BASEMENT IMPACT ASSESSMENT

for

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Technical Report Prepared For

Serendale Limited

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1.0 INTRODUCTION

1.1 Background

AWN have been requested by Serendale Limited to carry out a Basement Impact Assessment for a Strategic Housing Development at this site located primarily to the north west corner of Omni Park Shopping Centre, Santry and at Santry Hall Industrial Estate, Swords Road, Dublin 9.

The lands primarily comprise the former Molloy & Sherry Industrial / Warehouse premises and lands generally to the north west corner of the Omni Park Shopping Centre including revisions to part of existing surface carpark to facilitate a new public plaza. The site is c.2.5 ha in size and located primarily to the west of Lidl and to the north and east of the IMC Cinema within the Omni Park Shopping Centre and east of Shanliss Avenue

The development comprises the demolition of the existing industrial / warehouse buildings northwest of Omni Park Shopping Centre, Santry, Dublin 9 and the construction of 457 no. apartments across 4 no. blocks, ranging in height from 4-12 storeys (over basement). The proposal also includes 2 no. retail/café/restaurant units, 1 no. community building, 1 no. childcare facility, 1no. residential amenity space and 5 no. ESB substations. Refer to Figure 1.1 below for location of the subject site.

Figure 1.1 Site Location and Hydrological Environment (source: EPA, 2022)

1.2 Basement Impact Assessment Objectives

A Basement Impact Assessment (BIA) was undertaken for the proposed development at Santry, Dublin 9, following the methodology given in Basement Development Guidance (2019, now withdrawn) and Basement Development Policy documents published by the Dublin City Council.

The Basement Development Policy document explains the historical context which created the need for a new policy to be put in place. It also presents existing Planning and Legislative background relating to the matter and describes the implementation process of this new policy.

The Basement Development Guidance document presents a methodology where the impact of a basement on the surrounding ground and groundwater is assessed on a site specific basis. This policy sets out the requirements to complete this risk-based impact assessment with regard to hydrology, hydrogeology and land stability.

The BIA was undertaken to assess the likely impact on the existing water regime during and post construction of a basement within the proposed development. The objective is to ensure that the basement development:

- Protects and enhances where possible the groundwater quality, quantity and classification;
- Provides evidence that the construction of the basement shall not place groundwater at undue risk;
- Provides evidence that the structural stability of adjoining or neighbouring buildings and land areas are not put at risk;
- Provides a management plan for any demolition works and for the construction of the basement;
- Does not have an adverse effect on existing patterns of surface water drainage;
- Shall not significantly impact on groundwater or surface water flows to the extent that this is likely to increase the risk of flooding;
- Ensures appropriate handling and dealing with waste removal;
- Conserves and where possible enhances the biodiversity value of the site;
- Generally complies with the relevant regulations such as the Basement Development Policy and the Basement Development Guidance.

1.3 General Qualifications and Conditions of Use

The subject report is intended to be an accurate and unbiased account of what the potential impacts of constructing a basement within the proposed residential development. The assessment relies on information regarding construction and design provided by Serendale Ltd., its design team and carried out by AWN as follows:

- Omni SHD EIAR Chapters 6 and 7 (AWN Consulting);
- Pre-Planning Structural Design Report. Omni Plaza, Swords Road, Santry Residential Development. EIRENG (August 2022, included as Appendix A of this report);
- Ground Investigations Ireland (GII). Waste Classification Report. Santry Development (May 2019; included as Appendix 6.2 pf the EIAR).

This report was prepared by Marcelo Allende (BSc, BEng), and Teri Hayes (BSc MSc PGeol EurGeol). Marcelo is a Water Resources Engineer with over 15 years of experience in environmental consultancy and water resources studies. Marcelo is a Senior Environmental Consultant with AWN Consulting, a member of the

International Association of Hydrogeologists (Irish Group) and a member of Engineers Ireland (MIEI). Teri is a hydrogeologist with over 25 years of experience in water resource management and impact assessment. She has a Masters in Hydrogeology and is a former President of the Irish Group of the Association of Hydrogeologists (IAH) and has provided advisory services on water related environmental and planning issues to both public and private sector bodies. She is qualified as a competent person as recognised by the EPA in relation to contaminated land assessment (IGI Register of competent persons www.igi.ie). Her specialist area of expertise is water resource management eco-hydrogeology, hydrological assessment and environmental impact assessment.

2.0 ASSESSMENT OF HYDROLOGICAL AND HYDROGEOLOGICAL BASELINE AND GROUNDWATER BODY STATUS

2.1 Existing Ground Conditions

The site is located to the north west corner of the Omni Park Shopping Centre, Santry and at Santry Hall Industrial Estate, Swords Road, Dublin 9 D09FX31 and D09HC84. The site is bounded on the north by an existing industrial estate, on the west by residential houses, and on the south and east by the Omni Park Shopping Centre development. The site falls from the east (c. 59.5m AOD) to west (c. 56.6m AOD).

Site investigations were carried out by GII during April 2019. These investigations included the following:

- Excavation of fourteen (14 No.) Window sample boreholes to a maximum depth of 2.9 mbgl (metres below ground level);
- Collection of subsoil samples for chemical analysis;
- Environmental laboratory testing

Appendix 6.2 of the EIAR presents the GII report The locations of window sample boreholes are presented in Figure 2.1 below.

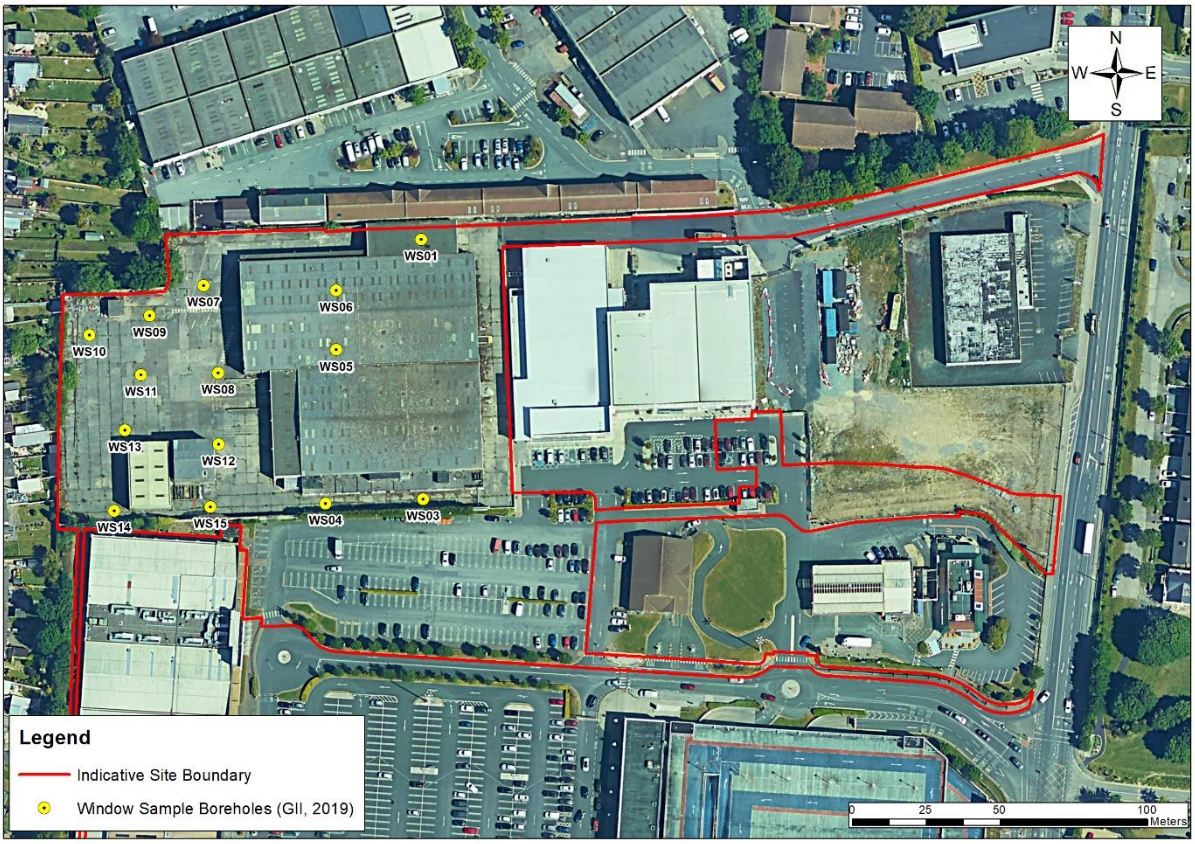

Figure 2.1 Site Investigation Points (GII, 2022)

The soil profile encountered can be summarised as follows:

- Top soil: Reinforce concrete up to 0.3 mbgl;
- Made Ground: Made ground deposits (described as sandy gravelly Clay with fragments of plastic redbrick, glass, ceramics, mortar and charcoal fragments) were encountered to a variable depths between 0.5-2.5 mbgl;
- Cohesive Deposits: Deposits described as low permeability stiff sandy gravelly Clay were encountered beneath the Made Ground up to the maximum explored depth (2.9 mbgl). According to information from the GSI, the cohesive deposit layer is believed to be up to about 20 m deep.
- The depth of bedrock head was not proven during the site investigation. According to the GSI geotechnical information, bedrock would be located at depths even deeper than 20 mbgl in the vicinity of the subject site.

During the GII 2019 site investigation no groundwater was encountered during the excavation of the window sample boreholes.

Review of the hydrogeology and geology in the surrounding region indicates that there are no sensitive receptors such as groundwater-fed wetlands, Council Water Supplies/ Group Water Schemes or geological heritage sites which could be impacted by this development. No evidence of disposal of waste material was identified in the subject area. Collection and analysis of representative soil samples for a wide range of parameters shows no evidence of contamination.

2.2 Geological and Hydrogeological Setting

Mapping from the Geological Society of Ireland (GSI, 2022 http://www.gsi.ie, accessed on 10-08-2022) indicates the bedrock underlying the site is part of the Lucan Formation (code CDLUCN) and made up of dark limestone and shale (Calp). The lithological description comprises dark-grey to black, fine-grained, occasionally cherty, micritic limestones that weather paler, usually to pale grey. There are rare dark coarser grained calcarenitic limestones, sometimes graded, and interbedded dark-grey calcar. The beds are predominantly fine-grained distal turbidites in the north Dublin Basin. The formation is intermittently exposed on the coast between Rush and Drumanagh Head. The formation ranges from 300m to 800m in thickness.

Bedrock was not encountered in any of the window sample boreholes undertaken by GII in 2019, which had a maximum exploration depth of 2.9 mbgl. The GSI geotechnical map presents a database of geotechnical boreholes across Ireland. In the wider area of the subject site, it shows a number of boreholes that have not encountered bedrock to depths much deeper than the GII window sample boreholes:

- Borehole located at N1 (c. 350 m to the east of the subject site): 28 mbgl;
- Borehole next to R104 (c.470 m to the northeast): 18 mbgl;
- A group of boreholes along Santry Avenue (c. 900 m to the northwest): up to 6.5 mbgl
- A borehole also located at N1 (c. 730 m to the southwest) did encounter bedrock at a depth of 29 mbgl.

The GSI also classifies the principal aquifer types in Ireland as:

- Lk - Locally Important Aquifer - Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- Rkd - Regionally Important Aquifer (karstified diffuse)

Presently, from the GSI (2022) National Bedrock Aquifer Map, the GSI classifies the bedrock aquifer beneath the subject site as a '*Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones*'. The proposed development is within the '*Dublin*' groundwater body (Ground Waterbody Code: IE_EA_G_008) and is classified under the WFD Status 2013-2018 (EPA, 2022) as having '*Good status'*. The WFD Risk Score system for this GWB is under review.

Aquifer vulnerability is a term used to represent the intrinsic geological and hydrological characteristics that determine the ease with which groundwater may be contaminated generally by human activities. The GSI (2022) guidance presently classifies the bedrock aquifer in the region of the subject site as having mainly '*Low*' vulnerability which indicates a general overburden depth potential greater than 10m, indicating that the aquifer is naturally well protected by low permeability tills. The GSI aquifer vulnerability class in the region of the site is presented as Figure 2.2 below.

Figure 2.2 Aquifer Vulnerability (source: GSI, 2022)

The GSI/ Teagasc (2022) mapping database of the quaternary sediments in the area of the subject site indicates the principal subsoil type in the residential area comprises Limestone till Carboniferous (TLs, i.e. Till derived from limestones).

2.3 Hydrological Setting

The subject site is located within the former ERBD (now the Irish River Basin District), as defined under the European Communities Directive 2000/60/EC, establishing a framework for community action in the field of water policy – this is commonly known as the Water Framework Directive (WFD The subject site is located in the Eastern River Basin District (ERBD) and the River Tolka WMU (Water Management Unit).

According to the EPA maps (EPA maps, https://gis.epa.ie/EPAMaps/ accessed on 10-08-2022), the proposed development site mainly lies within the Liffey and Dublin Bay Catchment (Hydrometric Area 09) and the Tolka River sub-catchment, although a minor part belongs to the Mayne River sub-catchment (refer to Figure 2.1 below). There are no open watercourses at the site or in the immediate vicinity of the site. The nearest watercourse to the site is the Santry River which resides c. 1 Km to the north of the site (refer to Figure 2.1 below) although the site lies within the Tolka River sub-catchment; the Tolka River is located c.2.5 Km to the south. The Dublin Bay coastal waterbody is the nearest water receptor and is located c. 9 Km southeast of the proposed development.

A review of the historical mapping records provided within the GeoHive website and bibliography consulted indicates that historical watercourses used to flow in the vicinity of the site (Naniken and Wad rivers; refer to Figure 2.2 below); however, these streams are currently culverted and therefore the subject site has no hydrological connection to them.

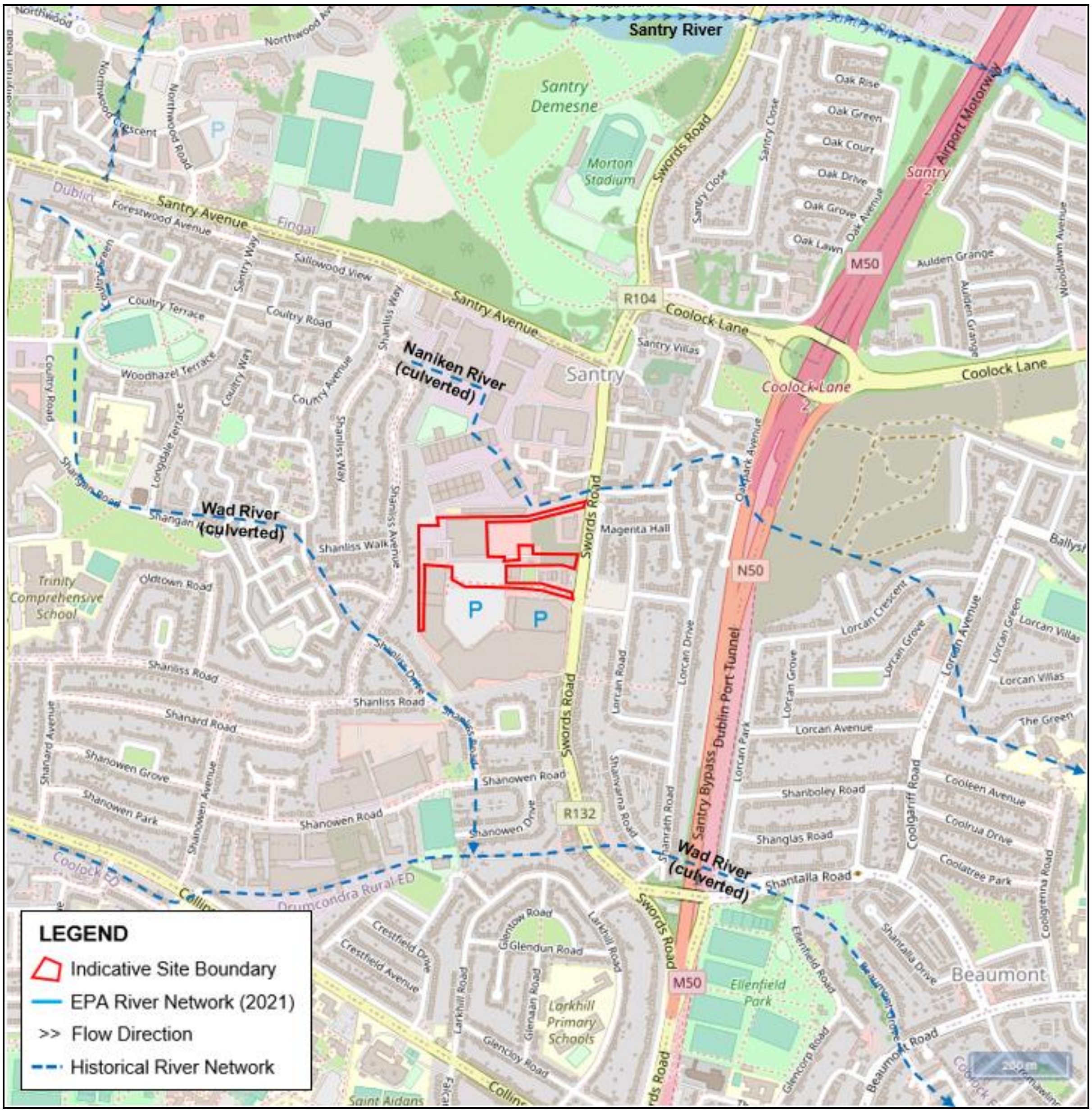

Figure 2.3 Site Location and Historical Rivers (The Rivers of Dublin, Sweeney, 2017)

The existing commercial units are currently drained via gravity into 2 no. private surface water drainage networks which connect into other private surface water networks within the site. The private sewer network flows east where it connects into a public surface water sewer located within Swords Road which ultimately drains to the Irish Sea via the Santry River.

A review of the NPWS (2022) on-line database indicates there are no NPWS protected areas in the immediate vicinity of the Proposed Development site. The closest European listed sites are as follows;

- Santry Demesne (site code 00178) pNHA – circa 350 m to the north of the subject site;
- The Royal Canal (site code 002103) pNHA – circa 3.6 km to the south of the site;
- South Dublin Bay and River Tolka Estuary SPA (site code 004024) and North Dublin Bay pNHA (site code 000206) – circa 3.8 km to the southeast of the site.

The site would have an indirect hydrological connection with the North Dublin Bay SAC/pNHA and North Bull Island SPA through the local drainage network (refer to EIAR Chapter 7).

The Environmental Protection Agency (EPA, 2022) on-line mapping presents the available water quality status information for water bodies in Ireland. The Tolka River belongs to the Tolka_060 WFD surface water body in its section closest to the development site. The EPA currently classifies this water body with '*Moderate*' status and is '*At risk of not achieving good status*'. According to EPA records, this water body has good acidification and nutrient conditions; however, it has performed poorly in terms of saturated dissolved oxygen.

The Santry River belongs to the Santry_010 WFD surface water body in its section closest to the development site. The EPA currently classifies this water body as having '*Poor*' status and is also '*At risk of not achieving good status*'. This '*Poor*' status is related to its biological and invertebrate status or potential; all the remaining conditions (oxygenation, acidification and nutrients) have a current 'Moderate' or 'High' status. (refer to www.catchments.ie).

According to a Flood Risk Assessment carried out by EirEng (2022) (refer to EIAR, Chapter 7), there is no risk of flooding affecting the site from fluvial or coastal sources, since the site lies within Flood Zone C (i.e., where the probability of flooding from rivers is less than 0.1% or 1 in 1000).

3.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

The development proposed for the site is a residential development comprising of 4 apartment blocks varying in height from 12 to 4 stories over basement. Figure 3.1 below presents the proposed ground floor plan whilst Figure 3.2 shows the basement plan.

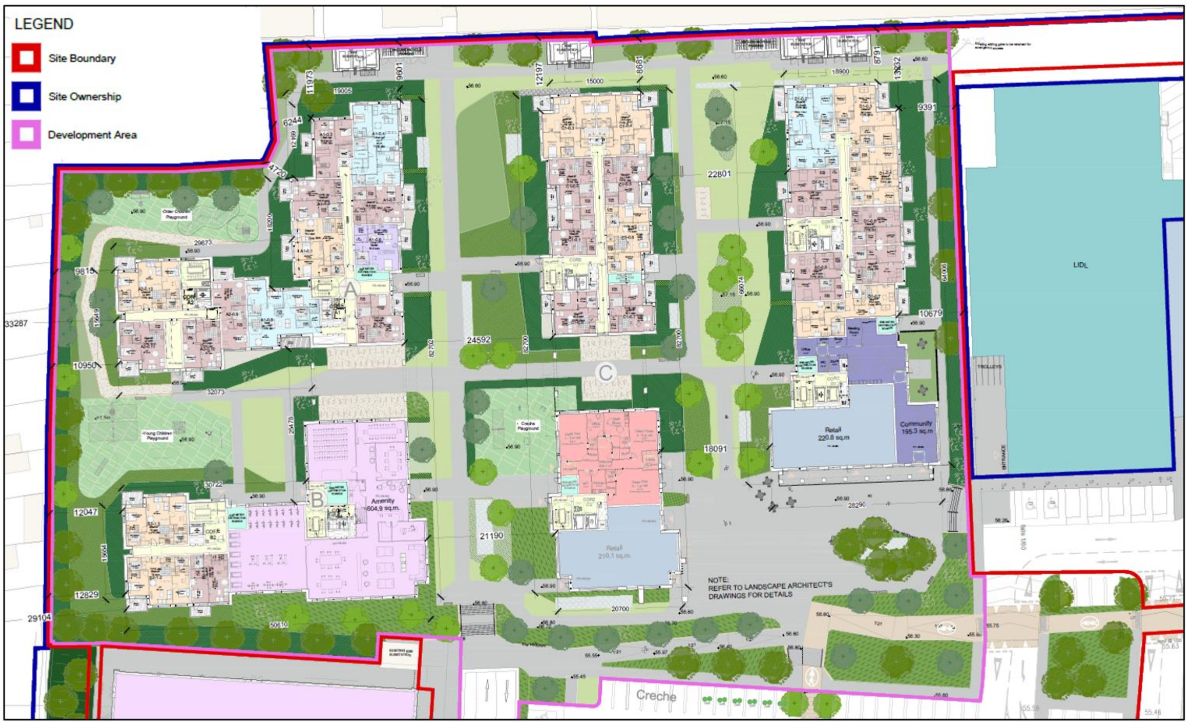

Figure 3.1 Proposed Ground Floor Plan (Source: OMN-JFA-ZZ-00-DR-A-P2000)

Figure 3.2 Proposed Basement Plan (Source: OMN-JFA-ZZ-00-DR-A-P2000)

The basement is a single-story basement with carparking and plant. The superstructure is assumed to be precast concrete twin wall construction and hollow core precast concrete floor slabs. The ground to first floor walls will act as deep beams supported by columns in the basement where possible. When this is not possible a transfer slab is installed. The depth of the transfer slab depends on the number of floors being supported and varies from 500 to 1200mm thickness.

The slab will also be stepped to accommodate the difference in build-up between the internal and external finishes. The podium deck/ground floor will be designed to support fire tender access and the external finishes.

Vents are to be provided in the podium slab to allow natural ventilation of the carpark.

3.1 Structural Design of the Proposed Development

The super structure above ground floor has been assumed to be precast concrete. Generally, within the apartment blocks the party walls, external walls and internal corridor walls will be load bearing structural walls. The cores will be precast concrete walls stitched together to provide stability to the buildings.

The floor above ground floor level will be hollow core slabs with increased cover to accommodate the fire protection requirements and a 75mm bonded concrete screed applied to the top of the units. The floor to floor height is 3m.

The external envelope has full height windows to the living rooms and balcony doors, the solid sections of the elevations will be structural and have a minimum thickness of 250mm and at least 800mm long.

There will be a perimeter edge beam over the openings which will support the cladding, the hollow core slabs, balconies and accommodate perforations for ventilation and kitchen exhaust.

The ground floor will be a transfer structure where the columns in the basement do not align with the load bearing walls above. The structural thickness of the transfer structure is dependent on the height of the supported building over.

The basement columns vary in size from 450 x 1100 with column heads below buildings to 450x450 below podium slab

The roofs of the blocks will be green roofs with solar panels (no amenity at roof level).

The ground floor will be perforated with vents to achieve the free area required for natural ventilation.

The finished floor level of the ground floor will be to nominal falls to prevent pluvial flooding. The structural slab depth will vary to suit the required thickness for the structural design and the internal and external finish build-up.

3.2 Basement Construction

The basement will be primarily used for car parking and plant. Based on the restricted nature of the site and the proximity of the basement to the boundary, the Structural Design Report (EirEng, 2022; included as Appendix A) suggests that the retaining wall to the basement be an embedded cantilevered piled wall which would allow the site to be excavated without internal props.

The embedded piled wall will be designed by the piling contractor based on the information provided in the soils report and the performance specification provided by the Structural/Civil Engineer. The pile diameter has been estimated in the sketches below in Figure 3.3 and when designed by the piling contractor a greater diameter may prove to be more economical and it is therefore recommended an allowance for an additional 150mm on the calculated build-up required for the basement retaining wall.

The basement slab level is proposed to be 52.0m AOD, ground floor level is c. 56.4m AOD (i.e., 4.4 m deep). No groundwater is expected to ingress to the excavation area. However, given the characteristics of the subsoil it is expected during the excavation works that localised dewatering of the subsoils will be required to address perched groundwater even though the site investigations at the site did not encounter any groundwater.

Ground water levels from soils investigation reports received for adjacent sites indicate the expected ground water level is between 54.0 and 55.0m AOD. The loads from the structure over will resist any uplift due to buoyancy however uplift due to buoyancy acting on the basement slab will need to be considered in the temporary condition during construction.

Typical Sections at Perimeter of basement and step in ground floor slab between internal and external spaces are presented in Figure 3.2 and 3.3 below.

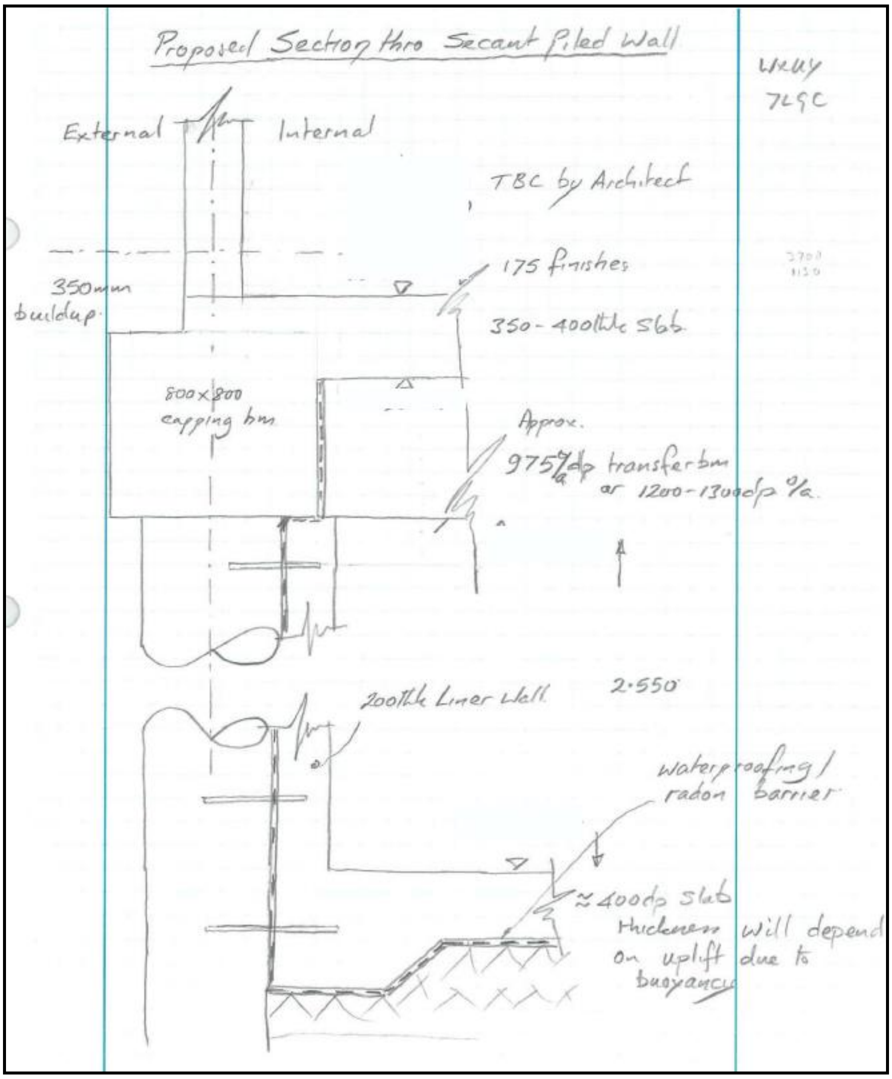

Figure 3.3 Proposed Section through Secant Pile Wall (Source: EirENG, 2022)

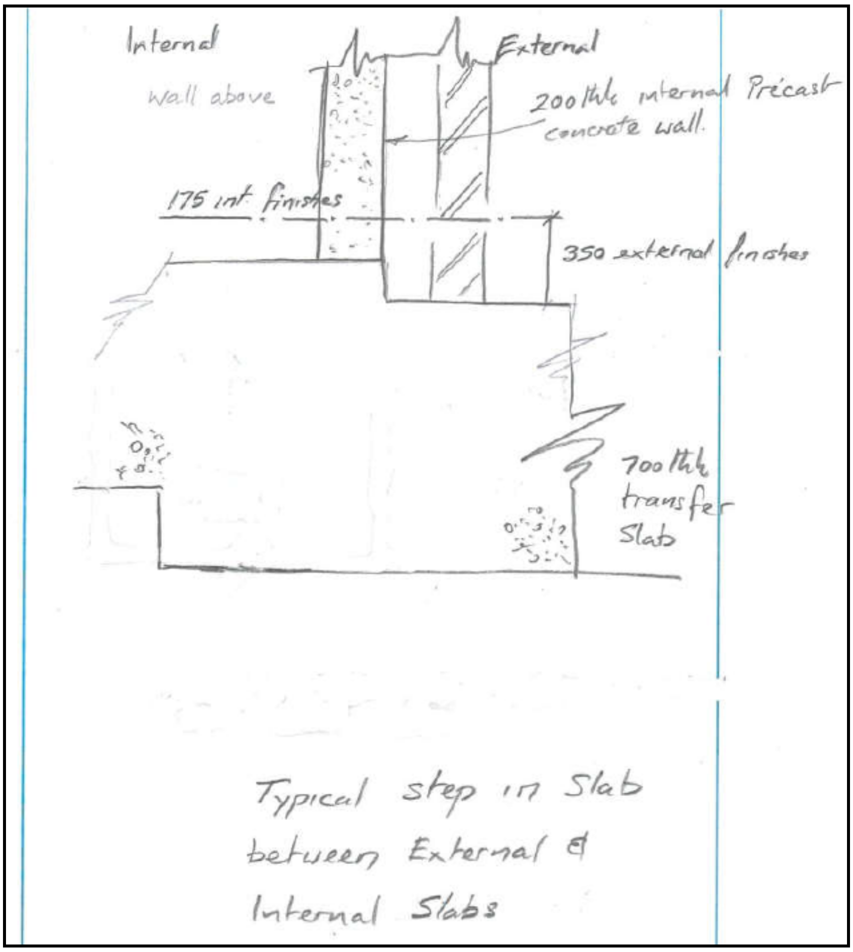

Figure 3.4 Typical Step between External and Internal Slabs (Source: EirENG, 2022)

3.3 Construction Work Programme

The approximate basement Construction Sequence is outlined below:

i. Demolition Works

The existing buildings on the site are proposed to be demolished as part of the planning application. Demolition will be completed by the appointed contractor in accordance with the relevant standards and guidelines. Contaminated materials used in the existing buildings will be identified and disposed of by a specialised contractor. Demolition will be carried out as described below to permit basement construction without undermining or causing loss of support to adjacent structures.

ii. Basement Construction

A full site investigation will be carried out prior to construction commencing. A specialist ground works contractor will be appointed to carry out the excavation and any rock breaking works that may be required. The appointed specialist contractor will carry out a full risk assessment prior to the commencement of work.

A ground works operation will be carried out in order to ensure that material removed from the ground is taken away at regular intervals in order to reduce the amount of material that will be stored on site. Excavated material will be reused on site where possible subject to the WAC analysis.

Localised sump pumps will be installed to remove the water through settlement tanks and after appropriate treatment into the local drainage network infrastructure for discharge. On completion of the excavation works to the formation level of the basement slab, this will be blinded to the final design levels. Any below ground services will be installed and tested below the basement slab. Prior to construction of the foundations and suspended slab at the lower basement level, a proprietary basement tanking system and water bar will be installed at all construction joints. A typical basement slab construction is as follows:

- Trim & grade to slab formation with suitable well compacted capping material.
- Cast mass concrete blinding to form a surface for applying waterproof membrane and tanking.
- Apply continuous waterproof tanking material and seal all laps (and along perimeter of secant/embedded wall/slab junction).
- Install slab reinforcement to slab area (including any columns and wall starters) Formwork to perimeter and any box-outs necessary (around raking props).
- Clean & inspect slab pour prior to concrete operations.
- Note: The placement of large volumes of concrete such as the deep foundations will be carried out by a mobile or static concrete pump. The above process will repeat until the foundation raft is constructed.

When a sufficient area of basement slab is constructed the vertical elements will be constructed to allow the upper level; basement slabs to be constructed.

4.0 CONCEPTUAL SITE MODEL

Based on the existing site conditions and the description of the proposed development, conceptual cross sections for the current situation, the construction phase and operation phase are shown in Figures 4.1 to 4.3 below.

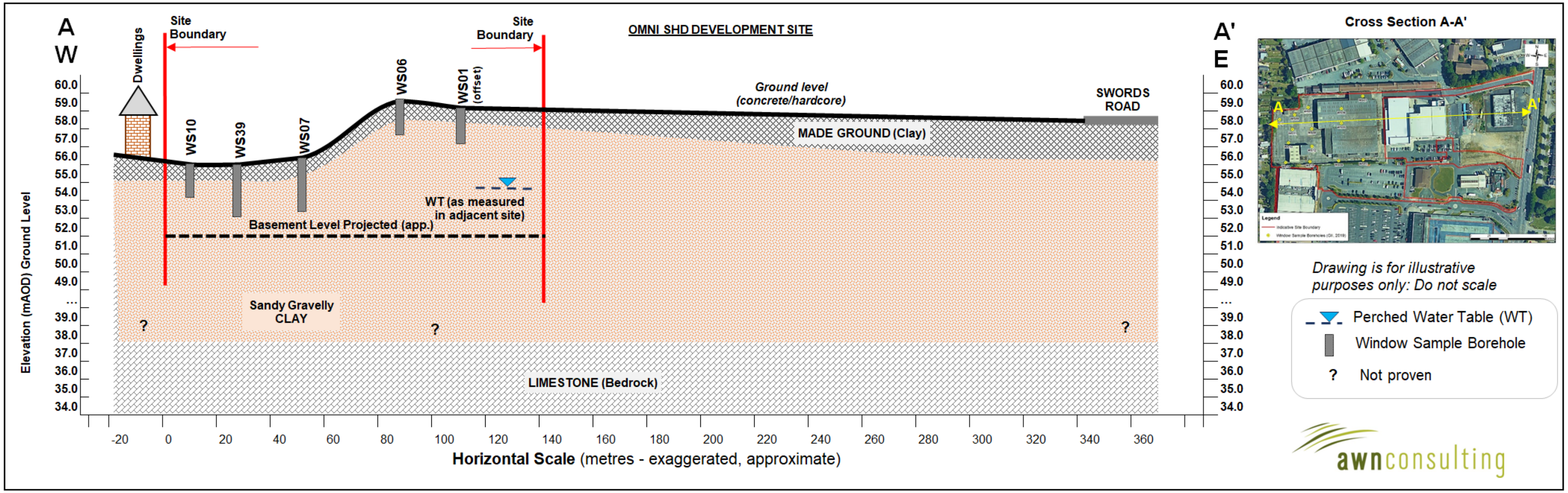

Figure 4.1 Conceptual Cross Section A-A' for current situation

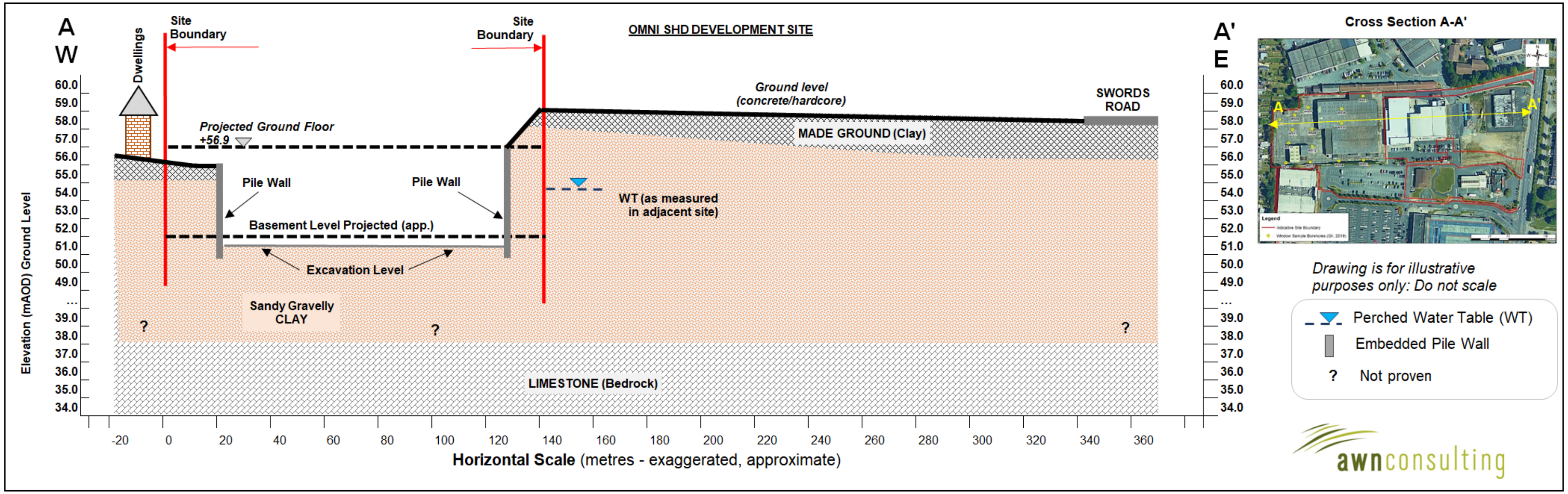

Figure 4.2 Conceptual Cross Section A-A' during Construction Phase

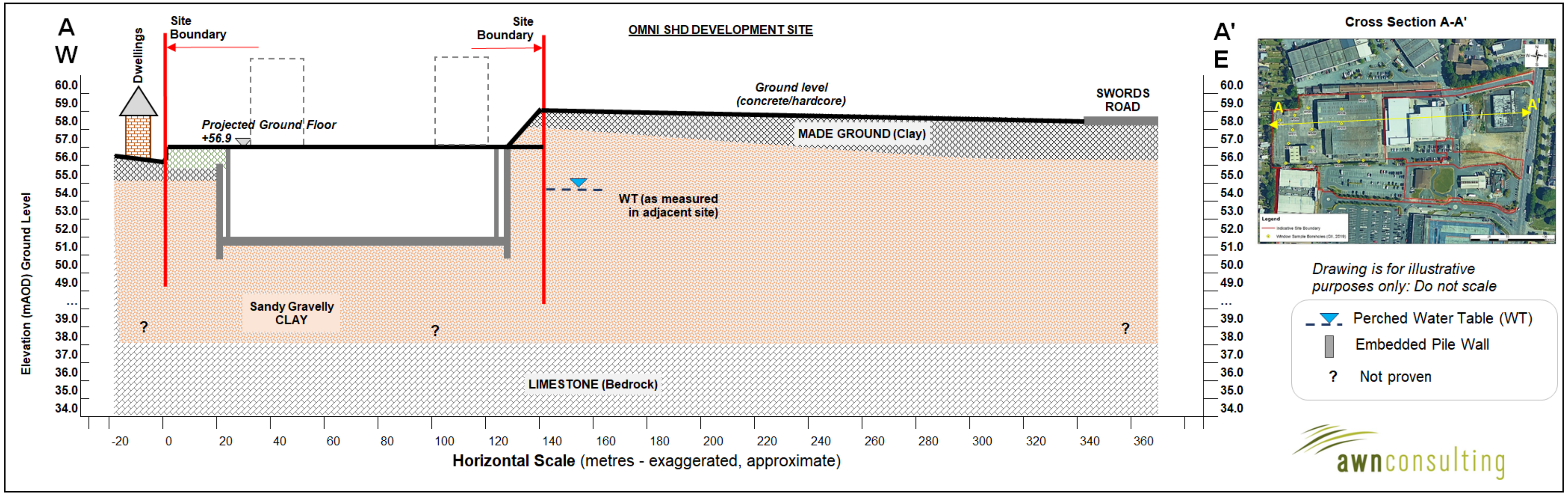

Figure 4.3 Conceptual Cross Section A-A' during Operational Phase

5.0 POTENTIAL IMPACTS

There is no expected long term impact on groundwater levels around the proposed site development as a result of the installation of a retaining wall. Local shallow groundwater within overburden (Made ground and cohesive deposits – low permeability sandy gravelly Clay) will be intercepted (refer to Conceptual Ground Model above) by the basement retaining wall but following basement construction groundwater will migrate around the structure with no overall change in the groundwater and surface water regime.

The basement does not intersect bedrock. No continuous perched water table was encountered during site investigation. Water levels in adjacent site investigation boreholes are indicative of porewater or possibly discontinuous lenses within the glacial clay. The excavation will likely require collection of minor groundwater inflows and any collected rainwater.

As stated above, the proposed development will not result in any changes in the local groundwater and surface water regime.

During construction, a very localised impact may occur during early stages of excavation and piling works until the embedded piles are in place. Once these are installed into the low permeability clay (made ground and cohesive deposits), there would be no inflows in the excavation area (with the exception of any collected rainwater).

The regional water table within bedrock will not be affected by the planned basement construction. The effect on the shallow water table will at most be temporary. The basement is estimated to be completed within approximately 20 weeks.

Since the site is currently hardstanding, the proposed development will not result in the increase in hardstanding area. Therefore, groundwater recharge and groundwater regime will not be affected. Based on the construction design and average hydraulic conductivity for this type of overburden, the zone of influence would be within or close to the embedded pile walls i.e. immediate to the basement boundary during construction with full recovery post construction.

The proposed basement construction, which would involve c. 5.0 m deep excavations has the potential to cause minor ground movements inside and outside the excavated area as a result of changes in vertical load on the ground. The construction sequence outlined in Section 3.1 of this report was developed to control any potential movement to within acceptable limits.

There is no source-pathway-receptor hydrogeological connection between the subject site and Dublin Bay through the Dublin aquifer as vertical migration to the underlying limestone bedrock is minimised due to the thickness of overburden (‘Low’ vulnerability) present at the site providing a high level of aquifer protection from any potential source. Therefore, no likely impact on the status of the aquifer is expected due to natural attenuation within overburden and reducing potential for off-site migration.

Excavation of the basement will cause elastic heave in response to the vertical stress reduction, followed by long term plastic swelling as the underlying soils and the presents of groundwater. No calculation of the vertical movement has taken place at this stage and this is normally carried out using proprietary software (Oasys PDISP™) or similar. The analysis is based on Boussinesq’s theory of analysis for calculating stresses and strains in soils due to vertically applied loads. Analysis of similar size and depth basements, in similar soil conditions, one would expect short term heave to in the region of 1-5mm and, long term heave of 5-10mm.

6.0 POTENTIAL CONTROL MEASURES

The following standard construction measures will be included in the design to protect water quality:

There may be localised pumping of surface run-off from the excavations during and after heavy rainfall events to ensure that the trenches are kept relatively dry. Any minor ingress of groundwater and collected rainfall in the excavation will be pumped out during construction. It is estimated that the inflow rate of groundwater will be low and limited to localised perched water. Due to the very low permeability of the Dublin Boulder Clay and the relative shallow nature for excavations, infiltration to the underlying aquifer is not anticipated.

Pre-treatment and silt reduction measures on site will include a combination of silt fencing, settlement measures (silt traps, 20 m buffer zone between machinery and watercourses, refuelling of machinery off site) and hydrocarbon interceptors. The use of silt traps and an oil interceptor (if required) will be adopted if the monitoring indicates the requirements for the same with no silt or contaminated water permitted to discharge to water. Extensive monitoring will be adopted to ensure that the water is of sufficient quality to discharge to water or sewer.

Site investigation has not identified any significant water bearing gravels within the basement footprint. However, if water bearing gravels encountered then the design should facilitate discharge around the basement structure.

To minimise any impact on the underlying subsurface strata from material spillages, all oils, solvents and paints used during construction will be stored within temporary bunded areas; these areas shall be bunded to a volume of 110% of the capacity of the largest tank/container.

Where feasible all ready-mixed concrete will be brought to site by truck. A suitable risk assessment for wet concrete will be completed prior to works being carried out which will include measures to prevent discharge of alkaline wastewaters or contaminated storm water to the underlying subsoil. Wash down and washout of concrete transporting vehicles will take place at an appropriate facility offsite.

In addition, monitoring of groundwater levels pre, during and post construction of basement works and monitoring of vibration and noise during the excavation and construction of the embedded pile walls will complement the measures described above.

Based on the site conditions, groundwater monitoring is not considered necessary. However, if required by the planning authority, monitoring of groundwater levels pre, during and post construction of basement works can be undertaken. As such, it is advisable to install a minimum of 3 no. boreholes with standpipes in order to measure these levels and their seasonal fluctuation.

A Construction and Environmental Management Plan (CEMP) undertaken by AWN is included as part of the planning application. A more detailed plan will be provided after the contractor is appointed. At that stage the contractors' detailed strategy during construction, including management of any collected water will be provided.

7.0 CONTINUOUS SITE INVESTIGATION

Site investigation comprises several stages. This included the pre-construction phase, during construction and post construction investigation.

7.1 Pre-Construction Stage

A desk study was carried out on the basis of a review of existing data sources such as the Geological Survey Ireland (GSI) and Environmental Protection Agency (EPA) websites. Results of this investigation are provided in the previous Section 2.0.

On the basis of this investigation, an interpretation is provided of the detailed site soil and geology and hydrogeology, of the geotechnical properties of the ground and an engineering and hydrogeological interpretation of the implications of the ground conditions in the previous Section 2.0. This interpretation was based on ground investigations within the site undertaken in 2019.

As such, it is recommended to install at least 3 no. boreholes with standpipes to carry out groundwater monitoring prior to commencing construction works.

7.2 Construction Stage

Due to the potential for minor ground movements during excavation works, at locations where movements are of critical importance, appropriate instrumentation will be installed and the wall and ground movements monitored accordingly. The predictions of ground movement based on the ground movement analysis should be checked by monitoring the basement wall. The monitoring will include the installation of inclinometers and/or tiltmeters in the basement retaining wall elements so the pattern of wall behaviour can be reviewed with predicted values. From this understanding, the designer will carry out back analysis of the observed (monitored) wall behaviour and recalibrate the analytical model in terms of the excavation geometry and the behaviour of the ground and the structural elements with appropriate modifications or contingencies applied as required. Conventional surveying techniques can also be used to monitor settlements and lateral movements of retaining walls and retained structures. The accuracy rates of ± 1-2mm is normally achievable.

It is recommended that movement monitoring should be undertaken with surveying points set up prior to commencement of the works and readings be undertaken at weekly intervals. It is recommended that trigger values for monitoring are based on the predicted ground movements to ensure conservatism and that they are agreed under the Party Wall Act. In cases where vibration from construction methods could potentially damage sensitive neighbouring buildings and structures vibration monitors are to be installed. The precise monitoring strategy will be developed at a later stage and it will be subject to discussions and agreements with the owners of the adjacent properties and structures. Contingency measures will be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.

Based on groundwater monitoring on the adjacent site, it is considered that there is a low risk of inflow during construction works. However, three (3 no.) groundwater monitoring wells are suggested outside of the basement footprint. Water level data collection will be undertaken before during and after construction.

8.0 CONCLUSIONS

The proposed basement will have no long term impact on water levels in the overburden or underlying aquifer and no impact on the current water body status. The bedrock water table will not be affected by the excavation works. Temporary dewatering of the perched water table within the clayey deposits to facilitate excavation works is expected to be minor and it will have a temporary local impact only.

The basement will need to be fully waterproofed to ensure no groundwater enters the finished basement. Site investigation has not identified any significant water bearing gravels within the basement footprint. However, if water bearing gravels encountered then the design should facilitate discharge around the basement structure.

Management of any collected rainwater and any groundwater seepage during basement excavations will be pumped to existing sewers (following appropriate treatment) in agreement with the regulatory authority.

By providing a secant pile wall there are no concerns regarding slope stability and horizontal movement can be easily limited to industry acceptable limits by careful detailed design.

Overall, the impact on the environment as a result of the proposed basement development in the area is predicted to be **long term-imperceptible and neutral**, provided mitigation measures above described are implemented.

APPENDIX A

Pre-Planning Structural Design Report. Omni Plaza, Swords Road, Santry Residential Development. EIRENG (August, 2022)

EIRENG
CONSULTING ENGINEERS

PLANNING STRUCTURAL DESIGN REPORT

OMNI PLAZA SHD

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DOCUMENT CONTROL:

Job title	Omni Plaza			Job No.	201121
Document title	Planning-Structural Report				
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Rev	Date	Status	Prepared by	Checked by	Approved by
PL1	23/08/22	INF	DC	TB	ED
Description		Planning Issue			

CONTENTS:

TABLE OF FIGURES

1.0 INTRODUCTION

This report forms part of a Planning Application for the proposed development at Swords Rd, Dublin 9 and Santry Avenue.

The site as highlighted on the photo below is presently occupied by a disused warehouse and hard standing.

Figure 1 Proposed Site Location

EirEng has been instructed by Serendale Limited to advise on the Structural and Civil engineering design of the proposed development which includes the following

1. Preliminary sizing of the primary structural elements
2. Determining the structural zones to allow the building envelope to be indicated correctly
3. Review structural options
4. Assess the site geotechnical conditions
5. Assess the drainage requirements for the site based on the proposed scheme and initiate discussions with Dublin County Council and Irish Water

2.0 PROPOSED DEVELOPMENT

2.1 The development proposed for the site is a mixed-use development comprising of 4 apartment blocks varying in height from 4 to 12 stories (Excluding the roof) over basement. The ground floor level includes retail/commercial accommodation, a creche and community centre.

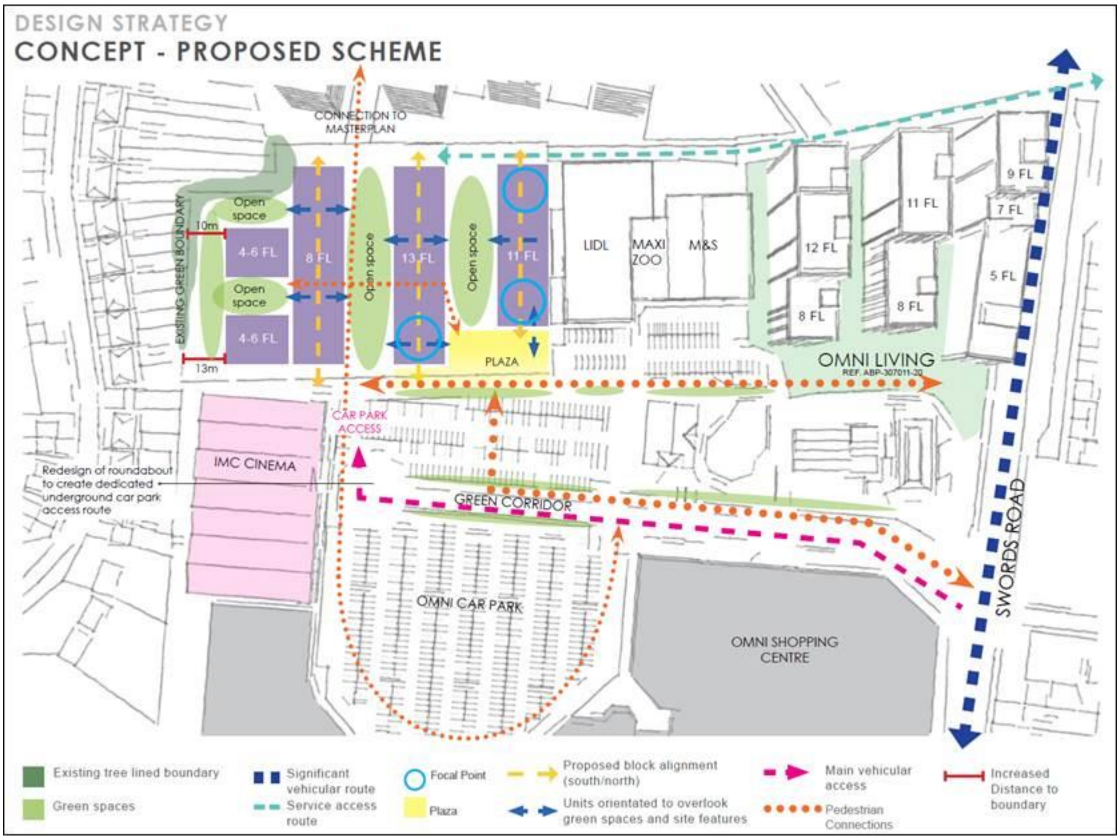


Figure 2 Proposed Development

2.1 The basement is a single-story basement with carparking and plant. The car park is naturally ventilated, and a service zone is allowed for with generally minimum headroom of 2.1m and 2.6m for disabled parking spaces and circulation routes.

2.2 The superstructure is assumed and currently designed to be precast concrete twin wall construction and hollow core precast concrete floor slabs. The ground to first floor walls will act as deep beams supported by columns in the basement where possible. When this is not possible a transfer slab is installed. The depth of the transfer slab depends on the number of floors being supported and varies from 500 to 1200mm thk. The slab will also be stepped to accommodate the difference in build-up between the internal and external finishes.

2.3 The podium deck/ground floor will be designed to support fire tender access and the external finishes.

2.4 Vents are to be provided in the podium slab to allow natural ventilation of the carpark

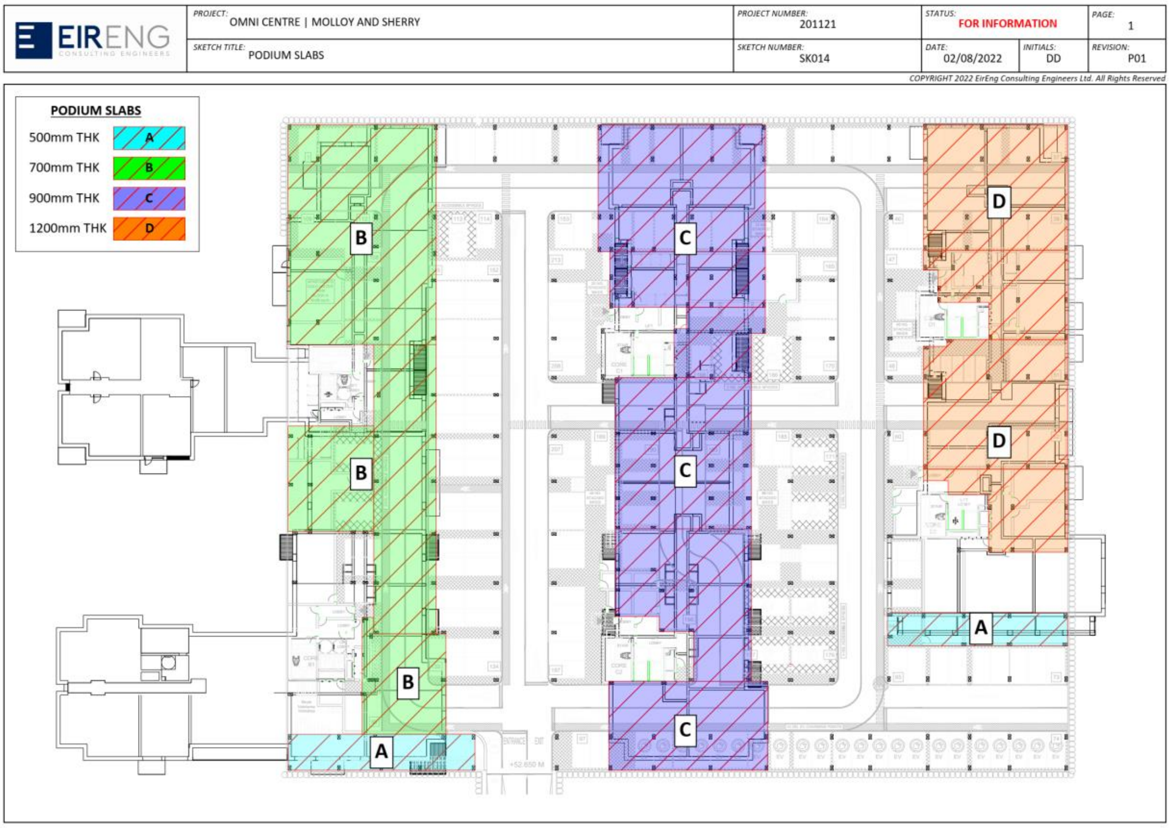


Figure 3 EirEng Podium Slab

3.0 STRUCTURAL DESIGN

3.1 Super Structure

3.1.1 The super structure above ground floor has been assumed to be precast concrete

Figure 4 Typical twin precast concrete wall system and hollowcore slabs

3.1.2 Generally, within the apartment blocks the party walls, external walls and internal corridor walls will be load bearing structural walls. The cores will be precast concrete walls stitched together to provide stability to the buildings.

3.1.3 The floor above ground floor level will be hollow core slabs with increased cover to accommodate the fire protection requirements and a 75mm bonded concrete screed applied to the top of the units. The floor-to-floor height is typically 3m and higher at ground floor for retail and commercial use.

Figure 5 Typical Hollow core slab construction

3.1.4 The external envelope has full height windows to the living rooms and balcony doors, the solid sections of the elevations will be structural and have a minimum thickness of 250mm and at least 800mm long.

3.1.5 There will be a perimeter edge beam over the openings which will support the cladding, the hollow core slabs, balconies and accommodate perforations for ventilation and kitchen exhaust as shown in the section below.

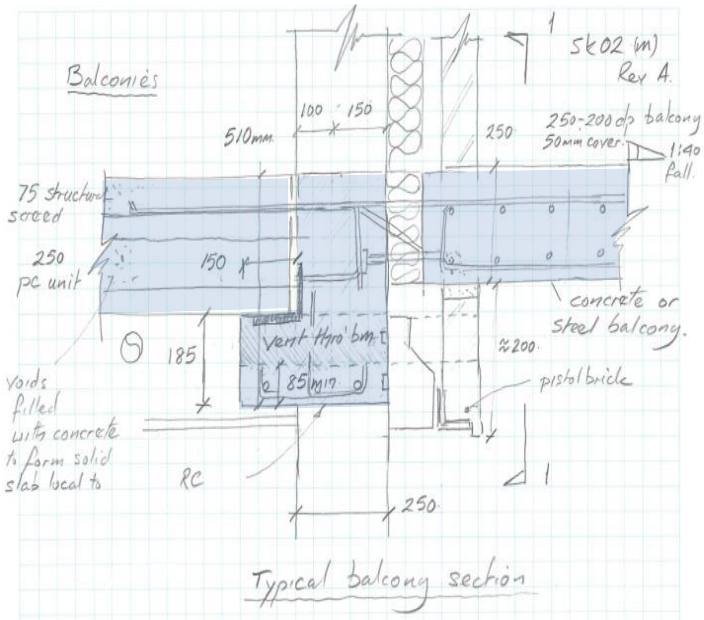


Figure 6 EirEng Typical Balcony Section

3.1.6 The ground floor will be a transfer structure where the columns in the basement do not align with the load bearing walls above. The structural thickness of the transfer structure is dependent on the height of the supported building over.

3.1.7 The basement columns vary in size from 450 x 1100 with column heads below buildings to 450x450 below podium slab

3.1.8 The roofs of the blocks will be a combination of green with solar panels or alternatively outdoor amenity space.

3.1.9 The ground floor will be perforated with vents to achieve the free area required for natural ventilation.

3.1.10 The finished floor level of the ground floor will be to nominal falls to prevent pluvial flooding. The structural slab depth will vary to suit the required thickness for the structural design and the internal and external finish build-up.

3.1.11 Basement construction, see 3.4

3.2 Balconies

Typical balconies are on the south east and west elevations of each block and the base supported. It is assumed the balconies will be either galvanised steelwork (powder coated if visually exposed) thermally isolated from the structure using insulated Halfen or Schöck thermal breaks, or concrete thermally isolated from the internal structure. Using halfen balcony supports or similar.

3.3 Basement Construction

The basement will be used for car parking and plant.

The Flowchart for the decision process required for the waterproofing is described in BS8102 2009 is as below

COMMENTARY ON FIGURE 1
Figure 1 outlines the principal factors and stages that need to be addressed in order to produce a robust waterproofing solution for a below ground structure.

It demonstrates that some matters are interrelated and that a degree of iteration might result from a need to address buildability and repairability. The principal issues (boxes) do not necessarily need to be addressed in the order shown but all need to be understood and evaluated.

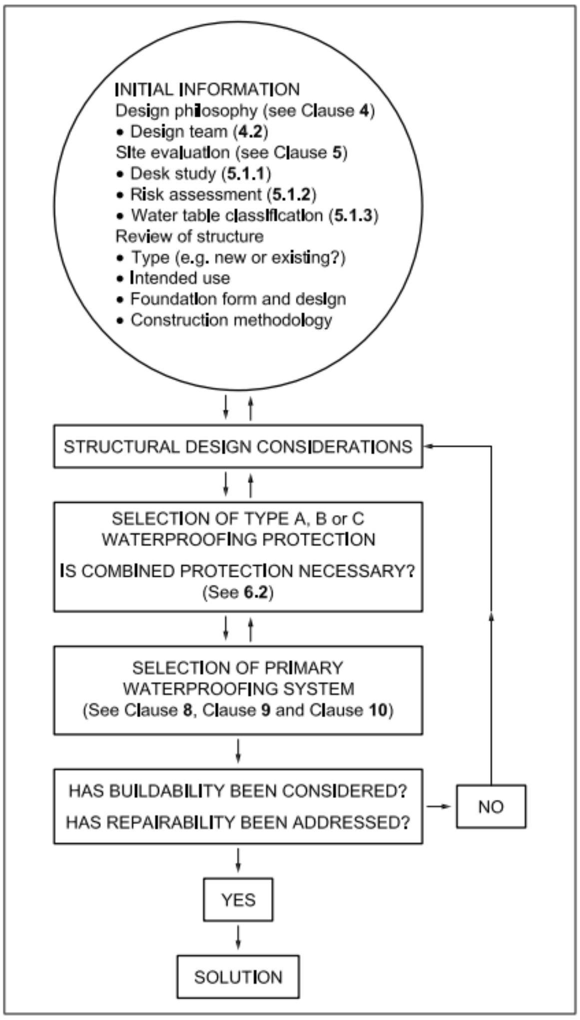


Figure 7 Design Flow Chart

The soils investigation report indicates the site is underlain with stiff Boulder clay with limited permeability.

One, or a combination, of the following types of waterproofing protection should be selected:
a) Type A (barrier) protection; (external tanking membrane)
b) Type B (structurally integral) protection; (waterproof concrete)
c) Type C (drained) protection (internal drained cavity)

To achieve a grade 2 or 3 environment, two different types of waterproofing (A, B or C) in combination would normally be specified, however further advice from a waterproofing expert is required. A type C protection would normally require a sump and possibly a pump chamber.
Based on the restricted nature of the site and the proximity of the basement to the boundary we are suggesting that the retaining wall to the basement be an embedded cantilevered piled wall which would allow the site to be excavated without internal props.

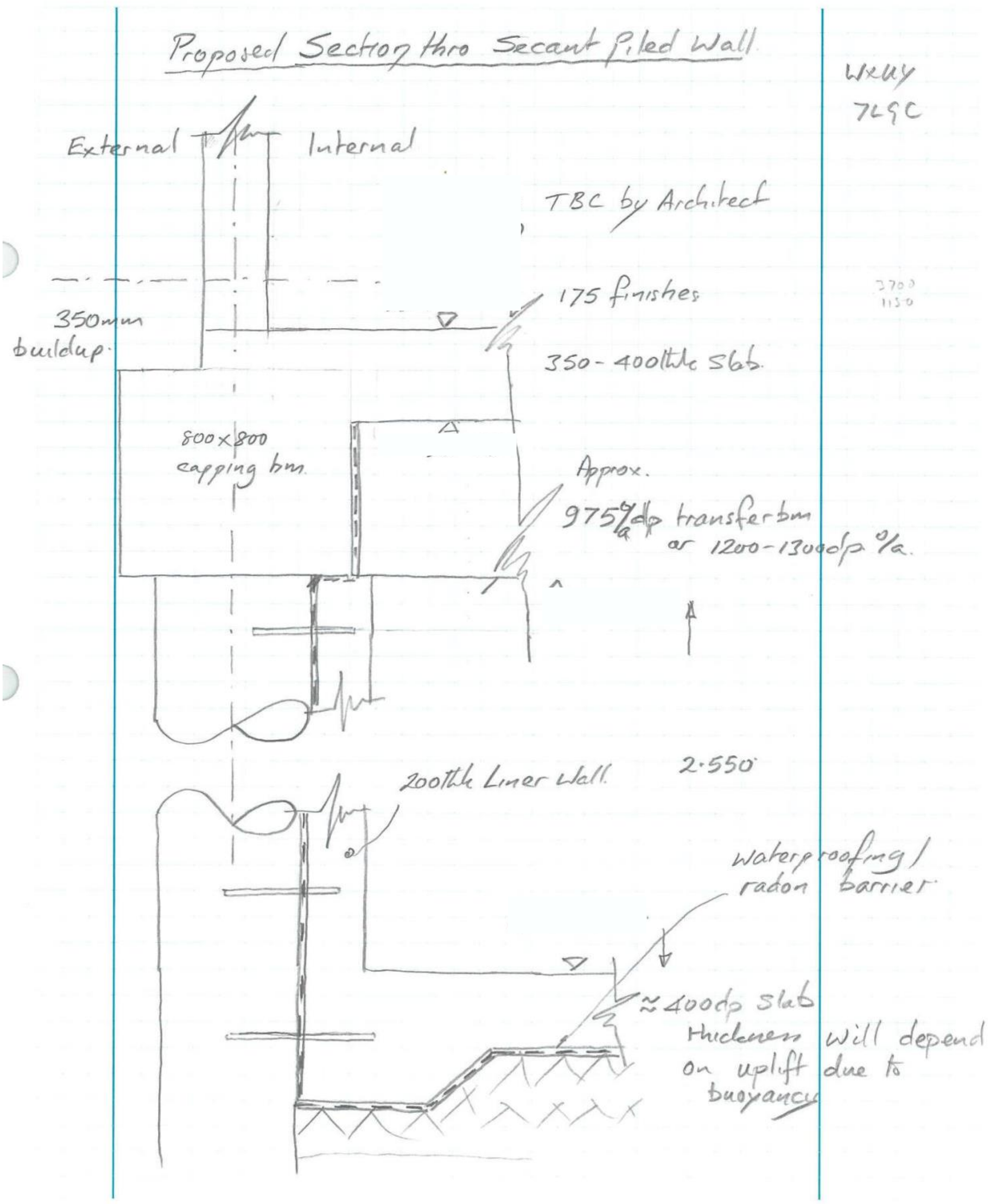
Figure 8 Embedded Piled Wall

The embedded piled wall will be designed by the piling contractor based on the information provided in the soils report and the performance specification provided by the Structural/Civil Engineer. The pile diameter has been estimated in the sketches below in 3.6 and when designed by the piling contractor a greater diameter may prove to be more economical and we would therefore recommend an allowance for an additional 150mm on the calculated buildup required for the basement retaining wall.

3.4 Basement Slab Construction

The basement slab level is proposed to be 52.000m, ground floor level is 56.400m and ground water level monitoring indicates levels OD between 54.000m and 55.000m is expected however ground water seepage within the stiff boulder clay is expected to be low.

3.5 Typical Section at Perimeter of basement and step in ground floor slab between internal and external spaces



4.0 DESIGN ASSUMPTIONS

4.1 Concrete Specification

The concrete cover will be specified to meet the requirements for durability and fire protection in accordance with BS-EN 1992.

- Reinforced concrete poured against the ground will have a minimum cover of 75mm
- Reinforced concrete poured against blinding will have cover of 50mm.
- In-situ walls and columns will have cover of at least the maximum compression bar or 30mm to links
- Walls 25mm cover or max compression bar size
- Slabs one- or two-way spanning require 30mm cover
- Flat slabs require minimum 30mm cover
- The grade of concrete and minimum cement content will be specified to satisfy concrete in aggressive soils.

4.2 Fire Resistance of the structure

The heights of some apartment blocks are in excess of 30m and therefore may require 2hrs fire rating to all elements of structure in accordance with table A2 of the building regulations. (Subject to fire consultant advices).

4.3 Corrosion Protection to structural steel

All internal steel to receive a fabrication primer and intumescent paint as required, the external structural steel will be galvanised to 80microns, and a decorative coating is assumed to be powder coated where specified by the architect.

4.4 Radon Protection

The residential occupied areas are all situated above the ventilated basement and therefore radon protection is not expected to be required for the residential properties.

4.5 Buoyancy

Ground water levels from soils investigation reports received for adjacent sites indicate the expected ground water level is between OD Level 54.0m and 55.0m. The loads from the structure over will resist any uplift due to buoyancy however uplift due to buoyancy acting on the basement slab will need to be considered in the temporary condition during construction. Ground water monitoring on adjacent sites were recorded as follows.

Location	*Groundwater strike,*		*Groundwater*			
			30/07/2008		*16/07/2019*	
	m bgl	*m OD*	*m bgl*	*m OD*	*m bgl*	*m OD*
RC100	-	-	-	-	*1.6*	***54.44***
RC101	-	-	-	-	*12.5*	*44.132*
RC102	*18.0*	*38.460*	-	-	*12.5*	*43.96*
	19.7	*36.760*	-	-		
TP102	*1.7*	*55.073*	-	-	-	-
BH1	*4.3*	*52.274*	*1.5*	***55.074***	-	-
BH2	*0.3*	*56.340*	*0.8*	*55.840*	-	-
BH3	*0.4*	*56.616*	*2.1*	*54.916*	-	-

Table 1 Groundwater Monitoring

4.6 Heave

Significant ground movement due to heave is normally not associated with stiff boulder clay

4.7 Deflections and tolerance

Maximum deflection limits according to EC:

- 'appearance': -'damage to elements': [(loading: quasi-permanent $\psi_2 Q_k$, ψ_2 = 0.3 for residential buildings)) 1.0SW+1.0DL+**0.3**IL]	**L/250** (total deflection long term) **L/500** (deflection after installation of elements)

Tolerance during construction will be in accordance with EN 13670:2009 (E)

4.8 Execution and Consequence Class

The Execution Classes in accordance with BS EN 1090-2 are described below and will be EXC2, A higher Inspection level and production Inspection may be required for the balcony support fixings

- Execution Class 1 – Farm buildings
- Execution Class 2 – Buildings in general
- Execution Class 3 – Bridges
- Execution Class 4 – Safety critical structures with a high consequence of failure

The consequence class for the building will be CC2b

Consequences classes		CC1		CC2		CC3	
Service Category		SC1	Sc2	SC1	SC2	SC1	SC2
Production Categories	PC1	EXC1	EXC2	EXC2	EXC3	EXC3[a]	EXC3[a]
	PC2	EXC2	EXC2	EXC2	EXC3	EXC3[a]	EXC4
Aexc4 should be applied to special structures or structures with extreme consequence of a structural failure as required by national provisions							

4.9 Materials

a) Concrete

C32/40 Topping to hollow core slabs superstructure

Perimeter Edge beams

In-situ Concrete Flat slabs

C40/50 Ground Floor Transfer Structure

In-situ Concrete Columns

b) Structural Steel balconies Grade S355

c) Reinforcement high yield deformed type 2 bars

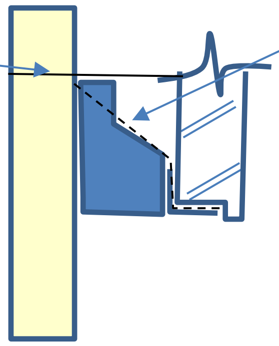
5.0 CLADDING

5.1 The proposed cladding system is a combination of glazing, rendered panels and brickwork.

The brickwork/rendered panels will require a support at either every level or alternate levels, the costs of the installation will need to be balanced with the effect on the supporting structure, movement joint size and the design of the brick support.

5.2 The glazed curtain walling at ground floor level will be supported at ground floor level.

5.3 There are soldier course brick strips over the windows which will be directly supported by the brick support angles which will require these to have rebates in the soffits to hide the angle. This will omit the need for lintels over the windows. If the support angles are placed above the soldier course, then additional lintels will be required.



5.4 Horizontal movement joints, nominally 10mmthk, will be required in the brickwork at each or alternate level coinciding with the brick support angle and vertical 10mm movement joints at a maximum of 10m apart and 1.5m on the return.

5.5 Cavity vents, cavity trays and insulation will be specified by the Architect. The ties connecting the brickwork to the structure will be type 1 stainless steel ties length to suit the cavity with a minimum embedment of 50mm into the brickwork. The ties will generally be at 900c/c horizontally and 450c/c vertically except at reveals where the vertical centres will be 225c/c. The first tie over the support angle will be as shown above in 5.4.

6.0 SERVICES AND MECHANCIAL ELECTRICAL COORDINATION

6.1 Full coordination between the structure and mechanical and electrical services has not yet been completed. 1No. 150mm square openings in the transfer slab for RWPs, SVPs have been assumed beside each column position.

7.0 PROGRESSIVE COLLAPSE

7.1 The building regulations require that all buildings do not suffer damage disproportionately to the cause. The requirement means that all buildings need to be classified based on their use and height.

7.2 The proposed apartment blocks are a maximum of 12 stories including ground floor level but excluding basement and roof. The robustness class therefore based on the sketch below will be Class 2B

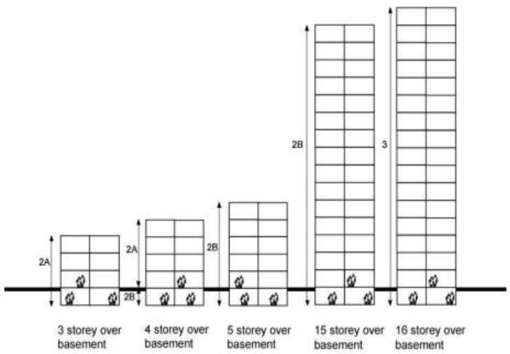


Figure 9 Classes of Robustness Measures

7.3 Class 2B buildings are required to be tied both vertically and horizontally. This requirement can be easily satisfied in insitu concrete buildings however precast concrete construction requires more thought, care and consideration for the detail design and reinforcement and tying details will be in accordance with the IStructE advisory publication 'Practical guide to structural robustness and disproportionate collapse in buildings'.

7.4 Where vertical ties do not continue to foundation level the supporting elements will need to be considered as key elements and checked for a horizontal or vertical load of 34kN/m2 applied to the surface of the key element.

7.5 The ground floor transfer slab is a key element and will need to be checked with an explosive load of 34kN/m2 applied to an area of 6m x 6m

7.6 The columns will need to be considered as tension elements in the situation where a column below is removed. The column will need to be checked for tension support to the load from the slab at the level being considered

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