PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

DEMOLITION

DOCUMENT No Z-0201

ISSUE 3 | 13 JUNE 2023

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
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Each item deleted is ~~struck through~~
Each item added is in red and shaded

PROJECT NO: 2010018

0201 DEMOLITION

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Carry out demolition, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0171 General requirements*.
- *0221 Site Preparation*
- *0222 Earthwork*
- *0223 Service Trenching*
- ~~*Future*~~ *Development Consent Approval Conditions*

1.3 STANDARDS & REQUIREMENTS

General
Demolition: To AS 2601.
- ~~*Future*~~ *Development Consent Approval Conditions*

Appropriate measures (eg. Fine water spray) shall be employed during demolition, excavation and construction works to prevent the emission of dust and other impurities into the surrounding environment. All such measures shall be co-ordinated with the site sedimentation controls to ensure polluted waters do not leave the site.

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection, the following definitions apply:
- Demolition: The complete or partial dismantling of a building or structure, by pre-planned and controlled methods or procedures.
- Dilapidation record: The photographic or video and written record of the condition of the portion of the existing building retained, adjacent buildings, and other relevant structures or facilities, before the start of demolition work.
- Dismantle: The reduction of an item to its components in a manner to allow re-assembly.
- Recover: The disconnection and removal of an item in a manner to allow re-installation.

1.5 SUBMISSIONS

Authority approvals
Evidence of compliance: Before starting demolition, submit evidence of the following:
- Requirements of authorities relating to the work under the contract have been obtained.
- A permit to demolish has been obtained from the appropriate authority.
- A scaffold permit has been obtained from the appropriate authority (if scaffolding is proposed to be used).
- Certification that each person having access to the construction site has completed site-specific WHS induction training.
- Precautions necessary for protection of persons and property have been taken and suitable protective and safety devices have been provided to the approval of the relevant authority.
- Certificate from the relevant authority confirming treatment for any rodent infestation has been caried out.
- ~~Treatment for rodent infestation has been carried out and a certificate has been obtained from the appropriate authority~~.
- Fees and other costs have been paid.

Execution details

Requirement: Submit the following, as documented:

- Hazardous Substances Management Plan by Contractor, including laboratory analysis of hazardous substances.
- Investigation and work plan by Contractor.
- Safe Work Method Statement.

Off-site disposal locations: Submit details of the proposed locations for the disposal of material required to be removed from the site, and evidence of conformance with the requirements of relevant authorities.

Recycling: Submit details of the proposed recycling facility.

- Certification: Submit evidence of delivery of recycled materials.
- Concrete crushing: If proposed on site, submit details of plant and environmental controls.

Stockpile locations: Submit details of the proposed locations of on-site stockpiles for demolished materials for recycling in the works. Coordinate with the locations for storage of other waste streams, and prevent mixing or pollution.

Records

Dilapidation record:

- Before demolition: Submit to each owner of each adjacent property, a copy of the part of the record relating to that property and obtain their written agreement to the contents.
- Before demolition: Provide a Dilapidation Report of buildings adjacent to the proposed owned by the School. Submit to Proprietor a, a copy of the part of the record relating to that property and obtain their written agreement to the contents.
- Rectification work: Submit written acceptance of rectification works from the owner of each adjoining property affected.

Tests

Requirement: Submit test results of compliance tests for building service components to be re-used.

1.6 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Adjacent structures before starting and at completion of demolition.
- Services before disconnection or diversion.
- Trees documented to be retained, before starting demolition.
- Contents of building before starting demolition.
- Structure after stripping and removal of roof coverings and external cladding.
- Underground structures after demolition above them.
- Excavations remaining after removal of underground work.
- Site after removal of demolished materials.
- Services after reconnection or diversion.
- Adjoining and adjacent structures at completion of demolition.

2 PRODUCTS

2.1 DEMOLISHED MATERIALS

Demolished material diverted from landfill

Minimum percentage of demolished material not sent to landfill:

The Subcontractor shall provide the following options with accompanying tender pricing:

- Base case of what the Subcontractor would normally price
- 25% not sent to landfill
- 50% not sent to landfill

Demolished material classes table

Class	Requirement	Ownership

Class	Requirement	Ownership
Recovered items for re-use in the works	Recover without damage items identified in the **Recovered items for re-use in the works schedule**	Principal/proprietor
Recovered items for delivery to the principal	Recover without damage items identified in the **Recovered items for delivery to the principal schedule**	Principal/proprietor
Demolished material for recycling in the works	Stockpile material identified in the **Demolished material for recycling in the works schedule**	Contractor
Demolished material for recycling off-site	Demolish and deliver for recycling material identified in the **Demolished material for recycling off-site schedule**	Contractor
Dismantle for relocation as part of the works	Dismantle without damage and store items identified in the **Dismantle for relocation schedule**	Principal/proprietor
Demolish for removal	Remove from the site demolished materials identified in the **Demolish for removal schedule**. Do not burn or bury on site Transit: Prevent spillage of demolished materials in transit	Contractor

3 EXECUTION

3.1 HAZARDOUS SUBSTANCES

Identified hazardous substances

Register: Hazardous substances have been identified as present on site and a Hazardous substances register has been prepared.

Availability: A Hazardous Substances Register has not been done, please provide one as early as possible once contract has been awarded.

Audit

Requirement: Prepare a Hazardous Substances Management Plan to AS 2601 clause 1.6.1. Include the following:

- Asbestos or material containing asbestos.
- Flammable or explosive liquids or gases.
- Toxic, infective or contaminated materials.
- Radiation or radioactive materials.
- Noxious or explosive chemicals.
- Tanks or other containers which have been used for storage of explosive, toxic, infective or contaminated substances.
- Timing: just after contract has been awarded

Removal of hazardous substances

Standard: To AS 2601 clause 1.6.2.

Procedure for asbestos removal: Where asbestos material shall be removed or disturbed as a result of any proposed demolition, alteration or addition, all work must be carried out by a person licensed under Chapter 10 of the Occupational Health and Safety Regulation and undertaken in accordance with the requirements of clause 29 of the Protection of the Environment Operations (Waste)

Regulation. All asbestos to be removed must be removed must be disposed of at a tip recommended by the NSW Environment Protection Authority and under no circumstances shall be re-used or sold.

Also in accordance WHS Code of Practice, Safe Work Australia and any other relevant Australia Standards, statutes or codes.

3.2 INVESTIGATION AND WORK PLAN

General

Requirement: Before demolition or stripping work, prepare the work plan to AS 2601 Section 2. Include the check list items appropriate to the project from AS 2601 Appendix A, and the following:

- Method of protection and support for adjacent property.
- Locations and details of service deviations and terminations.
- Sequence of work.
- If the demolition program results in components temporarily cantilevered, provide a certificate from a professional engineer.
- Proposals for the safe use of mobile plant on suspended structural members including provisions for the protection of lower floors in the event of structural failure.
- If implosion methods are proposed, provide a separate report of methods and safeguards.
- Wheel loads of tipping or loading vehicles.

3.3 SUPPORT

Temporary support

General: If temporary support is required, certification for its design and installation is required from a professional engineer engaged by the contractor.

Existing buildings: Until permanent support is provided, provide temporary support for sections of existing buildings which are to be altered and which normally rely for support on work to be demolished.

Suspended slabs: If mobile plant is required for use on suspended structural members, conform to structural engineering requirements, and the work plan.

Ground support: Support excavations for demolition of underground structures.

Adjoining or adjacent structures: Provide supports to adjoining or adjacent structures where necessary, sufficient to prevent damage resulting from the works.

Lateral and vertical supports: At least equal in capacity to that originally provided by the structural element or structure to be demolished.

~~Adjacent structures: Provide supports to adjacent structures where necessary, sufficient to prevent damage resulting from the works.~~

~~Lateral supports: Provide lateral support equal to that given by the structure to be demolished.~~

~~Vertical supports: Provide vertical support equal to that given by the structure to be demolished.~~

Permanent supports

General: If permanent supports for adjacent structures are necessary and are not documented, give notice and obtain instructions.

3.4 PROTECTION

Encroachment

General: Prevent the encroachment of demolished materials onto adjoining property, including public places.

Weather protection

General: If walls or roofs are opened for alterations and additions or the surfaces of adjoining buildings are exposed, provide temporary covers to prevent water penetration. Provide covers to protect existing plant, equipment and materials intended for re-use.

Dust protection

General: Provide dustproof screens, bulkheads and covers to protect existing finishes and the immediate environment from dust and debris.

Security

General: If walls or roofs are opened for alterations or additions, provide security against unauthorised entry to the building.

Temporary screens

General: Fill the whole of designated temporary openings or other spaces using dustproof and weatherproof temporary screens, fixed securely to the existing structure, and installed to shed water to avoid damage to retained existing elements or adjacent structures and contents.

Type: Timber framed screens sheeted with 12 mm plywood and painted. Seal the junctions between the screens and the openings.

Temporary access

General: If required, provide a substantial temporary doorset fitted with a rim deadlock, and remove on completion of demolition.

Exposed surfaces

General: Where necessary, protect and weatherproof the surfaces of adjacent structures exposed by demolition.

Existing services

Location: Before starting demolition, locate and mark existing underground services in the areas which will be affected by the demolition operations.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Essential services: Shut off, cap or control services not required for the demolition work, at or outside the building line before commencing demolition. Conform to the requirements of the relevant existing utility authority, as appropriate.

Excavation: Do not excavate by machine within 1 m of existing underground services.

Fixed items

Individual protection: Protect the following items in their existing positions:

refer to Demolition documents and drawings. Recovered items

General: If items are documented for recovery and re-use, minimise damage during removal and recover all associated components required for their re-use.

3.5 DEMOLITION – BUILDING WORKS

General

Requirement: To the approved Safe Work Method Statement and work plan.

Encroachment

General: If encroachments from adjacent structures are encountered and are not documented, give notice and obtain instructions.

Sequence

Sequence of demolition: The Contractor / Subcontractor is to provide a Work Methodology Statement

Concrete slabs

General: Using a diamond saw, neatly cut back or trim to new alignment with a clean true face existing concrete slabs to be partially demolished or penetrated. Do not overcut at corners.

Material below grade

Extent: Demolish the following:

- refer to Demolition documents and drawings.

Remaining voids: Stabilise and provide barriers.

Explosives

General: Do not use explosives.

3.6 DEMOLITION – BUILDING SERVICES

General

Requirement: Decommission, isolate, demolish and remove from the site all equipment and associated components that become redundant as a result of the demolition.

Breaking down: Disassemble or cut up equipment where necessary to allow removal.

Demolition of refrigeration systems

Standard: To AS/NZS 5149.4.

Components for re-use

General: Before returning to service, clean components and test for conformance to Australian Standards, as required.

3.7 COMPLETION

Notice of completion

General: Give at least 5 working days' notice of completion of demolition so that adjacent structures may be inspected following completion of demolition.

Reinstatement

Assessment of damage: Use the dilapidation record to assess the damage and rectification work arising from the demolition work.

Rectification: Repair damage arising out of demolition work. Obtain written acceptance from the owner of each adjoining property of the completeness and standard of the rectification work.

~~**Temporary support**~~

~~General: Remove at completion of demolition.~~

Removal of temporary supports

General: Obtain written instructions from the structural engineer at the completion of demolition before removing temporary supports.

4 SELECTIONS

4.1 DEMOLITION

Recovered items for re-use in the works schedule not required

Recovered items for delivery to the principal schedule not required

Demolished material for recycling in the works schedule not required

Demolished material for recycling off-site schedule not required

Dismantle for relocation schedule not required

Demolish for removal schedule all demolition

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ARCHITECTURAL SPECIFICATION

EARTHWORK

DOCUMENT No Z-0222

ISSUE 3 | 13 JUNE 2023

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A	08/10/2021	DRAFT TENDER	BFS	NS
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BVN

PROJECT NO: 2010018

0222 EARTHWORK

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide earthworks to the dimensions and tolerances, as documented.

1.2 DESIGN

General

Designer: Subcontractor to comply with requirements of Geotech and Structural documents

Geotechnical and environmental reports provided: Geotech Report

Requirements

General: To DESIGN in *0171 General requirements*.

Responsibility: The Subcontractor shall employ a suitably qualified Structural Engineer to complete the design of the Earthworks

Design of footing or pier depths: refer to Structural Engineer's documentation

Contract depths: The footing or pier depths shown on the drawings are provisional.

Authority requirements: Refer to DA Consent Conditions

1.3 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0171 General requirements*.
- *0221 Site Preparation*
- *0223 Service trenching*
- *Structural documents*
- *Hydraulic documents*
- *Landscape documents*
- ~~*Future*~~ *Development Consent Approval Conditions*

1.4 STANDARDS

General

Earthworks: Conform to the recommendations of those parts of AS 3798 that are referenced in this worksection.

Description and classification of soils: To AS 1726.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- GITA: Geotechnical inspection and testing authority.
- GTA: Geotechnical testing authority.

Definitions

General: For the purposes of this worksection the definitions given in AS 3798 and the following apply:

- Bad ground: Ground unsuitable for the works, including fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances and ground that is, or becomes, soft, wet or unstable.
- Rock: Monolithic material with volume greater than 0.3 m^3 that cannot be removed until broken up by rippers or percussion tools.

- Site topsoil: Natural soil, excavated from the site, that contains organic matter, supports plant life, conforms generally to the fine-to-medium texture classification to AS 4419 and is free from the following:
  . Stones more than 25 mm diameter.
  . Clay lumps more than 50 mm diameter.
  . Weeds and tree roots.
  . Sticks and rubbish.
  . Material toxic to plants.
- Subgrade: The trimmed or prepared earth material on which the pavement, footing or slab is constructed. Generally taken to relate to the upper line of the earth material.
- Zone of influence: A foundation zone bounded by planes extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement.

1.6 TOLERANCES

General

Finish: Finish the surface to the required level, grade and shape within the following tolerances:

- Under building slabs and load bearing elements: + 0, - 25 mm.
- Pavement subgrades: + 0, - 40 mm.
- Batters: No steeper than the slope shown on the drawings. Make sure flatter slopes do not impact on boundaries or required clearances to buildings, pavements or landscaping.
- Other ground surfaces: ± 50 mm, provided the area remains free draining and matches adjacent construction where required. Provide smoothness as normally produced by a scraper blade.

1.7 SUBMISSIONS

Design documentation

Calculations: Submit calculations by a professional engineer showing the stability and safety of proposed excavations and temporary supports, including supports required for adjacent structures.

Execution details

Report: Submit a time-based schedule detailing the methods and equipment proposed for the earthworks, including the following:

- Dewatering and groundwater control and disposal of surface water.
- Excavation methods, stages, clearances, batters and temporary supports.
- Stockpiles and borrow pits.
- Placing and compaction methods and stages.

Geotechnical site investigations: Provide a geotechnical report supporting the methods proposed for excavation.

Disposal location: Submit details of the locations and evidence of compliance with the appropriate authority requirements for the disposal of material requiring removal from site.

Temporary shoring: Submit a proposal for any temporary shoring required, including the progressive removal.

Proof rolling: Submit details of proposed method and equipment for proof rolling.

Records of measurement: Submit a certified copy of the agreed records of measurement.

Site records: Submit the following to AS 3798 clause 3.4 and Appendix B:

- Geotechnical site visit record.
- Earthworks summary report or daily geotechnical reports.

Products and materials

Imported fill: Submit certification or test results by a GTA registered laboratory of the imported fill as evidence of conformity with the contract, including the source.

Tests

Compaction: Submit certification and/or test results in conformance with the documented level of inspection and testing to AS 3798.

1.8 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Items to be measured as listed in **RECORDS OF MEASUREMENT**.
- Areas to be cleared and/or stripped of topsoil.
- Areas stripped of topsoil.
- Excavation completed to contract levels or founding material.
- Proof rolled subgrade before placing fill.
- Filling completed to contract levels.
- Stockpiled topsoil before spreading.

2 PRODUCTS

2.1 FILL MATERIALS

General

Suitable material: To AS 3798 clause 4.4 including inorganic, non-perishable material suitably graded and capable of compaction to the documented density.

Unsuitable materials: To AS 3798 clause 4.3.

Sulfur content: Do not provide material with sulfur content exceeding 0.5% within 500 mm of cement bound elements (for example concrete structures or masonry) unless the elements are protected by impermeable membranes or equivalent means.

Re-use of excavated material: Only re-use suitable material to AS 3798 clause 4.4.

Stockpiles

General: Segregate the earth and rock material and stockpile for re-use in backfilling operations.

Location: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along drainage channels.

2.2 BORROW OR IMPORTED FILL

General

Borrow or imported material: Use only when suitable excavated material from site is not available.

- Suitable material: To AS 3798 clause 4.4.

Material conforming to the following: refer to Structural documents

Borrow pits:

- Locate more than 3000 mm from any fence line, boundary, edge of excavation or embankment.
- Strip and stockpile topsoil.
- Provide erosion protection during winning operations of material and make sure drainage is maintained.
- On completion of winning operations grade abrupt changes of slope, respread topsoil, and apply and maintain hydroseeded grassing.

Borrow and imported fill additional testing: refer to Structural documents

2.3 GEOTEXTILE

General

Material: UV stabilised, permeable, polymeric, woven or non-woven textile material used in contact with soil/rock material.

Identification and marking: To AS 3705.

3 EXECUTION

3.1 SITE PREPARATION

Erosion and sedimentation control

Requirement: Refer to Development Approval Consent Conditions

3.2 GEOTECHNICAL

As found site conditions

General: If the following are encountered, give notice and obtain instructions before carrying out any further work in the affected area:

- Bad ground.
- Discrepancy in expected conditions.
- Rock.
- Springs, seepages.
- Topsoil more than 100 mm deep.

Inspection and testing

Level of inspection and testing: Level 1 inspection and testing to AS3798 clause 8.2 by a GITA

Frequency of testing: To AS 3798 Table 8.1.

3.3 RECORDS OF MEASUREMENT

Excavation and backfilling

Agreed quantities: If a schedule of rates applies, provisional quantities are documented, or there are variations to the contract levels or dimensions of excavations, do not backfill or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.
- Quantities of excavations in rock.

Method of measurement: By registered surveyor.

Rock

Level and class: If rock is measured for payment purposes, either as extra over excavation of material other than rock or for adjustment of provisional measurements, do not remove the rock until the commencing levels and the classes of rock have been determined.

3.4 REMOVAL OF TOPSOIL

General

Extent: Areas of cut or fill and areas occupied by structures, pavements and embankments.

Maximum depth: 200 mm.

Disposal: Remove topsoil unsuitable for re-use from the site to AS 3798 clause 6.1.8.

Topsoil stockpiles

General: Stockpile site topsoil intended for re-use.

Stockpile maximum height: 1.5 m.

Identification: Mark and label stockpiles of different soil types.

Vegetation: Do not burn off or remove plant growth that occurs during storage.

Protection: Conform to the following:

- Provide drainage and erosion protection.
- Do not allow traffic on stockpiles.
- If a stockpile is to remain for more than four weeks, sow with temporary grass.
- Protect the topsoil stockpiles from contamination by other excavated material, weeds and building debris.

3.5 EXCAVATION

Extent

Site surface: Excavate the site to the levels and profiles required for the documented structures, pavements, filling and landscaping. Make allowance for compaction, settlement or heaving.

Footings, pits, wells and shafts: Excavate to the required sizes and depths. Confirm that the foundation conditions meet the design bearing capacity.

Bearing surfaces

Requirement: Provide even plane bearing surfaces for loadbearing elements including footings. Step to accommodate level changes. If supporting masonry, make the steps appropriate to the courses.

Rock
General: Do not use explosives.

Existing footings
Requirement: If excavation is required within the zone of influence of an existing footing, provide supports to the footing sufficient to prevent damage arising from the works. Use methods including temporary shoring or underpinning.

Existing services
Location: Before starting earthworks, locate and mark existing underground services in the areas that will be affected by the earthworks operations including clearing, excavating and trenching.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Excavation: Do not excavate by machine within 1000 mm of existing services.

Proof rolling
Extent: Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the presence of bad ground.

Proof rolling method and equipment: To AS 3798 clause 5.5.

Requirement: If excessive settlement, rebound or heaving is encountered, provide test pits or trenching to determine the extent of bad ground.

Disposal of excess excavated material
General: Remove excess excavated material from site not required or unsuitable for fill.

Standard: To AS 3798 clause 6.1.8.

3.6 REINSTATEMENT

Deterioration of bearing surfaces
Requirement: If the bearing surface deteriorates because of water or other cause, excavate to a sound surface before placing the loadbearing element.

Subgrades affected by moisture
Requirement: If, due to high moisture content the subgrade cannot support construction equipment or the overlying pavement cannot be compacted, perform one or more of the following:

- Allow the subgrade to dry until it provides support for equipment and allows compaction.
- Scarify the subgrade to a depth of 150 mm, work as necessary to accelerate drying, and recompact when the moisture content is satisfactory.
- Excavate the wet material and remove to spoil, and backfill excavated areas.

Over excavation
Requirement: If excavation exceeds the required depths, reinstate to the correct depths, levels and bearing capacity.

Zone of influence: Within the zone of influence of footings, beams, or other structural elements, use concrete of strength equal to the structural element, minimum 15 MPa. Make sure that remedial concrete does not create differential bearing conditions.

Below slabs or pavements: Rectify the over excavation as follows:

- Generally: Provide selected fill compacted to the documented density.
- Less than 100 mm: Do not backfill. Increase the thickness of the layer above.

Rock depressions and subsoil drains: Backfill rock depressions and over excavation of subsoil drains using coarse subsoil filter.

3.7 SUPPORTING EXCAVATIONS

Removal of supports
General: Remove temporary supports progressively as backfilling proceeds.

Voids
General: If voids occur outside sheeting or sheet piling, fill and compact voids to a dry density similar to that of the surrounding material.

3.8 ADJACENT STRUCTURES

Temporary supports

General: If required, provide supports to adjacent structures, sufficient to prevent damage arising from the works.

Lateral supports: Provide lateral support with shoring.

Vertical supports: If required, provide vertical support with piling or underpinning or both.

Permanent supports

General: If permanent supports for adjacent structures are required and are not documented, give notice and obtain instructions.

Encroachments

General: If encroachments from adjacent structures are encountered and are not documented give notice and obtain instructions.

Zone of influence

Angle from horizontal: refer to Structural documents and Geotech advise

3.9 ROCK BOLTING

General

Requirement: For temporary or permanent support of rock faces, provide proprietary high strength steel bars or tubes anchored into holes drilled in the rock and tensioned against plates bearing on the rock face. Schedule the installation to conform to systematic bolting or calculated relief, as documented.

Standard: To AS 4678.

Protection

General: Protect permanent rock bolts by grouting the drilled hole with cement grout after tensioning the rock bolt. Protect the bearing plate and the exposed portion of rock bolt and anchorage with a protective coating or by embedment in concrete.

3.10 GEOTEXTILE

General

Preparation: Trim the ground to a smooth surface free from cavities and projecting rocks.

Installation: Lay the fabric flat, not stretched tight, and secure with anchor pins. Overlap joints 300 mm minimum.

3.11 PREPARATION FOR FILLING

Preparation

Stripping: Prepare the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements to AS 3798 clause 6.1.5. Remove material that inhibits or prevents satisfactory placement of fill layers, loose material, debris and organic matter.

Foundation preparation: To AS 3798 clause 6.1.7.

Compaction: Compact the ground exposed after stripping or excavation, to a minimum depth of 150 mm, to the minimum relative compaction in AS 3798 Table 5.1.

Ground treatment or improvement methods:

- Scarify method: Loosen exposed excavation by scarifying to a minimum of 150 mm, moisture-condition and compact to AS 3798 Section 5.
- Impact roller and impact compaction: Use an approved method.

Slope preparation: If fill is placed on a surface steeper than 4:1 (horizontal:vertical), bench the surface to form a key for the fill. As each layer of fill is placed, cut the existing ground surface progressively to form a series of horizontal steps more than 1 m in width and more than 100 mm deep. Recompact the excavated material as part of the filling. Shape to provide free drainage.

Working platform: If necessary obtain advice from Geotech Engineer / Structural Engineer

Under earth mounds

General: Cultivate the ground to a depth of 200 mm before mound formation.

Under slabs, paving and embankments

General: If required, loosen the ground to a depth of more than 200 mm and adjust the moisture content before compaction to a density consistent with subsequent filling.

Rock ledges

General: Remove overhanging rock ledges.

3.12 PLACING FILL

General

Extent: Place fill to the documented dimensions, levels, grades, and cross sections so that the surface is always self-draining.

Layers: Place fill in near-horizontal layers of uniform thickness, deposited systematically across the fill area.

Edges: At junctions of fill and existing surfaces, do not feather the edges.

Mix: Place fill in a uniform mixture.

Previous fill: Before placing subsequent fill layers, make sure that previously accepted layers still conform to requirements, including moisture content.

Protection: Protect the works from damage due to compaction operations. If required, limit the size of compaction equipment or compact by hand.

Protective covering to membranes: Do not disturb or damage during backfilling.

Placing at structures

Fill adjacent structures and trenches: To AS 3798 clause 6.2.6.

Requirement: Place and compact fill in layers simultaneously on both sides of structures, culverts and pipelines to avoid differential loading. Commence compacting each layer at the structure and proceed away from structure.

Over the top of structures: Carefully place first layers of fill.

Retaining walls: Do not place fill against concrete retaining walls until the concrete has been in place for 28 days unless the structure is supported by struts.

Compaction

General: Compact the subgrade and each layer of fill to the required depth and density, as a systematic construction operation. Shape surface to provide drainage and prevent ponding.

Maximum rock and lump size in layer after compaction: To AS 3798 clause 6.2.2.

Fill batter faces: Either compact separately, or overfill and cut back. Form roughened surfaces to the faces.

Minimum relative compaction: To AS 3798 Table 5.1.

3.13 PLACING TOPSOIL

Stockpiled topsoil

Cultivation: Rip subgrade to a depth of 100 mm or to the depth of rippable subgrade if less. Cultivate around services and tree roots by hand. Trim to allow for the required topsoil depth.

Herbicide: Apply before placing topsoil.

Herbicide product: Submit suitable product for approval by Superintendent and Landscape Architect

Placing: Spread and grade evenly.

Compaction: Lightly compact topsoil so that the finished surface is smooth, free from lumps of soil, at the required level, ready for cultivation and planting.

Edges: Finish topsoil flush with abutting kerbs, mowing strips and paved surfaces. Feather edges into adjoining undisturbed ground.

Disposal of excess topsoil

On-site: Dispose of surplus topsoil remaining on site by spreading evenly over the areas already placed subject to approval from Proprietor.

Off-site: Remove excess topsoil from the site and dispose of legally.

3.14 FILL MOISTURE CONTROL

General

Moisture content: Adjust the moisture content of fill during compaction within the range of 85% to 115% of the optimum moisture content determined by AS 1289.5.1.1 or AS 1289.5.2.1, as appropriate, to achieve the required density.

3.15 COMPACTION TESTS

Compaction control tests

Compaction control tests: To AS 1289.5.4.1 or AS 1289.5.7.1.

Compaction control test frequency

Standard: To AS 3798 Table 8.1.

Confined operations: 1 test per 2 layers per 50 m^2.

3.16 COMPLETION

Geotechnical report

Inspection and testing report: Level 1 Statement of compliance of Work

Grading

External areas: Grade to give falls away from buildings, minimum 1:100.

Subfloor areas: Grade the ground surface under suspended floors to drain ground or surface water away from buildings without ponding.

Site restoration

Requirement: If variation of existing ground surfaces is not required as part of the works, restore surfaces to the condition existing at the commencement of the contract.

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ARCHITECTURAL SPECIFICATION

QUALITY

DOCUMENT No Z-0160

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BVN

PROJECT NO: 2010018

0160 QUALITY

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide a project Quality Management System, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0131 Preliminaries* (not part of BVN specifications)
- *0171 General requirements*.

1.3 STANDARDS

General
Standard: To AS/NZS ISO 9001.

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection the definitions given in AS/NZS ISO 9000 and the following apply:

- Quality package: A designated part of the works, which may include the whole works, for which an individual quality system is required.
- Service: After sales' service, repairs, maintenance.

1.5 SUBMISSIONS

Quality Plan
Quality package: Submit a Quality Plan for each quality package, at least 10 working days before work on that package commences. Keep on site a copy of each approved quality plan.

Authority approvals
General: Provide project Quality Management System documents to the following authority: Provide as required by individual Authorities and the documents , refer to individual trade work sections and also to Pymble Ladies College's PPR document.

Calculations
Statistical techniques: Provide the methodology for statistical evaluation.

Execution details
Requirement: Provide the procedure for sign-off and audit.

1.6 INSPECTION

Notice
Inspection: Give notice so inspection may be made of the following: Provide as required by the documents, refer to individual trade work sections.

2 PROJECT QUALITY MANAGEMENT SYSTEM REQUIREMENTS

2.1 DOCUMENTATION REQUIREMENTS

Quality plan
Standard: Conform to the recommendations of AS ISO 10005. Include inspection and test plans.

Documented procedures
Review: Provide evidence of revision(s) (including dates), approval and status of each procedure.

Register: Maintain a register of documented procedures including the title, identifier and revision status.

2.2 DESIGN AND DEVELOPMENT OF PRODUCTS AND SERVICES

General

Plan and control of product design and development: Refer to in *0171 General requirements* also refer to each trade worksection.

2.3 CONTROL OF EXTERNALLY PROVIDED PROCESSES, PRODUCTS AND SERVICES

General

External audits: Perform pre-tender surveys of subcontractors and suppliers and audit subcontractors and suppliers, as necessary by an approved auditor. Include audit and surveillance proposals in the quality package Quality Plan along with results of pre-tender surveys.

Verification: The contract administrator may verify at source, or upon receipt, that purchased product conforms to requirements.

2.4 PRODUCTION AND SERVICE PROVISION

Product identification and traceability

General: As documented in the **Product identification and traceability schedule**.

Identification: Identify by lot / number / barcode all items of work, samples and site records.

Traceability: Provide and maintain records of components for audit.

Service

General: As documented in the **Service schedule**.

3 MONITORING AND MEASUREMENT

3.1 DOCUMENT CONTROL

Changes to documents

Revision: Review and approve changes to documents using the same functions or organisations that performed the original review and approval of the documents, unless documented otherwise ~~except as described in the **Document control schedule**.~~

Retention: As documented ~~in the **Quality records retention schedule**~~.

Evaluation: Make quality records available to the contract administrator for evaluation, within 2 days of the initial request.

Period of evaluation: Agree for each request, but at least 5 working days.

3.2 INSPECTION AND TEST PLANS

Content

Plan: Include the following:

- Detail all inspections and tests required including Hold points.
- Identify acceptance criteria, sampling and testing and frequency of sampling/testing.
- Identify responsibilities for inspection and testing and product/service approval.

Control of non-conforming product

Acceptance of concession: Before the provision or repair of a non-conforming product, obtain permission to use the product.

Hold points

Stages: Hold points during the construction/manufacturing process require release by the contract administrator.

Release: Requirements for release of a Hold point may include the following:

- Provision of information required by the technical specifications.
- Certification of design/construction or installation.
- Submission of any checklists or non-conformance forms as required.
- Inspection/demonstration of works.

~~Schedule: Conform to the **Inspections and Submissions** for test requirements specific to the appropriate worksection and the relevant standards~~

Frequency of testing
General: Conform to the test requirements of the relevant standards and worksections, as documented.

3.3 AUDITING

General
Audit plan: Conform to the recommendations of AS/NZS ISO 19011 clauses 6.4 and 6.5.

Initial systems audit: Carry out before date of site possession.

Compliance audits frequency: As required to meet requirements of documents

Compliance activities: As per work sections

Testing services
Testing authority: As per work sections

External audits
Nominated auditor: Not required

General
Review: Provide procedure to review the various control methods to minimise non-conformance. Record amendments to the project Quality Management System resulting from corrective action.

Non-conforming works: Include in the Quality Plan the procedure for reporting any non-conforming works to the contract administrator and any corrective action requests.

4 SELECTIONS

4.1 SCHEDULES

Project Quality Management System schedule

Quality package	Activities included	Standard	Options
The whole of the works	All	AS/NZS ISO 9001	

Design and development schedule refer to individual Worksections

Product identification and traceability refer to individual Worksections

Quality package	Product	Traceability required	Product identification required	Method

Service (maintenance) schedule refer to individual Worksections

Quality records retention schedule

Quality package	Retention period	Location during retention period	Form for retention	Content of documents
	7 years from Practical Completion	To be advised	Digitised on computer	Completed proforma evidencing conformance with the quality system

Servicing schedule refer to individual Worksections

Frequency of testing schedule refer to individual Worksections

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ARCHITECTURAL SPECIFICATION

SITE PREPARATION

DOCUMENT No Z-0221

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PROJECT NO: 2010018

0221 SITE PREPARATION

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide site preparation, as documented.

Performance

Areas for protection: Existing trees refer to Architectural drawings

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0171 General requirements*.
- *0222 Earthwork*
- *0223 Service trenching*
- *0201 Demolition*
- *0223 Service trenching*
- *Development Consent Approval Conditions*
- *Arborist Report*

1.3 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions apply:

- Authority: Any organisation with statutory authority relating to the project, including clearances.
- Clearances: A formal certificate, approval or condition issued by a statutory authority allowing work in a particular area.
- Plant establishment period: The period between the date of practical completion and the end of the defects liability period.
- Utility service provider: Includes organisations providing power, water, sewerage, gas and telecommunications services.

1.4 SUBMISSIONS

Certification

Vermin: Submit pest exterminator's certification as evidence that the completed site works are free from vermin.

Execution details

Requirement: Submit details of methods and equipment proposed for the following:

- Clearing and grubbing.
- Tree removal and transplanting.
- Protecting ground within and adjacent to tree driplines from compaction by proposed earthworks machinery.

1.5 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Enclosures around trees requiring protection.
- Trees requiring removal.
- Trees for transplanting to determine final orientation.

2 EXECUTION

2.1 COMMUNITY LIAISON

Notification

General: Notify residents about construction activities which will affect access to, or disrupt the use of, their properties.

Notice: Minimum 5 working days, unless the work is of an urgent nature with safety implications.

Notification content:

- Description of the work.
- The reason for the work.
- The expected duration.
- Changes to traffic arrangements and property access.
- The 24-hour contact number of the representative responsible.

2.2 EXISTING SERVICES

General

Requirement: Before starting earthworks, locate and mark existing underground services in the areas affected by the earthworks operations including clearing, excavating and trenching.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Excavation: Do not machine excavate within 1000 mm of existing services.

Existing service lines: If required, divert services detected during excavation, clear of the building, and reconnect to the utility service provider's requirements.

2.3 SITE CLEARING

Extent

Requirement: Clear only areas occupied by works such as structures, paving, excavation, regrading and landscaping or other areas documented for clearing.

Contractor’s site areas: If not included within the areas documented above, clear only to the extent necessary for the performance of the works.

Clearing and grubbing

Clearing: Remove everything on or above the site surface, including rubbish, scrap, grass, vegetable matter and organic debris, scrub, trees, timber, stumps, boulders and rubble.

Grubbing: Grub out stumps and roots over 75 mm diameter to a minimum depth as follows:

- Below subgrade under buildings, embankments or paving: 500 mm.
- Below finished surface in unpaved areas: 300 mm.

Backfilling: Fill holes remaining after grubbing with sand material to prevent ponding of water. Compact the material to the relative density of the existing adjacent ground material.

Redundant/decommissioned works: Remove works no longer required, including slabs, foundations, paving, drain, and access chambers and covers within the works zone.

Fire hazard reduction

Requirement: Not applicable

Batters

Temporary protection: If the change in level between crest and toe is more than 1500 mm, protect from erosion with geofabric, hessian and tar or heavy duty black polythene sheet cover. Securely fix down at crest and toe.

Surplus material

Topsoil and excavated material: Remove unwanted stripped soil and other material from the site as the work proceeds, including any material dropped on footpaths or roadways.

2.4 STORMWATER AND SEDIMENT CONTROL

General

Erosion and sediment control measures:

Development Certificate Approval also Civil and Hydraulic requirements

Waterways and drains

Waterways: If required, temporarily divert ditches, field drains and other waterways affected by excavation and reinstate on completion.

Stormwater drains: Divert drains detected during excavation, clear of the building, and reconnect as documented or obtain approval.

2.5 EXISTING WORKS TO REMAIN

Marking

Requirement: Identify existing works to remain with 1000 mm high, 50 x 50 mm timber stakes connected by yellow plastic tape to prevent accidental damage.

2.6 TREE REMOVAL

Designation

Marking: Identify trees and shrubs for removal by tagging 1000 mm above ground level.

Extent: Refer to Architectural documentation, Landscape documentation and Arborist Report

Tags: 100 x 50mmm zincanneal tags painted yellow and lettered to conform to tree number on drawings. Secure tags to trees using galvanised steel bands.

2.7 TREE PROTECTION

General

Refer to landscape documentation and Arborist Warning signs: In a prominent position at each entrance to the site, display warnings that trees and plantings require protection during the contract. Remove on completion.

Lettering: Road sign type sans serif letters, 100 mm high to AS 4970 Appendix C.

Protection measures: Provide before starting the earthworks.

Trees to remain

Extent: Trees not marked for removal.

Tree protection

Tree protection zone (TPZ): To AS 4970 Section 3.

Tree protective measures: To AS 4970 Section 4.

Monitoring and certification: To AS 4970 Section 5.

Work near trees

Materials placement: Conform to the following:

- Keep the area within the dripline of trees free of sheds and paths, construction material and debris.
- Do not place bulk materials and harmful materials within the dripline of trees.
- Do not place spoil from excavations against tree trunks.
- Prevent wind-blown materials such as cement from harming trees and plants.

Damage: Prevent damage to tree bark. Do not attach stays, guys and similar material to trees.

Work under trees: Do not remove topsoil from, or add topsoil to, the area within the dripline of the trees.

Excavation: If excavation is required near trees, give notice. Minimise period and extent of excavation within the dripline.

Hand methods: Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If excavation is required within the dripline, use hand methods so that root systems remain intact and undamaged.

Roots: Do not cut tree roots exceeding 50 mm diameter. If required to cut tree roots, use cutting methods that do not excessively disturb the remaining root system. Immediately after cutting, water the tree and apply a liquid rooting hormone to stimulate the growth of new roots.

Backfilling: Backfill excavations around tree roots. Place the backfill in layers of 300 mm maximum depth and compact to a dry density similar to that of the original or surrounding soil. Do not backfill around tree trunks to a height greater than 200 mm above the original ground surface. Immediately after backfilling, thoroughly water the root zone surrounding the tree.

Backfill material:

- Mix proportions (topsoil: well-rotted composts) by volume: 3:1.
- Neutral pH value.

- Free from weed growth and harmful materials.

Compacted ground: Do not compact the ground or use skid-steer vehicles under the tree dripline. If compaction occurs, give notice.

Compaction protection: Protect ground adjacent to the tree dripline.

Watering: Water trees as necessary, including where roots are exposed at ambient temperature more than 35°C.

Mulching: Spread 100 mm thick organic mulch to the whole of the area within the dripline of all existing trees to remain.

2.8 TEMPORARY LANDSCAPE FENCING

Fence dimensions

Height: 1200 mm.

Maximum post spacing: 5000 mm.

Component sizes

Corner and gate posts: Hardwood or preservative-treated softwood, 250 mm diameter.

Intermediate posts: Star picket.

Gate: Provide a suitable hinged gate with a gate latch.

Wire: Top, intermediate and bottom rows of 3.2 mm plain galvanized steel wire. Thread the top wire through pieces of plastic tube and through corner posts.

Removal

Completion: Remove the fence at the end of the planting establishment period.

2.9 TREE TRANSPLANTING REFER TO LANDSCAPING DRAWINGS / ABORIST REPORT IF REQUIRED

2.10 SITE NURSERY REFER TO LANDSCAPING DRAWINGS / ABORIST REPORT IF REQUIRED

2.11 TREE MAINTENANCE REFER TO LANDSCAPING DRAWINGS / ABORIST REPORT AS REQUIRED

General

Notice: Give notice before starting tree maintenance.

Pruning: To AS 4373 using a fully qualified and experienced arborist. Carry out all required works in a safe manner.

Execution

Requirement: Rectify any damage to existing trees to remain.

Operations: Remove dead and decayed wood or damaged limbs. Make all cuts at branch collars. If trees show signs of deterioration after the work is completed, ameliorate the soil by soil aeration, irrigation or incorporation of organic material. Continue this program until the end of the plant establishment period.

Root pruning: Do not excessively disturb the remaining root system. Cut off damaged roots cleanly inside the exposed or damaged area. Cover exposed root area with soil immediately after pruning, do not leave roots exposed.

Wetting and new root stimulation: Form a water collecting basin and apply a rooting hormone and wetting agent to the rootball.

Precautions: Avoid damage to trees being treated and to nearby trees and surroundings. Do not use trees as anchors for winching operations or bracing. Provide bracing as necessary before cutting to prevent uncontrolled breakages and damage to surroundings.

Failure: If repair work is impracticable, or is attempted and is rejected, remove the tree and root system and make restitution.

Restitution by replacement tree: Replace with tree of the same species and similar size

Tree maintenance schedule

Tree species	Description of work
Refer to Landscape documents	

Tree species	Description of work

2.12 COMPLETION

Temporary works

Remove at completion: temporary items including fences, tree protection and the like.

Site restoration

Requirement: Reinstate undeveloped ground surfaces to the condition existing at the commencement of the contract.

Clean up

Progressive cleaning: Keep the works clean and tidy, and regularly remove from the site, waste and surplus material arising from execution of the work.

Waste disposal: To *0172 Environmental management*.

Vermin management

Requirement: Employ a suitably qualified pest exterminator to remove vermin found during site preparation.

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ARCHITECTURAL SPECIFICATION

SERVICE TRENCHING

DOCUMENT No Z-0223

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BVN

PROJECT NO: 2010018

0223 SERVICE TRENCHING

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide trenching for underground services, as documented.

1.2 DESIGN

Requirements
General: To DESIGN in *0171 General requirements*.
Responsibility: Design and coordinate all trenching required for proposed inground services, as documented.
~~Trench design: Design and coordinate all trenching required for proposed inground services, as documented.~~
Existing services: Where possible, design to avoid all existing services. Locate existing services to **EXECUTION**, **EXISTING SERVICES**.
Authority requirements: Refer to Development Application Consent Conditions

1.3 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0171 General requirements*.
- *0221 Site preparation*
- *0222 Earthwork*
- *Landscape documents*
- *Hydraulic*
- *Electrical*
- *Other Services*
- ~~*Future* *Development Consent Approval Conditions*~~

1.4 STANDARDS

Trenching
Earthworks: To AS 3798.
Electrical services: To AS/NZS 3000.
Hydraulic services: To the AS/NZS 3500 series.
Communication services: AS/CA S009.

1.5 TOLERANCES

Surface levels
Earthworks: Finish the surface to the required level, grade and shape within the following tolerances:
- Under building slabs and load bearing elements: + 0, - 25 mm.
- Pavement subgrades: + 0, - 40 mm.
- Batters: No steeper than the slope shown on the drawings. Make sure flatter slopes do not impact on boundaries or required clearances to buildings, pavements or landscaping.
- Other ground surfaces: ± 50 mm, provided the area remains free draining and matches adjacent construction where required. Provide smoothness as normally produced by a scraper blade.

Pavement base and subbase: Finish the surface to the required level, grade and shape within the following tolerances:
- Subbase: + 10 mm, - 25 mm.
- Base: + 10 mm, - 5 mm.

Finished pavement or paving surface: Conform to the documented level within the following tolerances:

- Asphalt: ± 10 mm.
- Concrete: + 10 mm, - 0 mm.
- Paving:
  - Finished level: ± 8 mm.
  - Height deviation between adjacent units (lippage): ± 2 mm.
- Granular surfaces: ± 10 mm.
- Lippage between restored surface and adjacent existing surface: ± 5 mm.

1.6 SUBMISSIONS

Execution details

Excavation method: Submit details of proposed equipment and method of excavation, including the following:

- Service location and type: A plan of the trench works showing the location and type of service.
- Open excavation: Proposed duration.
- Shuttering and/or bracing of trench sides: If required for safety and stability, provide proposals.
- Geotechnical data: Geotechnical report supporting the procedures proposed for trenching and/or boring.
- Boring: Proposals for the following:
  - Limits on length.
  - Existence of other services and method of protection.
  - Pressure grouting to voids.
  - The effect of pressure grouting on other services, ground heave and proposals for minimising such effects.
  - Access to properties outside the site.
  - Council permits.
  - Service interruptions including a plan for minimising unintended interruptions.
- Hazards: Identify WHS hazards that may be encountered with deep trenches including toxic gases and liquids.

Off-site disposal location: Submit details of the proposed disposal locations and evidence of conformance with the relevant authorities for the disposal of material required to be removed from the site.

Records

As-built location: Upon completion submit to the relevant authority, as-built documentation to show the location of the installed services.

1.7 INSPECTION

Notice

Inspection: Give notice so that inspection may be made at the following stages:

- Items to be measured as listed in **GROUND CONDITIONS**, **Records of measurement**.
- Service trenches excavated before laying the service.
- Services laid in trenches and ready for backfilling.
- Completed surface restoration.

2 PRODUCTS

2.1 FILL MATERIALS

General

Suitable material: To AS 3798 clause 4.4 including inorganic, non-perishable material suitably graded and capable of compaction to the documented density.

Unsuitable materials: Do not use unsuitable material for fill in conformance with AS 3798 clause 4.3.

Sulfur content: Do not provide filling with sulfur content exceeding 0.5% within 500 mm of cement bound elements (for example concrete structures or masonry) unless such elements are protected by impermeable membranes or equivalent means.

Re-use of excavated material: Only re-use suitable material in conformance with AS 3798 clause 4.4.

Material in reactive clay areas: In sites classified M, M-D, H1, H1-D, H2, H2-D, E or E-D to AS 2870, re-use excavated site material at a moisture content within ± 1% of that of the adjoining in situ clay.

2.2 SURFACE RESTORATION MATERIALS

General

Re-use: If possible re-use the existing surface materials that were removed during trench excavation, whilst conforming to the documented material requirements.

Subbase and base

Requirement: Provide crushed rock material configured in layers and depths to match existing and adjacent work, as follows:

- Base: 20 mm nominal size.
- Subbase: 40 mm nominal size.

Pathways and paved surfaces generally

Requirement: Provide materials consistent with those of the existing surface before service trenching works commenced.

Concrete surfaces

Material requirements: Normal-class to AS 1379.

Concrete strength grade: N25.

Slump: Maximum 100 mm.

Asphalt surfaces

Aggregate: To AS 2758.5 or to AS 2758.2 for sprayed bituminous surfaces.

Asphalt: To AS 2150.

Medium cut back bitumen: To AS 2157.

Bitumen emulsion: To AS 1160.

Bitumen binder: Class 170.

Pavers

Concrete and clay pavers: To AS/NZS 4455.2.

Bedding and joint filling sand: Well-graded sand, free of deleterious material such as soluble salts which may cause efflorescence.

Stone pavers and setts: Provide sound stone pavers and setts of uniform quality. Reject any with defects liable to affect strength and durability.

Bedding mortar mix (cement:sand): Select from the range 1:3 to 1:4 to obtain satisfactory adhesion. Provide minimum water.

3 EXECUTION

3.1 EXISTING SERVICES

Location

Requirement: Before commencing service trenching, locate and mark existing underground services in the areas which will be affected by the service trenching operations.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Excavation

General: Do not excavate by machine within 1 m of existing underground services.

3.2 EXISTING SURFACES

Concrete and asphalt pavements

Method: Sawcut trench set out lines for the full depths of the bound pavement layers except where the set out line is located along expansion joints.

Removal of concrete and asphalt: Break out concrete or asphalt pavement material between the trench set out lines, remove and dispose of off-site.

Paving

Removal: Take up paving units both full and cut by hand, between the trench set out lines, and neatly stack on wooden pallets.

Concrete edging: Break out, remove and dispose of off-site.

Concrete subbase: If present, sawcut along the trench set-out lines.

Grass

Removal method: Neatly cut grass turf between trench set-out lines into 300 mm squares.

Grass suitable for re-use: Take up and store the turf and water during the storage period.

Unsuitable grass: Remove and dispose of off-site.

Small plants, shrubs and trees

Remove for re-planting: Take up and store. Wrap the rootball in a hessian or plastic bag with drain holes and water during the storage period.

Unsuitable vegetation: Remove and dispose of off-site.

3.3 GROUND CONDITIONS

As found site conditions

Unexpected conditions: If the following are encountered, give notice immediately and obtain instructions before carrying out any further work in the affected area:

- Bad ground.
- Discrepancies to expected ground conditions.
- Rock.
- Springs, seepages.
- Topsoil > 100 mm deep.

Records of measurement

Excavation and backfilling: If a schedule of rates applies, provisional quantities are specified, or there are variations to the contract levels or dimensions of excavations, do not commence backfilling or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.
- Quantities of excavations in rock.

3.4 EXCAVATION

General

Requirement: Excavate for underground services in conformance with the following:

- To required lines and levels, with uniform grades.
- Straight between access chambers, inspection points and junctions.
- With stable sides.
- Width tolerance: ± 50 mm, unless constrained by adjacent structures.
- Tree protection: To AS 4970.

Adjacent structures

Existing footings: If excavation is required within the zone of influence of an existing footing, use methods including (temporary) shoring or underpinning that maintain the support of the footing and make sure that the structure and finishes supported by the footing are not damaged.

Temporary supports: Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works, as follows:

- Lateral supports: Provide lateral support using shoring.
- Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

Permanent supports: If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

Encroachments: If encroachments from adjacent structures are encountered and are not shown on the drawings, give notice and obtain instructions.

Trench widths

General: Keep trench widths to the minimum, consistent with the laying and bedding of the relevant service and construction of access chambers and pits.

Trench depths

General: As required by the relevant service and its bedding method.

Obstructions

General: Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

Dewatering

General: Keep trenches free of water. Place bedding material, services and backfilling on firm ground, free of surface water.

Pumping: Provide pump-out from adjacent sumps or install well points.

Adjacent subsidence: Provide recharge points to isolate the dewatering zone.

Excess excavation

General: If trench excavation exceeds the correct depth, reinstate to the correct depth and bearing value using compacted bedding material or sand stabilised with 1 part of cement to 20 parts of sand by volume.

Stockpiles

Topsoil removal: Stockpile topsoil intended for re-use to a maximum height of 1500 mm.

Excavated material for backfill: If required, segregate the earth and rock material and stockpile, for re-use in backfilling operations.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted, dispose of excavated material off-site.

Unsuitable material

Disposal: Remove unsuitable material from the bottom of the trench or at foundation level and dispose of off-site. Replace with trench backfill material.

Boring

Subcontractor: If boring is required instead of trenches, engage a suitably qualified subcontractor to do the work.

3.5 TRENCH BACKFILL

General

Place fill: To AS 3798 clauses 6.2.2 and 6.2.6.

Timing: Backfill service trenches as soon as possible after laying and bedding the service, if possible on the same working day.

Removal of supports: Remove temporary supports progressively as backfilling proceeds.

Marking services

Marking tape: Provide marking tape above service, with appropriate labelling, to AS/NZS 2648.1 and as follows:

- Non-metallic services: Provide tape capable of being detected by inground scanning devices.
- Location: Locate tape approximately half the depth of the service being marked, to a maximum depth of 200 mm below the finished ground level.

Boring: If boring techniques are used to install the service, provide permanent on site labelling at the start and end of the service run and record on the as-built documentation.

Bedding, haunch, side and overlay zones

Installation and material: To the particular utility authority or utility service requirements. Secure pipes against floatation.

Bedding of services: Surround pipes or conduits on all sides with a minimum of 75 mm compacted bedding sand, or as documented.

Overlay zone thickness: Maximum 300 mm immediately over the utility service.

Trees

Backfill at trees: Backfill minimum 300 mm thick, around tree roots with a topsoil mixture. Place and compact in layers of 150 mm minimum depth to a dry density equal to that of the surrounding soil.

Original surface level: Do not place backfill above the original ground surface around tree trunks or over the root zone.

Watering: Thoroughly water immediately after backfilling the tree root zone.

Compaction

Control moisture within backfill: To AS 3798 clause 6.2.3.

Layers: Compact all material in layers not exceeding 150 mm compacted thickness. Compact each layer to the required relative compaction before starting the next layer.

Compaction: To AS 3798 Section 5.

Frequency of testing: To AS 3798 clause 8.7.

Precautions: Use compaction methods which do not cause damage or misalignment to utility services.

Density tests

Testing authority: Carry out density tests of pipe bedding and backfilling by an Accredited Testing Laboratory.

Test methods: Conform to the following:

- Compaction control tests: To AS 1289.5.4.1 or AS 1289.5.7.1.
- Field dry density: AS 1289.5.3.2 or AS 1289.5.3.5.
- Standard maximum dry density: AS 1289.5.1.1.
- Dry density ratio: AS 1289.5.4.1.
- Density index: AS 1289.5.6.1.

3.6 SURFACE RESTORATION

Subbase and base

Compaction: Uniformly compact each layer of the subbase and base courses over the full area and depth within the trench to a relative compaction of 100% when tested in conformance with AS 1289.5.4.1.

Compacted layer thickness:

- Maximum: 200 mm.
- Minimum: 100 mm.

Compaction test frequency: Minimum 1/every second layer/50 m² of restoration surface area.

Concrete surfaces

Construction: Conform to the following:

- Prime coat the cut edges of the existing surfaces with cement slurry. Lay and compact concrete so that the edges are flush and the centre is cambered 5 mm above the adjoining existing surfaces.
- Surface finish and pattern: Match existing adjoining work.
- Minimum thickness: 75 mm or the adjacent pavement thickness, whichever is thicker.
- Reinforcement and dowels: If required, provide steel reinforcement with dowels into the adjacent concrete.
- Expansion joints: 15 mm thick preformed jointing material of bituminous fibreboard placed in line with joints in existing concrete.
- Control joints:
  - Form control joints strictly in line with the control joints in existing concrete.
  - Around service poles: Terminate the concrete paving 200 mm from the pole and fill the resulting space with cold mix asphalt.

Weather: Do not place concrete in ambient temperatures above 30°C or below 10°C, without adequate precautions. Protect surface from rain damage, if required.

Compaction: Compact as follows:

- Thickness 100 mm or less: Compact by placing, screeding and finishing processes. If required use a hand-held vibrating screed at the surface. Do not use immersion vibrators.
- Thickness more than 100 mm and downturns: Use an immersion vibrator.

Curing: Cure by keeping continuously wet for 7 days.

Asphalt surfaces

Placement: To AS 2150.

Operations: Spread the asphalt mix in layers covering the full width of the trench.

Thickness: Match the adjoining asphalt surface.

Finish: Compact to a smooth even surface.

Sprayed bituminous surfaces: To AS 3727.1 Section 8.

Pavers

Bedding: Replicate the bedding used for the original paved surface. Use bedding methods and materials which are appropriate to the paver, the substrate, the conditions of service, and which leave the paver firmly and solidly bedded in the bedding material.

Laying: Re-lay to match the pattern and surface levels of the existing paving.

Damaged pavers unsuitable for relaying: Replace with new pavers of the same material, type, size and colour as the existing.

Landscaped areas

In topsoil areas: Complete the backfilling with topsoil for at least the top 100 mm.

Lawn: Re-lay stockpiled turf. If existing turf is no longer viable, re-sow the lawn over the trench and other disturbed areas.

Planted areas: Overfill to allow for settlement.

3.7 COMPLETION

General

As-built documentation: Upon completion, record the location of all installed services on the as-built documentation.

PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

QUALITY

DOCUMENT No Z-0160

ISSUE 4 | 15 MARCH 2024

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
2	28/01/2022	FOR TENDER	BFS	NS
3	13/06/2023	BAFO TENDER	BFS	NS
4	15/03/2024	CONSTRUCTION CERTIFICATE 1 APPROVAL	AC	AC

Each item deleted is ~~struck through~~
Each item added is in red and shaded

BVN

PROJECT NO: 2010018

PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

GENERAL REQUIREMENTS

DOCUMENT No Z-0171
ISSUE 4 | 15 MARCH 2024

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
2	28/01/2022	FOR TENDER	BFS	NS
3	13/06/2023	BAFO TENDER NB THIS SPEC IS BASED UPON APRIL 23 NATSPEC SPECIFICS FROM OLD SPEC HAVE BEEN TRANSFERRED TO THIS CURRENT SPEC	BFS	NS
4	15/03/2024	CONSTRUCTION CERTIFICATE 1 APPROVAL	AC	AC

Each item deleted is ~~struck through~~
Each item added is in red and shaded

BVN

PROJECT NO: 2010018

0171 GENERAL REQUIREMENTS

1 GENERAL

1.1 PRECEDENCE

General

Order of precedence: If there is conflict or inconsistency between the worksections of this specification, the requirements of worksections take the following order of precedence:

- All worksections other than those listed below.
- *0701 Mechanical systems, 0801 Hydraulic systems, 0901 Electrical systems* and *1001 Fire services systems.*
- *018 Common requirements* worksections.
- *0171 General requirements*.

1.2 CROSS REFERENCES

Common requirements

Requirement: Conform to the following worksections:

- *0181 Adhesives, sealants and fasteners*.
- *0182 Fire-stopping*.
- *0183 Metals and prefinishes*.
- *0184 Termite management*.
- *0185 Timber products, finishes and treatment*.
- *ESD Report*

Cross referencing styles

General: Within the text, titles are cross referenced using the following styles:

- Worksection titles are indicated by *Italicised* text.
- Subsection titles are indicated by CAPITAL text.
- Clause titles are indicated by **BOLD CAPITAL** text.
- Subclause titles are indicated by **Bold Sentence case** text.

1.3 MINIMUM STANDARDS

General

General: The architectural documents define the minimum acceptable standards for the respective works. Where the NCC-BCA, relevant statutes or codes, Australian Standards, product technical data, test certificates or relevant manufacturers' recommendations require or define superior or otherwise different requirements, provide those superior or different requirements, unless expressly documented or directed otherwise.

Obtain a direction

Requirement: In the event of any apparent conflict, ambiguity, omission or error within or between the various documents, obtain a direction before commencing the affected works.

1.4 MANUFACTURERS' RECOMMENDATIONS

General

General: Unless expressly documented or directed otherwise, provide and select, if no selection is given, transport, deliver, store, handle, protect, finish, adjust and prepare for use the manufactured items in conformance with the recommendations of the manufacturer or supplier (as appropriate for the particular item).

Proprietary items, systems and assemblies: Assemble, install or fix to substrates in conformance with the recommendations of the manufacturer or supplier.

Project modifications: Advise of activities that supplement or are contrary to the recommendations of the manufacturers or supplier.

- Requirement: Where modifications are proposed, obtain a direction before proceeding with the affected works.

-

1.5 REFERENCED DOCUMENTS

General

Precedence: The requirements of worksections override conflicting requirements of their referenced docuents. The requirements of the referenced documents are minimum requirements.

Contractual relationships

General: Responsibilities and duties of the principal, architect / managing contractor / superintendent and the respective subcontractors are not altered by requirements in the documents referenced in the specification worksections.

Current editions

General: Use referenced documents which are the editions, with amendments, current one month before the closing date for tenders, except where different editions or amendments are required by applicable legislation.

Site copies: As required by the Contract or by other architectural documents.

Format: Provide either hard copies or access to digital copie

Exception to current editions: If statutory requirements reference other editions or standards, conform to those other editions or standards.

Maintenance and repair works: If statutory requirements applicable to the maintenance or repair works reference other editions or standards, conform to those other editions or standards.

European standards: Any national European Standard (e.g. BS EN, IS EN or DIN EN) may be used in place of the equivalent referenced European Standard (EN).

1.6 CONTRACT DOCUMENTS

Services diagrammatic layouts

General: Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable.

Before commencing work:

- Obtain measurements and other necessary information.
- Coordinate the design and installation in conjunction with all trades.

Levels

General: Spot levels take precedence over contour lines and ground profile lines.

Drawings and manuals for existing services

Subsurface services: Information shown on the drawings relating to underground or submerged services is accurate to the following quality level:

- Quality level to AS 5488.1 (2022): A

Warranty: No warranty is given as to the completeness or accuracy of drawings and/or manuals of existing services.

1.7 INTERPRETATION

Abbreviations

General: For the purposes of this specification the following abbreviations apply:

- AS: Australian Standard.
- BCA: National Construction Code Series Volume One: Building Code of Australia Class 2 to 9 Buildings and Volume Two: Building Code of Australia Class 1 and Class 10 Buildings.
- EN: European Norm (European Standard).
- GRP: Glass Reinforced Plastic.
- IP: Ingress protection.
- NATA: National Association of Testing Authorities.
- NCC: National Construction Code.
- NZS: New Zealand Standard.
- PCA: National Construction Code Series Volume 3: Plumbing Code of Australia.
- PVC: Polyvinyl Chloride.
- PVC-U: Unplasticised Polyvinyl Chloride. Also known as UPVC.

- SDS: Safety data sheets.
- VOC: Volatile Organic Compound.
- WHS: Work Health and Safety.

Definitions

General: For the purposes of this specification, the following definitions apply:

- Acceptable: Means acceptable to the architect / superintendent / managing contractor
- Access for maintenance: Includes access for maintenance, inspection, measurement, operation, adjustment, repair, replacement and other maintenance related tasks.
- Accredited: Accredited, licensed, registered and similar terms mean accredited by a relevant statutory authority, or by an acceptable professional body, NATA-registered organisation, or product or material supplier, according to the context.
- Accessible, readily: Readily accessible, easily accessible, easy access and similar terms mean capable of being reached quickly and without the use of a tool, without hazard, climbing over or removing obstructions, using a movable ladder, and in any case not more than 2.0 m above the ground, floor or platform.
- Accredited Testing Laboratory:
  . An organisation accredited by the National Association of Testing Authorities (NATA) to undertake the relevant tests; or
  . An organisation outside Australia accredited to undertake the relevant tests by an authority recognised by NATA through a mutual recognition agreement; or
  . An organisation recognised as being an Accredited Testing Laboratory under legislation at the time the test was undertaken.
  . An organisation accredited for compliance with ISO/IEC 17025 (2017) to undertake the relevant tests.
- Appropriately qualified person: To NCC (2022) Schedule 1.
- Approved: Reviewed, directed, rejected, endorsed and similar expressions mean approved (reviewed, directed, rejected, endorsed) in writing by the contract administrator.
- Attendance: Attendance, provide attendance and similar expressions mean give assistance for examination and testing.
- Competent person: As defined by the relevant legislation, or otherwise as adjudged by the architect / superintendent / managing contractor / building certifier
- Baseline data: Data derived from the final design, installation and commissioning, which serve as a basis for verification of results of routine servicing.
- Commissioning: Advancement of an installation from static completion to full working order, including verification that the systems, subsystems, and their components meet the project requirements. This includes all work described as commissioning in referenced documents, even if carried out before static completion.
- Contract administrator: Has the same meaning as architect, superintendent or principal's authorised person superintendent and is the person appointed by the owner or principal under the contract.
- Contractor: Has the same meaning as builder and is the person or organisation bound to carry out and complete the work under the contract.
- Default: Specified value, product or installation method that is to be provided unless otherwise documented.
- Design life: The period of time for which it is assumed, in the design, that an asset will be able to perform its intended purpose with only anticipated maintenance but no major repair or replacement being necessary.
- Design parameters: Information used as the basis for design. It includes design requirements, performance criteria, performance parameters and similar terms.
- Documented: Documented, as documented and similar terms mean contained in the contract documents.
- Economic life: The period of time from the acquisition of an asset to the time when the asset, while still physically capable of fulfilling its function and with only anticipated maintenance, ceases to be the lowest cost alternative for satisfying that function.

- Electricity distributor: Any person or organisation that provides electricity from an electricity distribution system to one or more electrical installations. Includes distributor, supply authority, network operator, local network service provider, electricity retailer or electricity entity, as may be appropriate in the relevant jurisdiction.
- Errors and omissions: For the design prepared by the contractor, errors and omissions have the same meaning as defects.
- Fire hazard properties: To NCC (2022) Schedule 1.
- For consideration: Means for consideration by the architect / superintendent / managing contractor, in conjunction with relevant members the consulting team.
- Gas Network Operator: Has the same meaning as network operator in AS/NZS 5601.1 (2022).
- Geotechnical site investigation: The process of evaluating the geotechnical characteristics of the site in the context of existing or proposed construction.
- Give notice: Give notice, submit, advise, inform and similar expressions mean give notice (submit, advise, inform) in writing to the contract administrator.
- High level interface: Systems transfer information in a digital format using an open system interface.
- Hold point: The relevant activity may not proceed without the architect's / superintendent's / managing contractor's authorisation. Give the required notice and obtain a direction before proceeding with the affected works.
- Managing contractor: The person or organisation bound to carry out and complete the works under the contract with the principal.
- Non-combustible: Means a material or element that is non-combustible when tested in accordance with AS 1530.1 or is deemed non-combustible by the BCA, or by other acceptable means.
- Principal's Authorised Person: As defined in the contract
- Hot-dip galvanized: Zinc coated to AS/NZS 4680 (2006) after fabrication with coating thickness and mass to AS/NZS 4680 (2006) Table 1.
- Ingress protection: IP, IP code, IP rating and similar expression have the same meaning as IP Code in AS 60529 (2004).
- Joints:
  . Construction joint: A joint with continuous reinforcement provided to suit construction sequence.
  . Contraction joint: An opening control joint with a bond breaking coating separating the joint surfaces to allow independent and controlled contraction of different parts or components, induced by shrinkage, temperature changes or other causes. It may include unbound dowels to assist vertical deflection control.
  . Control joint: An unreinforced joint between or within discrete elements of construction that allows for relative movement of the elements.
  . Expansion joint: A closing control joint with the joint surfaces separated by a compressible filler to allow axial movement due to thermal expansion or contraction with changes in temperature or creep. It may include unbound dowels to assist vertical deflection control.
  . Sealant joint: A joint filled with a flexible synthetic compound that adheres to surfaces within the joint to prevent the passage of dust, moisture and gases.
  . Structural control joint: A control joint (contraction, expansion and isolation) in structural elements when used with applied material and finishes.
  . Substrate joint: A joint in the substrate, which includes construction joints and joints between different materials.
  . Weakened plane joint: A contraction joint created by forming a groove, extending at least one quarter the depth of the section, either by using a grooving tool, by sawing, or by inserting a premoulded strip.
- Local authority (local council): A body established for the purposes of local government by or under a law applying in a state or territory.
- Low level interface: Systems transfer information via terminals and voltage free contacts.
- Manufacturer's recommendations: Recommendations, instructions, requirements, specifications (and similar expressions) provided in written or other form by the manufacturer and/or supplier relating to the suitability, use, installation, storage and/or handling of a product.
- Metallic-coated: Steel coated with zinc or aluminium-zinc alloy as follows:

  - Metallic-coated steel sheet: To AS 1397 (2021). Metal thicknesses specified are base metal thicknesses.
  - Ferrous open sections zinc coated by an in-line process: To AS/NZS 4791 (2006).
  - Ferrous hollow sections zinc coated by a continuous or specialised process: To AS/NZS 4792 (2006).
- Network Utility Operator: To NCC (2022) Schedule 1. A person who undertakes the piped distribution of drinking water or non-drinking water for supply; or is the operator of a sewerage system or a stormwater drainage system.
- Obtain: Obtain, seek and similar expressions mean obtain (seek) in writing from the contract administrator.
- Pipe: Includes pipe and tube.
- Practical completion or defects free completion: The requirements for these stages of completion are defined in the relevant building contract for the project.
- Pre-commissioning: Verifying that the installation of a system is complete and ready for commissioning.
- Principal: Principal has the same meaning as owner, client and proprietor and is the party to whom the contractor is legally bound to construct the works.
- Professional engineer: To NCC (2022) Schedule 1.
- Proprietary: Identifiable by naming the manufacturer, supplier, installer, trade name, brand name, catalogue or reference number.
- Prototype: A full size mock-up of components, systems or elements to demonstrate or test construction methods, junctions and finishes, and to define the level of quality.
- Provide: Provide and similar expressions mean supply and install and include development of the design beyond that documented.
- Record drawings: Record drawings has the same meaning as as-installed drawings, as-built drawings and work-as-executed drawings.
- Recovered/reclaimed materials: Material previously used in a building or project that is then re-used in another project. The material may be altered, re-sized, refinished, or adapted, but is not reprocessed in any way, and remains in its original form.
- Referenced documents: Standards and other documents whose requirements are included in this specification by reference.
- Required: Required by the contract documents, the local or statutory authorities.
- If required: A conditional specification term for work that may be shown in the documents or is a legislative requirement.
- Sample: A physical example that illustrates workmanship, materials or equipment, and establishes standards by which the work will be judged. It includes samples and sample panels.
- Selected: Selected, selection and select mean selected by the architect / superintendent / managing contractor, in conjunction with the relevant members of the project consulting team.
- Statutory authority: A public sector entity created by legislation, that is, a specific law of the Commonwealth, State or Territory.
- Static completion: The state of a system when installation works are complete but have not been commissioned.
- Subcontractor / contractor / trade contractor: The person or entity carrying out works under a contract with the contractor / managing contractor
- Supply: Supply, furnish and similar expressions mean supply only.
- Tests - integrated system: Tests conducted on the project as a complete, integrated system to verify successful integration, interaction, and operation of all interrelated systems to the project requirements.
- Tests - production: Tests carried out on an item, before delivery to the site.
- Tests - site: Tests carried out on site.
- Tests - type: Tests carried out on an item identical with a production item, including with respect to materials, material suppliers, manufacturing processes, dimensions and marking.
- T-Sheet: refers to Technical Reference Schedule (also referred to as Schedules) which contains codes used on architectural documents (especially drawings), proprietary items and performance

requirements. When the T-Sheet is cross referenced in this specification all Architectural Schedules are deemed to be included.

- Tolerance: The permitted difference between the upper limit and the lower limit of dimension, value or quantity.
- Utility service provider: Includes Electricity distributor, Network Utility Operator, Gas Network Operator and organisations providing other reticulated utilities including data and telecommunications services.
- Verification: Provision of evidence or proof that a performance requirement has been met or a default exists.
- Witness point: The architect / superintendent / managing contractor may, at its discretion, inspect or review an item, but this does not involve an obligation. Give the required notice, but after that period the affected work may proceed without authorisation.

1.8 DESIGN LIFE

Design Life Criteria	Time Frame
External concrete elements	50 years
Structures (including membranes)	40 years
Building Fitout	12 years
Building engineering services	15 years*
Road pavements and hardstands	20 years
Cladding and roofs	20 years
Windows and sun shading measures	20 years
Building fabric	15 years
Internal finishes and fitments	5 years
Water reticulation systems/components	25 years
Sewerage reticulation systems/components	25 years
Stormwater drainage system/components	50 years

2 SUBMISSIONS AND INSPECTIONS

2.1 SUBMISSIONS

Purpose and review process

General: Submissions are generally provided for information only and impose no contractual obligations on the principal and the architect / superintendent / managing contractor or the consultant team.

Notwithstanding this, where submissions are noted as ‘hold points’, ‘for approval’, or similar terms, the affected works may not proceed without authorisation. The architect / superintendent / managing contractor also reserves the right to review and comment, or reject, any submissions that are considered non-compliant, inadequate or unsuitable.

Other requirements: Refer also to the Contract.

2.2 SUBMISSIONS CONTRACTOR'S / SUBCONTRACTOR'S RESPONSIBILITY

The following have components of Contractor / Subcontractor Design Responsibility (to read in conjunction with each trade section) :

- *Adhesives sealants and fasteners*
- *Timber products, finishes and treatment*
- *Curtain walling*
- ~~*Windows and glazed doors*~~
- ~~*Cladding – combined*~~
- ~~*Cladding – flat sheets and panels*~~
- ~~*Cladding – profiled sheet*~~
- ~~*Balustrades and handrails*~~
- *Fabricated metalwork*
- *Signage*
- Refer also to individual trade work sections

General

General: Where the documents allocate design responsibility to the contractor / subcontractor, they generally show the design intent, general arrangements and indicative detailing, and define performance criteria and quality. The ultimate responsibility for the compliance and performance of the completed items remains with the contractor / subcontractor.

Requirement: Engage acceptable registered, licensed or accredited persons (also including 'competent persons' to design, document, inspect and certify building and fitout elements as documented.

Structural design actions

General: Refer also to the structural documents.

Inspections and submissions

Carry out the following as required or as otherwise necessary:

- Submit credentials of proposed designers for consideration.
- Carry out detail design and documentation of aspects as documented and as otherwise necessary for the particular works.
- Submit copies of documentation and design certificates, also including authority-specific forms where required for initial building approval before commencement of the relevant works.
- Prepare any required authority applications and associated documentation and pay fees associated with any required approvals and licensing of installations. Submit copies demonstrating compliance.
- Submit inspection certificates, also including authority-specific forms where required for the issue of occupancy certificates, at or before Practical Completion of the works under the contract.

2.3 SAMPLES, PROTOTYPES AND SAMPLE PANELS

General: Provide samples, prototypes and sample panels where documented or otherwise required or directed. Maintain these items in good order and protect from damage during the contract.

Incorporation

General: Unless documented otherwise, approved items may be incorporated in the works, where suitable for that purpose and provided they are adequately protected during the contract.

Otherwise, demolish and remove traces prior to completion of the work under the relevant contract, unless directed otherwise.

Project record copies

General: Provide the principal with record copies of all project correspondence and documentation filed on the project administration website during the contract.

Document formats: As provided in the original uploads.

Medium: DVDs with fully descriptive labels.

Number of copies:6

Timing: Within 4 weeks after Practical Completion of the work under the contractGeneral

Requirement: Make submissions, as documented.

Submit to: [complete/delete]

Contractor review: Before submitting, review each submission item, and check for coordination with other work of the contract and conformance to contract documents.

Submission times

Default timing: Submit information or other material for information, comment or approval at least 5 working days before ordering products or starting installation of the respective portion of the works.

Submission programme times

Default timing: Make submissions submit a programme of proposed submission dates for the following critical items and major components:

- Prototyping including but not limited to
- Fabricated metalwork that is balustrades /supporting structure
- Timber products, finishes and treatment that is timber walkway and supports
- Shop drawings
- - Concrete – combined that is concrete wall
- - Fabricated metalwork that is balustrades /supporting structure and gates
- Options
- - motorised sliding metal gates pricing for materials / finishes / operating mechanisms

Refer to trade sections for further requirements

Submission response times: Allow in the construction program for at least the following times:

- Shop drawings: 7 working days for up to 50 drawings more for greater than 50 drawings
- Samples and prototypes: 5 working days
- Manufacturers' or suppliers' recommendations: 5 working days
- Product data: 5 working days
- Product/design substitution or modification: 5 working days

Proposed products schedules: Submit a schedule of proposed products that have not been specified as proprietary items within 3 weeks of starting work on site.

Identification

Requirement: Identify the project, contractor, subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include relevant contract document references. If the submission covers more than one item, identify the item in the contract documents the submitted items relate to.

Non-conformance: Identify proposals that do not conform with project requirements, and characteristics that may be detrimental to successful performance of the completed work.

Errors

Requirement: If a submission contains errors, make a new or amended submission as appropriate, indicating changes made since the previous submission.

Electronic submissions

Electronic copies file format: pdf and dwg / dxf / rivet (for 3 dimensional

Project requirements

General: Submit the following, as documented:

- Authority approvals: Notes of meetings with regulatory authorities and utility service providers whose requirements apply to the work and evidence that notices, fees and permits have been sought and paid, that utility service provider connections are complete and that statutory approvals by the authorities whose requirements apply to the work have been received.
- Baseline data: To **BASELINE DATA**.
- Building penetrations: Details of the methods to maintain the required structural, fire and other properties to **BUILDING PENETRATIONS**.
- Certification: Certificates of conformance to documented requirements.
- Commissioning plan: For the whole of the work to **COMMISSIONING**.
- Commissioning program: For the whole of the work to **COMMISSIONING**.
- Design documentation: Drawings, calculations and specifications as documented.
- Electronic facility and asset management information: For the whole of the work to **ELECTRONIC FACILITY AND ASSET MANAGEMENT INFORMATION**.

- Execution details: Execution programs, schedules and details of proposed methods and equipment. For building services include the following:
  - Embedded services: Proposed method for embedding services in concrete walls or floors or chasing into concrete or masonry walls.
  - Fixing of services: Typical details of locations, types and methods of fixing services to the building structure.
  - Inaccessible services: If services will be enclosed and not accessible after completion, submit proposals for location of service runs and fittings.
- Fire performance: Evidence of conformity to requirement for combustibility, fire hazard properties and fire-resistance of building elements.
- Marking and labelling: Samples and schedules of proposed marking and labels to **MARKING AND LABELLING**.
- Operation and maintenance manuals: For the whole of the work to **OPERATION AND MAINTENANCE MANUALS**.
- Products and materials: Products and materials data, including manufacturer's technical specifications and drawings, product data sheets, type tests results, evidence of conformity to documented requirements, product certification, performance and rating tables, service connection requirements and installation and maintenance recommendations.
- Prototypes: Prototypes of components, systems or elements.
- Records: As-built documents, photographs, system diagrams, schedules and logbooks to **RECORD DRAWINGS**.
- Samples: Representative of proposed products and materials and including proposals to incorporate samples into the works, if any to **SAMPLES AND PROTOTYPES**.
- Shop drawings: To **SHOP DRAWINGS**.
- Substitutions: To **SUBSTITUTIONS**.
- Tests:
  - Test reports for testing performed under the contract.
- Warranties: To **WARRANTIES**.

2.4 INSPECTION

Notice
Concealment: If notice of inspection is required for parts of the works that are to be concealed, give notice when the inspection can be made before concealment.

Notification times
Minimum notice: As documented.

Light levels
Lighting levels for inspection: To AS/NZS 1680.2.4 (2017).

Attendance
General: Provide attendance for documented inspections and tests.

2.5 FACADE TESTING

General *[*
General: Engage acceptable accredited independent consultants to carry out testing of facade prototype installations (cladding and windows) to demonstrate compliance with the documented requirements.

Fees and costs: Paid by the contractor / subcontractor.

Requirement: submit reports and test results.

Standards
Conform to the requirements of the following codes:

- Structure: AS 1170
- Windows installations: AS 2047.
- General testing protocols: AS/NZS 4284.
- Fire-resistance properties: AS 5113.
- Other codes as may be applicable to the particular works.

Extent of testing

.

General: Provide prototypes of the following system types:

Refer to each trade work sectionSize of each prototype:

- Width (mm): One structural grid
- Height: Two storeys.
- Refer to each trade work section

Required testing: allow for following to be confirmed by independent Façade Engineer

- Structural adequacy.
- Fire-resistant properties.
- Air infiltration.
- Water penetration.
- Seismic performance.
- Acoustic insulation refer to following Acoustic Installation testing and refer to each trade work section Prototype locations: Where directed.

Remedial works

- Requirements: Refer to the clause **REMEDIAL WORKS** in this worksection

2.6 ACOUSTICAL INSTALLATIONS TESTING

General

General: Engage an acceptable accredited consultant to carry out testing of completed acoustically-rated elements, to demonstrate compliance with the documented requirements.

Fees and costs: Paid by the contractor / subcontractor.

Standards

Conform to the requirements of AS/NZS 2107.

Extent of testing

General: Elements documented with an acoustical insulation rating:

- Building facades locations: Refer to trade work sections
- Partitions – framed and lined:
  - . All prototypes.
  - . As built installations:of each acoustically-rated partition type.
- Partitions – glazed:
  - . All prototypes.
  - . As built installations: of each acoustically rated partition and panel type.
- Operable walls: Each installation.
- Floors:
  - . All prototypes.
  - . As built installations: of each acoustically-rated floor type.

Requirement: Achieve an as-tested result no more than the amount indicated by the Acoustic Engineer and relevant BCA and Australian Standard requirements lessthan the documented Rw rating.

Testing locations: Where directed.

Remedial works

Requirements: Refer to the clause **REMEDIAL WORKS** in this worksection.

- Refer to the clause **REMEDIAL WORKS** in this worksection

2.7 SLIP-RESISTANCE OF FLOOR FINISHES

Standards generally

General: To AS/NZS 4586.

Other requirements: Achieve slip-resistance classifications for completed integral and applied floor finishes as documented. Where classifications of finishes are not documented, comply with the

recommendations of Australian Standards handbooks *HB 197* and *HB 198*, whichever provides the superior requirement.

Accelerated wear tests

General: Where product examples are not documented, or where substitutions are proposed, provide only materials and finishes that satisfy the documented slip-resistance requirements after being subjected to accelerated wear testing by an acceptable accredited laboratory.

- Number of cycles: 1000 (minimum).

Requirement: Submit evidence of compliance.

Minimum standards

Requirement: Unless expressly documented otherwise, achieve the following 'pendulum' results for slip-resistance classifications for floor finishes, when tested at completion of the respective works:

- Internal (dry): P2.
- Internal (sometimes wet): P3.
- Rooms with showers or baths: P3.
- External horizontal or near horizontal areas, including covered unenclosed areas: P4.
- External areas with a gradient of 1:20 and steeper, including covered unenclosed areas: P5.
- Carpark ramps: P5.

Ramp ('R') classifications: Not applicable (unless expressly documented otherwise).

Cleaning regimens

Requirement: Provide detailed recommendations for the maintenance of the slip-resistance ratings.

2.8 SLIP-RESISTANCE TESTING

General

Standard: To AS/NZS 4663

General: Engage and pay all fees for an acceptable licensed or otherwise accredited person to carry out testing of prototypes and completed external and internal finishes for slip-resistance performance, to ensure compliance with the documented requirements.

Extent: All self-finished floors and floor covering and coating types (other than carpet):

- Each prototype.
- Completed finishes: As documented. Where not documented, carry out a minimum of 2 tests for each finish type.
- Locations: Where directed.

Timing of testing: Complete the testing and provide certification in sufficient time to enable any required rectification and retesting of the surfaces to be carried out prior to Practical Completion.

Other requirements

General: Refer also to the drawings, finishes schedules and relevant trade work sections.

Requirement: Where there is any conflict or ambiguity, obtain a direction before proceeding with the affected works.

Remedial works

Requirements: Refer to the clause **REMEDIAL WORKS** in this work section.

2.9 REMEDIAL WORKS

General

General: Where any prototype or completed installation fails to meet the documented requirements or other relevant performance criteria resulting from inadequate design (where design is the contractor's / subcontractor's responsibility), materials or workmanship, submit proposals for remedial works for consideration. Obtain an instruction before proceeding with the affected works.

Requirement: Carry out remedial works and pay all costs for inspections and re-testing until the documented requirements and performance criteria are satisfied, all at no additional cost to the contract.

2.10 CONTRACTOR'S / SUBCONTRACTOR'S START-UP MEETING

General

General: Where documented or where directed, attend a start-up and review meeting before commencing detail design or ordering materials.

Attendees: The project manager's / architect's / managing contractor's representatives, relevant consultants' nominated representatives, the contractor's / subcontractor's project management personnel, and separate subcontractors carrying out adjacent works, as nominated by the architect / managing contractor.

Minutes: Prepared by the project manager / architect / managing contractor and distributed to all attendees.

3 PERFORMANCE

3.1 BUSHFIRE-PRONE AREAS

General

Bushfire Attack Level (BAL) to AS 3959 (2018): Non-applicable

Bushfire-resistant design and construction: To Non-applicable

3.2 CORROSION RESISTANCE

Atmospheric corrosivity category

General: Atmospheric corrosivity category as defined in AS 4312 (2019):

- Exterior atmospheric corrosivity category: C3
- Interior atmospheric corrosivity category: C2

Galvanizing

Severe conditions: Galvanize mild steel components (including fasteners) to AS/NZS 1214 (2016) or AS/NZS 4680 (2006) as appropriate, if:

- Exposed to weather.
- Embedded in masonry.
- Exposed to or in air spaces behind the external leaf of masonry walls.
- In contact with chemically treated timber, other than copper chrome arsenate (CCA).

Green Star

- NB this project is has an aspiration to achieve 5 Green Star, but necessarily to achieve formal certification.
- The Contractor shall confirm with the ESD requirements of the documents including but not limited to the ESD SSDA Report and ESD Specification . If there is any conflict between the ESD Report / ESD Specification and other documents then the greater shall be allowed for. Seek immediate clarification in writing.

3.3 NOISE LEVELS

General

Requirement: Install systems to operate within the noise level limits, as documented for the contract design and documented equipment performance.

Refer also ~~future~~ Development Approval Consent Conditions

3.4 STRUCTURE

General

Requirement: If required, provide structures, installations and components as follows:

- Fixed accessways: To AS 1657 (2018).
- Structural design actions: To the AS/NZS 1170 series.

Importance level: 11

4 DESIGN

4.1 DESIGN DEVELOPMENT

General

Requirement: Complete the design of the work, including development of the design beyond that documented.

Conflict with the documents: If it is believed that a conflict exists between statutory requirements and the documents, notify the contract administrator immediately and provide a recommendation to resolve the conflict.

Verification and validation: Provide and document a design that can be verified and validated as conforming to the documented design and statutory requirements.

Certification of the design

Requirement: Submit certification verifying conformance of the design to the documented and statutory requirements.

Certifier: To **DESIGNER**.

Design program

Requirement: Submit a program showing the dates for submission of design documents for the following stages:

- Schematic Design 10% of design.Design development 50% of design
- Completion of documentation 100% of design

Timing of program: Submit the programme no later than 10 working days from the date of execution of the contract..

Staged submissions

Timing: Submit the following:

- Tender specification: Submit copies of the tender specification when tenders are called.
- Amendments: Submit copies of amendments to the tender specification when they are issued to the contractor.

Requirement: Submit the documented items at the stages as follows:

Submit the programme no later than 10 working days from the date of execution of the contract..

Before commencing design

Requirement: Submit the names, qualifications, experience and registration details of persons responsible for design and certification.

Other submissions

Requirement: Make documented submissions, not listed above, progressively before completion of design.

Authority approvals

Requirement: Obtain authority approvals for the work documented to meet the construction program. The Contractor shall allow and include the payment of any fees.

4.2 DESIGNER

General

Design by contractor: If the contractor provides design, use only appropriately qualified and registered persons.

Engineering design by contractor: If the contractor provides engineering design:

- Provide design carried out by, or under the supervision of, a professional engineer qualified and experienced in the relevant field.
- Evidence: Signature of a nominated professional engineer in the respective discipline to each design document submitted.
- Insurance: Provide evidence of currency of insurance of the engineering designer for professional indemnity insurance and public liability.

Designer's services during construction

Designer's attendance on site: Carry out sufficient site inspections so that the design intent of the documents prepared by the designer is fulfilled including but not limited to:

- Review of shop drawings and equipment selection
- Review of calculations
- Review of construction and manufacturers' certificates
- Witnessing of completion tests
- Certification that the works conform to the documents prepared by the designer
- Any other task required to meet the requirements of the documents

NB the independent Façade Engineer is carry out all of the above and in addition:

- Provide advice as necessary to complete the design of awnings, façade picture window, balustrades, balustrades with tensile wires, palisade balustrade and glazing.
- Provide advise and co-ordinate with a Structural Engineer framing systems for all the façade systems

4.3 CONSULTATION

Statutory authorities
Requirement: Future Development Approval Consent Conditions.

User groups
Requirement: to be advised

Contract administrator
Requirement: The Superintendent shall be kept informed of the Contractors' dealings with Authorities in a progressive manner. The Contractor shall allow for reviews if so called upon the Superintendent particularly with major approvals.

4.4 ALTERNATIVE DESIGN SOLUTIONS

Conforming alternative design solutions
Requirement: If alternative design solutions are available within the documented requirements, submit the proposed solution with a comparison to alternatives. Compare the alternatives including for the following factors:

- Anticipated life.
- Energy consumption.
- Environmental impact, including greenhouse gas emissions.
- Maintenance requirements.
- Access for maintenance.
- Flexibility for future changes.
- Safety of building occupants including maintenance personnel.
- Safety of equipment.
- Sustainability.
- Other information required for submission in *Substitutions*.

Non-conforming alternative design solutions

Requirement: If the proposed design solution does not conform to the documented requirements, conform to *Substitutions*.

Costs
Requirement: Pay the cost of submissions and evaluation and/or testing of proposed alternatives, whether subsequently adopted or not. The costs will be calculated at the current charge-out rates of the relevant consultant.

4.5 DESIGN DOCUMENTS

General
Requirement: Provide calculations, drawing, shop drawings, digital models and specifications to document a design conforming to the documented design parameters and statutory requirements, as required.

Drawings
Requirement: To SHOP DRAWINGS.s

Drawing registers: Submit drawing registers with the drawings showing current and previous drawing issues.

Specifications
Requirement: Provide project specific specification using the NATSPEC National Master Specification and incorporating this specification by reference.

Variations from this specification: If it is proposed to depart from the wording of this specification, submit the proposed changes as documented in DESIGN DEVELOPMENT.

Licence: Provide specifications prepared by a current subscriber to the applicable NATSPEC package.

Worksections: Use worksections from the current update of NATSPEC and customise for the project.

Additional material: If the specification requires material not included in this specification, use worksections from the current update of NATSPEC and customise for the project.

Additional content: If additional content is required for the project specification not covered in either this or NATSPEC worksections, provide additional text using the NATSPEC structure, terminology and format.

Rendunant content: Delete redundant content from the NATSPEC worksection Templates.

4.6 ERRORS IN AND OMISSIONS FROM THE DESIGN

General

Requirement: If the design contains errors and/or omissions, correct the errors and make a new or amended submission, as appropriate, indicating changes made since the previous submission.

Notice: Immediately on detecting a design error and/or omission, submit notification in writing describing the error and/or omission, anticipated consequences and proposed corrective action.

Consequences of errors and/or omissions: Pay the costs associated with correcting design errors and/or omissions and minimise the effects of the errors.

5 PRODUCTS AND MATERIALS

5.1 GENERAL

Sources policy

General: A preference for Australia and New Zealand goods

Consistency

General: For each material or product use the same source or manufacturer and provide consistent type, size, quality and appearance.

Low VOC emitting paints

Paint types: To the recommendations of AS/NZS 2311 (2017) Table 4.2.

Prohibited materials

General: Do not provide the following:

- Materials, exceeding the limits of those listed, in the Safe Work Australia *Hazardous Chemical Information System* (HCIS) Workplace exposure standards.
- Blowing agents:
  - Materials that use chlorofluorocarbon (CFC) or hydrochlorofluorocarbon (HCFC) in the manufacturing process.
  - A blowing agent with a global warming potential (GWP) ≥ 700.

Certification

- General: Provide only products with certification by a NATA-accredited testing laboratory.
- Requirement: Submit documentary evidence attesting to compliance with this and the documented performance requirements where documented or when requested.
- Other materials not permitted on the project
- General: Unless expressly documented or directed otherwise, do not provide materials included in the *Living Building Challenge Red List* as published by the International Living Future Institute.
- Requirement: Submit evidence on request.

5.2 PROPRIETARY ITEMS

Manufacturer's or supplier's recommendations

General: Provide manufactured items to the manufacturer's or supplier's recommendations.

Proprietary items/systems/assemblies: Assemble, install or fix to substrate to the manufacturer's or supplier's recommendations.

Project modifications: Advise of activities that supplement, or are contrary to the manufacturer's or supplier's recommendations.

Identification of proprietary items

Sealed containers: If items are supplied by the manufacturer in closed or sealed containers or packages, bring them to point of use in the original containers or packages.

Other items: Marked to show the following, as applicable:

- Manufacturer's identification.
- Brand name.
- Product type.
- Quantity.
- Reference code and batch number.
- Date of manufacture.

5.3 SUBSTITUTIONS

General

General: Unless noted "substitutions not permitted" or similar terms, proposals for alternative materials, components or methods of equal or better quality may be submitted for consideration.

Requirements: Submit sufficient information to permit evaluation of the proposed substitutions, including but not necessarily limited to the following:

- Detailed breakdowns to explicitly demonstrate compliance with each of the individual requirements.
- Evidence that the performance is equal to or greater than the documented requirements.
- Evidence that the item will match the spatial and dimensional requirements of the product example.
- Effect on contract technical documents (if any) and necessary changes.
- Samples, prototypes and sample panels as directed.
- Essential technical information, in English.
- Statement of the extent of any revisions to the construction program.
- Statement of any consequential alterations to other parts of the works.
- Acknowledgement that the substitution will be of no additional cost to the contract, whether directly or incidental or consequential cost.
- Acknowledgement that the substitution will not adversely affect the construction program.

Timing of substation submissions

General: Submit proposals in writing in a timely manner, including technical data and samples as necessary, to demonstrate compliance with the documented requirements. Obtain acceptance from the architect / superintendent / managing contractor in writing before proceeding with the affected works.

Associated costs for proposed submissions

General

Requirement: Pay the cost of:

- Evaluations of documents and samples and any required tests of proposed substitutions, whether subsequently adopted or not,
- Changes to the contract technical documents, where made necessary by the substitution.

These costs will be calculated at the current charge-out rates of the relevant consultant or consultants.

Costs: Pay the cost of submissions and of evaluations and tests of proposed alternatives, whether subsequently adopted or not. The costs will be calculated at the current charge-out rates of the relevant consultant(s).

5.4 SAMPLES AND PROTOTYPES

General

Incorporation of samples: Only incorporate samples that have been endorsed for inclusion in the works. Do not incorporate other samples.

Retention of samples: Keep endorsed samples in good condition on site, until the date for practical completion.

Unincorporated samples: Remove on completion.

5.5 SHOP DRAWINGS

General

Standard: To AS 1100.101 (1992), AS 1100.201 (1992), AS 1100.301 (2008), AS 1100.401 (1984) and AS/NZS 1100.501 (2002) as applicable.

Documentation: Include dimensioned drawings showing details of the fabrication and installation of structural elements, building components, services and equipment, including relationship to building structure and other services, cable type and size, and marking details.

Diagrammatic layouts: Coordinate work shown diagrammatically in the contract documents, and prepare dimensioned set-out drawings.

Services coordination: Coordinate with other building and service elements. Show adjusted positions on the shop drawings.

Space requirements: Check space and access for maintenance requirements of equipment and services indicated diagrammatically in the contract documents.

Commissioning requirements: Show provisions for testing and commissioning on the drawings.

Access for maintenance: Show space and provisions for access for maintenance.

Building work drawings for building services: On dimensioned drawings show the following:

- Access doors and panels.
- Conduits to be cast in slabs.
- Holding down bolts and other anchorage and/or fixings required complete with loads to be imposed on the structure during installation and operation.
- Openings, penetrations and block-outs.
- Sleeves.
- Plinths, kerbs and bases.
- Required external openings.

Submission medium: Electronic copy

Drawing size: as appropriate

CAD base drawings: CAD drawings and schedules will be provided to the contractor / subcontractor on request.

Accuracy and completeness: The documents will be provided without warranty regarding their accuracy and completeness. The contractor / subcontractor must review the documents as provided and satisfy itself in these regards.

Not contract documents: Unless expressly documented otherwise, electronic document files are provided only for the convenience of the contractor / subcontractor, and are not contract documents. They do not replace documents formally issued for contract purposes.

Record drawings: Amend all documented shop drawings to include changes made during the progress of the work and up to the end of the defects liability period.

6 ANCILLARY BUILDING WORK

6.1 WALL CHASING

Holes and chases

General: If holes and chases are required in masonry walls, make sure structural integrity of the wall is maintained. Do not chase walls with a fire-resistance level or an acoustic rating.

Parallel chases or recesses on opposite faces of a wall: Not closer than 600 mm to each other.

Chasing blockwork: Only chase core-filled hollow blocks or solid blocks that are not documented as structural.

Concrete blockwork chasing table

Block thickness (mm)	Maximum depth of chase (mm)
190	35
140	25
90	20

6.2 FIXING

General

Suitability: If equipment is not suitable for fixing to non-structural building elements, fix directly to structure and trim around penetrations in non-structural elements.

Fasteners

General: Use proprietary fasteners capable of transmitting the loads imposed, and sufficient for the rigidity of the assembly.

6.3 BUILDING PENETRATIONS

Penetrations

Requirement: Maintain the required structural integrity, fire performance, waterproofing performance and other properties when penetrating or fixing to the following:

- Structural building elements including external walls, fire walls, fire doors and access panels, other tested and rated assemblies or elements, floor slabs and beams.
- Membrane elements including damp-proof courses, waterproofing membranes and roof coverings. If penetrating membranes, provide a waterproof seal between the membrane and the penetrating component.

Sealing

Fire-resisting building elements: Seal penetrations with a system conforming to AS 4072.1 (2005).

Non fire-resisting building elements: Seal penetrations around conduits and sleeves. Seal around cables within sleeves. If the building element is acoustically rated, maintain the rating.

Sleeves

General: If piping, cables or conduits penetrate building elements, provide metal or PVC-U sleeves formed from pipe sections as follows:

- Movement: Arrange to permit normal pipe or conduit movement.
- Diameter (for non fire-resisting building elements): Sufficient to provide a ring shaped space around the pipe or pipe insulation of at least 12 mm.
- Ferrous surfaces: Prime paint.
- Sealing: Seal between pipes or conduits and sleeves to prevent the entry of vermin.
- Terminations:
  - Cover plates fitted: Flush with the finished building surface.
  - Fire-resisting and acoustic rated building elements: 50 mm beyond finished building surface.
  - Floors draining to floor wastes: 50 mm above finished floor.
  - Other locations: 5 mm beyond finished building surface.
  - Termite management: To AS 3660.1 (2014).
- Thickness:
  - Metal: 1 mm or greater.
  - PVC-U: 3 mm or greater.

6.4 SUPPORT OF PLANT AND EQUIPMENT

Concrete plinths

General: Provide concrete plinths as documented and under all equipment located on concrete floor slabs as follows:

- Surround: Zinc (hot-dipped) coated steel, at least 75 mm high and 1.6 mm thick. Fix to the floor with masonry anchors. Fill with concrete.
- Height: 75 mm or greater, as documented.
- Reinforcement: Single layer of F62 fabric.
- Concrete: Grade N20.
- Finish: Steel float, flush with top edge of the surround.

Support of ground level plant and equipment

Ground level: Conform to the following:

- If the ground slope is 15° or more, or the area of the plant and equipment is extensive, obtain the advice of a professional engineer for the documentation of a suitable slab or platform.

- In all other cases, provide proprietary plastic or concrete supports installed with falls that achieve a raised, impervious and water shedding bearing surface.

Balustrades: If balustrades or screening are required, obtain the advice of a registered architect.

Support of plant and equipment mounted on roofs or elevated platforms

Platforms: If a platform is required, or the area of the plant and equipment mounted on roofs or elevated platforms is extensive, obtain the advice of a professional engineer for the documentation of a suitable platform.

Balustrades: If balustrades or screening are required, obtain the advice of a registered architect.

Roof level support: If any of the following apply to roof level support, obtain the advice of a professional engineer:

- The total load from any unit of plant or equipment exceeds 500 kg.
- The load from a unit of plant or equipment to any single support point exceeds 100 kg.
- The average loading of plant and equipment over the area extending 1 m on all sides beyond the plant and equipment exceeds 25 kg/m².

6.5 SEISMIC RESTRAINT OF NON-STRUCTURAL COMPONENTS

General

Earthquake design category: CAD drawings and schedules will be provided to the contractor / subcontractor on request.

Accuracy and completeness: The documents will be provided without warranty regarding their accuracy and completeness. The contractor / subcontractor must review the documents as provided and satisfy itself in these regards.

Not contract documents: Unless expressly documented otherwise, electronic document files are provided only for the convenience of the contractor / subcontractor, and are not contract documents. They do not replace documents formally issued for contract purposes.

Seismic restraint to AS 1170.4 (2007): refer to Structural documentation

7 BUILDING SERVICES

7.1 SERVICES CONNECTIONS

Connections

General: Connect to utility service provider services or service points. Excavate to locate and expose connection points. Reinstate the surfaces and facilities that have been disturbed.

Utility service provider requirements

General: If the utility service provider elects to perform or supply part of the works, make the necessary arrangements. Install equipment supplied, but not installed, by the utility service provider.

7.2 SERVICES INSTALLATION

General

Installation: Install equipment and services as follows:

- Plumb and securely fixed.
- Allow for movement in both structure and services.
- Arrange services running together, parallel to each other and adjacent building elements.

Concealment: Conceal all cables, ducts, trays and pipes except where installed in plant spaces, ceiling spaces and riser cupboards or documented to be exposed. If alternative routes are available, do not locate on external walls.

Lifting: Provide heavy items of equipment with permanent fixtures for lifting to the manufacturer's recommendations.

Suspended ground floors: Keep all parts of services suspended under ground floors at least 150 mm clear of the ground surface. Make sure services do not impede access.

Dissimilar metals

Jointing: Join dissimilar metals with fittings of electrolytically compatible material.

Temporary capping

Pipe ends: During construction, protect open ends of pipe with metal or plastic covers or caps.

Piping

General: Install piping in straight lines at uniform grades without sags. Arrange to prevent air locks. Provide sufficient unions, flanges and isolating valves to allow removal of piping and fittings for maintenance or replacement of plant.

Spacing: Provide at least 25 mm clear between pipes and between pipes and building elements, additional to insulation.

Changes of direction: Provide as follows:

- If practicable, long radius elbows or bends and sets, and swept branch connections.
- If pipes are led up or along walls and then through to fixtures, provide elbows or short radius bends.
- Do not provide mitred fittings.

Vibration: Arrange and support piping to prevent vibration whilst permitting necessary movement. Minimise the number of joints.

Embedded pipes: Do not embed pipes that operate under pressure in concrete or surfacing material.

Valve groupings: If possible, locate valves in groups.

Pressure testing precautions: Isolate items not rated for the test pressure. Restrain pipes and equipment to prevent movement during pressure testing.

Support and structure

Requirement: Provide incidental supports and structures to suit the services.

Pipe support systems

Standard: To AS 4041 (2006) clause 3.28.

General: Provide hangers, brackets, saddles, clips, and support system components to resist live and dead loads and to control pipe movement caused by thermal and water pressure effects. Incorporate provisions for adjustment of spacing, alignment, grading and load distribution. Support pipework from associated equipment or building structure. Support valves, strainers and major line fittings so that no load is placed on connected piping or transmitted to it during operation and maintenance.

Fixings: Provide fixings to the associated equipment or building structure designed to withstand the loads imposed by the pipe supports.

Channel section supports: Proprietary channel section with clamps and hangers sized to match external diameter of pipe being supported. Provide all components from the same manufacturer.

Channel and fixing material: Metallic-coated steel or as documented.

Vertical pipes: Provide anchors and guides to maintain long pipes in position, and supports designed for the mass of the pipe and its contents.

Saddles: Saddle type supports may only be used for pipes smaller than DN 25.

Dissimilar metals: If pipe and support materials are dissimilar, provide industrial grade electrically non-conductive material securely bonded to the pipe to separate them. Provide fasteners of electrolytically compatible material.

Fixing to masonry and concrete: Provide metallic-coated steel or non-ferrous metal bolts or screws into chemical or expanding metal masonry anchors.

Uninsulated pipes: Clamp piping supports directly to pipes. Provide electrical isolation of dissimilar metals.

Insulated pipes:

- Spacers: Provide spacers at least as thick as the insulation between piping supports and pipes. Extend either side of the support by at least 20 mm.
- Spacer material: Rigid insulation material of sufficient strength to support the piping and suitable for the temperature application.
- Vapour barriers: For cold pipes, apply aluminium foil tape over the circumference of the spacer to form a vapour barrier. Fit to spacer before installation of the bracket on the pipe.
- Metal sheathing: Provide a 0.55 mm thick metallic-coated steel band between the aluminium foil tape and the support for the full width of the spacer.

Hanger sizes: Conform to the following:

- Gas installations: To AS/NZS 5601.1 (2022) Table 5.8.3.
- Other pipes: Provide hangers sized to the manufacturer's recommendations to suit operating conditions and regulatory requirements including the loads due to valves and other attached components, pipe material, pipe contents and temperature and seismic loads.

Support spacing: Provide supports at no greater spacing than the following:

- Cold and heated water: To AS/NZS 3500.1 (2021) Table 5.7.4.
- Sanitary plumbing: To AS/NZS 3500.2 (2021) Table 10.2.1.
- Stormwater: To AS/NZS 3500.2 (2021) clause 4.9.
- Fuel gas: To AS/NZS 5601.1 (2022) Table 5.8.2.
- Fire sprinklers and combined wet suppression systems: To AS 2118.9 (1995) Table 2.6.1.
- Fire hydrants:
  - Metal piping: To AS 2419.1 (2021) clause 10.6.
  - Plastic piping: To AS/NZS 3500.1 (2021).
- Gaseous fire suppression systems:
  - General gaseous fire suppression systems: To AS 4214 (2018) clause 6.3.4.
  - Carbon dioxide fire suppression systems: To AS 6183 (2011) clause 6.3.4.
- Medical gases: To AS 2896 (2021) Table 4.1.
- Refrigerant: To AS/NZS 5149.2 (2016) Tables 5 and 6.
- Other ferrous pipes under pressure: To AS 4041 (2006) Table 3.28.2.
- Other copper pipes: To AS 4809 (2017) Table 6.2.
- ABS pipes: To AS/NZS 3690 (2009) Table 6.2.
- PVC pipes: To AS/NZS 2032 (2006) Table 6.3.
- PE pipes: To AS/NZS 2033 (2008) Table 6.1.
- Other non-ferrous pipe carrying liquids: To AS/NZS 3500.1 (2021) Table 5.7.4.
- Other pipes carrying air or gases: To AS/NZS 5601.1 (2022) Table 5.8.2.
- Proprietary grooved piping systems: To the manufacturer's recommendations.

Additional supports: Provide additional supports as follows:

- Proprietary grooved piping systems: To the manufacturer's recommendations.
- Valves and other heavy pipe mounted components: Adjacent to the valve or component.
- Adjacent pipe mounted components requiring regular maintenance.
- At changes of direction and adjacent to wall or floor penetrations.
- Where required to anchor piping or control thermal or other movement.

Differential movement

General: If the geotechnical site investigation report predicts differential movements between buildings and the ground in which pipes or conduits are buried, provide control joints in the pipes or conduits, as follows:

- Arrangement: Arrange pipes and conduits to minimise the number of control joints.
- Magnitude: Accommodate the predicted movements.

7.3 PLANT AND EQUIPMENT

General

Location: Locate so failure of plant and equipment (including leaks) does not create a hazard for the building occupants and causes a minimum or no damage to the building, its finishes and contents including water sensitive equipment or finishes.

Safe tray and an overflow pipe: Provide to each tank, hot water heater and storage vessel.

7.4 ACCESS FOR MAINTENANCE

General

Requirement: Provide access for maintenance of all items requiring inspection, measurement, operation, adjustment, repair, replacement and other maintenance-related tasks.

Standards: Conform to the relevant requirements of AS 1657 (2018), AS 1892.1 (2018), AS 2865 (2009) and AS/NZS 3666.1 (2011).

Work Health and Safety: Conform to the requirements of the applicable Work Health and Safety regulations.

Refrigerated or cooling plant: If the space is a refrigerated or cooling chamber inside a duct, air handling plant or similar, provided with an access door or personnel access panel and of sufficient size for a person to enter, provide the following to BCA (2022) G1D3:

- An access door.
- Internal lighting with external indicator lamp.
- An alarm.

Protection from injury: Protect personnel from injury caused by contact with objects including those that are sharp, hot or protrude at low level.

Plant room flooring surfaces: R10 Slip resistance classification to AS 4586 (2013).

Trip hazards: Do not run small services including drains and conduits across floors where they may be a trip hazard.

Manufacturer's standard equipment: If necessary, modify manufacturer's standard equipment to provide the plant access documented.

Clearances

Minimum clearances for access: Conform to the following:

- Vertical clearance: ≥ 2100 mm, vertically above horizontal floors, ground and platforms.
- Horizontal clearance: Preferably ≥ 750 mm clear, but in no case less than 600 mm between equipment or between equipment and building features including walls.
- If tools are required to operate, adjust or remove equipment, provide sufficient space so the tools can be used in their normal manner and without requiring the user to employ undue or awkward force.
- Hinged or removable components: To the manufacturer's recommendations.
- Within plant items: Conform to the preceding requirements, and not less than the clearances recommended in BS 8313 (1997).

Elevated services other than in occupied areas

Access classifications:

- Access class A: Readily accessible. Provide clear and immediate access to and around plant items. If plant or equipment is located more than 2.0 m above the ground, floor or platform, provide a platform with handrails accessible by a stair, all to AS 1657 (2018).
- Access class B: If the plant item requiring access is located more than 2.0 m above the ground, floor or platform, provide a platform with handrails accessible by a non-vertical ladder, all to AS 1657 (2018).
- Access class C: Locate plant so temporary means of access conforming to Work Health and Safety regulations can be provided.

Temporary means of access: Make sure there is adequate provision in place, which is safe and effective.

Areas in which access is restricted to authorised maintenance personnel: Provide access as follows:

- Instruments, gauges and indicators (including warning and indicating lights) requiring inspection at any frequency: Readily accessible.
- Access required monthly or more frequently: Access class A.
- Access required between monthly and six monthly: Access class A or B.
- Access required less frequently than six monthly: Access class A, B or C.

Other areas: Provide access as follows:

- Locate to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- In suspended ceilings, locate items of equipment that require inspection and/or maintenance above tiled parts. If not possible, provide access panels where located above set plaster or other inaccessible ceilings. Arrange services and plant locations to reduce the number of access panels. Coordinate with other trades to use common access panels where feasible.
- Do not locate equipment requiring access above partitions.
- Instruments, gauges and other items requiring inspection at any frequency: Readily accessible.
- Labelling: If equipment is concealed in ceilings, provide marking to **MARKING AND LABELLING**, **Equipment concealed in ceilings**.

Facilities for equipment removal and replacement

Requirement: Provide facilities to permit removal from the building and replacement of plant and equipment, including space large enough to accommodate it and any required lifting and/or transportation equipment. Arrange plant so large and/or heavy items can be moved with the minimum changes of direction.

Removal of components: Allow sufficient space for removal and replacement of equipment components including air filters, tubes of shell and tube heat exchangers, removable heat exchanger bundles, coils and fan shafts. Provide access panels or doors large enough to permit the safe removal and replacement of components within air handling units.

Facilities for access

Equipment behind hinged doors: Provide doors opening at least 150°.

Equipment behind removable panels: Provide panels with quick release fasteners or captive metal thread screws.

Removable panels: Provide handles to permit easy and safe removal and replacement.

Insulated plant and services: If insulation must be removed to access plant and services for maintenance, arrange it to allow for removal and replacement without damage.

Piping

Requirement: Conform to the following:

- Provide access and clearance at fittings that require maintenance, inspection or servicing, including control valves and joints intended to permit pipe removal.
- Arrange piping so it does not interfere with the removal or servicing of associated equipment or valves or block access or ventilation openings.
- Preferably run piping, conduits, cable trays and ducts at high level and drop vertically to equipment.

Electrical equipment and controls

Electrical equipment: Provide clearances and access space to AS/NZS 3000 (2018).

Switchboards and electrical control equipment: Locate near the main entrance to plant space and with switchboards visible from the plant being operated.

Control panels: Locate near and visible from the plant being controlled.

7.5 VIBRATION SUPPRESSION

General

Requirement: Minimise the transmission of vibration from rotating or reciprocating equipment to other building elements.

Standard

Machinery noise and vibration: Vibration severity in Zone A to ISO 20816-1 (2016) and ISO 20816-3 (2022).

Speeds

General: If no maximum speed is prescribed, do not exceed 1500 r/min for direct driven equipment.

Connections

General: Provide flexible connections to rotating machinery and assemblies containing rotating machinery. Isolate pipes by incorporating sufficient flexibility into the pipework or by use of proprietary flexible pipe connections installed to prevent placing stress on pipes due to end reaction.

Inertia bases

General: If necessary to achieve the required level of vibration isolation, provide inertia bases having appropriate mass and to the following:

- Construction: Steel or steel-framed reinforced concrete with reinforcing bars welded between base sections. Position foundation bolts for equipment before pouring concrete.
- Supports: Support on vibration isolation mountings using height saving support brackets.

Vibration isolation mountings

General: Except for external equipment that is not connected to the structure of any building, support rotating or reciprocating equipment on mountings as follows:

- For static deflections < 15 mm: Single or double deflection neoprene in-shear mountings incorporating steel top and base plates and a tapped hole for bolting to equipment.
- For static deflections ≥ 15 mm: Spring mountings.

Selection: Provide mountings selected to achieve 95% isolation efficiency at the normal operating speeds of the equipment.

Installation: Set and adjust vibration isolation mounting supports to give clearance for free movement of the supports.

Spring mountings: Provide freestanding laterally stable springs as follows:

- Clearances: ≥ 12 mm between springs and other members such as bolts and housing.
- High frequency isolation: 5 mm neoprene acoustic isolation pads between base plate and support.
- Levelling: Provide bolts and lock nuts.
- Minimum travel to solid: ≥ 150% of the designated minimum static deflection.
- Ratio of mean coil diameter to compressed length at the designated minimum static deflection: ≥ 0.8:1.
- Snubbing: Snub the springs to prevent bounce at start-up.
- Vertical resilient limit stops: To prevent spring extension when unloaded, to serve as blocking during erection and which remain out of contact during normal operation.

7.6 FINISHES TO BUILDING SERVICES

General

Requirement: If exposed to view (including in plant rooms), paint building services and equipment.

Surfaces painted or finished off-site: Conform to *0183 Metals and prefinishes*.

Exceptions: Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied off-site need not be re-painted on-site provided the corrosion resistance of the finish is not less than that of the respective finish documented.

Standard: Conform to the recommendations of AS/NZS 2311 (2017) Sections 3, 6 and 7 or AS 2312.1 (2014) Sections 6, 7 and 8, as applicable.

Inaccessible surfaces: If surfaces are inaccessible after installation, complete finish before installation.

Painting systems

New unpainted interior surfaces: To AS/NZS 2311 (2017) Table 5.1.

New unpainted exterior surfaces: To AS/NZS 2311 (2017) Table 5.2.

Paint application

Coats: Apply the first coat immediately after substrate preparation and before contamination of the substrate can occur. Make sure each coat of paint or clear finish is uniform in colour, gloss, thickness and texture and free of runs, sags, blisters or other discontinuities.

Combinations: Do not combine paints from different manufacturers in a paint system.

Protection: Remove fixtures before starting to paint and refix in position undamaged when painting is complete.

Underground metal piping

Requirement: Provide corrosion protection for the following:

- Underground ferrous piping.
- Underground non-ferrous metal piping in chemically aggressive soils and environments.

Corrosion protection: Select from the following:

- Cathodic protection: Sacrificial anodes or impressed current. Incorporate a facility for periodic testing. Conform to the recommendations of AS 2832.1 (2015).
- Continuous wrapping using proprietary petroleum taping material.
- Impermeable flexible plastic coating.
- Sealed polyethylene sleeve.

Aggressive soils: If metallic piping or components are installed in chemically aggressive soil, provide additional protection as follows:

- Material: Continuous polyethylene sleeve to ASTM D1248 (2016) with a minimum thickness of 0.25 mm.
- Installation: Wrap or sleeve pipes and components. Tape joints between sections of polyethylene and between polyethylene and piping.

Repairs to finishes

Requirement: Repair damaged finishes to restore their corrosion protection, appearance and service life.

Painting of pipe threads: After pipe installation and before other finishes or insulation are applied, paint exposed threads in metallic-coated steel pipe with zinc rich paint.

7.7 MARKING AND LABELLING

General

Requirement: Mark and label services and equipment for identification purposes as follows:

- Locations exposed to weather: Provide durable materials.
- Pipes, conduits and ducts: To AS 1345 (1995) throughout its length, including in concealed spaces.
- Cables: Label to indicate the origin and destination of the cable.

Consistency: Label and mark equipment using a consistent scheme across all services elements of the project.

Asset management labels and tags: [complete/delete]

Label samples and schedules

Requirement: For each item or type of item, prepare a schedule of marking and labelling, including the following:

- A description of the item or type of item for identification.
- The proposed text for marking or labelling.
- The proposed location of the marking and labelling.

Submission timing: Before marking or labelling.

Electrical accessories

Circuit identification: Label isolating switches and outlets to identify circuit origin.

Operable devices

Requirement: Mark to identify the following:

- Controls.
- Indicators, gauges, meters.
- Isolating switches.

Equipment concealed in ceilings

Location: Provide a label on the ceiling, to indicate the location of each concealed item requiring access for routine inspection, maintenance and/or operation and as follows:

- Tiled ceilings, locate the label on the ceiling grid closest to the concealed item access point.
- Flush lined ceilings, locate adjacent to closest access panel.

Concealed equipment: Items to be labelled include the following:

- Fan coil units and terminal equipment (e.g. VAV terminals).
- Fire and smoke dampers.
- Isolating valves not directly connected to items otherwise labelled.
- Motorised dampers.

Wall mounted equipment in occupied areas

Location: Provide labels on wall mounted items in occupied areas including the following:

- Services control switches.
- Temperature and humidity sensors.

Points lists

Automatic control points: Provide plasticised, fade-free points lists for each automatic control panel and include terminal numbers, point addresses, short and long descriptors in the lists. Store in a pocket on the door of the panel.

Pressure vessels

General: Mount manufacturer's certificates in glazed frames on a wall next to the vessel.

Valves and pumps

General: Label to associate pumps with their starters and valves. Screw fix labels to body or attach label to valve handwheels with a key ring.

Underground services

Survey: Accurately record the routes of underground cables and pipes before backfilling. Include on the record drawings.

Records: Provide digital photographic records of underground cable and pipe routes before backfilling. Include in operation and maintenance manual.

Location marking: Accurately mark the location of underground cables and pipes with route markers consisting of a marker plate set flush in a concrete base, engraved to show the direction of the line and the name of the service.

Markers: Place markers at ground level at each joint, route junction, change of direction, termination and building entry point and in straight runs at intervals of not more than 100 m.

Marker bases: 200 mm diameter x 200 mm deep, minimum concrete.

Direction marking: Show the direction of the cable and pipe run by means of direction arrows on the marker plate. Indicate distance to the next marker.

Plates: Brass, aluminium or stainless steel with black filled engraved lettering, minimum size 75 x 75 x 1 mm thick.

Plate fixing: Waterproof adhesive and 4 brass or stainless steel countersunk screws.

Marker height: Set the marker plate flush with paved surfaces, and 25 mm above other surfaces.

Marker tape: Where electric bricks or covers are not provided over underground wiring, provide a 150 mm wide yellow or orange marker tape bearing the words WARNING – electric cable buried below, laid in the trench 150 mm below ground level.

Plastic pipe: Provide a detectable marker tape with trace wire to identify the route of buried piping. Terminate with 1000 mm coil in a readily accessible location. Tag to match the record drawings.

Labels and notices

Materials: Select from the following:

- Cast metal.
- For indoor applications only, engraved two-colour laminated plastic.
- Proprietary pre-printed self-adhesive flexible plastic labels with machine printed black lettering.
- Stainless steel or brass minimum 1 mm thick with black filled engraved lettering.

Emergency functions: To AS 1319 (1994).

Colours: Generally to AS 1345 (1995) as appropriate, otherwise black lettering on white background except as follows:

- Danger, warning labels: White lettering on red background.
- Main switch and caution labels: Red lettering on white background.

Edges: If labels exceed 1.5 mm thickness, radius or bevel the edges.

Labelling text and marking: To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents and in operating and maintenance manuals.

Lettering heights:

- Danger, warning and caution notices: Minimum 10 mm for main heading, minimum 5 mm for remainder.
- Equipment labels within cabinets: Minimum 5 mm.
- Equipment nameplates: Minimum 40 mm.
- Identifying labels on outside of cabinets: Minimum 5 mm.
- Isolating switches: Minimum 5 mm.
- Switchboards, main assembly designation: Minimum 25 mm.
- Switchboards, outgoing functional units: Minimum 10 mm.
- Switchboards, sub assembly designations: Minimum 15 mm.
- Valves:
  - ≥ DN 65: Minimum 25 mm.
  - < DN 65: Minimum 10 mm.
- Self-adhesive flexible plastic labels:
  - Labels less than 2000 mm above floor: 5 mm.
  - Labels minimum 2000 mm above floor: 10 mm.

. Other locations: Minimum 5 mm.

Label locations: Locate labels so they are easily seen and are either attached to, below or next to the item being marked.

Fixing: Fix labels securely using screws, rivets, proprietary self-adhesive labels or double-sided adhesive tape and as follows:

- If labels are mounted in extruded aluminium sections, use rivets or countersunk screws to fix the extrusions.
- Use aluminium or monel rivets for aluminium labels.

Vapour barriers: Do not penetrate vapour barriers.

8 COMPLETION

8.1 TOOLS AND SPARE PARTS

Spare parts

General: Provide spare parts listed as documented.

Replacement: Replace spare parts used during the maintenance period.

Tools and spare parts schedule

Submission timing: At least 8 weeks before the date for practical completion.

Requirement: Prepare a schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

- Checking receipt, marking and numbering in conformance with the spare parts schedule.
- Packaging and delivery to site.
- Painting, greasing and packing to prevent deterioration during storage.
- Referencing equipment schedules in the operation and maintenance manuals.
- Suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.

8.2 TRAINING

General

Standard: To SA TS 5342 (2021).

Duration: Instruction to be available for the whole of the commissioning and running-in periods.

Format: Conduct training at agreed times, at system or equipment location. Also provide seminar instruction to cover all major components.

Operation and maintenance manuals: Use items and procedures listed in the final draft operation and maintenance manuals as the basis for instruction. Review contents in detail with the principal's staff.

Certification: Provide written certification of attendance and participation in training for each attendee. Provide register of certificates issued.

Demonstrators

General: Use only qualified manufacturer's representatives who are knowledgeable about the installations.

Operation

General: Explain and demonstrate to the principal's staff the purpose, function and operation of the installations.

Maintenance

General: Explain and demonstrate to the principal's staff the purpose, function and maintenance of the installations.

Seasonal operation

General: For equipment requiring seasonal operation, demonstrate during the appropriate season.

8.3 CLEANING

Final cleaning

General: Before the date for practical completion, clean throughout, including all exterior and interior surfaces except those totally and permanently concealed from view.

Labels: Remove all visible labels not required for maintenance.

Removal of material

General: Dispose of building waste material off site to the requirements of the relevant authorities.

8.4 WARRANTIES

General

Format: In addition to ordinary contractual obligations, provide collateral warranties from the respective manufacturers, suppliers and installers. Name the principal as warrantee and register the warranty with the manufacturer where required or appropriate.

Approval of installer: If installation is not by manufacturer, and the warranty is conditional on the manufacturer's approval of the installer, submit the manufacturer's written approval of the installer.

Assignment: Provide warranties that include automatic assignment of the balance of the warranty to the principal's successors or to future owners of the building within the nominated warranty periods.

Documentation: Submit acceptable warranty documentation at Practical Completion of those works.

Precedence

General: These warranty requirements prevail over any conflicting or inferior terms and conditions, qualifications or exclusions in the respective manufacturers, suppliers or subcontractor's warranty documents, unless expressly directed or agreed otherwise.

Scope of warranties

Provide warranties:

- Against failure or excessive degradation of the warranted items and the execution of the particular of the warranted items and the execution of the particular works, under reasonably anticipated environmental and use conditions.
- Including on-site repair (where practicable), or costs of removal, freight, repair and re-installation where necessary.
- Including demolition and disposal, replacement and installation costs and all reinstatement of other affected building works, services installations and applied finishes, as necessary to replace the warranted items.
- Where documented as an inclusion, against incidental or consequential damage to other building elements, services, finishes and building contents, resulting from the failure of the warranted items
- **Warranty periods**
- General: Refer to the **WARRANTY PERIODS SCHEDULE** and other documented requirements.
- **Commencement of warranty periods**
- For lump-sum and D&C projects
- General: Provide warranties that commence at Practical Completion of the entire works.
- Additional requirements
- Edit this item as necessary

Refer also to the Contract / Subcontract Agreement, the architectural schedules and specification sections and other documented requirements

9 TESTING AND COMMISSIONING

9.1 TESTING - GENERALLY

Inspection and testing plan

Requirement: Provide inspection and testing plan consistent with the construction program including details of test stages and procedures.

Notice

Site tests: Give notice of the time and place of documented tests.

Inspection: Give sufficient notice for inspection to be made of the commissioning, testing and verification tests on completion of commissioning.

Attendance

General: Provide attendance at tests.

Suppliers: If necessary to carry out documented tests, arrange equipment suppliers to assist.

Testing authorities

Requirement: Have tests carried out by an Accredited Testing Laboratory, accredited for the documented test method, except for site tests or test methods that do not have an accredited testing laboratory.

Test equipment

Accuracy: Use testing equipment designed to test and/or measure system performance within the documented tolerances.

Calibration: Use only instruments that have current calibration certificates issued by an Accredited Testing Laboratory. Tag or label instruments with calibration date and calibration authority name. Provide copies of certification if requested.

Maximum period since last calibration: As recommended by the manufacturer but less than 12 months, except as documented.

Recalibration: If dropped or damaged, recalibrate instruments.

Testing equipment: Provide test equipment and tools to perform documented tests as follows:

- Special testing equipment: If documented, provide special equipment, tools and instruments required for testing or calibration.
- Other testing equipment: Provide standard testing equipment.

Testing procedures

Verification: Verify test procedures by:

- Manual testing.
- Monitoring performance and analysing results using the control system trend logs.
- A combination of the above methods.

Sampling: Sampling may be used subject to the following:

- Use a sampling strategy only for multiple identical pieces of non-life-safety or otherwise non-critical equipment.
- If at any point, more than one identical item has failed, stop testing, determine the cause, rectify and document changes made to remaining units, before continuing with functional testing of the remaining units.

Type tests

Type test reports: Required, as evidence of conformance of proprietary equipment.

Sound pressure level measurements

Requirement: Conform to the following:

- Correction for background noise: To AS/NZS 2107 (2016) Table B1.
- External: To AS 1055 (2018).
- Internal: To AS/NZS 2107 (2016).
- Measurement positions: If a test position is designated only by reference to a room or space, do not take measurements less than 1 m from the floor, ground or walls. For large equipment items including chillers, measure at 2 m and 7 m from the equipment item.
- Sound pressure level analysis: Measure the sound pressure level and the background sound pressure level over the full range of octave band centre frequencies from 31.5 Hz to 8 kHz at the designated positions.
- Sound pressure levels: Measure the A-weighted sound pressure levels and the A-weighted background sound pressure levels at the designated positions.

Test outcome

Requirement: Test as documented and achieve the following:

- Pass the documented Pass/Fail test, and/or
- Values that meet documented requirements, and/or
- Verification of manufacturer's claimed performance.

Failure of multiple items

Requirement: If 10% or 3, whichever is greater, of identical pieces (size does not constitute a difference) of equipment fail to perform as documented for any reason, treat all identical units as having failed. Submit notice of failure and conform to the following:

- Within one week of notification, examine all other identical units and record the results. Submit a report of the findings within two weeks of the original failure notice.
- Within two weeks of the original failure notification, submit a signed and dated explanation of the problem, including the cause of failure, the proposed solution, full equipment details and any other information. Do not exceed the documented requirements of the original installation with the proposed solution.

Rectification of failure under test

Requirement: If an item fails a documented test, rectify the cause of failure and repeat the test.

Submissions: If submission of test results is documented, submit results of both successful and unsuccessful tests.

Test reports

Requirement: Include the following:

- Documented performance criteria including, if documented, tolerances.
- Observations and results of tests and conformance or non-conformance with documented requirements.

Test validity period

Requirement: As documented or, if no validity period is documented, no older than 5 years.

Controls

General: Calibrate, set and adjust control instruments, control systems and safety controls.

Circuit protection

General: Confirm that circuit protective devices are sized and adjusted to protect installed circuits.

Certification

General: On satisfactory completion of the installation, testing and commissioning and before the date for practical completion, certify that each installation is operating correctly.

Integrated system tests

Requirement: Conduct integrated system tests as documented.

Tests: Provide the following:

- Test the integrated operation of the systems listed in each mode documented.
- Restoration of the systems to their pre-test condition on completion of the tests above.

Failure: If any of the systems fails to perform as documented, including return to normal operation, rectify the cause and repeat the integrated system test.

Deferred and seasonal tests

Deferred tests: If documented testing cannot be completed at the scheduled or documented time, the Superintendent may direct that they be deferred to a later time but as soon as possible after the scheduled or documented time.

Seasonal tests: If documented tests are dependent on specific weather conditions, they may be deferred to a time when weather conditions are close to the documented test conditions. Complete seasonal testing as soon as possible but no later than one month before the end of the defects liability period.

Functional tests

Function: Carry out functional and operational tests on each energised equipment item and circuit.

9.2 COMMISSIONING

Standard

Requirement: Conform to SA TS 5342 (2021).

Static completion

Requirement: Systems, components and building elements are statically complete when:

- Their construction and installation is complete and as documented, including completion of all systems, components and building elements on which they are dependent for commissioning.
- All pre-commissioning tests have been successfully completed.
- They are safe and ready for commissioning.
- All cleaning that may adversely affect commissioning is complete.
- They have been inspected and all outstanding remedial work that may adversely affect commissioning is complete.

- All spaces required for access for commissioning are safe to use and cleared of obstructions that may adversely affect commissioning.

Commissioning plan

Requirement: Provide a commissioning plan to SA TS 5342 (2021) including the following:

- A summary of the work covered by the commissioning plan.
- The parties responsible for this work and any commissioning interrelationships.
- The basis of the design.
- General sequence of commissioning.
- Project specific commissioning methodologies for each system and building element to be commissioned.
- Pre-commissioning requirements.
- Project specific commissioning procedures for each commissioning activity including integrated system tests, deferred and seasonal tests
- A project specific building tuning plan for all commissioned systems. Include building tuning procedures and tuning team members.
- Requirements for witnessing of tests and documented demonstrations of completion of commissioning.
- Commissioning program to **COMMISSIONING**, **Commissioning program**.

Commissioning program

Submissions: Submit a program consistent with, and forming part of, the construction program as follows:

- Set out the proposed program for completion, commissioning, testing and instruction.
- Identify related works and timing of the works prerequisite to successful and timely completion of the works.

Revisions: Submit revisions of the program as the project proceeds.

Plant operating period: Include time in the program for the documented plant operating period before the date for practical completion.

Commissioning activities

Requirement: Provide the following to SA TS 5342 (2021):

- Manage the commissioning process.
- Establish and manage the completion process.
- Review design documents for commissionability. Submit a report including any recommended changes.
- Review documented commissioning requirements. Submit a report including any recommended changes.
- Review construction documents for commissionability. Submit a report including any recommended changes.
- Develop, review and update the commissioning plan and commissioning program.
- Develop, review and update commissioning methodologies.
- Develop, review and update commissioning procedures.
- Report on interdependencies between trades that may affect commissioning.
- Develop, review and update procedures for initial start-up of systems.
- Develop, review and update integrated system test procedures.
- Carry out pre-commissioning activities. Record results and submit pre-commissioning records.
- Conduct commissioning activities to the commissioning mythologies and procedures. Record and submit commissioning records.
- Facilitate and conduct integrated system tests and demonstrations. Record and submit integrated system test records.
- Conduct documented demonstrations of completion of commissioning.
- Report on the progress of commissioning work.
- Report on conformance to the commissioning plan and program.
- Report on commissioning defects and issues and progress on their resolution.

- Develop, review and update commissioning report.
- Develop, review and update training materials, conduct training sessions to **TRAINING**.
- Develop, review and update operation and maintenance manuals to **OPERATION AND MAINTENANCE MANUALS**.
- Manage and report deferred and seasonal testing activities to **TESTING - GENERALLY**.
- Management and reporting of building tuning process.
- Periodically review performance data.

Verification of commissioning

Requirement: On completion of commissioning of the equipment or system, provide additional tests to verify that it is fully commissioned and operating to documented requirements.

9.3 BUILDING TUNING

General

Standard: To SA TS 5342 (2021).

Frequency: Three monthly or more frequently.

Duration: Until the end of the maintenance period. Provide last building tuning in the month before the end of the maintenance period.

Requirement: Provide the following:

- Review data from all recording systems against documented requirements.
- Review of building occupant feedback.
- If discrepancies are identified from the above, take corrective action to rectify them.
- Report on the findings of the reviews, corrective action and effect of corrective action.
- Recommend other action to improve the effectiveness, reliability and efficiency of systems.

10 PROJECT RECORDS

10.1 TACTICAL FIRE DRAWINGS

General

Requirement: Provide sets of colour coded tactical fire drawings, showing all items and systems relevant in a fire to BCA (2022) Spec 19.

Scale: 1:200 or larger if required to be easily read under emergency conditions.

Coordination: Agree the format, colour coding and contents of the tactical fire plans with the Local Fire Authority before beginning documentation.

Location: Provide one set of the laminated drawings fixed to the wall or supplied in a vertical plan hanger in the fire control room.

Loose set: Provide a second set of identical drawings.

Operation and maintenance manuals: Provide a set of colour coded tactical fire drawings in each copy of the operating and maintenance manual.

Inclusions

Requirement: Include the following on the tactical fire drawings:

- Legend sheet at front of set.
- Colour coding key.
- Building: As follows:
  - Floor plans.
  - Pressurised and non-pressurised fire isolated stairs and passages.
  - Smoke and fire compartments.
  - Special risk areas.
- Fire services: As follows:
  - Automatic fire detection systems.
  - Automatic suppression systems including gas flooding systems.
  - Communications including warden intercommunication points.
  - Fire control room.

  - Fire equipment including booster connections.
  - Fire hydrants, hose reels, portable fire extinguishers.
  - Fire detection control and indicating equipment (FDCIE).
  - Fire service lifts.
  - Fire telephone and control panel.
  - Hydrant and sprinkler pumps.
  - Hydrant/hose reels.
  - Sprinkler and hydrant, suction and booster connections.
  - Sprinkler control valves.
- Electrical services: As follows:
  - Emergency power supplies.
  - Essential services switchboards.
  - Evacuation warning panel.
  - Standby power plant.
  - Substations/transformers.
  - Switchboards, main switchroom.
- Mechanical ventilation and air handling equipment: As follows:
  - Air intakes, fans, ducts, shafts.
  - Conditioners and mixing boxes.
  - Fire dampers.
  - General exhaust air fans, ducts, shafts, discharges.
  - Smoke dampers.
  - Smoke fans including exhaust fans, zone and stair pressurisation fans.
  - Stair pressurisation systems.
  - Supply air system.
- Mechanical ventilation and air handling equipment operation: As follows:
  - Statement of normal condition.
  - Condition upon fire alarm.
  - Manual controls available.
- Hydraulic services: As follows:
  - Gas meters.
  - Gas supply control.
  - Incoming water supplies and valves for the sprinkler, hydrant and fire hose reel systems.
  - Water tank.

10.2 RECORD DRAWINGS

General

Requirement: Prepare record drawings showing the following:

- Installed locations of building elements, services, plant and equipment.
- Off-the-grid dimensions and depth if applicable.
- Any provisions for the future.

Recording, format and submission

Requirement: Record changes made during the progress of the works on a set of drawings kept on site for that specific purpose.

Drawing layout: Use the same borders and title block as the contract drawings.

Quantity and format: Conform to **SUBMISSIONS**.

Endorsement: Sign and date all record drawings.

Accuracy: If errors in, or omissions from, the record drawings are found, amend the drawings and re-issue in the quantity and format documented for **SUBMISSIONS**.

Date for submission: Not later than 2 weeks after the date for practical completion.

Services record drawings

General: To **RECORD DRAWINGS**, **General** and **Recording, format and submission** and the following:

- Extensions and/or changes to existing: If a drawing shows extensions and/or alterations to existing installations, include sufficient of the existing installation to make the drawing comprehensible without reference to drawings of the original installation.
- Detention: If on-site detention tanks or pondage are provided, include the volume required on the drawing and the permitted flow rate to the connected system.
- Domestic cold water or fire mains: Show the pressure available at the initial connection point and the pressure available at the most disadvantaged location on each major section of the works.
- Stormwater: If storm water pipes are shown, include the pipe size and pipe grade together with the maximum acceptable flow and the actual design flow.

Diagrams: Provide diagrammatic drawings of each system including the following:

- Controls.
- Piping including all valves and valve identification tags.
- Principal items of equipment.
- Single line wiring diagrams.
- Acoustic and thermal insulation.
- Access provisions and space allowances.
- Fasteners.
- Fixtures.
- Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.
- Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

CAD base drawings: [complete/delete]

Subsurface services: Record information on underground or submerged services to the documented quality level, conforming to AS 5488.1 (2022).

Subsurface services recording quality level: [complete/delete]

10.3 BASELINE DATA

General

Requirement: Provide baseline data to permit routine service of fire protection systems and equipment to AS 1668.1 (2015), AS 1670.1 (2018), AS 1851 (2012) and AS/NZS 2293.1 (2018). Include baseline data for the following:

- Active fire and smoke systems including automatic fire sprinkler systems, fire pumpsets, fire hydrant systems and water storage tanks for fire protection systems.
- Fire detection and alarm systems.
- EWIS, exit signs and emergency lighting.
- Standby generator sets and batteries.
- Lay flat fire hose, fire hose reels, portable and wheeled fire extinguishers and fire blankets.
- Passive fire and smoke systems including vertical and horizontal fire and smoke elements including walls, floors, ceilings, access panels and hatches, structural fire-resistant elements - beams, columns, girders, trusses, fire-resisting doorsets - hinged, pivoted and horizontal sliding, smoke doors - hinged and pivoted, fire shutters, fire-resisting glazing, ducts and dampers.
- Fire and smoke control features of mechanical services.
- Emergency planning in facilities.

Format: Provide baseline data in a format that facilitates the carrying out and recording of routine service tasks including drawings showing the extent and location of items to be serviced, schedules of items and unique identification of each item.

10.4 OPERATION AND MAINTENANCE MANUALS

General

Standard: To SA TS 5342 (2021).

Authors and compilers: Personnel experienced in the maintenance and operation of equipment and systems installed, and with editorial ability.

Referenced documents: If referenced documents or worksections require submissions of manuals, include corresponding material in the operation and maintenance manuals.

Subdivision: By installation or system, depending on project size.

Revisions: Amend operation and maintenance manuals to include changes made to the installation during the construction and maintenance.

Contents of manual

Table of contents: Include a table of contents in each volume. Title to match cover.

Table of amendments: Include a table of amendments.

Directory: Include names, addresses, email addresses and telephone and facsimile numbers of principal consultant, subconsultants, contractor, subcontractors and names of responsible parties.

Record drawings: Include complete set of record drawings, full size.

Drawings and technical data: Include as necessary for the efficient operation and maintenance of the installation.

Installation description: Include a general description of the installation.

Systems descriptions and performance: Include a technical description of the systems installed including the basis of design, the interrelation with other systems and the building and mode of operation, presented in a clear and concise format readily understandable by the principal's staff. Identify function, normal operating characteristics, safety features and limiting conditions.

Baseline data: Include the baseline data to **BASELINE DATA**.

Commissioning records: Include commissioning records to SA TS 5342 (2021). Link commissioning records to item codes on the record drawings.

Training material: Include materials used to provide training to **TRAINING** in a form that can be used to train others.

Fire systems and equipment: Include documentation to AS 1851 (2012), including the schedule of essential functionality and performance requirements.

Digital photographic records: Include records to **MARKING AND LABELLING, Underground services**.

Equipment: Include schedules with the following details for installed equipment:

- Item code for use on record and diagrammatic drawings, and spare parts schedule.
- Equipment name plate data including serial number, if any.
- Name and contact details of the manufacturer and supplier.
- Catalogue list number(s).
- Location.
- Function.
- Performance figures and capacity data.
- Date of manufacture.
- Manufacturer's product data sheets including only relevant matter for the project. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.
- Additional information and commentary to illustrate relations of component parts.

Certificates:

- Certificates from authorities.
- Product certification.
- Test certificates for each service installation and all equipment.
- Warranties.

Trends: 7 day record of all trends at commissioning.

Operation procedures: Include for systems installed:

- Manufacturer's technical literature as appropriate.
- Safe starting up, running-in, operating and shutting down procedures. Include logical step-by-step instructions for each procedure.

- Control sequences and flow diagrams.
- Legend for colour-codes services.
- Schedules of fixed and variable equipment settings established during commissioning and maintenance.
- A list of special safety devices and their set points.
- Procedures for seasonal changeovers.
- Warnings to operators.
- Procedures for identifying and rectifying common faults.
- Recommendations for efficient plant operation.
- If the installation includes cooling towers, recommendations for water efficiency.
- Building tuning plan and procedure to **COMMISSIONING**, **Commissioning plan**.

Building occupants' guide: Include a concise guide written and illustrated for building occupants with no technical background. Include the following:

- Security provisions.
- Safety and access.
- Environmental features, including energy and water efficiency and waste management.
- Occupant relevant information on design and operation.
- Information for occupants on environmental systems that rely partially or wholly on local controls for heating, lighting, cooling, and ventilation.
- Contact details for faults, maintenance and emergencies.

Maintenance procedures:

- Detailed recommendations for periodic maintenance and procedures, including schedule of maintenance work with frequency and manufacturers' recommended tests.
- Manufacturer's technical literature as appropriate. Register with manufacturer as necessary. Retain copies delivered with equipment.
- Safe trouble-shooting, disassembly, repair and reassembly, cleaning, alignment and adjustment, balancing and checking procedures. Provide logical step-by-step instructions for each procedure.
- Schedule of spares, recommended to be held on site, for those items subject to wear or deterioration and that may involve the principal in extended deliveries when replacements are required. Include complete nomenclature and model numbers, and local sources of supply.
- Schedule of normal consumable items, local sources of supply, and expected replacement intervals up to a running time of 40 000 hours. Include lubrication schedules for equipment.
- Instructions for use of tools and testing equipment.
- Troubleshooting procedures.
- Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding.
- Safety data sheets (SDS).
- Instructions and schedules conforming to AS 1851 (2012), AS/NZS 3666.2 (2011), AS/NZS 3666.3 (2011) and AS/NZS 3666.4 (2011).

Maintenance records:

- Prototype routine service records conforming to AS 1851 (2012) prepared to include project specific details.
- Prototype periodic maintenance records and report to AS/NZS 3666.2 (2011), AS/NZS 3666.3 (2011) and AS/NZS 3666.4 (2011) as appropriate, prepared to include project specific details.
- Hard copies: Binders to match the manuals, containing loose leaf logbook pages designed for recording completion activities including operational and maintenance procedures, materials used, test results, comments for future maintenance actions and notes covering the condition of the installation. Include completed logbook pages recording the operational and maintenance activities performed up to the date for practical completion.
- Number of pages: The greater of 100 pages or enough pages for the maintenance period and a further 12 months.

Emergency information: For each type of emergency, including fire, flood, gas leak, water leak, power failure, water failure, system or subsystem failure, chemical release or spill, include the following:

- Emergency instructions.
- Emergency procedures including:
  - Instructions for stopping or isolating.
  - Shutdown procedures and sequences.
  - Instructions for actions outside the property.
  - Special operating instructions relevant to the emergency.
  - Contact details relevant to the emergency.

Emergency information manual

Form of emergency information: Provide one of the following:

- An index and coloured tabs identifying emergency information for each type of emergency within the Operation and maintenance manual.
- A separate Emergency manual containing copies of emergency information from the main Operation and maintenance manual.

Format – electronic copies

Scope: Provide the same material as documented for hardcopy in electronic format.

Delivery method: [complete/delete]

Quantity and format: Conform to **SUBMISSIONS**, **Electronic submissions**.

Printing: Except for drawings required in **RECORD DRAWINGS** provide material that can be legibly printed on A4 size paper.

Format – hard copies

General: A4 size loose leaf, in commercial quality, 4 ring binders with hard covers, each indexed, divided and titled. Include the following features:

- Cover: Identify each binder with typed or printed title *OPERATION AND MAINTENANCE MANUAL*, to spine. Identify title of project, volume number, volume subject matter, and date of issue.
- Dividers: Durable divider for each separate element, with typed description of system and major equipment components. Clearly print short titles under laminated plastic tabs.
- Drawings: Fold drawings to A4 size with title visible, insert in plastic sleeves (one per drawing) and accommodate them in the binders.
- Pagination: Number pages.
- Ring size: 50 mm maximum, with compressor bars.
- Text: Manufacturers' printed data, including associated diagrams, or typewritten, single-sided on bond paper, in clear concise English.

Number of copies: 3.

Date for submission

Draft submission: The earlier of the following:

- 4 weeks before the date for practical completion.
- Commencement of training.

Final submission: Within 2 weeks after practical completion.

10.5 ELECTRONIC FACILITY AND ASSET MANAGEMENT INFORMATION

Data

Facility and asset data: Refer to Services Documents

Data exchange schema: Refer to Services Documents

Software compatibility requirements: Refer to Services Documents

File format: Refer to Services Documents

Timing: Refer to Services Documents

11 MAINTENANCE

11.1 PERIODIC MAINTENANCE

General

Requirement: Provide documented maintenance so that the condition and performance of the maintained work throughout and at the end of the maintenance period is equal to or better than that at the beginning of the maintenance period including with respect to the following:

- Performance, service delivery.
- Service life and reliability.
- Compliance with statutory requirements.
- Compliance with building rating requirements.
- Energy and water efficiency.
- Environmental impact.
- Health and safety.
- Risk management.

Inclusions: Include the following:

- Periodic and statutory maintenance, cleaning and replacement of consumables.
- Emergency repairs.
- Condition reporting.

Duration: From the time systems and equipment are put into service to the end of the maintenance period.

Maintenance period: The greater of the defects liability period and the period documented.

Faults: Rectify promptly.

Emergencies: Attend emergency calls promptly.

Annual maintenance: Carry out recommended annual maintenance procedures within the four weeks before the end of the maintenance period.

Maintenance program

General: Submit details of maintenance procedures and program, relating to installed plant and equipment, 6 weeks before the date for practical completion. Indicate dates of service visits. State contact telephone numbers of service operators and describe arrangements for emergency calls.

Maintenance records

General: Record in binders provided with the operation and maintenance manuals.

Referenced documents: If referenced documents or technical worksections require that logbooks or records be submitted, include this material in the maintenance records.

Certificates: Include test and approval certificates.

Service visits: Record comments on the functioning of the systems, work carried out, items requiring corrective action, adjustments made and name of service operator. On completion of the visit, obtain the signature of the principal's designated representative on the record of the work undertaken.

Site control

General: Report to the principal’s designated representative on arriving at and before leaving the site.

11.2 STATUTORY INSPECTIONS AND MAINTENANCE

General

Duration: From the time systems and equipment are put into service to the end of the maintenance period.

Requirement: Provide inspections and maintenance of safety measures required by the following:

- AS 1851 (2012).
- Other statutory requirements applicable to the work.

Records: Provide mandatory records.

Certification: Certify that mandatory inspections and maintenance have been carried out and that the respective items conform to statutory requirements.

Annual inspection: Perform an annual inspection and maintenance immediately before the end of the maintenance period.

12 SELECTIONS REFER TO ARCHITECTURAL DOCUMENTS AND SERVICES DOCUMENTS

12.1 PERFORMANCE

Noise level schedule

	A	B	C
Upper limit of noise caused by services	Refer to Services drawings		

12.2 SUBMISSIONS AND INSPECTIONS

12.3 TESTS

Tests schedule

Test	Requirements
Refer to Inspections and Submissions	
Refer to Services documents	

12.4 COMPLETION

Warranty schedule

Warranty	Form	Period
Refer to Inspections and Submissions		
Refer to Services documents		

12.5 MAINTENANCE

Maintenance requirements schedule

Provision	Maintenance period (months)	Requirement
Refer to Services documents		

PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

DEMOLITION

DOCUMENT No Z-0201

ISSUE 4 | 15 MARCH 2024

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
2	28/01/2022	FOR TENDER	BFS	NS
3	13/06/2023	BAFO TENDER	BFS	NS
4	15/03/2024	CONSTRUCTION CERTIFICATE 1 APPROVAL	AC	AC

Each item deleted is ~~struck through~~
Each item added is in red and shaded

PROJECT NO: 2010018

0201 DEMOLITION

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Carry out demolition, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0171 General requirements*.
- *0221 Site Preparation*
- *0222 Earthwork*
- *0223 Service Trenching*
- ~~*Future*~~ *Development Consent Approval Conditions*

1.3 STANDARDS & REQUIREMENTS

General
Demolition: To AS 2601.
- ~~*Future*~~ *Development Consent Approval Conditions*

Appropriate measures (eg. Fine water spray) shall be employed during demolition, excavation and construction works to prevent the emission of dust and other impurities into the surrounding environment. All such measures shall be co-ordinated with the site sedimentation controls to ensure polluted waters do not leave the site.

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection, the following definitions apply:
- Demolition: The complete or partial dismantling of a building or structure, by pre-planned and controlled methods or procedures.
- Dilapidation record: The photographic or video and written record of the condition of the portion of the existing building retained, adjacent buildings, and other relevant structures or facilities, before the start of demolition work.
- Dismantle: The reduction of an item to its components in a manner to allow re-assembly.
- Recover: The disconnection and removal of an item in a manner to allow re-installation.

1.5 SUBMISSIONS

Authority approvals
Evidence of compliance: Before starting demolition, submit evidence of the following:
- Requirements of authorities relating to the work under the contract have been obtained.
- A permit to demolish has been obtained from the appropriate authority.
- A scaffold permit has been obtained from the appropriate authority (if scaffolding is proposed to be used).
- Certification that each person having access to the construction site has completed site-specific WHS induction training.
- Precautions necessary for protection of persons and property have been taken and suitable protective and safety devices have been provided to the approval of the relevant authority.
- Certificate from the relevant authority confirming treatment for any rodent infestation has been caried out.
- ~~Treatment for rodent infestation has been carried out and a certificate has been obtained from the appropriate authority~~.
- Fees and other costs have been paid.

Execution details

Requirement: Submit the following, as documented:

- Hazardous Substances Management Plan by Contractor, including laboratory analysis of hazardous substances.
- Investigation and work plan by Contractor.
- Safe Work Method Statement.

Off-site disposal locations: Submit details of the proposed locations for the disposal of material required to be removed from the site, and evidence of conformance with the requirements of relevant authorities.

Recycling: Submit details of the proposed recycling facility.

- Certification: Submit evidence of delivery of recycled materials.
- Concrete crushing: If proposed on site, submit details of plant and environmental controls.

Stockpile locations: Submit details of the proposed locations of on-site stockpiles for demolished materials for recycling in the works. Coordinate with the locations for storage of other waste streams, and prevent mixing or pollution.

Records

Dilapidation record:

- Before demolition: Submit to each owner of each adjacent property, a copy of the part of the record relating to that property and obtain their written agreement to the contents.
- Before demolition: Provide a Dilapidation Report of buildings adjacent to the proposed owned by the School. Submit to Proprietor a, a copy of the part of the record relating to that property and obtain their written agreement to the contents.
- Rectification work: Submit written acceptance of rectification works from the owner of each adjoining property affected.

Tests

Requirement: Submit test results of compliance tests for building service components to be re-used.

1.6 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Adjacent structures before starting and at completion of demolition.
- Services before disconnection or diversion.
- Trees documented to be retained, before starting demolition.
- Contents of building before starting demolition.
- Structure after stripping and removal of roof coverings and external cladding.
- Underground structures after demolition above them.
- Excavations remaining after removal of underground work.
- Site after removal of demolished materials.
- Services after reconnection or diversion.
- Adjoining and adjacent structures at completion of demolition.

2 PRODUCTS

2.1 DEMOLISHED MATERIALS

Demolished material diverted from landfill

Minimum percentage of demolished material not sent to landfill:

The Subcontractor shall provide the following options with accompanying tender pricing:

- Base case of what the Subcontractor would normally price
- 25% not sent to landfill
- 50% not sent to landfill

Demolished material classes table

Class	Requirement	Ownership

Class	Requirement	Ownership
Recovered items for re-use in the works	Recover without damage items identified in the **Recovered items for re-use in the works schedule**	Principal/proprietor
Recovered items for delivery to the principal	Recover without damage items identified in the **Recovered items for delivery to the principal schedule**	Principal/proprietor
Demolished material for recycling in the works	Stockpile material identified in the **Demolished material for recycling in the works schedule**	Contractor
Demolished material for recycling off-site	Demolish and deliver for recycling material identified in the **Demolished material for recycling off-site schedule**	Contractor
Dismantle for relocation as part of the works	Dismantle without damage and store items identified in the **Dismantle for relocation schedule**	Principal/proprietor
Demolish for removal	Remove from the site demolished materials identified in the **Demolish for removal schedule**. Do not burn or bury on site Transit: Prevent spillage of demolished materials in transit	Contractor

3 EXECUTION

3.1 HAZARDOUS SUBSTANCES

Identified hazardous substances

Register: Hazardous substances have been identified as present on site and a Hazardous substances register has been prepared.

Availability: A Hazardous Substances Register has not been done, please provide one as early as possible once contract has been awarded.

Audit

Requirement: Prepare a Hazardous Substances Management Plan to AS 2601 clause 1.6.1. Include the following:

- Asbestos or material containing asbestos.
- Flammable or explosive liquids or gases.
- Toxic, infective or contaminated materials.
- Radiation or radioactive materials.
- Noxious or explosive chemicals.
- Tanks or other containers which have been used for storage of explosive, toxic, infective or contaminated substances.
- Timing: just after contract has been awarded

Removal of hazardous substances

Standard: To AS 2601 clause 1.6.2.

Procedure for asbestos removal: Where asbestos material shall be removed or disturbed as a result of any proposed demolition, alteration or addition, all work must be carried out by a person licensed under Chapter 10 of the Occupational Health and Safety Regulation and undertaken in accordance with the requirements of clause 29 of the Protection of the Environment Operations (Waste)

Regulation. All asbestos to be removed must be removed must be disposed of at a tip recommended by the NSW Environment Protection Authority and under no circumstances shall be re-used or sold.

Also in accordance WHS Code of Practice, Safe Work Australia and any other relevant Australia Standards, statutes or codes.

3.2 INVESTIGATION AND WORK PLAN

General

Requirement: Before demolition or stripping work, prepare the work plan to AS 2601 Section 2. Include the check list items appropriate to the project from AS 2601 Appendix A, and the following:

- Method of protection and support for adjacent property.
- Locations and details of service deviations and terminations.
- Sequence of work.
- If the demolition program results in components temporarily cantilevered, provide a certificate from a professional engineer.
- Proposals for the safe use of mobile plant on suspended structural members including provisions for the protection of lower floors in the event of structural failure.
- If implosion methods are proposed, provide a separate report of methods and safeguards.
- Wheel loads of tipping or loading vehicles.

3.3 SUPPORT

Temporary support

General: If temporary support is required, certification for its design and installation is required from a professional engineer engaged by the contractor.

Existing buildings: Until permanent support is provided, provide temporary support for sections of existing buildings which are to be altered and which normally rely for support on work to be demolished.

Suspended slabs: If mobile plant is required for use on suspended structural members, conform to structural engineering requirements, and the work plan.

Ground support: Support excavations for demolition of underground structures.

Adjoining or adjacent structures: Provide supports to adjoining or adjacent structures where necessary, sufficient to prevent damage resulting from the works.

Lateral and vertical supports: At least equal in capacity to that originally provided by the structural element or structure to be demolished.

~~Adjacent structures: Provide supports to adjacent structures where necessary, sufficient to prevent damage resulting from the works.~~

~~Lateral supports: Provide lateral support equal to that given by the structure to be demolished.~~

~~Vertical supports: Provide vertical support equal to that given by the structure to be demolished.~~

Permanent supports

General: If permanent supports for adjacent structures are necessary and are not documented, give notice and obtain instructions.

3.4 PROTECTION

Encroachment

General: Prevent the encroachment of demolished materials onto adjoining property, including public places.

Weather protection

General: If walls or roofs are opened for alterations and additions or the surfaces of adjoining buildings are exposed, provide temporary covers to prevent water penetration. Provide covers to protect existing plant, equipment and materials intended for re-use.

Dust protection

General: Provide dustproof screens, bulkheads and covers to protect existing finishes and the immediate environment from dust and debris.

Security

General: If walls or roofs are opened for alterations or additions, provide security against unauthorised entry to the building.

Temporary screens
General: Fill the whole of designated temporary openings or other spaces using dustproof and weatherproof temporary screens, fixed securely to the existing structure, and installed to shed water to avoid damage to retained existing elements or adjacent structures and contents.

Type: Timber framed screens sheeted with 12 mm plywood and painted. Seal the junctions between the screens and the openings.

Temporary access
General: If required, provide a substantial temporary doorset fitted with a rim deadlock, and remove on completion of demolition.

Exposed surfaces
General: Where necessary, protect and weatherproof the surfaces of adjacent structures exposed by demolition.

Existing services
Location: Before starting demolition, locate and mark existing underground services in the areas which will be affected by the demolition operations.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Essential services: Shut off, cap or control services not required for the demolition work, at or outside the building line before commencing demolition. Conform to the requirements of the relevant existing utility authority, as appropriate.

Excavation: Do not excavate by machine within 1 m of existing underground services.

Fixed items
Individual protection: Protect the following items in their existing positions:

refer to Demolition documents and drawings. Recovered items
General: If items are documented for recovery and re-use, minimise damage during removal and recover all associated components required for their re-use.

3.5 DEMOLITION – BUILDING WORKS

General
Requirement: To the approved Safe Work Method Statement and work plan.

Encroachment
General: If encroachments from adjacent structures are encountered and are not documented, give notice and obtain instructions.

Sequence
Sequence of demolition: The Contractor / Subcontractor is to provide a Work Methodology Statement

Concrete slabs
General: Using a diamond saw, neatly cut back or trim to new alignment with a clean true face existing concrete slabs to be partially demolished or penetrated. Do not overcut at corners.

Material below grade
Extent: Demolish the following:

- refer to Demolition documents and drawings.

Remaining voids: Stabilise and provide barriers.

Explosives
General: Do not use explosives.

3.6 DEMOLITION – BUILDING SERVICES

General
Requirement: Decommission, isolate, demolish and remove from the site all equipment and associated components that become redundant as a result of the demolition.

Breaking down: Disassemble or cut up equipment where necessary to allow removal.

Demolition of refrigeration systems
Standard: To AS/NZS 5149.4.

Components for re-use
General: Before returning to service, clean components and test for conformance to Australian Standards, as required.

3.7 COMPLETION

Notice of completion

General: Give at least 5 working days' notice of completion of demolition so that adjacent structures may be inspected following completion of demolition.

Reinstatement

Assessment of damage: Use the dilapidation record to assess the damage and rectification work arising from the demolition work.

Rectification: Repair damage arising out of demolition work. Obtain written acceptance from the owner of each adjoining property of the completeness and standard of the rectification work.

~~**Temporary support**~~

~~General: Remove at completion of demolition.~~

Removal of temporary supports

General: Obtain written instructions from the structural engineer at the completion of demolition before removing temporary supports.

4 SELECTIONS

4.1 DEMOLITION

Recovered items for re-use in the works schedule not required

Recovered items for delivery to the principal schedule not required

Demolished material for recycling in the works schedule not required

Demolished material for recycling off-site schedule not required

Dismantle for relocation schedule not required

Demolish for removal schedule all demolition

Pymble Ladies' College

PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

SITE PREPARATION

DOCUMENT No Z-0221

ISSUE 4 | 15 March 2024

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
2	28/01/2022	FOR TENDER	BFS	NS
3	13/06/2023	BAFO TENDER	BFS	NS
4	15/03/2024	CONSTRUCTION CERTIFICATE 1 APPROVAL	AC	AC

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Each item added is in red and shaded

BVN

PROJECT NO: 2010018

0221 SITE PREPARATION

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide site preparation, as documented.

Performance

Areas for protection: Existing trees refer to Architectural drawings

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0171 General requirements*.
- *0222 Earthwork*
- *0223 Service trenching*
- *0201 Demolition*
- *0223 Service trenching*
- *Development Consent Approval Conditions*
- *Arborist Report*

1.3 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions apply:

- Authority: Any organisation with statutory authority relating to the project, including clearances.
- Clearances: A formal certificate, approval or condition issued by a statutory authority allowing work in a particular area.
- Plant establishment period: The period between the date of practical completion and the end of the defects liability period.
- Utility service provider: Includes organisations providing power, water, sewerage, gas and telecommunications services.

1.4 SUBMISSIONS

Certification

Vermin: Submit pest exterminator's certification as evidence that the completed site works are free from vermin.

Execution details

Requirement: Submit details of methods and equipment proposed for the following:

- Clearing and grubbing.
- Tree removal and transplanting.
- Protecting ground within and adjacent to tree driplines from compaction by proposed earthworks machinery.

1.5 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Enclosures around trees requiring protection.
- Trees requiring removal.
- Trees for transplanting to determine final orientation.

2 EXECUTION

2.1 COMMUNITY LIAISON

Notification

General: Notify residents about construction activities which will affect access to, or disrupt the use of, their properties.

Notice: Minimum 5 working days, unless the work is of an urgent nature with safety implications.

Notification content:

- Description of the work.
- The reason for the work.
- The expected duration.
- Changes to traffic arrangements and property access.
- The 24-hour contact number of the representative responsible.

2.2 EXISTING SERVICES

General

Requirement: Before starting earthworks, locate and mark existing underground services in the areas affected by the earthworks operations including clearing, excavating and trenching.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Excavation: Do not machine excavate within 1000 mm of existing services.

Existing service lines: If required, divert services detected during excavation, clear of the building, and reconnect to the utility service provider's requirements.

2.3 SITE CLEARING

Extent

Requirement: Clear only areas occupied by works such as structures, paving, excavation, regrading and landscaping or other areas documented for clearing.

Contractor’s site areas: If not included within the areas documented above, clear only to the extent necessary for the performance of the works.

Clearing and grubbing

Clearing: Remove everything on or above the site surface, including rubbish, scrap, grass, vegetable matter and organic debris, scrub, trees, timber, stumps, boulders and rubble.

Grubbing: Grub out stumps and roots over 75 mm diameter to a minimum depth as follows:

- Below subgrade under buildings, embankments or paving: 500 mm.
- Below finished surface in unpaved areas: 300 mm.

Backfilling: Fill holes remaining after grubbing with sand material to prevent ponding of water. Compact the material to the relative density of the existing adjacent ground material.

Redundant/decommissioned works: Remove works no longer required, including slabs, foundations, paving, drain, and access chambers and covers within the works zone.

Fire hazard reduction

Requirement: Not applicable

Batters

Temporary protection: If the change in level between crest and toe is more than 1500 mm, protect from erosion with geofabric, hessian and tar or heavy duty black polythene sheet cover. Securely fix down at crest and toe.

Surplus material

Topsoil and excavated material: Remove unwanted stripped soil and other material from the site as the work proceeds, including any material dropped on footpaths or roadways.

2.4 STORMWATER AND SEDIMENT CONTROL

General

Erosion and sediment control measures:

Development Certificate Approval also Civil and Hydraulic requirements

Waterways and drains

Waterways: If required, temporarily divert ditches, field drains and other waterways affected by excavation and reinstate on completion.

Stormwater drains: Divert drains detected during excavation, clear of the building, and reconnect as documented or obtain approval.

2.5 EXISTING WORKS TO REMAIN

Marking

Requirement: Identify existing works to remain with 1000 mm high, 50 x 50 mm timber stakes connected by yellow plastic tape to prevent accidental damage.

2.6 TREE REMOVAL

Designation

Marking: Identify trees and shrubs for removal by tagging 1000 mm above ground level.

Extent: Refer to Architectural documentation, Landscape documentation and Arborist Report

Tags: 100 x 50mmm zincanneal tags painted yellow and lettered to conform to tree number on drawings. Secure tags to trees using galvanised steel bands.

2.7 TREE PROTECTION

General

Refer to landscape documentation and Arborist Warning signs: In a prominent position at each entrance to the site, display warnings that trees and plantings require protection during the contract. Remove on completion.

Lettering: Road sign type sans serif letters, 100 mm high to AS 4970 Appendix C.

Protection measures: Provide before starting the earthworks.

Trees to remain

Extent: Trees not marked for removal.

Tree protection

Tree protection zone (TPZ): To AS 4970 Section 3.

Tree protective measures: To AS 4970 Section 4.

Monitoring and certification: To AS 4970 Section 5.

Work near trees

Materials placement: Conform to the following:

- Keep the area within the dripline of trees free of sheds and paths, construction material and debris.
- Do not place bulk materials and harmful materials within the dripline of trees.
- Do not place spoil from excavations against tree trunks.
- Prevent wind-blown materials such as cement from harming trees and plants.

Damage: Prevent damage to tree bark. Do not attach stays, guys and similar material to trees.

Work under trees: Do not remove topsoil from, or add topsoil to, the area within the dripline of the trees.

Excavation: If excavation is required near trees, give notice. Minimise period and extent of excavation within the dripline.

Hand methods: Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If excavation is required within the dripline, use hand methods so that root systems remain intact and undamaged.

Roots: Do not cut tree roots exceeding 50 mm diameter. If required to cut tree roots, use cutting methods that do not excessively disturb the remaining root system. Immediately after cutting, water the tree and apply a liquid rooting hormone to stimulate the growth of new roots.

Backfilling: Backfill excavations around tree roots. Place the backfill in layers of 300 mm maximum depth and compact to a dry density similar to that of the original or surrounding soil. Do not backfill around tree trunks to a height greater than 200 mm above the original ground surface. Immediately after backfilling, thoroughly water the root zone surrounding the tree.

Backfill material:

- Mix proportions (topsoil: well-rotted composts) by volume: 3:1.
- Neutral pH value.

- Free from weed growth and harmful materials.

Compacted ground: Do not compact the ground or use skid-steer vehicles under the tree dripline. If compaction occurs, give notice.

Compaction protection: Protect ground adjacent to the tree dripline.

Watering: Water trees as necessary, including where roots are exposed at ambient temperature more than 35°C.

Mulching: Spread 100 mm thick organic mulch to the whole of the area within the dripline of all existing trees to remain.

2.8 TEMPORARY LANDSCAPE FENCING

Fence dimensions

Height: 1200 mm.

Maximum post spacing: 5000 mm.

Component sizes

Corner and gate posts: Hardwood or preservative-treated softwood, 250 mm diameter.

Intermediate posts: Star picket.

Gate: Provide a suitable hinged gate with a gate latch.

Wire: Top, intermediate and bottom rows of 3.2 mm plain galvanized steel wire. Thread the top wire through pieces of plastic tube and through corner posts.

Removal

Completion: Remove the fence at the end of the planting establishment period.

2.9 TREE TRANSPLANTING REFER TO LANDSCAPING DRAWINGS / ABORIST REPORT IF REQUIRED

2.10 SITE NURSERY REFER TO LANDSCAPING DRAWINGS / ABORIST REPORT IF REQUIRED

2.11 TREE MAINTENANCE REFER TO LANDSCAPING DRAWINGS / ABORIST REPORT AS REQUIRED

General

Notice: Give notice before starting tree maintenance.

Pruning: To AS 4373 using a fully qualified and experienced arborist. Carry out all required works in a safe manner.

Execution

Requirement: Rectify any damage to existing trees to remain.

Operations: Remove dead and decayed wood or damaged limbs. Make all cuts at branch collars. If trees show signs of deterioration after the work is completed, ameliorate the soil by soil aeration, irrigation or incorporation of organic material. Continue this program until the end of the plant establishment period.

Root pruning: Do not excessively disturb the remaining root system. Cut off damaged roots cleanly inside the exposed or damaged area. Cover exposed root area with soil immediately after pruning, do not leave roots exposed.

Wetting and new root stimulation: Form a water collecting basin and apply a rooting hormone and wetting agent to the rootball.

Precautions: Avoid damage to trees being treated and to nearby trees and surroundings. Do not use trees as anchors for winching operations or bracing. Provide bracing as necessary before cutting to prevent uncontrolled breakages and damage to surroundings.

Failure: If repair work is impracticable, or is attempted and is rejected, remove the tree and root system and make restitution.

Restitution by replacement tree: Replace with tree of the same species and similar size

Tree maintenance schedule

Tree species	Description of work
Refer to Landscape documents	

Tree species	Description of work

2.12 COMPLETION

Temporary works

Remove at completion: temporary items including fences, tree protection and the like.

Site restoration

Requirement: Reinstate undeveloped ground surfaces to the condition existing at the commencement of the contract.

Clean up

Progressive cleaning: Keep the works clean and tidy, and regularly remove from the site, waste and surplus material arising from execution of the work.

Waste disposal: To *0172 Environmental management*.

Vermin management

Requirement: Employ a suitably qualified pest exterminator to remove vermin found during site preparation.

PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

EARTHWORK

DOCUMENT No Z-0222

ISSUE 4 | 15 MARCH 2024

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
2	28/01/2022	FOR TENDER	BFS	NS
3	13/06/2023	BAFO TENDER	BFS	NS
4	15/03/2024	CONSTRUCTION CERTIFICATE 1 APPROVAL	AC	AC

Each item deleted is ~~struck through~~
Each item added is in red and shaded

BVN

PROJECT NO: 2010018

0222 EARTHWORK

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide earthworks to the dimensions and tolerances, as documented.

1.2 DESIGN

General

Designer: Subcontractor to comply with requirements of Geotech and Structural documents

Geotechnical and environmental reports provided: Geotech Report

Requirements

General: To DESIGN in *0171 General requirements*.

Responsibility: The Subcontractor shall employ a suitably qualified Structural Engineer to complete the design of the Earthworks

Design of footing or pier depths: refer to Structural Engineer's documentation

Contract depths: The footing or pier depths shown on the drawings are provisional.

Authority requirements: Refer to DA Consent Conditions

1.3 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0171 General requirements*.
- *0221 Site Preparation*
- *0223 Service trenching*
- *Structural documents*
- *Hydraulic documents*
- *Landscape documents*
- ~~*Future*~~ *Development Consent Approval Conditions*

1.4 STANDARDS

General

Earthworks: Conform to the recommendations of those parts of AS 3798 that are referenced in this worksection.

Description and classification of soils: To AS 1726.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- GITA: Geotechnical inspection and testing authority.
- GTA: Geotechnical testing authority.

Definitions

General: For the purposes of this worksection the definitions given in AS 3798 and the following apply:

- Bad ground: Ground unsuitable for the works, including fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances and ground that is, or becomes, soft, wet or unstable.
- Rock: Monolithic material with volume greater than 0.3 m^3 that cannot be removed until broken up by rippers or percussion tools.

- Site topsoil: Natural soil, excavated from the site, that contains organic matter, supports plant life, conforms generally to the fine-to-medium texture classification to AS 4419 and is free from the following:
  - . Stones more than 25 mm diameter.
  - . Clay lumps more than 50 mm diameter.
  - . Weeds and tree roots.
  - . Sticks and rubbish.
  - . Material toxic to plants.
- Subgrade: The trimmed or prepared earth material on which the pavement, footing or slab is constructed. Generally taken to relate to the upper line of the earth material.
- Zone of influence: A foundation zone bounded by planes extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement.

1.6 TOLERANCES

General

Finish: Finish the surface to the required level, grade and shape within the following tolerances:

- Under building slabs and load bearing elements: + 0, - 25 mm.
- Pavement subgrades: + 0, - 40 mm.
- Batters: No steeper than the slope shown on the drawings. Make sure flatter slopes do not impact on boundaries or required clearances to buildings, pavements or landscaping.
- Other ground surfaces: ± 50 mm, provided the area remains free draining and matches adjacent construction where required. Provide smoothness as normally produced by a scraper blade.

1.7 SUBMISSIONS

Design documentation

Calculations: Submit calculations by a professional engineer showing the stability and safety of proposed excavations and temporary supports, including supports required for adjacent structures.

Execution details

Report: Submit a time-based schedule detailing the methods and equipment proposed for the earthworks, including the following:

- Dewatering and groundwater control and disposal of surface water.
- Excavation methods, stages, clearances, batters and temporary supports.
- Stockpiles and borrow pits.
- Placing and compaction methods and stages.

Geotechnical site investigations: Provide a geotechnical report supporting the methods proposed for excavation.

Disposal location: Submit details of the locations and evidence of compliance with the appropriate authority requirements for the disposal of material requiring removal from site.

Temporary shoring: Submit a proposal for any temporary shoring required, including the progressive removal.

Proof rolling: Submit details of proposed method and equipment for proof rolling.

Records of measurement: Submit a certified copy of the agreed records of measurement.

Site records: Submit the following to AS 3798 clause 3.4 and Appendix B:

- Geotechnical site visit record.
- Earthworks summary report or daily geotechnical reports.

Products and materials

Imported fill: Submit certification or test results by a GTA registered laboratory of the imported fill as evidence of conformity with the contract, including the source.

Tests

Compaction: Submit certification and/or test results in conformance with the documented level of inspection and testing to AS 3798.

1.8 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Items to be measured as listed in **RECORDS OF MEASUREMENT**.
- Areas to be cleared and/or stripped of topsoil.
- Areas stripped of topsoil.
- Excavation completed to contract levels or founding material.
- Proof rolled subgrade before placing fill.
- Filling completed to contract levels.
- Stockpiled topsoil before spreading.

2 PRODUCTS

2.1 FILL MATERIALS

General

Suitable material: To AS 3798 clause 4.4 including inorganic, non-perishable material suitably graded and capable of compaction to the documented density.

Unsuitable materials: To AS 3798 clause 4.3.

Sulfur content: Do not provide material with sulfur content exceeding 0.5% within 500 mm of cement bound elements (for example concrete structures or masonry) unless the elements are protected by impermeable membranes or equivalent means.

Re-use of excavated material: Only re-use suitable material to AS 3798 clause 4.4.

Stockpiles

General: Segregate the earth and rock material and stockpile for re-use in backfilling operations.

Location: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along drainage channels.

2.2 BORROW OR IMPORTED FILL

General

Borrow or imported material: Use only when suitable excavated material from site is not available.

- Suitable material: To AS 3798 clause 4.4.

Material conforming to the following: refer to Structural documents

Borrow pits:

- Locate more than 3000 mm from any fence line, boundary, edge of excavation or embankment.
- Strip and stockpile topsoil.
- Provide erosion protection during winning operations of material and make sure drainage is maintained.
- On completion of winning operations grade abrupt changes of slope, respread topsoil, and apply and maintain hydroseeded grassing.

Borrow and imported fill additional testing: refer to Structural documents

2.3 GEOTEXTILE

General

Material: UV stabilised, permeable, polymeric, woven or non-woven textile material used in contact with soil/rock material.

Identification and marking: To AS 3705.

3 EXECUTION

3.1 SITE PREPARATION

Erosion and sedimentation control

Requirement: Refer to Development Approval Consent Conditions

3.2 GEOTECHNICAL

As found site conditions

General: If the following are encountered, give notice and obtain instructions before carrying out any further work in the affected area:

- Bad ground.
- Discrepancy in expected conditions.
- Rock.
- Springs, seepages.
- Topsoil more than 100 mm deep.

Inspection and testing

Level of inspection and testing: Level 1 inspection and testing to AS3798 clause 8.2 by a GITA

Frequency of testing: To AS 3798 Table 8.1.

3.3 RECORDS OF MEASUREMENT

Excavation and backfilling

Agreed quantities: If a schedule of rates applies, provisional quantities are documented, or there are variations to the contract levels or dimensions of excavations, do not backfill or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.
- Quantities of excavations in rock.

Method of measurement: By registered surveyor.

Rock

Level and class: If rock is measured for payment purposes, either as extra over excavation of material other than rock or for adjustment of provisional measurements, do not remove the rock until the commencing levels and the classes of rock have been determined.

3.4 REMOVAL OF TOPSOIL

General

Extent: Areas of cut or fill and areas occupied by structures, pavements and embankments.

Maximum depth: 200 mm.

Disposal: Remove topsoil unsuitable for re-use from the site to AS 3798 clause 6.1.8.

Topsoil stockpiles

General: Stockpile site topsoil intended for re-use.

Stockpile maximum height: 1.5 m.

Identification: Mark and label stockpiles of different soil types.

Vegetation: Do not burn off or remove plant growth that occurs during storage.

Protection: Conform to the following:

- Provide drainage and erosion protection.
- Do not allow traffic on stockpiles.
- If a stockpile is to remain for more than four weeks, sow with temporary grass.
- Protect the topsoil stockpiles from contamination by other excavated material, weeds and building debris.

3.5 EXCAVATION

Extent

Site surface: Excavate the site to the levels and profiles required for the documented structures, pavements, filling and landscaping. Make allowance for compaction, settlement or heaving.

Footings, pits, wells and shafts: Excavate to the required sizes and depths. Confirm that the foundation conditions meet the design bearing capacity.

Bearing surfaces

Requirement: Provide even plane bearing surfaces for loadbearing elements including footings. Step to accommodate level changes. If supporting masonry, make the steps appropriate to the courses.

Rock
General: Do not use explosives.

Existing footings
Requirement: If excavation is required within the zone of influence of an existing footing, provide supports to the footing sufficient to prevent damage arising from the works. Use methods including temporary shoring or underpinning.

Existing services
Location: Before starting earthworks, locate and mark existing underground services in the areas that will be affected by the earthworks operations including clearing, excavating and trenching.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Excavation: Do not excavate by machine within 1000 mm of existing services.

Proof rolling
Extent: Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the presence of bad ground.

Proof rolling method and equipment: To AS 3798 clause 5.5.

Requirement: If excessive settlement, rebound or heaving is encountered, provide test pits or trenching to determine the extent of bad ground.

Disposal of excess excavated material
General: Remove excess excavated material from site not required or unsuitable for fill.

Standard: To AS 3798 clause 6.1.8.

3.6 REINSTATEMENT

Deterioration of bearing surfaces
Requirement: If the bearing surface deteriorates because of water or other cause, excavate to a sound surface before placing the loadbearing element.

Subgrades affected by moisture
Requirement: If, due to high moisture content the subgrade cannot support construction equipment or the overlying pavement cannot be compacted, perform one or more of the following:

- Allow the subgrade to dry until it provides support for equipment and allows compaction.
- Scarify the subgrade to a depth of 150 mm, work as necessary to accelerate drying, and recompact when the moisture content is satisfactory.
- Excavate the wet material and remove to spoil, and backfill excavated areas.

Over excavation
Requirement: If excavation exceeds the required depths, reinstate to the correct depths, levels and bearing capacity.

Zone of influence: Within the zone of influence of footings, beams, or other structural elements, use concrete of strength equal to the structural element, minimum 15 MPa. Make sure that remedial concrete does not create differential bearing conditions.

Below slabs or pavements: Rectify the over excavation as follows:

- Generally: Provide selected fill compacted to the documented density.
- Less than 100 mm: Do not backfill. Increase the thickness of the layer above.

Rock depressions and subsoil drains: Backfill rock depressions and over excavation of subsoil drains using coarse subsoil filter.

3.7 SUPPORTING EXCAVATIONS

Removal of supports
General: Remove temporary supports progressively as backfilling proceeds.

Voids
General: If voids occur outside sheeting or sheet piling, fill and compact voids to a dry density similar to that of the surrounding material.

3.8 ADJACENT STRUCTURES

Temporary supports

General: If required, provide supports to adjacent structures, sufficient to prevent damage arising from the works.

Lateral supports: Provide lateral support with shoring.

Vertical supports: If required, provide vertical support with piling or underpinning or both.

Permanent supports

General: If permanent supports for adjacent structures are required and are not documented, give notice and obtain instructions.

Encroachments

General: If encroachments from adjacent structures are encountered and are not documented give notice and obtain instructions.

Zone of influence

Angle from horizontal: refer to Structural documents and Geotech advise

3.9 ROCK BOLTING

General

Requirement: For temporary or permanent support of rock faces, provide proprietary high strength steel bars or tubes anchored into holes drilled in the rock and tensioned against plates bearing on the rock face. Schedule the installation to conform to systematic bolting or calculated relief, as documented.

Standard: To AS 4678.

Protection

General: Protect permanent rock bolts by grouting the drilled hole with cement grout after tensioning the rock bolt. Protect the bearing plate and the exposed portion of rock bolt and anchorage with a protective coating or by embedment in concrete.

3.10 GEOTEXTILE

General

Preparation: Trim the ground to a smooth surface free from cavities and projecting rocks.

Installation: Lay the fabric flat, not stretched tight, and secure with anchor pins. Overlap joints 300 mm minimum.

3.11 PREPARATION FOR FILLING

Preparation

Stripping: Prepare the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements to AS 3798 clause 6.1.5. Remove material that inhibits or prevents satisfactory placement of fill layers, loose material, debris and organic matter.

Foundation preparation: To AS 3798 clause 6.1.7.

Compaction: Compact the ground exposed after stripping or excavation, to a minimum depth of 150 mm, to the minimum relative compaction in AS 3798 Table 5.1.

Ground treatment or improvement methods:

- Scarify method: Loosen exposed excavation by scarifying to a minimum of 150 mm, moisture-condition and compact to AS 3798 Section 5.
- Impact roller and impact compaction: Use an approved method.

Slope preparation: If fill is placed on a surface steeper than 4:1 (horizontal:vertical), bench the surface to form a key for the fill. As each layer of fill is placed, cut the existing ground surface progressively to form a series of horizontal steps more than 1 m in width and more than 100 mm deep. Recompact the excavated material as part of the filling. Shape to provide free drainage.

Working platform: If necessary obtain advice from Geotech Engineer / Structural Engineer

Under earth mounds

General: Cultivate the ground to a depth of 200 mm before mound formation.

Under slabs, paving and embankments

General: If required, loosen the ground to a depth of more than 200 mm and adjust the moisture content before compaction to a density consistent with subsequent filling.

Rock ledges

General: Remove overhanging rock ledges.

3.12 PLACING FILL

General

Extent: Place fill to the documented dimensions, levels, grades, and cross sections so that the surface is always self-draining.

Layers: Place fill in near-horizontal layers of uniform thickness, deposited systematically across the fill area.

Edges: At junctions of fill and existing surfaces, do not feather the edges.

Mix: Place fill in a uniform mixture.

Previous fill: Before placing subsequent fill layers, make sure that previously accepted layers still conform to requirements, including moisture content.

Protection: Protect the works from damage due to compaction operations. If required, limit the size of compaction equipment or compact by hand.

Protective covering to membranes: Do not disturb or damage during backfilling.

Placing at structures

Fill adjacent structures and trenches: To AS 3798 clause 6.2.6.

Requirement: Place and compact fill in layers simultaneously on both sides of structures, culverts and pipelines to avoid differential loading. Commence compacting each layer at the structure and proceed away from structure.

Over the top of structures: Carefully place first layers of fill.

Retaining walls: Do not place fill against concrete retaining walls until the concrete has been in place for 28 days unless the structure is supported by struts.

Compaction

General: Compact the subgrade and each layer of fill to the required depth and density, as a systematic construction operation. Shape surface to provide drainage and prevent ponding.

Maximum rock and lump size in layer after compaction: To AS 3798 clause 6.2.2.

Fill batter faces: Either compact separately, or overfill and cut back. Form roughened surfaces to the faces.

Minimum relative compaction: To AS 3798 Table 5.1.

3.13 PLACING TOPSOIL

Stockpiled topsoil

Cultivation: Rip subgrade to a depth of 100 mm or to the depth of rippable subgrade if less. Cultivate around services and tree roots by hand. Trim to allow for the required topsoil depth.

Herbicide: Apply before placing topsoil.

Herbicide product: Submit suitable product for approval by Superintendent and Landscape Architect

Placing: Spread and grade evenly.

Compaction: Lightly compact topsoil so that the finished surface is smooth, free from lumps of soil, at the required level, ready for cultivation and planting.

Edges: Finish topsoil flush with abutting kerbs, mowing strips and paved surfaces. Feather edges into adjoining undisturbed ground.

Disposal of excess topsoil

On-site: Dispose of surplus topsoil remaining on site by spreading evenly over the areas already placed subject to approval from Proprietor.

Off-site: Remove excess topsoil from the site and dispose of legally.

3.14 FILL MOISTURE CONTROL

General

Moisture content: Adjust the moisture content of fill during compaction within the range of 85% to 115% of the optimum moisture content determined by AS 1289.5.1.1 or AS 1289.5.2.1, as appropriate, to achieve the required density.

3.15 COMPACTION TESTS

Compaction control tests

Compaction control tests: To AS 1289.5.4.1 or AS 1289.5.7.1.

Compaction control test frequency

Standard: To AS 3798 Table 8.1.

Confined operations: 1 test per 2 layers per 50 m^2.

3.16 COMPLETION

Geotechnical report

Inspection and testing report: Level 1 Statement of compliance of Work

Grading

External areas: Grade to give falls away from buildings, minimum 1:100.

Subfloor areas: Grade the ground surface under suspended floors to drain ground or surface water away from buildings without ponding.

Site restoration

Requirement: If variation of existing ground surfaces is not required as part of the works, restore surfaces to the condition existing at the commencement of the contract.

PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

SERVICE TRENCHING

DOCUMENT No Z-0223

ISSUE 4 | 15 MARCH 2024

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
2	28/01/2022	FOR TENDER	BFS	NS
3	13/06/2023	BAFO TENDER	BFS	NS
4	15/03/2024	CONSTRUCTION CERTIFICATE APPROVAL 1	AC	AC

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Each item added is in red and shaded

BVN

PROJECT NO: 2010018

0223 SERVICE TRENCHING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide trenching for underground services, as documented.

1.2 DESIGN

Requirements

General: To DESIGN in *0171 General requirements*.

Responsibility: Design and coordinate all trenching required for proposed inground services, as documented.

~~Trench design: Design and coordinate all trenching required for proposed inground services, as documented.~~

Existing services: Where possible, design to avoid all existing services. Locate existing services to **EXECUTION**, **EXISTING SERVICES**.

Authority requirements: Refer to Development Application Consent Conditions

1.3 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0171 General requirements*.
- *0221 Site preparation*
- *0222 Earthwork*
- *Landscape documents*
- *Hydraulic*
- *Electrical*
- *Other Services*
- ~~*Future*~~ *Development Consent Approval Conditions*

1.4 STANDARDS

Trenching

Earthworks: To AS 3798.

Electrical services: To AS/NZS 3000.

Hydraulic services: To the AS/NZS 3500 series.

Communication services: AS/CA S009.

1.5 TOLERANCES

Surface levels

Earthworks: Finish the surface to the required level, grade and shape within the following tolerances:

- Under building slabs and load bearing elements: + 0, - 25 mm.
- Pavement subgrades: + 0, - 40 mm.
- Batters: No steeper than the slope shown on the drawings. Make sure flatter slopes do not impact on boundaries or required clearances to buildings, pavements or landscaping.
- Other ground surfaces: ± 50 mm, provided the area remains free draining and matches adjacent construction where required. Provide smoothness as normally produced by a scraper blade.

Pavement base and subbase: Finish the surface to the required level, grade and shape within the following tolerances:

- Subbase: + 10 mm, - 25 mm.
- Base: + 10 mm, - 5 mm.

Finished pavement or paving surface: Conform to the documented level within the following tolerances:

- Asphalt: ± 10 mm.
- Concrete: + 10 mm, - 0 mm.
- Paving:
  - Finished level: ± 8 mm.
  - Height deviation between adjacent units (lippage): ± 2 mm.
- Granular surfaces: ± 10 mm.
- Lippage between restored surface and adjacent existing surface: ± 5 mm.

1.6 SUBMISSIONS

Execution details

Excavation method: Submit details of proposed equipment and method of excavation, including the following:

- Service location and type: A plan of the trench works showing the location and type of service.
- Open excavation: Proposed duration.
- Shuttering and/or bracing of trench sides: If required for safety and stability, provide proposals.
- Geotechnical data: Geotechnical report supporting the procedures proposed for trenching and/or boring.
- Boring: Proposals for the following:
  - Limits on length.
  - Existence of other services and method of protection.
  - Pressure grouting to voids.
  - The effect of pressure grouting on other services, ground heave and proposals for minimising such effects.
  - Access to properties outside the site.
  - Council permits.
  - Service interruptions including a plan for minimising unintended interruptions.
- Hazards: Identify WHS hazards that may be encountered with deep trenches including toxic gases and liquids.

Off-site disposal location: Submit details of the proposed disposal locations and evidence of conformance with the relevant authorities for the disposal of material required to be removed from the site.

Records

As-built location: Upon completion submit to the relevant authority, as-built documentation to show the location of the installed services.

1.7 INSPECTION

Notice

Inspection: Give notice so that inspection may be made at the following stages:

- Items to be measured as listed in **GROUND CONDITIONS**, **Records of measurement**.
- Service trenches excavated before laying the service.
- Services laid in trenches and ready for backfilling.
- Completed surface restoration.

2 PRODUCTS

2.1 FILL MATERIALS

General

Suitable material: To AS 3798 clause 4.4 including inorganic, non-perishable material suitably graded and capable of compaction to the documented density.

Unsuitable materials: Do not use unsuitable material for fill in conformance with AS 3798 clause 4.3.

Sulfur content: Do not provide filling with sulfur content exceeding 0.5% within 500 mm of cement bound elements (for example concrete structures or masonry) unless such elements are protected by impermeable membranes or equivalent means.

Re-use of excavated material: Only re-use suitable material in conformance with AS 3798 clause 4.4.

Material in reactive clay areas: In sites classified M, M-D, H1, H1-D, H2, H2-D, E or E-D to AS 2870, re-use excavated site material at a moisture content within ± 1% of that of the adjoining in situ clay.

2.2 SURFACE RESTORATION MATERIALS

General

Re-use: If possible re-use the existing surface materials that were removed during trench excavation, whilst conforming to the documented material requirements.

Subbase and base

Requirement: Provide crushed rock material configured in layers and depths to match existing and adjacent work, as follows:

- Base: 20 mm nominal size.
- Subbase: 40 mm nominal size.

Pathways and paved surfaces generally

Requirement: Provide materials consistent with those of the existing surface before service trenching works commenced.

Concrete surfaces

Material requirements: Normal-class to AS 1379.

Concrete strength grade: N25.

Slump: Maximum 100 mm.

Asphalt surfaces

Aggregate: To AS 2758.5 or to AS 2758.2 for sprayed bituminous surfaces.

Asphalt: To AS 2150.

Medium cut back bitumen: To AS 2157.

Bitumen emulsion: To AS 1160.

Bitumen binder: Class 170.

Pavers

Concrete and clay pavers: To AS/NZS 4455.2.

Bedding and joint filling sand: Well-graded sand, free of deleterious material such as soluble salts which may cause efflorescence.

Stone pavers and setts: Provide sound stone pavers and setts of uniform quality. Reject any with defects liable to affect strength and durability.

Bedding mortar mix (cement:sand): Select from the range 1:3 to 1:4 to obtain satisfactory adhesion. Provide minimum water.

3 EXECUTION

3.1 EXISTING SERVICES

Location

Requirement: Before commencing service trenching, locate and mark existing underground services in the areas which will be affected by the service trenching operations.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Excavation

General: Do not excavate by machine within 1 m of existing underground services.

3.2 EXISTING SURFACES

Concrete and asphalt pavements

Method: Sawcut trench set out lines for the full depths of the bound pavement layers except where the set out line is located along expansion joints.

Removal of concrete and asphalt: Break out concrete or asphalt pavement material between the trench set out lines, remove and dispose of off-site.

Paving

Removal: Take up paving units both full and cut by hand, between the trench set out lines, and neatly stack on wooden pallets.

Concrete edging: Break out, remove and dispose of off-site.

Concrete subbase: If present, sawcut along the trench set-out lines.

Grass

Removal method: Neatly cut grass turf between trench set-out lines into 300 mm squares.

Grass suitable for re-use: Take up and store the turf and water during the storage period.

Unsuitable grass: Remove and dispose of off-site.

Small plants, shrubs and trees

Remove for re-planting: Take up and store. Wrap the rootball in a hessian or plastic bag with drain holes and water during the storage period.

Unsuitable vegetation: Remove and dispose of off-site.

3.3 GROUND CONDITIONS

As found site conditions

Unexpected conditions: If the following are encountered, give notice immediately and obtain instructions before carrying out any further work in the affected area:

- Bad ground.
- Discrepancies to expected ground conditions.
- Rock.
- Springs, seepages.
- Topsoil > 100 mm deep.

Records of measurement

Excavation and backfilling: If a schedule of rates applies, provisional quantities are specified, or there are variations to the contract levels or dimensions of excavations, do not commence backfilling or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.
- Quantities of excavations in rock.

3.4 EXCAVATION

General

Requirement: Excavate for underground services in conformance with the following:

- To required lines and levels, with uniform grades.
- Straight between access chambers, inspection points and junctions.
- With stable sides.
- Width tolerance: ± 50 mm, unless constrained by adjacent structures.
- Tree protection: To AS 4970.

Adjacent structures

Existing footings: If excavation is required within the zone of influence of an existing footing, use methods including (temporary) shoring or underpinning that maintain the support of the footing and make sure that the structure and finishes supported by the footing are not damaged.

Temporary supports: Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works, as follows:

- Lateral supports: Provide lateral support using shoring.
- Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

Permanent supports: If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

Encroachments: If encroachments from adjacent structures are encountered and are not shown on the drawings, give notice and obtain instructions.

Trench widths

General: Keep trench widths to the minimum, consistent with the laying and bedding of the relevant service and construction of access chambers and pits.

Trench depths

General: As required by the relevant service and its bedding method.

Obstructions

General: Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

Dewatering

General: Keep trenches free of water. Place bedding material, services and backfilling on firm ground, free of surface water.

Pumping: Provide pump-out from adjacent sumps or install well points.

Adjacent subsidence: Provide recharge points to isolate the dewatering zone.

Excess excavation

General: If trench excavation exceeds the correct depth, reinstate to the correct depth and bearing value using compacted bedding material or sand stabilised with 1 part of cement to 20 parts of sand by volume.

Stockpiles

Topsoil removal: Stockpile topsoil intended for re-use to a maximum height of 1500 mm.

Excavated material for backfill: If required, segregate the earth and rock material and stockpile, for re-use in backfilling operations.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted, dispose of excavated material off-site.

Unsuitable material

Disposal: Remove unsuitable material from the bottom of the trench or at foundation level and dispose of off-site. Replace with trench backfill material.

Boring

Subcontractor: If boring is required instead of trenches, engage a suitably qualified subcontractor to do the work.

3.5 TRENCH BACKFILL

General

Place fill: To AS 3798 clauses 6.2.2 and 6.2.6.

Timing: Backfill service trenches as soon as possible after laying and bedding the service, if possible on the same working day.

Removal of supports: Remove temporary supports progressively as backfilling proceeds.

Marking services

Marking tape: Provide marking tape above service, with appropriate labelling, to AS/NZS 2648.1 and as follows:

- Non-metallic services: Provide tape capable of being detected by inground scanning devices.
- Location: Locate tape approximately half the depth of the service being marked, to a maximum depth of 200 mm below the finished ground level.

Boring: If boring techniques are used to install the service, provide permanent on site labelling at the start and end of the service run and record on the as-built documentation.

Bedding, haunch, side and overlay zones

Installation and material: To the particular utility authority or utility service requirements. Secure pipes against floatation.

Bedding of services: Surround pipes or conduits on all sides with a minimum of 75 mm compacted bedding sand, or as documented.

Overlay zone thickness: Maximum 300 mm immediately over the utility service.

Trees

Backfill at trees: Backfill minimum 300 mm thick, around tree roots with a topsoil mixture. Place and compact in layers of 150 mm minimum depth to a dry density equal to that of the surrounding soil.

Original surface level: Do not place backfill above the original ground surface around tree trunks or over the root zone.

Watering: Thoroughly water immediately after backfilling the tree root zone.

Compaction

Control moisture within backfill: To AS 3798 clause 6.2.3.

Layers: Compact all material in layers not exceeding 150 mm compacted thickness. Compact each layer to the required relative compaction before starting the next layer.

Compaction: To AS 3798 Section 5.

Frequency of testing: To AS 3798 clause 8.7.

Precautions: Use compaction methods which do not cause damage or misalignment to utility services.

Density tests

Testing authority: Carry out density tests of pipe bedding and backfilling by an Accredited Testing Laboratory.

Test methods: Conform to the following:

- Compaction control tests: To AS 1289.5.4.1 or AS 1289.5.7.1.
- Field dry density: AS 1289.5.3.2 or AS 1289.5.3.5.
- Standard maximum dry density: AS 1289.5.1.1.
- Dry density ratio: AS 1289.5.4.1.
- Density index: AS 1289.5.6.1.

3.6 SURFACE RESTORATION

Subbase and base

Compaction: Uniformly compact each layer of the subbase and base courses over the full area and depth within the trench to a relative compaction of 100% when tested in conformance with AS 1289.5.4.1.

Compacted layer thickness:

- Maximum: 200 mm.
- Minimum: 100 mm.

Compaction test frequency: Minimum 1/every second layer/50 m² of restoration surface area.

Concrete surfaces

Construction: Conform to the following:

- Prime coat the cut edges of the existing surfaces with cement slurry. Lay and compact concrete so that the edges are flush and the centre is cambered 5 mm above the adjoining existing surfaces.
- Surface finish and pattern: Match existing adjoining work.
- Minimum thickness: 75 mm or the adjacent pavement thickness, whichever is thicker.
- Reinforcement and dowels: If required, provide steel reinforcement with dowels into the adjacent concrete.
- Expansion joints: 15 mm thick preformed jointing material of bituminous fibreboard placed in line with joints in existing concrete.
- Control joints:
  - Form control joints strictly in line with the control joints in existing concrete.
  - Around service poles: Terminate the concrete paving 200 mm from the pole and fill the resulting space with cold mix asphalt.

Weather: Do not place concrete in ambient temperatures above 30°C or below 10°C, without adequate precautions. Protect surface from rain damage, if required.

Compaction: Compact as follows:

- Thickness 100 mm or less: Compact by placing, screeding and finishing processes. If required use a hand-held vibrating screed at the surface. Do not use immersion vibrators.
- Thickness more than 100 mm and downturns: Use an immersion vibrator.

Curing: Cure by keeping continuously wet for 7 days.

Asphalt surfaces

Placement: To AS 2150.

Operations: Spread the asphalt mix in layers covering the full width of the trench.

Thickness: Match the adjoining asphalt surface.

Finish: Compact to a smooth even surface.

Sprayed bituminous surfaces: To AS 3727.1 Section 8.

Pavers

Bedding: Replicate the bedding used for the original paved surface. Use bedding methods and materials which are appropriate to the paver, the substrate, the conditions of service, and which leave the paver firmly and solidly bedded in the bedding material.

Laying: Re-lay to match the pattern and surface levels of the existing paving.

Damaged pavers unsuitable for relaying: Replace with new pavers of the same material, type, size and colour as the existing.

Landscaped areas

In topsoil areas: Complete the backfilling with topsoil for at least the top 100 mm.

Lawn: Re-lay stockpiled turf. If existing turf is no longer viable, re-sow the lawn over the trench and other disturbed areas.

Planted areas: Overfill to allow for settlement.

3.7 COMPLETION

General

As-built documentation: Upon completion, record the location of all installed services on the as-built documentation.

PYMBLE LADIES COLLEGE

NEW SCHOOL BUILDING
GREY HOUSE PRECINCT

AVON ROAD
PYMBLE NSW 2073

ARCHITECTURAL SPECIFICATION

CONCRETE - COMBINED

DOCUMENT No Z-0310

ISSUE 4 | 15 MARCH 2024

ISSUE REGISTER

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	APPROVED
A	08/10/2021	DRAFT TENDER	BFS	NS
2	28/01/2022	FOR TENDER	BFS	NS
3	13/06/2023	BAFO TENDER	BFS	NS
4	15/03/2024	CONSTRUCTION CERTIFICATE 1 APPROVAL	AC	AC

Each item deleted is ~~struck through~~
Each item added is in red and shaded

BVN

PROJECT NO: 2010018

1 GENERAL CONCRETE

1.1 GENERAL REQUIREMENTS

Standard: Construct the concrete work in a safe manner using materials and methods complying with the relevant requirements of AS 3600 and AS 3610. For concrete structures used for retaining liquids comply also with the relevant requirements of AS 3735.

Environmentally Sustainable Concrete: This project aims to maximise the use of supplementary cementitious materials in concrete and post consumer recycled steel content in steel reinforcement.

This project aims to minimise embodied energy, minimise resource depletion and encourage the use of recycled materials and environmentally responsible practices. Refer to sections 2.3.1, 3.3.1 and 5.3.3 for specific requirements relating to timber formwork, recycled steel and supplementary cementitious materials.. Certification of the targets is required under the Green Star/other system. (Engineer to use where required on projects – check with project director).

Survey Certificates: These are to be certified by a licensed surveyor.

Costs: All items and associated costs referred to in this Specification and the Structural/Civil drawings shall form part of the Contractor's sum, unless noted otherwise. All Materials are to be supplied including wastage and over-supply construction.

Notice: Should any ambiguity, error, omissions, discrepancy or other faults exist or seem to exist in the contract documents then promptly notify in writing to the Superintendent.

Variations: Should the Contractor consider that a variation to the contract exists, then they should refer immediately to the superintendent and obtain written approval prior to variation work proceeding. Refer Contract Conditions.

Batches: All visible concrete including but not limited to visible insitu concrete walls, floors and soffits and visible precast concrete shall be from the one batch of materials and to be the same composition and visual appearance

1.2 QUALITY ASSURANCE

REQUIREMENT: A quality management system complying with the appropriate current Australian standard is required for a specified product or service, or in any case where the supplier already has in place such a system, provide assurance of quality in terms of that system.

Programme**:** Submit a copy of the Contractors quality assurance programme with the tender.

During the construction phase, the Contractor shall provide a written verification to the Superintendent that they have completed a quality assurance and control procedure on the construction works detailed in the specifications and drawings.

Description: Provide a written description of each quality management system, with specific reference to the following:

- the relevant Australian standard;
- where the standard provides for classification levels, the level adopted;
- the scope and field of application;
- the personnel involved and their responsibilities:
- Inspection Test Plans (I.T.P's)
- The various procedures required by the standard including those for management review, contract review, design and document control, process control, inspection and testing, etc.;
- the quality audit system;

- Where external quality audits are required by a recognized independent organizations, the name of that organization;
- other relevant information.

Quality control: The Contractor shall submit their Construction Method Statement and Inspection Test Plan (I.T.P) for each work procedure to the Superintendent for approval for a minimum of 14 days prior to commencing the relevant work. I.T.P's shall include checklists showing that the Contractor has checked that the work has been completed in accordance with the specifications and drawings and showing testing and inspection requirements.

1.3 ADJOINING ELEMENTS

Requirement: Obtain the requirements for adjoining elements to be fixed to or supported on the concrete and provide for the required fixings. Where applicable provide for temporary support of the adjoining elements during construction of the concrete.

1.4 VARIATIONS TO STRUCTURAL DRAWINGS

Should changes to the design/drawings be requested by the contractor, then the Contractor is to liaise with the Superintendent's representative and allow for all co-ordination and shop drawings to suit this process and shall be at the Contractors expense.

1.5 PROPRIETARY PRODUCTS

Where proprietary products are nominated on the drawings or in the specification, the Contractor shall provide written certification that the product incorporated in the works is fit for its intended use and has been installed in accordance with the manufacturers recommendations.

Alternative to Proprietary Products: Alternative products may be offered for review, but may be liable to rejection, at no cost to the project. Provide technical data and information to confirm any alternative complies with the design intent of the nominated product. Alternatives shall comply with the project specification and the intent of the design indicated on the project documents.

Any alterations to the works as a result of an alternative product being accepted must be carried out at no cost to the project.

1.6 PRODUCT DATA

Requirement: Before installation commences provide the following information:

Manufacturer's data: The Manufacturer's published product data including:

- technical specifications,
- recommendations for installation and maintenance
- type test or factory test data.
- performance and rating tables

Testing authorities reports: Test reports certified by an independent testing authority showing compliance with the criteria of specified tests.

Product warranties: The Manufacturer's written statement certifying the product complies with the Specification and is suitable for the intended use.

Approval of installer: If the installation is not by the Manufacturer, and the Manufacturer warranty is conditional on his approval of the installer, the manufacturer's written approval of the specialist installation firm is to be provided.

1.7 NON CONFORMING WORK

Where a section of works does not comply with the requirements of the specification and drawings (including requirements for inspection and testing) the Contractor shall submit a non-conformance report detailing the

proposed rectification method to the Superintendent for approval. Where the Superintendent deems that the proposed rectification method and work is to be reviewed and/ or inspected by the relevant consultant(s), this review and inspection shall be at the contractor's expense.

1.8 INSPECTION

It is the Contractors responsibility to construct the works in accordance with the specifications and drawings and any inspections by the Superintendent's representative shall not be construed as relieving or relaxing this requirement. The Superintendent and their representatives are not fulltime or part time inspectors for the Contractor, and any inspections made are for the Superintendents purpose only.

Bookings

General Contractor's Foreman is to check all work that is to be inspected for compliance with documents before confirming booking of site inspection.

Where inspection by the Superintendent's representative is required or notification to the Superintendent to allow opportunity to inspect is required, please give minimum 24 hours notice of required inspection.

Book inspections through TTW. Phone to confirm inspection 24 hours before appointed time.

Scheduled inspections should be cancelled a minimum of 4 hrs prior to the scheduled time if work will not be ready for inspection. Phone for cancellations, e.g. due to bad weather, as soon as possible, otherwise a charge for inspection may be incurred.

Inspection Times

Hours 8.00 am to 4.00 pm Monday to Friday only.

Generally no site visits on Saturdays, Sundays or Public Holidays except in emergency situations and by special booking.

Allow sufficient time, and not less than 4 hours prior to concreting, for the carrying out of the inspection.

Revisits

If the area of work is not completed at the scheduled time of inspection or is defective and requires re-inspection, re-inspection shall be at the Contractors expense. Follow normal booking procedures.

The Superintendent's representative cannot wait on site for work to be completed. However, if the Contractor requests the Superintendent's representative to wait on site while work is being completed then this will be charged to the Contractor at an hourly rate.

Documents

Keep copy of all specifications, current drawings and a drawing register on site. Drawings

approved by the Certifying Authority for CC or BA shall be held on site. Keep copies of all

Inspection Reports on site.

Alterations

Do not accept verbal approval of alterations.

Superintendent's representative should approve alterations in writing.

Responsibilities

The Contractor's Foreman is to accompany the Superintendent's representative on his inspections.

Any inspection carried out by the Superintendent's representative does not relieve the Contractor of his responsibility to construct the structure or works in accordance with the drawings and specifications.

Certificates by the Superintendent's representative do not relieve the Contractor of his obligation to obtain approvals from authorities having jurisdiction over the works.

1.9 WORKSHOP DRAWINGS

General

Where shop drawings are required by this Contract to be supplied by the Contractor, such shop drawings shall include drawings, diagrams, illustration, schedules, performance charts, brochures and other data prepared by the sub-Contractor, manufacturer, supplier or distributor illustrating some portion of the work.

The Superintendent shall receive shop drawings only for conformity with the design concept of the project and the information given in the contract Documents. The Superintendents permission to use a separate item will not indicate permission to use any assembly in which the item functions.

Number of copies: For each drawing, supply free of charge not less than three copies in the form of prints on paper or provide 1 copy in Adobe PDF format.

Shop drawings shall be thoroughly checked by the Contractor for completeness and for compliance with the Contract Documents before submitting them to the Superintendent and shall bear the Contractor's stamp of approval certifying that they have been checked.

Shop drawings submitted without this stamp of approval and certification, and shop drawings which, in the Superintendent's opinion are incomplete, contain numerous errors or have not been checked or only checked superficially, will be returned unchecked by the Superintendent for resubmission.

The drawings shall show, in standard Engineering drawing manner, clear and complete details of each assembly, component and connection of the work, together with all information, including surface treatment and erection.

In checking shop drawings the Contractor shall verify dimensions and site conditions and shall check and co-ordinate the shop drawings of any section or trade with the requirements of other sections or trades whose work is related thereto, as required for proper and complete installation of the work. Corrections required by the Superintendent shall be made and the shop drawings resubmitted until permission is given for their use.

The Engineering drawings shall be read in conjunction with the Architectural drawings and all other relevant drawings and provision made for all fixings noted therein.

Drawings will not be checked dimensionally for correctness of holes and cleats to suit other building trades. Drawings rejected by the Superintendent's representative shall be corrected and re-submitted before fabrication and shall not constitute a claim for extension of time.

Shop drawings shall be submitted suitably identified and in orderly sequence to cause no delay to the works. Drawings submitted shall correspond to the size of the contract drawings where practical.

Time required for examination: The Contractor shall provide the programme for shop detailing including the number of drawings in each issue making allowance for the examination time required by the Superintendent's representative. Minimum time required: 10 working days.

Construction: Do not commence construction until permission to use the relevant shop drawings has been obtained.
Do not commence construction until prototype has been fully approved.

Work-as-executed drawings and Survey certificates required for all work shop drawings and all concrete elements.

2 CONCRETE FORMWORK

2.1 GENERAL

2.1.1 CROSS REFERENCES

General

Conform to the General requirements worksection.

Related sections

Conform to associated worksections as follows:

- Concrete reinforcement.
- ESD Report

2.1.2 STANDARD

Any reference documents are as a guide only and the Contractor shall source all appropriate standards and codes and the latest editions are to be adopted.

General

Formwork design and construction: To AS 3610.

2.2 QUALITY

2.2.1 INSPECTION

Witness points

Give a minimum of 2 working days notice and provide the necessary access so that inspections may be made of the following:

- completed formwork before concrete placing.
- evaluation of the finish.
- used formwork, after cleaning and before reuse.

Hold points

- Contractor's structural Engineer's certificate confirming adequacy of formwork and falsework prior to casting concrete.

NB: To be included in the contractor's quality assurance submission. Superintendent

to be notified to allow opportunity for inspection if required.

2.2.2 CONTRACTOR'S SUBMISSIONS

Design

Submit calculations prepared by a professional engineer registered on NPER and experienced in formwork design to show that the allowable concrete stresses will not be exceeded if:

- formwork procedures or loadings differ from the information included in the project documentation;
- project documentation does not include formwork shoring or stripping procedures or allowable loadings from stacked materials; or
- props above a floor do not coincide with the props below.

Certification: Submit certification by a professional engineer registered on NPER and experienced in formwork design for verifying conformance of the design for the formwork, false work and back propping.

Samples / Prototypes

- Prototype of visible concrete insitu walls and exposed ceilings, location to be advised. Minimum requirements for wall and ceiling Class 2;
- Minimum 2 formwork panels wide to include:
- Full height wall
- Panel joints in formwork plywood

NB allow for cutting of form plywood to achieve even spacing for walls ceilings and other elements

- No Arisses (include in prototype)
- Flush pour joints
- Patching of bolt holes (nb hole is still expressed)

Minimum requirements for soffit Class 2;

- Minimum 2 formwork panels wide
- Panel joints in formwork plywood
- Typical penetrations

Coloured concrete: Submit sample of all floor finishes both inside and outside blocks of coloured concrete produced or on site prototype using the proposed mix and casting method before casting final concrete, as follows:

- Number: 4.
- Size (nominal): 1200 x 900 x 50 mm.

Honed concrete: Submit sample blocks of honed concrete produced using the proposed mix (allow for 3 varying mixes) and casting method before casting final concrete, as follows:

- Number: 4.
- Size (nominal): 600 x 600 x 50 mm.
- Samples to include sealers

Light grind concrete: Submit sample blocks of light grind concrete produced using the proposed mix (allow for 3 varying mixes) and casting method before casting final concrete, as follows:

- Number: 4.
- Size (nominal): 600 x 600 x 50 mm.
- Samples to include sealers

Concrete Formworker Statement

The project is a high end residential project and a high end finish to the concrete is hence accordingly expected. The proposed concrete formworker Subcontractor is to provide:

- A written statement indicating a level of experience in a similar scale project with comparable complexity
- Photographic examples of similar scale projects that upon request that can be visited by the Superintendent / Architect / Client
- Time of submission with Tender

Work Methodology Statement

The concrete formworker is to provide a Work Methodology Statement :

- That includes but is not limited to how the required quality of finish / colour, arrises etc are to be achieved
- - How colour consistency especially between differing concrete batches is to be achieved
- Suppression of honey-combing
- Suppression / elimination of leakage between form panels
- Consistency of appearance between straight walls and curved walls

Shop drawings

Submit shopdrawing showing location of construction joints, location and detail of tie holes for items with class 2C finishes.

Generally allow for even spacings on and between elements.

- The concrete formworker is to provide to a full and detailed set of work shop drawings that indicate:
- a complete layout of all visible off-form concrete elements
- Complete with all elements including but not limited to plywood sheet form panel layout (allow for cut sheets to achieve even spacing between elements), finishes, shu bolts, pour breaks, arises etc
- Services including but limited to electrical items light switches, lights, smoke detectors, thermostats, mechanical and hydraulic penetrations
- NB allow for cutting of form plywood to achieve even spacing for walls ceilings and other elements

The drawings shall show, in standard Engineering drawing manner, clear and complete details of each

assembly, component and connection of the work, together with all information, including surface treatment and erection. In checking shop drawings the Contractor shall verify dimensions and site conditions and shall check and co-ordinate the shop drawings of any section or trade with the requirements of other sections or trades whose work is related thereto, as required for proper and complete installation of the work. Corrections required by the Superintendent shall be made and the shop drawings resubmitted until permission is given for their use.

The Engineering drawings shall be read in conjunction with the Architectural drawings and all other relevant drawings and provision made for all fixings noted therein.

Drawings will not be checked dimensionally for correctness of holes and cleats to suit other building trades. Drawings rejected by the Superintendent's representative shall be corrected and re-submitted before fabrication and shall not constitute a claim for extension of time.
The Engineering drawings shall be read in conjunction with the Architectural drawings and all other relevant drawings and provision made for all fixings noted therein.

Shop drawings shall be submitted suitably identified and in orderly sequence to cause no delay to the works. Drawings submitted shall correspond to the size of the contract drawings where practical.

Execution proposals

Certification: Submit certification by a professional engineer registered on NPER and experienced in formwork design and construction for verifying conformance of the completed formwork, false work and back propping prior to concrete placing.

Documentation: Submit formwork documentation in accordance with AS 3610 clause 4.7 together with details of proposed form linings, form coatings, release agents and where applicable, reuse of formwork. Submit details of support propping required for construction loads which exceed design loads for concrete of that age.

Reshoring/Backpropping: If intended, submit proposals.

Slip formwork: Show on formwork drawings the method of lifting the forms during construction and the average rate of movement. Demonstrate that the proposed average rate will permit the production of concrete of the specified quality and surface.

Stripping multi-storey suspended work: If the requirements of AS 3610 cannot be met, or if shores are not concentric floor to floor, submit formwork documentation with reference to loads and concrete properties.

Stripping single storey suspended work: If the requirements of AS 3610 cannot be met, give notice.

The contractor shall submit details of the proposed formwork cycles including;

- Floor cycle time
- Number of levels of undisturbed props
- Number of levels of back propping
- Method statement for back propping and back propping layout

If the recommendations regarding back propping and stripping of AS3600 and AS3610 are not followed, the contractor shall submit calculations and details from a professional engineer registered on NPER and experienced in formwork design and construction to show the proposed method will not overstress the structure.

Surface repair method: Before commencing repairs, submit the proposed method method written for approval.
The method shall be submitted in writing or by email with photographic examples of before and after repairs to the concrete.
Once the methodology of repair has received approval a prototype of the repair is to be made for approval.

Tests

Void formers: Submit test certificates to confirm that the formers comply with the following requirements, under laboratory conditions, when placed on damp sand and loaded with a mass of wet concrete at least the

same mass of the beams or slabs they are required to support:

- Additional deflection between initial set and 7 days does not exceed span/400.
- Collapse and loss of load carrying capacity will occur not more than 48 hours after flooding with water, creating a void at least 60% of the original depth of the void former.
- Deflection during placing and compaction of the concrete is less than the span of the beam or slab divided by 1000.

Slip resistance test of completed installations. Once the combination of aggregate sizes types and mixes has been agreed proceed with further prototype panels for the exposing of the aggregate a minimum 600 x 600mm panel.
After acceptable exposing of aggregates has been achieved for the honed floor finish then conduct a Wet Pendulum Test by an acceptable accredited laboratory to a minimum of 2 acceptable panels for slip resistance of that stipulated in the Specification Schedules, one half with the scheduled sealer the other half without. Submit evidence of compliance
The Wet Pendulum Tests shall be completed to included but not limited to AS 4663.
Similarly conduct a Wet Pendulum Test for the light grind concrete

2.3 EXECUTION

2.3.1 MATERIALS AND COMPONENTS

Form linings and facings

Compatible with finishes applied to concrete.

Lost formwork

Not to contain timber or chlorides and not to impair the structural performance of the concrete members.

Release agents

Compatible with applied finishes to concrete and the contact surfaces.

The release agent used for class 2 concrete finishes items should not stain or adhere to the concrete, contaminate reinforcing steel or construction joint, or have a detrimental effect on any applied finishes. The thickness of the sprayed on release agent has to be the absolute minimum.

Steel decking

Acts as permanent formwork and positive tensile reinforcement in one way reinforced concrete slab construction. Do not use steel decking unless otherwise shown on structural drawings. Type of steel decking to be as shown on structural drawings

Suggested Structural Plywood for class 2 concrete

Manufacturer:	Armourform
Brand/number:	F22 Hardwood Formply (Density 960kg/m3)
Dimension:	1800mm x 1200mm (refer to architectural drawing)
Thickness:	min 17mm

Suggested Foam Tape for Joints for class 2 concrete

Manufacturer: Tesa Foam Tape self adhesive

2.3.2 FORMWORK

General

The Contractor is responsible for the design and construction of the formwork, false work and back propping.

Design and construct the formwork so that the concrete, when cast in the forms, will have the required dimensions, shape, profile, location and surface finish. Allow for dimensional changes, deflections and cambers resulting from the application of post-tensioning forces (if any), applied loads, temperature changes and concrete shrinkage and creep.

Install cast in items for wall cladding and formwork penetrations.

Openings: In vertical forms provide form openings or removable panels for inspection and cleaning at the base of columns, walls and deep beams. For thin walls and columns, provide access hatches for placing concrete.

Fixing of the plywood form for class 2 concrete has to be back-screwed from the rear of the form, so that the shaft of the screw will not penetrate to the exposed concrete surface. Selected screws for the formwork have to be steel.

Responsibility: The Contractor is responsible for the sufficiency of the formwork, except to the extent, if any, that formwork design is shown on the drawings or specified.

Cleaning

Before placing concrete, remove free water, dust, debris and stains from the forms and the formed space.

Corners

Work above ground: Chamfer at re-entrant angles, and fillet at corners.

- No arisses
- All class 2 concrete to have 15mm bevelled edges sharp edges. All formwork joints have to be sealed by using a compressible self adhesive foam tape. Protect corners from damage during and after stripping.

Drip Grooves

Provide drip grooves or alternative form to external slab soffits adjacent vertical concrete surfaces to architects details. If none shown submit proposal for approval.

Chases, Holes, Nibs Rebates and Reveals

Form chases, fillets, holes upstands and nibs as shown on the drawings. Position accurately at time of casting concrete.

Embedments

Fix embedments through formwork to prevent movement, or loss of slurry or concrete, during concrete placement.

Release agents

Before placing reinforcement, apply a release agent compatible with the contact surfaces, to the interior of the formwork, except where the concrete is to receive an applied finish for which there is no compatible release agent. Clean the reinforcement to remove all traces of release agent. Do not allow release agent to "puddle".

Steel linings (if used)

Clean off any rust and apply rust inhibiting agent prior to re-use.

Defective formwork

If formwork fails to meet the requirements of the contract, any concrete which has been cast in it may be rejected. In that case, remove the rejected concrete, form construction joints, reconstruct the formwork and recast the concrete. Submit proposals for approval prior to recasting concrete.

Location of Construction Joints for class 2 concrete

Refer to drawings. Provide complete shop drawings showing locations of construction joints, tie bolts, layout of form plywood sheets (with even spacing) and the like
Light grind concrete floor finish

General

General: Provide a smooth and consistent finish, without exposing the aggregate and sealed to provide a satin sheen, generally to be of even consistency variance of one tone either of side of colour????. Unless directed otherwise, comply also with the recommendations of the current edition of *The Specification of Honed or Polished Concrete Finishes*, published by Cement Concrete and Aggregates Australia (CCAA).

Method

Conform to the following:

- After machine floating, trowelling and curing, use a dustless grinding machine with progressively finer abrasives to produce an even-textured surface as documented.
- Machine grind the surface first using appropriate grit, and then immediately afterwards using a fine grit. Keep the surface wet during grinding. Prevent water from carrying grinding products into the drainage system or other parts of the building.
- Grouting: Remove grinding dust and fines using water and rinse the surface thoroughly using clean water. Grout the wet surface with cement to match the matrix colour. Fill voids. Cure the grout until stoning commences.
- Stoning: if necessary at least 3 days after grouting, machine grind using fine grit and hand stoning where necessary until the surface shows at least 75% of facing aggregate.
- Cleaning: Immediately upon completion of stoning, wash the surface using mild detergent soap or a solution of non-discolouring neutral cleaner and rinse.

Alternative methods

General: Alternative methods of achieving a light ground concrete finish may be submitted for consideration.
Requirement: Obtain a direction before proceeding.

Sealer

General: As soon as the surface is dry, apply a sealer as documented. Where not documented, provide a proprietary low-VOC penetrating sealer, free from harmful ingredients, specially prepared for honed concrete.

Samples and Prototypes

General: Refer to sections within this trade section

Slip-resistance

General: Refer to sections within this trade section

Honed concrete floor finish

General

General: Provide a smooth and consistent finish, with exposed aggregate and sealed to provide a satin sheen, generally to match the quality of traditional terrazzo. Unless directed otherwise, comply also with the recommendations of the current edition of *The Specification of Honed or Polished Concrete Finishes*, published by Cement Concrete and Aggregates Australia (CCAA).

Method

Conform to the following:

- After machine floating, steel trowelling and curing, use a dustless grinding machine with progressively finer abrasives to produce an even-textured surface as documented.
- Machine grind the surface first using coarse grit, and then immediately afterwards using a fine grit. Keep the surface wet during grinding. Prevent water from carrying grinding products into the drainage system or other parts of the building.
- Grouting: Remove grinding dust and fines using water and rinse the surface thoroughly using clean water. Grout the wet surface with cement to match the matrix colour. Fill voids. Cure the grout until stoning commences.
- Stoning: At least 3 days after grouting, machine grind using fine grit and hand stoning where necessary until the surface shows at least 75% of facing aggregate.
- Cleaning: Immediately upon completion of stoning, wash the surface using mild detergent soap or a solution of non-discolouring neutral cleaner and rinse.

Alternative methods

General: Alternative methods of achieving a honed concrete finish may be submitted for consideration.
Requirement: Obtain a direction before proceeding.

Sealer

General: As soon as the surface is dry, apply a sealer as documented. Where not documented, provide a

proprietary low-VOC penetrating sealer, free from harmful ingredients, specially prepared for honed concrete.

Samples and Prototypes

General: Refer to sections within this trade section

Slip-resistance

General: Refer to sections within this trade section

2.3.3 DIMENSIONAL TOLERANCES

Dimensional tolerances

Position: Construct formwork so that the position of finished concrete is within the tolerances stated in AS3610 and AS3600 but not exceeding tolerances stated in the Position tolerances table and Construction adjacent property boundary section below.

Plumb of elements > 8m high: 15mm.

Construction adjacent property boundary

For construction adjacent property boundaries the dimensional or position tolerance is to be maximum 10mm towards the boundary.

Table 2-1: Position tolerances table

Surface finish class to AS 3610	1	2	3	4	5
Maximum deviation from correct position (mm)	10	15	20	25	40

2.3.4 FORMED SURFACE FINISH

General

Conform to the Formed Surface Schedule

Table 2-2: Formed Surface Schedule

Concrete element or surface	Surface Finish Class to AS 3610	Form lining type	Bolt hole filling
Visibly exposed concrete walls visible concrete columns and soffits	2	Plastic faced plywood to AS 3610 table 3.3.1	Cement grout finished flush
Visibly exposed bridges and stairs	2	Plastic faced plywood to AS 3610 table 3.3.1	Cement grout finished flush
Civil Engineering Works, Unexposed columns, beams, walls, stairs and slab soffits	3	To comply with AS 3610 Table 3.3.1	Cement grout finished flush
Surfaces to receive render	4	To comply with AS 3610 Table 3.3.1	Cement grout finished flush
Surfaces to be Permanently Concealed: eg. Footings; rear faces of retaining wall	4	To comply with AS 3610 Table 3.3.1	Cement grout finished flush

Colour control to AS 3610: Use form linings not inferior to those described as "suitable" in AS 3610 Supplement 2 Table C5.4.1. Table 2-3: Colour control table

Location	Class	% of Reachings	Tone
Concrete Surfaces	2C	90	second lightest tone from AS3610

Note: Method of specifying colour shall range within the tonal scales of AS3610, Colour to be advised and to match precast. Acceptable colour variance +/- one tone. NB this one tone variance applies to all visible surfaces for Class 2 walls, ceilings and floors including all visible surfaces to Communication Stair 02. Nb to Back of House ,Plant Rooms and the like Class 3 concrete is to be used and tonal variation is not an issue.

Visually important surfaces

For concrete of surface finish classes 3 or 4 set out the formwork to give a regular arrangement of panels, joints, bolt holes, and similar visible elements in the formed surface. Form 45^{o} bevels, 15 mm on the face on corners and angles.

Evaluation: If the Superintendent considers that the formed surface finish of the completed work does not comply with the specification he may require evaluation of the finish in accordance with AS 3610 clause 5.6. In this case evaluation shall be carried out by the Contractor in the presence of the Superintendent.

Surface repair: To AS 3610 clause 5.6.5.

Exclusion: Repairs to Class 1 surfaces are not permitted.

Method: Before commencing repairs, submit the proposed method.

2.3.5 FORM TIE BOLTS

Bolt hole filling

Durability: Provide material with durability matching the concrete. Provide material with durability, colour, finish and texture of the parent concrete for class 1 and class 2 concrete.

Recessed filling: Fill or plug the hole to 10 mm below the surface. Refer to architectural drawings for detail. Finished filling must be included in the sample panels for review.

Cover

Position formwork tie bolts left in the concrete so that the tie does not project to within 50 mm of finished surface.

Removable bolts

Remove the bolts without causing damage to the concrete.

2.3.6 STRIPPINGAND REMOVAL

Formwork removal

Extent: Remove formwork, other than steel reinforcement decking, including formwork in concealed locations. Ensure the safe removal of all or any part of the formwork without shock or vibration or damage to the concrete.

Timing: Do not disturb forms until concrete is hard enough to withstand it. Do not remove formwork until approval given by Superintendents Representative. Back propping or reshoring shall comply with AS 3600.

Loading before stripping

Do not erect masonry walls or other permanent loading on the structure while it is still supported by formwork.

Stripping of formwork

General: To AS 3600 where it is more stringent than AS 3610.

Multi-storey work: Provide for stripping without disturbing props supporting succeeding floors.

Post-tensioned concrete: Do not remove form supports supporting post-tensioned concrete members until sufficient post-tensioning has been added to support the loads.

Back propping: Do not remove back propping without the superintendent's approval.

Maximum stripping times for walls with class 1 finish is 72 hours.

Plywood for class 1 concrete should not be used more than 2 times.

3 CONCRETE REINFORCEMENT

3.1 GENERAL

3.1.1 CROSS REFERENCES

General

Conform to the General requirements worksection.

Related sections

Conform to associated worksections as follows:

- Concrete formwork.
- In situ concrete.
- Precast concrete

3.1.2 STANDARDS

Any reference documents to as a guide only and the Contractor shall source all appropriate standards and codes and the latest editions are to be adopted.

General

Steel reinforcing materials: To AS/NZS 4671.

3.2 QUALITY

3.2.1 INSPECTION

Witness points

Give a minimum of 2 working days notice and provide the necessary access so that inspections may be made of the following;

- Reinforcement fixed in place.
- Cores and embedments fixed in place.

Hold points

- Reinforcement fixed in place.

Do not proceed until Superintendent's representative's inspection report is received and all items that require rectification are complete.

NB: To be included in the contractor's quality assurance submission. Superintendent

to be notified to allow opportunity for inspection if required.

3.2.2 CONTRACTOR'S SUBMISSIONS

Certification

The reinforcement material supplier must be certified by the Australian Certification Authority for Reinforcing Steels Ltd for the supply of reinforcement material. Submit current certificate.

Refer http://www.acrs.net.au/Certificates/Cert_Home.html for current certificate holders.

Design

Bending schedules: Submit marking plans and schedules showing location, shape, size and grade of reinforcement.

Tests

Certificate of compliance: Submit either the manufacturer's certificate of compliance with the relevant standard, or an independent testing authority's test certificates demonstrating compliance.

Execution

Changes: Submit proposed changes, if any, in the reinforcement shown on the drawings, including additional splicing.

Damaged galvanising: If repair to AS/NZS 4680 Appendix E is intended, submit proposals.

Mechanical splices: If mechanical bar splices are proposed or required submit details and test certificates for each size and type of bar to be spliced.

Provision for concrete placement: If spacing or cover of reinforcement does not comply give notice.

Splicing: Submit details of any additional splicing not documented.

3.3 EXECUTION

3.3.1 REINFORCEMENT

General

Extent: Supply and fix reinforcement, including the necessary tie wires, welding, support chairs, spacers and accessories.

Ductility grade: To AS/NZS 4671 class N.

Identification: To AS/NZS 4671 Section 9.

Surface condition: Free of loose mill scale, rust, oil, grease, mud or other material which would reduce the bond between the reinforcement and concrete.

Dowels

Standard: To AS/NZS 4671 grade 250N.

General: Provide each dowel in one piece, straight, with square cut ends free from burrs. Provide dowel expansion covers or apply 2 coats of bitumen emulsion to half the length of the dowel at one end. Refer to drawings.

Bending

General: To AS 3600.

Bending of bars only permitted in locations shown on the structural drawings. Do not heat bars to be bent. Do not bend galvanised bars.

Only N12 or N16 quenched and self tempered reinforcement may be used as pullout bars, using tools that maintain pin diameters given in AS 3600 and using a single smooth bending action. Cast the bar with the bend kept clear of the concrete. Do not use heat to bend bars.

Bending of bars where required must also be to manufacturer's approval and recommendations to ensure properties of reinforcement are not adversely affected.

Fabrication tolerances

General: To AS 3600.

Tie wire

General: Annealed iron 1.25 mm diameter (minimum).

3.3.2 REINFORCEMENT SUPPORTS

General

Provide proprietary concrete, metal or plastic supports, adequate to withstand construction and traffic loads, and in the form of chairs, spacers, stools, hangers and ties. Supports are to ensure clear covers to reinforcement from concrete surfaces are maintained as noted on the drawings. If ferrous metal supports extend to the surface of the concrete, or are used with galvanized reinforcement, provide a protective coating.

Exposure classification A1 (i.e. internal slabs and protected elements):

- Provide a protective coating to ferrous metal supports which extend to the surface of the concrete, or which are used with galvanized or zinc-coated reinforcement.
- Exposure classifications more severe than A1: Provide either
- plastic supports of adequate strength and of a shape appropriate to the location or;
- concrete supports of the same concrete quality as the concrete element.

Concrete cover

General structures: To AS 3600.

Structures for retaining liquids: To AS 3735.

Supports over membranes

General: Prevent damage to waterproofing membranes or concrete underlays. Place a metal or plastic plate under each support.

Support spacing

General: Provide supports in adequate numbers and spacing to maintain reinforcement in the correct position within the tolerances under the Fixing requirements subclause.

Standard: To AS 3600.

Minimum spacing:

- Bars: 60 diameters.
- Fabric: 800 mm.

Tolerances

To AS 3600 Section 19.

3.3.3 FIXING REINFORCEMENT

Dowels

Fixing: If the dowel has an unpainted half, embed this in the concrete first.

Tolerances:

- Alignment: 2 mm in 300 mm.
- Location: half the diameter of the dowel.

Fixing requirements

General: Secure the reinforcement against displacement by tying at intersections with either annealed iron 1.25 mm diameter (minimum) wire ties, or clips. Bend the ends of wire ties away from nearby faces of forms so that the ties do not project into the concrete cover.

Beams: Tie ligatures to bars in each corner of each ligature. Fix other longitudinal bars to ligatures at 1 m maximum intervals.

Columns: Secure longitudinal column reinforcement to all ligatures at every intersection.

Starter bars: Prior to the concrete placing, all starter bars shall be positioned and secured by the Contractor, to ensure correct location and alignment of bars. Costs associated to redesign and/or relocate starter bars that have not been positioned and secured adequately shall be at the Contractors expense.

Tolerances: To AS 3600 Section 19.

Splicing

General: To AS 3600 Subsection 13.2, for splicing additional to that documented. Obtain approval outlined in section 3.2.2 before implementation.

Welding

General: Do not weld reinforcement

- except where documented, or submitted and approved;
- within 75 mm of a bend with an internal radius < 12 bar diameters; or
- at points which have been re-bent. Standard: To AS 1554.3.

Certificate of compliance: Obtain from the manufacturer and furnish a certificate of compliance with the relevant standard AS 4671. Alternatively furnish test certificates from an independent testing authority. All reinforcement welds must be certified and approved by the above procedure before concrete works

commence.

3.3.4 REINFORCEMENT

Dowels Protection Unencased

Generally: Provide protection for “starter bars” and other items projecting from cast concrete forfuture additions, and exposed to the weather.

4 CONCRETE POST-TENSIONING

4.1 GENERAL

4.1.1 CROSS REFERENCES

General

Conform to the General requirements worksection.

Related sections:

Conform to associated worksections as follows:

- Concrete formwork
- In situ concrete
- Concrete reinforcement

4.1.2 STANDARD

Any reference documents are as a guide only and the Contractor shall source all appropriate standards and codes and the latest editions are to be adopted.

General

Post-tensioning: To AS 3600.

4.1.3 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions apply:

- Tendon: assembly of anchorages, duct and strand or bar
- Extension: elongation of strand or bar

4.1.4 INSPECTION

Witness points

Give a minimum of 2 working days notice and provide the necessary access so that inspections may be made of the following:

- Tendons fixed in place.
- Commencing initial or incremental stressing.
- Stressing strands or bars.
- Grouting tendons.
- Grouting of anchorage pockets.

Hold points

- Tendons fixed in place.

- Cut strands at anchorages prior to grouting anchorage recess.

Do not proceed until Superintendent's representative's inspection report is received and all items that require rectification are complete.

NB: To be included in the contractor's quality assurance submission. Superintendent to be notified to allow opportunity for inspection if required.

4.1.5 TESTS

General

Sample, test and assess the concrete for compliance. Standard:

To AS 1379.

Testing authority

Carry out testing and assessment of concrete and concrete materials using an authority registered with the National Association of Testing Authorities Australia (NATA) to perform the specified testing. Location of test results shall also be provided and referred to a structural element shown on the structural drawings (eg. Column 72 Level 3, wall 20 Level 6).

Frequency of sampling

Spread the site sampling evenly throughout the pour. The following minimum requirements shall apply in addition to those in AS 1379 but not less than project control testing (

Table *5-6*), in accordance with Table 4-1 .

Post-tensioned concrete: For each post-tensioned element, take at least 3 test samples for 3 day, 7 day and 28 day testing, from well distributed locations including the anchorage areas. Cure the 3 day and 7 day samples on site by the same method as the post-tensioned element from which it was taken. For hot weather construction the samples are to be kept in insulated compartments on site, to laboratory requirements, and cured by the same method as the post-tensioned element from which it was taken.

The 3 and 7 day samples may be tested on different days to suit the post-tensioning and construction sequence.

Acceptance criteria: The average strength of the samples representing an element shall be not less than the specified strength i.e. the '3 day' samples to be used for 7MPa (1-2 day) early age strength and '7 day' samples used for 22MPa (4-5 day) early age strength.

Refer

Table *5-6* for additional control testing requirements for post tensioned water proof slabs. Concrete samples for early age compressive strength shall be taken close to the end of the concrete pour.

Table 4-1: Samples for batches

NUMBERS OF BATCHES PER DAY	NUMBER OF SAMPLES
1	1
2 TO 5	2
6 TO 10	3
11 TO 20	4

For each additional 10 batches, one additional sample shall be taken

Grout for Tendon Ducts

Refer Table 4-2 below.

Table 4-2: Grout Testing for post-tensioning tendon ducts

GROUT FOR TENDON DUCTS	REQUIREMENT
Compressive strength (75 mm cube) (MPa)	50MPa
Sampling frequency:	3 samples during each days grouting
Number of specimens per sample:	3
Acceptance criteria:	The average shall exceed the required value
Bleeding	To AS 1012 Part 6
Test method:	Use a glass cylinder approximately 100mm in diameter filled with grout to a depth of approximately 100mm and covered to prevent evaporation.
Sampling frequency:	1 sample/floor
Acceptance criteria:	Bleeding shall not exceed 2% of the volume 3 hours after mixing and 4% of the volume at any time The separated water shall be reabsorbed after 24 hours.
Shrinkage (% at 24 hours)	Maximum 1%
Test method:	As per the Australian standards (AS1012).
Sampling frequency:	1 sample per floor.

4.1.6 SAMPLES

Materials

Tendon materials: If manufacturer's certification of compliance with AS 3600 is not available, submit minimum 3 samples for each batch of material for testing to an accredited NATA testing facility. Submit test results to the Superintendent for review and approval.

4.1.7 CONTRACTOR'S SUBMISSIONS

Certification

The reinforcement material supplier must be certified by the Australian Certification Authority for Reinforcing Steels Ltd for the supply of reinforcement) material i.e. strand. Submit current certificate.

Refer http://www.acrs.net.au/Certificates/Cert_Home.html for current certificate holders.

Subcontractor

Submit the proposed system and the name and contact details of the post-tensioner.

Requirement: Supply and install Post-tensioning tendons including the necessary strands or bar, anchorages, ducts, supports, grout and anchorage protection.

Design

Calculations: Submit calculations of strand jacking forces, extensions and losses for each stressing stage. Submit amount of draw-in expected in seating anchorages, friction wobble coefficient and friction curvature coefficient for strands and duct-forming material.

Shop drawings

Submit shop drawings of post-tensioned work showing details of the proposed system, including the following:

- Profiles, sizes and details of tendons, proprietary anchorages, ducts, duct formers, sheathing, end block reinforcement and other associated components.
- Stressing requirements including sequence of stressing, jacking forces, gauge pressures, and the basis of assumed loss calculations.
- Number, size and position of grout openings, vents and drain holes in the ducts.
- Stressing and grouting equipment,
- Grout mix including additives, if any.
- Calculated theoretical strand or bar extensions.

Note: calculated strand or bar extensions shall not be shown on shop drawings. Submit calculated theoretical extensions as a separate document with the shop drawings.

Tests

Grout: Before grouting submit certified test results for compressive strength and shrinkage of the proposed grout mix.

Anchorages: Submit performance test certificates for each type and size of anchorage and coupler.

Strand and bar: Submit test certificates prior to delivery of materials to site.

Materials

Grout: Submit proposed grout mix including additives, if any.

Certificate of compliance: Submit the manufacturer's certificate of compliance with the relevant Australian standard for each delivery of post-tensioning steel strand or bar and each delivery of anchorage components.

Epoxy grout: Submit proposed formulation.

Execution

Equipment: Submit details of proposed gauging, stressing and grouting equipment. Submit current calibration certificates for tensioning and tension measuring equipment.

Records

Post-tensioning: Record and submit the following data:

- Concrete mix and quality.
- Details of placing and curing including dates.
- Details of placing of reinforcement and tendons.
- Date of post-tensioning operation.
- Name of operator.
- Type and identification numbers of equipment used.
- Piston areas.
- Identification of tendons.
- Stressing method (single or double end, monostrand or multistrand).
- Calculated strand extension at each stressing stage.
- Site measured extensions on completion of tensioning after release of jacks.
- Typical certified stress-strain curves for each 10 coils of wire or strand, or each parcel of tendon materials.
- Strand breakage, if any.

- Ramming pressure, if applicable.

Grouting: For each duct grouted, record and submit a record identifying the duct and strands, giving the stressing and grouting dates, and showing the composition of the grout (water: cement ratio, admixtures), grout tests, and details of grouting (including interruptions, topping up).

4.1.8 SAFETY

A post-tensioned strand when tensioned contains a considerable amount of stored energy. In the rare event of a strand breaking, serious injury to persons and damage to equipment can be caused by the sudden release of energy. Therefore, reasonable precautions shall be taken when working with or near strands which have just been or are in the process of being tensioned or that have been tensioned but not yet grouted. To be included in the Contractor's work method statement.

4.2 PRODUCTS

4.2.1 GROUT

Grout Properties

Maximum shrinkage: 1% by volume after 24 hours. Maximum water: cement ratio: 0.45 (by weight). Minimum compressive strength (75 mm cube): 50 MPa at 28 days.

Grout materials
Fine aggregate: Do not include in the grout for ducts.

Admixtures: Do not provide admixtures containing chlorides, nitrates, sulphides or sulphites. Include an anti-bleed additive.

Cement type to AS 3972: GP, free from calcium chloride and < one month old from date of manufacture.

Fly ash: Maximum 10% by weight of cement.

Epoxy grout

Commercial epoxy formulation of high compressive strength.

4.2.2 DUCTS

Material

Robustness: Ducts shall have sufficient strength to retain their shape, resist damage during construction, and prevent entrance of cement paste and water from the concrete. Material to be left in place must not cause deterioration or electrolytic action.

Size
To allow feeding of strands or bars, and grouting. Refer to structural drawings.

4.3 EXECUTION

4.3.1 TENDONS

Tendons

General: Provide post-tensioning strands, anchorages, ducts, supports, grout and anchorage protection.

Care: Do not weld strand, do not expose them to sparks, ground current or excessive temperatures. Provide shelter for strand coil to minimise direct exposure to weather.

Minimum concrete cover to duct: 25mm

Do not modify tendon profiles where clashes with conduits or reinforcement occur without prior written approval from the Superintendent.

Other requirements: Refer structural drawings

4.3.2 POST-TENSIONING EQUIPMENT

Gauges
Standard: To AS 1349.
Maximum error in pressure indication: 1% of the maximum scale value.

Calibration of gauges and dynamometers

Calibrate at intervals not exceeding 6 months and more frequently if required by the Superintendent.

Jacks

Calibration: Calibrate and measure friction losses at least once a year, or after re-sealing, matched with the gauge calibration.

4.3.3 POST-TENSIONING

Standard

Concrete cover: To AS 3600.

Sheathing

General: If ducts are formed with sheaths, provide sheathing material strong enough to transfer the strand stresses into the body of the concrete.

Stiffening: If strands are to be installed after concreting, provide temporary stiffening within the sheath such that the duct shape and profile are maintained during concreting. After concreting remove the temporary stiffening and prove the duct using a suitable gauge before installing the strand.

Stressing

Commence stressing immediately after the concrete has attained the required transfer strength. It is very important that the initial 25% stress is carried out immediately after the concrete is up to strength and the longer strands stressed first. Organization, testing and resources must be effective so that the above is achieved without delay or misunderstanding. Notify the Superintendent before commencing second stage stressing of 100% of the required force to each strand.

When more than one wire or strand is stressed simultaneously, stress them equally. Do not leave a group of strands within a tendon unequally stressed.

Submit stressing records within 24 hours to the Superintendent. Do not proceed with any cutting or grouting of tendons until the Superintendent's approval has been given. If strands do not achieve the required extensions the contractor shall be required to restress them, possibly with a lubricant. If the strands continue to not achieve the required extensions, or if extension results are misplaced or strands are cut without instruction, the slab would be

liable to rejection and all the costs associated with achieving compliance shall be borne by the Contractor.

Measurement of Site Extensions

The ends of strands must be painted or suitably marked after wedges have been installed and prior to initial stress. The stressing records submitted are to be gross extensions measured on site and include initial and final stress extensions.

Site extensions are to be submitted for review and approval by comparison to the calculated theoretical extensions. The site extensions shall be within ±10% of theoretical extensions. Where discrepancies between site and theoretical extensions are >10%, the contractor shall ascertain the cause to the satisfaction of the Superintendent's representative prior to grouting.

Cutting tendons

Do not cut or grout tendons without written approval from the Superintendent's representative. Strand site extensions must be approved in writing before strands can be cut.

Protection of Strands and Anchorages:

On completion of stressing and grouting, permanently protect all anchorage parts and parts of tendons anchored thereto. Minimum cover to any strands or anchorage parts shall be the greater of the value to surrounding reinforcement or tendons as listed on structural drawings for the element in which they are located and the value in clause 4.3.1.

Anchorage recesses or pockets are to be protected by method shown below in Table 4-3 unless noted otherwise on structural drawings.

Table 4-3: Anchorage protection schedule.

Anchorage Type	Location	Protection Material	Requirements
Edge Recess	Internal	Sand Cement	
	External	Polymer modified repair mortar	Prepare and apply to manufacturer's specifications
Slab Pockets	Non Trafficable	Concrete (f'c same as main concrete element)	
	Trafficable	Concrete (f'c same as main concrete element)	Scabble and apply 'wet to dry' epoxy binder prior to concreting

Protection of grout fittings and ducts

For bonded construction, protect from collapse and other damage.

Post-tensioning Schedule

Refer to shop drawings.

4.3.4 GROUTING DUCTS

Preparation

Pressure testing of ducts is only required for fully encapsulated tendons, eg electrically isolated or fully corrosion protected. If required, pressure test the ducts prior to concreting at the actual grouting pressure with water. Rectify any leaks. Remove water from ducts with oil- free compressed air. Keep ducts dry until grouting starts.

Grouting

Grout tendons within 28 days of installation of the strand and within 48 hours of completion of stressing. Prevent damage to grout vents and fittings during grouting.

Grout injection shall be at the rate of between 5 and 10 metres of duct per minute. Completely fill the duct during grouting. Inject grout into voids between strands, ducts and anchorages, until grout flows from vents without air bubbles and at the consistency equivalent to that of the grout injected. Close vents as they fill, progressively in the direction of flow. If there is a blockage or interruption, completely flush grout from the duct using water.

Grout openings

General: Provide grout openings, vents and drain holes as necessary, including at each end, and at high points except where tendon curvature is small and tendon is relatively level. Remove protruding vents and drains after the grout has set and make good to match the adjacent surfaces.

Maximum spacing: 15 m.

Roofs Grout openings for watertight post-tensioned roofs are to be from side forms, not the top of slabs. Where membranes are used for watertightness of post-tensioned roofs, grout openings may be permitted from top of roof.

Grout pressure

Seal the duct on completion of grouting at a pressure ≥ 210 kPa. Fit pressure tap connections to each duct for this purpose.

5 IN SITU CONCRETE

5.1 GENERAL

5.1.1 CROSS REFERENCES

General

Conform to the General requirements worksection.

Related worksections

Conform to the associated worksections as follows:

- Concrete finishes.
- Concrete formwork.

5.1.2 STANDARDS

Any reference documents are as a guide only and the Contractor shall source all appropriate codes and the latest editions are to be adopted.

General

Concrete: To AS 1379.

Concrete structures for retaining liquids: To AS 3735. Materials

and construction: To AS 3600.

5.1.3 INTERPRETATION

Definitions

Assessment:

- Production: An assessment procedure for concrete specified by strength grade, carried out by the supplier and based on the statistical assessment of standard compressive strength tests on concrete, specified by compressive strength and produced by a specific supplying plant.
- Project: An assessment procedure for concrete specified by strength grade, specified at the customer's option, which provides additional test data for the statistical assessment of concrete supplied to a specific project.
- Concrete class:
- Normal: Concrete which is specified primarily by a standard compressive strength grade and otherwise in accordance with AS 1379 clause 1.6.3.

- Special: Concrete which is specified to have certain properties or characteristics different from, or additional to, those of normal-class concrete and otherwise in accordance with AS 1379 clause 1.6.4.

Batch: A quantity of concrete containing a fixed amount of ingredients and produced in a discrete operation.

Early age: Strength requirement at an age less than 28 days.

Joint:

- Construction: A joint provided to suit construction sequence with reinforcement continuous across the joint.
- Control: A weakened plane contraction joint created by forming a groove, extending at least one fifth the depth of the section, either by using a grooving tool, by sawing, or by inserting a premoulded strip.
- Expansion: An unreinforced joint with the joint surfaces separated by a compressible filler.

Sample: A portion of the material used in the works, or to take such a sample. Specimen:

A portion of a sample which is submitted for testing.

Weather:
Cold: Surrounding outdoor shade temperature <10°C
Hot: Surrounding outdoor shade temperature >32°C

5.2 QUALITY

5.2.1 INSPECTION

Witness points

Give a minimum of 2 working days notice and provide the necessary access so that inspection may be made of the following:

- Base or sub grade before covering.
- Commencement of concrete placing.
- Completed formwork, and reinforcement, cores and embedments fixed in place.
- Membrane or film underlay installed on the base.
- Surfaces or elements to be concealed in the final work before covering. NB: To be included in the contractor's quality assurance submission.

Superintendent to be notified to allow opportunity for inspection if required.

Rejection

Remove rejected concrete from the site.

5.2.2 CONCRETE TESTS

Production Assessment

Dissemination of production information: If concrete is manufactured off site, register the project in accordance with AS 1379 clause 6.4.3 and submit copies of each of the reports.

Concrete testing methods

Sampling, identification and testing: Sample the concrete on site, at the point of discharge from the agitator to AS 1012.

Testing authority: Carry out testing and assessment of concrete and concrete materials using an authority registered with the National Association of Testing Authorities Australia (NATA) to perform the specified testing. Location of test results shall also be provided and referred to

a structural element shown on the structural drawings (eg. Column 72 Level 3, wall 20 Level 6).

Control tests

General: Determine transfer strength and early strength using site cured specimens in conformance with the

Table 5-6 Control tests schedule.

Acceptance criteria:

- Average strength of all samples must exceed the required value.
- Strength of any one sample must be at least 0.85 of the required value.

Project Assessment

Standard: To AS 1379.

Drying shrinkage: Refer Table 5-4 Concrete performance schedule.

Frequency: Sample, test and assess the concrete for conformance with the Sampling frequency table and the Concrete performance schedule. For each property test at least two specimens from each sample.

Table 5-1: Sampling frequency table

Number of batches for each type and grade of concrete per day	**Minimum number of samples**	
	Columns and loadbearing wall elements per batch	**Other elements per day**
1	1	1
2 to 5	1	2
6 to 10	1	3
11 to 20	1	4
each additional 10	1	1 additional

Slump: Test at least one sample from each batch before placing concrete from that batch in the work. Take samples from point of discharge on site.

Strength grade/Characteristic compressive strength: Spread the site sampling evenly throughout the pour. Use at least 2 specimens from each sample.

- Specimen size: 200 x 100 mm diameter but, if aggregate size exceeds 20 mm, 300 x 150 mm diameter.

Acceptance criteria: The average strength of the samples representing an element shall be not less than the specified strength, and within the maximum specified standard deviation.

Test records

Records and reports to AS 1012.

The contractor shall review all test records and notify the Superintendent's representative of tests that do not meet early age strength, 7 days and the 28 days requirements as soon as they are known. Only submit a copy of test reports that do not meet the requirements. The contractor shall have on site an up to date file of test records that can be viewed at any time by the superintendent or their representatives.

5.2.3 SAMPLES

General

Supply sample panels to AS 3610 and the Sample panels schedule for the application specified.

Requirement: Supply sample panels to AS 3610 clause 3.6 for the application specified. Do not proceed with the related work until the test panels have been approved and for surface treatments, the accepted range of treatments determined.

Manufacture

Cast the panels using the formwork, concrete, compaction equipment, form release agents, curing and formwork removal methods which are to be used in the final work.

Storage

Maintain the panels on site undamaged and protected from the weather, as samples for future evaluation of completed work.

5.2.4 CONTRACTOR'S SUBMISSIONS

Design

Loading: Submit calculations to justify the adequacy of the structure to sustain any construction loads and procedures.

Execution

General: Submit proposals for mixing, placing, finishing and curing concrete including the following:

- Changes to the plastic concrete mix.
- Curing and protection methods.
- Curing for low-pressure steam curing, if proposed.
- Cutting or displacing reinforcement or cutting hardened concrete.
- Handling, placing, compaction and finishing methods and equipment including pumping.
- High early strength cement.
- Placing under water.
- Sequence and times for concrete pours, and construction joint locations.
- Site storage, mixing and transport methods and equipment, if applicable.
- Target strength, slump and proposed mix for each type and grade of concrete.
- Temperature control methods.

Sawn joints: Submit proposed methods, timing and sequence of sawing joints.

Materials

Concrete mixes: Submit details, for each grade and type of concrete including proposed use of special-purpose cement types, admixtures, fly ash or granulated slag.

Curing compounds: If it is proposed to use a liquid membrane-forming curing compound submit the following information:

- Certified test results for water retention to AS 3799 Appendix B.
- Efficiency index.
- Evidence of compatibility with concrete, and with applied finishes, if any.
- Evidence that an acceptable final surface colour will be obtained.
- Methods of obtaining the required adhesion for toppings and render.

Ready mixed supply

Delivery docket: For each batch, submit a docket listing the information required by AS 1379, and the following additional information:

- For special class performance concrete, specified performance and type of cement binder.
- For special class prescription concrete, details of mix, additives, and type of cement binder.
- Method of placement and climate conditions during pour.
- Name of concrete delivery supervisor.

- Project assessment carried out each day.
- Serial numbers of identification certificates of each batch.
- The amount of water, if any, added at the site.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.
- The total amount of water added at the plant and the maximum amount permitted to be added at the site.

Shop drawings

Cores, fixings and embedded items: If the locations of embedded items are not shown or are shown diagrammatically, submit shop drawings showing the proposed locations, clearances, cover and indicate proposed repositioning of reinforcement in accordance to section 1.9.

Provide shopdrawings showing locations of construction joints for class 1 concrete

Subcontractors

Submit names and contact details of proposed ready mixed concrete suppliers, and alternative source of supply in the event of breakdown of ready mixed or site mixed supply.

Fabrication: Do not commence fabrication until approval to use the relevant shop drawings has been obtained from the Superintendent's representative.

Work-as-executed drawings: Required for all workshop drawings

Survey certificates: Required for all concrete elements

Sampling and testing of specimens: Submit records providing the full history of sampling and testing. Submit test certificates and retain results in tabular form on site.

5.3 EXECUTION

5.3.1 POLYMERIC FILM UNDERLAY

General

Under internal slabs on ground including integral ground beams and footings, provide a concrete underlay or, in areas prone to rising damp or salt attack, a damp-proofing membrane.

Standard

Concrete underlays and damp-proofing membranes: To AS 2870.

Material: Concrete underlay to be 0.2mm thick medium impact resistance film to AS4347

Installation

Lay over the base, lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape. Face the laps away from the direction of concrete pour. Take the underlay up vertical faces as far as the damp proof course where applicable and fix at the top by tape sealing. Locate vertical laps only on vertical or inclined surfaces. Patch or seal punctures or tears before pouring concrete.

Membrane protection: Protect the membrane after installation with a permanent protective boarding in accordance with the manufacturer's recommendations. Use a low melt bitumen or suitable solvent-free adhesive to adhere the protection boards to the membrane with maximum 6 mm gap at joints in the boards.

Base preparation

According to base type, as follows:

- Concrete working base: Remove projections above the plane surface, and loose material.
- Graded stone base: Blind with sufficient sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay.

5.3.2 CONCRETE MATERIALS

General

Aggregate: To be unsegregated and uncontaminated. Aggregrate for concrete class 1 shall be obtained from the same batch.

Cementitious materials: To be dry and uncontaminated.

Admixtures: No deterioration.

Bagged cement

Standard: To AS 3972.

- Type: GP.
- Age: Less than 6 months old.

Chemical admixtures

Contents: Free of chlorides, fluorides and nitrates.

5.3.3 CONCRETE

The concrete supplier is to provide the concrete mix design for the Superintendent for review prior to manufacture.

General

Provide concrete in conformance with:

- Concrete performance schedule.

Concrete performance

Drying shrinkage: refer Table 5-4 Concrete performance schedule.

Placement: Mix must work readily into corners and angles, and around reinforcement, without segregation or excess free water on the surface, producing sound concrete, with minimal plastic settlement and shrinkage cracking.

Material requirements: Use materials complying with Australian Standards. Do not use breccia or dolerite in concrete mix.

Elapsed delivery time

Elapsed time between the wetting of the mix and the discharge of the mix at the site must be as short as possible and must conform to the Elapsed delivery timetable below. Do not discharge at ambient temperature below 10°C or above 30°C.

Table 5-2: Elapsed delivery timetable

Concrete temperature at time of discharge (°C)	Maximum elapsed time (hours)
10 to 24	2.00
24 – 27	1.50
27 – 30	1.00
30 to 32	0.75

Ready mixed supply

All concrete shall be ready mixed supply.

Addition of water: Do not add water at the site after starting discharge.

Method: To AS 1379, by the batch production process. Deliver in agitating trucks.

Transport: Mode must prevent segregation, loss of material and contamination, and must not adversely affect placing or compaction.

Note: Do not add water or any other material to the concrete after leaving the batch plant without prior approval from the Superintendent's representative.

Plastic cracking: Design the concrete mix to minimise plastic settlement and shrinkage cracking.

Site mixed supply

Emergencies: Do not mix by hand.

Plant: Mix concrete in a plant located on the construction site.

5.3.4 CORES, FIXINGS AND EMBEDDED ITEMS

Standard

To AS 3600 Section 14 and complying to B.C.A clause 11.1. Lifting,

bracing and fixing inserts for precast units: To AS 3850.

Shop drawings: If the locations of embedded items (including downpipes, electrical conduits, etc.) are not shown on the drawings, or are shown diagrammatically, or if it is proposed to vary the locations shown, submit for review shop drawings showing the proposed locations, clearances, cover, bleed holes and the like.

Adjoining elements

For adjoining elements to be fixed to or supported on the concrete, provide for the required fixings. Where applicable provide for temporary support of the adjoining elements during construction of the concrete.

Inserted fixings

Methods: Do not insert fixings using drilling (including masonry anchors), or using explosive tools, unless approved.

Protection

General: Grease threads. Cover and protect embedded items against damage. Threaded

fastenings: To AS 1214.

Structural sections: To AS/NZS 4680.

Compatibility: Ensure inserts, fixings and embedded items are compatible with each other, with the reinforcement and with the concrete mix to be used.

Corrosion: For all embedded and inserted ferrous fixings (other than stainless steel) provide galvanized surface coating passivated by dipping in 0.2% sodium dichromate solution.

Structural integrity

Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, do not cut or displace reinforcement, or cut or core hardened concrete. Ensure that embedded pipes and conduits do not adversely affect structural integrity.

Tolerances

Maximum deviation from correct positions:

- Anchor bolt groups for structural steel: To AS 4100.
- Cores and embedded items generally: ± 10 mm.

- Fixings, including anchor bolts: ± 3 mm.

Isolation: Isolate fixings so that water can not track from fixings to reinforcement.

5.3.5 CONCRETE WORKING BASE

Finish

Membrane support: Wood float finish or equivalent.

Material

N20 concrete. Lay over the base or sub grade and screed to the required level.

Surface tolerance

± 5 mm from the correct plane, ± 5 mm from a 2 m straight edge.

Thickness

Minimum 50 mm.

5.3.6 PLACING AND COMPACTION

Compaction

General: Remove air bubbles and fully compact the mix. Provide not less than one reserve vibrator in working order.

Methods: Use immersion and screed vibrators accompanied by hand methods as appropriate.

Vibrators: Do not allow vibrators to come into contact with partially hardened concrete, or reinforcement and items including pipes and conduits embedded in it. Do not use vibrators to move concrete along forms. Avoid over-vibration that may cause segregation.

Horizontal movement

Use suitable conveyors, clean chutes, troughs or pipes. Do not use water to facilitate the movement.

Placing

General: Use placing methods which minimise plastic settlement and shrinkage cracking. Avoid segregation. Avoid loss of materials. Continuous between construction joints and in such a manner that a plastic concrete edge is maintained.

Layers: Place concrete in layers not more than 500mmm thick, such that each succeeding layer is compacted before previous has taken initial set.

Placing slabs and pavements: Place concrete uniformly over the width of the slab so that the face is generally vertical and normal to the direction of placing.

Placing records

Keep on site and make available for inspection a log book recording each placement of concrete, including the following:

- Date.
- Specified grade and source of concrete.
- Slump measurements.
- The portion of work.
- Volume placed.

Rain

Do not expose concrete to rain before it has set, including during mixing, transport or placing.

Concrete exposed to rain before it has set, including during mixing, transport or placing shall be liable to rejection.

Sequence of pours

Minimise shrinkage effect by pouring the sections of the work between approved construction joints in a sequence such that there will be suitable time delays between adjacent pours.

Time delay between pours

Conform to Table 5-8 Minimum time delay schedule.

Vertical movement

In vertical elements, limit the free fall of concrete to 1500 mm (1000 mm for class 1 concrete) per 100 mm element thickness, up to a maximum free fall of 3000 mm, using enclosed chutes or access hatches in forms. As far as practicable keep chutes vertical and full of concrete during placement, with ends immersed in the placed concrete.

5.3.7 PLACING IN COLD WEATHER

Cement

General: Do not use high alumina cement.

Placing

Concrete: Maintain the temperature of the freshly mixed concrete at ≥ 5°C. When the air temperature is below 5°C, the concrete shall be placed at a temperature not less than 5°C.

Formwork and reinforcement: Before and during placing maintain temperature at ≥ 5°C.

Severe weather

General: If severe weather conditions are predicted, use high early strength cement to develop sufficient strength to permit formwork removal within the specified time. Do not use as a substitute for the heating of materials or for adequate protection of placed concrete against low temperatures.

Temperature control

General: Heat the concrete materials, other than cement, to the minimum temperature necessary to ensure that the temperature of the placed concrete is within the limits specified.

Admixtures: Do not use calcium chloride, salts, chemicals or other material in the mix to lower the freezing point of the concrete.

Frozen materials: Do not allow frozen materials or materials containing ice to enter the mixer, and keep free of frost and ice any forms, materials, and equipment coming in contact with the concrete.

Maximum temperature of water: 60°C when it is placed in the mixer.

Plastic concrete: Prevent plastic concrete from freezing, without using salts or chemicals.

5.3.8 PLACING IN HOT WEATHER

Handling

General: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses. Mix, transport, place and compact the concrete in conformance with the Table 5-2: Elapsed delivery time table.

Placing

Concrete: Maintain the temperature of the freshly mixed concrete in conformance with the Table 5-3: Hot

weather placing table.

Post tensioned waterproof slab concrete: When the air temperature exceeds 32°C, the concrete shall be placed at a temperature not exceeding 32°C.

Formwork and reinforcement: Before and during placing maintain temperature at ≤ 35°C.

Severe weather

General: If ambient shade temperature > 38°C, do not mix concrete.

Temperature control

General: Select one or more of the following methods of maintaining the specified temperature of the placed concrete:

- Cool the concrete using liquid nitrogen injection before placing.
- Cover the container in which the concrete is transported to the forms.
- Spray the coarse aggregate using cold water prior to mixing.
- Use chilled mixing water.

Table 5-3: Hot weather placing table

Concrete element	Temperature limit
Normal concrete in footings, beams, columns, walls and slabs	35°C
Concrete in sections ≥ 1 m in all dimensions except for concrete of strength 40 MPa or greater, in sections exceeding 600 mm in thickness	27°C

5.3.9 CURING

General

Curing period (from time of placing): Commence curing immediately after finishing, and cure continuously until the cumulative number of days or fractions thereof, not necessarily consecutive, during which the air temperature in contact with the concrete is above 10°C, totals not less than the following:

- For durability exposure categories A1 and A2: 3 days.
- For durability exposure categories B1, B2, and C: 7 days.

Additional protection for post tensioned waterproof slabs: Freshly cast concrete shall be protected from premature drying and excessively hot temperatures. The Contractor is to take due regard of climatic conditions which will increase the possibility of plastic cracking such as hot, dry or windy conditions. Inform the supplier of the conditions under which the concrete will be placed. If the temperature of the surrounding air is higher than 32°C, the Contractor shall apply aliphatic alcohol, using spraypacks, to the exposed surface of the concrete in accordance with the manufacturers specification. This is to occur immediately after initial screeding. In addition, suitable barriers shall be erected to protect the freshly placed plastic concrete from wind and sun until the concrete has hardened sufficiently to allow covering. Freshly finished concrete shall be protected from physical or thermal shock and traffic likely to damage the surface, including damage from rain.

Cold weather curing

Prevent plastic concrete from freezing, but do not use salt or chemicals. Maintain concrete temperature between 10 - 20°C for curing period.

Curing compounds

Standard: To AS 3799.

Application: provide a uniform continuous flexible coating without visible breaks or pinholes, which remains unbroken at least seven days after application.

Substrates: Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to concrete toppings and cement-based render and the like.

Curing compounds: If it is proposed to use a liquid membrane-forming curing compound submit the following information:

- Certified test results for water retention to AS 3799 Appendix B.
- Evidence that an acceptable final surface colour will be obtained.
- Evidence of compatibility with applied finishes, if any.
- Methods of obtaining the required adhesion for toppings and render.

Note 1: Superintendent's written permission is required prior to use of any curing compound.

Note 2: Quality control measures must be in place while curing is being carried out and verification of the actual quantity of curing compound used must be immediately supplied to the superintendent at the completion of every application to ensure that the required approved rate of application is achieved.

The sub contractor shall allow for the cost of a minimum of three random samples to be tested for water retention in accordance with AS 3799. Samples shall be taken from the material delivered to site during the period of the works as directed by the superintendent and shall be tested by an approved NATA registered laboratory.

Hot weather curing

Do not use curing compounds. After placement, either

- if the temperature exceeds 25°C or if not protected against drying winds, protect the concrete using a fog spray application of aliphatic alcohol evaporation retardant.
- immediately cover the concrete using an impervious membrane, or hessian kept wet, until curing begins; or
- pond or continuously sprinkle with water;

Visually important surfaces

Produce uniform colour on adjacent surfaces.

Curing methods

Acceptable methods of curing include the following:

- Ponding or continuous sprinkling with water (moist curing).
- An impermeable membrane. (i.e. plastic sheet)
- An absorptive cover kept continuously wet.
- 90% efficiency index equal to class C AS3799 (synthetic rubber-based compound) and type 1-D (containing a coloured fugitive dye only if curing is exposed to sun light)

Curing with an impenetrable membrane

The covering sheet joins must be taped and the sheet must cover at least 300mm beyond the edges and sides of the concrete. The sheet must not be able to be blown open or away.

5.3.10 PROTECTION

Loading

Notice: Give notice before loading the concrete structure.

Protection: Protect the concrete from damage due to load over-stresses, heavy shocks and excessive vibrations, particularly during the curing period. Do not place construction loads on self-supporting structures which will overstress them. Provide calculations to justify the adequacy of the structure to sustain construction loads.

Surface Protection

Protect finished and exposed aggregate concrete surfaces from damage from any cause, including mortar splashes and stains, timber stains, rust stains, chemical attack, additives, curing compounds, protective coatings, rain and running water.

Refer to formed surface section and architectural drawing AG0060 and AG0061 on this specification for protection of class 1 and 2 concrete.

Visually important surfaces

Rectification: Concrete is liable to be rejected if visually important surfaces are damaged. Rectification may be attempted only if prior approval is given. The Superintendent may refuse approval, or, if approval is given, may reject the concrete if the attempt fails.

5.3.11 CONSTRUCTION JOINTS

Location

Do not relocate or eliminate construction joints, or make construction joints not shown on the drawings without notifying the Superintendents Representative for instruction. Where no construction joints are shown on the contract drawings and such are required their location and design shall be to the approval of the Superintendents Representative. Indicate in shop drawings.

If emergency construction joints are made necessary by unforeseen interruptions to the concrete pour, submit a report on the action taken.

Finish at construction joints

Butt join the surfaces of adjoining pours. In visually important surfaces make the joint straight and true, and free from impermissible blemishes relevant to its surface finish class.

Joint preparation

Before fresh concrete is placed at a construction joint, roughen and clean the hardened concrete surface of the joint, so that all loose or soft material, free water, foreign matter and laitance is removed. Apply a wet to dry epoxy to the concrete surface immediately prior to casting adjacent slab. Submit details of the proposed product and apply in accordance with the manufacturers recommendations.

5.3.12 EXPANSION JOINTS

Joint Filling:

Joint filling: Fill with jointing materials. Finish visible jointing material neatly flush with adjoining surfaces.

Preparation: Before filling, dry and clean the joint surfaces, and prime.

Watertightness: Apply the jointing material so that joints subject to ingress of water are made watertight.

Sealants: Two-part gun grade polysulphide based sealant coloured to match the colour of the adjoining pavement colour and approved by the Superintendent. Pourable sealant shall not be used unless the installation method and sealant performance have been demonstrated and approved by the Superintendent.

Jointing Materials

Types: Use jointing materials, including sealants, mastics, primers, gaskets, compressible fillers, and joint covers, as recommended by the material manufacturers for the location and type of joint, compatible when used together, and non-staining to concrete in visible locations.

The Contractor is to submit the proposed product for review.

Preparation: Where joints are to be filled with jointing materials, including sealants, bond breakers, backing rods, taped edges and preformed strips, dry and clean the joint surfaces before application and prime as recommend by the joint material manufacturer.

Bond breaking: Use back-up materials for sealants, including backing rods, which do not adhere to the sealant. They may be faced with a non-adhering material.

Foamed materials (in compressible fillers): Closed-cell or impregnated types which do not absorb water.

Compressible Filler: Compressible filler, thickness as designated on drawings. Expanding Cork

Filler: Expanding cork filler, thickness as designated on drawings.

5.3.13 DOWELS

Joint dowels

Provide galvanised steel reinforcing rod dowels in expansion and contraction joints, where required. Embed dowels normal to the plane of the joint, so that half the dowel lies on each side of the joint. Heavily grease or bitumen coat one half and fit an expansion cap to that end. Dowels to have neatly sawn ends not sheared.

Location: Across joints at the required spacings and vertical locations correctly aligned parallel to the finished pavement surface and parallel to the longitudinal joints in plan. If the construction methods require alterations to the designed spacing, use a closer spacing with additional dowels or tie bars.

Placing in fixed-form paving: By the bonded-in-place method. Embed the unpainted half of the dowels in the slab placed first.

Dowel placement tolerances

General: To achieve the required tolerances the dowels should be securely attached to a reinforcing cage. Provide proposed details to the Superintendent for approvals prior to installation.

Horizontal and vertical location: Plus or minus half the diameter of the dowel.

Alignment: All bars in the joint shall be within 3 mm in 300 mm and adjacent bars shall not differ in alignment by more than 3 mm in 300 mm.

Pre-embedment testing: The Superintendent may require dowels to be fixed and tested before embedment by subjecting either end to a load of 100 kg in any direction normal to the bar.

Rejection: Dowels and tie bars are liable to rejection if they become distorted or displaced beyond the alignment tolerances under testing or during construction. Do not remove and replace dowels in pre-formed holes for any reason including to assist in form stripping.

5.3.14 WATER STOPS

Locations

Install water stops as shown on drawings, surrounded by fully compacted concrete, and located so that

- their correct positions in the finished work are ensured;
- the proper placing and compaction of the concrete is not inhibited; and
- reinforcement is not displaced from its correct position.

5.3.15 CONCRETE PLINTHS

Construction

General: Provide galvanised steel surround at least 75 mm high and 1.6 mm thick, fixed to floor with masonry anchors. Fill with concrete.

Reinforcement: Single layer of SL62 fabric.

Concrete: Grade N20.

- Finish: Steel float flush with the surround.

5.3.16 BLOCKWORK CORE FILLING

For all reinforced and load bearing walls, fill all cores with grout and thoroughly compact by mechanical vibrator and/or rodding with a plain round bar.

Grout shall be in accordance with the following specification, conforming to AS 3600.

Characteristic strength f'_c = refer structural drawings (20MPa if not specified) Specified

slump = 230mm

Maximum aggregate size = 10mm

Cleanout opening shall be provided at the bottom of each core containing vertical reinforcement. Reinforcing cores shall be cleaned of mortar protrusion before grouting.

5.3.17 SCHEDULES

Table 5-4 Concrete performance schedule

Item	Requirement
Normal and Special Class Concrete	
Maximum aggregate size (mm):	Refer Drawings (but not greater than 40mm)
Slump (mm)	Refer Structural Drawings, Test to AS 1012.3.1
Strength grade	Refer Drawings
Characteristic 28 day compressive strength f'_c (MPa)	Refer Drawings, Test to AS 1012.9
Special Class	
Cement Type	GP
Early age strength for post-tensioned concrete	Refer section Table 5-6 Test to AS 1012.9
Water/Cement ratio	0.55 maximum (0.45 for acidic and sulphate soils)
Intended method of placement	To AS 3600
Cement content	400 kg/m^3 SR cement minimum for acidic and sulphate soils

Item	Requirement
Drying shrinkage - to relevant Australian Standards	Maximum permissible drying shrinkage measured as a percentage change after 56 days (Test to AS 1012.13).
Duration of air drying:	56 days
Limits	Table 5-7 Drying shrinkage schedule Or
Sampling frequency	Prior to supply then every 3 months or 3000m^3 for each type of concrete
Number of specimens for sample	3
Acceptance criterion	Average strain of three specimens from each sample shall not exceed the required value
Early age shrinkage prediction:	Must be carried out on each sample at 7 days and must be issued to the superintendent within 10 calendar days of the concrete pour date

Table 5-5: Supplementary Cementitious Material Content Schedule

Concrete Element	Strength Designation (MPa)	Total minimum reduction in OPC content (%) via introduction of SCM
Footings/Piles	32	45%
Retaining walls, Slabs on ground	32	45%
Reinforced slabs and beams	40	45%
Post-tensioned slabs/beams	40	15%
Columns	60	20%
Columns/Walls	40	30%

Table 5-6 Control tests schedule

Concrete element	28 day strength (MPa)	Transfer strength (MPa)	Days after pouring	Early age strength (MPa)	Days or hours after pouring
Post-tensioned slabs	40	22	5	7	1 day

Table 5-7 Drying shrinkage schedule

Concrete element	Strength grade	Drying shrinkage limit (microstrain)
Pad and piled footings	N32	1000
Columns and walls	S40, S60	650
Slab on ground	S32	650
Suspended slabs and beam	S40	650
Post tensioned roof slab	S40	550

Table 5-8 Minimum time delay schedule

Between (pour locations)	Minimum period between adjacent pours (days)
Adjacent pours abutting vertical construction joints in walls	1
Columns or walls ≤ 4.5m high and Floor slabs/beams	2 hours
Columns or walls > 4.5m high and Floor slabs/beams	1 day
Horizontal construction joints in columns or wall	1
Floor Slab Construction Joints	1
Retaining wall construction joints	1
"Pour strips" and adjacent concrete	56

Table 5-9 Sample panels schedule

Application	Incorporated features	Panel size
E.g. class 1	All architectural requirements	Refer to architectural drawings/specification

6 CONCRETE FINISHES

6.1 GENERAL

6.1.1 AIMS

Responsibilities

General: Provide finishes to formed and unformed concrete surfaces which are as follows:

- Appropriate to the importance (visual or physical) of the concrete elements.
- Compatible with following trades and finishes.

6.1.2 CROSS REFERENCES

General

General: Conform to the General requirements worksection.

Associated worksections

Associated worksections: Conform to the following:

- Concrete formwork.
- In situ concrete.
- Shotcrete for shotcrete finishes.

6.1.3 STANDARDS

General

Formed surfaces: To AS 3610.

6.1.4 INTERPRETATIONS

Definitions

General: For the purposes of this worksection, the following definition applies:

- Green concrete: Concrete which has set but not appreciably hardened.

6.1.5 TOLERANCES

Surface quality

Formed surfaces: Confirm conformance with the surface finish requirements of AS 3610 for the surface class nominated in the Formed surface finishes schedule.

Flatness

Unformed surfaces: Confirm conformance with the Flatness tolerance class table for the class of finish nominated using a straight edge placed anywhere on the surface in any direction.

Determine tolerance classes using a straight edge placed anywhere on the surface in any direction in accordance with Cement and Concrete Association of Australia - Industrial Pavements (Guidelines for Construction).

Table 6-1: Flatness tolerance class table

Class	Measurement	Maximum deviation (mm)
A	3 m straight edge	3
B	3 m straight edge	6
C	600 mm straight edge	6

For classes A and B the specified maximum deviation shall not occur within a 500mm distance anywhere on the surface.

6.1.6 SAMPLE PANELS

General

Conformance: Supply sample panels to AS 3610 and in conformance with the Sample panels schedule for the application specified.

Manufacture

General: Cast the panels using the formwork, concrete, compaction equipment, form release agents, curing and formwork removal methods which are to be used in the final work.

Storage

General: Once accepted, maintain the panels on site undamaged and protected from the weather, as reference prototypes for future evaluation of completed work. Storage to be coordinated with superintendent/architects.

6.1.7 SURFACE TREATMENT

General

Range: Do not proceed with the related work until the acceptable range of surface treatments has been determined.

6.2 PRODUCTS

6.2.1 MATERIALS

Surface hardeners, Mineralisation product, sealants and protectors

Sealer: Protectosil BHN water repellent impregnate or equivalent product. Equivalent product to be tested and approved by architect for class 1 concrete

Supply: If required by the project documentation, provide proprietary products.

Clear Resin Sealer: refer to T-Sheet

6.3 EXECUTION

6.3.1 SURFACE MODIFIERS

General

Application: Apply to clean surfaces in accordance with the manufacturer's requirements.

6.3.2 UNFORMED SURFACES

General

General: Strike off, screed and level slab surfaces to finished levels, to the tolerance class noted in the Unformed surface finishes schedule.

Surface finishes

General: Provide surface finishes in conformance with the Unformed surface finishes schedule.

Surface repairs

Surface repair method: If surface repairs are required, submit proposals.

Finishing methods – primary finish

Machine float finish:

- After levelling, consolidate the surface using a machine float.
- Cut and fill and refloat immediately to a uniform, smooth, granular texture.
- Hand float in locations inaccessible to the machine float. Steel trowel finish: After machine floating finish

as follows:

- Use power or hand steel trowels to produce a smooth surface relatively free from defects.
- When the surface has hardened sufficiently, retrowel to produce the final consolidated finish free of trowel marks and uniform in texture and appearance.

Burnished finish: Continue steel trowelling until the concrete surface attains a polished or glossy appearance, uniform in texture, appearance and free of trowel marks and defects.

Wood float finish: After machine floating use wood or plastic hand floats to produce the final consolidated finish free of float marks and uniform in texture and appearance.

Broom finish: After machine floating and steel trowelling draw a broom or hessian belt across the surface to produce a coarse even-textured transverse-scored surface.

Scored or scratch finish: After screeding, give the surface a coarse scored texture using a stiff brush or rake drawn across the surface before final set.

Sponge finish: After machine floating and steel trowelling, produce an even textured sand finish by wiping the surface using a damp sponge.

6.3.3 FORMED SURFACES

General

General: Provide formed concrete finishes in conformance with the Formed surface finishes schedule.

Damage: Do not damage concrete works through premature removal of formwork.

Curing

General: If forms are stripped when concrete is at an age less than the minimum curing period, commence curing exposed faces as soon as the stripping is completed.

Evaluation of formed surfaces

General: If evaluation of formed surface tolerance or colour is required, complete the evaluation before surface treatment.

Finishing methods

General: If soffits of concrete elements or faces of concrete columns are to have a finish other than off the form, provide details of proposed procedures.

Floated finishes:

- Sand floated finish: Remove the vertical face forms while the concrete is green. Wet the surface and rub using a wood float. Rub fine sand into the surface until a uniform colour and texture are produced.
- Grout floated finish: Remove the forms while the concrete is green. Dampen the surface and spread a slurry, using hessian pads or sponge rubber floats. Remove surplus slurry and work until a uniform colour and texture are produced.

Smooth rubbed finish: Remove the vertical face forms while the concrete is green. Wet the surface and rub using a carborundum or similar abrasive brick until a uniform colour and texture are produced.

Protection for Class 2 concrete

Protect and maintain the specified finish during any handling, erection or subsequent construction operation to ensure a clean undamaged surface at completion of the contract work.

The insitu walls have to be protected with panels, using ventilated cavity and minimize the contact between the spacers and the concrete surface, so that no marks and stains shall occur.

All reinforcement bars sticking out of unfinished walls have to be protected so that no staining can occur from rusting steel.

Cleaning for Class 2concrete

Eight (8) weeks after pouring the concrete all exposed have to be cleaned following this method:

1. Rub slightly and evenly over the whole surface with a medium cleaning fibre mat, to even surface without destroying joints.
2. Clean surfaces without 2 times with a wet cloth, to get rid of any dirt

Surface Treatment for Class 2 concrete

Prior to applying any treatment a test sample must be approved by the architect.

Apply mineralization product (refer to material and component section of this specification) after cleaning concrete surface. Application of minerialisation product to be carried out strictly in accordance with manufacturer's specification.

Surface repairs

Surface repair method: If surface repairs are required, submit proposals.

Crack repair methods: Crack repair methods for existing and new cracks formed by the contract work shall be submitted to the Superintendent's representative for review during tender submission. Any damaged caused to the epoxy floor topping by inadequate crack repair shall be the responsibility of the Contractor. All damaged work shall be replaced at the Contractors expense.

Note: Refer PROPRIETARY PRODUCTS, Section 1.5.

6.4 SELECTIONS

6.4.1 SCHEDULES

Note: Tolerance class A is particularly high tolerance and contractor is to allow for special attention to achieve this if and where required.

Table 6-2: Unformed surface finishes schedule

Location	Property				
	Flatness tolerance class	**Primary finish**	**Supplementary finish**	**Slip resistance treatment & tests**	**Surface modifier**
Slab on ground Including those with recesses for matts	A	Steel trowelled		Required as specified	Required as specified
Suspended slab.	A	Steel trowelled		Required as specified	Required as specified

Internal & external slabs feature areas – refer architects drawings	A	Steel trowelled	Polished	Required as specified	Required as specified
Base to all tiled and granolithic or secondary slabs finishes	B	Wood float finish.(alternately machine floated then scored finish).		Required as specified	Required as specified
Areas to be vinyl finished. Kitchen	A	Steel float finish		Required as specified	Required as specified

Note: Flatness tolerance for suspended slabs to be measured prior to stripping formwork.

Table 6-3: Formed surface finishes schedule

Location	**Property**		
	Surface class	**Colour control**	**Surface finish type**
Exposed external slabs	A	Required as specified	Refer to architect drawing

Table 6-4: Sample panels schedule

Application	**Incorporated features**	**Panel size**
Class 2 off form concrete	All architectural requirements including form tie bolt layout	to architectural drawings and requirement

Documentation: The Contractor shall submit a copy of all design calculations and layout drawings for review and acceptance at least fourteen (14) days prior to work commencing.

Erection: The method of erection must be in accordance with the assumptions made during the design of the beams with regards to rigging configuration. The Contractor shall obtain written certification from the Structural Engineer responsible for the design of the beams confirming that the method is acceptable and the beams have been designed in accordance with AS 3850 and the contract documentation.

Cutting and Trimming: On and off site cutting of precast beams to obtain required lengths, shall be within the tolerances of the Formwork Section of this Specification. On immediate completion of any cutting of precast beams, adequate protection shall be provided to the post-tensioning strands and any reinforcement. The protective method shall comply with the durability and fire resistance requirements of AS 3600 Concrete Structures Code.

Formwork: Formwork shall comply with section 2 CONCRETE FORMWORK.

7 BORED PILES

7.1 GENERAL

7.1.1 CROSS REFERENCES General

Conform to the General requirements worksection.

Related worksections

Conform to associated worksections as follows:

- Concrete finishes.
- Concrete reinforcement.
- Concrete formwork.
- In situ concrete.

7.1.2 STANDARD

General

Construction and materials to requirements of AS 2159 and AS 3600.

8.2 BORED PILE EXCAVATION

Extent: The work specified under this section shall comprise:

- Excavation for pile holes in other than rock (OTR) and rock.
- Removal off site of excavated material.
- Provide an independent approved geotechnical engineer engaged at the Contractors expense to monitor and certify the foundations capacity of the installed bored piles.

Schedule Of Rates: The following items are to be covered in the Schedule of Rates, as these quantities are likely to vary from the Contract during construction (either addition or deduction).

- Excavation of pile holes in O.T.R. (for various diameters shown on the drawings).
- Excavation of pile holes in Rock (for various diameters shown on the drawings).
- Socketing base of piles.
- Proving Holes.

Site Investigation: Borehole information carried out by the client's Geotechnical Engineer shall be supplied as tender documents. Positions of the boreholes are shown on the Structural Engineers drawings.

The supply of this information is for the convenience of the Contractor and does not exempt him from the responsibility of satisfying himself as to the true nature of the material to be excavated.

Equipment: The Contractor shall provide all necessary equipment for boring, socket scouring, cleaning pile base out and proving pile holes together with power for operating it.

Provide all necessary lighting and ventilation where hand work is required within the pile excavation, in accordance with the requirements of Work Cover.

Levels: Bore depths and socketing shown on the Structural Engineers drawings are for contract purposes only. The final excavated base level of all pile holes will be as directed on site by the contractor's Geotechnical Engineer during construction.

Tolerances:

All piles are to be vertical to within 5mm in 1000mm.
Single pile excavations shall not vary from design plan position by more than 75mm. Contiguous piles excavations shall not vary from design plan position by more than;

- Inwards - toward excavation 0 mm
- Outwards - away from excavation 50 mm
- Spacing between piles 25 mm max

Should any pile be constructed outside the tolerances specified, the contractor shall have to rectify the foundations at no extra to the principal, including but not limited to the associated design, documentation, construction and delay costs.

Retaining of Excavation: The Contractor shall provide and install a casing in the bored hole where necessary to support the sides of the excavation to prevent loose material falling into the excavation up to time of concreting. The casing shall be provided in all pile holes where proving holes are required. The

Contractor shall design the casing to be a snug fit inside the bored hole and capable of withstanding all earth and water pressures. The casing shall be permanent and shall not be removed during concreting. The casing shall extend 150mm below rock level.

Trimming: Trimming between and on the exposed face of piles shall be carried out to expose the concrete piles as detailed and conform to the tolerances specified for the general excavation.

Socketing Base of Piles: The Contractor shall socket base of piles to achieve, with the end bearing the required load capacity as specified on the Structural Engineer's drawings by mechanical means to the satisfaction of the contractor's Geotechnical Engineer.

Cleaning Out: The base of all piles shall be cleaned out to remove all loose material to the satisfaction of the geotechnical engineer. Pile holes shall be free of water prior to placing concrete. Excavated material at top of pile hole shall be kept sufficiently clear so as not to fall into the excavation during placing of reinforcement and concrete.

Proving Holes: The Contractor shall provide proving holes to the base footings as required by the contractor's Geotechnical Engineer.

The Contractor shall provide all necessary equipment access, ventilation and lighting for inspection of the proving holes by the contractor's Geotechnical Engineer.

Open Excavations: Contractor to provide safety covers to openings of all unattended pile holes.

Prior To Concreting: After pile excavations have been taken to the required bearing base level and cleaned out, an instruction from the contractor's Geotechnical Engineer stating that end bearing and the sides are sufficient for the load capacity noted on the structural drawings must be given prior to placing reinforcement and concrete. The Contractor will be responsible for maintaining the excavation in its correct condition up to and including the time of placing concrete.

Removal Of Excavated Material: The Contractor shall remove all excavated material from the site.

8.3 BORED PILE CONCRETE

All these requirements are additional to those noted in related worksections.

Extent: The Contractor shall construct all reinforced concrete piles indicated on the Structural Engineers drawings including:

- Reinforcement and concrete to piles.
- Reinforcement and concrete to pile caps including casting in column starter bars.

Schedule Of Rates: The following items are to be covered in the Schedule of Rates for these quantities are likely to vary from Contract during construction (either addition or deduction) and be included in the tender contract.

- Reinforcement to piles.
- Concrete to piles.

Formwork: No form lining is required to the excavated face unless excavation is required to be retained as noted in 8.2 BORED PILE EXCAVATION.

Pile Caps: Provide permanent form lining to pile caps as shown on the Structural Engineers drawings. Remove form lining above top of pile cap after concrete has cured. (Minimum two days).

Reinforcement: Reinforcement to piles shall be fabricated into cages and carefully lowered into position so as to avoid dislodging material into the excavation. Reinforcement to piles shall be securely held in correct position during concreting operations.

Starter bars cast into pile caps shall be accurately set-out and securely held in correct position during concrete placement and curing.

Reinforcement to both piles and pile caps shall be inspected by the Superintendent prior to placing concrete.

Down-Pipes: Confirm requirement for down pipes cast into pile caps with superintendent.

Preparation Before Placing: Placing methods shall be submitted to the Superintendent before placing any concrete. Pile excavation to be completely cleaned and free of debris and water at time of placing concrete. Approval from the Superintendent shall be obtained prior to concreting any pile or pile cap.

The construction joint surface at the top of the pile shall be clean and scabbled to remove laitance.

Concrete Placing: Concrete to piles shall be placed using a tremie tube placed centrally within the reinforcement cage. The maximum drop permitted from underside of tremie tube to placement level will be 3 metres. The tremie tube and entry hopper will be supported independently from the reinforcing cage and shall be withdrawn as concreting proceeds.

Alternatively up to engineer's discretion.

Concrete to piles where there is no liner shall be placed using a tremie or funnel placed centrally within the reinforcement cage. The maximum drop permitted from underside of tremie tube to placement level can be up to 20m (Eng to add/delete) providing the freefall is vertical and does not hit the sides of the hole.

Where liners are used or if the diameter of the pile is 1.2 metres or greater, concrete may be placed with a freefall of up to 20 metres (Eng to add/delete) and is allowed to come in contact with the side of the liner.

Compaction: Compaction of freshly placed concrete shall be carried out immediately and continuously using mechanical immersion-type vibrators. In the case of piles the vibrator shall be lowered inside the reinforcement cage and vibration shall be co-ordinated with tremie or alternative placement. The maximum depth of concrete placed in piles prior to vibration shall be two lineal metres.

Finishing: Construction joint at top of pile shall be hand finished to provide a dense level surface free from laitance. The top of pile caps shall be smooth wood float finished around the perimeter of the starter bars to the levels shown on the drawings.

9 APPENDIX - DELIVERABLES SCHEDULE

Deliverables Schedule

The deliverables schedule shown below is informative only and is to assist Superintendent's representative and Contractor in identifying and supplying key deliverables under this specification required to be submitted to SDA Structures Pty Ltd Consulting Engineers.

Deliverable schedule

Section	Test Result/Submission Required	Frequency
1. GENERAL CONCRETE	Alternative proprietary products – Product data	Each instance
	Shop drawings	Each instance
	Design certification for D&C concrete elements	Completion of design and documentation
	Inspection certification for D&C concrete elements	Completion of slab construction
2. CONCRETE FORMWORK	Formwork stripping and back propping procedures	Each instance
	Proposals for concrete crack repair where required	Each instance
	Shop drawings for class 1 and class 2 concrete	Each instance

3. CONCRETE REINFORCEMENT	Certification from 'Australian Certification Authority for Reinforcing Steels Ltd' for the supply of reinforcement material.	Submit current certificate.
	Certificate of compliance for reinforcement	Each batch
	Certification of the post consumer recycled content of the reinforcement. (Eng add/delete if ESD requirement. Check with project director).	Each batch
	Additional splicing proposals	Each instance
4. CONCRETE POST-TENSIONING	Certification from 'Australian Certification Authority for Reinforcing Steels Ltd' for the supply of reinforcement(strand) material.	Submit current certificate.
	Strand certificates	Each coil
	Design calculations for strand/bar elongations i.e., theoretical extensions	Each concrete pour
	Shop drawings	Each concrete pour
	Post-tensioning equipment details and calibration certificates	Prior to commencing
	Post-tensioning records including site measured strand/bar elongations i.e., site extensions	Each concrete pour
5. IN SITU CONCRETE	Concrete Materials tests	Refer schedule
	Design calculations for structural adequacy under any proposed construction loads	Each instance

Section	**Test Result/Submission Required**	**Frequency**
	Concrete mix details	Each discrete mix
	Curing compound test data	Refer schedule
	Proposals for curing concrete	Prior to commencing
	Shop drawings for fixing of embedded items	Each instance
	ertification that the concrete utilised in the project meets this specification ESD requirements.	Each batch
6 CONCRETE FINISHES	Crack repair methods	Each instance
	Sample panels for class 1 and class 2 concrete	Each instance
	Shop drawings	All elements
	Design certification	All elements
	Inspection Certification (design and construct)	All elements
	s Certificate for precast construction and installation	All elements

	Lifting certification and procedure	All elements
8 BORED PILES	Geotechnical engineer's certification foundation materials	Each pile prior to pouring concrete
PRECAST CONCRETE Refer to *0321 Precast concrete*	Concrete Materials tests	Refer schedule
	Design calculations for structural adequacy under any proposed construction loads	Each instance

INSPECTIONS AND SUBMISSIONS SCHEDULE

General

General: Refer to specification worksection *0171 General requirements* for the following:

- Submissions detailed requirements.
- Notice periods.

'Status' column: Scheduled items are 'witness points', unless noted as 'hold' points.

No	Item	Requirements	Status
01	Project-specific submissions	Names and contact details of proposed formworker / concreter	Hold
		Evidence of licensing and experience	Hold
		Not used	
		Not used	
		Shop drawings /diagrams showing layouts, arrangements of forms, joints corners and details Supporting data adequate to demonstrate compliance with the documented requirements	Hold
		Technical data to demonstrate compliance with the contract documents	Hold
		Surface finish types: Submit descriptions of proposed methodologies	Hold
		Requirements: Refer to the specification	Hold
		Compatibility of surface modifiers and sealers with subsequent applied finishes	
		Methods of disposal of waste materials and contaminated water	
02	Start-up meeting	Attend a start-up and review meeting with the managing contractor and its nominated consultants and other subcontractors before commencing detail design or ordering materials Minutes: Prepared by the managing contractor	Hold
03	Prototype panels	Each floor finish type including but not limited to honed concrete floor	Hold
		Class 2 finishes, showing: Typical board joints Typical tie rods Edge detailing.	Hold

No	Item	Requirements	Status
		Other formed finishes: Wall Floors both internal and external Column Beam and slab soffit	Hold
		Provide each prototype with sealer on half the area	
		When prototypes are floors conduct a slip resistance test for each instance on the sealed area	
04	Slip-resistance (site tests)	Detail requirements: Refer to specification worksection *0171 General requirements*	
05	Surface repairs and other remedial works	Submit proposals for consideration	Hold
07	Completion submissions	Proposals for remedial works (where necessary)	Hold
06	Warranties	Period (years): 20 50 years design life Refer to specification worksection *0171 General requirements.*	

0160 QUALITY

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide a project Quality Management System, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0131 Preliminaries* (not part of BVN specifications)
- *0171 General requirements*.

1.3 STANDARDS

General
Standard: To AS/NZS ISO 9001.

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection the definitions given in AS/NZS ISO 9000 and the following apply:

- Quality package: A designated part of the works, which may include the whole works, for which an individual quality system is required.
- Service: After sales' service, repairs, maintenance.

1.5 SUBMISSIONS

Quality Plan
Quality package: Submit a Quality Plan for each quality package, at least 10 working days before work on that package commences. Keep on site a copy of each approved quality plan.

Authority approvals
General: Provide project Quality Management System documents to the following authority: Provide as required by individual Authorities and the documents , refer to individual trade work sections and also to Pymble Ladies College's PPR document.

Calculations
Statistical techniques: Provide the methodology for statistical evaluation.

Execution details
Requirement: Provide the procedure for sign-off and audit.

1.6 INSPECTION

Notice
Inspection: Give notice so inspection may be made of the following: Provide as required by the documents, refer to individual trade work sections.

2 PROJECT QUALITY MANAGEMENT SYSTEM REQUIREMENTS

2.1 DOCUMENTATION REQUIREMENTS

Quality plan
Standard: Conform to the recommendations of AS ISO 10005. Include inspection and test plans.

Documented procedures
Review: Provide evidence of revision(s) (including dates), approval and status of each procedure.

Register: Maintain a register of documented procedures including the title, identifier and revision status.

2.2 DESIGN AND DEVELOPMENT OF PRODUCTS AND SERVICES

General

Plan and control of product design and development: Refer to in *0171 General requirements* also refer to each trade worksection.

2.3 CONTROL OF EXTERNALLY PROVIDED PROCESSES, PRODUCTS AND SERVICES

General

External audits: Perform pre-tender surveys of subcontractors and suppliers and audit subcontractors and suppliers, as necessary by an approved auditor. Include audit and surveillance proposals in the quality package Quality Plan along with results of pre-tender surveys.

Verification: The contract administrator may verify at source, or upon receipt, that purchased product conforms to requirements.

2.4 PRODUCTION AND SERVICE PROVISION

Product identification and traceability

General: As documented in the **Product identification and traceability schedule**.

Identification: Identify by lot / number / barcode all items of work, samples and site records.

Traceability: Provide and maintain records of components for audit.

Service

General: As documented in the **Service schedule**.

3 MONITORING AND MEASUREMENT

3.1 DOCUMENT CONTROL

Changes to documents

Revision: Review and approve changes to documents using the same functions or organisations that performed the original review and approval of the documents, unless documented otherwise ~~except as described in the **Document control schedule**.~~

Retention: As documented ~~in the **Quality records retention schedule**~~.

Evaluation: Make quality records available to the contract administrator for evaluation, within 2 days of the initial request.

Period of evaluation: Agree for each request, but at least 5 working days.

3.2 INSPECTION AND TEST PLANS

Content

Plan: Include the following:

- Detail all inspections and tests required including Hold points.
- Identify acceptance criteria, sampling and testing and frequency of sampling/testing.
- Identify responsibilities for inspection and testing and product/service approval.

Control of non-conforming product

Acceptance of concession: Before the provision or repair of a non-conforming product, obtain permission to use the product.

Hold points

Stages: Hold points during the construction/manufacturing process require release by the contract administrator.

Release: Requirements for release of a Hold point may include the following:

- Provision of information required by the technical specifications.
- Certification of design/construction or installation.
- Submission of any checklists or non-conformance forms as required.
- Inspection/demonstration of works.

~~Schedule: Conform to the **Inspections and Submissions** for test requirements specific to the appropriate worksection and the relevant standards~~

Frequency of testing
General: Conform to the test requirements of the relevant standards and worksections, as documented.

3.3 AUDITING

General
Audit plan: Conform to the recommendations of AS/NZS ISO 19011 clauses 6.4 and 6.5.

Initial systems audit: Carry out before date of site possession.

Compliance audits frequency: As required to meet requirements of documents

Compliance activities: As per work sections

Testing services
Testing authority: As per work sections

External audits
Nominated auditor: Not required

General
Review: Provide procedure to review the various control methods to minimise non-conformance. Record amendments to the project Quality Management System resulting from corrective action.

Non-conforming works: Include in the Quality Plan the procedure for reporting any non-conforming works to the contract administrator and any corrective action requests.

4 SELECTIONS

4.1 SCHEDULES

Project Quality Management System schedule

Quality package	Activities included	Standard	Options
The whole of the works	All	AS/NZS ISO 9001	

Design and development schedule refer to individual Worksections

Product identification and traceability refer to individual Worksections

Quality package	Product	Traceability required	Product identification required	Method

Service (maintenance) schedule refer to individual Worksections

Quality records retention schedule

Quality package	Retention period	Location during retention period	Form for retention	Content of documents
	7 years from Practical Completion	To be advised	Digitised on computer	Completed proforma evidencing conformance with the quality system

Servicing schedule refer to individual Worksections

Frequency of testing schedule refer to individual Worksections

THIS SPECIFICATION HAS BEEN PRODUCED USING NATSPEC BUILDING STRUCTURE

211007

GREY HOUSE PRECINCT

PYMPLE LADIES COLLEGE

CONCRETE SPECIFICATION

DOCUMENT REGISTER

PREPARED BY	APPROVED BY	STATUS	ISSUE	DATE
HN	HN	80% AFT	A	12/11/2021
HN	HN	Tender D&C	1	12/12//2021
HN	HN	Construction Certificate	2	12/02/2024

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CONTENTS

1 GENERAL CONCRETE

1.1 CROSS REFERENCES

General

Refer to the General requirements worksection for general technical requirements.

Related sections

Refer to the following sections: Architectural specification, Architectural finishes specification

1.2 GENERAL REQUIREMENTS

Standard: *Construct the concrete work in a safe manner using materials and methods complying with the relevant requirements of AS 3600 and AS 3610. For concrete structures used for retaining liquids comply also with the relevant requirements of AS 3735.*

Any reference documents are as a guide only and the Contractor shall source all appropriate standards and codes and the latest editions are to be adopted.

Survey Certificates: *These are to be certified by a licensed surveyor.*

Costs: *All items and associated costs referred to in this Specification and the Structural/Civil drawings shall form part of the Contractor's sum unless noted otherwise. All Materials are to be supplied including wastage and over-supply construction.*

Notice: *Should any ambiguity, error, omissions, discrepancy or other faults exist or seem to exist in the contract documents then promptly notify in writing to the Superintendent.*

Variations: *Should the Contractor consider that a variation to the contract exists, then they should refer immediately to the superintendent and obtain written approval prior to variation work proceeding. Refer to Contract Conditions.*

1.3 SAFETY IN DESIGN

So far as is reasonably practicable, TTW has identified potential risks to the health and safety of persons who may be affected by the structural design.

Identified hazards & risks have been included in the Structural Risks and Solutions Register which has been forwarded to TTW's Client.

The principal contractor must familiarise itself with the hazards and risks identified in the report and the measures proposed to eliminate or mitigate those hazards and risks.

The principal contractor must notify TTW in a timely manner should they require any further information regarding any identified hazards or risks related to the structural design. If no request for further information is received the project principal contractor acknowledges that the information provided is adequate for its purpose.

The provision of such advice by TTW does not release the principal contractor from its own health and safety obligations under any legislation, contract or otherwise.

1.4 QUALITY ASSURANCE

REQUIREMENT: A quality management system complying with the appropriate current Australian standard is required for a specified product or service, or in any case, where the supplier already has in place such a system, provide assurance of quality in terms of that system.

Programme: Submit a copy of the Contractors quality assurance programme with the tender.

During the construction phase, the Contractor shall provide written verification to the Superintendent that they have completed a quality assurance and control procedure on the construction works detailed in the specifications and drawings.

Description: Provide a written description of each quality management system, with specific reference to the following:

- *the relevant Australian standard;*
- *where the standard provides for classification levels, the level adopted;*
- *the scope and field of application;*
- *the personnel involved and their responsibilities:*
- *Inspection Test Plans (I.T.P's)*
- *the various procedures required by the standard including those for management review, contract review, design and document control, process control, inspection and testing, etc.;*
- *the quality audit system;*
- *Where external quality audits are required by a recognized independent organization, the name of that organization;*
- *other relevant information.*

Quality control: *The Contractor shall submit their Construction Method Statement and Inspection Test Plan (I.T.P) for each work procedure to the Superintendent for approval for a minimum of 14 days prior to commencing the relevant work. I.T.P's shall include checklists showing that the Contractor has checked that the work has been completed in accordance with the specifications and drawings and showing testing and inspection requirements.*

1.5 ADJOINING ELEMENTS

Requirement: *Obtain the requirements for adjoining elements to be fixed to or supported on the concrete and provide for the required fixings. Where applicable provide for temporary support of the adjoining elements during the construction of the concrete.*

1.6 VARIATIONS TO STRUCTURAL DRAWINGS

Should changes to the design/drawings be requested by the contractor, then the Contractor is to liaise with the Superintendent's representative and allow for all coordination and shop drawings to suit this process and shall be at the Contractors expense.

1.7 PROPRIETARY PRODUCTS

Where proprietary products are nominated on the drawings or in the specification, the Contractor shall provide in writing to the superintendent from the proprietary product manufacturer certification and warranty specifically for its intended purpose and performance for this project prior to the product being ordered or used and that the product is suitable for its intended use in the project. The manufacturer shall visit the site during construction and at the completion of construction to certify in writing that the work has been carried out in accordance with their requirements. It is also the responsibility of the manufacturer to ensure that individual components of the proprietary product have not been substituted with alternative products.

Alternative to Proprietary Products: *An alternative product having the required properties may be offered for review. The Superintendents Representative may in his absolute discretion approve or reject the alternative. No claim shall arise from any rejection.*

Unless otherwise agreed, alternatives shall not be ground for any claim for a variation to cost or time. When offering an alternative for review, provide all available technical information, and any other relevant information requested by the Superintendent's representative. If so requested, the contractor shall obtain and submit reports on relevant tests by an independent testing authority. Failure by the contractor to submit sufficient information to allow the superintendent to review the product will result in its rejection.

State whether the use of the alternative will require alteration to any other part of the Works. If the alternative is accepted, carry out any such alteration without extra charge.

1.8 PRODUCT DATA

Requirement: *Before installation commences provide the following information:*

Manufacturer's data: The Manufacturer's published product data including:

- *technical specifications,*
- *recommendations for installation and maintenance*
- *type test or factory test data.*
- *performance and rating tables*

Testing authorities reports: Test reports certified by an independent testing authority showing compliance with the criteria of specified tests.

Product warranties: The Manufacturer's written statement certifying the product complies with the Specification and is suitable for the intended use.

Approval of installer: If the installation is not by the Manufacturer, and the Manufacturer warranty is conditional on his approval of the installer, the manufacturer's written approval of the specialist installation firm is to be provided.

1.9 CONTRACTORS SUBMISSIONS

General

Where test results and or certificates are required by this specification, the contractor is to supply prior to the issuing of a TTW structural inspection certificate their own certification confirming that all the concrete and reinforcement supplied for the project has been tested in accordance with, and meets the requirements of this specification and the structural drawings.

Non-conforming work

Where a section of works does not comply with the requirements of the specification and drawings (including requirements for inspection and testing) the Contractor shall notify the Superintendent's representative in writing immediately. Following this in a timely manner, the Contractor shall submit a non-conformance report detailing the proposed rectification method to the Superintendent for approval. Where the Superintendent deems that the proposed rectification method and work is to be reviewed and/ or inspected by the relevant consultant(s), this review and inspection shall be at the contractor's expense.

Non-conforming product

Any non-conforming products shall be removed from the site and not used.

1.10 INSPECTION

It is the Contractors responsibility to construct the works in accordance with the specifications and drawings and any inspections by the Superintendent's representative shall not be construed as relieving or relaxing this requirement. The Superintendent and their representatives are not full-time or part-time inspectors for the Contractor and any inspections made are for the Superintendent's purpose only.

Bookings

General Contractor's Foreman is to check all work that is to be inspected for compliance with documents before confirming the booking of the site inspection.

Where inspection by the Superintendent's representative is required or notification to the Superintendent to allow the opportunity to inspect is required, please give a minimum 24 hours notice of required inspection.

Book inspections through TTW. Phone to confirm inspection 4 hours before the appointed time.

Scheduled inspections should be cancelled a minimum of 4 hrs prior to the scheduled time if work will not be ready for inspection. Phone for cancellations, e.g. due to bad weather, as soon as possible, otherwise a charge for inspection may be incurred.

Inspection Times

Hours 8.00 am to 4.00 pm Monday to Friday only.

Generally, no site visits on Saturdays, Sundays or Public Holidays except in emergency situations and by special booking.

Allow sufficient time, and not less than 4 hours prior to concreting, for the carrying out of the inspection.

Revisits

If the area of work is not completed at the scheduled time of inspection or is defective and requires re-inspection, re-inspection shall be at the Contractors expense. Follow normal booking procedures.

The Superintendent's representative cannot wait on site for work to be completed. However, if the Contractor requests the Superintendent's representative to wait on site while work is being completed then this will be charged to the Contractor at an hourly rate.

Documents

Keep a copy of all specifications, current drawings and a drawing register on site.

Keep copies of all Inspection Reports on site.

Alterations

Do not accept verbal approval of alterations.

Superintendent's representative should approve alterations in writing.

Responsibilities

The Contractor's Foreman is to accompany the Superintendent's representative on his inspections.

Any inspection carried out by the Superintendent's representative does not relieve the Contractor of his responsibility to construct the structure or works in accordance with the drawings and specifications.

Certificates by the Superintendent's representative do not relieve the Contractor of his obligation to obtain approvals from authorities having jurisdiction over the works.

1.11 WORKSHOP DRAWINGS

General

Where shop drawings are required by this Contract to be supplied by the Contractor, such shop drawings shall include drawings, diagrams, illustration, schedules, performance charts, brochures and other data prepared by the sub-Contractor, manufacturer, supplier or distributor illustrating some portion of the work.

The Superintendent shall receive shop drawings only for conformity with the design concept of the project and the information given in the Contract Documents. The Superintendents permission to use a separate item will not indicate permission to use any assembly in which the item functions.

A number of copies: 1 copy in Adobe PDF format.

Shop drawings shall be thoroughly checked by the Contractor for completeness and for compliance with the Contract Documents before submitting them to the Superintendent and shall bear the Contractor's stamp of approval certifying that they have been checked.

Shop drawings submitted without this stamp of approval and certification, and shop drawings which, in the Superintendent's opinion are incomplete, contain numerous errors or have not been checked or only checked superficially, will be returned unchecked by the Superintendent for resubmission.

The drawings shall show, in standard Engineering drawing manner, clear and complete details of each assembly, component and connection of the work, together with all information, including surface treatment and erection.

In checking shop drawings the Contractor shall verify dimensions and site conditions and shall check and coordinate the shop drawings of any section or trade with the requirements of other sections or trades whose work is related thereto, as required for proper and complete installation of the work. Corrections required by the Superintendent shall be made and the shop drawings resubmitted until permission is given for their use.

The Engineering drawings shall be read in conjunction with the Architectural drawings and all other relevant drawings and provision made for all fixings noted therein.

Drawings will not be checked dimensionally for the correctness of holes and cleats to suit other building trades. Drawings rejected by the Superintendent's representative shall be corrected and re-submitted before fabrication and shall not constitute a claim for extension of time.

Shop drawings shall be submitted suitably identified and in an orderly sequence to cause no delay to the works. Drawings submitted shall correspond to the size of the contract drawings where practical.

***The time required for examination:** The Contractor shall provide the programme for shop detailing including the number of drawings in each issue making allowance for the examination time required by the Superintendent's representative. Minimum time required: 10 working days.*

***Construction:** Do not commence construction until permission to use the relevant shop drawings has been obtained.*

***Work-as-executed drawings and Survey certificates** required for all works shop drawings and all concrete elements.*

1.12 DESIGN AND CONSTRUCT ELEMENTS

Responsibilities

Where indicated on the structural drawings provide design and documentation for reinforced and post-tensioned concrete elements as follows:

- *In conformance with the performance criteria nominated in the 'Design and Construct' Design Brief.*
- *Independently designed and certified by a professional engineer registered with CPEng. Certificate to be submitted upon completion of design and documentation.*
- *Independently inspected and certified during construction by a professional engineer with CPEng. These inspections must be carried out prior to each concrete pour for design and construct elements and an inspection report submitted prior to engineer leaving the site. Inspection Certificate to be submitted upon completion of construction of all elements.*

2 CONCRETE FORMWORK

2.1 GENERAL

2.1.1 RESPONSIBILITIES

General

Requirement: Provide formwork for the concrete elements documented.

Design and construct the formwork so that the concrete, when cast in the forms, will have the required dimensions, shape, profile, location and surface finish.

Design

Formwork: The design of formwork, other than profiled steel sheeting composite formwork shown on the structural drawings, is the contractor's responsibility. Allow for dimensional changes, deflections and cambers resulting from the following:

- *Im*posed actions.
- Concrete shrinkage and creep.
- Temperature changes.
- The application of prestressing forces (if any).

2.1.2 CROSS REFERENCES

General

Requirement: Conform to the following workstation(s):

- *General* requirements.
- *General* Concrete.
- Concrete *Finishes*.
- Concrete *Reinforcement.*

2.1.3 STANDARDS

General

Formwork design and construction:

- To AS *3610* and AS 3610.1.
- *Workcover* NSW Formwork Code of Practice 1998

Plywood formwork: To AS 6669.

Profiled steel sheeting, including shear connectors: To AS 2327.1.

Reinforced concrete construction: To AS 3600.

2.1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions apply:

- *Formwork:*
  - *Jump formwork: Incrementally moved formwork.*
  - *Lost formwork: Sacrificial formwork left in place.*
  - *Slip formwork: Continuously slipped or moving formwork.*
  - *Table forms: Prefabricated and reusable formwork systems for slabs and beams.*

2.1.5 TOLERANCES

Formwork

Plumb of elements > 8 m high: 1:1000.

Plumb of elements ≤ 8 m high: To AS 3610.1.

Position: Construct formwork so that finished concrete conforms to AS 3600 clause 17.5.2 and as documented in the Formwork dimensional deviations schedule.

2.1.6 SUBMISSIONS

Calculations

Formwork calculations: Submit calculations by a professional engineer registered on NER with CPEng and experienced in formwork design to show that allowable concrete stresses will not be exceeded, and formwork capability will be maintained for the following:

- *Proposed formwork procedures or loadings which differ from those documented.*
- *Props above a floor that do not coincide with the props below.*
- *Undocumented formwork shoring or stripping procedures or allowable loadings from stacked materials.*

Certification

Formwork design certification: For other than profiled steel sheeting composite formwork, submit a certification by a professional engineer registered on NER with CPEng and experienced in formwork design verifying conformance of the design.

Formwork execution certification: Submit certification by a professional engineer registered on NER with CPEng and experienced in formwork design and construction verifying conformance of the completed formwork, falsework, back propping and including the suitability of the formwork for the documented surface finish class.

Execution details

Moveable formwork: Provide the following details on the formwork drawings:

- Table, slip and jump forms: Proposed method and sequence of moving the formwork to provide a *concrete of the documented quality and surface finish.*
- *Slip forms: The average rate of movement.*

Re-shoring: Submit details of any proposed re-shoring.

Surface repair method: Submit details of any proposed surface method before starting repairs. *Surface repairs to be in accordance with AS3610.1 section 5.5.*

Materials

Void formers: Use void formers tested under laboratory conditions. Place formers on damp sand and load with a mass of wet concrete at least equal to the mass of the beams or slabs to be supported. Submit certified test results to verify conformance with the following requirements:

- *Deflection during placing and compaction of the concrete does not exceed beam or slab span/1000.*
- *Additional deflection between the initial set and 7 days does not exceed span/400.*
- *Collapse and loss of load carrying capacity occur not more than 48 hours after flooding with water, creating a void at least 60% of the original depth of the void former.*

Shop drawings

Formwork: Submit shop drawings including details of proposed linings, bolt positions, facings, release agents and, where applicable, re-use of formwork.

Permanent Wall Formwork Systems

Submit names of proposed contractors and details of experience and manufacturer accreditation for installation of the relevant walling systems.

Submit proposed quality assurance procedure for construction including a quality testing plan to verify adequate compaction in walls.

2.1.7 INSPECTION

Notice

Inspection: Give a minimum of 2 days notice and provide necessary access so that inspection may be made of the following:

- *Completed formwork before placing concrete.*
- *Used formwork, after cleaning and before re-use.*

Hold points

- *Contractor's Formwork Engineer's execution certificate (or inspection certificate) confirming the adequacy of formwork and falsework prior to casting concrete.*

2.2 PRODUCTS

2.2.1 MATERIALS

General

Form linings, facings and release agents: Compatible with finishes applied to the concrete.

Lost formwork: Free of timber or chlorides and not to impair the structural performance of the concrete members.

Void formers: Material capable of maintaining rigidity and shape until the concrete has set, capable of withstanding construction loads and non-collapsible on the absorption of moisture.

Underslab insulation: Material capable of maintaining rigidity and shape during construction and for the life of the structure. Materials to be polystyrene with a minimum compressive strength of 165kPa and class VH complying with AS1366.

Profiled steel sheeting composite formwork

Type of steel sheeting formwork to be as noted on the structural drawings. Any alternatives must be submitted for review and approval prior to construction.

Material: Hot-dipped zinc-coated sheet steel to AS 1397.

Minimum steel grade: G550.

Zinc coating weight:

- Z350: 350 g/m2

Accessories: Adopt material and corrosion protection to match the profiled steel sheeting.

Plywood formwork

Material: Plywood sheeting to AS 6669.

Grade: Use appropriate grade for the documented design dimensions, loading and surface quality.

Joints: Seal the joints consistent with the documented surface finish class.

Tolerances: To AS 3610.1 Section 3.

Permanent Wall Formwork Systems

Where permanent wall formwork systems are specified they are to be installed strictly in accordance with manufacturers specifications and details documented on the contract drawings.

2.3 EXECUTION

2.3.1 PREPARATION

Substrate

Cleaning: Before placing concrete remove free water, dust, debris and stains from the formwork and the formed space.

Scabble all construction joints to remove all laitance and uncompacted concrete unless otherwise noted on the drawings.

2.3.2 CONSTRUCTION

General

Requirement: Conform to the CONCRETE FINISHES worksection.

Bolt hole filling

Removable bolts: Remove tie bolts without damaging the concrete.

Formwork tie bolts left in the concrete: Position more than 50 mm from the finished surface.

Bolt hole filling: Provide material with durability and colour matching the concrete.

Recessed filling: Fill or plug the hole to 6 mm below the finished surface.

Corners

Work above ground: Chamfer at re-entrant angles, and fillet at corners.

The face of bevel: 25 mm.

Drip Grooves

Provide drip grooves or alternative form to external slab soffits adjacent vertical concrete surfaces to architects details. If none show, submit a proposal for approval.

Embedments

Fixing: Fix embedments through formwork to prevent movement, or loss of slurry or concrete, during concrete placement.

Openings

General: In vertical forms provide form openings or removable panels for inspection and cleaning, at the base of columns, walls and deep beams.

Access: For thin walls and columns, provide access panels for placing concrete.

Release agents

Application: Before placing reinforcement, apply a release agent to form linings and facings, *except where the concrete is to receive an applied finish for which there is no compatible release agent. Do not allow the release agent to puddle.*

Slip formwork

Provision for inspection: Provide access below the movable formwork, from which surface treatment and inspection may be carried out.

Profiled steel sheeting composite formwork

Fixing: Fix sheeting to structural steel supports with puddle welds, or with welded shear studs in composite construction. If alternative fixing details proposed submit details for review and approval prior to construction.

Construction to be in accordance with manufacturer's recommendations where the requirements of the relevant Australian Standards are less stringent.

Propping: Provide temporary propping to the manufacturer's requirements and at locations indicated on structural drawings during concrete placing and curing.

Steel linings

Rust: Clean off any rust and apply rust inhibiting agent prior to reuse.

Visually important surfaces

Surface finish classes 1, 2 or 3: Set out the formwork to give a regular arrangement of panels, joints, bolt holes, and similar visible elements in the formed surface.

Void formers

Protection: Keep void formers dry until use, install on a firm level surface and place reinforcement and concrete with minimum delay.

Permanent Wall Formwork Systems

Installation: In accordance with manufacturer's specifications and details documented in the drawings. To be installed by an approved contractor experienced in the installation of the product including reinforcement and concrete placing. All temporary propping is the contractor's responsibility.

Concrete: The concrete mix is to be in accordance with the wall manufacturer's recommendations and must satisfy the other performance characteristics noted in the specification and on the structural drawings.

Concrete Compaction: The Contractor must ensure that adequate compaction is achieved in all walls. Testing is to be carried out to verify compaction. Carry out testing in accordance with manufacturer recommendations and the following as a minimum;

- All walls to be confirmed with hammer tap testing following concrete pour to verify no voids evident at the base of the walls and at corners

- 10% of walls are to be scanned to verify adequate compaction. Walls are to be selected at random on a set of plans and submitted to the project engineer for review. Locations to be scanned must include a selection of walls at corners and more heavily reinforced areas. When locations are approved, scanning can commence. Scanning to be carried out before the next wall level above is poured. Submit scan report with summary confirming no voids or notify of the location of voids. If areas of voids are found this will require further scanning of walls and possible destructive testing. Wall rectifications proposals are to be submitted and approved by the project engineer prior to the works being carried out.

Defective formwork

If formwork fails to meet the requirements of the contract, any concrete which has been cast in it may be rejected. In that case, remove the rejected concrete, form construction joints, reconstruct the formwork and recast the concrete. Submit proposals for approval prior to recasting concrete.

2.3.3 COMPLETION

Formwork removal

Extent: Remove formwork, other than profiled steel sheeting composite formwork and lost formwork, including formwork in concealed locations.

Timing: Do not disturb formwork until the concrete is hardened enough to withstand formwork movements and removal without damage.

Stripping:

- General: To AS 3600 where it is more stringent than AS 3610.1.

- Vertical formwork: To AS 3610.1 Appendix C Table C1.

- Multi-storey work: Remove formwork without disturbing props supporting succeeding floors.

- Post-tensioned concrete: Remove formwork supporting post-tensioned concrete members to AS 3600 clause 17.6.2.7.

Curing:

If formwork is stripped before the minimum curing period for the concrete has elapsed, continue curing the exposed faces as soon as the stripping is completed.

Loading before stripping

Unless noted otherwise do not erect masonry walls or other permanent loading on the structure while it is still supported by formwork.

Permanent Wall Formwork Systems

Provide contractor certification stating as a minimum:

- *All wall systems have been installed to the manufacturer's specification and the drawings details including, but not limited to, bottom tracks, wall thickness, wall type, concrete strength and reinforcement.*
- *All walls have been constructed with adequate compaction of concrete to ensure no voids and testing has been carried out to verify all concrete is homogeneous with no voids.*

The contractor is to notify the superintendent if any walls are found to have inadequate compaction. Further testing and rectification methods are to be submitted for approval prior to any repair work being carried out.

2.4 SELECTIONS

2.4.1 SCHEDULE

Table 2-1: Formwork dimensional deviation schedule

Dimension or measurement	Location or element	Maximum Deviation (mm)
EXPOSED ELEMENT	*Class 2 surface*	*15*
CLADDED ELEMENT	*Class 3 surface*	*20*
UNDERGROUND	*Class 4 surface*	*25*

3 CONCRETE REINFORCEMENT

3.1 GENERAL

3.1.1 RESPONSIBILITIES

General

Requirement: Provide concrete reinforcement, as documented.

3.1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- General requirements
- General Concrete.
- Concrete in situ.

3.1.3 STANDARDS

General

Reinforced concrete construction: To AS 3600.

3.1.4 TOLERANCES

General

Fabrication and fixing: To AS 3600 clause 17.2.

Reinforcement position: To AS 3600 clause 17.5.3.

3.1.5 SUBMISSIONS

Execution details

Reinforcement: Submit the following prior to casting concrete:

- General: Details of any proposed changes to documented reinforcement.
- Damaged galvanizing: Details of proposed repair to AS/NZS 4680 Section 8. Where allowable limits are exceeded, replace the galvanised reinforcement.
- Mechanical bar splices: Details and test certificates for each size and type of bar to be spliced.
- Provision for concrete placement: Details of spacing or cover to reinforcement that does not conform to AS 3600. *If the spacing or cover of reinforcement does not comply with project documentation give notice.*
- Splicing: Details of any proposed changes to documented requirements.
- Welding: Details of any proposed welding of reinforcement.

Products and Materials

Reinforcement strength and ductility: Submit type-test reports to verify conformance to AS 3600 Table 3.2.1 for each reinforcement type.

Certification

The reinforcement material supplier must be certified by the Australian Certification Authority for Reinforcing Steels Ltd for the supply of reinforcement material. Submit current certificate.

Refer http://www.steelcertification.com/search1.html for current certificate holders.

3.1.6 INSPECTION

Notice

Inspection: Give a minimum of 1 working days notice and provide necessary access so that inspection may be made of the following:

- Cores and embedments fixed in place.
- Reinforcement fixed in place, with formwork completed.

Hold points

- *Reinforcement fixed in place.*

Do not proceed until Superintendent's representative's inspection report is received and all items that require rectification are complete.

NB: To be included in the contractor's quality assurance submission. Provide written records showing that all of the defects identified have been rectified.

3.2 PRODUCTS

3.2.1 MATERIALS

Steel reinforcement

Standard: To AS/NZS 4671.

Shape, Ductility class and Strength grade as noted on the structural drawings.

Surface condition: Free of loose mill scale, rust, oil, grease, mud or other material which would reduce the bond between the reinforcement and concrete.

Tie wire

General: Annealed steel 1.25 mm diameter (minimum).

External and corrosive applications: Galvanized.

3.3 EXECUTION

3.3.1 CONSTRUCTION

General

Extent: Supply and fix reinforcement, including the necessary tie wires, support chairs, spacers, welding and accessories.

Dowels

General: Provide each dowel in one piece, straight, with square cut ends free from burrs.

Finish: Dowels to be galvanised unless noted otherwise on the documentation.

Fixing: If a dowel has an unpainted half, embed in the concrete placed first.

Dowels must be securely fixed to a reinforcement cage to ensure they remain in place during construction.

Tolerances:

- Alignment: 1:150.
- Location: ± half the diameter of the dowel.

Grade: 250 N.

Rejection: Dowels and tie bars are liable to rejection if they become distorted or displaced beyond the alignment tolerances during construction. Do not remove and replace dowels in pre-formed holes for any reason including to assist in form stripping. Submit rectification proposals for defect dowels for review and approval.

Cover

Concrete cover generally: To AS 3600 clause 4.10.

Concrete cover for structures for retaining liquids: To AS 3735 Clause 4.4.

Concrete cover for residential ground slabs and footings: To AS 2870.

Supports

Proprietary concrete, metal or plastic supports: To AS/NZS 2425, AS 3600 and as follows:

- Able to withstand construction and traffic loads to maintain the clear covers to reinforcement from concrete surfaces as noted on the drawings.
- With a protective coating if they are ferrous metal, located within the concrete cover zone, or are used with galvanized or zinc-coated reinforcement.
- Spacing:
  - Bars: ≤ 60 diameters.
  - Mesh: ≤ 600 mm.

Supports over membranes: Prevent damage to waterproofing membranes or vapour barriers. If appropriate, place a metal or plastic plate under each support.

Projecting reinforcement

Protection: If a starter or other bars extend beyond reinforcement mats or cages, through formwork or from cast concrete, provide a plastic protective cap to each bar until it is cast into later work.

Tying

General: Secure the reinforcement against displacement at intersections with either wire ties or clips. Bend the ends of wire ties away from nearby faces of formwork or unformed faces to prevent the ties projecting into the concrete cover.

Beams: Tie stirrups to bars in each corner of each stirrup. Fix other longitudinal bars to stirrups at 1 m maximum intervals.

Bundled bars: Tie bundled bars in closest possible contact. Provide tie wire at least 2.5 mm diameter and spaced not more than 24 times the diameter of the smallest bar in the bundle.

Columns: Secure longitudinal column reinforcement to all ties at every intersection.

Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections.

Exposed concrete soffits and edges

Areas of exposed concrete soffits and edges (such as balconies) to use suitable plastic or concrete chairs to support reinforcement. Do not use metal support chairs.

Bending

General: To AS 3600.

Bending of bars only permitted in locations shown on the structural drawings. Do not heat bars to be bent. Do not bend galvanised bars.

Only N12 or N16 quenched and self-tempered reinforcement may be used as pullout bars, using tools that maintain minimum radius pin diameters given in AS 3600 and using a single smooth bending action. Cast the bar with the bend kept clear of the concrete. Do not use heat to bend bars.

Bending of bars where required must also be to manufacturer's approval and recommendations to ensure properties of reinforcement are not adversely affected.

Starter bars

Prior to the concrete placing, all starter bars shall be positioned and secured by the Contractor, to ensure correct location and alignment of bars. Costs associated to redesign and/or relocate starter bars that have not been positioned and secured adequately shall be at the Contractor's expense.

Welding

General: Do not weld reinforcement;

- *except where documented, or submitted and approved;*
- *within 75 mm of a bend with an internal radius < 12 bar diameters; or*
- *at points which have been re-bent.*

Standard: To AS 1554.3.

***Certificate of compliance:** Obtain from the manufacturer and furnish a certificate of compliance with the relevant standard AS 4671. Alternatively, furnish test certificates from an independent testing authority. All*

reinforcement welds must be certified and approved by the above procedure before concrete works commence.

4 CONCRETE POST-TENSIONED

4.1 GENERAL

4.1.1 RESPONSIBILITIES

General

Requirement: Provide bonded post-tensioning of concrete as documented.

Design

Post-tensioning: To AS 3600.

Requirements in addition to AS 3600:

Concrete cover for structures retaining liquids: To AS 3735.

Safety

A post-tensioned strand when tensioned contains a considerable amount of stored energy. In the rare event of a strand breaking, serious injury to persons and damage to equipment can be caused by the sudden release of energy. Therefore, reasonable precautions shall be taken when working with or near strands which have just been or are in the process of being tensioned or that have been tensioned but not yet grouted. To be included in the Contractor's work method statement.

4.1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- General requirements
- General Concrete
- Concrete reinforcement
- Concrete in situ.

4.1.3 STANDARDS

General

Post-tensioning: To AS 3600.

Strand, bar and wire: To AS 4672.1

INTERPRETATION

Definitions

General: For the purpose of this worksection the definitions are given in AS/NZS 1314 and the following apply:

- Anti-burst reinforcement: Reinforcement cage surrounding anchorages to control the tensile bursting stresses.
- *Tendon: the assembly of anchorages, duct and strand or bar*

- *Extension: elongation of strand or bar*

4.1.4 SUBMISSIONS

Calculations

Post-extensions calculations: Submit the following:

- Calculations of tendon jacking forces, theoretical extensions and losses for each stressing stage. *Theoretical extensions are to be submitted for approval as a separate document with the post-tensioning shop drawings.*

- Amount of draw-in expected in seating anchorages, friction along with tendon (wobble) coefficient and friction curvature coefficient for tendons and duct-forming material.

Execution details

Post-tensioning: Submit the following:

- Details of the proposed post-tensioning system tested and certified to AS/NZS 1314, including performance test certificates for each type and size of Anchorage and coupler.

- Safe work method statements including the name and contact details of the subcontractor.

- Details of proposed gauging, stressing and grouting equipment. Submit current calibration certificates for tensioning and tension measuring equipment.

- Concrete strength early age test results.

- Calculated tendon extensions (theoretical extensions) at final stressing and for staged stressing if required, before stressing operations begin.

Materials

Grout: Submit proposed grout mix and certified test results (including grading, proportions, compressive strength, shrinkage and additives if any).

Epoxy grout: If required, submit the proposed formulation.

Duct-forming material: Submit samples of the proposed material.

Prestressing steel: Submit test certificates to AS/NZS 4672.2 for every delivery of strand, bar or wire proposed. The reinforcement material supplier must be certified by the Australian Certification Authority for Reinforcing Steels Ltd (ACRS) for the supply of reinforcement material i.e. strand. Submit current certificate. All certificates are to be submitted prior to delivery of materials on site.

Records

Post-tensioned concrete: submit the following:

- Post-tensioning record.
- Post-tensioning stressing schedule.
- Post-tensioning grouting record.

Shop drawings

Post-tensioned drawings: Submit shop drawings showing the following:

- Profiles, sizes and details of tendons, tendon numbers, anchorages, ducts, duct formers, splicing, sheathing, end block reinforcement and other associated components.

- Stressing requirements including a sequence of stressing, jacking forces and the basis of assumed loss calculations.

- Number, size and position of grout openings, vents and drain holes in the ducts.

4.1.5 INSPECTION

Notice

Inspection: Give a minimum of two working days' notice and provide access so that inspection may be made of the following:

- Tendons fixed in place before concreting.
- Commencing initial, incremental or final stressing of tendons.
- Grouting and cutting tendons
- Stressing of bars
- Grouting of anchorage pockets.

Hold points

- Approval of proposed post-tensioning system tested to AS/NZS 1314 before work begins.
- Tendons fixed in place.
- Approval of actual post-tensioning extensions, before tendons, are cut off or made inaccessible for stressing.
- Cut strands at anchorages prior to grouting anchorage recess.

Do not proceed until Superintendent's representative's inspection report is received and all items that require rectification are complete.

NB: To be included in the contractor's quality assurance submission. Provide written records showing that all of the defects identified have been rectified.

Superintendent to be notified to allow the opportunity for inspection if required.

4.2 PRODUCTS

4.2.1 GROUT

Grout properties

Standard: To AS 3600 clause 17.1.8.

Maximum shrinkage: 1% by volume after 24 hours.

Maximum water:cement ratio: 0.45 (by weight).

Compressive strength: 32 MPa at 7 days.

Minimum compressive strength (75 mm cube): 50 MPa at 28 days.

Grout materials

Fine aggregates: Do not use aggregates for post-tensioning grout unless the cross-sectional area of ducts is 5 times the cross-sectional area of the tendon.

Cement: To AS 3972 and free from calcium chloride and less than two months old.

Admixtures: To AS 1478.1. Include an anti-bleed additive.

Fly ash: To AS 3582.1 and proportioned according to early strength requirements.

Water: To AS 1379. Use clean water, free from oil, acid, alkali, organic or vegetable matter and not more than 500 mg/l of chloride ions.

Epoxy Grout

Type: Commercial epoxy formulation of compressive strength exceeding 40 MPa.

4.2.2 DUCTS

Material

Robustness: Provide ducts with sufficient strength to retain their shape, resist damage during construction, and prevents deterioration or electrolytic action by the entrance of cement paste or water from the concrete.

Wall thickness: To allow for abrasion during stressing of the tendon.

Size: To allow feeding of tendons and grouting. Refer to any specified requirements noted on the structural drawings.

4.2.3 STEEL

Tendon material

Prestressing steel: Type and grade of strand, wire or bar to AS 4672.1.

Type: 7 wire, stress relieved, high tensile steel and strand.

Quality: Make sure tendons have no nicks, damage or foreign matter such as mud and dirt. Inspect at delivery and store the prestressing steel on supports clear of the ground.

Straightening of tendons: Not permitted. Supply tendons in coils large enough to self straighten.

High tensile steel bars: Inspect individually and reject any bars with surface imperfections more than 0.40 mm deep.

Other steel

Anchor plates: Hot-dip galvanized to AS/NZS 4680.

Anchorages: To AS/NZS 1314.

Reinforcement: To AS/NZS 4671.

4.2.4 CONCRETE

Materials

Requirement: Conform to the Concrete in-situ worksection.

Properties

Concrete mix and supply: Conform to AS 1379.

Early strength requirements:

- For initial stressing stage: 9MPa (18-36hours)
- For final stressing stage: 22MPa (4-7 days), 25MPa for 15.2mm strand

Sampling and testing

Sampling: To AS 1012.1.

Testing: To the AS 1012 series.

Testing Authority: Must be NATA accredited for relevant testing.

Sampling frequency: For each post-tensioned element, take at least 3 samples for testing at the age of each intended stage of stressing plus at least 3 reserve samples. Take at least one sample every 2 batches.

Sampling locations: Distribute sampling locations randomly including anchorage areas and the final concrete placement area. Reference the structural element from which the sample is taken.

Curing: Site cure all test cylinders for early age testing. For slab samples, maintain exposure to the same weather and temperature by curing the samples on the adjacent deck. Leave test cylinders on site until the morning of the test.

4.3 EXECUTION

4.3.1 INSTALLATION

General

Protection: Protect post-tensioning tendons, anchorages, ducts, supports and grout from damage or contaminants, including from swarf, loose grease, oil and paint.

Tolerances: To AS 3600 clause 17.5.3.

Minimum concrete cover: As documented.

Post-tensioning record: Provide details of the following:

- Concrete mix.
- Concrete placing and curing, including dates.
- Placing of reinforcement and tendons.
- Dates of post-tensioning operations.
- Name of the operator.
- Identification of tendons.
- Stressing method (single or double end, monostrand or multistrand).
- Early age test result for strength.
- Tendon breakage and non-conformance reports.

Ducts

Standard: To AS 3600 clause 17.3.

Placement: Locate and secure to positions, as documented.

Supports: Support and positively fix support chairs at regular intervals. Protect from collapse and other damage. Where preformed permanent metal formwork is utilised fix chairs using light guard metal strap screwed to ribs or manufacturers proprietary systems.

Sheathing: If ducts are formed with sheaths, provide sheathing material capable of transferring the tendon stresses into the body of the concrete.

Sequence: Assemble tendons on site by installing strand, bar or wire within the duct before concreting.

Damage: If damaged, repair ducts as follows:

- Small holes: Waterproof adhesive tape.
- Larger holes: Metal strips wrapped around the duct, with 100 mm overlap and sealed by waterproof adhesive tape.

Crossover points: If ducts running in opposite directions clash, consult the superintendent's representative. Do not relocate ducts without approval.

Clashes: Do not modify tendon profiles where clashes with conduits or reinforcement occur without prior written approval from the Superintendent

Anchorages

Anti-burst reinforcement: As documented. Post Tensioning subcontractor to confirm specified reinforcement meets minimum system requirements and provide additional reinforcement if and as required to satisfy requirements.

Anchorage recesses and grout tubes must be located to ensure they are not visible at the completion of the project unless noted otherwise.

Tendons

Care: Do not weld tendons. Do not expose tendons to sparks, ground current or excessive temperatures such as flame or oxyacetylene cutting. Provide shelter for strand coil to minimise direct exposure to weather.

Grout fittings and ducts: For bonded construction, protect from collapse and other damage.

Conformance: Provide tendons as documented.

Protection: Make sure tendons are not displaced by heavy and prolonged vibration, the pressure of the concrete being placed, workmen or construction traffic.

Temperature: Maintain concrete around grouted tendons at 5°C or more for at least 3 days after grouting.

Soffit marking: Mark the tendon locations.

Staples: Remove staples from the slab, band or beam soffits.

Roofs: Grout openings for watertight post-tensioned roofs and Warehouse floors are to be from side forms, not the top of slabs. Where membranes are used for a water tightness of post-tensioned roofs, grout openings may be permitted from top of the roof.

Couplers

Standard: To AS/NZS 1314 Section 5.

Cover: Position and fix couplers to provide adequate cover.

Laying: Give coupled strands the same lay to prevent rotation.

Grout openings

Provision: Provide grout openings, vents and drain holes as documented, including at each end, and at high points except where the tendon curvature is small and the tendon is relatively level.

Removal: Remove protruding vents and drains after the grout has set and rectify to match surrounding surfaces.

Maximum spacing: 15 m.

Tubing: Provide plastic or other non-metallic material tubing to grout openings.

- Protection: Protect tubing from accidental damage during grouting and other construction operations.
- Fixings: Fasten tubing to the duct and make sure joints are airtight.

4.3.2 EQUIPMENT

Gauges and jacks

Standard: To AS 1349.

The maximum error in pressure indication: 1% of the maximum scale (concentric) value.

Period: Calibrate gauges and jacks at intervals not exceeding 6 months, after re-sealing of jack or gauge, or if any inaccuracy in the gauges is suspected.

Sets: Calibrate and use jacks and gauges as a set.

Grouting pumps

Type: Positive displacement with an outlet pressure of at least 1.0 MPa.

Capabilities: Include:

- Pumping the grout at the required rate.
- Seals: Make sure pumps are sealed to prevent oil and air contamination of the grout.
- Flow meters and pressure gauges used during air testing or grouting: To a NATA accredited laboratory calibration.

4.3.3 STRESSING

General

Post-tensioning: To AS 3600 clause 17.3.4.5.

Concrete strength: Complete early age tests before stressing.

Stressing procedure: Carry out stressing after age tests results indicate concrete has attained the required strength.

Stressing stages: Unless specifically documented stressing stages are to be as follows;

- Initial stressing stage: 25% of the stressing force is applied when the concrete strength reaches 9 MPa.

- Final stressing stage: 100% of stressing force is applied when the concrete strength reaches 22 MPa for 12.7 mm diameter strands and 25 MPa for 15.2 mm diameter strands. (Usually between 4 and 7 days based on site cured test cylinders).

Notification: Give notification before final stressing.

Multiple strands: Stress all strands equally and simultaneously.

Clearance: Use extended stressing stools either straight or deflected if clearances for jacks are insufficient.

Tendon extensions: To allow for variations in the duct friction characteristics, modify calculated tendon extensions with relevant material data. *If calculated tendon extensions are modified these must be resubmitted for approval before site extensions are measured and submitted. The reasons for changes and relevant material characteristics must be noted for review.*

Submit stressing records within 24 hours to the Superintendent. Do not proceed with any cutting or grouting of tendons until the Superintendent's approval has been given. If strands do not achieve the required extensions the contractor shall be required to restress them, possibly with a lubricant. If the strands continue to not achieve the required extensions, or if extension results are misplaced or strands are cut without instruction, the slab would be liable to rejection and all the costs associated with achieving compliance shall be borne by the Contractor.

Measurement of site extensions

Marking: Mark strands after wedges are installed and before initial stress.

Slip: Check markings whilst stressing to make sure there is no slip of strands.

Stress records: Measure gross extensions on site and include initial and final stress extensions.

Site extensions: Submit the site extensions on the same day as measured for review and approval by the structural engineer. *Do not cut tendons until approval has been received in writing from the Superintendent's representative.*

Non-conformance: If the difference between theoretical and measured extensions is greater than 10%, provides an explanation of the cause. Where no reasonable explanation exists (eg longer or shorter tendon placed on site) allow to restress tendons to achieve required extension.

Initial Force: If tendons are not marked at nil load, apply initial force or pressure if tendons are marked for measurement of elongations.

Cutting tendons: Do not cut tendons until the actual extensions are approved.

Re-stress or de-stress: Adjust stress in tendons if necessary, after the theoretical and site extensions are compared.

Records

Post-tensioning stressing schedule: Provide a stressing schedule, including the following information.

- Setting out, elongation and jacking forces.
- Identification number of dynamometers, gauges, pumps and jacks.
- Initial stressing force (or pressure) when tendons are marked for measurement of elongation, but not marked at nil load.
- Force applied (dynamometers).
- Pump or jack pressure and area of the piston.
- Elongation before anchoring.

- Elongation remaining after anchoring.

4.3.4 GROUTING DUCTS

Preparation

Water: Blow out any water within the duct with compressed oil-free air and keep the ducts dry until grouting starts.

Rectification: Before grouting, rectify any leaks, blockages or holes.

Grouting

Timing: Grout tendons as soon as practicable after stressing but not less than 48 hours and for corrosive environments within 3 weeks or as documented.

Procedure: Prevent damage to grout vents and fittings during grouting. Do not use manually powered grouting machines. Completely fill the duct during grouting. Inject grout into voids between tendons, ducts and anchorages, until grout flows from vents without air bubbles. Close vents as they fill, progressively in the direction of flow. If there is a blockage or interruption, completely flush grout from the duct using water.

Grout caps: Provide at each anchorage and seal for grouting and venting operations.

Grout pressure

Duct Sealing: Seal the duct on completion of grouting at a suitable pressure. Fit pressure tap connections to each duct for this purpose.

Testing of grout

Bleeding: Test to ASTM C940.

Acceptance criterion: No more than 2% bleed with all bleed water being re-absorbed within 24 hours.

Records

Post-tensioning grouting record: For each duct grouted, provide the following:

- Duct and tendon identification.
- Grouting date.
- The composition of the grout (water: cement ratio, admixtures).
- Grout tests, including air tests of ducts.
- Details of grouting (including pumping or supply interruptions, topping up).

Protection

Grout ducts: Do not subject grouted ducts to shock, vibration, construction traffic or similar loads until 24 hours after completion of grouting.

Voids

Voids within ducts at anchorages: If voids occur, fill using vacuum injected grouting or provide an alternative proposal.

4.3.5 COMPLETION

Cutting tendons

Trimming: Use high speed cutting discs. Cut within 50 mm of anchor block.

Permanent protection

Tendons and anchorages: On completion of stressing and grouting, permanently protect anchorage and tendons. Provide covers as documented but not less than 40mm over the cut tendons when the recesses are concreted. Keep anchorages free of foreign matter (rust, grease, oil, paint).

Anchorage recesses or pockets are to be fully grouted with a polymer modified repair mortar unless noted otherwise on structural drawings. Prepare the concrete surface to be grouted to manufacturer's details.

Or

Anchorage recesses or pockets are to be protected by the method shown below in ***Error! Reference source not found.*** *unless noted*

Removal of formwork

Formwork removal: Remove formwork supporting post-tensioned members to AS 3600 clause 17.6.2.7.

5 CONCRETE IN SITU

5.1 GENERAL

5.1.1 RESPONSIBILITIES

General

Requirement: Provide concrete in situ, as documented.

Performance

Requirements:

- Conforming to the design details and performance criteria.
- Satisfying the quality and inspection requirements.

5.1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- General requirements
- General Concrete
- Concrete Post-tensioned.
- Concrete Formwork.
- Concrete Reinforcement.
- Concrete Finishes.

5.1.3 STANDARDS

General

Reinforced concrete construction: To AS 3600.

Specification and supply of concrete: AS 1379.

Concrete structures for retaining liquids: To AS 3735.

Design, installation and testing of post-installed and cast-in fastenings: To AS 5216.

5.1.4 INTERPRETATION

General: For the purposes of this worksection the following definitions apply:

- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Average ambient temperature: Average value of the daily maximum and minimum ambient temperatures over the relevant period at a site.
- Batch: A quantity of concrete containing a fixed quantity of ingredients and produced in a discrete operation *i.e. a truck agitator*.
- Concrete class:
  - Normal: Concrete which is specified primarily by a standard compressive strength grade and otherwise conforming to with AS 1379 clause 1.5.3.

  - Special: Concrete which is specified to have certain properties or characteristics different from, or additional to, those of normal-class concrete and otherwise conforming to with AS 1379 clause 1.5.4.
- Early age strength: A mean compressive strength at 7 days exceeding the values shown in AS 1379 Table 1.2.
- Green concrete: Concrete which has set but not appreciably hardened.
- Production assessment: An assessment procedure for concrete specified by strength grade, carried out by the supplier on concrete produced by a specific supplying plant and based on the statistical assessment of standard compressive strength tests on concrete.
- Project assessment: An assessment procedure for concrete specified by strength grade, specified at the customer's option, which provides additional test data for the statistical assessment of concrete supplied to a specific project.
- Sample: A physical example that illustrates workmanship, materials or equipment, and establishes standards by which the work will be judged. It includes samples, prototypes and sample panels.
- Specimen: A portion of a sample which is submitted for testing.
- Weather:
  - Cold: Ambient shade temperature less than 10°C.
  - Hot: Ambient shade temperature greater than 30°C.

5.1.5 SUBMISSIONS

Design

Loading: Submit details of proposed construction systems, loads and procedures, including propping and re-shoring.

Execution details

Concrete: Submit proposals for mixing, placing, finishing and curing concrete including the following:

- Changes to the concrete mix.
- Curing and protection methods.
- Curing period for low-pressure steam curing.
- Cutting or displacing reinforcement, or cutting or coring hardened concrete.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Placing under water.
- Sequence and times for concrete placement, and construction joint locations and relocations.
- Site storage, mixing and transport methods and equipment, if applicable.
- Temperature control methods.
- Sequence of concrete placement: Submit details of any proposed sequential placement of slab segments.
- Sawn joints: Submit details of proposed methods, timing and sequence of sawing joints.

Pre-mixed supply delivery dockets: For each batch, submit a docket listing the information required by AS 1379, and the following:

- For special class performance concrete: Documented performance and type of cement binder.
- For special class prescription concrete: Details of mix, additives, and type of cement binder.
- Method of placement and climate conditions during the pour.
- Name of concrete delivery supervisor.
- Project assessment carried out each day.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.

- The total amount of water added at the plant and the maximum amount permitted to be added at the site.

Materials

Product conformity: Submit current assessments of conformity, as appropriate, as follows:

- Certificate of conformity by a JAS-ANZ accredited the third party.
- Report by a NATA accredited laboratory describing tests and giving results which demonstrate that the product conforms.

Concrete mixes: Submit details, for each grade and type of concrete including any proposed use of special-purpose cement types.

Curing compounds: Submit details of any proposed liquid membrane-forming curing compound, including the following:

- Certified test results for water retention to AS 3799 Appendix B for liquid membrane forming compounds.
- Evidence of compatibility with concrete, and with applied finishes including toppings and render, if any, including methods of obtaining the required adhesion.
- For visually important surfaces, evidence that an acceptable final surface colour will be obtained.

Admixtures: Submit details of any proposed admixtures, including the following:

- Brand name.
- Place of manufacture.
- Basic chemical composition.

Samples

Coloured concrete: Submit sample blocks of coloured concrete produced using the proposed mix and method before casting the final concrete as follows:

- Number: 4.
- Size (nominal): 300 x 300 x 50 mm.

Shop drawings

Cores, fixings and embedded items: Submit the proposed locations, clearances and cover and show any proposed repositioning of reinforcement.

Subcontractors

Pre-mixed supply: Submit names and contact details of proposed pre-mixed concrete suppliers and alternative source of supply in the event of a breakdown of pre-mixed or site mixed supply.

Tests

Other tests: Submit results, as follows:

- Concrete compressive strength test results to AS 1012.9.
- Other concrete properties. Test results as documented in the Tests schedule.

Fabrication

Do not commence fabrication until approval to use the relevant shop drawings has been obtained from the Superintendent's representative.

Work-as-executed drawings

Required for all workshop drawings

Survey certificates

Required for all concrete elements

5.1.6 INSPECTION

Notice

Inspection: Give a minimum of 1 working days notice so that inspection may be made of the following:

- Base or subgrade before covering.
- Membrane or film underlay installed on the base or subgrade.
- Completed formwork and reinforcement, tendons, cores, fixings and embedded items fixed in place.
- Concealed surfaces or elements before covering.
- Commencement of concrete placing.

5.2 PRODUCTS

5.2.1 MATERIALS

General

Stockpile: If uniform, consistent colour is documented, stockpile sand, cement and aggregates.

Aggregates

Standard: To AS 2758.1.

Cement

Standard: To AS 3972.

Age: Less than 6 months old.

Storage: Store cement bags under cover and above ground.

Supplementary Cementitious Materials:
- Flyash: To AS/NZS 3582.1
- Slag: To AS 3582.2
- Amorphous Silica: To AS/NZS 3582.3

Water

Standard: To AS 1379 clause 2.4.

Requirement: Clean, free from oil, acid, alkali, organic or vegetable matter and including not more than 500 mg/l of chloride ions.

Polymeric film underlay

Vapour barriers and damp-proofing membranes: To AS 2870 clause 5.3.3.

Chemical admixtures

Standard: To AS 1478.1.

Curing compounds

Standard: To AS 3799.

5.2.2 CONCRETE

Properties

Concrete mix and supply: Conform to the following:

- Normal-class: To AS 1379 clause 1.5.3.
  - Properties: As documented in Table 5-3: Concrete Properties Schedule – Performance.
- Special-class: To AS 1379 clause 1.5.4.
  - Properties: As documented in Table 5-3: Concrete Properties Schedule – Performance.

Coloured concrete

Standard: To AS 3610.1.

Where coloured concrete is specified in the architectural documentation use a concrete mix with mineral oxides and/or coloured cement to achieve the same performance as the mix and method to be used in the works.

5.2.3 TESTING

General

Test authority: NATA registered laboratory.

Reports and records of test results: To the relevant parts of the AS 1012 series. Keep results on site and made available for review.

The contractor shall review all test records and notify the Superintendent's representative of tests that do not meet early age strength, 7 days and the 28 days requirements as soon as they are known. Only submit a copy of test reports that do not meet the requirements. The contractor shall have on site and on the online centralised data management system (where used for a project) an up to date file of test records that can be viewed at any time by the superintendent or their representatives.

Assessment process of test results

Standard: To AS 1379.

Method of assessment: Project assessment.

Sampling

Method of sampling: AS 1012.1.

Sampling locations: To AS 1012.1 and the following:

- Slump tests: On-site, at the point of discharge from the agitator.
- Compressive strength tests: Spread the site sampling evenly throughout the pour.
- Sampling locations are to be referenced to specific locations of the concrete element

The frequency of sampling: To AS 1379 Sections 5 and 6 and the following:

- Slump tests: Take at least one sample from each batch.
- Compressive strength tests: To Table 5-1: Project assessment strength grade sampling table. Test at least two specimens from each sample.

Table 5-1: Project assessment strength grade sampling table

Number of batches for each type and grade of concrete per day	Minimum number of samples	
	Columns and loadbearing wall elements per batch	Other elements per day
1	1	1
2 to 5	1	2
6 to 10	1	3
11 to 20	1	4
each additional 10	1	1 additional

Making and curing of specimens

General: To AS 1012.8.1 and AS 1012.8.2.

Specimen size:

- Aggregate size ≤ 20 mm: Nominally 200 x 100 mm diameter.
- Aggregate size > 20 mm: Nominally 300 x 150 mm diameter.

Test methods

General: To the relevant parts of the AS 1012 series.

Acceptance criteria:

- General: As documented in Table 5-3: Concrete Properties Schedule – Performance.
- Early age compressive strength: As documented in **Error! Reference source not found.**.

Slump tests: Assess slump for every batch. Perform a slump test on each strength sample.

Drying shrinkage at 56 days: To AS 1012.8.4 and AS 1012.13.

Other concrete properties tests: As documented in the Tests schedule.

Embedded pressure pipes

General: Complete leak tests before embedding pipes.

Liquid retaining structures

Testing for liquid tightness: To AS 3735.

Curing Compounds

If used, the subcontractor shall allow for the cost of a minimum of three random samples to be tested for water retention in accordance with AS 3799. Samples shall be taken from the material delivered to the site during the period of the works as directed by the superintendent and shall be tested by an approved NATA registered laboratory.

5.3 EXECUTION

5.3.1 POLYMERIC FILM UNDERLAY

Location

General: Under slabs on ground, including integral ground beams and footings, provide a vapour barrier or, in areas prone to rising damp or salt attack, a damp-proofing membrane.

Base preparation

General: Conforming to the base type, as follows:

- Concrete working base: Remove projections above the plane surface and loose material.
- Graded prepared subgrade: Blind with sand to create a smooth surface free from hard projections. Lightly wet the sand just before laying the underlay.

Installation

Standard: To AS 2870 clause 5.3.3.

General: Lay underlay over the base as follows:

- Lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape.
- Face the laps away from the direction of the concrete pour.
- Continue up vertical faces past the damp-proof course where applicable, and tape fixes at the top.
- Patch or seal punctures or tears before placing concrete.
- Cut back as required after the concrete has gained strength and formwork has been removed.

5.3.2 CONCRETE

General

Performance properties: As documented in the Concrete Properties Schedule – Performance.

Elapsed delivery time

General: Make sure that the elapsed time between the wetting of the mix and the discharge of the mix at the site is in conformance with the Elapsed delivery . Do not discharge at ambient temperature below 10°C or above 30°C unless approved heating or cooling measures are taken to deliver concrete within the range 10°C to 32°C.

Table 5-2: Elapsed delivery timetable

The concrete temperature at the time of discharge (°C)	Maximum elapsed time (minutes)
10 to 24	120
24 - 27	90
27 - 30	60
30 to 32	45

Pre-mixed supply

Addition of water: To AS 1379 clause 4.2.3.

Transport method: Select to prevent segregation, loss of material and contamination of the environment, and not to adversely affect placing or compaction.

Site mixed supply

Plant: Mix concrete in a plant located on the construction site.

Emergencies: Do not mix concrete by hand on site.

5.3.3 CORES, FIXINGS AND EMBEDDED ITEMS

General

Requirement: Install fasteners to manufactures recommendations and the assumptions of AS 5216 Appendix D.

Adjoining elements

Fixings: Provide fixings for adjoining elements. If required, provide temporary support to the adjoining elements during concreting, to prevent movement.

Protection

General: Grease threads. Protect embedded items against damage.

Compatibility: Provide inserts, fixings and embedded items that are compatible with each other, with the reinforcement and with the documented concrete mix and the documented surface finish.

Corrosion: In external or exposed locations, galvanize anchor bolts and embedded fixings or submit proposed alternate materials.

Structural integrity

Position: Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, displace but do not cut reinforcement, and maintain cover to reinforcement.

Isolation: Isolate embedded items to prevent water tracking to concrete providing minimum cover to reinforcement.

Tolerances

General: Maximum deviation from correct positions:

- Anchor bolt groups for structural steel: To AS/NZS 5131.
- Cores and embedded items generally: 10 mm.
- Other fixing bolts: 3 mm.

5.3.4 CONCRETE WORKING BASE

Finish

Membrane support: Wood float finish or equivalent.

Installation

- General: Lay over the base or subgrade and screed to the required level.
- Surface tolerance
- Deviation: Flatness tolerance Class B.

5.3.5 PLACING AND COMPACTION

Placing

The concrete mix must work readily into corners and angles, and around reinforcement, without segregation or excess free water on the surface, producing sound concrete, with the minimal plastic settlement and shrinkage cracking.

Horizontal transport: Use suitable conveyors, clean chutes, troughs, hoppers or pipes.

Methods: Avoid segregation and loss of concrete and minimise plastic settlement. Maintain a nominally vertical and plastic concrete edge during placement.

Horizontal elements: Place concrete in layers not more than 300 mm thick. Compact the following layer into the previous layer before the previous layer has taken an initial set.

Compaction

Methods: Use immersion and screed vibrators accompanied by hand methods as appropriate to remove entrapped air and to fully compact the mix.

Vibrators: Do not allow vibrators to contact set concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the formwork. Avoid causing segregation by over-vibration.

Do not allow vibrators to come in contact with the formwork for visually important surfaces.

Provide at least one reserve vibrator in working order for all concrete pours.

Placing records

Logbook: Keep on site and make available for inspection a logbook recording each placement of concrete, including the following:

- Date.
- Specified grade and source of concrete.
- Slump measurements.

- The portion of work.
- Volume placed.

Rain

Protection: During placement and before setting, protect the surface from damage.

The time between adjacent placements

Minimum time delay: As documented in the Elapsed delivery .

Sequence of pours

Minimise shrinkage effect by pouring the sections of the work between approved construction joints in a sequence such that there will be suitable time delays between adjacent pours.

Vertical elements

Placement: Limit the free fall of concrete to a maximum of 2000 mm.

Placing in cold weather

Cement: Do not use high alumina cement.

Temperature limits: Maintain the following temperature limits:

- Freshly mixed concrete: ≥ 5°C.
- Formwork and reinforcement before and during placing: ≥ 5°C.
- Water: Maximum 60°C when placed in the mixer.

Severe weather: If severe weather conditions are predicted, use high early strength cement.

Temperature control: Heat the concrete materials, other than cement, to the minimum temperature necessary so that the temperature of the placed concrete is within the documented limits.

Admixtures: Do not use calcium chloride, salts, chemicals or other material in the mix to lower the freezing point of the concrete.

Frozen materials: Do not allow frozen materials or materials containing ice to enter the mixer, and keep free of frost and ice any formwork, materials, and equipment coming in contact with the concrete.

Freezing: Prevent concrete from freezing.

Placing in hot weather

Handling: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses.

Temperature limits: Maintain freshly mixed concrete at the following temperature limits:

- Normal concrete in footings, beams, columns, walls and slabs: ≤ 35°C.
- For concrete strength grade less than 40 MPa with section thickness ≥ 1 m in all dimensions: ≤ 27°C.
- For concrete strength grade 40 MPa or greater with section thickness ≥ 600 mm in all dimensions: ≤ 27°C.
- Formwork and reinforcement before and during placing: ≤ 35°C.

Evaporation control barriers: Erect barriers to protect freshly placed concrete from drying winds.

Temperature control: Select one or more of the following methods of maintaining the temperature of the placed concrete at 35°C or less:

- Cool the concrete using liquid nitrogen injection before placing.
- Cover horizontal transport containers.
- Spray the coarse aggregate using cold water before mixing.
- Use chilled mixing water.

Placing underwater

General: Do not place underwater unless conditions prevent dewatering.

Minimum cement content for the mix: Increase by 25%.

Method: If required, submit proposals.

5.3.6 CURING

General

Requirements: Taking into account the average ambient temperature at the site over the relevant period affecting the curing, adopt procedures to make sure of the following:

- Curing: Cure continuously of completion of finishing until the total cumulative number of days or fractions of days, during which the air temperature in contact with the concrete is above 10°C, conforms to the following unless accelerated curing is adopted:
  - Fully enclosed internal surfaces/Early age concrete: 3 days.
  - Other concrete surfaces: 7 days.
- End of curing period: Prevent rapid drying out at the end of the curing period.
- Protection: Maintain at a reasonably constant temperature with minimum moisture loss, during the curing period.

Curing method:

Curing compounds

Application: Provide a uniform continuous flexible coating without visible breaks or pinholes, which remains unbroken at least for the required curing period after application.

Substrates: Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to applied finishes, concrete toppings and cement-based render.

Self-levelling toppings: If used also as curing compounds, conform to AS 3799.

Visually important surfaces: Apply curing compounds to produce uniform colour on adjacent surfaces.

Quality: Quality control measures must be in place while curing is being carried out and verification of the actual quantity of curing compound used must be immediately supplied to the superintendent at the completion of every application to ensure that the required approved rate of application is achieved.

Cold weather curing

Temperature: Maintain concrete surface temperatures above 5°C for the duration of the curing period.

Hot weather curing

Curing compounds: If curing compounds are proposed, provide details.

Protection: Select a protection method from the following:

- If the concrete temperature is more than 25°C or if not protected against drying winds, protect the concrete using a fog spray application of aliphatic alcohol evaporation retardant.
- If ambient shade temperature is more than 35°C, protect from wind and sun using an evaporative retarder until curing is commenced.
- Immediately after finishing, either cover exposed surfaces using an impervious membrane or hessian kept wet until curing begins, or apply a curing compound.

Water curing

Method: Select a method of ponding or continuously sprinkling to prevent damage to the concrete surface during the required curing period.

5.3.7 JOINTS

Construction Joints

Location: Do not relocate or eliminate construction joints or form undocumented construction joints.

If emergency construction joints are made necessary by unforeseen interruptions to the concrete pour, submit a report *immediately on the action taken and prior to any rectifications. If an emergency construction joint is required, inform the structural engineer at the earliest possible time to determine any immediate best course of action to minimise rectification works.*

Finish: Butt-join the surfaces of adjoining pours. In visually important surfaces make the joint straight and true, and free from blemishes impermissible for its surface finish class.

Preparation: Refer to documented joint details. Unless noted otherwise, roughen and clean the hardened concrete joint surface. Remove loose or soft material, free water, foreign matter and laitance. Dampen the surface just before placing the fresh concrete and coat with a neat cement slurry *or an approved proprietary binder product*.

Expansion Joints

Joint filling: Fill with joining materials as documented. Finish visible jointing material neatly, flush with adjoining surfaces.

Preparation: Before filling, dry and clean the joint surfaces, and prime.

Watertightness: Apply the jointing material so that joints subject to the ingress of water are made watertight.

Sealants: Two-part gun grade polysulphide based sealant coloured to match the colour of the adjoining pavement colour and approved by the Superintendent. Pourable sealant shall not be used unless the installation method and sealant performance have been demonstrated and approved by the Superintendent.

Jointing materials: Provide jointing materials compatible with each other, and non-staining to concrete in visible locations. *Submit products for review and approval*.

Bond breaking: Provide back-up materials for sealants, including backing rods, which do not adhere to the sealant.

Foamed materials (incompressible fillers): Closed-cell or impregnated, not water absorbing.

Compressible Filler: Compressible filler, thickness as designated on drawings.

Expanding Cork Filler: Expanding cork filler, thickness as designated on drawings.

Control Joints

A weakened plane contraction joint created by forming a groove, extending at least one quarter the depth of the section, either by using a grooving tool, by sawing, or by inserting a pre-moulded strip.

Slip joints

Requirement: If concrete slabs are supported on loadbearing masonry walls, provide proprietary slip joints unless noted otherwise.

5.3.8 COMPLETION

Protection

General: Protect the concrete from damage due to construction load, physical and thermal shocks, and excessive vibrations, particularly during the curing period.

Do not place construction loads on self-supporting structures which will overstress them. Provide calculations to justify the adequacy of the structure to sustain construction loads.

Notice: Give notice before loading the concrete structure.

Surface protection: Protect finished concrete surfaces and applied finishes from damage from any cause.

Rectification: Concrete is liable to be rejected if visually important surfaces are damaged. Rectification may be attempted only if prior approval is given. The Superintendent may refuse approval, or, if approval is given, may reject the concrete if the attempt fails.

5.4 SELECTIONS

5.4.1 SCHEDULES

Table 5-3: Concrete Properties Schedule – Performance

Property	**A - Typical UNO**
A normal and special class	
Maximum aggregate size (mm)	Refer Drawings (but not greater than 40mm)
Assessment process	Normal Class: Production Assessment
Slump (mm)	Refer Structural Drawings
Strength grade/characteristic compressive strength f'c (MPa)	Refer Drawings
Special class	
Cement type	GP
Early age strength (MPa)	22 MPa at 4 days.

Property	A - Typical UNO
Flexural strength (MPa)	Refer Drawings
Water: cement ratio maximum	0.55 maximum (0.45 for acidic and sulphate soils)
Cement content	400 kg/m3 SR cement minimum
Fly ash content	For post-tensioned waterproof slabs fly ash content to be limited to the lesser of 10% of total cementitious content or 40kg/m3
Ground granulated slag	For post-tensioned waterproof slabs, ground granulated slag is not to be used in the concrete mix
Drying shrinkage	Maximum strain 650 x 10 -6

Table 5-4 Drying shrinkage schedule

Concrete element	Strength grade	Drying shrinkage limit (microstrain)
Pad and piled footings	*N40*	*650*
Columns and walls	*S40*	*650*
Slab on ground	*S32*	*650*
Suspended slabs and beam	*S40*	*650*
Post-tensioned waterproof slabs	*S40*	*550*

Table 5-5: Tests schedule

Property	Test method	Test/sampling frequency
Indirect tensile strength	To AS 1012.10	*0*
Modulus of rupture (flexural strength)	To AS 1012.11	*0*
Drying shrinkage	To AS 1012.13	*Prior to supply (on trial mixes) then every 3 months or 3000m^3 for each type of concrete*

Table 5-6 Minimum time delay schedule

Between (pour locations)	Minimum period between adjacent pours (days)
Adjacent pours abutting horizontal construction joints in walls or columns	*1*
Adjacent pours abutting vertical construction joints in walls	*1*
Columns or walls ≤ 4.5m high and Floor-slabs/beams	*2 hours*
Floor Slab Construction Joints	*1*
"Pour strips" and adjacent concrete	*56*

Between (pour locations)	Minimum period between adjacent pours (days)
Retaining wall construction joints	*1*

6 CONCRETE FINISHES

6.1 GENERAL

6.1.1 RESPONSIBILITIES

General

Requirement: Provide finishes to formed and unformed concrete surfaces, as documented.

Performance

Requirement: Compatible with documented finishes.

6.1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- General requirements
- General Concrete

6.1.3 STANDARDS

General

Formed surfaces: To AS 3610.1.

6.1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definition applies:

- Green concrete: Concrete which has set but not appreciably hardened.

6.1.5 TOLERANCES

Formed surfaces

Quality of the surface finishes: To AS 3610.1 Table 3.3.3.1.

Unformed surfaces

Unformed surfaces flatness: To the Flatness tolerance class table, using a straightedge placed anywhere on the surface in any direction, for the documented class of finish.

Table 6-1: Flatness tolerance class table

Class	Measurement	Maximum deviation (mm)
A	2 m straight edge	4
B	3 m straight edge	6
C	600 mm straight edge	6

Typically applied finishes for each flatness tolerance class are:

A: Resilient finishes.

B: Unfinished (plantrooms), carpet, Floor tiles glued down, substrates for bituminous coatings.

C: Floor tiles on screed (scored finish)

6.1.6 SUBMISSIONS

Tests

Slip resistance: Submit test results, as follows:

- Site slip resistance test of completed installation to AS 4586.

6.1.7 INSPECTION

Notice

Inspection: Give 1 working days' notice so that inspection may be made of the following:

- Evaluation of the off-form finishes.
- Evaluation of surface finish.

6.2 PRODUCTS

6.2.1 MATERIALS

Surface hardeners, sealants and protectors

Supply: If documented, provide proprietary products to the manufacturer's recommendations.

Slip resistance treatment

Slip resistance classification: To AS 4586.

6.3 EXECUTION

6.3.1 SURFACE MODIFIERS

General

Application: Apply to clean surfaces to the manufacturer's recommendations.

6.3.2 FORMED SURFACES

General

Surface finish: Provide formed concrete finishes as documented in the Surface Finish Class Schedule and Formed Finishes Schedules.

Damage: Do not damage concrete works through premature removal of formwork.

Curing

General: If formwork is stripped before the minimum curing period for the concrete has elapsed, continue curing the exposed faces as soon as the stripping is completed.

Evaluation of formed surfaces

General: If the evaluation of formed surface tolerance or colour is required, complete the evaluation before surface treatment.

Surface repairs

Method: If surface repairs are required, submit proposals.

Finishing methods

Details: If soffits of concrete elements or faces of concrete columns are to have a finish other than an off-form finish, provide finishes as documented.

Blasted finishes:

- Abrasive: Blast the cured surface using hard, sharp graded abrasive particles until the coarse aggregate is in uniform relief.
- Light abrasive: Blast the cured surface using hard, sharp graded abrasive particles to provide a uniform matt finish without exposing the coarse aggregate.
- Type of abrasive particles: [complete/delete]

Bush hammered finish: Remove the minimum matrix using bush hammering to expose the coarse aggregate, recessing the matrix no deeper than half the aggregate size, to give a uniform texture.

Exposed aggregate finish: Remove the vertical face formwork while the concrete is green. Wet the surface and scrub with stiff fibre or wire brushes, flushing continuously with clean water, until the aggregate is uniformly exposed. Do not use acid etching. Rinse the surface with water.

Floated finishes:

- Sand floated finish: Remove the vertical face formwork while the concrete is green. Wet the surface and rub using a wood float. Rub fine sand into the surface until a uniform colour and texture are produced.
- Grout floated finish: Remove the vertical face formwork while the concrete is green. Dampen the surface and spread a slurry, using hessian pads or sponge rubber floats. Remove surplus slurry and work until a uniform colour and texture are produced.

Smooth rubbed finish: Remove the vertical face formwork while the concrete is green. Wet the surface and rub using a carborundum or similar abrasive brick until a uniform colour and texture are produced.

6.3.3 UNFORMED SURFACES

General

Surface finish: As documented in the Unformed surface finishes schedule.

Finished levels: Strike off, screed and level slab surfaces to finished levels and to the flatness tolerance class documented.

Surface repairs

Method: If surface repairs are required, submit proposals.

Finishing methods – primary finish

Machine float finish:

- After levelling, consolidate the surface using a machine float.
- Cut and fill and refloat immediately to a uniform, smooth, granular texture.
- Hand float in locations inaccessible to the machine float.

Steel trowel finish: After machine floating finish, as follows:

- Use power or hand steel trowels to produce a smooth surface relatively free from defects.
- When the surface has hardened sufficiently, re-trowel to produce the final consolidated finish free of trowel marks and uniform in texture and appearance.

Burnished finish: Continue steel trowelling until the concrete surface attains a polished or glossy finish, uniform in texture and appearance, and free of trowel marks and defects.

Wood float finishes: After machine floating, use wood or plastic hand floats to produce the final consolidated finish free of float marks and uniform in texture and appearance.

Broom finish: After machine floating and steel trowelling use a broom or hessian belt is drawn across the surface to produce a coarse even-textured transverse-scored surface.

Scored or scratch finish: After screeding, use a stiff brush or rake drawn across the surface before the final set, to produce a coarse scored texture.

Sponge finish: After machine floating and steel trowelling, use a damp sponge to wipe the surface to produce an even-textured sand finish.

An exposed aggregate finish: After floating and when the concrete has stiffened, wet the surface and scrub with stiff fibre or wire brushes, flushing continuously with clean water, until the aggregate is uniformly exposed. Rinse the surface with water.

Finishing methods – supplementary finish

Abrasive blast: After steel trowelling, abrasive blast the cured surface to provide texture or to form patterns without exposing the coarse aggregate, using hard, sharp graded abrasive particles.

Coloured applied to finish: After machine floating, apply a proprietary liquid or dry shake material to the manufacturer's recommendations and trowel to achieve the required appearance.

Polished finish: After steel trowelling, grind the cured surface of the concrete.

6.4 SELECTIONS

6.4.1 SCHEDULES

Table 6 3: Formed Surface Finishes Schedule

Concrete element or surface	Surface finish class to AS 3610.1	Formwork lining type	Colour Control Refer AS3610.1 and Architect requirements	Bolt hole filling
Visibly exposed Columns, Beams, Stairs, Walls, Slabs.	2	Plastic faced plywood to AS 3610 table 3.3.1		Cement grout finished flush
Civil Engineering Works, Unexposed columns, beams, walls, stairs and slab soffits	3	To comply with AS 3610 Table 3.3.1		Cement grout finished flush
Surfaces to receive render	4	To comply with AS 3610 Table 3.3.1		Cement grout finished flush
Surfaces to be Permanently Concealed: eg. Footings; rear faces of retaining wall	5	To comply with AS 3610 Table 3.3.1		Cement grout finished flush

Table 6-2: Unformed surface finishes schedule

Location	Flatness tolerance class	Primary finish	Supplementary finish	Slip resistance treatment	Slip resistance classification	Surface modifier
Internal Slab on ground	B	Steel trowel finish		Required as specified		Required as specified
Internal Suspended slab.	B	Steel trowel finish		Required as specified		Required as specified
External pavements and driveways Internal and external ramps	B	Float finish then scored (broom finish).		Required as specified		Required as specified
Slab on ground driveway pavements	B	Float finish	Stamped and coloured faux paved	Required as specified		Required as specified
Base to all tiled and granolithic finishes	B	Float finish.(alternately steel trowel then broom finish).		Required as specified		Required as specified
Areas to be vinyl finished. Stairs.	A	Steel trowel finish		Required as specified		Required as specified

7 BORED PILES

7.1 GENERAL

7.1.1 CROSS REFERENCES

General

Conform to the General requirements worksection.

Related worksection

Conform to associated worksection as follows:

- *General requirements*
- *Concrete general*
- *Concrete Finishes.*
- *Concrete Reinforcement.*
- *Concrete Formwork.*
- *Concrete in situ.*

Related Documents

Refer to the current geotechnical investigation reports.

7.1.2 STANDARD

General

Construction and materials to requirements of AS 2159 and AS 3600.

7.2 BORED PILE EXCAVATION

Extent: *The work specified under this section shall comprise:*

- *Excavation for pile holes in other than rock (OTR) and rock.*
- *Removal off-site of excavated material.*
- *Provide an independent approved geotechnical engineer engaged at the Contractors expense to monitor and certify the foundations capacity of the installed bored piles. Geotechnical inspection records and certificates are to be kept on site in a folder made available to the Engineer for review*

Schedule Of Rates: *The following items are to be covered in the Schedule of Rates, as these quantities are likely to vary from the Contract during construction (either addition or deduction).*

- *Excavation of pile holes in O.T.R. (for various diameters shown on the drawings).*
- *Excavation of pile holes in Rock (for various diameters shown on the drawings).*
- *The socketing base of piles.*
- *Proving Holes.*

Site Investigation: *Borehole information carried out by the client's Geotechnical Engineer shall be supplied as tender documents. Positions of the boreholes are shown on the Structural Engineer's drawings and the Geotechnical report.*

The supply of this information is for the convenience of the Contractor and does not exempt him from the responsibility of satisfying himself as to the true nature of the material to be excavated.

The Contractor is to carry out a thorough investigation and review of the location of existing services in the ground, prior to installing any bored piles.

The Piling Contractor shall report immediately to the Superintendent any unexpected ground conditions encountered that significantly differ from his interpretation of the Geotechnical Investigation or in relation to the proximity of services which will materially affect the location or design or founding depth for the piles. Should this constitute a variation then further work shall not proceed until approved by the Superintendent.

Equipment: *The Contractor shall provide all necessary equipment for boring, socket scouring, cleaning pile base out and proving pile holes together with power for operating it. Provide all necessary lighting and ventilation where handwork is required within the pile excavation, in accordance with the requirements of Work Cover.*

Levels: *Bore depths and socketing shown on the Structural Engineers drawings are for contract purposes only. The final excavated base level of all pile holes will be as directed on site by the contractor's Geotechnical Engineer during construction.*

Tolerances:

All piles are to be vertical to within 5mm in 1000mm.

Single pile excavations shall not vary from the design plan position by more than 75mm.

Contiguous piles excavations shall not vary from design plan position by more than;

- *Inwards - toward excavation 0 mm*
- *Outwards - away from excavation 50 mm*
- *Spacing between piles 25 mm max*

Should any pile be constructed outside the tolerances specified, the contractor shall have to rectify the foundations at no extra to the principal, including but not limited to the associated design, documentation, construction and delay costs.

Retaining of Excavation: *The Contractor shall provide and install a casing in the borehole where necessary to support the sides of the excavation to prevent loose material falling into the excavation up to the time of concrete. The casing shall be provided in all pile holes where proving holes are required. The Contractor shall design the casing to be a snug fit inside the bored hole and capable of withstanding all earth and water pressures. The casing shall be permanent and shall not be removed during concreting. The casing shall extend 150mm below rock level.*

Trimming: *Trimming between and on the exposed face of piles shall be carried out to expose the concrete piles as detailed and conform to the tolerances specified for the general excavation.*

Socketing Base of Piles: *The Contractor shall socket base of piles to achieve, with the end bearing the required load capacity as specified on the Structural Engineer's drawings by mechanical means to the satisfaction of the contractor's Geotechnical Engineer.*

Cleaning Out: *The base of all piles shall be cleaned out to remove all loose material to the satisfaction of the geotechnical engineer. Pile holes shall be free of water prior to placing concrete. Excavated material at top of pile hole shall be kept sufficiently clear so as not to fall into the excavation during placing of reinforcement and concrete.*

Proving Holes: *The Contractor shall provide proving holes to the base footings as required by the contractor's Geotechnical Engineer.*

The Contractor shall provide all necessary equipment access, ventilation and lighting for inspection of the proving holes by the contractor's Geotechnical Engineer.

Open Excavations: *Contractor to provide safety covers to openings of all unattended pile holes.*

Prior To Concreting: *After pile, excavations have been taken to the required bearing base level and cleaned out, an instruction from the contractor's Geotechnical Engineer stating that end bearing and the sides are sufficient for the load capacity noted on the structural drawings must be given prior to placing reinforcement and concrete. The Contractor will be responsible for maintaining the excavation in its correct condition up to and including the time of placing concrete.*

Removal Of Excavated Material: *The Contractor shall remove all excavated material from the site.*

7.3 BORED PILE CONCRETE

All these requirements are additional to those noted in related worksections.

Extent: *The Contractor shall construct all reinforced concrete piles indicated on the Structural Engineers drawings including:*

- *Reinforcement and concrete to piles.*
- *Reinforcement and concrete to pile caps including casting in column starter bars.*

Schedule Of Rates: *The following items are to be covered in the Schedule of Rates for these quantities are likely to vary from Contract during construction (either addition or deduction) and be included in the tender contract.*

- *Reinforcement to piles.*
- *Concrete to piles.*

Formwork: *No form lining is required to the excavated face unless the excavation is required to be retained as noted in 7.2 BORED PILE EXCAVATION.*

Pile Caps*: Provide permanent form lining to pile caps as shown on the Structural Engineers drawings. Remove form lining above the top of pile cap after the concrete has cured. (Minimum two days).*

Reinforcement: *Reinforcement to piles shall be fabricated into cages and carefully lowered into position so as to avoid dislodging material into the excavation. Reinforcement to piles shall be securely held in the correct position during concreting operations.*

Starter bars cast into pile caps shall be accurately set-out and securely held in the correct position during concrete placement and curing.

Reinforcement to both piles and pile caps shall be inspected by the Superintendent prior to placing concrete.

Down-Pipes: *Confirm requirement for downpipes cast into pile caps with the superintendent.*

Preparation Before Placing: *Placing methods shall be submitted to the Superintendent before placing any concrete. Pile excavation to be completely cleaned and free of debris and water at the time of placing concrete. Approval from the Superintendent shall be obtained prior to concreting any pile or pile cap.*

The construction joint surface at the top of the pile shall be clean and scabbled to remove laitance.

Concrete Placing*: Concrete to piles shall be placed using a tremie tube placed centrally within the reinforcement cage. The maximum drop permitted from underside of tremie tube to placement level will be 3 metres. The tremie tube and entry hopper will be supported independently from the reinforcing cage and shall be withdrawn as concreting proceeds.*

Concrete to piles where there is no liner shall be placed using a tremie or funnel placed centrally within the reinforcement cage. The maximum drop permitted from underside of tremie tube to placement level can be up to 20m providing the freefall is vertical and does not hit the sides of the hole.

Where liners are used or if the diameter of the pile is 1.2 metres or greater, concrete may be placed with a freefall of up to 20 metresand is allowed to come in contact with the side of the liner.

***Compaction:** Compaction of freshly placed concrete shall be carried out immediately and continuously using mechanical immersion-type vibrators. In the case of piles, the vibrator shall be lowered inside the reinforcement cage and vibration shall be coordinated with tremie or alternative placement. The maximum depth of concrete placed in piles prior to vibration shall be two lineal metres.*

***Finishing:** Construction joint at top of the pile shall be hand finished to provide a dense level surface free from laitance. The top of pile caps shall be smooth wood float finished around the perimeter of the starter bars to the levels shown on the drawings.*

8 APPENDIX – SCHEDULES

Deliverables Schedule

The deliverables schedule shown below is informative only and is to assist the Superintendent's representative and Contractor in identifying and supplying key deliverables under this specification.

Deliverable Schedule

Section	Test Result/Submission Required	Frequency
1. GENERAL CONCRETE	Alternative proprietary products – Product data	Each instance
	Shop drawings	Each instance
	Design certification for D&C concrete elements	Completion of design and documentation
	Inspection certification for D&C concrete elements	Completion of slab construction
2. CONCRETE FORMWORK	Formwork stripping and back propping procedures	Each instance
	Proposals for concrete crack repair where required	Each instance
	Proposed locations for testing for permanent wall formwork system and scanned wall results	Each floor level
3. CONCRETE REINFORCEMENT	Certification from 'Australian Certification Authority for Reinforcing Steels Ltd' for the supply of reinforcement material.	Submit current certificate.
	Certificate of compliance for reinforcement (Eng check if required)	Each batch
	Additional splicing proposals	Each instance
4. CONCRETE POST-TENSIONED	Certification from 'Australian Certification Authority for Reinforcing Steels Ltd' for the supply of reinforcement(strand) material.	Submit current certificate.
	Strand certificates	Each coil
	Design calculations for strand/bar elongations i.e. theoretical extensions	Each concrete pour
	Shop drawings	Each concrete pour
	Post-tensioning equipment details and calibration certificates	Prior to commencing
	Post-tensioning records including site measured strand/bar elongations i.e. site extensions	Each concrete pour
5. CONCRETE IN SITU	Concrete Materials tests Note – engineer to check if specifically required for the project	Refer schedule

Section	Test Result/Submission Required	Frequency
	Details for sources of materials Note – engineer to check if specifically required for the project	Refer schedule
	Design calculations for structural adequacy under any proposed construction loads	Each instance
	Concrete mix details	Each discrete mix
	Curing compound test data	Refer schedule
	Proposals for curing concrete	Prior to commencing
	Shop drawings for fixing of embedded items	Each instance
6. CONCRETE FINISHES	Crack repair methods	Each instance
7. BORED PILES	Geotechnical engineers certification foundation materials	Each pile prior to pouring concrete

THIS SPECIFICATION HAS BEEN PRODUCED USING NATSPEC BUILDING STRUCTURE

211007

GREY HOUSE PRECINCT

PYMPLE LADIES COLLEGE

STRUCTURAL STEEL SPECIFICATION

DOCUMENT REGISTER

PREPARED BY	APPROVED BY	STATUS	ISSUE	DATE
HN	HN	80%	Issue A	12/11//2021
HN	HN	Tender D&C	1	12/12//2021
HN	HN	Construction Certificate	2	12/02/2024

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CONTENTS

1 GENERAL

1.1 SAFETY IN DESIGN

So far as is reasonably practicable, TTW has identified potential risks to the health and safety of persons who may be affected by the structural design.

Identified hazards & risks have been included in the Structural Risks and Solutions Register which has been forwarded to TTW's Client.

The principal contractor must familiarise itself with the hazards and risks identified in the report and the measures proposed to eliminate or mitigate those hazards and risks.

The principal contractor must notify TTW in a timely manner should they require any further information regarding any identified hazards or risks related to the structural design. If no request for further information is received the project principal contractor acknowledges that the information provided is adequate for its purpose.

The provision of such advice by TTW does not release the principal contractor from its own health and safety obligations under any legislation, contract or otherwise.

1.2 RESPONSIBILITIES

General

Requirement: Provide structural steelwork and protective paint and/or hot-dip galvanized coatings, as documented.

Performance

Construction category to AS/NZS 5131: CC2

- Treatment Grade to AS/NZS 5131 clause 9.8.4:
- All Painted steelwork: P2

Adjoining elements: Provide for the fixing of adjoining building elements that are to be connected to or supported on the structural steel. *Where applicable provide for temporary support of the adjoining elements during the construction of the structural steel.*

1.3 CROSS REFERENCES

General

Requirement: Conform to the following:

- Architectural specification

1.4 STANDARDS

General

Materials and design: To AS 4100.

Materials and design of cold-formed decking, purlins and girts: To AS/NZS 4600.

Fabrication and erection: To AS/NZS 5131.

Any reference documents referred to are for a guide only and the contractor shall source all appropriate codes and the latest editions are to be adopted.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AESS: Architecturally Exposed Structural Steelwork.
- CC: Construction Category. (CC1, CC2, CC3, CC4)
- DFT: Dry Film Thickness.
- ITP: Inspection and Test Plan.
- NDE: Non-Destructive Examination.

Definitions

General: For the purposes of this worksection the definitions are given in AS/NZS 5131 and the following apply:

- Contractor: the party responsible for the relevant scope of work. The contractor shall be designated by the contractual documentation.
- Hold point: an identified point in a process beyond which the relevant work cannot proceed without approval.
- Project Drawings: the set of drawings that describe in a diagrammatic fashion the extent and detail of the Works and the relationship of the Works to the overall construction. The Project Drawings may include the detail necessary to fabricate and erect the Works, depending on the contractual relationships established for the project.
- Steelwork: the fabricated structural steel.
- Witness point: An identified point in a construction process at which an activity is observed.

1.6 GENERAL REQUIREMENTS

General: *all drawings are to be read in conjunction with architectural drawings for the inclusion of additional miscellaneous steelwork that may not be shown on structural drawings but is necessary to install and complete the works. The contractor is to allow for any steelwork required as may be necessary to complete the works as documented but not necessarily shown on the architectural and structural drawings.*

Method: *Fabricate and erect the structural steel in a safe manner, without interfering with or damaging adjacent structures, using methods complying with the requirements of all relevant Australian Standards, authorities and statutory requirements for materials, construction, fabrication and erection.*

Cost: *All items and associated costs referred to in this Specification and the drawings shall form part of the contract price unless noted otherwise. All materials are to be supplied including wastage and over-supply construction.*

Variations: *Should the Contractor consider that a variation to the contract exists, and then they should refer immediately to the superintendent and obtain written approval prior to proceeding with variation work. Refer to Contract Conditions.*

Notice: *Should any ambiguity, error, omissions, discrepancy or other faults exist or seem to exist in the contract documents then promptly notify in writing to the Superintendent.*

Environmentally Sustainable Structural Steel

1.7 TOLERANCES

General

Requirement: To AS/NZS 5131 Section 12 and Appendix F.

Tolerance class: 1.

1.8 VARIATIONS TO STRUCTURAL DRAWINGS

Should the Contractor request changes to the design/drawings, then the Contractor is to liaise with the Superintendent and their representatives and allow for all coordination and shop drawings to suit this process and shall be at the Contractors expense.

1.9 PROPRIETARY PRODUCTS

Where proprietary products are nominated on the drawings or in the specification, the Contractor shall provide in writing to the Superintendent, from the proprietary product manufacturer, certification and warranty that the product is suitable for its intended use in the project prior to the product being ordered or used. The manufacturer shall visit the site during construction and at the completion of construction to certify in writing that the work has been carried out in accordance with their requirements. It is also the responsibility of the manufacturer to ensure that individual components of the proprietary product have not been substituted with alternative products.

Alternative to Proprietary Products: *An alternative product having the required properties may be offered for review. The Superintendent may in their absolute discretion approve or reject the alternative. No claim shall arise from any rejection.*

Unless otherwise agreed, alternatives shall not be grounds for any claim for the variation to cost or time. When offering an alternative for review, provide all available technical information, and any other relevant information requested by the Superintendent. If so requested, the contractor shall obtain and submit reports on relevant tests by an independent testing authority.

State whether the use of the alternative will require alteration to any other part of the Works. If the alternative is accepted, carry out any such alternative without extra charge.

2 QUALITY CONTROL

2.1 QUALITY ASSURANCE

Requirement: A quality management system complying as a minimum to AS/NZS ISO 9001 is required to be operated by the Contractor for the Works and a specified product or service.

Quality documentation

Provide quality documentation as required by Clause 4.5.1 of AS/NZS 5131.

Provide a Quality Plan as required by Clause 4.5.2 of AS/NZS 5131.

Certifications and compliance

The following certifications are required for this project:

- *All structural steel shall be sourced from mills with a relevant JAS ANZ accredited third-party certification scheme such as the ACRS Scheme (see http://steelcertification.com/). Alternative sourcing of third-party certified structural steel shall be submitted for review and must be approved prior to the commencement of procurement.*

- *Steelwork shall be fabricated by fabricators certified under the ASI 'National Structural Steelwork Compliance Scheme' (NSSCS) (see http://www.scacompliance.com.au/).*

- *High strength structural bolts shall be verified to AS/NZS 1252.2.*

The procurement, fabrication and erection of structural steelwork shall be undertaken under a documented Compliance Management Plan (CompMP). The CompMP shall include the requirements of the Quality Plan in AS/NZS 5131 and the following:

- *Process and documentation checklists for purchasing steel*

- *Process for identification and traceability of steel and steelwork from purchasing through to completion of the project*

- *Process and documentation checklists for the erection of structural steelwork*

- *Assigned responsibilities for compliance management, including names and CV's of relevant personnel*

The CompMP shall be provided by the contractor prior to the first procurement of materials for the project.

Identification and traceability

The Contractor shall implement systems to ensure identification and traceability complying with AS/NZS 5131 for the appropriate Construction Category, including by all subcontractors.

Purchasing – components and subcontracted services

The processes and documentation required for purchasing components or subcontracted services shall meet the requirements of Clause 4.6 of AS/NZS 5131.

***Quality control:** The Contractor shall submit their Erection Sequence Methodology (ESM) and Inspection Test Plan (ITP) as defined in AS/NZS 5131 for each work procedure to the Superintendent for approval for a minimum of 14 days prior to commencing the relevant work.*

2.2 SUBMISSIONS

General

Where test results and or certificates are required by this specification or AS/NZS 5131, the contractor is to supply prior to the issuing of a TTW structural inspection certificate their own certification that all the structural steel, bolts and welds supplied for the project has been tested in accordance with, and meets the requirements of, the specification and structural drawings. Any non-conformances or elements that have not been tested are to be highlighted and confirmed in writing with TTW as soon as the non-conformance has been identified.

Surface Finishes

Prior to the issuing of a TTW structural inspection certificate the contractor is to provide their own certification that the surface finishes have been applied, tested and inspected in accordance with the specification including surface preparation and the applied DFT (dry film thicknesses).

Products and materials

Origin of steel

The requirements in AS/NZS 5131 for documentation to demonstrate compliance with Australian Standards applies.

The steel shall be certified by an accredited third-party certifier. Provide documentation to demonstrate JAS ANZ accredited third-party certified steel has been sourced for this project. Where this is not possible, specific written approval shall be obtained for non-JAS ANZ accredited third-party certified steel.

The chemical composition of the steel

In addition to the requirements of the Australian Standards for structural steel (refer Section 3.2), the steel shall also comply with the following requirements for boron content:

- *the material test certificates shall report all elements required by the Australian Standards listed above, plus total boron.*
- *If boron is not specified on the material test certificates, then the material shall be tested to determine the total boron.*

Parent steel materials with total boron equal to or exceeding 0.0008% will require requalification of welding procedures using the higher boron content material.

Steel members and sections

Submit test reports or test certificates conforming to AS 4100 clause 2.2.2.

Bolts, nuts and washers

Submit test reports or test certificates conforming to AS/NZS 1252.1 Section 6.

Verification testing of bolt assemblies: Submit test reports or certificates conforming to AS/NZS 1252.2 Section 2, together with the Supplier Declaration of Conformity (SDoC).

Anchor bolts: If anchors, other than those documented, are required or proposed for supporting or fixing structural steel, submit evidence of the anchor capacity to carry the load.

Substitution: If alternative sections or connections are proposed, submit details.

Fabrication details

Distortions: Submit proposals for the following:

- *Preventing or minimising distortion of galvanized components, welded components or welded and galvanized components.*
- *Restoration to the designed shape.*

Identification marks: If members and/or connections will be exposed to view, submit details of proposed marking.

Program: Submit a fabrication program showing the proposed sequence of operations and time required.

Execution details

Anchor bolts: If anchor bolts do not meet documented location tolerances, submit proposals for rectification before proceeding.

Bolting connections: For connections not documented, submit proposals.

Bolt tensioning procedure: Submit details of the procedure, equipment to be used and calibration of the process.

Site base plate holing: If hand cutting of bolt holes in column base plates is required, submit details.

Purlins and girts: If purlins and girts support components other than roofing or cladding, submit details.

Site modifications: Submit details of proposed on-site modifications or rectifications to any steel member, a connection component, mechanical fastener, weld or corrosion protection.

Splices: If variations to documented splice locations or additional splices are proposed, submit details.

Temporary connections or attachments: If not documented, submit details.

Where alternative anchors are proposed, submit documentation for approval to substantiate the anchor capacity to carry the load where mechanical or chemical anchors are required or proposed for the support or fixing of structural steel.

Undocumented weld types: Submit proposals for weld type and electrodes.

Welding plan: Submit a welding plan to AS/NZS 5131 clause 7.2.

Work method statement: Before any erection work commences, submit a work method statement to AS/NZS 5131 clause 11.2.3.

Work-as-executed drawings: Required for all workshop drawings.

Protective Paint Coatings

Detailing features: If design and fabrication features of the items to be coated may lead to difficulties, identify these and submit details for improvement.

Repair of damaged coating: If the protective coating is damaged, submit a coating repair proposal, based on the coating manufacturer's recommendations for reinstating the corrosion protection function of the system.

Reinstatement: If final coat varies from the submitted sample, submit proposals for reinstatement of the visible final coating system.

Records

Survey: Submit survey of erected structural steel to verify components have been installed as documented *to the tolerances defined in AS/NZS 5131 and this specification. These are to be certified by a licensed surveyor.*

Drawings: Submit as-built structural drawings, upon completion.

Protective Paint Coatings: Prepare and maintain records of all surface preparation and coating application works, as follows:

- *Standards: To AS 3894.10, AS 3894.11, AS 3894.12, AS 3894.13 and AS 3894.14.*
- *Reference the relevant parts of the ITP and record conformance.*

Shop detail documentation

General: Submit shop detail documentation to a scale that best describes the detail, conforming to AS/NZS 5131 clause 4.4.

Drawing format

Supply drawings in Adobe PDF format. Supply a 3D shop drawing model of the steelwork in.IFC format (or similar) to assist in the review of individual shop drawings. Provide free of charge the viewer software (or internet link for download) to allow viewing of the 3D model file.

Where shop drawings are required by this Contract to be supplied by the Contractor, such shop drawings shall include marking plans, drawings, diagrams, illustration, schedules, performance charts, brochures and other data prepared by the sub-contractor, manufacturer, supplier or distributor illustrating some portion of the work.

Review of shop detail documentation

The Superintendent shall review shop drawings only for conformity with the design concept of the project and the information given in the Contract Documents.

Shop drawings shall be thoroughly checked by the Contractor for completeness and compliance with the Contract Documents before submitting them to the Superintendent and shall bear the Contractor's stamp of approval certifying that they have been checked. Shop drawings submitted without this stamp of approval and certification, and shop drawings which, in the Superintendent's opinion are incomplete, contain numerous errors or have not been checked or only checked superficially, will be returned by the Superintendent for resubmission.

The drawings shall show, in standard Engineering drawing manner, clear and complete details of each assembly, component and connection of the work, together with all information, including cambers, relative to their fabrication, surface treatment and erection.

In checking shop drawings the Contractor shall verify dimensions, site conditions and buildability. The contractor shall check and coordinate the shop drawings of any section or trade with the requirements of other sections or trades whose work is related thereto, as required for proper and complete installation of the work.

The Engineering drawings shall be read in conjunction with the Architects drawings and all other relevant drawings and provision made for fixings noted therein.

Submitted shop drawings will not be reviewed dimensionally for the correctness of holes and cleats to suit other building trades. Drawings that are found to be incorrect shall be corrected by the contractor and re-submitted before fabrication and shall not constitute a claim for extension of time or extra cost.

Shop drawings shall be submitted suitably identified and in an orderly sequence to cause no delay to the works. Each set of shop drawings submitted must be accompanied by an up to date marking plan clearly

tagged to locate all members. Drawings submitted shall correspond to the size of the contract drawings where practicable. The member tagging system used on the contract drawings is to be included on shop drawings for checking purposes.

Time required for examination: The Contractor shall provide the programme for shop detailing, including the number of drawings in each issue making allowance for the examination time required by the Superintendent, Architect and Engineers. Minimum time required: 10 working days.

Fabrication: Commence fabrication only with the superintendent's instruction and only with final reviewed shop drawings.

Subcontractors

General: Submit names and contact details of the proposed fabricator, detailer and installer.

Responsibilities: Submit names and contact details corresponding to the person/organisation assigned responsibility to the items listed in AS/NZS 5131 Table B3.

Tests

Site tests: Submit results, as follows:

- Bars and sections: Non-destructive tests.
- Plates: Ultrasonic tests.
- Welds: Non-destructive examinations.

Warranties

Requirement: Submit the following:

- Protective Coatings

2.3 PRODUCT DATA

Requirement: *Before installation commences provide the following information:*

The Manufacturer's published product data including:

- technical specifications
- recommendations for installation and
- type test or factory test data.

Testing authorities reports: Test reports certified by an independent testing authority showing compliance with the criteria of specified tests. For bolt, assembly requirements refer to section 2.2.

Product warranties:

The Manufacturer's written statement certifying the product complies with the Specification and is suitable for the intended use.

The Contractor's written guarantee that the steel products installed to comply with all relevant Australian Standards and the TTW Specification and drawings.

Approval of installer:

If the installation is not by the Manufacturer, and the Manufacturer warranty is conditional on their approval of the installer, the manufacturer's written approval of the specialist installing firm is to be provided.

2.4 NON-CONFORMING WORK

Where a section of works does not comply with the requirements of the specification and drawings (including requirements for materials, sections sizes, inspection and testing) the Contractor shall submit a non-conformance report detailing the proposed rectification method to the Superintendent for approval. Where the Superintendent deems that the proposed rectification method and work are to be reviewed and/ or inspected by the relevant consultant(s), including but not limited to review, inspection, design and documentation shall be at the contractor's expense.

2.5 INSPECTION

It is the Contractors responsibility to construct the works in accordance with the specifications and drawings and any inspections by the Superintendent or their representatives shall not be construed as relieving or relaxing this requirement. The Superintendent and their representatives are not fulltime or part-time inspectors for the Contractor and any inspections made are for the Superintendent's purpose only.

Bookings

General Contractor's Foreman is to check all work that is to be inspected for compliance with documents before confirming the booking of the site inspection.

Where inspection by the Engineer is required or notification to the Superintendent to allow the opportunity to inspect is required, please give a minimum 24 hours notice of required inspection.

Book through TTW Site Engineer. Please phone to confirm inspection 4 hours before the appointed time.

Scheduled inspections should be cancelled a minimum of 4 hrs prior to the scheduled time if work will not be ready for inspection. Phone for cancellations, e.g. due to bad weather, as soon as possible, otherwise a charge for inspection may be incurred.

Inspection Times

Hours 8.00 am to 4.00 pm Monday to Friday only.

Generally, no site visits on Saturdays, Sundays or Public Holidays except in emergency situations and by special booking.

Revisits

If the area of work is not completed at the scheduled time of inspection or is defective and requires re-inspection, re-inspection shall be at the Contractors expense. Follow normal booking procedures.

The Superintendent's Representative cannot wait on site for work to be completed. However, if the Contractor requests the Superintendent's Representative to wait on site while work is being completed then this will be charged to the Contractor at an hourly rate.

Documents

Keep a copy of all specifications, latest drawings and drawing list on site.

Drawings stamped/approved by Council should be held on site.

Keep copies of all TTW Inspection Reports on site.

Alterations

The elements inspected and all instructions are to be recorded on the TTW Inspection Report form by the Inspecting Engineer.

Do not accept verbal approval of structural or civil alterations.

Design Office should approve major alterations in writing.

Responsibilities

The Foreman is to accompany the Superintendent's Representative for inspections.

Any inspection carried out by TTW does not relieve the Contractor of their responsibility to construct the structure or works in accordance with the drawings and specifications.

Certificates by TTW do not relieve the Contractor of their obligation to obtain approvals from authorities having jurisdiction over the works.

Notice – off-site

Inspection: Give sufficient notice so that inspection may be made of the following:

- Materials including welding consumables before fabrication.
- Testing of welding procedures and welder qualification tests.
- Commencement of shop fabrication.
- Commencement of welding.
- Complete penetration butt welds before the placement of root runs.
- High-strength bolt tensioning (when completed off-site).
- Completion of fabrication before surface preparation.
- Surface preparation before protective coating.
- Completion of the protective coating before delivery to site.

Notice – on-site

Inspection: Give sufficient notice so that inspection may be made of the following:

- Steelwork on-site before erection.
- Anchor bolts in position before casting in.
- Steelwork and column bases erected on site, before grouting, encasing, site protective coating or cladding.
- Tensioning of bolts in categories 8.8/TB and 8.8/TF.
- Reinforcement and formwork in place before any encasement.
- Completed grouting, encasement, fire protection or site applied a protective coating.

***Engineering Inspection**: The Contractor is to allow in their price and program for the provision of equipment necessary for:*

- *The Superintendent's Representative to inspect all erected steelwork for verification of compliance with the contract documentation.*
- *Access to the steel fabricators works at all reasonable times during fabrication and erection and all necessary facilities to enable the work to be observed.*

Hold Points:

- *Reviewed shop drawings prior to commencing fabrication.*

- *Superintendent's Representative's certificate confirming the adequacy of completed steelwork prior to encasing or fixing cladding.*

3 PRODUCTS

3.1 GENERAL

Materials

Requirement: To AS/NZS 5131 Section 5.

Storage and handling

Requirement: Pack, support, transport and handle members and components without overstressing, deforming or damaging them or their protective coating.

Damaged items: Rectify or replace. Do not assemble into the structure without approval.

Protection: Wrap or otherwise protect members or components to prevent damage to surface finishes during handling and erection.

Storage: Store off the ground.

Lifting points: Do not allow steel slings to come into direct contact with coated steelwork.

Purlins and girts: If not required for immediate use, stack and cover bundled sections, raised off the ground and on a slight slope so that water can drain away.

Purchasing and traceability

Purchasing documentation and procedure: To AS/NZS 5131 clause 4.6.

3.2 STRUCTURAL STEEL

Steel grade: *If the grade of steel is not shown on the drawings, comply with the Steel members and sections steel grade table below.*

Table 3-1: Steel members and sections steel grade table

Type of steel	Minimum grade
Hot-rolled sections to AS/NZS 3679.1 and SA TS 102	300
Welded sections to AS/NZS 3679.2	300
Hot-rolled plates, floor plates and slabs to AS/NZS 3678 and SA TS 102	250
Hot-rolled flat products to AS/NZS 1594	HA300
Hollow sections to AS/NZS 1163 & SA TS 102 - Refer to structural drawings for specific sizes and strengths	
Circular Hollow Sections	C250, C350 & C450
Rectangular Hollow Sections	C350 & C450
Square Hollow Sections	C350 & C450
Stainless Steel	316
Cold-formed purlins and girts to AS 1397	G450, Z350 or Z450

Certification

Steel: Minimum requirements for test and inspection certificates, to the following:

- Hot-rolled bars or sections: To AS/NZS 3679.1 clause 11.2.4.
- Welded I sections: To AS/NZS 3679.2 clause 11.2.4.
- Hot-rolled plate: To AS/NZS 3678 clause 11.2.4.
- Cold-formed hollow sections: To AS/NZS 1163 clause 11.2.4.

3.3 MECHANICAL FASTENERS

Standards

Bolts: To AS 1110.1, AS 1111.1 and AS/NZS 1252.1.

Nuts: To AS 1112.1, AS 1112.2, AS 1112.3, AS 1112.4 and AS/NZS 1252.1.

Certification

High-strength bolt assemblies: Minimum requirements for test reports, to AS/NZS 1252.1 clause 6.4.2.

Finish

Bolts, nuts and washers: Hot-dip galvanized to AS/NZS 1214, corrosion-free, and in serviceable condition.

Mechanical and chemical anchors

Where anchors are required or proposed for the support or fixing of structural steel submit evidence of the maximum rated anchor capacity with the required edge distances, distance apart and embedment depth, details of structural steel plates to incorporate the anchor edge distances and distance apart.

All anchors are to be installed strictly in accordance with AS 5216:2018 and the manufacturer's specification and to the edge distances, distance apart and embedment depth for the maximum rated anchor capacity unless noted otherwise on structural drawing details. All anchors must be installed perpendicular to the substrate unless noted otherwise.

All anchors shall be tested in accordance with AS 5216:2018 and the manufactures specification and to their satisfaction. Provide copies of all test results to Superintendent for review.

Anchor Bolts

Hexagonal bolts: To AS 1111.1.

Hexagonal nuts: To AS 1112.3.

Plain washers: To AS 1237.1.

Requirement: Provide each anchor bolt with 2 nuts and 2 oversize washers with sufficient thread for the levelling nut and washer to set below the base plate.

3.4 OTHER MATERIALS

Welding consumables

Requirement: To the relevant part of the AS/NZS 1554 series and AS 4100.

Grout

Requirement: To AS/NZS 5131 clause 5.8.

- *Method: Dry pack with stiff cement mortar*
- *Type: Portland cement non-shrink grout*
- *Minimum compressive strength: 40 MPa at 28 days*
- *Minimum thickness: 20mm*
- *Maximum thickness: 65mm*

Grouting at supports: Where steelwork is supported by concrete, masonry or like material, it shall be set up on packing or wedges to facilitate alignment and permit subsequent grouting. Such packs, if permanent, shall be either of solid steel, high strength plastic or grout of similar strength to the permanent grout. All other packs or wedges shall be removed before completion of grouting.

Before grouting, the space between the base plate and the concrete shall be washed, blown dry, inspected and approved. Do not grout if the temperature of the base plate or the footing surface exceeds 35°C, where indicated on the drawings, higher strength grout shall be used.

3.5 DISSIMILAR METALS

General: The contractor shall ensure that all dissimilar metals are installed adequately to not to affect the warranty nor the design and service life metals.

Requirement: Copper and any other dissimilar metals are to be adequately isolated from steel members and fixings.

4 EXECUTION

4.1 PREPARATION, ASSEMBLY AND FABRICATION

Identification

Traceability: To AS/NZS 5131 clause 6.2.

Marking: Provide marks or other means of identifying each member compatible with the finish, for setting out, locating, erecting and connecting the steelwork to the marking plans.

High-strength bolting: If the work includes more than one bolting category, mark high-strength structural bolted connections with a 75 mm wide flash of colour, clear of holes.

Cold-formed members: Clearly mark material thickness.

Monorail beams: Identify and mark rated capacity in conformance with AS 1418.18 clause 5.12.6.

Cutting

Shearing: Do not shear edges in areas designated as yielding regions for seismic design to AS 4100 earthquake design categories D and E.

Shaping

Requirement: Where forming, shaping or correcting distorted members, avoid damage and conform to AS/NZS 5131 clause 6.6.

Splicing

Provide structural members in single lengths or advise the Superintendent for instruction.

Column splices: Unless otherwise shown, make column splices between 500 mm and 800 mm above-finished floor level in multi-storey construction.

Tolerances

Measurement: Check tolerances by measurement after fabrication and application of corrosion protection.

Surface preparation and treatment

Refer to Section 5 FINISHES.

4.2 WELDING

General

Requirements: To AS/NZS 5131 Section 7.

Standard: To AS/NZS 1554.1.

Weld category

Weld categories not documented: Category SP.

Site welds

Other than site welds shown on the shop drawings, do not weld on site without the Superintendent's instruction.

Completion: Weld only when correct alignment and preset or camber have been achieved.

Visual Welds: All visual welds are to be ground flush to connecting members with no blemishes or member misalignment. In grinding, do not reduce the welds below nominated size.

4.3 MECHANICAL FASTENING

Connection contact surfaces

General: To AS/NZS 5131 clause 8.4.1.

Bolting category 8.8/TF: Clean, as rolled and free from applied finishes.

Washers

Requirement: Place one washer under the part rotated during the tightening process (nut or bolt head).

Extra large flat washers for oversized bolt holes: To AS 1237 Appendix A.

Tensioning of bolting categories 8.8/TB and 8.8/TF

Method: Use the part-turn method or a direct tension indicator device. *Do not use torque control.*

Burred, damaged or otherwise unserviceable bolts shall not be used. 8.8/TF and 8.8/TB bolts shall not be re-used after tensioning.

Permanent bolting

Completion: Bolt only when correct alignment and preset or camber has been achieved.

Bolt assembly verification

High strength bolt assemblies to AS/NZS 1252.1 shall be verified to AS/NZS 1252.2. Documentation to meet requirements of AS/NZS 1252.2 shall be provided.

Rejection

All components of a bolting system not supplied by a single manufacturer are liable for rejection.

4.4 ERECTION

General

Execution: Make sure every part of the structure has sufficient design capacity and is stable under construction loads produced by the construction procedure.

Temporary work

General: Provide all necessary temporary bracing or propping.

Temporary connections: Detail required cleats, if not shown on shop detail documentation.

Temporary members: If temporary members are required, fix so as not to weaken or deface permanent steelwork.

Anchor Bolts

General: For each group of anchor bolts, provide a template with set-out lines clearly marked for positioning the bolts when casting in.

Beam camber

Requirement: If beam elements have a camber (natural or induced), erect them with the camber up.

Site work

General: Other than work shown on the shop detail documentation as site work, do not fabricate, modify or weld structural steel on-site.

Hand flame cutting

Do not hand flame cut bolt holes without prior approval.

Purlins

Trimming members: Provide to support edges of roof sheeting along hips, valleys and roof penetrations.

Movements

General: Allow for thermal movements during erection.

Work exposed to view

Shearing, flame cutting and chipping to be performed carefully and accurately.

Corners and edges: Grind fair those corners or edges that are sharp, marred or roughened.

Grouting at supports

Preparation: Before grouting steelwork supported by concrete or masonry, set steelwork on packing or wedges.

- Permanent packing or wedges: Form with solid steel, plastic or grout of similar strength to the permanent grout.
- Temporary packing or wedges: Remove before completion of grouting.

Timing: Grout at supports before constructing supported floors, walls and roofing.

Temperature: Do not grout if the temperature of the base plate or the footing surface exceeds 35°C.

Drifting

Limitation: Use drifting only to bring members into position, without enlarging holes or distorting components.

5 FINISHES

5.1 Standards

General

Surface preparation and coating: To AS/NZS 5131 Section 9 and the recommendations of AS/NZS 2312.1 or AS/NZS 2312.2 as required and the Protective Steelwork coatings schedule.

Preparation methods: To AS 1627.

Site testing of protective coatings

Test methods: To AS 3894.

5.2 IDENTIFICATION MARKS

General

Provide suitable and sufficient marks or other means for identifying each member, and for the correct setting out, location, erection and connection of the steelwork and compatible with the finish. Mark bolted connections to show the bolting category.

5.3 SURFACE PREPARATION

General

Requirement: Conform to AS/NZS 5131 clauses 9.3, 9.4 and 9.5.

Treatment of welds

Requirement: Clean welds to remove roughness, using power tools to AS 1627.2. Remove filings by vacuuming or compressed air.

Temporary welds: Grind flushes any temporary welds.

Porous, skip or stitch welds: Not permitted.

Site welding: If possible, avoid site welding. If on-site welding is required, prepare and treat the weld to AS/NZS 5131 clause 9.12.2.

Shop priming

Requirement: Dust off and apply a coat of primer in conformance with the manufacturer's recommendations.

Site coating

General: High pressure wash down all surfaces with clean water. Lightly sand down primer/intermediate coats, which have been shop applied, before site application of next coat.

Steel Contact Surface: *To AS 4100, clause 14.3.6.3*

Marking

On the contact surfaces of friction type joints, confine the use of marking ink to the minimum necessary for marking hole positions.

5.4 Preparation assessment

General

Conformance: Assess all surfaces of each steel member for conformance with the documented preparation requirements.

Abrasive blast cleaning

Assessment: To AS 1627.4 and AS 1627.9.

Minimum acceptance class: Refer to Protective Steelwork coatings schedule

5.5 Coating application

General

Requirement: Conform to AS/NZS 5131 clause 9.9 and the PDS.

Painting and coating colour: Verify all project finish colours with the retained samples.

Final surface preparation or coating application

Limits: If the environmental/climatic/substrate conditions listed in AS/NZS 5131 clause 9.9.10 and the following are present do not apply coating:

- Ambient air temperature below 5°C or above 40°C.
- Substrate temperature below 5°C or above 35°C.
- Full prime coat application cannot be carried out before the specified cleanliness of the surface deteriorates.
- Surface preparation standard has not been achieved.
- Time between final surface preparation and the commencement of coating has exceeded 4 hours.
- Visual tarnishing or black spots develop on the surface of the steel.

Exception: Preliminary blast or other surface preparations may be performed in conditions that are outside the limits, providing the final surface preparation and all coating applications are undertaken under the limit conditions.

Pre-coating: Before the spray application of each coating, stripe coat by brush method all edges, welds, seams, rivets, bolts, bolt holes (including slots) and difficult to spray areas. Prime the underlying surfaces of replacement bolting, washers and nuts before installation.

Procedure: Conform to the coating order shown in Protective Steelwork coatings schedule.

Subsequent coats: Before applying any subsequent coating layer, make sure the surface condition of the preceding coat conforms to Protective Steelwork coatings schedule and is clean and free from defects.

Concrete encasing: Where members are part concrete encased extend the priming 50 mm into the surface to be encased.

Wet film thickness (WFT)

Method of measurement: To AS 3894.3 Appendix C using an approved wet film gauge continuously during application.

Dry film thickness (DFT)

Method of measurement: To AS 3894.3 clause 10.

Extent: Measure all surfaces at the completion of each prime, intermediate and finish coats, including areas of the element difficult to paint, masked by structure, or where double or light coating is likely.

Number of measurements: To AS 3894.3 clause 7.

Coatings with DFT 150 µm or less: If testing, deduct the effect of the measured surface profile from all DFT readings.

Single readings: Conform to the following:

- The average of 5 point readings for each 10 m2 area of coating surface to be within the documented coating thickness range.
- No single point reading in any 10 m2 to be less than 80% of the specified minimum coating thickness. If the average of three readings is used to produce a point reading, the individual reading may be less than 80% of the minimum coating thickness.
- Check any single reading that is greater than 150% of the documented maximum DFT with three additional readings within 50 mm of the original reading. If the average of these three readings is not greater than 150% of the specified DFT, take the average reading as the point reading. If greater than 150%, reject the DFT for that area. If no maximum limit for DFT is documented, consult the manufacturer.

5.6 Protection

Contamination

Surfaces: Prevent contamination of the coated surface, which are not yet dry, from blasting dust, abrasive or surface preparation debris and any other foreign matter.

Post application care

General: Protect the coating against physical, chemical, or atmospheric damage until all components are fully cured.

Care: Stack and handle all coated items using fabric slings or padded chains. Use soft packaging, carpet strips or other deformable materials between all coated items.

Water ponding: Stack coated items to prevent water ponding.

5.7 Coating repair

Repair of coating damage

Coatings that become damaged need to be repaired to the coating manufacturer's recommendations.

Preparation: Feather back by hand or machine sanding all leading edges of intact coating adjacent to the repair, to remove any sharp edge.

Surface contamination: Remove by dusting or blowing down before applying the first coat of paint.

Sequence: Apply the repair coating in the same sequence and manner as the original coating.

Areas damaged without exposing the primer: Wash with a proprietary detergent solution, rinse with clean water and abrade so that edges of sound paint are feathered. Coat the area with the appropriate intermediate and finishing coat materials.

Areas damaged exposing the primer or steel surface: Blast clean to the original standard. Prepare at least 50 mm into the sound coating and to a further feathering zone of approximately 50 mm. Recoat with the documented system to restore the film thickness and integrity over the whole prepared surface including the feathered zone.

Aesthetic reinstatement: If required, repaint to a physical or discernible boundary line.

Defects: If corrosion pitting or areas of significant metal loss and defects are exposed by the blasting process, advise for inspection and have areas passed as being fit for service before proceeding with the coating system.

Timing: Apply the protective coating system within 4 hours of blast cleaning or in any case before visual tarnishing of the steel occurs.

Table 5-1: Protective Steelwork coatings schedule

Type	Locations Refer Drawings Atmospheric Category To AS/NZS 2312.1	Surface Preparation To AS1627.4	Generic Type Primer, Second and Third Coats (as required) Dry Film Thickness or Special Finish	System Designation
2A	Internal Non-decorative	Abrasive Blast Clean To Class 2½	75 µm Epoxy zinc phosphate conforming to AS/NZS 3750.13	
3D	External Decorative Stairs and Awning	Abrasive Blast Clean To Class 2½	1) 75 µm Zinc rich epoxy conforming to AS/NZS 3750.9 Type 2 2) 200 µm High-Build Epoxy MIO Conforming to AS/NZS 3750.14 3) 75 µm High Solids Polyurethane Conforming to AS/NZS 3750.6	
5B	Steel In Contact With Masonry Wall. Plant platforms	Hot Dip Galvanized (Refer Specification)	Hot Dip Galvanized	HDG600

Definitions:

Internal: *Steelwork concealed within the building facade and exposed to the clean atmosphere within a heated or air-conditioned building.*

External: *Steelwork external to the building facade, exposed to view, weather and the external atmosphere.*

5.8 GALVANIZING

Standards

General: To AS/NZS 4680.

Threaded fasteners: To AS 1214.

Durability: To AS/NZS 2312.2.

Components in contact with concrete

General: Chromate passivate.

Chromate passivation process: Dip in 0.15 - 0.2% sodium dichromate solution

Metal finishing

Coating mass/thickness minimum: Minimum average: 600 g/m^2, to *AS/NZS 4680.*

Threaded fasteners coating mass/thickness minimum: To AS/NZS 1214.

Execution details

Holes and lifting lugs: If holes and lifting lugs are required to facilitate handling, filling, venting and draining during galvanizing, submit details on size and location.

Detailing features: If design and fabrication features of the items to be galvanized may lead to dimensional change, distortion or difficulties during galvanizing, identify these and submit details for improvement.

Venting and Draining: The shop detailer and fabricator are to provide adequate preparation for venting and draining during galvanizing to recommendations of AS/NZS 4680, Appendix C.

Hollow sections: Provide a seal plate with breather holes. Locate holes so as not to occur in visible locations when installed. If holes can only occur in visible locations contractor is to provide a proposal to infill holes to match the surrounding area to the superintendent's satisfaction.

Friction-type bolted connections

General: Treat coated contact surfaces to achieve the required design slip factor, without removing excessive coating thickness as follows:

- Contact surface preparation: To *GAA After fabrication hot dip galvanizing* Chapter 4.
- Slip factor test: To AS/NZS 5131 Appendix G.

Damaged galvanizing

Weld areas: Reinstate coating to AS/NZS 4680 clause 8.

Rejection: If any item has damaged areas exceeding the limits specified for repair in AS/NZS 4680 clause 8.1*, the materials shall be rejected and removed from the site. Replace rejected material that complying with this specification at the Contractor's expense.*

Extent: Areas damaged by transport, site welding, site flame cutting, site handling, or erection.

Method: To AS/NZS 4680 clause 8. *Submit a proposal for review by Superintendent prior to carrying out repairs.*

5.9 Inspection

General

All painting work is to be inspected in accordance with AS/NZS 2312.1 or AS/NZS 2312.2 as required by an authorised independent inspector to the manufacturer's specification and all test certificates provided to the Superintendent for review prior to removal from the workshop. Each inspection location shall be at a maximum spacing of 10m along with the member and all faces of the member at that location will be measured for dry film thickness.

6 COMPLETION

6.1 COMPLETION

Notice of Completion

Give at least 7 working days notice of completion.

Tolerances

Conformance: After completing erection, verify conformance with AS/NZS 5131 Section 12 and Appendix F.

Temporary connections

General: Remove temporary cleats on completion and restore the surface to match adjacent areas.

Project Records

Provide the workshop drawings and survey certificates with all field modifications to the Superintendent for "as built" drawings.

Provide all Quality Record sheets.

Appendix - Deliverables Schedule

Deliverables Schedule

The deliverables schedule shown below is informative only and is to assist the Superintendent's representative and Contractor in identifying and supplying key deliverables under this specification required to be submitted to TTW.

Section	Test Result/Submission Required	Frequency
1 GENERAL	*Alternative proprietary products – Product data*	*Each instance*
2 QUALITY CONTROL	*Quality management system in accordance with AS ISO 9001*	*Each supplier*
	Quality documentation Quality Plan and Compliance Management Plan as required by AS/NZS 5131.	*Each supplier*
	Origin of steel in accordance with AS/NZS 5131	*Each batch*
	Certificate from a JAS ANZ accredited third-party certifier for the supply of the structural steel products	*Each supplier*
	Contractors certificate that all structural steel, bolts and welds have been tested in accordance with and meet the requirements of the specification	*Prior to TTW certificate*
	Bolt compliance/test certificates and SDoC	*Each batch*
	Subcontractors – proposed fabricators and installers	*Each instance*
	Shop drawings	*Each instance*
	Work as executed drawings	*Each shop drawing*
	Material test certificates	*Each batch*
	Anchors required to support or fix structural steel	*Each type*
	Any proposals for splicing steelwork	*Each instance*
	Design and Construct elements shop drawings	*Each instance*
	Design and construct elements design and inspection certificates	*Design & installation completion*
3 PRODUCTS	*Material test certificates*	*Each batch*
	Mechanical and chemical anchor testing certificates in accordance with TS 101:2015	*Each instance*
4 EXECUTION	*Non-destructive weld examination to AS/NZS 5131*	*Each instance*
	Anchors proposed for fixing structural steel and associated details	*Each instance*
	Bolt assembly verification	*All*
5 FINISHES	*Alternative steelwork coatings in accordance with AS/NZS2312*	*Each instance*
	Contractors certificate that all surface finishes have been applied, tested and inspected in accordance with and meet the requirements of the specification	*Prior to TTW certificate*
6 COMPLETION	*Notice of completion*	*Each significant stage*
	As built shop drawings	*On completion*

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Structural
Civil
Traffic
Façade

Civil Specification - Issue for Tender

Grey House Precinct (GHP) Pymble Ladies' College

Prepared for Pymble Ladies' College / 29 May 2023

211007

Taylor Thomson Whitting (NSW) Pty Ltd (ACN 113 578 377)
as trustee for the Taylor Thomson Whitting NSW Trust
(ABN 59 514 956 558) I Consulting Engineers
Level 3, 48 Chandos Street, St Leonards NSW 2065

Your Partner in Engineering

Rev	Date	Prepared By	Approved By	Remarks
A	20.10.21	NB	SB	Issue for 50% Tender
B	12.11.21	NB	SB	Issue for 80% Tender
C	31.01.22	DT	NB	Issue for Tender
D	29.05.23	JL	NB	Issue for Tender

Contents

1.0 GENERAL REQUIREMENTS

1.1 GENERAL

1.1.1 GENERAL

Precedence

Requirements of individual technical sections of the specification override conflicting requirements in this section.

Current editions

General: Use referenced documents which are editions, with amendments, current 3 months before the closing date for tenders, except where other editions or amendments are required by statutory authorities. Refer to individual specification sections for referenced documents.

Site copies: 1

Contractual relationships

Responsibilities and duties of the principal, contractor and contract administrator are not altered by requirements in referenced documents.

1.1.2 SAFETY IN DESIGN

So far as is reasonably practicable, TTW has identified potential risks to the health and safety of persons who may be affected by the civil design.

Identified hazards & risks have been included in the Civil Risks and Solutions Register which has been forwarded to Taylor Thomson Whitting's Client.

The principal contractor must familiarise itself with the hazards and risks identified in the report and the measures proposed to eliminate or mitigate those hazards and risks.

The principal contractor must notify TTW in a timely manner should they require any further information regarding any identified hazards or risks related to the civil design. If no request for further information is received the project principal contractor acknowledges that the information provided is adequate for its purpose.

The provision of such advice by TTW does not release the principal contractor from its own health and safety obligations under any legislation, contract or otherwise.

1.1.3 INTERPRETATION

General

Unless the context otherwise requires, the following definitions apply:

- Supply: "Supply", "furnish" and similar expressions mean "supply only".
- Provide: "Provide" and similar expressions mean "supply and install".
- Contract Administrator: “Contract Administrator”, “Project Manager”, Superintendent” means persons approved by the Principal to give direction to the Contractor.

- Approved: "Approved", "reviewed", "directed", "rejected", "endorsed" and similar expressions mean "approved (reviewed, directed, rejected, endorsed) in writing by the contract administrator".

- Give notice: "Give notice", "submit", "advise", "inform" and similar expressions mean "give notice (submit, advise, inform) in writing to the contract administrator".

- Obtain: "Obtain", "seek" and similar expressions mean "obtain (seek) in writing from the contract administrator".

- Proprietary: "Proprietary" mean identifiable by naming manufacturer, supplier, installer, trade name, brand name, catalogue or reference number.

- Samples: Includes samples, prototypes and sample panels.

Technical

Zinc-coated steel: Includes zinc-coated steel, zinc/iron alloy-coated steel, and aluminium/zinc-coated steel.

Pipe: Includes pipe and tube.

Maintenance period

Co-extensive with the defects liability period.

Abbreviations

ABS: Acrylonitrile-butadiene-styrene.

EPDM: Ethylene-propylene diene monomer.

GRP: Glass-fibre reinforced polyester.

NATA: National Association of Testing Authorities.

PTFE: Polytetrafluoroethylene.

RMS: Roads and Maritime Services (Formally Roads & Traffic Authority)

SSL: Scientific Services Laboratory.

uPVC: Unplastisised Poly Vinyl Chloride

1.1.4 CONTRACT DOCUMENTS

General

Diagrammatic layouts: Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable. Before commencing work, obtain measurements and other necessary information.

Levels: Spot levels take precedence over contour lines and ground profile lines. Inform the Contract Administrator of any apparent discrepancies before proceeding.

1.1.5 AUTHORITIES APPROVALS

General: Contractor is to arrange inspections and approvals as required by the relevant regulatory authority. Contractor is to provide documentary evidence of approvals prior to covering work.

Works by Statutory Authorities: If the responsible authority is required to or, pursuant to the statutory powers vested in it, elects to perform or supply part of the works or to inspect or test the works during construction, make the necessary arrangements with the authority and pay and bear the fees payable in connection therewith.

1.1.6 WORK OUTSIDE SITE

Requirement: Make necessary arrangements with adjoining property owners and the relevant authorities.

1.1.7 AUTHORITIES REQUIREMENTS

Where works are on public property, or property which is to come under the control of a Statutory Authority, or where the works are to come under the control of a Statutory Authority (i.e. stormwater drainage in a future easement), the works shall comply with the requirements of the relevant Statutory Authority, and where the requirements of the Statutory Authority are different to the requirements of this Specification, the requirements of the Statutory Authority will be applicable.

The Contractor shall be responsible for determining the requirements of any relevant Statutory Authorities.

1.2 QUALITY

1.2.1 INSPECTION

General: Refer to Appendix A for schedule of inspection and testing requirements. It is the contractor's responsibility to construct the works in accordance with the specifications and drawings and any inspections by the contract administrator or their representatives shall not be construed as relieving or relaxing this requirement. The contract administrator and their representatives are not fulltime or part time inspectors for the contractor, and any inspections made are for the contract administrator's purpose only.

Notice

Witness points: If notice of inspection is to be given in respect of parts of the works, advise if and when those parts are to be concealed.

Hold points: If notice of inspection is to be given in respect of parts of the works, do not conceal those parts without approval.

Concealed Work: Give notice before covering work so that inspection may be made.

Minimum Notice: Where inspection by the Engineer is required or notification to the contract administrator to allow opportunity to inspect is required, give 48 hours minimum notice. If the area of work is not completed at the scheduled time of inspection or is defective and requires re-inspection, re-inspection shall be at Contractors expense. Scheduled inspections should be cancelled a minimum of 4 hrs prior to the scheduled time if work will not be ready for inspection. Completed Contractors checklists and Materials Certificates and Test results as required shall be available at time of inspection.

1.2.2 TESTS

Notice

General: Give sufficient notice so that designated tests may be witnessed.

Hold points: Do not carry out designated tests without approval.

Minimum notice for tests to be witnessed:

- 5 working days for site tests; and
- 10 working days for local pre-delivery tests.

Testing authorities

General: Have tests carried out by authorities accredited by NATA to test in the relevant field, or an organisation outside Australia recognised by NATA through a mutual recognition agreement. Cooperate as required with testing authorities.

Process Control Tests: The specified process control tests are the minimum requirement. Perform tests of the type and frequency necessary to adequately control the materials and processes used in the construction of the Works.

Compliance Assessment Tests: Materials and work specified to be subject to testing may not be accepted as complying with the Contract until the results of all tests (including both compliance assessment and process control tests) relating to that material or work are satisfactory.

Compliance Assessment: If compliance assessment tests are specified to be carried out by an independent testing authority, arrange for the independent testing authority to submit three copies of each test result direct to the Superintendent.

Methods: Unless otherwise specified use applicable standard test methods specified in Australian standards.

Testing: Take and prepare the samples required for the specified tests. A plan showing the detail of proposed test lots shall be approved by the Contract Administrator prior to commencing any operation where testing is specified. Test lots shall be uniform, usually consisting of an area placed and/or compacted in one day, and the Contract Administrator shall select testing sites within each test lot on a random basis. If the test results show that part of a lot does not conform with the specification requirements, the Contract Administrator may direct that additional testing be performed to determine the extent of the non-conforming work. The cost of additional tests shall be borne by the Contractor.

For concrete work test lots shall consist of each separate concrete pour.

Timing: Unless otherwise specified materials samples shall be obtained at the time of delivery to the site.

Reports: Submit written test results including a plan showing the location and reduced level of tests. The location and reduced level of test locations shall be surveyed and co-ordinated and a level shall be recorded in accordance with the site grid and datum. Test reports shall state the purpose of the test i.e. stormwater trench backfill.

Costs of tests

The contractor is to bear the costs of tests and repeat tests in the case of failure.

Covering Work:

If tests are to be carried out on parts of the works, do not conceal those parts and do not commence further work on those parts until the tests have been satisfactorily completed and compliance verified.

1.2.3 SAMPLES

Timing

Delays: Coordinate submissions of related samples. Do not cause delays by making late submissions or submitting inadequate samples.

Quantity

General: Submit a sample of each designated item and 2 copies of supporting documentation. Include ancillary items such as fasteners, flashings and seals.

Identification

Identify the project, contractor, subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include pertinent contract document references. Include service connection requirements and product certification. Identify non-compliances with project requirements, and characteristics which may be detrimental to successful performance of the completed work.

Approval

General: Do not commence work affected by samples until the samples have been approved. Submit further samples as necessary.

Retention

Keep approved samples in good condition on site, until practical completion.

Incorporation

Incorporate in the works samples which have been approved for incorporation. Do not incorporate other samples.

Criteria

Match approved samples throughout the works.

1.2.4 CONTRACTOR'S SUBMISSIONS

Timing

General: Submit documents in a timely manner, to suit the construction program. Advise if any of the documents are to be returned.

Delays: Coordinate submissions of related items. Do not cause delays by making late or inadequate submissions.

Quantity

Bound documents:	3 copies.
Loose documents up to and including A3:	One copy.
Loose documents larger than A3:	One transparency on heavyweight plastic film the same size as the standard contract drawings.
Standard contract drawing size:	A1

Electronic Format: Provide copies of documents in agreed electronic format.

Identification

Identify the project, contractor, subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include pertinent contract document references. Include service connection requirements and product certification. Identify non-compliances with project requirements, and characteristics which may be detrimental to successful performance of the completed work.

Quality Assurance

Requirement: Where there is a recognized quality assurance program applicable to a specified product, provide assurance of product quality under the authority of that program. The program shall be one in which the Manufacturer has in place a quality control management system which is subject to continual monitoring through quality audits by a recognized independent organization.

Program: Submit a copy of the contractor's quality assurance programme with the Tender.

During the construction phase the contractor shall provide a written verification to the contract administrator that he has completed quality assurance procedures on the construction work detailed in the specifications and drawings.

Description: Provide a written description of each quality management system, with specific reference to the following:

- the relevant Australian standard
- where the standard provides for classification levels, the level adopted
- the scope and field of application
- the personnel involved and their responsibilities
- construction method statements
- Inspection Test Plans (ITP's)
- the various procedures required by the standard including those for management review, contract review, design and document control, process control, inspection and testing, etc.
- the quality audit system
- where external quality audits are required by a recognised independent organization, the name of that organisation
- other relevant information.

Quality control: The Contractor shall submit their Construction Method and Inspection Test Plan (I.T.P) for each work procedure to the contract administrator for approval a minimum of 14 days prior to commencing the relevant work. I.T.Ps shall include checklists showing that the Contractor has checked that the work has been completed in accordance with the specifications and drawings and showing testing and client inspection requirements.

Endorsement

Witness points: Give notice before commencing work affected by contractor's submissions, unless the submissions have been endorsed as satisfactory.

Hold points: Do not commence work affected by contractor's submissions until, if appropriate, the submissions have been endorsed as satisfactory.

Errors: If a document contains errors, submit a new or amended document as appropriate, indicating changes since the previous submission.

Design

General: If part or all of an installation is to be designed by the contractor, submit documents showing the layout and details of the installation.

Variation documents: If it is proposed to change the installation from that shown on the contract documents, or if changes are required by statutory authorities, submit variation documents showing the proposed changes. Where the contract administrator deems that the proposed variation work is to be reviewed and inspected by the relevant consultant(s), this review and inspection shall be at the contractor's expense.

Shop drawings

General: Submit dimensional drawings showing details of fabrication and installation of services and equipment, including relationship to building structure and other services.

Diagrammatic layouts: Coordinate work shown diagrammatically in the contract documents, and submit dimensioned set-out drawings.

Authorities

Correspondence: Submit copies of correspondence and notes of meetings with authorities.

Authorities' approvals: Submit documents showing approval of the authorities whose requirements apply to the work.

Tests

Tests program: Submit a testing and commissioning program which is consistent with the construction program. Include particulars of test stages and procedures.

Test records: For designated tests, including pre-delivery tests, record results and submit reports or certificates in a form suitable for inclusion in operation and maintenance manuals.

Samples

If it is intended to incorporate samples into the works, submit proposals.

Materials and components

Product data: Submit the manufacturer's product data including

- technical specifications and drawings
- type test reports
- performance and rating tables
- recommendations for installation and maintenance.

Proposed products schedules: For major products not specified as proprietary items, within 3 weeks of site possession submit a schedule of those proposed for use.

Product certification: If products must comply with product certification schemes, submit evidence of compliance.

Execution

Acceptance of substrate: Submit installers' statements verifying that the substrate is satisfactory for receiving the installation.

1.2.5 NON-CONFORMING WORK

Where a section of work does not comply with the requirements of the specification and drawings (including requirements for inspection and testing) the Contractor shall submit a non-conformance report detailing the proposed rectification method to the contract administrator for approval. Where the contract administrator deems that the proposed rectification method and work is to be reviewed and/ or inspected by the relevant consultant(s), this review and inspection shall be at the contractor's expense.

1.3 MATERIALS AND COMPONENTS

1.3.1 GENERAL

Sources policy >

Proprietary items

Implication: Identification of a proprietary item does not necessarily imply exclusive preference for the item so identified but indicates the necessary properties of the item.

Alternatives: Unless otherwise agreed, alternatives shall not be ground for any claim for variation to cost or time. If alternatives are proposed, submit proposed alternatives and include samples, available technical information and reasons for proposed substitutions. If necessary, provide an English translation. If so requested, obtain and submit reports on relevant tests by an independent testing authority. State if use of proposed alternatives will necessitate alteration to other parts of the works. If the alternative product is accepted, carry out any such alteration without extra charge.

Manufacturers' or suppliers' recommendations

General: Select, if no selection is given, and transport, deliver, store, handle, protect, finish, adjust, prepare for use, and use manufactured items in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Instructions: Submit the recommendations and instructions and advise of conflicts with other requirements.

Project modifications: Advise of activities that supplement, or are contrary to, manufacturer's or suppliers' written recommendations and instructions. Provide written certification and warranty from the product manufacturer specifically for its intended purpose and performance in this project.

Product certification: If products must comply with product certification schemes, use them in accordance with the certification requirements.

Installation: The manufacturer shall visit the site during construction and at completion of construction to certify in writing that the work has been carried out in accordance with their requirements. The manufacturer must also certify that individual components of the proprietary products have not been substituted with alternative products.

Sealed containers

If materials or products are supplied by the manufacturer in closed or sealed containers or packages, bring the materials or products to point of use in the original containers or packages.

Consistency

For the whole quantity of each material or product use the same manufacturer or source and provide consistent type, size, quality and appearance.

1.4 COMPLETION

1.4.1 GENERAL

Samples

Remove unincorporated samples on completion.

Contractor's submissions

Within 2 weeks after practical completion, submit 3 copies of designated documents.

Warranties

General: Name the principal as warrantee. Register with manufacturers as necessary. Retain copies delivered with components and equipment.

Commencement: Commence warranty periods at practical completion or at acceptance of installation, if acceptance is not concurrent with practical completion.

Approval of installer: If installation is not by manufacturer, and product warranty is conditional on the manufacturer's approval of the installer, submit the manufacturer's written approval of the installing firm.

Table 1.4.1-1: Warranty Schedule

Item	Period
Pipework	20 years
Pits	20 years
Access covers, grates and frames	20 years

1.4.2 RECORD DRAWINGS (WORK AS EXECUTED DRAWINGS AND CCTV)

General

It is the Contractor’s responsibility to provide adequate survey information to confirm what they have “installed” or constructed is in accordance with the design and documentation. Should the Contractor administrator deem the survey information provided inadequate, the contractor shall submit a new survey information to the contract administrator’s approval.

Submit record drawings. Show the "as installed" locations of all works constructed under this contract. Show off-the-grid dimensions where applicable. Record drawings are to be submitted in electronic data both in two and three-dimensional formats, accompanied by a “hard copy”. Electronic formats to be agreed with Contract Administrator. Record drawings are to be made by a registered surveyor.

It is the Contractor’s responsibility to provide Closed Circuit Television (CCTV) information of all the in-ground stormwater to confirm what they have “installed” or constructed is of good structural condition and no blockage present.

Services

Show dimensions, types and location of equipment, cables, piping and ductwork in relation to permanent site features and other underground services. Include relationship to building structure and other services, and changes made during commissioning and the maintenance period. Include diagrammatic drawings of each system showing piping and wiring, and principal items of equipment.

Format

Use the same borders and title block as the contract drawings.

2.0 SITE PREPARATION

2.1 GENERAL

Site preparation includes:

- service identification
- erosion and sediment control establishment
- dust control
- marking all items to be protected during the construction period
- dewatering
- site clearing and topsoil stripping
- traffic control establishment
- identification of underpinning extents if required

2.1.1 CROSS REFERENCES

General

Refer to the General requirements section.

Related sections

Refer to the following sections:

- General Requirements
- Earthwork
- Demolition
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

2.1.2 INTERPRETATION

Services: Pipes, cables, ducts, associated structures or similar objects, including electrical, communication and control cables, drains, sewers, water pipes, gas pipes, and the like.

2.2 QUALITY

2.2.1 INSPECTION

General

Refer also to General Requirements section and Appendix A.

Witness points

Give sufficient notice so that inspection may be made of the following:

- Enclosures to trees to be retained.
- Erosion control measures installed
- Stripping of Topsoil complete
- Site clearing complete
- Traffic control devices installed.

Hold points Refer to Schedule of Inspection and Testing Requirements

2.2.2 CONTRACTOR'S SUBMISSIONS

Materials

Submit details of materials proposed, including the following:

- Use of cleared vegetation for mulching.

Execution

Submit the methods and equipment proposed for the groundworks, including the following:

- Dewatering and groundwater control and disposal of surface water.
- Control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems.
- Dust control.
- Proposals for underpinning of existing structures.

2.3 SITE MANAGEMENT

2.3.1 REMOVAL OF TOPSOIL

General

Extent: Remove the topsoil layer of the natural ground containing substantial organic matter, over the areas to be excavated or regraded, and areas to be occupied by structures, pavements, embankments and the like, and other areas designated to have topsoil removed.

Depth to be removed: Refer to

- Geotechnical Investigation for Existing Carpark by JKGeotechnics (Ref: 29017ZHrpt) dated 14 January 2016;
- Geotechnical Investigation for Proposed Demountable Buildings by JKGeotechnics (Ref: 33554BCrpt) dated 21 October 2020;
- Geotechnical Investigation for Proposed School Building by JKGeotechnics (Ref: 33775SCrpt) dated 8 February 2021;
- Geotechnical Investigation for Proposed School Building by JKGeotechnics (Ref: 33775SCrpt2) dated 26 April 2021;
- Preliminary Waste Classification Assessment for Proposed New School Building by JKEnvironments (Ref: 33775PHlet) dated 3 February 2021.

Topsoil stockpiles

Dispose of topsoil off site unless directed otherwise by the Contract Administrator or contract documents. Where directed to stockpile topsoil on site, establish stockpiles to sizes and in locations as directed, to heights not exceeding 2.5 m. Provide adequate drainage and erosion protection. Do not burn off or remove plant growth which may occur during storage. Do not allow traffic on stockpiles. If a stockpile is to remain for more than four weeks, sow with temporary grass. Protect the topsoil stockpiles from contamination by other excavated material, weeds and building debris.

2.3.2 TREE PROTECTION

Warning sign

General: Display a sign in a prominent position at each entrance to the site, warning that trees and plantings are to be protected during the contract. Remove on completion.

Lettering: Road sign type sans serif letters, 100 mm high, in red on a white background, to AS 1744.

2.3.3 TREES TO BE RETAINED

Marking

General: Mark trees and shrubs to be retained using suitable non-injurious, easily visible and removable means of identification.

Tags: 100 x 50 mm zincanneal tags, painted yellow and lettered to conform with the tree number on the drawings. Secure tags to trees using loose galvanised steel wire bands.

Trees to be retained: Refer to Architectural / Landscape Drawings

Protection and repair

Protection: Protect from damage the trees and shrubs to be retained, including those beyond the site area, both above and below ground.

Repair: Repair trees damaged during the work.

Tree enclosures

General: Provide temporary protective enclosures or guards.

Wire enclosures: Four strands of fencing wire, or plastic mesh barrier, supported on star pickets spaced at not more than 4 m.

Mesh enclosures: SL62 reinforcing mesh 1800 mm high wired to 2400 mm long star pickets, driven 600 mm into the ground, spaced 1800 mm apart at a minimum distance of 1 m from the tree trunk.

Sheeting to excavations: Where excavations are to be made near trees, add continuous 900 mm high corrugated galvanised steel sheeting, bedded 150 mm into the ground, wired to the enclosure.

Trees to be enclosed: Refer to Architectural / Landscape Drawings

Type of enclosure: Refer to Architectural / Landscape Drawings

Work on trees

If it is proposed to perform work on trees, give notice and obtain instructions.

Removal

If a tree is damaged and repair work is considered impractical, or is attempted and fails, give notice and obtain instructions. If directed remove the tree and root system, make good and either replace the tree with a replacement tree of the same species and a similar size, or pay damages.

2.3.4 WORK NEAR TREES

Protection

Protect trees specified or shown to be retained from damage by groundworks. Take necessary precautions including the following:

Harmful materials

Keep the area within the dripline free of construction material and debris. Do not place bulk materials and harmful materials under or near trees. Do not place spoil from excavations against tree trunks. Prevent wind-blown materials such as cement from harming trees and plants.

Damage

Prevent damage to tree bark. Do not attach stays, guys and the like to trees.

Work under trees

General: Do not remove topsoil from, or add topsoil to, the area within the dripline of the trees.

Excavation: If excavation is required near trees to be retained, give notice and obtain instructions. Open up excavations under tree canopies for as short a period as possible.

Hand methods: Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If it is necessary to excavate within the drip line, use hand methods such that root systems are preserved intact and undamaged.

Roots

Do not cut tree roots exceeding 50 mm diameter. Where it is necessary to cut tree roots, use means such that the cutting does not unduly disturb the remaining root system.

Immediately after cutting, apply a bituminous fungicidal sealant to the cut surface to prevent the incursion of rot or disease.

Backfilling

Backfill to excavations around tree roots with a mixture consisting of three parts by volume of topsoil and one part of well-rotted compost with a neutral pH value, free from weed growth and harmful materials. Place the backfill layers, each of 300 mm maximum depth, compacted to a dry density similar to that of the original or surrounding soil. Do not backfill around tree trunks to a height greater than 300 mm above the original ground surface. Immediately after backfilling, thoroughly water the root zone surrounding the tree.

Compacted ground

Do not compact the ground under trees. If compaction occurs, give notice and obtain instructions.

2.3.5 EXISTING SERVICES

Approval: Do not excavate by machine within 1 m of existing underground services without prior approval.

Location: Position and number of existing services shown on drawings is only indicative and may not include all existing services. It is the Contractor's responsibility to confirm the position of all existing services prior to commencing work.

Alterations: Alter existing services as necessary. All work to comply with authorities requirements. Notify the superintendent prior to contacting authorities.

Interruptions: Obtain necessary approval before interrupting an existing service and perform the work so that the duration and number of interruptions are reduced to a minimum. Provide a program before starting this work.

Supporting existing work: If an existing service or structure, which is to be retained, crosses the line of a required trench/excavation, provide permanent support for the existing service or structure.

Costs: the contractor shall allow for all costs involved including obtaining approvals, fees and inspections as required by relevant authorities.

Existing Services to be removed

Remove exiting services which are not required for the completed works. Stage removal to suit the works program and to maintain supply as required. Where the service to be removed connects to a service which is to be retained, disconnect the section to be removed and carry out works as necessary such that the remaining section is protected and remains operational.

Following removal of existing services, backfill service trenches in accordance with the Services Trenches specification.

2.3.6 ENVIRONMENTAL PROTECTION

Erosion control

General: Plan and carry out the work so as to avoid erosion, contamination, and sedimentation of the site, surrounding areas, and drainage systems. Comply with the requirements of the erosion and sediment control drawings and relevant authorities. Maintain landscaped areas in good condition.

Temporary erosion control measures

Staging: Stage operations (e.g. clearing, stripping).

Restoration: Progressively restore disturbed areas.

Drains: Provide temporary drains, catch drains and sedimentation basins.

Dispersal: Divert and disperse concentrated flows to points where the water can pass through the site without damage.

Spreader banks or other structures: Disperse concentrated run-off.

Silt traps: Construct and maintain silt traps to prevent discharge of scoured material to downstream areas.

Temporary grassing to disturbed areas.

Temporary fencing: Required.

Maintenance: After each rain inspect, clean, and repair if required, temporary erosion and sediment control works.

Completion: Erosion and sediment control measures are to be repaired and left in a good condition at the completion of the works where they are still required. If erosion and sediment control measures are no longer required, remove temporary erosion and sediment control works and make good.

Dewatering

General: Keep groundworks free of surface and ground water. Provide and maintain slopes, crowns and drains on excavations and embankments to ensure free drainage. Install and maintain temporary sumps and dewatering equipment where necessary. All stormwater to be disposed of according to relevant authorities requirements. Place construction, including fill, masonry, concrete and services, on ground from which free water has been removed. Prevent water flow over freshly laid work.

2.3.7 SITE RESTORATION

Requirement

Where existing ground surfaces are not required to be varied as part of the works, restore them to the condition existing at the commencement of the contract.

2.3.8 RECORDS, EXISTING STRUCTURES

Provide dilapidation reports prepared by an independent consultant for existing structures and works to be retained including adjacent properties, public roads and areas which may be affected by the works.

2.3.9 UNDERPINNING, EXISTING STRUCTURES

The new works may involve underpinning of existing structures. The proposals, which shall be submitted for approval, shall ensure the operation of these buildings, paths and accesses is not adversely affected at any stage.

2.3.10 ARTEFACTS

The Superintendent is to be notified should any artefacts or old footings and structures be encountered during any excavation process.

2.3.11 NOISE, VIBRATION, DUST CONTROL

The contractor will demonstrate to the Superintendent that the proposed equipment is within acceptable limits for noise and vibration as determined by a registered acoustic consultant. A proposal detailing control measures shall be submitted before commencement of the works. Noise, vibration and dust levels shall comply with the requirements of relevant authorities and any specific contract requirements.

2.3.12 TRAFFIC MANAGEMENT

The Contractor shall construct the Works in a safe manner with the least possible obstruction to traffic, both vehicular and pedestrian.

The Contractor shall prepare a Traffic Guidance Scheme and submit it to the Contract Administrator and the relevant authorities where required. Carry out all activities for controlling traffic, both vehicular and pedestrian, in accordance with AS 1742.3, and the requirements of the relevant Authorities.

Vehicular and pedestrian access to properties shall be maintained wherever possible. Minimum notice of 48 hours shall be provided to property owners whose access will be restricted (give longer notice where required by relevant authorities).

The Contractor is required to consult with the affected property owners to minimise the impact of the works on the property owners' operations including impacts of works and Traffic Guidance Scheme on businesses and around commercial areas.

On State Roads, Regional Roads, in proximity to certain traffic control devices and where required by the relevant authorities, the Contractor shall obtain formal approval of the Traffic Guidance Scheme from the Statutory Road Authority, Council and Police.

In case of full road closures on local roads, the Contractor shall obtain prior approval form Council.

2.4 SITE CLEARING

2.4.1 SITE CLEARING

Extent

General: Clear only the following site areas:

- Areas to be occupied by works such as buildings, paving, excavation, regrading and landscaping.
- Other areas designated to be cleared.

Contractor's site areas: If not included within the areas specified above, clear generally only to the extent necessary for the performance of the works.

Clearing operations

Removal: Remove everything on or above the site surface, including rubbish, scrap, grass, vegetable matter and organic debris, scrub, trees, timber, stumps, boulders and rubble.

Grubbing: Grub out stumps and roots over 75 mm diameter to a minimum depth of 500 mm below subgrade under buildings, embankments or paving, or 300 mm below finished surface in unpaved areas.

Old works: Remove old works, including slabs, foundations, paving, drains and manholes.

Existing grass: Remove grass to a depth just sufficient to include the root zone.

2.4.2 SPOIL

Offsite disposal

General: Remove surplus excavated material and surplus site clearance material from the site unless directed otherwise by the Contract Administrator or the contract documents.

Surplus material: Dispose of surplus material according to relevant authority's requirements and pay for all associated costs.

Mulch

If directed by the Contract Administrator or contract documents put cleared vegetation through a chipper. Reduce to pieces not larger than 75 x 50 x 15 mm and stockpile for re-use as mulch. Otherwise remove from site and dispose in accordance with "Surplus material".

On site burial

Do not bury boulders, concrete fragments and the like on site.

2.5 COMPLETION

2.5.1 COMPLETION

Temporary works

Where directed by the Contract Administrator or contract documents, leave temporary works in good condition. Otherwise remove temporary works including:

- Tree enclosures: Remove temporary tree enclosures at completion and make good.
- Tree marking: Remove temporary marks and tags at completion.
- Erosion and Sediment Control devices: Remove devices which are no longer required at completion and make good. Devices which are to remain are to be cleaned and left in good condition.
- Traffic control measures: Remove temporary traffic control measures which are no longer required and make good.

3.0 EARTHWORKS

3.1 GENERAL

Earthworks includes;

- Review of the geotechnical report
- Identification of unsuitable material
- Providing complying fill material confirmed by testing
- Excavation to tolerances and testing
- Filling to tolerances, proof rolling and testing

3.1.1 CROSS REFERENCES

General

Refer to the General requirements section.

Related sections

Refer to the following sections:

- General Requirements
- Site Preparation
- Service Trenches
- Demolition
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

3.1.2 INTERPRETATION

Definitions

General: To AS 1348.1.

Description and classification of soils: To AS 1726.

Bad ground: Ground unsuitable for the purposes of the works, including fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances and ground which is or becomes soft, wet or unstable.

Unsuitable Material: Material containing rubbish, organic matter, contaminants and other deleterious material and material which does not comply with the type of fill specified.

Discrepancy: A difference between contract information about the site and conditions encountered on the site, including but not limited to discrepancies concerning:

- the nature or quantity of the material to be excavated or placed;
- existing site levels; and
- services or other obstructions beneath the site surface.

Line of influence: A line extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement. Generally extended at 26° below horizontal unless noted otherwise.

Rock: Monolithic material with volume greater than 0.5 m^3 which cannot be removed until broken up either by explosives or by rippers or percussion tools.

Subgrade: The trimmed or prepared portion of the formation on which the pavement or slab is constructed.

SITE INVESTIGATION

Geotechnical Report and Environmental Investigation

These reports are provided for information only. The geotechnical and environmental information given is information on the nature of the ground at each tested part. It is not a complete description of conditions existing at or below ground level.

Refer to

- Geotechnical Investigation for Existing Carpark by JKGeotechnics (Ref: 29017ZHrpt) dated 14 January 2016;
- Geotechnical Investigation for Proposed Demountable Buildings by JKGeotechnics (Ref: 33554BCrpt) dated 21 October 2020;
- Geotechnical Investigation for Proposed School Building by JKGeotechnics (Ref: 33775SCrpt) dated 8 February 2021;
- Geotechnical Investigation for Proposed School Building by JKGeotechnics (Ref: 33775SCrpt2) dated 26 April 2021;
- Preliminary Waste Classification Assessment for Proposed New School Building by JKEnvironments (Ref: 33775PHlet) dated 3 February 2021.

Notice

If conditions are encountered which are outside of the scope of the contract, give notice immediately and obtain instructions before carrying out any further work in the affected area.

Survey

Survey marks will be confirmed by the contractor using one or more existing features on site.

3.1.3 RECORDS OF MEASUREMENT

Excavation and Backfilling

Agreed quantities: If a schedule of rates applies, provisional quantities are specified, or there are variations to the contract levels or dimensions of excavations, do not commence backfilling or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.
- Quantities of excavations in rock (where rock is to be paid for at a different rate).
- Quantities of fill and topsoil, imports being recorded separately.
- Certified Records: Provide a copy of the agreed records of measurement certified by the contractor and the contract administrator.

Rock

Level and class: If rock is to be measured for payment purposes, whether as extra over excavation of material other than rock or for adjustment of provisional measurements, do not remove the rock until the commencing levels and the classes of rock have been determined.

3.2 QUALITY

3.2.1 INSPECTION

General

Refer also to General Requirements section and Appendix A.

Witness Points

Give sufficient notice so that inspection may be made of the following:

- Areas to be cleared and/or stripped of topsoil.
- Areas stripped of topsoil.
- Excavation completed to contract levels or founding material.
- Base completed to contract levels.
- Stockpiled topsoil before spreading.

Hold Points

Subgrade before placing sub-base, base, working base, filter fabric or membrane, as applicable.

Filter fabric in place before backfilling.

Items to be measured as listed in Records of measurement.

Provision: Provide a smooth drum 10 tonne static weight roller with operator for proof roll inspections. Contractor is to allow for provision of safe access for inspections as required.

3.2.2 TESTS

General

Refer also to General Requirements section and Appendix A.

Testing Authority

Use an independent testing laboratory.

Testing

Compaction (density): Test for compliance.

Retesting: Rework and retest areas which do not achieve the required density until that density is achieved.

Test methods

Field dry density: To AS 1289.5.3.1, AS 1289.5.3.5 or AS 1289.5.8.1. If using AS 1289.5.8.1 calibrate the surface moisture-density gauge in accordance with AS 1289.5.8.4 before use.

Density index: To AS 1289.5.6.1.

Standard maximum dry density: To AS 1289.5.1.1.

Modified maximum dry density: To AS 1289.5.2.1.

Fill: Test to AS 1141 or AS 1289 as appropriate.

California bearing ratio: Sample and test to AS 1289.6.1.1, AS 1289.6.1.2 or AS 1289.6.1.3, as appropriate.

Table 3.2.2-2: Test Schedule

Type of test:	Test Method: AS1289 Method No	Frequency/No. of Tests:
Material Properties of imported fill and excavated material	3.1.1, 3.3.1, 3.6.1 and 6.1.1 Contamination Testing	1 test per 500 m^3 min of 2 per source As required by the Relevant Authorities.
Field Density of compacted fill For confined areas	5.3.1, 5.8.1 or 5.6.1	1 test per 200 mm layer per 1000 m^2 1 test per layer per lot
Field Density of compacted fill under pavements	5.3.1, 5.8.1 or 5.6.1	1 test per layer per 500 m^3
Backfilling to structures	5.3.1, 5.6.1 or 5.8.1	1 test per two layers per 40 m. Min of 1 test per two layers per lot

Note to Engineers: Frequency of testing to be modified as required to suit the project i.e. smaller projects will require a higher frequency to be specified.

Contractor to submit testing plan for Superintendents approval.

3.2.3 SAMPLES

General

Submit samples of the following:

- Each type of filter fabric.
- Each type of imported fill.

3.2.4 CONTRACTOR'S SUBMISSIONS

Design

Calculations: Submit calculations to show that proposed excavations and temporary supports, including where applicable supports for adjacent structures, will be stable and safe.

Tests

Imported fill: Submit certification or test results which establish the compliance of imported fill with the contract.

Materials

Submit details of materials proposed, including the following:

- Sources of imported fill.

Execution

Submit the methods and equipment proposed for the groundwork's, including the following:

- Excavation methods, stages, clearances, batters and temporary supports.
- Stockpiles and borrow pits.
- Placing and compaction methods and stages.

The checking and certification of the stability of proposed excavations and the design and certification of temporary supports including, where applicable, supports for adjacent structures, shall be the responsibility of the contractor.

3.3 EXCAVATING

3.3.1 TOLERANCES

Surfaces

Finish groundworks to reasonably smooth and uniform surfaces conforming to the required tolerances.

Subgrades

General: The tolerances in the **Subgrade tolerances table** apply to finished subgrade levels unless overridden by the specific requirements (including tolerances) for finished surface levels and thicknesses of covering materials.

Absolute level tolerance: Maximum deviation from design level.

Relative level tolerance: Maximum deviation from a 3 m straight edge laid anywhere on each plane surface.

Table 3.3.1-3: Subgrade tolerances table

Item	Level tolerance (maximum)	
	Absolute	Relative
Cut subgrade in earth and fill subgrade	+ 0 - 20	Unspecified
Cut subgrade in rock	+ 0 - 20	Unspecified

Other Groundworks

Batters: Not steeper than the slope specified or shown on the Drawings or recommended in the Geotechnical report whichever is less steep.

Vertical: The tolerances on vertical faces of excavation in relation to the line of excavation shown on the drawing is:

Bulk Excavation

inside line of excavation: 0 mm

outside line of excavation: 150 mm

Detailed Excavation

inside line of excavation: 0 mm

outside line of excavation: 100 mm

3.3.2 EXCAVATION

Extent

Site surface: Excavate over the site to give correct levels and profiles as the basis for construction, paving, filling and landscaping. Make allowance for compaction or settlement.

Footings: Excavate for footings, pits, wells and shafts, to the required sizes and depths. Confirm that bearing capacity is adequate.

Crawl space: Provide clear space under timber floor bearers.

Minimum clearance: 400 mm.

Grading

External Areas: Grade external areas to give falls away from the building, minimum 1:100, unless shown otherwise on drawings.

Subfloor Areas: Grade the ground surface under suspended floors to drain ground or surface water away from the building without ponding, unless shown otherwise on drawings.

Electrical Substation: Where external electrical substations/kiosks are to be installed, prepare and grade the ground surface in accordance with the Relevant Authorities requirements.

Existing Footings

If excavation is required below the line of influence of an existing footing, use methods which maintain the support of the footing and ensure that the structure and finishes supported by the footing are not damaged.

Proof Rolling

Extent: Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the extent of any bad ground.

Proof rolling method:

- Roller type and size: Smooth drum 10 Tonne static weight
- Number of passes: 1
- Settlement limit (mm): 3

3.3.3 PROVISIONAL DEPTHS

Contract Depths

The footing or pier depths shown on the drawings are provisional.

3.3.4 EXPLOSIVES

General

Do not use explosives.

3.3.5 BAD GROUND

Requirement: Where the existing subgrade or excavated material is deemed unsuitable for the purposes of the works (refer 1.2 INTERPRETATION, Bad Ground/unsuitable material), the material shall be either reworked to comply with the specification or removed from site and replaced with material complying with the specification. Where necessary the Contractor should seek advice from a suitably qualified geotechnical engineer regarding alternative treatment of the bad ground.

The Contractor shall familiarise themselves with the site conditions and the geotechnical site investigation report and shall be deemed to have allowed for any work required to rectify bad ground.

Contaminated Ground

The contractor shall familiarise themselves with the site conditions and the Environmental Investigation Report and shall be deemed to have allowed for all costs associated with the excavation, offsite disposal or treatment and the replacement of contaminated materials as required. The contractor shall allow for the cost of verifying that all remedial works comply with the requirements of the Relevant Statutory Authorities.

3.3.6 BEARING SURFACES

General

Provide even plane bearing surfaces for loadbearing elements including footings. Step to accommodate level changes. Make the steps to the appropriate courses if supporting masonry.

Deterioration

If the bearing surface deteriorates after approval because of water or other cause, excavate further to a sound surface before placing the loadbearing element. The Contractor will be deemed to have caused the conditions and will conduct necessary additional work at no extra charge and without extension of time for completion.

3.3.7 REINSTATEMENT OF EXCAVATION

General

Where excavation exceeds the required depth, or deteriorates, reinstate to the correct depth, level and bearing value.

Particular

Below or within the "line of influence" of footings, beams, or other structural elements: Concrete of strength equal to the structural element, minimum 15 MPa.

Below slabs or pavements: Use selected filling compacted to the specified density. In cut subgrades if the over excavation is less than 100 mm, do not backfill, but make good by increasing the thickness of the layer above.

Line of influence

Angle from horizontal: 26°

3.3.8 SUPPORTING EXCAVATIONS

Removal of supports

Remove temporary supports progressively as backfilling proceeds.

Voids

Guard against the formation of voids outside sheeting or sheet piling if used. Fill and compact voids to a dry density similar to that of the surrounding material.

3.3.9 ADJACENT STRUCTURES

Temporary supports

General: Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works.

Lateral supports: Provide lateral support using shoring.

Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

Permanent supports

If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

Encroachments

If encroachments from adjacent structures are encountered and are not shown on the drawings, give notice and obtain instructions.

3.4 PLACING AND COMPACTION

3.4.1 FILL

Fill Material

General: Inorganic, non-perishable material. All fill to be select fill unless noted otherwise.

Sulphur content: Do not use filling with sulphur content exceeding 0.5% within 500 mm of cement bound elements (for example concrete structures or masonry) unless such elements are protected by impermeable membranes or equivalent means.

Sources:

Provide fill imported on to the site from suitable sources unless the fill type can be provided from

- spoil recovered from the excavations; or
- borrow material from designated borrow pits.

Imported fill must be uncontaminated material of a type approved by the Relevant Authorities for use as filling on this site. Contractor to undertake all necessary investigations and testing on proposed material.

Fill Types

General fill: Well graded material, maximum particle size 75 mm, low to medium plasticity and classified as Class A or Class S material in table 2.1 of AS 2870. Fill material to have a minimum 4 day soaked CBR of 4% in accordance with AS 1289.6.1.1 unless noted otherwise on drawings. Material to be a low dispersion risk, minimum Emerson class 3.

Select fill: Material complying with the following:

Table 3.4.1-4: Select fill grading table

Sieve aperture (mm) to AS 1152	Percentage passing (by mass)
75.0	100
9.5	100 to 50
2.36	100 to 30
0.60	50 to 15
0.075	<25%

- Plasticity index: ≥ 2%, ≤ 15%.
- Non dispersive (a rating of nil as defined by the “dispersion” test AS 1289.3.8.1).
- Minimum 4 day soaked CBR of 6% in accordance with AS 1289.6.1.1 unless noted otherwise on drawings.
- Granular fill: Granular backfill adjacent to retaining walls shall be free draining crushed hard rock or crushed natural gravel as specified below

Table 3.4.1-5: Granular fill grading table

Sieve aperture (mm) to AS 1152	Percentage passing (by mass)
9.5	100
6.70	95-98
4.75	58-78
2.36	37-50
1.38	22-30
0.425	10-17
0.075	2-10

- Plasticity Index: Not greater than 3%.
- Liquid Limit: Not greater than 25%.
- Coefficient of permeability: Not less than 0.1 mm/sec.
- Non-dispersive (a rating of nil as defined by the ‘dispersion test’ AS 1289.3.8.1).

Building Basecourse: Crushed hard rock or crushed natural gravel capable of being compacted to an even stable surface and complying with the grading and properties listed below:

Table 3.4.1-6: Building basecourse grading table

Sieve aperture (mm) to AS 1152	Percentage passing (by mass)
26.5	100
19.0	95-100
13.2	75-95
9.5	60-90
4.75	42-76
2.36	28-60
0.425	10-28
0.075	2-10

- Plasticity Index: Not greater than 10%.
- Liquid Limit: Not greater than 25%
- California Bearing Ratio: Not less than 35%.
- Unsound rock: Not greater than 20%.
- Non dispersive (a rating of nil defined by the 'dispersion' test AS 1289.3.8.1).

Subsoil filter: Crushed stone graded to the subsoil grading table.

Table 3.4.1-7: Subsoil grading table

ieve aperture (mm) to AS 1152	Percentage passing (by mass) Course filter
26.5	100
19.0	90-100
9.5	10-15
4.75	3-10
2.36	
1.18	0-5
0.60	
0.30	
0.15	
0.075	0-3

Fill Subgrades

Use material in the top 150 mm which has a maximum particle size of 40 mm.

3.4.2 PREPARATION FOR FILLING

General

Prepare the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements. Remove loose material, debris and organic matter and compact the ground to achieve the required density.

Benching

If fill is to be placed on a surface which slopes more than 1:4, bench the surface to form a key for the fill. As each of layer of fill is placed, cut the existing ground surface progressively to form a series of horizontal steps at least 1 m in width. Recompact the excavated material as part of the filling.

Under Earth Mounds

Cultivate the ground to a depth of 200 mm before mound formation.

Under Slabs, Paving and Embankments

Compact the ground to achieve the densities specified for these locations. If necessary loosen the ground to a depth of 200 mm and adjust the moisture content before compaction.

Rock Ledges

Remove overhanging rock ledges.

Tolerances

Finish the surface to the required level, grade and shape within the following tolerances:

- Under slabs pavements and loadbearing elements: +0, -20 mm.
- Other ground surfaces: ±20 mm, provided the area remains free draining and matches adjacent construction where required.

3.4.3 FILTER FABRIC

Material

Type: Polymeric fabric formed from a plastic yarn composed of at least 85% by weight of propylene, ethylene, amide or vinylidene chloride and containing stabilisers or inhibitors to make the filaments resistant to deterioration due to ultraviolet light.

Identification and marking: To AS 3705.

Protection

Provide heavy duty protective covering. Store clear of the ground and out of direct sunlight. During installation do not expose the filter fabric to sunlight for more than 14 days.

Preparation

Before placing the filter fabric trim the ground to a smooth surface free from cavities and projecting rocks.

Placing

Lay the fabric flat, but not stretched tight, and secure it with anchor pins. Overlap joints 300 mm minimum.

3.4.4 PLACING FILL

General

Layers: Place fill in layers not exceeding 200 mm compacted thickness.

Extent: Place and compact fill to the designated dimensions, levels, grades, and cross sections so that the surface is always self draining.

Placing at Structures

General: Place and compact fill in layers simultaneously on both sides of structures, culverts and pipelines to avoid differential loading.

Concrete: Do not place fill against concrete until the concrete has been in place for fourteen days.

Placing for Structural Platforms

Unless noted otherwise, compaction of fill for building floor slabs and pavements shall extend at least 2 m beyond the building or pavement extent at the bulk earthworks level.

Moisture Content

Adjustment: Where necessary to achieve the required density or moisture content, adjust the moisture content of the fill before compaction.

Proof rolling: Proof roll existing subgrade before placing filling and finished subgrade.

Location: At existing subgrade level and at finished subgrade.

Extent: All Fill Areas

Roller type and size: Smooth drum 10 (ten) tonne static weight

Acceptance criteria: Less than 3 mm movement

3.4.5 COMPACTION

Density

Compact each layer of fill to the required depth and density.

Table 3.4.5-8: Compaction schedule

AREA	COMPACTION RATIO % OF MAXIMUM DRY DENSITY OR DENSITY INDEX (DI)	MOISTURE % FROM OPTIMUM	TYPE OF FILL
Landscape Areas	95% Standard or 70 DI	-2,+2	General
Fill and subgrade under or within line of influence of structures	98% Standard or 80 DI	-2, +2	General
Fill and subgrade under or within line of influence of pavements or building slabs	98% Standard or 80 DI	-2, +2	General
Backfill behind retaining wall	98% standard or 80 DI	-2, +2	Granular fill
Building Basecourse	98% modified or 85 DI	-2, +2	Building Basecourse

Moisture variations shown are the maximum allowable variations from the optimum moisture content. The Contractor must ensure that the fill material is placed at a moisture content which allows it to be compacted and proof rolled in accordance with the specification (i.e. stricter moisture control may be required on site).

Protection

Protect the works from damage due to compaction operations. Where necessary, limit the size of compaction equipment or compact by hand. Commence compacting each layer at the structure and proceed away from it.

3.4.6 GRADING

External Areas

Grade to give falls away from buildings, minimum 1:100.

Subfloor Areas

General: Grade the ground surface under suspended floors to drain ground or surface water away from buildings without ponding.

3.5 BARRIERS AND MEMBRANES

3.5.1 PROTECTION TO MEMBRANES

Protective Covering

Do not disturb or damage the protective covering of membranes during backfilling.

3.6 RETAINING WALLS

3.6.1 REINFORCED CONCRETE BLOCK AND CAST INSITU CONCRETE WALLS

Reinforced concrete block walls and cast insitu concrete walls shall be constructed in accordance with the details and notes on the drawings.

3.6.2 CRIB WALLS

General

Type: Proprietary system of interlocking precast concrete or preservative treated timber cribs with selected backfill placed and compacted progressively with the crib to form a retaining wall. Crib walls to be installed in accordance with the Manufacturer's requirements.

3.6.3 GABIONS

General

Type: Proprietary system of steel mesh or fabric baskets wired together and filled with rock to form permeable scour protection linings and retaining walls. All work to be in accordance with manufacturers requirements. Place filter fabric under and behind the gabions.

Protection: >

Rock Fill

General: Clean, hard, durable crushed rock, rock spalls or river gravel, with minimum size larger than the maximum opening size of the mesh or fabric forming the basket.

Los Angeles value (to AS 1141.23): Maximum 45.

Assembly

Assemble the baskets and join them together by wiring along edges both horizontally and vertically in accordance with the manufacturers requirements before placing the rock fill. Fix the top of the basket by wiring to both the sides and the diaphragms.

3.6.4 EARTH REINFORCEMENT

General

Type: Proprietary system of galvanised steel strips or steel mesh strips placed in layers with compacted fill and connected to precast concrete facing panels to form vertical retaining walls. Provide the necessary accessories including levelling pad, bearing pads, and joint fillers or covers to keep the fill material out of the panel joints. Fill materials, compaction and other construction details to be in accordance with the manufacturer's requirements.

3.6.5 INTERLOCKING BLOCK WALL

Description

Proprietary system of dowelled precast concrete block with or without membrane reinforcement as specified by the Manufacturer and backfill material as specified by the Manufacturer placed and compacted progressively with the blockwork to form a retaining wall.

General Requirements

The Contractor shall design and construct the interlocking block wall to sustain vehicle loads during construction and service loads in accordance with all statutory requirements. Minimum serviceable life of 100 years is required.

Drawings and Calculation

The Contractor shall provide sets of design calculations and drawings showing clearly the design parameters, member sizes and details, backfill material and compaction for review by the superintendent 28 days prior to commencing work.

This review will not relieve the Contractor of fulfilling his responsibilities under the contract.

Certification

The Contractor will provide certificates certifying the design and construction for compliance with the relative standards and Local Authority requirements.

3.7 COMPLETION

3.7.1 COMPLETION

Records

Certified records of measurement: Submit a certified copy of the agreed records of measurement.

Temporary Works

Temporary supports: Remove temporary supports to adjacent structures at completion.

4.0 SERVICE TRENCHING

4.1 GENERAL

4.1.1 GENERAL

Service Trenching includes;

- Trench excavation
- Testing the trench base
- Bedding installation
- Backfill installation and testing
- Reinstating the surface

4.1.2 CROSS REFERENCES

General

Refer to the General requirements section.

Related sections

Refer to the following sections:

- General Requirements
- Site Preparation
- Earthwork
- Stormwater
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

4.1.3 APPLICATION OF THIS SPECIFICATION

This specification applies to work on privately owned property. Where works are on public property, or property which is to come under the control of a Statutory Authority (Council, State Road Authority etc), or where the works are to come under the control of a Statutory Authority (i.e. stormwater drainage in a future easement), works shall be carried out in accordance with the requirements of the relevant Statutory Authority.

4.2 QUALITY

4.2.1 INSPECTION

General

Refer also to General Requirements section and Appendix A.

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Service trenches excavated before laying the service.
- Services laid in trenches and ready for backfilling.

Hold points Refer to Schedule of Inspection and Testing Requirements

4.2.2 TESTS

General

Refer also to General Requirements section and Appendix A.

Testing

Compaction (density): Test for compliance.

Retesting: Rework and retest areas which do not achieve the required density until that density is achieved.

Test methods

Field dry density: To AS 1289.5.3.1, AS 1289.5.3.5 or AS 1289.5.8.1 calibrate the surface moisture-density gauge in accordance with AS 1289.5.8.4 before use.

Density index: To AS 1289.5.6.1.

Standard maximum dry density: To AS 1289.5.1.1.

Modified maximum dry density: To AS 1289.5.2.1.

Test frequency: One test per 40 lineal metres of trench per 2 layers of fill. At least 2 tests per section of work. A number of the specified tests should be conducted on the backfill to personnel access points and pits as directed by the contract administrator.

4.3 SERVICE TRENCHES

4.3.1 EXCAVATING

Existing Surfaces

Before excavating trenches, saw-cut existing concrete and bituminous surfaces on each side of the trench to provide a straight even joint. Lift and store unit paving for later reinstatement.

Excavation

Excavate for underground services, to required lines, levels and grades. Generally make the trenches straight between manholes, inspection points and junctions, with vertical sides and uniform grades.

Excavation of service trenches shall be completed prior to lime stabilisation of the subgrade. Notify the contract administrator if any trenches are be to excavated in stabilised ground. Any trenches in stabilised ground to be backfilled as specified in the Reinstatement of Surfaces Subsection.

Trench Widths

Keep trench widths to the minimum consistent with the laying and bedding of the relevant service and construction of personnel access ways and pits.

Trench Lengths

Excavate trenches in sections of suitable length.

Trench Depths

General: As required by the relevant service and its bedding method.

Notice: If excavation is necessary below the level of adjacent footings, give notice, and provide necessary support for the footings.

Obstructions

Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

Dewatering

Keep trenches free of water. Place bedding material, services and backfilling on firm ground free of surface water.

Excess Excavation

If trench excavation exceeds the correct depth, reinstate to the correct depth and bearing value using compacted bedding material or grade N20 concrete.

4.3.2 BORING

Subcontractor

If under road boring is required in lieu of trenches, engage a suitably qualified subcontractor to do the work.

Process

Ensure a tight fit to the service pipes. If voids are encountered, fill by pressure grouting.

4.3.3 BACKFILLING

These requirements apply to backfill to service trenches and service access points. Bedding and overlay to a minimum depth of 200 mm above the service shall be Pipe Bedding as specified below unless specified otherwise in relevant service specification. Trench backfill above this level shall be backfill material as specified below. Bedding, overlay and trench backfill to be compacted in accordance with the compaction schedule. Place filling in layers not exceeding 200 mm compacted layer thickness.

Marking services

Underground marking tape: To AS/NZS 2648.1.

Pipe Bedding

TYPE: Granular material (clean sharp washed river sand or clean unweathered hard basaltic or sedimentary crushed rock, free of salt, clay or organic contaminants) or cementitious material (mortar or concrete) as specified.

Sand:

Table 4.3.3-9: Sand criteria

Sieve Aperture (mm) to AS1152	Percentage Passing (by mass)
6.7	100
4.75	90 to 100
2.36	60 to 100
1.18	40 to 100
0.6	20 to 90
0.3	8 to 50
0.15	0 to 20
0.075	0 to 10

Table 4.3.3-10: Crushed Rock criteria

Sieve Aperture (mm) to AS1152	Percentage Passing (by mass)
9.5	98 to 100
6.7	50 to 100
4.75	15 to 75
2.36	0 to 40
1.18	0 to 5

Cement Mortar Bedding: 1 Portland cement: 4 sand.

Concrete Bedding: Not less than 20 MPa.

Backfill Material

General: General fill except with no stones greater than 25 mm occurring within 150 mm of the service, or other materials as required for particular services or locations. Well graded, inorganic, non-perishable material, maximum size 75 mm, plasticity index * 55% and classified as Class A or Class S material in Table 2.1 of AS 2870. Fill material to have a minimum 4 day soaked CBR of 6% in accordance with AS 1239.6.1.1 unless noted otherwise on drawings. Material to be non-dispersive (a rating of nil as defined by the dispersion test AS 1239.3.8.1).

Under roads and paved areas: Fine crushed rock, or 3% cement stabilised sand.

In topsoil areas: Complete the backfilling with topsoil for at least the top 50 mm.

In reactive clay: In sites classified M, H or E to AS2870, use an impervious material where trenches fall towards footings. In other trenches use selected fill, (See earthwork section), not sand.

Table 4.3.3-11: Compaction schedule - service trenches

AREA	COMPACTION RATIO % OF MAXIMUM DRY DENSITY OR DENSITY INDEX (DI)	MOISTURE % FROM OPTIMUM *
Landscape Areas		
- bedding and overlay	70 (DI)	-2, +2
- trench backfill	70 (DI) or 95% standard	-2, +2
Under or within line of influence of pavements, structures or building slabs		
- bedding and overlay	80 (DI)	-2, +2
- trench backfill	80 (DI) or 98% standard 98% modified	-2, +2
- pavement zone		-2, +2

NOTE: Moisture variations shown are maximum allowable variations from the optimum moisture content. The Contractor must ensure that the backfill material is placed at a moisture content which allows it to be compacted and proof rolled in accordance with the specification (i.e. stricter moisture control may be required).

4.3.4 REINSTATEMENT OF SURFACES

General

Reinstate existing surfaces removed or disturbed by trench excavations to match existing and adjacent work.

Lawn Areas

Provide 150 mm of loam and resow the lawn over the trench and other disturbed areas.

Paving and Roads

Reinstate to match adjacent work, paved surfaces and assets disturbed or removed during excavation of trenching. Where lime stabilised subgrade is disturbed, replace this layer with crushed rock material as specified for the sub-base.

Concrete Surfaces

Reinstate concrete surfaces to the original level. If necessary, provide steel reinforcement tied to the adjacent concrete and laid to prevent the reinstalled concrete from subsiding and cracking. Engineer to approve proposed reinforcing details. Provide crushed rock base and sub-base to match existing pavement.

Bituminous Surfaces

General: Provide crushed rock base and subbase to match the existing pavement. Prime coat the edges of the existing surfacing with bitumen. Lay and compact hot-mix asphalt so that the edges are flush and the centre is cambered 10 mm above the existing pavement.

Minimum asphalt thickness: 50 mm or the adjacent pavement thickness, whichever is thicker.

Unit Paving

Provide crushed rock base and subbase to match the existing pavement. Provide sand bedding. Reinstate the paving units. Replace any damaged units with matching items. Provide jointing sand and lay and compact

the paving units in accordance with the manufacturer's requirement. Replace damaged edge restraints to match existing.

5.0 STORMWATER

5.1 GENERAL

Stormwater includes:

- Pipe work installation
- Pit installation
- Subsoil installation
- Hydrostatic testing
- Maintenance of pipe covers and protection of pipe work during construction

5.1.1 CROSS REFERENCES

General

Refer to the General requirements section.

Related Sections

Refer to the following sections:

- General Requirements
- Site Preparation
- Earthwork
- Service Trenching
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

5.1.2 APPLICATION OF THIS SPECIFICATION

This specification applies to work on privately owned property. Where works are on public property, or property which is to come under the control of a Statutory Authority (Council, State Road Authority etc), or where the works are to come under the control of a Statutory Authority (i.e. stormwater drainage in a future easement), works shall be carried out in accordance with the requirements of the relevant Statutory Authority.

5.1.3 STANDARD

Stormwater Drainage

General: To AS 3500.3.2.

5.1.4 INTERPRETATION

Definition

Pipe surround: Includes pipe overlay, pipe side support, side zone and haunch zone.

5.1.5 EXISTING SERVICES

Refer to Site Preparation section.

5.2 QUALITY

5.2.1 INSPECTION

General

Refer also to General Requirements section and Appendix A.

5.2.2 SAMPLES

General

Submit samples of the following:

- Each type of imported pipe bedding material.
- Each type of filter material.

Certificates: With the samples also provide certificates from the supplier indicating that the sample conforms with the specified particle size distribution and material properties.

5.2.3 TESTS

General

Refer also to General Requirements section and Appendix A.

Table 5.2.3-12: Test Schedule

Type of test	Test Frequency	Test Method
Density tests: Bedding Pipe surround Backfill	Refer service trenching section	
Pipework tests	All pipework	AS 3500.3.2 and pipework testing schedule
Concrete Testing	Each concrete pour (refer concrete tests)	To AS 1012
Material Tests Subsoil filter, pipe bedding, pipe surround, trench backfill	1 test per 250 m^3, min of 2 tests per source of supply / material type	AS 1289

Pipework Testing

Requirement: Carry out required tests to AS 3500.3.2 and as required by relevant authorities. Supply the apparatus and materials necessary. Submit the test results in writing.

Hydrostatic Tests

Table 5.2.3-13: Tests (additional to AS 3500.3.2) schedule

Product	Test method	Criteria	Report
All downpipes	AS 3500.3.2 Section 10	Full compliance	Test certificate

All stormwater pipes	Hydrostatic test table	Full compliance	Test certificate

Table 5.2.3-14: Hydrostatic Test Table

Type of joint	Pressure Head (Height)	Test Period	Max Water Loss (Per 30 Metre Length of Drain)
Rubber ring	1750 mm min 1850 mm max	15 minutes	250 millilitres per 25 mm pipe diameter
Cement Mortar	1750 mm min 1850 mm max	15 minutes	250 millilitres per 25 mm pipe diameter
Solvent Welded	1750 mm min 1850 mm max	15 minutes	No loss permitted

Preparation for testing**:** Securely anchor pipes and fittings in position to prevent movement during the tests.

Concealed work**:** Do not cover or conceal work until it has been tested. Leave pipe joints exposed to enable observation during the tests.

Density Tests

Requirement: Obtain density tests for pipe bedding and trench backfill from an independent testing authority. Do not proceed with work subject to testing until tests are satisfactorily completed. Refer to the Service Trenching section for testing requirements.

Concrete Tests

Requirement: Carry out all necessary tests for concrete used in pits, pipe surround, pipe supports and the like.

Test Methods: To AS 1012.

Frequency of sampling: Where project assessment of strength grade is specified, spread the site sampling evenly throughout the pour. The following minimum requirements shall apply in addition to those in AS 1379 Clauses B 7.2 (b) and B 7.3 9 (b) but not less than project control testing, in accordance with the following table:

Table 5.2.3-15: Compressive Tests Schedule

NUMBERS OF BATCHES PER DAY	NUMBER OF SAMPLES
1	1
2 to 5	2
6 to 10	3
11 to 20	4
For each additional 10 batches, one additional sample shall be taken	

Acceptance criteria: The average strength of the samples representing an element shall be not less than the specified strength.

5.3 EXECUTION

5.3.1 EXECUTION

Requirement: Install the stormwater drains as necessary to connect downpipes, surface drains, subsoil drains and drainage pits to the outlet point or point of connection.

Excavation and Backfilling: Excavation, bedding and backfill requirements are specified in Earthwork and Service Trenching sections. All stormwater services beneath pavements should be installed prior to commencing stabilisation or final trimming of the subgrade.

Unstable Foundations (Unsuitable Trench Subgrade Material)

Requirement: Where the existing trench subgrade material is deemed unsuitable for the purposes of the works, the unsuitable material shall be either reworked to comply with the specification or removed from site and replaced with material complying with the specification. Where necessary the Contractor should seek advice from a suitably qualified geotechnical engineer regarding alternative treatment of the unsuitable trench subgrade material.

The Contractor shall familiarise themselves with the site conditions and the geotechnical site investigation report and shall be deemed to have allowed for any work required to rectify unsuitable trench subgrade material.

Gradients: Lay drains to gradients complying with the relevant authority's requirements, to the levels shown on the Drawings, and in any case, not less than the following:

Table 5.3.1-16: Minimum Pipe Gradients

Pipe Diameter (mm)	Stormwater Drains
100	1 in 100
150	1 in 150
225 and up	1 in 200

Downpipe connections: Turn up the drain branch pipeline with a suitable bend to meet the downpipe, to finish 50 mm above finished ground or pavement level unless detailed otherwise on drawings. Downpipe

connections to be made using manufactured adaptors and to be pressure tested in accordance with the Tests subsection. Refer to the architectural drawings for the exact location of the down pipes.

Tolerances: Place pipelines in accordance with the Pipeline maximum tolerances table.

Table 5.3.1-17: Pipeline maximum tolerances table

	Angular deviation from required alignment	Displacement from required alignment
Horizontal	1 in 300	15 mm
Vertical	1 in 500	5 mm

Conditions: Tolerances stated above are conditional on falls to outlets being maintained and no part of a pipeline being at less than the designated gradient.

Identification: Lay a detectable strip or plastic tape in the trench after pipelaying, testing and initial backfilling.

Pipe underlay: Bed the pipework on a continuous underlay of bedding material, not less than 75 mm thick after compaction. Grade the underlay evenly to the required gradient of the pipeline.

Chases: Form chases where necessary to prevent sockets, flanges or the like from bearing on the trench bottom or the underlay.

Anchor blocks: Install anchorages in the form of lateral or longitudinal anchor blocks, of not less than 15 MPa concrete, to restrain lateral movement in pipelines at ends and changes of gradient or direction or longitudinal movement in pipelines laid to gradients exceeding 7%. Bear anchorages against the body of the pipe only, clear of joints, and against firm undisturbed ground or compacted filling.

Lateral Anchor Blocks: Bear against the full diameter of the pipe for a length equal to not less than the pipe diameter, with a thrust bearing against the excavation of not less than 0.25 m2 or the (pipe diameter) 2, whichever is the greater.

Longitudinal Anchor Blocks: At 10 m maximum intervals. Extend 150 mm into the sides and bottom of the trench, and 75 mm above the crown of the pipe. Width (measured parallel to the pipe axis) 300 mm.

Encasement: Unless otherwise permitted by the relevant authority, concrete encase the following:

- Pipelines which cannot be provided with the required minimum cover;
- Pipelines shown on the drawings or otherwise specified to be encased.

Encase the pipeline in concrete not less than 150 mm above and below the pipe and 150 mm each side or the width of the trench, whichever is the greater.

Concrete: Grade N20 to AS 1379.

Pipe surround: The pipe surround shall include the haunch zone, side zone and overlay to a depth of 200 mm above the top of the pipe. Place the material in the pipe surround in layers not more than 100 mm loose thickness and compact in accordance with the compaction schedule without damaging or displacing the pipework. Material in the pipe surround shall conform with requirements for bedding material.

Minimum Cover Over Pipe: Unless overridden by regulatory authority requirements or otherwise specified, the following table shall apply:

Table 5.3.1-18: Minimum cover over pipe table

PIPE LOCATION	MINIMUM COVER
Pipes not subject to vehicular loading:	400 mm
Pipes subject to vehicular loading - not in roadways - under sealed roadways - under unsealed roadways	 600 mm 600 mm 750 mm
Pipes in embankments or subject to Construction equipment loading.	750 mm

Stormwater Pipeline Schedule

Unless noted otherwise the following schedule is to be complied with:

Table 5.3.1-19: Stormwater pipeline schedule

Location	Pipe material and size	Class	Jointing
All	Concrete	2	Rubber ring joint
All	uPVC	SH	Solvent welded
All	VCP	3	Rubber ring joint

Flexible Joints

Where pipes join to concreted fittings, pits, manholes and the like, two flexible joints shall be located on the pipe within 800 mm of the outer face of the structure, and not more than 600 mm apart.

Charged Lines

Stormwaters pipes are not to be changed unless noted on the drawings.

Connections To Existing

Connect new pipelines to existing drains as follows:

New Pits: Where a new pit is to be installed in an existing pipeline, cut the existing pipes back flush with the interior walls of the new pit and construct the new pit in accordance with the drawings and specification. If the existing pipe is damaged during construction or if construction requires the removal of existing pipes, replace the pipes with new pipes equivalent to the existing pipes. All connections between new pipes and existing pipes to use joints equivalent to the joints in the original pipeline. Where relevant provide new flexible connections either side of the pit as specified above.

To Authority's Main: As required by the regulatory authority. If the authority elects to perform the work, comply with Works by Statutory Authorities in Authorities Approvals (General Requirements Section).

To Pits, Culverts, Channels etc: All connections to existing pits, culverts etc to comply with the requirements of the Relevant Authorities where applicable. Make an opening in the existing structure to the minimum size required to accept the new pipe. New pipe to finish flush with the interior wall of the existing structure. Make good the opening in the structure and adjust the benching as required. Where relevant use flexible connections as specified above.

To Existing Pipelines Less than 375 mm : If the new pipeline is 300 mm or less, remove an appropriate length of the existing pipeline and insert a new slope junction and new pipework consistent with the existing pipeline.

To Existing Pipelines 375mm or Larger: Connection as specified in AS 3500.3.2 Clause 8.8.1(b). Centreline of branch to intersect centreline of main, and change of direction of flow at cut-in must be between 45° and 90°.

Junction Pits: Provide a junction pit for new branch drains greater than 100 mm, unless otherwise specified on drawings.

To Street Gutter: (Stormwater lines where shown): Enter the pipe into an opening made in the kerb, to finish flush with the kerb face, and seal by pointing in 1 cement: 3 sand. Restore the kerb and pavement as necessary, to match existing.

5.3.2 LINED SURFACE DRAINS

Half round pipe drains: Surface drains lined with half round pipe including the necessary bedding and jointing.

Grated trench: Cast is situ concrete trench. Grating as specified in pits subsection.

Lined surface drains schedule - as shown on the civil drawings

5.3.3 PRECAST BOX CULVERTS

Standards

Culverts < 1200 mm span x 900 mm high: To New South Wales Roads and Maritime Services Authority QA Specification No. R16.

Culverts 1500 - 4200 mm span x 4200 mm (maximum) high: To AS 1597.2 or New South Wales Roads and Maritime Services Authority QA Specification No. R16 as relevant.

General: Design loading shall include the depth of fill over the culvert as shown on the drawings and T44 truck loading in accordance with Austroads Standards. Certification of the concrete box culvert and manufacturers certificates shall be provided by the Contractor prior to culvert installation. The culvert manufacturer shall have an approved quality assurance program in place.

Precast box culverts schedule - as shown on the civil drawings.

Lifting gear: Provide suitable attachments for lifting gear to culverts of 600 x 450 mm or larger.

Base slab: Preparation of ground under base slabs shall be in accordance with the requirements of the Earthwork section for subgrade preparation under structures including requirements for compaction, testing and inspection. Unless specified otherwise, ground under base slabs shall be compacted to 98% Standard Maximum Dry Density (AS 1239.5.1.1). All workmanship, materials and testing for concrete base slabs to be in accordance with the requirements of AS 3600 and AS 1012 and the contract documents.

Installation: Screed and compact the bedding for precast bases to provide uniform support. Install culvert sections to provide a continuous waterway without abrupt changes in alignment or grade. Seal joints between box culvert units using 150 mm wide Densopol 60 HT tape or approved equivalent. Fill joint between culvert leg and base slab with grout and seal with Densopol 60 HT tape.

Backfilling: The backfill to the sides and above precast box culverts shall be selected filling (refer to the Earthwork section) compacted in accordance with the requirements of the compaction schedule for stormwater trench backfill (refer service trenching section). Place and compact filling in layers simultaneously on both sides of the culvert to avoid differential loading.

Where completed pavements (including lime or cement stabilised subgrade) are disturbed by excavation for culverts, the pavement shall be restored as specified in the Service Trenching section.

5.3.4 CORRUGATED STEEL PIPE DRAINS AND DETENTION TANKS

Standards

Products, design and installation: To AS 1761 and AS 1762 or AS 2041 as relevant.

Corrugated steel pipe drains schedule: As shown on the drawings.

5.3.5 SUBSOIL DRAINS

General

Provide PVC subsoil drains to intercept groundwater seepage and prevent water build-up behind walls and under floors and pavements. Connect subsoil drains to surface drains or to the stormwater drainage system as applicable.

Pipe depth

Provide the following minimum clear depths, measured to the crown of the pipe, where the pipe passes below the following elements:

- 100 mm below formation level of the pavement, kerb or channel.
- 100 mm below the average gradient of the bottom of footings.
- 450 mm below the finished surface of unpaved ground.

Jointing

At junctions of subsoil pipes provide tees, couplings or adaptors to AS 2439.1.

Trench width

Minimum 300 mm unless shown otherwise on the drawings.

Pipe Underlay

General: Grade the trench floor evenly to the gradient of the pipeline. If the trench floor is rock, correct any irregularities with compacted bedding material. Bed piping on a continuous layer of coarse filter material at least 100 mm thick after compaction. Lay the pipe with one line of perforations at the bottom.

Chases: If necessary, form chases to prevent projections such as sockets and flanges from bearing on the trench bottom.

Pipe Surrounds

General: Place the filter material in the pipe surround in layers of 200 mm loose thickness, and compact without damaging or displacing the piping.

Depth of overlay:

- To the underside of the bases of overlying structures such as pavements, slabs and channels.
- To within 150 mm of the finished surface of unpaved or landscaped areas.
- As shown on the drawings.

Filter Material

Surround to subsoil drains shall be crushed hard rock or natural gravel, complying with the following grading:

Table 5.3.5-20: Filter material criteria

Sieve Aperture (mm) to AS 1152	Percentage Passing (by mass) Coarse Filter (Nom. 20 mm)
26.5	100
19.0	90-100
9.5	10-15
4.75	3-10
2.36	
1.18	0-5
0.600	
0.300	
0.150	
0.075	0-3

Filter Fabric

General: Provide polymeric fabric formed from plastic yarn composed of at least 85% by weight propylene, ethylene, amide or vinylidene chloride, and containing stabilisers or inhibitors which provide resistance to deterioration due to ultraviolet light.

Marking: To AS 3705.

Protection: Provide heavy duty protective covering. Store clear of the ground and out of direct sunlight. During installation do not expose the filter fabric to sunlight for more than 14 days.

Filter Socks

Provide polyester permeable socks capable of retaining particles of 0.25 mm size. Securely overlay the sock at each joint.

Subsoil pipeline schedule - as shown on the civil drawings.

Backfilling: Backfill material above pipe overlay to be in accordance with the requirements of the drawings and the Service Trenching section.

Flushing Points: Shall be turned up and capped at the surface with a cast iron box with hinged lid set in a concrete surround 300 mm square by 150 mm deep.

Where a drain is under a pavement, risers shall be diverted from the line of the drain so that the cover will be at the outside edge of the nearer shoulder or behind the nearer kerb. Surround risers with compacted filter medium.

Flushing: Flush drains clean on completion by adding water at the flushing points at a rate between 1 and 2 L/s. Flush each point in turn, commencing at the high end. Observe outlets and continue flushing until clean water is discharged. Pump silt and water from silt traps while flushing upstream points to maintain free flow into traps during flushing. Install rodent proofing to outlets immediately on completion of flushing.

Tolerances: Pipelines shall be within 50 mm of design line and shall fall towards the outlet at all points. Subsoil drains to be installed at a minimum grade of 1% unless otherwise specified.

5.3.6 PITS AND OTHER STRUCTURES

Requirement: Construct pits, sumps, manholes, tanks, wells, headwalls, cast insitu culverts and the like as shown on the drawings and as follows, unless otherwise specified:

General: All materials, workmanship and testing to be in accordance with AS 3600 and AS 1012.

Floors and Walls:

In situ concrete: N25 MPa, reinforced with SL82 fabric (40 cover to inside face) unless shown otherwise. Thickness not less than 150 mm, unless otherwise shown or specified.

Prefabricated concrete: Walls of spun precast sections not less than 60 mm thick. Floor cast in situ or prefabricated. Provide cored holes as required. Details of the proposed pits are to be submitted to the Contract Administrator for approval.

Finish to exposed surfaces: Smooth, seamless, equal to steel trowelled render or concrete cast in steel forms. Cove or splay internal corners. Bench floors and fall to drain.

Render: 1 cement : 3 sand, minimum thickness 20 mm.

Pit Access Steps: To AS 1657, 24 mm diameter galvanised deformed mild steel. Provide steps to pits greater than 0.9 m deep, cast or built into the pit walls clear of drain outlet openings or discharges. Pit access step spacing and size to be in accordance with drawings and AS 1657.

Ladders: Where required, provide steel ladders, ladder cages and landings in accordance with AS 1657 and the requirements of the relevant authorities. Steelwork is to be hot dip galvanised as specified in AS 1650.

Pipe connections: Build inlet and outlet pipes into the pit walls during construction. In existing or prefabricated pits, make openings of the correct size and pack the joint around the pipe to the full thickness of the wall with 1:3 mortar. Pipes to finish flush with the inside wall of the pit.

Pipe Channels: When pipe channels are required in pit floors, form the channel to the full depth of the pipe.

Metal access covers and grates

Standard: To AS 3996.

Cover schedule: As shown on the civil drawings.

Cover levels: Top of cover or grate, including frame:

- In paved areas: Flush with the paving surface.
- In landscaped areas: 25 mm above finished surface (gratings to be flush).
- Gratings taking surface water runoff: Locate to receive runoff without ponding.

6.0 ROADBASE AND SUBBASE

6.1 GENERAL

Roadbase and subbase includes:

- Supply, installation and testing of roadbase and subbase

6.1.1 CROSS REFERENCES

General

Refer to the General Requirements section.

Related Sections

Refer to the following sections:

- General Requirements
- Site Preparation
- Earthwork
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

6.1.2 INTERPRETATION

Definitions

Standard: To AS 1348.1.

Absolute level tolerance: Maximum deviation from design levels.

Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.

RMS: Road and Maritime Services.

Rigid Pavement

Pavement construction in which the base consists of Portland cement concrete and the subbase consists of unbound materials, or cement treated materials, or lean mix Portland cement concrete.

6.1.3 APPLICATION OF THIS SPECIFICATION

This specification applies to work on privately owned property. Where works are on public property, or property which is to come under the control of a Statutory Authority (Council, State Road Authority etc), or where the works are to come under the control of a Statutory Authority, works shall be carried out in accordance with the requirements of the relevant Statutory Authority.

6.2 QUALITY

6.2.1 INSPECTION

General

Refer also to General Requirements section and Appendix A.

Witness Points

Give sufficient notice so that inspection may be made at the following stages:

- Materials or areas of work ready for tests.
- Testing including proof rolling.
- Each pavement layer placed and compacted.
- Automatic level control devices in place.
- Subgrade material opened up so that its nature can be assessed.
- Surfaces prepared for priming, sealing or surfacing.
- Placing subbase and base.
- Subbase and base completed.

Hold points - proof roll inspection and test certificates for underlying work (filling, subgrade etc).

6.2.2 TESTS

General

Refer also to General Requirements section and Appendix A.

Process Control Tests

Perform tests of the type and frequency necessary to adequately control the materials and processes used in the construction of the works. Tests described in the Process control schedule are the minimum requirement.

Table 6.2.2-21: Compliance assessment schedule

Type of Test	Test Frequency	Test Method
Material properties of subbase/ basecourse	In accordance with RMS Specification No.3051	In accordance with RMS specification No 3051
Material properties of Lime	1 per source	In accordance with RMS Teste Method T430.
Lime stabilised subgrade, lime content and cement stabilised subbase cement content	1 per 250 m^2	RMS Test Method T134 or RMS Test Method T143 as applicable

Sampling

Process control tests: Determine timing and location.

Compliance Assessment Tests:

Timing: Obtain materials samples from stockpiles prior to delivery to site. Ensure that material tested represents material delivered to site.

Location: Sample from selected sample sites within designated uniform test lots, consisting of an area placed, or compacted or both in one day. Test lots must be uniform in terms of material properties and density.

Subgrade, Subbase and Base

General: Test for compliance with the specified density, and for criteria given in the Subbase tests table and the Base tests table.

Density Test Methods:

- Field dry density: To AS 1289.5.3.1, AS 1289.5.3.5 or AS 1289.5.8.1. If using AS 1289.5.8.1 calibrate the surface moisture-density gauge in accordance with AS 1289.5.8.4 before use on the site.
- Standard maximum dry density: To AS 1289.5.1.1.
- Modified maximum dry density: To AS 1289.5.2.1.
- Compaction: To AS 1289.5.4.1.

Table 6.2.2-22: Density tests schedule

Location	Test frequency
Subgrade	1 per 250 m^2 or 3 No. per lot
Subbase	1 per 250 m^2 or 3 No. per lot
Base	1 per 250 m^2 or 3 No. per lot

6.2.3 SAMPLES

General

Submit samples of the following at least one month before use in the works:

Granular materials: One 20 kg sample of each proposed type and size of material including base, subbase and cement treated subbase.

Identification

Attach a tag to each sample showing relevant information including description, source and nominal size of material.

6.2.4 CONTRACTOR'S SUBMISSIONS

General

Refer also to General Requirements section for Quality Assurance and testing requirements.

Tests

Compliance assessment: If compliance assessment tests are to be carried out by an independent testing authority, have the authority submit 3 copies of each test result.

Certificate of compliance: If a certificate of compliance is acceptable as an alternative to testing a manufactured material, submit the manufacturer's certificate together with the results of recent tests undertaken by the manufacturer, showing compliance with test criteria.

Materials

Delivery dockets: Submit a delivery docket at the time and place of delivery for each truckload of subbase and base material, showing

- empty and loaded mass of vehicle;
- date and time of batching;
- supplier and location of mixing plant;
- registration number of the vehicle; and
- nature of material.

Execution

General: Submit proposals for the methods and equipment to be used for the roadworks, including the following:

- Staging of the work, access and traffic control methods.
- Disposal of surface water, control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems.
- Methods and equipment for each operation.
- Sources of materials.
- Material stockpiles.

Cement treated materials: Submit proposed method of mixing.

Compaction: If it is proposed that a layer is to exceed 150 mm in thickness, submit evidence demonstrating that the proposed compaction equipment can achieve the required density throughout the layer.

Records of measurement

Submit certified records of work performed as follows: >

6.3 MATERIALS

6.3.1 BASE MATERIALS

Source Material

Type: Crushed rock or natural gravel consisting of hard, dense, durable particles of uniform quality, free from deleterious materials or coatings including clay and organic matter.

River stones: If the material is produced by crushing rounded river stones, 75% of the particles larger than 9.5 mm must have at least 2 fractured faces.

If it is proposed to use recycled building material, details of the proposed material must be submitted for approval. Recycled building material must be crushed cement concrete only complying with the requirements of RMS QA Specification 3051 including Table 3051.3 Limits of Foreign Material for Recycled Building Materials.

Base material - Base material to conform with the particle size distribution and other required properties specified in RMS QA specification 3051 for Category 2(b) materials. Base material to be DGB20 unless otherwise specified on the drawings.

6.3.2 SUBBASE MATERIALS

Source Material

As specified for base material.

Subbase Material

Subbase material to conform with the particle size distribution and other properties specified in RMS QA specification 3051 for Category 2(b) materials. Subbase material to be DGS40 unless specified otherwise on the drawings.

6.3.3 CEMENT TREATED MATERIALS

Source Material

Type: Crushed rock or natural gravel consisting of hard, dense, durable particles of uniform quality, free from deleterious materials or coatings including clay and organic matter.

River stones: If the material is produced by crushing rounded river stones, 75% of the particles larger than 9.5 mm must have at least 2 fractured faces.

If it is proposed to use recycled building material, details of the proposed material must be submitted for approval. Recycled building material must be crushed cement concrete only complying with the requirements of RMS QA Specification 3052 including Table 3052.3 Limits of Foreign Material for Recycled Building Materials.

Subbase/Base Material

Material to conform with the particle size distribution and other required properties specified in RMS QA specification 3052 for Category 2(b) materials.

Cement Treated Base and Subbase

Cement type to AS 3972: GP.

Cement content (% by dry mass of aggregate): As specified on the drawings.

- Tolerance: ± 0.3%.

Mixing

Mix cement and water with the subbase/base material in mixing plant before placing the material. Provide mixes which are consistently uniform and of the required proportions and moisture content.

6.3.4 LIME STABILISED SUBGRADE

General: Hydrated lime shall be used for stabilisation.

Standard: RMS Test Method T430.

Hydrated lime: The hydrated lime shall have the following properties:

- The available lime calculated as calcium hydroxide, shall not be less than 85%.
- The material shall be dry.
- The material shall be in powder form and the residue on a 300 micrometre sieve shall not exceed 2%

6.3.5 LEAN MIX CONCRETE SUBBASE

Refer to the concrete road surfacing section.

6.4 SUBGRADE, SUBBASE AND BASE

6.4.1 TOLERANCES

Surface Level

General: Provide a finished surface which is free draining and evenly graded between level points.

Edges abutting gutters: Within ± 5 mm of the level of the actual gutter edge.

Tolerances: The tolerances in the Surface level tolerances table apply to the finished level of each layer, unless overridden by the requirements (including tolerances) for the finished level and thickness of the surface course.

Table 6.4.1-23: Surface level tolerances table

Item	Level tolerance:	
	Absolute	**Relative**
Cut subgrade in earth and fill subgrade	+ 0 mm - unspecified	20 mm
Cut subgrade in rock	+ 0 mm - unspecified	unspecified
Subbase surface	+ 0 mm	10 mm - 10 mm
Lean mix concrete subbase surface	+ 0 - 10 mm	5 mm
Base surface	+ 0 mm -20 mm	10 mm -20 mm
Base surface under segmental unit paving	+10 mm -0 mm	10 mm

Compacted Layer Thickness

Subbase and base (individual layers and total thickness): + unspecified, - 10 mm.

6.4.2 SUBGRADE PREPARATION

General

Trim the subgrade to an even surface free from loose material.

Subgrades Affected by Moisture

Where the existing subgrade or filling in unable to support construction equipment or it is not possible to compact the overlying pavement because of deterioration due to water or any other cause occurring after the exposure of the existing subgrade or filling the Contractor shall be deemed to have caused the conditions. Perform one or more of the following at no extra charge and without extension of time for completion.

- Allow the subgrade to dry until it will support equipment and allow compaction.

- Scarify the subgrade, work as necessary to accelerate drying, and recompact when the moisture content approximates the optimum.

- Excavate the wet material and remove to spoil.

Draining depressions

General: Grade depressions to drain to the edge of the formation.

Rock subgrades: In rock subgrades, drain depressions with subgrade drains at least 150 mm wide, backfilled with coarse filter, and connected to the stormwater system or to longitudinal subsoil drains.

- Depth of subgrade drain: 100 mm

Unsuitable Material

Remove roots, boulders, silt, organic matter and other unsuitable materials. Refer also to Earthworks Section regarding unsuitable material and bad ground.

Backfilling

Select filling: Replace over-excavation, including excavation for grub holes and removal of wet or unsuitable material, with granular material complying with the following:

- Maximum particle size: 75 mm.

- Proportion passing 0.075 mm sieve: 25% maximum.

- Plasticity index: > 2%, * 15%.

Subbase material: In cut subgrades, if over-excavation, other than excavation to remove unsuitable material, requires a replacement layer less than 100 mm thick, do not backfill, but make good by increasing the thickness of the lowest pavement layer.

Coarse filter: Backfill rock depressions and subgrade drains with coarse subsoil filter.

6.4.3 COMPACTION

Fill Subgrades

Maximum particle size of material in the top 150 mm: 75 mm.

Table 6.4.3-24: Compaction Schedule

Required Subgrade Densities: Location:	Minimum density required: (% of maximum dry density):	Moisture Content % variation from optimum *
Backfilling of grub holes:	98% Standard	± 2
Replacement of over excavation:	98% Standard	± 2
Replacement of unsuitable material:	98% Standard	± 2
Top 150 mm of fill subgrades:	98% Standard	± 2
Cut subgrade in earth to a minimum depth of 150mm	98% Standard	± 2
Lime stabilised subgrade	98% Standard	± 2
Required Base and Subbase Densities		
Item description:	**Minimum density required:**	
Base:	98% Modified	± 2
Subbase:	98% Modified	± 2
Cement-treated subbase:	98% Modified	± 2

* Moisture variations shown are the maximum allowable variations from the optimum moisture content. The Contractor must ensure that the fill material is placed at a moisture content which allows it to be compacted and proof rolled in accordance with the specification (i.e. stricter moisture control may be required on site).

Proof Rolling

Proof roll the subgrade using a smooth steel-wheeled roller of at least 10 t mass. Fill or replace depressions or soft spots developed on the subgrade during proof-rolling and continue rolling until uniform compaction is obtained.

Cement treated material: Begin compacting immediately after spreading and complete it in a continuous operation not more than 2 hours after the cement and water have been mixed into the material.

Compaction Requirements

Apply uniform and sufficient compactive effort over the whole area to be compacted. Use rollers appropriate to the materials and compaction requirements.

Layer Thickness

General: Compact the material in layers of 100 - 150 mm compacted thickness. Within these limits, provide layers of the same material in multi-layer courses which are of equal thickness.

Moisture Content

General: During spreading and compaction, maintain materials at the optimum moisture content appropriate to each material.

Moisture Control

General: Moisten prepared subgrades and preceding layers of subbase immediately before spreading subbase or base material. Keep the leading edges of subbase or base material moist until new material is added next to it. Do not wash fines from the subbase or base material.

Spraying: Maintain moisture content. Use water spraying equipment capable of distributing water uniformly in controlled quantities over uniform lane widths.

Cement treated material: Keep the compacted surface of each layer moist by watering until covered by further material or a bituminous curing seal. Apply bitumen emulsion or cut back bitumen to the final surface as soon as possible after the completion of compaction and in any case after not more than 8 hours.

Rectification

If a section of subgrade or pavement material fails to meet the required density or moisture content after compaction, rectify as follows:

- Fill subgrades: Remove the non-complying material, replace with fill material as specified in Subgrade preparation, and recompact.
- Cut subgrades: Rework the material and recompact.
- Pavement material: Remove the non-complying material, replace with new pavement material, and recompact.

Level Corrections

Rectify incorrect levels as follows:

- High areas, unbound layers: Grade off.
- High areas, bound layers: Remove to the full depth of the layer, replace with new cement-treated material, and recompact.
- Low areas: Remove bound layers to the full depth and unbound layers to a minimum depth of 75 mm, replace with new material and recompact.

6.4.4 PLACING BASE AND SUBBASE

General

Weak surfaces: Do not place material on a surface which has been so weakened by moisture that it will not support, without damage, the constructional plant required to perform the work.

Spreading: Spread material in uniform layers without segregation, by direct tipping from suitable vehicles or using a mechanical spreader.

Segregation: Do not tip materials in heaps and then spread by grader. If material becomes segregated, remix using a rotary hoe or other suitable equipment.

Moisture content: Maintain wet mixed materials at the required moisture content before and during spreading. Add water to dry mixed materials through fine sprays to the entire surface of the layer after spreading, to bring the material to the required moisture content.

Layer thickness: 100 - 150 mm (after compaction). Use equal layers in multilayer courses.

Joints

Plan spreading and delivery to minimise the number of joints. Offset joints in successive layers by at least 300 mm.

Cement Treated Subbase

Joints: Make longitudinal and transverse joints, as specified in Junctions with existing pavements:

- at the end of each day's work;
- where spreading has been halted for more than 2 hours; and
- where required.

6.4.5 JUNCTIONS WITH EXISTING PAVEMENTS

General

Trimming: Where the pavement is to be joined to an existing pavement remove a strip of the existing pavement at least 300 mm wide for its full depth and trim the edge to an angle of approximately 45° in steps of maximum height 150 mm before placing new pavement material.

6.4.6 FINISHING BASE SURFACES

Surfaces to be Primed

Produce a tight even surface without loose stones or a slurry of fines. Construct the fine crushed rock surface slightly higher than the required levels and cut it to profile using a power grader towards the end of the compaction process.

Disposal of Cuttings

Cuttings from the surface may be used in fills or elsewhere in the works.

Subbase to concrete pavements (debonding): The subbase under concrete pavements should be trimmed and compacted as described above for surfaces to be primed and covered with two coats of wax emulsion curing compound. The wax emulsion curing compound shall have a water retention efficiency of not less than 90% when tested to AS 3799, have a weight solid content of not less then 30% and comply with AS 3799 and RMS specification 3202. Each coat of wax emulsion is to be applied at a rate of 0.2L/m2. The first coat should be applied immediately upon completion of trimming the subbase material. Any damage or wear to the wax emulsion coating which occurs prior to placing the concrete base course shall be repaired at the Contractor's expense.

6.4.7 SERVICE TRENCHES AND PITS

General: Any reference to trenches also includes pits. All services beneath pavements should be installed prior to commencing stabilisation or final trim of subgrade. Where it is necessary to excavate a service trench in a partially completed or completed pavement area, the trench is to be restored as described below.

Requirement: Backfill the trench to the underside of the pavement zone in accordance with the requirements of the Service Trenching Section. The pavement zone includes subbase, base and pavement surfacing.

Any pavement material adjacent to the trench which has been disturbed or contaminated by the trench excavation shall be removed, and pavement material shall be removed for a minimum width of 300 mm either side of the trench excavation. The joint with existing pavement shall be trimmed as described in Junctions with Existing Pavements.

The pavement material shall be reinstated using material, layer thicknesses and compaction as specified for the original pavement. The pavement surface layer (concrete, asphaltic concrete etc.) is to be restored in accordance with the requirements of the relevant subsection of this specification.

Testing: Materials certificates are to be supplied for each type of pavement material used in the restoration in accordance with the relevant subsection of this specification.

Density tests are to be conducted on each layer of pavement material. Frequency of testing shall be:

1 test per 20 m, min of 1 test per layer per lot.

6.4.8 LIME STABILISATION OF SUBGRADE

Generally: Prior to in place mixing, the layer to be stabilised shall be compacted to a minimum of 95% standard and shall be trimmed parallel to the designed grade level. Lime stabilising shall be done after all services are backfilled. If it is necessary to excavate service trenches or pits following stabilisation, the trench or pit is to

be backfilled using DGB 20 fine crushed rock compacted to 98% modified maximum dry density over the depth of the lime stabilised layer.

Should ripping or tyning of the in-situ material be subsequently required to facilitate in place mixing, it shall be carried out prior to spreading of the lime in such a manner as not to disturb the layer beneath the layer to be stabilised.

The Contractor shall nominate the spread rate that will be used to achieve the specified proportion of lime.

Spreading shall be carried out using a mechanical spreader capable of spreading the lime uniformly, to an accuracy of 10% of the nominated rate.

The actual spread rate shall be verified on a daily basis and shall be within -10% and +20% of the nominated rate.

No traffic nor any equipment not actually used in the spreading or mixing of the lime agent shall be allowed to pass over the spread lime until it has been mixed in to the layer to be stabilised.

Mixing shall be done so that uniform mixing is achieved over the whole area and to the full nominated depth. Lime content throughout the full depth shall be in excess of the nominated percentage.

The uniformity of mixing in the vertical direction shall be checked by determining separately the percentage by weight of lime content in the top and bottom halves of a test hole, dug to the specified depth of mixing.

Water shall be added to the materials during the mixing process, as required, so as to achieve the specified moisture content.

No water shall be added to the mixed material after mixing and before compaction is completed, other than light surface wetting to reduce moisture loss and lay dust.

Spillage: Stabilising agent spilt shall be removed within four hours of occurrence at no cost to the Principal.

Placement: Spreading, trimming and compaction of the stabilised material shall be carried out in accordance with Earthworks and Roadworks Specifications except that the minimum dry density to be achieved shall be the comparative dry density performed on material taken by the Contractor, as soon as practicable after placement in the layer. Field dry density shall be carried out in approximately the same location from which the comparative dry density sample is obtained.

Stabilisation shall not be carried out during wet weather or if rain is likely to fall during the process. Stabilisation shall not be carried out during periods of wind which could cause loss of stabilising agent or cause nuisance or danger to people or property.

Trimming and compaction shall be done within 24 hours after the commencement of mixing. Reworking of materials will be allowed up to 24 hours after mixing, subject to the agreement of the Superintendent.

Material shall not be cut and spread onto the mixed layer but all trimmed material shall be either cut to waste, picked up and used as fill or spread as directed.

The depth of the stabilised layer as specified shall be maintained after such trimming protection.

Stabilisation shall be carried out so that the full width of carriageway specified is completed in the one day operation.

Stabilisation shall commence from any end or ends of the limits of the work and shall continue from that end or ends without gap to completion.

Special attention to compaction shall be given at the joints so that the material complies in all respects with the Specification and the existing edge is not damaged.

Longitudinal Joints: Stabilising operations shall be planned so that compaction is carried out without the need for longitudinal joints.

Longitudinal joints may only occur where the contractor can demonstrate that the joints are unavoidable. If compaction of adjoining runs cannot be affected within two hours of incorporating the lime, a longitudinal joint shall be formed between the runs as follows:

- Just prior to placing the next run, the edge of the previously placed and compacted run shall be cut back to the extent that the compacted mix at the cut face complies with the requirements of this Specification.
- The cut off material shall be removed from the site and the joint area left clean.
- If necessary, the cut face of the previous run shall be maintained in a damp condition prior to placing the next run.

- The roller shall be partly supported on previously compacted run when compacting fresh mix placed against the cut face.

Transverse Joints: Transverse joints may be formed in the following circumstances:

- Just prior to the commencement of the days stabilising operation.
- Following any delay in excess of 2 hours in the continuity of the stabilising operation.

The joint shall be formed just prior to the recommencement of the stabilising operation by cutting back into the existing material to the extent that the compacted mix at the cut face complies with the requirements of the Specification. The cut-off material shall be removed from the site and the joint area left clean.

If necessary, the cut face of the existing material shall be maintained in a damp condition prior to recommencement of the stabilising operation.

The roller shall be partly supported on the existing material when compacting the fresh mix placed against the cut face.

Curing: Stabilised layers shall be protected against rapid drying by keeping the surface of the layer continuously damp until such times as a covering layer is placed.

If the stabilised layer is situated immediately beneath the pavement and a pavement layer or bituminous surfacing is not to be placed within five days of the completion stabilisation, then curing shall be affected by the application of Rapid Setting Bitumen Emulsion complying with the requirements of MR Form No. 305 for Grade CRS, applied at the rate of at least 0.5 Litre/m2, within two days of the completion of compaction and trimming. The stabilised layer shall be kept continuously damp until the application of the bitumen emulsion or bituminous surfacing.

The Contractor shall repair all damage to the emulsion coat caused by construction traffic within 24 hours of the damage occurring at no cost to the Principal.

Testing: Refer to Testing Subsection and Appendix A, Schedule of Inspection and Testing Requirements.

7.0 ROADWORK ANCILLARIES

7.1 GENERAL

7.1.1 CROSS REFERENCES

General

Refer to the General requirements section.

Related sections

Refer to the following sections:

- General Requirements
- Roadbase and subbase
- Asphalt Road Surfacing
- Concrete Road Surfacing
- Sprayed Bituminous Surfacing
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

7.1.2 APPLICATION OF THIS SPECIFICATION

This specification applies to work on privately owned property. Where works are on public property, or property which is to come under the control of a Statutory Authority (Council, State Road Authority etc), or where the works are to come under the control of a Statutory Authority (ie stormwater drainage in a future easement), works shall be carried out in accordance with the requirements of the relevant Statutory Authority.

7.1.3 INTERPRETATION

Definition

Associated elements: Includes kerbs, gutters, footpaths and crossings.

RMS: Road and Maritime Services.

7.2 QUALITY

7.2.1 INSPECTION

Refer to General Requirements section and Appendix A for inspection requirements.

7.2.2 TESTING

Refer to General Requirements section and Appendix A for testing requirements.

7.3 EXECUTION

7.3.1 TOLERANCES

Associated elements

Absolute level tolerance: ± 10 mm.

Maximum deviation from design alignment: 25 mm.

Maximum deviation from a 3 m straightedge placed on horizontal, vertical, or sloping surfaces required to be straight: 5 mm.

7.3.2 REINSTATEMENT

General

Reinstate surfaces next to new pavement and associated elements.

7.4 COMPONENTS

7.4.1 ASSOCIATED ELEMENTS

Base

Place and compact base under associated elements to 75 mm compacted thickness and to the full width of the element.

Subbase

General: Subbase as specified in the Roadbase and Subbase section.

Concrete

Standard: To AS 1379 Grade N25 or as shown on Drawings.

Formwork: Form elements using fixed forms or slip forming equipment.

Curing: If using the curing compound method apply the curing compound at a rate of at least 0.5 L/m^2.

Minimum curing time: 7 days.

Surface finish:

General: Provide exposed surfaces with uniform texture and free from depressions in which water can lie. Finish to be equivalent to steel float finish unless shown otherwise on drawings. Footpaths to be wood float finish with suitable steel float edging unless shown otherwise on the drawings. Confirm footpath finish with Contract Administrator before commencing work.

Formed surfaces: Remove the forms while the concrete is still green and rub the surface to a uniform texture free from blowholes. Finish to be equivalent to steel float finish unless shown otherwise on drawings.

Joints

Contraction joints: Weakened plane joints 3 mm wide extending at least one quarter the depth of the section, at approximately 3 m intervals, adjusted if necessary to avoid short closing lengths unless shown otherwise on drawings.

Expansion joints: Locate at junctions with fixed structures such as drainage structures and buildings, at tangent points of curves of less than 25 m radius, and at 12 m intervals elsewhere unless shown otherwise on drawings. Do not tool off joint arrises abutting the seal.

Fill: Select from preformed self-expanding cork, or bitumen impregnated fibre board joint filler.

Width: 15 mm.

Footpaths

Standard: Construct footpaths as detailed on the drawings and in accordance with the pavement legend on the drawings. Footpaths consisting of unit pavers shall be constructed in accordance with the Concrete Segmental Unit Paving specification.

Integral Kerbs and Medians

Integral kerbs and medians shall be constructed in accordance with the specification for Concrete Road Surfacing. Joints shall be formed to match joints in the concrete road pavement.

7.4.2 TRAFFIC CONTROL DEVICES

Standard

General: To AS 1742.

7.4.3 LINE MARKING

Line marking shall be installed as shown on the Architectural or Civil drawings and in accordance with AS 1742.2, AS2890.1, AS2890.2, AS2890.5 and AS2890.6. Materials shall comply with the requirements of the relevant Statutory Authority or AS 4049 where works are on private property.

7.4.4 JUNCTIONS WITH EXISTING PAVEMENTS

General

Trimming: Where the pavement is to be joined to an existing pavement remove a strip of the existing pavement at least 300 mm wide for its full depth and trim the edge to an angle of approximately 45° in steps of maximum height 150 mm before placing new pavement material.

Existing sealed pavement: Trim the seal to a neat edge.

Minimum Blade height to be 2.5m.

7.4.5 ROAD SIGNAGE

Signage shall be installed as shown on the Architectural or Civil drawings. Installation and materials shall comply with the requirements of the relevant Statutory Authority or AS 1742.2, AS2890.1, AS2890.2, AS2890.5 and AS 2890.6 where works are on private property.

Signs are to be no less than 2.5m above surface for clearance to vehicles and pedestrians as per the requirements of AS1742.2.

Signs in multistorey carparks, the height can be reduced to 2.2m above road level.

7.4.6 GUARDRAILS / CRASH BARRIERS

The guardrails shall be manufactured and installed in accordance with the requirements of the RMS's Road Design Guide - Section 6 Safety Barriers for Roads and Bridges, Austroads Bridge Design Code or AS 1170.1 as applicable.

Details of the proposed safety barriers shall be submitted to the Contract Administrator for approval prior to ordering the barriers (refer also to General Requirements Section, Proprietary Items).

Crash Barriers

Crash Barriers to be 1.3m from the ground in accordance with AS2890.1 and AS1170.1.

8.0 ASPHALT ROAD SURFACING

8.1 GENERAL

Asphalt Road Surfacing includes:

- Asphalt supply, placement and testing

8.1.1 CROSS REFERENCES

General

Refer to the General Requirements section.

Related Sections

Refer to the following sections:

- General Requirements
- Site Preparation
- Earthwork
- Road Base and Subbase
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

8.1.2 APPLICATION OF THIS SPECIFICATION

General

This specification applies to works on privately owned property and is to be read in conjunction with AS 2150 and AS 2734, except that this specification shall take precedence where the requirements differ. Where works are on public property, or property which is to come under the control of a Statutory Authority (Council, State Road Authority etc), Asphalt Road Surfacing shall be carried out in accordance with the requirements of the relevant Statutory Authority.

8.1.3 INTERPRETATION

Definitions

Standard: To AS 1348.1.

Absolute level tolerance: Maximum deviation from design levels.

Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.

Relative compaction: The ratio between the field bulk density and the bulk density of the job mix when compacted in the laboratory.

RMS: Roads and Maritime Services.

8.2 QUALITY

8.2.1 INSPECTION

General

Refer also to General Requirements section and Appendix A.

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Materials or areas of work ready for tests.
- Automatic level control devices in place.
- Commencement of asphalt surfacing.

Hold Points

- Proof roll inspection and test certificates for underlying work (subgrade, basecourse etc).
- Surface prepared for priming, sealing or asphalt surfacing.

8.2.2 MIX TESTS

General

Refer also to General Requirements section and Appendix A.

Process Control Tests

Perform tests of the type and frequency necessary to adequately control the materials and processes used in the construction of the works. Tests described in the Compliance Assessment schedule are the minimum requirement.

Table 8.2.2-25: Compliance assessment schedule

Type of test	Test frequency	Test method
Mix properties	1 per 50T min 1 per lot	AS 2891
Aggregate properties	prior to supply	AS 1141.21, 22 and 23

Methods

Use wet preparation methods where applicable.

Sampling

Compliance assessment tests:

- Timing: Obtain materials samples from trucks at the mixing plant.

Mix Properties

Test for mix properties using one of the following methods as applicable:

- Tar mixes: To AS 2891.4.
- Bitumen mixes: To AS 2891 Clauses 3.1, 3.2 or 3.3.

Sampling

To AS 2891.1

Marshall Stability of Compacted Mix

To AS 2891.5

Compactive effort: 50 - blow.

Variations in Mix Properties

Ensure that the maximum variation between the mix property of each sample and the job mix value is in accordance with the Mix property table.

Table 8.2.2-26: Mix property table

Mix property	Maximum variation from job mix value
Aggregate passing 4.75 mm sieve or larger	± 4% by mass
Aggregate passing 2.36 to 0.3 mm sieves	± 3% by mass
Aggregate passing 0.15 mm sieve	± 2% by mass
Aggregate passing 0.075 mm sieve	± 1% by mass
Bitumen content	± 0.3% by mass
Added filler content	± 0.5% by mass
Mixing temperature	± 10°C

Plant site laboratory To AS 2150 Clause 9.1

8.2.3 COMPACTION TESTS

Density Tests

Test Lots: Each section of work performed in one continuous operation.

Frequency: Refer to the Asphalt compaction acceptance criteria table.

General: Perform a field bulk density test for each test site either

- on a core sample taken from the asphalt surfacing layer; or
- if the nominal layer thickness is > 50 mm, measured in situ using a nuclear gauge.

Sample preparation: To AS 2891.1.

Characteristic value of relative compaction: Calculate the value of relative compaction using the formulae in the **Relative compaction table**, in which X and S are the mean and the standard deviation, respectively of the individual relative compaction test values for the lot.

Table 8.2.3-27: Relative compaction table

Number of tests per lot	Characteristic value
6	X - 0.92S
10	X - 0.88S

Acceptance Criteria

The relative compaction of each lot of pavement must meet the criteria of the **Asphalt compaction acceptance criteria table**.

Table 8.2.3-28: Asphalt compaction acceptance criteria table

Number of test sites per lot: - Core sample tests	6*
- Nuclear gauge tests	10*
Lot value for relative compaction	Characteristic value
Minimum value: - Layer thickness up to 50 mm	96%
Layer thickness 50 mm or more	96%
	* or 1 test per 250 m^2 whichever is greater

8.2.4 CONTRACTOR'S SUBMISSIONS

Tests

Compliance assessment: If compliance assessment tests are to be carried out by an independent testing authority, have the authority submit 3 copies of each test result.

Certificate of compliance: If a certificate of compliance is acceptable as an alternative to testing a manufactured material, submit the manufacturer's certificate together with the results of recent tests undertaken by the manufacturer, showing compliance with test criteria.

Materials

Proposed job-mix: Submit the following details before commencing production:

- Combined aggregate particle size distribution.
- Test certificates for aggregate for resistance to abrasion, particle shape and strength.
- Binder content expressed as a percentage of the total mix.
- The filler content expressed as a percentage by mass of the combined aggregates.
- The asphalt mix properties.
- The proposed mixing temperature.

Delivery dockets: Submit a delivery docket at the time and place of asphalt mix delivery showing

- empty and loaded mass of the vehicle;
- date and time of loading;
- supplier and location of mixing plant;
- registration number of the vehicle;
- size and type of asphalt mix;
- class of binder;
- temperature of load at mixing plant; and
- laboratory stamp or other mark certifying compliance with the specified properties.

Execution

General: Submit proposals for the methods and equipment to be used the roadworks, including the following:

- Staging of the work, access and traffic control methods.
- Disposal of surface water, control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems.
- Methods and equipment for each operation.
- Sources of materials.
- Material stockpiles.

8.3 MATERIALS

8.3.1 ASPHALT MATERIALS

Asphalt Materials

Primer: Medium cut back bitumen to AS 2157, containing no fluxing oil.

Primer grade:

- Primer: AMC1
- Primer seal: AMC3

Tack coat mix: 3:2 bitumen emulsion:water.

Bitumen emulsion:

- To AS 1160.
- Designation: ARS/170-60.

Coarse Aggregate

- To AS 2758.5

Type: Clean, sound, hard, durable, angular crushed stone, gravel or slag, of uniform quality, free from deleterious matter.

- Crushed river gravel: At least 2 fractured faces to at least 75% by mass of all sieve fractions.
- Crushed slag: Air-cooled blast furnace slag of uniform quality, generally free from vesicular, glassy or other brittle pieces.
- Resistance to polishing (wearing course): >

Fine Aggregate

Type: Clean, sound, hard, durable particles of natural sand or particles derived from crushed stone, gravel or slag, free from injurious coating or particles of clay, silt, loam or other deleterious matter.

Table 8.3.1-29: Aggregate properties table

Property	Test method	Value
Resistance to abrasion	AS 1141.23	≤ 30 for wearing course ≤ 35 for binder course and corrective course
Particle shape	AS 1141.21	≤ 25 for wearing course ≤30 for binder course and corrective course
Wet strength	AS 1141.22	> 50 kN
Wet/dry strength variation	-	≤ 35%

Binder

Type: Bitumen Binder, Class 450.

Mineral Filler

Mineral fillers shall comply with AS 2357.

Reclaimed Asphalt Pavement (RAP)

If RAP is used, all properties of the final mix including the aggregate material properties must comply with this specification.

Combined Aggregate Grading

Provide a quantity of mineral filler at least 2% by mass of the combined aggregates, and the combined aggregate grading shall comply with Table 1 of AS 2150.

8.3.2 ASPHALT MIX DESIGN

Requirements

General: Design the asphalt mix using the Marshall method.

Asphalt mix design: As shown on the drawings

Mix Properties

Marshall stability: Table 5 of AS 1250 (50-blow).

Marshall flow: 4.0 mm maximum.

Voids in total mix (maximum theoretical density based on apparent specific gravity of aggregates):

- Wearing courses: 3% - 5%.
- Binder courses and 7 mm mixes: 4% - 6%.

Voids in aggregate filled with bitumen:

- Wearing courses: 75% - 85%.
- Binder courses and 7 mm mixes: 70% - 80%.

Binder content, percentage by mass of total mix:

- nominal mix size 5 to 10 mm: 5% - 7%
- nominal mix size 14 mm: 4.5% - 6.5%
- nominal mix size 20 mm: 4% - 6%
- nominal mix size 28 mm to 40 mm: 3.5% - 5.5%

8.3.3 POLYMER MODIFIED BITUMEN

Refer to Roads and Traffic Authority NSW QA Specification 3252.

8.4 ASPHALT SURFACING

8.4.1 TOLERANCES

Surface Level

General: Provide a finished surface which is free draining and evenly graded between level points.

Edges abutting gutters: Within ± 5 mm of the level of the actual gutter edge.

Tolerances: The tolerances in the **Asphalt surface level tolerances table** apply to the finished level of each layer, unless overridden by the requirements (including tolerances) for the finished level and thickness of the surface course.

Table 8.4.1-30: Asphalt surface level tolerances table

Item	**Level tolerance:**	
	Absolute	Relative
Longitudinal direction	± 10 mm	5 mm
Transverse direction	± 10 mm	10 mm

Thickness

Asphalt surface course: The following tolerances apply to variations in the compacted layer thickness from the specified thickness:

- Any one sample: + 10 mm, - 5 mm.
- The mean thickness of the core samples in a lot: + unspecified, - 0.

8.4.2 PREPARATION

Cleaning

Immediately before priming or tack coating remove loose stones, dust and foreign material from the base surface using a power broom or blower. Keep traffic off the cleaned surface.

Protection

Protect adjacent surfaces during spraying. Protect freshly sprayed surfaces from contamination.

Priming

Timing: Prime the base surface as soon as possible after compaction and finishing.

Application rate (L/m^2): 1

Potholes

Trim to a regular shape and a uniform depth of at least 75 mm, tack coat the edges and patch with asphaltic concrete.

8.4.3 TACK COATING

Tack Coating

Apply tack coat 30 - 120 minutes before asphalt surfacing is placed. Cover the surface uniformly to achieve a rate of 0.10 - 0.30 L/m^2 of residual binder. Brush out any pools of tack coat which may form in surface depressions before the emulsion breaks.

8.4.4 SPREADING ASPHALT SURFACING

Preconditions: Place asphalt surfacing in dry weather on a dry pavement surface at a pavement temperature not less than 10°C.

Method: Unless otherwise permitted, place asphalt surfacing by mechanical spreader, operated at the lowest uniform rate consistent with the continuous operation of the mixing plant. Place the mix with a minimum of delay after delivery. Keep the temperature of the mix in the hopper of the spreader at not less than 120°C. Do not reheat.

Hand Spreading: The Contract Administrator may approve hand spreading in areas where machine spreading is impracticable. In such cases deposit the mix outside the area on which it is to be spread, distribute it into place and spread and level it without segregation, using suitable lutes.

Operations: Spread the mix in layers covering the full width of the carriageway, or, if approved, in lanes of width normally not less than 3 m, to a surface parallel with the finished pavement surface, and to a depth as required by the specified compacted thickness. Layers placed in adjoining lanes shall have the same compacted thickness.

8.4.5 COMPACTING ASPHALT SURFACING

Generally: Work to generally be in accordance with AS 2734 section 8. Before commencing compaction, correct any irregularities in line or level. Trim lane edges to a straight line. Compact asphalt surfacing uniformly as soon as it will support rollers without undue displacement, and complete rolling while the mix temperature is above 80°C (initial passes to be compacted before temperature drops below 105°C). Operate rollers with the driving roll or wheels nearer the spreader, and at a speed slow enough to avoid displacement of the mix and not greater than 5 km/h. Disengage vibratory mechanisms before stopping or reversing direction. Operate steel wheeled rollers with minimum wetting of rolls. Operate pneumatic tyred rollers without wetting the tyres except during the initial stages of rolling, when only sufficient water is to be applied to the tyres to prevent adhesion of the mix until the tyres have gained heat. Make adjacent roller passes of different lengths.

Initial Rolling of Layers Less Than 100 mm Compacted thickness: Use a vibratory steel wheeled roller. Roll transverse and/or longitudinal joints first. Longitudinal joints should be compacted using a pass which extends 200 mm onto the previously laid mix. Transverse joints should be compacted with the roller travelling in the direction of the joint in non-vibratory mode. The first pass should extend 200 mm onto the new mix with subsequent passes extending 200 mm further onto the new mix until half the drum width is on the new mix. Continue rolling longitudinally, commencing on the lower side and proceeding to the higher side of the spreader run. The roller shall overhang the unsupported edges of the run by about 100 mm. Overlap each longitudinal pass on the previous pass by about 100 mm.

Initial Rolling of Layers 100 mm Compacted thickness Or Greater: Perform the initial rolling of transverse and longitudinal joints and of unsupported edges using a vibratory steel wheeled roller as described above. Elsewhere, perform the initial rolling using either a self propelled, pneumatic tyred, multi wheeled roller or a vibratory steel wheeled roller. Roll transverse and/or longitudinal joints first. Proceed from the lower side of the

spreader run to the higher side, but delay rolling within 200 mm of an unsupported edge to minimize possible displacement of the asphalt surfacing.

Reform initial rolling of the 200 mm strip adjacent to the unsupported edge with the steel wheeled roller. The first pass shall cover about half the width of the unrolled strip; the second pass shall cover the remainder of the width and may overhang the edge of the material by not more than 100 mm. Where a steel wheeled roller is used, overlap each longitudinal pass on the edge of the previous pass by about 100 mm. If a self propelled pneumatic tyred multi wheeled roller is used, overlap each longitudinal pass on the previous run by a minimum of about 1 m.

Secondary Rolling: Perform secondary rolling as soon as possible after initial rolling with a self propelled pneumatic tyred roller. Roll longitudinally commencing on the lower side and proceed to the higher side of the spreader run. Each roller pass shall overlap the previous pass.

Final Rolling: Perform final rolling with a steel wheeled non vibrating roller to eliminate all roller marks.

Echelon Paving: When paving in echelon, leave the edge of the run common to adjacent spreaders unrolled for a width of 200 mm until the longitudinal joint has been constructed. Roll this strip together with the edge of the adjacent spreader run. Commence rolling before the temperature of the material along the edge of the first spreader run has fallen below 95°C.

Avoidance of Surface Defects: Do not leave rollers stationary on asphalt surfacing which is still warm. Keep roller wheels free from any build up. Immediately correct surface defects resulting from rolling.

Inaccessible Areas: Compact asphalt surfacing in areas inaccessible to the specified rollers using small vibrating rollers or hand operated mechanical compactors of types approved by the Superintendent.

Surface Finish: Provide a surface uniform in appearance and free from depressions in which water can lie.

8.4.6 JOINTS

Joints

General: Minimise the number of joints. Make joints that are well bonded and sealed and provide a smooth riding surface across the joint.

Transverse joints: Construct a transverse joint if the operation is stopped for more than 20 minutes or the pavement temperature falls below 90°c. Construct to a straight vertical face for the full depth of the layer, and offset in adjoining spreader runs and layer to layer by at least 2 m.

Longitudinal joints: Offset joints from layer to layer by at least 150 mm. Position longitudinal joints in the wearing course to coincide with the lane line.

Method of Construction

Longitudinal joints: Form exposed edges of each spreader run while hot to a straight line with a dense face inclined between vertical and 45° to the vertical for the full depth of the layer. Tamp the unsupported longitudinal edges of spread material to raise the level of the asphalt surfacing slightly to secure maximum edge compaction from subsequent rolling. Do not damage the unsupported longitudinal edge by rolling, except that, on 10 mm courses, the Superintendent may permit such an edge to be rolled over. Make good longitudinal edges which contain segregated or open textured material, or which have been damaged by traffic or rolling by cutting back to expose a new straight dense inclined face. Do not cut with a diamond saw.

Overlap the screed of the spreader on the adjacent run by 25 mm to 50 mm. At joints constructed against cold edges, the overlapping asphaltic concrete shall be removed to waste or crowded back at the joint but not thrown on to the layer being spread. Treat joints as "cold" when the temperature of the first run has fallen below 60°C. Tack coat cold contact surfaces.

Transverse joints: Construct transverse joints at right angles to the direction of spreading and cut to a straight vertical face for the full depth of the layer. Unless otherwise approved, construct transverse joints if the spreading operation is stopped for 20 minutes, or if the pavement temperature falls below 90°C, whichever occurs sooner. Before placing asphalt surfacing to construct transverse joints, tack coat cold contact surfaces uniformly and thinly.

Abutting Structures

Place asphalt surfacing to match the level of abutting surfaces such as kerbs, gutters, edge strips, manholes, or adjoining pavement in the same manner as for longitudinal and transverse joints. Fill spaces left unfilled between the spreader run and abutting edges with sufficient material to the proper height before compaction.

Matched Junctions

General: If asphalt surfacing is to match an existing pavement, bridge deck, rail or other fixture, place the material to provide a smooth riding surface across the junction. Where necessary, remove sufficient of the existing pavement for this purpose. Where it is necessary to taper the thickness of a layer to provide a smooth riding junction, terminate the layer at a chase cut into the existing pavement about 20 mm deep and 400 mm wide. Where necessary, remove coarse particles from a layer of tapering thickness using hand raking.

Tack coat: Where the thickness of the layer tapers to less than twice the nominal size of the mix, tack coat the area upon which material of such thickness is to be placed uniformly at an application rate 0.50 - 0.75 L/m^2.

Surface Finish

Provide a surface uniform in appearance and free from depressions.

8.4.7 DEFECTIVE SURFACING

Defective Compaction

Asphalt surfacing rejected due to inadequate compaction is to be removed.

Defective Layer Thickness

Minimum criterion for retention:

- Mean thickness of the core sample in the lot: > the required layer thickness less 5 mm.

Rejection

Extent: Remove areas of rejected asphalt surfacing, including defective joints and finish, to the full depth of the layer, and replace with complying pavement.

Joints: Treat edges of remedial work as specified for cold joints.

8.5 COMPLETION

8.5.1 COMPLETION

Traffic on pavement

Do not allow traffic on pavements until they have cured sufficiently to support traffic without damage. Construction traffic should not be allowed on the pavement unless it is confirmed that the wheel loads for the vehicles are less than the design capacity of the pavement and the vehicles will not mark the pavement.

9.0 CONCRETE ROAD SURFACING (CONCRETE PAVEMENT)

9.1 GENERAL

9.1.1 GENERAL

Concrete Pavement includes:-

- Reinforcement fixing
- Joint installation
- Concrete supply, placement and testing
- Concrete curing

9.1.2 CROSS REFERENCES

General

Refer to the General Requirements section.

Related Sections

Refer to the following sections:

- General Requirements
- Site Preparation
- Earthworks
- Roadbase and Subbase
- Appendix A - Schedule of Inspection and Testing Requirements
- Appendix B - Safety in Design - Risks & Solutions Register.

Scope: This section specifies the requirements for concrete pavements including concrete base and lean mix concrete subbase.

9.1.3 APPLICATION OF THIS SPECIFICATION

This specification applies to work on privately owned property. Where works are on public property, or property which is to come under the control of a Statutory Authority (Council, State Road Authority etc), or where the works are to come under the control of a Statutory Authority (ie stormwater drainage in a future easement), works shall be carried out in accordance with the requirements of the relevant Statutory Authority.

9.1.4 STANDARDS

General

Materials and construction: To AS 3600, AS 4671.

Concrete: To AS 1379.

9.1.5 INTERPRETATION

Definitions

Standard: To AS 1348.1.

Absolute level tolerance: Maximum deviation from design levels.

Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.

RMS: Roads and Maritime Services.

9.2 QUALITY

9.2.1 INSPECTION

Witness Points

Give sufficient notice so that inspection may be made at the following stages:

- Materials or areas of work ready for tests.
- Automatic level control devices in place.
- Commencement of concrete placing.

Hold Points

- Concrete formwork, reinforcement and dowels in position.
- Proof roll inspection and test certificates on underlying work (subgrade, subbase etc).

9.2.2 TESTS

General

Refer to General Requirements Section for general testing and quality assurance requirements.

Concrete Testing: Sample, test and assess concrete for compliance with the specified quality parameters to AS 1379 Section 5 and Appendix B, including the requirements for project assessment except frequency of testing shall be as set out below.

Table 9.2.2-31: Compressive Tests

NUMBERS OF BATCHES PER DAY	NUMBER OF SAMPLES
1	1
2 TO 5	2
6 TO 10	3
11 TO 20	4
For each additional 10 batches, one additional sample shall be taken	

Drying Shrinkage - Drying shrinkage - to relevant Australian Standards Maximum permissible drying shrinkage measured as a percentage change after 56 days (to AS 1012.13).

- Duration of air drying: 56 days
- Limits: Maximum strain: Refer Section 3.2, Table 1

- Sampling frequency: Prior to supply then every 500 m3 for each type of concrete.
- Number of specimens for sample: 3
- Acceptance criterion: Average strain of three specimens from each sample shall not exceed the required value.

Curing Compound - The Contractor shall allow for the cost of a minimum of three random samples to be tested for water retention in accordance with AS 3799. Samples shall be taken from the material delivered to site during the period of the works as directed by the Superintendent and shall be tested by an approved NATA registered laboratory.

Trial Mix

Prepare a trial mix of the proposed mix design, to AS 1012.2. Test the trial mix for the following properties:

- Properties related to consistence: To AS 1012.3.
- Air content: To AS 1012.4.
- Mass per unit volume: To AS 1012.5.
- Compressive strength: To AS 1012.9. Prepare at least 8 specimens to AS 1012.8. Test at least 2 specimens after 7 days and the remainder after 28 days.
- Flexural strength: To AS 1012.11. Prepare at least 8 specimens to AS 1012.8. Test at least 2 specimens after 7 days and the remainder after 28 days.
- Drying Shrinkage: as specified above.

Discharge Slump Tests

General: Carry out slump tests at approximately one quarter and three quarter points of the load during discharge.

Maximum slump variation: 25 mm.

Standard: To AS 1012.3.

Flexural Strength Assessment Of Concrete

Standard: To AS 1012.8 and AS 1012.11.

Dowels

Pre-embedment testing: Fix and test dowels before embedment by subjecting either end to a load of 80 kg in any direction normal to the bar.

9.2.3 SAMPLES

General

Submit samples of the following at least one month before use in the works:

- Granular materials: One 20 kg sample of concrete aggregate.

Identification

Attach a tag to each sample showing relevant information including description, source and nominal size of material.

9.2.4 CONTRACTOR'S SUBMISSIONS

Tests

Compliance assessment: If compliance assessment tests are to be carried out by an independent testing authority, have the authority submit 3 copies of each test result.

Certificate of compliance: If a certificate of compliance is acceptable as an alternative to testing a manufactured material, submit the manufacturer's certificate together with the results of recent tests undertaken by the manufacturer, showing compliance with test criteria.

Dissemination of production information: Submit copies of the reports.

Curing compounds: If it is proposed to use a liquid membrane-forming curing compound submit certified test results for water retention to AS 3799 Appendix B.

Materials

Reinforcement: Submit the manufacturer's certificate of compliance with AS 4671, or submit test certificates from an independent testing authority.

Execution

General: Submit proposals for the methods and equipment to be used for the roadworks, including the following:

- Staging of the work, access and traffic control methods.
- Disposal of surface water, control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems.
- Methods and equipment for each operation.
- Sources of materials.
- Material stockpiles.
- Methods of concrete manufacture.
- Temperature control, curing and protection methods for concrete.

Trial mix design report: Six weeks before commencing production, submit a report for each mix design containing the information required in AS 1012.2, the individual and combined aggregate particle size distribution, and the records and reports for the tests.

Mix design variation: If a variation is proposed, submit a further mix design report.

Joint sealants: Submit the proposed installation method and sealant performance.

Concrete placing: Submit proposals for size of the area to be placed and the spacing of planned construction joints before placement commences.

Slip placing: If it is intended to construct pavement by slip forming, submit evidence of the availability of suitable equipment and the contractor's ability to produce a pavement complying with requirements.

Curing: Submit details of the proposed curing methods.

Repair materials: Submit proposals for epoxy resin/grout and elastomeric sealant.

Crack repair: Drill 100 mm diameter core holes along unplanned cracks in the finished pavement, and submit the cores for examination.

Formed weakened plant joints: Before concrete placing submit details of the proposed equipment.

Records of measurement

Submit certified records of work performed for items required to be measured for payment.

9.3 MATERIALS

9.3.1 REINFORCEMENT

Standard: To AS 3600 Cl19.2, AS 4671.

Identification

Supply reinforcement which is readily identifiable as to grade and origin.

Dowels

Standard: To AS 4671, Grade 250R.

General: Each dowel in one piece, straight, cut accurately to length with ends square and free from burrs. Apply 2 coats of bitumen emulsion to half the dowel, including the end.

Dowel end tolerances: Ensure that deformation of an end from its true circular shape does not exceed 1 mm nor extend more than 1 mm from the end.

Protective Coated Reinforcement

Extent: If an element is specified to contain protective coated reinforcement, provide the same coating type to all that element's reinforcement and embedded ferrous metal items, including tie wires, stools, spacers, stirrups, plates and ferrules, and protect other embedded metals by a suitable coating.

Galvanizing: To AS 1650.

Minimum coating mass:

For wire: Type A.

- For reinforcement: 600 g/m2.
- Preparation: Pickling to AS 1627.5.

Passivation: After galvanizing, passivate the coating by immersion in a bath of 0.2% sodium dichromate solution.

Damage: If damage occurs to the coating, either

- replace the damaged reinforcement; or
- if approved, repair to AS 1650 Appendix F.

Unencased reinforcement: Provide protection for "starter bars" and the like left projecting from cast concrete for future additions.

9.3.2 CONCRETE MATERIALS

Aggregate (Coarse and Fine)

Standard: To AS 2758.1.

Aggregate size (maximum):

- For fixed form placement: 40 mm.

- For slip form placement: A size compatible with the paving machine.

Washing: Wash aggregate as necessary or as directed to achieve requirements for soluble salt content or concrete drying shrinkage.

Concrete mix design

Requirement: Refer to Table 9.3.2-32 below.

Standard: To AS 1379.

Restrictions on chemical content: To AS 3600 clause 4.9.

Bagged cement: Do not use bagged cement more than 6 months old.

Material Requirements: Use materials complying with Australian Standards. Do not use breccia or dolerite in concrete mix and limit fly ash content to 20% by weight of cementitious content.

Table 9.3.2-32: Mix design requirements

			External Concrete Pavements	Lean Mix Concrete Subbase
Material	Cement Type		GP	GPor GB
Properties	Max Fly Ash (% of Cement Content)		20	50
	Min Content of Cementitious Material		310	250
	Max. W/C		0.5	-
	Strength (MPa)	Compressive - F'c 28	32	5 (max. 15)
		Flexural - Ft 28	4.4	-
	Initial Slump (mm)		65 ± 15	60 + 20
	Aggregate		Max. Nominal Coarse Size 20 mm.	Max. Nominal Coarse Size 40 mm
	Shrinkage limits		600 micro strain limit at 56 days	450 micro strain at 21 days

9.3.3 CONCRETE

Mix Design Variation

Do not vary the design mix, method of production or source of supply of constituents.

Ready Mixed Concrete

The concrete supplier is to provide the concrete mix design to the Superintendent for approval prior to manufacture.

Standard: To AS 1379, by the batch production process. Deliver in agitating trucks.

Elapsed delivery time: Concrete is liable to be rejected if the elapsed time between the wetting of the mix and the discharge of the mix at the site exceeds the criteria in the **Elapsed delivery timetable.**

Table 9.3.3-33: Elapsed delivery timetable

Concrete temperature at time of discharge (^{0}C)	Maximum elapsed time (hours)
Less than 24	2.00
24 - 27	1.50
27 - 30	1.00
More than 30	0.75

Delivery docket: For each batch, supply a docket listing the information required by AS 1379 clause 1.7.3, and the following additional information:

The concrete element or part of the works for which the concrete was ordered.

The total volume of water added at the plant.

Do not add water or any other material to the concrete after leaving the batch plant if not detailed in mix design.

Site Mixed Supply

Manufacture: Mix concrete in an approved plant located on the construction site and complying with the relevant requirements of AS 1379.

Emergencies: Mixing by hand is not permitted.

Alternative supply: Ensure an approved alternative source of supply is readily available at the time of each concrete pour.

Accuracy of batching (% by mass)

Cement: ± 1.

Aggregates: ± 2.

Water: ± 1.

Admixture: ± 3.

Admixture

Introduce in solution in a portion of the mixing water. Ensure a uniform distribution of the admixture in the batch within the mixing period.

Mixing

Mixing time: Measure the mixing time after solid materials are in the mixer, provided that mixing water is introduced before a quarter of the mixing time has elapsed. Increase mixing time if necessary to

obtain the required uniformity and consistence of concrete. Do not overmix such that additions of water are needed.

Uniformity: Differences specified in AS 1379 apply to samples taken from 3 locations in a batch. Do not exceed 2% difference in moisture content of the 3 samples.

Transport

General: Transport and discharge the concrete without segregation.

9.3.4 JOINTING MATERIALS

Types: Use jointing materials, including sealants, mastics, primers, gaskets, compressible fillers, and joint covers, as recommended by the material manufacturers for the location and type of joint, compatible when used together, and non-staining to concrete in visible locations.

The Contractor is to submit the proposed product for review.

Foamed materials (compressible fillers): Closed-cell or impregnated types which do not absorb water.

Bond breaking: Use back-up materials for sealants, including backing rods, which do not adhere to the sealant. They may be faced with a non-adhering material.

Compressible Filler: Compressible filler, thickness as designated on drawings. To comply with RMS QA Specification 3204.

Sealants: Sealants shall be Dow Corning 888 Silicone Joint Sealant unless otherwise specified on the drawings.

Self-expanding cork joint filler

General: Preformed self-expanding cork in factory bonded lengths, with taped top surface. To comply with RMS QA Specification 3204.

Length: Equal to the paving lane width for transverse joints, or 4 m for longitudinal joints.

Properties

Table 9.3.4-34: Cork joint filler properties table

Property	**Requirement**
Accelerated weathering:	No evidence of disintegration
Resistance to test fuel (48 hours' immersion in test fuel):	No evidence of; ▪ dislodgment of cork particles by test treatment ▪ dislodgment of cork particles when the faces of the material are rubbed with fingers ▪ loss of resilience i.e. may be broken into pieces more easily

Dimension tolerance (unexpanded state):	Width: ± 1.5 mm Depth: ± 3.0 mm

Table 9.3.4-35: Cork joint filler properties schedule

Property	**Requirement**	
	Minimum	**Maximum**
Density (kg/m^3)	335	-
Lateral restraining pressure in water at 27ºC ± 1°C (kPa): - After 6 hours' immersion	-	60
- After 24 hours' immersion	-	180
Lateral free swell in water at 27ºC ± 1ºC (% of initial width): - After 24 hours' immersion	25	-
- After 168 hours' immersion	30	-
Longitudinal free swell in water at 27ºC ± 1ºC after 168 hours' immersion (% of initial length)	-	2
Longitudinal shrinkage on drying for 12 days at 40°C - 50ºC after 168 hours' immersion in water (% of initial length)	-	2
Lateral expansion in boiling water after 1 hour's immersion (expanded width as % of initial width)	140	-
Compression and recovery: - Pressure required to compress to 50% of uncompressed width (kPa)	350	10,500
- Recovery after 1 hour following compression to 50% of uncompressed width (recovered width as % of uncompressed width)	90	-

Property	Requirement	
	Minimum	Maximum
Extrusion of free edge following compression to 50% of uncompressed width with three edges restrained (mm)	-	6

Preformed elastomeric seals

Standard: To ASTM D2628.

General: Vertical sidewalls, marked durably on the top surface every 300 mm ± 2 mm at the time of manufacture.

Depth: Adequate to retain the seal in the joint, but not greater than 50 mm when the seal is compressed laterally to 50% deflection.

Lubricant adhesive: A compound of the same base polymer as the seal, blended with suitable volatile solvents of viscosity suitable to the installation equipment, with the following properties:

- Average net mass per litre: 0.784 kg ± 5%.
- Film tensile strength: 15 MPa minimum.
- Elongation before breaking: 750% minimum.

Shelf life: Show date of manufacture on the container. Use within nine months of manufacture.

Properties testing:

Table 9.3.4-36: Force deflection requirements table

Nominal width of seal	Deflection (% of nominal width)	Required force (N/m)
10 mm and smaller	20	350 minimums
	50	2,100 maximums
12 mm and larger	20	350 minimums
	50	2,100 maximums
After heat aging: The same specimens heat aged in an oven for 70 hrs at 100°C under 50% deflection:		
10 mm and smaller	20	175 minimums
	50	2,100 maximums
12 mm and larger	20	260 minimums
	50	2,100 maximums

Inert Form Strip

Type: Fibreboard or polystyrene foam strip consisting of two parts:

- Removable upper section equal in depth to the preformed elastomeric seal.
- Permanent lower section.

Use: Use only with preformed elastomeric seals. After forming, remove the upper section of the inert form strip and insert the preformed elastomeric seal.

9.4 EXECUTION

9.4.1 TOLERANCES

Finished Levels

General: Provide a finished surface which is free draining and evenly graded between level points.

Edges abutting gutters: Within ± 5 mm of the level of the actual gutter edge.

Rigid pavement surface:

- Absolute tolerance: ± 10 mm.
- Relative tolerance: 5 mm.

Thickness

The following tolerances apply to variations in the compacted layer thickness from the specified thickness:

- Concrete surface course: + unspecified, - 5 mm.

Joint Locations (Rigid Pavement)

Maximum horizontal deviation from required alignment: 15 mm.

9.4.2 FORMWORK

Fixed Formwork

Requirement: Design and construct formwork so that concrete, when cast in forms, will have the dimension, shape, location and surface finish required by the Contract.

Tolerances on position:

- Absolute level tolerance: ± 5 mm (maximum departure of top surface from the required level).
- Relative level tolerance: 5 mm (maximum departure of top surface from a 3 m straightedge).
- Horizontal tolerance: ± 10 mm (maximum departure of face from a plane surface).
- Verticality: 3 mm departure from vertical.

Release agent: Before placing reinforcement, apply a release agent compatible with the contact surfaces, to the interior of the formwork, except where the concrete is to receive an applied finish for which there is no compatible release agent. Where necessary clean the reinforcement to remove all traces of release agent.

Re-use: Clean and recoat the forms each time before placing concrete.

Keyways

Form the keyways of keyed construction joints using timber dimensioned accurately in accordance with the drawings. Do not reuse timber keyway forms.

Stripping time

To AS 3600 Clause 19.6.2 where these requirements are more stringent than the relevant requirements of AS 3610.

9.4.3 FIXING REINFORCEMENT

Standard: To AS 3600 clause 19.2.

All fabric reinforcement to be a minimum of SL92 unless noted otherwise.

Splicing: As shown on drawings. Where not specified on drawings to AS 3600 clause 13.2.

Concrete cover: As shown on drawings. Where not specified on drawings to AS 3600 clause 4.10 or AS 3735 clause 4.4 as applicable.

Requirement: Supply and fix reinforcement, including the necessary tie wires, support chairs and spacers.

Welding reinforcement: Obtain permission before welding. Do not weld reinforcement which does not comply with AS 4671. Do not weld reinforcement within 75 mm of a section which has been affected by bending or re-bending.

Starter bars: Prior to the concrete placing, all starter bars shall be positioned and secured by the Contractor, to ensure correct location and alignment of bars. Costs associated to redesign and/or relocate starter bars that have not been positioned and secured adequately shall be at the Contractor's expense.

Fixing requirements: Secure the reinforcement against displacement by tying at intersections with annealed iron wire ties not smaller than 1.25 mm diameter, or by approved clips. Bend the ends of wire ties away from nearby faces of forms so that the ties do not project into the concrete cover.

Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections, and at other points as required.

Beams: Tie ligatures to bars in each corner of each ligature. Fix other longitudinal bars to ligatures at not more than 1000 mm intervals.

Bundled bars: Tie bundled bars together so that the bars are in closest possible contact. Use tie wire not less than 2.5 mm diameter at centres not more than 24 times the diameter of the smallest bar in the bundle.

Provision for concrete placement: If spacing or cover of reinforcement does not comply with AS 3600 clauses 8.1.7 and 4.10.2 respectively notify the Superintendent and obtain instructions prior to placing concrete.

Reinforcement Supports

Support types: Use purpose-made concrete, metal or plastic supports. For exposure classification A1, provide a protective coating to ferrous metal which extends to the surface of the concrete. For exposure classifications more severe than A1 use plastic supports of adequate strength and of a shape appropriate to the location, or concrete supports of the same concrete quality as the concrete element.

Supports over membranes: Prevent damage to waterproofing membranes or vapour barriers. Place a metal or plastic plate under each support to prevent puncturing.

Support spacing: Not more than 60 bar diameters for bars and 750 mm for fabric.

Dowels and Tie Bars

Location: Across joints at the required spacings and vertical locations correctly aligned parallel to the finished pavement surface and perpendicular to the joint in plan (except where the joint is not perpendicular to the long axis of the concrete pavement, in which case the engineer's advice shall be

sought). If the construction methods require alterations to the designed spacing, use a closer spacing with additional dowels or tie bars.

Placing in fixed-form paving: Use the bonded-in-place method. Embed the unpainted half of the dowels in the slab placed first. Dowels to be securely fixed in place prior to placing concrete (refer Tests subsection).

Placing in longitudinal joints in slip-form paving. Place using machine or vibrate into the plastic concrete using a suitable template.

Movement: Do not distort or displace beyond the alignment tolerances under testing or during construction. Do not remove and replace dowels in pre-formed holes.

Dowel Placement Tolerances

Horizontal and vertical location: ± half the diameter of the dowel.

Alignment: Locate bars in the joint within 2 mm in 300 mm and adjacent bars which do not differ in alignment by more than 2 mm in 300 mm.

9.5 PLACING AND CURING

9.5.1 CONCRETE PLACING

Standard: To AS 3600 Clause 19.1.3 and 19.1.4.

Preparation: Moisten the subbase sufficiently in advance of placing to ensure a firm, uniformly moist surface at the time of placing. Remove loose sand and other debris from the surface of the subbase. Do not operate construction equipment on the prepared subbase after approval to place concrete has been given.

A debonding treatment should be applied to the surface of the subbase prior to installing reinforcing. The debonding treatment for cement treated subbase is described in the Roadbase and Subbase section. Lean mix concrete subbase should be debonded with wax emulsion curing compound applied at a rate of 0.2L/m2 (in addition to the curing treatment). Wax emulsion curing compound to comply with AS 3799 Type 2 Class A.

Approval: The size of the area to be placed and the spacing of planned construction joints shall be subject to approval before placement commences.

Temperature Limits: The temperature of the concrete when placed in the forms shall be not less than 10°C and not more than 32°C.

Placing Records: Quality Assurance documentation shall include a record of each concrete pour including:

- date;
- the portion of work;
- specified grade and source of concrete;
- delivery dockets for each batch;
- the time at which each batch is completely discharged;
- slump measurements;

- volume placed;
- details of compressive strength samples (i.e. cylinder numbers etc).

Rain: Concrete exposed to rain before it has set, including during mixing, transport or placing shall be rejected.

9.5.2 COLD WEATHER PLACING

Requirement: Maintain the temperature of the freshly mixed concrete within the limits shown in the **Cold weather placing table**. "Outdoor" air temperature applies to the air temperature at the time of mixing and to the predicted or likely air temperature at any time during the subsequent 48 hours.

Table 9.5.2-37: Cold weather placing table

Outdoor air temperature	Temperature of concrete	
	Minimum	Maximum
Not less than 5°C	10°C	32°C
Less than 5°C	18°C	32°C

Additives: Do not use calcium chloride, salts, chemicals or other material in the mix to lower the freezing point of the concrete.

Frozen materials: Do not allow frozen materials or materials containing ice to enter the mixer, and keep free of frost and ice any forms, materials, subbase and equipment coming in contact with the concrete.

High early strength cement: In severe weather conditions high early strength cement may be used, subject to approval, to enable the concrete to develop sufficient strength to permit formwork removal within the specified time, but not as a substitute for the heating of materials or for adequate protection of placed concrete against low temperatures. Do not use high alumina cement.

Heating: Heat the concrete materials, other than cement, to a temperature not greater than the minimum necessary to ensure that the temperature of the placed concrete is within the limits specified in this clause. The temperature of water shall be not greater than 60°C when it is placed in the mixer.

9.5.3 HOT WEATHER PLACING

Requirement: The provisions of this clause apply to concreting when the surrounding shade outdoor temperature is greater than 32°C.

Mixing: Do not mix concrete when the outdoor shade temperature on the site exceeds 38°C, unless otherwise approved and then only subject to such conditions as may be imposed.

Handling: Take precautions to prevent premature stiffening of the fresh mix and to reduce water absorption and evaporation losses. Mix, transport, place and compact the concrete as rapidly as possible.

Placing: Before and during placing maintain the formwork and reinforcement at a temperature not greater than 32°C by protection, cold water spraying, or other effective means. When placed in the forms, the temperature of the concrete shall not exceed the criteria in the **Hot weather placing table.**

Table 9.5.3-38: Hot weather placing table

Concrete element	Temperature limit
Normal concrete in footings, beams, columns, walls and slabs	32°C
Concrete in large mass concrete sections; or concrete of strength 40 MPa or greater, in sections exceeding 600 mm in thickness	27°C

Temperature control methods: Acceptable methods of maintaining the specified temperature of the placed concrete include

- using chilled mixing water;
- spraying the coarse aggregate with cold water;
- covering the container in which the concrete is transported to the forms;
- cooling the concrete by liquid nitrogen injection prior to placing; and
- a combination of these methods.

9.5.4 PLACING IN FIXED FORMS

Spreading: Place concrete uniformly over the width of the slab or lane and so that the face is generally vertical and normal to the direction of placing. Hand spread concrete with shovels, not rakes. Do not use vibration to move concrete. Do not allow concrete to free fall more than 1500 mm. Do not allow cold joints to form within a pour. Place concrete such that each section is blended into the previously placed concrete by the compaction process.

Vibration: Compact concrete by internal mechanical vibration of sufficient amplitude to produce noticeable vibrations at 300 mm radius, using vibrators capable of transmitting at least 5000 impulses per minute when under load. Insert vibrators into the concrete to the depth which will provide the best compaction, but not deeper than 50 mm above the surface of the subbase, and for a duration sufficient to produce satisfactory compaction, but not longer than 30 seconds in any one location. Do not allow vibrators to come in contact with partially hardened concrete or the reinforcement embedded in it.

Vibrating beam type vibrators of adequate power to compact the whole depth of the concrete may be used. Supplementary immersion type vibrators should be used at slab edges, thickening etc.

Vibrators: There shall be one vibrator in full working order on the site for each 12 cubic metres or part thereof of concrete placed per hour.

Finishing: Immediately after placement, spreading and compaction of the plastic concrete, start finishing operations, comprising transverse finishing, longitudinal straightedge finishing and broom finishing, in that order. Complete as soon as possible, and prior to the concrete attaining initial set.

Transverse finishing: By mechanical vibrating screed equipped with handles and having twin beams at least 300 mm longer than the width of lane being finished, and a screed edge at least 100 mm wide. Alternatively, a counter rotating tube screed of suitable design may be used. Make at least two passes with the screed over each section of pavement.

Straightedge Finishing: After the transverse finishing is completed, but while the concrete is still plastic, eliminate minor irregularities and score marks in the pavement surface, particularly across formed contraction joints, by means of hand-operated long handled aluminium floats.

Broom Finishing: When most of the water glaze or sheen has disappeared and before the concrete becomes non-plastic, texture the whole surface of the pavement at right angles to the main traffic direction by means of coarse brooms at least 500 mm wide with bristles of nylon or flexible wire. Wash brooms regularly to remove slurry.

Finished Pavement Surface: Provide a surface uniform in appearance and free from depressions in which water can lie.

Surface Texture: Average texture depth: 2.0 - 2.5 mm.

9.5.5 SLIP FORM PLACEMENT

Slip Forming: Approval to construct pavement by slip forming shall be subject to the availability of suitable equipment and the Contractor's demonstrated ability to produce a pavement complying with the requirements of the Contract.

Spreading: Place the plastic concrete in a uniform layer over the width of the slab being placed. Prevent damage to the existing surface and edge of previously constructed concrete.

Vibration: By suitable internal vibrators or surface type equipment with vibrating beam or beams of adequate power to fully compact the whole depth of the concrete.

Slab edges: Use supplementary immersion type vibrators adjacent to slab edges if necessary to ensure that the sides of slabs present a uniform dense appearance free from honeycombing or areas deficient in fines over at least 95% of the surface.

Finishing: Produce a surface equal to that specified in PLACING IN FIXED FORMS.

9.5.6 CURING

Standard: To AS 3600 Clause 19.1.5.

Generally

Protect fresh concrete from premature drying and from excessively hot or cold temperatures. Maintain the concrete at a reasonably constant temperature with minimum moisture loss for the curing period.

Temperature

Maintain the concrete at a temperature > 5°C for at least 7 days.

Curing methods

Curing compound method: Spray the entire surface including edges using a mechanical sprayer, at a uniform application rate of at least 0.35 L/m^2.

Respray defective areas within 30 minutes. Respray within 3 hours after heavy rain. Apply as a continuous coating without visible breaks or pinholes.

- Curing compounds: To AS 3799, Type 2, white pigmented or containing aluminium reflective pigments.

Covering sheet method: Immediately after finishing operations cover concrete using damp hessian or cotton mats overlapped at least 150 mm and anchored against displacement by wind or other interference. Keep the mats continuously damp until covered by the covering sheet material. Repair tears and the like immediately.

- Covering sheet materials: White opaque polyethylene film, or white burlap-polyethylene sheet, or equivalent material to ASTM C171.

- Joint sawing: Sheet materials may be removed for the minimum distance and period to permit joint sawing, provided the concrete is kept moist by other means.

Moist curing method: Immediately after finishing operations keep the concrete surface continuously damp by spraying constantly with water, fog, or mist, using suitable spraying equipment.

Minimum curing time 7 days.

Lean Mix Concrete Subbase

Wax emulsion curing compound complying with AS 3799 Type 2 Class A applied at a rate of 0.2L/m^2 using suitable spray equipment.

9.5.7 PROTECTION

General

Concrete pavement: Keep traffic, including construction plant, off the pavement entirely during curing, and until the pavement is at least 14 days old. Protect concrete from damage from any cause including construction traffic, mortar splashes and stains, timber stains, rust stains, chemical attack additives, curing compounds, rain and running water.

Note that the pavement is designed for the wheel loads specified by the RMS for “general access” vehicles, and construction loadings on pavements must not exceed these limits. In the case of concrete

pavements less than 160 mm thickness, wheel loadings must not exceed 1 tonne (2 tonne per axle). This capacity of the pavement for loading from point loads or solid wheeled vehicles must be checked at the Contractor's expense.

9.5.8 FINISHING

General

Immediately after placement and spreading and compaction of the plastic concrete, start finishing operations, comprising transverse finishing, longitudinal straightedge finishing and broom finishing, in that order. Complete as soon as possible, and before the concrete attains initial set.

Transverse Finishing

Use either

- mechanical vibrating screed equipped with handles and twin beams at least 300 mm longer than the width of lane being finished, and a screed edge at least 100 mm wide; or
- a counter rotating tube screed of suitable design.

Passes

Make at least two passes with the screed over each section of pavement.

Straightedge Finishing

After the transverse finishing is completed, but while the concrete is still plastic, eliminate minor irregularities and score marks in the pavement surface, particularly across formed contraction joints, using hand-operated long handled aluminium floats.

Free Edge Finishing

All free edges to be finished with a steel trowel to eliminate broken edges and the sides of slabs present a clean finished appearance.

9.5.9 DEFECTIVE CONCRETE

General

Cracked or otherwise defective concrete can only be repaired or retained when approved by the Contract Administrator. Proposed repair methods must be approved by the Contract Administrator. If directed by the Contract Administrator, remove and replace defective concrete.

High Areas

Method: Reduce by rubbing or grinding, or both, as follows:

- Concrete < 36 hours old: Rub using carborundum brick and water. Discontinue rubbing as soon as contact with the coarse aggregate is made, and reduce further, if necessary, by grinding the concrete after it hardens.
- Hardened concrete (>14 days old): Machine grind.
- Retexturing: Retexture areas which have been surface ground, by cutting grooves 5 mm wide x 5 mm deep, at 25 mm centres.

Upper limit of surface ground areas: 10% of the area of a single slab, or 3% of the total surface area of the concrete pavement. Surface grinding will only be permitted where the minimum cover to the reinforcement can be maintained.

Thickness Deficiencies

Retention: Thickness deficiency exceeding the required tolerance must not exceed 10 mm.

9.6 REINSTATING ADJACENT SURFACES

General

Existing pavement: Reinstate surfaces next to new pavements and associated elements. Where an existing flexible road pavement has been disturbed, trim it back to a straight and undisturbed edge 250 - 300 mm from and parallel to the new concrete for the full depth of the slab. Backfill with asphalt rammed solid, using suitable rammers.

9.7 JOINTS

9.7.1 CONCRETE JOINTS

Generally

All pavements to have a maximum of 5 m joint spacing unless noted otherwise. Expansion joints to be located at a maximum of 30 m spacing unless shown otherwise on drawings. Construct expansion, contraction and construction joints straight and plumb in the locations and of the types shown on the drawings. Make transverse joints normal to longitudinal joints. Extend transverse expansion and contraction joints continuously from edge to edge of the pavement through interconnected slabs. In addition to this specification, refer also to the requirements of Technical Note TN47 - Joints in Concrete Road Pavements by the Cement and Concrete Association of Australia.

Transverse Construction Joints

Planned location: Terminate each day's placing operation at a transverse construction joint located to coincide with a planned expansion joint.

Unplanned joints: If placement is interrupted for 30 minutes or longer, form a tied transverse construction joint within the middle third of the distance between planned joints but no closer than 1.5 metres to the nearest planned joint. If necessary, remove placed concrete back to the required location.

Joint preparation: Before fresh concrete is placed at a construction joint, roughen and clean the hardened concrete surface of the joint, so that all loose or soft material, free water, foreign matter and laitance is removed. Just prior to placement, use wet to dry epoxy on the hardened concrete surface.

Finish at construction joints: Butt joint the surfaces of adjoining pours. Make the joint straight and true and free from impermissible blemishes relevant to its surface finish class.

Expansion joints abutting adjacent structures: Unless shown otherwise on the drawings provide 10 mm thick bitumen impregnated fibre board wherever the pavement abuts adjacent structures.

9.7.2 FORMED JOINTS

Full Depth Joints

Form the edge of the concrete placed first to provide a smooth, vertical face. After stripping and cleaning fix the joint filler with a suitable waterproof adhesive to the face of the slab, and place the adjoining concrete after the adhesive has set.

Keyed Joints

Refer Clause 4.2, keyways.

9.7.3 SAWN JOINTS

Weakened Plane Joints

General: Saw the hardened concrete to at least one quarter slab depth, and to a uniform width in the range of 3 - 5 mm.

Timing: Concrete saw cutting for pavement contraction joints shall be done as soon as the concrete sawing causes only slight edge ravelling. If no edge ravelling (straight corner edge) occurs, it may be too late to prevent uncontrolled cracking. Sawing too early will result in dislodgment of coarse aggregates or excessive ravelling of joint edges.

Sawing shall be performed by experienced personnel capable of determining the correct time to saw and the depth of cut allowing for blade wear.

Pavements will be liable for rejection if uncontrolled cracking occurs prior to or during saw cutting or excessive ravelling or aggregate dislodgment at joints occurs.

Sequence: Sawcut every second joint and then return backwards cutting the intermediate joints.

Cracking: If the concrete has already cracked near the location chosen for a joint, do not saw a joint in that location. If a crack develops ahead of the saw cut, discontinue sawing. If uncontrolled cracking occurs, suspend concrete placing.

Standby machines: Provide one standby sawing machine for each machine planned to be used.

Cleaning and protection: Immediately after each joint is sawn, flush the saw cut and adjacent concrete surface using water, until the waste from sawing is removed from the joint. Temporarily caulk the joint using plastic or rubber tubing, or a suitable "Tee" shaped extrusion. Leave the caulking in place until grooving and sealing commences.

Rebated Groove Joints

General: Saw straight, parallel sided grooves for joint seals on top of and centred on the sawn weakened plane joints.

Timing: Commence sawing after the curing period has ended, immediately before joint sealing. Saw during daylight hours and when the concrete temperature is at least 10°C.

Cracking: If cracks occur beneath initial saw cuts, increase the width of the groove by an amount equal to the width of the crack.

9.7.4 DOWELLED AND TIED JOINTS

Dowelled Joints

Formed or sawn joints reinforced with dowels and sealed.

Tied Joints

Formed or sawn joints reinforced with tie bars. Omit grooves and sealing unless shown on the drawings.

9.7.5 JOINT SEALING

General: Install sealants strictly in accordance with the Manufacturer's instructions. Where the Manufacturer's instructions contradict the drawings or specifications obtain advice.

Joint Preparation

General: The concrete at the sides of the joint must be sound, well compacted and cut to a smooth, even edge. Immediately before installation of the sealer ensure that the joint space is dry, clean and free from loose material. Remove laitance, curing compound and protrusions of hardened concrete from the sides and upper edges of the joint.

Formed full depth and rebated groove joints: After form stripping and when the concrete has cured sufficiently, clean formed arises using a rotary saw.

Sawn joints: Remove loosened material from the joint using compressed air or high pressure water jet.

Installing Self Expanding Cork Seals

Jointing: Join the factory-bound lengths of seal together by skiving and gluing with suitable waterproof adhesive. Make the seal continuous for the full length or width of the slab, in longitudinal and transverse joints respectively.

Ambient conditions: Install the seal only when the concrete in the vicinity of the joints is surface dry and the surface temperature in the range 20 - 30°C. Protect the seal from moisture before installation. Do not pre-soak.

Seal location: Install seals so that the top surface is flush with, or ± 5 mm below, the finished concrete surface.

Formed joints:

- Tape removal: Do not remove tape from the top surface of the seal until adjoining concrete has attained final set.
- Full depth and rebated groove joints: Fix the seal to the edge of the hardened concrete with a suitable waterproof adhesive and place the adjoining concrete after the adhesive has set.
- Weakened plane joints: Install the seal simultaneously with forming the crack inducing groove.

Sawn rebated groove joints: Coat one side of the seal with a suitable waterproof adhesive. Ease the seal, as a loose fit, into the joint and use gentle side pressure to adhere the coated side of the seal to the joint face. Approximately 24 - 48 hours after installation, remove the tape from the top surface of the seal and water thoroughly. Repeat watering for 5 days or until the cork has expanded to fill the groove completely.

Installing Preformed Elastomeric Seals

Apply a bead of lubricant adhesive to the top edge of each side of the joint, then install the seal by easing it into the joint, using a suitable roller, to finish 4 - 6 mm below the finished concrete surface.

9.8 COMPLETION

9.8.1 COMPLETION

Traffic on Pavement

Do not allow traffic on pavement until concrete is sufficiently cured to support traffic without damage. Refer also to Clause 5.7 – Protection.

APPENDIX A – SCHEDULE OF INSPECTION & TESTING REQUIREMENTS

ITEM	INSPECTION / TESTING REQUIREMENT
Existing Services	
▪ Locate existing services.	(2)
▪ Building over, relocating or modifying existing services.	(2) (5)
Erosion/stormwater control	
▪ Silt fences and hay bales installed prior to commencing earthworks and maintained during earthworks.	(2)
▪ Temporary detention basins installed prior to commencing earthworks and maintained as required.	(2)
Excavation/filling	
▪ Clearing and grubbing completed and topsoil stockpiled.	(2)
▪ Prior to construction of batter profiles and protection,	(2), (6)
▪ Shoring and ground anchors.	(1)
▪ Proof roll inspection of fill subgrades.	(1)
▪ Geofabric in place prior to filling.	(4)
▪ Material tests on filling materials.	(3)
▪ Compaction tests on each layer of fill.	(1)
▪ Proof roll inspection of completed earthworks.	
Service trenches	

ITEM	INSPECTION / TESTING REQUIREMENT
▪ Service trenches excavated prior to laying service.	(2)
▪ Material tests on bedding and trench backfill material.	(4)
▪ Backfilling of trenches.	(2)
▪ Compaction tests on bedding and trench backfill.	(3)
Placing topsoil	
▪ Cultivation of ground prior to placing topsoil.	(2)
Retaining walls	
▪ Underlying work.	(2), (3), (4)
▪ Material tests/ certificates for concrete and reinforcing.	(4)
▪ Prepour inspections of base reinforcing and formwork.	(1), (3)
▪ Site sampling of concrete.	(3)
▪ Prepour inspection of reinforced blockwork.	(1)
▪ Inspection of subsoil drains.	(1)
▪ Supply and compaction of granular backfill.	(3), (4)
Subsoil drainage	
▪ Material tests on filter material and trench backfill	(4)
▪ Trenches excavated prior to laying pipes	(2)

ITEM	INSPECTION / TESTING REQUIREMENT
▪ Subsoil pipes layer prior to covering	(2)
▪ Subsoil filter layer and filter fabric complete	(2)
▪ Compaction testing on trench backfill	(3)
Stormwater lines (including downpipe connections)	
▪ Material tests on bedding, pipe surround and trench backfill	(4)
▪ Manufacturers data submitted for pipe type	(4)
▪ Trenches excavated prior to laying pipe	(2)
▪ Compaction tests on pipe bedding	(3)
▪ Pipes laid prior to backfilling and pressure testing (including all downpipe connections etc)	(1)
▪ Compaction testing on pipe surround and trench backfill	(3)
▪ Connections to existing services	(1), (5)
Precast concrete box culverts	
▪ Compaction testing and proof rolling inspection of subgrade under base slab	(1), (3)
▪ Prepour inspection of base slab formwork and reinforcing	(1)
▪ Testing of concrete in accordance with Section 220 - Concrete	(4), (3)
▪ Manufacturers certification for design and manufacture of precast box culvert units	(4)

ITEM	INSPECTION / TESTING REQUIREMENT
▪ Sealing of joints prior to backfilling	(1)
▪ Material tests on backfill material	(4)
▪ Compaction testing on backfill	(3)
Concrete lined channels	
▪ Compaction testing and proof roll inspection of subgrade under base slab	(1), (3)
▪ Prepour inspection of reinforcing and formwork	(1)
▪ Testing of concrete in accordance with Section 220 - Concrete	(4), (3)
▪ Material tests on backfill material	(4)
▪ Compaction testing on backfill	(3)
Pits and other structures	
▪ Compaction testing and proof roll inspection of subgrade	(1), (3)
▪ Manufacturers certificates for precast items	(4)
▪ Prepour inspection of formwork and reinforcing	(1)
▪ Testing of concrete in accordance with Concrete specification	(4), (3)
▪ Inspection of completed concrete work prior to backfilling	(1)
▪ Material tests on backfill material	(4)
▪ Compaction testing on backfill	(3)

ITEM	INSPECTION / TESTING REQUIREMENT
Subgrade	
▪ Underlying filling and services trench backfill approved	(2), (3), (4)
▪ Compaction tests on completed subgrade	(3)
▪ Proof roll inspection of completed subgrade	(1)
Lime stabilised subgrade	
▪ Underlying work approved	(2), (3), (4)
▪ Layer to be stabilised compacted and trimmed	(2), (3)
▪ Compactive dry density tests	(3)
▪ Material certificates/ tests for hydrated lime	(4)
▪ Spread rate/ temperature/ working time for mixing of lime	(7)
▪ Uniformity of mixing/ lime content	(3)
▪ Compaction of stabilised layer	(3)
▪ Proof roll inspection on completed subgrade	(1)
Subbase and base	
▪ Underlying work approved	(2), (3), (4)
▪ Material tests/ certificates on subbase and base materials	(4)
▪ Compaction tests	(3)

ITEM	INSPECTION / TESTING REQUIREMENT
▪ Proof roll inspection of each completed pavement layer	(2)
▪ Application of wax emulsion to cement stabilised subbase	(7)
Concrete pavements	
▪ Underlying work approved	(2), (3), (4)
▪ Material tests/ certificates for concrete and reinforcing	(4)
▪ Prepour inspection of completed reinforcing, formwork, dowels etc.	(1)
▪ Site sampling of concrete	(3)
▪ Curing	(7)
▪ Cutting of sawn joints	(7)
Joints	
▪ Joint cleaned and prepared prior to priming	(2)
▪ Joint primed	(2)
▪ Material certification/ testing	(4)
Asphaltic concrete	
▪ Underlying work approved	(1), (3), (4)
▪ Kerbs etc completed	(1), (3)
▪ Placing asphaltic concrete	(2), (3), (4), (7)

ITEM	INSPECTION / TESTING REQUIREMENT
Sprayed bituminous surfacing	
▪ Materials tests/ certificates for aggregate, precoating agent, binder etc	(4)
▪ Underlying work approved	(1), (3), (4)
▪ Calculation of application rates etc	(6)
▪ Placing each coat of aggregate/ seal	(2), (3), (4), (7)
Associated Elements (kerbs, footpaths etc)	
▪ Material tests/ certificates for subbase, concrete etc,	(4)
▪ Placement of subbase	(2), (3)
▪ Subbase, formwork etc completed prior to pouring concrete	(1)
▪ Placing concrete	(2), (3), (7)
Guardrails	
▪ Manufactures certificates, shop drawings etc	(4), (7)
▪ Inspection of guardrail posts, prior to concrete encasement of footings	(1)

Key

1) Engineer to inspect

2) Engineer to be notified to allow opportunity to inspect

3) Test results from independent testing authority to be supplied to Engineer prior to covering work

ITEM	INSPECTION / TESTING REQUIREMENT
4) Materials certificates/ testing to be supplied to Engineer prior to commencing work	
5) Approval of relevant Statutory Authorities required	
6) Submit Certification of Contractors design check	
7) Contractors records of work	

APPENDIX B – RISKS & SOLUTIONS REGISTER

Structural Civil Traffic Façade

Civil Risks and Solutions Register

29/05/2023 211007 CAAA

Pymble Ladies' College
Avon Road
Pymble NSW 2073

Attention: Mr. Scott Egleton

Dear Scott,

As part of Safe Work Australia's 'Safe Design of Structures Code of Practice' (July 2012) which endeavours to foster safer work places, we have recently undertaken a Safety in Design review of our design on the Grey House Precinct - Pymble Ladies College project.

Attached is a summary of the findings of our review which identifies potential hazards and risks with the project and provides a method to address those hazards and risks relating to the design.

Other project documents which also identify potential design hazards and risks include:
1. Civil Engineering Report for SSDA Submission
2. Civil Drawings
3. Civil Specifications

It is a requirement of the Code of Practice for this information to be provided to the Principal Contractor for his review and incorporation into the project's safety report.

Any items designed by a Contractor for the Principal Contractor should be assessed for Safety in Design by the Contractor.

For our scope of work shown on the TTW project documentation, we confirm that all hazards/risks have been identified, reviewed and managed, as listed in the following risk register, So Far As Is Reasonably Practicable (SFAIRP).

For and on behalf of,
TAYLOR THOMSON WHITTING (NSW) PTY LTD
in its capacity as trustee for the
TAYLOR THOMSON WHITTING NSW TRUST

Job: Grey House Precinct (GHP) Pymble Job Number: 211007 CAAA Date: 29/05/2023

Civil Risks and Solutions Register

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Civil works				
Hazard: Existing Services Causes: Damage to existing services (in particular electricity) causing injury to both site personnel and the public @ risk: Contractors, Operatives, Workers and Public	High 3 likelihood 5 consequence	Service records plans to be requested from client. DBYD plans	Medium 2 likelihood 2 consequence	Contractor to verify presence and location of all services prior to commencement of works.
Hazard: Existing structures Causes: Damage to existing structures. Injury to site personnel, hospital workers and the public @ risk: Contractors, Operatives, Workers and Public	High 3 likelihood 5 consequence	Move works as far as possible from existing buildings/fences. Establish physical barriers for structures as a priority.	Medium 2 likelihood 2 consequence	Contractor to provide barriers and signs. Traffic management will be required
Hazard: Existing trees Causes: Damage to existing trees. Injury to site personnel, workers and the public @ risk: Contractors, Operatives, Workers and Public	Significant 2 likelihood 4 consequence	Liaise with tree protection expert to determine minimum stand off from trees. Move works as far as possible from existing trees.	Low 2 likelihood 1 consequence	Contractor to establish physical barriers for trees. Traffic management will be required.
Hazard: Vehicle/ Plant movement Causes: Injury to site operatives, workers + members of public. @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 4 consequence	Ensure contractor is made aware of risk.	Low 1 likelihood 2 consequence	Contractor to supply and comply with traffic management plan and provide adequate site traffic control including trained bankman to supervise vehicle movements where necessary.
Hazard: Site access/egress interface with public Causes: Injury to site operatives, workers + members of public. @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 4 consequence	Ensure contractor is made aware of risk.	Low 1 likelihood 2 consequence	Contractor to secure the site and take all necessary precautions in entering and leaving site and working in close proximity to public roads and adjacent properties.

Job: Grey House Precinct (GHP) Pymble Job Number: 211007 CAAA Date: 29/05/2023

Civil Risks and Solutions Register

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Hazard: Lifting of material by crane and hoist transportation of loads by excavator/forklifts Causes: Injury to site operatives, workers + members of public. @ risk: Contractors, Operatives, Workers and Public	High 3 likelihood 5 consequence	Ensure contractor is made aware of risk.	Medium 2 likelihood 2 consequence	Contractor to comply with relevant guidelines and statutory requirements and provide method statements for transfer of materials from point of delivery to site to incorporation into the permanent works
Hazard: Excavations Causes: Risk of collapse of drainage trench excavation. Risk of falling/tripping into open excavation @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 4 consequence	Minimise drainage design to reduce depths of required excavations.	Medium 2 likelihood 2 consequence	All excavations trenches & pits to be adequately supported. Areas of open excavation to be fenced off at the end of each working day. Ensure that materials are stored away from open excavations.
Hazard: Groundwater ingress into excavations Causes: Risk of flooding and collapse of structures @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 4 consequence	Check geotechnical report for anticipated ground water level. Provide dewatering system as necessary	Low 2 likelihood 1 consequence	Contractor to provide method statement for safe working
Hazard: Temporary instability of retaining walls/batters during construction Causes: Risk of collapse of structures/batters @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 4 consequence	Check geotechnical report for maximum safe batter slope. Minimise retaining.	Low 1 likelihood 2 consequence	Contractor to provide method statement for construction of walls and batters.
Hazard: Work at heights. Fall of persons or materials Causes: Risk of falling, dropping items from height @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 4 consequence	Ensure contractor is made aware of risk.	Medium 2 likelihood 2 consequence	Contractor to comply with relevant guidelines and statutory requirements. Fence off access to site when site is closed.
Hazard: Confined spaces Causes: Injury due to entry into existing/proposed manholes and drainage excavations. @ risk: Contractors and Operatives	Medium 3 likelihood 2 consequence	Ensure contractor is made aware of risk. Minimise drainage design to reduce depths of required excavations.	Low 1 likelihood 2 consequence	Contractor to provide method statement for safe working, PPE and supervision.

Job: Grey House Precinct (GHP) Pymble Job Number: 211007 CAAA Date: 29/05/2023

Civil Risks and Solutions Register

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Hazard: Hazardous materials Causes: Concrete + bituminous materials– burns to skin. Contact with drainage effluent @ risk: Contractors and Operatives	Significant 3 likelihood 3 consequence	Ensure contractor is aware that hazardous materials and COSHH assessments are to be provided prior to commencement of works	Low 1 likelihood 2 consequence	Contractor to adopt safe working practices (including adequate protective clothing and suitable hygiene facilities).
Hazard: Injury from reinforcement bars Causes: Cuts/abrasions/impaling @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 3 consequence	Length of reinforcement to be kept as short as possible. Minimise projections	Low 1 likelihood 1 consequence	Contractor to provide safety ends to projecting bars.
Hazard: Noise, vibration and dust Causes: High levels of noise, vibration and dust from construction plant and equipment. @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 3 consequence	Ensure contractor is made aware of risk. Discuss all requirements with client.	Medium 2 likelihood 2 consequence	Contractor to use noise reduced plant where required. Dust and vibration requirements to be determined prior to construction
Hazard: Water pollution Causes: Pollution of existing drainage network from site fuels/oils etc. @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 3 consequence	Ensure contractor is made aware of risk. Provide adequately sized oil interceptors within drainage design.	Low 1 likelihood 1 consequence	Contractor to bund all fuel tanks, oil storage areas. Contractor to provide suitable temporary pollution control measures during construction.
Hazard: Manual Handling / Lifting Causes: Incorrect lifting procedures could result in back or other muscular injury @ risk: Contractors and Operatives	Medium 3 likelihood 2 consequence	Ensure contractor is made aware of risk and carries out manual handling assessment prior to works commencing.	Low 1 likelihood 2 consequence	Manual handling procedures to be followed at all times. Contractor to use mechanical handling devices where applicable.
Hazard: Slips, trips and falls Causes: Injury to site operatives, workers + members of public. @ risk: Contractors, Operatives, Workers and Public	Significant 3 likelihood 4 consequence	Ensure contractor is made aware of risk.	Low 1 likelihood 2 consequence	Work area to be kept free of obstructions and debris as far as is practicable

Job: Grey House Precinct (GHP) Pymble Job Number: 211007 CAAA Date: 29/05/2023

Civil Risks and Solutions Register

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Hazard: Contaminated Ground Causes: Ground may be contaminated @ risk: Contractors and Operatives	Medium 2 likelihood 3 consequence	Site investigation studies to be undertaken prior to commencement of works to determine whether the ground is contaminated.	Low 1 likelihood 1 consequence	Contractor to carry out assessment if appropriate.
Hazard: Dust/mud on road Causes: Respiratory Effects Foreign Bodies in eye Skin contamination @ risk: Contractors, Operatives, Workers and Public	Medium 2 likelihood 2 consequence	Ensure that dust suppression measures are in place, such as dampening of materials.	Low 1 likelihood 1 consequence	Contractor to ensure vehicles entering/leaving the site and clean
Hazard: Incorrect level at the proposed stormwater connection point resulting in re-design, increase in project costs and a delay to project. Causes: • Incorrect survey. • Incorrect stormwater asset information. • Changes to design during construction due to unforeseeable reasons. @ risk: Client, contractors, end users	Significant 3 likelihood 3 consequence	• Engage surveyor to confirm invert connection points during tender documentation stage. • Engage plumber to review stormwater drainage design prior to construction.	Medium 2 likelihood 2 consequence	Project Manager, Civil Engineer, Contractor.
Hazard: Clash of stormwater connection with existing or proposed services resulting in asset relocation and/or redesign. Causes: • Incorrect survey. • Changes to design during construction. • Inadequate service clash checks during design. @ risk: Client, contractors, end users	Significant 3 likelihood 3 consequence	• Undertake DBYD services search during design phase. • Surveyor to confirm stormwater invert connection points during tender documentation stage. • Organise non-destructive service locators to confirm potential clash zones with existing services shown on DBYD plans during tender/prior to construction. • Contractor to undertaken own services investigation and ensure plumber reviews stormwater design.	Medium 2 likelihood 2 consequence	Project Manager, Civil Engineer, Contractor.

Job: Grey House Precinct (GHP) Pymble Job Number: 211007 CAAA Date: 29/05/2023

Civil Risks and Solutions Register

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Hazard: Maintenance crews carrying out routine inspection encounter toxic gases, incoming stormwater flows and/or fall when entering or exiting storm water pits. Causes: • Inadequate dimensions for necessary confined spaces equipment. • Inadequate training and PPE. @ risk: Maintenance contractors, client	Significant 2 likelihood 5 consequence	• Ensure adequate headroom for set up of the necessary confined spaces equipment. • Ensure two persons are present during routine inspections. • Confined spaces training, certification and gear (masks, harnesses etc) • Ensure that the grate hinge is on a different internal pit face to the step irons/access points. • Ensure sealed junction pits are allowed to air prior to entering for maintenance activities. • Carry out maintenance activities on dry days only. • ** NOTE:Consequence remains unchanged due to risk to human life.	Significant 1 likelihood 5 consequence	Civil Engineer, Contractor, End Users, Operations and Management.
Hazard: Accidents caused by vehicle/pedestrian movements and maintenance crews during routine cleaning of water quality devices. Causes: • Inadequate dimensions for to facilitate quick proprietary unit replacement. • Inadequate management of traffic and or pedestrians movements. @ risk: Maintenance contractors, client	Significant 2 likelihood 5 consequence	• Ensure adequate clearances inside and around precast units for ease of maintenance. • Ensure two persons are present during routine cleaning. • Locate manholes and access points away from potential clash zones. • Prepare access plan to manage vehicle and pedestrian movements during routine maintenance. • Set up appropriate signage and controls to manage pedestrian and vehicle movements.	Low 1 likelihood 2 consequence	Civil Engineer, Contractor, End Users, Operations and Management.

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Hazard: Risk of contamination to human and environmental receptors due to contaminants on site. Causes: Dermal contact, ingestion, inhalation via dust, exposure to plants and animals @ risk: Public, end users, workers, contractors	High 3 likelihood 5 consequence	• Undertake the necessary contamination remediation as per the recommendations in: • * • Geotechnical Investigation for Existing Carpark by JKGeotechnics (Ref: 29017ZHrpt) dated 14 January 2016 • * Geotechnical Investigation for Proposed Demountable Buildings by JKGeotechnics (Ref: 33554BCrpt) dated 21 October 2020 • * Geotechnical Investigation for Proposed School Building by JKGeotechnics (Ref: 33775SCrpt) dated 8 February 2021 • * Geotechnical Investigation for Proposed School Building by JKGeotechnics (Ref: 33775SCrpt2) dated 26 April 2021 • * Preliminary Waste Classification Assessment for Proposed New School Building by JKEnvironments (Ref: 33775PHlet) dated 3 February 2021 • ** NOTE:Consequence remains unchanged due to risk to human life.	Significant 1 likelihood 5 consequence	Contractor.
Hazard: Localised nuisance ponding or flooding of finished floor levels due to blockage of the site stormwater network. Causes: • Insufficient maintenance of water quantity and quality elements of the stormwater system. • Maintenance procedures not followed. • Stormwater network not constructed as designed. @ risk: Public, end users, workers, contractors	Medium 2 likelihood 3 consequence	• Regular inspection and maintenance is to be carried out on the elements of the site stormwater system as outlined in the maintenance schedule. • Provision of Works As Executed drawings by a registered surveyor showing all elements of the as built stormwater system.	Low 1 likelihood 2 consequence	Contractor, Management and Operations.
Hazard: Access into inlet structure, associated box culvert or energy dissipation structure. Causes: • Persons are able to lift the grates over inlet structure and enter the chamber. @ risk: Client, end users, potentially contractor	Significant 2 likelihood 5 consequence	• Provide bolt down type grates with locks over inlet structure. Management to ensure grates are locked at all times. • ** NOTE:Consequence remains unchanged due to risk to human life.	Significant 1 likelihood 5 consequence	Civil Engineer, Contractor, Management and Operations.

Job: Grey House Precinct (GHP) Pymble Job Number: 211007 CAAA Date: 29/05/2023

Civil Risks and Solutions Register

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Hazard: Flood flows leaving the outlet point result in the erosion of the downstream waterways. Causes: Concentration of stormwater into box culvert increases flow velocity increasing scour and erosion of the immediate area. @ risk: Environment, client	Significant 4 likelihood 3 consequence	• Provide energy dissipation structure as designed incorporating rip rap type blocks to slow jetted flows. • Provide dense vegetation immediately downstream and surrounding the energy dissipater to stabilise the slope and provide additional means for reduce flow velocity.	Medium 1 likelihood 3 consequence	Civil Engineer, Contractor.
Hazard: Pollution of the downstream waterways. Causes: Erosion of soil and transportation of sediment through the construction site into the receiving wayerways. @ risk: Environment, client	Significant 3 likelihood 3 consequence	• Ensure adequate sedimentation and erosion control measures are provided as part of the construction works. • Contractor to ensure final sediment and erosion control measures comply with the Department of Environment and Conservation 'Managing Urban Stormwater' aka Blue Book published by Landcom.	Medium 1 likelihood 3 consequence	Civil Engineer, Contractor.
Hazard: Excavation and destruction of cultural artifacts. Causes: Inadequate due diligence during the excavation, earthworks and trenching phase. @ risk: Client, contractor	Significant 3 likelihood 3 consequence	• Potential clashes with elements of the stormwater system and pavements with respect to test pit locations to be reviewed during tender design. • The contractor is to undertake all necessary measures as outlined in the Aboriginal Cultural Heritage Assessment Report	Medium 1 likelihood 3 consequence	Civil Engineer, Contractor.
Hazard: Inadequate traction during rain events causing wheels to spin when exiting the site. Cyclists losing control and risking injury. Causes: • Grate finish or pattern does not offer vehicles enough traction for vehicles or is not bike friendly. • Vehicles or cyclists entering/existing the site do so at too fast a speed. @ risk: Motorists, pedestrians, cyclists.	Significant 3 likelihood 3 consequence	• Provide anti-slip, bike friendly ductile iron grates. • Consider the installation of rubber speed humps either side of the inlet structure to slow vehicles down. • Consider speed limit sign posting.	Medium 2 likelihood 2 consequence	Civil engineer, architect, client.
Hazard: Insufficient support during excavation and construction of stormwater leading to instability of trees and potential for trench collapse/injury. Causes: Depth of excavation and inadequate support of trench/surrounding ground. @ risk: Contractor, Council, Client	Significant 3 likelihood 4 consequence	Contractor to consider and propose an appropriate construction methodology including shoring and liaise with Council/arborist regarding requirements of construction adjacent to the existing easement and trees.	Medium 2 likelihood 3 consequence	Contractor

Job: Grey House Precinct (GHP) Pymble Job Number: 211007 CAAA Date: 29/05/2023

Civil Risks and Solutions Register

Indentification	Initial Risk Rating	Risk Mitigation	Residual Risk Rating	Responsibility
Traffic				
Hazard: SITE ACCESS: Council or RMS or other road authority requires additional works (eg new traffic signals) Causes: Poor communication with authorities @ risk: Contractor, Client	Medium 2 likelihood 3 consequence	Discuss access requirements with relevant authorities and determine access requirements prior to commencement of work.	Low 1 likelihood 2 consequence	Civil Engineer

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Legend:

Consequence / Likelihood	Insignificant = 1	Minor = 2	Moderate = 3	Major = 4	Catastrophic = 5
Almost Certain = 5	Significant	Significant	High	High	High
Likely = 4	Medium	Significant	Significant	High	High
Possible = 3	Medium	Medium	Significant	Significant	High
Unlikely = 2	Low	Medium	Medium	Significant	Significant
Rare = 1	Low	Low	Medium	Medium	Significant

Likelihood		Consequence	
Almost Certain	Is expected to occur in most circumstances	Catastrophic	Severe adverse impact - (Death)
Likely	Will probably occur in most circumstances	Major	Major adverse impact - (Extensive Injuries)
Possible	Might occur at some time	Moderate	Moderate adverse impact - (Medical treatment required)
Unlikely	Could occur at some time	Minor	Minor adverse impact - (First aid treatment)
Rare	May only occur in exceptional circumstances	Insignificant	Insignificant adverse impact - (No injuries)

	Risk Control Actions
High	The risk is unacceptable. Eliminate the design feature
Significant	High Priority for action
Medium	Responsibility to be allocated
Low	Manage by routine procedure and control

PYMBLE LADIES'COLLEGE
GREY HOUSE PRECINCT

ISSUE	COMMENT	DATE	PREPARED BY	JOB NO.
A	CC1 ISSUE	15/3/2024	AC	240031

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TABLE OF CONTENTS

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL INFORMATION

1.1.1 Definitions

Architect	-	BVN Architects
Authority	-	The relevant statutory body / bodies responsible for the work.
Builder	-	The main / head Contractor responsible for the building works under the contract.
Consulting Engineer – Electrical	-	Stantec (TBC)
Consulting Engineer – Hydraulics	-	JHA Consulting Engineers
Consulting Engineer – Wet Fire	-	JHA Consulting Engineers
Consulting Engineer – Mechanical		Crest Air Conditioning
Consulting Engineer – Civil	-	TTW Consulting Engineers
Consulting Engineer - Structural	-	TTW Consulting Engineers
Contract Documents	-	Includes this Specification, Drawings and all the briefing and contract documents provided with the Tender documents.
Contractor	-	The company contracted to carry out the 'Works'
Council	-	Ku-ring-gai Council
Drawings	-	All the drawings related to the project including Architectural, Structure, Hydraulic, Fire, Mechanical, Electrical, Lifts, Landscape and any other specialist consultant drawings that form part of the Tender Package. Where the Works include for Design and/or Design Finalisation, Drawings also refer to the drawings produced by the Contractor as part of the Works.
Fire Authority	-	Fire and Rescue NSW
Gas Authority	-	Jemena / Department of Fair Trading
Hydraulic Drawings	-	The Hydraulic Drawings which in conjunction with this Specification outline the work included in the Hydraulic Services scope of work.
Principal	-	Pymble Ladies' College
Project Manager	-	The Superintendent / Principal's representative on site.
Provide	-	Design, obtain approval, pay fees, manufacture, supply, deliver, install, test, commission, warrant, guarantee, maintain, service, enter data for, and do all other things necessary to make the device / system a part of the Works.
Specification	-	This document which in conjunction with the Hydraulic Drawings outlines the work included in the Hydraulic Services scope of work.

Water Authority	-	Sydney Water / Department of Fair Trading
Works	-	As defined within the Contract Documents.

1.2 THE PROJECT

The project comprises a new education development at the existing Pymble Ladies College (PLC) school premises. The new building will consist of learning spaces, dance studios, staff areas and other amenities.

1.3 ROLES, OBJECTIVES & EXPECTATIONS

1.3.1 Specification Objectives

The intent of this Specification and the associated documents is:-

- To provide a clear statement of technical and performance requirements against which compliance can be assessed.
- To provide documentation required by Authorities to demonstrate design compliance with statutory requirements.
- To define the expectations of the Contractor, by the Consulting Engineer.
- To define the roles of the parties involved with the works.
- To enable other interested parties to assess their obligations and to understand expectations of them.
- To define the requirements of the Contractor with respect to Quality Assurance.

1.3.2 Consulting Engineers's role

During the construction phase the Consulting Engineer shall be given the opportunity to:

- Review the Hydraulic design calculations.
- Review the Hydraulic construction installation/workshop drawings prior to construction.
- Analysis of schedule of technical data and alternatives offered.
- Review of shop drawings.
- Review of samples for the purpose of establishing compliance with the Specification.
- Review of Contractor's inspection and test plans for each section of the works.
- Periodic review of the progress of the works, noting any observations with respect to quality of the installation or materials used.
- Issue of any clarification instruction required to interpret the Specification or drawings.
- Issue any instructions required to change the Specification or drawings.
- Value any progress claims made upon the works.
- Review and randomly verify commissioning data achieved.
- Review Contractor's Q.A. records.
- Inspect the works at Practical Completion and schedule any defective or incomplete items.
- Review 'As Installed drawings and operating and maintenance documents.
- Review maintenance records during the defects liability period.
- Inspect the works at the end of defects liability period.

1.3.3 Obligations of the Contractor

The Principal expects and relies upon the Contractor possessing specialist trade expertise necessary to complete the Works in accordance with documentation.

In addition, the Contractor has the following obligations:

- To raise in good time, issues requiring design input or clarification from the Consulting Engineer, particularly in respect to:-
- Interpretation and co-ordination of the Specification or Drawings
- Problems in complying with the Specification
- Omissions from the tender documents
- To allow the design verification costs of the Consulting Engineer when suggesting alternatives and departures from the Specification.
- To certify compliance with Contract documents, including all variation instructions, at Practical Completion.
- To certify compliance with Authority requirements.
- To pay all fees applicable to the works.
- To obtain all Authority permits and certificates to allow the progress of the work.
- To provide manufacturer's and construction drawings.
- To provide samples and prototypes where specified.

SECTION 2 - GENERAL REQUIREMENTS

2.1 GENERAL

2.1.1 Programme

The Contractor shall comply with the Builder's construction programme. The following are the key items for the Contractor to procure early to avoid delays.

- Early works such as diversions / temporary works required to enable the new construction works to proceed.
- Procurement of major plant and equipment including hot water plant & circulating pumps, cold water booster pumps, cold water storage tanks etc.

2.2 SCOPE OF WORK

The work under this section covers the complete supply, installation and testing of the following:

- Dial Before You Dig Searches, Pump applications and Watermain Pressure Inquiries
- Preparation of Work as Executed Drawings and Operation and Maintenance Manuals
- Authorities Applications and all associated fees, charges and permits
- Excavation, Backfilling and Restoration of Surfaces
- Subsoil drainage below the building slab
- Suspended stormwater drainage
- Inground stormwater drainage from suspended drainage connecting to the rainwater tank and OSD Tank.
- Sewer Drainage & Sanitary Plumbing
- Trade Waste Drainage Services
- Downpipes
- Cold Water Service
- Hot and Warm Water Services
- Fire Services Connections
- Fire Hydrant Service
- Fire Hosereel Service
- Fire Extinguishers
- Sanitary Fixtures, Taps and Outlets

All sections of this specification are to be taken in conjunction with any provisions and/or clauses in any one section and are to be taken as referring to all other sections if such provisions, etc., are in any way applicable.

2.3 QUALITY ASSURANCE

2.3.1 General

Prior to the Contractor commencing works on site, they shall submit to the Project Manager a project specific Quality Plan for acceptance. The plan shall detail the inspection and test plans to be used for

this project together with the relative check lists. Quality Assurance conducted on this project shall comply with ISO 9001 & 9002 and shall be used for all elements of the project.

Paying particular attention to Appendix C of ISO 9001& 9002 read in conjunction with all requirements of all works detailed within this Performance Specification and shown on drawings where supplied.

In establishing the procedures to be followed to administer the Quality Assurance System utilise the specific terms defined in ISO 9001 & 9002.
Note and observe the standards and requirements set out in the Specification and drawings as the minimum requirements and use these as a basis for developing the Quality Assurance System.

Submit to the Project Manager a monthly report outlining all non-conformances and quality information with the monthly progress claim.

2.3.2 Quality Plan

Provide a Quality Assurance Plan and program for the works prior to submitting Design/Workshop Drawings for approval prepared in accordance with ISO 9001 & 9002 including but not necessarily limited to:

- A Policy Statement signed by the Contractor's senior management setting out in brief the company's QA policy in general and the broad objectives covered by the QA policy for this project in particular.
- System Application specifying the full scope of work to which the QA system applies.
- Responsibilities and organisation encompassing an organisation chart and brief description of the responsibilities of individual staff of the project.
- Defining the QA representative's role and authority.
- A brief description of how critical activities will be controlled, identifying by whom and how.
- Details of QA co-ordination procedures for testing by the Contractor and other testing organisations.
- All system elements to be used and an index identifying the system headings
- Checklist detailing testing procedures, construction debris prevention, protection of finishes, asset list and verification of As- Built documentation.
- Manual Review as specified in ISO 9002.

Prepare the Quality Plan as a brief but concise document providing a total overview of the QA system.

2.3.3 System Elements

Prepare written descriptions for system elements covering all items of work.

- Purpose scope
- Responsibilities
- Outline of activities

Together with any attachments, such as pro forma sheets for check lists or registers, which are considered appropriate.

2.3.4 Inspection and Test Plans

Develop and implement inspection and test plans for each process. Acceptance criteria and testing frequency shall reflect the requirements set out in the specification and on Hydraulic Drawings (where supplied) for all items of equipment, material and labour.

2.3.5 Identification and Traceability

Identification of the work elements and their locations shall follow the Project Manager's Lot Numbering System as established for this project.

2.4 ALTERNATIVES

Generally, Tenderers are to adhere to the types of fixtures, plant and equipment detailed in the performance specification. Where these requirements preclude Tenderers from offering plant of their standard manufacture, alternatives may be submitted for approval.

The Principal / Project Manager must be provided with the opportunity to review the alternative and reserves the right to refuse its installation.

2.5 SAMPLES

The Contractor must submit to the Project Manager for approval, samples of selected equipment and fittings proposed to be used in the works and obtain approval.

2.6 HYDRAULIC DRAWINGS

The accompanying drawings indicate the general layout of the hydraulic services work and are diagrammatic only. These drawings are not fully coordinated with other building services and structure and shall not be used for determining details for any section of the work.

The Contractor is to maintain at all times on the job, an up-to-date set of hydraulic services installation/workshop drawings and Specification and these must be available for inspection by the Project Manager. This set must be separate from the Contractor's main set and must include separate sheets of all Hydraulic Services for marking and signing off by the relevant Authorities and the Project Manager, as installation testing proceeds, to maintain an accurate record of services.

The Contractor must allow for all necessary diversions and minor adjustments to pipework and equipment as may be necessary to complete the works. The Contractor must be kept two (2) sets of their drawings permanently on site. All dimensioning and detailing necessary for the correct preparation of working drawings must be obtained on site and not from the tender drawings(where supplied).

2.7 TENDER DOCUMENTS

No extra payment will be considered due to inaccuracy of the Tender Documents with regard to quantities and Authorities requirements. Any variation deemed necessary will be noted and included in the tender price.

2.8 SCHEDULE OF RATES

The successful Contractor must submit to the Project Manager/JHA a fully rated schedule of rates, which may be used in valuing deductions/variations.

2.9 REGULATIONS & AUTHORITIES

The whole of the work is to be carried out by or under the full supervision of a licensed plumber and licensed drainer in accordance with the Drawings, Specification and to the satisfaction of the Water Authority, Local Council, Project Manager and any other Authority having jurisdiction over the work.

The relevant Authorities and Regulations are as follows:

- Water Authority
- Local Council
- Fire Authority
- National Construction Code of Australia
- Wiring Rules
- Dept. of Industrial Relations - Dangerous Goods Branch
- Work Cover Authority N.S.W.
- Telstra
- The Division of Resources and Energy- Minerals & Petroleum
- AS/NZS 3500
- NSW Transport Roads & Maritime Services
- Optus
- Any other Authorities that may be applicable

The Contractor is responsible for ensuring that the works comply in all respects to the latest provisions of the Act of Parliament, the latest Australian Standard Codes, By-Laws, Requirements, Ordinances, Building Codes and Rules that may be applicable.

The Contractor is to provide certificates indicating compliance with the Authorities requirements and regulations and satisfactory completion of the services and hand over to the Project Manager before application for certificate of practical completion.

If any doubt exists as to whether a section of the design is able to comply with the relevant Authorities or regulations, the Project Manager is to be notified prior to commencement of any work. No consideration of claim for redundant work will be given if the Project Manager is not notified.

2.10 WELS SCHEME

WELS – Water Efficiency Labeling & Standards Scheme is a Federal Government initiative.

All water using fixtures installed must comply with the WELS scheme including all showers, taps, spouts, urinals, WC's, etc.

Confirmation of compliance with the WELS scheme shall be produced at the request of the Project Manager.

2.11 FEES & APPROVALS

The Contractor must pay all fees associated with Authorities services connections, approvals, testing and inspections, etc., required for the Works.

The whole of the installation must be carried out in accordance with the Drawings bearing the stamp of approval from the Authorities and/or the Project Manager. The Project Manager must be notified of all amendments and their approval obtained prior to commencement of any works.

2.12 SUPERVISION & SITE MEETINGS

The Contractor must supervise fully the whole of the works of this contract and including the works of all of their Sub-Contractors and Suppliers. For this purpose a responsible, efficient Supervisor who is empowered to receive and carry out instructions from the Project Manager must be appointed to run and control the Project. The Supervisor's duties in respect of this Project are to supervise and co-ordinate the works of all persons engaged under this Contract.

The Project Manager will arrange regular Site Meetings at a frequency dictated by the progress of the works. The Contractor's and Contractor's Supervisors when required by the Project Manager must attend such Meetings.

2.13 SITE CONDITIONS

The Contractor and their sub-contractors are obligated to inspect the site and be satisfied as to the conditions under which work will be carried out. No claims for additional costs resulting from the lack of knowledge of site conditions relating to works to be done or locations and levels of mains and mains connections to the Authorities mains will be accepted.

2.14 EXISTING SERVICES

The location, size and levels of the existing services shall be obtained from Authorities records and/or site inspection.

Immediately upon commencement of work, on site, the Contractor must locate, excavate and backfill over the existing services and confirm their location, size, material, depth, level, etc.

If pipe locating, ground penetrating radar or similar equipment is required then the cost of this equipment and time must be allowed for by the Contractor.

If the actual location, levels etc. are not as documented, the Contractor must notify the Project Manager, in writing setting out all details of findings and associated costs involved.

The Contractor must be completely satisfied that all existing services required to be connected are those to which their design documents indicate connection and that they are of the size and level shown on their drawings. No additional claims will be accepted for rectifying works that have been incorrectly connected as a result of failing to confirm the existing documented information on site, prior to commencing this work.

All existing services to be connected to, other than Authority services are to be cleaned, flushed out and tested to an equivalent standard of all new works, and to the satisfaction of the Project Manager prior to their connection.

The Contractor must not close down any existing services without giving at least 48 hours notification to the Project Manager or without written approval to do so. After notification to the Project Manager by the Contractor that the service is redundant, the Contractor may proceed to cap off or seal the service off in the correct manner, as is required by the Authorities and the Project Manager.

The Contractor will be responsible for checking with all Authorities and the Project Manager concerning the location of any existing services on the site.

All damage caused by the Contractor to operational services, building structure, paving and roads must be made good at their own expense as the work in the affected area proceeds.

2.15 TESTING

The Contractor must carry out all necessary testing of the services shown on the drawings and/or nominated in the Specification in the presence of the Authorities and the Project Manager.

Provide a record of any tests to the Project Manager.

The Contractor will be responsible for supplying all labour, plugs, pressure gauges, measuring gauges, pumping equipment and all other necessary materials and equipment, etc., required to do such tests.

Before enclosing or concealing pipework, carry out an operational test to the satisfaction of the Project Manager. Remedy any defects, particularly water hammer, and retest to the satisfaction of the Project Manager.

Underground or enclosed works must not be covered or concealed from view unless it has been inspected, tested and approved by the Project Manager and the Authorities concerned.

All services are to be inspected by the Project Manager and the Relevant Authorities.

Inspections carried out by the Relevant Authorities will not relieve the Contractor's responsibility of obtaining an inspection by the Project Manager.

The Project Manager, at all times reserves the right to inspect all pipework and services. Should, for any reason, pipework be concealed before the Project Manager has inspected the work, then the Contractor will expose all pipework requested by the Project Manager at their own cost. Any costs associated with the damage and/or repair to any other services, structure, surfaces, plant, equipment, etc. will be borne by the Contractor.

On completion, the works included under this part of the specification must be tested under normal working conditions and as directed by the Project Manager. All defects must be remedied immediately and the tests reapplied to the satisfaction of the Project Manager and the Authorities.

At least 48 hours' notice will be given to the carrying out of tests or longer periods may be instructed to be given by the Project Manager.

2.16 HYDROSTATIC TEST SCHEDULE

Pipework System	Test Pressure	Duration
All Water Services	2100 kPa	2 hours
Fire Services	2100 kPa	2 hours
Natural Gas Services	100 kPa	24 hours
Sewer Drainage & Sanitary Plumbing	Static	4 hours
Stormwater Drainage & Downpipes	Static	4 hours

2.17 CO-ORDINATION WITH WORK BY/FOR OTHER TRADES

Various items of apparatus and equipment will be provided and fixed under other contracts. The Contractor must familiarize himself with the requirements of these contracts and is to examine the plans and specification covering each of these contracts.

It is the responsibility of the Contractor to schedule their work closely so that their work may be installed at the proper time and without delaying the completion of the entire project.

The Contractor must carefully check space requirements with other Contractor s to ensure that their equipment, piping, etc., can be installed in the spaces allotted for same.

When equipment and/or installations associated with the work of the contract are installed by other Contractor s (e.g. sumps, electrical controls, float switches, etc.) the Contractor must attend and coordinate as necessary.

2.18 WORKSHOP & CO-ORDINATION DRAWINGS

The Contractor is required to prepare installation/workshop drawings at a minimum scale of 1:100/1:50 for plans and 1:20 for sections and details showing all services to be installed within and outside the building.

The Contractor must liaise with other trade Contractors to ensure that the installation of all services are fully coordinated, with due allowances for the various parts of the structure and the fittings to be installed.

The Project Manager is not to be regarded as the Contractor's checking agents. Approvals of workshop drawings will be given in principle only and without prejudice to the responsibility of the Contractor for the proper coordination, installation and operation of the Services.

All drawings must be prepared on an industry recognized CAD system and when submitted must be in DWG (AutoCAD) format.

Once all necessary corrections required by the Project Manager are made to the drawings, the Contractor will then issue all drawings in the following format: -

- One (1) set of computer files in DWG format
- One (1) set of computer files in PDF format
- Update of BIM Revit Model

Work may not be carried out until the Project Manager has approved the appropriate workshop drawings, which approval is in the terms of general layout only, and does not necessarily imply that this specification has been satisfied.

Documents where produced by the Consultant for this project were prepared on CAD and word processing programs. Copies of the computer files are available from the Consultant at commercial rates.

The Contractor is to prepare workshop drawings by their own methods and must not use the Consultants documents as a base. The Consultant's drawings must not be copied, scanned or reproduced in anyway.

The design and documentation must be carried out by a recognized Hydraulic Services Consultant, who must be a Full or Corporate Member of the Association of Hydraulic Services Consultants, Australia (NSW) Inc.

2.19 WORK AS EXECUTED DRAWINGS

During construction, the Contractor must maintain one set of the Hydraulic Services installation drawings on site, for recording work as executed. All in-ground services are to be located by a registered surveyor, noting coordinates, invert levels, surface levels, services nomination and sizes, changes of direction and relayed to the Work as Executed drawings.

These drawings are to be updated on a daily basis for inspection by the relevant Authorities and the Project Manager.

Any variations to the design of the Hydraulic Services, such as revisions to the drawings and site instructions, must be recorded.

The Contractor must deliver to the Project Manager before application for Notice of Practical Completion for checking one copy of the work as executed drawings, accurately indicating the invert depths and installed position of all services, fixtures, fittings, valves, including diagrammatic and details drawings.

Any necessary corrections will be made and a further copy of the work as executed drawings submitted to the Project Manager for their checking.

All drawings must be prepared on an industry recognized CAD system and when submitted must be in Revit format.

Once all necessary corrections required by the Project Manager are made to the drawings, the Contractor is to issue all drawings in the following format: -

- One (1) set of computer files in DWG format
- One (1) set of computer files in PDF format
- BIM / Revit model

Documents produced by the Consultant for this project were prepared in Revit. Copies of the computer files are available from the Consultant at a commercial rate.

The Contractor is to prepare work as executed drawings by their own methods and must not use the Consultant's documents as a base. The Consultants drawings must not be copied, scanned or reproduced in anyway.

All documents prepared by JHA are subjected to copyright and remain the property of JHA and must not be retained, copied or used without the written authority of JHA.

2.20 OPERATION AND MAINTENANCE MANUALS

Unless directed otherwise by the Head Contract, submit operation and maintenance manuals to the following minimum requirements.

Information contained within shall be built up from that supplied by manufacturers, authorities, as built service drawings, Certificates of Compliance and providing all information necessary for the complete maintenance and servicing of all of the hydraulic services, plant and equipment.

2.20.1 Format

For review purposes, allow to produce the manuals in the following format:

A4 size loose leaf, in commercial quality, 4 ring binders with hard covers, each indexed, divided and titled. Include the following features:

Pagination: Number pages consecutively.

Cover: Identify each binder with typed or printed title "Operation and Maintenance Manual" to spine. Identify title of project, volume number, volume subject matter, and date of issue.

Text: Manufacturers' printed data, including associated diagrams or typewritten, single-sided on bond paper, in clear concise English.

Dividers: Durable numbered divider for each separate element.

2.20.2 Contents

Include the following:

- Table of contents: For each volume. Title to match cover.
- Drawings and technical data: As necessary for the efficient operation and maintenance of the installation.
- Directory: Names, addresses, and telephone and facsimile numbers of principal consultant, sub-consultants, contractor, subcontractors and names of responsible parties.
- Installation description: General description of installation.

- Systems descriptions: Technical description of the systems installed, written to ensure that the principal's staff fully understand the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions.
- Systems performance: technical description of the mode of operation of the systems installed.

2.20.3 Equipment descriptions:

Name, address and telephone and facsimile numbers of the manufacturer and supplier of items of equipment installed, together with catalogue list numbers.

Schedules (system by system) of equipment, stating locations, duties, performance figures and dates of manufacture. Provide a unique code number cross-referenced to the record and diagrammatic drawings and schedules, including spare parts schedule, for each item of equipment installed.

Manufacturers' technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.

Supplements to product date to illustrate relations of component parts. Include typed text as necessary.

2.20.4 Operation procedures:

Manufacturer's technical literature as appropriate.

Safe starting up, running-in, operating and shutting down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure.

2.20.5 Maintenance procedures:

Manufacturer's technical literature as appropriate. Retain copies delivered with equipment.

Detailed recommendations for preventative maintenance frequency and procedures which should be adopted by the principal to ensure the most efficient operation of the systems installed.

Safe trouble-shooting, disassembly, repair and reassembly, cleaning, alignment and adjustment, balancing and checking procedures. Provide logical step-by-step sequence of instructions for each procedure.

Schedule of spares recommended to be held on site, being those items subject to wear or deterioration and which may involve the principal in extended deliveries when replacements are required. Include complete nomenclature and model numbers, and local sources of supply.

2.20.6 Emergency procedures:

Including telephone numbers for emergency services, and procedures for fault finding.

2.20.7 Certificates:

- Copies of manufacturers' warranties
- Certificates from authorities
- Copies of test certificates for the installation and equipment used in the installation
- Test and balancing reports
- Certificate of Compliance
- Essential services Certificate of Compliance

2.20.8 Drawings:

- Schedule of As-installed drawings
- Disc of As-Installed drawings (AutoCAD Version 2012)
- Schedule of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams
- Insert A3 copy of As-Installed drawings
- Submit 2 draft manuals 8 weeks before the date for practical completion for approval prior to final issue

Format: As for the final manuals, with temporary insertions for items which cannot be finalised until the installation is commissioned and tested

Submit 5 sets of final volumes within 2 weeks after practical completion. Incorporate feedback from review and from training of principal's staff, including preparation and insertion of additional data.

2.21 NATIONAL CONSTRUCTION CODE (NCC)

The final installed installation shall comply with the requirements of the NCC (including BCA) with respect to items listed below:

- Access panels
- Acoustics
- Incoming fire mains
- Fire rating
- Energy efficiency

Practical completion will not be issued for any service until this Certificate has been accepted by the relative authorities.

All penetrations through fire rated walls/floors etc. shall be sealed with fire rated materials to achieve the same level of fire rating as the floor/walls and certified by accredited Contractor in accordance with the requirements of the National Construction Code.

The Contractor shall be responsible for achieving the acoustic requirements of all hydraulic services in accordance with the requirements of the NCC and the Acoustic Report.

2.22 PERFORMANCE GUARANTEE

By accepting the Contract, the Contractor will be deemed to have guaranteed the performance of the installation under normal working conditions for a period of fifty two (52) weeks from the date of practical completion.

Should the installations or any part thereof fail to fulfill the requirements of this specification, performance to the relevant equipment is to be corrected by the Contractor at their own expense or the equipment will be liable to rejection.

The Contractor is responsible for the replacement of any portion of the installation so rejected and for all costs incurred thereby including the costs of any associated works of other trades. The guarantee period for the replaced portion must then be extended to cover fifty two (52) weeks trouble free performance.

2.23 WARRANTY

All plant, equipment and materials supplied under this Contract must be covered by fifty two (52) weeks warranty against faulty manufacture, workmanship and/or materials. The Contractor is responsible for the rectification and/or replacement of any portion of the installations, which fail under warranty.

2.24 DEFECTS LIABILITY

The Contractor shall be responsible for the rectification of all defects in the work due to faulty materials and/or workmanship for a period of twelve (12) months after all work is completed and handed over. Such defects shall be made good immediately by the Contractor on receipt from the Project Manager.

Any defects discovered during the defects liability period which are due to default or negligence of the Contractor in the performance or observance of any of their obligations shall extend the period by twelve (12) months to enable such defects to be made good by the Contractor and to allow the whole of the work after being made good in every respect to be proved satisfactory.

2.25 MAINTENANCE WORK DURING DEFECTS LIABILITY PERIOD

Provide maintenance and testing of the systems installed under this contract, all in accordance with the requirements of Contractor and the Authorities for the 12 months "defects liability period", beginning from the date of practical completion.
The Contractor shall be given notice of any isolation or shutdown of the systems necessary to carry out any maintenance or repair work.

The following schedule identifies the minimum maintenance work required during the defects and liability period. Upon completion of each task a report must be submitted to the CCLHD maintenance department.

SYSTEM COMPONENT	TASK	TIMING
Pumps	Activate each pump to start in correct order	3 months
Pumps Electrical Control Panels	Check that all controls are functioning in accordance with design requirements. Check with owner or building manager regarding operation of panel indicator lights. Correct, repair any non-functioning control or indicator lights.	3 months
Water level Sensors, Pressure Switches and System Shut Down Valves	Check that all sensors and switches activate the correct mechanism	3 months
Mains Pressure Hot Water Heaters	Activate temperature and pressure relief valve and ensure valve reseats	3 months
Hot & Cold Water Systems	Undertake microbial sampling of hot and cold water systems at a minimum of 5 x outlets, as directed by the LHD. Submit results of the microbial sampling for review and approval by the LHD	3 months
Thermostatic Mixing Valves	Check warm water temperatures Submit completed forms to the LHD, with the results of the temperature check.	1 month
	Remove and clean strainers/ non- return valves on cold and hot pipe sides, Check "O" Rings and seals. Service and repair where necessary. Check Temperature of hot, cold and mixed water at both minimum and maximum flow rates. Conduct thermal shut- off test	3months

SYSTEM COMPONENT	TASK	TIMING
	Check correct operation of hot and cold water isolation valves Submit completed forms to the LHD, with the results of all of the above checks & tests.	
Hydraulic Services Pipes and Valves	Inspect for leaks	3 months
Tapware	Inspect for water drips when tap in closed position	3 months
Pressure Reduction Valves	Inspect for leaks Check operation of diaphragm and adjust, if necessary	3 months
Stormwater System	Inspect for leaks and clear any blockages. Identify any system deficiencies.	3 months and after major storm events
Testable Backflow Prevention Devices	Remove and clean strainer on inlet side	3 months
	Test and provide compliance test certificate Submit completed forms to the LHD, with the results of the tests	12 months

2.26 NECESSARY INCLUSION RESPONSIBILITY

Where a method of construction, installation and finish is usual and proper, to the class of work generalised in this Specification, the same is to be provided notwithstanding that such method or necessary finish is not specifically specified or included in the drawings.

2.27 FIRE STOPPING OF SERVICES PENETRATIONS

Fire separation and integrity of the building elements shall be maintained at all times. Pipes passing through fire and/or smoke rated walls, floors, bulkheads etc., shall be suitably sealed utilising BCA approved materials, whether shown on the Drawings or not and maintain the required FRL of the building.

Install fire stopping products around all service pipe penetrations through masonry floors, walls, ceilings, ducts and other fire rated elements. Product used shall be of approved manufacture, compatible with materials being used in the installation.

Pipe work installed through a fire boundary to be set out with metal pipework situated at a minimum of 100mm from any combustible material 2m either side of the penetration. Alternatives to this shall be submitted for consideration by certifier prior to installation.

Fire stopping shall generally conform to:

- National Construction Code of Australia, particularly but not limited to Volume two Part C3.15
- Local Relevant Authorities

PVC and polyethylene pipes - fire stop collars and fire wrap applicable to the type and circumstance.

Insulated pipes - sleeved through fire barrier and wrapped or fire stopped with a system tested to AS 1530: Part 4

Metallic pipes - sleeved through fire barrier and then grouted around with fire retardant product with non-combustible fire wrap or similar approved system.

2.28 GREEN STAR REQUIREMENTS

Refer to the project specific Greenstar Report for responsibilities associated with the Design Finalisation and construction of the works. The required components of equipment have been included within the drawings and specifications however, specific commissioning and reporting items are included in the report that need to be undertaken as part of the works.

SECTION 3 - SEISMIC PROTECTION

3.1 GENERAL

3.1.1 Requirement

Engage a specialist seismic restraint Consultant / supplier to design, document and certify the required services and equipment restraints in accordance with AS1170.4 for the entire hydraulic services installation.

Install seismic restraints in accordance with the specialist design documentation and provide certification to the requirements of AS1170.4.

3.1.2 Component assemblies

In equipment specifically constructed for this project, such as electrical switchboards, control panels and the like, fix or restrain mechanical, electrical and electronic components to ensure the assemblies are capable of withstanding the specified seismic forces without damage, malfunction and displacement.

3.1.3 Proprietary items

Factory-manufactured proprietary components and equipment must be capable of withstanding without damage and malfunction, a seismic force equivalent to not less than twice gravitational acceleration acting in any direction, with the components and equipment installed to the manufacturers' recommendations.

3.2 SEISMIC FORCES

3.2.1 Direction

Acting through the centre of gravity of the item of equipment or component, non-simultaneously in any horizontal and vertical direction.

- Magnitude
- Calculated as follows:
- Horizontal seismic force Hp = SWp (kN)
- Vertical seismic force Vp = 1/2 SWp (kN)

Where S = Seismic force factor

Wp = Normal operating weight of item (kN)

3.3 SEISMIC FORCE CALCULATIONS

Refer to section 5 of AS1170.4 "Requirements for non-structural components."

3.3.1 Restriction

Do not include friction due to gravity in evaluating the required resistance to seismic forces.

3.4 SEISMIC CONTROL METHODS

3.4.1 Requirement

Use the method of seismic control appropriate to the type of attachment between the equipment and the building structure.

3.4.2 Attachment types

Fixed mounts or flexible mounts, to the following definitions:

3.4.3 Fixed mounts:

- Rigidly mounted equipment, with natural frequencies greater than 20 Hz;
- Equipment on resilient mounts, with natural frequencies greater than 15 Hz.

3.4.4 Flexible mounts:

- Equipment on vibration isolation mounts, with natural frequencies not greater than 15 Hz;
- Suspended equipment, with natural frequencies not greater than 15 Hz.

3.5 FIXED MOUNTS

3.5.1 Seismic control methods

Fix each item of equipment by means of the method appropriate to the item and the type of fixed mount.

3.5.2 RIGID MOUNTS

Fix the item rigidly to the building structure by means of appropriate fixings.

3.6 RESILIENT MOUNTS

Fix the item to the building structure by means of appropriate fixings.

Provide resilient washers and collars between the fixings and the mounting holes of the item to limit the transmission of vibration, without diminishing the required resistance to seismic forces.

3.6.1 Tall items

In addition where necessary, brace tall free-standing items, such as electrical switchboards, vessels and the like, to the building structure.

3.7 FLEXIBLE MOUNTS

3.7.1 Seismic control methods

Restrain each item of equipment on flexible mounts, by means of seismic snubbers or captive type vibration isolation mounts, to limit horizontal and vertical motion and inhibit resonance under seismic conditions.

3.7.2 Seismic Snubbers

Proprietary type, of proven design and performance for the required resistance to seismic forces and manufactured by a specialist seismic snubber manufacturer.

3.7.3 Description

To each seismic snubber include two interlocking steel elements and a resilient neoprene bush housed in one of the steel elements.

Maintain an operational clearance between the neoprene bush and the other steel element under normal operating conditions.

Under seismic conditions, limit the relative displacement between the steel elements in all directions, to the operational clearance plus the deformation of the neoprene bush.

3.7.4 Neoprene Bush

6 mm (minimum) to 19 mm thick in all directions, and field-replaceable.

3.7.5 Operational Clearance

6 mm (maximum) in all directions.

3.7.6 Installation

In accordance with the seismic snubber manufacturer's recommendations.
Provide 4 seismic snubbers (minimum) for each item of equipment, located as close as possible to the vibration isolation mounts.

Fix one steel element of each seismic snubber to the item and the other steel element to the building structure by means of appropriate fixings.

Ensure the required operational clearance is maintained.

3.8 FIXINGS

Use of fixings appropriate to the required applications, sized, selected and installed in accordance with the manufacturers' recommendations.

3.8.1 To Steel and Timber

Use steel bolts, nuts and washers, with appropriate corrosion protection for the service conditions.

3.8.2 To Masonry

Use steel bolts in expanding metal masonry anchors, with appropriate corrosion protection for the service conditions.

3.8.3 Restrictions

Do not install fixings to non-structural building elements unless evidence of the elements' load-carrying capacity can be provided.

Do not use explosive powered fixings.

SECTION 4 - WORKMANSHIP

4.1 NUISANCE

No work is to be carried out or materials handled in such a manner as to cause nuisance on the site or to other Contractors or to the public at large or occupants of adjacent buildings. Notify the Project Manager before commencement of necessary works that may cause inconvenience to the parties concerned.

All work causing a hazard to others must have safety barriers surrounding the works.

4.2 MAKING GOOD

The Contractor is responsible for, and must make good any damage he may cause to the building and surfaces generally and any other works that may be disturbed or injured by cartage, work generally or other operations. The reinstatement must be at least as good a state of repair as before commencement.

4.3 DIMENSIONS

The Contractor is responsible to liaise with the Builder for taking all dimensions on site. The dimensions must be checked by the Contractor before work is commenced or prefabricated, all levels and dimensions of existing services must be confirmed before commencing work. The invert levels if shown on the drawings are recommended only, and must be checked on site before excavation or installation of pipework to ensure connection to supply sources are correct.

4.4 PROTECTION OF PLANT & MATERIALS

The Contractor shall be entirely responsible for all apparatus, equipment and appurtenances furnished in connection with the Works.

Special care shall be taken to protect all such goods in a suitable manner.

The protection shall include covers to prevent moisture, grit, plaster or other foreign substances from entering the working parts of plant and equipment. Seal and protect all open ends of ductwork, piping and conduit (as applicable) whilst in storage and during the course of installation, and protect adequately all electrical and control equipment.

All materials, goods and equipment forming part of this Contract must be complete, intact and in new order when the Proprietor takes over the responsibility for the Works.

4.5 PROTECTION OF WORKS

Services shall be installed before plastering, false ceilings and/or bulkheads are completed and all ductwork piping and conduit (as applicable), and other concealed services shall be fixed in position before decorative work, floor finishes and/or painting are carried out.

The Contractor shall be responsible for any damage to finished work on site caused by the execution of the work.

The Contractor shall be responsible for the restoration or replacement of any part of their installation damaged prior to the installation being taken over by the Principal.

4.6 PROTECTION OF POLISHED SURFACES

All polished and exposed surfaces and such material as stainless steel, chromium plated, vitreous enamel surfaces must be protected during all stages of construction by an application of a strippable coating similar and equal in all respects to "Behr Manning M.B. 614".

The coating must be applied as soon as practicable and must not be removed until completion of the project. All damaged coating must be repaired immediately.

On removal of the coating, the surface of the material must be cleaned with methylated spirits and polished with a soft, dry cloth. Any scratched or damaged finished surface will not be accepted.

4.7 CLEANING OF SURFACES

After installation and prior to testing of the services, fixtures and equipment, the item must be thoroughly cleaned and flushed out in an approved manner. All valves, seats, tap washers, strainers, non-return valves and inspection openings must be checked and cleaned of any foreign matter.

Damaged seats, washers, installations and gaskets, etc., must be replaced. Any pipework buried or permanently enclosed before it has been thoroughly cleaned, inspected, tested and proved to be satisfactory by the Project Manager is to be uncovered at the expense of the Contractor.

4.8 EXPOSED PIPEWORK

Except as otherwise specified or directed, all internal copper exposed piping throughout and adjacent to plumbing fixtures must be chromium plated finished, and where passing through a finished wall, floor or ceiling must be fitted with an approved type chromium wall or cover plate. All other internal and external piping must be cleaned free of cement droppings.

4.9 FIXING & SUPPORTING OF PIPES

All service pipes must be positioned in approved locations before installation or fabrication of pipework commences.

All pipes must be adequately supported and secured to adjacent walls and slabs.

Pipework must not come into contact with any other service pipes or part of the building structure, except pipes in wall chases.

All pipework must be fixed in a manner so as to allow free movement without causing undue stresses in the pipework or in the pipe joints and without transmitting lateral stresses via fixing to walls, slab or ceilings.

Pipework must not be, either permanently or temporarily, fixed in position by the use of nails. Should leaking pipework occur due to electrolytic corrosion between the pipework and the nails, then the contractor will be responsible for all costs associated with the repair including pipework, walls, finishes, etc whenever the leaks may occur.

All supports must be galvanized mild steel "Unistrut" P1000 channel complete with all purpose made galvanized spring nuts, framings, fittings and pipe clamps for each pipe.

Vertical frames where used to support suspended horizontal runs of pipework, are to allow for complete adjustment of clamp support to suit pipe grading as required.

Channels are to be of concrete insert type wherever practicable, where not, the channel must be fixed with expansion type bolts fixed direct or with purpose made clips to walls or underside of slabs and hanger rods fixed into the channel.

Pipe hangers must be installed at every change of direction, no pipe hanger is allowed to be fixed to a pipe clamp already supported from other pipework.

All copper pipes must be separated from supports by one (1) mm thick PVC strip or similar approved materials.

All copper hot water pipes must be separated from supports by 30mm thickness purpose made wooden block spacer pieces.

Explosive power tools may not be used.

Remove all cement droppings, dirt and superfluous material from all pipe supports and paint them and all cut ends with one coat of cold galvanizing paint. Pipes must be fixed at the following maximum intervals, unless specified otherwise: -

PIPEWORK DETAILS		MAXIMUM SUPPORT SPACING	
MATERIAL	LOCATION	VERTICAL	GRADED
Copper or Copper Alloy	Internal	1,800 mm	1,800 mm
	External	1,800 mm	900 mm
PVC-U or Poly	Internal	1,800 mm	1,000 mm
	External	1,800 mm	900 mm

PVC-U or poly pipework must NOT be used for temperature above 50^{o}C.

In the case of spigot and socketed pipes such as PVC-U/HDPE there must be at least one (1) fixing behind each collar on the pipe and fittings. Where there are several fittings in succession, then a bracket must be placed behind the collar of every third (3rd) fixing.

Soil, waste and vent pipes must be regarded as being fixed at all supports where no provision has been made for axial and/or lateral movement. Provision for movement must be achieved by the provision at the support of an annular space around the pipe of not less than 8 mm clear.

Vertical soil and waste pipes must be clear to move vertically at least 8 mm in both directions through all ceilings, roofs, etc., through which they pass.

Vertical soil and waste pipes must be restricted against downward vertical movement at their junctions with house drains, at offsets and changes of direction below Ground Floor level, and at branches at all floors.

All pipes must be supported against sagging or distortion and must be held true to line and grade by means of approved clips, saddles or other fixings.

Horizontal supports for rising mains connected to pumps must be Mason Industries Type H.O. or approved type hangers.

Install Mason Industries type brackets or approved equal hangers for main riser pipes where vibration or expansion will occur.

4.10 WELDING

All welding of piping supports, brackets, pedestals, anchors and all ancillary items shall be carried out by qualified and competent tradesmen and with adequate supervision, all in accordance with AS 1554.

4.11 CAPPING OFF

During the construction the Contractor and their sub-contractors are responsible for checking that all unfinished work is left in a safe condition, protect against all damage or loss through any cause whatsoever, and make sure to prevent the entry of any foreign matter including liquids. All services capped off for future connection must be finished with an identification marker stating type of service and respective location to the satisfaction of the Project Manager.

4.12 CHASING OF PIPES

All chasing in walls for pipework and equipment must be carried out by the Contractor with a mechanical saw. Chasing will not be allowed in concrete walls, slabs or columns unless approval in writing to do so is given by the Project Manager.

Note: All chased water supply pipework must be lagged

4.13 BUILDING PENETRATIONS

Set Out: Obtain approval of the set-out of core holes and sleeves before proceeding.

Sleeves: Where pipes pass through building elements, including walls, floors, beams, ceilings, roofs and columns, provide purpose-made metal or plastic sleeves (in fire-rated elements, metal only) formed from pipe sections.

Sleeve terminations:

- Where cover plates are fitted: Flush with the finished building surface
- In floors draining to floor wastes: 50 mm above finished floor
- In fire-rated and acoustic-rated building elements: 50 mm beyond finished building service
- Elsewhere: 6 mm beyond finished building surface

Sleeve diameter:

- In fire-rated building elements: Sufficient to fit closely around the pipe insulation
- Elsewhere: Sufficient to provide an annular space around the pipe or pipe insulation of not less than 12 mm

Packing:

- In fire-rated building elements: Insulate the pipe where it passes through the sleeve and for 250 mm beyond the sleeve on both sides with a proprietary sectional ceramic fibre insulation material complying with, and tested to, FIRE STOPPING - FIRE PROTECTION. If the pipework insulation is specified to be sheathed, lap the sheathing not less than 32 mm over each end of the sleeve and strap firmly to the sleeve
- In acoustic-rated building elements: Pack mineral wood insulation into the annular space
- Elsewhere: Pack the annular space with a proprietary gunned silicone rubber joint sealer, self-extinguishing grade

Register & Labelling:

- Provide a register of fire penetration to the LHD, in accordance with the LHD's template.
- All fire penetration shall be labelled in accordance with the LHD's guidelines

4.13.1 Roof Penetrations

Flash penetrations through roofs and similar external elements of the building.

All fire rated sleeves are to be certified by an appropriate Contractor.

4.14 CORE HOLES & SLEEVES

The Contractor is required to set out all core holes and sleeves in floors, walls, beams and columns in conjunction with the fixing of formwork and/or placing of concrete and checking that the location of any core holes and/or sleeves already installed are correct.

To prevent weakening of the building structure all core holes must be approved by the Project Manager prior to placing of concrete. Strip holes from formwork and every pipe passing through a core hole must be backfilled with concrete to the satisfaction and approval of the Project Manager. All holes not used must be filled by the Contractor with concrete and to the approval of the Project Manager.

All core holes for soil or waste pipes on suspended floors must be made by means of a patented plastic slab seal unit with rubber diaphragm equal to those manufactured by Slabseal Pty Limited.

Materials used for forming core holes must be 0.7 mm galvanized sheet metal and must have a diameter of at least 50 mm greater than the outside diameter of the pipe it serves.

Core Holes and Pilot Holes: Where the concrete has been constructed The Contractor is to set out and mark all slab penetrations and drill pilot holes through slab and seek approval by the Project Manager prior to coring of holes.

4.15 FIXTURES & FIXTURE POINTS

The Contractor is required to supply and install all materials, backing plates and noggins necessary to make all fixtures and fixture outlet points rigid (i.e. sanitary fixtures and tap fittings, etc.).

4.16 LAYING OF PIPES

The Contractor must install or lay all pipes in a correct workmanlike manner with correct and even falls and grades, straight and correctly fitted into the other pipes with rings straight and equal with even pressure all round.

All rubber ringed joints must be cleaned free from sand, grit and moisture prior to the making of the joint.

4.17 INSPECTION OF SERVICES

The Contractor is required to provide all labour and fix all equipment and material necessary to enable the Contractor and Project Manager to carry out any inspection of services that he deems necessary during the construction period.

All services are to be inspected by the Project Manager and the Relevant Authorities.

Inspections carried out by the Relevant Authorities will not relieve the Contractor's responsibility of obtaining an inspection by the Project Manager.

The Project Manager, at all times reserves the right to inspect all pipework and services. Should, for any reason, pipework be concealed before the Project Manager has inspected the work, then the Contractor will expose all pipework requested by the Project Manager at their own cost. Any costs associated with the damage and/or repair to any other services, structure, surfaces, plant equipment etc must be borne by the Contractor.

4.18 RESTORATION OF SURFACES

Restore all roads, paving, bitumen surfaces, etc., damaged as a result of the executed work. Restore with equal quality materials to the same standards of construction and expected life as existing prior to commencement of works.

4.19 TUNNELING

Provide tunneling in lieu of trenches where required by Authorities or shown on the drawings.

Tunneling must comply with the requirements of WorkCover Authority and The Division of Resources and Energy- Minerals & Petroleum.

The use of explosives will not be permitted. Use adequate shoring to prevent the collapse of the tunnel under all conditions.

Leave shoring in tunnel and backfill with sand under pressure after approval of pipework by Authorities and the Project Manager.

4.20 PUBLIC UTILITIES AND EXISTING SERVICES

Where underground public utility lines, surface drainage works and underground pipes, conduits or cables exist in the vicinity of the works, the Contractor must take care to protect such services. Any damage to such services must be immediately reported to the responsible Authority and to the Project Manager.

The cost of the necessary repairs or renewals must be borne entirely by the Contractor.

4.21 PIPE IDENTIFICATION

The Contractor must label all service pipes and conduits exposed to view or in accessible locations such as ducts, ceiling spaces etc. They must be labelled to conform to the requirements of the AS Code 1345 -Identification of Piping, Conduits and Ducts.

Equipment identification must be accomplished with "Traffolyte" labels - white on black background fixed by screws or rivets. Adhesive type fixings are not acceptable.

4.22 ANCHOR BLOCKS

In cases where the gradients of the sanitary drain are such that there is a likelihood of the scouring of trench filling, or on very steep sections of sanitary drains, movement of the pipes or concrete, anchor blocks must be constructed as and where required.

Such anchor blocks must be constructed of reinforced concrete of not less than 150 mm in thickness and must:

- Extend across the full width of the trench and be firmly keyed into the sides of the trench.
- Extend above the top of the pipe to a height of not less than 150 mm.
- Extend below the floor of the trench for a depth of not less than 150 mm.
- Sanitary drains laid at a gradient of, or steeper than, one in five (1 in 5) must be deemed to be very steep.
- Such pipes must be provided with an anchor block at the fitting located at the top and at the base of the inclined section of sanitary drain, and
- At intervals of not more than 3 metres, or where indicated.

Every such bulkhead must be reinforced with two (2) reinforcing rods of not less than 12mm size and must be bent at a radius of at least 100 mm larger than the diameter of the sewer drain.

No bulkhead must cover any flexible joint.

4.23 WATER HAMMER

The Contractor is to install all pipework and equipment so that the installation is free of vibration and noise from water hammer. If water hammer occurs, he is to investigate the cause and modify the installation to the approval of the Contractor so as water hammer and its effects are eliminated from the installation.

Water hammer is a temporary change in pressure in a pipeline due to a change in the velocity of flow in a pipe with respect to time e.g. a valve opens or closes or a pump stops and starts.

The effects are exacerbated by:

- Fast closing/stopping valves/pumps
- High water velocities
- Air in the line
- Poor layout of pipe network, positioning of pumps etc.
- Fast closing tapware

Before concealing of any water service pipework the Contractor must carry out an operational test for water hammer.

Should there be any evidence of water hammer within the water services, the Contractor will be required to remedy the problems at their own cost.

Should any pipework be concealed prior to testing, and water hammer exist, then the Contractor will be required to remedy the problems and make good all surfaces, structure, fittings and fixtures at their own cost.

4.24 STERILISATION

Sterilisation of pipework systems and tanks is to occur on completion of various stages of the installation and testing of the following systems and again prior to handover:

- Domestic Cold Water System
- Domestic Hot Water System
- Water Tanks

Prior to undertaking the procedure, a detailed work method statement shall be submitted and approved by the Project Manager.

Purge the system of pipework, equipment, tanks in stages in accordance with the staging of completion of works.
Prepare sterilising solution in storage tanks and ensure that all pipes and branches are charged with same (See Clause below for sterilising procedure).
Ensure that the systems are completely free of sterilising solution and carry out testing of water until no sterilising solution can be detected.

On completion of the above procedures, no additional work will be permitted on these systems (i.e. no extensions of pipework, no cutting of branches, no removal of valve heads, seats, jumper valves, recess tap body, etc) without prior written approval.

Should it become necessary to carry out additional works post sterilisation due to an omission or error by the Contractor, the whole system affected shall be purged and re-sterilised in accordance with the above procedures at the Contractor's expense.

4.24.1 Sterilisation Procedure

The operation shall be carried out by placing in an empty clean container the necessary quantity of chloride of lime powder and adding a small quantity of water. This shall be mixed into a uniform cream and more water added.

The Contractor shall plug off all open ended drains, overflows, etc and the pipework shall be filled to their maximum capacity.

The pumps shall then be activated and the sterilising solution shall be pumped through the entire system. Water outlets shall be progressively turned on to ensure that all sections of the system are charged with the sterilising solution and then they shall be closed.
During the sterilising procedure ensure that no contaminants are allowed to enter the system and that tank covers, etc are in place.

The sterilisation of pipework shall be in strict accordance with AS/NZS 3500.1 Appendix I & J. The sterilisation process is to be certified by an accredited contractor.

4.25 PURGING

Every care shall be taken during the installation to minimise the entrance of sand, grit or foreign matter in the supply piping. Cold water supply pipes to the heater are to be purged prior to the installation of the heater and all hot water supply pipes from the heater to hot water draw off points are to be purged prior to the installation of taps, spouts, etc. The installation shall be left charged and ready for use when occupied.

SECTION 5 - MATERIALS

5.1 SUPPLY OF MATERIALS

Supply of all materials necessary for the work covered by this section and the Schedules section of the specification.

All pipes, fittings and other materials must be of the best quality and description of their respective kinds and must be approved by the Project Manager. They must conform to the Standards Association of Australia or if no Australian Standard exists, to the requirements of the relevant British Standards specification or the requirements of the American Society for testing materials.

The final selection, purchase and installation of all materials remains the responsibility of the installing contractor

5.2 AVAILABILITY OF MATERIALS

The Contractor must, at the time of construction, be fully satisfied that all specified materials and items relevant to this project are available from manufacturers of the relevant products.

5.3 REJECTION OF UNSATISFACTORY MATERIALS

All materials and finishes which are deemed not in accordance with this specification will be rejected and replaced with materials to comply with the instructions issued by the Project Manager at no extra cost to the Project Manager.

5.4 COPPER AND BRASS TUBES AND FITTINGS

Copper and Brass Tube: Tubes shall be solid - drawn coupling with the following Standards:

- Water Services Pipes AS 1432 Type B

Fittings: Copper to AS1589

Capillary Fittings: To AS 3688. Silver solder joints only.

Flanges: To AS 2129.

Jointing Methods: Use capillary fittings, silver brazed slip joints, flanged joints or press-fit fittings.
Silver brazed joints: Use low temperature silver brazing alloy rods to AS 1167, classification B2, and oxyacetylene heating.
Screwed joints: To AS 3500.4.
Making slip joints: Using a proper tool, soften and expand the pipe to form a slip joint of not less than the following lengths:

NOMINAL PIPE SIZE	LENGTH OF SLIP JOINT
15-20mm	10mm
25-32mm	12mm
40-65mm	16mm
80-100 mm	20mm

Press Fitting for Joining Copper Pipes

a) **Water Pipes**: Connection with press-fit fitting made of copper or gunmetal. Inspection of un-pressed fittings utilises a positive leak path for the whole range 2.2kPa to 300kPa when a dry pressure test is performed and 100kPa to 650kPa with a wet pressure test. This warranted safety function is facilitated by a channel in the metallic body of the fitting. After pressing, the connection is permanent and inseparable. The seal is made of EPDM, with performance characteristics

allowing use in solar applications. The fitting body has a cylindrical pipe guide in front of the seal. Fittings shall have Watermark Approval.

b) **Gas Pipes**: Connection with press-fit fittings made of copper or gunmetal. Inspection of un-pressed fittings utilises a positive leak path in the whole range 2.2kPa to 300kPa with a dry pressure test. This warranted safety function is facilitated by a channel in the metallic body of the fitting. After pressing, the connection is permanent and inseparable. The seal is made of HNBR and the fitting body has a cylindrical pipe guide in front of the seal. Fittings shall have conformance certifications to international Gas standards DVGW VP 614 and ANSI LC4.

All copper and brass fittings shall comply with AS 3500 and AS 1589.

c) **Training and Technical Field Support**

Viega will conduct training in the use and installation of the copper pressfit pipe joining system (tools and fittings) and run an onsite project start up session for the contractor prior to the commencement of the project. The training session will run approximately for an hour for users nominated by the contractor. At the end of the training session, Viega will provide accredited Contractor certificates for those who have completed the training session. A training DVD can also be provided for future reference. Continuous technical field support can be provided by Viega representatives. Contact 1800 484 342 for technical support and to arrange training.

5.5 STAINLESS STEEL PIPE

The Pipe shall be of metallic, AISI 316L annealed Stainless Steel manufactured to AS5200.53 and conforming to UNI EN 10088. Dimensional tolerances to conform to EN ISO 1127 D4/T4.

The pipe and fitting joint shall be 16 Bar rated at 20°C with a safety factor of 3:1. Up to 40 Bar pressures ratings are available on all approved applications.

All fittings shall be AISI 316L Stainless Steel Press Fit type manufactured to AS3688 and conforming to UNI EN 10088. All fittings to be 'M' Profile, with blue 'Press Fit Indicators'.

Fixing of pipe shall be of a type and spacing approved for use on AISI 316L Stainless Steel as per manufacturers Technical Manual.

Pipe dimensions shall be as follows:

Outside Diameter	Wall Thickness
15 mm	1.0 mm
18mm	1.0 mm
22 mm	1.2 mm
28 mm	1.2 mm
35 mm	1.5 mm
42 mm	1.5 mm
54 mm	1.5 mm
64 mm	2.0 mm
76.1 mm	2.0 mm
88.9 mm	2.0 mm
108.0 mm	2.0 mm

5.6 GALVANIZED MILD STEEL PIPE FOR FIRE HYDRANT SERVICES

Galvanised Mild Steel Pipes (GMS) shall be medium grade, hot dipped galvanised, conforming with AS 1074 and having Water Mark authorisation.

Galvanised mild steel pipework and fittings shall be jointed using rolled grooved couplings.

All cut ends of the pipe to be restored using a zinc rich primer after cutting and roll grooving.

All rolled grooved piping shall be cut, grooved and galvanised at the manufacturers' warehouse. Onsite roll grooving will not be permitted.

All pipe work shall meet the following criteria:

NOMINAL PIPE SIZE Ø (mm)	100	150
Required Pipe ØOD	114.30	168.30
Bevelled edge removed before rolled groove	Must be removed	Must be removed
Gasket seat width (+/-_mm)	15.88	15.88
Gasket seat tolerance (+/-_mm)	0.76	0.76
Groove Ø	110.08	163.96
Groove tolerances (+/-_mm)	0/0.51	0/0.56
Max allowable flare (Ømm)	116.80	170.90

Manufacturer's test and manufacturing certificates shall be supplied to the Hydraulic Consultant prior to installation of any pipework. Inspection & test plans must provide written evidence that all couplings achieve the criteria as detailed on the above table.

Fittings
Fittings shall be manufactured Ducco Style hot dipped galvanised and grooved in accordance with AS 2419 and AS 4118. All fitting shall be compatible with the roll groove coupling specified.

Jointing: Jointing: Pipes and fittings shall be joined by mechanical grooved joints utilising rolled grooved pipe dimensionally compatible with the fittings. Couplings shall be Ducco Style GT402R – Rigid and GT402 – Flexible heavy duty, Grade 65-45-15 ductile iron to ASTM A-536 as specified in ASTM D-2000 and shall be galvanised. Roll groove dimensions shall to comply with AWWA C606 specification.

The couplings used for mechanical grooved joints where the pressure exceeds 2100KPa shall have an angled bolt pad design which provides joint rigidity.

Gasket shall be EPDM as specified in ASTM D -2000.

Bolts and nuts shall be to ASTM A-183 Gr. 2 Hexagonal style nuts and bolts, mechanically galvanised or electroplated ASTM B – 633.

Flanges

Flanges shall conform to ANSI 300.

5.7 UPVC DRAINAGE PIPEWORK

uPVC Sewer Pipes, Downpipes and Fittings: (Unplasticized polyvinyl chloride): To AS 1260, suitable for the jointing method specified.

Pipe class: SH unless otherwise scheduled.

uPVC Stormwater Pipes and Fittings: To AS 1254.

Pipe class: Stormwater HD unless otherwise scheduled.

Jointing Methods: Solvent-cement joints: To AS 2032, Clause 3.2.1.

Rubber-ring joints: To AS 2032, Clause 3.2.2.

Pipeline Construction: Sewer pipelines: To AS 2032, Part 5.

Stormwater pipelines: To AS 2032, Part 7.

5.8 UPVC PRESSURE PIPES AND FITTINGS

uPVC pressure pipes and fittings for water services and pumped discharges shall be of first quality and be in accordance with AS 1477 Parts 1-6 and AS 2032.

Jointing: Solvent-cement: To AS 2032.

Pipe Classes:

Class 9 - for a maximum working pressure of 0.9 Mpa (90m head approximately) at 20°C material pressure.
Class 12 - For a maximum working pressure of 1.2 Mpa (120m head approximately) at 20°C material temperature.
Class 15 - For a maximum working pressure of 1.5 Mpa (150m head approximately) at 20°C material temperature.
Class 18 - For a maximum working pressure of 1.8 Mpa (180m head approximately) at 20°C material temperature.

5.9 HIGH DENSITY POLYPROPYLENE PIPES AND FITTINGS (DRAINAGE)

Polypropylene pipes and fittings for trade waste systems shall be first quality and in accordance with AS 2718,ISO 9001.

Jointing: Black injection moulded polypropylene pipes and fittings used for underground services are to be fusion welded and above ground pipes to be mechanical jointed. Jointing systems to be in accordance with the manufacturer's instructions and installed to AS 3723

5.10 CAST IRON PIPES & FITTINGS

Pipes and Fittings: Shall be manufactured to BSI EN 877 and as manufactured by 'Ensign' cast iron pipework. The pipework and fittings shall carry the Standards Australia Standard Mark Licence.
Dimensions: To ES 877

External Coating : Red protective coating

Internal Lining: Ocher epoxy tar lining.

Spigot end joints: Stainless steel couplings –'PAM Rapid NG" range complete with EPDM gasket. Nitrile gasket shall be installed if further scheduled.

Above Ground Pipework – PAM Ensign S

Below Ground Pipework –PAM- Ensign Plus

5.11 CROSS LINKED POLYETHYLENE PIPE & FITTINGS (PE-X)

Pipe materials shall be PE-Xa/PE construction, consisting of PE-Xa inner layer and a PE outer marking layer, certified to AS/NZS 2492 for water service applications.
Suitable for use in hot and cold water applications in buildings in accordance with AS/NZS 3500.
Water services pipes - not less than PN 20

Fittings: Brass Dezincification Resistant as to AS 3688.

Jointing Method: Compression fittings and sleeves

- Connections shall be axial compression sleeve mechanism
- Self-sealing pipe material – connection without the use of an O-ring
- As per manufacture instructions

Fittings and sleeves shall be REHAU RAUTITAN PX or MX, Watermark approved and certified to AS/NZS 2537.

Tube in Concrete Slabs: Tubes which are to be installed within concrete slabs are to be run in PVC conduits and shall comply with the requirements of the appropriate building Authority (AS 3500).

Prohibited Areas: Cross Linked Polyethylene will not be used in areas as specified in AS 3500.

5.12 FIRE STOP COLLARS

Where PVC-U pipework penetrates fire rated elements (floors, walls, etc.) allow to provide a fire stop collars to the required fire resistance rating for the element to the approval of the Council.

5.13 THRUST BLOCK

Must be mass concrete of sizes and locations as recommended by the pipe manufacturer

5.14 JOINTING MATERIALS

All joints must be cleaned free of any foreign materials, dirt and grease, etc., before any attempt is made to complete the joints.

Joints must be cut true and square, all burrs and swarfs, etc., removed and a chamfer lightly ground or filed around the pipe.

- Silver solder must contain not less than 5% silver, verification of the silver content must be given in writing to the Project Manager. Care must be taken not to overheat the joint, and apply the correct flux as recommended by the manufacturer. A slightly carbonizing flame must be used.
- Soft solder must be lead free. All joints must be properly prepared before commencing the soldering the and flux recommended by the manufacturer used.
  Cement Must be Portland cement type "A" and respective to AS 1315 stored in a dry and moisture free state and mixed as required.
- Rubber Ring Gaskets
- Lubricant: For lubricating the rubber ring and insertion type gaskets and the outside surfaces of spigot ends of pipes must be of an approved non-toxic vegetable based type and must be applied in accordance with the manufacturers' instructions.
- Nuts and Bolts: Must generally conform to the relevant Australian Standard and must be heavily galvanized by the hot-dip process. Where galvanized iron to cast iron flanges butt, galvanized bolts must be used. Where brass to brass and cast iron to cast iron flanges butt, brass bolts must be used.

- Silicon sealant: Must be self-polishing with anti-fungicide additive equal to Ciba-Geigy manufacture and used as recommended by the manufacturer. White must be used around vitreous china sanitary ware and clear for seal under fixture taps and stainless steel, etc.
- Polyvinylchloride (PVC-U). Pipes must be joined by solvent welding of the type recommended by the manufacturer. Clean joint with approved solvent cleaning fluid. Apply an even liberal layer of the approved solvent cement to both surfaces of the joint and allow to stand to become touch dry, apply a second coat to both surfaces of the joint and push together, remove all surplus solvent with a clean, dry cloth in accordance with AS 2032.

5.15 VALVES

All valves used must be "Tyco" or equal approved by the Project Manager and must be the best of their type, quality and grade available. All valves must be placed in easily accessible positions for operation and repair. Valve in ducts generally must be positioned at 600 mm from the finished floor level. All valves must have stuffing box glands. All small bore ball valves shall be equal to FSIS valves.

Valves to the pump connections, main branch lines and outlet positions must be of the gate valve pattern. Elsewhere the valves must be of the loose jumper pattern. All valves must be tested to a pressure of 2100 kPa by an approved testing Authority.

Balancing valves for hot water service must be globe type and manufactured of bronze, equal to STAD, STAT valves manufactured by Tour and Anderson.

Balancing valves for hot water service must be globe type and manufactured of bronze.

All valves up to 50mm must be screwed and of full bronze construction.

65 mm valves must be all bronze. Valves 80 mm and over may be cast iron with bronze trim.

All valves 65 mm and over must be flanged.

Spindles must be non-rising type and must not project into the bore of the valve when the valve is in the fully open position. The bore must be clear and unobstructed when this position.

The internal seats and washers of the valves must be cleaned of all foreign material during installation. Any valve faces or seats found damaged on completion of the installation must be replaced.

5.16 CHECK VALVES

Bronze screwed swing check valves for valves up to 50 mm in diameter equal to Caleffi.

Bronze flanged swing check valves for valves from 65 mm to 80 mm in diameter equal to Caleffi.

SG Iron flanged swing check valves for 100 mm check valves equal to Caleffi.

5.17 SLUICE VALVES

Sluice valves must be constructed with a cast iron body and brass stems and be in accordance with AS 2638 – Class 21.

5.18 STRAINERS

Bronze with stainless steel screen for strainers up to 50mm in diameter equal to "Bestobell" Figure No.510.

5.19 LINE STRAINERS

Description: Low resistance, Y form bronze bodied type with dezincification resistant brass, or corrosion resistant stainless steel or Monel screen. Screen perforations 0.8 mm maximum.

5.20 COVER PLATES

Requirement: Where exposed water lines emerge from wall, floor or ceiling finishes, provide cover plates of non-ferrous metal, finished to match the pipe, or of stainless steel, complying with the following table:

COVER PLATE SIZES

PIPE DIAMETER	COVER PLATE DIAMETER (NOMINAL)
up to 20mm	65 mm
21mm to 50 mm	100 mm
larger than 50 mm	50 mm larger than pipe

5.21 BACKFLOW PREVENTION DEVICES

Provide backflow prevention as required to meet code compliance and local Authority requirements.

Supply and install backflow prevention devices to all water supplies serving fixtures with possible cross connection hazard, to conform with AS 3500.1 Section 4 and AS 2845 parts 1 to 3.

Provide details of all cross-connections and devices and register with Sydney Water.

5.22 TAP WASHERS & VALVE SEATS

All washers to taps and control valves shall be best quality nylon and be compatible with the valve seating. Valve seats shall be machined without sharp edges which may damage the tap washer. Washers shall be replaced with new washers immediately prior to handing over on completion of contract. Cistern ball float valves shall also be fitted with new rubbers prior to handing over.

5.23 REFLUX VALVES - PVC

Reflux valves, where approved, must be PVC horizontal pattern with a flap, riser, handle, handle extension and cover and connected to the sanitary drainage system.

The reflux valve must be equal to Iplex MKII Cat No ZRV5100100 or approved equal.

The Reflux valve must be approved by the Relevant Authority and installed in accordance with the Manufacturers recommendations.

5.24 DIAPHRAGM VALVES

Must be hand wheel operation flanged cast iron rubber lined diaphragm valves equal to 'Saunders' manufacture.

5.25 WATER HAMMER ARRESTORS

Water Hammer Arrestor must be the hydraulic type equal to those supplied by Ryemetal Sioux Chief Hydra-Rester. Supply and install in locations indicated on the drawings and locations as nominated by the Project Manager

5.26 GALVANISING

All galvanizing of steel work must be hot-dip process to give 0.1 mm minimum thickness coating.

Works must not be galvanized until all work has been completely prefabricated, drilled and all jagged edges, welds, etc., have been ground and buffed off. All galvanizing is subject to the approval of the Project Manager.

5.27 CAST IRON SURFACE BOXES

Supply and install cast iron surface boxes marked S.V. over all underground valves.

The box must be concreted to a 150 mm diameter PVC-U pipe riser extending up from the valve.

5.28 FIXINGS

Fixings must be "Dynabolts" or equal approved expansion type bolts and must be installed in direct accordance with the manufacturer's instructions and to the approval of the Project Manager.

5.29 UNIONS

Unions must be three (3) piece brass, bull-nose taper type unions. Brass and copper type union connections must not be used under any circumstances. Unions must be located on the outlet side of all valves.

5.30 FLANGES

Flanges must conform to AS 2129 and be Table E. Use brass flanges for copper tubing, galvanized mild steel flanges screwed type for galvanized mild steel and cast iron flanges for cast iron pipes.

N.B. All bolts are required to be 316 Stainless Steel nuts and bolts.

5.31 FLEXIBLE CONNECTIONS

Flexible connections or anti-vibration couplings must be "S" flex flexible neoprene couplings installed in accordance with the manufacturer's instructions.

Flexible connections must be installed with the aid of adjustable threaded spacers and must be adjusted correctly to dimensions recommended by the manufacturer prior to fixing of the pipework; the maximum angular deflection allowed on the flexible connection must not exceed five (5) degrees and must be installed on the suction and discharge side of each pump.

5.32 PRESSURE GAUGES

Supply and install the following 100mm diameter pressure gauges to each separate installation of the following unit:

- All Pumps
- Pump suction - one (1) off
- Pump discharge – one (1) off

All gauges shall be graduated in metres head and kilopascals. The gauges shall be waterproof and shall be securely mounted as directed and shall be equal to Dobbie.

Each gauge shall be complete with an approved gunmetal stop valve and sufficient copper piping for connection to the pipework. All gauges shall be connected to the pipework in accordance with AS2417 Parts 1, 2 and 3 Code for Pump tests.

5.33 GAUGES

Gauges must be K.D.G. type or equal approved. The faces on the gauges must be a minimum of 100 mm diameter and gauges must be graduated in metres head and kilopascals.

All gauges must register one third kPa more than the maximum possible pressure obtainable from the system served.

Each gauge must be complete with approved gunmetal stop valve and sufficient copper piping for connection to the pipework; all gauges must be connected to the pipework in accordance with AS2417 Parts 1, 2 and 3 Code for Pump tests. Gauges must be installed on the suction and discharge sides of all pumps.

5.34 INSULATION MATERIALS

All water service pipework chased in walls must be pre-insulated, poly-lagged, copper tube.
Hot water flow and return pipework must be insulated with thermotec4-zero or equal approved for its entire length and include all fittings as detailed in Clause 8.2 of AS/NZS 3500.4.

Hot water flow pipework between heater room and the water meter/unit control valves must be insulated with a minimum IT/Armaflex Flexible Insulation of 30mm, Thermosil or Thermotec 32mm wall thickness, for buildings up to and including three floors. Over three floors the flow pipework is to be insulated with Glasswool, Thermosil or Thermotec 4-Zero 30mm insulation aluminum foil covering, or equivalent approved by NCC, as 30mm FR/Armaflex.

The insulation for the return pipework must be as specified for the flow pipework, however the flexible insulation in building up to three floors may be 13mm IT/Armaflex, 15mm wall thickness Thermosil or Thermotec Insulation. In building over three floors return pipework must be insulated with Glasswool 30mm, Thermosil, Thermotec 4-Zero insulation 30mm wall thickness, or equivalent approved by NCC, as 30mm FR/Armaflex.

Hot water flow and return lines above suspended ceilings, in roof spaces, in riser shafts and plant rooms must be insulated as above and sheathed with aluminum foil.

All piping exposed to view and where damage may occur must be sheathed with 0.5mm thickness zinc anneal sprung over the insulation in one piece with 32mm laps and fastened with approved zinc plated steel self tapping screws. Metal sheathing is to be coned down to valves and tees. On bends it is to be lobster backed.

All "dead-leg" hot water pipework must be insulated with Thermotec or equal insulation.

All cold water service pipework chased in walls must be pre-insulated, poly-lagged, copper tube.

5.35 ACOUSTIC TREATMENT OF SERVICES

Refer to acoustic reports for required acoustic treatment of hydraulic services, as a guide use the following table:

Service	Area	Treatment
Stormwater/ Sewer/ Sanitary Plumbing	Car Parks	Not Required
	Noise Sensitive Areas: - spaces which are habitable and transient spaces where staff and/or patients can reside or pass through (Eg. Offices / consult rooms / ward rooms / associated corridors etc.). Typically all areas other than stores / plant spaces and other permanently noisy environments.	50mm thick – 5.0kg/m²

	Wet Areas	25mm thick – 5.0kg/m²
Reticulated Hot & Cold Water Services	Car Parks	Not Required
	Noise Sensitive Areas - spaces which are habitable and transient spaces where staff and/or patients can reside or pass through (Eg. Offices / consult rooms / ward rooms / associated corridors etc.). Typically all areas other than stores / plant spaces and other permanently noisy environments.	25mm thick – 5.0kg/m²
	Wet Areas	25mm thick – 5.0kg/m²

5.36 ACOUSTIC LAGGING FOR PIPES

The acoustic lagging for the soil, waste and stormwater pipes will be NuWrap 5 manufactured by Thermotec Australia Pty Ltd or equal approved.

The material will be 5kg/m^2 loaded polymer barrier over 25mm nominal thickness convoluted polyurethane foam. The outer skin of the loaded polymer will be faced with a heavy duty reinforced aluminum foil, tested to achieve a fire performance of "four zeros" to AS1530.part 3.

When tested in a NATA (National Association of Testing Authorities) registered laboratory, the insertion loss of the material will be STC25 and when used in a system incorporating 10mm plasterboard and R1.6 insulation blanket will achieve a rating of Rw40 to the NCC requirements for sanitary and stormwater drainage pipes located above habitable rooms.

Material will be cut to size to neatly cover all pipe work. Straight lengths of pipe will incorporate a 50mm nominal overlap along the length. Fittings will be covered with NuWrap 5 carefully cut to ensure complete coverage. Use of factory precision cut NuWrap 5 (Flat Packs) for PVC-U fittings is recommended unless a professional lagging Contractor is employed to fit the insulation.

5.37 BUILDING MOVEMENT & EXPANSION JOINTS

Crossing building expansion joints with pipelines shall be avoided where possible. Where this is not possible, lines adjacent to a building expansion joint shall be located in a readily accessible position and fitted with an approved expansion joint.

Vertical cast iron and copper drainage pipe works shall be provided with 5mm rubber ring between spigot and collar at three-floor intervals to allow for long term settlement of the structure.

5.38 UNSTABLE OR WATER-CHARGED GROUND

Contact the relevant Authority to determine if the area is subject to mine subsidence or any other instability and obtain any specific installation requirements that the Authority may have, prior to tendering.

Should any part of the site be in unstable or water-charged ground, engage a structural engineer to provide recommendations for the support of pipework in unstable or water-charged ground.

Install pipework to the Authority's requirements and to the structural engineer's recommendation.

5.39 REACTIVE SOILS

Obtain and review the Geotech Report for the project to determine whether the site is located in reactive soil. Where the works are located in reactive soil and differential settlement and movement is expected

below the slab, allow for drainage pipework below the slab to be installed in loose, biodegradable fill and support the pipework to the slab with pear clips and hangers in accordance with the requirements for suspended pipework. The hangers and clips shall be powder coated or otherwise treated against corrosion.

Where differential settlement can occur between the building slab and external ground, provide a flexible joint within one metre of the slab edge where drainage pipework emerges from underneath the building. The flexible joint shall comprise of a swivel joint set with 5 degree fall connected to a commination swivel and expansion joint.

Avoid penetrations through edge beams and perimeter strip footings where possible, however where necessary, ensure pipe sleeves are utilised for any penetrations through edge beams. Pipework downstream of penetrations through perimeter beams should have flexible joints as described above.

Any water services pipework below the slab is to be installed within a conduit for the full length of pipework below the slab. The conduit shall terminate at least one metre outside the building line in a landscaped area in order to identify any leakage. Where possible, utilise HDPE pipework with minimal joints under the building.

5.40 CONCRETE

Concrete used for drainage and plumbing works must be of 20MPa strength when supplied by a ready-mixed concrete supplier, or site mixed concrete must be of 4:2:1 mix. Mortar must be 2:1 cement mix. Waterproof render must be 3:1 mortar waterproofed with approved brand of waterproofing compound used directly in accordance with the manufacturer's directions.

Concrete for the gas main slab to be 25MPa.

5.41 PITS, MANHOLES & SUMPS

Excavate, supply, install and backfill around pre-cast concrete pits, manholes and sumps to the locations as shown on the Hydraulic Services Drawings.

Pits, manholes and sumps must be bedded on maximum 50 mm sand layer and minimum of 50 mm, 2:1 cement mortar, with the cement mortar extending past the level of the knock out sections of all sides. The remainder must be backfilled with sand. Extension rings where used, must have a 300 mm wide bandage joint both internally and externally. The knock out sections and any other irregularities must be rendered with a 3:1 cement mortar mix to form a smooth waterproof internal finish. Step irons must be installed in pits and sumps over one (1) metre deep. Covers, grates and frames must be as shown and specified. Bench up base to match pipe size.

Manholes are to be benched in accordance with the WASSA code and Local Authority regulations

Where pits and sumps are to be installed within concrete paving or floor slabs they must be installed complete with starter bars to adequately prevent uplifting of the pit.

All pits and sumps must be approved by the local Authorities and installed in accordance with the Manufacturer's recommendations.

5.42 COVERS, GRATES & FRAMES

Covers, grates and frames must be BCP Precast or approved equal cast iron with all edges machine fitted and have removable plastic lifting hole plugs. The covers, grates and frames must be set to the level of the finished surface levels and covers filled in with the same materials as used for the surrounding surface.

Covers, Grates and Frames must be manufactured to AS.3996.

Covers, Grates and Frames must be manufactured to AS.3996 to the following Classes: -

Class A	For use in pedestrian precincts which are inaccessible to motor vehicles

Class B	Units for use on footpath or footways where it is possible for vehicles to mount the footway or for light vehicles, such as park tractors or livestock to use the pedestrian facility
Class C	i.) Units for use in areas normally reserved in for pedestrians and only occasionally open to vehicles (i.e., for delivery or cleaning purpose or in an emergency) where loads will not exceed 3.7 tonnes or:- ii.) Units for use in the carriageways of minor residential roads and cul-de-sacs carrying slow moving commercial vehicles (generating no impact load) where wheel loads will not exceed 7.5 tonnes.
Class D	i.) Units for unrestricted use in the carriageways of arterial and other roads that may carry fast moving heavy vehicles where wheel loads will not exceed 10.5 tonnes. ii.) iii.) Units for unrestricted use in areas trafficked by slow moving heavy (generally no impact loading) where wheel loads will not exceed 10.5 tonnes.

Cover and grate sizes and duty must be to minimum as indicated on the drawings and/or otherwise as per the application.

Galvanized steel grates and frames will not be considered as an alternative unless the manufacturing provides written certification that the grates installed comply with the above wheel and impact loads and are suitable for the intended purpose of the project.

5.43 PUMP COUPLINGS

Shall be approved flexible couplings of appropriate diameter, and length and strength to provide a minimum 95% vibration absorption under the maximum developed head.

5.44 PUMP MOUNTINGS

Shall be Silentblock or equal approved spring isolating mountings of appropriate size to provide a minimum 95% vibration absorption.

5.45 PURGING

Every care shall be taken during the installation to minimise the entrance of sand, grit or foreign matter in the supply piping.

Cold water supply pipes to the heater are to be purged prior to the installation of the heater and all hot water supply pipes from the heater to hot water draw off points are to be purged prior to the installation of faucets, cocks, etc. The installation to be left charged and ready for use when occupied.

5.46 PUMP CONTROL PANELS

Control panels should be totally enclosed dustproof cabinet type with front connected equipment. Cabinets must be fabricated generally of minimum 1.2 mm thick furniture grade zinc coated, mild steel.

Control panels must be lockable and must comply with AS.1939 for internal and external locations as required.

Equipment must be neatly arranged and readily accessible for maintenance.

Each control panel must be provided with an isolating switch and neutral and earth studs.

Control switches must be rotary type complying with AS.1431.

Indicator lights must match control switches with Colours to as follows:

- RED Pump fail, alarm - e.g. high and low level.
- AMBER Pump running.
- GREEN Power supply on.

Fuses must be HRC type complying with AS.2005 with fully shrouded base contacts.

Circuit breakers must be approved by Australian supply authorities and comply with AS.3111 and AS.2184 minimum interrupt capacity must be 6 KA.

Time clocks must be quartz crystal oscillator type with an accuracy of plus/minus 5 minutes per annum and complete with Ni-Cad battery to provide a 100 hour reserve.

Covered terminal strips with labeled terminals must be provided for connection of the Building Automation System (BAS) wiring by others. Wiring to terminals must provide voltage free contacts for all alarms and faults and for pump running indication. Contacts shall be Normally Open (N.O.) or Normally Closed (N.C.) as advised by the Consultant.

All control panels and equipment must be labelled with engraved laminated type labels. Labels must be black and white lettering. Size of lettering must match importance and location. Labels must be screw fixed.

Cabinets must be labeled to indicate function, e.g.:

"HOT WATER CIRCULATING PUMP CONTROLS"

In a clearly visible location adjacent to the control panel, provide an instruction panel setting out the pump operating instructions. The instruction panel must be in accordance with Authorities requirements.

SECTION 6 - EXCAVATION

6.1 TRENCH EXCAVATION

Keep adequate dewatering equipment on the site at all times and keep excavation free of water.

The ground must be excavated in material as found, in the form of trenches to enable the various pipelines to be constructed in the locations shown on the drawings. Trenches must be excavated in uniform grades and in straight lines. Unless directed otherwise the Contractor must allow for removal of spoil from the site.

6.2 EXCEEDING EXCAVATION

If the section area of excavation is exceeded as a consequence of any injudicious working, slips, falls, blasting or for any cause other than by instruction of the Project Manager, then remove such extra material and make good and fill in the extra excavation with concrete, sand or approved filling as instructed. No extra payment will be made for excavation in excess of that required by the drawings and specification.

6.3 EXCAVATION IN EXISTING PAVEMENT AND ROADWAYS

When excavating through existing pavement, saw the pavement and/or road to a depth of at least 100 mm and then remove the material with pneumatic tools. If required by the Project Manager, trenches across the existing roads must be excavated and the pipeline constructed therein so that half the roadway is always maintained open to traffic.

6.4 SHORING OF EXCAVATION

Where necessary for safe and efficient completion of work, erect shoring and timbering of sufficient strength and quality, in the correct manner, to prevent earth and other material slipping or falling or being shaken from the sides of the excavations.

As the work proceeds, all shoring and timbering must be withdrawn, in the correct manner, except in cases where instructed in writing that such shoring and/or timbering must be left in position. The supply, erection and withdrawal of all timber work must be included in the cost of excavation and no further claim in respect of this item will be accepted.

6.5 PRECAUTIONS & SAFEGUARDS

Carry out the work in a careful, secure and tidy manner and take all precautions against damage, whether arising from bad workmanship, breakage of machinery or plant, inefficient timbering, flooding or any other cause whatsoever.

Provide, erect and maintain warning signs, temporary fences, barriers and night lights adjacent to any work such as trenches and excavations or stacks of materials that would be a danger to persons or traffic of any kind.

Obey all directions given, with regard to the provisions of lighting and barriers. Obtain permission from Authorities prior to any excavation and before placement of barricades.

6.6 USE OF EXPLOSIVES

THE USE OF EXPLOSIVES WILL NOT BE PERMITTED.

6.7 BEDDING MATERIALS

After length of trench has been approved the following bedding material must be placed therein to approval:

- PVC-U Pipes for sanitary drainage must be bedded on a compacted 75mm thick layer of blue metal (9.5mm maximum).
- PVC-U Pipes for water services must be bedded on a 150mm layer of coarse river sand.
- PVC-U Pipes must be bedded on a 150mm layer of coarse river sand.
- Copper Pipes must be bedded on a 150 mm layer of course river sand.
- Nylon Pipes must be bedded on a 150 mm layer of course river sand.

6.8 SIDE SUPPORT & OVERLAY

After a length of pipeline has been constructed, tested and approved the following side support and overlay material must be placed therein to approval:

- PVC-U Pipes bedded on sand and cement must have side support extending from the bedding to a minimum height of a quarter of the outside diameter of pipe and tapered to the edge of the bedding. The overlay must consist of sand extending from the side support to 300 mm above the top of the pipe. The overlay material must be thoroughly compacted in layers not exceeding 150 mm thick.
- PVC-U Pipes bedded on blue metal must have side support and overlay consisting of blue metal, extending from the bedding to 150mm above the top of the pipe. The side support and overlay material must be thoroughly compacted in layers not exceeding 75mm.
- PVC-U Pipes bedded on coarse river sand must have side support and overlay consisting of sand, extending from the bedding to 150 mm above the top of the pipe. The side support and overlay material must be thoroughly compacted in layers not exceeding 75 mm
- Copper bedded on coarse river sand must have side support and overlay consisting of sand, extending from the bedding to 150 mm above the top of the pipe. The side support and overlay material must be thoroughly compacted in layers not exceeding 75 mm.
- Nylon Pipes bedded on coarse river sand must have side support and overlay consisting of sand, extending from the bedding to 150 mm above the top of the pipe. The side support and overlay material must be thoroughly compacted in layers not exceeding 75 mm.

6.9 BACKFILLING

After a length of pipeline has been provided with side support and overlay material, approved and permission given to backfill, the trench must be backfilled as follows: -

The first 300 mm of trench height, where applicable, must be filled with selected fill material free of stone or hard formation consisting of the best of the excavated material, such layer must be well consolidated to approval and watered as directed.

The remainder of the trench must be backfilled in layers not exceeding 300 mm in thickness with selected fill material from the excavation, each layer being well consolidated and watered as directed.

Pipes under floor slabs, roads and pavements must be completely backfilled with high grade compaction sand thoroughly compacted in layers not greater than 150mm to the under of the slab or pavement.

Should the Project Manager consider the excavated material unsuitable for re-filling of any portion of trenches not under pavement then such portions must, if so instructed by the Project Manager be re-filled with granular material, well compacted and watered in layers as specified above.

Backfilling between concrete structures and the sides of excavation must be made only by using granular materials consolidated in layers as directed.

Sub-soil drains must have minimum 150 mm of 20 mm aggregate surround wrapped with one layer of "terra-firma" or equal approved geotextile filter material. Backfill the remainder of the trench as previously specified.

6.10 BACKFILLING

All pipework below concrete slabs is to be backfilled with 20 sand to 1 cement mix.

After approval of construction and testing of pipelines, backfill trenches in the following manner:

- Copper - sand to 150mm. above pipe compacted to surface as specified
- P.V.C-U lines under roads – stabilised sand 30:1.
- P.V.C-U lines - sand to 300mm above collars compacted to surface as specified.
- MDPE or equivalent clean sand 350mm above pipework and compacted to surface as specified of trench.
- All pipework under roads or under buildings shall be stabilised sand 30:1

N.B. Selected fill shall be free from clay, gravel, shells or other hard particles retained on a 13.2mm sieve.

After a length of pipeline has been constructed, tested and approved, and permission has been given to backfill, the trench shall be backfilled as specified below with the material specified for the particular type of pipe, as soon as possible.

For pipelines other than those under road pavements (whether existing or proposed), the remainder of the trench shall be backfilled in layers not exceeding 150mm. in thickness with selected fill material from the excavation, each layer being well compacted by watering and tamping, puddling or rolling to at least 98% of the modified maximum dry density to AS.1289 – 5.4.1. The selected fill material shall be free from clay lumps larger than 50mm. and stones larger than 25mm. Should the Project Manager consider the excavated material unsuitable for backfilling of any portion of trenches then such portions shall be backfilled with other fill material approved by the Project Manager, well consolidated and watered in layers as specified above.

For pipelines under pavements whether such pavements are existing or to be constructed under this contract or shown on the drawings as to be constructed in the future, backfilling the remainder of the trench with excavated material shall not be permitted, but shall be carried out using approved granular material and to Council requirements or as directed by the Project Manager.

All granular material (including sand bedding) shall be backfilled in layers not exceeding 150mm in thickness, each layer being compacted by watering and tamping or puddling to at least 70% of the minimum dry density determined in accordance with the AS.1289 – 5.6.1.

Backfilling between concrete structures and the sides of excavations shall be with granular material consolidated in layers as directed, each layer not exceeding 150mm in thickness.

All pipework under roads and footpaths will be tested by a NATA accredited laboratory, all test results to be submitted and approved prior to installing road pavements.

Tests shall be taken one per trench with maximum length of 20m.

6.11 TUNNELING

Provide tunneling in lieu of trenches where required by Authorities or shown on the drawings.

Tunneling must comply with the requirements of WorkCover Authority and The Division of Resources and Energy- Minerals & Petroleum.

The use of explosives will not be permitted. Use adequate shoring to prevent the collapse of the tunnel under all conditions.

Leave shoring in tunnel and backfill with sand under pressure after approval of pipework by Authorities and the Project Manager.

6.12 RESTORATION OF SURFACES

All surfaces (walls, roads, pavements, etc.) must be restored to their original state to the satisfaction and approval of the Project Manager and/or Local Authority.

6.13 EXCESS SPOIL

The Contractor must be responsible for the removal from Site, all excess spoil that result from their excavations.

The excess spoil must be removed from Site immediately when requested by the Project Manager.

The contractor must be responsible for moving and storing all excess spoil in a manner and location approved by the Project Manager.

SECTION 7 - SEWER DRAINAGE & SANITARY PLUMBING

7.1 GENERAL

The work under this section comprises the complete installation/workshop drawings, excavation, supply and installation of the sewer drainage from the existing house drainage service and extending to all outlets and risers located in the development, as indicated on the drawings.

The Contractor must supply and install all manholes, junctions, bends, clear-outs, inspection openings and pipework as required by the Relevant Authority and as specified to complete the works.

The Contractor must arrange to pay all fees associated with the works.

7.2 PIPE MATERIAL SCHEDULE

Pipes and fittings shall be in materials as follows:

SERVICE	PIPE DIAMETER IN mm	PIPE MATERIAL
Sewer drainage	100-150	SN6 uPVC (DWV). Solvent welded.
Sanitary drainage stacks,	110-160	SN6 uPVC (DWV). Solvent welded.
Sanitary drainage branches	40-150	SN6 uPVC (DWV). Solvent welded.
Sewer drainage/ sanitary plumbing for relief drainage from hot water heaters	50 and 150	Lightweight cast iron pipework with stainless steel clamps, or Type "D" copper .
High temperature discharge drainage	50 - 150	Lightweight cast iron pipework with stainless steel clamps
Sewer rising main	As nominated	Black PE, PE100 PN16 pressure pipe with electrofusion welded joints. Provide long radius bends.
Electrical conduit between pumps control panel and pumps	100	Orange electrical conduit with power and liquid level control and alarm wiring.

Provide fire collars where plastic pipework penetrates fire rated elements.

7.3 SEWER CONNECTION

Ascertain the depth, position and suitability of the sewer connections prior to commencement of any work and advise if any adjustments are required to execute the work as shown on the drawings and specified.

7.4 SEWER DIVERSION

Undertake the private sewer diversion as documented on the Early Works drawing and ensure that continued operation of the sewer is maintained throughout the construction period. The permanent sewer diversion is to be carried out as documented on the main works drawings.

7.5 OVERFLOW GULLY

Overflow gullies must be installed in the position to meet AS3500 and local Authority requirements to provide a safe release of sewerage from the connection point. Gully must be constructed of a 100/150 mm "P" trap and riser.

Unless indicated otherwise, the top of the riser must terminate 75 mm above the surrounding surface area. The gully must be provided with concrete bedding, encasing and a dished pre-cast concrete surround as required.

7.6 BRANCHES

Where a branch line enters a vertical pipe the branch fitting must be wholly outside the vertical pipe such that the internal bore of the pipe is maintained at all times.

All horizontal branches must be made at 45 degrees to the main line.

7.7 EXPANSION JOINTS

Must be of a type, material and manufacture approved by the local Authority.

Must be installed with PVC-U/copper tubes in such a manner that axial movement with adjacent sections of the pipe to the extent of at least 8 mm in either direction is readily possible.

On vertical vent pipes, one expansion joint must be fitted at its base or in the vertical pipe above an offset bend, and at each alternate floor level except in the top storey. Such expansion joints must be installed immediately below the lowest branch connection for that floor.

Must be fitted on all horizontal branch soil, waste and vent pipes in excess of 6 m in length. In these cases, expansion joints must be installed at maximum intervals of 6 m and immediately upstream of the entry to the vertical stack or other graded line. Where branch pipes are fixed at closer intervals, an expansion joint must be installed between every two (2) fixed supports, which are more than 2 m apart.

7.8 TRAPS

Traps must be of the following types: -

Wall Basin:	Chrome Plated Copper
Dental Chair	Chrome Plated Copper
Cleaners Sink:	Chrome Plated Copper
Vanity Basin – cupboard:	Polypropylene
Vanity Basin – skirt only:	Polypropylene
Sink – cupboard:	Polypropylene
Sink – skirt only:	Polypropylene
Floor Waste:	PVC-U Palazzi with PVC-U Riser & C.P. Brass Grate
Shower:	PVC-U Palazzi with PVC-U Riser & C.P. Brass Grate

The shower and the floor waste riser must be 100mm with a 100mm grate.

Traps must have a minimum seal of 80mm.

Traps and waste pipe droppers must be chrome plated copper where exposed.

7.9 INSPECTION OPENINGS/ CLEAROUTS

Install inspection openings in pipes so that each section of pipework is accessible in at least one (1) direction. Inspection openings must be placed in accessible positions and to the approval of the Relevant Authority.

Inspection opening must be installed to each drainage riser, at each floor level, as a minimum.

Install bolted testing gates of the same diameter as the stack at the foot of each stack and at each alternate floor level for testing.

Allow to extend to finished surface level using a 45 degree junction and 45 degree bend.

Termination of inspection openings/ clear outs shall be as nominated in the below table:

AREA	FINISH	FLOOR WASTE
Internal	Vinyl	Suit 100mm uPVC riser Vinyl clamping ring Equal to SMC CO4VF
Internal	Concrete/ Tiling	Suit 100mm uPVC riser Equal to SMC CO4
External	Concrete/ Paving/ Grass	Suit 100mm uPVC riser Cast iron frame and cover, complete with bolt down Concrete surround

7.10 SEWER MANTENANCE SHAFTS (SMS)

All sewer maintenance shafts shall be equal to SMS Sewer Maintenance Shafts and in accordance with Sewerage Code of Australia. Provide Access covers to sewer maintenance shaft as follows:

- Landscaped Areas – (AC1) Class B Cover with concrete surround, complete with 375mm clear opening gatic lid
- All other areas – (AC6) Class D Cast Iron cover with 400mm clear opening

7.11 SEWER INSPECTION PITS (SIP)

All sewer inspection pits shall be equal to Mascot Engineering concrete pit, complete with class B, 50mm brass edging infill cover, final size to Australian Standard requirements based on depth

7.12 TUNDISH POINTS

Exposed tundish points shall be installed in stainless steel or chrome plate copper

7.13 FLOOR WASTES & SHOWER WASTES

Provide self-cleaning gully with 100mm riser, fitted with the following floor waste outlets

AREA	FINISH	FLOOR WASTE
Amenities Ensuites Clean rooms	Vinyl	Suit 100mm uPVC riser Chrome plated brass grate Solid brass body Vinyl clamping ring Equal to 3monkeez FW-100VR

Kitchen Clean up/ utility rooms Plantrooms	Vinyl	Suit 100mm HDPE riser Grate & body manufactured from 304 stainless steel Stainless steel grate Fixed secondary strainer Removable strainer basket Vinyl clamping ring Equal to 3monkeez FW-100VRBT
Plantrooms Garbage/ Waste Rooms	Concrete	Suit 100mm uPVC riser Grate & body manufactured from 304 stainless steel Stainless steel grate Fixed secondary strainer Removable strainer basket Equal to 3monkeez FW-150BR

7.14 PITS & SUMPS

Refer to the "Materials" section of the specification.

7.15 COVERS, GRATES & FRAMES

Refer to the "Materials" section of the specification.

7.16 VENT PENETRATIONS

All penetrations for vents passing through the roof must be carried out by the roofer.

The roofer must supply and install the flashing Dektite.

Allow to attend and assist as required.

All vents passing through the roof must be furnished with an upstand of the same material as the roof and terminating above parapet. Ensure that the sleeve is provided with a water intrusion flange and completely waterproofed to approval.

Provide over flashing, neatly dressed down and formed to shape to provide not less than 50 mm cover to the sleeve extending from the roof.

7.17 VENT TERMINAL

Except where located in a Bushfire Prone area, all vent pipes must terminate with an approved PVC-U basket cowl and be fitted with a weather proof apron.

In Bushfire Prone areas, provide Colorbond Steel vent cowls with metal screen mesh.

7.18 ACCEPTANCE & RESPONSIBILITY OF FIXTURES & APPLIANCES

The Contractor must allow to take receipt of all fixtures, appliances, plant, equipment, brackets, plugs, waste outlets and all associated items when delivered to site by the manufacturer. He must coordinate this operation with the Project Manager.

On receiving the goods he must be totally responsible for their numbers and condition until the completion of the project.

7.19 TESTING

The complete sanitary drainage installation must be tested to the approval of the Relevant Authority and the Project Manager.

Pay all associated fees, supply and operate all necessary test equipment. All lines must be subject to a hydrostatic test for a minimum period of 24 hours. The line must be free of air pockets whilst under test. For inspection of falls and straightness by the Project Manager, the Contractor must have a string line set up on the pipeline.

7.20 CCTV

All new and existing sewer drainage lines, including connection to existing systems shall be CCTV'd prior to occupation certificate. The CCTV shall confirm that all sewer drainage lines have been laid with the adequate falls and have no construction debris contained within them

A soft copy of the CCTV footage shall be submitted to the project manager for review and approval prior to occupation certificate. The contractor shall allow adequate time for review and approval

7.21 SEWAGE PUMPOUT STATION

Provide a pre-packaged sewage pumpout station where indicated on the Drawings as follows:
Make : Qmax
Model : FRP-1520
Size : 5,000L
Flow Rate : 2 L/s
Duty : 100 kPa
Number of : Two
Location : External. Refer to Plans
Power Supply : 415V 3 Phase 2.2 kW (Hard Wired to Control Panel)

Complete with valves, and control panel. Install the pumpout station, pumps and other associated items in accordance with the manufacturer's recommendations.

7.21.1 Pumps

Pumps shall be dual Flygt or equal pumps as indicated on the Drawings. Fix the pumps on purpose made guide rails and provide lifting chains to allow for easy removal of the pumps for inspection and maintenance. Provide all associated pipework and valves, including an isolation valve and check valve on the outlet of each pump.

7.21.2 Pumpout Chamber

The pumpout chamber shall incorporate gas tight concrete infill covers with duty relevant to the imposed loads and the location of the cover. The chamber shall be installed to the manufacturer's recommendations with particular attention to the requirements to prevent hydrostatic pressure from lifting the chamber. This may include the need for a reinforced concrete base and encasement or surround with reinforced concrete as recommended by the manufacturer.

The final capacity of the sewer pumpout chamber shall be confirmed as part of the Design Finalisation in review of fixtures that are discharging to the pumpout system. The size indicated on the plans is indicative only.

7.21.3 Electrical Control Panels

Provide electrical control panels for each pumpout station. Provide control panel cabinets, mounting brackets, contactors, isolating and control switches, auxiliary switches, alarms and wiring between the pumps / switches and the control panel to enable the lights, switches and functions to operate as noted below and for the safe and effective operation of the pumps.

Control panels shall be wall mounted adjacent to the pumps or in a location with the top at approximately 1800mm high above floor. Panels may be mounted on the pumpset frame where this comes standard with the installation. The face of the panel is to be oriented so as to be easily accessible and visible.

Control panels located internal to buildings shall be constructed with an IP50 rating. Control panels exposed to the weather shall be enclosed in purpose built weatherproof cabinet constructed with an IP54 rating.

Provide lockable doors with dustproof neoprene seals. Panels not located in plant rooms are to be fitted with an additional lockable cover to house the switches and indicator lights in order to prevent unauthorised tampering of the switches.

Control panels shall be designed for ease of access to all equipment and wiring and shall be provided with at least 10% spare space for the addition of future equipment. The panel functions, switches and lights on the face of the control panel shall be in accordance with the following:-

SEWAGE PUMPOUT STATION ELECTRICAL CONTROL PANEL FUNCTIONS

SWITCHES	INDICATOR LIGHTS	FUNCTIONS
----	Power On – Blue Light	Indicates power to panel
Pump 1 On/Off/Auto	Pump 1 Run – Green Light	Indicates Pump 1 in operation
----	Pump 1 Off – Amber Light	Indicates Pump 1 on stand-by
----	Pump 1 Fail – Red Flashing Light	Indicates failure of pump 1. Audible alarm is to be triggered with this function.
----	----	Pump 1 run meter (requires time clock). To indicate the number of hours the pump has run over it's life.
Pump 2 On/Off/Auto	Pump 2 Run – Green Light	Indicates Pump 2 in operation
----	Pump 2 Off – Amber Light	Indicates Pump 2 on stand-by
----	Pump 2 Fail – Red Flashing Light	Indicates failure of pump 2. Audible alarm is to be triggered with this function.
----	----	Pump 2 run meter (requires time clock). To indicate the number of hours the pump has run over it's life.
----	High level alarm – Red Flashing Light	Audible alarm is to be triggered with this function and both pumps to operate simultaneously.
Panel Light Test Button	----	Tests all lights on panel
Reset Button	----	To clear a pump fail indicator
----	----	Alternation of duty and stand-by pump after each pump operation.
----	----	Terminate all pump run / fail / alarm signals on a terminal strip for wiring to a BMS (liaise with electrical contractor to determine the size of the terminals required).
----	----	Transformers 415V / 240V to 24V for control wiring

SECTION 8 - TRADE WASTE DRAINAGE SERVICES

8.1 GENERAL

The work under this section comprises the complete installation workshop drawings ,supply and installation of the trade waste and vent pipes from the drainage connection points as shown on the drawings to vent terminals and includes for all bends, offsets, expansion joints, branches, brackets, sanitary fixtures and sundry equipment necessary to complete the installation.

8.2 PIPE MATERIAL SCHEDULE

Pipes and fittings shall be in materials as follows:

SERVICE	PIPE DIAMETER IN mm	PIPE MATERIAL
Trade Waste Drainage	40-110	Sewer Grade HDPE pipe and fittings all jointed with electrofusion socket fittings.
High temperature discharge drainage	50 - 150	Lightweight cast iron pipework with stainless steel clamps

8.3 BRANCHES

Where a branch line enters a vertical pipe the branch fitting must be wholly outside the vertical pipe such that the internal bore of the pipe is maintained at all times.

All horizontal branches must be made at 45 degrees to the main line.

8.4 EXPANSION JOINTS

Must be of a type, material and manufacture approved by the local authority.

Must be installed with HDPE/copper tubes/ cast iron in such a manner that axial movement with adjacent sections of the pipe to the extent of at least 8 mm in either direction is readily possible.

On vertical vent pipes, one expansion joint must be fitted at its base or in the vertical pipe above an offset bend, and at each alternate floor level except in the top storey. Such expansion joints must be installed immediately below the lowest branch connection for that floor.

Must be fitted on all sections in excess of 6 m in length and below all building movement joints. In these cases, expansion joints must be installed at maximum intervals of 6 m and immediately upstream of the entry to the vertical stack or other graded line. Where branch pipes are fixed at closer intervals, an expansion joint must be installed between every two (2) fixed supports, which are more than 2 m apart.

8.5 INSPECTION OPENINGS AND GATES

Install inspection openings in pipes so that each section of pipework is accessible in at least one (1) direction. Inspection openings must be placed in accessible positions and to the approval of the Relevant Authority.

Install bolted testing gates of the same diameter as the stack at the foot of each stack and at each alternate floor level for testing.

8.6 TRAPS

Traps must be of the following types: -

Tundish:	Chrome Plated Copper
Utensil Washer	Chrome Plated Copper
Floor Waste:	Cast Iron Palazzi with Cast Iron Riser & 304 Stainless steel grate

The floor waste riser must be 100mm with a 150mm grate.

Traps must have a minimum seal of 80mm.

Traps and waste pipe droppers must be chrome plated copper where exposed.

8.7 GREASE ARRESTOR

Provide a Water Authority approved grease arrestor as follows:
Make : Halgan Py Ltd
Model : MGTS2000, Below Ground
Material : High Density Polyethylene (HDPE)
Size : 2,000L
Location : External. Refer to Plans
Power Supply : 240V 10A (GPO) Within 5m of grease chamber.

Include for a remote pumpout point and kamlock fittings to enable remote pumpout.

8.8 TRADE WASTE PIPES

All waste pipes pipework located within the building, including ducts shall be insulated with 25mm Acoustic fibreglass sectional pipe insulation with aluminium vinyl loaded backing and fixed with purpose made clips to meet a minimum 40 DBA noise level.

8.9 VENT PENETRATIONS

All penetrations for vents passing through the roof must be carried out by the roofer.

The roofer must supply and install the flashing Dektite. Allow to attend and assist as required.

All vents passing through the roof must be furnished with an upstand of the same material as the roof and terminating above parapet. Ensure that the sleeve is provided with a water intrusion flange and completely waterproofed to approval.

Provide over flashing, neatly dressed down and formed to shape to provide not less than 50 mm cover to the sleeve extending from the roof.

8.10 VENT TERMINAL

Except where located in a Bushfire Prone area, all vent pipes must terminate with an approved PVC-U basket cowl and be fitted with a weather proof apron.

In Bushfire Prone areas, provide Colorbond Steel vent cowls with metal screen mesh.

8.11 ACCEPTANCE & RESPONSIBILITY OF FIXTURES & APPLIANCES

The Contractor must allow to take receipt of all fixtures, appliances, plant, equipment, brackets, plugs, waste outlets and all associated items when delivered to site by the manufacturer. He must coordinate this operation with the Project Manager.

On receiving the goods he must be totally responsible for their numbers and condition until the completion of the project.

8.12 TESTING

The complete sanitary drainage installation must be tested to the approval of the Relevant Authority and the Project Manager.

Pay all associated fees, supply and operate all necessary test equipment. All lines must be subject to a hydrostatic test for a minimum period of 24 hours. The line must be free of air pockets whilst under test. For inspection of falls and straightness by the Project Manager, the Contractor must have a string line set up on the pipeline.

Each floor must be given static water test, for a minimum period of 4 hours, in the presence of the Project Manager, whether or not such a test is required by the local authority Inspector. Where the intermediate floor is not provided with a testing gate, the outlet points to that floor must be plugged off and the stack filled to the highest overflow point on the floor above.

SECTION 9 - DOWNPIPES

9.1 GENERAL

The work under this part comprises the complete supply and installation of the downpipes from the roof gutters and roof outlets and drainage to the Civil stormwater OSD tank / rainwater tank as designed by the Civil Engineer and indicated on the drawings.

Allow for supply and fixing of all bends, tees, junctions, roof outlets, piping and sundry equipment necessary to complete the installation as shown on the drawings and specified.

9.2 PIPE MATERIAL SCHEDULE

Pipes and fittings shall be in materials as follows:

SERVICE	PIPE DIAMETER IN mm	PIPE MATERIAL
Concealed downpipes, elevated drainage	100-375	Sewer Grade HDPE pipe and fittings all jointed with electrofusion socket fittings HDPE
Exposed downpipes	100 - 150	Zincalume with custom riveted joints
In-ground drainage	100 - 225	uPVC (DWV). Solvent welded
In-ground drainage	300 - 450	Class 2 Fibre Reinforced Concrete, with rubber ring joints

9.3 RAINWATER OUTLETS

Supply and install cast iron roof and roof water outlets in the positions indicated on the drawings and as scheduled.

Rainwater outlets shall be cast iron construction as manufactured by "SPS" complete with membrane clamping ring, as shown on the drawings.

Rainwater outlet types shall be in accordance with the following:

LOCATION	RAINWATER OUTLET TYPE
Roof decks	SPS Truflo 100mm & 150mm with dome grate, membrane clamp & gravel guard. TIA100D2
Accessible Terraces	SPS Truflo 100 TIB100F2 or equal
Inaccessible Terraces	SPS Truflo 100mm & 150mm with dome grate, membrane clamp & gravel guard. TIA100D2
Trafficable roof decks and all courtyards	SPS Truflo 100 TIB100F2 or equal
Planter boxes	SPS Truflo 100 TIB100F2 or equal

9.4 INSPECTION OPENINGS

Inspection openings generally must be provided at every junction, bend/ change of direction and at the base of all downpipes, to facilitate maintenance.

9.5 TESTING

On completion all work must be hydrostatically tested under expected maximum choke conditions for a period of two (2) hours. Any defects must be remedied and the test re-applied. Provide all testing gates and apparatus necessary for the test.

9.6 SAFETRAYS

Provide stainless steel safety trays under all stormwater drainage that is suspended over habitable spaces below. Trays are to include a leak detection system for the full length of the tray and be drained to tundishes, connected to stackwork on the floor below.

9.7 WATER LEAK DETECTION AND ALARM

The Contractor shall supply, install and commission the water leak detection system including cable sensors, point sensors, interconnecting cable and controller necessary for a complete installation of an integrated Water Leak Detection and Location System.

Product Data: Application information can be obtained from Pentair TRACETEK Leak Detection System Commercial Building Application and Product Selection Guide H53147.

Operation and Maintenance Manuals: Provide Pentair TRACETEK operation and maintenance manuals for controls and communications, electronic monitoring, sensing products, accessories, and installation tools and equipment.

Circuit Layout: Provide a water leak detection circuit layout drawing detailing the following information for each circuit:

- Point sensors and location;
- Cable sensors and location;
- Sensor interface modules and location;
- Main control panel and location.

Shop Drawings: Shall include a floor plan map of the building with sensor location and resistance reading at point sensor and cable sensor.

Manufacturers: All manufacturers shall have a minimum of thirty years of experience in the manufacturing of water leak detection sensors, cable, controls and equipment. The manufacturer shall provide written verification of current ISO 9001 registration.
Contractors: All Contractors shall be professionally trained and experienced in the installation of water leak detection systems.

Storage and Handling Requirements: Sensors, cable and controllers shall be stored in a clean and dry location prior to installation of the water leak detection system. Take precautions necessary to prevent damage from contact with sharp objects to cables and sensors.

Leak Detection Site Conditions: Floor area in and around the water leak detection floor sensor shall be cleaned, prepped, sealed and painted prior to the installation of the water sensors.

Manufacturer Warranty: Contractor shall provide standard manufacturer's warranty of 24 months from the date of purchase of the leak detection system;
Extended Warranty: Contractor shall submit all system testing records to manufacturer to qualify for manufacturer extended warranty on the following products:

- TT1000 Sensor Cables – 10 years.

Water Sensing Cables and Water Point Sensors.

Type: The water sensing cable for suspended pipe (TT1100-OHP) shall be a four (4) wire design, with two (2) sensing wires, one (1) alarm wire and one (1) continuity wire embedded in a flame retarded polymer carrier rod which can sense the presence of water at any point along its length and shall not detect hydrocarbons. The sensing cable design shall have the ability to provide continuous verification of sensing circuit integrity.

Corrosion Protection: The sensing wires shall be jacketed with a conductive fluoropolymer and shall be constructed with no metal parts exposed to the environment for corrosion resistance.

Absorptive Braiding: Sensing cable shall be supplied with an absorptive synthetic fibre braid that provides extra mechanical protection and designed to wick water along the cable even when the water leak is miniscule.

Tensile Strength: The sensing cable shall have a tensile breaking strength of >220 pounds.

Termination: Water sensing cable shall be pre-terminated and modular for quick connection to cables and leak detection components.

Soldering: Soldering or the use of wire nut shall not be a permitted method to join leak detection cable.

Modular Connections: The sensing cable system shall feature modular branching connectors in order to introduce tee splices into the layout.

Fixing: The sensing cable shall be fastened to the pipe every 18 inches, and shall be positioned at the lowest point of the pipe or fittings (typically the 6 o'clock position on horizontal pipes) such that any liquid leaking from the pipe or fittings will drip onto the cable surface as it drips off the bottom of the pipe or fitting. For vertical or angled pipe, the sensing cable shall be spiralled around the pipe and secured with straps.

Sensor Interface Modules: Contractor shall furnish and install for each leak detection circuit a TRACETEK Sensor Interface Module model.

Fault Monitoring: The sensor interface module shall continuously monitor the sensor cable for continuity faults. The loss of continuity in any of the wires shall result in an LED indication of the trouble condition, and optional actuation of the alarm relay by user.

Accessories: Contractor to provide all TRACETEK brand modular branch connectors, jumper cables and cable connectors for a complete leak detection system.

Suspended Pipes:

- Sensing cable TT1100-OHP which is designed to be attached directly onto pipes either by using nylon tie or Velcro straps and detect a water leak originating from a small pin hole or crack in the pipe;
- Can be added to the system components as described in the above Large Scale System application.

Sumps and Drip Trays:

- Water detection point sensor TT-FLAT-PROBE to detect water in low spots, drip trays or sumps.
- As an alternative, the TT1100-OHP-THIN can be placed inside drip pans.
- TT-FLAT-PROBE can be interconnected with other TT-FLAT-PROBE or cable sensing segments and can be monitored with TT-TS12 or TTSIM alarm module.

Installation: All TRACETEK leak detection system components shall be installed in accordance with the manufacturer's installation instructions, NEC, and local code requirements.

Timing: The sensing cable shall be installed after all piping, air conditioning, raised flooring, and other mechanical work has been completed, and prior to installation of other data or power distribution cabling.

Preparation: The sub floor sensing cable path shall remain clear of water, oil, solder, flux, dirt or other materials that may soil the sensing cable. Contractor shall prepare floor surface for cable installation, install hold down clips for sensing cable, route and fix the sensor cable, route and fix any interconnect accessories such as jumper cable, point probes, branch connectors, leader cables and end terminations.

Location: The sensing cable shall be installed beneath the raised flooring and around the perimeter of all rooms, a maximum of 900 mm from the outside wall. Route the sensing cable a minimum distance of 900 mm beyond the perimeter of all A/C units.

Fixing: The sensing cable should be kept clear of any sharp edges, floor pedestals and uninsulated ground conductors. In addition, lay the cable in a serpentine pattern, on 1.2 m – 2.4 m minimum centres, to protect interior surface areas where water sources are found, such as A/C unit, CPU piping, floor drains, chillers, etc. The sensing cable should be installed under the centre of floor tiles to facilitate access to, and visual location of, leaks. Sensing cable shall be secured to the sub floor with hold-down clips (TT-HDC-1/4) at approximately 1.8 m intervals and at every change in direction.

Positioning: The sensor cable shall be on the bottom layer of all cabling in contact with the slab floor and positioned such that it will be in the path of any water leaking from chilled water supply and return lines, valves and fittings in the chilled water system, leaks from condensate tray overflows in air handlers, and similar source of water in the sub-floor and surrounding wall spaces.

Contractors Responsibilities: The Contractor shall be responsible for providing a clean and functional system. The Contractor shall be responsible for installation of the sensing cable, functional testing, and mapping of the system. Contractor shall supply supervision and training to the end user for the leak detection system.

Graphic Display Map: A graphic display map, prepared from as-built drawings, shall be furnished upon completion. The map shall indicate the location of the sensing cables, landmarks such as equipment, A/C units, walls, floor drains, change of cable direction, and cable distance readings. The map shall be mounted next to the alarm and locating module.

Tests: The system shall be tested in accordance with the manufacturer's recommendations and industry standards.

Commissioining: The system shall be commissioned upon completion of the installation by personnel authorized by the manufacturer in accordance with manufacturer's instructions. At this time demonstration and basic operation shall be provided to the owner.

Maintenance and Service Contractor: At the time of commissioning the system, the system supplier shall provide the Project Manager with the name of an authorised manufacturer's service contractor who can provide preventive maintenance and service contracts for the leak detection system at least once a year, inclusive of removing debris from sensing cables, ensuring the interconnection and integrity of the electronic components in accordance with the manufacturer's recommendations.

SECTION 10 - STORMWATER AND SUBSOIL DRAINAGE

10.1 GENERAL

The work under this part comprises the complete supply and installation of the suspended and inground drainage from the building to the OSD / Rainwater tank (under the Civil Engineer's scope of work). The scope of work also includes subsoil drainage below the building to a point outside the building for continuation under the Civil Engineer's scope of work.

Allow for supply and fixing of all bends, tees, junctions, roof outlets, piping and sundry equipment necessary to complete the installation as shown on the drawings and specified.

10.2 PIPE MATERIAL SCHEDULE

Pipes and fittings shall be in materials as follows:

SERVICE	PIPE DIAMETER IN mm	PIPE MATERIAL
Concealed downpipes, elevated drainage	100-375	Sewer Grade HDPE pipe and fittings all jointed with electrofusion socket fittings HDPE
In-ground drainage	100 - 225	uPVC (DWV). Solvent welded
In-ground drainage	300 - 450	Class 2 Fibre Reinforced Concrete, with rubber ring joints
Stormwater Rising Mains	50 -150	HDPE Pressure Pipe

10.3 RAINWATER OUTLETS

Refer to Downpipe Section.

10.4 SUBSOIL DRAINAGE

Shall be 100mm slotted uPVC pipework wrapped in cloth sock. Pipework is to be surrounded by 150mm thickness of 10mm and 20mm blue metal or reconstituted concrete. The blue metal surround is to be surrounded further by geotextile fabric.

10.5 STORMWATER PITS

Stormwater pits 600mm x 600mm and larger, shall be precast concrete unless noted otherwise on the Drawings. Provide extension risers to standard depth pits to meet finished surface level.

Pit bases shall be cast in situ or prefabricated. Provide benching in the base of the pit with fall towards the outlet (unless sediment traps are specified). Provide core holes in the sides of the pit as required for inlet and outlet pipes.

The finish of exposed surfaces shall be smooth, seamless, equal to steel trowelled render or concrete cast in steel forms. Cove or splay internal corners.

Stormwater pits 300mm x 300mm and 450mm x 450mm shall be ACO Polycrete pre-cast FRC pits.

10.5.1 Sediment Traps

Stormwater pits are to incorporate a 150mm deep sediment trap with weepholes in the base of the pit. The pit is to be located on a bed of blue metal or reconstituted concrete with geotextile filter fabric immediately below the base of the pit.

10.5.2 Access Ladders

Provide ladders to pits deeper than one metre, cast or built into the pit walls clear of pipework. Ladders will be installed to comply with AS 1657, stile type to Clause 5.7 or individual rung type to Clause 5.8, as applicable.

Rungs shall be mild steel rod, galvanised to AS 1650, 450mm wide or a plastic rung to AS 1657 available from ICON Industries. Rungs shall be spaced at 300mm maximum centres, 250mm minimum centres, with bottom rung not more than 450mm from the floor and top rung not more than 450mm below surface level.

10.5.3 Covers

Covers are to be filled with the same materials as used for the surrounding surface and shall incorporate removable lifting hole plugs. Covers and frames shall be cast iron with concrete infill.

Covers and frames located internally, in aesthetically important areas or as nominated on the Drawings shall incorporate a set-down with brass or stainless steel edge trim to allow paving or other floor finishes to be carried through the cover.

Cover sizes and duties shall be as required to comply with the maximum loading anticipated for its location in accordance with Australian Standards. Duties indicated on the Drawings to be used as a guide only. Obtain from the manufacturer a certificate stating the suitability over the cover and frame for its location and use in accordance with the standards.

Rebate the top of the pit walls to suit the cover frame or provide a precast rebated surround, and grout the frame into the rebate with infill concrete.

The reduced levels provided on the Drawings are indicative of the proposed finished surface levels of the pits. Top of cover levels in paved areas (including any paving infill) shall finish flush with the surrounding paving levels. In grassed areas, the top of the covers shall finish 25mm above surrounding finished surface levels.

10.5.4 Grates

Grate sizes and duties shall be as required to comply with the maximum loading anticipated for its location in accordance with Australian Standards. Duties indicated on the Drawings to be used as a guide only. Obtain from the manufacturer a certificate stating the suitability over the cover and frame for its location and use in accordance with the standards. Rebate the top of the pit walls to suit the grate frame or provide a precast rebated surround, and grout the frame into the rebate with infill concrete.

Grates shall be galvanised mild steel with hinges to allow easy access and maintenance.

10.6 LONGITUDINAL TRENCH GRATES (LTG)

Provide longitudinal trench grates where indicated on the Drawings. The duty of the grates and frames shall be selected to suit the application.

10.6.1 Samples

Provide samples of all trench grates to the Project Manager for approval. Obtain approval from the Project Manager prior to installation of any trench grates.

10.7 DRAINAGE TURN-UPS (DTU)

Provide drainage turn-ups where indicated on the Drawings. Drainage turn-ups inside voids, trench grates and elsewhere shall have open pipe ends (collars) with loose fitting uPVC grates.

10.8 REFLUX VALVES (RV)

Provide reflux valves where indicated on the Drawings and as required to protect sensitive areas from surcharge of stormwater.

Reflux valves shall be uPVC swing check type valves approved for stormwater applications. They shall be provided with riser pipe and clear out to surface to allow maintenance and removal of the swing check.

10.9 TEMPORARY CONSTRUCTION DEWATERING

Refer to Civil Engineer's documentation for requirements.

10.10 TEMPORARY STORMWATER DRAINAGE

Allow to Provide temporary stormwater drainage systems / connections during the construction process to allow ensure the site is adequately protected against rainfall events during construction. The temporary drainage may be required to be modified during various stages of the construction work.

Liaise with the Builder to confirm which areas of the site need to be protected by installation of temporary stormwater drainage.

SECTION 11 - WATER SERVICES

11.1 EXTENT OF WORK

The work specified in this section comprises the complete installation/workshop drawings supply, installation, testing and commissioning of:

- Potable water services
- Potable hot water services.
- Warm water services.
- Rainwater reuse service

11.2 WATER SERVICE CONNECTION TO SITE

Connect to the existing water service on site and reticulate to the cold water tank/pumproom.

11.3 PIPE MATERIAL SCHEDULE

Pipes and fittings shall be in materials as follows:-

SERVICE	PIPE DIAMETER in mm	PIPE MATERIAL
Potable Cold Water Service.	As indicated on the drawings	**Large Watermains Underground** - PE pipe with blue stripe PN 16 with electrofusion socket type fittings. Provide coloured detectable marker tape over, with words Potable Cold Water Service. Tape to have copper wire bound within. **Small Water Services Underground** - Type "B" copper tube, silver brazed joints with pipework to be within blue poly bag. **Above Ground** - Type "B" copper tube, silver brazed joints or stainless steel with press fittings
Potable Cold Water Service. (upstream of isolation valves to apartments or public accessible fixtures)	25 – 100	
Potable Cold and Hot Water Service (downstream of group isolation valves)	15-25	Rehau cross linked polyethylene pipe with non-metallic fittings.
Fire Hose Reel Service	25-40	Type "B" copper tube, silver brazed joints or stainless steel with press fittings
Potable Hot Water Service – Flow and Return (upstream of group isolation valves)	15 - 100	Table B Copper Pipe. Insulate all hot water pipes where not within walls with 30mm thermotec 4 Zero sectional insulation.
Potable Cold, Hot and Warm Water Service Branches in Masonry Walls	15 - 25	Green plastic covered Kemlag Copper Pipe.
Potable cold, hot, warm water service branches in dry walls	16-25	Rehau cross linked polyethylene pipe with non-metallic fittings.

SERVICE	PIPE DIAMETER in mm	PIPE MATERIAL
Pipes Under Concrete Floor	15 - 25	Rehau PE-X within 100 diameter uPVC conduit.
Exposed Water Pipes	15 - 25	Chrome plated copper tube and fittings.
Rainwater Reuse Cold Water Service	20 – 100	PE pipe with blue stripe PN 16 with electrofusion socket type fittings. Provide coloured detectable marker tape over, with words Potable Cold Water Service. Tape to have copper wire bound within.

Bolts and nuts used underground and above ground shall be 316 grade stainless steel.

Flanges required underground shall be 316 grade stainless steel.

Metal backing flanges behind polyethylene electrofusion stub flanges required underground shall be 316 grade stainless steel.

11.4 POLYETHYLENE PIPE AND FITTINGS (PE)

Polyethylene pipework and fittings shall be PE100, SDR11 equal to Georg Fischer with "blue stripe". Jointing for all PE Pipe and fittings shall be via electrofusion joints.

11.5 CROSS LINKED HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS (PE-X)

Requirements: Cross linked polyethylene pipe and fittings (PE-X) for cold water, hot water, warm water, rainwater reuse and recycled water systems, shall be first quality and in accordance with AS 2492.

Water Services Pipes:	PN 20 complying with AS 3500.1 PE-X pipes shall be one pipe size larger than the equivalent copper pipe size if nominated as per AS3500 requirement. **The current design for the internal layouts and other fixture branch piping has been sized for Rehau and not copper.**
Fittings:	Rehau plastic fitting range and fittings manufactured of Brass which are Dezincification Resistant to AS 3688.
Jointing Method:	As per manufacturer's instructions.
Prohibited Areas of installation:	Cross Linked Polyethylene will not be used in areas as specified in AS 3500.1
Colour of Pipes:	Cold drinking water - silver Hot and warm drinking water - Red Rainwater reuse - green Recycled water - purple

11.6 FILTERS

Supply and install filters as nominated in the below table

APPLICATION	NOMINATED PRODUCT
Rainwater Reuse – Automatic Backwash Filters	Make : Judo Model : JPF 40mm Flow Rate : 1.5 L/s Number of : Two Location : Level 00 Hydraulic Plant Room Power Supply : 240V 10A (Double GPO)
Rainwater Reuse – Bag Filters.	Make : Southland Filtration Model : SLB-SS-02 Flow Rate : 1.5 L/s Number of : One Location : Level 00 Hydraulic Plant Room
Rainwater Reuse – UV Filters.	Make : Southland Filtration - Viqua Model : K (660001-R, 660004-R) Flow Rate : 1.5 L/s Number of : One Location : Level 00 Hydraulic Plant Room Power Supply : 240V 10A (Double GPO)

11.7 ADJUSTABLE PRESSURE REDUCING VALVES

Adjustable pressure reducing valves shall be installed where required as follows:

- Caleffi 535 series, bronze, spring adjustable pressure reducing valve. Set outlet water pressure to 500kPa.
- Screwed 20 to 50mm.
- 25mm to 40mm diameter main cold and hot water valves, Caleffi 535 series, bronze, spring adjustable pressure reducing valve. Set outlet water pressure to 500kPa.
- 15mm diameter cold water pressure reducing valve, Caleffi Code 533545 with outlet pressure set to 500kPa.
- Bronze flanged when larger then 50mm.
- Provide screwed bronze union each side of screwed pressure reducing valves.

11.8 BACKFLOW PREVENTION DEVICES/ REDUCED PRESSURE ZONE DEVICE

Supply and install backflow prevention devices to all water supplies serving fixtures with possible cross connection hazard, to conform with AS 3500.1 Section 4 and AS 2845 parts 1 to 3.

Provide details of all cross-connections and devices and register with the Water Authority.

11.9 DOUBLE CHECK DETECTOR VALVES

Provide in location shown on the drawings Tyco Double detector Check valves complete with isolating valves and strainers, metered by-pass as approved to as 2845.1 and AS3500. The valves shall be of the size and capacity indicated on the drawings.

11.10 DOUBLE CHECK VALVES

Provide in locations shown on the drawings Tyco DC03 Double Check valves complete with isolating valves and strainers as approved to as 2845.1. The valves shall be of the size and capacity indicated on the drawings.

11.11 REDUCED PRESSURE ZONE DEVICE

Provide Reduced Pressure Zone devices to the size and location shown on the drawings.

Reduced Pressure Zone Devices shall be ValvCheQ RP03 or equal.

11.12 COLD WATER BOOSTER PUMPS

Provide domestic cold water vertical Multistage centrifugal variable speed pressure pump sets, equal to:
Make : Grundfos
Model : 2CRE5-9, Vertically Mounted
Flow Rate : 3.5 L/s
Duty : 500 kPa
Number of : Two
Location : Level 00 Hydraulic Plant Room
Power Supply : 415V 3 Phase 2.2 kW (Hard Wired to Control Panel)
Complete with the following;

- Variable Speed Drive Controls
- MBS Pressure Transducer
- 316SS Manifolds
- Watermarked valves and fittings
- 24 litre Pressure vessel
- All 16 Bar Rated
- Distribution Board complete with Mains Isolator ,Circuit breaker per pump, Surge protection to suit number the number of pumps, 4 x terminals per pump, earth bar, IP55 powder Coated enclosure
- All mounted on a common Stainless Steel Baseplate

The complete pressure set inclusive of pumps, pipe work, fittings and control panel shall be manufactured on a common base plate by the pump manufacturer and complete with a 2 year warranty.

11.13 COLD WATER STORAGE TANK

Provide a new cold water storage tank as follows:
Make : Aline
Model : Mega Nominal 6,000L Panel Tank
Dimensions : 2.2m Wide x 2.2m Long x 1.9m High. To include 50% internal partition
Type : Metal Panel including internal liner
Number of : One
Location : Level 00 Hydraulic Plant Room

Complete with:

- Inlet valves and inlet boxes
- Divisional wall across width
- outlet connection
- overflow lines
- sludge outlets
- External and internal stainless steel access ladders
- Internal Stainless steel partition
- Water level controls for each section of the tank
- Roof and access hatch and access platforms to suit authority requirements
- External Visual Water level indicators dual for tank with internal partition

- Provision and fixing of signs on the water storage tanks

11.14 COLD WATER STORAGE TANK WATER LEVEL ALARMS

Provide a system of water level alarms to the Domestic Water storage tank to automatically activate alarm circuitry in the event of high or low level water. The water levels shall be monitored and controlled by a multi-trode liquid sensing system.

- Activate High Level Alarm – at same level as overflow
- Activate Low Level Alarm – 250 from bottom.

The system shall be installed in accordance with the manufacturer's instructions.
Provide a clean set of contacts to indicate the above fault functions for security monitoring
A 240volt power supply shall be provided by the electrical contractor.

11.15 WATER METERS

Provide cold water sub- meters in accordance with Greenstar Requirements, where shown on the drawings and as follows:

- Cold water supply to domestic hot water plant
- Cold water supply to each level
- Hot water supply to each level
- Cold water supply to rainwater tank
- Any other significant water demands.

Cold water meters shall be equal to Elster, complete with pulse output and connected to the BMCS.

11.16 RAINWATER REUSE WATER BOOSTER PUMPS

Provide rainwater reuse pressure pump sets, equal to:
Make : Grundfos
Model : SP27-12, Submersible, Vertically Mounted
Flow Rate : 1.5 L/s
Duty : 500 kPa
Number of : Two
Location : Rainwater Tank (External)
Power Supply : 415V 3 Phase 2.2 kW (Hard Wired to Control Panel)
Complete with the following;

- MBS Pressure Transducer
- Watermarked valves and fittings
- Distribution Board complete with Mains Isolator ,Circuit breaker per pump, Surge protection to suit number the number of pumps, 4 x terminals per pump, earth bar, IP55 powder Coated enclosure
- All mounted on a common Stainless Steel Baseplate
- Connection to the existing BMCS system

System is to include a potable water changeover to enable water supply from potable water supply should rainwater tank be empty.

11.17 RAINWATER STORAGE TANK

The rainwater storage tank is documented as part of the Civil Engineer's package.

11.18 RAINWATER REUSE COLD WATER STORAGE TANK WATER LEVEL ALARMS

Provide a system of water level alarms to the Domestic Water storage tank to automatically activate alarm circuitry in the event of high or low level water. The water levels shall be monitored and controlled by a multi-trode liquid sensing system.

- Activate High Level Alarm – at same level as overflow
- Activate potable water changeover system – 150 from bottom.

The system shall be installed in accordance with the manufacturer's instructions.
Provide a clean set of contacts to indicate the above fault functions for security monitoring
A 240volt power supply shall be provided by the electrical contractor.

11.19 FIRST FLUSH DEVICE

Provide 300mm diameter first flush devices on the inlets to the rainwater reuse tank. First flush device shall include ball float valve and bleed tube discharging to stormwater system.

11.20 HOT WATER HEATERS

Supply and install a dedicated centralised heavy duty electric / solar hot water plant commprising of the following:
Type : Heavy Duty Electric Storage with 50% Solar Pre-Heat
Make : Rheem
Model : 3 x Model 6163507 HD Electric Heaters (6 x 3.6 kW). 4 x 610430 Solar Storage Units &14 x Rheem NPT200 Solar Collectors
First Hour Delivery : 2,060 Litres
Number of : 3 x Electric Storage Heating Units, 4 x Solar Storage Units and 14 x Solar Collectors
Location : Level 04 Plant Room and Roof
Power Supply : 415V 3 Phase (64.8 kW Total) Include for complete installation and commissioning.

The system shall be complete with box, cover, valve cover, valves, wiring, primary circulators, and all accessories to complete the installation, as required in accordance with the Manufacturer's instructions and to the approval of the Principal.

11.21 HOT WATER CIRCULATION PUMP SET

Provide a dual hot water circulator pumpset as follows:
Make : Grundfos
Model : CM3-2
Flow Rate : 0.8 L/s
Duty : 9m Head
Number of : Two
Location : Level 04 Plant Room
Power Supply : 240V 10A (Double GPO)
Including the following:

- The pumps shall have stainless steel wetted parts pump and manifolds, normal flows.
- The pumps shall be certified for potable water use to AS 4020.
- The complete system shall be mounted on a hot dipped galvanised steel folded base frame with two 12 mm holes on the each side for easy mounting on the wall.
- The complete system should be supplied by the pump manufacturer and tested in their test facilities.
- The complete system shall have a certificate of manufacture from the pump manufacturer.
- The system will include non-return valves and shut off vales integrated into a manifold arrangement to allow removal of one pump whilst the other is in operation.

- The manifold construction shall in compliance with Australian standards for welding, surface preparation, surface finish, and wall thickness.
- The minimum compliance shall be:-
    - Finish (Hot Dip Galvanizing): AS 4680
    - Structural Steel Welding: AS 1554
    - Pipework Material Grade: ASTM A312 316L (minimum) Or copper
    - Welding: AS 4041-1998
    - Welding Surface Finish: AS 1554.6-1994 Grade II (a) & (b)
    - Threads (Sealing): AS 1722.1-1975

All Electrical controls shall be Schneider brand (readily available) and have an electrical test certificate and wiring diagram inserted on the inside of the control panel door.

Plastic control panels are not acceptable.

11.21.1 Hot Water Circulating Pumps Control Panel

Pump Controller shall single phase 18amp, contactor, overload to suit pumps, complete with following:

- Powder Coated Metal Enclosure, Wall Mount, IP65 with Inner Door
- Main Isolator Switch
- Individual Pump Isolation
- Contactors and Thermal Overloads for Control and Protection of Pump

Motors shall be as follows:

- Circuit Breaker protected Control Circuit
- Low Voltage Control and input Circuitry
- Auto/Off/Manual Operation of Both Pumps
- LED Indicator Lights for System Status indication
- Visual and Audible Alarms c/w Mute Switch, mounted on inner door
- Seven Day digital time clock for pump run time control
- Input for thermostat for pump run control
- Configured for time based duty alternation

The Control panel is to have auto change over on pumps duty on a time run basis every twelve hours.

The time clock shall be also available time turn off the pumps at night and on again in the morning time to be determined on site, to enable energy savings.

The control panel shall have Pump 1 and Pump 2 auto / off /manual switches on the front panel (optional lockable switches). It should also include red for fault / green for run indicator lights on the front panel. Panel shall be lockable.

Allow 2 volt free run / alarm out puts points on a marked terminal strip for the BMCS.

11.22 THERMOSTATIC MIXING VALVES / VALVE CONTROL GROUPS (TMV/VCG)

Thermostatic mixing valves shall be:
Make : Enware
Model : Aquablend1500 in recessed lockable S/S box
Flow Rate : 28 L/min

Number of : Refer to Plans
Location : Amenity Areas behind mirrors generally. Refer to Plans

11.23 FLEXIBLE BRAIDED WATER CONNECTIONS

Braided connection (Plumb-easy or similar) shall not be used in hot water installations, service ducts or plantrooms. They may be used in ablution areas where 100mm floor wastes are provided and, if they fail, no real damage is caused. Where they are used they shall be of the correct type to prevent straining, kinking or twisting or stresses on the connections. They shall be correct length to match the installation requirements.

11.24 WATER CONNECTIONS TO BASINS

Provide and install 15mm BSP brass male thread at the wall for both cold and hot water points. Supply and install 15mm mini ball valves to all water outlets.

Provide and install chromium plated cover plate at wall for cold and hot water points.

Provide and install approved stainless steel braided flexible connector, "Aquaconnect" or equal.

Cold and hot water connections to wall basins shall be carried out with annealed, 15mm diameter, chromium plated Type B copper tube. Join the tube to fitting threads at the wall and at the tap sets complete with chromium plated brass Kinco nuts and formed Kinco Knurl ("olives" connection shall not be used)

11.25 TRAP PRIMERS

Provide pressure differential trap primers only if there is no other way of charging the floor waste. Trap primers shall be equal to Precision Plumbing Products Trap Primer Valve

11.26 COVER PLATES

Provide cover plates to all water services connection where horizontal connections are made at wall and cupboard surfaces.

Cover plates are to be a close fit around the pipe of which they surround, and close against the wall or floor and be chrome plated.

11.27 INSULATION OF HOT, WARM, AND COLD WATER PIPES

Insulate pipe works generally as detailed hereunder.

All hot water piping located externally, concealed in ducts and ceilings spaces shall be insulated with 25mm thick Thermotec 4 Zero type sectional lagging incorporating aluminium foil wrap and overlap secured as below and to approval.

Hot and cold water pipework, located externally and exposed (e.g. surface mounted pipework serving the decontamination showers) shall also be insulated with 25mm thick Thermotec 4 Zero, as nominated above.

All cold water, hot water and warm water piping concealed in brickwork and or blockwork shall be insulated with expanded vinyl equal to "Kembla" Prelag. Over wrap all joints to approval.

Prior to application of insulation materials, all surfaces shall be thoroughly cleaned to remove scale, grease, oil, dirt and any other foreign matter, and where subject to condensation shall be protected against corrosion. All insulation material shall be of best quality in their respective types.

Irrespective of the method of attachment, all insulating materials shall be in close contact with the surfaces to which they are applied. Where performed sectional insulation is used, the edges and ends of sections shall be arranged to butt up close to one another over the whole insulated surface.

Edges or ends of section shall be cut or shaped at site where necessary.

Pre-formed sections shall be complete with a sisal covering connected to the entire external surface.

The covering shall be installed to provide a lap of not less than 25mm at all longitudinal and circumferential joints. The insulation thus applied shall be further secured with bands of noncorrosive metal. Metal bands shall be not less than 19mm wide, installed generally on 450mm centres and at all points where insulation has been cut or shaped.

At flanges, valves and other similar connections, the insulation shall be bevelled and cut back to provide adequate access to bolts and fittings. Valves, flanges and unions, are not required to be insulated.

No insulation shall be applied prior to pressure testing of the respective parts of the installation. Insulation shall be applied in an approved manner.

Approved wood blocks, the same external diameter as the insulation material shall be provided at all bracket points. The blocks shall be in two halves and shall be a minimum of 25mm wide.

11.28 HOSE TAPS

Provide and install Type B copper tube extended to hose tap points.

Depth of pipe work shall be 300mm minimum below finished levels.

Hose taps shall be Cimberio lever handle hose taps Code CIM 34 available from All Valve Industries Tel 9558 9911.

Each hose tap shall be complete with a Watts 8A vacuum breaker.

Support each hose tap standpipe by securing brass back plate elbow to 100 x 50mm treated pine post concreted (minimum 150mm concrete base and surround) into the ground behind each hose tap.

Secure each back plate elbow to post with three (3) round head stainless steel screws, 25mm in length.

Supply and fix with stainless steel screws adjacent to recycled water hose taps, an approved sign with the words "Not Suitable For Drinking" and in accordance with Authorities requirements.

Where hose taps are shown on the drawings to be fixed to external walls, provide brass back plate elbow and secure with three (3) stainless steel screws into expansion fastenings.

11.29 VALVES IN COLD, PIPE SYSTEMS

All valves shall be "Standards Mark" certified to the relevant Australian Standard.

All valves installed in hot water or heating water systems shall be bronze for all pipe sizes.

Valves up to and including 80mm diameter shall be all bronze. Valves 150mm or over may be cast iron with bronze trim, excepting when installed in hot water or heating water pipelines, in which case they shall be 100% bronze or stainless steel.

Valves to pump connections, main branch lines and outlet positions shall be butterfly type.

Valves shall be tested to a pressure of 2,100 kPa by an approved testing Authority.

A. FLANGED VALVES: Valves 55mm and over shall be flanged. All other valves shall be screwed complete with union connection located on the outlet side of the valve.

B. BALANCING VALVES shall be "Tour and Anderson" manufacture "STAD" type screwed up to 50mm in diameter and "STAF" type flanged 55mm and larger diameter.

Above ground valves shall be complete with hand wheel unless they are lever operated ball valves or butterfly valves.

C. BRONZE SCREWED BALL VALVES: Valves 10mm up to and including 50mm shall be either: Pegler Beacon Australia Fig No. 350G, 350DR, 353DK.

All Valve Industries CIMBERIO Fig No. 11-CR 10mm to 50mm.

Austral Engineering ISIS DZR 10mm to 80mm.

Valves to be brass construction approved for use with hot and cold water supply systems.

D. BUTTERFLY VALVES shall be either:

All Valve Industries Keystone cast iron butterfly valves, wafer style to suit Table "E" flanges.

Austral Engineering Valve Butterfly Valves Fig 725 Wafer Style or 755 Lugged design, working pressure 15 bar, AS 2129 Table E, disc, 315 stainless steel, one piece shaft, square disc drive with no locating bolts on taper pins. Components of these valves shall be manufactured from the following materials:

Body - Cast Iron

Shaft - Chrome and stainless steel

Disc - Cupro - Aluminium

Liner - E.P.D.M.

E. BRONZE SCREWED GATE VALVES: Bronze screwed gate valves for valves up to 50mm in diameter shall be either:

Pegler Beacon Australia Fig No. 1070M DZR brass gate valves, 10mm to 100mm screwed.

Austral Engineering Toyo tested AS 1528-1999 Gate and Check valves, 15mm to 100mm screwed.

F. BRONZE FLANGED GATE VALVES: Bronze flanged gate valves for valves from 65mm to 100mm in diameter shall be either:

Pegler Beacon Australia Fig No. 1035E.

Austral Engineering Braemar Fig No. T60M

G. GLOBE VALVES: Bronze screwed globe valves for valves up to 50mm in diameter shall be either:

Pegler Beacon Australia Fig No. 5, GL-5BSP

Austral Engineering Fig No. RHB-3 screwed bronze globe valves 10mm to 50mm.

H. CAST IRON FLANGED GATE VALVES: Cast iron flanged gate valves for 100mm diameter and above shall be local water authority approved.

I. UNDERGROUND VALVES: 100 diameter and above shall be local Water Authority approved "Sluice

Valves" to AS 2638 Class 21, flanged Table F. Provide 150mm diameter uPVC pipe as riser to ground surface with hinged cast iron (SV) path box and concrete surround.

J. CHECK VALVES: Bronze screwed swing check valves for valve up to 40mm in diameter shall be either:

All Valve Industries 15mm to 80mm

Austral Engineering Fig No. C236A 15mm to 80mm screwed.

Check valves on outlet connections to all pumps to be "Mission Duo" check II. Water check: Valves style C, Fig G, 15 BMF, Bronze Alloy 952 body with Vulcanized Buna 'N' seal.

Bronze flanged wafer check valves for valves 50mm and above shall be Austral Engineering Fig No. 301E 50mm to 300mm.

With the exception of loose jumper type valves, spindles shall be non-rising type and must not project into the bore of the valve when the valve is in the fully open position. The bore shall be clear and unobstructed when in this position.

Underground loose jumper type valves shall be path taps, which shall have the bonnet locked into position with the valve body with a bronze set screw. Provide 100 diameter uPVC pipe as riser to ground surface with hinged cast iron (W) path box and concrete surround.

Prior to practical completion provide to the Contractor, valve keys, suitable for each kind of valve spindle head installed underground inside valve surface boxes.

Each valve key shall consist of a socket suitable to fit over the spindle head, a length of steel rod or pipe and Tee handle.

Valve keys shall be hot dip galvanised.

The internal seats and washers of the valves must be cleaned of all foreign material during installation. Any valve faces or seats found damaged on completion of the installation shall be replaced.

11.30 FLANGES AND UNIONS IN PIPE LINES

Disconnecting unions shall be utilized to connect pipework up to 50mm diameter and flanges are to be utilized to connect pipework (50mm diameter and larger) to items of valves, plant and equipment, so all plant and valves can be easily removed and maintained.

Flanges shall confirm with AS 2129. Use brass or bronze brazing flanges for copper tubing. All flanges provided as mating flanges to valves where water pressure exceeds 1000 kPa shall be Table E.

Cop-A-Mate flanges with loose painted steel flanged backing ring are not considered to be equal to bronze brazing flanges and will not be accepted for this project.

11.31 RESSURE GAUGES

Gauges shall be K.D.G. type except where otherwise noted on the drawings. The faces on the gauges shall be 100 mm diameter. Gauges shall be graduated in metres head and kilo Pascal.

Gauges shall register one-third kPa more than the maximum possible pressure obtainable from the system served.

Each gauge shall be complete with bronze ball valve and sufficient copper piping for connection to the pipe work.

Allow the project manager and CCLHD the opportunity to witness the working pressure during the commissioning of the hot and cold water services.

11.32 STRAINERS

Strainers shall be RMC LS50, LS75 or LSI 00 with 60mm stainless steel gauze.

Plantrooms: Strainers shall be 'Spirax Sarco' bronze bodied on all lines up to and including 50mm and Cast Iron above 50mm with easily removed perforated stainless steel strainer having perforations 0.4mm maximum.

11.33 PATH BOXES

Valves located below ground shall be supplied with cast iron path boxes complete with hinged lid to allow for later access and clearly marked for their respective service type complete with 150mm PVC riser conduit from valve spindle and bedded in minimum 150mm concrete base and surround to finish flush with finished ground or paving level. Maintain 75mm minimum clearance between the top of the valve spindle and the underside of the lid of the box.

11.34 STERILISATION OF WATER SERVICES

Disinfect pipe work installation in accordance with AS 3500 before practical completion. All storage tanks and pipelines shall be flushed clean then with disinfectant using 50mg of chlorine per litre of water. The system should remain charged for a period of at least three days, checked and adjusted for free residual chorine and flushed out thoroughly with clean water before being used. Repeat procedure where necessary.

11.35 CLEANING AND TESTING OF PIPEWORK

All cleaning and testing of pipework shall be carried out as early as possible after testing of each section of the piping and before any points are concealed, ceilings installed, or finishing trades have commenced their work.

All services pipework shall be thoroughly washed out and the system operated with a full flow of water until all foreign matter is removed. Temporary conditions to supply and drain shall be carried out as required and all equipment shall be bypassed during the cleaning and testing period.

Hydraulically to 2100kPa and potable water, rainwater reuse pipework shall be tested hydraulically to 1400 kPa. Maintain test pressure for minimum period of eight (8) hours.

11.36 TESTING OF PIPEWORK SYSTEM

On completion, all pipework shall be subject to a pressure test of 2,100 kPa for a period of twenty four (24) hours. Any defects found in the system shall be remedied and the test reapplied. Disconnect pipes from mechanical and hydraulic equipment prior to testing and reconnect on completion.

SECTION 12 - FIRE SERVICES CONNECTIONS

12.1 GENERAL

The fire services connection scope of work includes the following:

- Connecting to the existing fire hydrant service on site.
- Update the existing Fire hydrant Block Plan.

12.2 FIRE SERVICES PIPEWORK

SERVICE	PIPE MATERIAL	JOINTING
In- ground fire hydrant pipework.	PE100 SDR11 Pipe PN16 with red stripe pressure pipe in straight lengths with electrofusion coupling fittings. Provide marker tape over with "Fire Main". Fire hydrant services tape to have copper wire bound within for detection.	Electrofusion coupling fittings. Connect polyethylene pipe to galvanised mild steel pipe with 316 grade stainless steel table "E" flange and 316 grade stainless steel bolts and nuts.
Fire systems aerially within building, and fire hydrant standpipes externally.	Hot dipped galvanized medium steel fire hydrant pipe and fittings. Hot dipped galvanising to comply with AS 4792 with coating mass of 300 grams per square metre average both sides as a minimum. These pipes shall not be installed in ground. All pipe fittings and joints shall be suitable for boosted pressure up to 1700 kPa and shall be UL and FM approved galvanized steel, Code 1GS fittings and couplings pressure rated to 2100 kPa.	Joints shall be hot dipped galvanized steel roll grooved joints and couplings with synthetic gaskets UL and FM approved.

Bolts and nuts used underground and above ground shall be 316 grade stainless steel.

Flanges required underground shall be 316 grade stainless steel.

Metal backing flanges behind polyethylene electrofusion stub flanges required underground shall be 316 grade stainless steel.

12.3 PIPE SIZES

The pipe sizes nominated on the Drawings are nominal pipe sizes and represent minimum internal bore sizes for PE pipework. This may require larger PE pipework to be installed to achieve equivalent sizes and performance.

12.4 PIPE SUPPORTS

Pipe Supports for the Fire Hydrant Service are to comply with the requirements of AS 2419.1. Particular attention is drawn to the requirement for Fire Rating of Pipework Supports in a building not protected by sprinklers or located within a fire rated passage / stair.

12.5 PIPE PENETRATIONS

Sleeves shall be provided at all pipe penetrations. Where pipework passes through walls, galvanised steel sleeves of 1.6mm minimum thickness shall be installed. Where pipework penetrates floor slabs, galvanised steel sleeves shall be installed which extent at least 100mm above the floor.

Where acoustic seals are required or necessary, the space between the pipe and the wall or floor sleeve shall be filled with high-density mineral wool or fibreglass insulation as an acoustic seal. The acoustic rating of the seal shall be equivalent to the partition through which the pipe passes or to achieve the noise level required in the quieter area.
Where pipes pass through firewalls or floors, all sleeves shall be removed and the space between the piping and the building structure shall be sealed with fire resistance seal of rating equal to that of the structure as approved by all local Authorities.

12.6 WARNING TAPE

During the installation of the below ground fire hydrant pipework, allow to supply and install plastic warning tape for the full length of underground pipework.

The warning tape shall indicate that a fire hydrant pipe exists below the tape.

The tape shall be installed 150mm above the fire hydrant pipe.

12.7 TRACE WIRE

During the installation of the fire hydrant pipework, provide a trace wire to allow for future location of the fire hydrant service.

The trace wire system shall be intact for the full length of the fire hydrant service.

Provide terminal/connection points at each fire hydrant.

On completion of the fire hydrant service, the trace wire system shall be tested for integrity. Any faults shall be located and repaired.

12.8 THRUST BLOCKS

Where required shall be mass concrete of sizes and locations as recommended by the manufacturer and are to comply with the requirements of AS2419.1.

12.9 BELOW GROUND CONTROL VALVES

Control valves installed below ground must:

- Be key-operated sluice valves complying with AS2638
- Have a concrete surround at the surface with a cast iron valve box, with 150mm PVC-U riser from spindle to underside of valve box.
- Valves shall be clearly identified with a tag showing the valve number on the Block Plan

12.10 ABOVE GROUND CONTROL VALVES

Control valves installed above ground shall:

- Be full-flow outside screw and yoke wheel gate valve complying with AS3579

  or
- Be approved butterfly valve closed by rotating the wheel clockwise
- Be secured in the open position by means of a strap and approved lock

- Have affixed to the valve body or strap a plate inscribed with the works "FIRE MAIN VALVE - SECURE OPEN" in uppercase letters not less than 8mm high
- Be of the indicating type
- Be monitored by a supervisory circuit connected to an alarm panel. All in accordance with AS4118.1.4
- Be clearly identified with a tag showing the valve number on the Block Plan

Note: wedge type valves are not permitted.

12.11 PAINTING

Paint and rust proof all exposed pipework and equipment.
Authority requirements.

12.12 FIRE HYDRANT BOOSTER VALVE ASSEMBLY

The system has an existing fire hydrant booster valve assembly.

12.12.1 Block Plan

A block plan is to be provided on the internal door of the hydrant booster cupboard/cabinet updated to include the existing and new works for the site.

12.12.2 Notice of Test and Boost Pressure

Permanent signage with lettering no less than 25mm in height shall be fixed within the booster valve assembly stating the Test Pressure and Boost Pressure of the system in accordance with AS 2419.1.

12.13 FIRE HYDRANT SYSTEM BLOCK PLAN

Provide Fire Hydrant System Block Plans of the site on a minimum A3 size drawing. Copies of the Block Plan are to be located in the fire hydrant booster cabinet, fire pump room, Fire Control Room or Centre (where provided) and elsewhere as nominated by the Fire Authority.

12.13.1 Material and Fixing

The block plan shall be in the form of a permanent diagram that is laser etched onto a non-ferrous metallic sheet and screw fixed to the Booster Cabinet or as otherwise directed by the Fire Authority.

12.13.2 Contents of Drawing

The block plan shall be a simplistic drawing in accordance with AS2419.1 showing the full site, adjacent streets, outline of the buildings on the site and shall include as a minimum the following:

- Location of the site and adjacent streets.
- Location of all fire hydrants on the site (in plan form for low rise developments and in elevation for highrise developments).
- Location of the fire hydrant booster valve assembly and fire sprinkler booster valve assembly where installed.
- Location and size of the watermains and street hydrants in the public way (dimensioned).
- Location and sizes of all fire hydrant pipework in schematic form.
- Location and duty of the fire hydrant pumpset (where installed)
- Location and size of water storage tanks (where installed)
- Location and reference number of isolating and non-return valves.

- Any connections to other installed fire protection systems.
- A legend.
- Location of the main electrical switchroom.
- Location of LPG tanks and gas supply shutdown valves.
- Location of flammable storage areas.
- The name of the contractor installing the system.
- The year of the installation
- The height of the highest hydrant valve above the booster assembly.
- The operational design and test flow and pressure.
- Commissioning test flow and pressure

12.13.3 Existing Fire Hydrant Service

Where the installation involves connection to an existing fire hydrant service, the Block Plan is to include all existing fire hydrant system information as noted above, combined with the proposed additions and extensions related to the work being undertaken.

Where an existing fire hydrant booster valve assembly and Block Plan exists, remove the redundant Block Plan and replace with a new Block Plan showing the new and existing system in total.

12.14 TESTING

All previously specified under "Cold Water Service" and as required by AS 2419.1.

12.15 HYDROSTATIC TEST

Upon completion of the fire main installation, all trapped air within the system is to be removed and the system fully flushed to remove any debris, which may have accumulated within the system during construction of the installation.

The System is to be tested to achieve at the highest elevation not less than 2100kPa or 1.5 times the highest working pressure, whichever is greater, to which the system will be subjected, to achieve the required flow rate.

The test must be applied for a duration of not less than 2 hours or to the satisfaction of the regulatory authority.

Where hydrant pipework is underground or may be otherwise rendered inaccessible. The hydrostatic test must be made before covering or concealment takes place.

The system must include a safety device to ensure the integrity of the fire main is always protected.

SECTION 13 - FIRE HYDRANT SYSTEM

13.1 GENERAL

The extent of work in this Section requires the payment of all fees and permits, supply of labour, equipment and services necessary to complete works in accordance with the Drawings. This includes, but not limited to, the following: -

- Extend pipework from the existing fire hydrant service on site.
- Provide external and internal fire hydrants as nominated on the Drawings.
- Confirm the capacity of the existing pumpset / system to provide compliant flow and pressure to the building.

13.2 FIRE HYDRANT PIPEWORK

SERVICE	PIPE MATERIAL	JOINTING
In- ground fire hydrant pipework.	PE100 SDR11 Pipe PN16 with red stripe pressure pipe in straight lengths with electrofusion coupling fittings. Provide marker tape over with "Fire Main". Fire hydrant services tape to have copper wire bound within for detection.	Electrofusion coupling fittings. Connect polyethylene pipe to galvanised mild steel pipe with 316 grade stainless steel table "E" flange and 316 grade stainless steel bolts and nuts.
Fire hydrant service aerially within building, and fire hydrant standpipes externally.	Hot dipped galvanized medium steel fire hydrant pipe and fittings. Hot dipped galvanising to comply with AS 4792 with coating mass of 300 grams per square metre average both sides as a minimum. These pipes shall not be installed in ground. All pipe fittings and joints shall be suitable for boosted pressure up to 1700 kPa and shall be UL and FM approved galvanized steel, Code 1GS fittings and couplings pressure rated to 2100 kPa.	Joints shall be hot dipped galvanized steel roll grooved joints and couplings with synthetic gaskets UL and FM approved.

Bolts and nuts used underground and above ground shall be 316 grade stainless steel.

Flanges required underground shall be 316 grade stainless steel.

Metal backing flanges behind polyethylene electrofusion stub flanges required underground shall be 316 grade stainless steel.

13.3 PIPE SIZES

The pipe sizes nominated on the Drawings are nominal pipe sizes and represent minimum internal bore sizes for PE pipework. This may require larger PE pipework to be installed to achieve equivalent sizes and performance.

13.4 VALVES

All valves (other than underground sluice valves) shall be provided complete with handwheels or levers. Provide valves capable of normal operation under pressure from one side only. Provide valves with permanent markings indicating the direction of closing on handwheels. Valves shall have open/close indicator and be Victaulic geared 708 butterfly valves or gate valves with rising spindles. Provide straps and locks to hold the valve in the open position.

13.4.1 Location and Access

Valves are to be located in easily accessible positions for operation and repair in accordance with AS 2419.1 and also where nominated on the Drawings. Valves shall be located no higher than two metres above the finished floor level adjacent for access. Valves are to be located within fire isolated passages and stairs for safe access by the Fire Authority.

13.4.2 Labeling

Provide a permanent numbered label for each isolation valve. The number should be readily visible from the floor adjacent and the valve number noted on the Block Plan. Where the isolation valves are monitored, the valve number is to be referenced at the Fire Indicator Panel.

13.4.3 Valve Specification

Provide valves of suitable materials, and designed for the service for which they are to be used. Valves shall be tested to a pressure of 2,100 kPa by an approved testing Authority. Unless otherwise specified, valves are to be not less than the nominal size of the pipeline in which the valve is installed.

Valves shall not be brazed direct to pipes. Valves shall connect to pipes by either using a three brass bull nose union or flanges. Use a brass thread to capillary straight connector to join valves into the pipe system.

Valves up to and including 50mm shall be bronze with screwed connections. Valves 65mm and 80mm shall be bronze with flanged connections. Valves 100mm and larger shall be cast iron with flanged connections.

13.4.4 Commissioning

At the completion of the project, inspect and clean the internal seats and washers of the valves of all foreign material. Replace any valve faces or seats found damaged.

13.5 VALVES BELOW GROUND

All valves other than sluice valves installed below ground are to be located in precast concrete access pits with cast iron, concrete infill covers and frames. The duty of the cover is to be in accordance with the proposed loadings. Provide infill covers with brass edge strips where pits are located in paved areas or areas with finishes other than concrete, to allow the surface finish to be continued through the cover.

Provide 200mm clear space below and on all sides of the valves in the access pit.

Grade the floor of the pit to a point on one side and provide a weephole to allow water to drain from the pit base.

13.6 SLUICE VALVES BELOW GROUND

13.6.1 Path Boxes

Where sluice valves are located below ground, provide proprietary cast iron path boxes with hinged covers for access. Set the top of the cover flush with pavement, or 30mm above unpaved surfaces, and encase in formed concrete 150mm deep and 150mm wide to sides of box with top surface trowelled smooth.

13.6.2 Access Riser

Set beneath each box a shaft formed of uPVC pipe from the cover to the body of the valve to give clear access to the valve spindle.

13.6.3 Support of Valves

Valves 80mm diameter and larger shall be supported on a 50mm thick 5 MPa concrete pad extending 50mm beyond the flanges on both sides of the valve.

13.7 CHECK VALVES

Provide bronze screwed swing check valves for valves up to 40mm in diameter. Provide bronze flanged Mission Duo Check II, Style G, Figure G15 BMF for valves 50mm and larger.

13.8 FIRE HYDRANT LANDING VALVES

Provide 65mm diameter brass hydrant landing valves, complete with hand wheel, forged (not cast) stortz fire hose couplings and caps and chains.

13.9 STANDPIPE FIRE HYDRANTS

Provide standpipe fire hydrants with dual fire hydrants in external locations nominated on the Drawings. Standpipes shall be installed in accordance with AS 2419.1 and shall be painted for corrosion resistance.

Provide "Ned Kelly" style hydrant valve covers over both hydrant valves with Fire Authority approved padlocks to prevent unauthorised access.

13.10 FIRE SAFETY CERTIFICATE

Engage an approved Registered Company with the Australian Securities Commission which provides as its main business, the work of Fire Services Consultancy to attend the site to carry out tests on the Fire Hydrant System and to provide a Fire Safety Certificate for the fire hydrant services installation as required by Building Code of Australia. Such firm and personnel shall be recorded as being qualified and acceptable to undertake the work of certification for the project. Submit in writing names of three (3) firms for approval to the Superintendent.

The selected certifying company shall provide to Superintendent typewritten results of flow tests, static pressure tests at each fire hydrant in the development.

13.11 TAGGING OF FIRE HYDRANTS

On completion of the fire hydrant installation, provide 'tags' for all fire hydrants and engage a Fire Protection contractor to inspect the hydrants for compliance.

13.12 PRESSURE GAUGES

Provide pressure gauges to inlet and outlet sides of pumps and adjustable pressure stations and elsewhere as shown on the Drawings. Isolate from pump vibration and install complete with isolation valve on the inlet.

Provide gauges with full-scale reading in kPa, a minimum diameter of 100mm and capable of reading pressures at least 25% higher than the maximum static pressure of the system.

Pressure gauges available from Pegler Beacon. Pressure Gauge model Wika 213.53.

13.13 FIRE HYDRANT PUMP SET

Allow a provisional sum to upgrade the existing hydrant pumpset following site testing.

13.14 PUMP DISCHARGE PRESSURE GAUGE AT BOOSTER ASSEMBLY

Where pumpsets are connected in series (relay) with the booster assembly (inline, downstream of the booster assembly), provide a 150mm diameter liquid filled pressure gauge at the hydrant booster assembly, which indicates the pressure at the pump discharge manifold. Provide pipework between the discharge manifold of the pumpset and the gauge in the booster assembly.

13.15 FIRE PROTECTION DURING CONSTRUCTION

13.15.1 General Construction

Fire fighting systems must be operational (including all infrastructure such as pumps, tanks, booster valve assemblies) once the main building structure has been erected and prior to internal combustible finishes being fitted to the building. For larger buildings, this may require the fire protection systems to be operational while other parts of the building and fire protection services are still under construction.

13.15.2 Buildings Over 12m in Effective Height

Once the building has reached an effective height of 12m, the fire hydrants must be operational in at least every storey of the building that is covered by the roof or the floor structure above, except for the two uppermost storeys and booster valve assemblies must be installed and operational.

13.15.3 Staged Construction

Where staged construction of the development is to occur and hand over of part of the site is required prior to the completion of the remaining works, all fire protection measures associated with the completed portion are to be operational and code compliant prior to hand over (this includes all infrastructure such as pumps, tanks, booster valves etc.).

13.16 TESTING

Subject the commissioned fire system to a series of pre-inspection tests during which time all necessary adjustments are to be undertaken to achieve perfect operation in accordance with Fire Authority requirements.

Subject the adjusted system to performance tests as required by the Fire Authority. Wait on and liaise with the Fire Authority testing officers including fire pump manufacturer attendance at all Fire Brigade acceptance tests.

Subject the entire fire service to visual sighting and hydrostatic tests as required by the Water Authority.

Allow for both unassisted (without Fire Authority appliance) and assisted (with Fire Authority appliance boosting) tests to confirm the system complies with all the performance requirements under AS2419.1.

SECTION 14 - FIRE HOSEREEL SERVICE

14.1 GENERAL

Fire hosereels have been exempted from the development as part of a Fire Engineered Solution.

SECTION 15 - PORTABLE FIRE EXTINGUISHERS AND FIRE BLANKETS

15.1 PORTABLE FIRE EXTINGUISHERS

Provide portable fire extinguishers in accordance with AS 2444, the Fire Engineered Solution (related to omission of fire hosereels) and as shown on the drawings.

All portable fire extinguishers shall be approved by the Fire Authority and Local Council. An inspection certificate shall be included with each fire extinguisher.

The extinguishers must be complete with brackets, hoses and nozzles.

15.2 INSTALLATION OF EXTINGUISHERS

Provide portable extinguishers to BCA and Fire Authority requirements.

- Mount the extinguishers in position on an approved mounting bracket a minimum of 100mm from floor level to the bottom of the cylinder (maximum 1200mm to the top of the extinguisher).
- Provide a corresponding identification plate above each extinguisher.
- Mount the extinguishers in exact positions as directed by the Project Manager on site.

15.3 EXTINGUISHER TYPE

Portable extinguishers shall:

- Be rechargeable
- Be hand operated
- Comply with AS 2444
- Be of approved manufacture
- Be acceptable to the Fire Authority
- Suitable for the location and materials found within the vicinity of the extinguisher

15.4 LOCATIONS OF EXTINGUISHERS

The contractor shall provide all necessary fire extinguishers to satisfy BCA and Council requirements throughout the development.

The exact number, location and type of extinguisher is to be confirmed by the extinguisher supplier who will certify the installation of extinguishers as being in accordance with the relevant codes and Authorities.

15.5 EXISTING MAINTENANCE CONTRACTOR

Where the site has an existing fire maintenance contractor who will carry out the ongoing maintenance of fire extinguishers for the development, ensure that this contractor is in agreement with the proposed extinguisher selections. In this situation, we recommend that the existing fire maintenance contractor is engaged to provide the fire extinguishers.

15.6 EXAMPLE OF EXTINGUISHERS

Below is an example of likely locations, types and capacity of fire extinguishers required in particular areas of buildings.

EXTINGUISHER LOCATIONS

AREA	TYPE	CAPACITY
Switch rooms, Electrical rooms and Lift Motor rooms	CO_2	3.5kg
Plantrooms (without flammable gases)	CO_2	3.5kg
Plantrooms (with flammable gases)	ABE Powder	4.5kg
Carpark Areas / loading docks	Foam	9 litre
Hosereel cupboards/ cabinets in Office areas / corridors	Foam	9 litre
Fire compartments less than 500m^2 not protected by fire hosereels	Water	9 litre
Classrooms and associated corridors, not protected by hosereels	Water	9 litre
Commercial Kitchens	BE Powder	5kg

15.7 FIRE BLANKETS

Provide fire blankets in each commercial kitchen, Staff Tea/ Lunch Areas. Fire Blanket Size is to be 1.2m x 1.8m.

15.8 FIRE PROTECTION DURING CONSTRUCTION

Not less than one fire extinguisher to suit Class A, B and C fires and electrical fires must be provided at all times on each storey adjacent to each required exit or temporary stairway or exit.

SECTION 16 - AUTOMATIC DRENCHER SYSTEM

16.1 GENERAL

The extent of works covered by these documents includes the manufacture, supply, installation, testing, commissioning and 12 months maintenance for an automatic window drencher system as specified herein and shown on the drawings.

The automatic drencher system shall include all pipe, fittings, hangers and interfacing between various building services.

The Contractor shall be responsible for the provision of all manufactured items, materials, labour, cartage, tools, scaffold, plant, appliances and fixings necessary for the proper execution of the works, together with all minor and incidental works.

16.2 INSTALLATION STANDARDS

The drencher system shall be installed in conformity with all requirements of the relevant authorities and in accordance with the latest addition of the BCA , AS 2118.1 and AS 2118.2 Wall Wetting Sprinkler Code.

The drencher system shall be fed from the main sprinkler system where available or otherwise connected to the fire hydrant system (with prior approval) or provided with an independent connection to the Authority's watermain.

All piping and equipment shall be placed so that it does not interfere or inhibit the functioning of placement of other building services components. Coordinate with all other building services, including mechanical and electrical contractors.

16.3 SPRINKLER HEADS

Sprinkler heads shall be as follows:

- External drencher sprinkler heads shall be fast response 15mm side wall pendant style spray pattern (spraying onto glass), 93°C exposed type head.
- Internal drencher sprinkler heads shall be fast response 15mm side wall pendant style spray pattern (spraying onto glass), 68°C type head.
- Where located below another sprinkler head (and not located below an overhanging beam), the sprinkler head shall be provided with a 75mm diameter metal shield.

16.4 PIPEWORK MATERIALS AND QUALITY

Pipework above ground on the system side of the ~~drencher control~~ valve assembly shall be at least equivalent to medium grade black steel tube complying with AS 1074, and shall be suitable for threading with pipe threads of "whitworth" form, or complying with AS 1579, AS 1835 or AS 1836, subject to a minimum wall thickness of 4.76mm.

Pipework below ground on the system of the alarm valve and/or the supply side of the alarm valve shall comply with (subject to approval of the Water Supply Authority):-

- D.I.C.L pipe to AS 1724, AS 2544, AS 1281 and AS 1516.
- Galvanised steel pipe to AS 1074, AS 1579, AS 1835, AS 1836 subject to a minimum wall thickness of 5.3mm.
- Copper tube type B to AS 1432.

Joints on galvanised steel pipes installed below ground shall be complete with a suitable wrapping (50% overlap) of "DENSO" tape or approved equivalent, with tape being provided to 600mm on both sides of the joint.

Pipework above ground, serving booster pumps, suction tanks, fire brigade suction and booster connections etc., may be fabricated from heavy grade black steel pipe if hot-dipped galvanised after fabrication.

Welded pipework hot-dipped galvanised after fabrication shall be subject to testing/stamping by the relevant Water Authority (if applicable) and shall be the responsibility of the Contractor.

All cast in pipework shall be copper tube type B and wrapped in Denso tape to allow for pipe movement.

All system drain pipework shall be galvanised steel pipe.

The drawings indicate the manner in which the various systems of piping are to be run.

The Contractor shall size all pipes in accordance with AS 2118. No extra payment shall be allowed for wrong sizing.

All work specified, shall be installed in an approved manner to meet structural, architectural and other site and/or service conditions.

Pipework shall be concealed above ceiling areas as noted, otherwise it shall be exposed.

All pipework must be so constructed that it shall be free for contraction and expansion so that it shall not damage any other work or effect injury to itself.

Special care shall be taken in the arrangement of piping to ensure neat and workmanlike appearance and true alignment and grade.

All pipes and fittings shall be thoroughly cleaned before erection, removing all scale, burrs, fins and obstructions and the section shall be blown out to remove all scale, slag, pipe cutting residue etc.

Horizontal lines of piping shall be graded down toward the installation control valves.

In areas where the sprinkler pipework is below the level of the installation drain valves, and in other trapped sections of the system, auxiliary drain valves of the following minimum sizes shall be provided:-

For pipes up to 50mm ø	-	20mm
For pipes 65mm ø	-	25mm
For pipes larger than 65mm ø	-	32mm

An air release valve shall be provided on the installation with 15mm ø line taken as close as practicable from the highest point of the installation and run to a convenient accessible location, terminating with a 15mm lock shut cock, lock and label. Note: valves not indicated in the drawings.

The pipework reticulation shall be designed and fabricated in such a manner as to permit progressive testing and commissioning of portions of an installation to suit individual floors, tenancies or zones, or as directed on site by the Consulting Engineer.

All levels and heights of pipework shall be detailed on the shop drawings submitted for approval.

Pipes 50mm and smaller may be joined by welded paps/threaded end, screwed sockets, grooved couplings and screwed fittings. The butt welding of two (2) different sized pipes may be accepted on range pipes providing that the smaller pipe is of the next manufactured size under the larger pipe.

Threaded pipe joints shall be sealed as follows:-

- Hemp in conjunction with an approved sealing compound; or
- Teflon tape; or

- Liquid sealant.

Where exposed pipework is to be situated in accessible positions eg. Cooking hoods freezer and cool rooms hemp shall not be used to seal screwed joints.

Pipes 65mm and larger may be jointed by welding, grooved couplings, flanges (welded inside and outside) to table 'E' drilling, complete with approved type insertion rubbers. Threaded joints on these pipes are to be kept to a minimum, and are only to be used where absolutely imperative to design and/or installation procedures.

Pipes 65mm and larger shall incorporate either butt weld or fabricated bends, butt weld or fabricated tees, and butt weld concentric/eccentric reducers.

On site welding operations shall be avoided as far as possible, however, if unavoidable, then shall be carried out in accordance with AS 1674.

Pipes may be joined by mechanical grooved fittings in accordance with the following:-

- The fittings, gaskets and grooves shall be an approved combination.
- The grooves shall not be cut, but are to be rolled and shall be dimensionally compatible with the couplings.
- The gaskets shall be suitable for continuous service for both air and water in temperature range 40°C – 250°C and shall be pliable, smooth and free from obvious surface porosity and mould flash.

The assembled coupling shall fully enclose the gasket within the housing of the coupling.

Should mechanical grooved couplings be used, flanged connections shall be provided as a means of isolating individual floors, tenancies or zones.

All galvanised malleable cast iron pipe fittings shall comply with BS 1256 and shall be suitable for threading to the specified AS 1074 pipework.

On small diameter pipework, plain end locking type fittings as manufactured by Victaulic Company or similar approved may be acceptable with prior approval from the Superintendent.

The use of lead wool for the caulking of leaks on threaded joints and welded joints on pipework must receive prior approval from the Superintendent, however, the use of lead wool is not normally accepted and the joint would need to be disconnected and made good.

16.5 PIPEWORK MATERIALS

Pipework shall be painted black mild steel or galvanised mild steel. Pipework up to 65mm shall be screwed jointed. Pipe above 65mm diameter shall be flange jointed or have rolled grooved joints. All pipe lengths shall be cut with standard pie cutters, or jig fitted pipe saws, thread cut with standard thread disc and end reamed before assembly.

No welding is allowed for galvanised steel pipes.

Flanges and bolts for flange joints shall comply with Australian Standards. Flanged joint shall be made with machined flanges kept truly parallel so that bolts are not used to pull flanges into true alignment. Flange gaskets shall be of non asbestos composition or cotton duck reinforced red rubber gaskets suitable for the temperature and pressure of the particular system. All bolts and nuts shall be stainless steel. Screwed pipe shall be machine threaded and reamed to the full bore of the pipe. The fittings shall be malleable cast iron. Union joints shall be made tight using litharge, glycerine or permacell tape, as approved.

The welding of black steel pipe and fittings shall be effected by means of electric arc welding using welding using rods of such composition that welds produced will have the same analysis as the steel in the pipe and fittings.

Pipe ends shall be prepared for welding by machine bevelling to the required angle. Only qualified welders are allowed to carry out the work. All scale and oxide formed after the weld shall be removed with chisel and hammer or file.

16.6 ERECTION AND FABRICATION OF PIPEWORK

All pipework to be incorporated into the contract works must be new and unused, free from corrosion and internal obstructions. All piping shall be protected against entry of moisture and foreign matter while stored on the site. Open ends shall be securely plugged or capped during storage and the installation period. Wood shavings, rags, paper or the like will not be accepted for this purpose.

When preparing pipework for installation, all ends shall be square cut with a hacksaw and all burrs and sharp edges removed by reaming and filing. Excessive tool-marking of pipework will not be accepted.

16.7 PIPE JOINTS

Removable joints shall be provided on all pipework fittings and equipment to facilitate erection and future inspection or repair. The extent and locations of removable joints shall be to the satisfaction of the Superintendent.

Removable joints shall be made up as follows:

On black mild steel pipework - up to and including 50 mm diameter - unions with screwed ends, two bronze conical settings ground in and galvanised malleable bodies. Seatings are to be correctly tapered and ground true.

65mm diameter and over - pairs of mild steel flanges - table E.

Flanges or flanged adaptors shall be provided on mating connections to flanged valves, manifolds and connections to plant and equipment.

Where tees, etc. have one or more branches 65mm diameter or over, all branches shall be flanged. Screwing of branches more than 65mm diameter will not be permitted.

16.8 SPECIALISED JOINTING TOOL

Where a proprietary jointing system requiring a specialised jointing tool is utilised for an installation on a premises with maintenance staff, provide to the maintenance manager, jointing tool/s for all pipe sizes installed as part of the works.

16.9 FLANGES

All flanges shall be manufactured in accordance with the provisions of AS 2129-2000, latest edition, suitable for working pressures up to 1000 kPa and not less than Table E.

All flanges shall be machined on mating faces, turned on edges and spot faced for bolts and nuts.

All flanges shall be drilled for mild steel, hexagon headed, cadmium plated bolts and nuts, the number and size of bolts to be in accordance with the relevant flange size. The bolts shall be coated with graphite and oil before connecting. After assembly the bolt projection from the nut shall not be more than one and a half threads.

Jointing material between flanges shall be of an approved type and suitable for the particular service concerned. The material shall be not less than 1.6 mm thick, the hole to be 3mm larger than the bore of the pipe to be jointed. Gaskets shall be full flange size.

Flanges shall be in correct alignment with opposing faces parallel before being pulled together.

Flanged fittings shall be jointed in a similar manner to that specified for pipework.

16.10 SCREWED JOINTS

Screwed joints in pipework shall comply with the requirements of AS 1722 Part I and II and AS 1572 and all other relevant Australian or British Codes or Specifications and shall be to the approval of the Superintendent. Malleable banded fittings of suitable manufacture only shall be used.

Threads on pipework shall be accurately cut so as to match the thread of the fitting or valve being joined, both in thread profile, length and taper.

All screwed joints shall be made with fine stranded hemp and approved jointed compound.

16.11 ROLL GROOVE COUPLINGS

Victaulic or other approved roll groove couplings may be used subject to approval.

Roll groove couplings shall:-

- Have approval of all relevant Authorities.
- Be installed and supported strictly in accordance with the manufacturers recommendations.
- Be a uniform type throughout the fire services.
- Not be used on pipes smaller than 65 NB.
- Not to be used on blank end pipe stubs.

Housing, gaskets and grooves shall be an approved combination and all couplings and gaskets shall be readily available from local suppliers.

Each housing and gasket shall be compatible with the pipe to which it is fitted.

The whole assembly shall be used in accordance with the manufacturer's recommendations.

The grooves shall not be cut, but are to be rolled and will be dimensionally compatible with the gaskets and couplings.

The gaskets shall be a central pressure-responsive design suitable for the application and will be of rubber grade and compound approved for continual service within the application temperature and pressure ranges.

Housing shall consist of a one or more piece, ductile or malleable iron casting with nuts, bolts, locking toggle or lugs to secure the unit together. They shall be free from obvious surface porosity and mound flash.

16.12 PIPE SUPPORTS

All pipework supports, unless specified or directed otherwise, shall be constructed of black mild steel. Details of all hangers, supports, etc., shall be submitted to the Superintendent for approval. Gaskets of cork, rubber, plastic or other suitable material shall be inserted between each pipe support and non-ferrous pipework.

Unless specified or directed otherwise, all pipework shall be supported at intervals not exceeding the following:

PIPEWORK SUPPORT INTERVALS

PIPE SIZE (STEEL)	HORIZONTAL INTERVAL (mm)
15 mm	1800
20 mm	2400
25 mm	2400
32 mm	2700
40 mm	3000
50 mm	3000
65 mm	3600
80 mm	3600
100 mm and over	4000

Hanger rods shall be of the following sizes:

HANGER ROD SIZES

PIPE SIZE	HANGER ROD DIAMETER
Up to 50 mm	10 mm
65 mm and 80 mm	12mm
100 mm and over	16mm

16.13 FITTINGS

All tees and bends shall be of sweep pattern except the square tee which shall be use where draw-off connections are made or where air may be trapped in the upper part of the tee.

16.14 VALVES

The Contractor shall supply and install all necessary stop valves, test valves, etc. as required by the regulations of the Insurance Council, the Sydney Fire Services, local city Council and other relevant authorities.

All valves shall be clearly labelled to indicate their functions, etc., as specified previously in this specification.

All valves shall be located in accessible positions for operation and maintenance. The connection between each valve and connecting equipment or pipework shall be made with either a flanged or screwed joint as specified above except that all valves in plant rooms and adjacent areas shall be with flanged joints. All valves shall be carefully packed with an approved graphite packing and threads of screwed joints coated with graphite oil before installation.

Sufficient valves shall be provided throughout the system to enable the areas to be drained without having to drain the complete installation.

Valves shall be bronze bodies for valve size up to 50 mm. For pipes over 50 mm cast iron or steel type shall be used.

Bronze valves shall have brass caps, asbestos gasket and stainless steel 304 screen basket.

Cast iron valves shall have cast iron covers, stainless steel plugs, non-asbestos gasket and stainless steel 304 screen basket.

16.14.1 Gate Valves

Valves shall be bronze bodies for valve size up to 50mm. For pipes over 50 mm cast iron or steel type shall be used.

Bronze valves shall have brass spindles, bronze disc, brass gland and nuts, removable bronze bonnet and ductile iron handwheels.

Cast iron valves shall have non rising stem, having forged brass spindles, cast iron disc, cast bronze disc seat rings, carbon steel bolts and nuts, ductile iron gland, Asbestos Graphite packing, removable cast iron bonnet and cast iron handwheels with indicators showing the valve positions. Indicators must be provided on gate valve below alarm valve and locked open with padlocked strap.

16.14.2 Globe Valves

Valves shall have bronze bodies for valve size up to 50 mm. For pipes over 50 mm cast iron or steel type shall be used.

For bronze valves, it shall have brass spinders, bronze disc, brass gland and nuts, removable bronze bonnet and ductile iron handwheels.

16.14.3 Check Valves

The valves shall be wafer swing, dual disc, spring loaded design.

Valves shall be bronze bodies for valve size up to 50 mm. For pipes over 50 mm cast iron or steel type shall be used.

Bronze valves shall have stainless steel hinges pins and pin retainers, cast iron disc.

Cast iron valves shall be stainless steel hinges pins and pin retainers, cast iron disc.

16.14.4 Butterfly Valve

Butterfly valve shall be locked level type with cast iron body and disc and stainless steel stem and Teflon seat ring.

16.14.5 Air Release Valve

Automatic air release valves shall be installed on high points of piping and on flow and return headers. Valves shall be bronze body type.

16.14.6 Drain Valves

Drain valve shall be fitted at the base of pipe risers, headers and at all low points of water system. The valve shall have brass bibcock type with hose connection. Allow to extend pipework from these valves (to enable drain down) to discharge of stormwater pits/grates.

16.15 PRESSURE GAUGES

Provide pressure gauges on the new control valve and at the suction and delivery of the fire pumps and on incoming sprinkler main pipework.

100mm diameter dial type pressure gauges with stop cocks shall be installed as indicated on the drawings. All gauges shall be calibrated before installation. The gauge scale provided shall be such that the normal system reading is at the centre of the gauges. Where suction is negative, a compound vacuum pressure gauge shall be used.

Pressure gauges shall be of an approved manufacture with diameter polished brass casing, chromium-plated and fitted with all necessary gauge, changeover and shut-off cocks, graduated to read between 0 and 2000kPa with white dial and black figures.

Pressure gauges shall comply with AS 1349 and shall have scale graduation as follows:-

MAX SCALE READING (MPa)	MAX. GRADUATION INTERVAL (kPa)
1	20
1.6	50
>1.6	100

The pressure gauges shall be installed so that they can be removed from the sprinkler without causing interruption to the water supply. All gauges shall have a pet cock and siphon.

16.16 PRESSURE SWITCHES

Pressure switches shall be approved by the Fire Authority and the Insurance Council. Pressure switches shall have testing arrangements as stipulation AS 2118-1999.

All wiring associated with fire trip wiring shall be installed in MIMS.

16.17 STRAINERS

Y-type strainers shall be supplied and install where indicated on the drawings.

SECTION 17 - SANITARY FIXTURES, APPLIANCES AND TAPWARE

17.1 EXTENT OF WORK

The work specified in this section comprises the ordering, storing on site and installation of sanitary fixtures, appliances, tapware fittings as detailed in the fixture schedule and necessary for complete installation.

All items shall be new and of first quality, free of defects and shall be subject to inspection prior to installation. Such inspection shall not relieve the Contractor of responsibility to ensure all items are free of defects at Occupation Certificate.

Prior to placing order provide samples and obtain guarantees from the manufacture that any items which craze or show any other defects within twelve months of issue of Occupation certificate will be replaced providing that such crazing or other detects are not caused by abuse or inappropriate use of the item.

17.2 SANITARY FIXTURES

Receive and store all sanitary fixtures and be responsible for installation of same.
Fix and support sanitary fixtures strictly to respective manufacturer's recommendations. All exposed waste pipes and fixture traps shall be chrome plated.

17.3 TAPS AND OUTLETS

Receive and store all taps and outlet fittings and be responsible for installation of same to the fixtures and appliances nominated and connect same to the water service. All exposed pipework including shall be chrome plated.

17.3.1 Tapware Indicator Colours

- Cold water taps - Blue
- Hot water taps - Red
- Warm water taps - Yellow

17.4 SANITARY FIXTURES, APPLIANCES, TAPS AND OUTLETS SCHEDULE

FIXTURE / LOCATION	MAKE / MODEL	
Toilet Suites Showers Hand Basins	Make Model Colour Tapware	Refer to Architectural Schedules
In Wall Tundish All Areas	Model	Mod Tech in wall tundish 316 grade stainless steel, complete with removable stainless steel cover with window and 50mm top inlet.
Hose Taps where internal to toilet washrooms	Tapware	Enware CP hot and cold hose bib tap quarter turn.
External Hose Taps and Plantroom Hose Taps	Tapware	20mm diameter Cimberio Code CIM 34 lever handle hose taps. Fix with stainless steel screws to structure or support post. Install Watts 8A backflow preventer on outlet. Provide signage above hose tap adjacent to grease arrestor "Not Suitable for Drinking".

17.5 APPLIANCE, TAPS AND OUTLET INSTALLATION

Provide quarter turn mini cistern, right angle, chrome plated stop taps, at rough in point preceding connection to all taps apart from shower mixers. Taps and water outlets and other fittings shall be bright chromium plated.

Provide and install to all wall mounted and hob mounted taps, extension spindles of sufficient length to enable top cover plates to be screwed onto spindles. In determining the length check thickness of wall finishes and benches described in the architectural drawings and specification section.

Provide and install to each tap spindle and bonnet assembly where within dry and masonry walls a "Water Bar" tap penetration flange designed for the purpose of preventing water entering the wall.
Provide these flanges to all taps and outlets at baths, showers, sinks and tubs.
Water outlets shall be the aerated type unless otherwise specified to be spray type or without aerator or spray nozzle.

Seal sanitary ware, wall surfaces, bench/counter tops with white anti-fungal silicone sealant.

Plugs and washers for basins shall be 40mm diameter chrome plated brass, complete with approved type plastic plug, white in colour. Plug and washers for stainless steel sinks shall be stainless steel on plastic type complete with approved type plastic plug, grey in colour. Plastic plug and washers in wash basins are not acceptable. Set each plug and washer in position with clear anti fungi Silicone Sealant.

The number of tap holes in sanitary fixtures must be the same number of outlets required by the Taps and Outlets Schedule.

Water closet pans shall be set to the floor with screws and silicon sealed around the base to seal between pan and floor finish all to manufacturers recommendations.

SECTION 18 - BMCS POINTS

Where a BMCS system is provided as part of the development or is available in existing buildings, provide hydraulic plant and equipment controls such that the equipment can be controlled and monitored by the BMCS. Liaise with the BMCS designer in incorporating the plant control, monitoring and graphics.

Provide the necessary controls and outputs from the hydraulics plant to allow the following typical types of functions and parameters:

ITEM	POINT/S	TYPE
Automatic Backwash Filters	Fault Alarm	Digital Input
Bag Filters	Fault Alarm	Digital Input
Cold and Hot Water Sub Meters	Pulse Output for Consumption	Analogue Input
UV Filters	Fault Alarm	Digital Input
Potable Water Booster Pumps	Pump Run / Fail / Alarm (each pump)	Digital Input
Potable Water Storage Tanks	High Level Alarm Low Level Alarm	Digital Input
Secondary Hot Water Circulating Pumps	Pump Fail (each pump)	Digital Input
Hot Water Temperature (2 off) Main flow & return	Temperature Readings	Analogue Input
Hot Water Units	Hot Water Unit Fail (each unit)	Digital Input

SECTION 19 - TENDER RETURN SCHEDULES

19.1 TENDER PRICE

Tender for the Supply, Delivery, Installation, Testing & Maintenance of the Hydraulic Services.

I/We

_____

Hereby tender for the supply, installation, testing and maintenance of all work exactly in accordance with the JHA Specification and Drawings.

LUMP SUM TENDER PRICE FIXED TO: **$** _____ (Inc. GST)

_____ (Inc. GST)
(In Words)

_____ _____ _____
(Name) (Signature) (Date)

19.2 TENDER SUMMARY

Tenderers shall submit a breakdown of the total tender price including administration cost and profit for each section of the works. The amounts included in the Total Tender sum including overhead costs and profit margins are as follows:

TENDER PRICE BREAK-UP	
Sewer Drainage and Sanitary Pluming	$
Trade Waste Drainage	$
Downpipes	$
Cold Water Service	$
Hot Water Service	$
Fire Service Connections	$
Fire Hydrant Service	$
Fire Extinguishers and Fire Blankets	$
Sanitary Fixtures and Tapware	$
Miscellaneous items including plinths, painting, pipe sleeves.	$
Shop drawings and working drawings.	$
Testing and Commissioning.	$
Maintenance during defects liability period.	$
"As Built" drawing, O&M manuals	$
	$
	$
	$
	$
	$
TOTAL FIXED LUMP SUM TENDER PRICE EXCLUDING GST	**$**
TOTAL INCLUDING GST	**$**

19.3 OPTIONAL / VARIATION COMPONENT PRICES

Where noted in the Contract Documents, provide alternative costs for Options listed therein and/or provide variation cost offers for any alternatives proposed by the Tenderer .

OPTION / VARIATION DESCRIPTION	COST DIFFERENCE
	$
	$
	$
	$
TOTAL EXCLUDING GST	**$**
TOTAL INCLUDING GST	**$**

Pymble Ladies College - Grey House Precinct (GHP)

Hydraulic Services Specification

Date: 26th May 2023

Prepared by: Matt Mee

Ref: 301350239

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Stantec

Revision

Revision	Date	Comment	Prepared By	Approved By
001	15.10.21	50% Issue	JZK	MHM
002	12.11.21	70% Issue	JZK	MHM
003	10.12.21	D&C Tender Issue	JZK	MHM
004	26.05.23	Revised D&C Tender Issue – Building Move & Dance Area Mod		

Checked and approved by Project Engineer

Name: **Matt Mee**

Signature: _____

Contents

PART A. Preliminaries

Refer to Head Contract for Preliminaries.

A.1.1 DESIGN & CONSTRUCT NOTE:

Stantecs role on this project is to produce engineering services design and our agreement does not include an allowance for the Managing contractors commercial risks on the project. Under this type of D&C contract, The hydraulic contractor shall understand that the documentation is not complete and shall make due consideration of risks and make their own judgement on the completeness of documents at the time of pricing. It is likely that additional costs will arise as the design and documentation phase is completed by the head contractor and associated sub-contractors. This is characteristic of the D&C process. The hydraulic sub-contractor must allow suitable cost contingencies considering the progress and completeness of the documentation at the time of pricing. Stantec is not liable for any cost increase due to initial pricing being based on documentation that is not fully comprehensive. The hydraulic contractor's price shall allow sufficient contingency to cover the risk due the nature of the docs being a D&C package.

Given the D & C nature of this project, the contractor must inspect the existing site to familiarise with the site, understanding the scope of the proposed services and the complexities surrounding it's installation, extent of existing services and the demolition scope and importantly to ascertain any potential conditions that could hinder services design and installation. Site inspection must be carried out prior to signing of contract. No variations will be allowed whatsoever resulting from the lack of site knowledge on the part of the D & C contractor. Any variations resulting from the lack of site knowledge will be the sole responsibility of the D & C contractor.

The contractor shall review, interrogate and satisfy themselves that the design herein is adequate for the project and meets the requirements of;

- BCA 2022
- BCA Compliance Statement.
- Fire Engineering Safety Report.
- Services position attached.
- Australian Standards
- DA Consent conditions
- Architectural intent
- Any other code or standard that is applicable to the project.

A.1.2 DESIGN RESPONSIBILITIES

The documented design highlights the design intent and outlines the expected quality and deliverables on the project. Deviations from the design documents shall be submitted for approval and need include supporting evidence of:

- Compliance issues with local codes, standards and authority requirements
- Client benefits (financial or marketing benefits)
- Project requirements: coordination / consent conditions etc.
- Architectural sign-off
- Programme implications

Hydraulic contractor along with all other trades are to actively participate and shall be responsible for services coordination during design completion stage.

PART B. Project Specific Information

B.1 Project Overview

The project comprises of a new education development at the existing Pymble Ladies College (PLC) school premises. The new building will consist of learning spaces, dance studios, staff areas and other amenities. The hydraulic scope shall consist of new connections to existing provisions provided by the early works and extending them to new plant infrastructure and reticulations throughout the new development. The new development is shown on the site plan image below:

Figure 1 – Site Plan

B.2 Design Standards and Criteria

B.2.1 Design Standards

- Hydraulic Services to comply with the Building Code of Australia 2022.
- Hydraulic Services to comply with all current statutory requirements and guidelines including Kuringai Council, Sydney Water, Fire and Rescue New South Wales, Health Department and Department of Environmental Protection
- Hydraulic Services to comply with current Australian Standards where applicable and particularly the following:

AS 3500	:	National Plumbing and Drainage Code incorporating: Part 1 - 2021 Water Supply Part 2 - 2021 Sanitary Plumbing and Drainage Part 3 - 2021 Stormwater Drainage Part 4 - 2021 Heated Water Services
AS 2419.1	:	2021 Fire Hydrant Installations
AS 2441	:	2005 Fire Hose Reel Installations

AS 2444 : 2001 Portable Fire Extinguishers & Blankets: Selection & Location

B.2.2 Design Criteria

- Hot Water : Storage Temperature (domestic use) minimum 60°C
  : Supply Temperature (domestic use) maximum 50°C
  : Supply Temperature to disabled facilities maximum 42°C
- Stormwater

Box Gutter Systems : Average recurrence interval (ARI) 1:100 years.
: Intensity ***270****mm*/hour.
: Duration 5 minutes.

Eaves Gutter Systems : Average recurrence interval (ARI) 1:20 years.
: Intensity ***210***mm/hour.
: Duration 5 minutes.

Paved Areas : Average recurrence interval (ARI) 1:10 years.
: Intensity ***60***mm/hour.
: Duration 5 minutes

Note: Average recurrence intervals and storm intensities have been taken from AS 3500 3:2003 Stormwater Drainage.

B.3 Hydraulic Services

AS 3500.3: **2021** is the current standard

The work included in this section of the specification is for the supply of all labour and materials for the execution of the hydraulic services work indicated on the drawings and/or specified as follows:

- Site services connections
- Sanitary fixtures and fittings
- Sanitary waste and drainage/plumbing
- Industrial waste & drainage/trade waste
- Cold water service
- Hot water service
- Rainwater harvesting and re-use services
- Stormwater collection and drainage
- Fire hydrant service
- Fire extinguishers
- ESD initiatives
- Landscape irrigation
- Authority fees and charges
- Maintenance manuals and as-constructed drawings

B.4 Detailed Scope of Work

B.4.1 Site Services

- Property sewer services incorporating:
  - The existing Sydney Water manhole and sideline connection on the southern end of the site is to be maintained for the gravity connection of the development (Level 01-Roof)
  - The sanitary sewer scope also includes deviating upstream sewer collecting buildings on the west and north of the site and extending them through the GHP building footprint below ground to the southern manhole collection. Refer to Appendix G for proposd routing.
  - Gravity sewer to on-site sewer pump station with rising main connection to the Authority's main sewer infrastructure located on southern end of site for level 00 fixtures only.
- Domestic cold water supplies incorporating:
  - An existing 32mm cold water supply has been terminated adjacent to the GHP development site including isolation valve, backflow prevention device and sub-meter as apart of the early works. A new 32mm supply is to be extended into the level 00 plant room. Refer to Figure 2 below for approximate location:

Figure 2 – Early Works Services Provision

  - The plant room is to consist of 6,000L potable water storage tank complete with internal partition (50% volume), filtration and pumping equipment.
- Fire services incorporating:
  - The existing fire hydrant system comprises of a booster, pump, on-site tank and site wide ring main. The existing town's main connection and associated infrastructure is provided on Avon Road adjacent to gate 3.
  - An existing 150mmmm fire hydrant supply has been terminated adjacent to the GHP development site including isolation valve as apart of the early works. A new 150mm supply is to be extended into the level 00 plant room and level 00 high level. 100mm reticulations to fire hydrant landing valves in the development as per the design documentation. Refer to Figure 2 above for approximate location.
  - Stantec have conducted fire hydrant proving calculations for the purposes of achieving 700kpa of the two topmost hydrants for the new GHP precinct. The calculations were based off testing & commissioning data we received of the existing diesel pumpset adjacent to gate 3 as provided by the maintenance contractor. Stantec's calculations estimate the pressure at the topmost hydrant outlets to be 770 kPa. The contractor is to allow a provisional sum to perform any required pump upgrades i..e upgrade of pump impeller size, driver size etc to increase the head duty during the testing and commissioning procedure for the GHP project.

B.4.2 Sanitary Fixtures and Fittings

- Provision for first grade commercial quality sanitary fixtures, fittings and tapware to the following areas:
  - Staff male/female toilet areas
  - Cleaner's facility

- Amenity areas
- Staff kitchen and tea preparation areas

- Provision of fixtures and tapware conforming to the WELS (Water Efficiency Labelling Standards) which identifies flow rates in accordance with the sustainability engineer's requirements. Refer to sustainability engineers specification for required flow rates.
- Provision for all required vandal resistant features to fixtures and tapware.
- Refer to architectural equipment schedule and specification for fixture selections.

B.4.3 Sanitary Waste and Drainage

- Provision for the collection of all domestic waste discharges from fixtures and fittings via PVC fixture and branch wastes and including:
  - Toilets
  - Hand basins
  - Showers
  - Dishwashers
  - Kitchen sinks
  - Cleaner's sink
  - Troughs

  Note: Exposed fixture wastes shall be chrome plated copper
- Provision for all required floor wastes and tundish wastes, maintenance access and inspection openings
- Provision for all required fire stop collars to services passing through structural slabs, fire walls and floors
- Provision for all required sanitary waste and drainage ventilation services terminating to atmosphere at roof level
- Provision for below ground PVC sanitary drainage services collecting waste discharges from waste stacks, fixture wastes etc with gravity connection to the sites sanitary drainage services infrastructure and incorporating all required maintenance and inspection openings

B.4.4 Industrial Waste and Drainage

- Provision for the collection of all grease waste from kitchen cooking and food preparation areas (Levels 00 and 02 as documented) via fixture wastes from food preparation sinks, hand wash basins, bain-maries, coolroom/freezer washdown and condensate waste drains, bucket traps and industrial floor wastes discharging to a 2,000 litre capacity below ground filtered grease trap/arrestor
- Note: Fixture wastes from glass washers, dishwashers and pre-rinse sinks will discharge directly to the domestic sanitary drainage system so that excessive and high temperature waste water discharges bypass the grease trap
- Provision for a 15mm hose connection tap located within 6m of the grease/dilution chamber to assist maintenance cleaning and complete with required backflow prevention device
- Provision for a 240 volt, 10 amp, 3 pin weatherproof GPO to be located within 2m of the grease/dilution chamber industrial waste sampling point to assist the Authorities use of sample and monitoring process equipment
- Provision for independent venting to atmosphere of grease/dilution chamber
- All trade waste pipework up to the inlet of the grease arrestor is to be of HDPE material.

B.4.5 Cold Water Services

- Provision for reticulated cold water supplies to all sanitary fixtures, fittings and tapware as required incorporating all required maintenance isolation valves
- Provision for all required internal/external hose connection taps to assist general cleaning, wash down and minor landscape irrigation complete with vacuum breakers and all necessary backflow prevention devices
- Provision for all required sub-metering via remote electronic meter reading
- Provision for all required backflow prevention devices to mechanical equipment, hot water units, hose taps, laboratory tapware etc
- Provision for fluid aprons to all tap breaches in walls and ducts

B.4.6 Hot Water Services

- Provision for hot water heating plant providing hot water to the following areas:
  - Cleaners Sink Areas
  - Staff Kitchenette and Tea Preparation Areas
  - Amenity Areas
- Provision for reticulated hot water services with connections to all fixtures and tapware and incorporating all required maintenance isolating valves and temperature control devices
- Provision for insulation to all reticulated hot water services as required
- Temperature control devices are to be utilised to restrict hot water temperatures to the following areas:
  - Disabled Facilities - max 43°C
  - Adolescent Amenities - max 50°C
  - Staff toilet amenities - max 50°C
  - Kitchen Areas - max 50°C
- Provision for all required backflow prevention devices and temperature relief valves.
- Provision for hot water heating plant comprising the following:
  - Rheem Heavy Duty (HD) Electric Storage Units equipped with 50% solar pre-heat contribution as per below:

WATER HEATING PLANT:

3 x Rheem model 61631507 Electric water heater with 6 x 3.6kW heating elements

Providing up to 2,060 litres of hot water raised 50°C over the 1 hour peak period

- Commercial grade vitreous enamel for durability in a wider range of water quality environments.
- Fast commercial recovery providing plenty of hot water.

WEIGHT and PLANT SPACE inclusive of service clearances:
Maximum weight (in operation): 1260kg
3 x Rheem model 616315 Electric water heater requires 3m(W) x 2m(D)

ELECTRICAL REQUIREMENTS:
- Each heater requires 21.6kW input and 30Amps per phase, 3 phase power.
- Total Kw input = 64.8kW

SOLAR PRE HEAT PLANT:

We propose the following solar pre heat plant to contribute an annual average of 50%. Solar plant below to be paired with either water heating plant as specified in above option:

SOLAR PREHEAT COLLECTORS & FRAMES:

14 x Rheem model NPT200 collectors
6 x Variable Pitch Frames 2 x Collector
2 x Variable Pitch Frames 1 x Collector
Flat roof frames proposed, please confirm prior to ordering

WEIGHT and PLANT SPACE inclusive of service clearances:
14 x NPT200 Collectors with frames weigh approximately 883kg full
14 x NPT200 Collectors installed in 2 x arrays of 7 x collectors require a flat roof area of 8.9m(W) x 6.1m(D)

SOLAR STORAGE:

4 x Rheem model 610430 storage units
1 x Solar Controller
2 x Sensor Leads

WEIGHT and PLANT SPACE inclusive of service clearances:
4 x Rheem model 610430 storage tanks weigh approximately 2,108kg (full)
4 x Rheem model 610430 tanks installed require an area of 4m(W) x 2m(D)

B.4.7 Rainwater Harvesting

- Provision of pre-treatment first flush device on inlet pipework to rainwater tank (by civil engineer).
- Provision of all required eaves/box gutters, gutter sumps, overflows, expansion joints and downpipes shall be made by the roofing contractor and covered in the Architectural documents
- Provision for the collection of all storm water runoff from roof areas, canopies and balconies via internal/external downpipes terminating at below ground rainwater tank to be provided by the civil engineer.
- Rainwater re-use plant to consist of dual submersibile pumpsets provided within the rainwater tank, above ground backwash, bag and UV filtration devices to be provided in the level 00 hydraulic plant room. Re-use reticulation to extend to irrigation system, wash down hose taps and toilet flushing.
- Re-use services reticulation to be provided with labelling and signage as required.

B.4.8 Stormwater Collection

- Provision of all required eaves/box gutters, gutter sumps, overflows, expansion joints and downpipes shall be made by the roofing contractor and covered in the Architectural documents
- Provision for the collection of all storm water runoff from non-roof impervious areas, canopies and balconies via internal/external downpipes terminating at civil stormwater pits.

B.4.9 Fire Hydrant Services & Extinguishers

- Provision for all required internal fire hydrants providing building protection to all areas and located within 4m of a fire exit or inside fire stair well and allowing full coverage from a 10m hose stream issuing from a 30m hose
- Fire hose reels have been omitted from the design in accordance with the fire engineering report. Fire extinguishers will supplement this omission.
- Provision for fire extinguishers and blankets as noted on the drawings.

- Provision of dedicate fire drencher services including locked open isolation valve, pipework and drencher heads to affected openings as noted on the drawings.
- Stantec have conducted fire hydrant proving calculations for the purposes of achieving 700kpa of the two topmost hydrants for the new GHP precinct. The calculations were based off testing & commissioning data we received of the existing diesel pumpset adjacent to gate 3 as provided by the maintenance contractor. Stantec's calculations estimate the pressure at the topmost hydrant outlets to be 770 kPa. The contractor is to allow a provisional sum to perform any required pump upgrades i..e upgrade of pump impeller size, driver size etc to increase the head duty during the testing and commissioning procedure for the GHP project.

B.4.10 Perimeter Drainage

- Provision of rainwater outlet and associated stormwater drainage to plenum areas as documented.

B.4.11 ESD Initiatives

The following ESD Initiatives will be incorporated as part of the hydraulic services documentation:

- Reduction of water consumption utilizing approved limited flow tapware and fixtures in accordance with WELS
- Sub metering of cold water services.
- Insulation of all hot water plant and reticulated hot water pipework
- Collection, storage and re-use of rainwater runoff for toilet flushing, landscape irrigation and minor cleaning and washdown

B.5 Work By Other Trades

Excluded from the hydraulic services part of the work are:

B.5.1 Building Work

- Provide all hydraulic ducts and form large hydraulic penetrations as shown on structural and architectural drawings. All other penetrations by Hydraulic Contractor
- Access panels to all ducts and ceilings, inspection openings and fire hose reel housings (where agreed with architect)
- Cut all holes in finished surfaces, timber, cupboards, false ceilings, vanity units, shelves, etc., as required by the Hydraulic Contractor and shown on Hydraulic Contractors penetration drawings
- Supply and installation of waterproof membranes in all wet areas
- Set out of building grids to allow set out of core holes
- Supply and installation of all roof under flashing to external penetrations
- Fire hose reel & fire hydrant cupboards and necessary signs
- Supply and install roof parapet and balcony overflows
- Concrete dish drains
- Boxing out to conceal exposed pipe risers
- Painting and signage of water storage tanks
- Making good and fire rating of all penetrations

B.5.2 Electrical Work

Electrical supply and a connection to all equipment requiring power and mentioned within this specification to the control panels where required and direct to equipment where required, including the following:

- Electrical supply to hot water plant
- Electrical supply to domestic cold water pumps
- Electric supply to boiling water units
- Electric supply to sewer pump control panels
- Electric supply to lockable isolating switches and control panel for hot water circulation pumps
- Power and control cabling and associated connections between equipment and associated control panels

B.5.3 Mechanical Work

- Extension of condensate wastes from A/C unit to floor wastes or tundishes provided by the Hydraulics Contractor

B.5.4 Building Maintenance System Contractor

Electrical alarm wiring from the following equipment:

- Sewer pump failure
- Sub-soil pump, failure
- Sub-meter for cold water services

All work not included in the foregoing and required to complete the installation shall be part of the hydraulics work.

B.6 Equipment Schedule

B.6.1 Cold Water Booster Pump

Make	: Grundfos
Model	: 2CRE5-9, Vertically Mounted
Flow Rate	: 3.5 L/s
Duty	: 500 kPa
Number of	: Two
Location	: Level 00 Hydraulic Plant Room
Power Supply	: 415V 3 Phase 2.2 kW (Hard Wired to Control Panel)

B.6.2 Cold Water Storage Tank

Make	: Aline
Model	: Mega Nominal 6,000L Panel Tank
Dimensions	: 2.2m Wide x 2.2m Long x 1.9m High. To include 50% internal partition
Type	: Metal Panel including internal liner
Number of	: One
Location	: Level 00 Hydraulic Plant Room

B.6.3 Hot Water Recirculating Pumps

Make	: Grundfos
Model	: CM3-2
Flow Rate	: 0.8 L/s
Duty	: 9m Head
Number of	: Two
Location	: Level 04 Plant Room
Power Supply	: 240V 10A (Double GPO)

B.6.4 Hot Water Plant - Major

Type	: Heavy Duty Electric Storage with 50% Solar Pre-Heat
Make	: Rheem
Model	: 3 x Model 6163507 HD Electric Heaters (6 x 3.6 kW). 4 x 610430 Solar Storage Units &14 x Rheem NPT200 Solar Collectors
First Hour Delivery	: 2,060 Litres
Number of	: 3 x Electric Storage Heating Units, 4 x Solar Storage Units and 14 x Solar Collectors
Location	: Level 04 Plant Room and Roof
Power Supply	: 415V 3 Phase (64.8 kW Total)

B.6.5 Boiling/Chilled Water Units

Make	: Zip Industries
Model	: BCHA160/175 G4 Model providing Boiling/Chilled/Filtered Cold/Hot Water
Number of	: Refer to Plans
Location	: Refer to Plans
Power Supply	: 240V 10A (Double GPO)

B.6.6 Sewage Pumping Station

Make	: Qmax
Model	: FRP-1520
Size	: 5,000L
Flow Rate	: 2 L/s
Duty	: 100 kPa
Number of	: Two
Location	: External. Refer to Plans
Power Supply	: 415V 3 Phase 2.2 kW (Hard Wired to Control Panel)

B.6.7 Grease Suction Pumping Station

Make	: Qmax
Model	: FRP
Size	: 2,000L
Flow Rate	: 2 L/s
Duty	: 250 kPa
Number of	: Two
Location	: External. Refer to Plans
Power Supply	: 415V 3 Phase 2.2 kW (Hard Wired to Control Panel)

B.6.8 Grease Arrestor

Make	: Halgan Py Ltd
Model	: MGTS2000, Below Ground
Material	: High Density Polyethylene (HDPE)
Size	: 2,000L
Location	: External. Refer to Plans
Power Supply	: 240V 10A (GPO) Within 5m of grease chamber

B.6.9 Rainwater Re-Use Booster Pump

Make	: Grundfos
Model	: SP27-12, Submersible, Vertically Mounted
Flow Rate	: 1.5 L/s
Duty	: 500 kPa
Number of	: Two
Location	: Rainwater Tank (External)
Power Supply	: 415V 3 Phase 2.2 kW (Hard Wired to Control Panel)

B.6.10 Automatic Backwash Filtration Device

Make	: Judo
Model	: JPF 40mm
Flow Rate	: 1.5 L/s
Number of	: Two
Location	: Level 00 Hydraulic Plant Room
Power Supply	: 240V 10A (Double GPO)

B.6.11 Bag Filtration Device

Make	: Southland Filtration
Model	: SLB-SS-02
Flow Rate	: 1.5 L/s
Number of	: One
Location	: Level 00 Hydraulic Plant Room

B.6.12 UV Filtration Device

Make	: Southland Filtration - Viqua
Model	: K (660001-R, 660004-R)
Flow Rate	: 1.5 L/s
Number of	: One
Location	: Level 00 Hydraulic Plant Room
Power Supply	: 240V 10A (Double GPO)

B.6.13 Thermostatic Mixing Valve (TMV's)

Make	: Enware
Model	: Aquablend1500 in recessed lockable S/S box
Flow Rate	: 28 L/min
Number of	: Refer to Plans
Location	: Amenity Areas behind mirrors generally. Refer to Plans

PART C. Technical

C.1 General

Attention is directed to the Head Contract, all conditions of which form an integral part, of this section are equally binding and applicable to all sections of this specification and accompanying drawings as listed.

C.1.1 Contract

The Contractor shall tender to cover the supply, installation and commissioning of the Hydraulic Services as described in section A.2 with the price broken down as set out in the Tender Breakdown located in section A.4.

C.1.2 Unforeseen Site Conditions

The Services drawings indicate services being installed in this contract. Deviations of services other than that indicated are to be brought to the attention of the Superintendent prior to the commencement of any installation relating to such deviation.

C.1.3 Site Inspections

The Contractor is advised to visit and inspect the site, the existing and/or adjacent structures prior to tendering to acquaint himself with its nature, means of access and working space. Take note of levels and local conditions and include and allow for in this tender all necessary items which are implied but which may not be stated or shown on the drawings. The Contractor acknowledges that before tendering that he has inspected the site, and has become conversant with all visible existing conditions of access to the site for building purposes and with existing services as shown on the hydraulic contract documents.

No claims arising from the neglect of the foregoing on the grounds of ignorance of the amount and kind of work involved and the conditions under which the works will be executed will be allowed.

C.1.4 Tender Submission

Tenders are to conform strictly as per the specification and drawings. This will be deemed a conforming tender.

C.1.5 Construction Staging

The construction phase of this contract is to be staged as detailed in the Head Contract. The contractor is to make himself familiar with the staging program and ensure that all temporary services that may be required are allowed for.

All services are to remain in operation during construction works and any interruptions are to be kept to a minimum and carried out at time to suit the Superintendent.

C.1.6 Making Good

All disturbed surfaces are to be made good (particularly paving, footpaths, gardens and roadways) to the satisfaction of the Superintendent.

Take all reasonable care to prevent any damage to existing water, communication, irrigation, electrical or underground/overhead services. Any damage to services due to the activity of the Contractor or otherwise shall be made good to the satisfaction of the Superintendent at the Contractor's expense.

Prior to commencement of any work, the Contractor shall liaise with all relevant authorities and or management of the site to ascertain the exact location of such services and whether any alterations will be required to them.

C.1.7 Clean Up

Periodically, but not less than three times per week, clean up and remove from site all excess materials and debris resulting from undertaking the works.

C.1.8 Compliance with Australian Standards

The Contractor without in any way restricting his obligations under the Contract shall comply with the requirements of all Statutory Authorities. Work not covered by Statutory Authorities shall comply with the appropriate publication of the Standards Association of Australia.

The Contractor shall carry out all tests necessary for the satisfactory, compliant completion of the works. Reasonable notice shall be given prior to commissioning tests so that the Superintendent may be present. A record of such tests as applicable shall be kept and submitted as a test report.

The intent of this Specification and drawing/s is to procure the execution of the Works in accordance with the Standards described herein.

Where an item is usual or necessary or is reasonably or properly to be inferred in the type of work generalised in this Specification but not specifically mentioned, it shall be deemed to be included in the Specification.

C.1.9 Dimensions

The Contractor shall be fully responsible for all dimensions including site dimension, required for the production of drawings or included on the drawings and shall be responsible for their accuracy.

Any errors or inaccuracies and the consequences of such errors or inaccuracies shall be rectified at the Contractor's expense.

C.1.10 Regulations

The whole of the Hydraulic Services installation shall be carried out by and/or under the direct supervision of a fully licensed Plumber in strict accordance with the latest licensing authority requirements. Notwithstanding the foregoing, the whole of the Hydraulic Services installation shall be to the entire satisfaction of the Superintendent.

C.1.11 Authority Requirements

The Contractor shall submit evidence that:

- Requirements of authorities relating to the work under the contract have been ascertained prior to the commencement of the hydraulic services installation
- Fees to authorities, if any, have been paid and all types of approvals obtained
- Certificates of compliance with regard to the extent of the installation. Such certificates have to be obtained on completion of the installation
- All fittings, pipes, accessories and the like used in the works shall bear approval marks where and as required by the regulatory authorities
- Test certificates for all essential service fittings to be provided prior to completion

C.1.12 Standards

The quality and performance of the hydraulic services works specified herein shall comply with the requirements nominated in the current edition of the Australian Standards, BCA, By-Laws, Rules, Regulations and any other Authority having jurisdiction over the project.

A complete and up to date copy of AS/NZS 3500 is to be kept on site during the construction phase.

Materials, manufactured articles and workmanship shall conform to the latest edition of the relative Standards Association of Australia Specification and Codes (including the latest amendments) except where the provision thereof conflict with the specification or the requirements of the statutory authorities. Where relevant Standards Association of Australia publications do not exist, the latest edition of the relevant British Standards specification shall apply.

Compliance with these requirements shall not result in a variation.

C.1.13 Certificates

On completion of work, the Contractor shall provide certificates of compliance for the installation of the hydraulic services, as

required by the Building Code of Australia (BCA), and any other governing authority. All certificates and test results to be included in the operating and maintenance manual.

C.1.14 Foreman

A competent Foreman Plumber with documented accreditation of previous experience as a Plumbing Foreman on projects of a similar size and nature, empowered to receive and carry out instructions from the Superintendent, must be employed on the site **at all times**.

An essential requirement of this specification is that, the appointed foreman shall be **fully conversant** with **all** regulations governing **all** aspects of the design and installation of the Hydraulic Services, has a **working** knowledge of building construction methods and an **appreciation** of the requirements of all other trades involved in this project.

C.1.15 Coordination and Liaison

It should be noted that the layout, sizing, arrangement and routing of services have generally been coordinated with mechanical and electrical services layout and must not be varied without consultation. Notwithstanding this requirement, the Contractor shall make such variation as may be necessary and dictated by site conditions and the most up to date Architectural/Structural and other services layouts to obtain clearances from obstructions and other services. Do not scale the tender drawings. Verify all dimensions from the architectural drawings and by site measurements.

Note: The mechanical services shop drawings may differ to the mechanical consultant's contract drawings. The contractor is to obtain and maintain a copy of all shop drawings for the purposes of co-ordination.

Maintain continuous liaison with all other trades to ensure that possible problems arising from the conflict with structural elements or other services are minimised, and can be resolved before any of the work is committed or installed.

Liaison includes lodging notice of interest including a standing request to all trades to be included as recipient for all issues of all shop drawings, checking and commenting in reply.

C.1.16 Existing Services

Existing services indicated on the contract drawings are shown in approximate locations only. The Contractor shall remain responsible for obtaining the location of all existing utility services including sewer, water, gas, telecommunications and power both within the site boundary and external to the site. Prior to commencement of any site works the contractor shall liaise with all utility services provided to ascertain extent of contractors scope of work and restriction or excavations in close proximity, in order to eliminate the risk of accidental damage to main services.

The contractor shall allow for all required investigations up to 2.0m radius and to a depth of 1.0m fro the location indicated on the drawings.

Where it is necessary to shut down existing services to make connections, liaise with the Superintendent, relevant trades and authorities to determine a suitable program, outlining the agreed times and dates to ensure that such works cause the least disruption to the activities/operation of the complex.

During the currency of the Contract, protect all existing sewers and appurtenances, telecommunication cables, water, electricity and gas or other services from damage, which may result from the work.

In the event of any damage being done to any of the abovementioned services during the execution of the work, the Contractor shall bear the cost of restoration. This work may be carried out either by the Contractor or by another appropriate agency as directed by the Superintendent.

C.1.17 Setting Out

Physically check and confirm all details pertaining to main service connections before commencing any committing work.

Notwithstanding approved documents, establish an early on-site liaison with the particular relevant Authority Area Inspectors for the purpose of identifying any aspect of the works, which, in the opinion of the Inspector, conflicts with the relevant regulations.

The drawings show the general layout and are generally diagrammatic only. Reference shall be made to architectural details for positions of fixtures, plant, equipment, etc.

All invert levels shown on plumbing and drainage design drawings are recommended only and must be checked on site before excavation or fabrication and installation of pipework to ensure correct cover and fall.

The Contractor shall be responsible for checking all dimensions and levels indicated against site restrictions and ensure that the proposed layout is practical before commencing work.

Before setting out each of the various stages of building, set up on-site models of the various Hydraulic Services installations appropriate to that stage of the construction, and obtain approval from the Superintendent for the purpose of providing all setting out dimensions. Models shall be complete with all necessary piping and fittings for accurate assessment of dimensions.

- Core Holes & Penetrations

The Hydraulic Contractor shall set out all core holes and openings as required and necessary for the passage of pipes and/or conduits throughout the structure.

All penetrations through suspended floor slabs shall be individually sleeved and fire stopped. Foam blocks are not structurally permitted.

Sleeves exposed in rooms without ceilings and the like shall give a neat appearance and be fully sealed and grouted from the underside.

Should any penetration sleeve be inadvertently omitted all holes required shall be diamond saw core hole drilled. Take all necessary precautions to retain water adjacent to hole being drilled and prevent damage elsewhere.

All penetrations shall be 10mm oversized and made good to maintain fire rating requirements and where appropriate, watertightness.

Do not cut any holes, openings, chases or otherwise interfere with the work of other trades without the specific approval of the Superintendent. Any damage done to other trades shall be made good at the contractor's expense.

- Accessibility

The set-out of piping, valves and equipment shall be arranged in conjunction with other trades so as to be readily accessible for operating, servicing, maintaining and repairing same.

In no circumstances shall any pipes, valves, etc. be concealed before inspection and approval by the Authorities and/or the Superintendent.

Piping, valves, etc. which are installed in unsuitable locations shall be removed and relocated as directed by the Superintendent. All expenses caused by this action shall be made good without extra charge.

If the Specification and Drawings does not make mention of minor parts, which in the opinion of the Superintendent are reasonably and obviously necessary for the satisfactory completion of the Works, then such parts are to be provided without extra charge.

C.1.18 Obvious Work

The nature and spirit of the Specification and Drawings is to provide for the work herein enumerated and shown on the tender documents to be fully understood that the Contractor, on accepting the contract, agreed to furnish everything necessary for such construction notwithstanding any omission in the Specification and Drawings.

C.1.19 Trade Name References

Any reference in this Specification to trade names or to a particular manufactured product should not be interpreted to mean that the particular article or product is the only one to be supplied or used.

The reference is given as an indication of the quality, class, type and finish of the items to be used and as information to Contractors on the amount to be allowed for the items concerned.

Articles or products of equal type and quality produced by the other manufacturers may be submitted by the Contractor to the Superintendent for approval at tender. The reference "equal to" shall be taken in all cases to be the same as the

reference “equal in all respects to”.

Any alternative product that is put forward for consideration and use must be proved to be “approved equal” to that specified, at the discretion of the Superintendent.

C.1.20 Samples

Samples are required to demonstrate workmanship, techniques, designs and materials of key components within the installation. The following samples at least will be supplied in adequate dimensions and detail to demonstrate the above:

- Submission of all equipment/accessories whose appearance will be visible and any other items as requested
- Approved prior to installation
- Be held on site after approval and used as a standard for acceptance or rejection of subsequent production units. Samples will be returned on completion of the project
- Be labelled to identify their intended use

C.1.21 Measurements

Before beginning any work or taking delivery of materials check all levels and dimensions at the site and call attention to any discrepancies.

C.1.22 Construction Program

The Contractor shall ensure that all work is manufactured, installed, commissioned and tested as required by the construction program.

C.1.23 Protection

The Contractor shall be entirely responsible for all apparatus, equipment and appurtenances furnished by him or his Sub-Contractors in connection with this work, and special care shall be taken to protect all parts thereof in such a manner as may be necessary or as directed. This protection shall include covers, crating, sheds, stores, or other means to protect the apparatus, equipment and materials from the weather and to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment.

Sanitary fixtures are to be adequately protected against damage and any item not considered in first class condition on completion of the work shall be removed and replaced upon receipt of notice from the Superintendent at no variation to the contract.

Pipe ends and openings into pipes shall be provided with adequate temporary end closures maintained during the full term of construction.

All drainage inlets and similar fittings cast flush with floor level are to be sealed by the fixing of a suitable sized 1mm thick P.G.I cover plate laid over the fitting and secured at two corners with appropriate C.S.H screws into masonry anchors.

The Contractor shall protect all parts of the building and the work of other Sub-Contractors from damage which may be caused by the Contractor’s workmen or Sub-Contractors. The Contractor shall be responsible for making good any such damage.

Suitable fire extinguishers shall be readily available at the position where such work is proceeding.

C.1.24 Identification of Services

Provide permanent identification of all Hydraulic Services in accordance with Australian Standard 1345. Identification may be of applied durable proprietary adhesive labels.

All valves shall be identified by a machine engraved tone on tone tag not less than 40mm x 20mm secured to the valve spindle with a heavy gauge brass wire split ring. Engraving shall identify purpose and extent of control and shall correspond with 'As Constructed' drawing information.

All items of mechanical equipment, boilers, hot water units, gauges, controls and alarms shall be adequately identified by

applied sign writing or tags as appropriate to identify function, extent of control or purpose.

In ground water, fire, sewer and gas main extensions from boundary and up to the building shall be identified with a plastic service indicator tape with the appropriate service name facing upwards.

Indicator wrapping shall be a minimum of 80mm wide and buried 300mm above the service and be of aluminium type.

C.1.25 Testing and Commissioning

The complete installation shall be tested in the presence of the Superintendent and approved by all governing authorities having jurisdiction therein. Prior to handing over the completed works, the Contractor shall deliver to the Superintendent two (2) copies of all approval and test certificates issued by Authorities. The Superintendent shall be given seven (7) days written notice of commencement of tests.

Provide all fees, labour, materials and instruments required for the purpose of carrying out tests.

On completion, the whole of the equipment and installation is to be inspected by the appropriate authorities in the presence of the Superintendent. Where certificates are to be obtained from the Local Authorities concerned, to the effect that equipment and installations comply with their requirements, they shall be forwarded to the Superintendent as a prerequisite of practical completion.

C.1.26 Fire Stopping of Services Penetrations

Fire separation and integrity of the building elements shall be maintained at all times. Pipes passing through fire and/or smoke rated walls, floors, bulkheads etc., shall be suitably sealed utilising BCA approved materials, whether shown on the Drawings or not and maintain the required FRL of the building.

Install fire stopping products around all service pipe penetrations through masonry floors, walls, ceilings, ducts and other fire rated elements. Product used shall be of approved manufacture, compatible with materials being used in the installation.

Pipe work installed through a fire boundary to be set out with metal pipework situated at a minimum of 100mm from any combustible material 2m either side of the penetration. Alternatives to this shall be submitted for consideration by certifier prior to installation.

Fire stopping shall generally conform to:

- National Construction Code of Australia, particularly but not limited to Volume two Part C3.15
- Local Relevant Authorities

PVC and polyethylene pipes - fire stop collars and fire wrap applicable to the type and circumstance.

Insulated pipes - sleeved through fire barrier and wrapped or fire stopped with a system tested to AS 1530: Part 4

Metallic pipes - sleeved through fire barrier and then grouted around with fire retardant product with non-combustible fire wrap or similar approved system.

Fire stopping required for Class 9b Type A construction is -/120/-120. -/60/60 or -/90/90 refs are not suitable.

In addition fire test reports to be provided for proposed fire stopping.

FRL Required	Pipe Type	Product	Description
-/60/60	PVC/DWV/P-EX	Promat Fire Collar	Intumescent fire collar
-/60/60	Copper	PROMASEAL® Wrap	Ablative wrap to be wrapped on each side of the penetration.
-/60/60	Copper Lagged	PROMASEAL® FlexiWrap	Intumescent wrap installed over the lagged pipe, and extending through the penetration by 50mm on each side.

-/60/60	Steel	PROMASEAL® Wrap	Ablative wrap to be wrapped on each side of the penetration.
-/90/90	PVC/DWV/P-EX	Promat Fire Collar	Intumescent fire collar
-/90/90	Copper	PROMASEAL® Wrap	Ablative wrap to be wrapped on each side of the penetration.
-/90/90	Copper Lagged	PPROMASEAL® Flexi Wrap	Intumescent wrap installed over the lagged pipe, and extending through the penetration by 50mm on each side.
-/90/90	Steel	PROMASEAL® Wrap	Ablative wrap to be wrapped on each side of the penetration.
-/120/120	PVC/DWV/P-EX	Promat Fire Collar	Intumescent fire collar
-/120/120	Copper	PROMASEAL® Wrap	Ablative wrap to be wrapped on each side of the penetration.
-/120/120	Copper Lagged	PROMASEAL® FlexiWrap	Intumescent wrap installed over the lagged pipe, and extending through the penetration by 50mm on each side.
-/120/120	Steel	PROMASEAL® Wrap	Ablative wrap to be wrapped on each side of the penetration.
-/180/180	PVC/DWV/P-EX	Promat Fire Collar	Intumescent fire collar
-/180/180	Copper	Promat Board System	Please consult Promat WA for details- 08 9445 8300
-/180/120*	Copper Lagged	PROMASEAL® FlexiWrap	Intumescent wrap installed over the lagged pipe, and extending through the penetration by 50mm on each side.
-/180/180	Steel	Promat Board System	Please consult Promat WA for details- 08 9445 8300
-/240/240	PVC/DWV/P-EX	Promat Fire Collar	Intumescent fire collar- Consult Promat WA for correct collar 08 9445 8300
-/240/240	Copper	Promat Board System	Please consult Promat WA for details- 08 9445 8300
-/240/120*	Copper Lagged	PROMASEAL® FlexiWrap	Intumescent wrap installed over the lagged pipe, and extending through the penetration by 50mm on each side.
-/240/240	Steel	Promat Board System	Please consult Promat WA for details- 08 9445 8300

*FRL changed to reflect tested system. No 3 + 4 hour insulation criteria available for FlexiWrap

Contractor to submit specific fire penetration product to be used and certifier/certification prior to installation of pipework through fire boundaries

C.1.27 Fire Rating Certification

Provide fire rating certification for all installed hydraulic services, such as fire stop collars, sealants, materials and the like, to maintain the integrity of the fire compartments. Certification shall be provided by an independent party.

C.1.28 Testing & Sterilisation of Systems

Carry out progressive testing of the services shown on the drawings and/or nominated in the Section and required by the respective Authorities.

The following types of tests shall be applied to the pipe services:

- Sewer Drainage & Stormwater Drainage

Water tests by gravity to the flood point of each sewer and stormwater pipe being tested.

- Sanitary Plumbing

Water test by gravity to the flood point of each pipe section being tested.

Alternatively an air test may be applied @ 30kPa for a minimum of 30 minutes.

- Cold Water Services, Hot Water Services & Fire Hydrant Service

Fill pipework with water, remove all air from the pipework and then water pressure test the pipework.

- Water Test Pressures

Before applying water pressure tests check with the manufacturers of each different piping material installed, considering the material of which the pipes and fittings are manufactured, the class of pipe (ie. suitable for certain pressures) and the pipe wall thickness to determine which maximum pressure should apply to the water test to be applied to each particular pipe material and pipe diameter. As a minimum, water test pressures shall be 1.5 times the working pressure of the system.

PROHIBITED: Air testing of any water pipe during the progress of the works or completion of the works.

Testing may be required at any time during the progress of the works, for the examination of any materials used and inspect the workmanship employed. Any materials and workmanship that are not in accordance with the specification and drawings may be rejected.

Supply all labour, plugs, pressure gauges, measuring gauges, plumbing equipment and necessary materials and equipment etc. required for testing.

Precaution shall be taken during testing of pipe services to pressurise to the limits recommended by the manufacturer of the piping material. Seal off items of equipment not designed to withstand the test pressure.

Pipework, fittings, valves and ancillaries damaged, such as annealed copper tube yielding and distorting at joints and other pipework either breaking, cracking, fittings leaking or blown off or apart from pipework, caused by excessive test pressures and procedures shall be replaced at no variation to the contract.

- uPVC Pipework

Ensure solvent cement joints have been cured for at least 24 hours before testing.

Underground or enclosed works shall not be covered or concealed from view until it has been inspected, tested and approved by the Authorities concerned.

On completion, the works shall be tested under normal working conditions and as directed and passed by all Authorities having jurisdiction over the works. All defects shall be remedied immediately and the tests re-applied to the satisfaction of the Authorities. Make good at no cost any defects disclosed during tests.

- Sanitary Fixtures

Shall be tested by subjecting them to normal use and visually checked for leaks.

- Electrical Connections

All plant and equipment having electrical connections shall be tested for insulation and earth resistance and approved by the Supply Authority. Give seven (7) days written notice of commencement of final tests.

- Sterilisation of Completed Cold Water, Domestic Hot Water Pipework Systems

Disinfect pipework installations before practical completion to comply with AS/NZS 3500.

All pipelines shall be flushed clean then charged with disinfectant using 50 mg of chlorine per litre of water. The system should remain charged for a period of at least three days, checked and adjusted for free residual chlorine and flushed out thoroughly with clean water before being used. Repeat procedure where necessary.

C.1.29 Contract Maintenance

In addition to the requirements of maintenance during the defects liability period, provide all necessary operating and preventive maintenance required for the period of the defects liability period to service items of mechanical equipment, boilers, hot water units etc, supplied and installed in the execution of the Hydraulic Services work.

C.1.30 Warranties

Warranties for items of equipment supplied in the Hydraulic Services installations shall date from the date of Practical Completion and this fact shall be stated in all orders placed for equipment. In the event of any warranty claim the Practical Completion date reckoning will be applied at no variation to the contract.

C.2 Commissioning

C.2.1 General

The Contractor shall be responsible for commissioning the various installations carried out under this Contract in accordance with the programme and to the approval of the Superintendent and Local Authorities.

Subject all systems to a commissioning and testing procedure before they are put into service.

Provide all test instruments and other testing facilities required to verify system and equipment performance and to complete all inspection test plan records.

Any work which does not comply with the specification shall be made good.

Allow in the Tender Price to pay the Authorities for any necessary and chargeable testing work.

Give at least two (2) weeks notice of the commissioning of any particular system, and submit a programme of testing and commissioning procedures for that system. Modify the programme as required.

C.2.2 Inspection Test Plan

Prepare a detailed and comprehensive Inspection Test Plan (ITP) prior to commissioning and testing. Gather information required for this check list, submit three months prior to the start of commissioning the proposed ITP for approval.

The purpose of the check list is to:

- Ensure that all items that should be checked are checked
- Produce a permanent record of the commissioning checks carried out

Accordingly the check list must be built up from information contained in this specification, from suppliers, manufacturers' installation and commissioning data and from experience in commissioning similar equipment and systems.

C.2.3 Electrical Work

All equipment supplied and work carried out under the contract shall comply with the requirements of the latest appropriate Australian Code of Practice.

The electrical installation shall be carried out in accordance with the requirements of the Local Supply Authority.

All items of equipment shall be of first grade with regard to design and manufacture and shall be completely satisfactory for operation, control, safety and maintenance under all conditions of service.

Uniformity of type and manufacture of switch gear, control gear, fittings and accessories shall be preserved throughout the whole of the installation, refer to the Electrical and Mechanical Specification for the type of fittings, wiring, conduits, control gear, etc.

C.2.4 On Completion and Cleaning Up

On completion of the work all pipe lines and drains shall be flushed until clear, taps and valves are to be inspected and re-washered if necessary, filters and strainers shall be cleaned, ducts, manholes and pits shall be cleared of debris, all fixings shall be tightened, pipework shall be cleaned, taps, outlets and the like and sanitary fixtures shall be cleaned and polished, tap buttons shall be tightened, cistern flushes adjusted and pan seats tightened.

Mechanical equipment shall be tested and commissioned, services performance balancing shall be completed and the whole of the work shall be left in perfect condition to the satisfaction of the relevant Authorities and the Superintendent.

C.3 Drawings

C.3.1 Contract Drawings

The design drawings as scheduled are issued to indicate the installation intent as coordinated by the Head Consultant's design team. The drawings and specification are intended to be mutually explanatory and complete, but all work called for by one, even if not by the other, shall be fully executed. Should the documents be in conflict, the Hydraulic Contractor will be deemed to have included in his tender price for the larger quantity and the more expensive components, as applicable.

Final set outs shall be determined from the latest architectural layouts. Do not scale the tender drawings. Verify all dimensions by site measurement.

This specification shall be read in conjunction with the following Hydraulic Services drawings and amendments during the construction of the project.

DRAWING LIST	
DRAWING NUMBER	DRAWING NAME
HY-000-00	COVER SHEET
HY-000-01	NOTES AND LEGEND
HY-100-00	SITE PLAN
HY-200-01	GROUND FLOOR DRAINAGE LAYOUT - SHEET 1
HY-201-01	LEVEL 01 DRAINAGE LAYOUT - SHEET 1
HY-201-02	LEVEL 01 DRAINAGE LAYOUT - SHEET 2
HY-202-01	LEVEL 02 DRAINAGE LAYOUT - SHEET 1
HY-202-02	LEVEL 02 DRAINAGE LAYOUT - SHEET 2
HY-203-01	LEVEL 03 DRAINAGE LAYOUT - SHEET 1
HY-203-02	LEVEL 03 DRAINAGE LAYOUT - SHEET 2
HY-204-01	LEVEL 04 DRAINAGE LAYOUT - SHEET 1
HY-204-02	LEVEL 04 DRAINAGE LAYOUT - SHEET 2
HY-205-01	ROOF DRAINAGE LAYOUT - SHEET 1
HY-205-02	ROOF DRAINAGE LAYOUT - SHEET 2
HY-300-02	GROUND WATER & GAS LAYOUT - SHEET 2
HY-301-01	LEVEL 01 WATER & GAS LAYOUT - SHEET 1
HY-301-02	LEVEL 01 WATER & GAS LAYOUT - SHEET 2
HY-302-01	LEVEL 02 WATER & GAS LAYOUT - SHEET 1
HY-302-02	LEVEL 02 WATER & GAS LAYOUT - SHEET 2
HY-303-01	LEVEL 03 WATER & GAS LAYOUT - SHEET 1
HY-303-02	LEVEL 03 WATER & GAS LAYOUT - SHEET 2
HY-304-01	LEVEL 04 WATER & GAS LAYOUT - SHEET 1
HY-304-02	LEVEL 04 WATER & GAS LAYOUT - SHEET 2
HY-305-01	ROOF WATER & GAS LAYOUT - SHEET 1
HY-800-00	DETAIL SHEET
HY-801-00	DETAIL SHEET
HY-900-00	DRAINAGE SERVICES SCHEMATIC
HY-901-00	PRESSURE SERVICES SCHEMATIC

These drawings must not be used for architectural or structural work but are to be read in conjunction with architectural, structural and all other relevant drawings including preliminary and final shop drawings prepared by other trades which form part of the contract documents or as issued **from time to time** in clarification of contract documents.

Ensure all reference drawings utilised are of current issue.

Take Note: The details of hydraulic services shown on the contract drawings indicate the principles of design and design coordinated routes of piping. Notwithstanding the information shown on drawings or specified herein, coordinate the installation of all hydraulic services without conflict with structural elements or the services of other trades and in complete accordance with the requirements of all relevant Authorities.

Any discrepancies between the relevant drawings which may effect the Hydraulic Services installation shall be reported to the Superintendent before the work proceeds.

Deviation from the drawings will not be permitted unless approval from the Superintendent is obtained in writing.

C.3.2 Workshop Drawings

Workshop drawings required to be produced under this contract must reflect the tendered hydraulic design (unless previously scheduled by an Authority or Principal), and incorporate all the implied design intent as detailed in the Specification.

Workshop drawings shall include all the elements and requirements of the Head Consultants Specification and in all respects the design should conform with the relevant Australian Standards and Codes applicable.

A copy of the approved for construction drawings shall remain on site at all times (if applicable). The installation of hydraulic services shall adhere to the design. Any major diversion to approved documentation shall be designed and documented by a professional hydraulic design consultant, with qualifications suitable for entry to the AHSCA and obtain relevant approvals from the local governing authority prior to installation of work.

Generally, prepare and submit detailed coordinated layouts, prepared using Auto CAD release 2012 or later to the same standard as the tender drawings.

Workshop drawings shall be prepared and submitted for approval and coordination prior to manufacture of works, and shall include but not be limited to the following:

- Hydraulic site services drawings of all the pipe systems for the project including all invert levels of pipework
- Co-ordination table indicating drawing numbers and ACAD reference for services co-ordinated with:
  - Dimensioned drawings of all core holes proposed throughout the buildings
  - Hydraulic services floor plans, including the position of control equipment and valves
  - Plant room and equipment room floor plans indicating all hydraulic services, pipework, valves and ancillaries
- Detail drawings of, but not limited to the following:
  - Sewer and stormwater boundary connection arrangements
  - Sewer manholes, stormwater pits, grated drains and other pit type structures
  - Pumps, and pump sets
  - Electric control panels for all pump sets and electrical equipment (obtain from manufacturer)
  - Mains pressure hot water heaters
  - Water storage tanks
  - Float regulators and water level controllers
  - Diagrammatic drawings of electrical power and control wiring for all hydraulic services equipment (obtain from manufacturer)
  - Show or acknowledge Structural/Mechanical/Plant/Architectural or all other relevant elements necessary for co-ordination

****THE WORKSHOP DRAWING PRODUCED UNDER THIS CONTRACT SHOULD REFLECT ALL ELEMENTS OF CO-ORDINATION REQUIRED TO INSTALL THE WORKS AND SHALL BE A STANDALONE DOCUMENT WITHOUT THE AID OF SECONDARY DOCUMENTATION.****

C.4 Documentation at Practical Completion

C.4.1 As Constructed Drawings

One (1) week prior to practical completion submit for approval Operating and Maintenance Manuals. The Contractor shall allow to develop the workshop drawings or design drawings for the purpose of recording all variations to installed work. A set of Drawings shall be kept on site and progressively marked up as the work proceeds to record the locations, inverts and details of all the installed services, equipment and valves.

At the completion of construction, update the original dimensioned construction Drawings to provide as-constructed record Drawings without individual revision notations. Produce additional drawings as required to form a complete record of the installation.

The as-constructed Drawings shall show precise details of all services exactly as installed and shall record any variations or modifications made during installation, testing and commissioning. As constructed drawings shall be produced to the same quality as tender drawings provided, using AutoCAD version 2008 (or later) by a qualified computer drafts person.

Supply two (2) copies of all approved installation drawings together with an electronic copy suitably burnt onto CD ROM which have been correctly brought up to date to reflect all field changes and are a true and accurate representation of the actual installations. These Drawings shall also include the following:

- The as-installed location of all equipment and fittings

- The arrangement of all pipework including the position of all pits and cleaning eyes, including inverts, grades of pipework and size
- 'As Installed' locations of all pipework systems to be dimensioned off building elements and grids
- Survey all inground pipework system and provide exact invert levels
- The location of all isolating valves
- The location of all meters and control panels

The above Drawings shall be reduced to A3 size and incorporated in the maintenance manuals.

C.4.2 Operating and Maintenance Manual

On completion of satisfactory performance tests and subject to approval by the consulting engineer, supply (3) copies of Operating and Maintenance Manuals. The manual shall include a full description of the installation and functioning of the systems involved and instructions for the efficient operation and maintenance of the installations.

The manuals shall include all relevant information necessary for the maintenance, testing, procurement of parts and removal of the service or items of equipment.

Contents to Include the Following Information:

- Dates of Practical Completion
- Dates for end of defects liability period
- Index of Contents
- Drawing List
- Definition of Terms
- Outline Description of Systems and Design reference
- Commissioning Information and Test Data
- Manufacturer's Installation and Service Manuals
- Manufacturer's Spare Parts List including recommended Prices and contacts for supply
- Manufacturer's Spare Ordering instructions
- Manufacturer's Warranties/Guarantees
- Operational Routines, inspection and test plans
- A fully detailed preventative maintenance and procedure schedule including recommended maintenance procedures and equipment maintenance intervals
- Maintenance duties in general, daily and other periodic maintenance and lubrication chart
- Annual testing of essential services
- Details of emergency measures including a fault finding guide to assist in the rectification of minor operation breakdowns
- A schedule of suppliers with postal addresses and telephone numbers
- Name of firm, postal address and telephone number of specialist service contractors
- Equipment schedule

- Completed quality assurance certificates
- One copy of all 'As Installed' drawings, diagrams, schedules and arrangements for each manual
- Test Certificates for equipment and associated service reticulation installed
- Any other information and instructions necessary for operation and maintenance of the equipment
- Electronic copy of the produced fire block plan in Auto CAD format
- Certification of independent Fire Certifier to state that all hydraulic penetrations through fire walls have been sealed in accordance with relevant Australian Standards

Format to Include:

- "A4" size ring binder with substantial hard cover
- Title and volume number printed on spine and face of manual
- All contents to have reinforced binding holes
- All 'punched' contents able to be read without removing from binder
- Where this is not possible, contents to be contained in high quality plastic pockets for easy removal
- Suitable 'dividers' provided
- Contents numbered or in other defined order

C.5 Materials and Workmanship

C.5.1 General

All equipment, materials and accessories used in this contract shall be new, shall conform to the appropriate current Australian Standard specification and shall comply with Local Authority requirements.

The whole of the work shall be carried out by skilled, qualified tradesmen, supervised by the Contractor, and/or his authorised representative. Workmanship shall be of the **highest** standard and each section of the work shall be properly and neatly executed to the best current trade practice.

Untidy work whether **exposed** or **concealed** will not be accepted.

If required, samples of any materials or item of workmanship shall be submitted for the approval of the Main Contractor before being installed.

C.5.2 Excavation

Tenderers must form their own opinion, and take what tests on site they consider necessary to ascertain what is the nature of the ground, sub-surface strata and ground water levels.

Excavations of all trenches shall be true to line and level, performed in strict observance of sound engineering principles with consideration for the preservation of adjacent structures and services and where necessary adequate sheet piling shall be provided to maintain such structures or services. Trench widths shall be kept to a minimum consistent with the bed width requirements and the requirements of adequate working space and shoring.

Where required by regulation, all excavations shall be surrounded by adequate barricades for protection of the public and/or site workers and clearly defined at night by illuminated lanterns.

Excavations shall be performed, serviced and backfilled in the shortest possible period and none shall be left open unnecessarily. Where over excavation occurs, below the required level of excavation, the over excavation shall be replaced with well compacted granular material as approved by the Main Contractor. Prepare the base of excavations with clean sharp sand. Allow for sand to be imported if necessary, free of stones and not less than 100mm depth, true to line

and grade and of density equal to that required by relevant regulation where appropriate, but in no case less than that of the natural un-excavated material.

Excavations shall be kept free from water, debris and falling earth.

Where it is found necessary to excavate adjacent to or below the level of adjacent footings, obtain approval from the Superintendent as to the method of excavation and protection of footings and method of backfill to be used prior to starting such excavations. Excavation by mechanical means shall not continue to a depth greater than 100mm above the invert level of the pipe at any point.

The Superintendent shall at any time during the Contract stop any works he considers necessary if, in his opinion, any part of the work is in an unsafe condition. The Contractor shall immediately rectify the unsafe condition as directed by the Superintendent. The Contractor shall be responsible for safety at all times.

C.5.3 Excavation in Rock

The removal of all rock and/or stone required to perform adequate excavation and trenching for the installation of Hydraulic Services shall be by Mechanical means. Removal by the use of explosives will not be permitted.

No additional charges will be considered for excavation in rock.

C.5.4 Dewatering

The Contractor shall allow within this Tender the cost of all dewatering and any additional construction costs due to wet ground conditions.

Dewatering for any reason arising shall be in continuous operation implemented to preserve prepared excavations and installed services from the consequences of flooding.

Dewatering discharge shall be controlled, directed clear of the site for disposal in a manner not causing interference with adjacent property or the public and to the entire satisfaction of the relevant Authorities.

Excavations, which have been flooded, shall not be utilised until completely dried out and the base re-consolidated. Where the consequential delay of drying out cannot be tolerated or where drying out is not possible the matter shall be referred for instruction before proceeding further.

C.5.5 Timber and Shoring

During excavation the contractor shall advance work in a careful, secure and safe manner and take all precautions against accidents. Where necessary erect approved shoring/timbering to prevent earth or other materials from slipping, falling or being shaken from the faces and sides of the excavation. All costs associated with the supply, erection, withdrawing or abandoning of shoring/timbering shall be included in the tender price.

C.5.6 Tunnelling

Provide tunnelling in lieu of trenches where required by Authorities.

Tunnelling shall comply with the requirements of the required authority. Use adequate shoring to prevent the collapse of the tunnel under all conditions.

Leave shoring in tunnel and backfill with sand under pressure after approval of pipework by Authorities and the Superintendent.

C.5.7 Public Utilities & Existing Services

Where underground public utility lines and surface drainage works and underground pipes, conduits or cables exist in the vicinity of the works, take care to protect such services. Any damage to such services must immediately be reported to the responsible Authority and to the Superintendent.

C.5.8 Excavation in Existing Pavement & Roadways

When excavating through existing pavement, saw the pavement and/or road to a depth of at least 100mm and then remove the material with pneumatic tools. If required by the Superintendent, trenches across the existing roads shall be excavated and the pipeline constructed therein so that half the roadway is always maintained open to traffic.

Allow to place 25mm thickness steel plates to Council approval over open drainage trenches during and after each days work so as vehicular and pedestrian traffic flow is maintained.

C.5.9 Making Good

Make good any damage that may be caused to the building and surfaces generally and any other works that may be distributed or injured by cartage, work generally or other operations. The reinstatement shall be at least as good a state of repair as before commencement.

C.5.10 Existing Service Connections

Seal off all existing service connections to Authorities mains to their satisfaction.

C.5.11 Gradients

Lay drains to gradients complying with the relevant authority's requirements, to the levels, if any shown on the Drawings, and in any case not less than the following:

Pipe diameter (mm)	Sewer drains
65-80	1 in 40
100	1 in 60
150	1 in 100
225	1 in 150

C.5.12 Bedding of Pipes

All pipes shall be laid in trenches free of any large objects such as tree roots, rocks or other large protruding objects. To enable proper bedding under the barrels of the pipes for the whole length of the pipeline approved compressible supports shall be placed under the pipes at intervals of not more than 1.5m and cement mortar of four to one placed there under. Where the excavation is in sand or loam and free of rock or other hard objects, the pipes may be laid direct onto the base of the trench, provided such base is suitably graded and pipes are supported along their entire length. Pipes shall be free from loading of any objects.

Where the base of a trench is unstable or water charged ground, drains shall be supported on steel reinforced concrete beams and piers designed for that purpose. Submit details of all beams and supports for approval before commencing installation.

Inspection openings shall be installed at intervals of not less than 30m continuous run of drains, downstream of change in direction or grade or elsewhere where required by the Local Authority, or where specified or indicated on drawings.

Lay a detectable strap or plastic tape in the trench after pipe laying, testing and initial backfilling for all services.

Provide a marker plate at ground level at each change of direction of underground gas services, engraved to show the direction of the line and the name of the service. Inset the marker in a 150 x 150 x 150 mm concrete block, with top set flush with the finished ground or surface level.

C.5.13 Backfill

Backfill surrounding the installed service shall be of clean, sharp sand, imported if necessary, free of stones to depth of 300mm over the service pipe barrel, placed by hand and consolidated as specified hereafter. Backfill above this level may be original material granulated, free of stones and machine placed in layers not exceeding 150mm depth before compaction.

Where the excavated material, in the opinion of the Main Contractor is not suitable for trench backfilling, the material shall be disposed of as directed by the Main Contractor. Unless the excavated material is of a granular nature the material will not be considered as being suitable for backfilling.

C.5.14 Consolidation

Backfill to excavations in areas where consolidated fill is specified shall be consolidated to the requirements of the structural specification, and to adhere to minimum requirements as outlined in AS/NZS 3500 and as mentioned below.

Fill to not less than 150mm above the top of the pipes. Compact in layers of not more than 150mm loose thickness without damage to the pipework. Compact to AS 1289. Backfill service trenches as soon as possible after approval of laid and bedded service, generally as specified. Compact as specified to the compaction density which applies to the location of the service trench. However, do not place backfill against concrete until the concrete has been in place for fourteen days, unless otherwise approved.

Compact each layer of general filling to the specified dry density of 90% modified mean dry density.

Backfill for services under roads, pavements and concrete slabs shall be gravel sub-base class 2 compacted to 95% modified mean dry density placed as nominated for general filing.

Protect the works during compaction from damage by compaction operations. Compact by hand if necessary to prevent damage or disturbance to services, pipe joints and the like.

Vibrating rollers shall not be used for consolidation of backfill over services for the first 600mm minimum above pipe barrel. Consolidation to this depth shall be done with a mechanical hand tamper of approved type.

Compaction by vibration will not be accepted and the Plumber shall be responsible for marking the locations of any underground piping to ensure no vehicular traffic passes over such after installation.

C.5.15 Anchorages

Install anchorages in the form of lateral or longitudinal anchor blocks, of not less than 15 MPa concrete, to restrain lateral movement in pipelines at bends and changes of direction on pipework of 100mm diameter and above. Bear anchor blocks against the body of the fitting only, clear of joints, and against firm undisturbed ground or compacted filling.

Where the gradient is greater than 1 in 20 (5%) concrete stops shall be provided 150mm thick and built around the pipe extending from the bottom of the trench up to a height of 300mm above pipe and recessed 75mm into each side of the trench.

C.5.16 Bedding Fittings

Provide short lengths (not more than 600mm) of flexibly jointed pipe on each side of concreted fittings, pits, manholes, and the like, in principle as illustrated in AS/NZS 3500 Part 2.

C.5.17 Concrete Encasing

Unless otherwise permitted by the relevant Authority, concrete encase the following:

- Vitrified clay sewer pipelines beneath buildings
- Pipelines which cannot be provided with the required minimum cover

Encase with 20 MPa concrete, not less than 150mm above and below the pipe and 150mm each side or the width of the trench, whichever is the greater.

C.5.18 Drains Beneath Building

Where sewer drains pass beneath footings, encase pipes with not less than 150mm of 20 MPa concrete measured clear of the line of collars.

With the exception of cast iron penetrations build into structural concrete, where drains of any kind pass through foundation walls make neat opening, minimum 6mm clear of pipe all round.

Provide suitable arch wall construction so that no superimposed loading is imparted to pipe. Seal pipe in approved manner. At outer walls make suitable approved provisions to prevent ingress of rodents and other vermin.

C.5.19 Minimum Cover over Pipe

Unless overridden by regulatory authority requirement or otherwise specified, the following table shall apply:

Pipes not subject to vehicular loading:	300mm
Pipes subject to vehicular loading:	
Not in roadways:	500mm
Under sealed roadways:	500mm
Under unsealed roadways:	500mm
Pipes in embankments or subject to Construction equipment loading:	750mm

C.5.20 Installation

Install pipework in straight lines and uniform grades without sags. Provide bends and sets as required, and sufficient unions, flanges, isolating valves and the like for satisfactory removal of piping and fittings for maintenance. Arrange and support pipework as necessary where suspended, so that it remains free from vibration whilst permitting necessary movements such as thermal expansion and contraction. Keep the number of joints to a minimum.

Do not install copper in contact with steel, zinc or other materials likely to generate electrolytic, galvanic or corrosive action. Make junctions between dissimilar metals with special fittings manufactured in suitable compatible material.

For changes of direction use bends where practicable in preference to elbows. Use elbows where pipes are led up or along walls and then through to fixtures.

Arrange valves together in operational grouping, in convenient and readily accessible positions.

Concealed pipework, located in false ceilings, roof spaces, under suspended ground floors, plant rooms, and the like shall be arranged adjacent to and horizontally parallel with each other and with walls, beams and the like. Keep at least 150mm above ground surface if under suspended ground floors. Provide adequate spacing of at least 25mm between pipes or pipe insulation, 50mm between pipes or pipe insulation and electrical cables. Take off branches at right angles.

C.5.21 Concealment

Wherever possible, pipework is to be concealed in ducts, ceiling spaces, cavities or by chasing into walls, where walls are not load bearing as defined by the Superintendent or designated as face brickwork on the Superintendent's drawings.

Pipes concealed in wall chases shall be recessed to a depth providing not less than 10mm cover to pipe barrel from rough face of wall.

Pipes concealed in wall chases shall be spiral wrapped in approved insulation not less than 6mm thick and fully mortar grouted. Copper services shall be pre-lagged 'Kemlag' type.

Water supply pipes **shall not under any circumstances** be directly cast into or under concrete floor slabs unless installed in adequately sized sleeves or where conduits are provided as part of a specific manufacturers product such as 'Rehau'.

C.5.22 Accessibility

Locate fittings and valving in accessible positions, with adequate clearance to allow, pipe fittings requiring maintenance or servicing, including inspection openings, cleaning points, joints designed to enable removal of pipes, control valves and the like.

As far as practicable, install plumbing work inside buildings so that it is removable without damage to the building structure or finishes.

Where practicable, conceal pipework so that it is accessible within ducts or non-habitable enclosed spaces and does not appear on external walls. Obtain prior approval for the location of exposed pipework.

If pipework is proposed to be enclosed so as to be not accessible after completion, obtain prior approval for the location of pipe runs and pipe fittings, and record the actual locations on work as constructed drawings.

C.5.23 Core Holes and Sleeves

The Contractor shall be responsible for setting out work and shall ensure that provision is made for core holes by fitting sleeves or other devices to formwork for floors, walls, beams, columns, etc., in conjunction with the fixing of formwork and/or placing of concrete.

To prevent weakening of the building structure, the size and location of all core holes shall be approved by the Main Contractor and project structural engineer prior to coring.

The Contractor shall make good all holes and chases through walls, floors, etc., including fitting flush after the installation of pipework.

Provide fire stop collars for uPVC pipework, check for damage prior to installation of pipework. All penetrations shall be waterproof sealed to prevent penetration of water to lower floors.

C.5.24 Wall & Floor Penetrations

Pipes passing through walls below ground level shall be provided with a water stop puddle flange.

Metal pipes penetrating fire rated walls, ceilings or floors shall incorporate galvanised mild steel sleeves, overall diameter not less than 40mm larger than the penetrating pipe. Seal with a fire stop material/fire prevention, to comply with AS 1530 Part 4.

Provide approved fire collars to uPVC piping wherever a fire rated wall, ceiling or floor is penetrated. The rating of the fire collar is to be the same fire rating of the wall, ceiling or floor penetrated, to comply to AS 1530 Part 4.

C.5.25 Pipe Supports and Fixings

All pipework shall be fixed clear of walls and each other with appropriate clips securely fixed to structural elements. Where the method of support is not detailed or specified the method proposed shall be submitted to the main contractor for approval before installation commences.

- Requirements for Supports

Piping shall be adequately supported and secured in an approved manner.

All pipes shall be adequately supported and secured to adjacent walls or slab. Pipework, except in chases, must not come into contact with any other service pipes or part of the building structure unless insulated with 25mm minimum thick section mineral wool lagging.

Pipes chased or built into walls shall be installed with one (1) layer of 4mm "DENSO" tape or be pre-lagged “Kemlag” type. All pipework shall be free to move without causing stresses in the pipework.

Elsewhere pipework must be free to move without causing stresses in the pipework or in pipe joints.

Where provision has been made for movement in mains, the branch lines shall be unrestrained and in the case of copper tube, annealed for a minimum of 2m from the main. Where this is not feasible some other approved provision for movement shall be made.

Pipework supports shall be galvanised mild steel complete with purpose made galvanised spring nuts, framing fittings, pipe clamps, and insulator.

Pipework supports shall be in accordance with the manufacturer's instructions.

Mild Steel brackets shall be hot dipped galvanised after fabrication. Vertical frames where used to support suspended horizontal runs shall allow for complete adjustment of clamps supports to suit pipe gradients as required.

Secure all supports and necessary sanitary fixtures with "RAWLOCK" or equal approved metal anchors.

Where pipework is insulated, provide supports formed to fit around the insulation. Remove the insulation in the way of the supports and replace with wood spacer blocks formed to fit the pipe, and with outside diameter equal to that of the insulation. Butt the insulation up to the blocks and seal with silicone compound. Pipes of nominal size less than 25mm may be supported without wooden blocks.

uPVC pipework shall be supported to AS 2032, Clause 6.8, at maximum spacings to Table 6.3.

Pipe hangers shall be installed at every change of direction. No pipe hanger shall be fixed to a pipe clamp already supported from other pipework, or other services.

NOTE: Explosive fixings, wooden plugs or screw-ins shall not be used.

Provisions for movement in pipework are to be made in accordance with AS 2032 and AS 2033.

- Support Intervals

Fixings shall be provided and spaced as scheduled herein; or unless otherwise required at closer centres by controlling Authority or Code requirements. Notwithstanding, all fixings shall be spaced at centres required to adequately support the particular pipe, including content, and hydraulic performance without deflection.

Pipework Material	Pipe Size mm (dia)	Maximum Spacing of Brackets, Supports and Clips-Meters		
Cast Iron	100 and 200	3.0	3.0	3.0
Copper/Copper	15 and 20	1.5	-	3.0
Alloy	25	2.0	-	3.0
	32 and 40	2.5	2	3.0
	50 and 65	3.0	2	3.0
	80 and 150	3.0	2.5	3.0
uPVC	40-50	1.0	.9	1.8
	65	1.2	1.2	2.5
	80	1.4	1.4	2.7
	100	1.5	1.5	3.0
	150	2.0	2.0	3.0
Polybutylene	10	.5	.5	1.0
	18	.6	.6	1.2
	22	.7	.7	1.4
	25	.75	.75	1.5

In the case of spigot and socketed pipes such as cast iron, etc., there shall be at least one fixing behind each collar of pipe or fitting.

All pipework shall be supported against sagging or distortion and must be held to line and grade by means of approved clips, saddles or other fixings.

Plan hot water pipe routes on site to ensure that sufficient offsetting is achieved to compensate for length increases due to expansion of the pipe. Pipe brackets on hot water pipework systems are to be guide type only and are not to restrain the pipe from longitudinal movement.

Hanger rods shall be sized in accordance with the Manufacturer's recommendations and generally as scheduled herein.

Pipe Diameter	Hanger Thread Size
mm	mm
15-80	10
100 - 150	16
230 - 375	Purpose made bracket and frame.

Where hangers exceed 250mm in length side bracket bracing shall be provided to prevent sway.

C.5.26 Dissimilar Materials

The Contractor shall be responsible for separating dissimilar metals from direct contact with each other. All necessary gaskets, dielectric couplings, etc., required shall be supplied and installed by the Contractor. All metal screws, clamps, etc shall be of the same metal and finish as the materials supported.

Where clips, brackets and pipe supports are of dissimilar metal to the actual piping used, completely insulate the piping at all fixing points with at least 10mm thick Aeroflex insulation or 8mm thick Vibration Resistant Rubber wrapped around the pipe prior to fixing in position.

C.5.27 Corrosion Protection

"Denso 600 tape" shall be used to protect all underground copper piping, nuts and bolts on all fittings, valves, hydrants, mechanical joints, tapping bands and as directed.

All pipework in stud wall cavities shall be insulated with 8mm thick Aeroflex installed to manufacturer's specification.

All copper service lines chased into masonry constructions shall be spirally wrapped with 6mm thick x 65mm wide foam insulation, with all joints tape sealed. The chase shall be fully grouted and packed firm.

Any service lines cast in concrete shall be spirally wrapped with foam insulation as specified in clause above and cover wrapped with Denso 600 tape.

All steelwork shall be hot dipped galvanised after fabrication.

All nuts, bolts, washers, clips etc., used in connection with any of the services shall be of non-corrosive material, compatible with materials in contact.

Surface rust, scale, build-up, etc., on any component in the installation shall be removed during the progress of the works and the affected area de-scaled, brushed and treated with a compound recommended by the manufacturer of the product.

On completion of joint, all residual flux must be removed. This is to be done by quenching in water,

C.5.28 Capping Off

During construction, temporarily seal open ends of pipes flush with the surrounding slab to prevent a trip hazard or the ingress of foreign matter into pipework. Seal pipes with "Templugs" as supplied by Civil and General or approved equivalent.

C.5.29 Chases and Encasing

Cut chases with a power saw unless otherwise approved. Do not chase reinforced concrete work without approval.

Pipes chased into masonry or encased in concrete shall not cross any movement joint and shall be insulated so that expansion and contraction can take place without damage to the pipe or to the material or surface finish of the surrounding element.

Provide a minimum cover of 25mm and lay in continuous lengths without fittings unless the fittings are permanently accessible.

C.5.30 Clean Outs

Install cleanouts in positions as indicated on the drawings, and as required by Local Authorities. Allow to extend from drain lines to finished surface level using a 60° junction and 30° bend.

Provide 100mm diameter, brass cleanouts at finished floor level. Clean out cover plates shall be of antislip design and shall have a rubber seal insert to achieve a airtight seal.

C.5.31 Chrome Plating

All pipes, valves, cover plates, unions and fittings exposed to view with exception to plant room and under floor areas shall be chrome plated.

Surfaces to be bright chrome plated to AS 1192.

C.5.32 Cover Plates

Where water services emerge from wall, floor or ceiling surfaces, provide cover plates or non-ferrous metal, finished to match the pipe, or of stainless steel as follows:

Sizes:

Pipe diameter:	Cover plate diameter (nominal):
up to 20mm	65mm
up to 50mm	100mm
larger than 50mm	50mm larger than pipe

C.5.33 Protection of Finished Surfaces

Protect stainless steel and chromium plated exposed surfaces during construction by an application of a strippable polyethylene coating. Apply the coating as soon as practicable and do not remove until completion of the job. On removal, clean the surface with methylated spirits and polish with a soft dry cloth.

C.5.34 Pipe Identification

Satisfactory label all pipework to conform with the requirements of AS 1345 - Identification of Piping, Conduits and Ducts.

Pipe Markers shall be of the vinyl, pressure sensitive, self adhesive type consisting of combined flow direction arrow and name of service.

Markers shall be provided on all hydraulic pipe lines at not greater than 3 metre centres. Additional markers shall be provided for:

- Both sides of a wall or partition through which a pipe passes
- A marker adjacent to valves
- Both legs of a bend
- Both sides of a pipe, which can be approached from two directions

Markers shall be ‘SAFETYMAN’ or approved equal to comply with AS 1345 (NAZ2257):

Prior to the application of self-adhesive type pipe markers clean pipe surfaces with steel wool to remove oxide films and dirt. Pipe markers that peel off or crack shall be replaced with new pipe markers without additional cost.

C.5.35 Copper and Brass Pipes and Fittings

Copper pipes shall conform to AS 1432 Tables as below:

Domestic Water Service - Type B in protected position above ground

Domestic Water Services - Type B buried or inaccessible positions wrapped with 4mm thick "Denso" tape

Gas Service pipes - Type B

Brass Pipes shall be 60/40 alloy not less than 1.6mm wall thickness when used as part of the sanitary plumbing system.

Fittings for copper and brass pipes shall be properly formed manufactured units of approved type as specified.

C.5.36 Cross Linked Polyethylene Pipe & Fittings (pe-x)

Cross linked polyethylene pipe and fittings (PE-X) for hot and cold water system, shall be of first quality and in accordance with AS 2492.

Water services pipes shall be not less than Class 16 to comply with AS/NZS 3500.

Fittings shall be Brass Dezincification Resistant as to AS 3688 with jointing as per manufacturer instructions.

Tubes which are to be installed within concrete slabs are to be run in retractable sleeves and shall comply with the requirements of the appropriate building authority (AS/NZS 3500).

Retractable sleeves Cross Linked Polyethylene will not be used in areas as specified in AS/NZS 3500.

C.5.37 PVC Pipes and Fittings

Unplasticised polyvinyl chloride pipes and fittings shall be manufactured in accordance with Australian Standard AS 1415 for soil, waste and vent applications, AS 1260 for sewer drains and AS 1464 Type 2, Class 100 for gas installations.

C.5.38 uPVC Pressure Pipes and Fittings

uPVC pressure pipes and fittings for water services and pumped discharges shall be of first quality and be in accordance with AS 1477 Parts 1-6 and AS 2032.

Solvent-cement or rubber ring joints: To AS 2032.

- Pipe Classes

Class PN 16 - For a maximum working pressure of 1.6 MPa (160m head approximately) at 20°C material temperature.

Class PN 20 - For a maximum working pressure of 2.0 MPa (200m head approximately) at 20°C material temperature.

C.5.39 uPVC Pressure Pipe for Fire Hydrant Services

uPVC pipe and fittings for fire hydrant services shall be first quality and in accordance with AS 1477 Parts 1 to 6. Equal to Blue Brute Class 18 as manufactured by Hardie Iplex or class 16 as manufactured by Acutech.

C.5.40 Polybutylene

Polybutylene pipes and fittings shall be manufactured in accordance with Australian Standard Specification AS 2642 Parts 1, 2 and 3 and installed in accordance with Australian Standard Specification AS/NZS 3500 Part 1 and Part 4 or any subsequent revision thereof and of class as required by the local governing authority except the minimum acceptable polybutylene pipe used shall be Class 16.

C.5.41 Polyethylene

Polyethylene pipes and fittings shall be manufactured in accordance with Australian Standard specification AS 1159 - 1079 and installed in accordance with Australian Standard specification AS 2033 - 1977.

C.5.42 Galvanised Mild Steel Pipe for Hydrant Services

Pipes and fittings shall be first quality hot dipped galvanised mild steel to AS 1074.

Pipes and fittings shall be joined, threaded and screwed or assembled using a roll grooved jointing system similar to Victaulic 77 fittings and couplings.

C.5.43 Cast Iron Non-Pressure Pipes and Fittings

Cast iron non-pressure pipes and fittings shall be manufactured in accordance with Australian Standard AS 1631/1974 and shall be installed in accordance with local authority manufacturers requirements.

C.5.44 Materials for Subsoil Drainage

Pipework shall be either:

- uPVC pipe with longitudinal slots

Sub-soil drainage shall be laid on blue metal 20mm single size round or crushed aggregate conforming to AS 2758.1.

Permeable Fabric shall be of Geo-textile fabric of mass not less than 150 grams per square metre.

C.5.45 Vitrified Clay Pipes and Fittings

Vitrified clay pipes and fittings for sewer systems shall be first quality and in accordance with AS 1741, Class Y. Pipes and fittings shall be jointed with black sewer standard type rubber rings, complying with AS 1693.

C.5.46 Ductile Iron Pipes and Fittings

Ductile iron pipes and fittings for water services shall be first quality and in accordance with AS 2280, AS/NZS 2544.

Pipe Class: Below ground class 9

Above ground class 10

Ductile iron pipes and fittings shall be jointed in accordance with manufacturer's instructions:

- rubber ring for below ground installations
- flanges for above ground installations

C.5.47 Piping Jointing

- Copper and Brass Pipe Joints

Copper and brass pipe and pipe fittings shall be jointed with a lap. Brazed using not less than 2% silver solder.

For lapped joints the copper tube shall be annealed and expanded one end to form a socket. The procedure shall be to clean the inside of the socket and the outside of the mating tube with steel wool to remove all traces of discolouration.

Joints made with proprietary brand capillary fittings shall be cleaned with steel wool, fluxed and heated in accordance with the manufacturer's instructions.

Upon completion of the joints all traces of flux shall be removed from the joints.

- Flanged Joints

Where flanged joints are necessary or shown on the drawings, or needed to match valves, AS B52 Table F flange shall be used.

- Silicone Sealant

Silicone sealant shall be self-polishing with anti-fungicide additive equal to Ciba-Geigy manufacture and used as recommended by the manufacturer. White shall be used around vitreous china sanitary ware and clear for sealing under fixture taps and stainless steel.

- Solvent-Welding Joint

Polyvinyl Chloride (PVC or uPVC) pipes shall be jointed by solvent-welding of the type recommended by the manufacturer. Clean joint with approved solvent cleaning fluid. Apply liberally an even layer of the approved solvent cement to both surfaces of the joint and allow to stand to become touch dry. Apply a second coat to both surfaces of the joint and push together. Remove surplus solvent with a clean, dry cloth complying with AS/NZS 3879.

C.5.48 Cement

Cement shall be 'Portland' cement of approved local manufacture conforming to Australian Standard 1315/1973.

The cement shall be supplied and delivered to the site in the Manufacturers branded and sealed bags. Arrange for adequate protective cover and storage to prevent deterioration.

Cement which does not comply with the required standards or has been adversely affected in storage shall be removed from the site.

C.5.49 Sand

Sand shall be clean sharp pit sand, screened if necessary free from all foreign or organic matter and conforming in cleanliness with the requirements of Australia Standard No A1465/1974.

C.5.50 Coarse Aggregate

Shall be nominal 20mm graded sharp bluestone or other approved screenings of hard durable uncoated particles free from all foreign or organic matter and conforming in cleanliness with the requirements of the Australian Standard No A1465/1974.

C.5.51 Concrete

Properties for all concrete in this Contract shall be:

- 20 MPa - full curing characteristic compressive strength at 28 days
- 75mm – slump
- 20mm - maximum aggregate size
- Cement - approved white cement
- Aggregate - salt free river gravel
- Cement Render - 1 part cement; 2 parts graded blue metal screenings (max. size 5) and 1 part sand: slump zero

C.5.52 Access Chamber and Pit Construction

Construct pits, sumps, access chambers and the like to the dimensions and locations as shown on the drawings and as follows, unless otherwise specified. Access chambers, pits and sumps shall be precast concrete where scheduled, cast in-situ structures shall be made on site.

Cast In situ concrete: 20mpa, unreinforced unless otherwise shown. Thickness not less than 100mm, unless otherwise shown or specified. Walls of square or rectangular pits not more than 1500mm deep may be brickwork 230m thick in cement mortar, rendered, instead of un-reinforced concrete.

Prefabricated pits shall have walls of spun precast sections not less than 60mm thick. Floor cast in situ or prefabricated. Provide cored holes as required.

If depth of pit exceeds 1500mm: F718 mesh to AS 1304 in floor, and in walls from depth 1200mm downward. Cover 50mm from inner face of walls and lower face of floor. Place main wires in walls horizontally.

Provide ladders to AS 1657, stile type to clause 5.7 or individual rung type to clause 5.8, as applicable. Provide ladder to pits deeper than one metre, cast or built into the pit walls clear of drain outlet openings or discharges. Rungs shall be mild steel rod, galvanised to AS 1650, 450mm wide, installed with a spacing of 300mm maximum, 250mm minimum with bottom rung not more than 450mm from the floor and top rung not more than 450mm below surface level.

All access chambers and grated sumps whether of the precast type or cast in-situ shall have the entire base of each pit or sump benched with 4:2:1 concrete to form half pipe channels for straight through or branch flow. The benching shall have considerable slope from the structure walls to the half pipe channel. In all cases 50mm cross fall shall be provided at the pipe inverts across the structure.

C.5.53 Pit Covers

Provide each pit with a pit cover as shown on the Drawings or scheduled, of a size appropriate to the pit.

Cast iron covers shall be complete with frames with all edges machine fitted and have removable plastic lifting hole plugs. All covers and frames shall be set to the level of the finished surface levels and filled in with the same materials as used for the surrounding surface. Provide a brass edge trim around each cover situated inside the building.

C.5.54 Grated Drains

Cast iron grating and frames shall be set to the level of the finished surface levels. Grating sizes and type shall be as indicated on the drawings.

Grates shall be provided for the following duties:-

Class A Light Duty	-	10 kN (1 Tonne)
Class B Medium Duty	-	80 kN (8 Tonne)
Class C Heavy Duty	-	150 kN (15 Tonne)
Class D Extra Heavy Duty	-	210 kN (21 Tonne)

C.5.55 Valve Boxes – Cast Iron

Provide cast iron valve boxes with removable covers for access to underground valves. Set beneath each box a shaft formed of uPVC pipe to give clear access to the valve wheel or spindle. Set top flush with pavement surface, or 15mm above unpaved surfaces and encase in formed concrete 150mm deep and 150mm wide to sides of box with top surface trowelled smooth.

C.5.56 Valve Boxes – Plastic

Provide and install valve boxes similar and/or equal to ‘Everhard’ from high density UV stabilised polyethylene, designed to withstand light vehicular traffic. Lids shall be supplied with standard marking ‘water control valve’ identification.

Valve boxes shall be appropriately sized for the application and size of valve installed.

C.5.57 Access Pits

Water meters, stop valves, control valves and the like, if installed below ground, in concrete access pits with removable pit covers. Construct with internal dimensions to give 100mm clear space below and on all sides of the fittings in the pit.

Pits shall be constructed of 20mpa concrete, 100mm thick, reinforced with F82 fabric to AS 1304. Provide pit covers of galvanised mild steel floor plate 5mm thick, with lifting holes, hinged to a galvanised steel angle frame with lugs for casting in.

C.5.58 Wall Boxes

Provide wall boxes to accommodate above ground valves, regulators and the like, constructed of 1.2mm galvanised steel plate continuous welded box construction with leading edge twice folded at 90° to form 25 x 25mm frontal surround. Fix to

masonry backing with four 10mm galvanised masonry bolts.

C.5.59 Fittings Generally

Provide the necessary fittings for the proper functioning of the hydraulic service, including taps, valves, pressure and temperature control devices, strainers, gauges, automatic controls, alarms and the like to the following standards unless otherwise specified:

Safety valves generally (including relief valves): To AS 1271.

Pressure and temperature relief valves for storage water heaters: To AS 1357.

Pressure-reducing, pressure-limiting and pressure-ratio valves for storage water heaters: To AS 1357.

Non-return devices for water storage heaters: To AS 1357.

Vacuum relief valves for storage water heaters: To AS 1357.

Air release valves: To AS 1271.

Water hammer devices to be 15mm stainless steel. Install on all cold water supplies to each apartment, retail outlet, etc.

Thermostats and energy regulators generally: To AS/NZS 3161.

Thermostats and over-temperature energy cut-outs for electric water heaters: To AS 1308, adjustable or fixed settings as required.

Water gauges: To AS 1271.

C.5.60 Taps

To AS 1718, dezincification-resistant, pressure tested to 2.0 MPa.

C.5.61 Valves

Valves shall be provided wherever specified or shown on drawings and whenever necessary for isolating sections of the system.

Valves shall be of "JOHNS" manufacture or equivalent approved for the particular application and shall bear the Testing Authority's stamp where applicable.

Valves shall be placed in approved accessible positions for maintenance.

All valves up to 80mm shall be bronze, gunmetal or of other non-ferrous metal construction. Valves in excess of 80mm shall be cast iron with bronze or other non-ferrous metal internal trim.

All brass used in manufacture of valves shall have copper content in excess of 75% and preferably containing 0.05 to 0.6% arsenic to inhibit dezincification. Bodies of brass valves shall be of LG2-C (85% copper, 5% lead, 5% zinc, 0.5% arsenic).

- Isolation Valves Generally

Shut off valves up to and including 50mm diameter shall be fitted by screwing to a tube bush brazed to pipe on inlet side and to a flare boiler union on the outlet side.

All shut off valves of 65mm diameter and larger shall be flanged unless otherwise indicated.

Unless otherwise shown on the drawings isolating valves for use with cold water shall be high pressure brass stop cocks and screwed ends. Gate valves shall be flanged bronze gate valves.

Isolating valves for use with hot water shall be bronze body ball valves with stainless steel ball resilient seating for hot water application to withstand 90°C minimum.

Check valves shall be bronze spring loaded type with screwed ends. Check valves for use on hot and cold water piping 65mm diameter and over shall be bronze swing check valves with flanged ends.

- Hose Taps

All hose taps shall be fitted with integral hose connection vacuum breakers. Chrome plated hose taps and fittings exposed inside building and polished brass elsewhere.

C.5.62 Gate Valves and Control Valves

- 15mm to 50mm

Gate Valves shall be "JOHNS", or equivalent approved pattern of gunmetal with screwed ends and with seats cast integral with the body. The spindle shall be gunmetal of the non-rising type and must not project into the bore of the valve when valve is in the 'Full Open' position.

The bore shall be clear and unobstructed in this position. The valve shall be a wedge shaped single piece casting and valve faces and seats shall be accurately machined.

C.5.63 Non-Return Valves

- 15mm to 40mm

Check valves 15mm to 40mm shall be of the horizontal pattern with gunmetal body, and gunmetal swing check with a limit stop to prevent it from remaining open.

The body shall be globe shaped and shall provide a clear passage equal in area to that of the pipe to which it is connected.

The face angle of the swing check in the 'Closed' position shall be as near as practicable to the vertical.

Check valves of over 50mm shall be tilting disc horizontal pattern with disc pivoted off centre and inclined at an angle to provide non-slam characteristics. Valves shall be lined with approved material.

Valves shall be flanged to AS B52 Table F.

C.5.64 Double Check Valves - RPZ Valves

Double Check Valve - RPZ valve assemblies shall be Watts/RMC type or similar approved of applicable sizes as indicated on drawings, installed to manufacturer's recommendations. Install lockable isolating valves on inlet and outlet.

C.5.65 Sluice Valves

To be installed on all incoming water, fire hydrant and sprinkler services. Provide and locate flanged valves in underground valve box to comply with AS 2638.

C.5.66 Gas Valves

Install valves to control and cut off gas flow in gas lines to AG 601, Clause 2.6.2 and to approval list AG 201 of AGA and ALPGA 'Approved Appliances and Components'.

C.5.67 Pressure Reduction Valves

Install reduction Valves, pressure limiting valves, or ratio valves, to produce the specified reduction in pressure. Prior to installation, obtain a guarantee from the manufacturer stating the reduction in pressure and flow rates obtained under test conditions.

C.5.68 Globe Valves

Install valves on hot water reticulation systems to AS 1357.2 and as indicated on drawings. Fit with unions on each side of valve for easy maintenance and removal.

C.5.69 Balancing Valves

Install on all hot water return lines as indicated on drawings to comply with AS 1357.2. Valves to be installed with unions for easy maintenance and removal. Valves shall be suitable for water temperatures not exceeding 99°C and pressures not exceeding 1600 kPa.

C.5.70 Ratio Valves

Shall be 2:1 ratio valves, to be installed in fire hydrant service as indicated. Valves to be equal to PHILMAC Ratio Pressure Reducing Valves. Size: 150mm flanged. Installation as per manufacturers requirements.

C.5.71 Diaphragm Valves

Shall be hand wheel operation, cast iron rubber lined diaphragm valves installed to the discharge side of the sub-soil stormwater and sewage drainage pumps.

C.5.72 Y' Strainer

Strainers shall be installed after the water meter and on each branch line with a flow control valve, solenoid or thermostatic mixing valve. Strainers are to be capable of arresting particles larger than 1.2mm, having a mesh surface area of not less than four (4) times that of the pipe.

Install check valve and control valve before each strainer. Fit each strainer with valve and drain line to facilitate ease of maintenance.

C.5.73 Flow Control Valves

Supply and install to all tapware and fittings water conservation flow control valves similar or equal to those manufactured by Conserv.

Install to manufacturer's requirements; provide all necessary valving, unions and fittings required.

Water conservation valves shall be selected to provide a water conservation rating in accordance with WELS (Water Efficiency Labelling Standards).

C.5.74 Water Conservation - Urinals

Supply and install passive infrared urinal flush control valve similar and/or equal to Zip Pearl Urinal Flush Controller No.41091. The urinal flush sensor shall be complete with adjustable fill and delay times, Janitorial flush each 12 hours of non-use, single battery input and low battery detection and identification lamp.

C.5.75 Backflow Prevention

Provide backflow prevention devices as required by the local Regulatory Authority or in accordance with the provisions of AS/NZS 3500 Part 1 Section 4 and Section 8 where applicable.

Wash down Hose Points	Hose vacuum breaker
Hose Taps Generally	Non-testable air vacuum breaker at outlet equal to R.M.C. "Aqua Gard"
Fire hose reels	Double Check Valves
Irrigation Service	RPZ valve
Non-potable Water service	RPZ Valve
Garbage Room	RPZ Valve
Rainwater & Fire Tank Automatic Infill	Dual Check Valve

C.5.76 Unions

Unions shall be three (3) piece brass, bull-nose taper type unions. Brass and nylon olive type connections shall not be used under any circumstances. Unions shall be located on the outlet side of all valves.

C.5.77 Gauges/Thermometers

- Gauges

Pressure gauges shall be installed on the suction and discharge sides of all pump sets, and equal to those manufactured

by Shearer Wright, be a minimum of 100mm diameter and be graduated in metres head and kilo Pascals, be of bronze construction mid pointing and activated by a double spring. Each gauge shall be complete with an approved gunmetal stop cock under the gauge and connected to the pipework, in accordance with CB 9 Code for pump tests.

- Dial Thermometers

Provide adjacent to the hot water flow and return lines vapour pressure type thermometers with a range of 10°C to 120°C. Fix each thermometer head to a 150 x 25mm pre-painted timber panel in a position adjacent to the equipment served and easily visible for the balancing of the system.

Provide on the upstream side of each balancing valve a thermometer well having an internal bore of not less than 16mm and inserted in a section of pipe having a free flow area of not less than the line being served.

C.6 Sanitary Plumbing and Drainage

C.6.1 Extent of Work

The work in this section of the Specification shall include the supply, installation testing and commissioning of the sanitary plumbing and drainage services as shown on the drawings and specified herein in accordance with all relevant Australian Standards and Codes of Practice. All work shall conform to the requirements of the Local Authority having jurisdiction.

The work includes the supply and installation of all pipework and fittings, hangers, brackets, and all miscellaneous equipment, gaskets, jointing materials, hardware and fixings including the use of all necessary tools and work aids as may be necessary for the proper and satisfactory completion of the Contract works.

Generally lines shall be run as shown on the drawings to correct grade, true to bore and alignment and connected to the sewer drainage where shown on the drawing.

Dimensions must be checked before work is put in hand or prefabricated.

Verify the invert levels and surface levels indicated on the drawings before excavation or installation of pipework to ensure gravity connection to supply service with correct cover and fall.

Allow for all necessary diversions and minor adjustments of pipework and equipment as may be necessary to complete the works.

C.6.2 Pipes and Fittings

All pipes and fittings shall be of the diameters as shown on the drawings and shall comply with the relevant standards indicated for each material and to the current regulations of the Local Authority.

- Inground Drainage

Shall be uPVC pipes and fittings conforming to AS 1260 and AS 2032.

- Elevated Pipework

Elevated pipework 100 diameter and over to be uPVC SWV grade and fixed as previously specified. Drainage under 100 diameter to be uPVC DWV grade. All pipework to be installed to the requirements of the Local Authority.

Provide expansion joints as required in accordance with AS/NZS 3500, AS 2032 and AS 2033 of a type approved by the Local Authority.

- Testing

As specified under ‘Testing and Commissioning’ in this Specification.

C.6.3 Inspection Openings

Install inspection openings where indicated on the drawings and where required by the Local Authority. Extend inspection openings to the surface where indicated on the drawings and as detailed. Internal inspection caps shall be brass, external in landscape gardens to be uPVC, brass elsewhere including in paved areas.

Internal inspection openings to have a rubber seal installed to achieve a air and gastight seal.

Install inspection openings in pipes so that each section of pipework is accessible in at least one direction. Inspection openings shall be placed in accessible positions and to the approval of the Local Authority.

C.6.4 Overflow Relief Gully Trap

The tops of vertical risers on overflow or disconnector gully traps in external locations shall be fitted with loose grates and finishing collars installed not less than 150mm below the outlet grating or overflow level of the lowest inlet fitting or fixture connected to the building drainage installation, and not less than 75mm above ground surface.

C.6.5 Reflux Valves

Provide reflux valves for stormwater and sanitary drainage, manufactured and tested to AS 3718 and AS 3578.

Install within a pit where positioned underground, to the requirements for access pits in this specification.

C.6.6 Covers

Shall be 600 x 600 'Faston' class A cast iron covers and frames with concrete infill to match surrounds. Where subject to vehicular traffic covers shall be class C.

C.6.7 Fixture/Wastes

Chrome plated copper where exposed and uPVC / poly in cupboards.

C.6.8 Expansion Joints

Are to be installed and shall be of a type, material and manufacture approved by the Local Authority. Install expansion joints between fixed points and where pipework crosses building structural expansion joints.

C.6.9 Floor Wastes

Shall be 80mm x 50mm, or 65mm as shown on the drawings and shall consist of a self-cleansing 'P' trap with 80mm riser and screwed chrome plated brass grate set at level to ensure adequate drainage of all floor areas. The maximum length of the riser shall be 600mm.

C.6.10 Condensate Drains

All condensate drains installed above ground to be fully insulated with 'Thermotec' insulation to the first point of connection to the drainage system.

C.6.11 Traps

Traps to fixture outlets and floor fittings shall be as scheduled hereafter. All traps shall be 'Universal' pattern type except where otherwise noted. Like traps shall be of the same brand and style throughout. Chrome plating shall be of even thickness, dense and without defect and all unions and inspection openings shall be brass with chrome plate finish where appropriate.

FIXTURE TRAP	TRAP EXPOSED	TRAP CONCEALED	FINISH	UNION
Basin (Vanity)	B	-	C	D
Basin (Handicapped)	B	-	C	D

Basin (Wall)	B	-	C	D
Sink & Trough	-	P	PL	D
Sink & Trough	B	-	C	D
Floor Waste Gully	B	P	PL/C	-

B= Brass, C=Chrome Plated, D=Double, N=Nil, P=Plastic, PL=Plain, Cu=Copper, CI=Cast Iron

C.6.12 Mechanical Plant Room Drains

In positions indicated in mechanical plant rooms and elsewhere as shown on drawings provide and install floor wastes of dimension and trap seal depth nominated and generally as previously specified, connect with wastes of diameters noted and extend to and connect to floor waste stack and stormwater drains.

Note that position of all plant room drains shown on hydraulic services drawings for mechanical services equipment are indicative only. Actual installation positions are to be determined from mechanical services shop drawings in conjunction and liaison with Mechanical Services Sub-Contractor.

C.6.13 Branches - Sanitary

When a branch line enters a vertical pipe, the branch fitting shall be wholly outside the vertical pipe so that the internal bore is maintained. Form a 25mm radius at the throat of the bend in branches up to 80mm diameter and 50mm radius in branches above 80mm diameter.

C.6.14 Offsets

Where stacks, waste pipes and vents are required to be offset, sweep bends shall be used and the maximum fall shall be given to the pipe work within the space available.

C.6.15 Vent Pipes

Provide and install all duct, group vents and relief vents of sizes shown on drawings and complete with all bends, junctions and reducers. Terminate all vents through roof with a uPVC cowl. Confirm locations of vent penetrations with Main Contractor prior to installation.

C.6.16 Flashing Metal Roof

Use ‘Dektite’ rubber flashing consisting of an upstand to tightly fit around the vent pipe and an aluminium reinforced rubber skirt to provide an easily moulded firm base for sealing and fixing to the roof.

The rubber shall be an EPDM rubber compound with carbon black to give maximum resistance to weathering and sunlight.

Flashing shall be shaped to the roofing profile, continuously sealed under all edges with silicone sealer and self tap screwed or riveted along the top and bottom edges. Roof surface shall be cleaned and de-greased prior to sealing.

Vent pipes shall be free to move through the weatherproof flashing.

C.6.17 Air Admittance Valves

Shall comply with AS/NZS 4936, and be similar and or equal to that manufactured by Studor. Selection of valve shall be sized to comply with AS/NZS 3500.2 Table 6.6 and table 6.7.

C.6.18 Access Chambers

Provide and install precast concrete sewer manholes to sizes and in locations as nominated on drawings. Refer to drawings for structural details and specifications.

C.6.19 Sewerage Pump Lift Station

Provide and install effluent/sewerage pumps in duplicate located in positions as nominated on drawings. Pumps shall be installed with all float control switches, control panels and audio/visual alarms. Refer to drawings for pump specifications, duty and performance.

Excavate for and construct basement sewerage pump pit where indicated, generally in accordance with detail shown on drawings and to the complete satisfaction of the Local governing authority.

Excavate for, provide and lay rising main in uPVC pressure piping from pump pit to discharge connection with gravity drain. Connect to pumps with flanged joints at each pump discharge bend. Provide suitable brackets and clips within pit and brace back to pit walls.

Provide individual isolating gate check valves to each pump discharge pipe external to pump pit and located in valve access pit.

Connect to gravity drain via anti-syphons inverted 'U' bend with throat 300mm above finished ground level, fitted with disconnection flanges to each leg and all securely clipped to adjacent structure.

C.7 Trade Waste Plumbing and Drainage

C.7.1 Generally

Refer to 'Sanitary Plumbing' section of this specification. The work under this part comprises the complete supply and installation of the trade waste plumbing from the trade waste drainage points including final connection to all equipment, fixtures and apparatus as shown on the drawings, to vent terminals. The Contractor shall supply and install all junctions, bends and pipework as required by the Local Authority.

C.7.2 Pipework

- General

All pipework shall be HDPE (UV Resistant) high temperature (82ºCelsius) installed to AS/NZS 3500 and the manufacturer's recommendations.

- In Ground Pipework

All in-ground trade waste pipework including all fittings shall be electro fusion welded with spigot and socket joints made from the same manufacturer.

- Elevated Pipework

All elevated trade waste pipework including all fittings may be either electrofusion welded with spigot and socket joints or be of push fit type HDPE. Installation type must be advised at tender process to the Hydraulic Consultant for approval and nominated on tender forms.

C.7.3 Floor Wastes

As specified in 'Sanitary Plumbing and drainage'.

C.7.4 Vent Pipes

As specified in 'Sanitary Plumbing and Drainage' and shall be concealed.

C.7.5 Testing

As specified in 'Testing and Commissioning' in this specification.

C.7.6 Equipment

The Contractor shall connect to installed equipment, and provide all required fittings, traps, pipework, etc, as necessary and required to complete the installation.

C.7.7 Grease Arrestors

Provide grease arrestor with a class of cover as shown on the drawings or scheduled.

C.7.8 Grease Arrestor Tanker Suction Pipeline

Provide an 65mm diameter uPVC pressure pipe suction pipeline from the grease arrestor fitted with a bend and 'KAMLOK' fitting as shown on the drawings. Provide an 65mm diameter flanged bronze check valve and a 'KAMLOK' fitting where indicated on the drawings. Fit an 65mm flanged bronze gate valve at the discharge point.

C.7.9 Basket Traps/Garbage Sumps

Basket traps/garbage sumps shall be similar to Galvin Engineering variable height deep body floor drain. Trap to have stainless steel sediment bucket with secondary strainer fitted to 100mm mechanical joint outlet. Floor grate to be SPS Vari-Level (or approved equivalent) to suit falls in floor slab.

C.7.10 Heat Tracing and Insulation

Supply and install heat tracing to all greasy waste lines as required. The heat tracing system is to be compatible to the pipework installed and self limited design to ensure the heat tracing is burnout proof and inherently safe. Heat tracing is to be CT type for use in Class 1 Zone 1 hazardous areas. Heat tracing system to be equal to those manufactured by BEP instruments. All lines are to be insulated with 25mm thick sectional lagging covered with aluminium foil.

Heat tracing shall be similar or equal to Raychem - HWAT Plus System, Model No. HWAT-R (60°C), P/N 49.3010 including the following components. Power and end seal kit, junction box, insulation entry kit, safety labels, glass tape and splicing kit.

Hot water flushing systems for WA.

C.8 Rainwater Plumbing and Drainage

C.8.1 Generally

Provide and install rainwater plumbing and drainage system complete with, pipe, fittings, components and outlets, draining generally by gravity to suitably coordinated stormwater drainage connection as provided by the Civil Drainage Contractor.

C.8.2 Subsoil Drains

Pipes and fittings shall be perforated plastic to AS 2439, Part 1. Unless otherwise shown as specified, whichever of the following is applicable:

- as required by levels shown on the drawings
- not less than 1:300 (where drawings do not indicate required invert levels or gradients)

Sub-soil drainage shall be installed to the following minimum depth, unless otherwise shown on the drawings or specified, whichever of the following is applicable, measured to the crown of the pipe:

- 100mm below formation level of the pavement, kerb or channel
- 100mm below the average gradient of the bottom of footings
- 450mm below the finished surface of unpaved ground

Grade the trench floor uniformly to the required gradient of the pipework. If the trench floor is rock, place and compact a layer of fine filter material not less than 50mm thick and similarly correct any irregularities which would cause ponding deeper than 20mm. Lay the pipes on the graded floor with one line of slots at the bottom.

C.8.3 Storm Tech Underground Stormwater System

Provide and install a complete Storm Tech parabolic arch underground stormwater system with cantilever foot and end plates as documented on the hydraulic drawings complete with pipes, inlet pits, end caps, geo fabric wrapping to comply with AS 4678. System to be supplied and installed as a complete system including all required excavation works, compaction, backfilling to comply with manufacturers standards and specification.

C.8.4 Stormwater Trench Grating & Channel

Provide and install cast in-situ and/or precast concrete stormwater channelling with grating, to sizes and in locations as nominated on the drawings. Refer to drawings for structural details and specifications.

C.8.5 Downpipes

Provide and cast into columns sewer class uPVC downpipes of diameter nominated, complete with solvent welded joints and all necessary junctions for branch drain connections. Ensure all downpipes are correctly plumbed and secured centrally in columns to the satisfaction of the structural engineer. All pipework and fittings cast into concrete shall be wrapped with two (2) layers each 1mm thick of 50mm wide fabric reinforced tape. Provide suitable protective measures to ensure downpipes are not damaged in any way during concrete pouring and in the course of all subsequent stages of construction.

Downpipes shall be installed in lengths not exceeding one floor to floor interval, to permit visual internal inspection during the course of each column pour.

Prior to the pouring of concrete columns, hydrostatic test downpipes for a period of 4 hours to determine soundness of installed pipes. On completion of test, downpipes shall remain charged with water for the duration of the concrete pour, provide slip cap to open top of each downpipe to prevent entry of concrete or debris.

C.8.6 Downpipes Connections

Connect to the base of external downpipes using pre-fabricated sump boxes, grate and outlet of size shown and extend as shown on the drawings.

C.8.7 Concrete Roof and Balcony Outlets

Supply and install cast iron roof and balcony drainage outlets in the positions indicated on the drawings and as scheduled.

New roof outlets shall be cast iron construction as manufactured by Galvin complete with integral safe tray and grate and extension ring in locations as shown on the drawings.

Each outlet shall be cast into the concrete slab complete with rubber ringed inverted adapter and connected to the vertical downpipes via min 65mm uPVC pipe material. Support each sump during construction with wire ties, set level both ways, to suit roof falls.

C.8.8 Spoon Drain Outlets (SDO)

Install drainage turn up in spoon drains by terminating pipe collar at the invert of the spoon drain. Cast iron grates are only required if specifically noted on the drawings.

Encase drainage turn up riser in 150mm thick concrete surround.

C.8.9 Stormwater Soakwells

Excavate for, provide and construct where shown on drawings, reinforced precast concrete pipe section louvred wall stormwater soakwells of diameters nominated.

Provide reinforced concrete trafficable cover slab to each soakwell where required holed for an including approved cast iron trafficable cover or grating as nominated and of type and dimension shown. Build into soakwell walls all necessary inlet and outlet pipes and make good with full mortar grout.

Soakwells to be covered externally in open weave geofabric or similar approved and contractor to provide a 300mm layer of filter aggregate of 20mm blue metal similar approval all round and at base level.

C.9 Cold Water Service

C.9.1 Generally

The work under this part comprises the complete supply and installation of the cold water service from the existing water service as shown on the drawings, to the various connection points either mentioned in this specification or shown on the drawings, or as necessary to complete the whole of the installation.

Allow for the supply and fixing of all piping, valves, unions, fittings and sundry equipment to the satisfaction of the Main Contractor. All pipework shall be copper tube Type B to AS 1432.

C.9.2 Pipework

- Copper Pipes

Copper pipes shall be jointed by brazing copper and brass to copper with low-temperature silver brazing alloy containing not less than 2% silver. Use oxyacetylene heating for all low-temperature brazing.

When copper-to-copper joints are made the pipe shall be softened and expanded with a proper expanding tool to form a slip joint to the following table:

Pipe Size O.D.	Length of Slip Joint
13mm to 20mm	10mm
25mm to 32mm	13mm
40mm to 65mm	16mm
80mm to 100mm	20mm

No valves shall be brazed or soldered direct to pipes.

Connections shall be made with brass union type adaptor silver-soldered to pipe, and fittings screwed or flanged.

Under no circumstances will a compression fitting or back nut and rubber ring or brass or copper cone type fitting be permitted to be used on the installation, except at service pipe connections to fixtures.

All fittings shall be brass or copper and shall be MP52 compliant and bear the stamp of approval of the testing authority.

In addition to general provisions for installation of copper pipe, pipes shall be fixed in continuous lengths wherever practicable and bent at changes of direction in preference to using brass fittings.

All pipework shall be of the sizes shown on the drawings or as specified. Wherever possible, pipes shall be run parallel with walls, slabs, etc., and with each other and all other branches taken off at right angles.

Where pipes are let up along walls and then through to fixtures, the pipes shall not be bent but are to be fitted with elbows to allow for correct fitting of cover plates.

Short pipe extension pieces from walls connecting fixtures shall be fitted with union connections to allow for removal of fixtures. Pipes shall be separated from the building structure with unistrut type brackets.

Provide 4mm thick PVC insulation between pipe and bracket.

External pipework shall be buried a minimum of 600mm below ground level measured from the top of the collar or flange, wrap all external underground copper pipework in 4mm thick 'Denso' tape, to the satisfaction of the Local Authority. Allow to connect to equipment provided by others once equipment is installed.

- Cross-Link Polyethylene (PE-X)

PE-X piping shall be used for all water rough-in. Rough-in piping shown in concrete slabs must be installed in retractable sleeving as per manufacturer’s instructions.

C.9.3 Testing

On completion, all pipework shall be subject to a pressure test of 1800 kPa for 8 hours. Any defects found in the system shall be remedied and test re-applied. Disconnect pipes from mechanical and hydraulic equipment prior to testing and re-

connect on completion. All testing shall be conducted prior to backfilling of trenches to enable ease of trouble shooting in the event of leakage.

C.9.4 Flow Control Valves

Supply and install to all tapware and fittings water conservation flow control valves similar or equal to those manufactured by Conserv.

Install to manufacturer's requirements; provide necessary valving, unions and fittings required.

Water conservation valves shall be selected to provide conformance ratings with WELS (Water Efficiency Labelling Standards).

C.9.5 Protection of Potable Water Supplies

All water supply systems shall be installed and maintained so as to prevent contaminants being introduced into the potable water supply.

No device or system that may permit the introduction of any foreign substance into the water service, shall be connected directly or indirectly to any part of the water supply service, including fire service, garden water and irrigation systems or to any temporary attachment to the water service without a method of cross-connection control and backflow prevention authorised by the regulatory authority.

C.9.6 Backflow Prevention Devices

In all cases backflow prevention devices shall comply and be installed to all the requirements of AS/NZS 3500/1, as and where directed by the relevant Authority.

Where specific backflow prevention devices are nominated on the contract drawings that include reduced zone pressure devices, double check valve assemblies or registered air gap and break tank installations, the contractor shall complete the relevant test recording sheets (within this specification) for inclusion into the operating and maintenance manual. A copy of all relevant test recording sheets shall additionally be submitted to the local governing authority.

Note: All backflow prevention device installations and completion of test recording sheets shall be carried out by a registered backflow prevention installer. **Backflow prevention valve test sheets contained in the appendix to this specification** require to be duly completed and included in the operating and maintenance manuals.

C.9.7 Water Storage Tanks

- General

Domestic water tank shall have a capacity of 6,000L litres and internal dimensions shall be 2.2m L x 2.2m W x 1.9m H high plus free board for valved inlet and overflow. Overall dimensions shall be subject to site measurement and confirmation before commencing shop drawings. Inlet, outlet and overflow connections shall be as required for tank purpose, confirmed by installer to tank manufacturer. All connection penetrations through tank walls shall be heavily reinforced.

All tanks shall bear permanent identification placed on the approach side identifying purpose of tank, together with name of manufacturer and date of fabrication.

Baffles shall be provided internally each way, with man sized access ways into each compartment of tank. Reinforcement shall be designed for site hoisting attachment.

Provide access manhole of size nominated and in location indicated on the drawings to suit and facilitate maintenance of inlet ball float valves. Provide fabricated galvanised mild steel ladder secured to reinforced fixing points on external wall of tank for access to manhole. Provide additional reinforcement in walls at fixing points for service pipe support brackets. Provide internal reinforced fixing (anti-torque) for ball float valve.

Tank shall be static water tested after fabrication for a continuous 7 day period witnessed by the Superintendent before site delivery and shall be the subject of a written 10 year warranty by the manufacturer in favour of the proprietor against defective materials or workmanship.

Main structure under the tank will be provided by the Main contractor.

The Contractor shall provide and coordinate all connections as follows and as further detailed on the drawings.

- Tank panel support beams - (coordinate only)
- All inlet and outlet connections
- Sludge drain and overflow
- External and internal stainless steel/galvanised access ladders
- Water level controls
- “Light weight” roof and ventilation cowl
- Roof access hatch and inlet box
- All internal components below water level shall be stainless steel
- Water level indicators
- Wave eliminator tube - for level controls (transparent)

- Stainless Steel Panel Tank

Stainless steel tanks shall be (304) stainless steel panel type, externally bolted and generally as shown on the drawings.

C.9.8 Water Level Controls

Provide a system of water level controls to the storage tank, to automatically operate the domestic cold water booster pumps and activate the alarms, including wiring/connection to the booster pumps control panel.

The water level controls shall be Kelair Micro 10 differential float switch system.

The float junction shall be mounted to the wall of the tank section at high level in an accessible location and the electrodes set to:-

- 1.Activate High Level Alarm
- 2.Stop Duty Pump
- 3.Start Duty Pump
- 4.Stop Standby Pump
- 5.Start Standby Pump
- 6.Activate Low Level Alarm
- 7.Earth

The high and low level floats shall activate an alarm with mute button located where shown on the drawings. Provide 24 V AC volt free relays and terminal strip for connection by others to BMS.

Provide all control wiring between booster pumps.

The system shall be installed in accordance with the manufacturer’s instructions and Authorities requirements.

A 240 volt power supply shall be provided by the electrical contractor. (Ensure co-ordination with electrical consultant).

C.9.9 Water Hammer

Water hammer shall be eliminated by suitable approved devices inserted in the water supply pipework, should it prove impossible to eliminate the problem by water supply pipework modification, and at the Contractor’s expense. Any pipework

subject to water hammer shall be fitted with adequate anchors, and bends in the pipework and shall be arranged clear of brackets to avoid stress points. Where pipework is installed within buildings the maximum water velocity shall be 1.6m/sec.

C.10 Hot Water Service

C.10.1 Generally

The work under this section comprises the complete supply and installation of the hot water storage and reticulation system and associated valves and pipework to the various fittings and connection points mentioned in this specification or shown on the drawings.

The system consists of:

The supply and fixing of all hot water plant piping, valves, unions, fittings and all sundry equipment to the satisfaction of the Main Contractor and the Local Authority. Pipework installation shall conform strictly with the manufacturer's recommendations and to the approval of the Main Contractor.

C.10.2 Temperature Settings

Temperature settings shall be as follows:

- Individual apartment hot water distribution 50 degrees C (to AS/NZS 3500)
- Disable amenities 42 degrees C

C.10.3 Pipework

As specified in 'Cold Water Service'. Allow to connect to equipment provided by others once equipment is installed.

C.10.4 Pipe Supports and Fixings

As specified in 'Pipe Supports and Fixings'.

C.10.5 Testing

As specified in ‘Testing and Commissioning’.

C.10.6 Expansion and Contraction

Make adequate provision for expansion and contraction so that under all working conditions no strain is imposed on pipework or fittings. Pipes located in walls and floors shall be provided with sufficient insulation so that expansion and contraction does not impose a strain on the pipework or finished surfaces. No joints will be allowed within or under concrete slabs. Expansion joints to be provided at a maximum of 18 metre centres and either side of building construction joints at every level. Expansion joints to be similar to Bestobell bellows type.

C.10.7 Backflow Prevention Devices

Backflow prevention devices shall be installed in hot water supply systems in the same manner as for cold water supply systems and must be suitable for hot water application.

C.10.8 Temperature Control

In the absence of approved tempering valves or thermostatic mixing valves in hotels, motels, sports complexes and domestic situations the Contractor shall make use of all necessary ‘Hot Water Shut-down Valves’ to prevent scalding.

The Contractor shall provide and install valves similar or equal to RMC ‘Safe n Easy’ ‘Bathsafe’ ‘Showersafe’ and ‘Tapsafe’ as appropriate.

C.10.9 Thermostatic Mixing Valves

Each thermostatic mixing valve shall be installed in accordance with the manufacturer’s instructions and the requirements of AS/NZS 3500.4 and any relevant authority.

Each thermostatic mixing valve shall have a isolating valve, line strainer and non-return valve fitted to the hot and cold water supply lines.

Thermostatic mixing valves are to be adequately supported independent of all pipework and shall be readily accessible.

The thermostatic mixing valves shall be supplied with the manufacturers/agent's full directions for the commissioning, operation and maintenance of the valve/s.

Supply and install thermostatic mixing valve similar or equal to 'Enware Aqua blend 1500' where indicated on the hydraulic drawings to comply with AS/NZS 4032.

C.10.10 Tempering Valves

Each tempering valve shall be installed in accordance with the manufacturer's instruction and the requirement of AS/NZS 3500.4 and any relevant authority.

Each tempering valve shall have an isolating valve, line strainer and non return valve fitted to both the hot and cold water supply lines.

Each tempering valve is to be adequately supported independent of all pipework and shall be readily accessible.

All tempering valves shall be supplied with the manufacturer/supplier full directions for the commissioning, operation and maintenance of the valve(s).

C.10.11 Hot Water Heaters

Supply and fix the hot water heaters in the locations indicated on the drawings and as scheduled.

Each hot water heater shall be constructed with a double coating of high temperature corrosive resistant vitreous enamel lined steel cylinder, insulated with a high density insulation or approved equal and totally enclosed in a heavy gauge zincanneal outer jacket.

The jacket shall be finished in baked enamel to an approved colour.

Provide heaters with the following:-

An automatic surface mounted temperature control thermostat with adjustable ranges on automatic over-temperature cut out to shut down the fuel or power supply should the thermostat malfunction.

A temperature and pressure relief valve to conform with the requirements of AS/NZS 1357 and terminate over a tundish or F.W. as noted on drawings.

Electric hot water heaters shall be in accordance with AS/NZS 1056 and be tested and approved by the electrical supply authority.

A copper safe tray shall be supplied and installed under the hot water heater and shall be constructed of 1.8mm sheet copper. Joints shall have soldered edges, be reinforced and turned up 50mm. a 32mm outlet shall be fitted and sealed to the tray and discharge in the position noted on the drawings.

Hot water heaters shall be mounted on the safe trays and supported on 40mm x 25mm hardwood batons, no closer than 20mm from the sides of the tray.

C.10.12 Solar Water Heaters

Supply and install solar hot water heaters as shown on the drawings to comply with AS/NZS 3500.4, AS 2712.

High performance collector plates are to be all copper, treated with a chrome block plated surface and glazed with solar low-iron annealed glass. Collector castings to be aluminium or galvanised steel.

Collectors performance to AS 2535.

Thermal insulation to AS 2712.

Each cylinder shall be constructed with a double coating of high temperature corrosive resistant vitreous enamel lined steel, insulated with a high density insulation and totally enclosed in a heavy gauge zincanneal outer jacket to AS/NZS 1056.

C.10.13 Pipe Insulation Generally

Hot water pipelines wherever they are installed throughout the buildings shall be insulated with 25mm thick Thermotec 4-Zero, insulation, in one (1) metre lengths.

“Thermotec 4-Zero” insulation shall be covered with reinforced aluminium foil incorporating an overlap. Provide and fix to longitudinal joints and circumferential butt joints 75mm wide, self adhesive reinforced aluminium tape.

Pipework located in plant rooms, service areas, non ceiling areas where exposed to view shall after insulation be covered in 0.5mm thick zincanneal sheathing.

Hot water and cold water copper pipework within stud wall framing, chased in masonry or concrete walls shall be hard drawn pre-lagged type similar to “KEMLAG”.

C.10.14 Circulating Pumps

“Grundfos” or similar/equal circulating pump.

Pump shall be 3 speed electric motor controlled by a seven (7) day time clock complete with two (2) day omission facility. The pumps are to have thermal overload protection, auto/off/manual selector for each pump, auto/changeover selector switch, motor circuit breakers, control circuit breakers, automatic alternation, AC on light, pump run lights, pump fail lights for overload, alarm bell and mute button.

ON/OFF timer switch.

The circulating pump shall be constructed of materials which shall not cause contamination of the circulated water.

The circulating pump shall be rigidly supported on a properly designed base/frame and the pipework arranged so that no perceptible vibration is transmitted by either the pipework or the building. The circulation pump and controls shall be fitted and connected in an accessible position strictly in accordance with the manufacturers instructions. Supply and install all necessary valves and pipework for the removal of the pump for maintenance.

C.10.15 Boiling Water Units

Supply and install boiling water units finished in white enamelled casing, equal to “Zip”. Each unit shall have a storage capacity and single phase element as scheduled, and shall be thermostatically controlled.

Each unit shall fit automatically and be complete with inlet and outlet connection, drain plug, steam condensing, cowl and spring loaded non-drip fixed outlet tap.

C.11 Rainwater Harvesting Systems

C.11.1 Generally

The work under this section comprises the complete supply and installation of rainwater harvesting systems, subsequent water reuse distribution from the rainwater storage tank, to the areas as nominated on the drawings.

Use of water supplied from the rainwater tank for drinking purposes is not recommended.

Rainwater supply installations shall be installed to adhere to the following:

- To avoid likelihood of contamination, preventing the possibility of cross connection between rainwater and the Authority’s potable water system. This shall be provided by means, which are appropriate to the hazard, as outlined in AS/NZS 3500
- Provide rainwater to fixture nominated at a flow rate and pressure that is acceptable for the correct operation of fixtures and fittings

- System components such as float switches, pressure pumps, tanks and fittings, are durable and best quality of there kind, requiring minimal maintenance. All components shall be adequately protected from aggressive environments
- Provide adequate access for maintenance of equipment and tank, allowing ease of replacement for mechanical components

C.11.2 Rainwater Tanks

All in ground rainwater tanks shall comply with the minimum requirements with the local authority guidelines for horizontal separation to septic systems and on-site STP.

Above ground tanks shall be separated from a building by a minimum of 25mm.

Rainwater tank shall be installed a minimum of 20m from any above ground and/or buried petroleum or chemical storage. Rainwater tank shall not be permitted to be installed contaminated ground.

- Underground Cast In-situ Tanks

Rainwater tanks constructed of materials other than that would be certified under AS/NZS 4766 or ATS 5200.026, including concrete cast in-situ tanks.

Tank installation and manufacture shall be certified by a qualified third party, confirming that the tank has been designed, manufactured, installed and tested in accordance with the local governing authority standards.

Underground water storage tanks shall be installed with sealed access covers terminating at a minimum height of 150mm above the finished ground level. Tank shall be effectively sealed to prevent the entry of surface and or ground water entering. Access covers shall be designed and installed to prevent child access.

All tanks installed in water charged ground shall be designed and installed to prevent hydrostatic uplift.

Adequate provision shall be made for adequate access to inspect, carry out maintenance and dislodge.

C.11.3 Tank Overflow

Tank overflow shall be provided with a suitable connection to the in ground stormwater system, to ensure no ponding occurs and/or to ensure rainwater from the tank overflow system will not enter the adjoining buildings.

Where a tank back up supply from the authority water main has been installed directly to the tank. Overflow shall be provided as such that a registered air gap is maintained, to comply with the back flow provisions of AS/NZS 3500.

C.11.4 Mosquito Control

Proper measures shall be taken during the installation of the rainwater harvesting system, to ensure adequate protection has been taken to ensure the prevention of mosquito breeding. The following measures shall be taken:

- At downpipe heads, leaf and debris screens, tank inlet and outlet, flap valve screens shall comply with the relevant Health Regulations for mosquito prevention and destruction
- Mosquito proof screens shall be made of brass, copper, aluminium or stainless steel gauze not coarser than 1mm aperture mesh and shall be installed to ensure it does not cause or accelerate corrosion
- Tank lids and covers shall be close fitted to exclude the entry of mosquitoes
- Screens shall be positioned for ease of removal and periodical maintenance

C.11.5 Pre-treatment Devices

Supply and install pre treatment devices to manage the first flush of contaminants washed from roof, to prevent the risk of potential contaminants adversely affecting the rainwater quality. The following measures shall be applied;

- Provide suitable gutter leaf and debris guards, combine with additional screening at each downpipe rainwater head. Screen mesh shall be 4 – 6 mm designed to be self cleansing

- Provide and install first flush device to collect and discard the first 20 litres per 100m2 of roofing. Fist flush devices shall be installed with an automated diversion and drainage system

Capillary bleed tubing draining the first flush system shall not exceed a flow rate of 4 L/hr . Install a micron filter at the base of the first flush device to prevent blockage of the capillary bleed tube.

C.11.6 Supply Service from Rainwater Tank

Piped rainwater service from rainwater tank supply serving nominated fixtures and fittings shall comply with the requirements of AS/NZS 3500 and relevant sections of this specification.

C.11.7 Flow Control

Supply and install to all tapware and fittings water conservation flow control valves similar or equal to those manufactured by Conserv.

Install to manufacturers requirements; provide necessary valving, unions and fittings required.

Water conservation valves shall be selected to provide a Triple A water conservation ratings as scheduled on the drawings.

C.11.8 Marking and Labelling

Satisfactory label all pipework to conform with the requirements of AS 1345 - Identification of Piping, Conduits and Ducts.

Pipe markers shall be of the vinyl, pressure sensitive, self adhesive type consisting of combined flow direction arrow and name of service.

Markers shall be provided on all hydraulic pipe lines at not greater than 3 metre centres. Additional markers shall be provided for:

- Both sides of a wall or partition through which a pipe passes
- A marker adjacent to valves
- Both legs of a bend
- Both sides of a pipe, which can be approached from two directions

Markers shall be ‘SAFETYMAN’ or approved equal to comply with AS 1234 (NAZ2257).

- Roof Catchment Rainwater Marking

All stormwater and water supply systems including irrigation, to and from a rainwater tank shall be clearly marked with contrasting coloured wording on green background, with the wording ‘RAINWATER’.

In ground piping shall be marked with green identification tape, with the wording ‘CAUTION RAINWATER LINE BURIED BELOW’ at 1 meter intervals. Identification tape shall be 75 – 100mm wide.

Internal taps and outlets supplied with rainwater, shall be appropriately marked with identification buttons containing the wording ‘RAINWATER’.

Provide external hose taps with metallic signage (100 x 75) labelled ‘RAINWATER’. Wording and hose tap symbol shall be black on yellow background. Securely fix sign to brickwork or hard wood post above the rainwater hose tap outlet. Signs shall comply with AS1319.

- Surface Water Marking

All stormwater and water supply systems including irrigation, to and from a rainwater tank shall be clearly marked with contrasting coloured wording on green background, with the wording ‘NON-DRINKING WATER’.

In ground piping shall be marked with green identification tape, with the wording ‘THE PIPE BELOW IS NON-DRINKING WATER’ at 1 meter intervals. Identification tape shall be 75 – 100mm wide.

Provide external hose taps with metallic signage (100 x 75) labelled 'NON-DRINKING WATER DO NOT DRINK'. Include a symbol of a hose tap and cup with red circle and diagonal cross through the circle. Securely fix sign to brickwork or hard wood post above the rainwater hose tap outlet. Signs shall comply with AS1319.

C.11.9 Tank Back-up Supply

All rainwater tanks used for plumbing purposes shall be connected to the local authority mains to maintain supply at all times.

Supply and install a Davey Rainbank and power supply system complete with tank level sensor to switch over rainwater supply to the mains whether tank level reaches a pre-set low level.

Provide a register air gap to comply with the back flow requirements of AS/NZS 3500.

C.12 Fire Hydrant Service

C.12.1 Generally

The work under this section comprises the complete supply and installation of the hose reel system and hydrant service from the existing water main to all hose reels and hydrants as shown on the drawings.

Allow for the supply and installation of all piping, hose reels, valves, brackets and bolts, necessary to complete the installation to the approval of the Local Fire Brigade, Local Authority and the Main Contractor.

Testing of the system shall be carried out by an independent testing authority at the Contractor's expense.

The Contractor is required to commission the fire service at the earliest possible stage of the contract. All fire service connections into the site are to be applied for and completed as a priority with the contractor providing all necessary flow and pressure data available on the connection to the Hydraulic Services consultant. Provide and maintain the service including all fire hose reels in operative condition in accordance with the Building Code of Australia.

C.12.2 Pipework Generally

Underground pipework shall be HDPE, PN 16. Provided thrust blocks to comply with the manufacturer's instructions to all underground pipework.

Above ground pipework shall be steel in accordance with AS1596.

All pipework shall be of the sizes shown on the drawing or as specified. Wherever possible, pipes shall be run parallel with the building slabs, walls etc. and all branch take-offs shall be at right angles.

External pipework shall be buried a minimum of 600mm below ground measured from the top of collar of flange.

C.12.3 Valves

Refer to 'Valves' section of this specification.

All valves used shall be 'Johns' or equal approved by the Main Contractor and shall be the best of their type, quality and grade. All external valves shall be installed as detailed on the drawings.

C.12.4 Testing

As specified in 'Testing and Commissioning'.

C.12.5 Fire Hydrants

Install valves with spindles uppermost and hose connection orifice at 90° to ground level. Set valves with hose connection centre at 750mm minimum above ground level. Provide hydrant valve clips and brace back to dual hydrant support structure.

Internal fire hydrants shall comprise of FRNSW approved Galvins 65mmϕ *(confirm local authority requirements)* FRNSW pattern thread hydrant valve located within all fire equipment cabinets, fire isolated stair risers or fire hydrant cabinet locations and complete with caps and chain.

Install valves with spindle uppermost and hose connection orifice at 90° to floor level. Set valves with hose connection centre at 750mm minimum above floor level. Provide where necessary hydrant valve clip and brace back to rigid structure.

C.12.6 Cabinets and Enclosures

Cabinets and enclosures for external hydrants and hose reels shall be of weatherproof design. The words 'Fire Hydrant' as applicable, in letters of contrasting colour and not less than 75mm high shall be displayed on the front of the cabinet. Doors shall be secured shut by means of a lock, operable by a square taper or other key carried by the local Fire Authority.

Cabinets and enclosures for internal hydrants and hose reels shall have the words 'Fire Hydrant' or 'Hose Reel' or both as applicable, displayed on the front of the cabinet in letters not less than 50mm high of contrasting colour.

C.12.7 Block Plans

Fire hydrant block plan shall consist of photo-sensitised aluminium plate, showing a diagram of the complete fire hydrant/hose reel system, and are to be located in the fire hydrant booster cupboard to comply with AS 2419, using upper case lettering of minimum 25mm high identifying:

WORKING PRESSURE - (*) kPa

SYSTEM TEST PRESSURE - (*) kPa

The following additional information shall be identified in the block plans:

- Size and location of Supply Authorities mains (dimensioned)
- Connections and valve locations
- Storage tank capacities where applicable
- Location and duties of pumps where applicable
- Location and total number of hydrants
- Location of booster connection
- Location of main isolating valves
- Connection to other installed fire services such as fire hose reels
- Year of installation
- Major extensions where applicable
- Unusual features where applicable
- Names of installing Contractor
- Operational discharge pressure
- Height of highest hydrant outlet above booster inlet connection

C.12.8 Temporary Fire Protection (During Construction)

Provide on each floor, during the construction process, at least one fire extinguisher, suitable for Class A, B & C fires and electrical fires adjacent to each required exit or temporary stair as required in the BCA Clause E1.9.

When the building reaches an "effective height" of 12m, any hydrants and hose reels required by (Pt E1 BCA) to be installed in the finished building must be operational in each storey that is covered by the roof or floor structure above (except the two uppermost storeys) and any required boosters installed.

The temporary fire protection will be supplied by the permanent 150mm fire mains and booster when required by the permanent fire booster pumps.

C.12.9 Fire Drencher Heads and Reflector Hoods

Drencher heads shall be of the glass bulb types as approved by the Insurance Council of Australia.

Drencher heads shall be constructed of bronze or other approved corrosion resistant material and fitted with stainless steel spray deflector hoods.

The Contractor shall be responsible for installing the drencher heads having operating temperature of 93°C.

Spare drencher heads in accordance with AS 2118 shall be placed in suitable cabinets provided by this Contractor adjacent to the control valve position where ambient temperature does not exceed 38°C. The temperature ratings of all spare heads shall be clearly marked. A spanner for each type of sprinkler head shall be provided by this Contractor.

C.12.10 Fire Drencher Equipment Labels

Each item of plant and equipment shall be labelled to clearly identify the item and its function. The labels shall be of bevelled edge traffolyte with engraved white block type lettering and shall be to the approval of the Consultant. Punched type adhesive labels will not be accepted. Suppliers' and installing Contractors' nameplates shall be approved size, type, location and lettering. Valves shall be labelled with approved engraved labels as noted above, secured to the valve handwheel or adjacent to the operating device as applicable, or alternatively, by means of a numbered brass or plastic tag 25mm diameter secured by a brass link.

Each identification plate shall be 120mm x 120mm 'Traffolyte' with white and red engraved lettering not less than 15mm high and each shall be bracketed to the valve in an easily readable position.

C.13 Fire Extinguishers & Blankets

C.13.1 Generally

Provide fire extinguishers and blankets in accordance with NCC and Australian Standard requirements. Sizes and types are documented on the drawings.

C.14 Pumps and Controls

C.14.1 Generally

Before setting out for any aspect of pump installation obtain pump manufactures shop drawing for all set-out and physical dimensions and cross check against documented provisions including interfaces with other trades.

Provide and install in positions indicated electric pump units as scheduled herein.

Each pumping unit shall be capable of performing the duty nominated.

All pumping units are to be mounted on inertia blocks or are to have anti-vibrations mountings.

Pump units in duplicate are to be installed in parallel with one duty pump and one standby pump. In all cases pump units are to be properly located and connected to the relevant service complete with stop vales, check valves and flexible couplings. Connection to inlet and outlet of each pump is to be made with a flanged joint or flare type union as applicable.

Thoroughly flush all services free of all debris before fitting of any pump unit.

All pumps shall be installed strictly in accordance with manufacturers instructions and all pump installations shall be inspected and commissioned by the manufacturers agent before being put into service.

On completion of installation all pump units shall be sign written to identify purpose and pump unit number corresponding with Hydraulic connection code.

C.14.2 Flexible Pump Couplings

Flexible connections or anti-vibration couplings shall be 'S' flex flexible couplings installed on the suction and discharge side of each pump in accordance with the manufacturer's instructions.

Each flexible connector shall have a hose length of not less than four (4) times the pipe diameter installed with a maximum angular deflection not exceeding five (5) degrees.

C.14.3 Pump Mountings

Shall be Silentbloc or approved equal spring isolating mountings on an appropriate size to provide a minimum 95% vibration absorption.

C.14.4 Domestic Water Pressure Pumps

'Ajax' or similar equal custom built automatic pressure system pump package comprising dual centrifugal back pull-out mechanical seal water pumps with all bronze casing, bronze impellor and stainless steel shaft.

Both pumps shall be mounted on a common fabricated mild steel base galvanised after fabrication.

All inter-component piping, valves, controls and wiring are to be provided by pump manufacturer with the assembled package and include pressure vessels of manufacturer nominated capacity for minimum number of starts, dial pressure gauges, pressure switch, flow switch and control panel all necessary Hydraulic control equipment including relays, fuses, starters, switches and wiring for functioning of system, all to SAA Code and Western Power requirements.

Pressure/flow switch control to be such that switch will function on no flow. Diaphragm pressure tanks of fabricated steel construction, epoxy coated on all metal surfaces in contact with water. Performance and capacity as scheduled. Pre-charge the tanks with air.

Main power will be provided to the control panel isolator switch by the electrician and is specified elsewhere.

C.14.5 Sewerage Pumps

'Ajax or equal, 3 phase 2.2kW submersible sewerage pump with 100mm self-lock discharge elbow and FQ 8 automatic liquid level controllers.

Pump duty is 2 litres per second against a total head of 10 metres.

Two pump units are required, connected in parallel, with duty/stand by on alternate cycles.

Pump control shall be by an 'Ajax' or equal custom built slimline control panel, including all necessary relays, fuses, starters, switches and wiring for functioning of system, all to SAA Code and Western Power requirements, installed by Ajax and connected to pumps and float switches through conduits as shown on drawings.

Pumps shall be complete with custom selected galvanised pump removal guide rails, including top and bottom fixing plates secured in pump pit with galvanised bolts, nuts and washers, connecting flanges, galvanised lifting chains with shackles and custom fabricated galvanised mild steel support bracket suitable for retaining lifting chains and all Hydraulic cables including demountable cable-clamps.

C.14.6 Control Panels

All pump control panels shall be custom built to suit available space, site measured where necessary. Cabinets shall be weatherproofed where required, finished in selected colour with hinged key lockable doors. Keys shall be compatible with the master key type utilised for mechanical equipment items.

Allow for all control cabinets, mounting brackets, contactors, isolating and control switches, auxiliary switches, alarms, wiring between pump and panel, panel and level controls, and other associated equipment necessary for the safe and effective operation of the pumps as required for the installation and in accordance with statutory requirements to AS 3000.

Dual Control Panels: Each dual control panel shall contain the following minimum equipment plus any additional equipment under the appropriate control panel.

1. Circuit breakers for each pump.
2. Control circuit breaker.
3. Auto/off/manual switch to each pump.

4. Direct on line magnetically operated contactor starters fitted with hand reset thermal overload relays for motors under 15 kW. All motors 15 kW and over to be Star Delta starting unless otherwise specified.

5. Panels shall have automatic alternation so each pump alternates on each cycle.

6. Indicating lights for the following:

-	Power on	1 off
-	Pumps run	1 off for each pump
-	Pump fail - from overload	1 off for each pump
-	Low level alarm	1 off
-	High level alarm	1 off

7. Audio alarm or bell complete with reset type mute button located on front of panel.

8. Auto-Pump One-Pump Two-Selector.

9. Volt free terminals on separate terminal strip for each pump run, each pump fail, high level and low level alarm, wiring to remote indication panel by other nominated sub-contractors.

10. Individual digital hour meters for each pump operation.

Cold Water Booster Pumps: Dual Unit

Note: If Dual units as per Dual Pump Panel above.

1. Circuit breakers for each pump.

2. Control circuit breaker.

3. Auto/off/manual switch to each pump.

4. Star Delta operated contactor starters fitted with hand reset thermal overload relays if over 11 kW.

5. Automatic alternation. Duty pumps shall alternate every 24 hours.

6. Indicating lights for the following:

Power on	1 off
Pumps run	1 off each pump (3 off)
Pumps fail - from overload	1 off each pump (3 off)
Low level alarm	1 off
High level alarm (will stop pumps)	1 off
Low suction (will stop pump)	1 off

7. Reset push button type mute button located on front of panel.

8. Audible alarm.

9. Auto-Pump 1,2,3-Pump 2,3,1-Pump 3,1,2-Selector

10. Volt free terminals on separate terminal strip for:

Pumps run	3 off
Pumps fail	3 off

High level alarm	1 off
Low level alarm	1 off
Low suction	1 off

11. Individual digital hour run meters for each pump operation.

Control Panels:

Construction:

1. Control panel shall be provided to house electrical switch gear associated with pumps, and any other equipment requiring electrical controls for proper operation and safety. The control panels shall be wall mounted adjacent to equipment or in location shown with top at approximately 1800mm high above floor. In some cases approval will be given for control panels to be mounted on equipment

2. Control panels shall be totally enclosed cabinet type with generally of minimum 1.2mm thick furniture grade zinc coated mild steel. Painting shall be in accordance with “painting” clause

3. All seams shall be welded and ground to a smooth finish. Internal stiffening of panels and doors shall be provided where necessary to prevent buckling. The rear panels of wall mounted cabinets shall be dimpled or spaces provided

4. Control panels shall be designed for ease of access to all equipment and wiring and shall be provided with at least 10% spare space for the addition of future equipment

5. Control panels shall comply with AS 1339 as follows:

   - IP50 for internal locations

   - IP54 for external locations or where as weatherproof cabinet or enclosure is specified

6. Doors shall have concealed hinges and an approved key operated lock

   - Two locks for doors in excess of 1000mm

   - Vertical locking bars to provide top and bottom fastening shall be provided on all doors exceeding 1500mm in height

7. A dustproof seal consisting of a substantial mould neoprene rubber strip shall be provided for doors or removable panels and covers. Escutcheon panels need not be provided with seals

8. All screw fixings, nuts, etc. shall be held captive. All bolts, nuts, handles and fittings, etc., to view shall be chromium plated and polished. All other screws, nuts, etc., shall zinc plates. Visible nuts shall be ‘acorn’ or ‘knurled knob’ type. Screw fastenings for large hinged or removable panels shall be chromed knurled knob type

   Switches, indicators, etc. to which wiring is connected shall not be fitted on removable plates. In such cases mounting plates shall be hinged

10. Where conduits or cables enter cabinets, (cables must enter from the bottom), drill the cabinet and locknut the conduits or the cable glands to the cabinet. Note - No top or side entry without approval

Equipment:

1. DIN standard rail mounted terminal strips shall be provided for the termination of all external control circuit wiring and BAS identification

2. Equipment shall be neatly arranged and readily accessible for maintenance

3. Each control panel shall be provided with an isolating switch, neutral and earth link

4. Control switches shall be rotary type complying with AS 1431

5. Indicator lights shall match control switches with colours to as follows:

   RED Pump fail, alarm - eg. high and low level

   AMBER Pump running

   GREEN Power supply on

6. Fuses shall be HRC type complying with AS 2005 with fully shrouded base contacts

7. Circuit breakers shall be approved by Australian supply authorities and comply with AS 3111 and AS 2184 minimum interrupt capacity shall be 6 kA

8. Time clocks shall be quartz crystal oscillator type with an accuracy of plus/minus 5 minutes per annum and complete with nickel cadmium battery to proved a 50 hour reserve/digital 100 hour

9. Covered terminal strips with labelled terminals shall be provided for connection of the Building Automatic System (BAS) wiring by others. Wiring to terminals shall provide voltage free contacts for all alarms and faults and for pump running indication. Contacts to be either normally open or normally closed contacts

Labelling:

1. All control panels and equipment shall be labelled with engraved laminated type labels. Labels shall be black and white lettering. Size of lettering shall match importance and location. Labels shall be screw fixed

2. Cabinets shall be labelled to indicate function eg:

   "SUMP PUMP CONTROLS"

3. Equipment shall be labelled to indicate function and to identify any associated equipment, eg:

   "PUMP CONTROL SELECTOR"

   AUTO/OFF/MANUAL

Painting: "Powder coating" in the following manner:

1. Panel submerged in a bath or primer using the principle of "Electrophoresis"

2. Final coat is electrostatically sprayed and is a durable polyester coating with a minimum thickness of 50-60 microns

C.14.7 Ancillary Float Switches

Provide and install 'Ajax' CR - CF or similar equal encapsulated float switches for controlling water supply pumps.

C.15 Sanitary Fixtures and Taps

C.15.1 Taps & Outlets

Taps and outlets shall be tested and stamped by an approved Testing Authority and shall be manufactured from approved copper alloy or other approved material.

Provide breeching pieces and pipe fittings, service nuts, necessary for the correct installation of faucets, taps and fittings.

Ensure that the installation procedures for all fittings is in accordance with the Manufacturer's specification and that fittings as installed are of the type recommended by the Manufacturer for the particular service conditions and that adjustments and settings for supply pressure, flow rates, mixing valves orifice sizes, etc are correct for the given application.

Generally all fittings in a given internal area shall be of matching type. Particular care shall be taken during installation to avoid damage to the finish and any fittings with scratches, burrs or tool marks be replaced by the Contractor at his expense.

Fittings shall be solid brass and plated finishes shall be of first quality plating applied using an approved electro-plating process such as copper, nickel, chrome or other approved method. All plated and other finishes shall be subject to sample approval.

All tapware, shall be provided by the builder. Allow to take delivery of and installation of tapware as scheduled by the Architect.

C.15.2 Fixtures

Install fixtures, fittings, taps and outlets in the position shown. Connect to water waste and vent systems. Vitreous china shall be white. All fixtures shall be complete with all necessary fixing bolts, screws, brackets and stainless steel trimmed uPVC waste outlets with rubber stoppers where required and connected to all services as specified. All fixtures shall incorporate internal overflows where required by the local authority.

All sanitary fixtures, shall be provided by the builder. Allow to take delivery of and installation of fixtures as scheduled by the Architect.

C.16 Acoustic Treatment of Hydraulic Services

C.16.1 Generally

Noise generated from the hydraulics system and plant shall not exceed the levels as specified in the BCA and as otherwise directed by the project acoustic engineer. Unless noted otherwise, noise level criteria should not be exceeded with the plant operating under normal operating conditions. Provide all necessary treatment as specified to achieve the specified noise criteria.

C.16.2 Noise Generated by the Hydraulic System

Noise from the hydraulics system should be minimised by:

- Limiting pipe velocities in water systems to not more than 1.5m/s
- Laying out pipes to minimise the number of changes in direction and installing pipes so that the effective cross-sectional area of the pipe is maintained at pipe bends and junctions
- Selecting valves and fittings that minimise the generation of noise
- Installing pressure reducing stations as required to eliminate excessive pressure at the terminal valves
- Controlling structure-borne noise (ie. plant and pipe vibration transmitted into the building

C.16.3 Structure Borne Noise and Vibration

The Sub-Contractor shall minimise the transmission of vibration to the building structure to ensure the noise and vibration criteria are achieved by:

- Statically and dynamically balancing rotating plant and equipment. Out of balance should not exceed 0.03mm kg/kg of rotating element after installation. Where specified, provide balancing test certificates
- Providing isolation mounts or hangers for vibrating plant and equipment
- Providing inertia blocks where required to limit the vibration amplitude
- Isolating piping, electrical conduit, etc. subject to vibration from the building structure
- Providing flexible connections where piping is connected to vibrating plant and machinery

Submit a schedule of isolation mounts indicating make, model, rated load and static deflection, actual load and static deflection, unloaded height, fully loaded height.

C.16.4 Pipe Vibration Isolation

Where required install neoprene pipe sleeves between the pipe and pipe clamps to isolate pipe vibration from the clamps.

The neoprene should compress 10-20% under the weight of the filled pipe. Do not compress sleeve more than 30% when clamp is tightened. Use 10mm thick neoprene rubber for pipe O.D. 65mm to 150mm; 4mm thick rubber for pipe O.D. up to 65mm.

Where required install pipe vibration hangers or supports of the type indicated in the table below in Section 5.4.

Flexible connections should be fitted to all pump piping connections. These should be twin sphere reinforced-rubber elements, be capable of withstanding internal pressure and other forces and be compatible with the fluid in the pipe.

C.16.5 Equipment Bases

Mount equipment on rigid bases. The bases shall be sufficiently rigid not to deform under the weight of the machinery or during operation and reduce the effectiveness of the isolation mounts.

Where required, concrete inertia bases shall be installed, the mass of the base shall be at least 1.5 times the mass of the equipment being supported including pipe fittings, etc. Bases shall minimise the height of the centre of gravity of the machine/base.

C.16.6 Installation of Vibration Isolation Mounts

The mounts shall be levelled once the equipment is fully loaded in its operating condition with a minimum clearance between the machine and the structure of 20mm, and adjusted to ensure that the isolators are loaded correctly. Ensure that the isolators are not bridged by mounting bolts or contact between any part of the machine or an unisolated part of the isolation mounts and the structure.

The number and spacing of the mountings shall be selected to minimise machine rocking. Static and dynamic forces during operation and start-up shall be considered when selecting the mounts.

During construction, pump isolation mounts shall be bridged with a timber block to prevent the possibility of overloading of the mounts during the installation of the piping.

Piping hangers and mounts shall be adjusted so that there is minimum strain on piping with the system operating in its normal condition.

Where there is a possibility of significant lateral loads occurring use hold down bolts, lateral restraints, or housed mounts to locate equipment.

C.16.7 Pipe Penetrations

Seal pipes penetrating slabs or walls according to the project noise criteria in the adjacent spaces, as follows:

PROJECT NOISE CRITERION IN ADJACENT SPACES	SEAL TYPE
Greater than 40 dB (A)	Type PA or PB seal.
Less than or equal to 40 dB (A)	Type PB seal.

PART D. Appendices

D.1 Appendix A - Contract Drawings

Drawing No	Description	Revision

D.2 Appendix B - Provisional Sums/Contingency sum

D.2.1 Provisional Sums

Description	Cost	GST	Total

D.2.2 Contingency Sum

Contingency Sum : $_____

o Appendix C - Tender Summary

Tenderers shall submit a breakdown of the total tender price including administration cost and profit for each section of the works as follows:

The amounts included in the Total Tender sum including overhead costs and profit margins are as follows:

(a)	Provision for all sanitary fixtures, fittings and tapware	$ _____
(b)	Provision for connection to existing utility services ie., sewer, potable water, and fire	$ _____
(c)	Soil, waste and ventilation services.	$ _____
(d)	Industrial waste and drainage services.	$ _____
(e)	Hot and cold water services including all necessary temperature control equipment and hot water units	$ _____
(f)	Rainwater Harvesting & Stormwater Drainage	$ _____
(g)	Fire hydrants and fire extinguishers	$ _____
(h)	Authority Fees and Charges	$ _____
(i)	Testing and Commissioning	$ _____
(j)	Maintenance (during defects liability period)	$ _____
(k)	Operating and Maintenance Manuals including As-Constructed Drawings	$ _____
(l)	Provisional Sums	$ _____
	TOTAL TENDER AMOUNT (EXCLUDING GST)	$ _____
	GOODS & SERVICES TAX (10%)	$ _____
	TOTAL TENDER AMOUNT (INCLUDING GST)	$ _____

NAME OF TENDERER: _____

CONTRACT: _____

o Appendix D - Schedule of Contract Rates

Tenderers shall submit the following Schedule to allow assessment of variations:

Composite Rates:

The following rates shall include for the supply and delivery of all materials, transport, erection and labour to complete the installation of the following elements in the works:

Description	Unit	Cost/Unit	GST	Total/Unit
Stand-down of Works	Day			

Hourly Labour Rates (including GST):

Period	Labour 1	Labour 2	Labour 3	Labour 4	Labour 5	Labour 6
Ordinary Time						
Time and a Half						
Double time						

NAME OF TENDERER: _____

CONTRACT: _____

o Appendix E – Claims Form

Item		Tender Amount	% Complete	Amount Claimed
(a)	Preliminaries and Mobilisation	$	%	$
(b)	Demolition and Removal	$	%	$
(c)		$	%	$
(d)		$	%	$
(e)		$	%	$
(f)		$	%	$
(g)		$	%	$
(h)	Commissioning	$	%	$
(i)	Insurance, Transport and On-Costs	$	%	$
(j)	Shop Drawings	$	%	$
(k)	Provisional Sums	$	%	$
(l)	Variations Approved			
	- Variation Order No. 1	$	%	$
	- Variation Order No. 2	$	%	$
TOTAL VALUE OF WORK CLAIMED (EXCLUDING GST)		$		
GOODS & SERVICES TAX (10%)		$		
TOTAL PRICE OF WORK CLAIMED (INCLUDING GST)		$		
LESS PREVIOUS CLAIM		- $		
CURRENT CLAIM		$		

o Appendix F - Project Specific Quality Assurance Items

Hydraulic Services

Quality Assurance Certificate

Sample or Equipment Detail

Project: Pymble Ladies College - Grey House Precinct (GHP)

Project No: 301350239

Contractor: _____

Description of Sample or Equipment Detail:

_____

_____

_____

_____

Manufacturer/Supplier: _____

Model No/Catalogue No: _____

Does sample or equipment proposed meet the requirements of the specification and drawings? **YES/NO**

If no, provide details and reasons for deviations.

Contractors Signature: _____

Date: _____

Hydraulic Services

Quality Assurance Certificate

Progress Claim

Project: Pymble Ladies College - Grey House Precinct (GHP)

Project No: 301350239

Contractor: _____

Original Contract Sum	$_____
Adjusted Contract Amount at this date (Includes approved variations only)	$_____
We certify that we have completed work on this Contract to the value of	$_____
Amount previously claimed	$_____
Amount claimed in this certificate	$_____
Breakdown of progress claim attached in accordance with specification	**YES/NO**
Details showing calculation of adjusted contract amount attached	**YES/NO**
We certify that the work completed and materials used comply with the specification, drawings, instructions and variations.	**YES/NO**

If no attach details of any alterations.

Contractors Signature: _____

Date: _____

Hydraulic Services

Quality Assurance Certificate

Practical Completion

Project: Pymble Ladies College - Grey House Precinct (GHP)

Project No: 301350239

Contractor: _____

We confirm that:

The Hydraulic Services installation is complete and ready for operation **YES/NO**
If no, attach details of any work that is incomplete.

The Hydraulic Services installation complies with the specification,
drawings, instructions and variations. **YES/NO**
If no, attach details of any deviations

Hydraulic Services commissioning and testing has been completed and results recorded. **YES/NO**

Hydraulic Services As Constructed Drawings and Operating and Maintenance Manuals
have been provided **YES/NO**

Contractors Signature: _____

Date: _____

Hydraulic Services

Quality Assurance Certificate

Final Completion

Project: Pymble Ladies College - Grey House Precinct (GHP)

Project No: 301350239

Contractor: _____

Date of Practical Completion: _____

Date of Final Completion: _____

We confirm that:

All Hydraulic Services defects brought to our attention have been rectified **YES/NO**
If no, attach details of any defects that have not been rectified.

We have recently inspected the Hydraulic services installation and it is in efficient working order. **YES/NO**

Date of inspection:

Hydraulic Services maintenance has been carried out in accordance with the specification and we have retained copies of records of all preventative and corrective maintenance work. **YES/NO**

Contractors Signature: _____

Date: _____

Hydraulic Services

Quality Assurance Certificate

Test recording sheet for reduced pressure zone device

Project: Pymble Ladies College - Grey House Precinct (GHP)

Project No: 301350239

Contact Person: _____

Location of Device: _____

Make: _____ **Size:** _____ **Serial No.** _____

No 1 CHECK VALVE	
No 2 CHECK VALVE	
D/STREAM ISOLATING VALVE	
RELIEF PORT OPENING	

TEST KIT INFORMATION

Brand: _____ **Serial No.** _____

NATA Certificate No. _____

Recalibration Date Due. _____

I certify that the above individual tests were checked by me and comply with the requirements of AS 3500, AS 2845 and the Water Corporation's by-laws and policies.

NAME: _____ B/FLOW No. _____

SIGNATURE: _____

DATE: _____

Hydraulic Services

Quality Assurance Certificate

Test recording sheet for double check valve assembly

Project: Pymble Ladies College - Grey House Precinct (GHP)

Project No: 301350239

Contact Person: _____

Location of Device: _____

Make: _____ **Size:** _____ **Serial No.** _____

No 1 CHECK VALVE	
No 2 CHECK VALVE	

TEST KIT INFORMATION

Brand: _____ **Serial No.** _____

NATA Certificate No. _____

Recalibration Date Due. _____

I certify that the above individual tests were checked by me and comply with the requirements of AS 3500, AS 2845 and the Water Corporation's by-laws and policies.

NAME: _____ B/FLOW No. _____

SIGNATURE: _____

DATE: _____

Hydraulic Services

Quality Assurance Certificate

Test recording sheet for a registered break tank or a registered air gap installation

Project: Pymble Ladies College - Grey House Precinct (GHP)

Project No: 301350239

Contact Person: _____

Location of Installation: _____

AIR GAP REQUIREMENTS

Air gap dimensions: _____ mm

BREAK TANK DIMENSIONS

Air gap: _____ mm

Head of water above invert of overflow: _____ mm

Minimum size of overflow: _____ mm

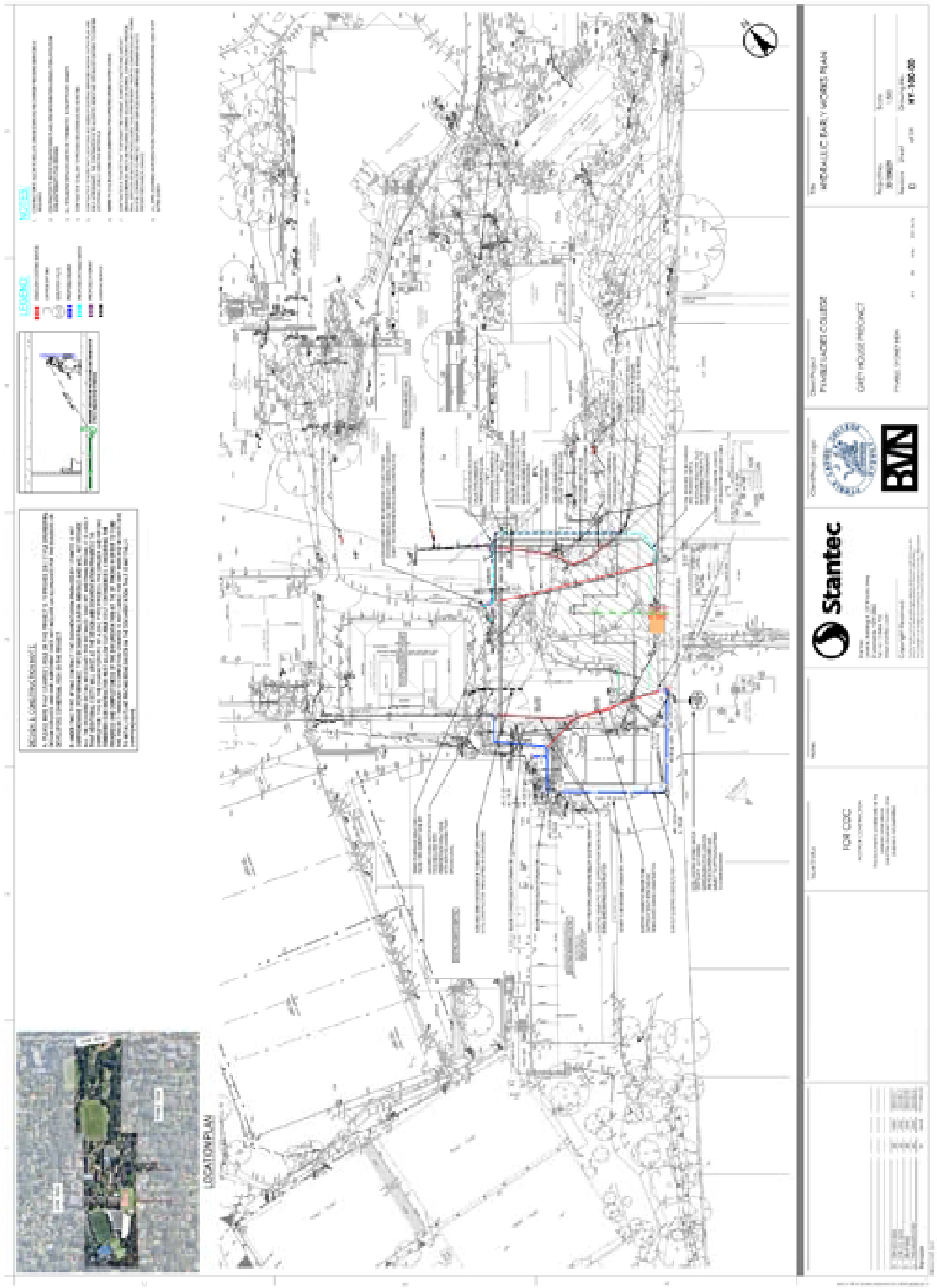
I certify that the above individual tests were checked by me and comply with the requirements of AS 3500 and AS 2845.

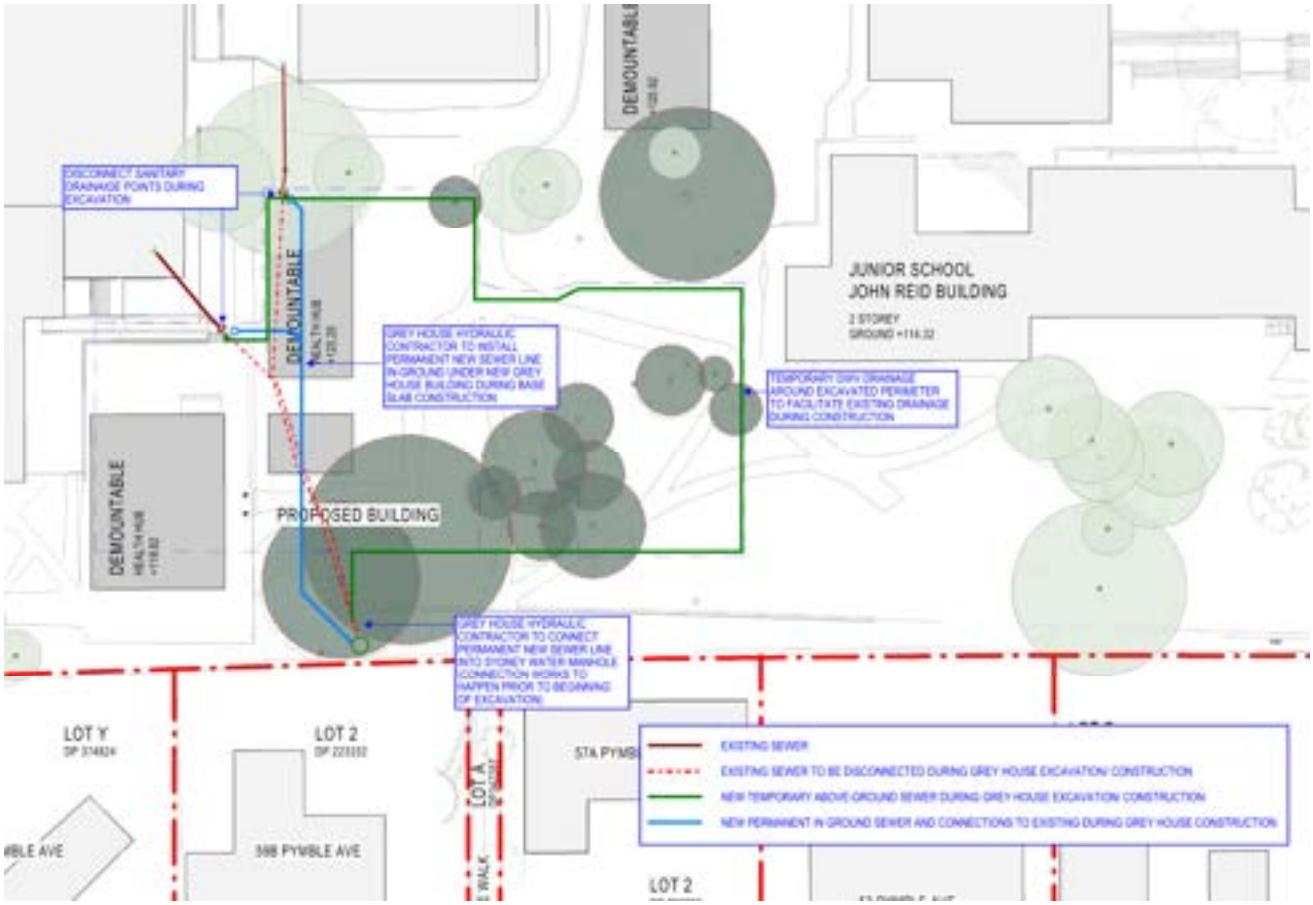
NAME: _____ B/FLOW No. _____

SIGNATURE: _____

DATE: __

o Appendix G – Early Works Hydraulic Plan





o Appendix H – Sydney Water Pressure & Flow

Statement of Available Pressure and Flow

Sydney WATER

John Knezevic
207 Pacific Highway
St Leonards NSW 2065

Attention: John Knezevic Date: 12/03/2021

Pressure & Flow Application Number: 1071309
Your Pressure Inquiry Dated: 2021-02-22
Property Address: 16-46 Avon Road, Pymble NSW 2073

The expected maximum and minimum pressures available in the water main given below relate to modelled existing demand conditions, either with or without extra flows for emergency fire fighting, and are not to be construed as availability for normal domestic supply for any proposed development.

ASSUMED CONNECTION DETAILS

Street Name: Avon Road	Side of Street: South
Distance & Direction from Nearest Cross Street	255 metres West from Pymble Street
Approximate Ground Level (AHD):	144 metres
Nominal Size of Water Main (DN):	150 mm

EXPECTED WATER MAIN PRESSURES AT CONNECTION POINT

Normal Supply Conditions	
Maximum Pressure	121 metre head
Minimum Pressure	54 metre head

WITH PROPERTY FIRE PREVENTION SYSTEM DEMANDS	Flow l/s	Pressure head m
Fire Hose Reel Installations (Two hose reels simultaneously)	0.66	55
Fire Hydrant / Sprinkler Installations (Pressure expected to be maintained for 95% of the time)	5 10 15	54 38 10
Fire Installations based on peak demand (Pressure expected to be maintained with flows combined with peak demand in the water main)	5 10	53 33
Maximum Permissible Flow	15	4

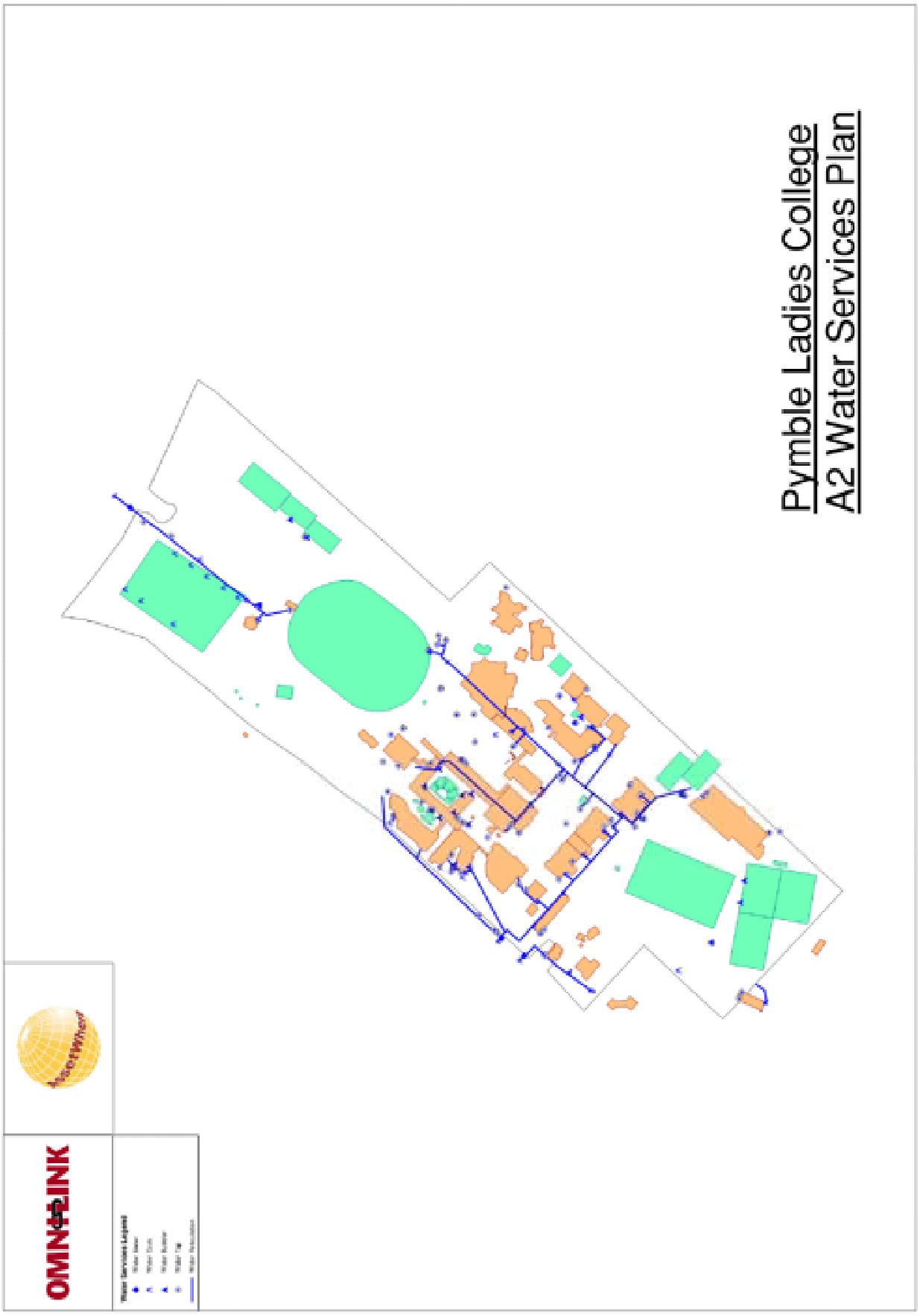
(Please refer to reverse side for Notes)

For any further inquiries regarding this application please email :

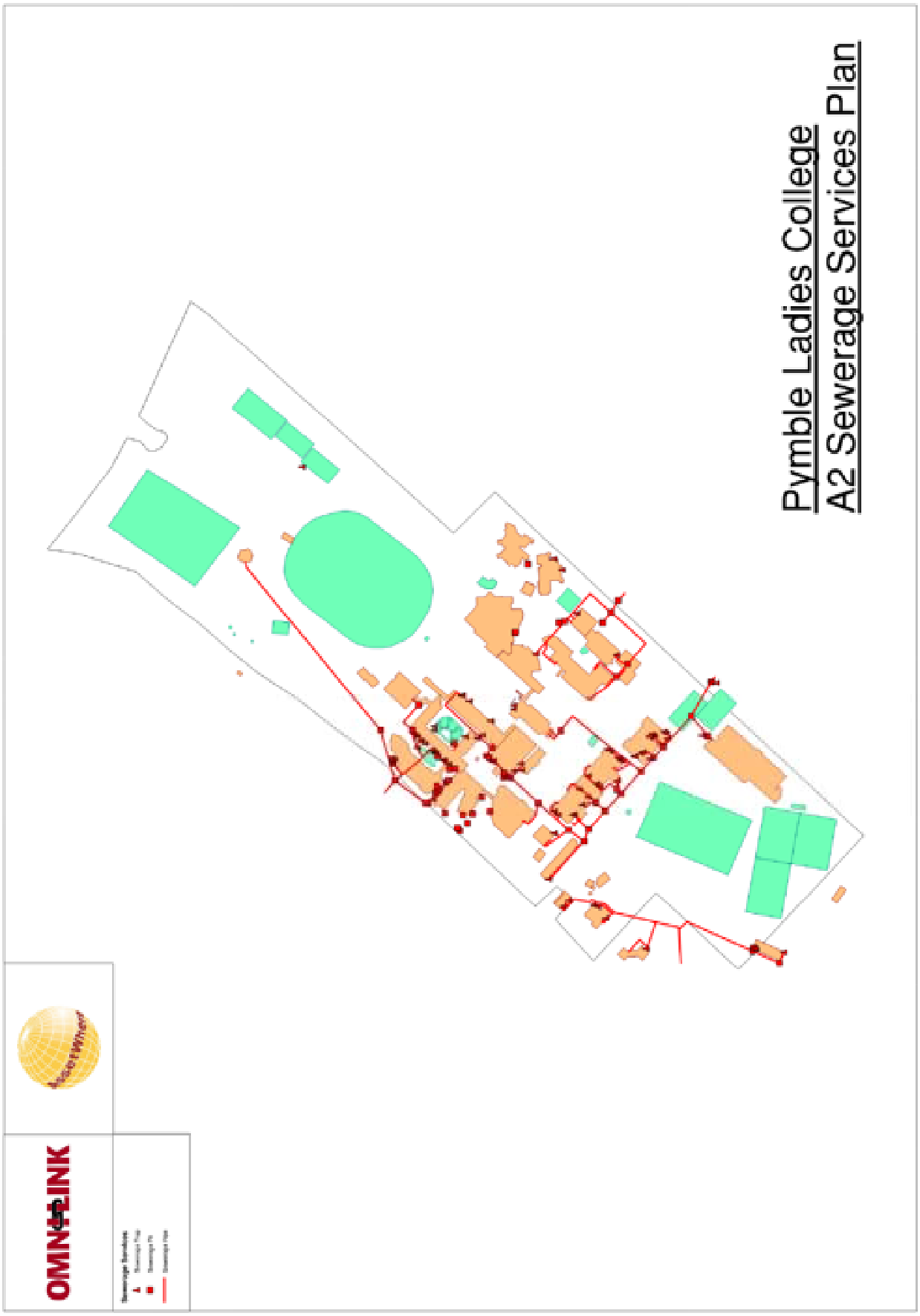
swtapin@sydneywater.com.au

Sydney Water Corporation ABN 49 776 225 038
1 Smith St Parramatta 2150 | PO Box 399 Parramatta 2124 | DX 14 Sydney | T 13 20 92 | www.sydneywater.com.au
Delivering essential and sustainable water services for the benefit of the community

o Appendix I – Existing Site Water Plan



o Appendix J – Existing Site Sewerage Plan



Pre-Application Submission Form

Certificate Case NumberCFT-505652

Apply for certificate

Select the certificate action you would like to apply for	Construction certificate
Select the type of certificate you wish to apply for	Certificate for part of the development
Is the application for modification of a current construction certificate?	No
Do you want to direct this application to a Principal Certifier or State Agency for assessment?	Principal Certifier
Which approval type is this certificate in relation to?	State determined (SSI / SSD)
Enter State determined number of the approval which is related to this certificate application (please include the SSD/SSI prefix)	SSD17424905
Has the SSI / SSD case been determined?	Yes
Date of determination of the state determined case	9/12/22
Is the development exempt from the *State Environmental Planning Policy (Sustainable Buildings) 2022 Chapter 3* relating to non-residential buildings, for any of the following reasons? • The DA was submitted on the NSW Planning Portal before 1st October 2023 • The DA was submitted on the NSW Planning Portal on or after 1st October 2023 but was deemed exempt due to the reasons outlined in Chapter 3.1.	Yes

Site address #	1
Street address	20 AVON ROAD PYMBLE 2073
Local government area	KU-RING-GAI
Lot / Section Number / Plan	8/-/DP7131 ☐ 23/-/DP7131 ☐ 5/-/DP7131 ☐ 12/-/DP7131 ☐ 20/-/DP7131 ☐ 18/-/DP7131 ☐ 25/-/DP7131 ☐ 9/-/DP7131 ☐ 1/-/DP69541 ☑ 2/-/DP567503 ☐ A/-/DP342267 ☐ 16/-/DP7131 ☐ 24/-/DP7131 ☐ 15/-/DP7131 ☐ 19/-/DP7131 ☐ 7/-/DP7131 ☐

	22/-/DP7131 ☐ 26/-/DP7131 ☐ 6/-/DP7131 ☐ 17/-/DP7131 ☐ 21/-/DP7131 ☐ 5/-/DP3532 ☐ 4/-/DP7131 ☐ 11/-/DP7131 ☐ 3/-/DP7131 ☐ 10/-/DP7131 ☐ 14/-/DP7131 ☐ 1/-/DP7131 ☐ 13/-/DP7131 ☐
Primary address?	Yes
Planning controls affecting property	Land Application LEP Land Zoning Height of Building Floor Space Ratio (n:1) Minimum Lot Size Heritage Land Reservation Acquisition Foreshore Building Line Acid Sulfate Soils Riparian Lands and Watercourses Terrestrial Biodiversity Bushfire Prone Land Sydney Trains Corridor Protection Zone Sydney Trains Infrastructure Protection Zone

Applicant details

Title	Ms
First given name	Ros
Other given name/s	
Family name	Petteno
Contact number	0420959064

Email	rosanna@pierproperty.com.au
Address	20 AVON ROAD PYMBLE 2073
Is the applicant a company?	No

Developer details

Name	PYMBLE LADIES' COLLEGE
ABN	75 645 100 670
ACN	645 100 670
Trading Name	
Email	ghastie@pymblelc.nsw.edu.au
Address	20 AVON ROAD PYMBLE 2073

Land owner details

Owner/s of the Development Site	A company, business, government entity or other similar body owns the development site
Owner Builder?	
Title	
First given name	
Other given name/s	
Family name	
Contact number	
Email	
Address	
Company name (if applicable)	Pymble Ladies College
ABN/ACN	645 100 670
I declare that I have shown this document, including all attached drawings, to the owner(s) of the land, and that I have obtained their consent to submit this application.	
Who will be doing the building work?	Licensed Builder

Builder or Principal contractor details

Builder Type	A Company , business , government entity or other similar body
Company Name	STEPHEN EDWARDS CONSTRUCTIONS PTY LTD
ABN	65001824139
ACN	001824139
Trading Name	STEPHEN EDWARDS CONSTRUCTIONS PTY LIMITED
Billing Address	140 WICKS ROAD MACQUARIE PARK 2113
Email Address	

Long Service Levy

Have you paid the Long Service Levy?	No
Are there any security or site conditions which may impact on the person undertaking the inspection? eg: locked gates, dogs, animals etc	Yes
Provide details	Site is located within school grounds, as such the site is enclosed with safety fencing and a locked gate.

Payer details

Payer Type	A company, business, government entity or other similar body
Company Name	PYMBLE LADIES' COLLEGE
ABN	75645100670
ACN	645100670
Trading Name	
Billing Address	20 AVON ROAD PYMBLE 2073

Email ID	accounts@pymblelc
Title	
First given name	
Other given name/s	
Family name	
Contact number	
Email	
Billing address	

Proposed development details

Selected common application types	Demolition
Class of development	Class 9b
Please provide a detailed description of the development	Demolition of existing structures and construction of a building to accommodate the following: • junior school classrooms (5&6); • science, technology engineering & mathematics laboratories; • health and wellbeing facilities (consulting rooms/wards); • a dance academy; • out-of-school-hours care; • a new early learning centre for 90 children & 20 staff; • outdoor learning spaces for existing students; & • tree removal & associated landscaping CC1 - Demolition, earthworks, foundations, in-ground services
Estimated Development Cost	$46,665,813.00
Please provide the estimated development cost including GST	$51,332,394.30

Information to be collected for the Australian Bureau of Statistics

Total site area (m2)	0
Existing gross floor area (m2)	6700
Total Net Lettable Area (m2))	0
Proposed gross floor area (m2)	0
What are the current uses of all parts of the building (s)/land? (if vacant please state)	class 9b class 5
What is the proposed use of all parts of the building (s)/land?	class 9b class 5
Is the proposed building is attached, detached (i.e. free standing) or semi-detached?	Detached (Free-standing)

Ultimate height of the development (m)	134.3
Number of pre-existing dwellings on site	0
Number of storeys proposed in the new building(s)	5
Number of proposed lots	

Fire safety measures

Are you proposing to carry out alterations/modifications to existing 'relevant fire safety systems'?	No
Are proposed fire safety measures to be installed in the building?	No

Registered certifier

The applicant has selected the following certifying organisation to assess this application

Company name	CITY PLAN SERVICES PTY LIMITED
Trading name	
ABN	30075223353
ACN	075 223 353
Address	Level 6, 120 Sussex Street Sydney NSW 2000

Email	reception@cityplan.com.au

Principal certifier

The applicant has selected the following certifying organisation to assess this application

Company name	CITY PLAN SERVICES PTY LIMITED
Trading name	
ABN	30 075 223 353
ACN	075 223 353
Address	Level 6, 120 Sussex Street Sydney NSW 2000
Email	reception@cityplan.com.au

Declarations

I declare that all the information in the application and checklist is, to the best of my knowledge, true and correct	Yes
I agree to the appropriately delegated assessment officers attending the site for the purpose of inspection	Yes
I/we own the subject land, consent to this application and consent to Council officers entering the premises during normal office hours for the purpose of conducting inspections relative to this application. I accept that all communication regarding this application will be through the nominated applicant. In the case of an owners corporation, a seal is required, or if crown land, written authorisation of the relevant statutory authority.	Yes
I have read and agree to the collection and use of my personal information as outlined in the Privacy Notice.	Yes
I declare that all works that are the subject of the relevant consent have been completed and that all conditions that are required to be satisfied prior to the issue of this certificate have been satisfied	Yes
I agree to pay any required NSW Planning Portal Service Fee/s specified under Part 9, Schedule 4 of the Environmental Planning and Assessment Regulation 2021 to the Department of Planning and Environment.	Yes

Review of application

What is the outcome of your review?	Accept application
Additional certifier comments	.
Certifier reference number	200618/1
Has the applicant paid the application fees?	Yes
Enter the date the application was lodged into the certifier's system	8/04/24

Pymble Ladies College – Grey House Precinct project

CONSULTANTS DESIGN STATEMENT – DEVELOPMENT CONSENT CONSISTENCY

Client:	Stephen Edwards Constructions Pty Ltd
Consultant:	BVN Architecture Pty. Ltd
Reference No.	SSD-17424905
Date:	22.03.2024

SCOPE

This Statement is given in relation to the Deed of Novation for the provision of Architectural Consultancy Services and associated scope and deliverables entered into between BVN Architecture Pty Ltd (BVN) and Stephen Edwards Constructions Pty Ltd for the Pymble Ladies College – Grey House Precinct project.

This statement is applicable to the scope of works proposed for the staged Construction Certificate 01. The proposed works are understood to comprise:

- Demolition
- Earthworks
- Foundations
- Inground services
- Retaining structures

The scope of works for CC1 excludes all other works to complete the development including waterproofing. The basement perimeter wall has been designed as a drained cavity system which does not require tanking or waterproofing associated with the shoring wall.

STATEMENT

BVN confirms that the CC1 design documents meet the Contractor's design obligations under the Contract in so far as they are required by BVN's contracted scope of service and standard of care to the Contractor.

BVN confirms that the design documents have been prepared in accordance with the development consent drawings and documents and consent conditions where relevant to CC1 works.

255 Pitt Street, Sydney, NSW 2000 Australia, +61 2 8297 7200, bvn.com.au
BVN Architecture Pty Ltd, ABN 46 010 724 339, ACN 010 724 339
NSW Architects Registration Board, Nominated Architect 9356 Ninotschka Titchkosky
7115 Julian Ashton, 7053 Matthew Blair, 7151 Phillip Rossington ,7439 Peter Titmuss,
10447 Alison Bounds, 10705 Catherine Skinner, 8011 William Dowzer

The following Architectural documentation has been provided (See Appendix A and B) to demonstrate consistency with the development approval and consent conditions for CC1.

APPENDIX A
General Arrangement plans:

AR-B10-00-01 (A) – GA PLAN LEVEL 0

AR-U10-XX-01 (B) – DEMOLITION AND BULK EXCAVATION PLAN

APPENDIX B
Architectural Specification sections:

AR-Z-0160 (4) – Quality

AR-Z-0171 (4) – General Requirements

AR-Z-0201 (4) – Demolition

AR-Z-0221 (4) – Site Preparation

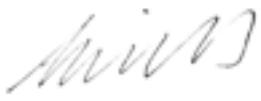
AR-Z-0222 (4) – Earthwork

AR-Z-0223 (4) – Service Trenching

AR-Z-0310 (4) – Concrete combined

Signed for and on behalf of BVN Architecture Pty. Ltd.

Alison Bounds
PRINCIPAL



.....

Signature

15 March 2024 211007

Stephen Edwards Constructions
140 Wicks Rd
Macquarie Park NSW 2113

Attention: Nick Souden

Pymble Ladies College - Grey House Precinct (GHP)

Structural Design Certificate for Construction Certificate CC1 – Shoring, Excavation and Foundations

Dear Nick,

We certify that we have prepared the structural design of Grey House Precinct (GHP) Pymble Ladies' Collage – Shoring, Excavation and Foundations, as shown on the list of drawings attached in accordance with the following Australian Standards:

AS 3600-2018	Concrete Structures (Amdt 1)
AS 2159-2009	Piling (Amdt 1)
AS 4100-2020	Steel Structures
BCA-2022	Part B1 and C2
Development Consent	SSD17424905 – Condition D3

And the structure shown would be sufficient to carry the relevant loads specified on our drawings and in

AS 1170.0-2002	Structural design actions – General principles (Amdt 1,3 &4)
AS 1170.1-2002	Structural design actions – Permanent, imposed and other actions (Amdt 1 & 2)
AS 1170.2-2011	Structural design actions – Wind actions
AS 1170.4-2007	Structural design actions – Earthquake actions in Australia (Amdt 1 & 2)

The foundation has been designed in accordance with Geotechnical Report No. 33775SCrpt dated 8 Feb 2021 and Report No. 33775SCrpt2 dated 26 April 2021 by JKGeotechnics.

All load bearing structural elements requiring a fire rating have been designed to achieve an FRL of 120/120/120.

Yours faithfully,
TTW (NSW) PTY LTD

HUNG NGUYEN
Technical Director

P:\2021\2110\211007\Certificates\240315 Structural Certifcate for CC1.docx

15 March 2024

ABN 48 612 666 172
Sydney | Brisbane | Melbourne
Level 20, 2 Market St
Sydney NSW 2000
PO Box Q453
Queen Victoria Building
NSW 1230
Ph (02) 9437 1000

Stephen Edwards Constructions

140 Wicks Road

MACQUARIE PARK NSW 2113

DESIGN CERTIFICATE - HYDRAULIC SERVICES

SUBJECT PREMISES: **Pymble Ladies College – Grey House Precinct CC1 – Inground Services**

JOB NO.: 240031

REVISION NO.:[C]

Pursuant to the provisions of **Clause A5G3 of NCC 2022 Volume 1 - Building Code of Australia**, I hereby certify that the design documented on the drawings listed below related to the CC1 scope including inground services has been designed in accordance with normal engineering practice and meets the requirements of the Building Code of Australia and the following Australian Standards (with the exception of any approved Design Departures / Alternative Solutions):

- AS3500.1:2021 – Plumbing and drainage - Water services
- AS3500.2:2021 – Plumbing and drainage - Sanitary plumbing and drainage (Amd 1)
- AS3500.3:2021 – Plumbing and drainage – Stormwater drainage (upstream of the OSD/Rainwater tank)
- AS3500.4:2021 - Plumbing and drainage – Heated Water Services
- AS2419.1:2021 – Fire hydrant installations – System design, installation and commissioning
- NCC2022 Volume 1 – E1D2 – Fire Hydrants
- NCC 2022 Volume 1 - J8D2 and Part B2 of NCC Volume 3:2022 – Heated Water Services
- NCC 2022 Volume 3 - Hydraulic Services
- NCC 2022 Section J J1V3 for Part J4 Compliance Design Report (Rev 5)
- Conditions of the Development Consent relevant to the inground hydraulic services design.

We also note the following:

- Fire stopping / penetrations in slabs is not relevant to CC1 scope as this scope of work does not include structure or slab on ground.
- Penetrations through fire isolated exits are not relevant as the CC1 scope does not include slabs or structure associated with fire isolated passages.
- There is no alteration/removal of existing hydrants under the CC1 scope of works and therefore we confirm that this does not affect any performance/coverage to any other adjacent buildings they serve.
- NCC 2022 Volume C3D13 (separation of fire pumps) does not apply to the CC1 scope of works.

Drawing Schedule

DRAWING NUMBER	DRAWING NAME	REVISION
HY-100-00	HYDRAULICS EARLY WORKS PLAN	G
HY-000-01	LEGEND OF SYMBOLS AND GENERAL NOTES	H
HY-200-01	GROUND FLOOR DRAINAGE LAYOUT - SHEET 1	H
HY-201-01	LEVEL 01 DRAINAGE LAYOUT - SHEET 1	H
HY-300-02	GROUND WATER & GAS LAYOUT - SHEET 2	H
HY-301-01	LEVEL 01 WATER & GAS LAYOUT - SHEET 1	H
240031_HydSpec	HYDRAULIC SERVICES SPECIFICATIION	A

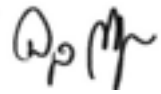
I am an appropriately qualified and competent person in this area and as such can certify that the design complies with the above.

Full Name of Designer:	Adrian Cassar
Qualifications:	BE (Civil), MIEAust.
Address of Designer:	Level 20, 2 Market Street, SYDNEY NSW 2000
Business Telephone No:	(02) 9437 1000
Name of Employer:	JHA Consulting Engineers

Adrian Cassar

Associate / Senior Hydraulic Engineer

Full Name of Designer:	Diego Montelvere
Qualifications:	Master in Design Science (Building Services) Diploma in Hydraulic Services Full Member – Hydraulic Consultants Association (Australasia) Full Member – Fire Protection Association Australia
Accreditation:	FPAS No. F045722D
Address of Designer:	Level 20, 2 Market Street, SYDNEY NSW 2000
Business Telephone No:	(02) 9437 1000
Name of Employer:	JHA Consulting Engineers



Diego Montelvere
Director

Receipt No.L0000147340

Levy Receipt

Date: 27/03/2024

Development Applicant

PYMBLE LADIES COLLEGE TRUST
SCHOOL PYMBLE LADIES 20 AVON RD PYMBLE NSW 2073 AU

Development Details

Application Type:	Construction Certificate
Application No.:	SSD17424905
Approving Authority:	KU-RING-GAI COUNCIL
Site Address:	SCHOOL PYMBLE LADIES 20 AVON RD PYMBLE NSW 2073

Levy Details

Levy No.:	L0000147340
Cost of Works (incl. GST):	$46,665,813.00
Levy Payable:	$116,664.00
Total Amount Paid (excl. Surcharge):	**$116,664.00**

REPORT TO

PYMBLE LADIES COLLEGE

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED SCHOOL BUILDING

AT

20 AVON ROAD, PYMBLE, NSW

Date: 26 April 2021
Ref: 33775SCrpt2

JKGeotechnics
www.jkgeotechnics.com.au

T: +61 2 9888 5000
JK Geotechnics Pty Ltd
ABN 17 003 550 801

Report prepared by:

Thomas Client
Senior Engineering Geologist

Report reviewed by:

Paul Stubbs
Principal | Geotechnical Engineer

For and on behalf of
JK GEOTECHNICS
PO BOX 976
NORTH RYDE BC NSW 1670

DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
33775SCrpt	Final Report	8 February 2021
33775SCrpt2	Additional Geotechnical Investigation	26 April 2021

Table of Contents

ATTACHMENTS

1 INTRODUCTION

This report presents the results of a geotechnical investigation for a proposed school building within Pymble Ladies College, Avon Road, Pymble, NSW. The location of the site is shown in Figure 1. The investigation has been carried out in two stages; the first stage being presented in our report 33775SCrpt dated 8 February 2021. Additional investigation was commissioned by Malcolm Boyes of Pymble Ladies College and carried out in accordance with our proposal (Ref: P53314SC) dated 26 February 2021. This report presents the results of both stages of the investigation and supersedes the earlier report.

We understand the development is at an early stage and the location of the proposed structures, building levels, proposed earthworks and structural loads were unavailable at the time of investigation and preparation of this report. However, based on discussions with Mr Malcolm Boyes of Pymble Ladies College, we understand that a new school building is proposed for this part of the site and is likely to comprise a five storey building, potentially with a lower ground floor or basement level. Due to the sloping nature of the site we expect excavations to a maximum depth of about 3m may be required.

The purpose of the investigations was to obtain further detailed subsurface information on the subsurface conditions as a basis for comments and recommendations on excavation, earthworks, retention and footing design.

2 INVESTIGATION PROCEDURE

The initial fieldwork was carried out on 14 and 15 January 2021 and the additional investigation was carried out on 8 April 2021, in total comprising the drilling of nine boreholes (BH201 to BH204 and BH301 to BH305 inclusive). Boreholes were drilled using our track mounted JK305 drilling rig to total depths ranging from 1.5m to 10.47m below existing ground surface levels.

- BH201, BH202, BH301 and BH302 were initially auger drilled to depths ranging from 2.2m to 4.33m and were then continued by diamond coring techniques using an NMLC core barrel with water flush to total depths ranging from 7.9m to 10.47m, respectively.
- BH203, BH204, BH303 to BH305 were auger drilled using a Tungsten Carbide (TC) bit to depths ranging from 1.5m to 6m.

The borehole locations, as shown on the attached Figure 2, were set out by taped measurements from existing surface features. The approximate surface levels, as shown on the borehole logs, were estimated by interpolation between spot levels and contours shown on the supplied survey plan by LTS Lockley (Drawing No. 15263 00 DT, dated 8 October 2020, Issue H) The datum of the levels is Australian Height Datum (AHD).

The apparent compaction of the fill and the strength of the residual soils were assessed from Standard Penetration Test (SPT) 'N' values, augmented by hand penetrometer test results on cohesive samples recovered by the SPT split tube sampler. Within the augered portions of the boreholes, the strength of the underlying weathered bedrock was assessed from observation of the resistance to penetration of the TC bit attached to the augers, together with inspection of the recovered rock chip samples and subsequent

correlations with laboratory moisture content test results. The strength of the cored siltstone and sandstone was assessed from inspection of the recovered core and subsequent laboratory Point Load Strength Index ($I_{S(50)}$) test results. The point load strength index test results are summarised on the cored borehole logs.

Groundwater observations were made during and on completion of auger drilling. Thereafter, the use of water for core drilling limited further meaningful measurements of groundwater levels. A slotted PVC monitoring well was installed within BH302 on completion of the drilling. A return visit to the site was made on 21 April 2021 to measure groundwater level. No longer term monitoring of groundwater levels was carried out.

Our Geotechnical Engineers, Mr Ben Sheppard and Warren Smith, set out the borehole locations, nominated the sampling and testing locations, and prepared logs of the strata encountered. The borehole logs, including colour photographs of the recovered core, are attached to this report together with a set of explanatory notes, which describe the investigation techniques, and their limitations, and define the logging terms and symbols used.

Selected soil samples were returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd, both NATA accredited laboratories, for testing to determine moisture contents, Atterberg limits, linear shrinkages, california bearing ratio (CBR), point load strength index values, pH, sulphate contents, chloride contents and resistivity. The results of the laboratory testing are presented in the attached STS Tables A, B, C and Envirolab Certificate of Analysis 259686.

3 RESULTS OF INVESTIGATION

3.1 Site Description

For the purpose of this site description, the 'site' shall be regarded as the general area where the new school building is proposed, as shown on the attached Figure 1.

The site is located within the school grounds of Pymble Ladies College, which is situated within the upper reaches of a hill within undulating topography. The site itself was positioned on a north-easterly facing hillside with an overall slope of about 7° and contained lawns, footpaths, marquees and demountable buildings. The demountable buildings were single storey and the marquee constructed from canvas and steel framing; both structures appeared to be in good external condition based on a cursory inspection. The footpaths were concrete surfaced and appeared to be in generally good condition, however some areas of paving showed signs of distress and cracking. The vegetation on site comprised sloping lawns, planter beds and medium to large sized trees.

To the north-western of the site was a two-storey brick building which had been built into the hillside. On the southern-eastern side of the building was a rendered block wall ranging in height from about 1m to 2m, which retained the hillside slope. The building and retaining wall both appeared to be in good condition based on cursory inspection. To the east of the site the sloping lawns continued down to the east.

On the south-eastern site boundary were a series of residential properties with swimming pools and yard areas abutting the common boundary. The setback distances and ground surface levels across this boundary could not be observed, however due to the overall direction and sloping nature of the site, the neighbouring ground levels are likely to be lower than the subject site.

To the south-west of the site was a two-storey brick school building with similar surface levels to the subject site. The brick building appeared to be in good external condition based on cursory inspection.

3.2 Subsurface Conditions

The 1:100,000 geological map of Penrith (Geological Survey of NSW, Geological Series Sheet 9030) indicates the site to be underlain by Ashfield Shale of the Wianamatta Group. Generally, the boreholes encountered fill overlying residual soil, then weathered siltstone and sandstone at depth. A summary of subsurface conditions is presented below but reference should be made to the attached borehole logs for details at each specific location.

Fill

Fill comprising silty clay of low to medium plasticity, was encountered to depths ranging from 0.2m to 0.8m. Based on SPT 'N' values the fill was assessed to be moderately compacted.

Residual Silty Clay

Residual silty clay, typically of medium to high plasticity, was encountered in all boreholes and was assessed to be of at least very stiff to hard strength with varying fractions of ironstone gravel inclusions.

Weathered Bedrock

Weathered siltstone bedrock (Ashfield Shale) was encountered at depths ranging from 1.2m (BH201) to 2.5m (BH202). The reduced level of the top of rock reduced towards the east of the site. On first rock contact the weathered siltstone was typically either extremely weathered and hard (soil strength) to distinctly weathered and very low strength, increasing to low to medium strength with depth.

The cored portions of BH201, BH301 and BH302 were similar with the cored siltstone initially assessed to be highly weathered to moderately weathered and of very low strength but improving to low to medium strength then medium to high strength below levels ranging from about RL114m to RL116m. However, the cored portion of BH202 encountered extremely weathered and highly weathered siltstone of hard (soil strength) to very low strength to a depth of 10.2m (or RL104.3m), at which medium to high strength sandstone was encountered.

Defects within the cored siltstone and sandstone comprised extremely weathered seams of generally less than 100mm thickness, sub-horizontal bedding partings, and joints inclined at up to 90°.

Rock Classification

The following table summarises the rock levels for which we consider that at least Class 3 or better siltstone bedrock in accordance Foundations on Shale and Sandstone by Pells et al 2019, has been encountered. We note that the upper 2m to 4m of bedrock was auger drilled therefore an accurate rock classification wasn't undertaken within the current investigation boreholes. We have assumed Class 4/Class 5 for this upper material.

Borehole	Reduced Level Top of Class 4/Class 5 (mAHD)	Reduced Level Top of Class 3 or better (mAHD)
201	119m	116m
202	107m	104m*
203	115m	-
204	117.2m	-
301	118.8m	115.5m
302	118.5m	114.8m
103	119.4m	116.4m

Notes: * Only proved for 0.2m, bedrock quality may reduce.

Groundwater

Groundwater seepage was not encountered during auger drilling of the boreholes, which were dry on completion of auger drilling. Once coring is commenced water is introduced which obscures the true groundwater level. A groundwater monitoring well was installed in BH302 to a depth of 8m. The groundwater monitoring well was allowed to stabilise over thirteen days and a return visit was made to site on the 21 April 2021 and groundwater was measured at a depth of 6m (RL113.7m).

3.3 Laboratory Test Results

Based on the Atterberg limits and linear shrinkage test results, the silty clays tested are of medium plasticity and are assessed to have a moderate to high potential for shrink/swell movements with changes in moisture content.

The Four Day Soaked CBR tests carried out on samples of the residual silty clay resulted in soaked CBR values ranging from 4.5% to 5% when compacted to 98% of Standard Maximum Dry Density (SMDD) and at their respective Standard Optimum Moisture Contents (SOMC).

The moisture content and point load strength index test results showed reasonably good correlation with our field assessment of rock strength. The Unconfined Compressive Strength (UCS) of the rock core, estimated from the point load strength index test results, generally ranged from 6MPa to 66MPa in BH201 however BH202 resulted in much lower values of generally between 1MPa and 6MPa, with a higher value of 84MPa for the sandstone. BH301 and BH302 ranged from 6MPa to 60MPa.

The pH values on samples of the clayey fill, residual silty clay and weathered siltstone ranged from 5.2 to 7.5, indicating slightly acidic to neutral soil conditions. The sulphate contents ranged from 30mg/kg to 370mg/kg, the chloride contents ranging from <10mg/kg to 81mg/kg, and the resistivity ranged from 5,600ohm.cm to 53,000ohm.cm. Based on these results, the clayey fill, residual silty clay and weathered siltstone would classify as 'mild' exposure classification for concrete piles in accordance with Table 6.4.2(C) of AS2159-2009 'Piling – Design and Installation' and 'non-aggressive' exposure classification for steel piles in accordance with Table 6.5.2(C) of AS2159-2009.

4 COMMENTS AND RECOMMENDATIONS

4.1 Excavation and Groundwater

Due to the sloping nature of the site we envisage excavations of up to about 3m depth will be required to form the building platform. Excavation to such depths will encounter clayey fill, residual soils and weathered siltstone.

Excavation of the soils and upper rock of up to very low strength should be achievable using conventional excavation equipment, such as the buckets of hydraulic excavators. Some ripping of higher strength bands may be necessary if they are encountered within the weaker rock.

Excavation of bedrock of low strength or higher strength will require assistance with rock excavation equipment. Such equipment may comprise hydraulic rock hammers, ripping hooks, rotary grinders or rock saws. Hydraulic rock hammers must be used with care due to the risk of damage to the neighbouring buildings. If hydraulic rock hammers are to be used the vibrations transmitted to the buildings should be quantitatively monitored at least at the start of rock hammer operation to confirm that the transmitted vibrations are within acceptable limits. If during the initial monitoring the transmitted vibrations are close to acceptable limits full time monitoring may then be warranted. Reference should be made to the attached Vibration Emission Design Goals sheet for acceptable limits of transmitted vibrations. Where the transmitted vibrations are excessive it would be necessary to change to alternative excavation equipment, such as a smaller rock hammer, ripping hooks, rotary grinders or rock saws.

No groundwater seepage was encountered during auger drilling of the boreholes. As such we do not consider that groundwater will be a significant issue for the proposed development. Nevertheless, some seepage may occur into the excavation and this would likely tend to occur along the soil/rock interface and through joints and bedding partings within the rock, particularly during and following rainfall. Any such seepage that does occur should be able to be controlled during construction using gravity drainage and conventional sump and pump techniques. In the long term, drainage should be provided behind all retaining walls and possibly below the lowest floor slab. The completed excavation should be inspected by the hydraulic consultant to confirm that the designed drainage system is adequate for the actual seepage flows.

4.2 Subgrade Preparation and Filling

The boreholes encountered limited fill across the site and we expect that the fill will be excavated and removed as part of the proposed bulk excavation. However, where floor slabs are proposed we recommend that where the fill is not excavated as part of the bulk excavations that it be removed and replaced with controlled, engineered fill. Alternatively, if the fill is left in place the ground floor slab should be designed as a fully suspended slab supported on the piled footing system. For the proposed pavements the fill may be left in place provided it is treated as required following proof rolling.

Within areas where floor slabs are proposed all existing fill should be fully stripped to expose the residual silty clay or weathered siltstone. Within pavement areas the vegetation and root affected soils should be stripped, but the fill below may be left in place. This root affected fill is not suitable to reuse as engineered fill, but may be reused within landscaped areas.

Following stripping, the exposed subgrade should be proof rolled with at least 7 passes of a minimum 8 tonne dead weight, smooth drum, vibratory roller. The final pass of the proof rolling should be carried out without vibration and in the presence of a geotechnical engineer to detect any weak subgrades areas. Care must be taken during rolling due to the risk of damage to adjoining structures from the vibrations generated by the roller. If vibrations are of concern the rolling may need to be carried out with a static roller only.

Any weak or unstable areas detected during proof rolling should be locally excavated to a sound base and the excavated material replaced with controlled, engineered fill, or as directed by the geotechnical engineer during proof rolling. Some weak subgrade areas may be experienced where the existing fill is left in place or where the clays are allowed to soften due to water ponding. Following treatment of weak areas, engineered fill should be placed in thin layers as recommended in Section 4.2.1 below.

In view of the high reactivity potential of some of the residual clays, particular attention should be given to providing adequate drainage both during construction and for long term site maintenance. The principal aim of the drainage should be to promote run-off and reduce ponding. Placement of a blinding layer of durable granular fill or subbase material to provide a trafficable surface during construction may be necessary or desirable. The earthworks should be carefully planned and scheduled to maintain cross-falls during construction. If the clay is exposed to prolonged periods of rainfall, softening will result and site trafficability will be poor. If soil softening occurs, the subgrade should be over-excavated to below the depth of moisture softening and the excavated material replaced with engineered fill.

4.2.1 Engineered Fill and Compaction Control

Engineered fill should preferably comprise well graded granular materials, such as ripped rock or crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75mm. Such fill should be compacted in horizontal layers of not greater than 200mm loose thickness, to a density of at least 98% of Standard Maximum Dry Density (SMDD). For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

The excavated material may be reused as engineered fill, provided it is free of deleterious materials and particles greater than 75mm in size. All excavated material should be inspected and approved by a geotechnical engineer prior to reuse. Any clay fill should be compacted in maximum 200mm loose thickness layers to a density strictly between 98% and 102% of SMDD and at moisture contents within 2% of Standard Optimum Moisture Content (SOMC).

Density tests should be regularly carried out on the fill to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per 500m^2 or three tests per visit, whichever requires the most tests. Where fill is to support footing loads it should be placed under Level 1 control as defined by AS3798-2007. Preferably the geotechnical testing authority should be engaged directly on behalf of the client and not by the earthworks subcontractor.

4.3 Batters and Retaining Wall

Suitable retention systems will depend on the proposed basement depth and set-back distances from adjoining structures and properties. For basements which extend up to or close to the site boundaries, full depth retention systems will need to be installed prior to the start of excavation.

Where space permits, temporary batters through the clayey soils and poor-quality siltstone bedrock may be formed at no steeper than 1 Vertical (V): 1 Horizontal (H). Where adopted all surcharge loads such as stockpiles, traffic loads etc must be kept well clear of the crest of the batters. Where permanent batters are adopted, they should be formed at no steeper than 1 Vertical (V): 2 Horizontal (H) and should be protected from erosion by vegetation, shotcrete and mesh or similar. For maintenance purposes it may be more practical to from permanent batters at no stepper than 1V:3H or 4H.

Where space does not allow for the formation of batters and excavation will extend below adjoining buildings a retention system will need to be installed prior to the commencement of excavation. Such a retention system may comprise soldier pile walls with shotcrete infill panels. From experience the construction of such shoring systems has become very cost effective and we do not expect that creation of temporary batters, stockpiling of materials for use as backfill, export of surplus materials to tip, import of expensive drainage gravel and construction of “conventional” retaining walls will necessarily be the most economical option.

Bored piers would be appropriate for the piled walls, but some groundwater seepage may be encountered requiring the use of pumps and tremie concreting techniques. The piers should be founded at least 1m below the base of the excavation, including excavations for footings and services, but more as required for stability design.

Piles supporting cuts up to 3m can probably be designed as cantilevers unless the surcharge loads of adjacent footings are high.

If required, temporary lateral restraint of the retention system could be provided by external anchors or internal props, with each restraining point progressively installed as it is exposed during excavation. Long term lateral support would be provided by the floor slabs within the excavation and the toe sockets of the

piles. If anchors are to locally extend below neighbouring properties, permission would need to be obtained from the owners of the adjoining properties before the installation of the anchors below their properties. Such permission can take some time to obtain, which should be allowed for within the project program. The use of anchors will need to take into account the neighbouring site levels and location of any basements and services within the adjoining buildings so that these can be avoided. However, this will be subject to the final building layout plan and proposed ground floor/basement levels.

Cantilever walls can be designed using an active earth pressure coefficient, K_a of 0.35 where there are no structures or services adjacent, but increase of 0.6, where movements are to be kept low.

Propped or anchored retaining walls may be designed based on a trapezoidal earth pressure distribution of magnitude 6H kPa, where H is the retained height in metres, where structures or movement sensitive services are located beyond a horizontal distance of 2H from the wall. Where structures or movement sensitive services are located within 2H of the wall, a trapezoidal earth pressure distribution of 8H kPa should be used. These pressures should be constant over the central 50% of the trapezoidal pressure distribution. In addition to these pressures, the retention wall design should be checked and designed to accommodate a wedge formed by a joint inclined at 45° intersecting the excavation face at the base of the cut.

The above pressures assume horizontal backfill behind the walls and any inclined backfill should be taken as a surcharge load. All surcharge loads should be allowed for in the design, plus full hydrostatic pressures, unless measures are undertaken to provide complete and permanent drainage behind the wall.

Anchors should have their bond formed within rock outside a line drawn up at 45° from the base of the excavation, with a minimum bond length of 3m and a minimum free length of 3m. Provisional design of the anchors may be based on a bond stress of 100kPa for rock of at least very low to low strength and 200kPa for low or higher strength rock. All anchors should be proof loaded to at least 1.3 times their design working load before locking off at about 80% of their working load. Lift-off tests should be carried out on at least 10% of the anchors 24 to 48 hours following locking off to confirm that the anchors are holding their load. Generally, anchors are installed on a design and construct basis so that optimisation of the bond stresses does not become a contractual issue in the event of anchors failing to hold their test loads.

Passive toe resistance of the retention system below the base of the bulk excavation may be estimated based on an allowable lateral resistance of 200kPa for rock of at least very low to low strength. The passive resistance should be ignored for at least 0.5m below the base of the excavation, including footing and service excavations.

4.4 Footings

Weathered siltstone was encountered at levels ranging from about RL112m to RL119m, where the bulk excavation depth is greater than about 3m, weathered siltstone is likely to be exposed at bulk excavation level, however this will depend on the final building layout and floor levels. Notwithstanding, we recommend that the building is supported on the underlying siltstone or sandstone bedrock to provide uniform support and reduce the risk of differential movements.

Depending on the proposed building loads, where competent siltstone bedrock is less than say 1m depth below the bulk excavation level, pad/strip footings founded within the siltstone would be appropriate. Where the depth to competent siltstone bedrock is greater than deeper than say 1m, then piles would be more suitable. Piles would also be required for parts of the above ground portions of the building which extend outside the ground floor/basement excavation, so the footings are founded within bedrock below the zone of influence of the basement excavation.

We recommend that for footings founded within Class 4 or Class 5 bedrock an allowable bearing pressure (ABP) of 800kPa is suitable for use in design. For footings founded within the Class 3 bedrock an allowable bearing pressure (ABP) of 3500kPa may be used in design.

Where piles are used, allowable shaft adhesion equivalent to 10% of the allowable end bearing pressure may be used for the design of piles in compression, below a nominal 0.3m socket and provided socket roughness and cleanliness are adequate.

The footing excavations should be inspected by a geotechnical engineer to confirm that the appropriate foundation material has been encountered.

4.5 Floor Slabs and Pavements

Floor Slabs

The subgrade in the deeper parts of the excavation will likely comprise weathered siltstone but elsewhere will be clay soil or even fill if there is little or no excavation. As recommended above, drainage will need to be provided below the basement slab. The drainage will need to be connected to a permanent fail-safe pump out system, which is fitted with automatic level controls to avoid flooding unless gravity drainage can be provided (which it probably can in this case)

The basement slab on grade should be designed with a subbase layer of at least 100mm thickness of crushed rock to RMS QA specification 3051 (2013) unbound base material (or other approved good quality and durable fine crushed rock), which is compacted to at least 100% of Standard Maximum Dry Density (SMDD) unless a suspended slab is adopted. This subbase layer will provide a separation between the subgrade and the slab at slab joints and provide a uniform base for the slab and inhibit pumping.

Alternatively, to avoid subgrade preparation difficulties on clay and weathered siltstone (Shale), especially if high quality floor finishes are required, we recommend a suspended slab be adopted. Use of void formers is recommended where the subgrade comprises clay soil or fill and should be at least 50mm in thickness.

External Pavements

Based on the laboratory test results, we recommend that proposed external pavements be designed for a soaked CBR value of 2% for subgrades comprising the residual silty clays. This is a relatively low soaked CBR, and therefore consideration could be given to providing either a select subgrade of good quality crushed sandstone and/or leanmix concrete so that a higher effective subgrade CBR can be used and pavement thicknesses can be reduced.

Trafficked concrete pavements should be designed for the proposed traffic loading and should be supported on an unbound granular sub-base of at least 100mm thickness, comprising good quality fine crushed rock such as DGB20 (RMS QA Specification 3051 unbound granular material) and compacted to a minimum density ratio of 100% of SMDD. Adequate moisture conditioning to within 2% of SOMC should be provided during placement. The sub-base material would provide more uniform slab support and would reduce 'pumping' of subgrade 'fines' at joints due to vehicular movements. Slab joints should be designed to resist shear forces but not bending moments by providing dowelled or keyed joints.

For flexible pavements, we recommend that all base course materials comprise DGB20 (RMS QA Specification 3051). The base course material should be compacted in maximum 200mm thick loose layers using a large static smooth drum roller to at least 100% of SMDD.

We further recommend that all sub-base materials comprise DGS20 or DGS40 (RMS QA Specification 3051). The sub-base material should be compacted in maximum 200mm thick loose layers using a large static smooth drum roller to at least 98% of SMDD. Again, adequate moisture conditioning to within 2% of SOMC should be provided during placement.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer.

Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A
MOISTURE CONTENT, ATTERBERG LIMIT AND LINEAR SHRINKAGE TEST REPORT

Client:	JK Geotechnics	**Ref No:**	33775BC
Project:	Proposed School Building	**Report:**	A
Location:	20 Avon Road, Pymble, NSW	**Report Date:**	22/01/2021
		Page 1 of 1	

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
201	0.50 - 0.95	21.3	48	22	26	11.5
203	2.00 - 3.00	7.5	-	-	-	-
203	3.80 - 4.20	6.6	-	-	-	-
203	5.00 - 6.00	7.4	-	-	-	-
204	2.70 - 3.00	5.7	-	-	-	-
204	3.50 - 4.50	6.4	-	-	-	-
204	5.20 - 6.00	5.9	-	-	-	-

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 15/01/2021.
- Sampled and supplied by client. Samples tested as received.

NATA

NATA Accredited Laboratory Number:1327

22/01/2021

Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client:	JK Geotechnics	**Ref No:**	33775BC
Project:	Proposed School Building	**Report:**	B
Location:	20 Avon Road, Pymble, NSW	**Report Date:**	20/04/2021
		Page 1 of 1	

BOREHOLE NUMBER	BH 303	BH 304	BH 305
DEPTH (m)	0.40 - 1.50	0.30 - 0.90	0.40 - 1.50
Surcharge (kg)	7.5	7.5	7.5
Maximum Dry Density (t/m^3)	1.64 STD	1.60 STD	1.52 STD
Optimum Moisture Content (%)	19.9	23.5	27.4
Moulded Dry Density (t/m^3)	1.61	1.58	1.49
Sample Density Ratio (%)	98	99	98
Sample Moisture Ratio (%)	99	100	101
Moisture Contents			
Insitu (%)	22.2	24.1	26.6
Moulded (%)	19.6	23.6	27.7
After soaking and			
After Test, Top 30mm(%)	22.6	25.2	29.0
Remaining Depth (%)	22.6	24.8	28.4
Material Retained on 19mm Sieve (%)	0	0	0
Swell (%)	1.0	0.0	0.0
C.B.R. value: @2.5mm penetration	4.5	5	5

NOTES: Sampled and supplied by client. Samples tested as received.

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 09/04/2021.
- BH 303 dried back prior to testing as sample was too saturated.

NATA

NATA Accredited Laboratory Number:1327

20/04/2021

Authorised Signature / Date
(D. Treweek)

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	Pymble Ladies College	**Ref No:**	33775BC
Project:	Proposed School Building	**Report:**	C
Location:	20 Avon Road, PYMBLE, NSW	**Report Date:**	9/04/21
		Page 1 of 1	

BOREHOLE NUMBER	DEPTH (m)	IS (50) (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
301	3.30 - 3.34	0.5	10	A
	3.70 - 3.72	0.7	14	A
	4.21 - 4.24	0.3	6	A
	4.88 - 4.91	2.4	48	A
	5.21 - 5.24	3	60	A
	5.70 - 5.74	3.1	62	A
	6.24 - 6.27	2.4	48	A
	6.77 - 6.80	3	60	A
	7.20 - 7.23	2.7	54	A
	7.67 - 7.70	2.7	54	A
302	2.75 - 2.79	0.4	8	A
	3.24 - 3.26	0.3	6	A
	3.78 - 3.81	0.4	8	A
	4.32 - 4.35	0.7	14	A
	4.96 - 4.99	0.5	10	A
	5.35 - 5.38	2.2	44	A
	5.89 - 5.92	2.3	46	A
	6.28 - 6.32	2.5	50	A
	6.76 - 6.79	2.9	58	A
	7.25 - 7.28	3	60	A
	7.73 - 7.77	2.5	50	A

NOTES

1. In the above table, testing was completed in test direction A for the axial direction, D for the diametral direction, B for the block test and L for the lump test.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the IS(50) has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa.
5. The estimated Unconfined Compressive Strength was calculated from the Point Load Strength Index based on the correlation provided in AS1726:2017 'Geotechnical Site Investigations' and rounded off to the nearest whole number: U.C.S. = 20 IS(50).

TABLE C
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	Pymble Ladies College	**Ref No:**	33775BC
Project:	Proposed School Building	**Report:**	C
Location:	20 Avon Road, PYMBLE, NSW	**Report Date:**	18/01/21
		Page 1 of 1	

BOREHOLE NUMBER	DEPTH (m)	IS (50) (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
201	2.60 - 2.62	0.3	6	A
	3.18 - 3.21	0.3	6	A
	3.78 - 3.81	0.7	14	A
	4.09 - 4.12	0.6	12	A
	4.49 - 4.53	0.6	12	A
	5.21 - 5.24	1.3	26	A
	5.90 - 5.93	2	40	A
	6.32 - 6.35	2.4	48	A
	6.86 - 6.89	2.2	44	A
	7.06 - 7.08	3.3	66	A
	7.62 - 7.64	2.3	46	A
	8.27 - 8.30	1.8	36	A
	8.86 - 8.89	2.6	52	A
	9.07 - 9.09	1.5	30	A
	9.53 - 9.55	2.1	42	A
202	7.56 - 7.59	0.04	1	A
	7.76 - 7.78	0.3	6	A
	8.91 - 8.93	0.02	<1	A
	9.05 - 9.08	0.04	1	A
	9.31 - 9.33	0.6	12	A
	9.61 - 9.63	0.09	2	A
	10.00 - 10.02	0.2	4	A
	10.31 - 10.34	4.2	84	A

NOTES

1. In the above table, testing was completed in test direction A for the axial direction, D for the diametral direction, B for the block test and L for the lump test.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the IS(50) has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa.
5. The estimated Unconfined Compressive Strength was calculated from the Point Load Strength Index based on the correlation provided in AS1726:2017 'Geotechnical Site Investigations' and rounded off to the nearest whole number: U.C.S. = 20 IS(50).

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CERTIFICATE OF ANALYSIS 259686

Client Details

Client	JK Geotechnics
Attention	Ben Sheppard
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**33775BC, Pymble**
Number of Samples	3 Soil
Date samples received	18/01/2021
Date completed instructions received	18/01/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	25/01/2021
Date of Issue	22/01/2021

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		259686-1	259686-2	259686-3
Your Reference	UNITS	BH202	BH203	BH204
Depth		0.2-0.3	1.2-1.3	0.75-0.95
Date Sampled		14/01/2021	15/01/2021	15/01/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	20/01/2021	20/01/2021	20/01/2021
Date analysed	-	20/01/2021	20/01/2021	20/01/2021
pH 1:5 soil:water	pH Units	7.5	5.9	5.2
Chloride, Cl 1:5 soil:water	mg/kg	10	<10	81
Sulphate, SO4 1:5 soil:water	mg/kg	33	30	370
Resistivity in soil*	ohm m	280	530	56

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			20/01/2021	[NT]	[NT]	[NT]	[NT]	20/01/2021	[NT]
Date analysed	-			20/01/2021	[NT]	[NT]	[NT]	[NT]	20/01/2021	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	118	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	109	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

JKGeotechnics

BOREHOLE LOG

Borehole No. 201

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~121 m

Date: 14/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	■									FILL: Silty clay, medium plasticity, dark brown, with root fibres, trace of fine grained sand, fine to medium grained ironstone gravel.	w~PL			GRASS COVER
									CI-CH		w<PL	Hd		RESIDUAL
				■	N = 13 5,6,7					Silty CLAY: medium to high plasticity, orange brown, trace of fine to medium grained ironstone gravel, ash and root fibres.			510 >600 590	
	■					120	1							
									-	Extremely Weathered siltstone: silty CLAY, high plasticity, light grey and grey, with iron indurated and very low strength bands.	XW	Hd		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
				■	N=SPT 11/ 50mm REFUSAL								>600 >600 >600	
						119	2			SILTSTONE: grey and brown, with iron indurated bands.	DW	VL - L		LOW RESISTANCE
										REFER TO CORED BOREHOLE LOG				
						118	3							
						117	4							
						116	5							
						115	6							

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 201

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~121 m

Date: 14/1/21 **Inclination:** VERTICAL **Datum:** AHD

Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** B.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 2.20m						
50% RETURN		118	3		NO CORE 0.09m SILTSTONE: dark grey and brown, with iron indurated bands and laminae up to 5°.	HW	VL - L	0.30		(2.29-2.40m) Highly Fractured, Numerious Be, P, S, Cn (2.42m) XWS, 0°, 4 mm.t (2.45m) XWS, 0°, 3 mm.t (2.49m) XWS, 0°, 4 mm.t (2.62m) XWS, 0°, 4 mm.t (2.69m) J, 90°, Ir, R, Fe Sn, and Be, 0°, P R, Fe, St (2.71m) Be, 0°, P, R, Fe Sn (2.72m) XWS, 0°, 20 mm.t (2.78m) XWS, 0°, 7 mm.t (2.82m) XWS, 0°, 10 mm.t (2.85m) J, 70 - 90°, Ir, R, Clay Ct (2.95m) J x 2, 70 - 80°, P, S, XWS FILLED, and XWS, 0°, 110mm.t	Ashfield Shale
						MW	L - M	0.30		(3.14m) J, 80 - 90°, St, R, Fe Sn (3.30m) XWS, 0°, 5 mm.t (3.38m) XWS, 0°, 20 mm.t (3.41m) Be, 0°, P, R, Cn (3.58m) J, 90°, P, R, Fe Sn (3.60m) J, 0°, P, R, Fe Sn (3.66m) Be, 0°, P, R, Fe Sn, and J, 90°, P R, Cn (3.74m) XWS, 0°, 4 mm.t (3.88m) XWS, 0°, 12 mm.t (3.92m) Be, 5°, Un, R, Fe Sn (3.96m) CS, 0°, 6 mm.t (4.13m) Be, 5°, Un, R, Fe Sn	
		117	4					0.70		(4.25m) J, 60°, P, R, XWS FILLED, 15 mm.t	
								0.60			
								0.60			
					Extremely Weathered siltstone: silty CLAY, medium plasticity, with light grey laminae up to 10°.	XW	Hd			(4.70m) J, 90°, Un, R, XW Fines, 15 mm.t	
					SILTSTONE: dark grey and brown, with iron indurated bands and laminae up to 5°.	MW	L - M			(4.84m) XWS, 0°, 35 mm.t	
		116	5			SW	H	1.3		(5.08m) Be, 0°, P, R, Cn	
					SILTSTONE: dark grey, with light grey laminae up to 10°.					(5.35m) J x 3, 70 - 90°, C, Cn	
										(5.54m) J, 80°, P, R, Fe Sn	
		115	6					2.0		(5.93m) Be, 0°, P, R, Cn	
										(6.17m) J, 70°, Un, R, Fe Sn	
								2.4			
										(6.56m) J, 70°, Un, R, Cn	
								2.2			
		114	7					3.3			
										(7.27m) J, 60°, Un, R, Fe Sn	
						FR		2.3			
		113	8					1.8			
								2.6			

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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CORED BOREHOLE LOG

Borehole No. 201 **3 / 3**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~121 m

Date: 14/1/21 **Inclination:** VERTICAL **Datum:** AHD

Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** B.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
50% RETURN					SILTSTONE: dark grey, with light grey laminae up to 10°. *(continued)*	FR	H	1.5, 2.1			Ashfield Shale
					END OF BOREHOLE AT 9.72 m						
		111	10								
		110	11								
		109	12								
		108	13								
		107	14								
		106	15								

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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Job No: 337758C
Borehole No: BH201
Depth: 2.20m - 9.72m

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BOREHOLE LOG

Borehole No. 202 **1 / 2**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~114.5 m

Date: 14/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING						114				FILL: silty clay, low plasticity, dark brown, trace of fine grained sand, fine grained ironstone gravel, concrete fragments and root fibres.	w>PL			GRASS COVER APPEARS MODERATELY COMPACTED
					N = 9 5,4,5					as above, but without concrete fragments.				
							1		CI	Silty CLAY: medium plasticity, orange brown and brown, trace of fine grained ironstone gravel and root fibres.	w>PL	VSt	290 300 240	RESIDUAL
						113			CI-CH	Silty CLAY: medium to high plasticity, orange brown, red brown and grey, with fine grained ironstone gravel, trace of root fibres.	w~PL	Hd	>600 >600 >600	
					N = 16 6,6,10		2							
						112			-	Extremely Weathered siltstone: silty CLAY, high plasticity, grey brown, with iron indurated bands and very low strength brands.	XW	(Hd)		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
							3							
						111								
							4			SILTSTONE: grey and brown, with extremely weathered bands and iron indurated bands.	DW	VL		VERY LOW TO LOW BANDED RESISTANCE
										REFER TO CORED BOREHOLE LOG				
						110								
							5							
						109								
							6							
						108								

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 202 **2 / 2**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~114.5 m

Date: 14/1/21 **Inclination:** VERTICAL **Datum:** AHD

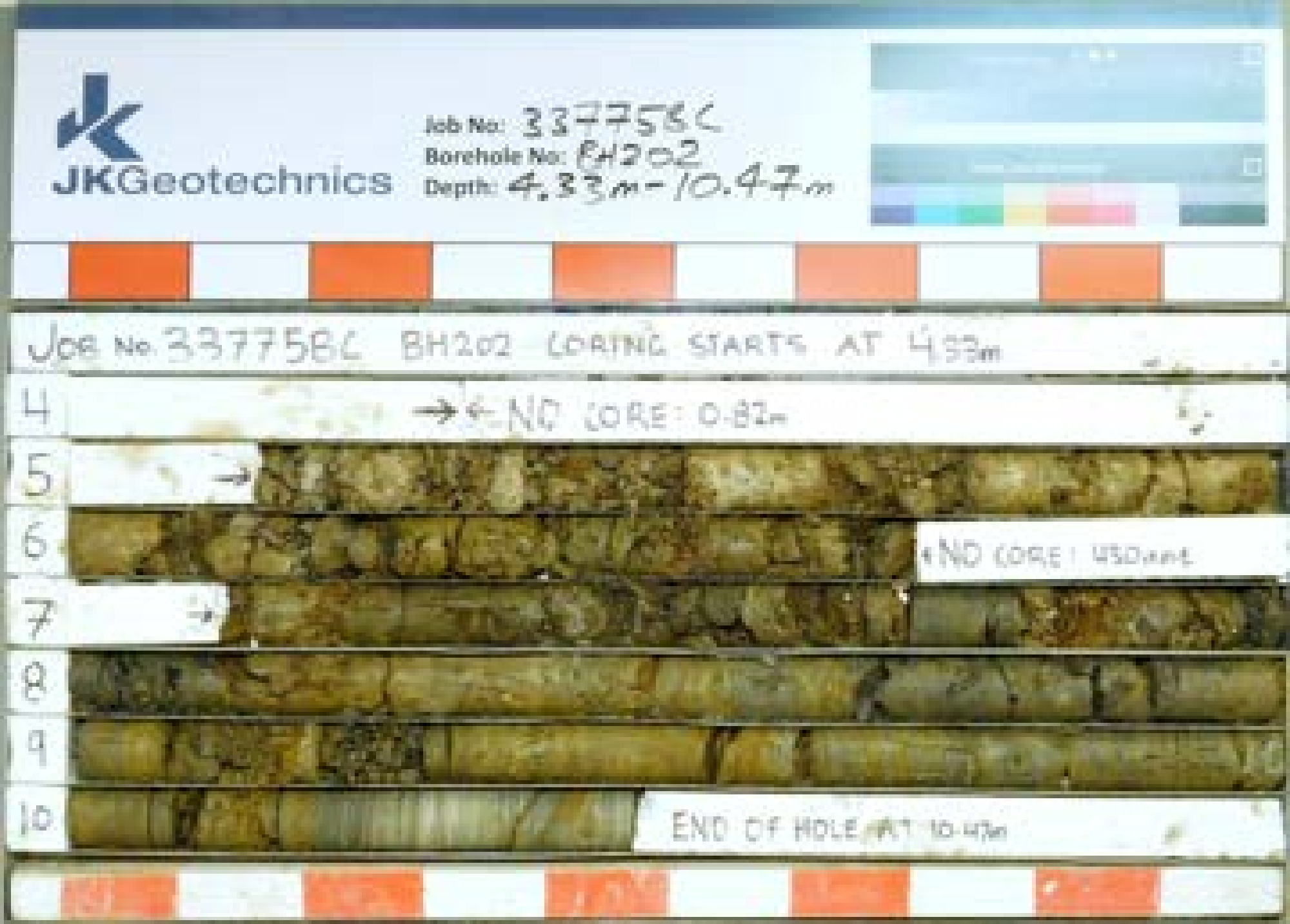
Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** B.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 4.33m						
		110	5		NO CORE 0.82m						
		109	6		Extremely Weathered siltstone: silty CLAY, high plasticity, grey, with high strength bands and iron indurated bands.	XW	Hd			(5.80m) HP: >600 kPa (6.08m) HP: >600 kPa	Ashfield Shale
		108	7		NO CORE 0.43m						
50% RETURN		107			SILTSTONE: grey and brown.	HW	VL	0.040 0.30		(7.14m) XWS, 0°, 45 mm.t (7.40m) XWS, 0°, 30 mm.t (7.43-7.62m) Numerous, Be, 0°, P, R, Fe, and J, 20-80°, P, R, Fe, St (7.78m) Be, 5°, P, R, Fe Sn	
		106	8		Extremely Weathered siltstone: silty CLAY, high plasticity, with iron indurated bands.	XW	Hd			(8.24m) HP: >600 kPa (8.40m) HP: >600 kPa	
			9		SILTSTONE: dark grey.	HW	VL	0.020 0.040		(9.10m) XWS, 0°, 100 mm.t (9.20m) J, 90°, P, R, Fe Sn	Ashfield Shale
		105			Interbedded SILTSTONE: grey and brown and SANDSTONE: fine to medium grained, grey, with iron indurated bands.	MW	VL - L	0.60 0.090		(9.55m) XWS, 0°, 50 mm.t	
			10					0.20		(10.10m) Be, 0°, Un, R, Fe Sn, and XWS, 0°, 75mm.t	
					SANDSTONE: fine grained, grey, with siltstone bands.	SW	M - H	4.2		(10.37m) J, 30°, Un, R, Fe Sn (10.42m) Ji, 30°	
		104			END OF BOREHOLE AT 10.47 m						

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

Job No: 337758C
Borehole No: BH202
Depth: 4.33m - 10.47m



JKGeotechnics

BOREHOLE LOG

Borehole No. 203 1 / 1

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~117 m

Date: 15/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION										FILL: Silty clay, dark brown, trace of fine to medium grained sand, fine to medium grained ironstone gravel, concrete fragments and root fibres.	w~PL			GRASS COVER
									CI-CH		w~PL	Hd		RESIDUAL
					N = 14 6,6,8					Silty CLAY: medium to high plasticity, orange brown, trace of fine to coarse grained ironstone gravel, ash and root fibres.			>600 >600 >600	
						116	1							
									-	SILTSTONE: dark grey, with extremely weathered bands and iron indurated bands.	DW	L		ASHFIELD SHALE
												L		VERY LOW TO LOW 'TC' BIT RESISTANCE
						115	2							LOW RESISTANCE WITH MODERATE BANDS
						114	3			SILTSTONE: dark grey and grey, with extremely weathered seams.		M		MODERATE RESISTANCE
						113	4							
										as above, but iron indurated bands.		M - H		MODERATE RESISTANCE WITH HIGH BANDS
						112	5							
						111	6			END OF BOREHOLE AT 6.00 m				

JKGeotechnics

BOREHOLE LOG

Borehole No. 204 1 / 1

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~119.9 m

Date: 15/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION									-	CONCRETE:20mm.t	M			APPEARS MODERATELY COMPACTED
										FILL: Silty sand, fine to medium grained, dark brown, trace of concrete fragments and clay nodules.	w<PL			
					N = 11 4,6,5					FILL: Silty clay, low plasticity, brown, trace of fine to coarse grained igneous and ironstone gravel, ash and slag fragments.				
						119	1		CI		w<PL	Hd	>600 >600 >600	RESIDUAL
										Silty CLAY: medium plasticity, orange brown, trace of fine to medium grained ironstone gravel, ash and root fibres.				
									CI-CH	Silty CLAY: medium to high plasticity, light grey and red brown, trace of fine to coarse grained ironstone gravel.	w~PL			
					N = 16 7,7,9								>600 >600 >600	
						118	2		-	Extremely Weathered siltstone: silty CLAY, medium to high plasticity, grey, with iron indurated bands.	XW	Hd		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
										SILTSTONE: dark grey and brown, with iron indurated bands and extremely weathered bands.	DW	L		LOW RESISTANCE WITH MODERATE BANDS
						117	3					M		MODERATE RESISTANCE WITH LOW BANDS
						116	4							
						115	5							
										as above, but without extremely weathered bands.		M - H		MODERATE RESISTANCE WITH HIGH BANDS
						114	6			END OF BOREHOLE AT 6.00 m				
						113								

JKGeotechnics

BOREHOLE LOG

Borehole No. 301 1 / 2

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~120 m

Date: 8/4/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** W.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING									-	CONCRETE: 40mm.t	w>PL			NO OBSERVED REINFORCEMENT
										FILL: Silty clay, medium plasticity, grey brown, with fine to coarse grained igneous gravel.				
				■	N = 19 5,7,12				CH	Silty CLAY: high plasticity, red brown and orange brown, trace of fine to medium grained ironstone gravel.	w~PL	Hd	600 450 460	RESIDUAL
						119	1							
				■	N=SPT 3/ 150mm REFUSAL				-	SILTSTONE: grey.	DW	VL - L		ASHFIELD SHALE VERY LOW TO LOW 'TC' BIT RESISTANCE
				■		118	2					L		LOW RESISTANCE
										REFER TO CORED BOREHOLE LOG				
						117	3							
						116	4							
						115	5							
						114	6							

JK 9.02.4 LIB GLB Log JK AUGERHOLE - MASTER 33775BC PYMBLE.GPJ <<DrawingFile>> 23/04/2021 13:01 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 301 **2 / 2**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~120 m

Date: 8/4/21 **Inclination:** VERTICAL **Datum:** AHD

Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** W.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 2.80m						
100% RETURN		117	3		SILTSTONE: grey and red brown, bedded at 0-15°.	SW	M	0.50, 0.70, 0.30		(2.81m) Be, 5°, P, S, Fe Sn; (2.95m) XWS, 0°, 20 mm.t; (3.17m) Be, 5°, P, S, Clay FILLED; (3.72m) Be, 9°, P, S, Clay FILLED; (3.90m) J, 70 - 90°, Ir, R, Fe Sn; (4.30m) J, 90°, Ir, R, Fe Sn; (4.50m) XWS, 0°, 20 mm.t; (4.75m) J, 90°, S, Ca Cn	Ashfield Shale
		116	4								
		115	5		SILTSTONE: dark grey, bedded at 0-10°.	FR	H	2.4, 3.0, 3.1, 2.4, 3.0, 2.7, 2.7		(6.10m) J, 45°, P, S, Cn	
		114	6								
		113	7								
		112	8		END OF BOREHOLE AT 7.90 m						

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

Job No: 33775BC
Borehole No: 301
Depth: 2.80m - 7.90m

JKGeotechnics

BOREHOLE LOG

Borehole No. 302 1 / 2

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~119.7 m

Date: 8/4/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** W.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING										FILL: Silty sandy clay, medium plasticity, brown.	w>PL			GRASS COVER
				■	N = 20 5,8,12	119	1		-	Extremely Weathered siltstone: silty CLAY, medium plasticity, grey and red brown, with occasional low strength bands.	XW	Hd		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
ON COMPLETIO OF CORING ▽				■		118	2			SILTSTONE: grey brown.	DW	L - M		LOW TO MODERATE RESISTANCE
				■		117	3			REFER TO CORED BOREHOLE LOG				Groundwater monitoring well installed to 8.0m. Machine slotted / Hand slotted 50mm dia. PVC standpipe 5.0m to 8.0m. Casing 0m to 5.0m. 2mm sand filter pack 5.0m to 8.0m. Bentonite seal 2.0m to 5.0m. Backfilled with sand (and/or cuttings) to the surface. Completed with a concreted gatic cover.
						116	4							
						115	5							
						114	6							
						113								

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 302 **2 / 2**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~119.7 m

Date: 8/4/21 **Inclination:** VERTICAL **Datum:** AHD

Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** W.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 2.70m						
100% RETURN		117	3		SILTSTONE: grey and brown, bedded at 0-15°.	SW	M	0.40 0.30 0.40 0.70		(2.80m) Be, 0°, P, S, Clay FILLED (2.85m) XWS, 0°, 50 mm.t (2.95m) Be, 0°, P, S, Fe Sn (3.25m) XWS, 0°, 150 mm.t (3.50m) Be, 0°, P, S, Clay FILLED (3.63m) XWS, 0°, 10 mm.t (3.80m) XWS, 0°, 20 mm.t (4.04m) XWS, 0°, 40 mm.t (4.20m) Be, 5°, P, S, Fe Sn (4.29m) J, 25°, P, S, Fe Sn (4.40m) XWS, 0°, 10 mm.t (4.54m) J, 25°, P, S, Fe Sn (4.57m) J, 30°, P, S, Fe Sn (4.70m) J, 45°, P, S, Cn (4.83m) Be, 0°, P, S, Cn	Ashfield Shale
		116	4								
		115	5				H	0.50		(5.00m) Cr, 0°, 50 mm.t (5.10m) J, 45°, P, S, Fe Sn (5.25m) XWS, 0°, 20 mm.t	
		114	6		SILTSTONE: grey, bedded at 0-10°.	FR		2.2 2.3 2.5	600 200 60 20	(5.50m) J, 35°, P, S, Cn (6.55m) J, 50°, P, S, Cn	
		113	7					2.9 3.0			
		112	8					2.5			
		111			END OF BOREHOLE AT 8.05 m						

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

Job No: 33775BC
Borehole No: 302
Depth: 2.70m - 8.05m

Job No. 33775BC BH302 START DEPTH AT 2.7m

JKGeotechnics

BOREHOLE LOG

Borehole No. 303 1 / 1

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~119.9 m

Date: 8/4/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** W.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION										FILL: Silty clay, medium plasticity, grey brown, with fine to coarse grained siltstone gravel.				MULCH COVER
				■		119	1		CH	Silty CLAY: high plasticity, red brown, trace of fine to medium grained ironstone gravel.	w>PL	VSt	220 350 280	RESIDUAL
						118	2			END OF BOREHOLE AT 1.50 m				
						117	3							
						116	4							
						115	5							
						114	6							
						113								

JKGeotechnics

BOREHOLE LOG

Borehole No. 304 **1 / 1**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~116.4 m

Date: 8/4/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** W.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION										FILL: Silty clay, medium plasticity, dark brown, trace of root fibres.	w~PL			GRASS COVER
						116			CH	Silty CLAY: high plasticity, red brown and orange brown, trace of fine to medium grained ironstone gravel.	w>PL	VSt - Hd	350 400 430	RESIDUAL
							1							
						115				as above, but mottled light grey, orange brown and red brown.	w~PL			
										END OF BOREHOLE AT 1.50 m				
						114	2							
						113	3							
						112	4							
						111	5							
						110	6							

JKGeotechnics

BOREHOLE LOG

Borehole No. 305 **1 / 1**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

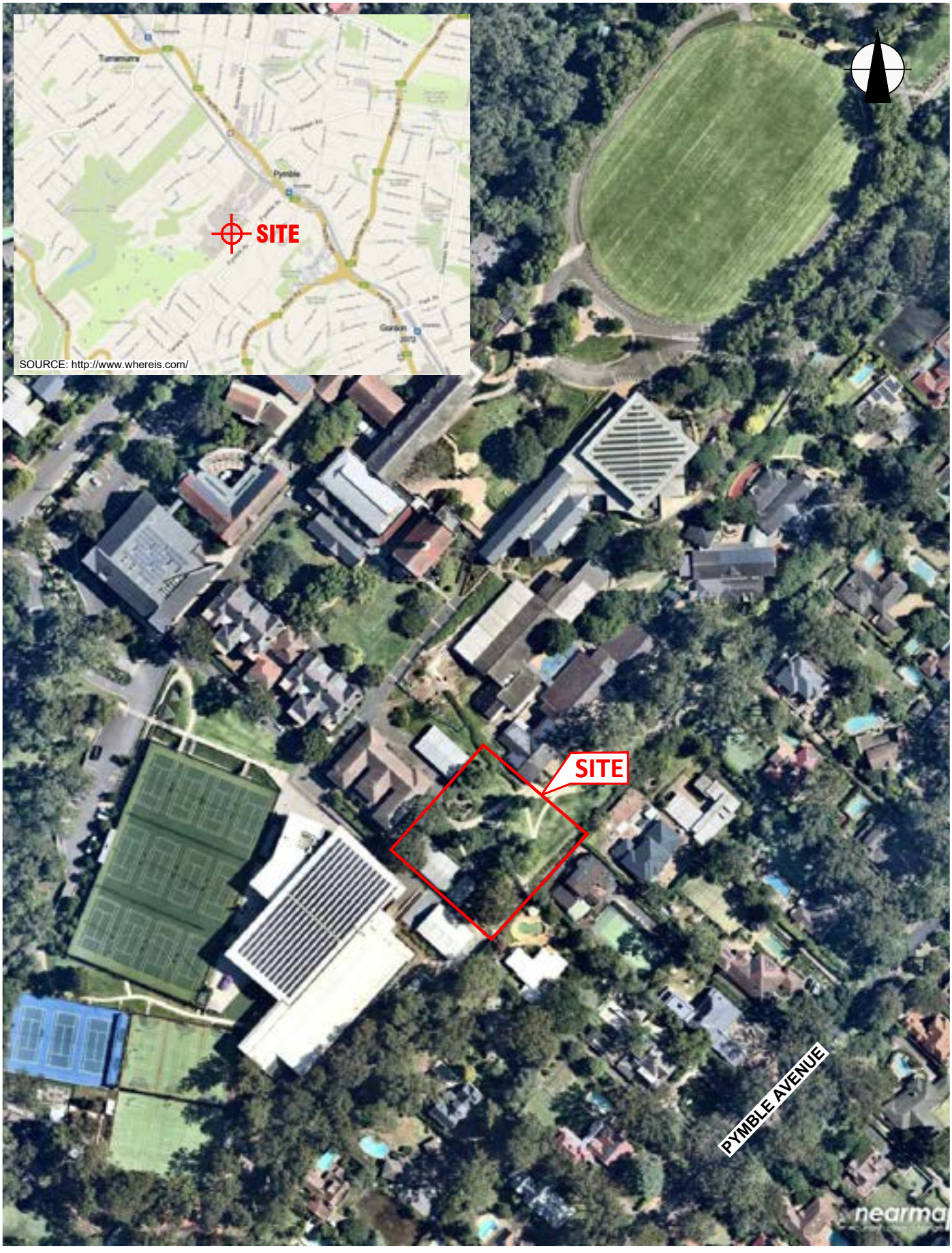
Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~114.1 m

Date: 8/4/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** W.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION						114				FILL: Silty clay, low plasticity, brown, trace of sand, ash and root fibres.	w<PL			GRASS COVER
									CH	Silty CLAY: high plasticity, orange brown and red brown, trace of fine to medium grained ironstone gravel.	w>PL	VSt	250 300 350	RESIDUAL
						113	1							
										END OF BOREHOLE AT 1.50 m				
						112	2							
						111	3							
						110	4							
						109	5							
						108	6							



AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

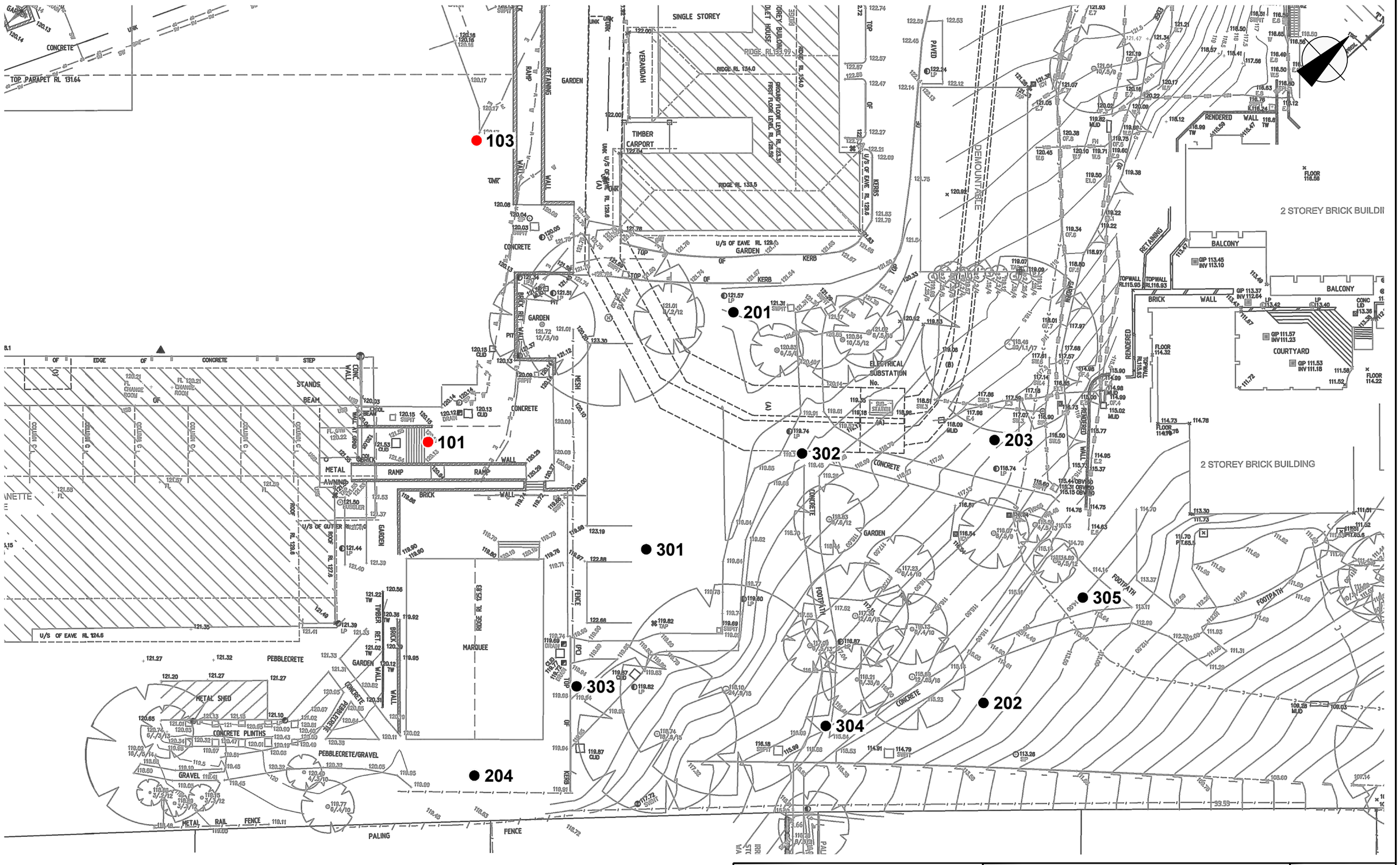
Location: 20 AVON ROAD, PYMBLE, NSW

Report No: 33775BC

Figure No: 1

JKGeotechnics

PLOT DATE: 25/01/2021 9:42:37 AM DWG FILE: Z:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\33000'S\33775BC PYMBLE\CAD\33775BC.DWG



NOTE:
BOREHOLES 101, 103 AND 201 TO 204 ARE FROM OUR PREVIOUS GEOTECHNICAL INVESTIGATION.

0 4 8 12 16 20
SCALE 1:400 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **BOREHOLE LOCATION PLAN**

Location: 20 AVON ROAD, PYMBLE, NSW

Report No: 33775BC

Figure No: 2

JKGeotechnics

PLOT DATE: 23/04/2021 2:04:08 PM DWG FILE: Y:\33000\S\33775SC PYMBLE\CAD\33775BC.DWG

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shrink-swell behaviour, strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

As penetration occurs (at a rate of approximately 20mm per second), the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Reasonable care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.
- Details of the development that the Company could not reasonably be expected to anticipate.

If these occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a joint design review which involves an experienced geotechnical engineer/engineering geologist.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

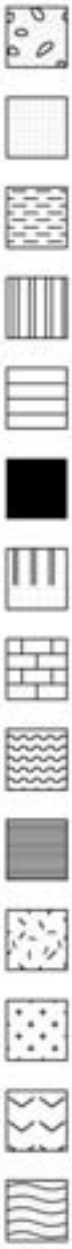
ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL

ROCK



OTHER MATERIALS

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

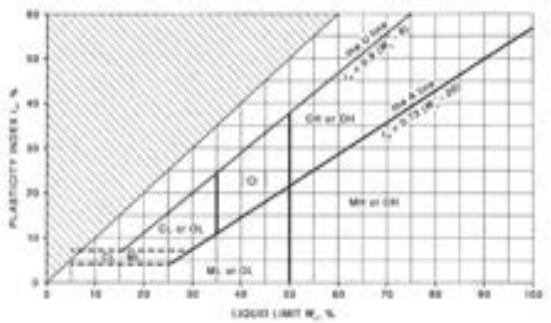
$$C_U = \frac{D_{60}}{D_{10}} \qquad and \qquad C_C = \frac{(D_{30})^2}{D_{10}\, D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

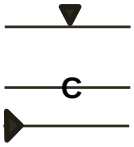
NOTES:

1. For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.
2. Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.
3. Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.
4. The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record		Standing water level. Time delay following completion of drilling/excavation may be shown. Extent of borehole/test pit collapse shortly after drilling/excavation. Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES U50 DB DS ASB ASS SAL	Sample taken over depth indicated, for environmental analysis. Undisturbed 50mm diameter tube sample taken over depth indicated. Bulk disturbed sample taken over depth indicated. Small disturbed bag sample taken over depth indicated. Soil sample taken over depth indicated, for asbestos analysis. Soil sample taken over depth indicated, for acid sulfate soil analysis. Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25 PID = 100	Vane shear reading in kPa of undrained shear strength. Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	w > PL $w \approx$ PL w < PL $w \approx$ LL w > LL	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. Moisture content estimated to be near liquid limit. Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D M W	DRY – runs freely through fingers. MOIST – does not run freely but no free water visible on soil surface. WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt Hd Fr ( )	VERY SOFT – unconfined compressive strength ≤ 25kPa. SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa. FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa. STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa. VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa. HARD – unconfined compressive strength > 400kPa. FRIABLE – strength not attainable, soil crumbles. Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.
Density Index/ Relative Density (Cohesionless Soils)	VL L MD D VD ( )	**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)** VERY LOOSE ≤ 15 / 0 – 4 LOOSE > 15 and ≤ 35 / 4 – 10 MEDIUM DENSE > 35 and ≤ 65 / 10 – 30 DENSE > 65 and ≤ 85 / 30 – 50 VERY DENSE > 85 / > 50 Bracketed symbol indicates estimated density based on ease of drilling or other assessment.
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered (Note 1)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength	
			Point Load Strength Index $Is_{(50)}$ (MPa)	Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres

APPENDIX A

BH103 (REF:25921ZH2)

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **101** 1/1

Client: PYMBLE LADIES' COLLEGE

Project: PROPOSED REDEVELOPMENT

Location: PYMBLE LADIES COLLEGE, AVON ROAD, PYMBLE, NSW

Job No. 25921ZH2 **Method:** SPIRAL AUGER JK250 **R.L. Surface:** ≈ 120.2m

Date: 8-10-13 **Datum:** AHD

Logged/Checked by: A.P.C./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION						0			FILL: Silty clay topsoil, medium plasticity, brown, with roots and root fibres.				GRASS COVER
								CL-CH		MC<PL	(H)		RESIDUAL
				■	N > 18 10,18/ 150mm			-	SILTY CLAY: medium to high plasticity, orange brown.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
					REFUSAL	1			SHALE: light grey and orange brown.				
				■						DW	L-M		LOW RESISTANCE WITH HIGH BANDS
				■		2					M		MODERATE TO HIGH RESISTANCE
									END OF BOREHOLE AT 2.1m				'TC' BIT REFUSAL
						3							
						4							
						5							
						6							
						7							

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **103** 1/2

Client: PYMBLE LADIES' COLLEGE

Project: PROPOSED REDEVELOPMENT

Location: PYMBLE LADIES COLLEGE, AVON ROAD, PYMBLE, NSW

Job No. 25921ZH2 **Method:** SPIRAL AUGER JK250 **R.L. Surface:** ≈ 121.4m

Date: 8-10-13 **Datum:** AHD

Logged/Checked by: A.P.C./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION OF AUGER-ING						0			FILL: Silty clay, medium plasticity, brown, with roots, root fibres and timber fragments.	MC<PL			
				■	N = 19 12,9,10			CH	SILTY CLAY: high plasticity, orange brown, with fine to medium grained ironstone gravel.	MC<PL	H	>600 >600 >600	RESIDUAL
						1							
								-	SHALE: light grey and orange brown.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
				■	N > 10 19,10/ 50mm REFUSAL								
						2			SHALE: grey and orange brown.	DW	VL-L		LOW TO MODERATE RESISTANCE
				■					as above, but with M-H strength bands.		L		LOW RESISTANCE WITH HIGH BANDS
						3			SHALE: grey to orange brown.		M		MODERATE RESISTANCE
				■		4			as above, but dark grey and grey.	SW	H		MODERATE RESISTANCE WITH HIGH BANDS
									REFER TO CORED BOREHOLE LOG				
						5							
						6							
						7							

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No. **103** **2/2**

Client: PYMBLE LADIES' COLLEGE

Project: PROPOSED REDEVELOPMENT

Location: PYMBLE LADIES COLLEGE, AVON ROAD, PYMBLE, NSW

Job No. 25921ZH2 **Core Size:** NMLC **R.L. Surface:** ≈ 121.4m

Date: 8-10-13 **Inclination:** VERTICAL **Datum:** AHD

Drill Type: JK250 **Bearing:** - **Logged/Checked by:** A.P.C./A.J.H.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
		4		START CORING AT 4.45m					
FULL RET-URN				SHALE: dark grey and grey, highly fractured.	SW	H			- DEFECTS NOT INDIVIDUALLY DESCRIBED BETWEEN 4.45m and 7.04m DEPTH ARE Be, 0-20°, P, R, IS
				CORE LOSS 0.05m	SW	M			
		5		SHALE: dark grey and grey, with orange brown laminae, bedded at 0-5°. Shale is hightly fractured.					
		6		as above, but shale is fragmented.					J, 45°, P, R, IS
		7		SHALE: dark grey and grey, with orange laminae bedded at 10-15°. Shale is slightly fractured.					- Cr, 10°, 30mm.t - J, 30°, P, IS - XWS, 15°, 40mm.t - J, 15°, P, S - 2xJ, SUBVERTICAL, Un, IS
					SW-Fr	H-VH			- Cr, 10°, 40mm.t
		8							- XWS, 5°, 5mm.t - Cr, 15°, 20mm.t - XWS, 10°, 20mm.t - J, 50°, P, S
				END OF BOREHOLE AT 8.49m					
		9							
		10							


JK Geotechnics
Job No: 259217H
BH103
Start Coring at 4.45m
4
5
6
7
8
CL
DDE
End of Hde at 8.49m

Building plan assessment application

Application number: 1824388
Property address: 16-46 Avon Rd, Pymble 2073
Lot details: Lot 1, Deposited Plan 69541

13/02/2024

Dear Diego Montelvere

Your building plan assessment application has been

APPROVED

This Approval is provided subject to the Conditions and Important Information issued to you by Sydney Water, which you are taken to have accepted by using the approval.

This Approval is based on the information you provided to us through Sydney Water Tap in.

If any of the information you have provided is incorrect or incomplete, Sydney Water may revoke this Approval.

This approval is valid until 12/02/2025 (one year).

ANY QUESTIONS?

Email us
swtapin@sydneywater.com.au

Call us
1300 082 746

STRUCTURES

The structures and information you supplied are displayed below.

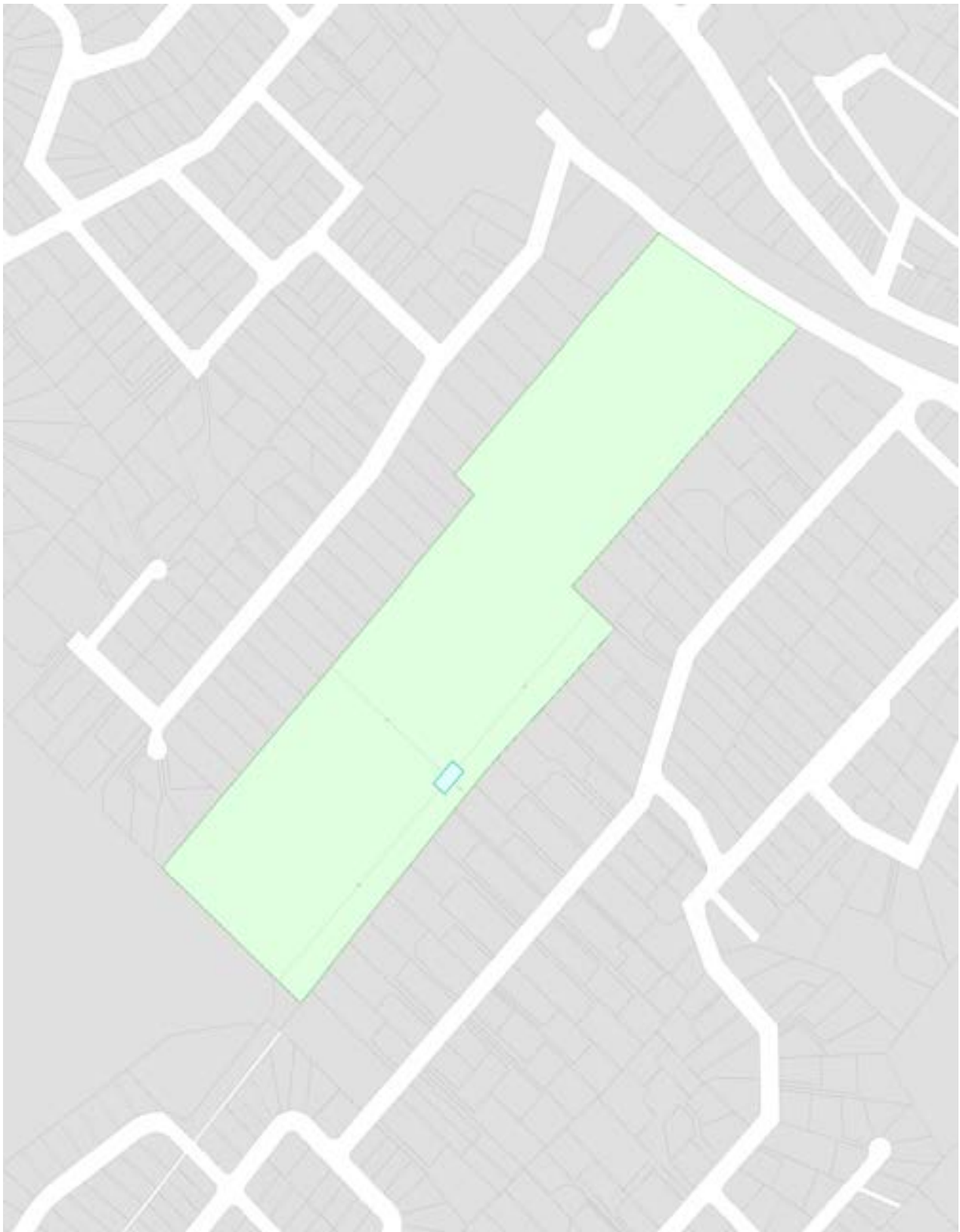
Structure(s) that will not impact Sydney Water infrastructure

Structure 1	School	29.0 m x 15.0 m x 3.0 m
Structure 2	School	47.0 m x 14.0 m x 2.0 m
Structure 3	School	37.0 m x 29.0 m x 7.0 m
Structure 4	School	45.0 m x 28.0 m x 2.7 m
Structure 5	Stormwater detention	12.0 m x 5.0 m x 7.0 m

Structure 1 of 5: School

Application number: 1824388
Property address: 16-46 Avon Rd, Pymble 2073
Lot details: Lot 1, Deposited Plan 69541

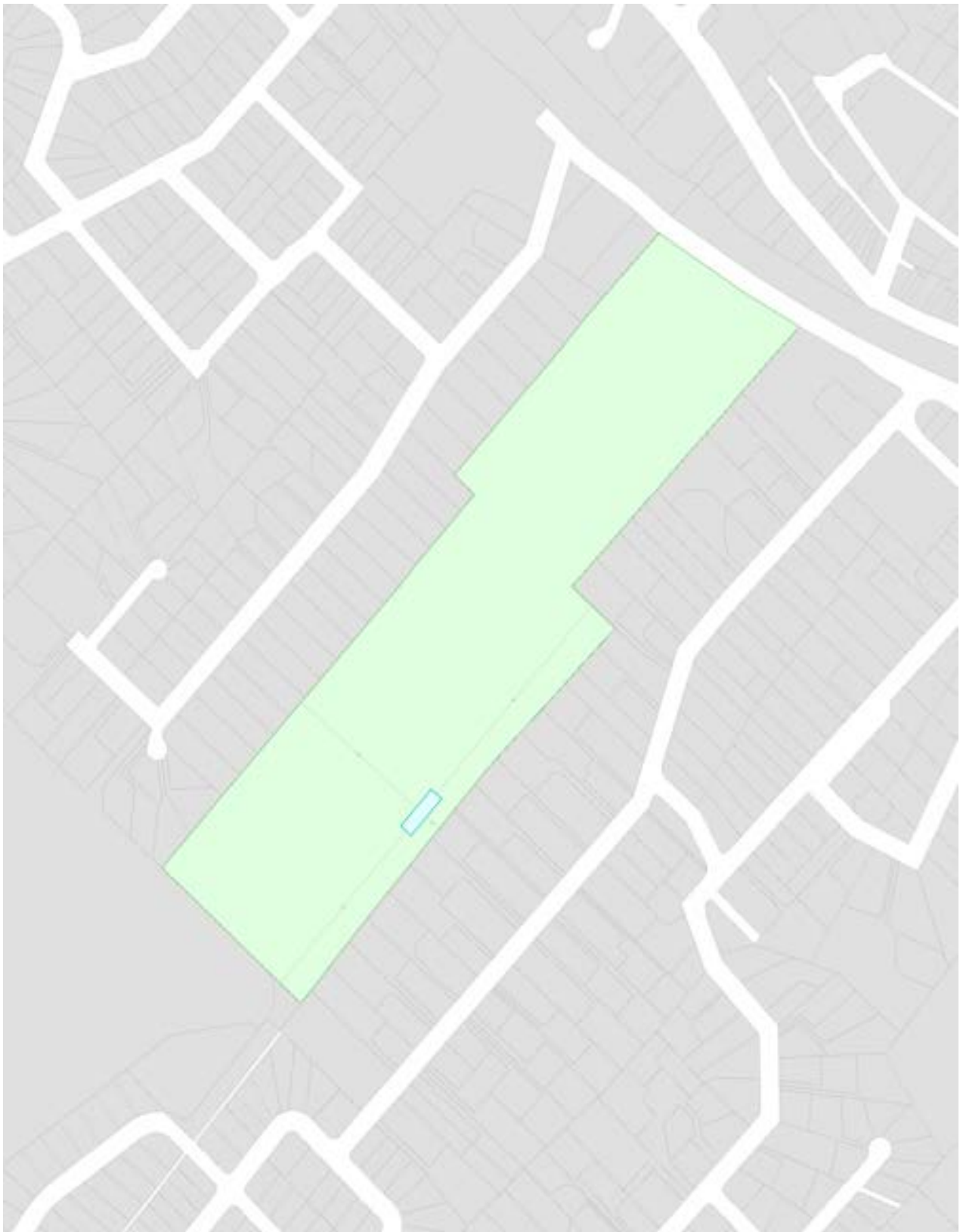
This structure will not impact Sydney Water infrastructure.



Structure 2 of 5: School

Application number: 1824388
Property address: 16-46 Avon Rd, Pymble 2073
Lot details: Lot 1, Deposited Plan 69541

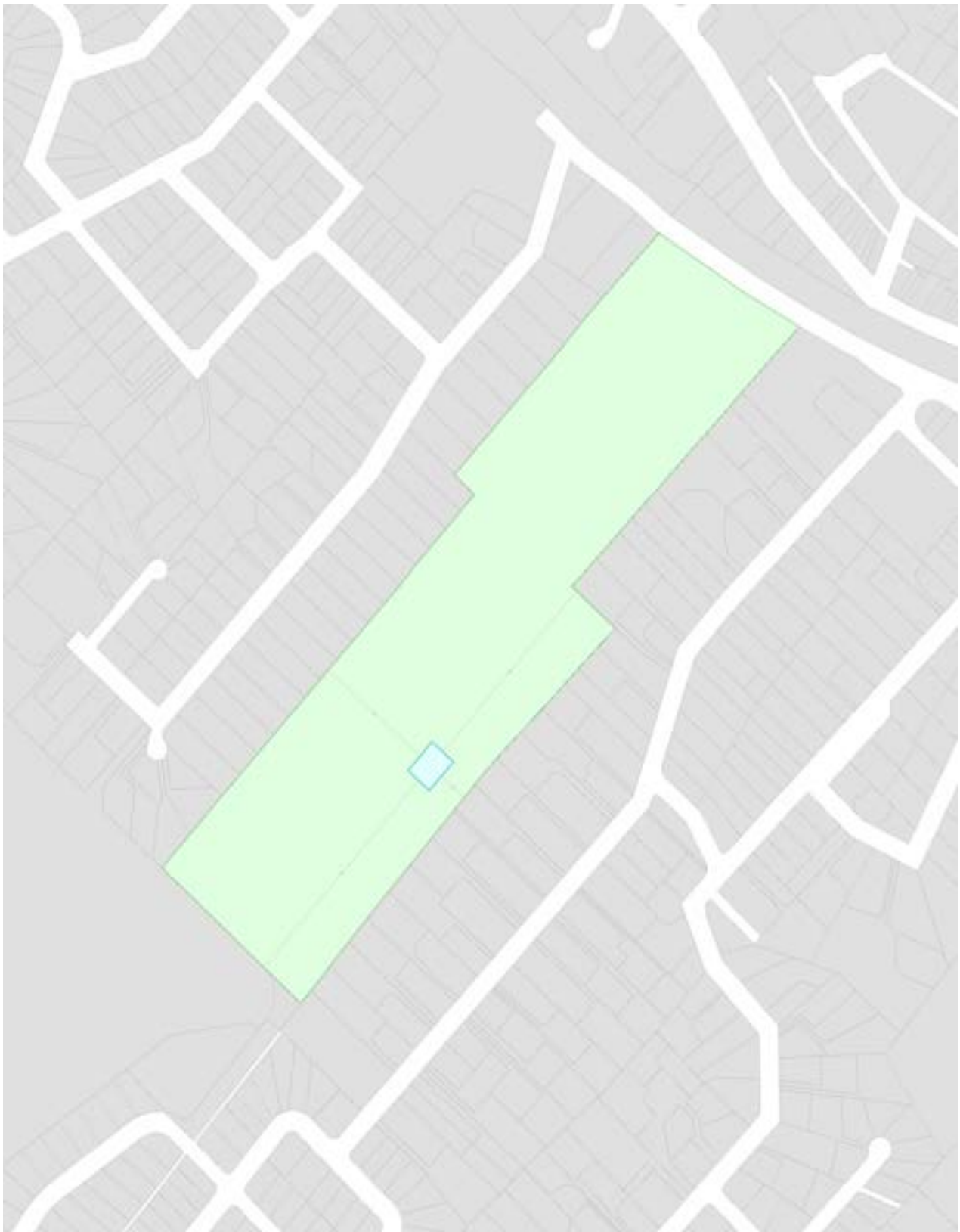
This structure will not impact Sydney Water infrastructure.



Structure 3 of 5: School

Application number: 1824388
Property address: 16-46 Avon Rd, Pymble 2073
Lot details: Lot 1, Deposited Plan 69541

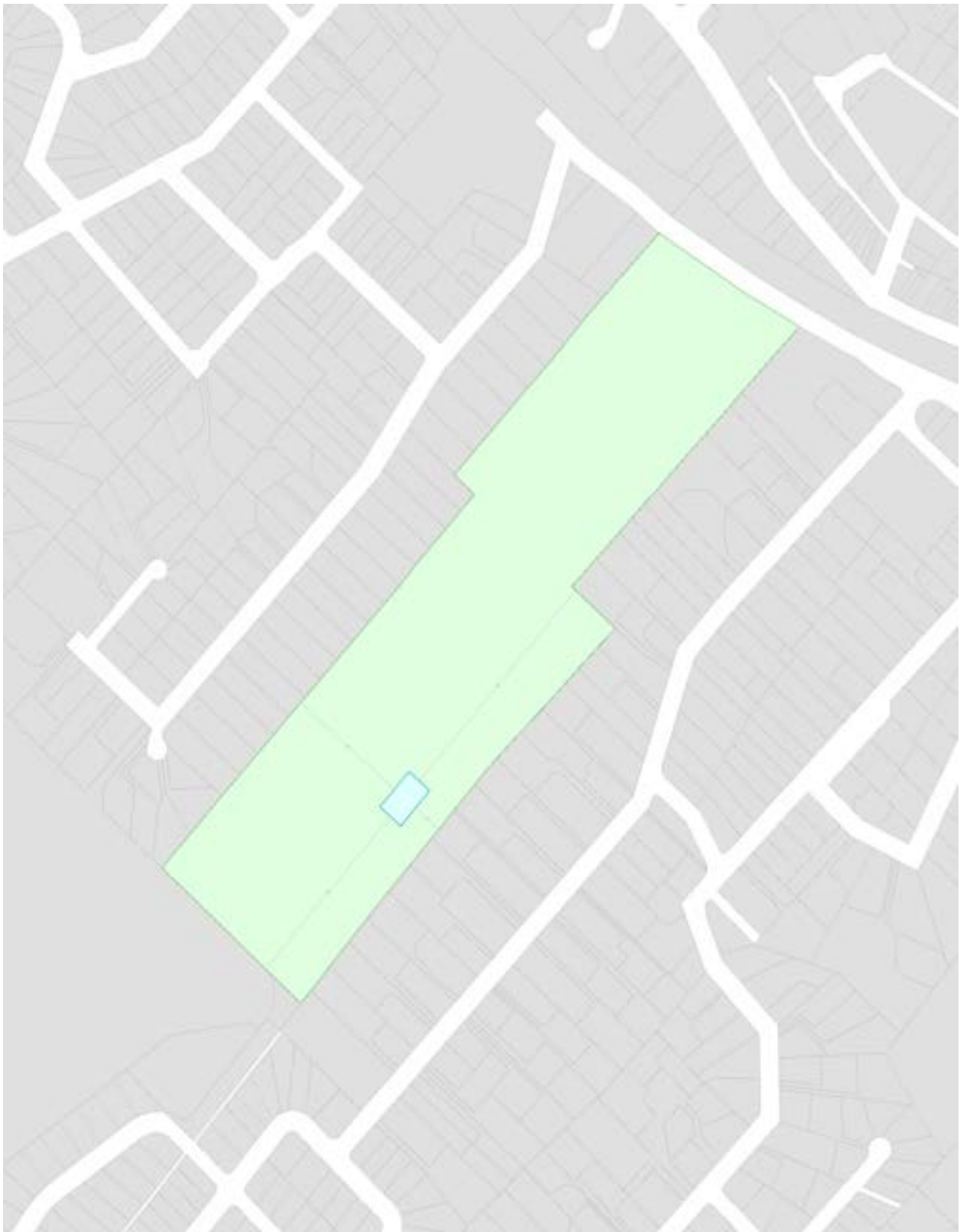
This structure will not impact Sydney Water infrastructure.



Structure 4 of 5: School

Application number: 1824388
Property address: 16-46 Avon Rd, Pymble 2073
Lot details: Lot 1, Deposited Plan 69541

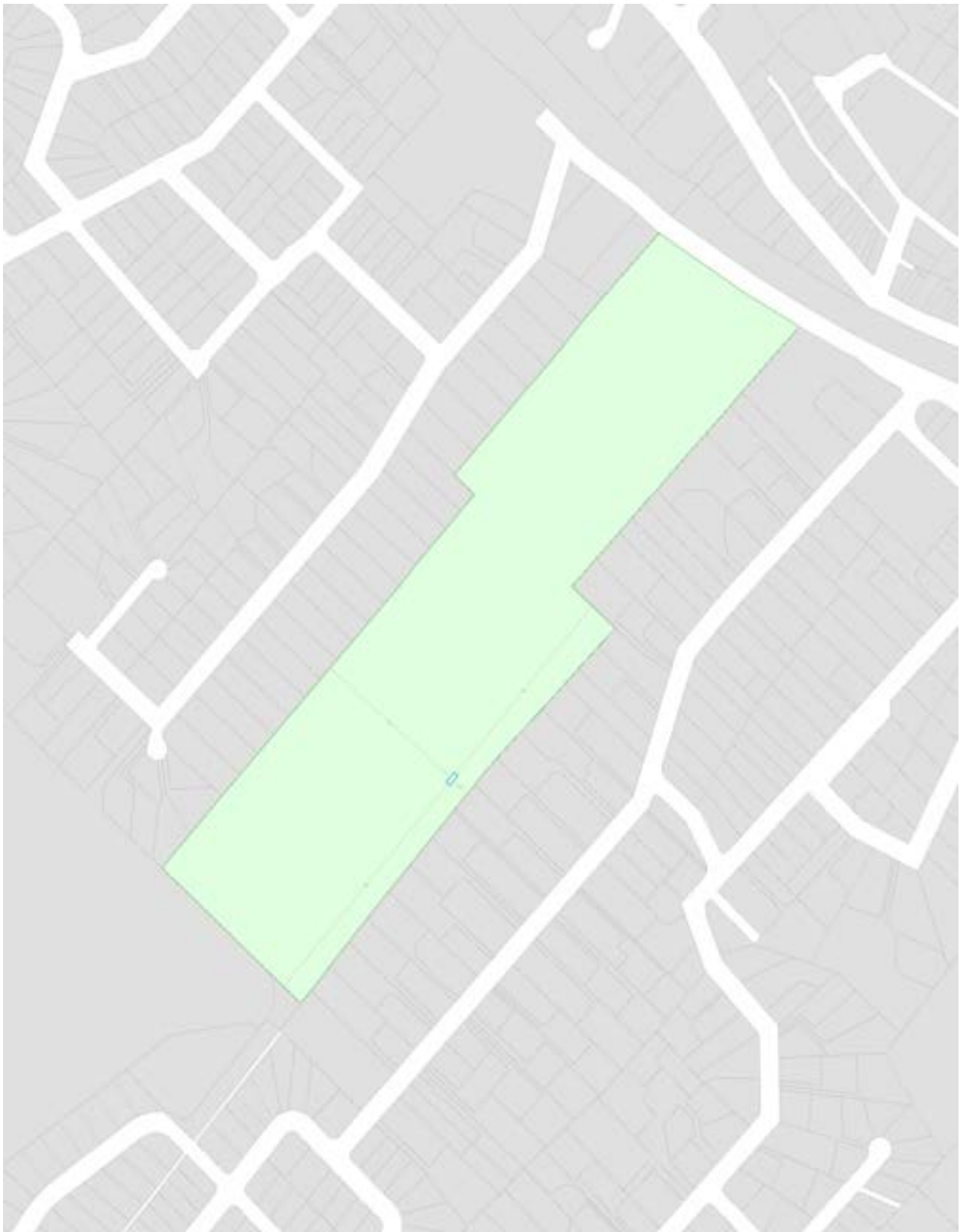
This structure will not impact Sydney Water infrastructure.



Structure 5 of 5: Stormwater detention

Application number: 1824388
Property address: 16-46 Avon Rd, Pymble 2073
Lot details: Lot 1, Deposited Plan 69541

This structure will not impact Sydney Water infrastructure.



CONDITIONS AND IMPORTANT INFORMATION

Conditions and Important Information

Attention: You must read the information below.

1 The approval of your building plan by Sydney Water (Approval) has been generated by an automated system based on the information you have provided to Sydney Water through the Sydney Water Tap in. Sydney Water does not make any representation or give any guarantee, warranty or undertaking (express or implied) as to the currency, accuracy, completeness, effectiveness or reliability of the Approval.

2 It is your responsibility to ensure that the information is correct and complete when submitting your building plan for approval through Sydney Water Tap in and, if any of the information is incorrect or incomplete, to resubmit information that is correct and complete. If any of the information that you have provided is incorrect or incomplete, this may result in the revocation of the Approval.

3 The Approval is provided on each of the following conditions which you are taken to have accepted by using the Approval. To the fullest extent permitted by law:

(a) all conditions and guarantees concerning the Approval (whether as to quality, outcome, fitness, care, skill or otherwise) expressed or implied by statute, common law, equity, trade, custom or usage or otherwise are expressly excluded and to the extent that those statutory guarantees cannot be excluded, the liability of Sydney Water to you is limited to either of the following as nominated by Sydney Water in its discretion, which you agree is your only remedy:

i. the supplying of the Approval again; or

ii. payment of the cost of having the Approval supplied again;

(b) in no event will Sydney Water be liable for, and you release Sydney Water from all Losses arising out of or in connection with you providing incorrect or incomplete information to Sydney Water in connection with the Approval:

i. whether arising under statute or in contract, tort or any other legal doctrine, including any negligent act, omission or default (including wilful default) by Sydney Water; and

ii. regardless of whether Sydney Water is or ought to have been aware of, or advised of, the possibility of such loss, costs or damages;

(c) you will indemnify, defend and hold harmless Sydney Water from and against all Losses of Sydney Water in respect of, or in connection with loss or damage to any property, personal injury (including death or illness of any person), arising out of or in connection with:

i. you providing incorrect or incomplete information to Sydney Water in connection with the Approval; or

ii. any third party claim against Sydney Water; and

(d) you assume all risks associated with the use of the Sydney Water Tap in and Sydney Water websites, including risk to your computer, software or data being damaged by any virus, and you release and discharge Sydney Water from all Losses which might arise in respect of your use of the websites.

4 Subject to condition numbered 3(c) in this document, your liability under condition numbered 3(c) in this document is reduced to the extent that the loss, liability, expense or damage:

(a) is caused solely and directly by any negligent act or omission of Sydney Water; or

(b) could not reasonably be foreseen and was not reasonably within the contemplation of you and Sydney Water at the time of the loss, liability, expense or damage.

5 The position of the proposed building/building works in relation to Sydney Water's pipes and structures is satisfactory. You are responsible for, amongst other things:

(a) protecting underground structures, including Sydney Water's pipelines, from damage and interference;

(b) maintaining minimum clearances between Sydney Water's structures and structures belonging to others;

(c) preventing loss or damage to any property, personal injury (including death or illness of any person) arising out of or in connection with you providing incorrect or incomplete information to Sydney Water in connection with the Approval;

(d) repairing or making good loss or damage to any property or the environment arising out of or in connection with you providing incorrect or incomplete information to Sydney Water in connection with the Approval;

(e) ensuring that connections to Sydney Water's sewer, watermain or stormwater are only be made following the issue of a permit to a licensed plumber/drainer;

(f) ensuring that all proposed fittings will drain to Sydney Water's sewer;

(g) ensuring that all plumbing and/or drainage Work is to be carried out in accordance with the NSW Code of Practice, AS 3500 and the Sydney Water Act 1994;

(h) ensuring that gullies, inspection shafts and boundary traps are not placed under any roof, balcony, verandah, floor or other cover unless otherwise approved by Sydney Water; and

(i) notifying Sydney Water immediately of any damage caused or threat of damage to Sydney Water's structures.

6 "**Sydney Water**" means Sydney Water Corporation and its employees, agents, representatives and contractors. References to "you" include references to your employees, agents, representatives, contractors, executors, administrators, successors, substitutes, assigns and anyone else using the Approval. References to "Losses" means all liabilities, losses, damages, expenses, compensations, fines, penalties, charges and costs (including legal costs on a full indemnity basis and whether incurred or awarded) of any kind or nature however they arise and whether they are present or future, fixed or unascertained, actual or contingent and including any loss of profits, loss of revenue or loss of opportunity. To the extent of any inconsistency, the conditions numbered 1 to 6 in this document will prevail over any other information provided or made available to you by Sydney Water.

In an emergency, or to notify Sydney Water of damage or threats to its structures, call 13 20 92 (24 hours, 7 days).

FW: Grey House Precinct - Pymble Ladies College - Planning Agreement - CC1 Requirements List item 15.1 Planning Agreement

Rosanna Petteno <Rosanna@pierproperty.com.au>

Fri 2/23/2024 12:48 PM

To:Alison Brown <alisonb@cityplan.com.au>
Cc:ghastie@pymblelc.nsw.edu.au <ghastie@pymblelc.nsw.edu.au>;Chris Michaels <ChrisM@cityplan.com.au>

Some people who received this message don't often get email from rosanna@pierproperty.com.au. Learn why this is important

Hi Alison,
To satisfy Item 15.1 of CPS' CC Requirements List please see the Planners advice below confirming no planning agreement is applicable.

regards,

Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Sally Prowd <sprowd@willowtp.com.au>
Sent: Friday, February 23, 2024 12:43 PM
To: Rosanna Petteno <Rosanna@pierproperty.com.au>
Subject: RE: Grey House Precinct - Pymble Ladies College - Planning Agreement

Hi Rosanna

No Planning agreement was entered into or conditioned.

Kind Regards

Sally Prowd | Senior Associate
sprowd@willowtp.com.au | 0448 972 959
Willowtree Planning
07 5625 3031
Level 3, 240 Queen Street, Brisbane QLD 4000
www.willowtreeplanning.com.au
Registered Planner + EIA

Planning Institute Australia
Registered Planner
Behind this email is a person passionate about Planning

From: Rosanna Petteno <Rosanna@pierproperty.com.au>
Sent: Friday, February 23, 2024 11:40 AM
To: Sally Prowd <sprowd@willowtp.com.au>
Subject: Grey House Precinct - Pymble Ladies College - Planning Agreement

Hi Sally,
Thankyou, the college has satisfied all their SSDA requirements to commence the construction works, with our Head Contractor now resolving the final remaining few.

Our PCA has however requested the following non-SSDA requirement on list. Could you please assist with providing a copy if applicable. I have looked through the EIS and note no references to a site specific planning agreement for GHP site – the Master Concept plan being outside of the GHP footprint.

15.	**PLANNING AGREEMENT (Section 21 DCFS Reg 2021)[11]**		
15.1.	Provide a copy of the planning agreement (if relevant). If the planning agreement specifies requirements that are required to be complied with prior to a construction certificate being issued, those requirements must be complied with.	CC1	OUTSTANDING

regards,

Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Sally Prowd <sprowd@willowtp.com.au>
Sent: Wednesday, February 21, 2024 3:05 PM
To: Rosanna Petteno <Rosanna@pierproperty.com.au>
Subject: RE: Grey House Precinct - Pymble Ladies College - SSDA Condition B9

Hi Rosanna

The amendment was part of the approval conditions and is detailed in the consent at Condition B9. There was no separate modification or the like undertaken. The attached was submitted to DPE during the assessment process.

Kind Regards

Sally Prowd | Senior Associate
sprowd@willowtp.com.au | 0448 972 959
Willowtree Planning
07 5625 3031
Level 3, 240 Queen Street, Brisbane QLD 4000
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Registered Planner + EIA

Planning Institute Australia
Registered Planner
Behind this email is a person passionate about Planning

From: Rosanna Petteno <Rosanna@pierproperty.com.au>
Sent: Wednesday, February 21, 2024 1:54 PM
To: Sally Prowd <sprowd@willowtp.com.au>
Subject: FW: Grey House Precinct - Pymble Ladies College - SSDA Condition B9

Hi Sally,
In reference to the below reply, can you please share evidence of the approved amendment which removes the Healthcare Centre footprint with replacement of the GHP from the concept Masterplan?
regards,

ppc pier property corporation
Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Sally Prowd <sprowd@willowtp.com.au>
Sent: Tuesday, December 19, 2023 3:54 PM
To: Eleanor Hassell <eleanor@pierproperty.com.au>
Cc: Rosanna Petteno <Rosanna@pierproperty.com.au>; Scott Egelton <Scott@pierproperty.com.au>
Subject: RE: Grey House Precinct - Pymble Ladies College

Hi Eleanor

SSD5314 relates to the concept masterplan approval over the whole of PLC – a copy of the full documentation can be found here:

Pymble Ladies College - Upgrade | Planning Portal - Department of Planning and Environment (nsw.gov.au)

The conditions of consent required an amendment to this consent to remove the building footprint which sat across the Grey House Precinct site. There is no other action required to satisfy this condition as amended plans were provided to DPE dealing with this change.

Kind Regards

Sally Prowd | Senior Associate
sprowd@willowtp.com.au | 0448 972 959
Willowtree Planning
07 5625 3031
Level 3, 240 Queen Street, Brisbane QLD 4000
www.willowtreeplanning.com.au
Registered Planner + EIA

Planning Institute Australia
Registered Planner

Behind this email is a person passionate about Planning

Willowtree Planning wishes you a Merry Christmas!

Our office will be closed from midday on Thursday 21st December 2023, and will reopen on Monday 8th January 2024

SYDNEY | NEWCASTLE | GOLD COAST | BRISBANE

From: Eleanor Hassell <eleanor@pierproperty.com.au>
Sent: Tuesday, December 19, 2023 2:47 PM
To: Sally Prowd <sprowd@willowtp.com.au>
Cc: Rosanna Petteno <Rosanna@pierproperty.com.au>; Scott Egelton <Scott@pierproperty.com.au>
Subject: RE: Grey House Precinct - Pymble Ladies College

Thanks Sally,

Of the back of this could I please follow up what SSD513 deals with and what is PLC required to do in relation to this DA condition?

Kind regards,

Eleanor Hassell | Assistant Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | **Fax** 02 9249 0499 | **Mob** 0433 044 550
eleanor@pierproperty.com.au | www.pierproperty.com.au

From: Sally Prowd <sprowd@willowtp.com.au>
Sent: Tuesday, December 19, 2023 3:44 PM
To: Eleanor Hassell <eleanor@pierproperty.com.au>
Cc: Rosanna Petteno <Rosanna@pierproperty.com.au>; Scott Egelton <Scott@pierproperty.com.au>
Subject: RE: Grey House Precinct - Pymble Ladies College

Hi Eleanor

The pack is always available online via the link below: Pymble Ladies College - Grey House Precinct | Planning Portal - Department of Planning and Environment (nsw.gov.au)

Kind Regards

Sally Prowd | Senior Associate
sprowd@willowtp.com.au | 0448 972 959
Willowtree Planning
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Level 3, 240 Queen Street, Brisbane QLD 4000
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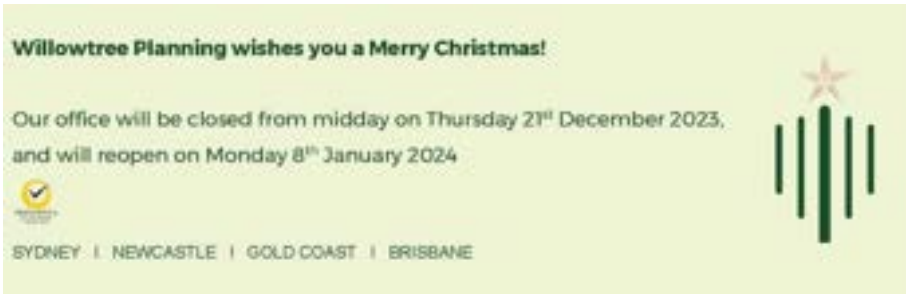
Registered Planner + EIA

Planning Institute Australia
Registered Planner

Behind this email is a person passionate about Planning



From: Eleanor Hassell <eleanor@pierproperty.com.au>
Sent: Tuesday, December 19, 2023 2:39 PM
To: Sally Prowd <sprowd@willowtp.com.au>
Cc: Rosanna Petteno <Rosanna@pierproperty.com.au>; Scott Egelton <Scott@pierproperty.com.au>
Subject: Grey House Precinct - Pymble Ladies College

Hi Sally,

We are after:

- The Environmental Impact Statement (EIS)
- Response to Submissions and supplementary (rTs)?

Could you please send these over to us via return email at your earliest convenience?

Kind regards,

Eleanor Hassell | Assistant Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | **Fax** 02 9249 0499 | **Mob** 0433 044 550
eleanor@pierproperty.com.au | www.pierproperty.com.au

warringtonfire
Proud to be part of element

Peer review of fire engineering brief questionnaire

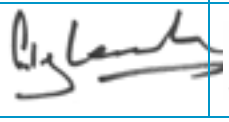
Pymble Ladies' College Grey House Precinct

Client: Pymble Ladies' College

Job number: SY23035

Date: 27 November 2023 Revision: PR1.0

Quality management

Version	Date	Information about the report			
PR1.0	27 Nov 2023	Description	Report issued to Pymble Ladies' College and Pier Property Corporation for review and comment.		
			Prepared by	Reviewed by	Authorised by
		Name	Greg Leach	Matt Booth	Greg Leach
		Signature			

Contents

1. Introduction

Pymble Ladies' College has requested that Warringtonfire undertake a peer review of the Fire Engineering Brief Questionnaire prepared by Stantec relating to the proposed Grey House Precinct development at Pymble Ladies' College. The peer review is intended to provide an independent technical evaluation of the report by an appropriately qualified and experienced fire safety engineer. The review was undertaken in general accordance with the Australian Fire Engineering Guidelines (AFEG)[1].

Stantec has produced a Fire Engineering Brief Questionnaire (FEBQ) for this project and Fire & Rescue NSW (FRNSW) has responded with comments – the latest version is 06. FRNSW has not provided 'In principle support' for all of the issues and has requested that sprinklers be included in the design.

Warringtonfire has been requested to provide a peer review of the FEBQ V06 in regard to the issues not supported by FRNSW and to advise if sprinklers are considered to be necessary for the design.

2. Scope

The scope of the peer review includes detailed review of the FEBQ prepared by Stantec, with comments from FRNSW. The peer review is limited to the issues not supported by FRNSW and to advise if sprinklers are considered to be necessary for the design.

The peer review will consider the following components of the report:

- objectives and regulatory scope, applicable codes, standards, and guidance documents referenced
- appropriateness of the fire safety strategy and fire safety measures, and specifically whether sprinklers are considered to be necessary for the design
- appropriateness of the proposed methods of assessments and models
- input data and assumptions to the assessment method and models

Architectural drawings and other supporting documentation – identified in Appendix A – will be reviewed as necessary to assist in the peer review of the report.

The scope does not include a design review of project documentation to check compliance with the National Construction Code Volume One – Building Code of Australia (NCC) 2022[2] or applicable standards.

[1] Australian Fire Engineering Guidelines, 2021, version 1.0, Australian Building Codes Board, Australia.
[2] National Construction Code Volume One – Building Code of Australia 2022, Australian Building Codes Board, Australia

3. Description of report

3.1 Identification

The peer reviewed document is identified in Table 1. The main characteristics of the building to which the document relates are summarised in Table 2.

Table 1 Report details

Report	
Company	Stantec
Report reference	301350239
Current version	06
Fire safety engineer	Stephen King
Accreditation details	BDC04982

Table 2 General building characteristics

Details	Comment
Applicable building or part	Whole
Class of building or part	5 and 9b
Rise in storeys	5
Levels contained	5
Effective height	16.3 m
Note: We have relied upon the FEBQ prepared by Stantec to determine the building characteristics above.	

3.2 Overview

The project is the construction of a five storey multiple purpose building, referred to as the PLC Grey House Precinct. The building is to be used as an education, sports, recreation and performing arts building, and consists of classrooms for the Junior School years 5 and 6, out of school hours care, dance, health services and an early learning centre. The storeys within the building are designated as level 0, level 1, level 2, level 3 and level 4.

The Early Learning Centre (ELC) for the new junior school is located on level 2, which is provided with direct egress to open space.

The external walls of the subject building are located a minimum of approximately 4.9 m from the external walls of the adjacent Junior School Building.

An open stair and void connect levels 1-4 within the centre of the building. The central stair void is defined as an atrium under the NCC. The atrium space is a circulation area and is smoke separated from the adjacent building areas. The north and south façade of the atrium space are provided with permanently open or automatic opening louvres to vent smoke in the event of a fire.

A sprinkler system is not currently proposed to be installed within the building.

Stantec has produced an FEBQ for this project and FRNSW has responded with comments. FRNSW has not provided 'In principle support' for all of the issues and has requested that sprinklers be included in the design.

Warringtonfire has been requested to provide a peer review of the FEBQ V06 in regard to the issues not supported by FRNSW and to advise if sprinklers are considered to be necessary for the design.

3.3 Performance solutions

Table 3 describes the NCC requirements associated with the performance solutions included in the report.

Table 3 NCC requirements associated with the performance solutions

No	Description of performance solutions	DTS provision	Performance requirements
1.	Separation of external walls and openings	Clauses S5C1, C4D3, C4D5	C1P1, C1P2, C1P8
2.	Hydrant booster location	Clause E1D2	E1P3
3.	Omission of fire hose reels	Clause E1D3	E1P1
4.	Atrium construction	Clauses G3D1–G3D8	C1P2, E1P4, E2P2
5.	Doors opening directly into a fire stair	Clause D2D12	D1P5, E2P2
6.	Reduced egress width within the eastern fire-isolated stair	Clause D2D8	D1P4
7.	Bounding construction - use of drencher protected glazed openings within walls that separate fire compartments	Clause C3D8	C1P2
8.	Direction of door swing	Clause D3D25	D1P4, D1P2
9.	Egress from the primary school – every part of the primary school does not have direct egress to road or open space	Clause D2D23	D1P4
10.	Unprotected opening along the fire stair FS02 discharge path	Clause D2D12	D1P5, E2P2

4. Limitations and clarifications

- Matters such as property protection (other than the protection of adjoining property), business interruption, public perception, environmental impacts and broader community issues – such as loss of a major employer and impact on tourism – have not been considered as they are outside the scope of the NCC.
- The views expressed in this report are Warringtonfire's professional opinion only, at the time of this report's preparation, and based upon the information available at the time of its preparation. Where information has been provided to us but not verified by us, we have assumed that it is correct.
- The scope of the review documented within this report is limited to technical compliance with the relevant performance requirements of the NCC. It is important to note that the scope and perspective of any comment from Fire and Rescue NSW may not be limited to technical compliance with the relevant performance requirements of the NCC. Fire and Rescue NSW also have separate obligations under their acts / regulations. Therefore, Fire and Rescue NSW may have differing opinions to those offered within this peer review report. Warringtonfire shall not be held responsible for any loss, damage, liability, claim or demand in connection with any written or verbal comments from Fire and Rescue NSW that occur at any time.
- This peer review relates specifically to the report identified in Table 1. Any changes to the report, or changes to the design of the building which impact the report, may affect the outcomes of the peer review.
- The building complies with the current DTS provisions of the NCC relating to fire safety except for the specific performance solutions identified within the reviewed report.
- All the fire safety systems are to be designed, installed, operated and maintained in accordance with the appropriate Australian standards, other design codes, legislation and regulations relevant to the project unless specifically stated otherwise.
- Warringtonfire has not undertaken a design review of project documentation to check compliance with the National Construction Code Volume One – Building Code of Australia (NCC) 2022 or applicable standards.

5. Report comments

Detailed comments on the FEBQ are provided in Table 4.

The comments are identified as either:

- **Observation** – Identification of key information or endorsement of technical methods and analysis.
- **Minor** – Issues which would not typically impact on the overall outcomes of the peer review. Comments provided to identify minor errors, improve clarity, correctness, missing references, technical clarifications, and typographical errors where they impact the assessment.
- **Major** – Essential technical issues which need to be addressed and may significantly impact the outcomes of the assessment and peer review.

Table 4 Comments on FEBQ version 06

No.	Section reference (page)	Comment (Warringtonfire)	Type of comment	Response (Stantec)	Status (Warringtonfire)
1.	Section 6.9 (pages 11-12)	This section provides information relating to the Early Learning Centre design, where it is noted that the provision of an early learning centre in this building does not trigger the requirement for sprinklers under the applicable DTS provisions of the NCC, noting the location of the ELC with direct ground access. FRNSW have noted that children within an early childhood centre are considered 'vulnerable occupants' due to these occupants requiring assisted evacuation in the event of an emergency and therefore are considered to have a higher risk profile that is to be addressed accordingly. As a result, FRNSW have recommended the installation of sprinklers throughout the entire building. It is considered that the higher risk profile of such occupants has been taken into consideration by the Australian Building Codes Board (ABCB) in the latest revision of the NCC2022, which does require additional fire safety measures to be provided throughout a building containing an early childhood centre depending on the building's configuration and characteristics, including the provision of a sprinkler system, fire separation of the early childhood centre from the remainder of the building, and fire	Observation	None required	Closed

No.	Section reference (page)	Comment (Warringtonfire)	Type of comment	Response (Stantec)	Status (Warringtonfire)
		compartments within the early childhood centre to facilitate horizontal evacuation. However, these additional provisions do not apply to an early childhood centre that is wholly within a storey that provides direct egress to a road or open space, or with a building with a rise in storeys of not more than 2, where the early childhood centre is the only use in the building. That is, for such configurations it is not considered necessary to require these additional fire safety measures to address the higher risk profile of such occupants, since evacuation directly to outside is available or evacuation down a single storey only is required. As noted in Stantec's comments in the FEBQ, the provision of an early learning centre in this building does not trigger the requirement for sprinklers under the applicable DTS provisions of the NCC, and having regard to the above comments this is considered to be appropriate. In addition, the aspect of the building containing an atrium is not considered to adversely affect the risk to the occupants of the early learning centre, having regard to the location of the early learning centre and the fire and smoke separation provided. Further comments regarding the provision of a sprinkler system throughout the building to safeguard occupants within other parts of the building as a result of the atrium construction are provided in the following sections.			
2.	Section 7, Issue 1 (page 17)	This section provides details of a performance solution to address the separation of external walls and openings of the Junior School building and the subject building. FRNSW have provided 'In principle support' for this issue. No further review by Warringtonfire has been undertaken.	Observation	None required	Closed

No.	Section reference (page)	Comment (Warringtonfire)	Type of comment	Response (Stantec)	Status (Warringtonfire)
3.	Section 7, Issue 2 (page 31)	This section provides details of a performance solution to address the location of the hydrant booster in a position that is not immediately visible from the main entrance to the building. FRNSW have provided comments within this section that indicate they are in support of this issue. However, they have not explicitly stated that they have provided 'In principle support'. The fire safety measures and proposed performance solution are considered to be appropriate.	Observation	None required	Closed
4.	Section 7, Issue 3 (page 36)	This section provides details of a performance solution to address the use of fire extinguishers instead of fire hose reels for the ELC Childcare on level 2 and Wellness Centre on level 4. FRNSW have provided 'In principle support' for this issue. No further review by Warringtonfire has been undertaken.	Observation	None required	Closed
5.	Section 7, Issue 4 (page 41)	This section provides details of a performance solution to address the atrium construction issues associated with the open stair and void connecting levels 1-4 within the centre of the building. FRNSW have not provided support for this issue and recommend that a sprinkler system be installed in the building. The fire safety measures, including the omission of a sprinkler system, and the proposed performance solution are generally considered to be appropriate. Further comments on this issue are provided in the sections below.	Minor		Open

No.	Section reference (page)	Comment (Warringtonfire)	Type of comment	Response (Stantec)	Status (Warringtonfire)
6.	Section 7, Issue 4 (page 42)	Stantec have made the following statements: • 'The bounding walls surrounding the atrium provide a smoke separation from the atrium space.' • 'The proposed solution relies on the smoke separation of the surrounding FRL rated bounding walls, which separate the surrounding occupant compartments from the open atrium space.' Clarification should be provided regarding the extent of fire rated walls, noting that the details in section 6.10 only include a specification for smoke walls. However, the architectural drawings indicate certain fire rated walls, and Issue 7 deals with drenched glazing in the level 1 fire rated wall bounding the atrium.	Minor	At Level 1 and Level 2 the bounding walls separating the Atrium is to achieve an FRL of 120 minutes and opening within the fire rated construction is to be provided with wall wetting sprinklers and 6mm toughened glazing. All levels from Level 1 to Level 4 is to be provided with smoke separation system in addition to the Fire rated construction for the Level 1 and Level 2. This will be appropriately reflected in the FER	Open
7.	Section 7, Issue 4 (pages 46-47)	It is noted that the fire scenario within the atrium space and the associated 1 MW medium growth design fire is based on the use of this area as a circulation space and the limited amount of combustibles permitted within the atrium space. This is considered to be reasonable within the context of this space. A 5 MW fire as recommended by FRNSW is not considered to be a reasonable design fire that could practically occur within this space.	Observation	None required	Closed
8.	Section 7, Issue 4 (pages 46-47)	It is recommended that further details be provided to benchmark typical fuel sources that would achieve a heat release rate of up to 1 MW and that additional comments be provided regarding the lockers located on levels 1-3 in regard to their likely impact on the nominated design fire size. Clarification should be provided that the level 1 main comms room is fire separated from the atrium space as indicated on the architectural drawings.	Minor	Noted, Fuel sources that achieve a 1MW will be included in the FER. Total HRR for Flight luggage is in the range of 600kW to 1200kW The Lockers will be non combustible in nature except for the door which will be timber. The Comms room is to be fire separated with 120 FRL and the door to be -/60/30 fire door. This will be included in the FER	Open

No.	Section reference (page)	Comment (Warringtonfire)	Type of comment	Response (Stantec)	Status (Warringtonfire)
9.	Section 7, Issue 4 (pages 47-48)	The fire scenario within the compartment adjoining the atrium space and the associated 5 MW medium growth design fire is considered to be appropriate. However, the 5 MW fire in the adjoining classroom spaces should be a base case fire scenario and not a sensitivity scenario, and therefore it should incorporate the nominated safety factor. The location of the 5 MW fire in the adjoining classroom is likely to lead to the majority of the smoke that spreads into the atrium space venting direct to outside without significant smoke spread up the atrium void. It is recommended that a fire also be located in the eastern compartment – approximately grid reference I3.	Major	Comments noted regarding Safety Factor, Assessment will be reviewed and updated as appropriate.	Open
10.	Section 7, Issue 4 (page 46)	The nominated wind scenarios are considered to be appropriate as sensitivity scenarios.	Observation	None required	Closed
11.	Section 7, Issue 5 (page 51)	This section provides details of a performance solution to address doorways in classroom areas opening directly into fire-isolated stairways. FRNSW have provided 'In principle support' for this issue. No further review by Warringtonfire has been undertaken.	Observation	None required	Closed
12.	Section 7, Issue 6 (page 56)	This section provides details of a performance solution to address the reduction of egress widths within the eastern fire-isolated stair due to the requirement of stairwell handrail extensions. FRNSW have provided 'In principle support' for this issue. No further review by Warringtonfire has been undertaken.	Observation	None required	Closed

No.	Section reference (page)	Comment (Warringtonfire)	Type of comment	Response (Stantec)	Status (Warringtonfire)
13.	Section 7, Issue 7 (page 62)	This section provides details of a performance solution to address the use of drencher protected glazed openings within walls that separate fire compartments. FRNSW have not provided support for this issue. Warringtonfire agree with the comments provided by FRNSW for this issue. An AS 2118.2 system is not considered to be appropriate for the exposure conditions being assessed. Consideration also needs to be given to the ability for the glazing to achieve sufficient water coverage having regard to the partition wall that connects to the glazing, as well as a suitable barrier such as a pony wall to prevent items being located directly against the glazing.	Major	Noted, the distance nominated was based on the NRC Publication, Canada Fire tests on window assemblies protected by automatic sprinklers Richardson, J. K.; Oleszkiewicz, I.- . However, Tyco WS or similar systems can be considered. Comment noted regarding the pony wall, to be implemented to the window scenarios... however this will not be required for doorways as the space will be required to be kept free based on the use as a thoroughfare.	Open
14.	Section 7, Issue 8 (page 67)	This section provides details of a performance solution to address the doors separating the atrium section of the building to swing against the direction of egress. FRNSW have not provided support for this issue. It is understood that the subject doors are doors in the path of travel to the required exit and are not doors in a required exit. Therefore, it is considered that there is not a requirement for the subject doors to swing in the direction of egress. This should be clarified further. Despite the above comment, the fire safety measures and the proposed performance solution are considered to be appropriate.	Minor	Noted to be clarified by the BCA consultant.	Open

No.	Section reference (page)	Comment (Warringtonfire)	Type of comment	Response (Stantec)	Status (Warringtonfire)
15.	Section 7, Issue 9 (page 74)	This section provides details of a performance solution to address the primary school not being provided with direct egress to road or open space from every part. Whilst FRNSW have provided 'In principle support' for this issue, it is subject to the building being provided with a sprinkler system throughout. The fire safety measures and the proposed performance solution are considered to be appropriate. The installation of a sprinkler system to address this issue is not considered to be necessary.	Observation	None required	Closed
16.	Section 7, Issue 10 (page 79)	This section provides details of a performance solution to address an unprotected opening along the Fire Stair FS02 discharge path. FRNSW Comment: 'FRNSW seek clarification on the opening subject to this performance solution. If the opening is protected in accordance with C4D5, FRNSW consider this to be a DTS design.' Warringtonfire agree with this comment from FRNSW. The assessment indicates that an internal wall-wetting sprinkler is to be installed to protect the subject window and therefore it is considered that this issue does not require a performance solution.	Minor	The recommendation for the wall wetting sprinkler is based on the assessment, as it was demonstrated that radiant heat received from the subject unprotected opening along the discharge path is not acceptable. However happy to exclude from the FEBQ	Open

6. Conclusion

Warringtonfire have undertaken a peer review of the Fire Engineering Brief Questionnaire relating to Pymble Ladies' College Grey House Precinct prepared by Stantec.

A sprinkler system is not considered necessary for the design in relation to the building having an atrium void connecting levels 1-4, the provision of an Early Learning Centre on level 2, or due to the egress from the primary school not having direct egress to road or open space from part.

Although the fire safety strategy appears to be broadly acceptable, additional information and analysis are required to be included in the assessment, as detailed in Table 4.

Even with the provision of such additional information and analysis, there is still a significant risk that FRNSW still will not support the design without the inclusion of a sprinkler system.

In relation to Issue 7 addressing the use of drencher protected glazed openings within walls that separate fire compartments, changes to the design specification are required in order to support the proposed analysis.

Appendix A Drawings and information

Drawing title	Dwg no	Date	Drawn
GA Plan – Level 0	AR-B10-00-01 Issue 15	12 May 2023	BVN
GA Plan – Level 1	AR-B10-01-01 Issue 15	12 May 2023	BVN
GA Plan – Level 2	AR-B10-02-01 Issue 15	12 May 2023	BVN
GA Plan – Level 3	AR-B10-03-01 Issue 15	12 May 2023	BVN
GA Plan – Level 4	AR-B10-04-01 Issue 18	12 May 2023	BVN
GA Plan – Roof Level	AR-B10-04-01 Issue 4	12 May 2023	BVN
Elevation – North & South	AR-C10-XX-01 Issue 10	12 May 2023	BVN
Elevation – East & West	AR-C10-XX-02 Issue 11	12 May 2023	BVN
Sections – Sheet 1	AR-D10-XX-01 Issue 9	12 May 2023	BVN
Sections – Sheet 2	AR-D10-XX-02 Issue 9	12 May 2023	BVN
Sections – Sheet 3	AR-D10-XX-03 Issue 9	12 May 2023	BVN

warringtonfire
Proud to be part of element

Global locations

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19 May 2023

Sally Prowd
Associate
Willowtree Planning Pty Ltd
sprowd@willowtp.com.au

Cc: Aditi.Coomar@planning.nsw.gov.au

Dear Ms Prowd,

Pymble Ladies College – Grey House Precinct (SSD-17424905)

Pursuant to conditions A1, A2 and A3 of the development consent for Pymble Ladies College – Grey House Precinct (SSD-17424905), the Commission has instructed me to write to you to confirm that the requirements of the deferred commencement conditions have been satisfied.

Should you require any further information, please contact me on (02) 9383 2165 or bradley.james@ipcn.nsw.gov.au.

Yours sincerely,

Brad James
A/ Planning Director

19 May 2023

Sally Prowd
Associate
Willowtree Planning Pty Ltd
sprowd@willowtp.com.au

Cc: Aditi.Coomar@planning.nsw.gov.au

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Should you require any further information, please contact me on (02) 9383 2165 or bradley.james@ipcn.nsw.gov.au.

Yours sincerely,

Brad James
A/ Planning Director

18 March 2024 211007

Stephen Edwards Constructions
140 Wicks Rd
Macquarie Park, NSW 2113

Attention: Nick Souden

Pymble Ladies College - Grey House Precinct (GHP)
Civil Design Certificate – CC1

Dear Nick,

We certify that we have prepared the civil design of Grey House Precinct (GHP) Pymble Ladies' Collage as shown on the list of drawings attached in accordance with the following where applicable:

- AS 3500.3 National Plumbing and Drainage Code, 2021
- Australian Rainfall and Runoff 2019
- Ku-ring-gai DCP Section C Part 24 – Water Management
- NSW Department of Housing Managing Urban Stormwater ('Blue Book'), 2004

This civil certificate and documentation has also been provided to address to the following SSDA Consent Conditions:

Consent Conditions **Development Consent SSDA 17424950 dated 09/12/2022.**		
No.	**Condition Description**	**TTW Response**
C7	**Stormwater Management System** Prior to the issue of any relevant construction certificate, the Applicant must design an operational stormwater management system for the development and submit it to the Certifier for approval. The system must: a) be designed by a suitably qualified and experienced person(s); b) be generally in accordance with the conceptual design in the civil works plans submitted with the EIS; c) include all stormwater quality treatment measures as outlined in the civil works report submitted with the EIS; and d) be in accordance with applicable Australian Standards and Council's requirements.	Refer to civil drawing C04– Overall Stormwater Plan and C50 OSD Tank Details for the design plans in accordance with AS3500 and Ku-ring-gai DCP Section C Part24 – Water Management. Refer to civil drawing C50 OSD Tank Details for the water quality treatment measures in accordance with civil works report submitted with the EIS.

C9	**Geotechnical recommendations** Prior to the issue of any relevant construction certificate for a construction stage, which involves ground disturbance, the construction certificate plans must demonstrate compliance with the recommendations as outlined in Geotechnical Investigations prepared by JK Geotechnics dated 08 February 2023 and 26 April 2021.	Refer to C13 Bulk earthworks and for the design plans involving earthworks which are designed in accordance with the following sections of the Geotechnical Investigation prepared by JK Geotechnics 08 February 2023 and dated 26 April 2021. 4.1 Excavation and Groundwater 4.2 Subgrade Preparation and Filling 4.3 Batters and Retaining Wall

Yours faithfully,
TTW (NSW) PTY LTD

TIM MOORE
NSW Civil Manager

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TITLE	DWG No.	REVISION No.
COVER SHEET, GENERAL NOTES AND LEGENDS, LOCALITY PLAN AND DRAWING SCHEDULE	C01	A
SEDIMENT AND EROSION CONTROL PLAN	C02	A
SEDIMENT AND EROSION CONTROL DETAILS	C03	A
OVERALL STORMWATER PLAN	C04	A
LEVEL 00 SITEWORKS	C05	A
LEVEL 01 SITEWORKS	C06	A
LEVEL 02 SITEWORKS	C07	A
BULK EARTHWORKS	C13	A
TYPICAL DETAILS, SHEET 1	C20	A
TYPICAL DETAILS, SHEET 2	C21	A
OSD TANK DETAILS, SHEET 1	C50	A

REPORT TO

PYMBLE LADIES COLLEGE

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED SCHOOL BUILDING

AT

20 AVON ROAD, PYMBLE, NSW

Date: 8 February 2021
Ref: 33775SCrpt

JKGeotechnics
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JK Geotechnics Pty Ltd
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Report prepared by:

Thomas Clent
Senior Engineering Geologist

Report reviewed by:

Paul Stubbs
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For and on behalf of
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NORTH RYDE BC NSW 1670

DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
33775SCrpt	Final Report	8 February 2021

Table of Contents

ATTACHMENTS

1 INTRODUCTION

This report presents the results of a geotechnical investigation for a proposed school building within Pymble Ladies College, Avon Road, Pymble, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Malcolm Boyes of Pymble Ladies College and carried out in accordance with our proposal (Ref: P53314PH) dated 8 January 2021.

We understand the development is at an early stage and the location of the proposed structures, building levels, proposed earthworks and structural loads were unavailable at the time of investigation and preparation of this report. However, based on discussions with Mr Malcolm Boyes of Pymble Ladies College, we understand that a new school building is proposed for this part of the site and is likely to comprise a five storey building potentially with a lower ground floor or basement level. Due to the sloping nature of the site we expect excavations to a maximum depth of about 3m may be required.

The purpose of the investigation was to obtain geotechnical information on the subsurface conditions as a basis for comments and recommendations on excavation, earthworks, retention and footing design.

2 INVESTIGATION PROCEDURE

The fieldwork was carried out on 14 and 15 January 2021 and comprised the drilling of four boreholes (BH201 to BH204 inclusive). Boreholes were drilled using our track mounted JK305 drilling rig to total depths ranging from 6m to 10.47m below existing ground surface levels.

- BH201 and BH202 were initially auger drilled to depths of 2.2m and 4.33m and were then continued by diamond coring techniques using an NMLC core barrel with water flush to total depths of 9.72m and 10.47m, respectively.
- BH203 and BH204 were auger drilled using a Tungsten Carbide (TC) bit to depths of 6m.

The borehole locations, as shown on the attached Figure 2, were set out by taped measurements from existing surface features. The approximate surface levels, as shown on the borehole logs, were estimated by interpolation between spot levels and contours shown on the supplied survey plan by LTS Lockley (Drawing No. 15263 00 DT, dated 8 October 2020, Issue H) The datum of the levels is Australian Height Datum (AHD).

The apparent compaction of the fill and the strength of the residual soils were assessed from Standard Penetration Test (SPT) 'N' values, augmented by hand penetrometer test results on cohesive samples recovered by the SPT split tube sampler. Within the augered portions of the boreholes, the strength of the underlying weathered bedrock was assessed from observation of the resistance to penetration of the TC bit attached to the augers, together with inspection of the recovered rock chip samples and subsequent correlations with laboratory moisture content test results. The strength of the cored siltstone and sandstone was assessed from inspection of the recovered core and subsequent laboratory Point Load Strength Index ($I_{S(50)}$) test results. The point load strength index test results are summarised on the cored borehole logs.

Groundwater observations were made during and on completion of auger drilling. Thereafter, the use of water for core drilling limited further meaningful measurements of groundwater levels. No longer term monitoring of groundwater levels was carried out.

Our Geotechnical Engineer, Mr Ben Smith, set out the borehole locations, nominated the sampling and testing locations, and prepared logs of the strata encountered. The borehole logs, including colour photographs of the recovered core, are attached to this report together with a set of explanatory notes, which describe the investigation techniques, and their limitations, and define the logging terms and symbols used.

Selected soil samples were returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd, both NATA accredited laboratories, for testing to determine moisture contents, Atterberg limits, linear shrinkages, point load strength index values, pH, sulphate contents, chloride contents and resistivity. The results of the laboratory testing are presented in the attached STS Tables A and B and Envirolab Certificate of Analysis 259686.

3 RESULTS OF INVESTIGATION

3.1 Site Description

For the purpose of this site description, the 'site' shall be regarded as the general area where the new school building is proposed, as shown on the attached Figure 1.

The site is located within the school grounds of Pymble Ladies College, which is situated within the upper reaches of a hill within undulating topography. The site itself was positioned on a north-easterly facing hillside which sloped at about 10° to 15° and contained lawns, footpaths, marquees and demountable buildings. The demountable buildings were single storey and the marquee constructed from canvas and steel framing; both structures appeared to be in good external condition based on a cursory inspection. The footpaths were concrete surfaced and appeared to be in generally good condition, however some areas of paving showed signs of distress and cracking. The vegetation on site comprised sloping lawns, planter beds and medium to large sized trees.

To the north of the site was a two-storey brick building which had been built into the hillside. On the southern side of the building was a rendered block wall ranging in height from about 1m to 2m, which retained the hillside slope. The building and retaining wall both appeared to be in good condition based on cursory inspection. To the north-east of the site the sloping lawns continued down to the north-east.

On the eastern site boundary were a series of residential properties with swimming pools and yard areas abutting the common boundary. The setback distances and ground surface levels across this boundary could not be observed, however due to the overall direction and sloping nature of the site, the neighbouring ground levels are likely to be lower than the subject site.

To the west of the site was a two-storey brick school building with similar surface levels to the subject site. The brick building appeared to be in good external condition based on cursory inspection.

To the south of the site was the sports complex and synthetic sports fields which were approximately 2m higher than the subject site being supported by brick retaining walls to facilitate the difference in surface levels.

3.2 Subsurface Conditions

The 1:100,000 geological map of Penrith (Geological Survey of NSW, Geological Series Sheet 9030) indicates the site to be underlain by Ashfield Shale of the Wianamatta Group. Generally, the boreholes encountered fill overlying residual soil, then weathered siltstone and sandstone at depth. A summary of subsurface conditions is presented below but reference should be made to the attached borehole logs for details at each specific location.

Fill

Fill comprising silty clay of low to medium plasticity, was encountered to depths ranging from 0.2m to 0.8m. Based on SPT 'N' values the fill was assessed to be moderately compacted.

Residual Silty Clay

Residual silty clay typically of medium to high plasticity was encountered in all boreholes and was assessed to be of at least very stiff to hard strength with varying fractions of ironstone gravel inclusions.

Weathered Bedrock

Weathered siltstone bedrock (Ashfield Shale) was encountered at depths ranging from 1.2m (BH201) to 2.5m (BH202). The reduced level of the top of rock reduced towards the east of the site. On first rock contact the weathered siltstone was typically either extremely weathered and hard (soil strength) to distinctly weathered and very low strength, increasing to low to medium strength with depth.

The cored portions of BH201 and BH202 were very different, in BH201 the cored siltstone was initially assessed to be highly weathered to moderately weathered and of very low strength but improving to low to medium strength then medium to high strength below a depth of 5m. However, the cored portion of BH202 encountered extremely weathered and highly weathered siltstone of hard (soil strength) to very low strength to a depth of 10.2m, at which medium to high strength sandstone was encountered. BH203 and BH204 were similar to BH201.

Defects within the cored siltstone and sandstone comprised extremely weathered seams of generally less than 100mm, sub-horizontal bedding partings, and joints inclined at up to 90°.

Groundwater

All boreholes were 'dry' during and for a short period after completion of drilling. No longer term groundwater monitoring was carried out.

3.3 Laboratory Test Results

Based on the Atterberg limits and linear shrinkage test results, the silty clays tested are of medium plasticity and are assessed to have a moderate to high potential for shrink/swell movements with changes in moisture content.

The moisture content and point load strength index test results showed reasonably good correlation with our field assessment of rock strength. The Unconfined Compressive Strength (UCS) of the rock core, estimated from the point load strength index test results, generally ranged from 6MPa to 66MPa in BH201 however BH202 resulted in much lower values of generally between 1MPa and 6MPa, with a higher value of 84MPa for the sandstone.

The pH values on samples of the clayey fill, residual silty clay and weathered siltstone ranged from 5.2 to 7.5, indicating slightly acidic to neutral soil conditions. The sulphate contents ranged from 30mg/kg to 370mg/kg, the chloride contents ranging from <10mg/kg to 81mg/kg, and the resistivity ranged from 5,600ohm.cm to 53,000ohm.cm. Based on these results, the clayey fill, residual silty clay and weathered siltstone would classify as 'mild' exposure classification for concrete piles in accordance with Table 6.4.2(C) of AS2159-2009 'Piling – Design and Installation' and 'non-aggressive' exposure classification for steel piles in accordance with Table 6.5.2(C) of AS2159-2009.

4 COMMENTS AND RECOMMENDATIONS

4.1 Excavation and Groundwater

Due to the sloping nature of the site we envisage excavations of up to about 3m depth will be required to form the building platform. Excavation to such depths will encounter clayey fill, residual soils and weathered siltstone.

Excavation of the soils and upper rock of up to very low strength should be achievable using conventional excavation equipment, such as the buckets of hydraulic excavators. Some ripping of higher strength bands may be necessary if they are encountered within the weaker rock.

Excavation of bedrock of low strength or higher strength will require assistance with rock excavation equipment. Such equipment may comprise hydraulic rock hammers, ripping hooks, rotary grinders or rock saws. Hydraulic rock hammers must be used with care due to the risk of damage to the neighbouring buildings. If hydraulic rock hammers are to be used the vibrations transmitted to the buildings should be quantitatively monitored at least at the start of rock hammer operation to confirm that the transmitted vibrations are within acceptable limits. If during the initial monitoring the transmitted vibrations are close to acceptable limits full time monitoring may then be warranted. Reference should be made to the attached Vibration Emission Design Goals sheet for acceptable limits of transmitted vibrations. Where the transmitted vibrations are excessive it would be necessary to change to alternative excavation equipment, such as a smaller rock hammer, ripping hooks, rotary grinders or rock saws.

No groundwater seepage was encountered during auger drilling of the boreholes. As such we do not consider that groundwater will be a significant issue for the proposed development. Nevertheless, some seepage may occur into the excavation and this would likely tend to occur along the soil/rock interface and through joints and bedding partings within the rock, particularly during and following rainfall. Any such seepage that does occur should be able to be controlled during construction using gravity drainage and conventional sump and pump techniques. In the long term, drainage should be provided behind all retaining walls and possibly below the lowest floor slab. The completed excavation should be inspected by the hydraulic consultant to confirm that the designed drainage system is adequate for the actual seepage flows.

4.2 Subgrade Preparation and Filling

The boreholes encountered limited fill across the site and we expect that the fill will be excavated and removed as part of the proposed bulk excavation. However, where floor slabs are proposed we recommend that where the fill is not excavated as part of the bulk excavations that it be removed and replaced with controlled, engineered fill. Alternatively, if the fill is left in place the ground floor slab should be designed as a fully suspended slab supported on the piled footing system. For the proposed pavements the fill may be left in place provided it is treated as required following proof rolling.

Within areas where floor slabs are proposed all existing fill should be fully stripped to expose the residual silty clay or weathered siltstone. Within pavement areas the vegetation and root affected soils should be stripped, but the fill below may be left in place. This root affected fill is not suitable to reuse as engineered fill, but may be reused within landscaped areas.

Following stripping, the exposed subgrade should be proof rolled with at least 7 passes of a minimum 8 tonne dead weight, smooth drum, vibratory roller. The final pass of the proof rolling should be carried out without vibration and in the presence of a geotechnical engineer to detect any weak subgrades areas. Care must be taken during rolling due to the risk of damage to adjoining structures from the vibrations generated by the roller. If vibrations are of concern the rolling may need to be carried out with a static roller only.

Any weak or unstable areas detected during proof rolling should be locally excavated to a sound base and the excavated material replaced with controlled, engineered fill, or as directed by the geotechnical engineer during proof rolling. Some weak subgrade areas may be experienced where the existing fill is left in place or where the clays are allowed to soften due to water ponding. Following treatment of weak areas, engineered fill should be placed in thin layers as recommended in Section 4.2.1 below.

In view of the high reactivity potential of some of the residual clays, particular attention should be given to providing adequate drainage both during construction and for long term site maintenance. The principal aim of the drainage should be to promote run-off and reduce ponding. Placement of a blinding layer of durable granular fill or subbase material to provide a trafficable surface during construction may be necessary or desirable. The earthworks should be carefully planned and scheduled to maintain cross-falls during construction. If the clay is exposed to prolonged periods of rainfall, softening will result and site trafficability will be poor. If soil softening occurs, the subgrade should be over-excavated to below the depth of moisture softening and the excavated material replaced with engineered fill.

4.2.1 Engineered Fill and Compaction Control

Engineered fill should preferably comprise well graded granular materials, such as ripped rock or crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75mm. Such fill should be compacted in horizontal layers of not greater than 200mm loose thickness, to a density of at least 98% of Standard Maximum Dry Density (SMDD). For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

The excavated material may be reused as engineered fill, provided it is free of deleterious materials and particles greater than 75mm in size. All excavated material should be inspected and approved by a geotechnical engineer prior to reuse. Any clay fill should be compacted in maximum 200mm loose thickness layers to a density strictly between 98% and 102% of SMDD and at moisture contents within 2% of Standard Optimum Moisture Content (SOMC).

Density tests should be regularly carried out on the fill to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per 500m^2 or three tests per visit, whichever requires the most tests. Where fill is to support footing loads it should be placed under Level 1 control as defined by AS3798-2007. Preferably the geotechnical testing authority should be engaged directly on behalf of the client and not by the earthworks subcontractor.

4.3 Batters and Retaining Wall

Suitable retention systems will depend on the proposed basement depth and set-back distances from adjoining structures and properties. For basements which extend up to or close to the site boundaries, full depth retention systems will need to be installed prior to the start of excavation.

Where space permits, temporary batters through the clayey soils and poor-quality siltstone bedrock may be formed at no steeper than 1 Vertical (V): 1 Horizontal (H). Where adopted all surcharge loads such as stockpiles, traffic loads etc must be kept well clear of the crest of the batters. Where permanent batters are adopted, they should be formed at no steeper than 1 Vertical (V): 2 Horizontal (H) and should be protected from erosion by vegetation, shotcrete and mesh or similar. For maintenance purposes it may be more practical to from permanent batters at no stepper than 1V:3H or 4H.

Where space does not allow for the formation of batters and excavation will extend below adjoining buildings a retention system will need to be installed prior to the commencement of excavation. Such a retention system may comprise soldier pile walls with shotcrete infill panels. From experience the construction of such shoring systems has become very cost effective and we do not expect that creation of temporary batters, stockpiling of materials for use as back fill, export of surplus materials to tip, import of expensive drainage gravel and construction of “conventional” retaining walls will necessarily be the most economical option.

Bored piers would be appropriate for the piled walls, but some groundwater seepage may be encountered requiring the use of pumps and tremie concreting techniques. The piers should be founded at least 1m below the base of the excavation, including excavations for footings and services, but more as required for stability design.

Piles supporting cuts up to 3m can probably be designed as cantilevers unless the surcharge loads of adjacent footings are high.

If required, temporary lateral restraint of the retention system could be provided by external anchors or internal props, with each restraining point progressively installed as it is exposed during excavation. Long term lateral support would be provided by the floor slabs within the excavation and the toe sockets of the piles. If anchors are to locally extend below neighbouring properties, permission would need to be obtained from the owners of the adjoining properties before the installation of the anchors below their properties. Such permission can take some time to obtain, which should be allowed for within the project program. The use of anchors will need to take into account the neighbouring site levels and location of any basements and services within the adjoining buildings so that these can be avoided. However, this will be subject to the final building layout plan and proposed ground floor/basement levels.

Cantilever walls can be designed using an active earth pressure coefficient , K_a of 0.35 where there are no structures or services adjacent, but increase to 0.6, where movements are to be kept low.

Propped or anchored retaining walls may be designed based on a trapezoidal earth pressure distribution of magnitude 6H kPa, where H is the retained height in metres, where structures or movement sensitive services are located beyond a horizontal distance of 2H from the wall. Where structures or movement sensitive services are located within 2H of the wall, a trapezoidal earth pressure distribution of 8H kPa should be used. These pressures should be constant over the central 50% of the trapezoidal pressure distribution. In addition to these pressures, the retention wall design should be checked and designed to accommodate a wedge formed by a joint inclined at 45° intersecting the excavation face at the base of the cut.

The above pressures assume horizontal backfill behind the walls and any inclined backfill should be taken as a surcharge load. All surcharge loads should be allowed for in the design, plus full hydrostatic pressures, unless measures are undertaken to provide complete and permanent drainage behind the wall.

Anchors should have their bond formed within rock outside a line drawn up at 45° from the base of the excavation, with a minimum bond length of 3m and a minimum free length of 3m. Provisional design of the anchors may be based on a bond stress of 100kPa for rock of at least very low to low strength and 200kPa for low or higher strength rock. All anchors should be proof loaded to at least 1.3 times their design working load before locking off at about 80% of their working load. Lift-off tests should be carried out on at least 10% of the anchors 24 to 48 hours following locking off to confirm that the anchors are holding their load. Generally, anchors are installed on a design and construct basis so that optimisation of the bond stresses does not become a contractual issue in the event of anchors failing to hold their test loads.

Passive toe resistance of the retention system below the base of the bulk excavation may be estimated based on an allowable lateral resistance of 200kPa for rock of at least very low to low strength. The passive resistance should be ignored for at least 0.5m below the base of the excavation, including footing and service excavations.

4.4 Footings

Weathered siltstone was encountered at levels ranging from about RL112m to RL119m, therefore the bulk excavation depth is greater than about 3m, weathered siltstone is likely to be exposed at bulk excavation level, however this will depend on the final building layout and floor levels. Notwithstanding, we recommend that the building is supported on the underlying siltstone or sandstone bedrock to provide uniform support and reduce the risk of differential movements.

We expect that pad/strip footings founded within the siltstone and sandstone would be appropriate. Where above ground portions of the buildings extend outside the ground floor/basement excavation the use of piles may be required so that the footings are founded within bedrock below the zone of influence of the basement excavation.

Due to the variable bedrock quality encountered within the boreholes, an appropriate allowable bearing pressure for footings founded within the weathered siltstone would commence at 700kPa for siltstone of at least very low strength, but higher bearing pressures are expected to be possible if medium or high strength siltstone and sandstone is encountered, which will depend partly on the depth of excavation. Bored piles bearing on low strength siltstone can be designed for an allowable bearing pressure of 1000kPa. Subject to additional cored boreholes confirming the quality of the medium strength siltstone and clearing up the uncertainty around BH202, allowable bearing pressure of 3500kPa should be achievable at depths of about 5m.

Where piles are used, allowable shaft adhesions equivalent to 10% of the allowable end bearing pressure may be used for the design of piles in compression, below a nominal 0.3m socket and provided socket roughness and cleanliness is maintained.

The footing excavations should be inspected by a geotechnical engineer to confirm that the appropriate foundation material has been encountered.

4.5 Floor Slabs

The subgrade at bulk excavation level will likely comprise weathered siltstone. As recommended above, drainage will need to be provided below the basement slab either as a closely spaced grid of subsoil drains or a gravel blanket. The drainage will need to be connected to a permanent fail-safe pump out system, which is fitted with automatic level controls to avoid flooding unless gravity drainage can be provided.

The basement slab should be designed with a subbase layer of at least 100mm thickness of crushed rock to RMS QA specification 3051 (2013) unbound base material (or other approved good quality and durable fine crushed rock), which is compacted to at least 100% of Standard Maximum Dry Density (SMDD) if a continuous drainage blanket is not adopted. This subbase layer will provide a separation between the siltstone subgrade and the slab and provide a uniform base for the slab.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated

delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A
MOISTURE CONTENT, ATTERBERG LIMIT AND LINEAR SHRINKAGE TEST REPORT

Client:	JK Geotechnics	**Ref No:**	33775BC
Project:	Proposed School Building	**Report:**	A
Location:	20 Avon Road, Pymble, NSW	**Report Date:**	22/01/2021
		Page 1 of 1	

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
201	0.50 - 0.95	21.3	48	22	26	11.5
203	2.00 - 3.00	7.5	-	-	-	-
203	3.80 - 4.20	6.6	-	-	-	-
203	5.00 - 6.00	7.4	-	-	-	-
204	2.70 - 3.00	5.7	-	-	-	-
204	3.50 - 4.50	6.4	-	-	-	-
204	5.20 - 6.00	5.9	-	-	-	-

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 15/01/2021.
- Sampled and supplied by client. Samples tested as received.

NATA

NATA Accredited Laboratory Number:1327

22/01/2021

Authorised Signature / Date
(D. Treweek)

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	Pymble Ladies College	**Ref No:**	33775BC
Project:	Proposed School Building	**Report:**	B
Location:	20 Avon Road, PYMBLE, NSW	**Report Date:**	18/01/21
		Page 1 of 1	

BOREHOLE NUMBER	DEPTH (m)	IS (50) (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
201	2.60 - 2.62	0.3	6	A
	3.18 - 3.21	0.3	6	A
	3.78 - 3.81	0.7	14	A
	4.09 - 4.12	0.6	12	A
	4.49 - 4.53	0.6	12	A
	5.21 - 5.24	1.3	26	A
	5.90 - 5.93	2	40	A
	6.32 - 6.35	2.4	48	A
	6.86 - 6.89	2.2	44	A
	7.06 - 7.08	3.3	66	A
	7.62 - 7.64	2.3	46	A
	8.27 - 8.30	1.8	36	A
	8.86 - 8.89	2.6	52	A
	9.07 - 9.09	1.5	30	A
	9.53 - 9.55	2.1	42	A
202	7.56 - 7.59	0.04	1	A
	7.76 - 7.78	0.3	6	A
	8.91 - 8.93	0.02	<1	A
	9.05 - 9.08	0.04	1	A
	9.31 - 9.33	0.6	12	A
	9.61 - 9.63	0.09	2	A
	10.00 - 10.02	0.2	4	A
	10.31 - 10.34	4.2	84	A

NOTES

1. In the above table, testing was completed in test direction A for the axial direction, D for the diametral direction, B for the block test and L for the lump test.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the IS(50) has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa.
5. The estimated Unconfined Compressive Strength was calculated from the Point Load Strength Index based on the correlation provided in AS1726:2017 'Geotechnical Site Investigations' and rounded off to the nearest whole number: U.C.S. = 20 IS(50).

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CERTIFICATE OF ANALYSIS 259686

Client Details

Client	JK Geotechnics
Attention	Ben Sheppard
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**33775BC, Pymble**
Number of Samples	3 Soil
Date samples received	18/01/2021
Date completed instructions received	18/01/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	25/01/2021
Date of Issue	22/01/2021

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		259686-1	259686-2	259686-3
Your Reference	UNITS	BH202	BH203	BH204
Depth		0.2-0.3	1.2-1.3	0.75-0.95
Date Sampled		14/01/2021	15/01/2021	15/01/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	20/01/2021	20/01/2021	20/01/2021
Date analysed	-	20/01/2021	20/01/2021	20/01/2021
pH 1:5 soil:water	pH Units	7.5	5.9	5.2
Chloride, Cl 1:5 soil:water	mg/kg	10	<10	81
Sulphate, SO4 1:5 soil:water	mg/kg	33	30	370
Resistivity in soil*	ohm m	280	530	56

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			20/01/2021	[NT]	[NT]	[NT]	[NT]	20/01/2021	[NT]
Date analysed	-			20/01/2021	[NT]	[NT]	[NT]	[NT]	20/01/2021	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	118	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	109	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

JKGeotechnics

BOREHOLE LOG

Borehole No. 201

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~121 m

Date: 14/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING										FILL: Silty clay, medium plasticity, dark brown, with root fibres, trace of fine grained sand, fine to medium grained ironstone gravel.	w~PL			GRASS COVER
									CI-CH		w<PL	Hd		RESIDUAL
					N = 13 5,6,7					Silty CLAY: medium to high plasticity, orange brown, trace of fine to medium grained ironstone gravel, ash and root fibres.			510 >600 590	
						120	1							
									-	Extremely Weathered siltstone: silty CLAY, high plasticity, light grey and grey, with iron indurated and very low strength bands.	XW	Hd		ASHFIELD SHALE
					N=SPT 11/ 50mm REFUSAL								>600 >600 >600	VERY LOW 'TC' BIT RESISTANCE
						119	2			SILTSTONE: grey and brown, with iron indurated bands.	DW	VL - L		LOW RESISTANCE
										REFER TO CORED BOREHOLE LOG				
						118	3							
						117	4							
						116	5							
						115	6							

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 201

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~121 m

Date: 14/1/21 **Inclination:** VERTICAL **Datum:** AHD

Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** B.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific / General	Formation
					START CORING AT 2.20m						
50% RETURN					NO CORE 0.09m						
		118	3		SILTSTONE: dark grey and brown, with iron indurated bands and laminae up to 5°.	HW	VL - L	0.30		(2.29-2.40m) Highly Fractured, Numerious Be, P, S, Cn (2.42m) XWS, 0°, 4 mm.t (2.45m) XWS, 0°, 3 mm.t (2.49m) XWS, 0°, 4 mm.t (2.62m) XWS, 0°, 4 mm.t (2.69m) J, 90°, Ir, R, Fe Sn, and Be, 0°, P R, Fe, St (2.71m) Be, 0°, P, R, Fe Sn (2.72m) XWS, 0°, 20 mm.t (2.78m) XWS, 0°, 7 mm.t (2.82m) XWS, 0°, 10 mm.t (2.85m) J, 70 - 90°, Ir, R, Clay Ct (2.95m) J x 2, 70 - 80°, P, S, XWS FILLED, and XWS, 0°, 110mm.t	
						MW	L - M	0.30		(3.14m) J, 80 - 90°, St, R, Fe Sn (3.30m) XWS, 0°, 5 mm.t (3.38m) XWS, 0°, 20 mm.t (3.41m) Be, 0°, P, R, Cn (3.58m) J, 90°, P, R, Fe Sn (3.60m) J, 0°, P, R, Fe Sn (3.66m) Be, 0°, P, R, Fe Sn, and J, 90°, P R, Cn (3.74m) XWS, 0°, 4 mm.t	
		117	4					0.70 0.60 0.60		(3.88m) XWS, 0°, 12 mm.t (3.92m) Be, 5°, Un, R, Fe Sn (3.96m) CS, 0°, 6 mm.t (4.13m) Be, 5°, Un, R, Fe Sn (4.25m) J, 60°, P, R, XWS FILLED, 15 mm.t	
					Extremely Weathered siltstone: silty CLAY, medium plasticity, with light grey laminae up to 10°.	XW	Hd			(4.70m) J, 90°, Un, R, XW Fines, 15 mm.t	
						MW	L - M			(4.84m) XWS, 0°, 35 mm.t	
		116	5		SILTSTONE: dark grey and brown, with iron indurated bands and laminae up to 5°.	SW	M - H	1.3	60 20	(5.08m) Be, 0°, P, R, Cn (5.35m) J x 3, 70 - 90°, C, Cn	
					SILTSTONE: dark grey, with light grey laminae up to 10°.					(5.54m) J, 80°, P, R, Fe Sn	
		115	6					2.0		(5.93m) Be, 0°, P, R, Cn	
										(6.17m) J, 70°, Un, R, Fe Sn	
								2.4			
										(6.56m) J, 70°, Un, R, Cn	
								2.2			
		114	7					3.3		(7.11m) J, 15°, Un, R, Cn (7.21m) Be, 0°, Un, R, Fe Sn (7.27m) J, 60°, Un, R, Fe Sn	
						FR					
								2.3			
		113	8					1.8			
								2.6	600 200 60 20		

JK 9.02.4 LIB GLB Log JK CORED BOREHOLE - MASTER 33775BC PYMBLE.GPJ <<DrawingFile>> 08/02/2021 10:05 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 201 3 / 3

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~121 m

Date: 14/1/21 **Inclination:** VERTICAL **Datum:** AHD

Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** B.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
50% RETURN					SILTSTONE: dark grey, with light grey laminae up to 10°. *(continued)*	FR	M	•1.5 •2.1			Ashfield Shale
					END OF BOREHOLE AT 9.72 m						

111 10
110 11
109 12
108 13
107 14
106 15

JK 9.02.4 LIB GLB Log JK CORED BOREHOLE - MASTER 33775BC PYMBLE.GPJ <<DrawingFile>> 08/02/2021 10:05 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

Job No: 337758C
Borehole No: BH201
Depth: 2.20m - 9.72m

JKGeotechnics

BOREHOLE LOG

Borehole No. 202

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~114.5 m

Date: 14/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING						114				FILL: silty clay, low plasticity, dark brown, trace of fine grained sand, fine grained ironstone gravel, concrete fragments and root fibres.	w>PL			GRASS COVER APPEARS MODERATELY COMPACTED
					N = 9 5,4,5					as above, but without concrete fragments.				
							1		CI	Silty CLAY: medium plasticity, orange brown and brown, trace of fine grained ironstone gravel and root fibres.	w>PL	VSt	290 300 240	RESIDUAL
						113			CI-CH	Silty CLAY: medium to high plasticity, orange brown, red brown and grey, with fine grained ironstone gravel, trace of root fibres.	w~PL	Hd	>600 >600 >600	
					N = 16 6,6,10		2							
						112			-	Extremely Weathered siltstone: silty CLAY, high plasticity, grey brown, with iron indurated bands and very low strength brands.	XW	(Hd)		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
						111	3							
							4			SILTSTONE: grey and brown, with extremely weathered bands and iron indurated bands.	DW	VL		VERY LOW TO LOW BANDED RESISTANCE
						110				REFER TO CORED BOREHOLE LOG				
							5							
						109								
							6							
						108								

JKGeotechnics

CORED BOREHOLE LOG

Borehole No. 202 **2 / 2**

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Core Size:** NMLC **R.L. Surface:** ~114.5 m

Date: 14/1/21 **Inclination:** VERTICAL **Datum:** AHD

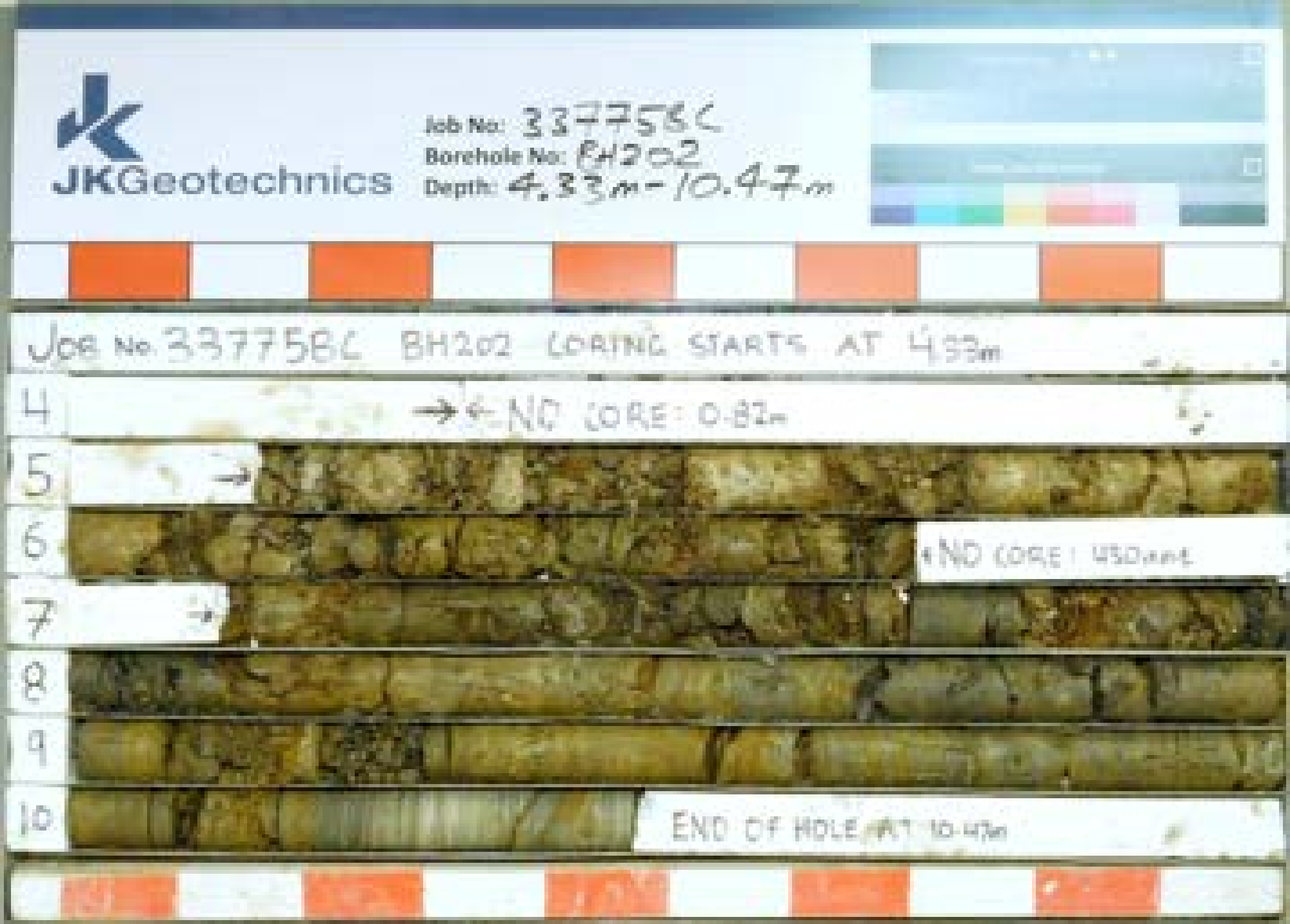
Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** B.S./T.C.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 4.33m						
		110	5		NO CORE 0.82m						
		109	6		Extremely Weathered siltstone: silty CLAY, high plasticity, grey, with high strength bands and iron indurated bands.	XW	Hd			(5.80m) HP: >600 kPa (6.08m) HP: >600 kPa	Ashfield Shale
		108	7		NO CORE 0.43m						
50% RETURN		107			SILTSTONE: grey and brown.	HW	VL	0.040 0.30		(7.14m) XWS, 0°, 45 mm.t (7.40m) XWS, 0°, 30 mm.t (7.43-7.62m) Numerous, Be, 0°, P, R, Fe, and J, 20-80°, P, R, Fe, St (7.78m) Be, 5°, P, R, Fe Sn	
		106	8		Extremely Weathered siltstone: silty CLAY, high plasticity, with iron indurated bands.	XW	Hd			(8.24m) HP: >600 kPa (8.40m) HP: >600 kPa	
			9		SILTSTONE: dark grey.	HW	VL	0.020 0.040		(9.10m) XWS, 0°, 100 mm.t (9.20m) J, 90°, P, R, Fe Sn	Ashfield Shale
		105			Interbedded SILTSTONE: grey and brown and SANDSTONE: fine to medium grained, grey, with iron indurated bands.	MW	VL - L	0.60 0.090		(9.55m) XWS, 0°, 50 mm.t	
			10					0.20		(10.10m) Be, 0°, Un, R, Fe Sn, and XWS, 0°, 75mm.t	
					SANDSTONE: fine grained, grey, with siltstone bands.	SW	M - H	4.2		(10.37m) J, 30°, Un, R, Fe Sn (10.42m) Ji, 30°	
		104			END OF BOREHOLE AT 10.47 m						

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

Job No: 337758C
Borehole No: BH202
Depth: 4.33m - 10.47m



JKGeotechnics

BOREHOLE LOG

Borehole No. 203 1 / 1

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~117 m

Date: 15/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION										FILL: Silty clay, dark brown, trace of fine to medium grained sand, fine to medium grained ironstone gravel, concrete fragments and root fibres.	w~PL			GRASS COVER
									CI-CH		w~PL	Hd		RESIDUAL
					N = 14 6,6,8					Silty CLAY: medium to high plasticity, orange brown, trace of fine to coarse grained ironstone gravel, ash and root fibres.			>600 >600 >600	
						116	1							
									-	SILTSTONE: dark grey, with extremely weathered bands and iron indurated bands.	DW	L		ASHFIELD SHALE
												L		VERY LOW TO LOW 'TC' BIT RESISTANCE
						115	2							LOW RESISTANCE WITH MODERATE BANDS
						114	3			SILTSTONE: dark grey and grey, with extremely weathered seams.		M		MODERATE RESISTANCE
						113	4							
										as above, but iron indurated bands.		M - H		MODERATE RESISTANCE WITH HIGH BANDS
						112	5							
						111	6			END OF BOREHOLE AT 6.00 m				

JKGeotechnics

BOREHOLE LOG

Borehole No. 204 1 / 1

Client: PYMBLE LADIES COLLEGE

Project: PROPOSED SCHOOL BUILDING

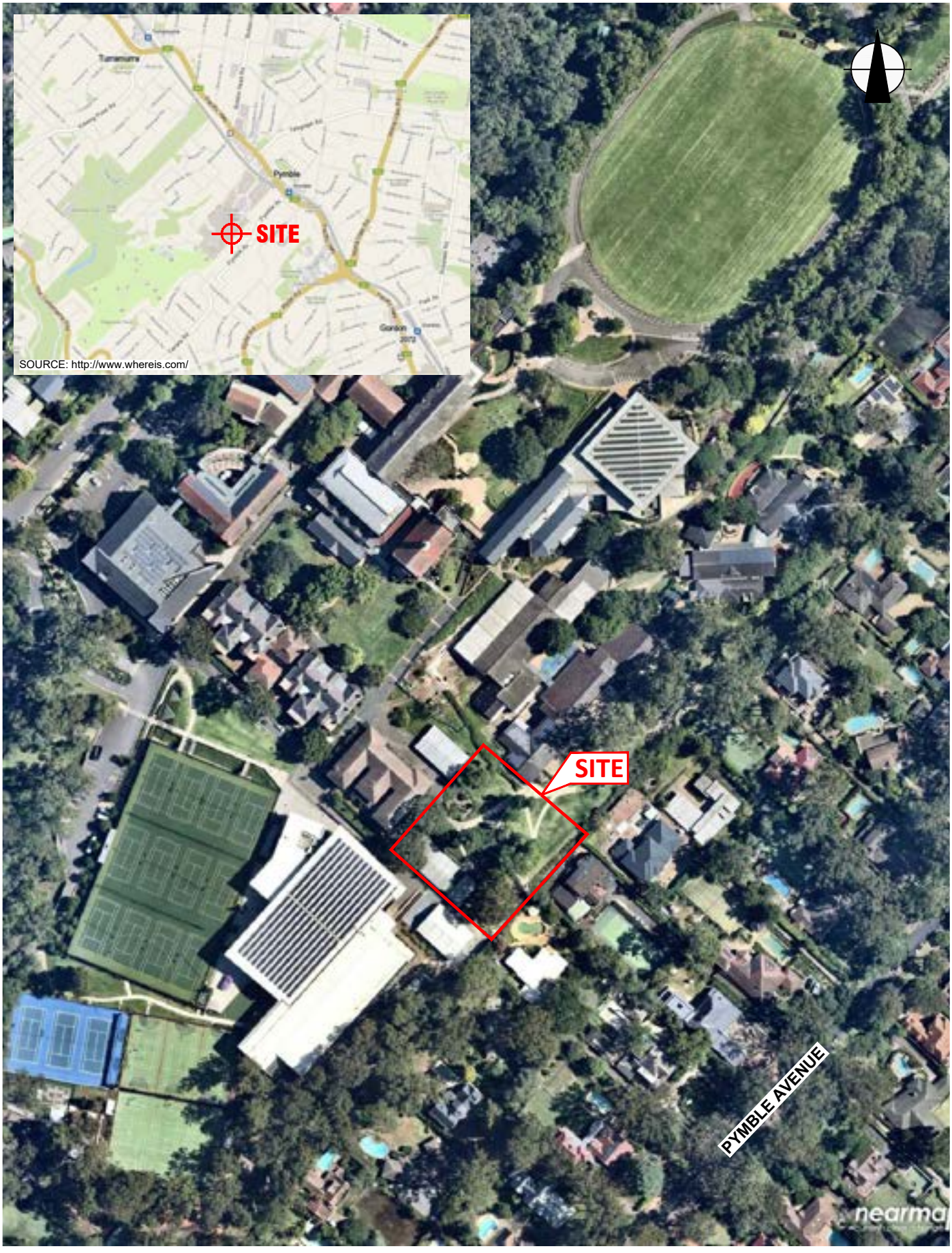
Location: 20 AVON ROAD, PYMBLE, NSW

Job No.: 33775BC **Method:** SPIRAL AUGER **R.L. Surface:** ~119.9 m

Date: 15/1/21 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** B.S./T.C.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION									-	CONCRETE:20mm.t	M			APPEARS MODERATELY COMPACTED
										FILL: Silty sand, fine to medium grained, dark brown, trace of concrete fragments and clay nodules.	w<PL			
					N = 11 4,6,5					FILL: Silty clay, low plasticity, brown, trace of fine to coarse grained igneous and ironstone gravel, ash and slag fragments.				
						119	1		CI		w<PL	Hd	>600 >600 >600	RESIDUAL
										Silty CLAY: medium plasticity, orange brown, trace of fine to medium grained ironstone gravel, ash and root fibres.				
									CI-CH	Silty CLAY: medium to high plasticity, light grey and red brown, trace of fine to coarse grained ironstone gravel.	w~PL			
					N = 16 7,7,9								>600 >600 >600	
						118	2							
									-	Extremely Weathered siltstone: silty CLAY, medium to high plasticity, grey, with iron indurated bands.	XW	Hd		ASHFIELD SHALE VERY LOW 'TC' BIT RESISTANCE
										SILTSTONE: dark grey and brown, with iron indurated bands and extremely weathered bands.	DW	L		LOW RESISTANCE WITH MODERATE BANDS
						117	3					M		MODERATE RESISTANCE WITH LOW BANDS
						116	4							
						115	5							
										as above, but without extremely weathered bands.		M - H		MODERATE RESISTANCE WITH HIGH BANDS
						114	6			END OF BOREHOLE AT 6.00 m				
						113								



AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

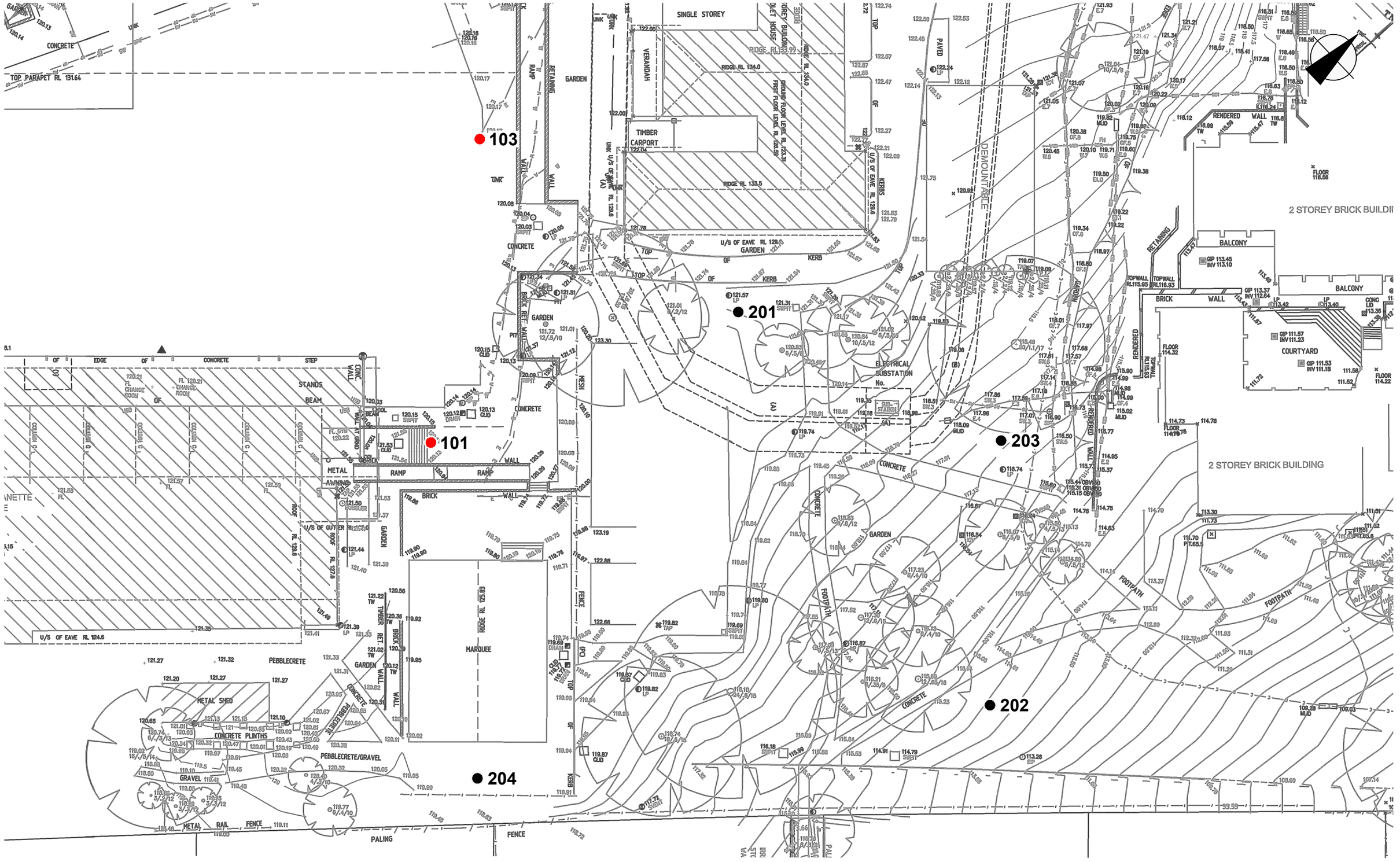
Location: 20 AVON ROAD, PYMBLE, NSW

Report No: 33775BC

Figure No: 1

JKGeotechnics

PLOT DATE: 25/01/2021 9:42:37 AM DWG FILE: Z:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\33000'S\33775BC PYMBLE\CAD\33775BC.DWG



NOTE:
BOREHOLES 101 & 103 ARE FROM OUR PREVIOUS GEOTECHNICAL INVESTIGATION.

0 4 8 12 16 20
SCALE 1:400 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **BOREHOLE LOCATION PLAN**

Location: 20 AVON ROAD, PYMBLE, NSW

Report No: 33775BC

Figure No: 2

JKGeotechnics

PLOT DATE: 29/01/2021 4:10:32 PM DWG FILE: Z:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\33000'S\33775BC PYMBLE\CAD\33775BC.DWG

VIBRATION EMISSION DESIGN GOALS

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 1 below.

It should be noted that peak vibration velocities higher than the minimum figures in Table 1 for low frequencies may be quite 'safe', depending on the frequency content of the vibration and the actual condition of the structure.

It should also be noted that these levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the 'safe limits', then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

Table 1: DIN 4150 – Structural Damage – Safe Limits for Building Vibration

Group	Type of Structure	Peak Vibration Velocity in mm/s			
		At Foundation Level at a Frequency of:			Plane of Floor of Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (eg. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

Note: For frequencies above 100Hz, the higher values in the 50Hz to 100Hz column should be used.

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shrink-swell behaviour, strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

As penetration occurs (at a rate of approximately 20mm per second), the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Reasonable care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.
- Details of the development that the Company could not reasonably be expected to anticipate.

If these occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a joint design review which involves an experienced geotechnical engineer/engineering geologist.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

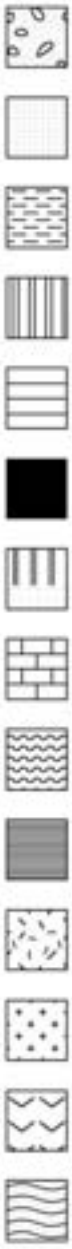
ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL

ROCK



OTHER MATERIALS

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

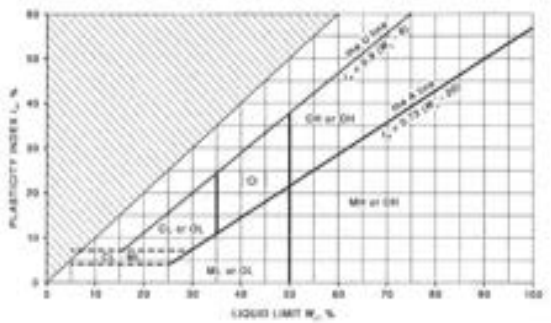
$$C_U = \frac{D_{60}}{D_{10}} \qquad and \qquad C_C = \frac{(D_{30})^2}{D_{10}\, D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

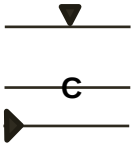
NOTES:

1. For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.
2. Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.
3. Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.
4. The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record		Standing water level. Time delay following completion of drilling/excavation may be shown. Extent of borehole/test pit collapse shortly after drilling/excavation. Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES U50 DB DS ASB ASS SAL	Sample taken over depth indicated, for environmental analysis. Undisturbed 50mm diameter tube sample taken over depth indicated. Bulk disturbed sample taken over depth indicated. Small disturbed bag sample taken over depth indicated. Soil sample taken over depth indicated, for asbestos analysis. Soil sample taken over depth indicated, for acid sulfate soil analysis. Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25 PID = 100	Vane shear reading in kPa of undrained shear strength. Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	w > PL $w \approx$ PL w < PL $w \approx$ LL w > LL	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. Moisture content estimated to be near liquid limit. Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D M W	DRY – runs freely through fingers. MOIST – does not run freely but no free water visible on soil surface. WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt Hd Fr ( )	VERY SOFT – unconfined compressive strength ≤ 25kPa. SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa. FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa. STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa. VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa. HARD – unconfined compressive strength > 400kPa. FRIABLE – strength not attainable, soil crumbles. Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.
Density Index/ Relative Density (Cohesionless Soils)	VL L MD D VD ( )	**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)** VERY LOOSE ≤ 15 / 0 – 4 LOOSE > 15 and ≤ 35 / 4 – 10 MEDIUM DENSE > 35 and ≤ 65 / 10 – 30 DENSE > 65 and ≤ 85 / 30 – 50 VERY DENSE > 85 / > 50 Bracketed symbol indicates estimated density based on ease of drilling or other assessment.
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered (Note 1)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength	
			Point Load Strength Index $Is_{(50)}$ (MPa)	Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres

Receipt/Tax Invoice

ABN: 86 408 856 411
818 Pacific Highway
GORDON NSW 2072
Phone: 02 9424 0000

Receipt No	D000812320
Date	05 Mar 2024
Time	12:55:20PM
Register	REGISTER03

Name
Pymble Ladies College Property Limited
Att: Greg Hastle
Pymble Ladies College
20 Avon Rd
PYMBLE NSW 2073

Item/Description	*Qty*	*Price*	*GST*	*Amount*
Application ID: DC24/0094 - Section 94A - 466658.130000	1.00	466,658.13	0.00	466,658.13
		Total Amount:	0.00	466,658.13

Payment	*Amount*
Agency	466,658.13
Total Tendered	466,658.13
Rounding Amount	0.00
Change	0.00
Includes GST	0.00

Contributions Statement

818 Pacific Highway, Gordon NSW 2072
Locked Bag 1006, Gordon NSW 2072
Office hours: 8:30am - 4:30pm, Monday to Friday
T 02 9424 0000 **E** krg@krg.nsw.gov.au
W krg.nsw.gov.au
ABN 86 408 856 411

QUOTE COUNCIL REFERENCE
ON ALL CORRESPONDENCE

27 February 2024

Council Reference: DC24/0094

Pymble Ladies College Property Limited
Att: Greg Hastle
Pymble Ladies College
20 Avon Rd
PYMBLE NSW 2073

RE: Section 7.12 (94A) Development Contributions for
PREMISES: 20 Avon Road PYMBLE NSW 2073

Notice of Payment for s7.12 Contributions

Development Contributions Total **$466658.13**

This notice refers to your Complying Development Certificate or Development Consent for building works at the above address.

A fixed development consent levy is payable pursuant to section 7.12 of the Environmental Planning and Assessment Act 1979 and **Ku-ring-gai Council s7.12 Local Levy Contributions Plan 2023**. Payment should occur prior to the commencement of building works in accordance with the terms of the relevant condition imposed on the Complying Development Certificate or Development Consent. Please note s7.12 contributions paid are not refundable. Owners and applicants should ensure that the proposed construction work is ready to commence before proceeding to payment.

The amount specified above is calculated at the indexed rate applicable as at the date of this letter. These figures will continue to be indexed to reflect changes in the Consumer Price Index (CPI) until they are paid in accordance with Ku-ring-gai Council s7.12 Local Levy Contributions Plan 2023. **Prior to payment please enquire with our Customer Service team to ensure your s7.12 levy calculation is to the current inflation quarter.**

Should you have any further enquiries please contact Council on 02 9424 0000 between 8:30am – 5:00pm Monday to Friday, or email krg@krg.nsw.gov.au.

Yours sincerely

David Marshall
Acting General Manager
per

FW: Pymble Ladies College - Grey House Precinct - Construction Commencement Notification

Rosanna Petteno <Rosanna@pierproperty.com.au>
Wed 4/3/2024 1:11 PM
To:Chris Michaels <ChrisM@cityplan.com.au>
Cc:Alison Brown <alisonb@cityplan.com.au>

Hi Chris,

Please see below acknowledgement from the Department in response to the Construction Commencement Notification letter we submitted to DoP to satisfy SSDA D1.

regards,

Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Gregory Hastie <ghastie@pymblelc.nsw.edu.au>
Sent: Wednesday, April 3, 2024 1:03 PM
To: Rosanna Petteno <Rosanna@pierproperty.com.au>
Cc: Tony Macri <tmacri@stephenedwards.com.au>; Andrew Kyrillos <akyrillos@stephenedwards.com.au>
Subject: FW: Pymble Ladies College - Grey House Precinct - Construction Commencement Notification

Hi Ros

Please see below – DoP has no comment on the Notification of Construction Commencement.

Regards

Greg Hastie
Project Director
Masterplanning and Capital Works

Pymble Ladies' College
Avon Road, Pymble NSW 2073
T: +61 2 9855 7628 | **M:** +61 411 477 006
www.pymblelc.nsw.edu.au

I work and send correspondence at times that are traditionally not seen as work hours. That is my choice. Please understand there is no expectation, nor should you feel any implied pressure to read emails nor respond other than in normal work hours.

From: no-reply@majorprojects.planning.nsw.gov.au <no-reply@majorprojects.planning.nsw.gov.au>
Sent: Wednesday, April 3, 2024 1:01 PM
To: sprowd@willowtp.com.au
Cc: brigitte.healey@dpie.nsw.gov.au; Gregory Hastie <ghastie@pymblelc.nsw.edu.au>
Subject: Pymble Ladies College - Grey House Precinct - Construction Commencement Notification

This email is to acknowledge receipt of the Construction Commencement Notification for the Pymble Ladies College - Grey House Precinct .

The Department has no comments on the document at this time.

If you have any enquiries, please contact Brigitte Healey on 02 8229 2936 at brigitte.healey@dpie.nsw.gov.au.

To sign in to your account click here or visit the Major Projects Website.

Please do not reply to this email.

Kind regards

The Department of Planning and Environment

Subscribe to our newsletter

FW: PLC Grey House Precinct - Commencement - SSDA D1

Rosanna Petteno </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2A80A8F5D38A461982B3FA19B44239F9-ROSANNA>

Fri 3/22/2024 9:36 AM

To:Sally Prowd <sprowd@willowtp.com.au>
Cc:ghastie@pymblelc.nsw.edu.au <ghastie@pymblelc.nsw.edu.au>;Chris Michaels <ChrisM@cityplan.com.au>

1 attachments (395 KB)

GHP - Site Establishment Commencement.pdf;

Good morning Sally,

Per the below email, the Department has approved the attached Notice of Commencement. Please upload to the PLC GHP projects portal.

regards,

ppc pier property corporation

Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Brigitte Healey <brigitte.healey@dpie.nsw.gov.au>
Sent: Friday, March 22, 2024 9:28 AM
To: Rosanna Petteno <Rosanna@pierproperty.com.au>
Subject: RE: Grey House Precinct - Commencement

Hi Rosanna,

Thank you. Please upload the notification to the Major Projects portal.

Kind regards,

Brigitte Healey *she/her*
Compliance Officer
Metro
Department of Planning, Housing and Infrastructure

T 02 8229 2936 **E** brigitte.healey@dpie.nsw.gov.au

dphi.nsw.gov.au

Locked Bag 5022 PARRAMATTA NSW 2124

Working days Monday to Friday, 09:00am - 05:00pm

NSW GOVERNMENT

I acknowledge the traditional custodians of the land and pay respects to Elders past and present. I also acknowledge all the Aboriginal and Torres Strait Islander staff working with NSW Government at this time.

Please consider the environment before printing this email.

From: Rosanna Petteno <Rosanna@pierproperty.com.au>
Sent: Friday, 22 March 2024 9:05 AM
To: Brigitte Healey <brigitte.healey@dpie.nsw.gov.au>
Subject: FW: Grey House Precinct - Site Visit - Commencement

Morning Brigitte,

Just following up to see if we may we upload the attached Commencement letter to the PLC GHP portal ?

regards,

Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Rosanna Petteno
Sent: Thursday, March 21, 2024 9:28 AM
To: 'Brigitte Healey' <brigitte.healey@dpie.nsw.gov.au>
Cc: ghastie@pymblelc.nsw.edu.au; Astrid Christensen <astrid.christensen@planning.nsw.gov.au>
Subject: RE: Grey House Precinct - Site Visit - Commencement

Good morning Brigitte,

Stephen Edwards Constructions have provided us with the attached letter.

We have run this wording through our PCA to ensure the letter does not infer that Construction has commenced without the issuing of a Construction Certificate.

Please confirm if you are happy for PLC to upload the attached letter to the portal ?

regards,

Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Brigitte Healey <brigitte.healey@dpie.nsw.gov.au>
Sent: Thursday, March 14, 2024 11:56 AM

To: Rosanna Petteno <Rosanna@pierproperty.com.au>
Subject: RE: Grey House Precinct - Site Visit - Commencement

Hi Rosanna,

Thank you for uploading the CEMP.

The letter must state when construction, as defined by the consent, commenced.

Please find the definition below.

The demolition and removal of buildings or works, the carrying out of works for the purpose of the development, including site investigation and establishment works, relocation of utilities, earthworks, and erection of buildings and other infrastructure permitted by this consent.

Kind regards,

Brigitte Healey *she/her*
Compliance Officer
Metro
Department of Planning, Housing and Infrastructure

T 02 8229 2936 **E** brigitte.healey@dpie.nsw.gov.au

dphi.nsw.gov.au

Locked Bag 5022 PARRAMATTA NSW 2124

Working days Monday to Friday, 09:00am - 05:00pm

From: Rosanna Petteno <Rosanna@pierproperty.com.au>
Sent: Thursday, 14 March 2024 11:38 AM
To: Brigitte Healey <brigitte.healey@dpie.nsw.gov.au>
Subject: RE: Grey House Precinct - Site Visit - Commencement

Hi Brigitte,

We have uploaded the CEMP to the Major projects planning portal yesterday.

Regarding the commencement notice, would the following approach be acceptable?

To address Condition D1 of SSDA, we will ask Stephen Edwards Construction to prepare a letter addressed to the Planning Secretary, informing the Department that initial site establishment

construction works have commenced, with actual construction commencement expected Monday 25 March.

regards,

Rosanna Petteno | Senior Project Manager | Pier Property Corporation
Suite 305, Level 3, 25 Lime St King Street Wharf NSW 2000
Tel (02) 9249 0400 | Fax 02 9249 0499 | Mob 0420 959 064
rosanna@pierproperty.com.au | | www.pierproperty.com.au

From: Gregory Hastie <ghastie@pymblelc.nsw.edu.au>
Sent: Wednesday, March 13, 2024 10:37 AM
To: Brigitte Healey <brigitte.healey@dpie.nsw.gov.au>
Cc: Astrid Christensen <astrid.christensen@planning.nsw.gov.au>; Rosanna Petteno <Rosanna@pierproperty.com.au>
Subject: Grey House Precinct - Site Visit

Hi Brigitte

Thank you for your time today.

Per our discussion, we are initiating the portal for this project, will advise of works commencement and will submit the CMP through the portal.

Regards

Greg Hastie
Project Director
Masterplanning and Capital Works

Pymble Ladies' College
Avon Road, Pymble NSW 2073
T: +61 2 9855 7628 | **M:** +61 411 477 006
www.pymblelc.nsw.edu.au

I work and send correspondence at times that are traditionally not seen as work hours. That is my choice. Please understand there is no expectation, nor should you feel any implied pressure to read emails nor respond other than in normal work hours.

Pymble Ladies' College and Vision Valley are situated on sacred Aboriginal Country. We pay respect to the Elders past and present and extend that respect to the other First Nations people within the College community.