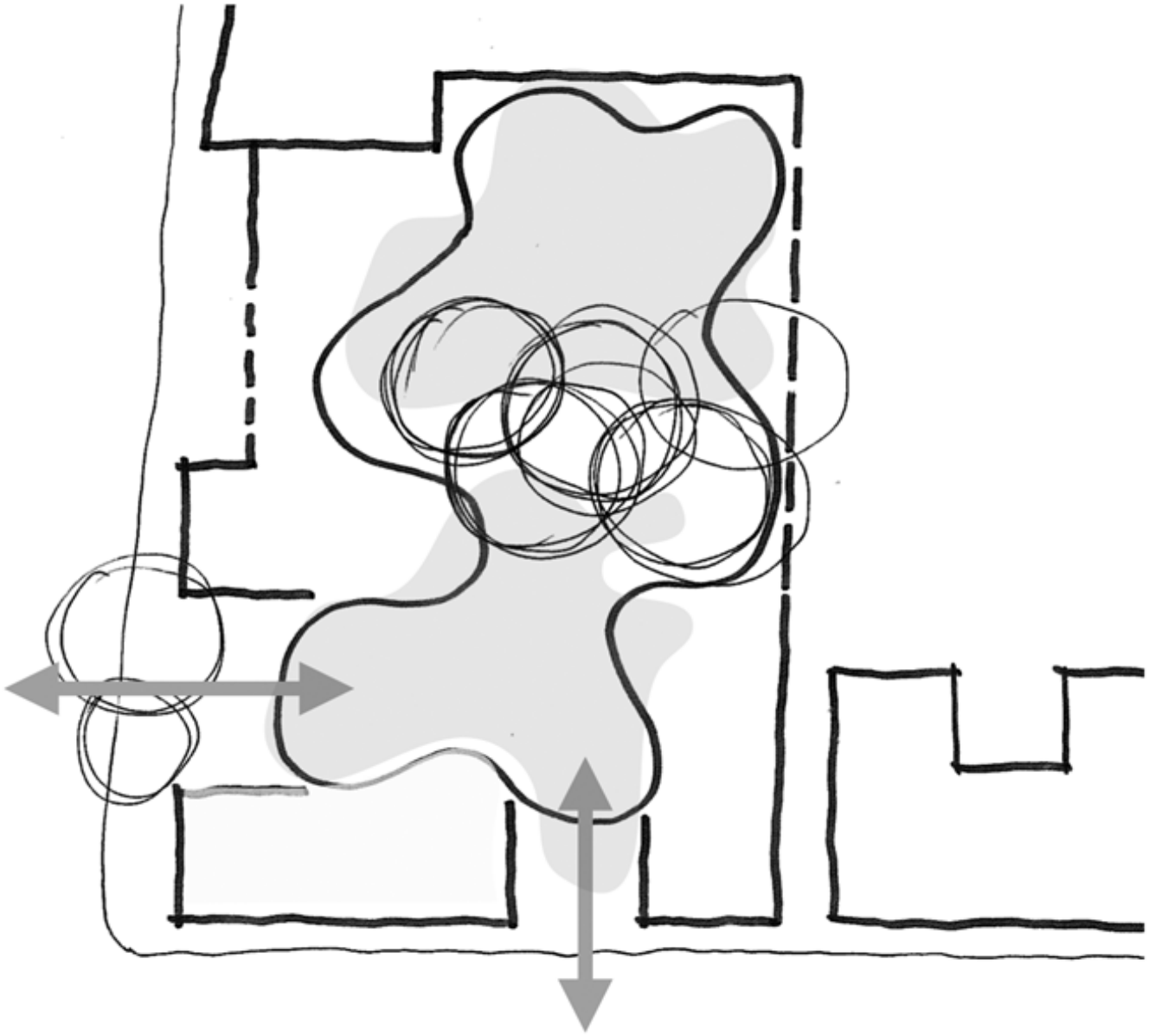
DARLINGTON PUBLIC SCHOOL REDEVELOPMENT

Appendix W — Operational Waste Management Plan

SSD-9914

Prepared by JBS&G

For NSW Department of Education



School Infrastructure NSW

Operational Waste Management Plan

Darlington Public School
Golden Grove Street, Darlington, NSW

22 April 2020

56243/129064 (Rev 1)

JBS&G Australia Pty Ltd

www.jbsg.com.au

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JBS&G Australia Pty Ltd

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1. Introduction

1.1 Introduction and Purpose

JBS&G Australia Pty Ltd (JBS&G) has been engaged on behalf of School Infrastructure NSW (SINSW, the client), to prepare an Operational Waste Management Plan (OWMP) for ongoing operations at Darlington Public School, following redevelopment (the site, **Figure 1**) with an area size of approximate 7,450 m^2. Darlington Public School is located on the corner of Golden Grove Street and Abercrombie Street, Darlington, within the City of Sydney Local Government Area. The school is adjacent to the University of Sydney Darlington Campus and within walking distance to Redfern and Macdonaldtown train stations. The site is legally described as Lot 100 in DP 623500 and Lot 592 in DP 7523049.

The State Significant Development (SSD) application seeks consent for demolition of existing school buildings and construction of a new part 2, part 3-storey building, increasing the school capacity from 230 to 437 students. The works also include replacement of the existing child-care facility (to the same capacity of 60 students), earthworks and landscaping. For a detailed project description refer to the Environmental Impact Statement (EIS) prepared by Ethos Urban.

The purpose of the OWMP is to ensure that the waste generated on site during operation of the school post redevelopment will be minimised to the extent practicable and provide documented procedures on how generated waste will be managed.

1.2 Scope

This OWMP has been developed to address the Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning and Environment for application SSD 19_9914[1], dated 19 March 2019. **Table 1.1** presents the SEARs required to be addressed to support the SSDA:

Table 1.1: SEARS Requirements

SEARS Requirements	Report Section
Identify, quantify and classify the likely waste streams to be generated during construction and operation and describe the measures to be implemented to manage, reuse, recycle and safely dispose of this waste.	Waste streams associated with the construction phase of the project is presented in **Section 4.**
Identify and detail how any asbestos waste, lead-based paint and Polychlorinated biphenyls (PCBs) that may be encountered will be handled, transported and disposed.	Hazardous material handling, transport and disposal requirements are detailed in **Section 5** and **Table 5.1**
Identify appropriate servicing arrangements (including but not limited to, waste management, loading zones, mechanical plant) for the site.	Servicing arrangements are presented in **Section 5**.
Assess, quantify and report on waste management in the context of the waste management hierarchy.	Waste Hierarchy is presented in **Section 3.3**. Waste Management is detailed in **Section 5**.

[1] *Application Number SSD – 9914 Darlington Public School Redevelopment. Golden Grove Street, Darlington within City of Sydney. Department of Education.* Secretary's Environmental Assessment Requirements, Section 4.12(8) of the Environmental Planning and Assessment Act 1979 Schedule 2 of the Environmental Planning and Assessment Regulation 2000 dated 19 March 2019 (SSD 9914)

2. Legislation and Guidelines

2.1 Legislation

This OWMP has been prepared in accordance with the requirements of the NSW *Waste Avoidance and Resource Recovery Act 2001*, and the NSW *Protection of the Environment Operations Act 1997* (POEO *Act*). These and other key legislation relevant to waste management at the site are provided in **Table 2.1**.

Table 2.1: NSW Waste Legislation Summary

Legislation	Purpose
Protection of the Environment Operations Act 1997 *Protection of the Environment Operations (Waste) Regulation 2014* *Protection of the Environment Operations (General) Regulation 2009*	The Act is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA). The object of the Act is to achieve the protection, restoration and enhancement of the quality of the NSW environment. The Act enables the Government to establish policy instruments for setting environmental standards, goals, protocols and guidelines.
Waste Avoidance and Resource Recovery Act 2001	The WARR Act promotes waste avoidance and resource recovery to achieve a continual reduction in waste generation, provides for development of a state-wide Waste Strategy, and introduces a scheme to promote extended producer responsibility for the life-cycle of a product. Objectives of the Act include: • To encourage the most efficient use of resources and to reduce environmental harm; • To ensure that resource management options are considered against a hierarchy (see **Section 3.3**); • Provide for the continual reduction in waste generation; • To minimise the consumption of natural resources and the final disposal of waste; • To ensure that industry shares with the community the responsibility for reducing and dealing with waste; and • To assist in the achievement of the objectives of the *POEO Act.*
Environmental Planning and Assessment Act 1979 *Environmental Planning and Assessment Regulation 2000*	The Act and the Regulation provide the overarching structure for planning in NSW. They provide for a number of other statutory documents to support the planning structure, including State Environmental Planning Policies and Local Environmental Plans. The objectives include: • The proper management, development and conservation of natural and artificial resources; and • To encourage ecologically sustainable development.
Environmentally Hazardous Chemicals Act 1985 (NSW)	The Act provides for control of the effect on the environment of chemicals and chemical wastes. The EPA is responsible for administering this legislation, in partnership with other state government agencies. It is the primary legislation for specifically regulating environmentally hazardous chemicals throughout their life cycle. The Act sets out requirements for: • Chemical Control Orders (CCOs) which are used to manage specified hazardous chemicals and chemical wastes; • Technology assessments, which ensure that premises treating or destroying chemicals are safe and appropriate for their purpose; and • Licensing of individuals or industries who manage chemicals that are subject to a CCO.
Contaminated Land Management Act, 1997 and *Regulation 2013*	The Act establishes a process for investigating and (where appropriate) remediating land that the EPA considers to be contaminated significantly enough to require regulation.

2.2 Guidelines

Guidance documents and policies considered in the preparation of this OWMP are included in **Table 2.2**.

Table 2.2: NSW Guidance Summary

Guideline	Purpose
NSW Environment Protection Authority (EPA) Waste Classification Guidelines 2014 (EPA 2014)	The Waste Classification Guidelines have been established by the NSW EPA to assist waste generators to classify wastes. Wastes are classified into groups that pose similar risks to environment and human health. Waste classifications are discussed further in **Section 3.**
Building Code of Australia (BCA)	The BCA contains technical provisions for the design and construction of buildings and other structures, covering such matters as structure, fire resistance, access and egress, services and equipment, and energy efficiency as well as certain aspects of health and amenity.
NSW EPA's Waste Avoidance and Resource Recovery (WARR) Strategy 2014-21	The WARR strategy provides a framework for waste management for the state until 2021. Key targets include: • Avoid and reduce waste generation; • Increase recycling; • Divert more waste from landfill; • Manage problem wastes better; • Reduce litter; and • Reduce illegal dumping.
NSW EPA's Better Practice Guidelines for Waste Management and Recycling in Commercial and Industrial Facilities 2012	The guide provides advice to assist architects, developers, council staff and building managers to incorporate better waste management practice into the design, establishment, operation and ongoing management of waste services in commercial and industrial developments.
NSW Government Resource Efficiency Policy (GREP) 2019	The policy aims to reduce the NSW Government's operating costs and lead by example in increasing the efficiency of its resource use. The policy will continue to drive resource efficiency by NSW Government agencies in four main areas – energy, water, waste and air emissions from government operations. The GREP was introduced in 2014 and reviewed in 2018 to take into account implementation challenges, technology development and market trends. Local government, state-owned corporations, public trading enterprises and public financial enterprises are strongly encouraged to adopt this policy's approach.
How to manage and control asbestos in the workplace, SafeWork NSW Code of Practice, 2016 (NSW Government)	The Code of Practice is an approved code of practice under the *Work Health and Safety Act 2011*. It is only relevant where asbestos is present in the workplace. The code provides guidance on how to manage risks associated with asbestos and asbestos containing material at the workplace and thereby minimise the incidence of asbestos-related diseases such as mesothelioma, asbestosis and lung cancer.
How to safely remove asbestos, SafeWork NSW Code of Practice, 2016 (NSW Government)	The Code of Practice is an approved code of practice under the *Work Health and Safety Act 2011*. It is only relevant where asbestos requires removal. The code provides practical guidance on how to safely remove asbestos from all workplaces including structures, plant and equipment and should be read in conjunction with *How to manage and control asbestos in the work place* Code of Practice.
Australian Government Construction and Demolition Waste Guide, 2011	The aim of the guide is to help develop effective markets for materials diverted or derived from the construction and demolition waste stream.
Australian Government Sustainable Procurement Guide, 2018.	The guide aims to reduce the adverse environmental, social and economic impacts of purchased products and services throughout their life through considerations such as waste disposal and the cost of operation and maintenance over the life of the goods. The guide was developed to assist Australian Government purchasers to include sustainability considerations in all stages of the procurement process, from identifying the business need to disposal of goods.
Sampling Design Guidelines – Contaminated Sites. NSW EPA, 1995	The Sampling Design Guidelines were established by the NSW EPA to: • Encourage the use of a statistically based approach to the design and sampling for contaminated sites and the interpretation of these samples for assessing and validating contaminated sites; and • Provide a convenient summary of statistical methods.

2.3 Council Requirements

The Sydney Guidelines for Waste Management in a New Development (2012) details the requirements of ongoing waste management at a school as that consistent with a 'Commercial and Retail' development. Controls listed as part of the Sydney Guidelines for Waste Management to achieve waste minimisation and management objectives include the following:

- The school must provide a waste collection point that is level, free of obstructions and with sufficient height clearance to enable the safe mechanical pick-up and set down of bins.
- The location of the proposed waste and recycling collection point(s) is to be detailed on the development application (DA) plans.
- The size of storage areas and number of storage containers must be sufficient to handle and store the waste likely to be generated and stored on the premises between collections. The space is to be calculated using information in the Sydney Development Control Plan (Sydney DCP 2012[2]) and the requirements of storage spaces may differ depending on development details.
- All waste and recycling storage rooms and areas must be designed and constructed in accordance with the requirements of Sydney DCP (2012).
- In multi storey buildings, consideration must be given to the convenient transportation of waste and recycling from the various floors to the central/external waste storage area. Such transportation system may include a passenger or goods lifts, or a garbage chute system.
- Waste must be minimised through source separation of waste, reuse and recycling by ensuring appropriate storage and collection facilities.
- The development must incorporate convenient access for waste collection.
- Additional space must be provided for the storage of bulky wastes or green wastes where appropriate.
- Relevant details of waste storage, waste facility design and access thereto proposed as part of the development must be clearly illustrated on the plans of the proposed development accompanying the DA.
- All waste facilities must comply with the BCA and all relevant Australian Standards (AS).

[2] City of Sydney *Development Control Plan.* 2012. Found at: https://www.cityofsydney.nsw.gov.au/development/planning-controls/development-control-plans

3. Waste Streams and Classification

3.1 EPA Waste Classification

The NSW EPA Waste Classification Guidelines (NSW EPA, 2014[3]) provide for the classification of wastes into groups that pose similar risks to the environment and human health, which are defined in the *Protection of the Environment Operations Act 1997*. Classes of waste described in the guideline are:

- Special waste
- Liquid waste
- Pre-classified waste, or wastes classified by chemical assessment as:
  - Hazardous waste
  - Restricted solid waste
  - General solid waste (putrescible)
  - General solid waste (non-putrescible).

Special Waste

Special wastes are wastes that pose specific regulatory requirements due to the risks of harm to the environment and human health. These wastes include clinical and related waste, asbestos waste, waste tyres, and anything classified as special waste under an EPA gazettal notice.

Liquid Waste

Liquid waste is classified as any waste (other than special waste) that meets the following criteria:

- has an angle of repose of less than 5 degrees above horizontal;
- becomes free-flowing at or below 60 degrees Celsius or when it is transported;
- is generally not capable of being picked up by a spade or shovel; and/or
- is classified as liquid waste under an EPA gazettal notice.

Pre-classified Waste (Hazardous, Restricted, General Solid – non-putrescible, General Solid – putrescible)

Where the waste is neither liquid nor special waste; the EPA has pre-classified other commonly generated waste types, as defined in Schedule 1 of the *Protection of the Environment Operations Act 1997*. This includes hazardous waste, restricted solid waste, general solid (putrescible) and general solid (non-putrescible) waste. Putrescible waste is the component of the waste stream that is liable to become putrid, and usually refers to vegetative, food and animal products.

A list of all currently gazetted waste classifications is provided on the EPA website[4].

Waste Classified by Chemical Assessment (Hazardous, Restricted, General Solid – non-putrescible, General Solid – putrescible)

Where the waste does not fall into one of the above categories, chemical assessment of the material is required to finalise a waste classification as per the procedures outlined in detail in EPA (2014) and/or via consideration of General or Specific Waste immobilisation approvals as approved under the *Protection of the Environmental Operations (Waste) Regulation* (2014).

[3] Waste Classification Guidelines. Part 1: Classifying Waste. NSW Environment Protection Authority (EPA 2014)
[4] www.epa.nsw.gov.au/waste/wastetypes.htm

3.2 Site Specific Waste Streams

Potential waste types and corresponding EPA classifications for the operation of Darlington Public School and associated facilities are summarised in **Table 3.1**.

Table 3.1: Potential Waste Types and Classifications

Waste Type	EPA Classification	Waste Stream
Paper including all types of recyclable paper but excluding paper towels, toilet paper and tissues.	General solid waste (non-putrescible)	Paper recycling
Cardboard, excluding waxed cardboard.	General solid waste (non-putrescible)	Cardboard recycling
Metals (steel, aluminium, stainless steel, and copper piping or wire)	General solid waste (non-putrescible)	Co-mingled recycling, specific recycling or general waste
Plastics (recyclables)	General solid waste (non-putrescible)	Co-mingled recycling
Plastics (non-recyclables)	General solid waste (non-putrescible)	General waste
Garden waste (grass clippings, tree pruning, chicken coop manure)	General solid waste (non-putrescible)	General waste or compost
Glass including bottles and containers.	General solid waste (non-putrescible)	Co-mingled recycling
Light bulbs, batteries, e-waste	Potentially hazardous waste	Specific recycling
General refuse such as food scraps and non-recyclable plastics.	General solid waste (putrescible) or General solid waste (non-putrescible)	General waste or compost

4. Waste Generation Quantities

4.1 Estimated Waste Quantities After Redevelopment Works

Based on communications with the client, it is anticipated that school will be able to accommodate approximately 415 students after the completion of proposed redevelopment works. As such, the quantities of waste generated are likely to increase due to increased facilities and potentially increased occupants. On this basis, it is appropriate to estimate indicative waste generation quantities for the site from published waste generation rates as per Table 16 in *Better Practice Guidelines for Waste Management and Recycling in Commercial and Industrial Facilities* (EPA 2012) and Section 3 of Sydney DCP (2012).

To derive indicative quantities of waste, the following assumptions have been applied as per the NSW EPA (2012):

- The future school buildings comprising classrooms, library, presentation rooms, school hall, staff and administrative offices have been assumed to be analogous to the "Primary Education" category as per NSW EPA (2012) and comprises an area of approximately 2,209m^2 (based on design drawings in **Appendix A**).
- The proposed canteen located on the ground floor has been assumed to be analogous to the "takeaway food shop" category as per NSW EPA (2012) and comprises an area of approximately 46 m^2 (based on design drawings in **Appendix A**).
- The site will operate on a five-day working week.

Table 4.1 summarises the waste generation rates based on EPA (2012).

Table 4.1: EPA (2012) Estimated Average Waste and Recycling Generation Rates

Premises Type	Average Waste Generation	Average Recycling Generation
Primary Education	7 L / 100 m^2/ per day	0 L /100 m^2 / per day
Takeaway	175 L / 100 m^2/ per day	685 L /100 m^2 / per day

As a conservative approach, the higher average waste and the lower recycling generation rates from the tables above have been adopted, thus it is estimated that the facility will produce approximately 1,176 litres of waste per week (5 working days) and 1,576litres of recycling per week (5 working days).

It is considered that the estimates generated are adequately conservative. It is expected that actual waste quantities and composition will depend on the final activities of the site.

Strategies that will be implemented to minimise waste generation and maximise reuse and recycling are outlined in **Section 5**.

5. Waste Management

5.1 Waste Hierarchy

Waste management for the project will be undertaken in accordance with the waste hierarchy, which underpins the objectives of the *Waste Avoidance and Resource Recovery Act 2001*. The waste hierarchy shown below demonstrates preferred approaches to waste management to ensure sustainable development and use of resources.

Figure 5.1: Waste Hierarchy

The hierarchy also aims to maximise efficiency and avoid unnecessary consumption of resources. This WMP seeks to implement the waste hierarchy to minimise waste disposal and promote waste reduction in order of preference:

- Reduce or avoid waste through selection of items and design.
- Reuse materials without further processing.
- Recycle and process waste for reuse as a new product.
- Recover energy through combustion of materials where acceptable and in accordance EPA regulations.
- Treat waste to stabilise the waste product for disposal or reuse.
- Dispose of waste when no other management options are appropriate.

This section describes waste management measures in line with the hierarchy.

5.1.1 Avoidance and Reduction of Waste

The ongoing site users will be required to minimise waste generation, and endeavour to reuse waste were available. Waste will be avoided through strategic selection of materials during purchasing which takes into account options which may reduce waste generation during ongoing operation of the site. This includes considering procurement of materials which use minimal packaging and are suitable for reuse. Selection of operational materials will also consider the use of recycled items where practicable.

Opportunities to avoid wastes generated by operation include:

- Develop a procurement policy which considers waste avoidance measures such as:

- Order site specific or prefabricated items where practicable to minimise surplus material.
- Consider packaging material provided by suppliers during purchasing and reduce this requirement where possible or consider returnable packaging.
- Material selection to consider recycled items.

- Refine waste stream estimates to ensure adequate on-site storage and waste segregation, and to inform future procurement policies.

5.1.2 Reuse and Recycling

Measures to separate waste streams will be implemented to maximize re-use and recycling. This includes segregating wastes into appropriate dedicated bins or areas for reclamation on site or transportation to a designated recycling facility.

Procedures to manage the reuse and recycling of waste materials during operation include:

- Incorporate waste management into site management procedures to promote reuse and/or recycling of materials.
- Ensure areas for waste segregation are easily accessible and clearly defined.
- Ensure staff are familiar with onsite waste storage areas for appropriate waste segregation.
- Consider opportunities for materials reuse and/or recycling where practicable.

5.1.3 Treatment and Disposal

Operational wastes may require treatment to stabilise them for appropriate disposal to reduce the risk of harm to human health or the environment. These materials may not be suitable for reuse or recycling and will be segregated and disposed of via a suitably qualified contractor for the waste stream.

Wastes will only be sent to landfill or disposal facilities where the prioritised management methods in the hierarchy cannot be implemented in a cost effective or practical manner. The site manager will liaise with the local council to determine appropriate disposal locations for potential waste streams.

Measures to manage the treatment and disposal of waste materials during operation include:

- Ensure wastes which cannot be reused or recycled and require disposal are clearly segregated from those which have the potential to be reused.
- Provision of segregated waste bins for each waste type.
- School operations and maintenance staff to be inducted into site waste management practices.
- Hazardous materials to be disposed of in accordance with the handling and disposal requirements of SafeWork NSW and NSW EPA.
- General wastes to be disposed of in accordance with local council requirements.

5.2 Waste Storage Systems

It is anticipated that 660L mobile garbage bins (MGBs) will be utilised within the waste storage area in the northern portion of the site next to the visitor and accessible carparks (as shown in **Appendix A**), however any combination of MGBs are suitable to use for waste streams so long as they meet the required volume of waste storage. Based on the proposed size of the waste bins, up to four 660L

MGBs would be adequate for the anticipated amount of waste and recycling per week as discussed in **Section 4.1** above and **Section 5.3** below. All waste is to be sorted and stored on site and not within a public place. **Table 5.1** presents options for potential waste storage systems.

Table 5.1: Waste Storage System Options

Waste	Quantity Generated Per Week	MGB System	Clearance Frequency
General Waste	1,176 L	1 X 1,100L or 2 X 660L or 4 X 240L or a combination of MGBs with 1,176 litres of storage.	Minimum of once per week
Recycling	1,576 L	2 X 1,100L or 2 x 660L or 6 X 240 L or a combination of MGBs with 1,576 litres of storage. To be divided between co-mingled, paper and cardboard streams.	Minimum of once per week

Waste areas and waste/recycling bins shall be clearly marked through appropriate signage and colour coding in accordance with Australia Standards. Each waste stream should be located within a designated area to prevent cross contamination of waste streams.

Small quantities of hazardous wastes may be generated (e.g. light bulbs, batteries, oil, chemicals or paint). Separate containers for the safe storage of these wastes in the waste storage areas will be provided where applicable, prior to removal offsite by an appropriately licensed contractor for recycling or disposal at a licensed facility.

Paper Recycling

Each desk, printing/copying area and classroom should be provided with an under-bench paper recycling bin. Cleaners will collect and empty the paper recycling bins into larger paper recycling MGBs for storage within the waste storage areas prior to transport to the loading dock and collection. Confidential document bins (if required) will be 240L MGBs and placed in nominated office areas and will be subject to collection as required by contractors.

Co-mingled Recycling

Central co-mingled recycling bins will be provided in the canteen area, sports grounds and/or open spaced play areas. Cleaners will collect and empty the co-mingled recycling into larger co-mingled recycling MGBs for storage within the waste storage areas prior to transport to the loading bay and collection.

Cardboard Recycling

Flattened cardboard will be placed within designated areas by staff. Cleaners will collect the flattened cardboard and place within larger MGBs for storage within the waste storage rooms prior to transport to the loading bay and collection. Where possible, cardboard should be returned to the supplier.

General Waste

General waste bins will be provided within classrooms, canteen, offices and open space playground areas. Cleaners will collect and empty general waste bins into larger general waste MGBs for storage within the waste storage areas prior to transport to the loading bay and collection.

E-waste

Specific recyclable wastes such as toner cartridges, light bulbs, batteries and e-waste should be securely stored within designated maintenance/storage rooms prior to being recycled as required.

5.3 Waste Storage Areas

One waste storage area is proposed to be placed in the northern portion of the site, adjacent Golden Grove Street, as shown in **Appendix A**. It is considered that the waste storage area is located in an appropriate location, on the ground level, within a locked room (to restrict student access) with suitable access to the road curb for collection via the waste contractor.

The dimensions of suitable 660L waste storage bins are approximately 1.4 m in length by 1.07 m width, with a total area of 1.5 m^2 per bin. A maximum of four 660L MGB have been calculated to be required based on conservative estimates of waste generation. As per Sydney DCP (2012) guidance, the area of a single 660 L MGB is approximately 1.5 m^2, meaning that four 660 L MGBs will occupy approximately 6.0 m^2 of the waste storage area. On this basis, a waste storage area of approximately 9 m^2 would be considered to be sufficiently sized for the proposed waste generation/storage requirements of the facility, based on the collection events of once per week.

5.4 Waste Facilities Construction / Maintenance

All waste facilities must comply with the Building Code of Australia (BCA) and all relevant Australian Standards (AS) in accordance with the requirements of Sydney DCP 2012.

5.5 Waste Movement

It is anticipated that staff and visitors will place general waste and recycling into small waste and recycling bins (paper and co-mingled) located in the offices, canteen, classrooms and open space playground areas. These small waste bins should be segregated as per the final waste streams. Waste will then be transported by cleaning contractors via the nominated egress corridors to the waste storage area and placed in the correct waste stream bins. Where waste is required to be transported from upper and lower levels to the waste storage area, this will be undertaken via the use of stair wells or service lifts located within the buildings.

5.6 Waste Collection Point

The curb of Golden Grove Street on the western boundary of the site has been nominated as the Waste collection point for the site. Appointed waste contractors shall bring waste from the designated waste storage area to the curb for collection at nominated times in accordance with the relevant waste contract. No waste vehicles will enter the site.

5.7 Waste Collection Vehicle Movements

The curb of Golden Grove Street has been nominated as the waste collection point to be used by waste collection vehicles. Waste collection vehicles will not enter the site as per the existing conditions for the site. Waste collection vehicles shall not obstruct access to adjacent premises, roadways or the footpath. In addition, waste collection must be carried out with due care for public safety including other road users, cyclists and pedestrians.

5.8 Waste Collection Hours

Collection of waste and recycling is anticipated to occur outside of school hours by an external contractor to minimise disturbance to the school and noting the sensitive nature of the site (i.e. students' safety).

It is a requirement that waste collection services are not undertaken outside of the hours of 6.00 am and 10.00 pm, Monday to Saturday and 8.00 am to 10.00 pm on Sundays, per the City of Sydney Waste Collection requirements[5]

5.9 Waste Collection Contractor

It is understood that a licensed waste contractor is currently engaged for the removal of waste from the facility. It is noted that the current contract is anticipated to be updated to allow for the increased capacity within a reasonable timeframe from issue of the occupation certificate.

The updated contract should also include provisions for the collection and recycling of all potential waste streams including batteries, electronics, light bulbs, smoke detectors and any other recyclable waste generated.

Upon actioning of the updated contract, written evidence of the amended contract with the licensed collector for waste and recycling collection shall be provided to the client and City of Sydney Council and held on site. The updated contract should include details on the method, timing and disposal of waste.

[5] Waste Policy: Managing Waste in Public places. City of Sydney. 2020. Found at: https://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0007/194380/Waste-Policy-local-approvals-policy-for-managing-waste-in-public-places.pdf

6. Ongoing Management

This OWMP forms the basis of operational waste management on site for the Darlington Public School. It is a living document which will be reviewed and revised throughout the lifespan of the school. Review of the OWMP will provide for increased accuracy of waste generation estimates and to ensure appropriate onsite waste management in accordance with current and future waste management regulations.

Having suitable waste management systems in place is only one element of an effective waste management system at a "commercial" facility. Compliance by the administrative manager, staff, cleaning contractors and waste collection contractor is essential to ensure the efficacy of the system.

6.1 Roles and Responsibilities

It is expected that all personnel will commit to the OWMP and be responsible for their own actions in adhering to the waste management objectives.

An Administrative Manager will be the key person responsible for implementation of the OWMP and adherence to applicable legislation, guidelines, licensing and project conditions. The Administrative Manager will also be responsible for maintenance of the cleaning infrastructure such as the service doors, locks, lighting, signage, colour coding and repair/replacement of MGBs.

Cleaning contractors will be responsible for the transfer of waste to the MGBs and the transfer of the MGBs to the waste collection point. In addition, the cleaning contractor will be responsible for cleaning of the waste storage areas.

Table 6.1 below presents suggested responsibilities for waste management.

Table 6.1: Roles and Responsibilities

Role	Responsibility
Administrative Manager	Ensuring staff (and students) are inducted into the OWMP and other applicable management plans. Responsible for undertaking procurement of operational materials in accordance with the waste management hierarchy. Segregation of waste streams where required to ensure appropriate use, treatment and/or disposal. Compliance with applicable environmental legislation and project conditions. Ensure environmental management plan(s) across the site are adhered to and accurate to site conditions. Undertake inspections to ensure compliance. Maintenance of waste-related signage, colour coding and MGBs. Security of waste storage areas during day to day business. Ensure no waste is placed on the public way.
Cleaners	Responsible for acting in accordance with the OWMP. Transfer of waste within the facility. Transfer of MGBs to the nominated waste collection point and return of MGBs to waste storage areas. Responsible for cleaning of waste storage areas. Security of waste storage areas (during working hours). Ensure no waste is placed on the public way. Informing the Administrative Manager of any waste management incidences.
Staff	Adherence to the OWMP. Placement of waste/recycling within correct bins. Notify manager/cleaning contractor when bins are overfull and require transport to the MGBs. Informing the Administrative Manager of any waste management incidences.
Licensed Waste Collection Contractor	Responsible for collection, disposal and/or recycling of waste in accordance with contract and relevant legislation and guidance. Provide feedback on actual volumes of waste and recycling collected to enable waste volume evaluation by Administrative Manager.

6.2 Training and Awareness

All staff and contractors, including cleaning contractors, should undertake awareness training of the OWMP and site-specific waste management. This includes:

- Induction to the waste management hierarchy and use across the site.
- Details of responsibilities for waste management and key personnel.
- Site specific waste management practices such as:
  - Waste storage and stockpiling locations;
  - Waste disposal requirements;
  - Hazardous or special wastes; and
  - Record of waste disposal details and receipts.
- Knowledge of emergency response procedures and contacts.

Signage will be provided on site to ensure waste management measures are communicated across the site. Signage will highlight correct procedures for separating wastes where required, locations of bins and waste storage areas, labelling of designated bins, potential hazards associated with the waste streams and handling, and contact details should any issues be encountered.

Signage will be prepared and located on site in accordance with the Australian Standard (AS 1319) for safety signs, and the NSW EPA and Australian Standard for recycling signage.

7. Monitoring and Reporting

The following activities will be undertaken to inform future onsite waste management and to improve the efficiency in achieving the outcomes of the OWMP:

- Review of waste streams and waste quantities.
- Review the OWMP in light of any changes to operational activities or further information which may alter waste management practices.
- Undertake auditing of waste management across the site as a component of broader environmental site audits.
- Undertake visual inspections to ensure waste management controls are implemented and maintained across site.
- Undertake annual review of the OWMP to ensure information accurately reflects site activities, and to assist future waste management.

Where formal auditing, general inspections or incident reporting identify incorrect storage or disposal procedures, or maintenance or waste management issues, observations will be promptly reported to the Administrative Manager and recorded. The Administrative Manager will determine appropriate measures to rectify the issues in a timely manner.

8. Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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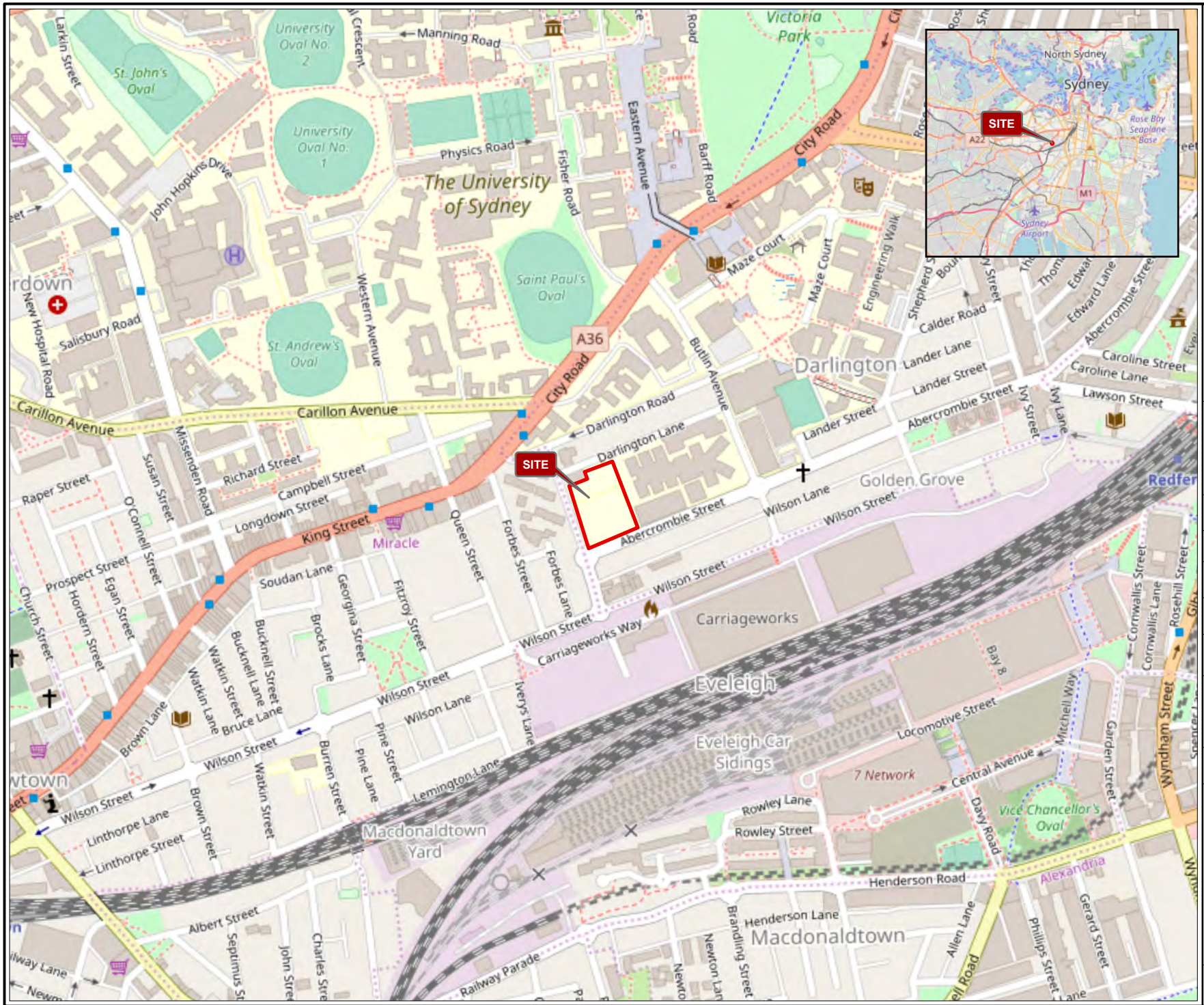
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.

Figures



Legend:

Approximate Site Boundary

JBS&G

Job Number: 58181	
Client: School Infrastructure	
Version: R01 Rev A	Date: 31/03/2020
Drawn By: AV	Checked By: RL
Scale 1:7,500	

0 70 140

metres

Coord. Sys.

417 – 445 Abercrombie Street Darlington, NSW

SITE LOCATION

FIGURE 1

File Name: N:\Projects\School Infrastructure\56243 Darlington PS WMPs\GIS\56243.aprx

Legend:
Approximate Site Boundary

JBS&G

Job Number: 58181	
Client: School Infrastructure	
Version: R01 Rev A	Date: 31/03/2020
Drawn By: AV	Checked By: RL
Scale 1:750	

0 7 14
metres

Coord. Sys. GDA 1994 MGA Zone 56

417 – 445 Abercrombie Street
Darlington, NSW

SITE LAYOUT

FIGURE 2

File Name: N:\Projects\School Infrastructure\56243 Darlington PS WMPs\GIS\56243.aprx
Reference: Nearmap - www.nearmap.com - Imagery Date: 12-05-2019

Appendix A Detailed Design Drawings

NEIGHBOURING PROPERTY
UNIVERSITY OF SYDNEY

1

2

3

4

Bulk Waste Store
7.5 m2

CC.17
Comms
10.49 m2

EDB

CC.09
Laundry
5.2 m2

CC.04
Toilets
7.35 m2

CC.18
Indoor/Outdoor
Store
9.2 m2

35.600

FFL +36.830

CC.12
Cleaner
1.45 m2

CC.10
Staff WC
11.04 m2

PAA
3.14 m2

CC.01
Preschool 1
65.19 m2

Mech Plant
14.38 m2

CC.08
Staff Room
17.47 m2

CC.02
Preschool 2
75.19 m2

Cold
Water
Pump
10 m2

PAA
3.12 m2

Circulation

Water Meter
3.75 m2

PV
Inverters

CC.11
Kitchen
19.06 m2

CC.15
Store
2.61 m2

MSB

Circ

Riser

CC.05
Toilets
12.53 m2

CC.14
Store
2.61 m2

FFL +35.520

35.50

CC.07
Office
9.66 m2

CC.03
Preschool 3
75.5 m2

EMERGENCY PARKING
ONLY

FFL 35.500

Foyer

PAA
2.75 m2

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1	Claudia Bennett	Matthew Bennett	Matthew Bennett		27/04/2020

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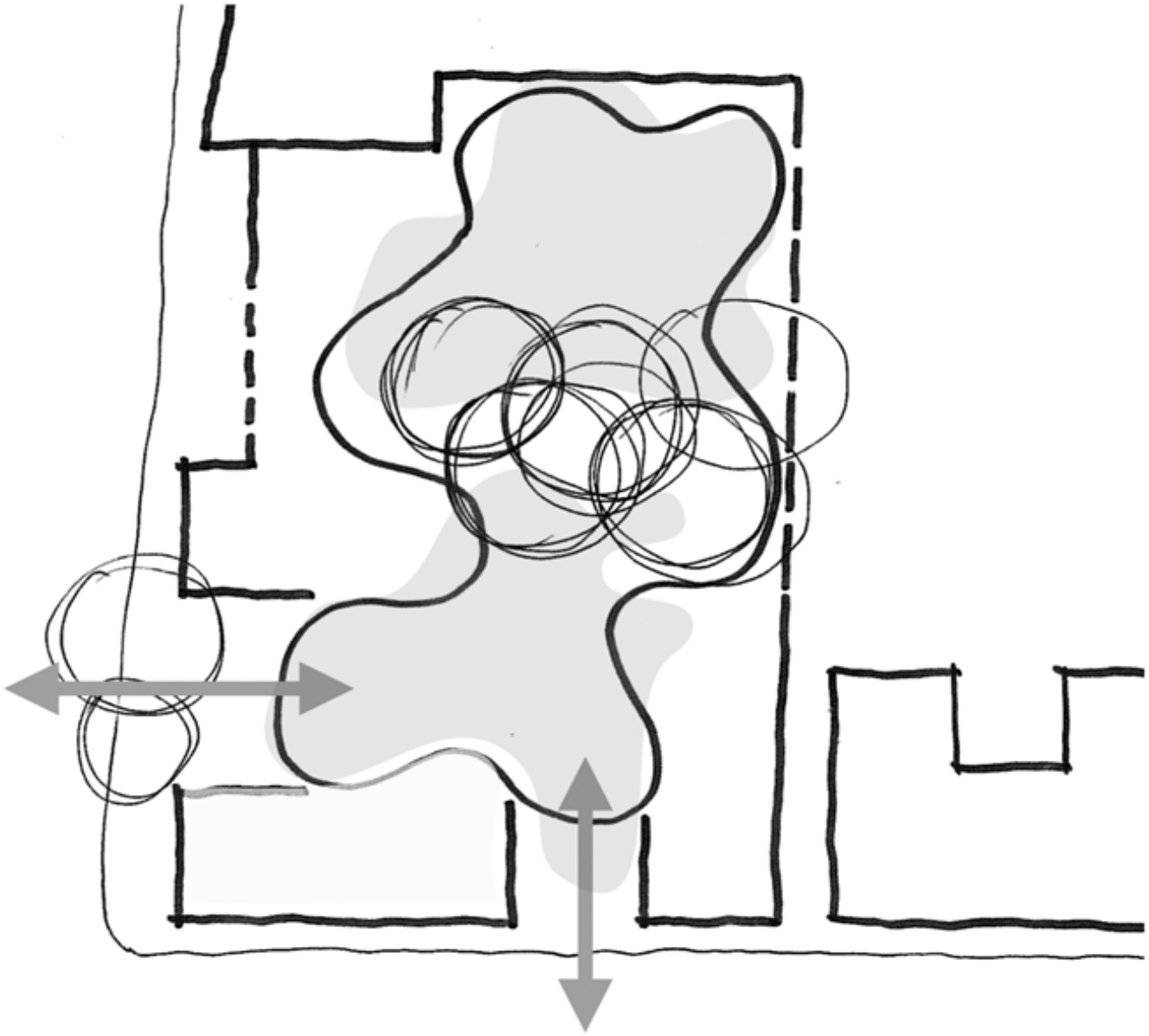
DARLINGTON PUBLIC SCHOOL REDEVELOPMENT

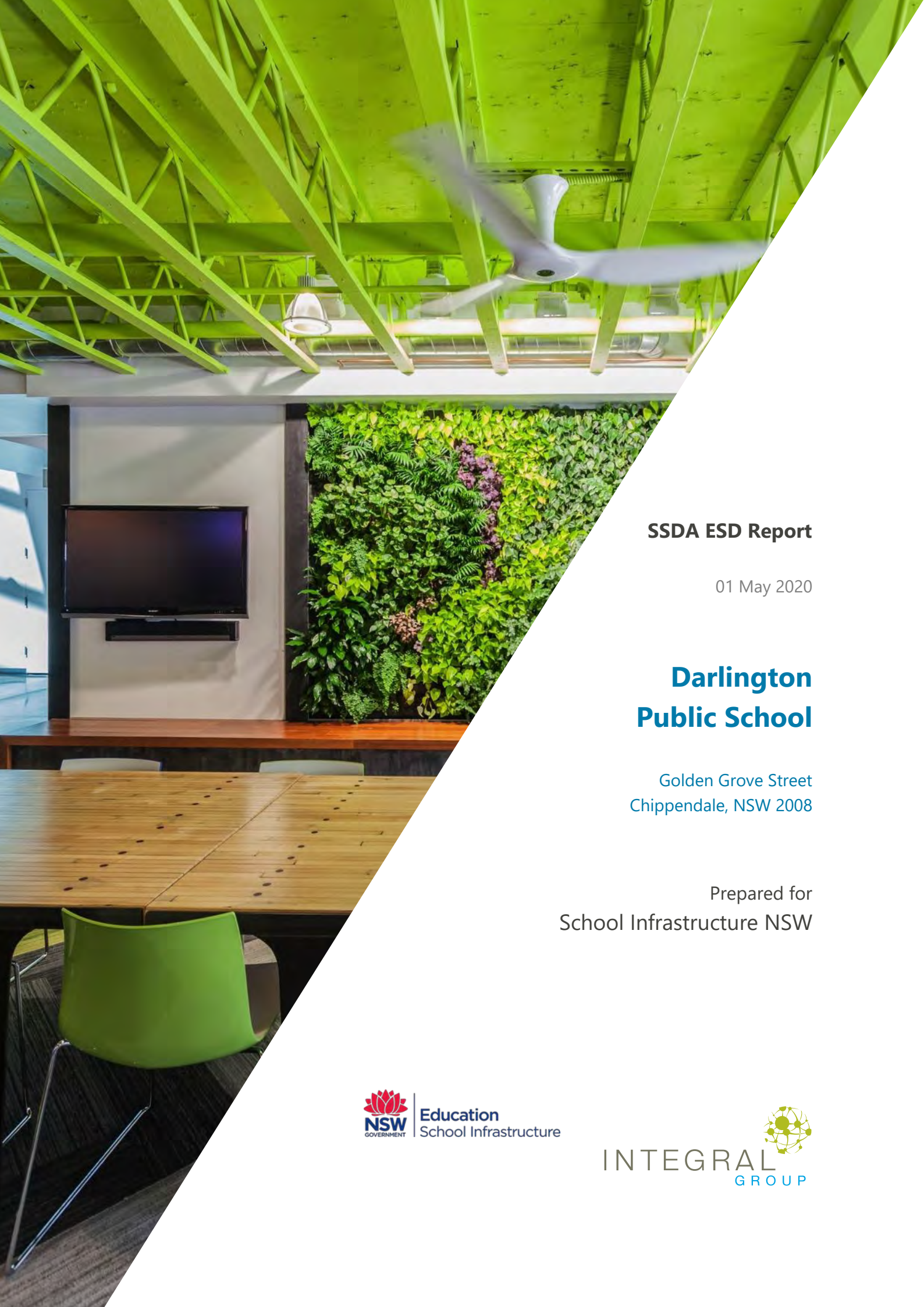
Appendix X — ESD Report

SSD-9914

Prepared by Integral

For NSW Department of Education





SSDA ESD Report

01 May 2020

Darlington Public School

Golden Grove Street
Chippendale, NSW 2008

Prepared for
School Infrastructure NSW

NSW GOVERNMENT Education School Infrastructure

INTEGRAL GROUP

Document Control

Revision #	Date	Revision details	Author	Verifier
01	03.04.2020	DRAFT	AC	DA
02	22.04.2020	Updated with comments	AC	DA
03	01.05.2020	Final Draft	AC	DA
04	01.05.2020	Final	AC	DA

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Contents

1 SEARS Requirements

Table 1 outlines the SEARS requirements for Darlington specifically relating to the Ecological Sustainable Design (ESD) report. Other references to ESD do exist within SEARS, such as "demonstrate good environmental amenity", and these are addressed within other consultants' reports, such as the Architects.

Table 1 SEARS Requirements

Key Sustainability Issues	Relevant Report Section
Detail how ESD principles (as defined in clause 7(4) of Schedule 2 of the Regulation) will be incorporated in the design and ongoing operation phases of the development.	*Section 3, Pg 7*
Include a framework for how the future development will be designed to consider and reflect national best practice sustainable building principles to improve environmental performance and reduce ecological impact. This should be based on: - a materiality assessment and include waste reduction design measures - future proofing - use of sustainable and low-carbon materials - energy and water efficient design (including water sensitive urban design) and technology - and use of renewable energy.	*Section 4, Pg 11*
Include preliminary consideration of building performance and mitigation of climate change.	*Section 5, Pg 14*
Include an assessment against an accredited ESD rating system or an equivalent program of ESD performance. This should include a minimum rating scheme target level.	Section 7, Pg 17.
Provide a statement regarding how the design of the future development is responsive to the CSIRO projected impacts of climate change, specifically: - hotter days and more frequent heatwave events - extended drought periods - more extreme rainfall events - gustier wind conditions - how these will inform landscape design, material selection and social equity aspects (respite/shelter areas).	*Section 6, Pg 16*

2 Introduction

2.1 General

This ESD Report has been prepared by Integral Group on behalf of Schools Infrastructure New South Wales (SINSW). It accompanies an Environmental Impact Statement (EIS) prepared in support of the development of Darlington Public School (Darlington) at Golden Grove Street, Sydney, NSW (the 'Site').

The purpose of this ESD Report is to address the items identified in part "8. Ecologically Sustainable Development" of the Planning Secretary's Environmental Assessment Requirements, application number SSD-9912; to outline the measures that are proposed to be implemented to minimise consumption of resources, energy and water, and to demonstrate that the project has been assessed against a suitable sustainability framework.

2.2 Project Description

Darlington Public School is located on the corner of Golden Grove Street and Abercrombie Street, Darlington, within the City of Sydney Local Government Area. The school is adjacent to the University of Sydney Darlington Campus and within walking distance to Redfern and Macdonaldtown train stations. The site is legally described as Lot 100 in DP 623500 and Lot 592 in DP 7523049.

The SSD application seeks consent for demolition of existing school buildings and construction of a new part 2, part 3-storey building, increasing the school capacity from 230 to 437 students. The works also include replacement of the existing child-care facility (to the same capacity of 60 students), earthworks and landscaping. For a detailed project description refer to the EIS prepared by Ethos Urban.

2.3 Referenced Standards

This report has been undertaken with reference to the following:

- Clause 7(4) Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (EP&A Regulations)
- SINSW Sustainability Framework Tool
- Green Building Council of Australia, Green Star Design & As-Built v1.3 Rating Tool
- SEARS Application number SSD 9912, relevant clauses
- CSIRO projected impacts of climate change
- NSW and ACT Government Regional Climate Modelling (NARCliM) climate change projections.

2.4 Source Documentation

The project's architectural documentation has been used in preparation of this report. Inputs have also been coordinated with all relevant Consultants.

2.5 Limitations of This Report

Due care and skill have been exercised in the preparation of this report.

The purpose of this ESD Report is to outline the measures that are proposed to be implemented to minimise consumption of resources, energy and water, and to demonstrate that the project has been assessed against a suitable accredited rating scheme, as detailed within the EIS. It should be read in conjunction with the current project documentation and specific applications may vary during the design development of the project.

No responsibility or liability to any third party is accepted for any loss or damage arising out of the use of this report by any third party. Any third party wishing to act upon any material contained in this report should first contact Integral Group for detailed advice which will consider that party's requirements.

2.6 Departures from the EFSG

There are no departures from the EFSG to note for the ESD requirements.

3 Schedule 2 of EP&A Regulation 2000

The followings section details how the proposed Darlington Public School incorporates the principles of ecologically sustainable development (ESD) in accordance with Schedule 2 Clause 7(4) of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

3.1 The Precautionary Principle

Per Schedule 2 Clause 7(4) of the EP & A Regulation:

*(a) the **"precautionary principle",** namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:*

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

(ii) an assessment of the risk-weighted consequences of various options.

3.1.1 Project Response

The precautionary principle has been adopted and all potential impacts have been considered and mitigated where a risk is present, as outlined in this report and any accompanying documentation.

The built form embraces sustainable design principles as it has been planned to maximise the passive (i.e. energy free) performance of the building. The building is generally formed around a shallow plan allowing daylight to penetrate the spaces; on the upper levels south facing skylights have been incorporated to improve daylight access without increasing the heat load. Where zones are designed around a deep plan, increasing the ceiling heights improves daylight availability and air movement through the spaces, such as the Main Hall.

Incorporating natural ventilation across the site will assist minimising energy consumption from mechanical systems. A Green Light / Blue Light system, Figure 1, is being incorporated to display when conditions are suitable for natural ventilation, and mechanical systems can be shut down.

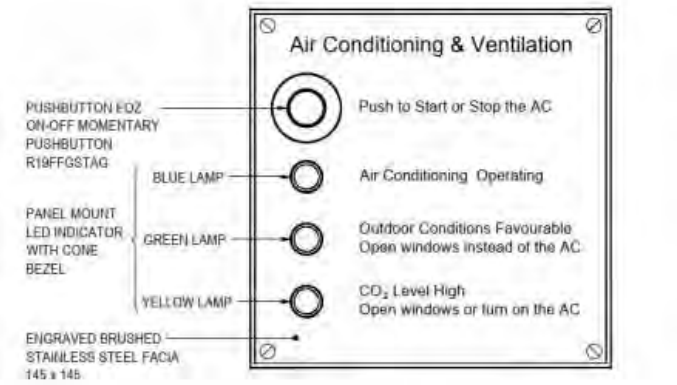


Figure 1 Green Light / Blue Controls Panel

External shading detailing will reduce solar gain during the summer months in turn reducing cooling loads and the risk of overheating. The walkway along the Eastern Façade, Figure 2, ensures that the entire façade is shaded during the summer months to mitigate solar gain. The Western Façade incorporates deep reveals to limit late afternoon sun, when zones are most likely to overheat.

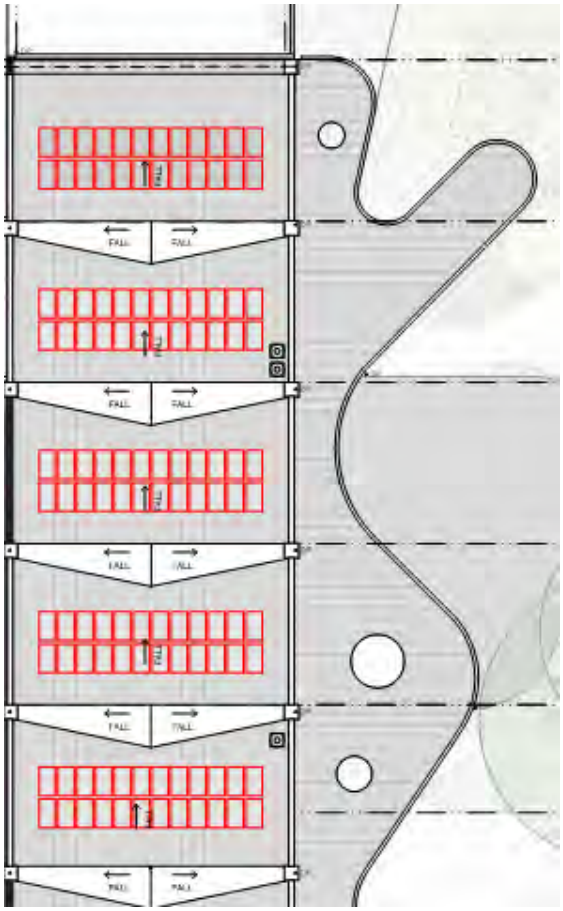


Figure 2 Roof Layout showing Eastern Walkway

Stormwater design will ensure post-development peak event discharge rates do not exceed pre-development rates and design development will explore the feasibility for all rainwater from new upper site roofing is to be captured and re-used on site for irrigation. Roof materials and colours will also be carefully selected in order to contribute to a cooler microclimate and mitigate any potential for the 'Heat Island Effect'.

Building services, lighting and equipment will be specified to be highly energy efficient using current best practice approaches and products. We are also currently investigation routes to allow the building to be classified as "all electric". A building developed now that all electric will have lower emissions than a comparable gas building. This is due to the NSW grid decarbonising as more renewables come online.

Whilst a comprehensive climate risk assessment has not been carried out on this site, any potential future climate-driven risks relating to this site have been considered, with the highest risk being an increase in maximum temperatures and the length and frequency of heat events.

In relation to any predicted increases in temperatures, the current concept design pays attention to addressing high external heat loads by proposing measured glass to façade ratios and other passive measures to support energy efficient mechanical solutions. Design development will further explore options for enhancements to the building thermal envelope through increased insulation, high-performance glazing, detailing of the building fabric to minimise unwanted infiltration and careful consideration of thermal mass.

Therefore, the design directly addresses Greenhouse Gas Emissions (GHG Emissions) and their impact on climate change.

3.2 Inter-Generational Equity

Per Schedule 2 Clause 7(4) of the EP & A Regulation:

(b) ***"inter-generational equity",*** *namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.*

3.2.1 Project Response

Good architecture often outlasts the architect, great architecture may endure ten times as long. The impact of architecture on its environment is enduring and significant. What architects do today will shape the environment for future generations; Darlington Public School embodies this approach by proposing a keystone building for the local precinct, acting as a landmark for the local area.

The concept design has embraced Indoor Environmental Quality as a fundamental requirement by focusing on delivering fresh air, quality acoustics, and low toxicity materials and finishes.

The proposed design places an emphasis on daylight access that will result in the project actively engaging its occupants with their surroundings, considered a key factor in the link between building design and occupant wellbeing – commonly referred to as our 'biophilic response'.

The building targets high levels of energy efficiency and low operational energy consumption. A low energy building minimises the GHG gas emissions during use. GHG Emissions are a known key contributor to human-caused climate change, considered one of the most critical inter-generational issues of our time. By addressing this at an early stage the building aims to "meet the needs of the present without compromising the ability of future generations to meet their own needs" a key takeaway from the infamous Brundtland Report. [1]

[1] Our Common Future ('Brundtland Report'). 1987. Brundtland. G et al.

3.3 Conservation of Biological Diversity and Ecological Integrity

Per Schedule 2 Clause 7(4) of the EP & A Regulation:

*(c) **"conservation of biological diversity and ecological integrity",** namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration.*

3.3.1 Project Response

The proposed works have minimal impact on existing vegetation and biological communities on the site, moreover the intended works increase the number of plant species improving biodiversity across the area. The landscape design will consider a range of initiatives to enhance the biodiversity on the site, including native plants, educational aspects and community food gardens. Refer to the landscape architectural package for more information on proposed landscape.

3.4 Improved Valuation, pricing and incentive mechanisms

Per Schedule 2 Clause 7(4) of the EP & A Regulation:

*(d) **"improved valuation, pricing and incentive mechanisms"**, namely, that environmental factors should be included in the valuation of assets and services, such as:*

(i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

3.4.1 Project Response

The environmental targets for the project have largely been embedded in the nature of the development rather than as additional 'add-on' items. For example, the proposed areas will have a high degree of thermal efficiency and careful considerations has been given to incorporate excellent distribution of daylight and optimisation of mechanical ventilation systems throughout the learning areas - reducing ongoing operating costs for the school.

In many areas a Whole of Life (WOL) costing approach has been taken. For example, going beyond Section J insulation requirements allows for a reduction in HVAC capex as the peak loads placed on the system are reduced. By taking a holistic approach to the design and recognising where trade-offs in spending can be made, overall savings are realised by the project.

A reduction in waste directed to landfill will be realised through planned waste management strategies and as such a cost saving may be realised. Further cost savings will be achieved by a reduction in potable water consumption via rainwater harvesting and re-use. Finally, by ensuring the total volume of stormwater discharge is not increased this development will place no greater strain on existing infrastructure, thus negating the need to upgrade said infrastructure. The cost of which ultimately gets passed onto the rate payer in the medium to long term.

4 Developing a Framework

SINSW has a vision that "*by 2030, it will be a leading provider of sustainable infrastructure that inspires students and enriches learning." (SINSW – Framework vision – 6.8.19)*

In pursuing this vision, SINSW have elected to focus on five discrete themes. These themes and their associated objectives are set out in the *SINSW Sustainability Strategy* and are as follows:

Table 2 SINSW Sustainability Strategy

Theme	2030 Objective
Energy & Carbon	*SINSW are targeting carbon neutrality by 2030 and will support communities to reduce their greenhouse gas footprints*
Water	*SINSW will use and discharge water responsibly to improve their impact on the water cycle*
Waste & Materials	*SINSW will responsibly select materials and manage wastes throughout the life cycle of their facilities*
Place	*SINSW will create places that people want to use by enhancing connections to the natural and cultural environments*
Resilience	*SINSW will ensure their infrastructure assets are ready for an uncertain future and the emerging needs of schools and communities*

In order to embed this vision across its projects, SINSW has developed a sustainability framework to guide consultants throughout the design process.

Appendix A – SINSW Sustainability Framework" contains this framework; throughout the initial design stages the consultants have provided information for how the measures within the framework will address the five sustainability themes highlighted above. This has been documented throughout the Appendix. Broadly the themes above align with the following SEARS requirements:

- a materiality assessment and include waste reduction design measures.
- use of sustainable and low-carbon materials
- energy and water efficient design (including water sensitive urban design) and technology and use of renewable energy.

Below we will provide a summary of how each requirement is responded to for Darlington Public School:

4.1 A Materiality Assessment Including Waste Reduction Design Measures

A systematic and methodical Environmental Management plan will be formalised for implementation during the construction phase by the Contractor such as ISO 14001.

During the construction and demolition phase of the project, waste shall be recycled to a minimum 80%.

The design will include infrastructure for operational waste management and the separation of waste streams in order to facilitate recycling throughout the school.

On-site biodigesters are being investigated with the aim, if possible, to create a compost stream for the landscape areas from compostable waste on site.

4.2 The use of Sustainable and Low Carbon Materials

Material use for building adhesives, sealants, flooring and paint products will aim to be selected to contain low or no Volatile Organic Compounds (VOCs) and all engineered wood products used in exposed or concealed applications are specified to contain low or no formaldehyde to avoid harmful emissions that can cause illness and discomfort for occupants.

Internal furnishings within the building can be selected based on their recycled content, end-of-life recyclability and reduction of carbon footprint.

The project where possible will implement an independent environmental certification, for example use 'Ecospecifier' or Good Environmental Choice Australia related products, the project will confidently reduce environmental impacts and waste from furnishings over the life of the building.

Use building's structural and reinforcing steel sourced from a responsible steel maker.

Steel will aspire have a post-consumer recycled content or be reused steel. Sustainable timber shall be specified for at least half of the timber products used on the project. Recycled concrete shall be specified using recycled aggregate or manufactured sand and reduced quantities of Portland cement to reduce environmental impacts of concrete production and embodied energy.

Investigations into using low carbon concrete such as Ground Granulated Blast Furnace Slag (GGBS) is being undertaken by Integral Group and Bonacci (the Structural Engineer). Recommendations have been made for a 40-50% GGBS mix for any in-situ concrete on site. As Figure 3 illustrates, this can equate to a 35% saving in embodied carbon.

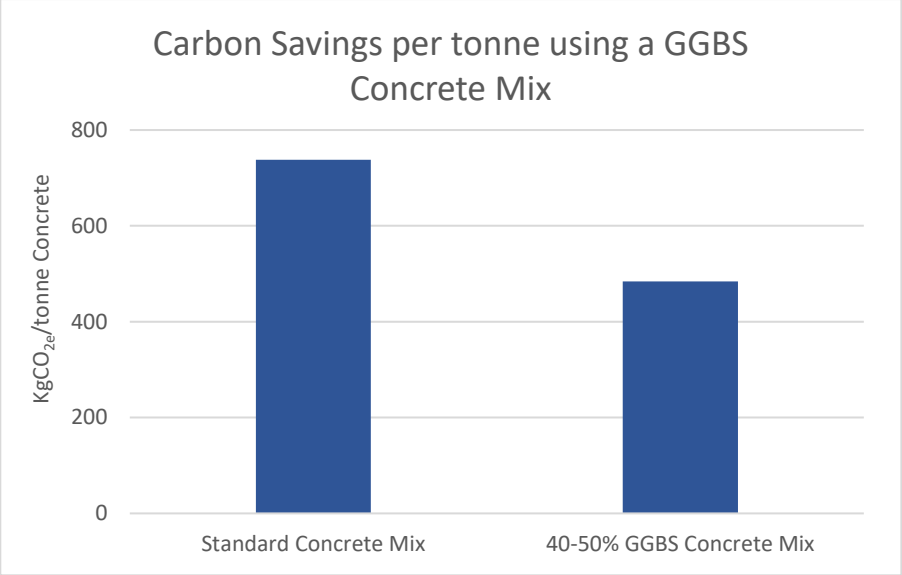


Figure 3 Embodied carbon in a GGBS mix in comparison to standard concrete (Cementmineralproducts.org)

4.3 Energy and Water Efficient Design (Including Water Sensitive Urban Design) and Technology and Use of Renewable Energy

The design intends to build on the sustainability principles of 'be lean, be clean and be green". We're aiming to reduce energy demand through passive design measures, provide HVAC services as cleanly as possibly using high COP chillers & maximise onsite generation through Solar PV. This three-stage approach is coupled with control systems which further minimise energy use. The green/light blue light ventilation system indicates when air quality is beneficial for natural ventilation m, reducing the HVAC systems operational hours and minimising energy consumption. Ceiling fans throughout the teaching spaces reduce operational hours further by increasing levels of comfort, raising the cooling set point.

Beyond energy and carbon, a diverse landscape is being created, improving the site's biodiversity and connecting pupils with nature. The site will feature various green zones (food production, wildflower zones, water swales) throughout the playground. Rainwater will be capture onsite and utilised to mitigate potable water consumption for irrigation. Measures are also in place to respond to climatic change events such as high intensity storms and deluges, preventing the site from flooding. Water efficient fixtures and fittings will be implemented to reduce water consumption in accordance with the Australian Government's Water Efficiency Labelling Scheme (WELS).

5 Preliminary assessment of Building Performance and Climate Change

As previously mentioned, a three-stage approach has been taken to designing a low energy building. The principles of "be lean, be clean and be green". Following this approach provides the best value for low energy building design, as illustrated in Figure 4.

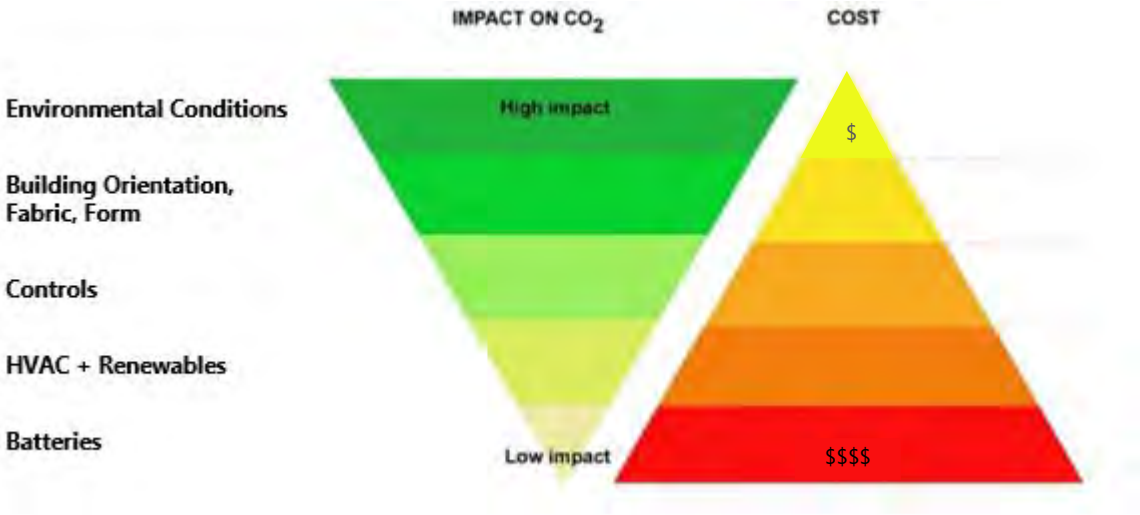


Figure 4 Sustainability hierarchy of cost beneficial measures for reducing Carbon

These principles can be outlined as follows:

- **Passive Measures** - *minimise building energy use by considering building form ("passive environmental control") in order to avoid or minimise the need for mechanical cooling and heating, and artificial lighting;*

Our response:

To minimise the inherent energy use of the building, we have firstly considered the form, orientation and structure of the building.

The façade has been optimised using energy analysis, to maximise benefits of natural daylight and views out of the building, whilst minimising the winter heat loss, limiting solar gain in summer, and reducing problems associated with glare.

Maximising cross ventilation through teaching spaces to allow for air flow, reducing the operational hours for the mechanical cooling system.

- **Efficient Services** - *minimise plant energy use by selecting the most appropriate engineering systems and optimising system performance ("active environmental control"); and*

Our Response:

In addition to these low energy measures, we will look to incorporate the following conventional energy saving ideals into the proposed design:

- Low energy/LED Lighting, with automatic switching and dimming.
- Variable speed pumps and fans.
- Control of plant via carbon dioxide monitoring.
- Provision of mix-mode ventilation design, blue light/green light system reducing the mechanical cooling system's operational hours.
- Post Occupancy Evaluation by the SINSW delivery team, providing an aftercare service to ensure all HVAC plant, and wider services systems, have been commissioned.
- Sizing mechanical systems to account for future climatic scenarios such as increased peak temperatures.

- **Renewable Energy** - the use of appropriate on-site renewable energy technologies.

Our response:

A 52 kWp solar system will aim to be installed on site. The performance of which has been amplified by orientating the saw tooth roof design to the North to increase the efficiency of the PV panels. A battery system has been investigated but the electrical engineer calculated that there would be little to no excess electricity for storage within the battery.

6 SEARS / CSIRO Response

This section responds to the following SEARS requirement:

Provide a statement regarding how the design of the future development is responsive to the CSIRO projected impacts of climate change, specifically:

o hotter days and more frequent heatwave events

o extended drought periods

o more extreme rainfall events

o gustier wind conditions

o how these will inform landscape design, material selection and social equity aspects (respite/shelter areas).

Climatic events such as heat waves cause additional stress on building's systems. High performance building envelopes help to mitigate these effects, shielding the environment from extreme weather events. Measures to achieve this include:

- Attention to solar gain through shading devices, high-performance windows, orientating glazing away from North and sensible glazing ratios, to provide excellent daylight, without causing an uplift in peak loads.
- Airtight construction and controlled ventilation; with a responsive cooling system providing year-round thermal comfort.
- High levels of insulation minimise the heat gains through the building fabric.
- Attention to the size of cooling coils has been considered by the mechanical engineers to adapt for peak day temperatures under a future climate scenario.

Storm water detention rates will be sized to account for increase, prolonged rainfall events. By slowly releasing water from the site there is less pressure on the local storm water system, reducing the chance of flash floods.

Changes to wind patterns in future climates is unclear, with little agreement between statistical data. However, increasingly frequent extreme weather events will lead to short, intense high wind periods. Strengthening the frame and foundation design will accommodate the additional loading. Intense wind periods usually occur during storms, which subject buildings to driving rain. Driving rain will be mitigated by a tightly detailed façade stopping water ingress and preserving the building fabric.

Landscape design will maximise permeable surfaces to slow the run-off of rainfall from the site. Furthermore, green spaces in the surrounding area will incorporate shading and rain refuge to cover occupants and visitors during climatic events. The large, covered entrance zone to the school will provide excellent refuge for a high number of occupants during a storm event.

7 Rating Scheme Equivalence - Green Star

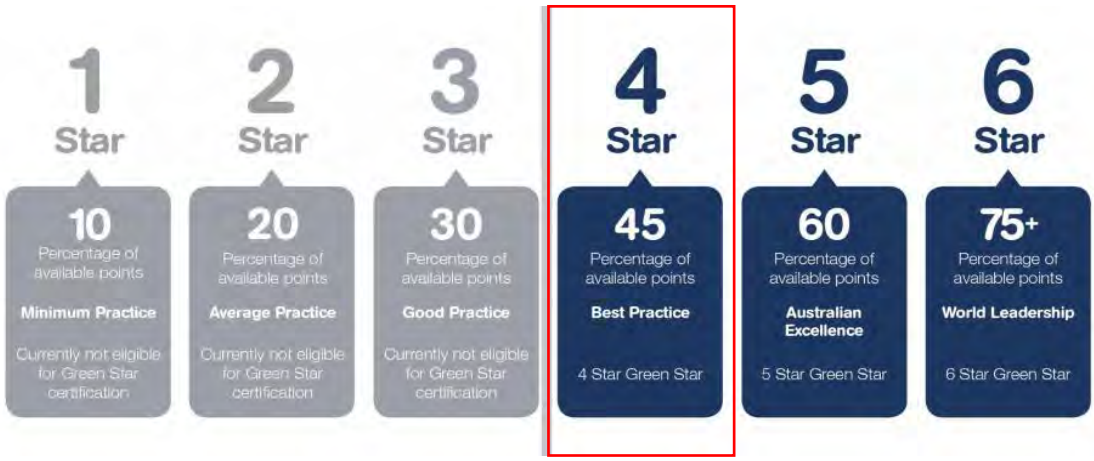
While the overarching driver for this project is to work towards the SINSW sustainability framework, as requested by the SEARS documents, we will demonstrate how the proposed design aligns with the Green Star Rating tool to demonstrate best practice equivalency.

Green Star is a comprehensive environmental rating system for buildings and communities. Green Star separately evaluates the environmental initiatives of design, projects and/or buildings based on several criteria, including energy and water efficiency, indoor environmental quality and resource conservations.

The proposal's informal (i.e. not formally certified by the Green Building Council of Australia, the administrators for Green Star) rating achieves 4-Stars, which is considered 'Best Practice' equivalency outcome.

The Green Star environmental rating system for buildings was created for the property industry in order to:

- Establish a common language;
- Set a standard of measurement for green buildings;
- Promote integrated, whole-building design;
- Recognise environmental leadership;
- Identify building life-cycle impacts; and
- Raise awareness of green building benefits.



7.1 Green Star Categories

The Green Star rating systems is made up of the following environmental categories:

- Management
- Indoor Environmental Quality
- Energy
- Transport
- Water
- Materials
- Land Use and Ecology
- Emissions
- Innovation

The categories are then divided into individual credits, each of which addresses an initiative that improves or has the potential to improve, a design, project or building's environmental performance. Points are awarded in each credit for actions that demonstrate the project has met the overall objectives or Green Star and the specific aims of the rating tool.

In establishing the project's level of alignment with the Green Star rating tool 'scorecard', several assumptions must be made relating to how the future school will be managed and operated. Given that Green Star rewards projects not only for built works but also for how the completed building is operated, it is necessary during design phases to assume a minimum or best practice level of operational performance. The assumptions made within are considered 'typical' for new buildings and will without exception contribute to better environmental and financial performance of the completed site.

7.1.1 Management

The management category encourages and rewards the adoption of practices and processes that enable and support best practice sustainability outcomes throughout the different phases of a project's design, construction and its ongoing operation. The management category recognises projects which improve their sustainability performance by influencing areas where decision-making is critical, rewarding the implementation of processes and strategies that support positive sustainability outcomes during construction. The category also promotes practices that ensure a project will be used to its optimum operational potential.

The Project will include the following initiatives:

1. During design and documentation, the Project team will review the design for its ease of maintenance for all building services and building fabric.
2. Building user guides will be produced by the Contractor to help users interact effectively with the buildings, optimising building performance and user comfort. The Guides will include guidance on all sustainability attributes of the site, and information on maintenance requirements.
3. A systematic and methodical Environmental Management plan will be formalised for implementation during the construction phase by the Contractor such as ISO 14001.
4. The main contractor will aim to implement on-site staff wellbeing practice and enhance site workers knowledge on sustainable practice through educational programmes.

5. The design will include infrastructure for operational waste management and the separation of waste streams.

7.1.2 Indoor Environmental Quality

The Indoor Environment Quality category aims to encourage and reward initiatives that enhance the comfort and well-being of occupants. The credits within this category address issues such as air quality, thermal comfort and acoustic comfort. This category rewards projects that achieve sustainability performance improvements in a manner that also improves occupants' experience of the space. The 'Indoor Environment Quality' category recognises that buildings are designed for people and that a holistic approach should be taken where reductions in energy use and occupants' health and wellbeing are not pursued to the detriment of each other.

The Project will include the following initiatives:

1. The project will seek to address noise in enclosed spaces by aiming to reduce noise levels to no more than 5dB(A) above the satisfactory levels provided in Table 1 AS/NZS 2107:2000 and mitigation reverberation. Noise transmission and reverberation times will be through detailed acoustic separation and acoustic attenuators.
2. Light fittings shall be selected, where possible, such that glare is controlled or reduced and where required glare from sunlight will be reduced through a combination of blinds, screen, fixed devices, or other means. Occupants will also control lighting in the spaces through manual lighting controls.
3. All paints, sealants, adhesives, floor coverings and composite timbers used internally will aim to meet low VOC (Volatile Organic Compound) emissions limits in accordance with Green Star Design and As-Built v1.3 VOC Emissions limits tables.
4. Any engineered wood products will meet stipulated formaldehyde limits as per Green Star Design and As-Built v1.3 Table 13.2: Formaldehyde Emissions Limit Values for Engineering Wood Products.

7.1.3 Energy

The Energy category aims to reward projects that are designed and constructed to reduce their overall operational energy consumption below that of a comparable standard-practice building. Such reductions are directly related to reduced greenhouse gas emissions, lower overall energy demand as well as reductions in operating costs for building owners and occupants. The Energy category rewards projects that facilitate reductions in greenhouse gas emissions through energy efficient design and encourage the utilisation of energy generated by low-emission sources.

The Project will include the following initiatives:

1. Good passive design features will be incorporated into the proposal to achieve measurable impacts on both building services strategies and the thermal comfort of occupants.
2. LED lighting, which offers life cycle cost advantages and reduced annual energy consumption, shall be utilised wherever possible. A high percentage of lighting will be controlled either through occupant detection, daylight controls or time clock controlled to meet BCA Section J6 requirements.
3. The domestic hot water system (DHW), will be electric to take advantage of a decarbonising gird.

4. The project will make provisions for the inclusion of solar photovoltaic (PV) arrays to supplement energy consumption and reduce ongoing operating costs. It is proposed the available roof space is reviewed and a suitable PV system be assessed for feasibility in detailed design stage.

7.1.4 Transport

The Transport category aims to reward projects that facilitate a reduction in the dependency on private car use and promote the use of alternative means of transport to reduce overall greenhouse gas emissions.

If reliance on individual motor vehicle transportation is to be reduced, it is necessary to maximise alternative transportation options. Rather than limiting access to private fossil fuel vehicles, the Transport category aims to encourage and reward initiatives that reduce the need for their use. This may include initiatives that encourage and make possible the use of mass transport options, cycling or walking, and the selection of sites that are close to many amenities.

A Green Travel Plan and Work Travel Plan are being developed by TTPA which will encourage modes of Transport beyond the use of private cars, including End of Trip facilities for staff that use active means to get to work.

Additionally, given the projects location to various transport nodes, such as Redfern train station and numerous bus stops, the project is easily accessible by public transport. With good transport accessibility occupants will rely less on private transport to reach Darlington School.

7.1.5 Water

The Water category aims to encourage and reward initiatives that reduce the consumption of potable water through measures such as the incorporation of water efficient fixtures and building systems and water re-use.

Reductions in operational water consumption may be achieved through the maximisation of water efficiency within the project.

The Project will include the following initiatives:

1. The proposal includes rainwater harvest and re-use for irrigation across the landscape areas.
2. All bathroom fixtures (toilet pans, urinals, hand basin taps and showers) will meet minimum WELS ratings in accordance with the applicable Green Star Guidelines:
    a. Basin taps and urinals to be equal to or more than 5 Star WELS
    b. Showers to be equal to or more than 3 Star WELS
    c. Toilets to be equal to or more than 4 Star WELS
3. Landscape areas will be irrigated using sub-soil drip irrigation with wherever practical, the design aspiration is to provide automated controls to limit unnecessary irrigation

7.1.6 Materials

The Materials category aims to address the consumption of resources within a building construction context, by encouraging the selection of lower-impact materials. The category also encourages absolute reductions in the amount of waste generated or the recycling of as much of the waste generated as possible.

The Project will include the following initiative:

1. A minimum 80% of all construction waste generated will aimed to be diverted from landfill by either re-use or recycling.

In addition, the following options are being explored and may also be incorporated:

2. A high percentage of PVC products used in the project including those in all formwork, pipes, flooring, blinds and cables shall meet the *Best Practice Guidelines for PVC in the Built Environment*, published by the Green Building Council of Australia.
3. A high percentage of timber used in building and construction will be from a reused source or certified by a forest certification scheme.

7.1.7 Land Use and Ecology

The Land Use and Ecology category aims to reduce the negative impact on the sites' ecological value as a result of urban development and reward projects that minimise harm and enhance the quality of local ecology.

The Project addresses this category through the following:

1. The site's current ecological value will be improved through well-considered landscape design.
2. The site makes use of previously developed land by upgrading the existing school and therefore does not develop any Green Space.
3. Rooftops that will contribute to a cooler microclimate using light coloured roof materials to reduce the 'Heat Island Effect'.

7.1.8 Emissions

The Emissions category aims to assess the environmental impacts of 'point source' pollution generated by projects. Negative impacts commonly associated with buildings might include increased stormwater discharge and pollutants entering the public sewer or disturbances to native animals and their migratory patterns as a result of light pollution.

The Project will include the following initiatives:

1. The lighting design shall be compliant with AS1158: Lighting for Roads and Public Spaces and AS4282: Control of the Obtrusive Effects of Outdoor Lighting. This would be achieved through control of upward light output ration (LOR) or control of direct illuminance.
2. Stormwater design will aim to ensure post-development peak event discharge rates do not exceed pre-development rates and that pollution reduction targets will be met.
3. Landscape solutions will be applied to achieve a high level of stormwater performance across the site, improving water quality prior to discharge from the site.

4. Water based heat rejection has been avoided to avert any potential impacts associated with harmful microbes in building cooling systems.

7.1.9 Innovation

The Innovation category is a way of encouraging, recognising, and rewarding the spread of innovative practices, processes and strategies that promote sustainable communities and cities.

The Innovation category acknowledges efforts which demonstrate that sustainable development principles have been incorporated not only for the community for which the Green Star criteria apply, but also in a broader sense. This may include collaboration between developers and other parties and is recognised separately from any outcomes rewarded in other categories.

1. The design team are considering proposals for the innovation challenge credits, going beyond the normal rigors of Greenstar by providing exemplary targets for the building.
2. The design team are currently investigating ways to exceed Greenstar benchmarks. Surpassing the storm water pollution requirements by improving the sites discharge filtration is their current target.

8 Appendix A – SINSW Sustainability Framework

ID	Theme & objective (SINSW Sustainability Strategy)	Indicator	Sustainability initiatives / requirements from EFSGs	EFSG type	Crossover with Green Star	Criteria Owner (Design)	Comment	Has this been implemented in project? Y or N	Is this documentary evidence available? Otherwise please propose alternative evidence
EC1-a	**Energy & carbon**	EC1: Energy efficiency	**Improvement over NCC** Building is designed and built so that energy consumtpion is predicted to be at least 10% lower than if build to minimum compliance with NCC requirements.	Mandatory	DAB c15E.0 GHG Emissions Reduction - Conditional Requirement	**ESD lead, Input from Mechanical, Electrical, Hydraulics**			
EC1-b			**Energy conservation** Design and construct all school buildings within the parameters specified in the: - Government Energy Management Program (GEMP) - NSW Public Works Energy Manual for Buildings - Building Code of Australia (BCA) Section J for Energy Efficiency The GEMP recognises that savings must be made in energy usage and maintenance to maintain the program of capital works. The NSW Public Energy Manual for Buildings provides an energy-saving strategy by identifying aspects of the building and services where reductions in operating and maintenance costs can be made through proper selection of: - Building fabric - Insulation materials - Shading and ventilation - Services and control It also requires the formulation of an energy impact statement.	Mandatory	DAB c15 GHG Emissions Reduction	**ESD lead, Input from Mech, Electric, Hydraulics**	Hydraulics: Generally WS+P specifies that heated water services pipes are insulated to minimise heat losses throughout the system.		Hydraulics: Documentry evidence of insulation requirements will be given in the Hydraulic Specification.
EC1-c			**Daylighting** - Maximise natural daylight in all habitable spaces to reduce energy usage through windows and skylights - Including daylight sensors in rooms to reduce light output or turn off light when sufficient daylight is provided within the space - When the space is large and perimeter lighting is adjacent to windows, perimeter lighting is on a separate zone to make maximum use of daylight	Mandatory	DAB c15 GHG Emissions Reduction	**TBC**	Arch: We are aiming for glazed areas to be 15% of the floor area as advised by ESD consultant.		
EC1-d			**Shading devices** On exposed facades subject to direct sunlight, external window shading has been considered as part of the building design	Mandatory	DAB c15 GHG Emissions Reduction	**Architect**	Arch: Sunshading is provided by the vertical screening across the eastern facade of the classrooms. Windows on the western facade are to be limited in size and recessed to provide solar protection. The facades are currently undergoing an internal design review and shading is being considered.		
EC1-e			**Lighting energy conservation** Lighting system must have timed or sensor feedback functionality for energy conservation	Mandatory	DAB c15 GHG Emissions Reduction	**Electrical**	To be included within scope		
EC1-f			**Energy efficient lighting** - LED lighting must be installed - The design of the lighting systems and the selection of fittings is to be undertaken based on a Whole of Life approach - System must support sustainable design principles including reducing energy consumption - Use light sources lamps and control gear with a long life	Mandatory	DAB c15 GHG Emissions Reduction	**Electrical**	To be included within scope		
EC1-g			**Maximum illumination power densities** Section J part 6 of the National Construction Code provides tables that define the maximum illumination power density that is acceptable in various locations. This, and all other elements of Section J part 6 should be applied appropriately.	Mandatory	DAB c15 GHG Emissions Reduction	**Electrical**	To be included within scope		
EC1-h			**Lighting control** The required communication protocol for the luminaires is DALI. The following systems for the control of luminaires fitted with DALI control gear are considered acceptable: - Diginet Rapix suite of products. - Clipsal C-bus suite of products - Philips Dynalite suite of products - KNX based systems Systems must be designed to be as simple as possible. This simplicity must extend from the topography to ease of use. It is a specific requirement that programming of any control system must be relatively simple and not limited to costly specialist consultants. Allowances should be made in system design specifications for user group training of control systems and for the programming of the system as part of the commissioning and hand over process. All equipment and manuals necessary to operate and maintain the system must be provided to the school and Asset Management	Mandatory	DAB c15 GHG Emissions Reduction DAB c4 Building Information	**Electrical**	Confirming the Sustainability Framework requires DALI lighting control for the project.		

EC1-i			**Constant light output / Daylighting** -Constant Light Output (CLO) systems consisting of dimming luminaires and light level sensors are highly recommended as they are effective in maintaining the required illuminance values. CLO systems ensure that the lit environment remains compliant at the lowest possible Watts per square metre for the reasonable operating life of the luminaires. Maintained illuminance values required for design compliance will result in areas being over-lit for a large proportion of their operating life without a CLO system. - Sensors can be fitted to each luminaire or by utilising sensors that control groups of luminaires. - Once in operation a CLO system delivers compliant light levels over the life of a system by reducing the light through dimming and ramping the levels up over the lifespan of the luminaire. These systems should be seamless and invisible in operation to users of the locations. - Daylight Harvesting can be delivered as a component of a CLO system and requires no additional hardware above and beyond that required for a CLO to operate. - Daylight harvesting is recommended in areas where there is a rapid transition from natural day light to a dark environment, such as when entering a multi deck or underground car park from a street in full daylight, or in a classroom where daylight from windows is within the field of view.	Mandatory	DAB c15 GHG Emissions Reduction	**Electrical**	To be included within scope		
EC1-j			**Switching strategy** - Local switching should be provided where it is identified that the users can benefit from manual operation of the lighting and other lighting automation technology is considered cost prohibitive. The switching should be clearly marked and robust. - Achieve energy efficient switching in Schools by: The use of multiple switching groups Automatic control of these groups to operate as follows: Controlled luminaires are to automatically turn-off nominally 3 minutes after the bell sounds. Turn-off is to be in two steps other than in small rooms, one step after 3 minutes and the second group 2 minutes later (5 min). If the lighting is required for the next period, occupants of that room can prevent the lights turning off by pressing the ON switch/es after the bell sounds. The luminaires in each room can be turned off at any time by pressing the OFF switch/es. The off signal is to be capable of transmission at the end of normal school hours or at other selected times without the bells sounding, with the lighting turning off in two steps (other than in small rooms).	Negotiable / TBC	DAB c15 GHG Emissions Reduction	**Electrical**	To be included within scope		
EC1-k			**Energy efficient HVAC system** HVAC system must have timed or sensor feedback functionality for energy conservation Systems shall be designed to minimise energy consumption. System design / equipment selection is to be based on whole of life cost analysis. Specifically air conditioning equipment should: - support sustainable design principles including reducing energy consumption; and - be easily accessible and serviceable – easy to maintain with minimal impact on school operations / activities when maintenance is being performed. All new school buildings are to be designed to meet or exceed the requirements of building regulations for conditioned spaces	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Equipment selection is in-line with DG55 recommendations for a school of this size (VRF system) System has timer functionality and shall be controlled in-line with DG55 requirements	Y	
EC1-l			**Energy efficient appliances & equipment** Electrical equipment must be at least 0.5 stars above the market average star rating or comply with high efficiency standards specified in the GREP	Mandatory	DAB c15 GHG Emissions Reduction	**FF&E / Arch**			
EC1-m			**Heat loss/gain** Building/HVAC design must consider: - Climate/ micro-climate: This data shall come from the current AIRAH handbook and where a specific area is not referenced in the handbook, the Bureau of Meteorology statistics shall be utilised. - Orientation: exposure to sun(solar) and wind - Natural Ventilation and cross ventilation - Insulation, thermal capacity and time lag of building fabric. - Energy and Resources Cost: Initial and on-going, of heating and cooling. Reduced energy consumption provides future cost savings and a reduced carbon footprint. - Activities / Equipment that may produce excess heat. Energy modelling software is to be used to determine heating and cooling loads as part of the Whole of Life analysis that is to be undertaken. (ie Camel or Carrier).	Mandatory	DAB c15 GHG Emissions Reduction	**ESD / Mechanical**			

EC1-n			**Passive design** The need for active cooling and heating shall be minimised by employing passive / sustainable design principles. Windows: The size and proportions of windows need to be carefully considered in the design to provide maximum efficiency and a balance between the ESD factors such as; maximising daylight in rooms but avoiding unnecessary solar heat gain and thermal loss etc. Roofing: The colour selected will have an impact on the thermal performance. Light colours will reflect more of the sun's heat and darker colours absorb more of the sun's heat, which will be transferred into the roof structure. Orientation (as close to True North as possible). With appropriate shading, this will provide a balanced approach to reducing summer heat ingress and encouraging solar warmth during winter. Appropriate glazing/ shading strategy (related to orientation and local environment), Depending on the climate, windows would be minimised on southern, eastern & western elevations with external shading on western and eastern facades). Use of thermal mass (to stabilise internal temperatures). Insulation: maximise insulation in line with	Mandatory / Recommended	DAB c15 GHG Emissions Reduction	**Arch / ESD**	FJMT: The buildings are mainly oriented along Golden Grove Street, with the long facades facing east-west. External shading for glazing exposed to direct sunlight is being address in the building design.		
EC1-o			**Ventilation strategy** A ventilation strategy is to be developed to ensure that sufficient ventilation is provided to all spaces to meet the requirements of the BCA/NCC and associated standards. Specifically ventilation equipment should: - Support sustainable design principles including reducing energy consumption - Be accessible and serviceable - easy to maintain with minimal impact on school use when maintenance is being performed	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Ventilation shall be in-line with AS1668.2 as a minimum Access shall be provided to all in-ceiling or roof mounted fans and equipment	Y	
EC1-p			**Natural ventilation** - Is required to all classrooms for comfort in summer and to maintain a healthy indoor environment. - Where cross ventilation may be restricted (ie where rooms are located on each side of a corridor, at least one whole wall of operable windows plus ceiling fans are required, to provide air movement. - Some windows need to be operable in driving rain and so must be protected with appropriately designed weather hoods, eaves overhang or other method of protection.	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Ceiling fans shall be provided to all larning spaces	Y	
EC1-q			**Mechanically assisted cross-ventilation** In two storey blocks where cross flow ventilation is not possible to the lower floor, mechanically assisted cross ventilation is to be provided to the lower floor learning spaces nominated in the EFSG. The ventilation system is to be sized to provide at least 7 air changes per hour. The system is to be thermostatically controlled to activate when room temperature exceeds 28 deg C and is to run continuously until the room temperature drops below 27 deg C. Additionally the system is not to be activated unless the outdoor temperature is lower than the indoor temperature and is to be immediately de-activated as soon as the outdoor temperature exceeds indoor air temperature. Provide programmable seven-day time clock and 0-2 hrs adjustable after-hour timer to control each mechanically assisted exhaust ventilation system.	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	As air conditioning is being provided with a cooling mode to 27deg C. As such mechanical cross ventilation has not been provided. Architect to advise if natural cross ventilation is achievable	N	
EC1-r			**Ceiling void ventilation** Provide ventilation so as to remove hot air build-up in large enclosed roof spaces. Roof mounted turbo ventilators are an approved method. - The size and number of ventilators to be included will depend upon the volume and use of the individual rooms and the local climatic conditions to provide suitable air changes and room cross ventilation. - Provide a minimum of two roof ventilators to each Secondary General Learning Space or a Primary Home Base unless otherwise directed, or other number recommended by the manufacturer for the size of the space (whichever is the greater). - Ventilator throat diameter to be no less than 400mm.	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	To be confirmed if this is required as the roof design progresses	TBC	
EC1-s			**Roof ventilator control** Provide controls for the operation of the motorised dampers on the roof ventilators. Generally one switch is required for each space within the school where roof ventilators are installed	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical / Electrical**	See above	TBC	
EC1-t			**Wind powered roof ventilators** School buildings can use wind powered roof ventilators with dampers to provide effective summer ventilation. Design to suit local ambient climatic conditions to ensure correct sizes, locations and numbers are provided for each particular application. Co-ordinate the locations of ventilators with the ceiling fans to achieve effective air movement. Fan assisted ventilators should also be considered on days of low wind Provide a wall mounted switch to open /close the damper.	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	See above	TBC	
EC1-u			**Ventilation in sanitary spaces** - Greater air circulation than that required by building regulations is required, with sufficient natural ventilation or mechanical ventilation, to disperse odours and /or humidity. - Cross ventilation is to be used where possible. - Provide mechanical ventilation to all Disabled Toilets. - Operate the system by time control equipment (time switches or run-on timers as appropriate).	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Mechanical ventilation with adequate make-up air shall be provided to all sanitary spaces in line with AS1668.2	Y	

EC1-v			**Ventilation in storage spaces** - Permanent air ventilation openings are to be provided (without compromising security), to prevent concentration of odours.	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Mechanical ventilation with adequate make-up air shall be provided to all storage spaces in line with AS1668.2	Y	
EC1-w			**Ventilation in permanent learning spaces and libraries** Where feasible / practical: - Ceiling fans shall be installed where ceiling height is equal to or greater than 2,700mm. - Wall fans shall be installed where ceiling heights are less than 2,700mm	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Shall be documented	Y	
EC1-x			**Indoor enviroment controls** - Both the thermal comfort and indoor air quality shall be controlled automatically within specified parameters. - Controls shall be simple and intuitive to use. - A prominent green light shall highlight to occupants when conditions are suited to opening windows and doors to utilise natural ventilation. - A prominent blue light shall highlight to occupants when the air conditioning is operating. - The lights shall be clearly labelled with trafolyte labels as follows: + Green light – "External conditions are suited to opening windows and doors" + Blue light – "Air conditioning is operating. Windows and doors should be closed" - Temperature and CO2 sensors are to be installed within the space and be readily accessible for maintenance. - Sensors must be located so as to accurately record the actual room temperature and indoor air quality (CO2). - Controls shall be designed to minimise energy consumption – e.g.: by minimising over cooling and heating and automatically switching off when the space is unoccupied. - Controls shall be designed so that the system/s will shut down automatically if a room is unoccupied for greater than 10 minutes (except in specific cases such as designated computer rooms). - Controls shall be properly labelled and suitably located in the space (preferably near the light switch) and incorporate: + a key operated auto / manual / off switch; and + a push on / push off adjustable hour run timer. The run timer shall be adjustable from 1 to 4 hours and initially be set at 2 hours	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Shall be documented	Y	
EC1-y			**Access for maintenance** All systems and equipment that is installed within a school is to be provided with suitable access to ensure that this equipment is safely and efficiently maintainable. In order to ensure that maintenance is available, on the completion of all buildings, drawings are to be provided showing the completed (As Built) building including all equipment and equipment access arrangements. **Communication services** DoE requires a 4 hour on-site training session for up to four persons on the use of the SCS. Training is to be accompanied by appropriate documentation and a video that demonstrates operation of the system and its components, including patching, cable management for voice, video and data of the SCS installed on site. Include explanation of detailed drawings left on site. The video / CD ROM may be generated from the on-site training for future use by DoE school staff. The Project Manager will, in consultation with the School Principal, nominate the timing of this session together with the number of attendees. Manuals are to be handed to the school during the training session. Include in copies of all cabling test reports and the (minimum) 20-year warranty certificate the manual. As built documentation and manufacturers warranty and test results are required **Building user's guide** Produce a Building User's Guide to enable the client to understand the building systems and operate systems to maximise efficiency. This must: - Clearly and concisely describe the operation of building and its services - Detail a reasonable maintenance program - Advise the user of the most suitable replacements for consumables	Mandatory	DAB c4 Building Information	**Mechanical / Electrical / Hydraulics**	Mech: Coordination shall be completed during the design phase to ensure that maintenance access is achievable. Access panels shall be documented on the design drawings Hydraulics: Design generally completed in alignment with good practice industry standards	Y	
EC2-a		EC2: Scope 1 & 2 emissions	**Renewable energy** A grid connected solar PV system must be installed Where feasible, PV systems shall be installed to offset as much of the electricity consumed by the school as is practicable	Mandatory	DAB c15 GHG Emissions Reduction; DAB c16 Peak Electricity Demand Reduction	**Electrical / ESD**	Energy modelling report to be provided by PV installation contractor.		
EC2-b			**Energy storage** Battery used as energy storage of grid or solar energy may be used for grid forming, grid support, peak-demand management and load shifting, and self-consumption of renewable electricity. Energy storage is substantiated when: - there is historical evidence of grid outages and a need for backup power; - there are critical loads which require an uninterruptible power supply or backup power supply; - It is economical for energy storage systems to supplement or replace an existing backup generator (financial assessment required); - the DNSP requires that the energy storage be implemented; - The financial benefit of the system outweighs the cost of the system. This can be demonstrated by calculating and showing that the Levelised Cost of Electricity (LCOE) from a battery energy system with a certain operation regime is less than the retail tariff rate experienced at the site, or by showing that the BESS can reduce energy cost at the site and achieve a payback period of 8 years or less.	Mandatory	DAB c15 GHG Emissions Reduction; DAB c16 Peak Electricity Demand Reduction	**Electrical / ESD**	Battery systems are not appropriate for this site for the following reasons: - Load profile of the energy consumption on site does not align with typical optimal battery usage. - Sufficient power supply available at LV to site. - Confined space on site for batteries.		

EC2-c			**Heaters** In rooms where reverse cycle air conditioning is installed gas heaters shall not be provided. The only exception to this may be in the coldest parts of the state where reverse cycle air conditioning may be unable to provide effective heating. Heating equipment should: - Support sustainable design principles including reducing energy consumption - Be accessible and serviceable - easy to maintain with minimal impact on school use when maintenance is being performed	Mandatory	DAB c15 GHG Emissions Reduction	**Mechanical**	Not required	N	
EC2-d			**Water heaters** - Hot water and tempered water generation for schools should be carefully considered to ensure that a Whole of Life assessment is undertaken to minimise life cycle costs - Environmentally friendly options such as solar heating (if vandal resistant), high efficiency instantaneous gas and heat pumps are preferred energy sources to minimise energy consumption.	Mandatory	DAB c15 GHG Emissions Reduction	**Hydraulics**	Due to a recent push in previous ERG meetings (safety), WS+P has opted for electric methods for heating hot water throughout the school. Additionally, the mechanical services do not rely on the provision of natural gas services.		
EC3-a		EC3: Scope 3 emissions	Transport plan	N/A	DAB c17 Sustainable Transport	**Transport Consultant?**			
EC3-b			**Bicycle storage** Provide 1 space for every 20 students to AS2890.3 standard	TBC	DAB c17 Sustainable Transport	**Architect**	Arch: Bicycle storage has been increased to 21 spaces to cater for 418 students.		
W1-a	**Water**	W1: Water use efficiency	**Potable water conservation** The following are to be implemented on school sites where possible: Manual flush urinal systems: New and replacement urinals shall use manual in lieu of automatic flushing mechanisms. A microwave-activated urinal flushing system may be used as an alternative. Water conserving taps: Wherever possible and practical, use metal flow control valves and /or push down taps with pre set flow limits.	Mandatory	DAB c18 Potable Water	**Hydraulics / Arch**	Hyd: Generally completed in alignment with good practice industry standards. Water conservation strategies such as the inclusion of manual flush urinal systems and water conserving tapware are to be documented by the architect. Arch: Noted. These requirements will be considered during schematic design when selecting the fixtures and fittings.		
W1-b			**Fixture efficiency** All products must be rated to AS 6400 to the following minimum WELS ratings: - Tapware to 5 star flow rating requirements - Showers to have 3 star flow rating requirements - Water Closet Pans to 4 star flow rating requirements - Flow restrictors can be used to minimise water usage and wastage for staff amenities - Taps with timed flow can be used to minimise water usage and wastage in student amenities. In any case, all fixtures and fittings must be at least the average WELS star rating by product type. Where WELS rating is not available, use the alternative WaterMark rating scheme.	Mandatory	DAB c18B.1 Potable Water - Sanitary Fixture Efficiency	**Hydraulics / Arch**	Hyd: Selection of FFE elements generally falls within architect scope. Arch: Noted. These requirements will be considered during schematic design when selecting the fixtures and fittings.		
W1-c			**Hydraulic services** Hydraulic services should: - Support sustainable design principles including reducing water consumption and waste production. - Appropriately treat any trade waste to ensure minimal environmental impact - Be accessible and serviceable - easy to maintain with minimal impact on school use when maintenance is being performed - Use products with a long life span – many hydraulic services are concealed so durability is essential	Mandatory	DAB c18 Potable Water	**Hydraulics**	Design generally completed in alignment with good practice industry standards.		
W1-d			**Water sub-metering** In addition to the main water meter for the site provide sub meters for the following: - Mixed irrigation systems - Laboratory buildings - Amenities blocks - Canteens - Any other major water use on the site	Mandatory		**Hydraulics**	WS+P is happy to provide sub-metering as required by the ESD. This item should be worked through in future design stages to confirm metering approach.		
W2-a		W2 – Proportion of potable vs non-potable water	**Rainwater collection** It is DoE policy to include roof water harvesting and tank storage in new schools and to encourage it where practical in existing schools, to reduce the demand on drinking water supplies. Tank water can connect to drip irrigation systems for adjacent landscape/gardens with the major preference being for gravity fed supply to minimise ongoing maintenance.	Mandatory	DAB c18B.2 Rainwater Reuse	**Hydraulics / civil / landscape**	WS+P will provide roof drainage and downpipes for inground collection by Civil Engineer. Civil Engineer to document rainwater tank and relevant services. Civil has modelled a rainwater tank (size 30kL) with water to be used for irrigation only. This assists in meeting Council water quality targets. Hydraulic/Landscape Engineer to provide additional advice (including irrigation strategy/methods, any hydraulic requirements		Civil Concept Design Report - FINAL has been provided to macegroup.
W2-b			**Fire system water reuse** Where schools are required to install a sprinkler system for fire safety, it is recommended to install a closed loop system to capture and reuse fire systems testing and maintenance water, or by using an alternative non-potable water source.	Optional	DAB c18B.5 Fire System Test Water	**Fire**	The school is not provided with a fire sprinkler system therefore W2-b is not applicable in this case.		

W2-c			**Ground water** Where ground water is available for use for irrigation purposes, enquiries should be undertaken with DPIE to determine the suitability of a ground water system.	Mandatory	DAB c18 Potable Water	**Hydraulics / civil**	According to the Geotech report "no free groundwater was observed in the bores during drilling for the short time that they were left open" (Section 6.1). Additionally, WS+P does not believe that the benefits of utilitsing ground water to irrigate would outweigh the costs of installing/maintaining this system. In accordance with the Detailed Site Investigation for Contamination on the Darlington Public School by Douglas Partners dated February 2019, ref: 92277.01, no free groundwater was observed in the boreholes for the short time they were open.		
W3-a		W3 – Responsible water discharge	**Stormwater management** Aim to minimise the transportation of toxicants to waterways and other offsite environments, and maintain the existing hydrological regimes.	Mandatory	DAB c26 Stormwater	**Civil**	Refer to Civil Concept Design Report for proposed water quality and water quantity control measures.		Civil Concept Design Report - FINAL has been provided to macegroup.
W3-b			**Trade waste** Arrestors for acid, grease, plaster and clay of adequate capacity must be installed to treat wastewater from science laboratories, kitchens, art rooms and canteens as required in DG52.	Mandatory	Not covered in Green Star	**Civil**	Design generally completed in alignment with good practice industry standards. WS+P has confirmed in the recent TSG meeting that grease cooking will not be utilised and hence no need for any grease arrestors. Plaster/clay arrestors will be provided to art wash sinks as required.		
WM1-a	**Waste & materials**	WM1: Materials selection and use	**Life cycle assessment (environmental)** Environmental impacts of products and materials has been assessed and inform material selection	Recommended	DAB c19A - Life cycle assessment	**Arch / ESD**	Arch: Material selection will be undertaken during schematic design in consultation with the ESD consultant and Cost Planner.		
WM1-b			**Whole of life costing (WOL)** Total cost of ownership (TCO) assessment / Analysis of direct and indirect costs and benefits / Life cycle costing analysis When calculating the whole of life cost for the different materials / building elements or systems, the following must be considered: - the total initial capital cost of the system/s – including design, project management, builder and building services works in connections etc. - resources (energy and where applicable water) consumption. - Maintenance. - the replacement of component parts. - disposal costs - ecological sustainable options - durability - vandalism - safety The whole of life cost shall be calculated over the estimated life of the asset/s.	Recommended	GSC c20 - Return on Investment	**All**	Arch: Material selection will be undertaken during schematic design in consultation with the ESD consultant and Cost Planner and in reference to the design guides. Fjmt will contribute to WOL costing anaylsis as required.		
WM1-c			**Sustainable materials** The use of the following materials in construction is encouraged: - Materials that have lower adverse environmental impacts throughout their life cycle; - Reduce the demand for rare or non-renewable resources; - Have low embodied energy and water; - Are made from or contain recycled materials or can be recycled at the end of their useful life.	Optional	DAB c21 Sustainable Products	**Arch / ESD**	Arch: Material selection will be undertaken during schematic design in consultation with the ESD consultant and Cost Planner. Sustainable materials will be specified where possible.		
WM1-d			**Sustainable timber** - Use only recycled timber, engineered and glued timber composite products, timber from plantations or from sustainably managed regrowth forests. - All timber used is to be termite (white ant) resistant or treated to be termite resistant to the appropriate hazard level.	Mandatory	DAB c20.2 Responsible Building Materials - Timber	**Arch / ESD**	Arch: Noted		
WM1-e			**Built for disassembly** Consider the use of building materials which are able to be disassembled for re-use, in conjunction with considerations for the addition and removal of accommodation over time.	Mandatory		**Arch**	Arch: Noted		
WM1-f			**Concrete** - Use materials complying with AS based on the Whole of Life approach to materials selection. - Do not use breccia or dolerite in concrete mixes. - Fly ash is a manufacturing bi-product that can be used as a cement replacement but should limited to a maximum of 20% by weight of cement content.	Mandatory	DAB c19B.1	**Structural**	The requirements have been considered in the design and will be reflected on the documentation in next phases of te project i.e. Design Development Stage		
WM2-a		WM2 – Resource efficient school operations	**Operational waste** Consider opportunities for re-use and recycling of materials in the operation of the facilities	Mandatory	DAB c8 Operational Waste	**Arch**	Arch: Noted		

WM2-b			**Building flexibility** Position structural members considering the future flexibility of the structure. Avoid ad hoc placing of columns internally, giving preference to uniformity in layout. Design all internal walls as non-load bearing to enable future flexibility.	Mandatory	Not covered in Green Star	**Structural**	The requirement will be further considered in design development stage. At present, where possible, Ground Zone roofs have been designed with additional loading capacty to accomadate possible expansion at a later date.		
WM3-a		WM3 – Responsible management of waste	**Construction waste** Consider opportunities for re-use and recycling of materials in the construction phase	Mandatory	DAB c22 Construction and Demolition Waste	**Main Contractor**	To be addressed by the contractor, takens to be taken from best practice Australian standards.		
WM3-b			**Operational waste** A waste storage area must be included in all new school sites, with the provision of space for the separation of waste and receptacles for multiple waste streams, including: - general rubbish, - co-mingled recycling, - paper and cardboard, - secure waste, and - green waste. Safe methods for vehicle access and the transfer of waste must also be considered.	Mandatory	DAB c8 Operational Waste	**Arch**	Arch: A covered and locakable bulk waste area has been provided adjacent to Abercrombie Street. Vehicle assess is being further explored (ie. whether the bulk waste area should be accessed from inside the school boundary or if a door should open onto the street).		
P1-a	**Place**	P1 – Green infrastructure	**Environmental conservation education** The design of the facilities provide unique and valuable environmental conservation learning opportunities and effective environmental modelling to the wider community.	Mandatory		**Ecologist**			
P1-b			**Productive landscape** Consider including opportunities for development of community garden within the site and relationships with community groups for this to occur.	Optional	GSC c14.2 Local Food Production	**Landscape**	Due to space constaints on site to provide sufficient space for pupils, a community garden has been been addressed within the landscape design.	N	
P1-c			**Drinking water catchment protection** For developments within drinking water catchement areas, a water cycle management study is to be included with the Development Application for Education Facility developments involving: - Agriculture facilities - Biosolids and effluent re-use schemes - Sewerage systems or works (including package sewerage treatment plants) - Stormwater or works involving the disposal of untreated runoff	Mandatory	GSC c24 Integrated Water Cycle	**Civil**	1. The site is not within drinking water catchment 2. Refer to Civil Concept Design Report for proposed water quality and water quantity control measures.		Civil Concept Design Report - FINAL has been provided to macegroup.
P2-a		P2 – Community & heritage connections	**Site investigations for place making / community connections** The following detailed reports/ surveys/ information should be considered in developing the business case: - Local environment/ character - Climate and microclimate - Heritage significance / impact - Appraisal of physical and visual factors affecting site development - Available transport/ road infrastructure servicing the site - Geo-technical and Soil reports will be required for each site to investigate the suitability of the topsoil and anticipated sub-grade materials for horticultural purposes. - Testing for toxic residues must be undertaken in all areas identified as being a possible risk - i.e. filled or dumped ground.	Negotiable	GSC c12 Culture, Heritage and Identity DAB 24.2 Contamination and Hazardous Materials	**Various**			
P2-b			**Sense of place** The following design principles to every landscape zone of the school. - A healthy and safe landscape - A sense of place - A sustainable landscape - A low maintenance landscape	TBC	Not covered in Green Star	**Landscape**	These design principles form the core of the landscaping strategy, schools have a vital role and form a an important part of the community. School's enageg with communities in boarder ways beyound education, creating a sens eof place helps to embed schools within the community.	Y	
P2-c			**Community use of facilities** Some school facilities are used out of hours for activities such as weekend church groups, sport events and public meetings. Liaise with the Project Director to gain an understanding of any shared use, or community use arrangements that are being considered for the site. New schools should be designed so that direct access to the open play space, fields , hall and gym can be achieved without the public gaining access to the buildings.	TBC	DAB c30B Community Benefits	**Arch / SINSW**	Arch / SINSW:SINSW and City of Sydney are currently discussing joint usage of the Community Hall, Preschool and Basketball court. FJMT:A public entry has been provided to the proposed school hall on the corner of Abercrombie and Golden Grove Streets. The school buildings will be lockable at ground level so that the school grounds can be used outside of hours for organised events. A community preschool has been approved and will form part of the new school works.		
P2-d			Reconciliation action plan	N/A	DAB c30D Reconciliation Action Plkan	**SINSW**			
P3-a		P3 – Welcoming learning spaces	**Daylighting** Maximise natural daylight in all habitable spaces to improve indoor amenity and create a pleasant environment.	Mandatory	DAB c12 Visual Comfort	**TBC**	Arch: We are aiming for glazed areas to be 15% of the floor area as advised by ESD consultant. This Windows to floor ratio aims to provide 3% daylight factor for learning spaces		

P3-b			**Daylight glare control** Discomforting glare and brightness contrasts must be avoided. It is recommended to: - Exclude direct sunlight from all learning spaces, libraries, administrative offices and staff studies for the period of 9.00am to 3.30pm including Eastern Daylight Saving Time between 21st September to 21st March (equinoxes). Elimination of direct sunlight into the spaces will also reduce unwanted heat gain in summer. - Exclude direct sunlight from desk level in all learning spaces between 9am and 3:30pm. Sun exclusion and glare control can be achieved by the use of elements such as; Sun shades, eave extensions, vertical blades and the like. Glare should only be controlled by blinds as a last resort. Prepare sun diagrams in the design phase as a minimum requirement.	Mandatory	DAB c12.0 Glare Reduction	**Arch / ESD**	Arch: As part of the facade design we will undertake some preliminary solar studies to determine direct sunlight penetration into learning spaces.		
P3-c			**Lighting comfort** - Consider the furniture layouts to determine the orientation of luminaires. Especially when positioning luminaires in Materials Technology spaces to ensure adequate illumination on machines and work surfaces; - avoid potential stroboscopic effects and avoid shadows from ductwork - Mount luminaires as high as possible, but generally no higher than 4000mm AFFL (excluding Gymnasiums and Halls), to improve luminance uniformity and reduce direct glare in the direction of normal view - The standard lamp colour temperature is 4,000°K, except in certain toilet areas where the Design Guide requires the use of blue colours - Compliance with the uniformity requirements of the applicable standard should be demonstrated by the presentation of the output from lighting design software. - Unified Glare Rating (UGR) must be calculated using design software and compliant with the maximum recommended in AS/NZS 1680.1:2006	Mandatory	DAB c11 Lighting Comfort	**Electrical / Arch**	Item has been identified as achievable		
P3-d			**Lighting modelling** Lighting designs should be carried out utilising industry standard lighting design software such as AGI32, Dialux or Relux. Modelling must provide output that clearly demonstrates that the proposed design is compliant with the standards including but not limited to the following parameters: - Maintained illuminance values (average, maximum and minimum) on horizontal surfaces such as floors or working planes as required, broken down to identify the parameters defined in AS/NZS1680.4 or AS/NZS1158 as applicable - Maintained illuminance values (average, maximum and minimum) on vertical surfaces such as walls, shelves or racks as required, broken down to identify the parameters defined in AS/NZS1680.4 or AS/NZS1158 as applicable - Unified Glare Rating (UGR) as defined by AS/NZS1680, - Uniformity as defined by the applicable standard for indoor or outdoor illumination, - Lighting power density in System Watts/m2	Mandatory	DAB c11.1 General Illuminance and Glare Reduction	**Electrical**	Item has been identified as achievable		
P3-e			**External access lighting** External Access Lighting shall be provided to illuminate building entrances, footpaths, sheltered walkways, roadways and car park. External Access Lighting must: - Be minimal and designed to prevent glare to pedestrians, nearby residents and to motorists. Evidence of compliance with AS4282, AS/NZS 1158 and other applicable Australian Standards must be provided by the designer. - Be located so as to link various sources of illumination such as street lighting (for carpark and roadways) and internal security lighting (for footpaths, walkways and entrances). - Illuminate building entry doors. - Highlight 'accident-prone' areas such as changes in level, stairs and ramps. - Provide vertical illumination.	Mandatory	DAB c27.0 Light Pollution to Neighbouring Bodies	**Electrical**	Item has been identified as achievable		
P3-f			**Thermal comfort** The inclusion of active cooling within school facilities is directed by the Department's Air Cooling policy: 2.1 Schools with a long term average mean maximum January temperature of 33 oC and above: Generally, air conditioning is to be provided to all school buildings. 2.2 Schools with a long term average mean maximum January temperature of below 33oC: Air conditioning is to be installed in all permanent learning spaces and libraries forming part of each projects scope. - Thermal modelling is undertaken to demonstrate that learning spaces and libraries have been designed to achieve a predicted mean vote (PMV) of +/- 0.5 for 95% of occupied hours	Mandatory	DAB c14 Thermal Comfort	**Mechanical / ESD**	Shall be completed as per guidelines	Y	

P3-g			**Background noise levels** - HVAC systems shall be designed in accordance with the recommended internal noise levels noted in table 1 of DG55.02. The noise levels are the result from the cumulative contribution of traffic noise (via the façade) PLUS the building air-conditioning /ventilation systems. The noise measurement and documentation must be provided by a qualified acoustic consultant and in accordance with AS/NZS 2107. Noise measurement must account for all internal and external noise including noise arising from building services equipment, noise emission from outdoor sources such as traffic, and (where known) noise from industrial process. Occupancy noise is excluded. Compliance shall be demonstrated through measurement, and the measurements shall be conducted in at least 10% of the spaces in the nominated area. The selection of representative spaces must be justified and must consider how the spaces are considered to be the most conservative with respect to both internal, and external noise sources. The range of measurement locations shall be representative of all spaces available within the nominated area. All relevant building systems must be in operation at the time of measurement. Projects less than 500m2 Gross Floor Area (GFA) must account for measurements conducted in at least 95% of spaces within the nominated area. - Enclosed circulation areas should be acoustically absorptive	Mandatory	DAB c10.1 Internal Noise Levels	**Acoustics**			
P3-h			**Room-to-room noise control** The following elements have prescriptive acoustic performance or construction requirements: - Operable walls (between general learning areas, all schools): Rw 45 - Entry doors to occupied teaching, music, drama and sports spaces: Solid core, minimum 35 mm thick with acoustic weather (where external) seals on all rebated closing faces. Gap at floor to be minimized. - Internal glazed sections in walls and vision panels in or adjacent to internal doors: minimum 10.38 mm laminated glass. In some situations acoustic windows may be needed for satisfactory noise separation. - Construction separating wastewater pipework from occupied spaces: Rw 40 - Where adjacent to an occupied space (and not serving that space), hydraulic supply pipework and wastewater pipework shall be separated from the adjacent occupied space. Construction between the adjacent spaces in this instance shall be a 'staggered stud' arrangement or otherwise discontinuous.	Mandatory	DAB c10.3 Acoustic Separation	**Acoustics**			
P3-i			**Noise emissions** Generally noise emission to the environment from mechanical services noise sources (such as air conditioners) are the subject of a development consent conditions. In NSW the development consent conditions will refer to the Industrial Noise Policy (INP) or Local Council requirement. Where no condition regarding noise sources exists for a school development, noise emission from such sources should be designed, in-principle, to satisfy the requirements of the Industrial Noise Policy.	Optional	Not covered in Green Star	**Acoustics**			
P3-j			**Acoustic post-occupancy evaluation** Post Occupancy evaluations are often undertaken to assess the performance of recently completed or existing facilities. Where a Post Occupancy Evaluation is to be undertaken it should be conducted by the project team or acoustic engineer and should be undertaken of selected acoustic parameters only. Evaluation may include: - Internal noise levels, - Room acoustics, - Noise emission, - Room-to-room acoustics performance	Optional	GSP c13 Internal Noise Levels	**Acoustics / SINSW**			
P3-k			**Low VOC-emitting materials** All surface coatings, and other Volatile Organic Compound (VOC) emitting products including adhesives, sealants, carpets and carpet underlays, must be made from Low-VOC emission materials. In terms of surface coatings, the Australian Paint Approval Scheme's (APAS) VOC limits for Low VOC paints or lower are to be used	Mandatory	DAB c13 Indoor Pollutants	**Arch**	Noted		
P3-l			**Low formaldehyde-emitting materials** Only low formaldehyde-emitting engineered wood products should be used, such as those that meet the Australian Standards for formaldehyde emission limit E1 (NICNAS classification) or lower.	Mandatory	DAB c13 Indoor Pollutants	**Arch**	Noted		
P3-m			**Ventilation in printing rooms** The ventilation system is to be designed to serve the whole room and is not intended to provide localised exhaust at equipment. - Discharge air from the ventilation unit to the outside of the building via a vermin proofed louvre. - Draw make-up air from inside the building through wall or door grilles. - Locate the inlet/s and exhaust to achieve good airflow across the room in plan and elevation to pick up all machine emissions. -Ensure the airflow doesn't draw equipment emissions across operator's face. -Note that the room door in many schools may be left open in normal daily operation. Allow for this when locating the exhaust fan so that cross ventilation is achieved with make-up air drawn through the door opening. - Required speed range: minimum of 6 air changes per hour and maximum of 15 air changes per hour.	Mandatory	DAB c9.3 Exhaust or Elimination of Pollutants	**Arch / FF&E**	Noted		

P3-n			**Chemical store ventilation** - Provide mechanical exhaust system with high and low level exhaust points to all chemical stores, with a minimum of 15 air changes per hour flow rate. - Discharge air according to the requirements of BCA. The discharge outlet is to be fitted with bird wire mesh. - Provide make up air to all chemical stores, (to replace exhausted air) through openings in an external wall, fitted with weatherproof louvres. All grilles and louvres are to be fitted with vandal proof bars and be fitted with vermin mesh. - For security and fire rating reasons do not use windows/doors or door grilles for air intake. - The chemical stores ventilation systems are to run continuously.	Mandatory	Not covered in Green Star	**Mechanical**	Not required	N	
P3-o			**Pesticide free environments** Schools are designed, constructed and maintained, without using chemicals for termite and other pest control. No chemical pesticides and termicide to be used. Preventive treatments to be by physical means and careful design to minimise risk	Mandatory	Not covered in Green Star	**Landscape / Ecology**	Pesticides will not be used on site	Y	
P3-p			**Green cleaning**	N/A	GSP c6 Green Cleaning	**SINSW**			
P3-q			**Fly free indoors** Fly screening must be provided in all schools to the doors, windows and other openings in food preparation, biology, and non-water-closet toilet spaces or where specifically nominated in the EFSG. Schools in localities where fly incidence constitutes a health hazard (especially trachoma or other nuisance) will require fly screens to all opening sashes.	Mandatory	Not covered in Green Star	**Arch**	Noted		
P3-r			**Indoor CO2 levels** For mechanically ventilated spaces: 1. Outdoor air ventilation rates are in accordance with requirements of AS 1668.2. 2. Mechanical ventilation systems shall be linked to CO2 sensors to provide demand-controlled ventilation within each space to ensure that CO2 levels are maintained below the required CO2 threshold. 3. Mechanical ventilation systems shall be designed to provide adequate access for maintenance and cleaning. 4. Ventilation systems are designed to maintain an average daily CO2 concentration as per the latest NCC code, and so that the maximum concentration does not exceed 1,500ppm for more than 20 consecutive minutes in each day. 5. The required outdoor air ventilation rates and CO2 concentrations shall be maintained without the need for any human intervention e.g. the opening of windows or external louvres. 6. Ventilation systems shall be designed minimise the entry of outdoor pollutants through ensuring that the ventilation system design is in accordance with the relevant parts of AS 1668.2. and ASHRAE Standard 62.1. 7. Where local sources of pollutants are present e.g. photocopiers, minimum exhaust ventilation flow rates should be provided in accordance with AS1668.2: Table B1.	Mandatory	DAB c9 Indoor Air Quality	**Mechanical**	Shall be completed as per guidelines Required outdoor ventilation rates and C02 concentrations shall be maintained without the need for human intervention while in air conditioning mode only. In all other instances, outdoor ventilation shall be achieved by opening of windows.	Y	
P3-s			**Ecological conservation** School sites must conserve for future generations, the biological diversity of genetic materials, species and ecosystems on that site - Consider including opportunities to preserve or re-establish native flora and create new landscapes through liaising with local government authorities, Landcare and environmental groups, and the use of native low water use plants. - Where practicable, retain both existing native and exotic trees and flora, plus under storey native vegetation, in accordance with any 'Fauna and Flora' study, Environmental Impact Statement recommendations and local authority (Council) tree preservation orders.	Mandatory	DAB c23 Ecological Value GSC c29 Ecological Value (incl Biodiversity Enhancement)	**Ecology / Landscape Arch**	Native Flora will be protected where possible, new planting on site will predominantly be hardy, low water use indigenous specieis.	Y	
P3-t			**Accessibility** -All new facilities must meet current DTS provisions of the NCC and the associated standards. Generally AS 1428.1 is the minimum design standard for access and mobility. However, it is DoE's policy that any enhanced requirements noted in AS 1428.2 be incorporated in any new design. -Additionally, DoE have enhanced circulation requirements as noted in DG / CIRCULATION - Provide hearing augmentation system for areas that have amplification, generally within Gymnasium, libraries, movement studios and Communal Halls, provide a system to assist the aurally challenged to hear music and speech within the main auditorium and on the stage - Provide the International Symbol for Deafness to indicate that an assistive hearing device is installed.	Mandatory	DAB 30D Universal design	**Arch / Access**	Noted		
P3-u			**Weather protection** Circulation areas provided between administrative, staff and all student spaces (except Agriculture), should be protected from sun, rain and unfavourable winds.	Mandatory	Not covered in Green Star	**Arch**	Noted. We are currently reviewing the extent of cover over these routes		

P3-v			**Open play space** Open play space must be provided for students to access during recess, lunch breaks and for outdoor learning. Open play space can be comprised of - Paved and grassed areas - Rooftops and terraces - Covered outdoor areas The designated open play space must be easily monitored and managed by school staff. Where a joint use agreement can be negotiated with a local council or land owner, the required play space can be located off-site, providing the facilities are - In close proximity to the school - Easily accessible - Safe and secure Designs must aim to achieve a minimum of 10m2 per student. Where this figure is not achievable the proposed m2 per student of the completed project must not be less than the existing m2 per student currently on the site.	Mandatory	Not covered in Green Star	**Arch / Landscape**	Arch: Noted. The proposed playspace area meets the 10sqm per student requirement.	Y	
P3-w			**Staff room**	N/A	GSI c Amenity Space		Arch: The staff room has been designed in line with the EFSG requirements for the Staff Unit.		
P3-x			**Healthy canteen policy**	N/A	DAB c30D Integrating Healthy Environments				
P3-y			**Safety by design** - The Work Health and Safety Act and the Department of Education principles of student safety and welfare mandate the avoidance of accidents through careful design of facilities - The designer must ensure, so far as is reasonably practicable, that the plant, substance or structure is designed to minimise risks to the health and safety of all parties who will work on a site connected with its design as well as the end users of the facility. - An important part of the Safety by Design principle is recording the risk assessments that are conducted during the design and providing to the client, owners, any users/occupiers of the facilities and those who will be building or maintaining the facilities, details of risks and hazards identified. - The design of facilities should not only be inherently safe but visually and pragmatically safe and not tempt students or the general public into unsafe practice. Examples: Glazing: The safety of occupants is paramount where glass is being used, especially in areas subject to human impact. All glazing types and thickness are to comply with the relevant AS as a minimum. Hot water: To minimise scalding risk all hand basins, showers and the kitchen sink in practical activities areas serving IO/IS classes, require "warm" rather than "hot" water provided at a specified temperature, by mixing hot and cold water through a Thermostatic Mixing Valve. (Note: Tempering Valves are not permitted in schools) Drinking water tanks: Ensure rainwater is not collected from areas containing lead materials. All coating materials used inside the reservoir must be suitable for drinking water and guaranteed against liner leakage for a period of 20 years. A filtering and UV system to be provided where drinking water tanks are present.	Mandatory	Not covered in Green Star	**All**	Hyd: Design generally completed in alignment with good practice industry standards and to incorporate 'Safety in Design' considerations Arch: Noted. FJMT will attend, host and facilitate Safety in Design workshops at each phase of the design process.		
P3-z			**Microbial control** As a measure to prevent legionella, heated water to hand basins, showers etc. shall be stored at temperature above 65 C. Thermostatic mixing valves are to be used for tempered water generation at each point of use. Valves nees to comply with microbe disinfection requirements - "Code of Practice for Thermostatic Mixing Valves NSW" as approved by the NSW Health Department.	Mandatory	DAB c28 Microbial Control	**Hydraulic**	Design generally completed in alignment with good practice industry standards. WS+P will look to minimise the length of dead legs to reduce the risk of legionella growth in the system.		
P3-aa			**Security** Safety in Design and Crime Prevention Through Environmental Design (CPTED) principles are to be implemented in project planning stage. Advice on the electronic surveilance systems can be sought early in the design phase. CCTV systems are required in several locations where indicated in the Rooms and Spaces Technical Data table,including: - Secondary clinic - Primary sick bay - Library	TBC	GSC c15 Safe Places	**Security / Comms**			

P3-ab			**Hazardous materials** Where a new school is to be developed a Hazardous materials study is to be conducted, including: - Asbestos Containing Materials (ACM) - Synthetic Mineral Fibres (SMF) - Polychlorinated Biphenyl's (PCB) - Lead Paint - Ozone Depleting Substances Any existing structures and all parts of the site should be examined in order to determine the presence of hazardous materials before commencement of any renovation or demolition. Inspection should be conducted by organisations with the National Association of Testing Authorities (NATA) accreditation complying with the requirements of AS/NZS ISO.IEC 17020 for the inspection of hazardous materials (HazMat) including asbestos. Hazardous Materials inspection reports should be produced in accordance with the requirements of the various Safe Work Australia "Codes of Practice" for the management and control of hazardous substances. Where hazardous materials are found a Hazardous Materials Management Plan should be prepared	Mandatory	DAB 24.2 Contamination and Hazardous Materials	**Geo-Investigation / Main Contractor**			
P3-ac			**Digital infrastructure** New buildings and refurbishments are required to provide a common wireless solution compatible across the school, providing a consistent user experience and support mechanism. This involves the replacement of existing legacy wireless equipment, such as wireless access points and site switches	Mandatory	GSC c22.2 Digital Infrastructure	**Comms**			
R1-a	**Resilience**	R1 – Preparation for shocks	**Site investigations for resilience** The following detailed reports/ surveys/ information should be considered in developing the business case: - Slope, drainage and erosion issues including flood risks (if any) - Geotechnical and soil conditions - Airborne pollutants - Bushfire risks - Appraisal of available services infrastructure An environmental risk report will be required for developments proposed within sensitive natural environments or sites subject to natural risks (i.e. flood prone sites, bush fire areas).	Negotiable	DAB c3 Adaptation and Resilience	**Various**			
R1-b			**Bushfire protection** Development applications on bush fire prone land must be accompanied by a Bush Fire Assessment Report demonstrating compliance with the aim and objectives of Planning for Bush Fire Protection and the specific objectives and performance criteria for the land use proposed. Local Authorities and the Rural Fire Service can provide advice on the design of buildings in bush fire prone areas. The Building Code of Australia and AS3959 "Construction of buildings in bushfire-prone areas" set out the requirements for buildings which are within close proximity to a defined bush fire zone. Mandatory landscape management strategies: - Keep the amount of fuel (leaves, twigs, logs, dead grass) in the vicinity of buildings to a minimum. - Ensure trees are located at aways from buildings to avoid branches overhanging and leaves collecting on roofs. - Do not plant shrubs against buildings. - The crowns of trees planted on the hazard side of the development should not be contiguous. - Plant fire resistant trees and shrubs on the hazard side of the development to reduce the potential impact of wind, fire intensity, radiant heat, and rate of spread as well as intercepting burning embers. - Avoid combustible fencing materials. - Provide irrigation and garden sprinklers to water areas near the buildings (subject to water authority approval).	Mandatory	DAB c3 Adaptation and Resilience	**Arch**	Arch: The school is not located on bushfire prone land.		
R2-a		R2 – Preparation for stresses	**Response to climate risks** Consideration to be given to how sites and school communities will be able to adaptively respond to climate change over time, especially for projects involving vulnerable communities e.g. climate generating exacerbated flood, storm surge, inundation, heatwaves, bush fires, extreme storm and weather events.	Mandatory	DAB c3 Adaptation and Resilience	**Arch / ESD**	Arch: Noted. FJMT will contribute to climate risk assessment as required in conultation with ESD consultant. ESD: Climate Risk assessment is addressed through the SEARS requiremnts in the SSDA report		

9 Appendix B – Green Star Pathway Demonstrating The SINSW's Framework Equivalency.

Darlington Public School: GREEN STAR PATHWAY

New South Wales	Green Star Design & As-Built Credit	v1.3 Available Points	4 Star Target	Optional for Consideration	Compliance Requirements & Comment	Client	Design Team	Contractor	Cost Impact	Integral Comment
MANAGEMENT		**14%**								
1.0	Green Star Accredited Professional	1	1	-	Requires a Green Star Accredited Professional (GSAP) to be engaged for all stages of the project.		Y		Negligible	ESD consultant engaged already
2.0	Environmental Performance Targets	-	Complies	-	Targets for energy and water consumption to be set and documented. E.g. 25% improvement on min DTS Energy Performance. 50% potable water reduction than typical school building.	Y			Negligible	No cost to developing targets internally
2.1	Services and Maintainability Review	1	1	-	School FM staff to review design during design stage and prior to construction. FM to consider commissionability, controlability, maintanability, fit for purpose and safety.	Y			Negligible	This would be done by School as good practice
2.2	Building Commissioning	1	1		Pre-commissioning & commissioning must be undertaken to CIBSE, ASHRAE and/or AIRAH standards/guidelines. Now also requires air tightness testing. This is largely standard practice now for upper tier builders, with the exception of airtightness testing. point not targeted due to air tightness requirement		Y	Y	Low	Commissioning activites primarily negligible cost, with exception of airtightness testing.
2.3	Building Systems Tuning	1	1	-	Requires formal 12month building tuning period with minimum quarterly tuning meetings and recommissioning. Differs from normal DLP activities.	Y	Y	Y	Moderate	Excellent initiative to ensure building is optimised for energy/water/IEQ performance. Cost associated with additional consultant/contractor time.
2.4	Independent Commissioning Agent	1		Y	Requires engagement of ICA to lead/coordinate commissioning & building tuning activities	Y			Moderate	ICA represents additional consultant and cost to project (e.g. $35k to $50k).
3.1	Implementation of a Climate Adaptation Plan	2	2	-		Y	Y	-		
4.0	Building Information	1	1	-	Involves developing package for occupants about building functions, initiatives to enhance energy efficiency, and O&M Information package and a Building Log Book. Intent to provide central point of information for those managing the facility.		Y	Y	Negligible	Generally included within Contractor scope as best practice hand-over materials for schools operation team.
5.1	Environmental Building Performance	1	1	-	Require the School to commitment to set, measure and report on Environmental Performance targets set through Credit 2.0.	Y			Negligible	No cost to developing targets internally
5.2	End of Life Waste Performance	1		-	Not claimed.	-	-	-		
6.0	Metering	-	Complies	-	Metering to be provided to monitor building energy and water consumption. Sub-metering must be provided to all major energy/water/gas demands (more extensive than minimum compliance). Excluded as it is unlikely the design has incorporated the level of sub-metering required		Y	Y	Low	Allowance above base Section J metering
6.1	Monitoring Systems	1	1	-	Requires strategy for how to monitor and use data from collected from BMS. Cloud based technology platforms can be applied for utility management and benchmarking.		Y	Y	Low	Base functionality provided by BMS, however dedicated cloud platforms are better suited.
7.0	Environmental Management Plan	-	Complies	-	A comprehensive project-specific Environmental Management Plan (EMP) must be in place for consutruction. To be included in Head contractor clauses/specification.			Y	Negligible	Good site practice anyway.
7.1	Formalised Environmental Management System	1	1	-	Formalised, systematic and methodical approach to planning, implementing and auditing the EMP to ensure conformance to EMP. To be included in Head contractor clauses/specification. Requires ISO14001 certification for the head contractor.			Y	Negligible	Expected of responsible contractor
7.2	High Quality Staff Support	1	1	-	Contractor required to implement on-site staff wellbeing practices and enhance site workers' knowledge on sustainable practices through educational programs			Y	Negligible	Higher tier contractors likely to have site practices which are consistent with the requirements.
8B	Operational Waste	1	1	-	Requires on-site waste recycling system which are consistent with best practice requirements. Requires engagment of Waste Consultant		Y		Negligible	Integrated with school waste management practices.
	Category Total	14	**12**							

New South Wales	Green Star Design & As-Built Credit	v1.3 Available Points	4 Star Target	Optional for Consideration	Compliance Requirements & Comment	Client	Design Team	Contractor	Cost Impact	Integral Comment
INDOOR ENVIRONMENTAL QUALITY		**17%**								
9.1	Ventilation System Attribiutes	1	1	-	Ventilation system design must meet best practice requirements with regards to intakes and exhaust locations	-	-	-	Negligible	Good design practices
9.2	Provision of Outdoor Air	2			1 point awarded for increase of 50% on AS 1668 minimum OA requirements or CO2 sensors are installed to prevent CO2 concentrations from exceeding 800ppm. 2 points available for 100% increase or not exceeding 700ppm		Y		Low	Nat vent must meet the requirements of AS 1668.4-2012 for quantity of air supplied.
9.3	Exhaust or Elimination of Pollutants	1	1	-	Exhausting pollutants from print/photocopy equipment, cooking equipment, and carpark vehicle exhaust through dedicated exhaust systems. Print/photocopy must be isolated in enclosed spaces.		Y		Low	Good design practice. Check if the staff office will have ptining/photocopying as currently there isn't a dedicated room
10.1	Internal Noise Levels	1	1	-	Acoustic Consultant to confirm. Internal ambient noise levels no more than 5dB(A) above the statisfactory levels provided in Table 1 AS/NZS 2107:2000.		Y		Low	Confirm if requires acoustic systems beyond minimum requirements
10.2	Reverberation	1	1	-	Acoustic Consultant to confirm. Requires mitigation of reverberation in accordance with Australian Standard		Y		Low	Acoustic Consultant to confirm.
10.3	Acuostic Separation	1	1	-	Acoustic Consultant to confirm. Partition between spaces should achieve a weighted sound reduction index (Rw) of at least 45.		Y		Negligible	Acoustic Consultant to confirm.
11.0	Minimum Lighting Comfort	-	Complies	-	Pending lighting design. Lights to be flicker free and address perception of colour in the spaces.		Y		Negligible	Good lighting design and fitting selection
11.1	General Illuminance and Glare Reduction	1	1	-	Pending lighting design. Lighting levels will comply with best practice guidelines (AS 1680.2.4) and glare is eliminated.		Y		Low	May require alternative fitting selection
11.2	Surface Illuminance	1		Y	Surface reflectacne of ceiling to be at least 0.75 (matt white) and ceiling area to have at least 30% illuminance of light on the working plane	-	-	-	-	Dependant on finish specification and lighting design
11.3	Localised Lighting Control	1	1	-	Consideration of lighting control provisions within individual spaces		Y		Low	Requires further review of credit criteria in context of a school.
12.0	Glare Reduction	-	Complies	-	Limited extent of glazing.		Y		Low	
12.1	Daylight	2		Y	Requires space to achieve good levels of daylight. Requires daylight modelling.		Y		Low	Modelling costs to verify
12.2	Views	1	1	-	Determine if glazing at high level is prohibited of views		Y		Negligible	No cost
13.1	Paints, Adhesives, Sealants and Carpets	1	1	-	Internally applied paints, adhesives, sealants and carpets meet stipulated Total VOC Limits. Refer to Green Star Design and As-Built guidelines for limits.		Y	Y	Negligible	Standard industry practice now and contributes to conducive learning environments.
13.2	Engineered Wood Products	1	1	Y	All engineered wood products meet stipulated formaldehyde limits or no new engineered wood products are used in the building. Refer to Green Star Design and As-Built guidelines for limits. Includes particleboard, plywood, fibreboard etc.		Y	Y	Negligible	Standard industry practice now and contributes to conducive learning environments.
14.1	Thermal Comfort	1		Y	Verification of thermal comfort performance required through the application of thermal comfort modelling.		Y		Moderate	Requires additional engagement of thermal comfort modelling by ESD consultant.
14.2	Advanced Thermal Comfort	1		-	90% Occupant satisfaction	-	Y	-		
	Category Total	17	**10**							

Darlington Public School: GREEN STAR PATHWAY

New South Wales	Green Star Design & As-Built Credit	v1.3 Available Points	4 Star Target	Optional for Consideration	Compliance Requirements & Comment	Client	Design Team	Contractor	Cost Impact	Integral Comment
ENERGY		**22%**								
15A.0	Conditional Requirement	NA	Complies	-	Requires minimum Deemed-to-Satisfy (DTS) requirements of Parts J1 (building fabric) and J2 (glazing) of Section J to be exceeded by 5%.		Y			
15A.1	Building Envelope	1	1	-	Nominal increase of 10% over Section J minimum R-Value requirements for building fabric.		Y			
15A.2	Glazing	1	1	-	Requires 10% improvement on minimum Section J Glazing U-Value and SHGC requirements.		Y			
15A.3	Lighting	1	1		Lighting power density is 10% less than maximum allowed in Section J. Automated lighting control systems (occupant detection, daylight, time switches) provided.		Y			
15A.4	Ventilation and Air Conditioning	1	1		The space is naturally ventilated or 10% improvement on Section J efficiency requirements for fan, pump, water heater and air conditioning equipment.		Y			
15A.5	Domestic Hot Water	1	1	-	Domestic Hot Water to be powered by electric heat pump. Can be powered by natural gas but this is least preferrable option.		Y			
15A.7	Accredited GreenPower	5		Y	Requires ongoing purchase of green power energy premium.	Y				
15A - New credits	Optional Prescriptive Point: Transition Plan	1		Y	Requires to reduce fossil fuel use and develop a transition plan to phase them out. Project teams need to publicly commit to a transition plan and show it has been developed, demonstrating how the building will transition away from the use of fossil fuels.	Y				
	Optional Prescriptive Point: Fuel Switching	1	1	Y	Required to demonstrate that a percentage of energy required by the building annually is generated by on site renewable solutions; OR Other points have been achieved in the pathway		Y			
	Optional Prescriptive Point: Onsite Storage	1		Y	• A renewable energy storage procurement and use strategy has been developed and demonstrates that the storage is sized to match the requirements of the building and that value will be provided to the project; • The stored renewable energy is used to reduce the peak electricity demand; and • The onsite storage must be set up to receive renewable energy (onsite or offsite)		Y			
	Optional Prescriptive Point: Vertical Transport	1	Not targeted		Required that the energy associated with lift machinery or other vertical transportation meets: • The minimum lift energy efficiency is class B in accordance with ISO 25745-2; and • The minimum lift idle and standby energy performance level is 1 in accordance with ISO 25745-2. • The minimum escalator energy performance is class A+ in accordance with ISO 25745-3. Where projects have both lifts and elevators installed, all three criteria must be met.					
15E	GHG Emissions Reduction - Modelled Performance	20		Y	Requires energy modelling to demonstrate reduction in energy consumption and GHG emissions of the propsed building as compared to a reference building. Points are awarded based on efficient building services, PV renewable energy generation.		Y		Moderate	
16A	Peak Electricity Demand Reduction - On-Site Energy Generation	2	2	-	Requires to reduce total peak electricity demand by 15%. Achieved through the application of passive design features, efficient building services and embedded generation.					
	Category Total	36	**8**							
TRANSPORT		**10%**								
17B.1	Access by Public Transport	3	Not targeted	-	Based on accessibility of the site by public transport. Site achieves a good 'Walk Score'. Further work required to verify		Y		Negligible	Product of site characteristics
17B.2	Reduced car Parking Provision	1	1	Y	Requires consideration of additional on-site carparking.	-	Y	-	Negligible	School bus? Would need to review current parking numbers more closely
17B.3	Low Emisson Vehicle Infrastructure	1		Y	Requires provision of electric vehicle charging infrastructure and/or dedicated car share spaces.	-	Y	-	Moderate	Cost of chargers to be considered
17B.4	Active Transport Facilities	1	Not targeted	-	Requires bicycle parking, access to showers and lockers on site for occupants/visitors. Schools have an additional requirement for bicycle parking which is significant		Y			
17B.5	Walkable Neighbourhoods	1	Not targeted	-	The site achieves a good walk score due to location (receives a score of 73 where minimum required is 80).	-	Y	-		
	Category Total	7	**1**							

Darlington Public School: GREEN STAR PATHWAY

New South Wales	Green Star Design & As-Built Credit	v1.3 Available Points	4 Star Target	Optional for Consideration	Compliance Requirements & Comment	Client	Design Team	Contractor	Cost Impact	Integral Comment
WATER		**12%**								
18A	Potable Water - Performance Pathway	12	6	-	Fixtures to meet minimum WELS ratings: taps (6 *), urinals (6 *), toilets (5 *), showers (3 *), rainwater harvesting, avoidance of water-based heat rejection (standard for schools), efficient landscape irrigation system and fire system test water harvesting (TBC fire protection system).		Y		Negligible	Rainwater capture and reuse covered in the return brief report
	Category Total	12	**6**							
MATERIALS		**14%**								
19	Life Cycle Impacts	7		-	Not claimed.	-	-	-		
20.1	Structural and Reinforcing Steel	1		-	Not claimed.	-	-	-		
20.2	Timber Products	1	1	-	Requires timber used in building and construction to be from a reused source or certified by a forest certification scheme. To be confirm if this was included in the specification.			Y	Low	Generally attainable based on proactive management of sub-contractor material procurement.
20.3	Permanent Formwork, Pipes, Flooring, Blinds and Cables	1	1	-	Requires materials to have no PVC and have an Environmental Product Declaration, or PVC to meet bet practice guidelines for PVC. To be confirm if this was included in the specification.			Y	Low	Generally attainable based on proactive management of sub-contractor material procurement.
21	Product Transparency and Sustainability	3				-	Y	-	Low	Environmentally friendly building materials covered in the design brief
22B	Construction and Demolition Waste	1	1	-	Requires reducing construction waste going to landfill by reusing or recycling 90% of the waste generated during construction.			Y	Negligible	Good contractor practices
	Category Total	14	**3**							
LAND USE & ECOLOGY		**6%**								
23.0	Endangered, Threatened or Vulnerable Species	-	Complies	-		Y			Negligible	Product of site characteristics
23.1	Ecological Value	3	1	Y	Points awarded where the ecological value of the site is improved by the project. Assumed one point achieve, however verification required via Ecological Value Calculator.					Landscape design to be confirmed around Sports Hall
24.0	Sustainable Site	-	Complies	-			Y		Negligible	Product of the site characteristics
24.1	Reuse of Land	1		-	Available where 75% of the site was previously developed.					
24.2	Contamination and Hazardous Materials	1		-	Awarded where the site, or an existing building, was previoulsy contaminated and the site has been remediated in accordance with best practice remediation strategies. To be confirmed by geotechnical engineer.					
25.0	Heat Island Effect Reduction	1	1	-	Generally requires appropriate selection of roof materials, selection of hardscape treatment and extent of landscape/tree coverage. Would require conscious review of site landscape/hardscape.		Y		Low	Dependant on material selection / landscape design proposals
	Category Total	6	**2**							
EMISSIONS		**5%**								
26.1	Stormwater: Reduced Peak Discharge	1	1	-	Civil Engineer to confirm. Post-development peak event discharge from site does not exceed the pre-development peak event discharge.		Y		Moderate	Pending comment from Civil Engineer. Requirements may align with minimum council requirements.
26.2	Stormwater: Reduced Pollution Targets	1	1	-	Civil Engineer to confirm. All stormwater from the site meets specified Pollution Reduction Targets.		Y		Moderate	Pending comment from Civil Engineer. Requirements may align with minimum council requirements.
27.0	Light Pollution to Neighbouring Bodies	-	Complies	-	Pending lighting design. Project to comply with AS 4282:1997 Control of the Obtrusive Effects of Outdoor Lighting		Y		Negligible	Product of good lighting design
27.1	Light Pollution to Night Sky	1	1	-	Pending lighting design. It can be demonstrated that a specified reduction in light pollution has been achieved.		Y		Negligible	Product of good lighting design
28.0	Legionella Impacts From Cooling Systems	1	1	-	To be confirmed by mechanical. Awarded where water-based heat rejection is avoided for mechanical services.		Y		Negligible	Product of appropriate mechanical services design. Confirm if water based heat rejection systems are currently not proposed within project.
29.0	Refrigerants Impacts	1		-	Not claimed. Exceptionally challenging credit to achieve.	-	-	-		
	Category Total	5	**4**							

New South Wales	Green Star Design & As-Built Credit	v1.3 Available Points	4 Star Target	Optional for Consideration	Compliance Requirements & Comment	Client	Design Team	Contractor	Cost Impact	Integral Comment
INNOVATION										
30A	Innovative Technology or Process		1	-	Passive water treatment systems + Onsite renewable energy	-	Y	-	Moderate	PVs as per design brief
30B	Market Transformation			Y	Potentially Soft landings if ICA engaged	-	-	-	Moderate	ICA costs
30C	Exceeding Green Star Benchmarks		1	Y	1) If 15E pursued, can we achieve over 12 points through passive design strategies? 2) Civil engineer to confirm if project can improve on pollution reduction targets. 3) Construction and demo waste reductions to 5Kg/sqm of GFA		Y		Moderate	1) Extra modelling required. 2) Civil works for proprietary treatment systems. 3) Further waste avoidance/management
30D	Innovation Challenge	10	2	Y	1) Community benefits - potential benefits of the program to the student community 2) Contractor education 3) Financial transparency 4)Integrating healthy environments - health & wellness benefits to occupants of living/working/studying in the natural bush environment of the site?		Y			Points awarded based on sustainable initiatives taken which fall outside of available Green Star credits, such as "community engagement". Further work required
30E	Global Sustainability			-		-	-	-	-	
	Category Total	10	**4**							
TOTAL			**50.0**							

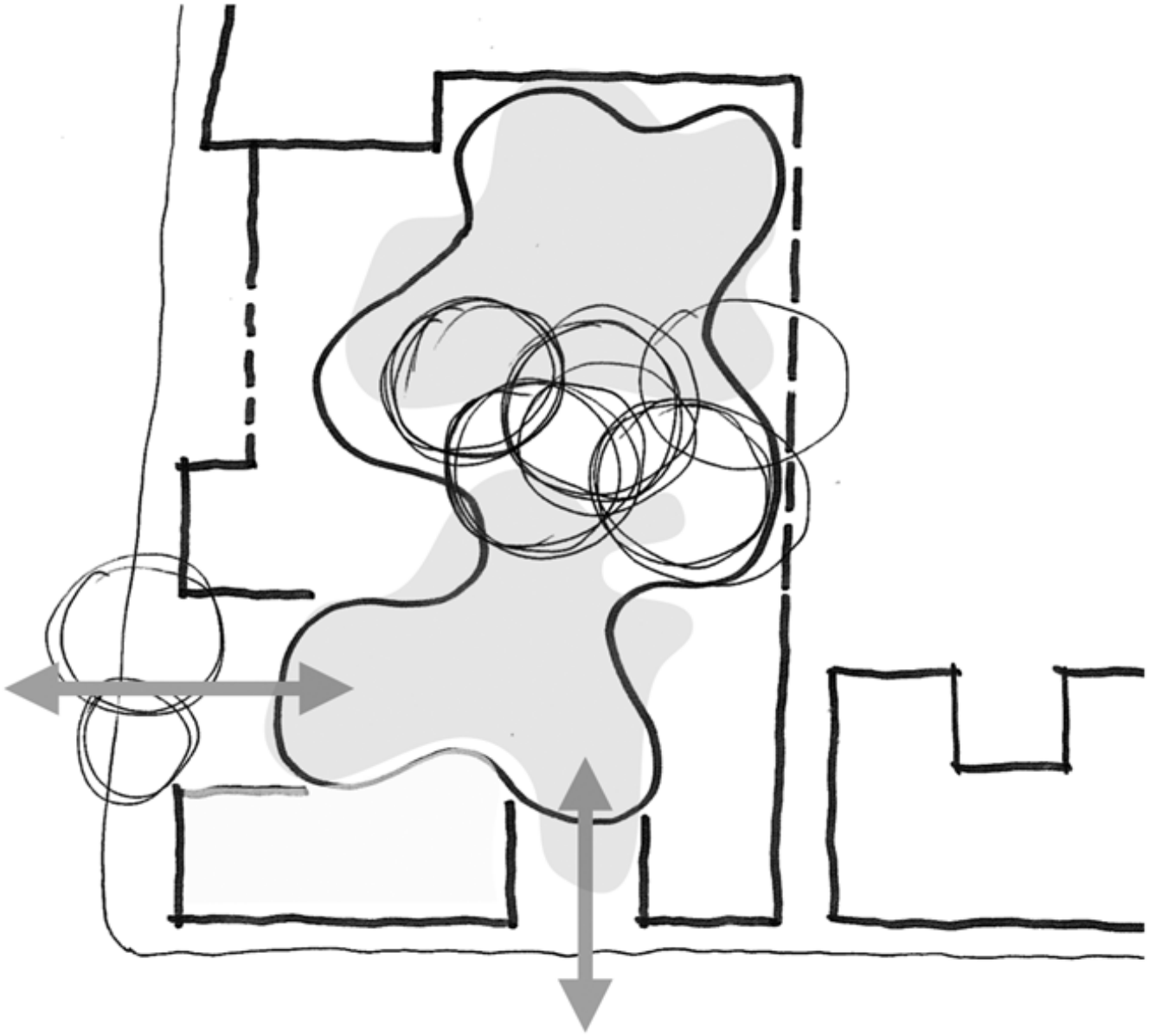
DARLINGTON PUBLIC SCHOOL REDEVELOPMENT

Appendix Y — Geotechnical Report

SSD-9914

Prepared by Douglas Partners

For NSW Department of Education



Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Upgrade Works
Darlington Public School, Darlington

Prepared for
Gardner Wetherill & Associates

Project 92277.01
February 2019

Douglas Partners
Geotechnics / Environment / Groundwater

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		12 February 2019
Reviewer	pp MJT	12 February 2019

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Report on Geotechnical Investigation
Proposed Upgrade Works
Darlington Public School, Darlington

1. Introduction

This report presents the results of a supplementary geotechnical investigation undertaken for proposed upgrade works at Darlington Public School, Darlington. The investigation was commissioned by Luen Samonte of Gardner Wetherill & Associates and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal MAC180298 dated 13 September 2018.

DP understands that the site currently comprises an operating primary school and preschool. It is also understood that the proposed redevelopment and upgrading works include the demolition of existing buildings and the construction of new teaching blocks within the site; however the detailed design information of the proposed buildings and or any cut-fill plans were yet to be finalised at the time of this report.

A preliminary geotechnical investigation was previously undertaken by DP (Project 92277.00) which comprised the drilling of nine shallow boreholes to auger refusal. This supplementary investigation was undertaken to support the preliminary investigation report and assist in the design of proposed upgrade works.

The supplementary investigation included the drilling of six cored boreholes and laboratory testing of selected samples. Details of the work performed and the results obtained are given within this report, together with comments relating to foundation design and earthworks. This report should be read in conjunction with the Preliminary Geotechnical Investigation Report.

DP has undertaken a Detailed Site Investigation (DSI) for Contamination in conjunction with this investigation (Report 92277.01.R.002) which will be reported on separately. A prior Contamination Assessment (Report 92277.00.R.001) and Hazmat Survey (Report 92277.00.R.003) were also undertaken concurrently with the Preliminary Geotechnical Investigation for the site.

2. Site Description

Darlington Public School is located on the corner of Golden Grove Street and Abercrombie Street at Darlington, and covers a rectangular area of approximately 0.72 ha with maximum north-south and east-west dimensions of approximately 100 m and 80 m, respectively.

The school campus consists of two basketball courts to the north, school buildings to the south and west, and playgrounds in the central portion of the site.

At the time of the investigation, large trees covered most of the playgrounds, as well as surrounding the basketball courts. The playground areas were variably concrete and rubber matting.

3. Regional Geology

Reference to the 1:100 000 Sydney Geological Series Sheet (Ref 1) indicates that the site is underlain by Ashfield Shale (mapping unit Rwa) of the Wianamatta Group of Triassic age. This formation typically comprises siltstone and laminite which weather to form clays of high plasticity. The results of the investigation were generally consistent with the geological mapping where residual clays and shale of variable weathering and strength conditions were encountered in all boreholes.

4. Field Work

4.1 Methods

The field work comprised the drilling of six boreholes (Bores A – F) to a depths of up to 10.4 m using a bobcat mounted drilling rig and a combination of continuous solid flight augers with a nominal 100 mm diameter and 'NMLC' rotary coring techniques and water flush with steel casing to obtain continual rock core samples. Standard penetration tests (AS 1289.6.3.1) were also carried out at regular intervals whilst augering. The standard penetration test procedure is given in the attached notes and the penetration 'N' value obtained during testing is shown on the borehole logs.

The field work was undertaken by a geotechnical engineer who logged the boreholes and collected disturbed samples to assist in strata identification and for laboratory testing. Following logging, testing and sampling, each borehole was backfilled and the ground surface reinstated with either cold-mix asphalt, quick-set concrete or spoil material depending on surface material at each borehole location.

The borehole locations were nominated by the client and located on site by DP. The locations are shown on Drawing 1 (Appendix A) and were surveyed with a differential GPS, for which an accuracy of ± 20 mm is typical.

All field measurements and mapping for this project has been carried out using the Geodetic Datum of Australia 1994 (GDA94) and the Map Grid of Australia 1994 (MGA94 Zone 56). All reduced levels are given in relation to Australian Height Datum (AHD).

4.2 Results

The borehole logs are included in Appendix B, and should be read in conjunction with the accompanying standard notes that define classification methods and descriptive terms. Relatively uniform conditions were encountered underlying the site, with the general succession of strata broadly summarised as follows:

- FILLING – comprising asphaltic concrete, concrete and sandy clay with some gravel to depths in the range of 0.07 – 0.20 m encountered in Bores A, B and D – F, with clayey silt topsoil to a depth of 0.2 m in Bore C;
- FILLING – variable mixtures of sand, silt and clay filling with some gravel to depths in the range of 0.7 – 2.4 m in all boreholes;
- CLAY – stiff to hard silty clay to depths of 2.0 – 3.5 m in all boreholes; and

- BEDROCK – extremely low strength shale first encountered at depths of 2.0 – 3.5 m in all boreholes and generally increased in strength with depth. Shale generally became medium strength, interbedded siltstone and fine-grained quartz-lithic sandstone at depths in the range of 8.30 – 9.04 m and continued to the termination depths of 9.80 – 10.44 m in all boreholes, except for Bore D which terminated in low strength shale at 9.55 m.

No free groundwater was observed in the boreholes during auger drilling and for the short time that they were left open. The introduction of water into the boreholes during the rotary coring and the immediate backfilling of the test locations precluded any long-term observations of groundwater levels that might be present. It is noted that groundwater levels are affected by factors such as weather conditions and can fluctuate with time.

5. Laboratory Testing

5.1 Plasticity Testing

Selected samples from the boreholes excavated for the preliminary geotechnical investigation were tested in the laboratory for measurement of field moisture content, Atterberg limits and linear shrinkage. The detailed laboratory test report sheets are given in Appendix C, with the results summarised in Table 1.

Table 1: Results of Plasticity Testing

Bore No	Depth (m)	Material	W_F (%)	LL (%)	PL (%)	PI (%)	LS (%)
A	1.0 – 1.45	Silty Clay	21.0	68	23	45	14.0
B	1.0 – 1.45	Silty Clay	23.4	66	24	42	13.5
C	1.0 – 1.45	Silty Clay	25.8	72	23	49	16.5
F	1.0 – 1.45	Filling	14.9	41	23	18	8.0

Where W_F = Field moisture content, W_P = Plastic limit, W_L = Liquid limit, PI = Plasticity Index, LS = Linear shrinkage

The results indicate that the natural clays and clay filling encountered on site appear to be of moderate to high plasticity and as such, would be expected to be susceptible to shrinkage and swelling movements due to seasonal moisture variations.

5.2 Point Load Testing

Selected rock core samples were tested in the laboratory for measurement of point load strength index ($Is_{(50)}$) to estimate rock strength at variable depths. The detailed laboratory test report sheets are given in Appendix C and the values of $Is_{(50)}$ are shown on the borehole logs.

6. Proposed Development

It is understood that conceptual planning for the site is in progress, with detailed design not yet completed. Based on preliminary information, the redevelopment works are likely to comprise the demolition of some buildings within the site and the construction of new teaching blocks. The proposed buildings are likely to be multi-storey, however, the locations, design loads and other design information of the structures are unknown to DP at this time. Once design details are known, the advice given within this report must be reassessed prior to finalisation.

7. Comments

7.1 General

The following comments are based on the surface and subsurface profiles encountered in the boreholes. Comments are provided in the following sections on development constraints related to geotechnical and geological factors to assist in the foundation design of the proposed new buildings. As detailed design of the proposed redevelopment works has not been undertaken, the comments given must also be considered as being preliminary in nature. Once details are available, they should be forwarded to DP for review to determine if comments given within this report are appropriate or require revision.

7.2 Subsurface Conditions

The following comments are based on the surface and subsurface profiles encountered during the investigation and the results of laboratory testing of selected samples collected at the borehole locations. The investigation findings have shown that subsurface conditions underlying the site generally comprise topsoil, concrete or asphaltic concrete to a depth of 0.07 – 0.2 m underlain by filling to depths of 0.7 – 2.4 m. The filling is underlain by generally stiff to hard silty clays to depths in the range of 2.0 – 3.5 m which in turn is underlain by bedrock comprising extremely low to medium strength, weathered shale of interbedded siltstone and sandstone which continued to the termination depths of the boreholes.

The bedrock from the cored boreholes has been classified in accordance with Reference 3 and depths/RLs of each rock class are summarised in Table 2.

Table 2: Depth/Level of Rock Classes

Bore	RL Depth (m)	Thickness (m)	Rock Class (Shale)
A Surface Level: 38.1m AHD	35.6 – 29.7	5.9	IV
	29.7 – 27.6	2.1	III
B Surface Level: 36.0m AHD	33.4 – 27.9	5.5	IV
	27.9 – 27.0	0.9	III
	27.0 – 25.5	1.5	II
C Surface Level: 34.6m AHD	30.1 – 27.8	2.3	IV
	27.8 – 26.4	1.4	III
	26.4 – 24.6	1.8	II
D Surface Level: 33.0m AHD	27.8 – 26.2	1.6	IV
	26.2 – 23.4	2.8	III
E Surface Level: 34.1m AHD	30.1 – 25.7	4.4	IV
	25.7 – 24.8	0.9	III
	24.8 – 24.3	0.5	II
F Surface Level: 34.9m AHD	31.1 – 29.5	1.6	IV
	29.5 – 26.6	3.3	III
	26.6 – 24.7	1.9	II

The cored borehole logs indicate that the rock structure is mainly governed by horizontal to sub-horizontal (0º – 10º) bedding and horizontal to steeply-inclined (0° – 45°) jointing observed mainly in fractured shale. The fracture spacings shown on the recovered core samples show 'highly fragmented' and weathered rock to depths of 7.0 – 8.3 m in the boreholes. Better quality shale was encountered in the boreholes at RL's 25.7 – 29.7 m AHD and identified as Class III shale as detailed in Pells et al – 1998 (Ref3).

7.3 Foundations

The results of the investigation indicate that good quality weathered rock will be expected at depths ranging from 7.0 – 8.3 m at the borehole locations, and hence, pending the required excavation depth, deep foundations in the form of bored piles would be suitable options to accommodate the loads of the proposed multi- storey buildings. The use of shallow footings may only be justified for the lightly loaded structures founded in controlled filling or stiff natural clay or if deep excavations for basement parking are proposed.

Based on the results of the field investigation and laboratory testing, retaining wall and building footings could be proportioned using the maximum design parameters presented in Table 3. The footing recommendations and design parameters for any given strata will need to be confirmed following completion of the design stage when final excavation depth, footing size and design loads are specified.

Table 3: Estimated Design Parameters

Material		Ultimate Base Bearing Pressures (kPa) (1)	Ultimate Shaft Adhesion Pressures (kPa) (2)	Allowable Base Bearing Pressures (kPa) (3)	Allowable Shaft Adhesion Pressures (kPa)	Allowable Lateral Resistance (kPa)
Controlled fill		-	-	100	-	-
Very stiff to hard clay		-	-	200	-	-
Shale	Class V	3000	100	700	70	200
	Class IV	6000	150	1000	100	300
	Class III	20000	750	3500	350	1200

Notes (1) The values are in accordance with Pells et al - 1998 (Ref3);
(2) Ultimate values occur at large settlements (generally >5% of the minimum footing width);
(3) Values can only be adopted for clean sockets of roughness category R2 or better. Values may need to be reduced to account for smear;
(4) Value for rock based on settlements of <1% of minimum footing width.

Base bearing and shaft adhesion values have also been provided for Limit State design. The geotechnical strength reduction factor Φg of 0.45 shall be applied in accordance with AS 2159-2009 (Ref 4), Table 4.3.2 based on the available information.

Reference should be made to the borehole logs (Appendix B) and Table 2 with respect to the depth/levels of the various bearing strata.

7.4 Earthworks

It is considered that some bulk earthworks, including the removal of existing structures and underlying moisture affected or unsuitable material will be expected. The final earthworks plans have not been finalized at the time of preparing this report. It can be inferred from the conceptual design drawing that a lower ground floor is incorporated in the proposed buildings. Filling is expected to be limited to grading the site surface for light demountable buildings, pavement construction and installation of services.

7.4.1 Site Preparation

It is recommended that all filling be placed and compacted in accordance with Level 1 requirements (AS 3798 – 2007, Ref 2). To prepare the site for the construction of new buildings, the following procedures are suggested:

- Stripping of vegetation and organic topsoils and pavement material. Topsoil may separately be stockpiled for use in landscaping or removed off site;
- Stripping of uncontrolled fill and unsuitable material within the footprint of the proposed buildings. Inspection of the stripped surface by a geotechnical engineer;
- Compaction of the exposed surface with at least of 8 passes of a 12 tonne (minimum dead weight) roller, followed by test rolling in the presence of a geotechnical engineer. Where soft spots are identified, they should be excavated and then backfilled using a suitable granular material. Additional filling may also be required to elevate building platforms. All filling should be placed in 250 mm (loose thickness) layers and compacted with placement moisture contents within the range of -2% to +2% of OMC in order to limit surface deflection during proof rolling;
- Surface drainage should be maintained at all times by adopting appropriate cross-falls across the site. Surface drainage should be installed as soon as is practicable in order to capture and remove surface flows to prevent erosion and softening of the exposed surface.

Filling delivered to site must be approved by the geotechnical consultant prior to delivery to site. Highly reactive clay filling should be avoided.

Site observations and laboratory test results have indicated the presence of high plasticity silty clays in some areas which could be adversely affected by inclement weather. Whilst these soils are typically of a stiff to very stiff consistency when dry, they can rapidly lose strength during rainfall and subsequent partial saturation and result in difficult trafficability conditions.

Conventional sediment and erosion control measures should be implemented during the construction phase, with exposed surfaces to be topsoiled and vegetated as soon as practicable following the completion of earthworks.

7.4.2 Excavation

All topsoil, filling, natural soils and bedrock up to very low to low strength should be readily removed using a conventional medium sized excavator fitted with a toothed bucket possibly with some light ripping in the weathered bedrock. These conditions were generally encountered to depths of about 7.0 – 8.0 m within all borehole locations

The excavation is expected to include any moisture affected material within the footprint of demolished buildings and then extend further to the design level at the base of the lower ground level or any proposed basement level.

Where low to medium strength rock is encountered, these areas will, for the most part, be adequately removed during bulk earthworks using a large excavator with some light to medium ripping. However, larger plant may provide greater excavation efficiency particularly during drilling of pier foundations.

Medium to high strength rock will offer greater resistance to light ripping. These areas will require pneumatic/hydraulic hammering equipment in combination with rock sawing and/or grinding to achieve the required cut depths.

Due to the proximity of surrounding buildings and presence of filling at shallow depth, the vibration resulting from the excavation could cause damage to the underground services or brick structures. It is recommended, if the use of percussive equipment is required within 40 m of any vibration sensitive structures, vibration monitoring should be undertaken. If the monitoring indicates unacceptable levels of vibration, then the use of non-percussive (ie: rock sawing and ripping) excavation methods will be required. This requirement however, will need to be determined on site once the details of the bulk earthworks and proposed excavation equipment are known.

Anticipated equipment required for excavations are given as a guide only. Rock strength and quality are expected to vary within the footprint of the proposed buildings. Assessment of excavation difficulties are best determined by intending contractors based on inspection of the core samples, the equipment they have at their disposal and the experience of the operators. For information on soil and rock types and indicative strength, reference must be made to the individual logs which are included in Appendix B.

7.4.3 Reuse of Excavated Materials

Generally, the filling, natural clays and bedrock of up to low strength encountered during the investigation, will be suitable for reuse as engineered filling within the site. The material should not contain any particle sizes greater than 150 mm as these may cause inadequate compaction, and should not contain silts due to their propensity for saturation and erosion. It is expected that the extremely weathered or low strength rock should readily break down beneath the weight of the rollers. However, bedrock of medium strength or higher may potentially need to be crushed using a rock crusher.

Topsoil and other deleterious materials will not be suitable as a fill material but could be stockpiled for potential use in landscaping or alternatively, removal from site.

7.4.4 Batter Slopes

While cut slopes within the clays may often stand vertically and unsupported (provided no nearby structures are present) for short periods of time, they will rapidly lose strength upon exposure to weather. A maximum batter slope of 1(H):1(V) is recommended for unsurcharged temporary slopes in stiff clays. The maximum batter slope should be reduced to 3(H):1(V) for temporary batters in uncontrolled filling.

Where the slopes are to be vegetated to prevent erosion, a maximum final batter slope of 3(H):1(V) is recommended. If batters greater than 4 m in height are required, the inclusion of a 2 m wide intermediate bench in mid-height is recommended to reduce the effects of scour and erosion.

Where filling batters are formed, similar parameters to those recommended for cut slopes can be adopted. However, it is recommended that whilst the slope is being formed, the batters should be over-filled in near-horizontal lifts and cut back to form the design grades.

7.5 Excavation Support

Once bulk excavations are required, temporary or permanent batters at recommended batter angles may not be feasible due to insufficient space for batters adjacent of the excavation.

The design of shoring will therefore be required for subsurface materials as batters steeper that those suggested in Section 7.4 are not expected to remain stable for a long period of time. The design should take account of the lateral loads due to adjacent structures.

Pending the final excavation depth, the following options may be adopted for retaining the excavations in this project. The feasible options would include either anchored soldier piles (drilled at maximum 2.4 m spacings) with close shuttering / shotcrete infill panels or contiguous piling. In the absence of details of adjacent footings being available, contiguous piles should be used for excavations adjacent to neighbouring buildings. Contiguous piling is the cheapest form of concrete pile wall, however, is not a water retaining structure and may not be suitable for any material due to gaps between piles.

Excavation of panels for a shotcreting at anchored soldier piles option should be staged to allow a hit and miss approach with the first panel extending no more than 1.0 m below the base of the adjacent building foundation, including the reinforcement overlap. The next row of panels should not exceed 1.5 m with subsequent panels not exceeding 2 m in height.

Drainage is normally provided behind shotcrete walls. The sprayed concrete wall should provide adequate structural support, however it may be appropriate to install a false wall (single brickwork or block work) for aesthetic purposes and to avoid dampness. Care should be exercised in construction to ensure that anchors are installed progressively with excavation (and stressed up) and that the shotcreting is carried out at regular intervals to limit the exposed sections. The first row of anchors should be installed as high as possible and stressed up to 80% of its working load prior to excavation of the next row of panels.

A high capacity piling rig will be required to penetrate the high strength rock. Otherwise, the piers may refuse in the high strength rock, well above the excavation levels and additional anchors may need to be installed in the toe of each pier to provide support/restraint of the structure and rock mass.

As a result of moderately to steeply-inclined jointing especially in fractured shale and presence of highly weathered overburden material there is a potential for 'wedge-type' failures within the batters. Therefore, allowance will need to be made for the support of the fractured rock where contiguous walling is not installed. The support requirements will depend on a number of factors including extent of disturbance during excavation; orientation (bearing), persistence (lateral continuity) and spacing (horizontal separation) of jointing; clay infilling of open jointing; and groundwater. As such, detailed design should be reviewed and verified by DP to ensure the allowance has been made for variable subsurface strata encountered.

As a guide, in addition to the soldier piles, preliminary design of infilled panel sections should allow for the application of a steel mesh-reinforced shotcrete layer with a minimum nominal thickness of 150 mm where permanent support is required or 75 mm for temporary support. Due to the highly fractured nature of the rock stratum, the installation of rock bolts may be considered to support the temporary excavations batters based on inspections carried out by an engineering geologist. The final required bolt lengths can only be determined following assessment of fracture characteristics observed in the face.

Earth pressures acting on multi-anchored shoring structures and retaining walls can be estimated on the basis of a trapezoidal pressure distribution (ie: triangular to 0.25 H, uniform from 0.25 H to 0.75 H and triangular decreasing to zero from 0.75 H to H) with depth using appropriate values of bulk density and active (Ka) or 'at rest' (Ko) lateral earth pressure coefficients as set out in Table 4.

Table 4: Suggested Lateral Earth Pressure Design Parameters – Retaining Structures

Retained Material	Bulk Density (kN/m^3)	K_0	Ka	
			Short Term	Long Term
Stiff to hard clay and extremely weathered rock	20	0.6	0.25	0.3
Very low strength shale	22	0.45	0.3	0.35
Medium strength or greater shale	22	-	10 kPa*	10 kPa*

* A uniform pressure of 10 kPa should be adopted for the support of the medium strength shale to account for possible defects, but subject to inspection during the early stages of excavation to confirm bedding/jointing and revision of lateral restraint, if appropriate.

'At rest' pressure coefficients are appropriate where support must be provided to boundaries and where movement intolerant services or adjacent structures are present. Surcharge lateral pressure due to any adjacent structure will also need to be taken into account where the footings found on low strength or weaker rock or unfavourably orientated jointing is encountered.

The current investigation is not suggesting any indication of the groundwater table to the limit of investigation. In the event that, a tanked basement is required for this project, full hydrostatic pressure should be allowed for in design. As such, densities of the retained soils can be appropriately reduced to the buoyant values. Where applicable, superimposed surcharge loads due to adjacent driveways and developments should also be accommodated in the design of such structures.

Where appropriate, lateral restraint may also be developed by embedding piles below the base of the excavation and developing passive pressure. Suggested ultimate passive resistance values are given in Table 5 and may be adopted below one pile diameter beneath the bulk excavation level and should incorporate a factor of safety to limit wall movement.

Table 5: Suggested Ultimate Passive Pressure Values

Material	Ultimate Passive Pressure (kPa)
Extremely low and very low strength siltstone	300
Low strength shale	1200
Medium or greater strength shale	4000

Where engineer-designed retaining walls are proposed, the following measures should be incorporated into the design:

- Backfilling of the void between the wall and the slope using imported, free draining granular material connected into a drainage pipe at the base of the wall;
- Capping of the backfill (where exposed) with compacted clay or concrete to prevent surface runoff entering the backfill;
- Provision of an open drain to collect and divert surface runoff from ponding above the wall;
- For horizontal backfill or retained soils, design based on an average bulk unit weight for retained material of 20 kN/m^3 and on a triangular earth pressure distribution based on an active earth pressure coefficient of (K_a) 0.3 for compacted filling and natural clay where no movement sensitive structures are located within a horizontal distance of 2H (where H is the vertical height of the retained zone) of the rear of the wall;
- Where there are movement sensitive structures located within the abovementioned critical zone, an at rest pressure coefficient (K_0) of 0.6 should be adopted; and
- If hydrostatic pressures are allowed, soil densities could be reduced to the buoyant values.

If an adequate drainage medium is not provided behind the retaining wall, then hydrostatic pressures must be incorporated within the design with soil parameters reduced to their buoyant values.

7.6 Earthquake Actions – Sub-soil Class

The site stratigraphy comprises minor filling and topsoil underlain by stiff to hard silty clays, overlying bedrock at depths ranging from 2.2 m to 4.5 m within the footprint of the proposed structure. Therefore, the site's sub-soil class when assessed in accordance with AS 1170.4 – 2007 (Ref 5) is considered a rock site and a classification of Class B_e is suggested.

8. Summary

The investigation included the drilling of six cored boreholes to a maximum depth of 10.4 m within the proposed school site at the locations nominated by the client. The boreholes have indicated that subsurface conditions underlying the site generally comprise variable depths of filling and topsoil overlying silty clay and clay of very stiff to hard consistency. Rock was encountered in all boreholes on first contact at depths of between within the range 2.2 m to 4.5 m.

Bearing capacity recommendations are provided in Section 7.3. The site preparation, earthworks and excavation support recommendations are to be undertaken in accordance with Sections 7.4 and 7.5.

Consideration must be given to the preliminary nature of the investigation and potential for variability in the subsurface condition across the site. Once design is suitably advanced, DP must review the plans to determine if the comments given within are appropriate or if additional investigations are required.

9. References

1. Geology of 1:100 000 Sydney Geological Series Sheet No 9130, Dept of Mineral Resources, (1983).
2. AS 3798 – 2007, "Guidelines on Earthworks for Commercial and Residential Developments".
3. Foundations on Shales and Sandstones in the Sydney Region, Pells *et al*, Australian Geomechanics Journal (1998).
4. Australian Standard AS 2159 – 2009 "*Piling – Design and Installation"*.
5. AS 1170.4 – 2007, "Structural Design Actions – Part 4: Earthquake Actions in Australia".
6. AS 1170.4 – 1993, "Structural Design Actions – Part 4: Earthquake Actions in Australia".

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Darlington Public School in accordance with DP's proposal dated 13 September 2018 and acceptance received from Ms Luen Samonte. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Gardner Wetherill & Associates Pty Ltd for this project only and for the purposes as described in the report. It should not be used or relied upon for other projects or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this report did not include the assessment of surface or subsurface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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Appendix A

About This Report
Drawing 1

About this Report

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Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole 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. They may not be the same at the time of construction as are indicated in the report; and
- 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 first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or 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 a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

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, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report 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. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

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Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm 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 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

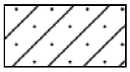
Soils


Topsoil

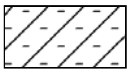

Peat


Clay

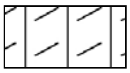

Silty clay

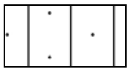

Sandy clay

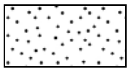

Gravelly clay

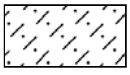

Shaly clay

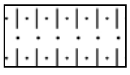

Silt


Clayey silt


Sandy silt

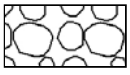

Sand

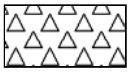

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

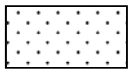

Talus

Sedimentary Rocks

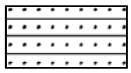

Boulder conglomerate

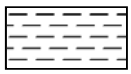

Conglomerate


Conglomeratic sandstone

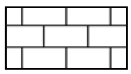

Sandstone


Siltstone


Laminite

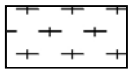

Mudstone, claystone, shale

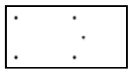

Coal


Limestone

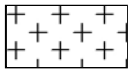
Metamorphic Rocks

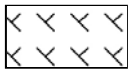

Slate, phyllite, schist

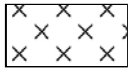

Gneiss

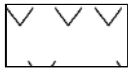

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Gardner Wetherill & Associates	
	OFFICE: Macarthur	DRAWN BY: JHB
	SCALE: As shown	DATE: 07.02.2019

TITLE: **Borehole Locations - Goetechnical Investigation**
Proposed Upgrade Works
Darlington Public School, Darlington NSW

MGA

PROJ. #:	92277.01
DRAWING No:	1
REVISION:	0

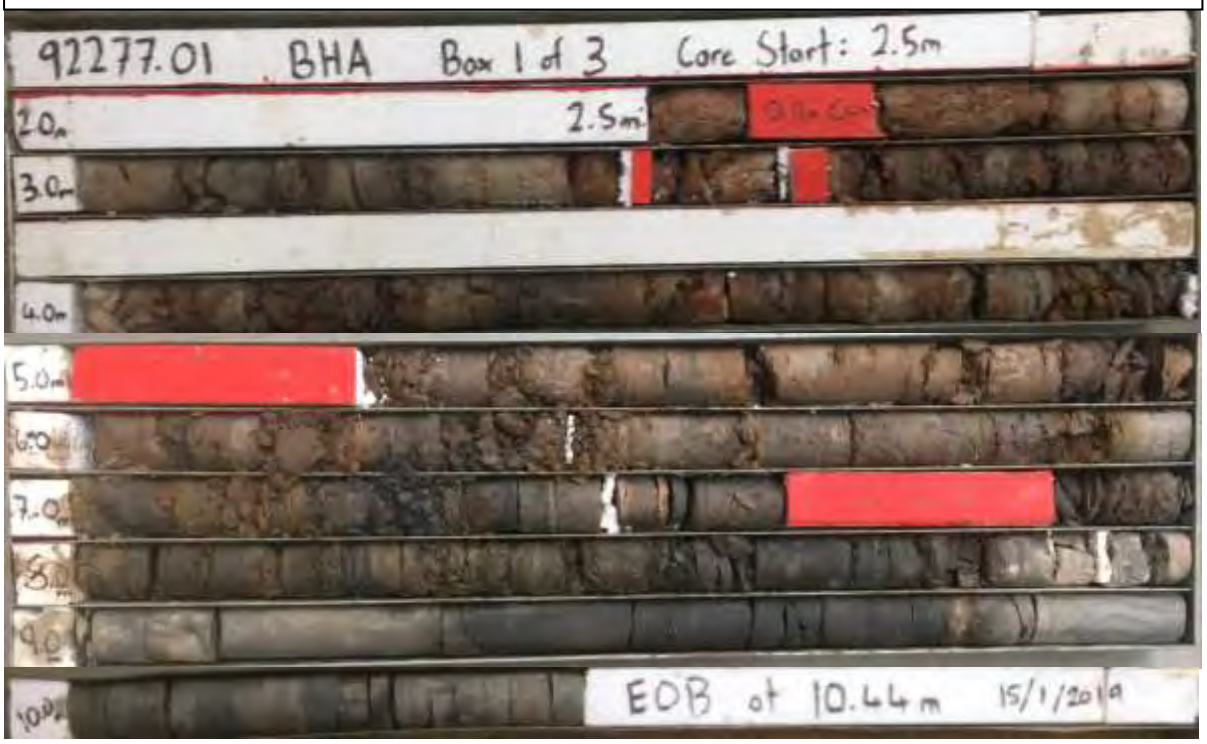
Appendix B

Borehole Logs (A – F)

Douglas Partners Pty Ltd

Proposed Upgrade Works
Darlington Public School, Darlington

BORE: A DEPTH: 2.50m – 10.44m PROJECT: 92277.01 Jan/Feb 2019



BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 38.1 mAHD
EASTING: 332579
NORTHING: 6248317
DIP/AZIMUTH: 90°/--

BORE No: A
PROJECT No: 92277.01
DATE: 14/1/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
38	0.02	ASPHALTIC CONCRETE										
	0.13	CONCRETE										
		FILLING - dark grey and brown medium to coarse grained silty sand with some clay and gravel							D			
	0.8	- sandstone boulder 150mm thick							D			
37	1								S			4,4,7 N = 11
		SILTY CLAY - stiff, grey mottled yellow-brown and red silty clay with some ironstone gravel and extremely low strength, extremely weathered shale bands, MC~PL										
36	2	2.0 SHALE - very low strength, highly weathered, grey, red and yellow brown iron indurated shale							S			12,22,25/30mm refusal
	2.5							2.83m: fg 40mm	C	89	0	PL(A) = 0.27
		SHALE - very low to low strength, highly weathered, fractured, red, grey and brown shale with iron indurated bands and extremely low strength, extremely weathered bands						3.08m: fg 40mm 3.18m: J, sh, cu, sm, fe stn				
35	3											
	3.5								C	81	0	
	3.67							3.23m: Cs 20mm 3.27m: fg 40mm 3.33m: Cs 20mm 3.43m: B, sh, pl, vr, fe stn 3.47m: CORE LOSS: 30mm 3.55m: B, sh, pl, ir, fe stn	C	97	0	PL(A) = 0.23 PL(A) = 0.19
34	4											
33	5							3.63m: CORE LOSS: 40mm 3.71m: J, sh, pl, ro, fe stn 3.76m: fg 40mm 3.82m: J, sh, cu, ro, clay inf 3.86m: fg 40mm 4.16m: J, sv, un, ro, fe stn 130mm	C	83	0	PL(A) = 0.02
32	6											
31	7							4.45m: J, sv, un, ro, fe stn 4.58m: B, sh, pl, sm, fe stn 4.69m: J, 45°, cu, sm, clay co	C	100	13	PL(A) = 0.03 PL(A) = 0.17
	7.86							4.83m: J, 45°, cu, ro, clay co 4.88m: J, sv, un, ro, fe stn 120mm 5m: CORE LOSS: 250mm	C	83	61	PL(A) = 0.14
30	8	- becoming medium strength, fresh, slightly fractured, dark grey interbedded siltstone and quartz-lithic sandstone below 8.3m						5.36m: fg 50mm 5.61m: J, sh, pl, sm, fe stn				PL(A) = 0.31
29	9							5.79m: fg 40mm 5.92m: J, sv, cu, ro, fe stn 110mm 6.08m: J, sh, cu, ro, clay co 6.32m: J, sv, cu, ro, fe stn 120mm 6.6m: B, sh, pl, sm, fe stn	C	100	100	PL(A) = 0.39 PL(A) = 0.27
28	10											
	10.44	Bore discontinued at 10.44m - limit of investigation						6.69m: B, sh, pl, sm, fe stn 6.82m: B, sh, pl, sm, fe stn 6.84m: J, sv, cu, ro, fe stn 80mm 6.95m: Cs 50mm 7.03m: J, 45°, cu, ro, fe stn				
27	11											

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m

TYPE OF BORING: 150mm diameter SFA to 2.5m, then NMLC coring to 10.44m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 38.1 mAHD
EASTING: 332579
NORTHING: 6248317
DIP/AZIMUTH: 90°/--

BORE No: A
PROJECT No: 92277.01
DATE: 14/1/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW, HW, MW, SW, FS, FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
26								7.13m: fg 90mm 7.26m: J, sv, cu, ro, fe stn 100mm 7.62m: CORE LOSS: 240mm 7.86m: fg 70mm 8.12m: J, sh, pl, ro, fe stn 8.2m: fg 30mm 8.31m: fg 40mm 8.5m: fg 40mm 8.57m: J, 45°, cu, sm, clay 8.74m: J, sv, cu, ro, cln 230mm 9.34m: J, 45°, cu, sm, cln 9.75m: J, sv, pl, sm, cln 50mm 9.85m: J, 45°, cu, sm, cln				
25	13											
24	14											
23	15											
22	16											
21	17											
20	18											
19	19											
18	20											
17	21											
16	22											
15	23											

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m

TYPE OF BORING: 150mm diameter SFA to 2.5m, then NMLC coring to 10.44m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd

Proposed Upgrade Works
Darlington Public School, Darlington

BORE: B DEPTH: 2.60m – 10.44m PROJECT: 92277.01 Jan/Feb 2019

BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 36.0 mAHD
EASTING: 332571
NORTHING: 6248290
DIP/AZIMUTH: 90°/--

BORE No: B
PROJECT No: 92277.01
DATE: 15/1/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
36	0.1	ASPHALT										
		FILLING - brown silty clay with a trace of sand, MC<PL							D			
	0.7	SILTY CLAY - very stiff, grey mottled yellow brown and red silty clay with some ironstone gravel and extremely low strength, extremely weathered shale bands, MC~PL							D			
35	1								S			4,7,8 N = 15
34	2								D			
	2.6											
	2.75	SHALE - very low to low strength, highly weathered, fractured, grey, red and brown shale with iron indurated bands and extremely low strength, extremely weathered bands						2.6m: CORE LOSS: 150mm	S			~~11,16,25/100mm~~ refusal
33	3							3m: fg 150mm 3.39m: B, sh, pl, ro, fe stn	C	86		PL(A) = 0.24
	3.65							3.62m: CORE LOSS: 30mm 3.65m: fg 50mm	C	97		PL(A) = 0.07
32	4							4.19m: B, sh, pl, ro, fe stn 4.49m: J, 45°, cu, ro, fe stn 4.56m: fg 50mm				
	4.92							4.73m: CORE LOSS: 190mm 4.92m: fg 100mm	C	85	9	PL(A) = 0.13
31	5							5.35m: J, 45°, cu, ro, fe stn 5.61m: J, 45°, cu, ro, fe stn	C	100	62	PL(A) = 0.11
30	6							5.68m: J, 45°, cu, ro, fe stn 5.88m: fg 120mm	C	33	0	
	6.63							6.24m: CORE LOSS: 390mm				
29	7							6.85m: J, sv, cu, ro, cln 200mm 7.18m: fg 50mm	C	100	11	
	7.78							7.28m: J, 60°, cu, ro, fe stn 130mm 7.4m: J, 60°, cu, ro, fe stn 130mm 7.51m: CORE LOSS: 270mm	C	92	27	PL(A) = 0.2
28	8							7.78m: J, sv, un, vr, fe stn 440mm 8.31m: J, sv, ir, ro, cln 110mm				
27	9	- becoming medium strength, fresh, unbroken, dark grey interbedded siltstone and quartz-lithic sandstone below 8.93m						8.51m: J, sv, ir, ro, cln 410mm	C	100	100	PL(A) = 0.51
26	10											PL(A) = 1.04
	10.44	Bore discontinued at 10.44m - limit of investigation										
25	11											

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m

TYPE OF BORING: 150mm diameter SFA to 2.5m, wash boring to 2.6m, then NMLC coring to 10.44m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd

Proposed Upgrade Works
Darlington Public School, Darlington

BORE: C DEPTH: 4.50m – 10.03m PROJECT: 92277.01 Jan/Feb 2019

BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 34.6 mAHD
EASTING: 332592
NORTHING: 6248292
DIP/AZIMUTH: 90°/--

BORE No: C
PROJECT No: 92277.01
DATE: 16/1/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
34	0.2	TOPSOIL - dark brown clayey silt with some rootlets, moist										
		FILLING - dark brown silty clay with a trace of sand, MC<PL							D			
	0.8	SILTY CLAY - very stiff, red brown silty clay with a trace of ironstone gravel, MC~PL							D			
33	1	- becoming grey mottled red and brown below 1.1m							S			4,5,6 N = 11
	2	- with extremely low strength, extremely weathered shale bands below 2.2m										
32	2.7	SHALE - extremely low strength, extremely weathered, grey and red shale with very low strength, highly weathered iron indurated bands							S			3,6,10 N = 16
31	3											
	4								S			9,19,25/140mm refusal
30	4.5	SHALE - extremely low strength, extremely weathered, grey and red shale with very low strength, highly weathered iron indurated bands							C	100	0	PL(A) = 0.08
29	5							5.48m: B, sh, pl, ro, clay co 5.58m: Cs 20mm				
	5.65							5.6m: CORE LOSS: 50mm 5.81m: fg 80mm	C	96	18	PL(A) = 0.06
28	6											
	7											PL(A) = 0.05
	7.22							7.03m: CORE LOSS: 190mm 7.22m: J, 60°, cu, ro, fe stn 130m 7.37m: J, 60°, cu, sm, fe stn 120mm 7.79m: J, 45°, cu, ro, fe stn	C	84	48	PL(A) = 0.21
27	8											
26		- becoming fresh, unbroken, dark grey interbedded siltstone and quartz-lithic sandstone below 8.31m							C	100	89	PL(A) = 0.54
	9							8.55m: J, 60°, cu, cm, cln 8.7m: J, 80°, cu, sm, cln 140mm 8.79m: J, 60°, pl, sm, cln 100mm 8.88m: J, 60°, pl, sm, cln 100mm 9m: J, sv, pl, sm, cln 80mm 9.45m: J, 45°, pl, sm, cln 9.81m: J, 60°, pl, sm, cln 110mm	C	100	78	PL(A) = 0.94
25	10											
	10.03	Bore discontinued at 10.03m - limit of investigation										
24	11											
23												

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m

TYPE OF BORING: 110mm diameter SFA to 2.5m, wash boring to 4.5m, then NMLC coring to 10.03m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd

Proposed Upgrade Works
Darlington Public School, Darlington

BORE: D DEPTH: 5.17m – 9.55m PROJECT: 92277.01 Jan/Feb 2019

BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 33.0 mAHD
EASTING: 332574
NORTHING: 6248260
DIP/AZIMUTH: 90°/--

BORE No: D
PROJECT No: 92277.01
DATE: 17/1/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
33	0.2	CONCRETE										
		FILLING - red brown silty clay with a trace of sand, MC~PL							D			
	0.6	FILLING - yellow and light brown medium grained clayey sand, dry							D			
32	1								S			7,10,10 N = 20
	1.1	FILLING - brown, red, grey and yellow silty clay with some sand and gravel, MC<PL - becoming dark brown below 1.7m										
31	2								D			
	2.4	SILTY CLAY - very stiff, grey mottled red and brown silty clay with a trace of ironstone gravel							S			3,6,10 N = 16
	2.8	SHALE - extremely low strength, extremely weathered, grey and red shale with very low strength, highly weathered iron indurated bands										
30	3											
29	4								S			7,11,21 N = 32
28	5											
	5.17	SHALE - extremely low strength, extremely weathered, fractured, grey and red shale with very low strength, highly weathered iron indurated bands						5.74m: J, 45°, cu, ro, fe stn	C	100	0	PL(A) = 0.44
								5.88m: J, sh, cu, ro, fe stn				
	6.25							5.9m: J, sh, cu, ro, fe stn	C	77	0	PL(A) = 0.08
27	6							6.05m: CORE LOSS: 200mm				
								6.367m: B, sh, pl, ro, fe stn				
26	7							6.42m: B, sh, pl, ro, fe stn	C	100	14	
								6.49m: B, sh, pl, ro, fe stn				
25	8							6.73m: B, sh, pl, ro, fe stn				PL(A) = 0.12
	8.27							6.87m: J, sv, ir, vr, fe stn 130mm				
								7.51m: fg 60mm				
								7.8m: J, sh, pl, ro, fe stn	C	100	55	PL(A) = 0.14
24	9							7.87m: J, 45°, cu, ro, fe stn				
								8.08m: fg 100mm				PL(A) = 0.11
	9.55	Bore discontinued at 9.55m - limit of investigation						8.19m: J, 45°, cu, ro, fe stn				PL(A) = 0.09
23	10							8.23m: CORE LOSS: 40mm				
								8.27m: fg 90mm				
								8.43m: J, sv, ir, ro, fe stn 140mm				
								8.67m: J, sh, cu, vr, fe stn				
22	11							9.11m: J, sh, cu, sm, fe stn				
								9.12m: J, sh, cu, sm, fe stn				
								9.13m: J, sh, cu, sm, fe stn				
								9.14m: J, sh, cu, sm, fe				

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m; HQ to 5.17m

TYPE OF BORING: Concrete coring to 0.2m, 110mm diameter SFA to 2.5m, wash boring to 5.17m, then NMLC coring to 9.55m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 33.0 mAHD
EASTING: 332574
NORTHING: 6248260
DIP/AZIMUTH: 90°/--

BORE No: D
PROJECT No: 92277.01
DATE: 17/1/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
21								stn 9.16m: J, sv, ir, ro, cln 60mm 9.29m: B, sh, pl, ro, fe stn 9.43m: B, sh, pl, ro, fe stn				
20	13											
19	14											
18	15											
17	16											
16	17											
15	18											
14	19											
13	20											
12	21											
11	22											
10	23											

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m; HQ to 5.17m

TYPE OF BORING: Concrete coring to 0.2m, 110mm diameter SFA to 2.5m, wash boring to 5.17m, then NMLC coring to 9.55m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd

Proposed Upgrade Works
Darlington Public School, Darlington

BORE: E DEPTH: 4.00m – 9.80m PROJECT: 92277.01 Jan/Feb 2019

BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 34.1 mAHD
EASTING: 332550
NORTHING: 6248228
DIP/AZIMUTH: 90°/--

BORE No: E
PROJECT No: 92277.01
DATE: 18/1/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
34	0.17	CONCRETE										
		FILLING - brown, red and grey silty clay with a trace of ironstone gravel, MC~PL							D			
									D			
33	1								S			4,5,7 N = 12
	1.3	SILTY CLAY - very stiff, grey mottled red and brown silty clay with a trace of ironstone gravel, MC~PL										
									D			
32	2											
		- with extremely low strength, extremely weathered iron indurated shale bands below 2.7m							S			5,8,13 N = 21
31	3											
	3.5	SHALE - extremely low strength, extremely weathered, grey and red shale with very low strength, highly weathered iron indurated bands										
30	4								S			23,25/50mm,- refusal
	4.0	SHALE - extremely low strength, extremely weathered, grey and red shale with very low strength, highly weathered iron indurated bands						4.16m: J, sv, ir, vr, clay inf 40mm 4.6m: J, sh, pl, ro, clay inf 4.77m: Cs 20mm 4.86m: J, 80°, ir, ro, clay inf 100mm 5.13m: J, sh, cu, ro, fe stn 5.27m: J, sh, cu, ro, fe stn 5.39m: J, sh, cu, ro, fe stn 5.43m: CORE LOSS: 520mm 6.15m: Cs 20mm 6.27m: fg 60mm 6.34m: J, 60°, cu, ro, fe stn 110mm 6.57m: J, sh, cu, ro, fe stn 6.63m: J, 45°, cu, ro, fe stn 6.69m: J, sv, ir, vr, fe stn 140mm 6.83m: CORE LOSS: 420mm 7.25m: fg 100mm 7.55m: J, 45°, cu, ro, fe stn 7.85m: J, sv, ir, vr, fe stn 20mm 8.08m: J, 45°, cu, sm, fe stn 8.09m: J, sv, ir, ro, fe stn 100mm 8.26m: fg 50mm 8.33m: CORE LOSS: 90mm 8.41m: fg 70mm 8.57m: fg 230mm 8.89m: B, sh, pl, ro, cln 9.02m: fg 30mm 9.22m: B, h, pl, sm, cln 9.25m: B, h, pl, sm, cln 9.54m: J, 45°, cu, sm, cln	C	100	0	PL(A) = 0.51 PL(A) = 0.06 PL(A) = 0.02
29	5											
	5.95								C	64	0	PL(A) = 0.56
28	6											
	7.25								C	73	0	PL(A) = 0.08
27	7											
	8.42								C	92	63	PL(A) = 0.13 PL(A) = 0.48
26	8											
25	9	- becoming medium strength, slightly weathered, slightly fractured interbedded siltstone and quartz lithic sandstone below 9.04m										
	9.8	- becoming fresh below 9.31m										
24	10	Bore discontinued at 9.8m - limit of investigation										
23	11											

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m; HQ to 4.0m

TYPE OF BORING: Concrete coring to 0.17m, 110mm diameter SFA to 2.5m, wash boring to 4.0m, then NMLC coring to 9.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd

Proposed Upgrade Works
Darlington Public School, Darlington

BORE: F DEPTH: 3.74m – 10.23m PROJECT: 92277.01 Jan/Feb 2019

BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 34.9 mAHD
EASTING: 332545
NORTHING: 6248280
DIP/AZIMUTH: 90°/--

BORE No: F
PROJECT No: 92277.01
DATE: 17/1/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
34	0.07	ASPHALTIC CONCRETE										
	0.2	FILLING - brown clayey sand with some silt and gravel, moist							D			
		FILLING - brown silty clay with some gravel and sand, MC<PL							D			
33	1	- becoming dark brown with a trace of ceramic and ash below 0.8m							S			3,6,6 N = 12
	1.9	SILTY CLAY - hard, grey mottled red and light brown silty clay with extremely low strength, extremely weathered iron indurated shale bands and a trace of gravel, MC~PL							D			
32	2.7	SHALE - extremely low strength, extremely weathered, grey and red shale with very low strength, highly weathered iron indurated bands							S			9,13,22 N = 35
31	3.74								C	100	0	PL(A) = 0.05
30	5.06							4.63m: J, sv, cu, vr, fe stn 40mm 4.86m: J, sv, cu, vr, fe stn 40mm 4.9m: CORE LOSS: 160mm 5.06m: J, sv, un, vr, fe stn 210mm	C	84	0	PL(A) = 0.17 PL(A) = 0.05
29	6.12							5.85m: fg zone 50mm 5.92m: CORE LOSS: 200mm 6.12m: fg zone 170mm	C	91	43	PL(A) = 0.54
28								6.42m: J, sh, cu, sm, fe stn 6.47m: J, 45°, cu, sm, fe stn 6.51m: J, sh, cu, sm, fe stn				PL(A) = 0.32
27								6.54m: J, sh, cu, sm, fe stn 6.59m: J, sh, cu, sm, fe stn 6.81m: J, sh, cu, sm, fe stn 6.88m: J, sh, cu, sm, fe stn 6.97m: J, sh, cu, sm, fe stn	C	84	59	
26	8.29	- becoming medium strength, fresh, unbroken, dark grey interbedded siltstone and quartz lithic sandstone below 8.45m										PL(A) = 0.69
25	9							7.03m: J, sh, cu, sm, fe stn 7.17m: J, sh, cu, sm, fe stn 7.32m: J, sh, cu, sm, fe stn	C	100	100	PL(A) = 0.54
24	10.23	Bore discontinued at 10.23m - limit of investigation						7.4m: J, sh, cu, sm, fe stn 7.46m: J, sh, cu, sm, fe stn 7.67m: J, sh, cu, sm, fe stn 7.81m: J, 45°, cu, sm, fe stn 7.84m: fg 50mm 7.97m: J, 45°, cu, sm, fe stn				
23	11											

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m

TYPE OF BORING: 110mm diameter SFA to 2.5m, wash boring to 3.74m, then NMLC coring to 10.23m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Gardner Wetherill & Associates
PROJECT: Proposed Upgrade Works
LOCATION: Darlington Public School, Cnr Golden Grove and Abercrombie Streets. Darlington, NSW

SURFACE LEVEL: 34.9 mAHD
EASTING: 332545
NORTHING: 6248280
DIP/AZIMUTH: 90°/--

BORE No: F
PROJECT No: 92277.01
DATE: 17/1/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
22	13							8.04m: CORE LOSS: 250mm 8.29m: fg 160mm 8.47m: J, sv, pl, sm, cln 130mm 8.68m: J, 45°, cu, sm, cln				
21	14											
20	15											
19	16											
18	17											
17	18											
16	19											
15	20											
14	21											
13	22											
12	23											
11												

RIG: Bobcat **DRILLER:** Groundtest **LOGGED:** JHB **CASING:** HW to 2.5m

TYPE OF BORING: 110mm diameter SFA to 2.5m, wash boring to 3.74m, then NMLC coring to 10.23m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix C

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: john.purcell@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

J.T. Purcell

Approved Signatory: John Purcell
Lab technician

NATA Accredited Laboratory Number: 828

Report Number: **92277.01-1**
Issue Number: 1
Date Issued: 30/01/2019
Client: Gardner Wetherill & Associates
Level 2, Suite 201, St Leonards NSW 2065
Contact: Luen Samonte
Project Number: 92277.01
Project Name: Proposed Upgrade Works
Project Location: Darlington Public School, Darlington
Work Request: 557
Sample Number: 19-557A
Date Sampled: 14/01/2019
Sampling Method: Sampled by Engineering Department
Remarks: Field moisture content = 21.0%
Sample Location: **BH A (1.0m - 1.45m)**
Material: SILTY CLAY - grey mottled yellow brown and red silty clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	68		
Plastic Limit (%)	23		
Plasticity Index (%)	**45**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.0		
Cracking Crumbling Curling	None		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: john.purcell@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

J.T. Purcell

Approved Signatory: John Purcell
Lab technician
NATA Accredited Laboratory Number: 828

Report Number: **92277.01-1**
Issue Number: 1
Date Issued: 30/01/2019
Client: Gardner Wetherill & Associates
Level 2, Suite 201, St Leonards NSW 2065
Contact: Luen Samonte
Project Number: 92277.01
Project Name: Proposed Upgrade Works
Project Location: Darlington Public School, Darlington
Work Request: 557
Sample Number: 19-557B
Date Sampled: 14/01/2019
Sampling Method: Sampled by Engineering Department
Remarks: Field moisture content = 23.4%
Sample Location: **BH B (1.0m - 1.45m)**
Material: SILTY CLAY - grey mottled yellow brown and red silty clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	66		
Plastic Limit (%)	24		
Plasticity Index (%)	**42**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.5		
Cracking Crumbling Curling	Curling		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
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Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

J.T. Purcell

Approved Signatory: John Purcell
Lab technician
NATA Accredited Laboratory Number: 828

Report Number: **92277.01-1**
Issue Number: 1
Date Issued: 30/01/2019
Client: Gardner Wetherill & Associates
Level 2, Suite 201, St Leonards NSW 2065
Contact: Luen Samonte
Project Number: 92277.01
Project Name: Proposed Upgrade Works
Project Location: Darlington Public School, Darlington
Work Request: 557
Sample Number: 19-557C
Date Sampled: 14/01/2019
Sampling Method: Sampled by Engineering Department
Remarks: Field moisture content = 25.8%
Sample Location: **BH C (1.0m - 1.45m)**
Material: SILTY CLAY - red brown silty clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	72		
Plastic Limit (%)	23		
Plasticity Index (%)	**49**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	16.5		
Cracking Crumbling Curling	None		

Material Test Report

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Client: Gardner Wetherill & Associates
Level 2, Suite 201, St Leonards NSW 2065
Contact: Luen Samonte
Project Number: 92277.01
Project Name: Proposed Upgrade Works
Project Location: Darlington Public School, Darlington
Work Request: 557
Sample Number: 19-557D
Date Sampled: 14/01/2019
Sampling Method: Sampled by Engineering Department
Remarks: Field moisture content = 14.9%
Sample Location: **BH F (1.0m - 1.45m)**
Material: FILLING - brown silty clay filling

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	41		
Plastic Limit (%)	23		
Plasticity Index (%)	**18**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	8.0		
Cracking Crumbling Curling	None		

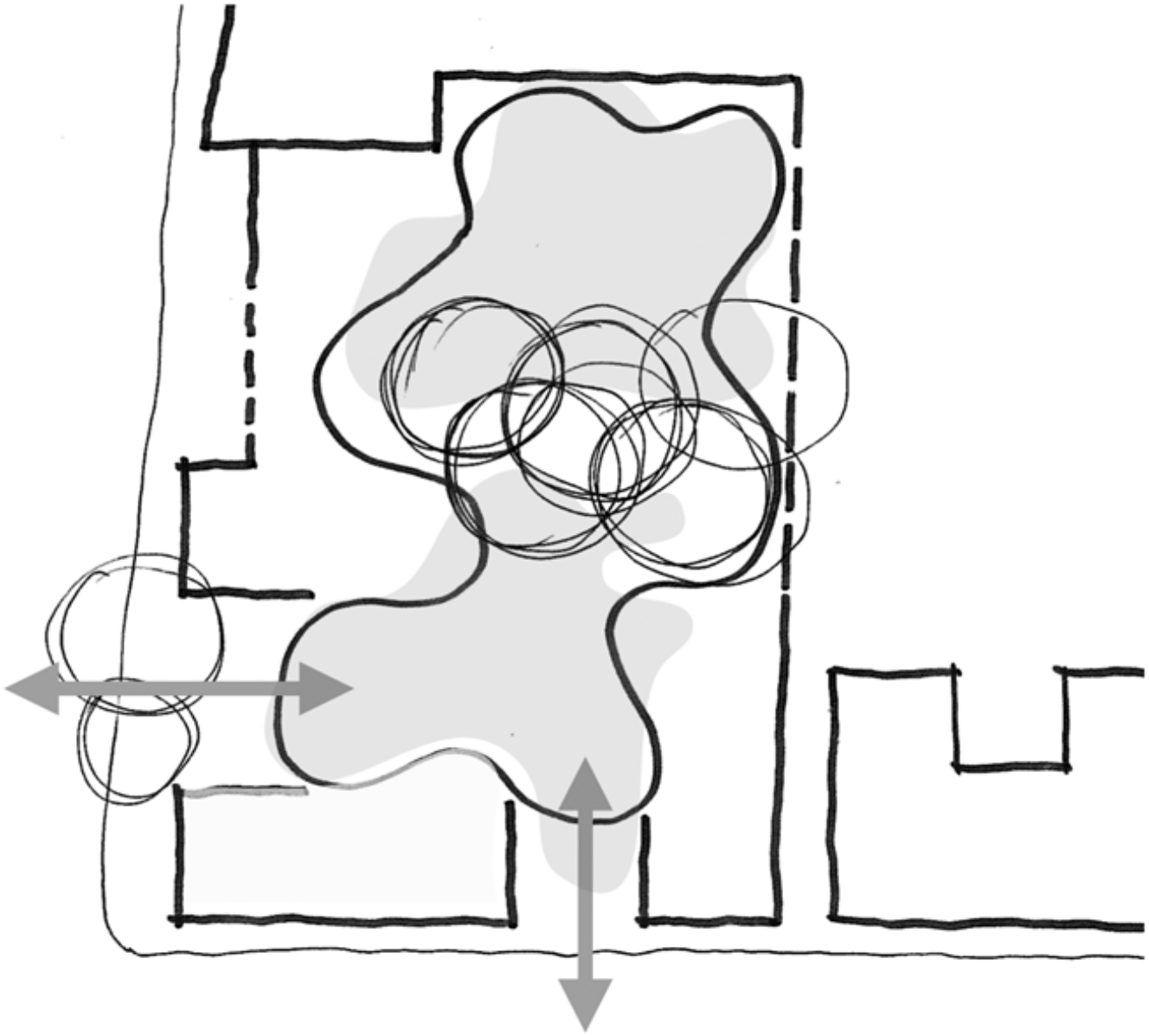
DARLINGTON PUBLIC SCHOOL REDEVELOPMENT

Appendix Z — Structural Report

SSD-9914

Prepared by Bonacci

For NSW Department of Education



Darlington Public School

State Significant Development –

Structural statement

Issued for:

11917-BON-ST-SSDRPT-001

Revision: 1

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Report Amendment Register

Rev. No.	Section & Page No.	Issue/Amendment	Author/Initials		Reviewer/Initials		Date
0	-	SD Report for SSDA	Brian N	BN	Amir B	AB	06/04/20
1	6,8	Ethos Urban + MACE Comments	Brian N	BN	Amir B	AB	17/04/2020

Prepared by: Brian Naughton

Date: 17/04/2020

Project No: 11917

Issued for: SD Report For SSDA Submission

Discipline: Structural

Table Of contents

1. Introduction

Darlington Public School is located on the corner of Golden Grove Street and Abercrombie Street, Darlington, within the City of Sydney Local Government Area. The school is adjacent to the University of Sydney Darlington Campus and within walking distance to Redfern and Macdonaldtown train stations. The site is legally described as Lot 100 in DP 623500 and Lot 592 in DP 7523049. \

The SSD application seeks consent for demolition of existing school buildings and construction of a new part 2, part 3-storey building, increasing the school capacity from 230 to 437 students. The works also include replacement of the existing child-care facility (to the same capacity of 60 students), earthworks and landscaping. For a detailed project description refer to the EIS prepared by Ethos Urban.

Bonacci Group (NSW) Pty Ltd has been engaged by School Infrastructure NSW to provide civil and structural design services for Darlington Public School Redevelopment.

The Contents of this report summarizes the outcome of the investigation/analysis of the site conditions, authority requirements, relevant structural requirements, tested structural systems and provide the preferred structural scheme.

1.1. Scope

The scope of this report is to summaries the site conditions and the various structural design aspects of Darlington Public School, as follows:

This site conditions section will outline the following aspects

- Staging considerations
- Presence of heritage listed buildings
- Existing building condition
- Further investigations

The design section will outline the following:

- RC concrete column design;
- Concrete core walls
- PT slab (D&C contractor);
- Vibration criteria;
- Foundations such as pad footings/Pile design;
- Architectural features such as large span zones, sawtooth roof, curved façade

The Input Parameters section will outline the following:

- Loadings considered and referenced codes and building standards;
- Relevant performance criteria used in design;
- Fire Resistant Levels

2. Site Conditions

2.1. Location

Site is located on the corner of Golden Grove Street and Abercrombie Street, Chippendale. Darlington Public School is located within the City of Sydney Council adjacent to the University of Sydney Darlington Campus, close to Carriage works, Redfern & Macdonald town Train Stations.

It is surrounded by medium density residential units, terrace housing, St Michael's Melkite Cathedral and the University of Sydney Business School. The rear of the site abuts the University of Sydney Regiment Building, on the corner of Darlington Lane and Golden Grove Street. On the north side of Darlington Lane is a proposed student housing redevelopment of a row of terraces along Darlington Road.

Figure 1 - Locality Map (Nearmap)

2.2. Staging and Existing Buildings

The redevelopment is proposed to be in two stages. In stage 1 new buildings will be constructed in the north of the site. The existing building at south west of the site would be trimmed to allow construction of the northern building which would be up to three storey high. The existing south building will remain in stage 1. In stage 2 the existing south wing and the remainder of the south west corner building would be demolished and replaced with a new one storey building. The stage 1 north wing would be extended south in stage 2.

Retaining of the current Hall building at south west corner for stage 1 will require careful consideration of adjoining structures proposed to be demolished. The record drawings for the existing buildings provides insight to this. It is envisaged that installation of the temporary supports and footing would be needed at cut structural faces to ensure the stability of the remaining structure. See section 3.2.4 of this report for further discussion.

The existing buildings also show signs of concrete structure deterioration including signs of concrete spalling due to reinforcement corrosion hence if stage 2 works are not to follow the stage 1 works immediately then some repair works might be needed to address structural concrete defects.

The lot consolidation process is not expected to have any major impact on structure. The main consideration on this point is how it effects BCA requirements in terms of fire compartmentation and setbacks from boundaries.

2.3. Building Adjacent to the Heritage Listed Neighboring Property

There is an existing neighboring building in north west side of the site which is understood to be heritage listed and owned by Sydney University. A study of proposed FFL's and surveys indicates the proposed stage 1 building will have to excavate up to 1000mm below the existing structure to the north. There are potential issues with this including the risk of undermining the existing footing of the building- pending the new floor level in relation to the footing base level.

Test Pits were carried out by Douglas and Partners to establish the levels and composition of existing heritage footings to the north west side of the site. We have since provided several options, each providing alternate load paths to prevent loading existing foundations. One such option is that the final ground floor slab would be suspended supported by piles drilled away from the heritage wall to avoid damaging the wall/foundations – Refer to SD Drawings in Appendix A of this report. The excavation induced vibration should also be managed through onsite vibration monitoring during construction.

2.4. Site Contamination

Contamination report indicates that different types of contaminants being present in the fill on site including TRH, PAH and lead. While mostly sealed by hard paving's, some hazardous materials are identified to be exposed especially in north zone. This include asbestos traces. The disturbance to the fill on site must be kept to the absolute minimum needed. This will ensure no costly treatment or disposal processes. Refer contamination report no. 922277.01-R-002 by Douglas Partners and associated RAP. Section 3 of this report describes how the proposed structural scheme minimizes any soil disturbance.

2.5. Existing Live Services

There is possibility of existing services on site buried under the existing buildings that could be damaged during demolition. The site must be thoroughly investigated during the construction works to ensure no damage to the existing live services.

2.6. Geotechnical Investigation

A geotechnical and contamination investigation has been carried out by Douglas Partners in February 2019. The site consists of deep filling of up to 2.4m depth over hard clay layer followed by low strength bedrock at 2-3.5m depth. Medium strength bedrock is encountered in depths of 9.8 to 10.44m. No groundwater was encountered during investigation. The existing buildings are noted to be piled based on the record structural drawings. Refer Geotechnical report no. 92277.01-R.001 by Douglas Partners.

2.7. Risks

	Item	Risk	Mitigation
Sitewide	In ground contamination	Hazardous material potentially present in fill	Limit the proposed excavation- further investigation might be needed
	Existing Live Services	Services disrupted/damaged during site works- WHS issues	Identify all the existing services early on through further survey, DBYD etc…
Neighbouring heritage building	Proximity of the proposed building to the heritage listed building	Damaging/undermining the heritage building	Plan the new building away from the heritage building or alternatively incorporate the appropriate footing system to redistribute loads.
Staging	Retaining the existing building	Temporary structural works required	Demolish if possible- Alternatively investigate the existing structure through further site inspection/review of the record drawings
	Construction activities	Site occupant health and safety during the construction	The demolition works are to be carried out in school holidays where possible- the construction zone is physically separated from the rest of the site.
	Extended time gap in between stages	Further deterioration to the concrete structure	No delay in between stages or repair to the defective structure to increase its life or mitigate the associated structural risks

Table 1 - Major risk items

3. Structural Design

Several structural systems were considered during Concept Design Stage. This included a CLT option- cross laminated timber- followed by post tensioned concrete structure, lightweight steel floors i.e. post strut floors, precast planks i.e. Ultra Floor or hollow core floors. The CLT option was ruled out based on NCC and EFSG compliance issues as well as high maintenance concerns.

A few different footing systems were also proposed based on limited floor level information in concept stage. Refer to preliminary structural concepts issued 6th September 2019.

This section of the report outlines the final structural systems selected, which is not only compliant with the National Construction Code- performance requirements- i.e. fire rating and acoustic- EFSG guideline and as per quantity surveyor advice. The preferred footing system has also been chosen based on mitigating the risk of disturbing the contaminated soil on site.

3.1. Footing System

According to the geotechnical investigation, the depth of rock varies across site. Due to the stepping nature of the natural ground levels, and due to the presence of contaminated soil, we are proceeding with a bored pier/screw pile solution with a suspended ground floor slab. This prevents the need for excess excavation and treatment of uncontrolled fill, as outlined in Douglas Partners geotechnical report, section 7.4.1. It also minimizes any disturbance of contaminated soils. Refer to appendix A, Bon-SK-01 for proposed footing layout. For consistency during installation of piles, we have proposed 600mm piles throughout the site.

Piles supporting RC columns will be 600mm Diameter, with 750*750*450mm Deep Pile caps, refer to figure 2 below for typical section. Piles supporting higher loads of the superstructure columns must bear on Class III shale, and socket min 4500mm into Class IV Shale above. Intermediate piles supporting suspended slab on ground are lightly loaded hence these piles could bear on class IV shale, and socketed a minimum 300mm into class IV Shale. Refer to table 01 below for Overview of piling required.

Location	Pile Diameter	Base Resistance (Rock Strata)	Socket Length (Rock Strata)	Approximate Max Loading (Working) (kN)
Piles supporting RC columns	600mm	Class III Shale	4500mm (Class IV Shale)	1650
Intermediate Piles	600mm	Class IV Shale	300mm (Class IV Shale)	280

Table 2 – Summary of piled footings required

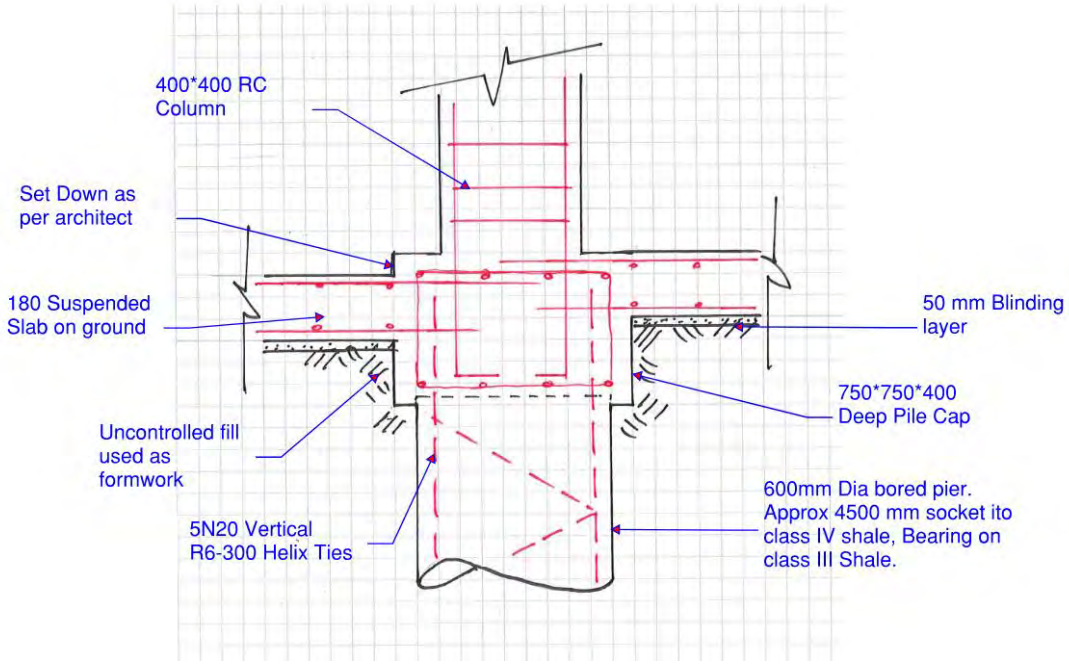

Figure 2 - Typical section at Pile Cap

3.1.1. Suspended Slab on Ground

Due to the presence of uncontrolled fill throughout the site, a suspended slab on ground is the most economical system to prevent the requirement for excavation and treatment of existing contaminated soils, as per geotechnical report section 7.4.1. This will utilise the site fill material as formwork during construction until the floor has gained enough strength to span in between the support piles.

3.2. Superstructure

Following concept design stage a concrete framed structure with post tensioned banded slab as floor structure was chosen as the preferred option based on the following:

- Complies easily with performance requirements including NCC and EFSG requirements such as durability and fire performance.
- Ability to achieve large column free spaces, allowing future flexibility for home base unit spaces as well as school entry column free space as per architectural requirements.
- Quantity Surveyor input confirming it the most economical solution.
- Post tensioned structure being lighter that conventionally reinforced structure need less/smaller footings hence less risk of disturbing the contaminated soil on site.

3.2.1. PT Bands and Slab

PT beam are generally 1200mm wide with depth ranging from 400mm to 500mm depending on spans, refer to drawings in appendix A for sizes. One-way slabs between beams are generally 160mm thick.

3.2.2. Vertical Elements

400mm square RC Columns have been nominated to achieve required fire rating as per NCC Report. If required, these may be modified in certain areas to suit architectural requirements.

200 thick RC walls have been nominated to provide both vertical and lateral support. These walls will extend to roof level where possible to remove the requirement to fire rate alternate steel columns. Where not allowed by architectural requirements, fire rated steel columns have been adopted to support the roof loads.

3.2.3. Steelwork

Steel structure will be adopted for the upper roof. This will comprise of primary steel structure supporting proprietary sawtooth roof trusses. Layout of roof structure was on hold at the time of writing this report, preliminary design an be seen in Appedix A.

The proprietary sawtooth roof will be either timber or steel trusses at approximately 1200 mm centers, designed by D&C contractor.

3.2.4. Link Between old and new structure during staging

Following reviewal of record architectural and structural documentation the proposed break line between stage 1 and 2 appears to occur through the mono-pitched timber roof as illustrated below. It is believed that prior to demolition of existing load bearing double skin brick, the truss must be propped, and additional structural posts and footings installed.

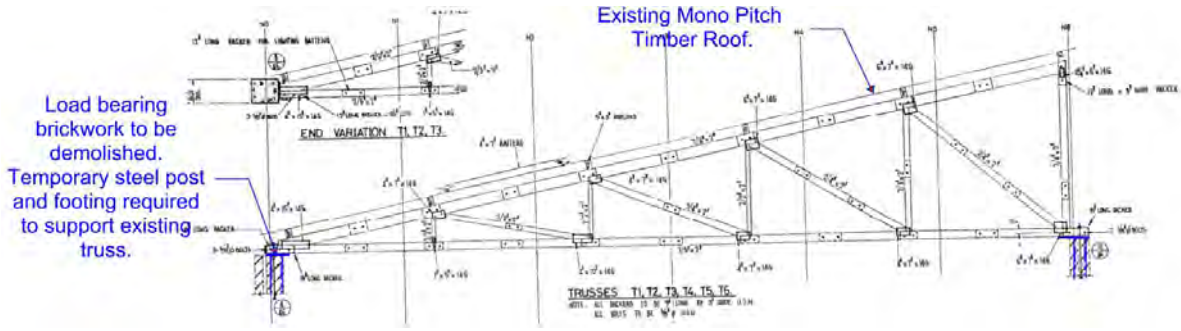

Figure 3 -Typical section of existing structure, at the link between stage 1 and 2.

Note this is an initial review based on record drawings hence consultation with contractor and further investigation/ opening up work will be required to confirm the works.

4. Design Parameters

4.1. Australian Standards and NCC

The following Australian Standards in combination with NCC 2019 are used in the structural design of this project.

- AS/NZS 1170.0/2002 – Part 0: Structural design actions
- AS/NZS 1170.1/2002 – Part 1: Permanent, imposed and other actions
- AS/NZS 1170.2/2011 – Part 2: Wind actions
- AS/NZS 1170.4/2007– Part 4: Earthquake loads
- AS3600 – 2018: Concrete structures
- AS4100 – 1998: Steel structures
- AS1720- 2010: Timber Structures
- AS3700 – 2018: Masonry Structures
- AS2159 – 1995: Piling
- AS/NZS4600 – 2001: Cold-formed steel structures
- AS/NZS3828 – Guidelines for the erection of building steelwork

4.2. Design Loading Information

Loads and their appropriate load combinations will be in accordance with AS1170.0, AS1170.1, AS1170.2 and AS1170.4. The applied loading is summarised in this section of this design brief.

This section is to be read in conjunction with the structural drawings, which will indicate the design loads of each floor on the concrete outline drawing. Note, masonry walls loads are excluded from these loading drawings and should be taken from the relevant architectural drawings.

4.2.1. Self-Weight Loads

Self-Weight loads shall be calculated as provided for in the current version of AS1170. Part 1: Permanent, imposed and other actions.

Material densities are taken from AS1170.1.

4.2.2. Super Imposed Dead Loads and live loads

Live loads are taken from AS1170. Part 1: Permanent, imposed and other actions. The following table describes the more significant loading on the project, and further clarification of floor loads can be obtained by referring to the loading diagrams in the structural set of drawings.

Pattern Live loads shall be considered if applicable in accordance with Clause 2.4.4 of AS3600. Live load reduction shall be applied to AS1170.1 if appropriate for vertical elements.

Location	Dead Load	Live Load
Basement Storage, Library, Bulk storage rooms, Stage, Kiln dry	0.5 kPa	5.0 kPa
Other stores, canteen, gymnasium, technology, food, preparation areas, applied studies, computer areas, arts, plants	0.5 kPa	5 kPa
Classrooms	1 kPa	3.0 kPa
Gym	2.0 kPa	5.0 kPa
Community Facilities	2.0 kPa	5.0 kPa
Corridors	1.5 kPa	4.0 kPa
Lobbies, Corridors and stairs etc	1.5 kPa	4.0 kPa
Trafficable concrete roofs	2.5 kPa (Inclusive of Falls)	5.0 kPa
Lift Lids	1.5 kPa	2.0 kPa or Lifting loads
Roof top plant loads	2.5 kPa	7.5 kPa or plant loads, whichever is greater
Fire Stairs	0.5kPa	4.0kPa

4.2.3. Façade Loading

Assumed to be masonry veneer with internal dry stick plasterboard with 20% openings, the line load on a typical floor is equivalent to.

- Masonry = (19x0.11 + 0.01x24 + 0.1) x 2.8m high
- Adopt = 7.5 kN/m

4.2.4. Balustrade Loading

According to AS1170.1 Table 3.3, horizontal balustrade loading for 1.5kN/m for C1/C2 Occupancy, and 0.75kN/m for C3 occupancy.

If perforated metal façade is required, the horizontal loading will be approx. 1.0kPA, applied to the first 1200mm from the base, or a point load of 0.5 kN applied over a panel of 2000 mm^2 or over two adjacent vertical balustrades, as appropriate.

4.2.5. Earthquake

Project will be designed in accordance with AS1170.4-2007 and NCC 2019.

- Hazard Factor: Z = 0.08
- Life Span: 50 years
- Site subsoil TBC
- Probability of exceedance kp = 1.3
- Importance Level 2

4.2.6. Wind

To AS1170.2 for a Region A2 wind and a Terrain Category 3.

4.2.7. Robustness

In accordance with the requirements of AS1170.0/2002 Amendment 3 the robustness load is taken as 1.5% of the gravity load (G + ψcQ).

4.2.8. Blast and impact loading

It is noted that the design of the building and structure and boundary walls if any, has not been designed for any vehicle impact loads (other than car-park barriers loads taken from AS1170.1), nor has the building or its structure been designed for any blast/explosion loadings or terrorist induced loading events.

4.3. Limit State Design Criteria for structural elements

4.3.1. General Design Approach

The limit state design for strength, serviceability and stability of the relevant structural elements within the building will generally follow the established criteria in the relevant material design codes AS4100 and AS3600 unless noted otherwise below.

4.3.2. Structural Movements

Building Sways (Deflection) subject to service wind loads shall satisfy;

- Total lateral deflection to not exceed height/500.
- Inter-storey deflection to not exceed inter-storey/500 or 12mm, whichever is lesser

Floor Deflections to AS3600 and AS4100, limited to span/250 total and span/500 incremental for flexible partitions, and span/500 total and span/1000 incremental for (non flexible) rigid partition walls without regularly spaced movement joints. Deflections for transfer elements shall be limited to the lesser of Span/360 or 10mm max total deflection.

4.3.3. Fire Resistance

Fire rating to AS3600/AS3700/AS4100.

4.3.4. Crack Control

Generally, all internal suspended slabs will be designed for a moderate degree of crack control, except for external roof slabs over living areas where a strong degree of crack control will be adopted. For Post tension slabs, this will result in a minimum post tension stress of 1.4MPa and 2.0MPa for moderate and strong degree of crack control, respectively. Refer to Section 4.8 for further minimum requirement to external slabs over living areas.

Pour strips or Temporary Movement Joints (TMJs) will be introduced where appropriate to minimise the long-term creep and shrinkage effect of the concrete and these will be coordinated with the builder construction programe.

4.3.5. Minimum Connection Requirements and Ties

All connections, including but not limited to beam/slabs to columns/wall, precast, etc, shall be designed to clause 6.2.3 AS1170.1 for the transfer of the lateral loads and robustness.

4.3.6. Durability

Durability to be to AS3600/AS4100/AS2311 / 2312. Maintenance levels and design life are to be nominated by the client regarding surface coatings.

4.3.7. Column Stiffness

For the purposes of both post tension and reinforced slab designs, column stiffness's are to be limited to a maximum of 20% for the slab flexure and one-way shear design, but 80% for punching shear design.

4.3.8. Concrete Roof Slabs

External suspended slabs that form part of a roof will have the following minimum design measures to improve the performance of the slab and minimise the risk of water egress directly under them. However, the slab will not be designed to retain water alone and waterproofing measures to both the slab and joints are to be in accordance with the waterproofing consultant details.

Roof slabs immediately over living spaces below will include a minimum of the following;

- A concrete strength of 40 MPa
- A minimum post tension stress of 2.0MPa, and
- A minimum of SL82 top reinforcement throughout.

Waterproofing membranes and concrete additives to Architects and waterproofing subcontractor's details.

4.3.9. Floor Vibrations

Floors shall be designed to ensure that there are only slight perceptible vibrations under footfall effects, or from other internal or external sources.

Floors shall be designed to ensure they comply with the recommended acceleration and velocity limits in the relevant standards. The R value method outlined in Annex A of AS2670.2 and Appendix A of BS6472 will be used. A dynamic assessment shall be undertaken in accordance with SCI p354 Design Guidelines or approved equivalent. The floor structures shall be designed to achieve a maximum "Multiplying Factor" R value as appropriate.

The following parameters shall be used for the analysis:

- Weight of 1 person 746N (76kg x 9.81)
- Dynamic Concrete Modulus – of 1.2 x Ec as provided in AS3600 is to be used

Slabs are not designed for vibration emanating from plant equipment, ducting, fans etc. All vibrations from plant are to be isolated at the source with dampers and vibration isolation devices.

4.3.10. Vertical Deflection Criteria for Structural Steel

The design criteria for vertical deflections of structural steel rafters and beams are as follows;

Total Deflection (after precambers)

Self-Weight and Dead Load:	Span/300 or 20mm
Self-Weight, Dead Load and short-term Live Load:	Span/250

Incremental Deflection

Short Term Live Load or Wind Load:	Span/200 or 30mm
Ceiling Dead Load only:	Span/500

Notes:

Note these deflection limitations are as per the Australian standard, rather than EFSG limitations.

Incremental and Total Deflection criteria are based on AS1170.0:2002 Table C1 for Rippling, sagging and cracking limit requirements for hung ceilings

Incremental deflections to rafters and primary beams can be additional and consideration of suitable deflection heads to walls is required.

It is assumed that appropriate movement and expansion joints are installed into brittle ceiling finishes and fixtures to assist in controlling cracking from the roof deflections described above.

For Cantilever beams and rafters, the deflection limit at the ends of the cantilevers are based on the above limits but with the span being equivalent to twice the distance from the support to the end of the cantilever.

5. Construction Materials: Codes, Properties and Construction Practices

5.1. Concrete

The design, material properties and construction of all reinforced and pre-stressed concrete elements shall comply with the provisions of AS3600 and any other relevant reference noted in this brief

For detailed information on the specification of concrete elements refer to the Concrete Specification.

Take note of the curing requirements within the specification to prevent shrinkage and drying shrinkage cracking.

5.2. Structural steel

The design, material properties and construction of all structural steel elements shall comply with the provisions of AS4100 and any other relevant reference noted in this brief

For detailed information on the specification of steel elements refer to the Structural Steel Specification.

5.3. Masonry

The design, material properties and construction of all masonry elements shall comply with the provisions of AS3700 and any other relevant reference noted in this brief

Bonacci Group will provide generic details of masonry walls and stiffeners for guidance on the joint locations and stiffeners for the use of the architect to place this information on their masonry drawings.

6. Certification

Design certification will be issued on completion of the detailed design and documentation.

A Site Inspection Certificate will be issued after construction.

7. Design certification by others

Design and construct elements must be certified by relevant qualified designer, such as the following elements.

7.1. Design and Certification of Waterproofing

All roofs, retaining walls, hydrostatic basement slabs, and balconies that require waterproofing will not be structurally designed to be watertight. It is not intended to rely on the inherent crack resistance of the reinforce/post-tensioned slabs and walls to resist water ingress. The crack control measures adopted for these concrete elements cannot be solely relied upon for water tightness. As such, the water tightness of the slab shall be achieved through the application of appropriate waterproofing membranes that are applied, designed, specified, and certified by another consultant.

7.2. Design and certification of PT Slabs

We have carried out initial design checks for the PT banded option. However, the detailed design, installation and certification of PT elements will be carried out by specialist D&C contractor.

Appendix A – Structural Concept Sketches