Design Note

101 Albert Street EDQ Coordination

Project Name: 101 Albert Street
Project No: 22131
Document No: RBG-DN-S-002

PLANS AND DOCUMENTS referred to in the PDA DEVELOPMENT APPROVAL
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S01	Draft Issue	N. Doyle	M. Avery		26/05/2023
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Abbreviations and Terminology

The following abbreviations and terminology are used within this Design Note.

ETABS	3D Lateral Stability Analysis Software.
RAPT	2D Concrete Analysis Software.
PT	Post tensioned concrete slabs or beams use high-strength steel strands that are stressed to compress the slab or beam.
CRR	Cross River Rail
IStructE	The Institution of Structural Engineers is a professional body for structural engineering based in the United Kingdom
EDQ	Economic Development Queensland is a government body overseeing development of priority development areas.

1.0 Purpose

The purpose of this documents is to outline the fundamental characteristics of the 101 Albert Street commercial building structure and to communicate on and close out the questions raised by EDQ's independent structural engineer Arup.

2.0 Overview

Header and title info are content controls which automatically update common fields through the document. Please update header section above.

2.1 Building Characteristics

101 Albert Street **(Project)** is a 39 storey plus 3 basements, commercial and mix-use building on Albert Street in Brisbane CBD. The Project site is positioned adjacent to the CRR caverns, the structural concept design offsets the building's mass inboard of the Albert Street site frontage, towards 110 Mary Street, to minimize vertical and lateral loading on the CRR structures in-line with their project requirements.

The approximate building stack:

- Ground level is set at approximately RL4.6
- Below ground (3 Basements) ≈ 9.6 m
- Above ground to upper commercial floor L37 (37 Storeys) ≈ 167.43 m with 3.85 m typical floor to floors
- Approximately 180.53 m to top of crown from ground level
- Total building height approximately 190.53 m to top of crown from top of footing.
- **H/500 Ratio:** Above Footing Level = 381 mm and above Ground Level = 361 mm.
- **Plan Dimensions**: Typical commercial floor Length (Parallel to Albert) = 57.1 m and Width (Perpendicular to Albert) = 33.1 m. Aspect = 1.73.

The building is narrower in the north-south direction perpendicular to Albert Street. Figure 1 and Figure 2 indicate the typical floor plan and building elevation respectively.

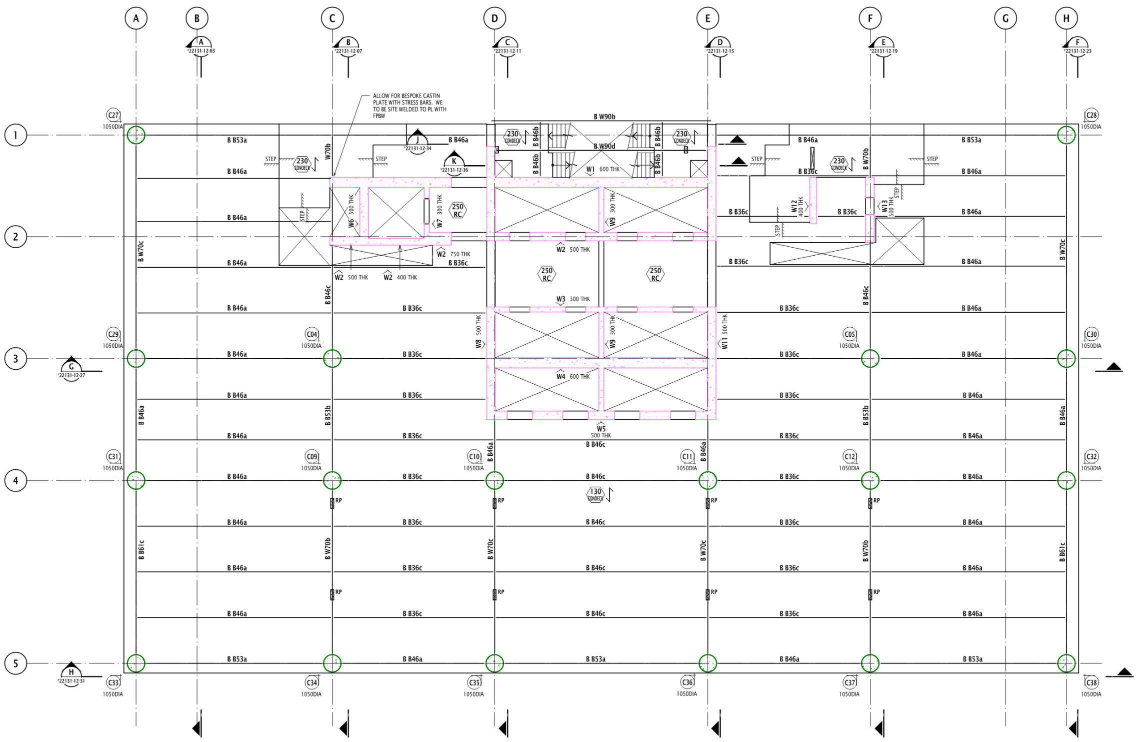


Figure 1: Typical Floor Plan

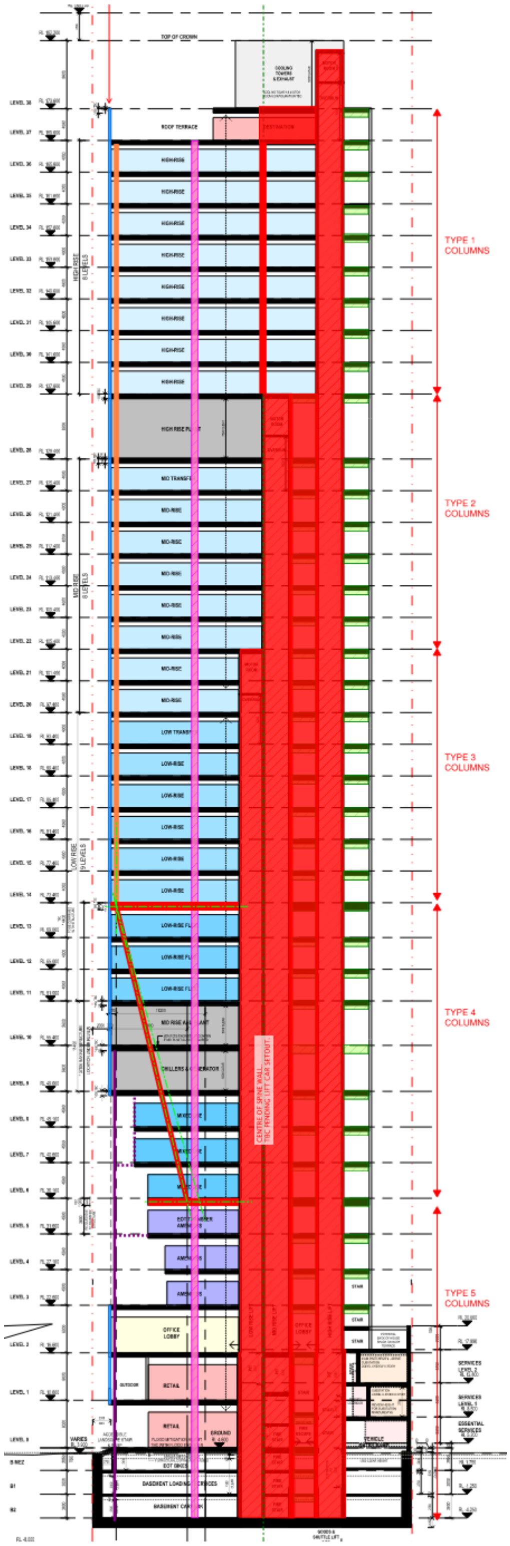


Figure 2: Typical Building Elevations Perpendicular to Albert Street

2.2 Structure

The primary structural elements of the building are summarised as follows:

Element	Description
Foundations	Core and tower columns on pile caps and large diameter bored piers. Piles socketed into high strength rock. Podium and basement only columns within the extent of the maximum excavation RL-8 on isolated pad and raft footings.
Gravity Load Resisting System	Columns – typically concrete filled steel tubes above ground level and conventional reinforced concrete below ground level. A significant column transfer occurs between L06 and L14 over which some columns rake. Core – traditional reinforced concrete.
Lateral Load Resisting System	Cantilever reinforced concrete core. The core is offset to the north of the site and is therefore considered a side core. Modules of the core drop off at L10, L14 and L29 in line with tenant lifting and lateral demands. The stair core module cantilevers of the external face of the core above L2. Two outrigger walls at the roof plant level connect the Sky-rise module to internal columns.
Floor Plates	Floor plates primarily consist of concrete slabs on composite steel beams. Concrete slabs are formed with condeck metal decking and are typically in the order of 130 mm to 150 mm thick.

2.3 Analysis Register

The following is a summary of the different analysis techniques used:

Design Aspect	Technique/Software	Comments
Column Design	In House Software and ETABS	Analysis undertaken for RC Columns and Concrete filled steel tubes
Floor plate Design	CompPanel, Compos, OASYS GSA	Analysis undertaken for Composite Slab floor. OASYS GSA for footfall vibration.
Lateral Stability Design	ETABS	Serviceability and ultimate state models for assessing wall stresses, building lateral displacements and axial shortening of columns and core. Construction staging and time dependent material properties are considered for permanent loads.

3.0 EDQ and Arup Queries

As requested in the EDQ meeting minutes (101 Albert Street – Engineering Further Issues Key Notes and Actions dated 2 May), RBG have developed this Technical Note to address and close out key structural questions raised by Arup as listed in the spreadsheet ('230508 Arup review summary). The structural questions required to be closed out include Items

B5.10, BA.3, BA.9 to BA.11. To do this RBG has extracted and summarised key analysis information below for each item. Analysis results are based on Schematic Design level models and documentation and further design development is underway.

3.1 Building Lateral and Vertical Loads

The building vertical and lateral foundation loads determined through Schematic Design Phase were compiled and issued to the Geotechnical Engineer EDG for use in the Cavern Assessment Modelling and Report. Please refer to **Appendix A** for shoring wall, tower and core foundation loads.

3.2 Lateral Displacements (B5.10)

Due to the side positioned core, the structure naturally tends to lean towards Albert Street under gravity loading. The elastic movement from permanent loads is also magnified by creep which increases the lean. The lateral displacement under gravity must be combined with the displacements from lateral loading (wind, seismic, robustness) when checking against the lateral deflection criteria defined for the Project.

Figure 3 and Figure 4 summarise the building displacements under the vertical and key lateral loading cases. Due to the small lateral displacements from seismic loading this has not been shown. For wind the lateral deflection criteria of H/500 or 381 mm at the top of the building (Above footing level) is plotted for comparison. In the ‘X’ direction (parallel to Albert Street) of the core there is evidently no concern with achieving the defined deflection limit. In the ‘Y’ direction (perpendicular to Albert Street) the combined deflection parallels the limit line however is typically approximately 50mm under at all levels.

Figure 3: Building Lateral Displacements in X Direction (E-W)

Graph Legend Commentary – [01A] Total G based on no staging and linear material properties; [01B] Total G based on floor-by-floor staging and linear material properties; [01C] Total G based on floor-by-floor staging and nonlinear material properties; [02] Total Q based on no staging and linear material properties; [03] AS1170 Wind Loads and linear material properties.

Figure 4: Building Lateral Displacement in Y Direction (N-S)

Individual storey drifts from wind also need to be computed and compared to the H/500 limit as between approximately RL+40 and RL+80 the slope of the combined deflection line is greater than the limit line. It's worth noting however the following conservative aspects of these plots:

1. Basic floor by floor construction sequencing adopted.
2. SDL applied at the time as self-weight, while in reality it will be applied significantly later.
3. The total live load is included in the combined deflection without a combination factor or live load reduction.
4. Wind displacements are based on code calculations. Assessment of the preliminary loads provided by the wind consultant indicate the actual loads are approximately 10% lower.
5. Wind displacements are also based on V100 wind speeds but could be reduced to V50.
6. Core stiffness has been reduced by 30% despite stress plots indicating very little cracking even at foundation level as discussed in Section 3.3.

The maximum inter-storey drift based on combination 01C+02+Wind Y at V50, between RL+40 and RL+80 is approximately h/470. Approximately 50% of this drift is due to the dead load of which a component will occur prior to façade install. With refined modelling of the items outlined above and wind tunnel loads it is expected this inter-storey drift will comply with the lateral deflection limit of h/500.

3.3 Rear Core Wall Performance (BA.3)

In a side core building the rear wall of the core, or the wall that is displaced closer to the boundary, inevitably supports less gravity load than that of the internal walls. To the contrary there is little to no change in the tension forces under lateral loading (i.e. wind, seismic, robustness) between the rear and internal walls and the net effect is that there is typically a large tension force that needs to be considered by the rear wall at ultimate limit states. There may also be high tension stresses at serviceability level loads resulting in cracking, softening of the core and magnified lateral displacements of the structure.

To offset some of the impact of the side core extensive coordination was undertaken to achieve a "T" shape core arrangement with the larger flange located to the rear of the core which compliments the material strengths of concrete and steel. Additionally, the rear stair core module is cantilevered off the rear of the core to minimise unbalanced gravity loading and to reduce the tension forces in the rear wall. The rear wall was although thickened to 600mm to reduce the vertical stress (but not force).

Conservatively taking the concrete tensile stress limit before cracking in the rear wall as $0.36.\sqrt{50}. \approx 2.5MPa$, the rear wall concrete tension capacity before cracking is approximately 1,500kN/m. Figure 5 and Figure 6 summarise the core wall stresses based on the current state of modelling, and indicate that while tension stresses do prevail, they are within a reasonable range and will not significantly reduce the stiffness of the core. These plots are based on ultimate loading and under service level loads there is little to no tension behind the core beyond the concrete capacity before cracking.

The left-hand side figure is the rear wall elevation viewed from Albert Street. The central figure is the 3D view of the core viewed from the rear. The right-hand side figure is the 3D view of the core viewed from Albert Street.

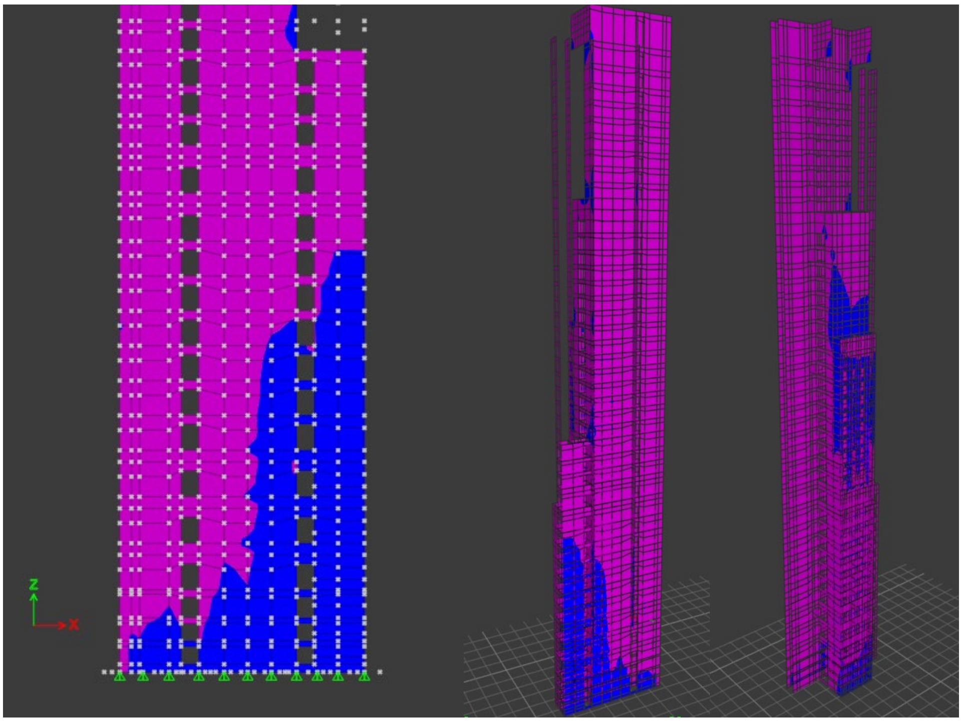


Figure 5: Core Wall Stress 0.9G+WU (Blue >1.0MPa, Magenta <1.0MPa)

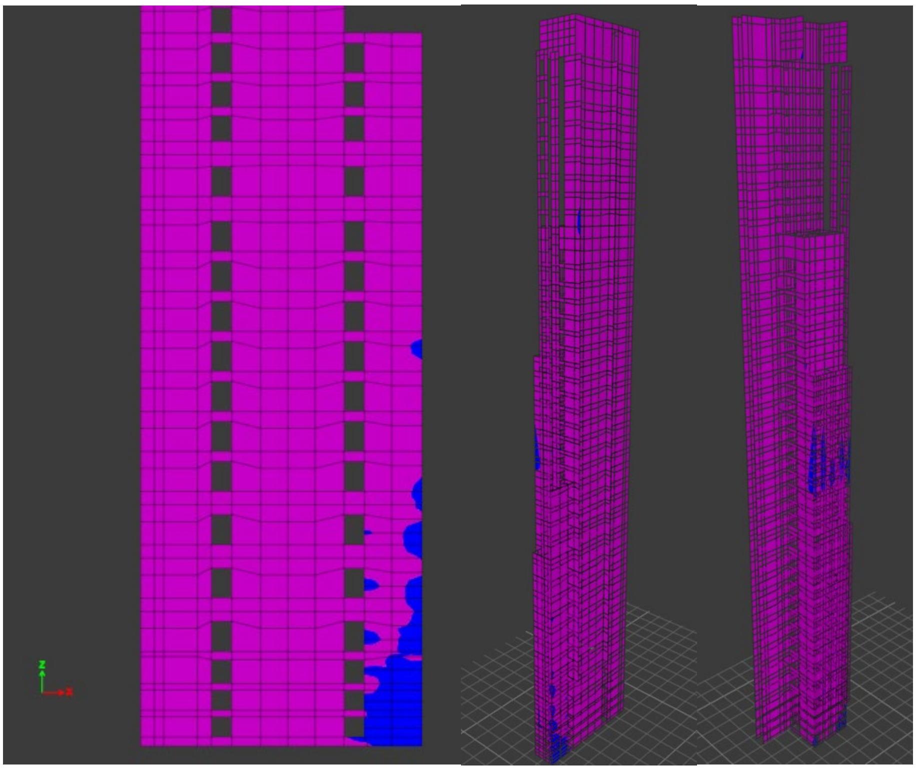


Figure 6: Core Wall Stress 0.9G+WU (Blue >2.5MPa, Magenta <2.5MPa)

3.4 Floor Vibrations (BA.9) (Work in Progress)

RBG are currently in the process of developing the typical Mid-rise commercial floor footfall vibration model using OASYS GSA to assess the response of the typical office levels. The criteria for these levels defined in the Structural Design Criteria Report is RF8. The initial results from the analysis are shown below with the peak response factor of 7.70 noting these preliminary results need to be verified.

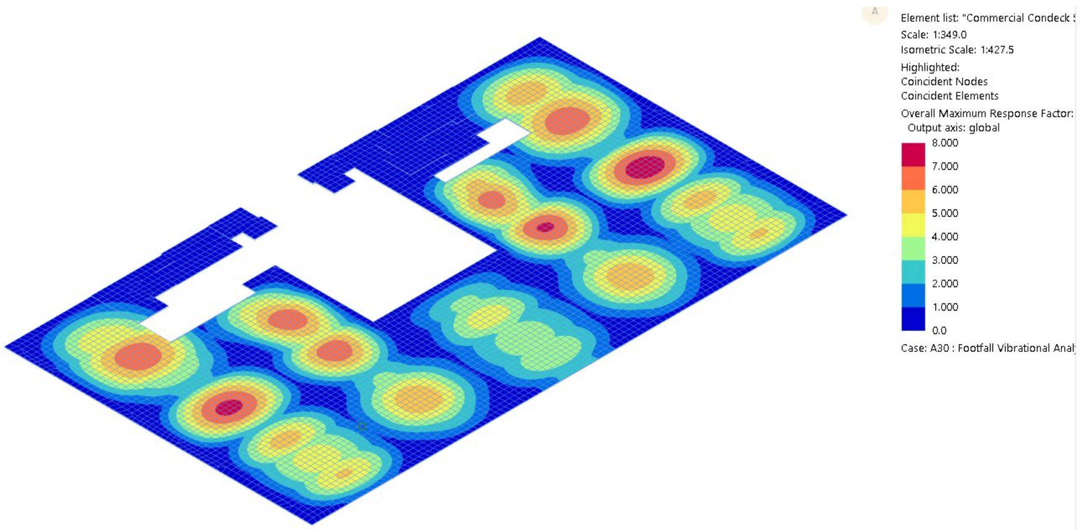


Figure 7: Typical Mid-rise Commercial Floor Response Factor Plot

3.5 Wall Forces/Stresses (BA.10)

Figure 8 to Figure 11 summarise the key core actions based on the current state of the lateral model. The disturbances seen in the shear plots between 40m and 80m above base are a result of the raking columns and the diaphragm levels. The sudden increment in shear approximately represents the total in-plane force to be resisted by the diaphragm at each level. In the 'X' direction (parallel to Albert Street) these forces are benign. In the 'Y' direction (perpendicular to Albert Street) there is approximately 20MN from G and 10MN from Q generated in the core. In the same direction there is a net loss in wind shear from the core over the raking column extent, indicating the raking columns will be participating in the lateral system and supporting wind load between the diaphragm levels.

The jumps in magnitude seen in the moment diagrams are a result of the various core modules dropping away up the tower. This causes the pier centroid to suddenly move a large distance while the net centre of vertical load remains relatively unchanged.

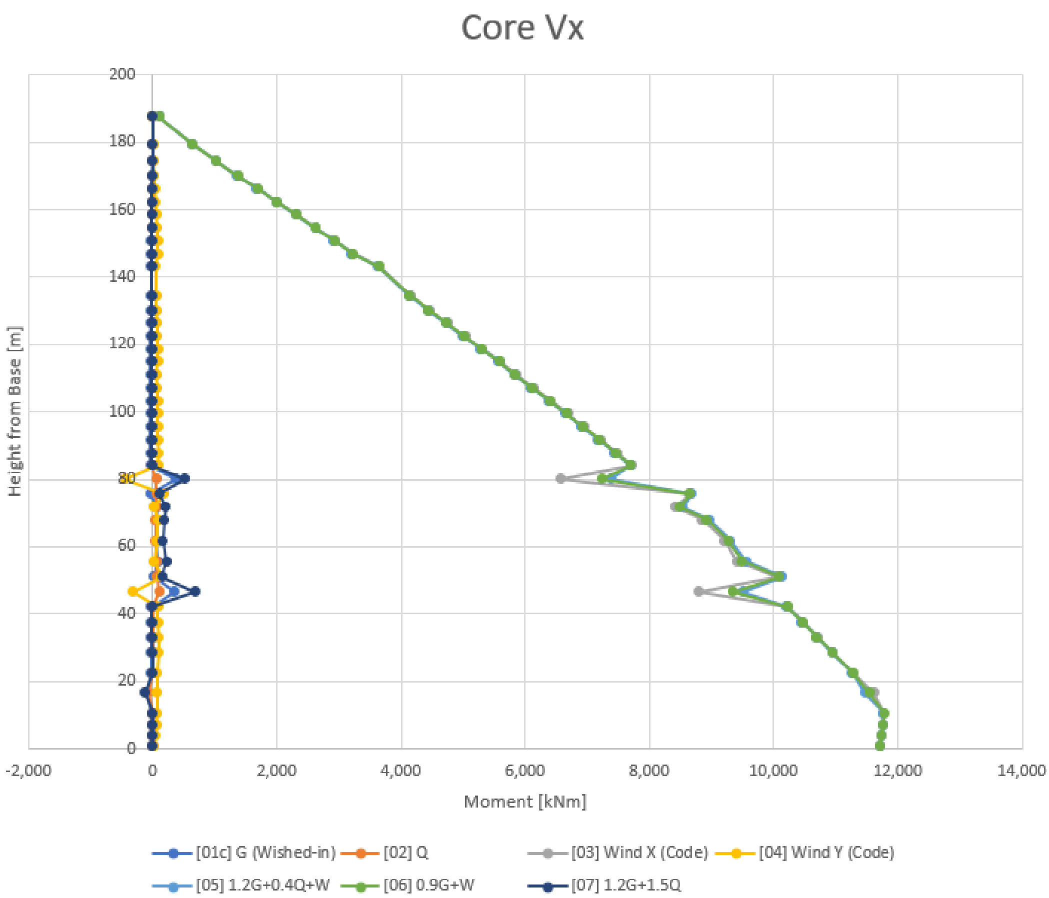


Figure 8: Core Shear in X Direction (E-W

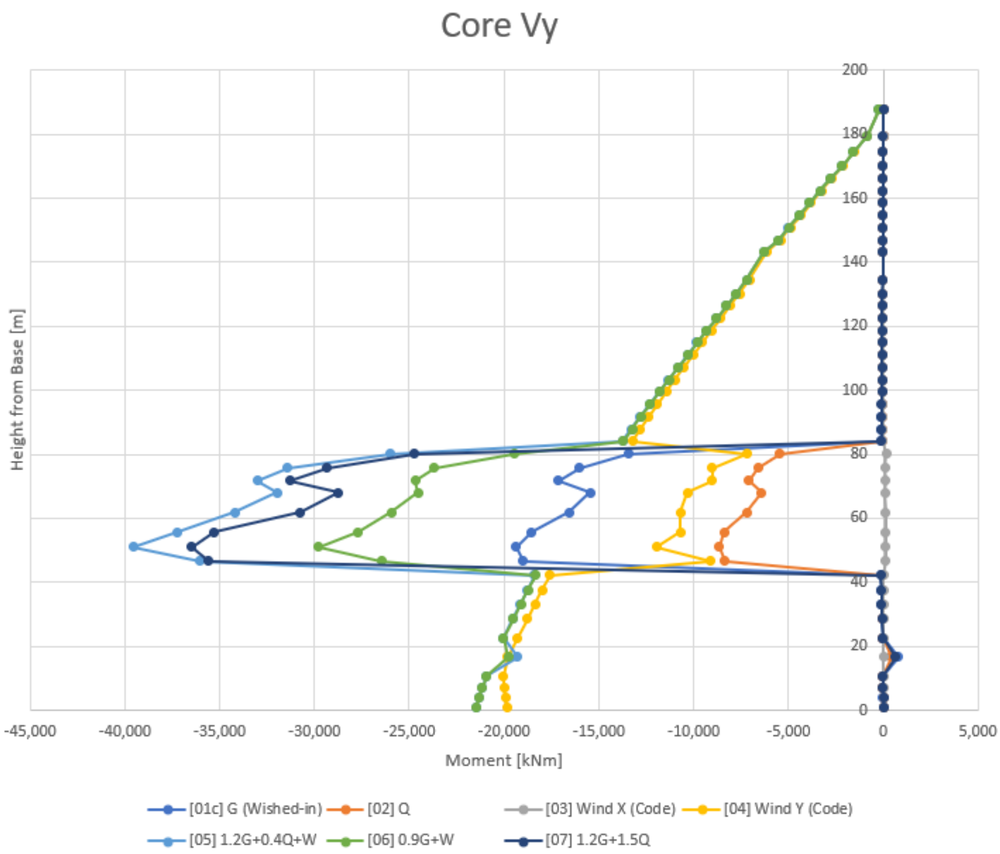


Figure 9: Core Shear in Y Direction (N-S)

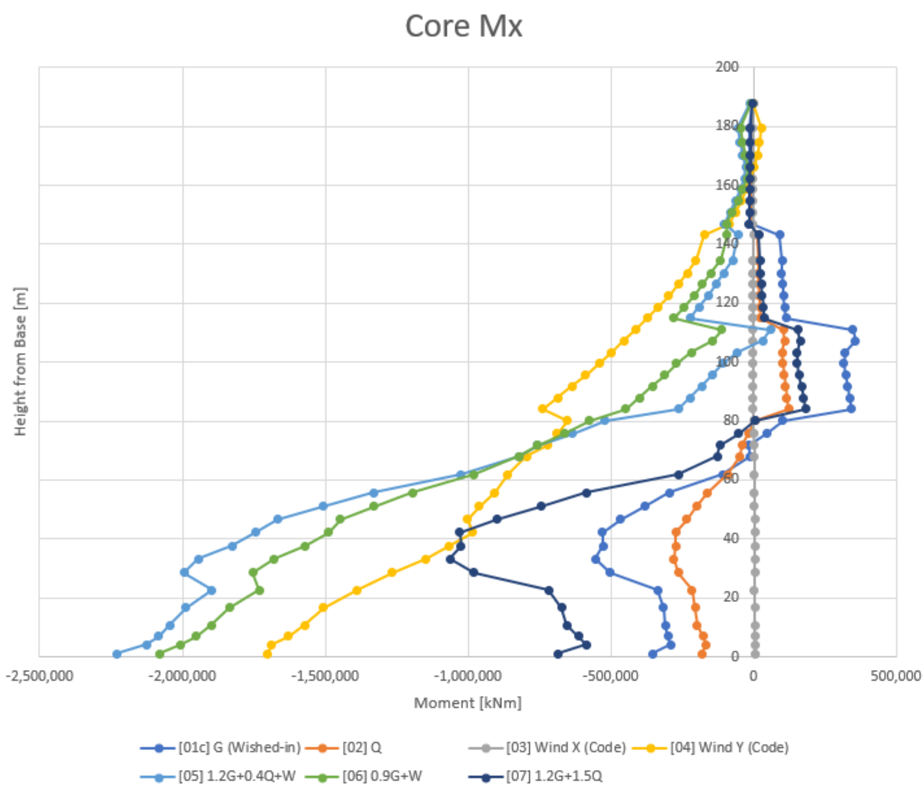


Figure 10: Core Moment About X Axis (Mx)

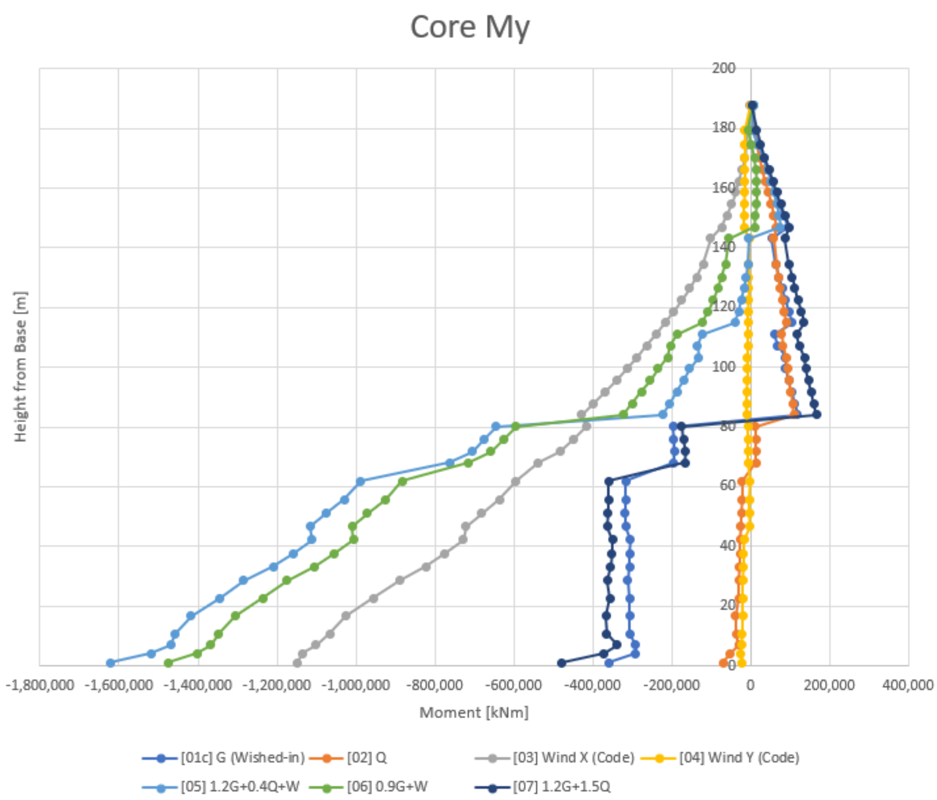


Figure 11: Core Moment About Y Axis (My)

3.6 Basement Shoring and Retention Wall (BA.11)

During the Schematic Design Phase, the initial focus was to confirm the adequacy of the primary lateral stability system by modelling the core only and ignoring the basement shoring and retention walls. The initial lateral loads provided to EDG for the initial Cavern Assessment Modelling and Report were based on this assumption.

Now that the structural design has been sufficiently developed and to understand the interaction between the core and shoring and retention walls, the shoring and retention walls have been incorporated into the lateral stability model. This includes modelling the soldier piles and infill shotcrete panels for the height of the basement walls. Wind loads based on received wind tunnel results have also been incorporated along with updated building loads.

The shoring and retention walls typically extend through alluvium and residual soils with soldier piles typically socketing into residual soil or low strength rock and the infill shotcrete panels terminating in residual soil. Based on this condition EDG estimated a first pass shoring pile stiffness of approximately 200-300MN/m and 250MN/m was adopted in the lateral model for all shoring wall piles. Shoring walls were assumed uncracked, i.e. 100% in-plane stiffness with no consideration of articulation from joints. Revised vertical and lateral loads for core piles and the new shoring piles were then extracted and provided back to EDG for use in the Cavern Assessment Model. From this EDG provided updated Analysis Group 1 results as summarised in the EDG Cavern Assessment Update attached in **Appendix B**. Results from the revised analysis show the latest change in vertical and horizontal cavern liner displacements and change in cavern liner normal stresses to be less than the initial results. Other model refinements (e.g. wind tunnel results, storey heights, diaphragm levels) will also have contributed to this.

From this first iteration of the Cavern Assessment including shoring walls, EDG calculated more accurate vertical springs for the bases of the piles – summarised in Figure 12. The lateral model was updated to align and the latest shoring wall loads for Group 2 and 3 are presented in Figure 13 tables. Given the proximity of Group 2 and 3 to the Cavern this load check iteration has been limited to Group 2 and 3 shoring walls at this time. Overall these loads are similar the assessment performed by EDG based on 250MN/m springs everywhere and so the outcome of the Cavern Assessment isn't expected to change. As the project develops and the lateral model is updated to reflect design development, the Cavern Assessment will be performed again to ensure the project remains within the outlined performance criteria.

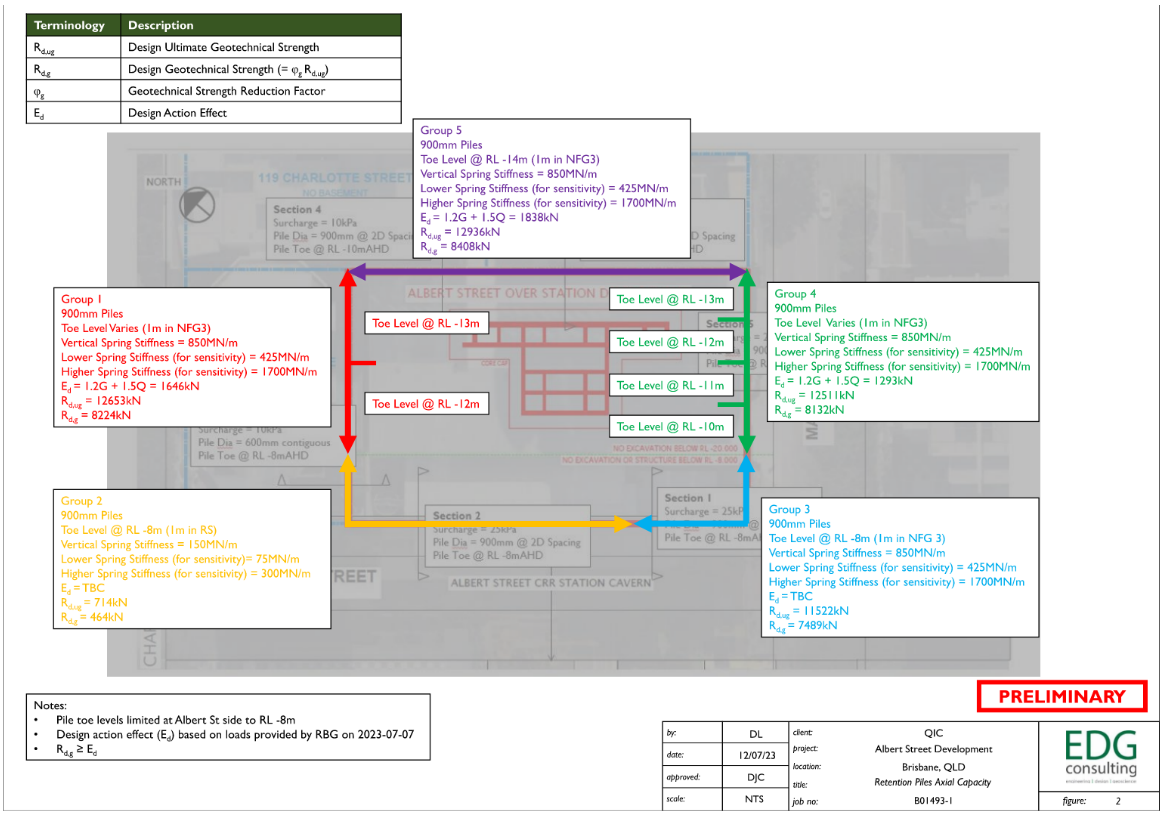


Figure 12: EDG Pile Stiffness Assessment from B01493-1AL report

F_z [kN]	0: Total G (Wished-in)		0: RWDI_25 (01-24 Envelope)		0: EQSpecY+0.3EQSpecX	
	Min	Max	Min	Max	Min	Max
SW - West 1	-1020	-1020	-1180	950	-890	890
SW - East 1	-2000	-2000	-2200	1790	-1630	1630
SW - South 1	-5140	-5140	-2440	1990	-1810	1810
SW - South 2	-2850	-2850	-1940	1590	-1400	1400

V_{IP} [kN]	0: Total G (Wished-in)		0: RWDI_25 (01-24 Envelope)		0: EQSpecY+0.3EQSpecX	
	Min	Max	Min	Max	Min	Max
SW - West 1	-70	-70	-330	290	-340	340
SW - East 1	-220	-220	-1210	1000	-1310	1310
SW - South 1	130	130	-650	590	-750	750
SW - South 2	-20	-20	-770	690	-1020	1020

V_{OOP} [kN]	0: Total G (Wished-in)		0: RWDI_25 (01-24 Envelope)		0: EQSpecY+0.3EQSpecX	
	Min	Max	Min	Max	Min	Max
SW - West 1	10	10	-40	40	-50	50
SW - East 1	-20	-20	-80	90	-120	120
SW - South 1	0	0	-160	140	-190	190
SW - South 2	-40	-40	-230	190	-270	270

M_{IP} [kNm]	0: Total G (Wished-in)		0: RWDI_25 (01-24 Envelope)		0: EQSpecY+0.3EQSpecX	
	Min	Max	Min	Max	Min	Max
SW - West 1	-520	-520	-1080	890	-860	860
SW - East 1	-210	-210	-2240	1810	-1870	1870
SW - South 1	-6450	-6450	-27670	22210	-20990	20990
SW - South 2	-1050	-1050	-2440	2870	-2080	2080

M_{OOP} [kNm]	0: Total G (Wished-in)		0: RWDI_25 (01-24 Envelope)		0: EQSpecY+0.3EQSpecX	
	Min	Max	Min	Max	Min	Max
SW - West 1	10	10	-40	40	-50	50
SW - East 1	-20	-20	-80	90	-120	120
SW - South 1	0	0	-160	140	-190	190
SW - South 2	-40	-40	-230	190	-270	270

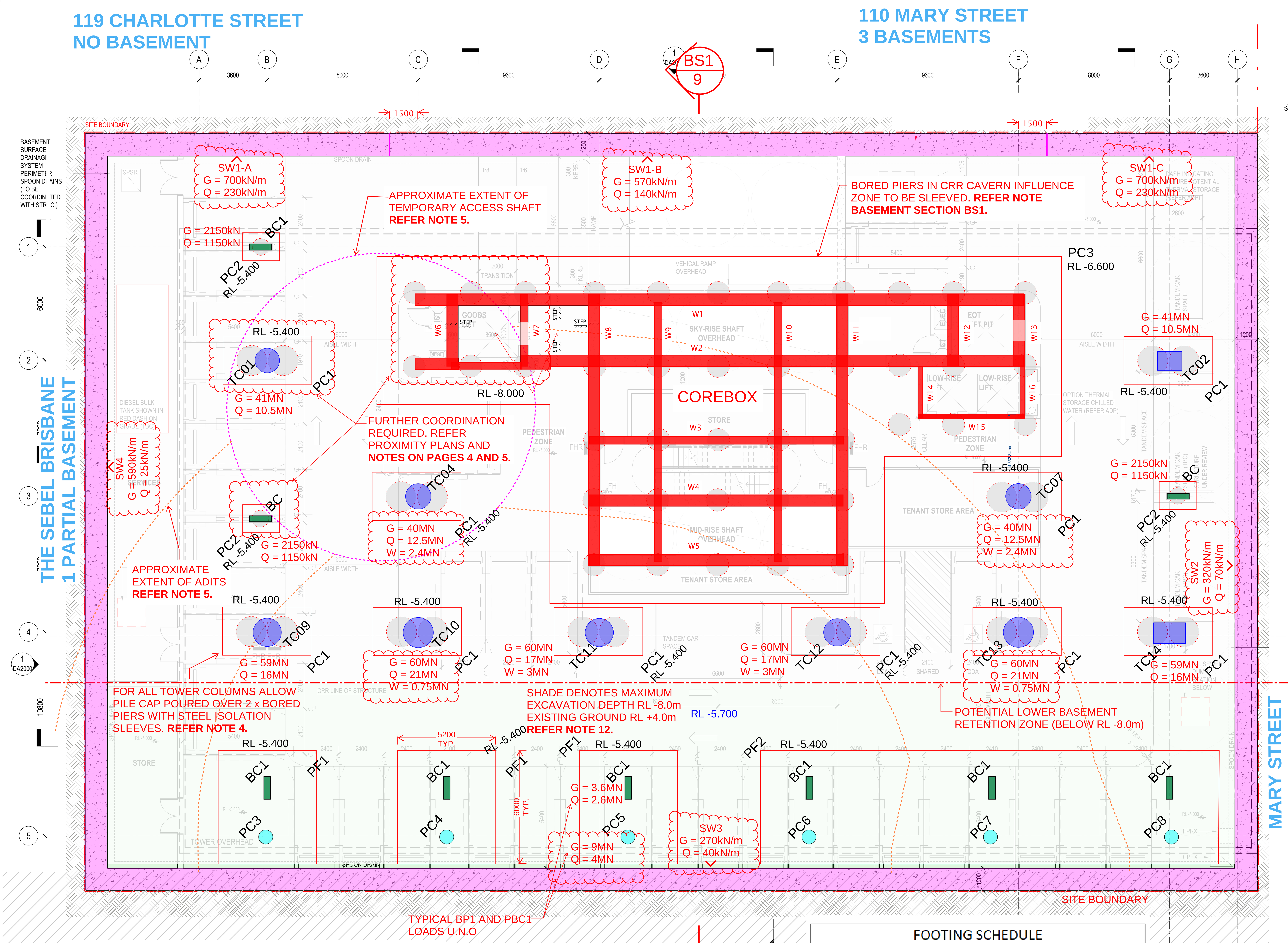
Figure 13: Shoring wall forces based on EDG estimated vertical springs. With reference to Figure 12, only Group 2 and Group 3 are included. The southern shoring wall has been broken at the boundary of Groups 2 and 3.

4.0 Summary

We believe the analysis results shown and discussed above demonstrate the proposed structural systems for 101 Albert Street are performing well and in accordance with the Project Design Criteria Report and Principal Project Requirements. The level of analysis undertaken at this stage will keep being development during the remainder of the DD design phase and beyond into Construction documentation stage.

Appendix A Preliminary Corebox Bored Pier Load Summary

THE FOLLOWING INFORMATION IS BASED UPON A PARTIALLY HYDROSTATIC BASEMENT STRATEGY WITH HYDROSTATIC WALLS AND DRAINED BASEMENT B2 SLAB. TO BE CONFIRMED BY GEOTECHNICAL ENGINEER. REFER **SCHEMATIC REPORT 22131S-RBG-ZZ-XX-RP-ST-00003** FOR MORE DETAILS.



RL -5.400 DENOTES APPROXIMATE TOP OF FOOTING
RL -5.700 DENOTES BULK EXCAVATION

LEGEND:

- DENOTES SHORING WALL WITH A THICKNESS PROVISION OF 1200mm TO ALLOW FOR OUT OF POSITION, VERTICALITY, GUIDE WALL, CAPPING BEAM AND PILE DIAMETER/WALL THICKNESS. ALLOW 900mm DIAMETER SOLDIERS AT 1.8m CENTRES WITH SHOTCRETE INFILL PANELS (THK TBC).
- DENOTES TOWER COLUMN
- DENOTES PODIUM COLUMN
- DENOTES BASEMENT COLUMN
- DENOTES COREBOX WALL
- PF DENOTES PAD FOOTING
- PC DENOTES PILE CAP
- DENOTES BORED PIER

NOTES:

1. PILE CAPS TO BE POURED ON COMPRESSIBLE MATERIAL RMAX GEOFOAM OR SIMILAR OUTSIDE OF THE BORED PIER EXTENTS TO CONTROL LOAD DISTRIBUTION INTO THE BORED PIERS.
2. BORED PIERS TO BE SOCKETED INTO VERY HIGH STRENGTH ROCK NFG1. STEEL ISOLATION SLEEVES TO EXTEND 1m BELOW THE 1:1 CRR INFLUENCE LINE.
3. BORED PIER SIZES AND SOCKET LENGTHS INTO NFG2/NFG1, AS FOLLOWS:
   CORE BOX (REFER GA) - 1200DIA + 8m SOCKET
   TOWER COLUMNS - TWIN 1600DIA + 10m SOCKET
4. NOT ALL EXISTING IN-GROUND STRUCTURE HAS BEEN SHOWN FOR CLARITY. FURTHER COORDINATION REQUIRED TO RESOLVE CLASHES BETWEEN NEW AND EXISTING IN-GROUND STRUCTURE.
5. CONFIRMATION REQUIRED ON METHODOLGY AND MATERIAL TO BE USED TO FILL ADITS AND ACCESS SHAFT.
6. SHEET PILLING MAY BE REQUIRED SUBJECT TO GEOTECHNICAL ENGINEER REVIEW.
7. THE FOOTING DESIGN CONSIDERS PERMANENT CONDITION ONLY WITH NO ALLOWANCE CURRENTLY MADE FOR TEMPORARY WORKS LOADS, TOP-DOWN CONSTRUCTION METHODOLOGY, STAGED CONSTRUCTION ETC. ADDITIONAL PROVISION TO BE MADE BY CONTRACTOR.
8. BORED PIERS TO COLUMNS AND COREBOX MAY BE INSTALLED FROM GROUND LEVEL PROVIDED ADDITIONAL PROVISIONS ARE MADE AS PER NOTE 7. THE CURRENT DESIGN DOES NOT ALLOW FOR BORED PIER OUT OF POSITION ASSOCIATED WITH THE PRIOR AND THIS WOULD NEED TO BE REVIEWED AS PART OF THE TEMPORARY WORKS PACKAGE. ALLOW FOR A PILING MAT AS PER GEOTECHNICAL REQUIREMENTS.
9. ALLOW FOR COST ASSOCIATED WITH TEMPERATURE MONITORING AND CONTROL TO PILE CAPS DEEPER THAN 1m. THIS MIGHT INCLUDE THERMOCOUPLES, INSULATION, ICE TO THE CONCRETE MIX ETC.
10. PAD FOOTINGS TO BE FOUND ON LOW STRENGTH ROCK WITH MINIMUM 1MPa ALLOWABLE END BEARING CAPACITY. PROVIDE MASS CONCRETE BELOW FOOTING AS REQUIRED TO REACH LOW STRENGTH ROCK TO MAXIMUM DEPTH OF RL-8.
11. EXTENT OF NEW INGROUND SERVICES TO BE CONFIRMED. PAD FOOTINGS TO BE DEEPENED AS REQUIRED TO EXTEND BELOW INFLUENCE ZONE. REFER TO COVER NOTES ON PAGE 1.
12. ALLOW FOR 1500mm THK RAFT TO EXTENT OF MAXIMUM EXCAVATION DEPTH RL -8.0m INCASE ADDITIONAL DISTRIBUTION OF VERTICAL LOAD FROM THE PODIUM AND BASEMENT COLUMNS IS REQUIRED TO ACHIEVE CRR CAVERN DESIGN CRITERIA. SUBJECT TO GEOTECHNICAL ANALYSIS.

FOOTING SCHEDULE

MARK	WIDTH	LENGTH	DEPTH	f'c
	mm	mm	mm	(MPa)
PC1	2000	4500	2500	80
PC2	1500	2000	1200	50
PC3	REFER GA		3000	80
PF1	5200	6000	1500	50
PF2	24400	6000	1500	50

SCALE: 1:200 @ A3

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DRAWING TITLE: FOUNDATION PLAN	DESIGNED BY: MJ	DATE: 30/11/22
PROJECT: ALBERT ST OSD	CHECKED BY: -	PROJECT No: 22131
CLIENT: QIC	DRAWING NO S01-01	REVISION: P04

COREBOX BORED PIER LOADS

Pile	0: Total G (Staged)						0: Total Q					
	P_{MAX} [kN]	P_{MIN} [kN]	$V_{x,MAX}$ [kN]	$V_{x,MIN}$ [kN]	$V_{y,MAX}$ [kN]	$V_{y,MIN}$ [kN]	P_{MAX} [kN]	P_{MIN} [kN]	$V_{x,MAX}$ [kN]	$V_{x,MIN}$ [kN]	$V_{y,MAX}$ [kN]	$V_{y,MIN}$ [kN]
CP01	7844	0	581	-202	244	0	1491	0	94	0	30	0
CP02	16110	0	490	0	50	-200	3524	0	37	0	0	-26
CP03	12201	0	3	-79	169	0	2439	0	0	-31	3	0
CP04	13817	0	407	-6	92	-386	2701	0	77	0	0	-74
CP05	12268	0	135	-33	84	-349	2331	0	33	0	0	-76
CP06	9022	0	0	-103	150	0	1646	0	0	-9	9	0
CP07	11818	0	23	-291	83	-319	2258	0	0	-45	0	-71
CP08	10402	0	6	-516	61	-361	2025	0	0	-90	0	-74
CP09	4900	0	94	0	129	0	925	0	27	0	4	0
CP10	8830	0	0	-505	157	0	1822	0	0	-82	9	0
CP11	9831	0	294	-358	264	-122	1884	0	0	-75	0	-29
CP12	8497	0	853	-47	0	-136	1884	0	198	0	17	0
CP13	17933	0	492	0	237	-129	4379	0	88	0	105	0
CP14	12907	0	34	-68	0	-166	3028	0	0	-25	16	0
CP15	12577	0	283	0	0	-296	2949	0	71	0	0	-65
CP16	11035	0	50	0	0	-221	2647	0	16	0	0	-60
CP17	6059	0	8	-6	13	0	1397	0	5	0	1	0
CP18	10795	0	0	-30	0	-230	2620	0	0	-1	0	-62
CP19	9526	0	0	-405	0	-276	2310	0	0	-96	0	-68
CP20	7042	0	458	0	0	-134	1841	0	126	0	0	-30
CP21	11495	0	0	-450	0	-102	3110	0	0	-93	9	0
CP22	13523	0	133	-674	233	-139	3434	0	0	-192	96	0
CP23	2519	0	0	-63	0	-32	496	0	0	-14	2	0
CP24	4580	0	0	-132	0	-88	1160	0	0	-25	0	-13
CP25	4979	0	54	-115	205	-57	1115	0	0	-36	69	0
CP26	12010	0	345	-78	49	-570	3371	0	110	0	0	-248
CP27	11973	0	73	0	27	-380	3476	0	13	0	0	-164
CP28	4620	0	4	-1	9	-3	1148	0	2	0	2	0
CP29	11335	0	0	-71	24	-358	3304	0	0	-14	0	-160
CP30	10734	0	1	-380	44	-614	3162	0	0	-112	0	-245
CP31	22190	0	1199	-171	130	0	6980	0	418	0	0	-14
CP32	23931	0	506	0	64	-10	7730	0	161	0	0	-15
CP33	12584	0	5	-29	10	-33	3988	0	15	0	3	0
CP34	22589	0	0	-541	75	0	7406	0	0	-158	0	-24
CP35	20307	0	117	-1129	130	0	6492	0	0	-391	0	-4
CP36	14977	0	341	-192	1158	-61	4536	0	130	0	358	0
CP37	18662	0	275	0	749	-53	6003	0	61	0	236	0
CP38	9864	0	0	-35	0	-113	3026	0	0	-7	0	-1
CP39	17820	0	0	-226	734	-36	5820	0	0	-63	229	0
CP40	13797	0	178	-294	1024	-67	4206	0	0	-122	332	0

Pile	EQ(Response Spectrum)						0: Wind Envelope					
	P_{MAX} [kN]	P_{MIN} [kN]	$V_{x,MAX}$ [kN]	$V_{x,MIN}$ [kN]	$V_{y,MAX}$ [kN]	$V_{y,MIN}$ [kN]	P_{MAX} [kN]	P_{MIN} [kN]	$V_{x,MAX}$ [kN]	$V_{x,MIN}$ [kN]	$V_{y,MAX}$ [kN]	$V_{y,MIN}$ [kN]
CP01	6693	-6693	1149	-1149	660	-660	10142	-10142	1325	-1325	680	-680
CP02	14889	-14889	1357	-1357	1692	-1692	24050	-24050	1169	-1169	1888	-1888
CP03	10484	-10484	2090	-2090	841	-841	20780	-20780	1364	-1364	971	-971
CP04	11224	-11224	2525	-2525	1771	-1771	22208	-22208	1987	-1987	2192	-2192
CP05	9767	-9767	3019	-3019	1019	-1019	21054	-21054	1903	-1903	1276	-1276
CP06	6786	-6786	2948	-2948	153	-153	15535	-15535	1722	-1722	201	-201
CP07	10002	-10002	2940	-2940	910	-910	21043	-21043	2084	-2084	1098	-1098
CP08	10140	-10140	2432	-2432	1450	-1450	19314	-19314	2155	-2155	1781	-1781
CP09	5855	-5855	1730	-1730	291	-291	11254	-11254	1066	-1066	332	-332
CP10	12075	-12075	2163	-2163	787	-787	21382	-21382	1545	-1545	821	-821
CP11	13639	-13639	1551	-1551	2265	-2265	20285	-20285	1911	-1911	2479	-2479
CP12	6759	-6759	1147	-1147	683	-683	4843	-4843	722	-722	603	-603
CP13	13984	-13984	745	-745	1654	-1654	10739	-10739	447	-447	1431	-1431
CP14	6079	-6079	1019	-1019	828	-828	4988	-4988	606	-606	790	-790
CP15	4923	-4923	702	-702	2283	-2283	6492	-6492	371	-371	2088	-2088
CP16	2375	-2375	441	-441	1126	-1126	4709	-4709	194	-194	860	-860
CP17	544	-544	455	-455	40	-40	1986	-1986	200	-200	29	-29
CP18	2288	-2288	416	-416	948	-948	5342	-5342	166	-166	615	-615
CP19	4246	-4246	634	-634	1963	-1963	6474	-6474	357	-357	1649	-1649
CP20	2548	-2548	541	-541	376	-376	3392	-3392	292	-292	354	-354
CP21	7963	-7963	1133	-1133	814	-814	8204	-8204	763	-763	663	-663
CP22	13861	-13861	1097	-1097	2657	-2657	12230	-12230	845	-845	1901	-1901
CP23	2184	-2184	173	-173	259	-259	1883	-1883	114	-114	228	-228
CP24	4262	-4262	395	-395	301	-301	4811	-4811	270	-270	269	-269
CP25	5538	-5538	289	-289	1190	-1190	5297	-5297	235	-235	959	-959
CP26	6897	-6897	565	-565	2452	-2452	6278	-6278	402	-402	1911	-1911
CP27	3646	-3646	341	-341	1143	-1143	4155	-4155	190	-190	762	-762
CP28	515	-515	330	-330	43	-43	264	-264	182	-182	49	-49
CP29	3109	-3109	324	-324	958	-958	3734	-3734	186	-186	520	-520
CP30	6792	-6792	539	-539	2178	-2178	6327	-6327	393	-393	1555	-1555
CP31	12319	-12319	1742	-1742	2604	-2604	22148	-22148	2037	-2037	2611	-2611
CP32	8984	-8984	2506	-2506	1518	-1518	21582	-21582	1817	-1817	1453	-1453
CP33	3555	-3555	2783	-2783	96	-96	10375	-10375	1827	-1827	117	-117
CP34	8663	-8663	2508	-2508	1301	-1301	21981	-21981	1994	-1994	1130	-1130
CP35	12084	-12084	1731	-1731	2164	-2164	22790	-22790	2135	-2135	2041	-2041
CP36	9293	-9293	1105	-1105	1593	-1593	18359	-18359	1225	-1225	2337	-2337
CP37	11171	-11171	1467	-1467	1107	-1107	24716	-24716	1070	-1070	1612	-1612
CP38	5081	-5081	1608	-1608	132	-132	12223	-12223	1181	-1181	194	-194
CP39	10721	-10721	1464	-1464	981	-981	24205	-24205	1187	-1187	1393	-1393
CP40	9219	-9219	1104	-1104	1433	-1433	18649	-18649	1293	-1293	2046	-2046

Pile	0: Robustness Envelope					
	P_{MAX} [kN]	P_{MIN} [kN]	$V_{x,MAX}$ [kN]	$V_{x,MIN}$ [kN]	$V_{y,MAX}$ [kN]	$V_{y,MIN}$ [kN]
CP01	5132	-5132	784	-784	250	-250
CP02	11322	-11322	446	-446	684	-684
CP03	9559	-9559	202	-202	402	-402
CP04	11692	-11692	410	-410	987	-987
CP05	11717	-11717	294	-294	699	-699
CP06	9122	-9122	169	-169	151	-151
CP07	12188	-12188	337	-337	673	-673
CP08	10808	-10808	586	-586	856	-856
CP09	5155	-5155	59	-59	156	-156
CP10	10063	-10063	296	-296	299	-299
CP11	9606	-9606	755	-755	899	-899
CP12	4118	-4118	683	-683	203	-203
CP13	8409	-8409	564	-564	455	-455
CP14	2915	-2915	534	-534	303	-303
CP15	3366	-3366	439	-439	775	-775
CP16	2149	-2149	258	-258	433	-433
CP17	1047	-1047	269	-269	40	-40
CP18	2585	-2585	237	-237	380	-380
CP19	3155	-3155	424	-424	609	-609
CP20	1905	-1905	187	-187	153	-153
CP21	5985	-5985	719	-719	208	-208
CP22	10057	-10057	871	-871	376	-376
CP23	513	-513	107	-107	93	-93
CP24	1743	-1743	231	-231	103	-103
CP25	1693	-1693	234	-234	264	-264
CP26	4373	-4373	367	-367	656	-656
CP27	2190	-2190	208	-208	355	-355
CP28	58	-58	203	-203	48	-48
CP29	1913	-1913	194	-194	304	-304
CP30	4319	-4319	349	-349	604	-604
CP31	10112	-10112	966	-966	1005	-1005
CP32	11493	-11493	1173	-1173	758	-758
CP33	5899	-5899	1258	-1258	96	-96
CP34	11382	-11382	1158	-1158	700	-700
CP35	10253	-10253	921	-921	804	-804
CP36	10670	-10670	584	-584	1227	-1227
CP37	14209	-14209	691	-691	914	-914
CP38	7102	-7102	723	-723	142	-142
CP39	14000	-14000	681	-681	875	-875
CP40	10398	-10398	556	-556	1149	-1149

NOTES:

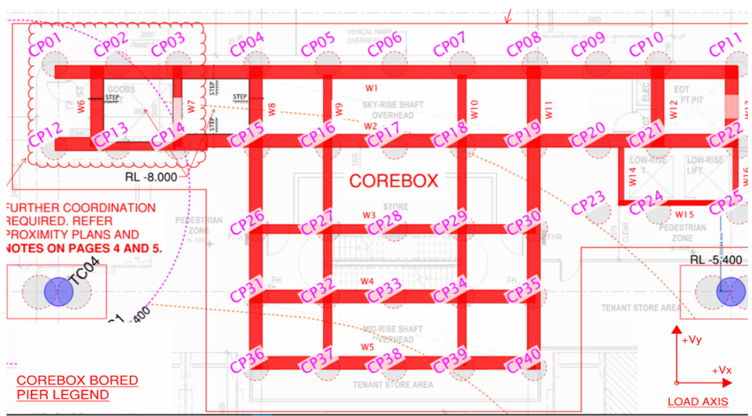
1 (+P) DENOTES VERTICAL LOAD IN SAME DIRECTION AS GRAVITY
(-P) DENOTES VERTICAL LOAD IN OPPOSITE DIRECTION AS GRAVITY (TENSION)

2 WIND LOADS SHOWN ARE ULTIMATE. APPLY 0.64 FACTOR TO CONVERT TO PERMISSIBLE.

3 SEISMIC (EQ) LOADS SHOWN ARE ULTIMATE. APPLY 0.5 FACTOR TO CONVERT TO PERMISSIBLE.

4 WIND AND SEISMIC LOADS ARE FULLY REVERSIBLE.

5 ALLOW AN CONTINGENCY FACTOR OF 1.1 ON ALL LOADS FOR FUTURE CHANGES.



Appendix B Cavern Assessment Update

EDG consulting

Package / Issue:	Cavern Assessment Update		**Doc Ref:**	B01493-1AN
			Version:	A
Location:	Brisbane, QLD		**Date:**	21 July 2023
Distribution:	Mark Avery, Nicholas Doyle			
Prepared:	Darron Lee	**Reviewed:**	David Cunliffe	
Attachments:	Appendix A – Design Loads Appendix B – Finite Element Outputs			
References:				

1 Background

EDG has previously issued a cavern assessment report ref. B01493-1AE, which considered the loads provided by Robert Bird Group (RBG) dated 30 November 2022. Robert Bird Group (RBG) has since provided EDG with an updated set of loads dated 5 July 2023, and requested EDG to revise the cavern assessment considering the updated loads. It is understood that the updated set of loads provided by RBG dated 5 July 2023 considers the spring stiffness values provided by EDG and the updated wind actions from wind tunnel testing.

2 Basis of Assessment

Our finite element model considered the following:

- All soil and rock parameters, ground model as previously documented in ref. B01493-1AE.
- Design Loads provided by RBG dated 5 July 2023 (included as Appendix A).
- Design Action Effect of 1.1(G+Q+0.5E+0.64W), where G = dead load, Q = live load, E = earthquake load, W = wind load. For the wind load combinations, RBG has requested EDG to consider load case RWDI_11 (wind load in x direction) and RWDI_01(wind load in y direction).

3 Attachments

Appendix A – Design Loads provided by RBG 5 July 2023

Appendix B – Finite Element Outputs of Cavern Assessment

For comparison purposes, we have included both the results considering the updated loads dated 5 July 2023, and the superseded loads dated 30 November 2022 (as per our previous report ref. B01493-1AE), in the plots of Appendix B.

4 Commentary

We assess that the calculated vertical and horizontal distortions associated with the updated building loads dated 5 July 2023 are within the calculated values from the CRR PSTR Load Cases 1 to 7, and are smaller than those previously calculated from the previous building loads dated 30 November 2022.

Calculated cavern lining normal stresses from the updated building loads were within those calculated from Load cases 1 to 7, however locally spike at the cavern corner closest to the applied load. This is considered to be an artefact of the preliminary modelling and not representative of the lining stress. This will be further addressed in subsequent design stages.

We consider that the analysis outcomes indicate that predicted effects associated with the updated building loads dated 5 July 2023 are within the effects associated with the PSTR design load cases.

For and on behalf of EDG Consulting Pty Ltd

Darron Lee
Senior Engineer

EDG consulting

Ground conditions and the natural environment often present the highest potential risks to project construction and operation. Helping our clients manage their geotechnical risk is fundamental to the role of EDG. We have prepared these notes to assist our clients to understand the information we provide and to help them to manage their risk. Where there is uncertainty about the site, project or geotechnical conditions, contact EDG for assistance.

Scope of Services

The information provided in this document is based on the scope of services defined in the client's agreement with EDG Consulting Pty Ltd (EDG). In undertaking the work, EDG has relied on information provided by the client and other individuals and organisations. Unless stated in the document, EDG has not verified the accuracy of that information and does not accept responsibility for the conclusions, recommendations or designs developed based on that information should it be incorrect, misrepresented or withheld.

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EDG will not be liable to update or revise the document to take into account information any events or circumstances or facts occurring or becoming apparent after the date of the report.

All site conditions cannot be identified

The scope of work undertaken represents a professional assessment of the information cited to develop a basic geotechnical model of the site based on EDG's understanding of the client's risk profile. In some cases, increasing the frequency of investigations and/or sampling, or considering alternative investigation techniques may improve the interpretation, but may not identify all relevant subsurface conditions at the site.

The document presents an interpretation

Geotechnical information is an interpretation of conditions evident based on a limited number of facts established during a site investigation. Engineering logs are an interpretation of observations of samples and test results at discrete locations in the subsurface profile. A geotechnical model is an interpretation of site conditions, developed using information from discrete locations on the site and an understanding of geological processes. Interpreted conditions at and between investigation locations may be different to those inferred on the engineering logs and geotechnical model. The client must consider how variations in conditions could affect the project and seek advice to reduce risk if it is unacceptable to the client.

Conditions can change

The geotechnical information provided is based on the conditions observed at the time of the investigation. Such conditions may be time dependent and subject to external influences. Many things could influence the site conditions, including geological processes, variation in groundwater or surface water levels, other natural cycles and influence from human activities (on this site or nearby sites). Specific advice should be sought if conditions on site change from those observed at the time the report was prepared.

How to deal with different site conditions

The sub-surface conditions on the site may not be as inferred in this report. Geotechnical uncertainties can be managed throughout the project life cycle, but particularly during construction.

Knowledge of site conditions must be further developed as the ground is exposed during construction and/or operation. It is essential that the client implements the nominated design and construction requirements, including observation, interpretation and assessment of the exposed conditions during construction and operation using skilled staff familiar with the design assumptions and assumed geotechnical conditions, or engaging EDG to undertake this role on your behalf.

Appendix A

Loading Provided by RBG 5 July 2023

				0: Total G (Wished-in)			0: Total Q			0: RWDI_01			0: RWDI_05			0: RWDI_13			0: RWDI_11			0: EQSpecX			0: EQSpecY		
Joint	X [m]	Y [m]	Group	F_x [kN]	F_y [kN]	F_z [kN]	F_x [kN]	F_y [kN]	F_z [kN]	F_x [kN]	F_y [kN]	F_z [kN]	F_x [kN]	F_y [kN]	F_z [kN]	F_x [kN]	F_y [kN]	F_z [kN]	F_x [kN]	F_y [kN]	F_z [kN]	F_x [kN]	F_y [kN]	F_z [kN]	F_x [kN]	F_y [kN]	F_z [kN]
11058	12.60	-0.80	South SW	-3	-12	372	-2	-4	156	-30	-2	-19	36	-12	-20	32	-24	-49	-42	33	61	-41	-15	-7	-58	-44	-48
3250	17.45	28.37	Core Piles	52	-6	12475	17	-12	2448	-140	-25	-531	171	-99	6388	77	-214	8513	-2	312	-9150	-133	-170	-2126	-139	-575	-3953
3267	21.30	28.37	Core Piles	25	-16	12074	9	-18	2273	-128	-33	618	169	-86	5371	83	-185	8169	-12	256	-9055	-129	-114	-1433	-134	-498	-4230
3270	24.55	28.37	Core Piles	4	-20	11089	3	-19	2013	-121	-46	1608	169	-81	4227	91	-175	7484	-22	226	-8535	-128	-65	-757	-130	-432	-4208
3274	27.60	28.37	Core Piles	-15	-25	10650	-3	-20	1895	-117	-63	2479	172	-84	3321	99	-181	7019	-31	216	-8219	-127	-25	-255	-127	-385	-4355
3281	30.65	28.37	Core Piles	-30	-23	9967	-8	-17	1748	-115	-84	3228	178	-91	2393	109	-196	6406	-43	217	-7713	-127	-37	-431	-126	-431	-4389
3293	33.90	28.37	Core Piles	-43	-19	9555	-12	-13	1674	-113	-110	4044	186	-106	1471	123	-227	5877	-59	234	-7329	-128	-82	-965	-128	-513	-4414
18092	42.60	-0.80	South SW	10	-8	379	4	-1	140	-46	-17	-17	13	-12	-41	-16	-28	-73	15	29	82	-39	-13	-8	-67	-50	-59
7314	55.99	-0.80	South SW	16	24	501	5	10	165	-52	-48	-129	3	-31	-239	-35	-78	-454	37	81	515	-39	-34	-38	-81	-119	-374
6927	21.30	10.80	Tower Columns	-2	-1	38020	-1	-1	19158	22	7	-1445	-18	13	-875	-10	27	-2590	12	-34	3147	-22	-8	-239	-27	-41	-1510
6928	33.90	10.80	Tower Columns	-1	-2	38121	-1	-1	18869	24	13	-620	-15	13	-1546	-3	29	-2786	4	-32	3209	-21	-6	-267	-28	-43	-1376
7996	3.60	0.00	Basement/Podium Columns	1	-1	4515	0	-1	2074	3	1	-498	-5	3	-584	-5	7	-1333	6	-9	1627	-5	-4	-141	-7	-10	-1203
8001	51.60	0.00	Basement/Podium Columns	-1	-2	4362	0	-1	1603	5	4	-519	-1	3	-1016	2	7	-1900	-2	-7	2158	-4	-3	-166	-8	-11	-1539
7287	3.60	10.80	Tower Columns	-3	-10	40878	-1	-6	18955	23	10	-1171	-26	30	-2350	-20	61	-4704	24	-83	5808	-26	-33	-958	-32	-95	-3231
7285	3.60	25.20	Tower Columns	-5	-6	26438	-3	-3	12133	11	7	1066	-9	18	2521	-2	38	4837	-2	-53	-5914	-7	-21	-957	-6	-61	-3168
7288	51.60	10.80	Tower Columns	0	-13	37779	-1	-7	16349	26	36	-2433	-12	28	-1909	3	65	-4720	-3	-68	5323	-21	-27	-913	-32	-98	-3562
7286	51.60	25.20	Tower Columns	3	-7	28134	1	-5	11208	8	22	2803	-11	22	1819	-7	46	4948	5	-47	-5667	-7	-18	-947	-4	-68	-3655
7997	13.20	0.00	Basement/Podium Columns	0	0	3675	0	0	1698	3	1	-22	-3	2	8	-3	4	-14	4	-5	28	-4	-2	-20	-5	-6	-33
7998	22.80	0.00	Basement/Podium Columns	0	0	3585	0	0	1565	3	1	130	-3	1	165	-1	3	356	2	-3	-417	-4	-1	-16	-5	-4	-309
7999	32.40	0.00	Basement/Podium Columns	0	0	3542	0	0	1509	4	1	155	-2	1	136	0	3	336	0	-3	-399	-3	0	-20	-5	-4	-310
8000	42.00	0.00	Basement/Podium Columns	-1	-1	3678	0	0	1530	4	2	11	-1	2	-126	1	4	-166	-1	-4	178	-4	-1	-43	-6	-6	-100
18229	12.60	37.00	North SW	10	-9	979	5	2	441	-17	-3	-14	7	-9	217	-13	-19	291	27	27	-311	-19	-13	-72	-40	-38	-182
18328	42.60	37.00	North SW	-9	-9	894	-7	1	374	-3	-12	211	27	-12	-25	30	-25	168	-24	25	-238	-18	-11	-81	-37	-43	-192
9064	55.99	37.00	East SW	-17	13	746	-11	11	265	0	-30	414	34	-42	-20	42	-77	365	-37	76	-497	-20	-32	-149	-48	-110	-410
6935	3.60	2.60	Basement/Podium Columns	0	-1	2482	0	0	1687	2	1	-6	-3	2	-22	-2	4	-42	3	-6	54	-3	-2	-16	-4	-6	-36
6936	13.20	2.60	Basement/Podium Columns	0	0	2820	0	0	1997	2	1	61	-3	2	77	-2	3	168	3	-4	-201	-3	-1	-10	-4	-5	-133
6937	22.80	2.60	Basement/Podium Columns	0	0	3120	0	0	1711	3	1	59	-2	1	63	-1	2	145	2	-3	-173	-3	-1	-6	-4	-3	-128
6938	32.40	2.60	Basement/Podium Columns	0	0	3384	0	0	1659	3	1	60	-2	1	81	0	3	171	0	-3	-200	-3	0	-9	-4	-4	-146
6939	42.00	2.60	Basement/Podium Columns	-1	-1	3577	0	0	1650	4	2	76	-1	2	86	1	4	191	-1	-4	-223	-3	-1	-9	-5	-6	-154
6940	51.60	2.60	Basement/Podium Columns	-1	-1	2804	0	-1	1165	3	3	-89	-1	2	-97	1	5	-212	-1	-5	239	-2	-2	-28	-4	-7	-180
9763	-5.40	37.00	West SW	18	15	911	11	9	368	-24	-19	-44	0	-28	578	-29	-71	785	47	100	-861	-22	-42	-204	-56	-118	-543
9792	-5.40	-0.80	South SW	-15	26	664	-8	14	296	-21	-8	-216	50	-43	-272	60	-82	-605	-75	110	737	-44	-44	-65	-77	-121	-548
6513	36.57	28.37	Core Piles	-52	-5	9310	-16	-5	1634	-112	-132	4677	194	-125	734	135	-261	5448	-73	258	-7032	-130	-121	-1394	-132	-583	-4305
6618	14.10	28.37	Core Piles	73	0	11915	23	-6	2391	-147	-22	-1293	178	-122	6744	79	-259	8290	-3	382	-8717	-136	-220	-2491	-139	-656	-3567
10157	36.57	21.97	Core Piles	-26	-11	9536	-2	-8	2165	-158	-131	1661	154	-118	-2358	68	-250	-1762	-36	245	1533	-116	-123	-1289	-64	-584	-722
3254	17.45	25.10	Core Piles	46	-8	13231	13	-13	2876	-148	-23	-2094	179	-98	4652	95	-210	4565	-43	307	-4447	-119	-171	-2122	-84	-575	-1268
3272	21.30	25.10	Core Piles	22	-16	12630	7	-19	2676	-140	-28	-946	170	-81	3538	90	-174	4105	-41	244	-4256	-114	-115	-1403	-84	-498	-1633
3279	24.55	25.10	Core Piles	4	-24	11572	3	-20	2395	-135	-45	103	165	-82	2402	88	-176	3491	-39	227	-3833	-111	-65	-700	-84	-434	-1681
3298	30.65	25.10	Core Piles	-25	-25	10447	-4	-18	2112	-134	-84	1792	165	-91	654	90	-196	2597	-42	216	-3224	-110	-37	-435	-83	-433	-1922
3311	33.90	25.10	Core Piles	-36	-21	9941	-7	-14	2005	-135	-109	2618	169	-103	-214	95	-220	2159	-48	226	-2951	-112	-84	-973	-82	-516	-1917
10345	27.60	25.10	Core Piles	-11	-30	11293	-1	-21	2303	-134	-62	1020	165	-83	1547	89	-179	3139	-41	214	-3649	-110	-25	-150	-83	-387	-1830
10141	36.57	25.10	Core Piles	-33	-7	9640	-7	-7	1936	-134	-131	3264	172	-122	-864	101	-256	1882	-55	252	-2848	-112	-122	-1378	-81	-584	-1722
11626	14.10	25.10	Core Piles	69	2	12850	19	-5	2839	-154	-22	-2820	190	-120	5145	105	-256	4552	-53	379	-4227	-125	-220	-2513	-85	-654	-947
3275	21.30	20.85	Core Piles	7	-28	13288	5	-23	3340	-159	-24	-3345	161	-83	731	80	-174	-2062	-55	244	2941	-124	-119	-1421	-77	-506	-2120
3289	24.55	20.85	Core Piles	1	-24	12327	3	-20	3059	-157	-46	-2152	158	-85	-287	78	-180	-2407	-53	232	3087	-123	-66	-679	-77	-437	-1667
3351	30.65	20.85	Core Piles	-21	-26	11357	-1	-18	2769	-158	-86	-244	156	-93	-1906	76	-200	-2968	-51	220	3361	-122	-38	-542	-80	-438	-1356
3602	33.90	20.85	Core Piles	-26	-34	10711	-2	-19	2600	-162	-112	616	154	-99	-2657	69	-217	-3233	-44	221	3470	-124	-87	-1070	-87	-526	-1436
10519	27.60	20.85	Core Piles	-11	-20	12015	1	-20	2948	-157	-63	-1171	157	-84	-1136	77	-181	-2720	-53	215	3254	-122	-25	-82	-78	-393	-1323
3283	21.30	17.65	Core Piles	7	-15	13897	7	-19	3845	-184	-28	-4990	153	-87	-1240	63	-183	-6363	-54	256	7966	-160	-119	-1436	-162	-508	-4790
3616	33.90	17.65	Core Piles	-33	-24	11884	-3	-15	3188	-180	-115	-724	159	-103	-4565	75	-225	-7229	-69	231	8195	-160	-87	-1248	-166	-528	-3799
3594	27.60	17.65	Core Piles	-12	-31	13177	1	-21	3594	-177	-65	-2855	154	-88	-3185	70	-187	-7202	-63	223	8537	-157	-25	-167	-160	-389	-3926
3295	21.30	14.49	Core Piles	-2	-5	13291	5	-17	3931	-210	-33	-5967	157	-91	-2768	60	-194	-9441	-70	268	11547	-206	-118	-1329	-247	-509	-6983
3596	24.55	14.49	Core Piles	0	-24	12896	6	-21	3798	-210	-47	-4910	156	-88	-3805	58	-186	-9962	-67	239	11947	-205	-66	-630	-248	-440	-6566
3623	30.65	14.49	Core Piles	-26	-27	12409	-1	-19	3594	-205	-89	-2943	162	-95	-5268	72	-206	-10282	-83	228	11995	-205	-39	-718	-248	-443	-5947
3635	33.90	14.49	Core Piles	-25	-14	11800	0	-13	3393	-207	-117	-1835	162	-107	-5886	70	-233	-10151	-81	241	11652	-205	-87	-1302	-250	-527	-5875
10513	27.60	14.49	Core Piles	-12	-26	13088	3	-20	3822	-207	-67	-4080	159	-90	-4734	65	-193	-10547	-75	230	12471	-205	-25	-280	-247	-392	-6300
3307	23.85	17.65	Core Piles	4	-22	13309	6	-20	3667	-181	-43	-4054	152	-87	-2047	64	-183	-6659	-56	240	8127	-158	-77	-840	-160	-452	-4389
3613	31.35	17.65	Core Piles	-29	-26	12362	-3	-18	3337	-177	-94	-1508	158	-96	-4011	75	-208	-7162	-69	226	8270	-158	-48	-797	-163	-459	-3762
6929	43.60	10.80	Tower Columns	-1	-7	44303	-1	-5	22221	31	29	-132	-16	23	-44	2	54	-179	-1	-56	215	-26	-20	-71	-37	-83	-431
6934	43.60	18.48	Tower Columns	1	-3	20153	0	-2	9224	8	11	407	-6	10	-968	-2	22	-956	1	-23	909	-6	-8	-451	-6	-34	-354
6926	11.60	10.80	Tower Columns	-3	-5	43259	-1	-3	22865	25	8	-30	-26	22	-119	-18	46	-204	22	-61	240	-27	-23	-81	-33	-73	-462
6933	11.60	18.48	Tower Columns	-3	-2	21441	-1	-1	11129	9	4	-666	-9	10	278	-5	21	-244	4	-28	436	-8	-11	-318	-7	-35	-221
3264	11.60	25.10	Core Piles	80	5	11344	22	-2	2510	-158	-18	-3027	196	-132	4720	110	-280	3749	-57	421	-3292	-127	-254	-2456	-86	-704	-706
3256	11.60	28.37	Core Piles	81	6	10329	25	-2	2055	-149	-18	-1526	182	-133	6214	83	-281	7314	-7	421	-7588	-137	-254	-2407	-137	-704	-2992
5152	39.75	28.37	Core Piles	-61	14	9480	-19	6	1668	-112	-166	5603	202	-156	-90	147	-321	5176	-86	309	-6978	-132	-171	-1953	-140	-688	-4367
5154	39.75	25.10	Core Piles	-46	17	9782	-11	6	1943	-139	-162	4178	177	-155	-1611	103	-316	1726	-57	302	-2945	-115	-171	-1912	-80	-685	-1682
5153	43.15	28.37	Core Piles	-65	36	9484	-21	19	1656	-113	-209	6498	206	-192	-925	151	-395	4852	-90	374	-6850	-133	-227	-2510	-142	-812	-4449

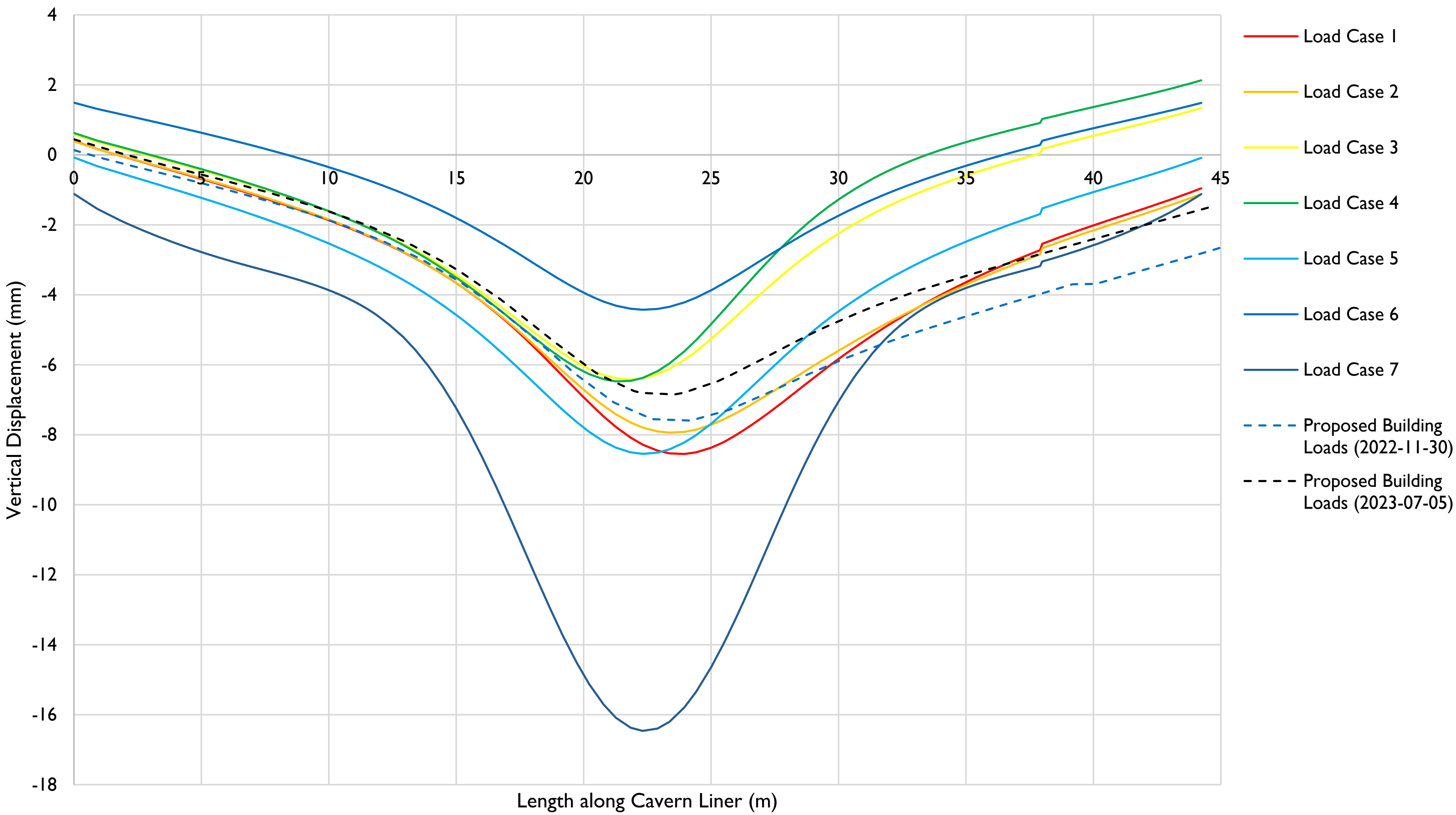
5157	43.15	25.10	Core Piles	-51	46	9753	-12	21	1912	-142	-203	5079	180	-196	-2397	105	-395	1485	-58	371	-2921	-117	-227	-2458	-80	-813	-1780
10905	43.15	21.97	Core Piles	-26	50	8742	-1	21	1893	-165	-198	3025	152	-196	-3440	59	-390	-1906	-26	365	1230	-118	-226	-2099	-73	-807	-1352
10908	39.90	21.97	Core Piles	-28	16	8998	-2	5	1986	-163	-164	2309	154	-155	-2842	63	-317	-1770	-31	303	1296	-118	-173	-1661	-71	-689	-1091
17642	-5.40	1.20	West SW	-6	26	693	-5	13	307	-19	-8	-193	38	-43	-245	45	-81	-546	-56	110	665	-35	-45	-62	-59	-121	-496
17644	-5.40	3.20	West SW	2	25	721	-4	13	318	-17	-9	-172	31	-42	-216	34	-80	-484	-43	108	591	-30	-44	-57	-48	-120	-443
17646	-5.40	5.20	West SW	7	24	745	-2	12	327	-17	-9	-154	27	-41	-183	29	-79	-418	-36	106	514	-26	-44	-52	-41	-119	-389
17648	-5.40	7.20	West SW	12	22	768	0	12	335	-16	-9	-139	24	-39	-147	24	-77	-351	-30	105	435	-24	-43	-46	-35	-118	-333
17661	-5.40	9.20	West SW	17	21	786	1	11	341	-15	-10	-124	21	-38	-108	20	-76	-282	-24	104	354	-21	-43	-41	-29	-117	-276
17663	-5.40	11.20	West SW	20	20	805	1	11	348	-14	-10	-111	18	-37	-69	16	-75	-212	-20	102	272	-18	-43	-37	-24	-117	-219
17665	-5.40	13.20	West SW	24	19	822	2	10	353	-14	-11	-100	16	-36	-28	13	-74	-142	-15	102	190	-16	-43	-37	-20	-116	-162
17667	-5.40	15.20	West SW	28	18	834	3	10	357	-13	-12	-89	14	-35	14	10	-73	-71	-12	101	108	-13	-42	-41	-15	-116	-105
17669	-5.40	17.20	West SW	30	17	848	2	9	361	-12	-13	-80	13	-34	57	8	-73	1	-9	100	25	-11	-42	-47	-12	-116	-48
17736	-5.40	19.20	West SW	28	17	854	2	9	362	-11	-13	-72	11	-33	102	6	-72	73	-6	100	-58	-10	-42	-57	-9	-116	-24
17738	-5.40	21.20	West SW	27	16	863	2	9	363	-11	-14	-65	10	-32	148	4	-72	146	-3	100	-142	-8	-42	-68	-6	-116	-67
17740	-5.40	23.20	West SW	24	16	867	2	9	363	-11	-15	-60	9	-31	196	2	-71	221	1	100	-227	-7	-42	-82	-4	-116	-124
17742	-5.40	25.20	West SW	22	16	874	3	9	364	-11	-16	-55	8	-30	246	0	-71	297	4	100	-314	-7	-42	-97	-8	-117	-182
17744	-5.40	27.20	West SW	23	16	880	3	9	365	-12	-17	-52	7	-29	298	-3	-71	375	8	100	-402	-7	-42	-113	-13	-117	-240
17885	-5.40	29.20	West SW	24	16	890	3	9	367	-13	-18	-50	6	-29	352	-6	-71	455	13	100	-492	-9	-42	-131	-19	-117	-300
17887	-5.40	31.20	West SW	24	15	897	4	9	369	-14	-19	-49	4	-28	408	-10	-71	537	19	100	-583	-11	-42	-149	-25	-118	-359
17889	-5.40	33.20	West SW	21	15	901	6	9	368	-15	-19	-47	3	-28	466	-15	-71	621	25	101	-677	-13	-42	-168	-32	-118	-421
17891	-5.40	35.20	West SW	18	15	907	7	9	368	-18	-20	-46	2	-28	524	-20	-71	706	33	101	-772	-16	-42	-187	-41	-118	-483
17972	55.99	1.20	East SW	11	24	527	4	10	169	-39	-48	-118	4	-31	-215	-25	-79	-409	26	82	464	-29	-35	-35	-60	-120	-339
17978	55.99	3.20	East SW	9	24	554	3	10	174	-35	-48	-105	5	-31	-194	-19	-79	-366	20	82	415	-27	-34	-33	-52	-119	-305
17984	55.99	5.20	East SW	-1	23	583	0	10	181	-28	-47	-91	5	-32	-174	-13	-78	-325	14	81	366	-22	-34	-32	-41	-118	-272
17990	55.99	7.20	East SW	-7	22	611	-2	10	187	-26	-46	-76	7	-32	-156	-10	-78	-284	10	80	318	-21	-34	-31	-37	-118	-238
17996	55.99	9.20	East SW	-15	21	632	-6	10	192	-21	-45	-58	7	-32	-138	-6	-77	-244	6	79	270	-17	-34	-31	-29	-117	-203
18002	55.99	11.20	East SW	-15	20	653	-6	10	197	-20	-43	-39	8	-33	-122	-4	-76	-203	4	78	222	-17	-34	-32	-26	-116	-167
18008	55.99	13.20	East SW	-17	18	670	-6	9	201	-17	-42	-19	8	-33	-108	-2	-76	-164	2	78	174	-14	-33	-33	-22	-115	-133
18014	55.99	15.20	East SW	-19	17	679	-6	9	202	-15	-41	4	8	-34	-93	-1	-76	-123	1	77	124	-12	-33	-35	-17	-114	-95
18020	55.99	17.20	East SW	-20	15	689	-5	9	204	-13	-40	28	8	-35	-81	1	-76	-82	0	77	75	-10	-33	-39	-13	-114	-58
18026	55.99	19.20	East SW	-17	14	691	-5	9	206	-10	-38	55	8	-36	-70	2	-76	-42	-2	77	25	-8	-33	-44	-8	-113	-21
18032	55.99	21.20	East SW	-9	14	693	-2	9	208	-9	-37	84	9	-37	-60	4	-76	-1	-3	77	-26	-7	-33	-50	-5	-113	-48
18038	55.99	23.20	East SW	-3	13	693	-1	10	211	-8	-36	116	10	-38	-52	6	-76	40	-5	77	-77	-6	-32	-57	-2	-112	-84
18044	55.99	25.20	East SW	1	14	695	0	11	216	-6	-34	150	11	-39	-45	9	-77	82	-7	77	-131	-6	-32	-67	-5	-112	-122
18050	55.99	27.20	East SW	-4	15	706	-2	11	224	-5	-33	188	13	-40	-40	11	-77	125	-9	77	-186	-7	-32	-78	-9	-112	-162
18056	55.99	29.20	East SW	-11	15	719	-4	11	234	-4	-32	230	15	-41	-36	15	-78	169	-12	77	-243	-8	-32	-90	-14	-112	-204
18062	55.99	31.20	East SW	-16	14	729	-6	12	243	-3	-31	274	16	-42	-33	17	-78	215	-15	77	-303	-9	-32	-104	-18	-112	-248
18068	55.99	33.20	East SW	-17	14	739	-8	12	252	-2	-30	320	21	-42	-30	24	-78	263	-20	77	-366	-12	-32	-119	-27	-111	-299
18074	55.99	35.20	East SW	-16	14	744	-9	12	260	-1	-30	369	26	-42	-26	31	-78	314	-27	77	-433	-15	-32	-135	-35	-111	-354
7295	-3.40	-0.80	South SW	-15	20	619	-8	9	275	-22	-6	-180	50	-32	-233	60	-61	-514	-76	83	626	-44	-35	-57	-78	-95	-465
7301	-1.40	-0.80	South SW	-15	16	573	-8	6	253	-22	-5	-147	49	-27	-191	59	-52	-422	-74	71	513	-44	-31	-47	-77	-84	-382
7308	0.60	-0.80	South SW	-14	4	523	-8	1	230	-23	-3	-117	48	-22	-151	56	-42	-334	-71	59	406	-44	-28	-38	-75	-73	-303
7315	2.60	-0.80	South SW	-13	-4	471	-7	-1	205	-24	-2	-89	46	-18	-113	53	-34	-252	-67	48	307	-44	-25	-29	-72	-63	-230
7331	4.60	-0.80	South SW	-9	-7	437	-5	-2	189	-26	-1	-68	44	-15	-84	48	-29	-189	-61	41	231	-43	-22	-22	-68	-56	-173
9453	6.60	-0.80	South SW	-7	-5	424	-4	-1	181	-27	-2	-53	42	-14	-63	44	-27	-144	-55	39	176	-42	-21	-17	-65	-53	-133
9458	8.60	-0.80	South SW	-6	-1	410	-3	-1	174	-28	-2	-40	40	-13	-46	40	-26	-106	-51	37	131	-42	-19	-13	-62	-50	-99
9788	10.60	-0.80	South SW	-5	1	393	-3	0	166	-29	-3	-28	38	-13	-32	36	-26	-75	-46	36	92	-41	-17	-10	-60	-48	-71
11077	14.60	-0.80	South SW	-1	-5	367	-1	-2	152	-31	-2	-11	35	-10	-11	29	-19	-28	-38	27	35	-41	-12	-5	-56	-36	-29
11119	16.60	-0.80	South SW	0	4	366	-1	1	150	-32	-2	-5	33	-9	-4	26	-18	-11	-34	25	15	-40	-11	-4	-54	-35	-14
15380	18.60	-0.80	South SW	0	3	362	-1	0	147	-33	-3	-1	31	-9	1	22	-17	0	-30	23	1	-40	-9	-3	-53	-32	-4
15389	20.60	-0.80	South SW	1	0	356	0	-1	143	-34	-3	2	30	-8	4	19	-16	7	-26	22	-7	-39	-7	-2	-52	-30	-8
16356	22.60	-0.80	South SW	2	-15	345	0	-5	137	-35	-4	4	28	-9	5	16	-18	10	-22	23	-11	-39	-6	-2	-52	-30	-10
16736	24.60	-0.80	South SW	4	-9	350	1	-3	137	-36	-5	7	27	-8	7	13	-16	15	-19	20	-17	-39	-3	-2	-52	-25	-15
16775	26.60	-0.80	South SW	4	0	356	1	0	137	-37	-5	8	25	-7	7	10	-15	17	-15	18	-20	-39	-2	-2	-53	-23	-17
17063	28.60	-0.80	South SW	4	0	358	2	0	137	-38	-6	8	24	-7	6	7	-15	16	-11	18	-18	-39	-1	-1	-54	-23	-15
17631	30.60	-0.80	South SW	5	-9	354	2	-3	136	-39	-7	7	22	-8	3	4	-17	11	-8	19	-13	-39	-2	-2	-55	-25	-11
17636	32.60	-0.80	South SW	6	-15	351	3	-5	135	-40	-9	5	21	-8	-1	1	-19	3	-4	21	-4	-39	-4	-2	-56	-31	-5
17641	34.60	-0.80	South SW	8	0	365	3	0	138	-41	-10	4	19	-8	-5	-2	-18	-4	-1	20	3	-39	-6	-3	-58	-32	-1
18077	36.60	-0.80	South SW	7	4	374	3	2	140	-42	-11	1	18	-8	-11	-6	-20	-14	3	21	15	-39	-7	-4	-60	-35	-9
18082	38.60	-0.80	South SW	8	5	377	3	2	141	-44	-12	-3	16	-9	-19	-9	-22	-29	7	22	32	-39	-9	-5	-62	-39	-21
18087	40.60	-0.80	South SW	8	-2	377	4	0	140	-45	-14	-9	15	-10	-29	-12	-23	-48	11	24	54	-39	-10	-6	-64	-41	-38
18093	44.60	-0.80	South SW	11	-3	398	4	1	145	-48	-18	-26	12	-12	-57	-19	-30	-104	19	30	117	-39	-15	-10	-70	-53	-84
18098	46.60	-0.80	South SW	11	1	413	4	2	148	-49	-21	-38	10	-13	-77	-23	-32	-142	23	32	160	-39	-17	-13	-72	-58	-116
18103	48.60	-0.80	South SW	12	4	421	4	3	149	-50	-23	-51	8	-14	-98	-26	-35	-185	27	35	209	-39	-20	-16	-75	-63	-152
18108	50.60	-0.80	South SW	13	1	425	5	2	149	-52	-26	-68	7	-15	-124	-30	-38	-235	31	38	267	-39	-22	-20	-78	-68	-195
18113	52.60	-0.80	South SW	15	2	445	5	3	152	-53	-30	-89	5	-17	-160	-34	-45	-305	35	45	347	-39	-25	-25	-81	-78	-254
18118	54.60	-0.80	South SW	16	9	479	6	5	160	-53	-37	-114	4	-22	-206	-36	-58	-393	37	60	446	-39	-28	-33	-82	-94	-326
18173	-3.40	37.00	North SW	18	6	926	10	8	382	-24	-14	-43	0	-22	531	-29	-55	718	47	79	-786	-22	-34	-188	-56	-94	-491
18180	-1.40	37.00	North SW	17	-1	940	10	7	395	-23	-12	-42	0	-20	484	-28	-49	651	46	69	-710	-22	-30	-171	-55	-83	-438

18187	0.60	37.00	North SW	16	-6	953	9	7	407	-22	-10	-40	1	-18	438	-27	-44	586	45	62	-637	-22	-27	-154	-54	-76	-389
18194	2.60	37.00	North SW	15	-9	962	9	6	416	-22	-8	-38	1	-16	395	-25	-38	526	43	54	-569	-21	-24	-139	-52	-68	-343
18201	4.60	37.00	North SW	14	-12	965	8	2	422	-21	-7	-35	2	-14	354	-23	-33	469	40	46	-506	-21	-21	-124	-50	-58	-300
18208	6.60	37.00	North SW	14	-13	970	7	2	428	-20	-6	-31	3	-12	316	-21	-28	417	37	40	-449	-21	-18	-109	-48	-52	-262
18215	8.60	37.00	North SW	12	-10	977	7	3	435	-19	-5	-26	4	-11	280	-19	-26	371	34	37	-397	-20	-17	-96	-45	-48	-228
18222	10.60	37.00	North SW	11	-8	978	6	3	439	-18	-4	-20	5	-10	247	-16	-23	329	31	32	-351	-20	-15	-83	-43	-44	-201
18230	14.60	37.00	North SW	9	-9	978	4	1	442	-16	-3	-6	8	-8	188	-10	-16	258	23	23	-275	-19	-11	-61	-37	-34	-166
18237	16.60	37.00	North SW	8	-9	979	3	1	442	-15	-2	3	9	-7	162	-7	-14	229	20	20	-245	-18	-9	-50	-34	-30	-151
18244	18.60	37.00	North SW	7	-9	977	3	1	442	-14	-2	12	11	-6	138	-4	-13	203	16	17	-220	-18	-7	-40	-31	-27	-139
18251	20.60	37.00	North SW	5	-10	976	2	0	440	-13	-2	23	12	-5	116	-1	-11	182	12	15	-200	-17	-6	-30	-28	-24	-130
18258	22.60	37.00	North SW	4	-11	972	1	0	438	-12	-3	34	13	-5	95	2	-10	165	9	14	-184	-17	-4	-20	-26	-21	-122
18265	24.60	37.00	North SW	3	-11	970	0	0	436	-11	-3	47	15	-5	77	5	-10	151	5	13	-173	-17	-3	-11	-23	-20	-117
18272	26.60	37.00	North SW	1	-11	966	0	0	432	-10	-3	60	16	-5	60	7	-10	140	2	12	-165	-17	-2	-7	-22	-18	-114
18279	28.60	37.00	North SW	0	-11	959	-1	-1	427	-10	-4	75	17	-5	44	10	-10	133	-2	12	-161	-17	-1	-14	-21	-18	-113
18286	30.60	37.00	North SW	-1	-11	954	-2	-1	422	-9	-5	90	19	-5	30	13	-11	129	-5	12	-162	-17	-2	-22	-22	-20	-115
18293	32.60	37.00	North SW	-3	-10	945	-3	0	416	-8	-5	107	20	-5	18	16	-12	127	-8	13	-166	-17	-3	-32	-24	-22	-120
18300	34.60	37.00	North SW	-4	-10	938	-3	0	410	-7	-6	125	21	-6	7	19	-13	129	-11	14	-173	-17	-4	-41	-26	-25	-127
18307	36.60	37.00	North SW	-6	-10	927	-4	0	402	-6	-7	145	23	-7	-3	21	-15	134	-14	15	-184	-17	-6	-51	-29	-29	-140
18314	38.60	37.00	North SW	-7	-9	917	-5	0	394	-5	-9	165	24	-8	-12	24	-18	142	-18	18	-198	-17	-8	-61	-31	-33	-155
18321	40.60	37.00	North SW	-8	-9	905	-6	1	384	-4	-10	187	26	-10	-19	27	-21	153	-21	21	-216	-18	-9	-71	-34	-37	-172
18329	44.60	37.00	North SW	-11	-8	881	-7	1	363	-2	-14	236	29	-14	-29	33	-29	186	-27	29	-263	-19	-13	-91	-39	-49	-213
18336	46.60	37.00	North SW	-12	-9	866	-8	1	350	-2	-16	263	30	-17	-32	35	-33	207	-30	33	-293	-19	-15	-100	-41	-55	-237
18343	48.60	37.00	North SW	-14	-8	844	-9	1	334	-1	-17	292	32	-19	-33	38	-37	232	-32	37	-327	-19	-17	-110	-43	-59	-264
18350	50.60	37.00	North SW	-15	-5	822	-10	3	317	-1	-19	323	33	-22	-32	40	-44	263	-35	43	-367	-20	-19	-121	-45	-67	-296
18357	52.60	37.00	North SW	-16	1	798	-10	5	299	0	-22	356	34	-28	-29	42	-53	298	-36	52	-412	-20	-23	-131	-47	-79	-335
18364	54.60	37.00	North SW	-17	7	767	-11	8	279	0	-25	389	35	-34	-23	42	-62	337	-37	62	-462	-20	-26	-142	-48	-91	-379

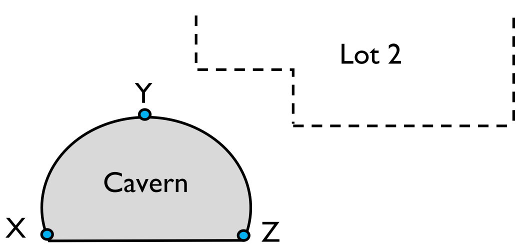
Appendix B

Finite Element Outputs of Cavern Assessment

Analysis Group 1 (1a) - Total Vertical Displacement on Cavern Liner

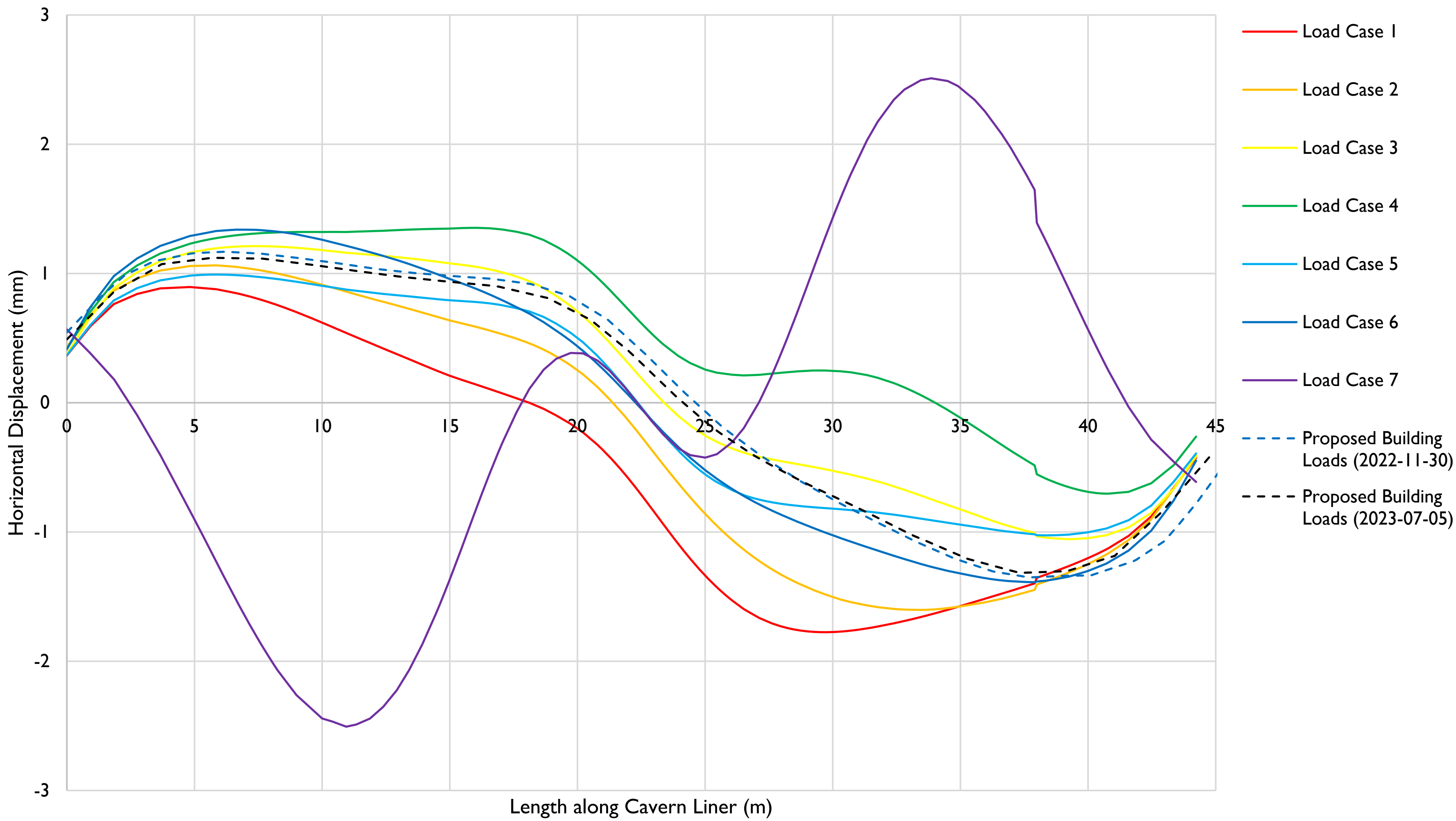


Point X | Point Y | Point Z



by:	DL	*client:*	RCP	EDG consulting engineering | design | geosciences
date:	21/07/2023	*project:*	Albert Street Development	
approved:	DJC	*location:*	Brisbane	
scale:	NTS	*title:*	*Finite Element Outputs*	
		job no:	B01493-1	*figure:* *1a*

Analysis Group 1 (1b) - Total Horizontal Displacement on Cavern Liner



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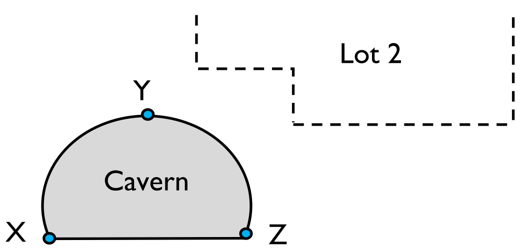

by:	DL	*client:*	RCP
date:	21/07/2023	*project:*	Albert Street Development
approved:	DJC	*location:*	Brisbane
scale:	NTS	*title:*	*Finite Element Outputs*
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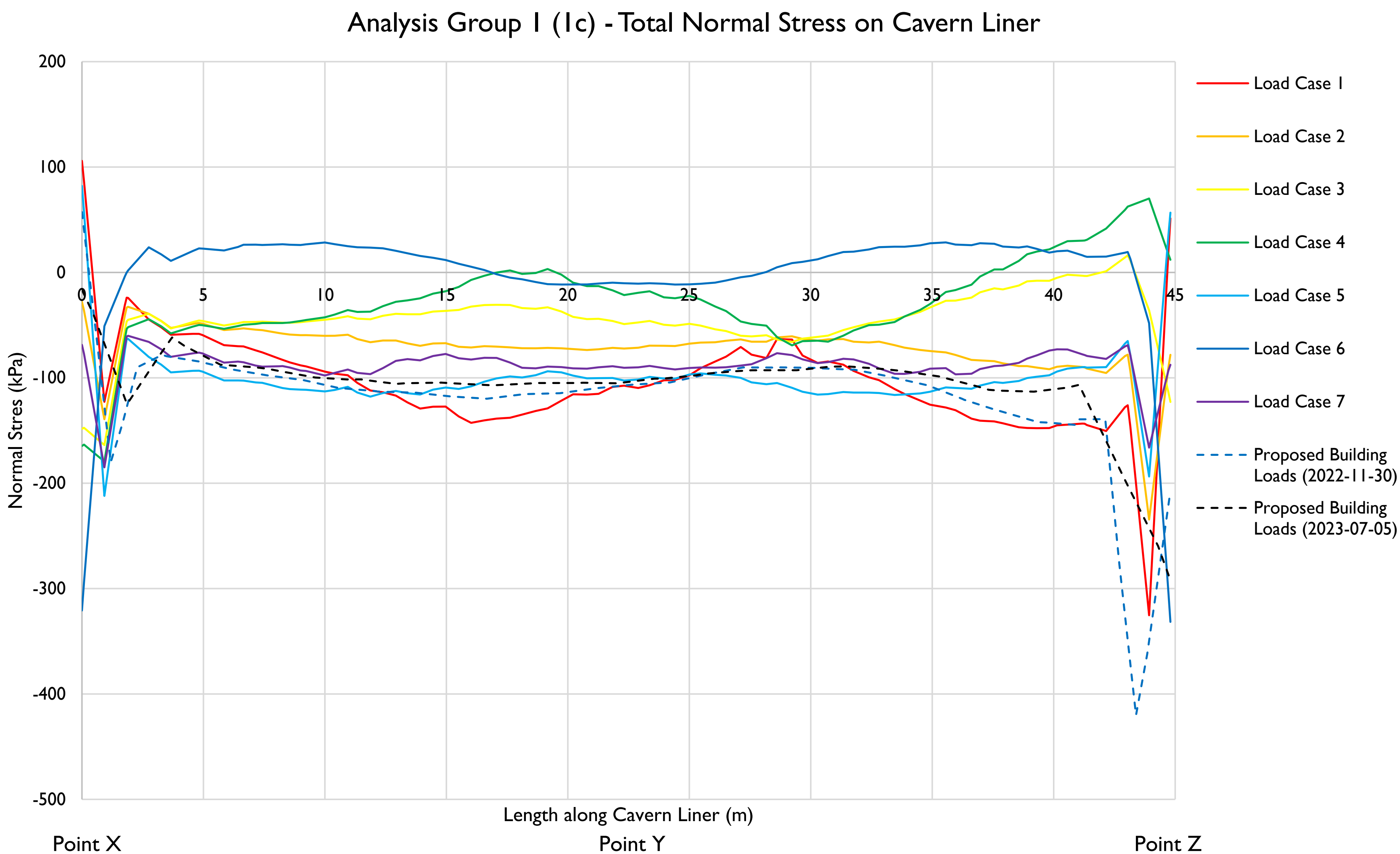
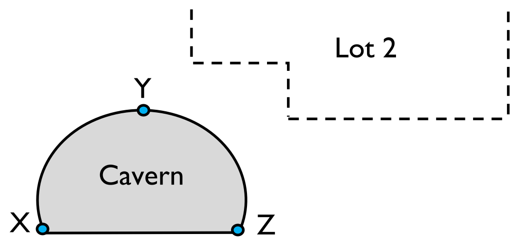
figure: *1b*





by:	DL	*client:*	RCP
date:	21/07/2023	*project:*	Albert Street Development
approved:	DJC	*location:*	Brisbane
scale:	NTS	*title:*	*Finite Element Outputs*
		job no:	B01493-1

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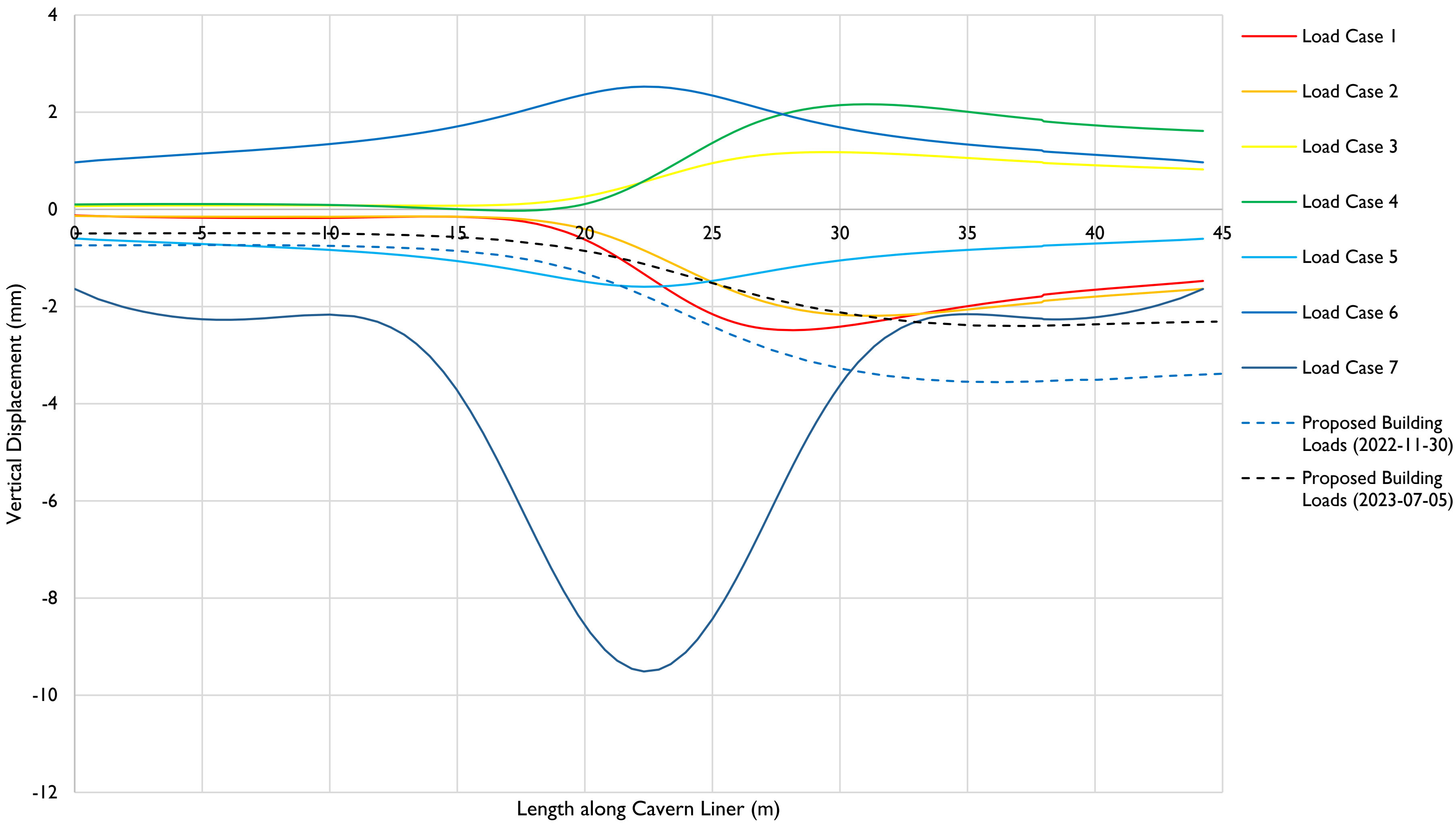
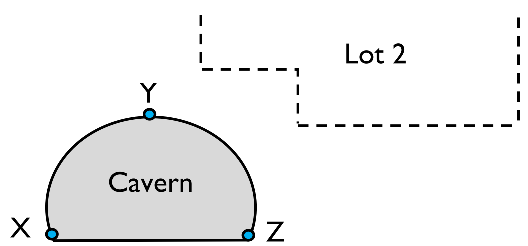
figure: 1c

Analysis Group 1 (1d) - Change in Vertical Displacement on Cavern Liner

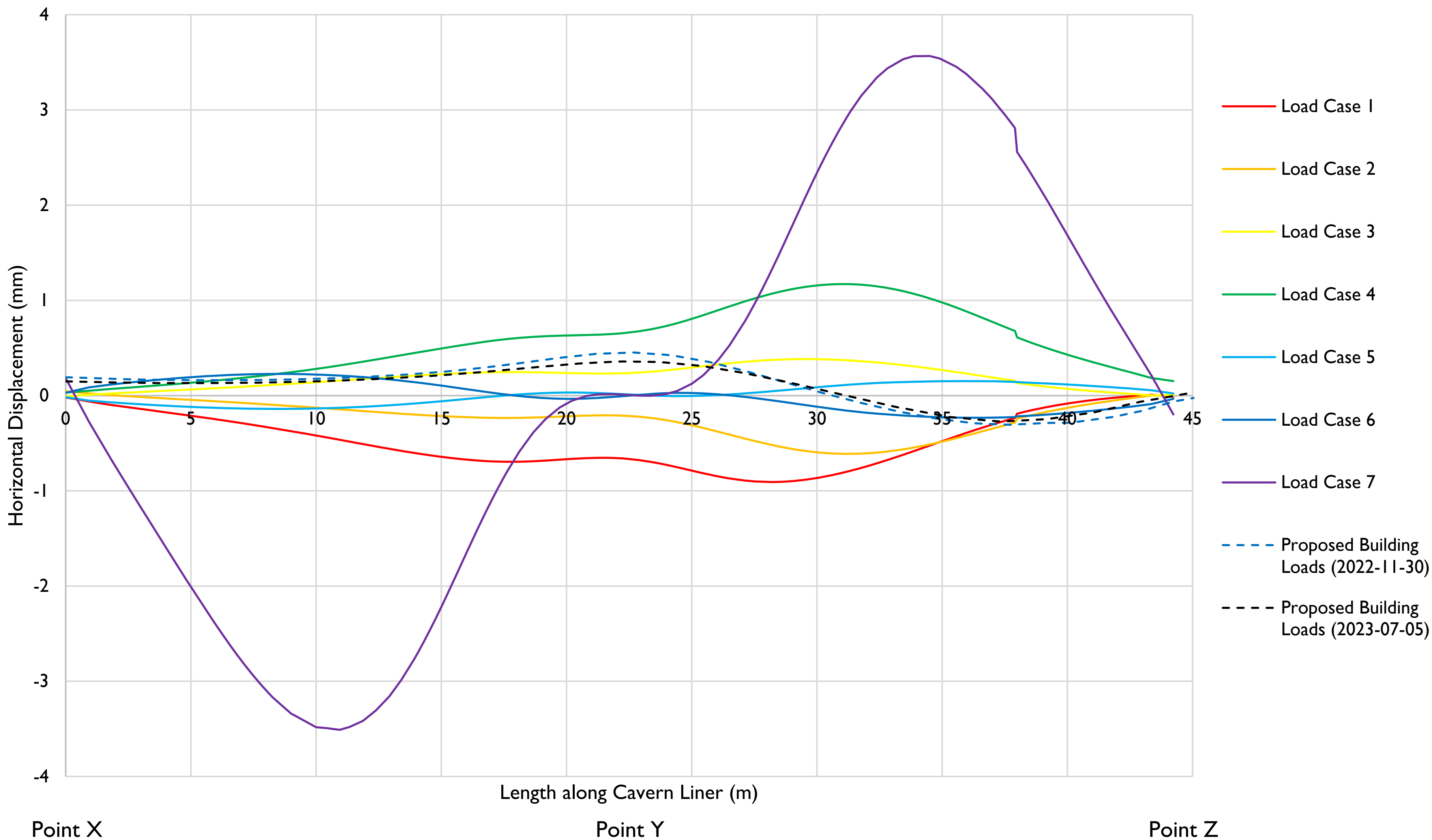


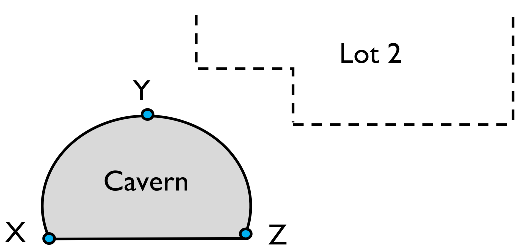
Point X Point Y Point Z



by:	DL	*client:*	RCP	EDG consulting engineering | design | geosciences
date:	25/05/2023	*project:*	Albert Street Development	
approved:	DJC	*location:*	Brisbane	
		title:	*Finite Element Outputs*	
scale:	NTS	*job no:*	B01493-1	*figure:* 1d

Analysis Group 1 (1e) - Change in Horizontal Displacement on Cavern Liner





by:	DL	*client:*	RCP
date:	25/05/2023	*project:*	Albert Street Development
approved:	DJC	*location:*	Brisbane
scale:	NTS	*title:*	*Finite Element Outputs*
		job no:	B01493-1

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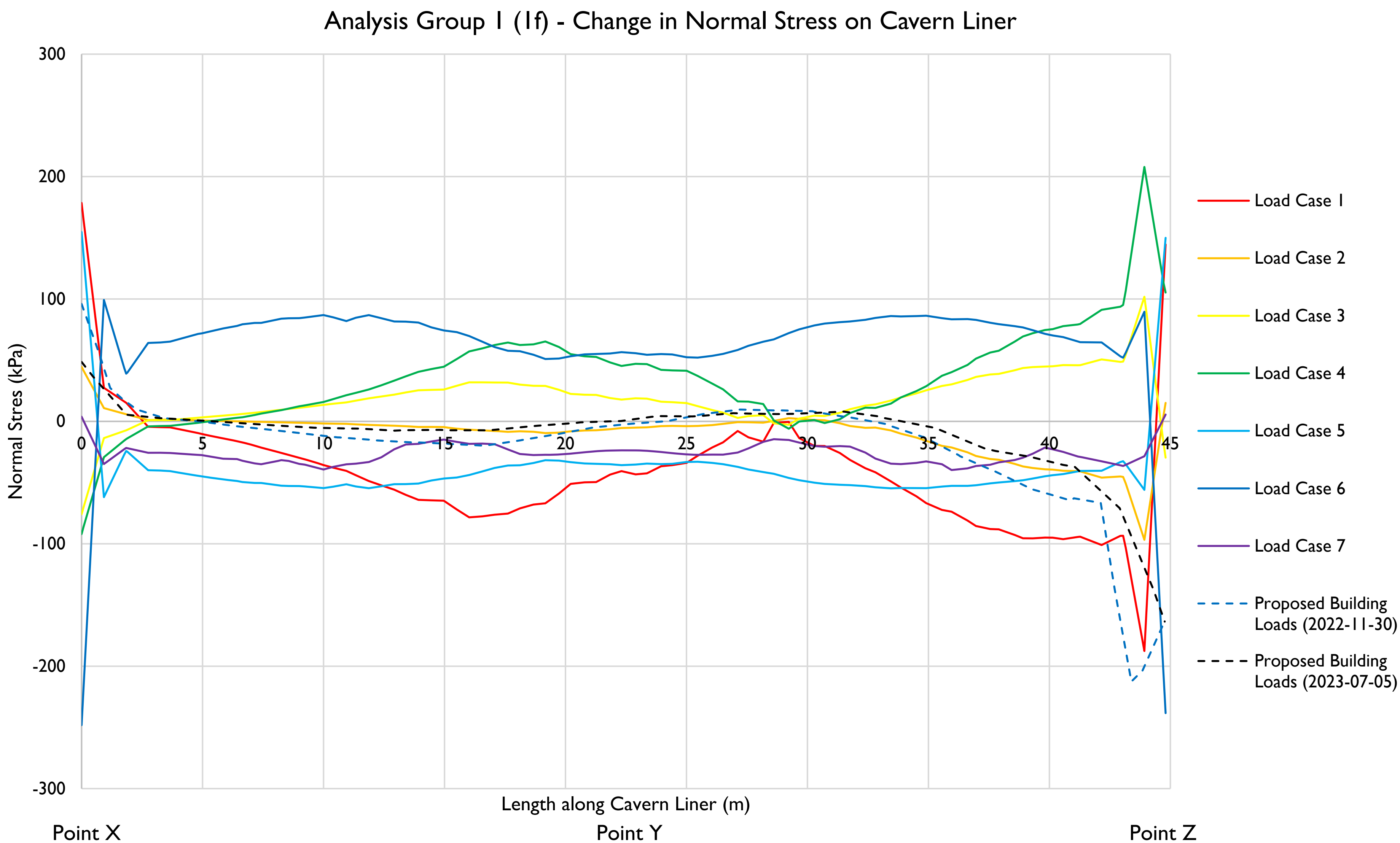
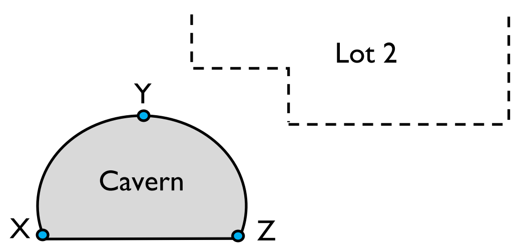
figure: 1e





by:	DL	*client:*	RCP	EDG consulting engineering | design | geosciences
date:	25/05/2023	*project:*	Albert Street Development	
approved:	DJC	*location:*	Brisbane	
		title:	*Finite Element Outputs*	
scale:	NTS	*job no:*	B01493-1	*figure:* *1f*