetated Riparian Zone

Existing Site Element to be Retained

Existing Vegetation on Site to be Retained

Existing Hollow Bearing Trees (HBT) and E. Robusta (ER)

Existing HBT and ER to be retained (Proposed Local Park)

Existing Nest Tree to be Retained

Tree Protection Zone for Nest Tree

Reassessed AHIMS Sites

Tree Protection Zone for Culturally Modified Trees

Proposed Land Use Envelope

Commercial Premise (Max 2 Storey)

Commercial Premise (Max 4 Storey)

Residential Flat Building (Max 2 Storey)

Residential Flat Building (Max 4 Storey)

Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

Retail on Ground Level

Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)

NOTES

* Area identified for potential future land resumption along Main Road has been provided by Northrop and is indicative only. Actual size and location of land to be acquired for the purpose of road widening is subject to future detail design by Transport for New South Wales.



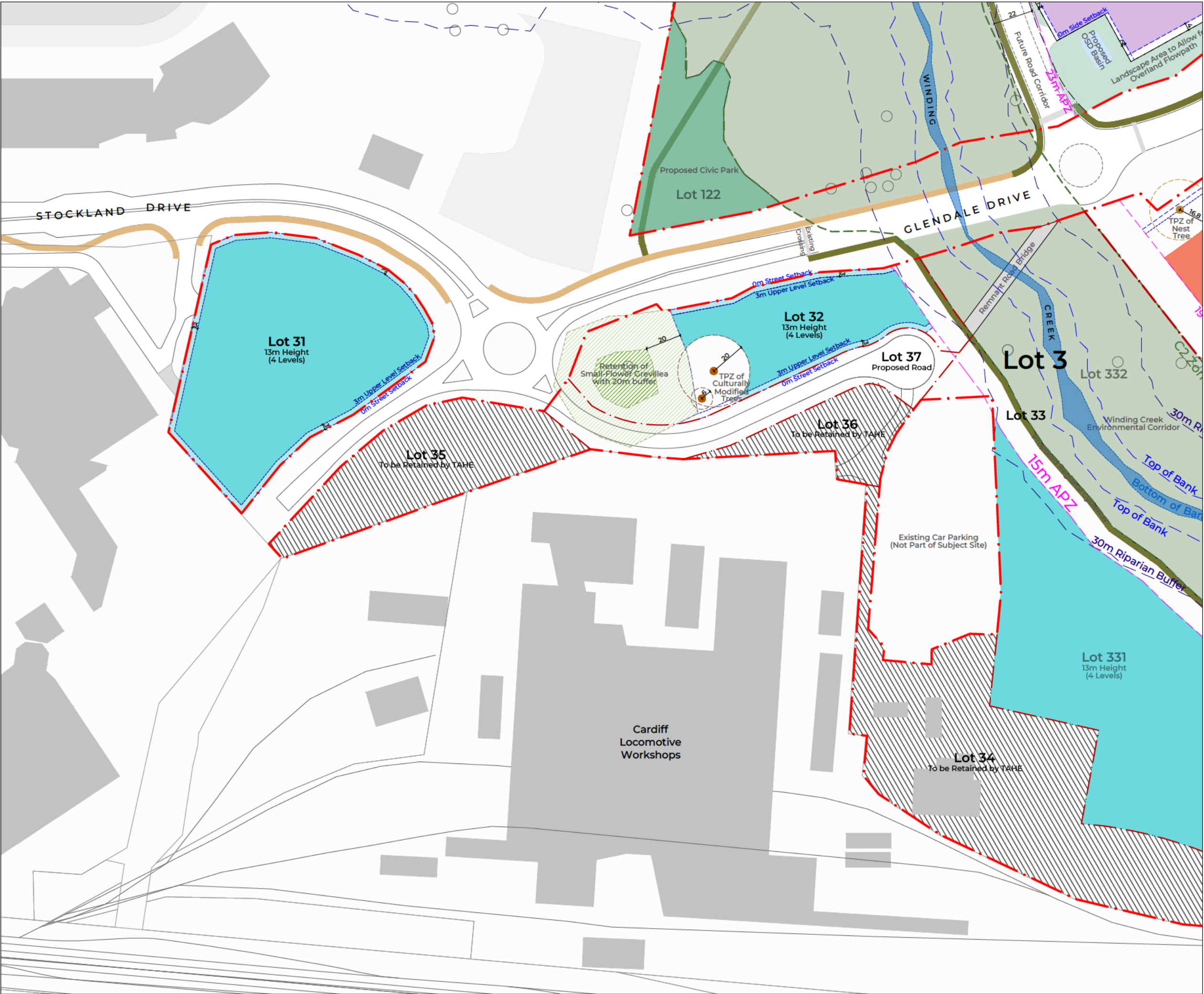
DRAWING

A-13
/A Glendale Concept DA
Envelope Plan - Lot 1 East

JOB NO.	DWG NO.	ISSUE	DATE	DRAWN BY
2210945	A-13	A	19.02.24	CT

PROJECT

Concept Development
Application and First
Stage of Development at
65 Glendale Road, Glendale



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LEGEND

- Subject Site

SixMap Cadastre

Context Buildings

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Existing Cycle Path / Shared Space
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Proposed Winding Creek Riparian Corridor

Winding Creek

Winding Creek Bottom of Bank

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30m Vegetated Riparian Zone
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Proposed Stage 1 Subdivision Boundary

Proposed Stage 2 Subdivision Boundary

Future Development Lots (Subject to Future Subdivision DA)

Lots to be Retained by TAHE

Lot xx

Stage 1 Subdivision Lot Identification Numbers

Stage 2 Subdivision Lot Identification Numbers

Future Subdivision Lot Identification Numbers
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Existing Nest Tree to be Retained

Tree Protection Zone for Nest Tree

Reassessed AHIMS Sites

Tree Protection Zone for Culturally Modified Trees
- Planning Controls (DCP & ADG)

DCP Street Setback

DCP Side Setback

DCP Upper Level Setback

DCP Setback to Residential Zone

ADG Building Separation

Bushfire Asset Protection Zone
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Residential Flat Building (Max 4 Storey)

Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

Retail on Ground Level
- Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space
- Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)



DRAWING

A-1.4 Glendale Concept DA Envelope Plan - Lot 3 West

JOB NO.	DWG NO.	ISSUE	DATE	DRAWN BY
2270945	A-1.4	A	19.02.24	CT

PROJECT

Concept Development Application and First Stage of Development at 65 Glendale Road, Glendale



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LEGEND

- Subject Site

SixMap Cadastre

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Multi-Dwelling Housing (Max 4 Storey)

Retail on Ground Level
- Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space
- Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)



DRAWING

A-1.5 Glendale Concept DA
/A Envelope Plan - Lot 3 East & Lot 2

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PROJECT

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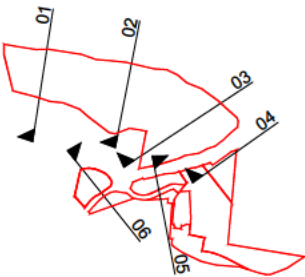
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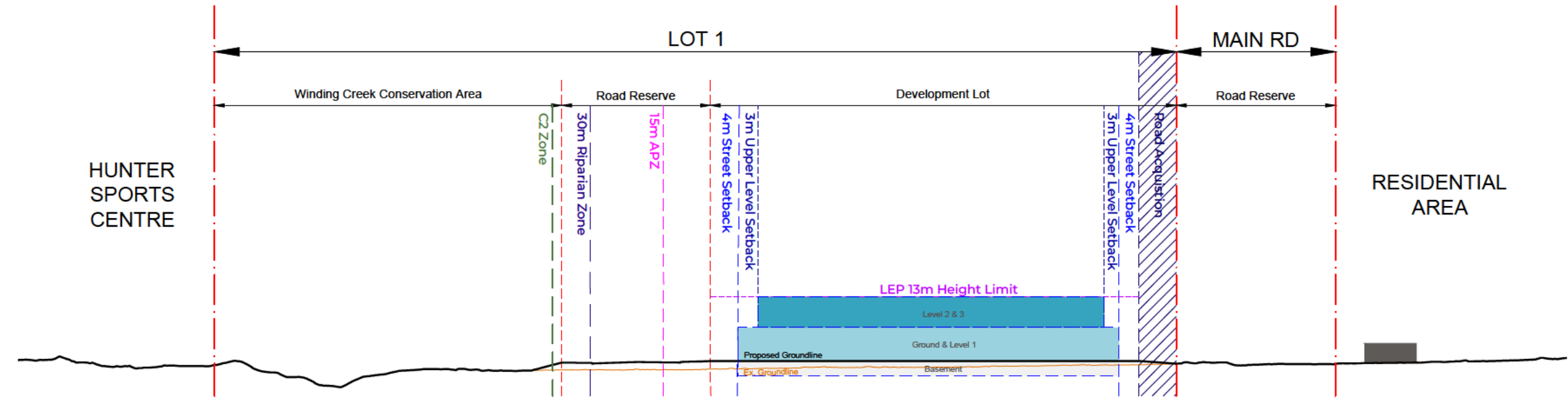
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P4	16.02.24	Final Draft	CT	IIP
A	19.02.24	For Lodgement	CT	IIP

KEY PLAN



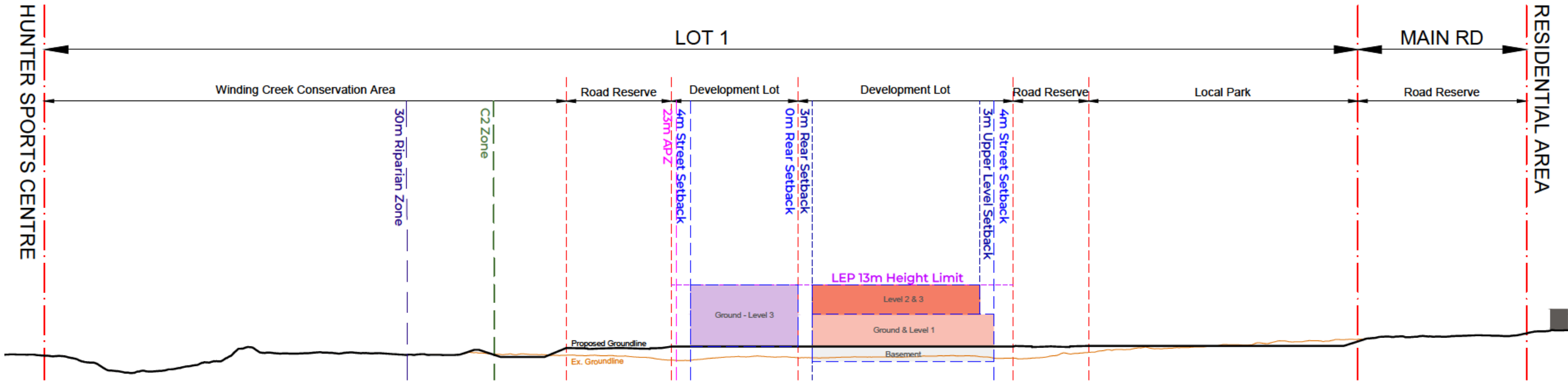
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Section 01

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Section 02

1:1000 @ A3

0 5 10 25 50

DRAWING

A-2.1
/A

Glendale Concept DA
Envelope Section 01 & 02

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PROJECT

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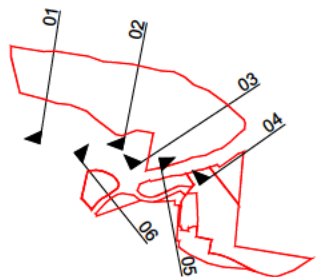
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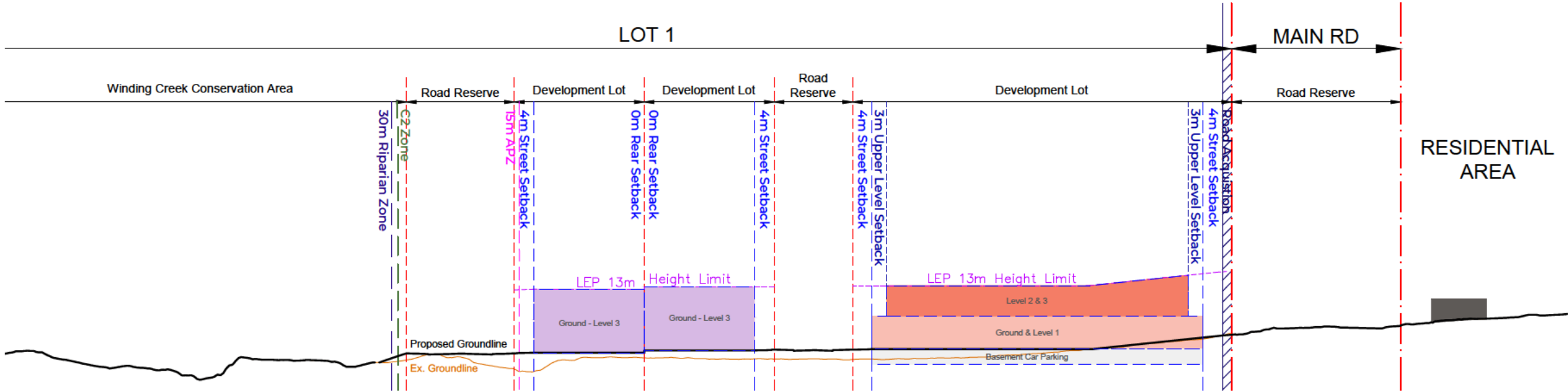


LEGEND

Section 03

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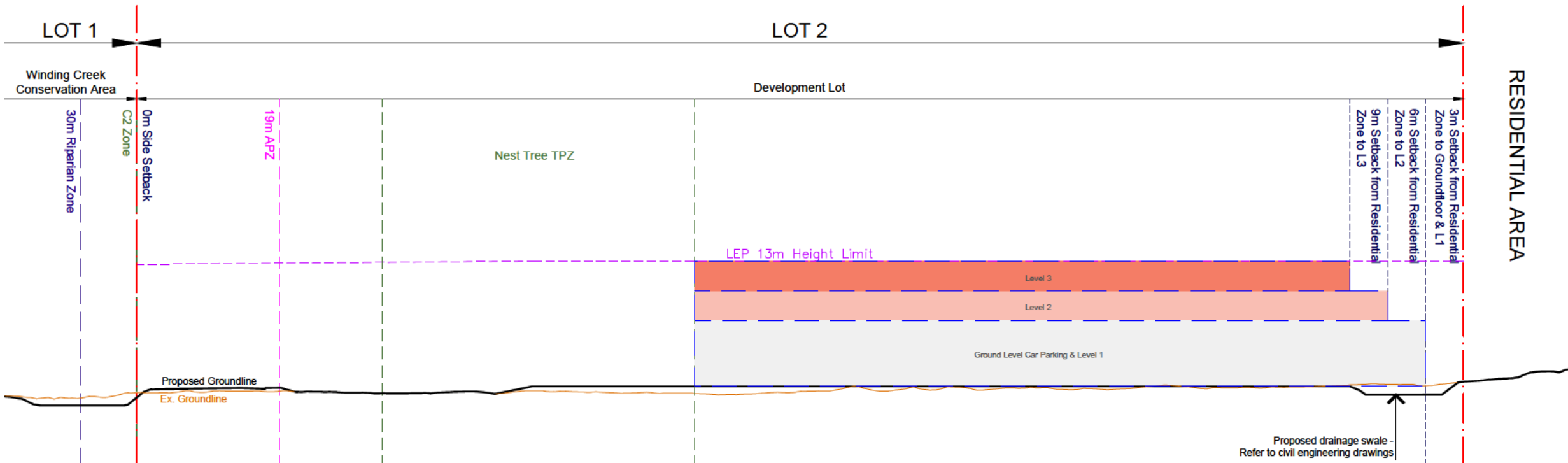
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LOT 1

LOT 2

RESIDENTIAL AREA



Section 04

1:500 @ A3

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DRAWING

A-2.2 Glendale Concept DA
/A Envelope Section 03 & 04

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65 Glendale Road, Glendale

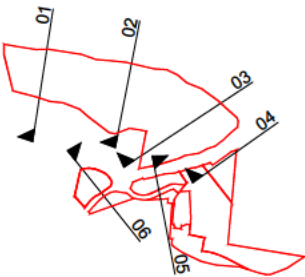
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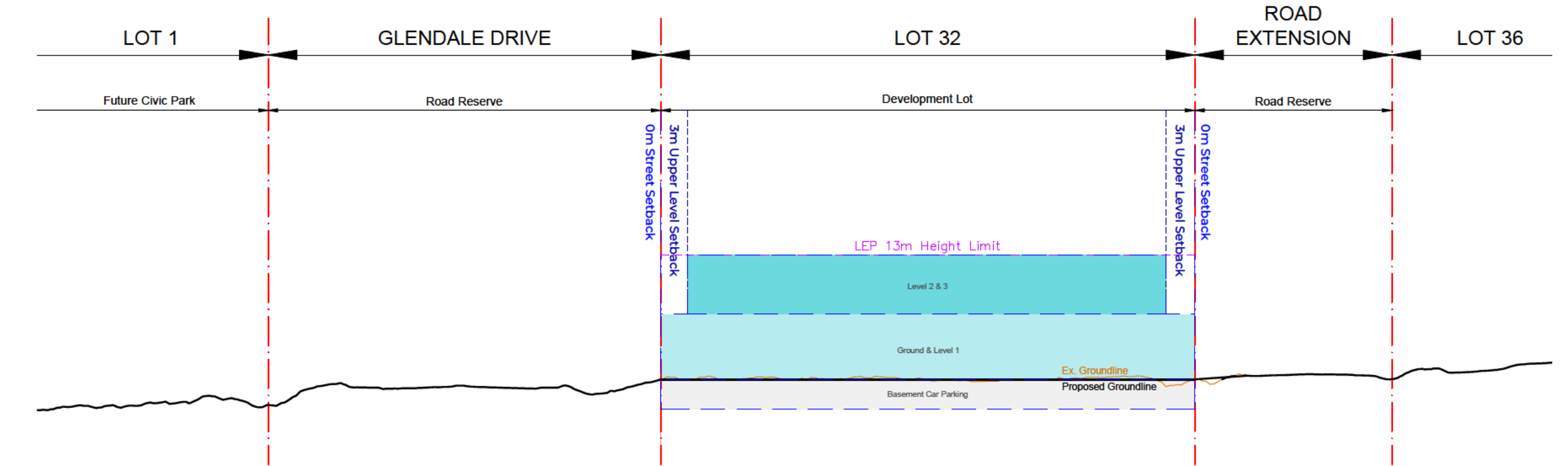
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KEY PLAN



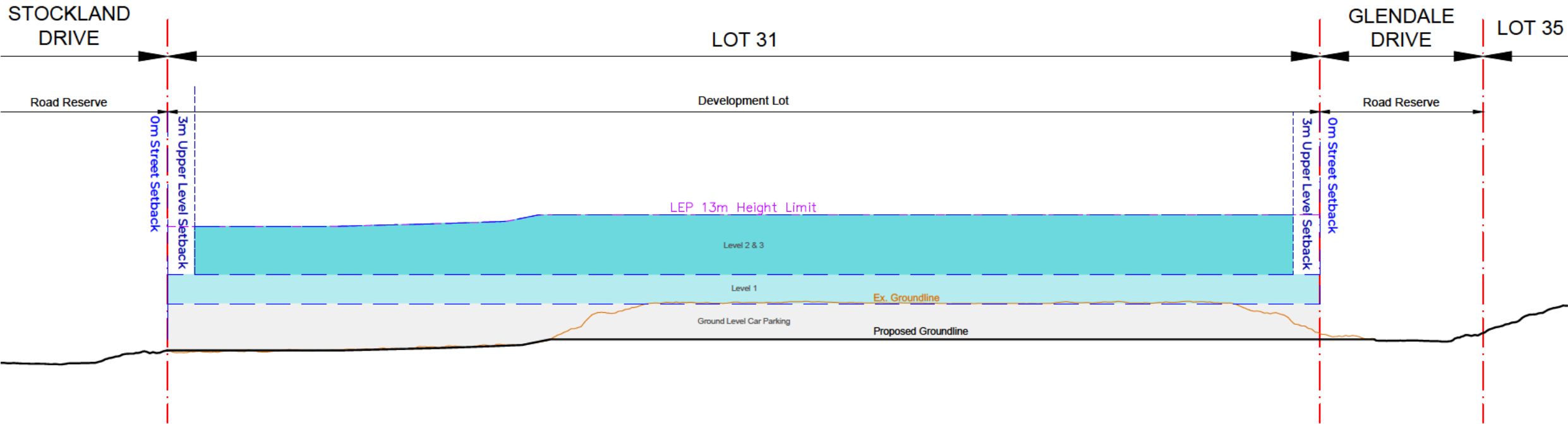
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Section 05

1:500 @ A3

0 1 5 10 15 20 25



Section 06

1:500 @ A3

0 1 5 10 15 20 25

DRAWING

A-2.3
/A

Glendale Concept DA
Envelope Section 05 & 06

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PROJECT

Concept Development
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Stage of Development at
65 Glendale Road, Glendale

APPENDIX D: ENGINEERS IMPACT STATEMENT

16 February 2024

NL221237

Mr. Simon Baker
Tetra Tech Coffey
Unit 4 Griffiths Road
LAMBTON NSW 2299

Re: Glendale Concept DA and First Stage of Development – Mine Impact Assessment

Dear Simon,

Transport for NSW engaged Tetra Tech Coffey to carry out a mine subsidence desktop study for a large portion of land south of Main Road Glendale. Part of the brief for that study was for Tetra Tech Coffey to obtain a mine subsidence impact study from a structural engineer.

Accordingly, this report presents the results of that Mines Impact Study.

We have reviewed the findings of Tetra Tech Coffey's Mine Subsidence Assessment Report prepared for the site report No. 754-NTLGE320046-AC dated 11th, September 2023.

The general layout of the proposed development is shown on Ethos Urban drawing A-1.1, *Glendale Concept DA Overall Envelope Plan*, included in Appendix A.

As shown on the drawing referenced above, the proposed development consists of a number of different uses across the site including the following:

- Bulky Goods Retail – Single storey with basement car parking or two storey with undercroft car parking.
- Retail Shops – within four storey buildings with one level of basement parking.
- Multi Dwelling Houses – Of up to three storeys with no basement.
- Residential Flat Buildings – Of up to four storeys of residential apartments with a single level basement.
- Commercial Development – Of up to four storeys with a single level of basement car parking.

The details above have been derived from Ethos Urban drawings A1.2 – A1.5, included in Appendix B below.

		Date
Prepared by	NP	16/02/2024
Checked by	MA	16/02/2024
Admin	LD	16/02/2024

According to the Tetra Tech Coffey report the assessed maximum potential subsidence parameters are as follows:

- Maximum potential subsidence 80mm.
- Maximum tensile strains 1mm/m.
- Maximum compressive strains 3mm/m over a length of 20m, reducing to 1mm/m for the outer 10m of the panel.
- Maximum tilts of 1.2mm/m.
- Maximum curvature of 10km concave down and 3.5km concave up.

Of particular interest in the Tetra Tech Coffey report is that remaining coal pillars beneath the site have a width to height ratio of greater than 5 and the panel has a factor of safety of greater than 2.1. Based on the above and current SA NSW Policy any building structures constructed on the site will only need to be designed to remain safe (i.e. not to collapse) after a mine subsidence event generating the subsidence parameters listed above.

This will still require engineering design and detailing particularly for larger longer buildings.

I would note that individual mine subsidence parameters for each site should be derived by a geotechnical engineer experienced in mine subsidence before detailed design of any building structures or site infrastructure is undertaken.

Impact Assessment

Site Infrastructure and In Ground Services

The effects of mine subsidence do not only affect buildings but also affect site infrastructure. Typically, this will involve the use of asphalt for road pavements rather than ridged pavements as they are less susceptible to damage and much easier to repair. Additionally kerb and gutter or other ridged structures should be jointed at 3m cts.

In ground services need to be completely encapsulated in sand to minimize transfer of ground strains and any gravity services need to be laid at a steeper grade than that required for design due to ground tilt.

On this site however given the design requirement is for safety none of these measures outlined above will be required and construction may be carried out as for any other site not affected by subsidence. The exception to this would be a gas main if gas is to be used on the site further consideration should be given.

Building Structures

Building structures proposed for the site will require site specific subsidence parameters to be developed for each site as the generic parameters listed in the executive summary are likely to be conservative.

Unlike site infrastructure buildings can pose a safety risk to occupants and detailed consideration of mine subsidence parameters needs to be considered particularly for large, long or tall buildings.

Vertical subsidence itself is not necessarily a big issue, obviously if the entire building was to settle by 80mm at the same time the building would not experience any loading. What does cause issues with a building is differential settlement and the movement of subsidence across the site as the subsidence event occurs. These differential settlements result in tilts and strains being generated across the site.

The predicted tilt of 1.2mm/m for instance would lead to a differential settlement across a 8m column grid of 9.6mm. This level of differential settlement would be unlikely to cause damage to a structure let alone cause any building to be in danger of collapse.

Ground strain on the other hand can be more difficult to deal with. Generally, an engineer experienced in designing buildings for subsidence would attempt to isolate the building from ground strains as the loads imparted to a building via ground strain can be very large. Ground strains can be particularly problematic when there are large rigid cores at each end of a building that are rigidly tied into the ground by piled foundations. For this site a 3mm/m compressive strain even over 20m of length results in the building being compressed by 60mm.

Typically, high level pad footings or waffle pod slabs would be the preference for smaller buildings.

For larger buildings locating all of the cores together, preferably in the center of the building will assist as often the cores require tension piles that are more difficult to isolate from horizontal ground movements. If the cores are located together and towards the center of the building, then the core will stay stationary being locked into the ground while the ground beneath the rest of the building can move away. For piles just carrying downward loads this can be achieved by not connecting the pile cap to the pile or providing a nominal connection that can yield and fail in the event of a mine subsidence event.

For buildings incorporating basements similar principals can be applied to those described above however it would be normal to incorporate a compressible styrene board around the outside of the building to deal with compressive strains that could potentially damage the basement walls. If the building over is independently supported and you were only considering the building for the not to collapse case this may not be required but this is a matter for the design engineer to consider.

Similarly for long buildings subject to tensile or compressive ground strains care will need to be taken to provide sufficient isolation or articulation to ensure that the ground strains are either not imparted into the building or if they are that there is sufficient articulation within the building to allow these ground strains to relieve.

For buildings greater than two storeys a 3D finite element model should be built to model the effect of the design mine subsidence parameters using the predicted ground movements as another load case and looking for bending moment reversal or overload situations. An engineer experienced in designing for mine subsidence will be across this.

Conclusion

Based on the mine subsidence parameters provided and the fact that the mine workings panel has a factor of safety greater than 2.1 under current SA NSW Policy any buildings or infrastructure will only be required to remain safe after a subsidence event.

Accordingly, road pavements and site infrastructure will not require any additional design requirements other than potentially a gas main if gas is to be used on the site this may require consideration.

Any building structures proposed for the site as identified in the masterplan document contained in Appendix A, can in our opinion, be designed for the mine subsidence parameters outlined above and remain safe. This will require design by an engineer experienced in designing structures for mine subsidence.

There may be some additional construction cost in designing these buildings for mine subsidence however we would expect on this site these cost would be minimal.

We trust this report meets your current requirements however should you require anything further please contact the undersigned.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Neil Petherbridge".

Neil Petherbridge

Principal | Northern NSW Business Manager

BEng (Civil), Grad Dip (Struct) FIEAust CPEng NER (Civil)

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Northrop Consulting Engineers Pty Ltd (Northrop) has been retained to prepare this report based on specific instructions, scope of work and purpose pursuant to a contract with its client. It has been prepared in accordance with the usual care and thoroughness of the consulting profession for use by Tetra Tech Coffey. The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report.

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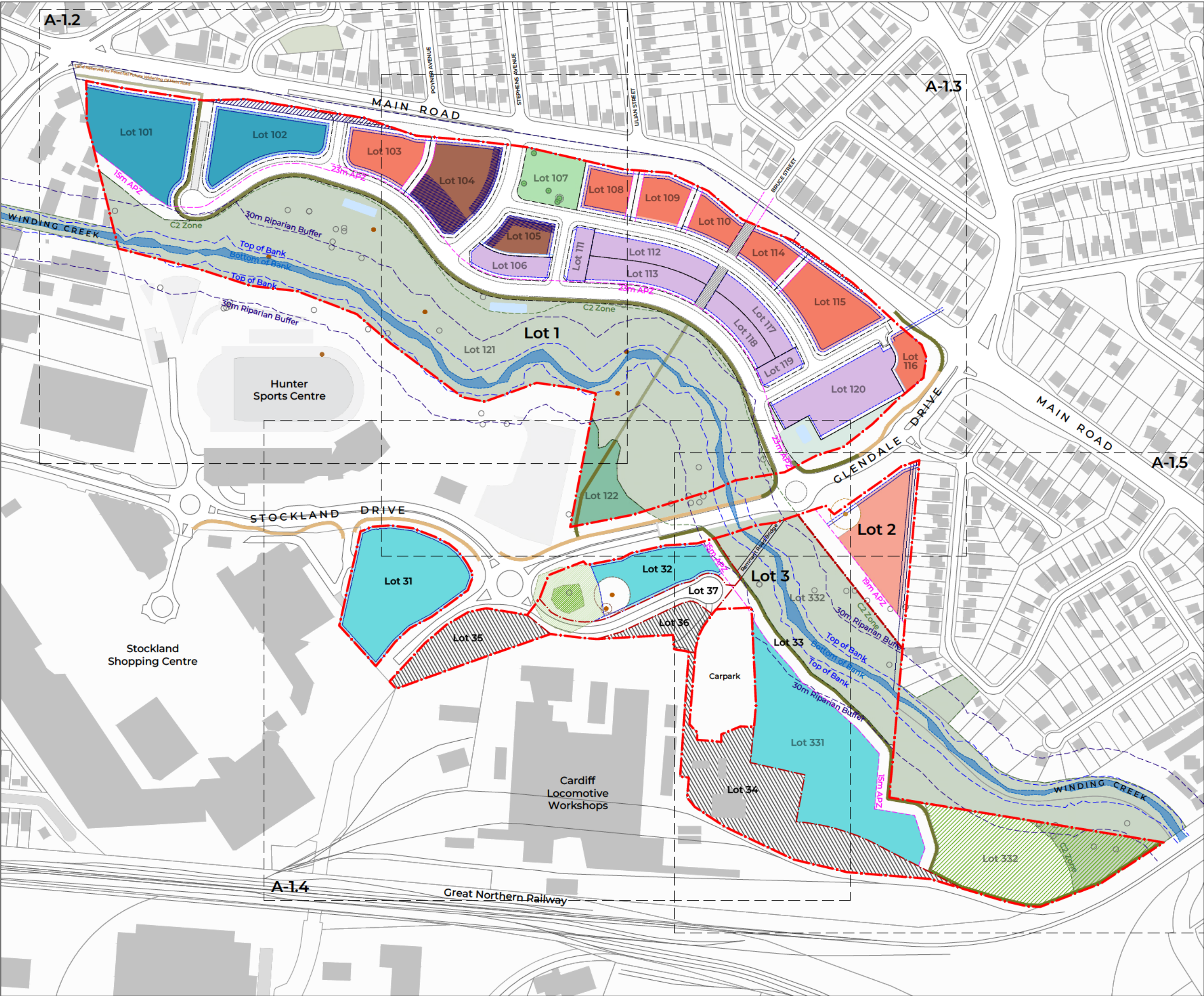
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Appendix A

Ethos Urban Drawing A-1.1



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LEGEND

- Subject Site

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Permissible Use (Max 2 Storey)

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DRAWING

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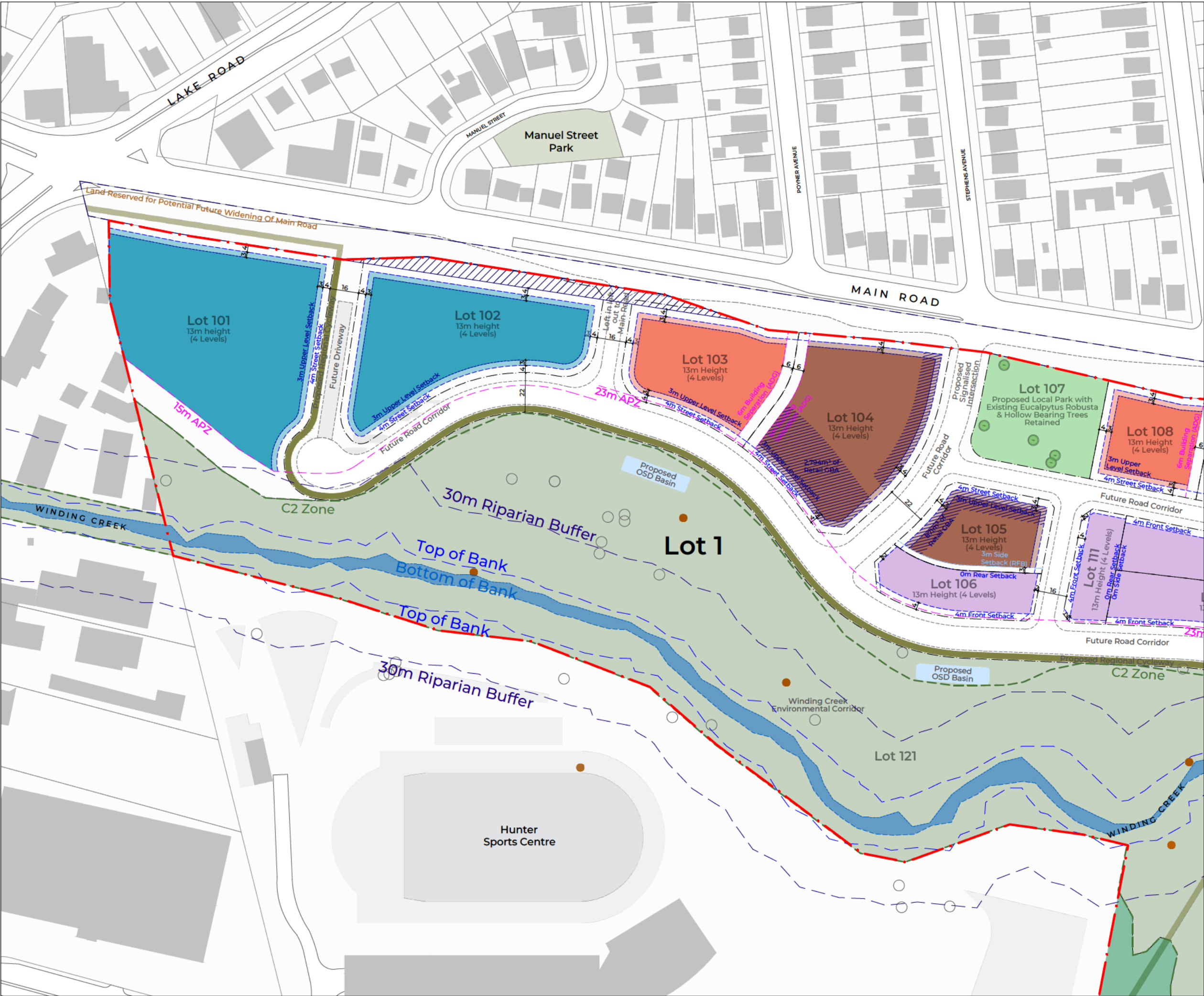
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PROJECT

Concept Development Application and First Stage of Development at 65 Glendale Road, Glendale

Appendix B

Ethos Urban Drawings A1.2 – A1.5



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Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

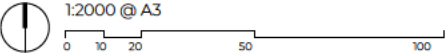
Retail on Ground Level

Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)

NOTES

* Area identified for potential future land resumption along Main Road has been provided by Northrop and is indicative only. Actual size and location of land to be acquired for the purpose of road widening is subject to future detail design by Transport for New South Wales.



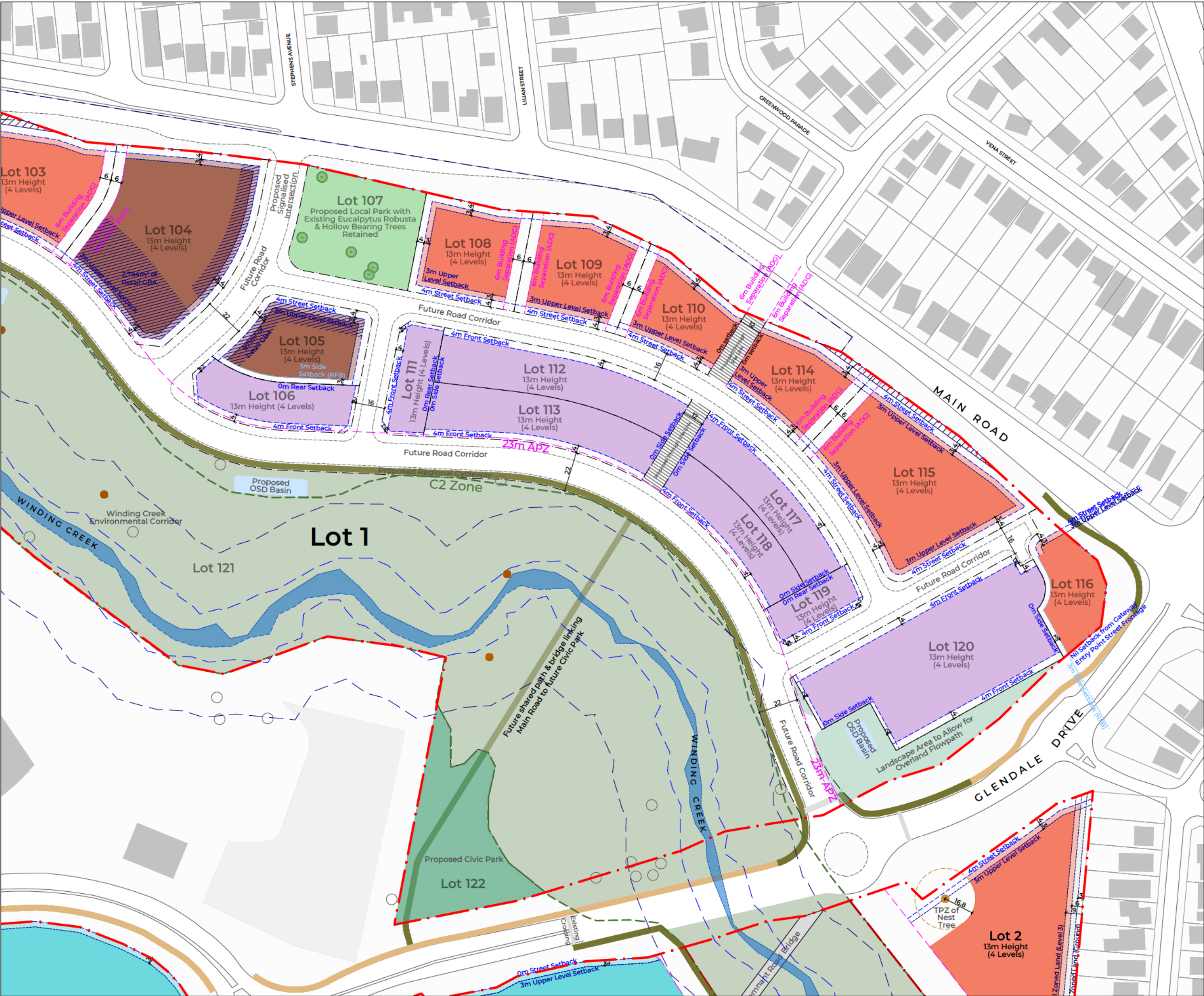
DRAWING

A-1.2
/A Glendale Concept DA
Envelope Plan - Lot 1 West

JOB NO.	DWG NO.	ISSUE	DATE	DRAWN BY
2210945	A-1.2	A	19.02.24	CT

PROJECT

Concept Development
Application and First
Stage of Development at
65 Glendale Road, Glendale



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ISSUE	DATE	REVISION	REVISION BY	APPROVED BY
P1	14.09.23	Coordination Issue 1	CT	IIP
P2	23.10.23	Coordination Issue 2	CT	IIP
P3	11.12.23	Final Draft	CT	IIP
A	19.02.24	For Lodgement	CT	IIP

LEGEND

- Subject Site

SixMap Cadastre

Context Buildings

Existing Kerbs

Existing Cycle Path / Shared Space

Potential Future Road Widening (DCP)

Potential Land Resumption Subject to confirmation with TNSW

Proposed Subdivision Boundary

Proposed Stage 1 Subdivision Boundary

Proposed Stage 2 Subdivision Boundary

Future Development Lots (Subject to Future Subdivision DA)

Lots to be Retained by TAHE

Lot xx

Lot xx

Planning Controls (DCP & ADG)

DCP Street Setback

DCP Side Setback

DCP Upper Level Setback

DCP Setback to Residential Zone

ADG Building Separation

Bushfire Asset Protection Zone

Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space

C2 Zone (Lake Macquarie LEP 2014)

Proposed Winding Creek Riparian Corridor

Winding Creek

Winding Creek Bottom of Bank

Winding Creek Top of Bank

30m Vegetated Riparian Zone

Existing Site Element to be Retained

Existing Vegetation on Site to be Retained

Existing Hollow Bearing Trees (HBT) and E. Robusta (ER)

Existing HBT and ER to be retained (Proposed Local Park)

Existing Nest Tree to be Retained

Tree Protection Zone for Nest Tree

Reassessed AHIMS Sites

Tree Protection Zone for Culturally Modified Trees

Proposed Land Use Envelope

Commercial Premise (Max 2 Storey)

Commercial Premise (Max 4 Storey)

Residential Flat Building (Max 2 Storey)

Residential Flat Building (Max 4 Storey)

Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

Retail on Ground Level

Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)

NOTES

* Area identified for potential future land resumption along Main Road has been provided by Northrop and is indicative only. Actual size and location of land to be acquired for the purpose of road widening is subject to future detail design by Transport for New South Wales.



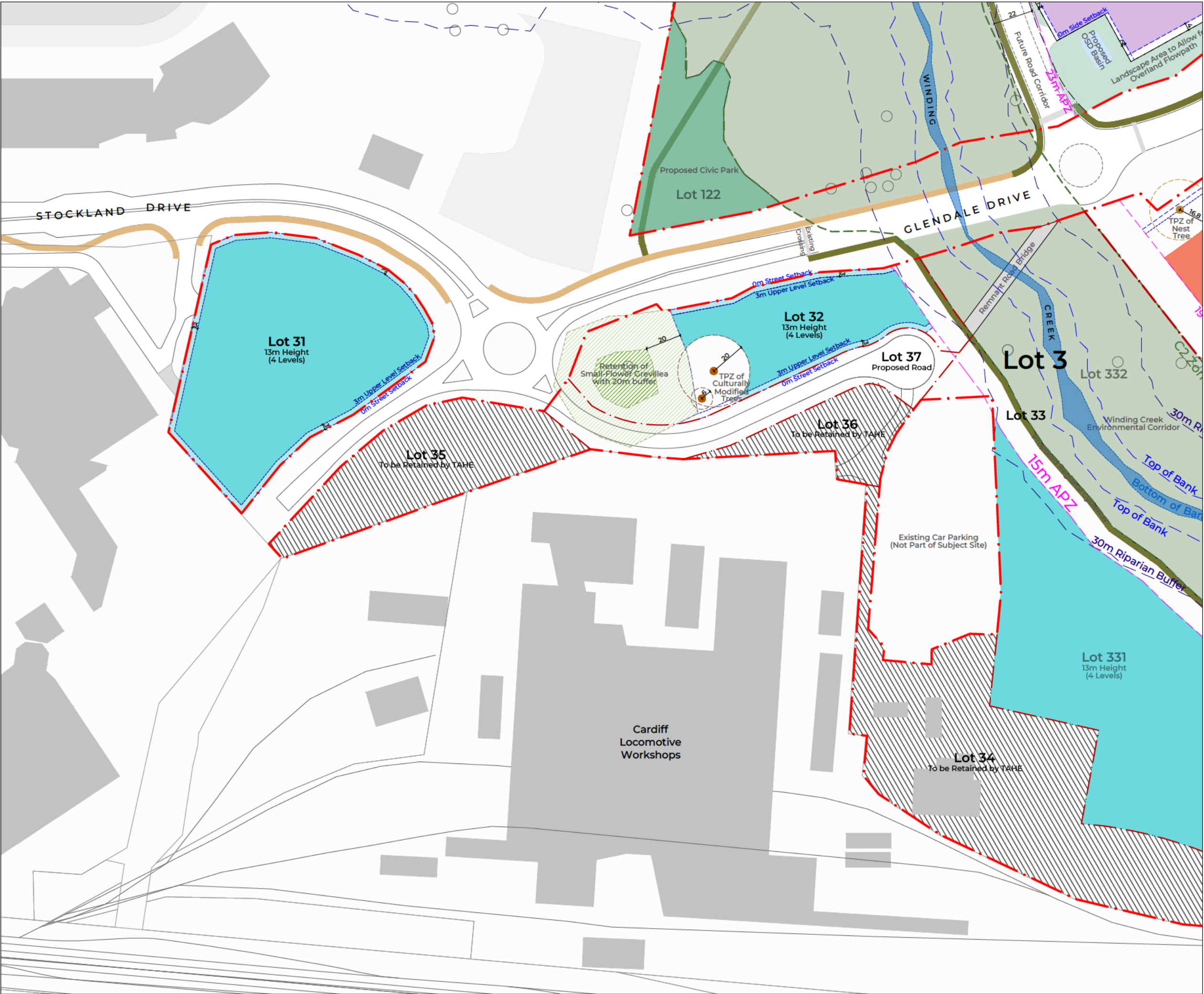
DRAWING

A-13
/A Glendale Concept DA
Envelope Plan - Lot 1 East

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P3	11.12.23	Final Draft	CT	IIP
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LEGEND

- Subject Site

SixMap Cadastre

Context Buildings

Existing Kerbs

Existing Cycle Path / Shared Space

Proposed Stage 1 Subdivision Boundary

Proposed Stage 2 Subdivision Boundary

Future Development Lots (Subject to Future Subdivision DA)

Lots to be Retained by TAHE

Lot xx

Lot xx

Lot xx

Planning Controls (DCP & ADG)

DCP Street Setback

DCP Side Setback

DCP Upper Level Setback

DCP Setback to Residential Zone

ADG Building Separation

Bushfire Asset Protection Zone

Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space
- C2 Zone (Lake Macquarie LEP 2014)

Proposed Winding Creek Riparian Corridor

Winding Creek

Winding Creek Bottom of Bank

Winding Creek Top of Bank

30m Vegetated Riparian Zone

Existing Site Element to be Retained

Existing Vegetation on Site to be Retained

Existing Hollow Bearing Trees (HBT) and E-robusta (ER)

Existing HBT and ER to be retained (Proposed Local Park)

Existing Nest Tree to be Retained

Tree Protection Zone for Nest Tree

Reassessed AHIMS Sites

Tree Protection Zone for Culturally Modified Trees

Proposed Land Use Envelope

Commercial Premise (Max 2 Storey)

Commercial Premise (Max 4 Storey)

Residential Flat Building (Max 2 Storey)

Residential Flat Building (Max 4 Storey)

Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

Retail on Ground Level

Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)



DRAWING

A-1.4
/A

Glendale Concept DA
Envelope Plan - Lot 3 West

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LEGEND

- Subject Site

SixMap Cadastre

Context Buildings

Existing Kerbs

Existing Cycle Path / Shared Space
- C2 Zone (Lake Macquarie LEP 2014)

Proposed Winding Creek Riparian Corridor

Winding Creek

Winding Creek Bottom of Bank

Winding Creek Top of Bank

30m Vegetated Riparian Zone
- Proposed Subdivision Boundary

Proposed Stage 1 Subdivision Boundary

Proposed Stage 2 Subdivision Boundary

Future Development Lots (Subject to Future Subdivision DA)

Lots to be Retained by TAHE

Stage 1 Subdivision Lot Identification Numbers

Stage 2 Subdivision Lot Identification Numbers

Future Subdivision Lot Identification Numbers
- Existing Site Element to be Retained

Existing Vegetation on Site to be Retained

Existing Hollow Bearing Trees (HBT) and E-robusta (ER)

Existing HBT and ER to be retained (Proposed Local Park)

Existing Nest Tree to be Retained

Tree Protection Zone for Nest Tree

Reassessed AHIMS Sites

Tree Protection Zone for Culturally Modified Trees
- Planning Controls (DCP & ADG)

DCP Street Setback

DCP Side Setback

DCP Upper Level Setback

DCP Setback to Residential Zone

ADG Building Separation

Bushfire Asset Protection Zone
- Proposed Land Use Envelope

Commercial Premise (Max 2 Storey)

Commercial Premise (Max 4 Storey)

Residential Flat Building (Max 2 Storey)

Residential Flat Building (Max 4 Storey)

Mixed Use Building (Max 2 Storey)

Mixed Use Building (Max 4 Storey)

Multi-Dwelling Housing (Max 4 Storey)

Retail on Ground Level
- Proposed Infrastructure

Future Kerbs

Proposed Regional Cycle Path

Proposed Through Site Link

Proposed Local Park

Proposed Landscape Area

Future Civic Park

Potential Future Cycle Path / Shared Space
- Permissible Use (Max 2 Storey)

Permissible Use (Max 4 Storey)



DRAWING

A-1.5
/A **Glendale Concept DA**
Envelope Plan - Lot 3 East & Lot 2

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2210945	A-1.5	A	19.02.24	CT

PROJECT

Concept Development
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