



Our Ref: PSM1986-019L
Date: 14 May 2013

Lend Lease
The Bond
30 Hickson Road
MILLERS POINT NSW 2000

ATTENTION: MATTHEW KIRKWOOD
Via. email: Matthew.Kirkwood@lendlease.com

Dear Matt,

RE: STUDENT ACCOMMODATION TOWER
DARLING HARBOUR
ASSESSMENT OF IMPACTS ON ADJACENT INFRASTRUCTURE

1. INTRODUCTION

This letter presents an assessment of the impacts of the proposed student accommodation tower on the following existing tunnel infrastructure:

- Sydney Water Corporation (SWC) trunk sewer tunnel, and
- Energy Australia City West Cable Tunnel (CWCT).

This work was undertaken by Pells Sullivan Meynink (PSM) for Lend Lease Development Pty Ltd (Lend Lease) in accordance with the Professional Services Agreement executed on 21 February 2013 and our fee proposal dated 11 April 2013. Lend-Lease approved the work in an e-mail dated 12 April 2013.

It is understood that the project is progressing towards a Stage 2 Development Application (DA). PSM has previously provided advice in regards to the project, most recently in our report dated 11 March 2013 (Ref. PSM1986-009R).

The building details have changed in comparison to those assessed previously. The current proposal involves a single building at the southern end of the site, which will be taller and longer than the northern building. Only the southern building is being considered at present.

Foundation layouts and pile loads were provided to PSM in an e-mail from Northrop Consulting Engineers Pty Ltd (Northrop) on 12 April 2013. Northrop have been commissioned separately by Lend Lease to provide structural engineering services for the development. Details of the building relevant to the current assessment are presented in the following section.

2. PROPOSED STUDENT ACCOMMODATION BUILDING

Figure 1 shows a plan of the site, including the outline of the proposed building, pile locations, and alignments of both the trunk sewer tunnel and the cable tunnel.

The building has plan dimensions of approximately 18 m by 50 m. The cable tunnel passes beneath the building over a length of about 40 m. The sewer tunnel alignment passes close to the north-east corner of the building.

The Northrop drawing has been overlaid on the site plan in Figure 1 and indicates 'characteristic' pile loads of between 9000 kN (compression), and 3900 kN (tension). Scaling from the Northrop drawing indicates pile diameters of 1.2 m, which is the same as assumed in the previous assessment.

It is noted that the current compression loads are less than those considered in PSM's previous assessment. The previously proposed building foundation detail included a single pile above the tunnel with a compression load of 17,000 kN, as well as 15 piles subject to compression working loads of 13,600 kN.

Based on our previous analysis, pile toe levels are likely to extend to about RL -7 m. This level would provide about 10 m of rock cover between the pile toe level and the crown of the cable tunnel.

3. IMPACT ON CITY WEST CABLE TUNNEL

3.1. Tunnel lining deformation criteria

Our previous advice to Lend Lease included PSM's own assessment of the tolerable deformation of the segmentally lined tunnel. This was based on our experience with similar tunnels, and from details shown in the tender stage tunnel drawings. There was no input from either Energy Australia (EA) or the tunnel designer.

PSM's assessment was summarised in Table 5 of our previous report. It considered three deformation mechanisms which could potentially adversely affect the structural integrity and watertightness of the lining.

Since issuing our previous report, PSM has obtained a design report from EA which includes an assessment of the effects on the tunnel from the Darling Walk development (Ref. SMEC Australia Pty Ltd memorandum dated 31 March 2008, included as Appendix 11 of the City West Cable Tunnel 100% Design Report for Tunnel Lining, Project No. 3001375). The SMEC assessment concluded that the segmental lining could accommodate imposed distortion of up to 29 mm. It is understood that this assessment was based on consideration of the ultimate structural capacity of the lining, though did not consider serviceability issues such as cracking and watertightness.

The tolerable deformations assessed previously by PSM are significantly less than the 29 mm in the SMEC memorandum. The deformation criteria adopted by PSM previously has been adopted for the assessment of the impacts on the Stage 2 student accommodation building.

3.2. Assessment of impacts

Specific numerical analysis of the proposed building foundation layout and pile loads is outside the current scope of work. Therefore the current assessment is based on extrapolation of the analysis undertaken for the building configuration presented in our previous report.

The tunnel deformation due to the building foundation is expected to be less than that calculated previously because:

- Pile loads have reduced, and
- Pile lengths would also tend to decrease.

Therefore vertical convergence less than about 2 mm is anticipated, which is less than either of the deformation limits discussed in the preceding section.

4. IMPACT ON TRUNK SEWER TUNNEL

The previous building foundation detail included piles located either side of the trunk sewer tunnel. An assessment was undertaken to estimate the deformation of the sewer due to construction and settlement of the adjacent piles. This was based on a separation distance of 1.5 m between the pile shaft and the sewer, and on a pile design that results in pile head settlement of less than about 10 mm. Deformation of the sewer of less than 2 mm was assessed.

The tolerable deformation adopted previously was based on the bending of the reinforced concrete box which surrounds the sewer, as well as the glass reinforced plastic sleeve which forms the pipe lining.

For the current proposal there are only two piles close to the sewer, and these are located on only one side, as shown in Figure 1. Therefore the sewer deformation is expected to be less than that assessed previously, and within the adopted tolerances.

5. CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations provided in our previous report dated 11 March 2013 (Ref. PSM1986-009R) remain relevant to the current proposal. PSM's assessment demonstrates that the proposed student accommodation building can be constructed so as to result in acceptable effects on the adjacent existing tunnel infrastructure, i.e.:

- Trunk sewer tunnel, and
- City West Cable Tunnel (CWCT)

The student buildings are to be supported on piled foundations which will be founded in Hawkesbury sandstone bedrock. To protect the trunk sewer, the pile layout will firstly need to avoid the sewer alignment, and also provide a separation distance between the pile and the sewer.

To avoid damaging the reinforced concrete box which surrounds around the sewer, the adjacent piles will need to extend below the sewer invert level and be proportioned so that settlement at the pile founding level is less than a few millimetres. This proposed settlement limit is for a separation distance of 1.5 m between the pile shaft and the reinforced concrete box in which the sewer is encased. Other separation distances may be feasible and these can be further tested at detailed design phase.

The cable tunnel is located about 20 m below the surface, and is overlain by approximately 13 m of bedrock. The pile toe levels are likely to be located about 10 m above the crown of the cable tunnel. It is assessed that the vertical convergence of the tunnel will be less than about 2 mm, which is less than the adopted allowable deformation limits.

In summary, PSM is satisfied that the proposed student accommodation building can be developed over the existing Energy Australia City West Cable Tunnel (CWCT), and adjacent to SWC's trunk sewer tunnel.

It is recommended that once the building design is sufficiently progressed, and subsequent to further consultation with the respective utility providers, that the analysis and modelling undertaken to date be further refined to confirm the conclusions of this letter.

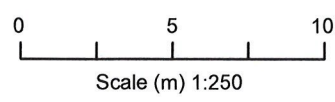
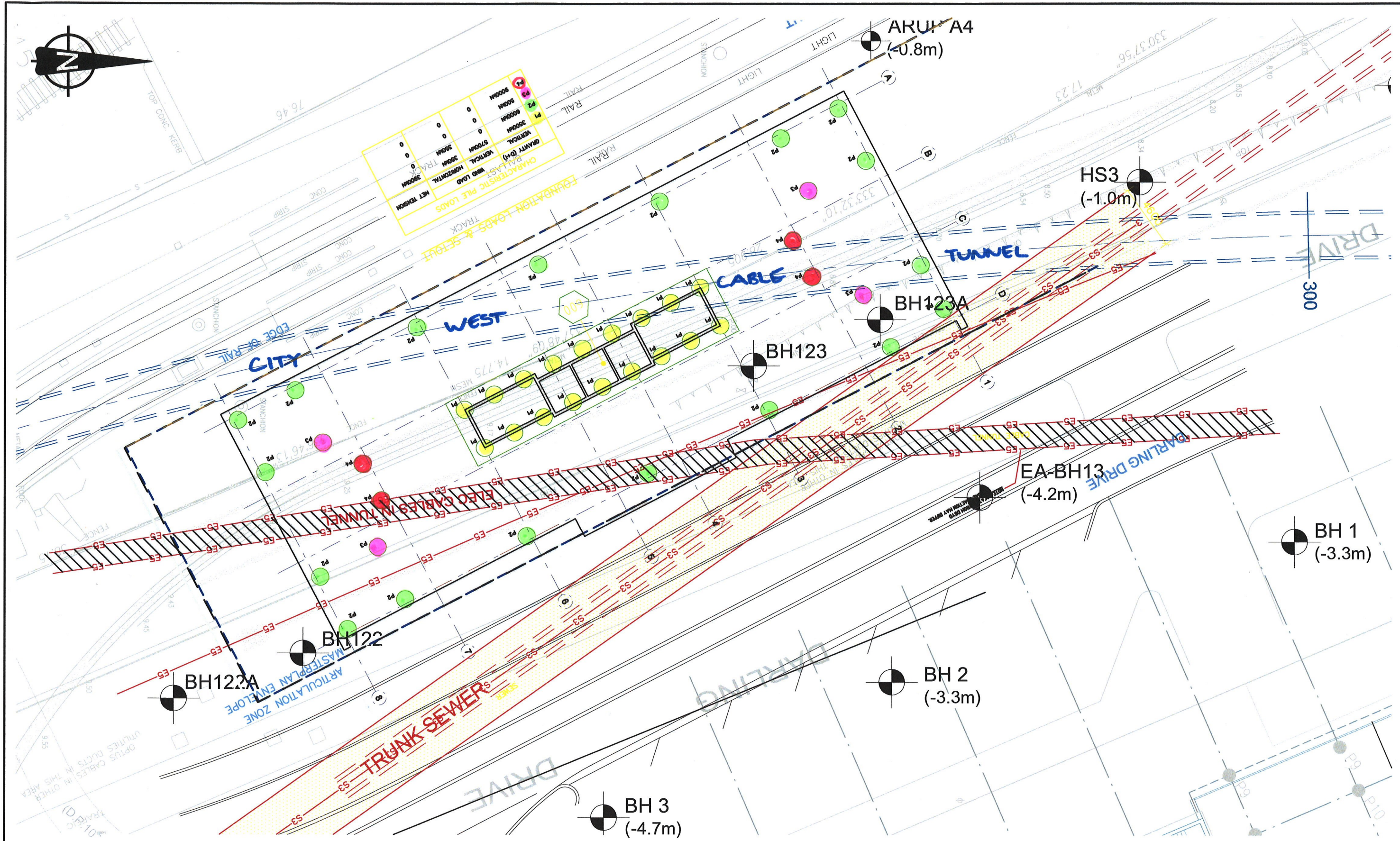
Should you have any queries, please do not hesitate to contact the undersigned.

For and on behalf of
PELLS SULLIVAN MEYNINK



STRATH CLARKE
Principal

Encl. Figure 1 – Site plan



Pells Sullivan Meynink

Lend Lease Development Pty Ltd Darling Harbour Redevelopment Proposed student accomodation towers SITE PLAN	
PSM1986- 019 L	FIGURE 1