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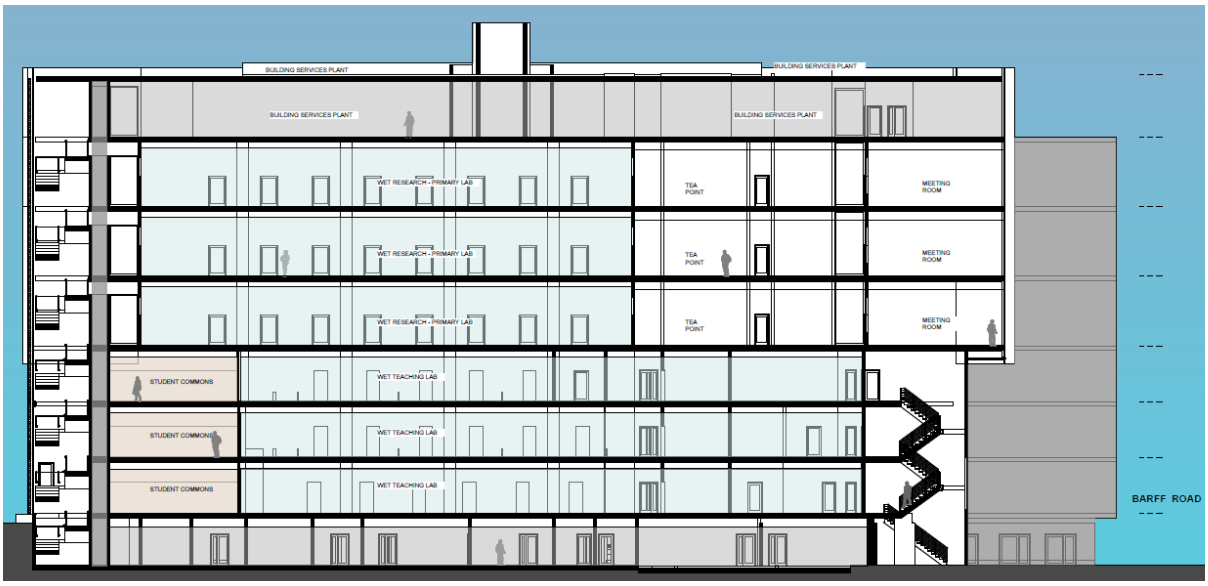
UNIVERSITY OF SYDNEY AND RICHARD CROOKES CONSTRUCTIONS

PRELIMINARY HAZARD ANALYSIS OF THE PROPOSED LEES1

DANGEROUS GOODS CONSULTANCY FOR THE DA APPLICATION



REPORT VERSION – 2.2

OUR REFERENCE: CN160302

DATE: 28 APRIL 2016

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PROJECT:	CETEC REF:	CLIENT REF:	ISSUE
Preliminary Hazard Analysis of the Proposed LEES1 Dangerous Goods Consultancy for the DA Application	**CN160302**	**LEES 1**	**2.2**

AMD	DESCRIPTION	INT	REVIEWED	DATE
1.0	Preliminary report for the consideration of the DA application	PDS	AG / VG	27th July, 2015
2.0	Updated report incorporating final DA design for project	PDS	AG / VG	1st March, 2016
2.1	Updated report addressing Council Comments	PDS	AG / VG	28th April, 2016
2.2	Updated report with additional comments	PDS	AG / VG	28th April, 2016

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1. INTRODUCTION

1.1. BACKGROUND

The University of Sydney is developing a new campus gateway at the City Road entrance to the Camperdown Campus (Eastern Avenue). The gateway comprises of two new buildings to the west and an eastern building for teaching and research across the Life, Earth and Environmental Sciences (LEES). Most of these staff will be members of a new School of Life and Environmental Sciences (SOLES).

Currently the staff who contribute to the life, earth and environmental sciences at the University are geographically dispersed, across the Faculties of Agriculture and Environment, and Veterinary Science, and the Schools of Molecular Bioscience and Biological Sciences in the Faculty of Science. Therefore the purpose of LEES1 project is to locate teaching, research and faculty accommodation from the faculties described above that are already located within the university campus into one building.

This report will form part of an appendix to the Environmental Assessment and provides detail of the Preliminary Hazard Analysis (PHA) undertaken for the proposed LEES1 building.

1.1. SCOPE AND AIM OF STUDY

The objective of this PHA is to present the hazards and risks associated with the proposed development of the LEES1 building.

Through the evaluation of the likelihood and consequences of the major identified hazards, the risks to the community associated with the proposed LEES1 building may be estimated and compared to the NSW Department of Planning risk criteria.

The scope of this report includes the following;

- Systematic identification and documentation of the identified hazards, based on information supplied and relevant experience from similar projects.
- Establishment of the consequence of each identified hazard and determination as to their offsite effects. Note that this process is quantitative, actual impacts would be determined following design finalisation, plume modelling and calculations.
- Where offsite effects are identified, the frequency of occurrences is determined based on historical data.
- Identification of risk reduction measures as deemed necessary.

1.2. Does SEPP 33 Apply and is the New Facility Considered Hazardous Or Offensive

In reviewing 'Table 2' of the Department of Planning's Hazardous and Offensive Development Application Guidelines - Applying SEPP 33, that details the cumulative annual and weekly chemical volume transportation threshold for SEPP 33 to be applicable (refer to Insert 1).

Insert 1: Table 2: Transportation Screening Thresholds from the Department of Planning's Hazardous and Offensive Development Application Guidelines - Applying SEPP 33

Table 2: Transportation Screening Thresholds

	Vehicle Movements		**Minimum quantity*** **per load (tonne)**	
	Cumulative	Peak		
Class	Annual *or*	Weekly	Bulk	Packages
1	see note	see note	see note	
2.1	>500	>30	2	5
2.3	>100	>6	1	2
3PGI	>500	>30	1	1
3PGII	>750	>45	3	10
3PGIII	>1000	>60	10	no limit
4.1	>200	>12	1	2
4.2	>100	>3	2	5
4.3	>200	>12	5	10
5	>500	>30	2	5
6.1	all	all	1	3
6.2	see note	see note	see note	
7	see note	see note	see note	
8	>500	>30	2	5
9	>1000	>60	no limit	

Note: *Where proposals include materials of class 1, 6.2 or 7, the Department of Planning should be contacted for advice. Classes used are those referred to in the Dangerous Goods Code and are explained in Appendix 7.*

** If quantities are below this level, the potential risk is unlikely to be significant unless the number of traffic movements is high.*

It would be expected that under normal running conditions of the new building that these volumes would be exceeded for the 'Vehicle Movements'. Therefore CETEC would consider that SEPP 33 applies to this facility. However considering the overall proposed chemical storage within the facility, this building would be considered more as an 'Offensive Industry' rather than a 'Hazardous Industry' due to the low chemical storage volumes within the building. Note that chemical volumes would be limited to allowable volumes as detailed within AS/NZS 2243.10.

Considering that SEPP 33 applies to this proposal, the detailed risk assessment of the design is to be undertaken at the Detailed Design stages of the project.

2. Site and Spatial Requirements

2.1. Site Location and Surrounding Areas

The proposed site is an important gateway to Eastern Avenue and the University, at the intersection of Butlin Avenue, Eastern Avenue and City Road, and will play an increasingly important role in connecting the developing Darlington Campus and the more established Camperdown Campus, Figure 1.

The site allows an interface with the Carslaw building and has the opportunity to provide an address directly from Eastern Avenue and at a higher level from the City Road foot-bridge. The existing Carslaw building service roadway from Butlin Avenue sits within the proposed site. The roadway provides access to the existing Carslaw substation on the south west corner of the building and to the Level 01 loading dock sitting centrally on the southern face of the building. Access to the loading dock and goods lift is to be maintained. The project is to investigate opportunities to relocate the existing substation.

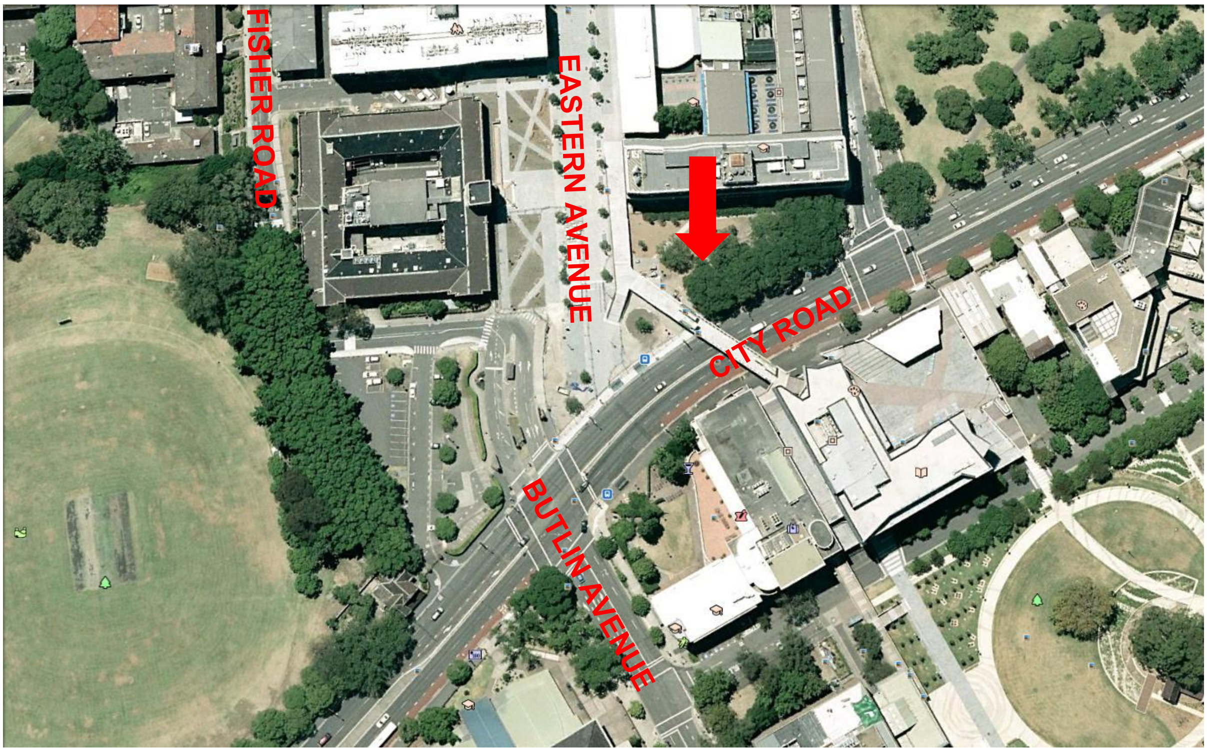

Figure 1: Site Location

2.2. Spatial Requirements of LEES1

2.2.1. Accommodation Summary

2.2.1.1. Research

- 3 x 50-person PC2 capable wet research laboratory and associated dry workspaces (classrooms/offices).
- NMR and associated crystallography facility.

2.2.1.2. Teaching

- 2 x 144 PC2 capable student teaching laboratories.
- 1 x 96 PC2 capable student teaching laboratories.
- Learning Hub.

2.2.1.3. Building Support Spaces

- Loading Dock.
- Central Stores (Class 3, Class 8 and Mixed, Gasses and Cryogenic Liquids).
- Field equipment store.
- Decontamination.
- Glass Wash-up.
- Preparation Area.
- Hazardous material and waste storage.

3. Study Methodology

3.1. Introduction to Methodology

The methodology for the PHA is well established and documented in Australia utilising the criteria as detailed in the Department of Planning's HIPAP No 6 (Guidelines for Hazard Analysis) and HIPAP No 4 (Risk Criteria for Land Use Planning, Ref 2). These documents describe the methodology and criteria to be used in PHAs, as required by the NSW Department of Planning for major 'potentially hazardous' developments.

As per HIPAP No 6, there are five (5) stages in the risk assessment, which are;

Stage 1: Hazard Identification – The review of potential hazards associated with all hazardous goods to be stored and used onsite, including transportation to and from the site.

The hazard identification also includes identification of potential incidences which may arise and their impact on the local public and neighbouring areas, from which possible mitigating strategies to minimise the likelihood of the incident and/or decrease the impact on the public which are to be considered.

Stage 2: **Consequence and Effect Analysis** – The consequences of identified hazards are assessed using current techniques for risk assessment with the implementation of well-known correlations between exposure and effect on people is used to calculate/assess the impact.

Stage 3: **Frequency Analysis** – For incidents identified with significant effects, whether to people, property or the neighbouring external environment, the frequency of occurrence is estimated or evaluated based on historical data.

Stage 4: **Quantitative Risk Analysis –** The combination of an outcome (such as death or injury) combined with the frequency of an event results in the risk from the event,

i.e. *Risk = Consequence x Frequency*

The risk is therefore obtained by adding together the results from the risk calculations for each incident and the results from the risk analysis are presented in three forms;

- Individual fatality risk.
- Injury or irritation risk.
- Societal risk.

The risk results are then assessed against the guidelines adopted by the NSW Department of Planning.

Stage 5: **Risk Reduction** – Where possible, risk reduction measures are identified throughout the course of the study in the form of recommendations.

3.2. Risk Criteria

Having determined the risk from a development, it must then be compared to acceptable criteria in order to assess whether or not the risk level is tolerable. If not, then specific risk mitigating measures must be developed and incorporated to reduce the risk to an acceptable level. Where no measures are found, then the development is not compatible with the surrounding environment and land uses.

4. Hazard Analysis

4.1. Hazard Identification – Summary of Hazardous Goods Onsite

For the nature of the building, the expected dangerous goods and volumes that would be stored and used onsite are listed below in Table 1.

Table 1: Chemicals likely to be Stored and Used Onsite

Building Area / Use	Chemical / Product	Expected Storage Capacity
Natural gas supply	Natural gas	No storage onsite, gas will be reticulated from the gas supplier's lines into the building and distributed to all locations to be used. Pipe dimensions and pressures as per applicable Australian Standards.
Compressed gases in laboratory spaces	Class 2.1, 2.2, 2.2 sub 5.1 and 2.3	Volumes onsite will be limited to AS 4332 requirements.
Flammable liquids	Class 3	Volumes onsite will be limited to AS 2243.10 requirements.
Flammable solids	Class 4	Volumes onsite will be limited to AS 2243.10 requirements.
Oxidising chemicals	Class 5	Volumes onsite will be limited to AS 2243.10 requirements.
Toxic chemicals	Class 6.1	Volumes onsite will be limited to AS 2243.10 requirements.
Corrosive chemicals	Class 8	Volumes onsite will be limited to AS 2243.10 requirements.
Radioactive agents	Class 7	Volumes onsite will be limited to the requirements of the Australian Radiation Protection and Nuclear Safety Agency
Miscellaneous hazardous goods	Class 9	Volumes onsite will be limited to AS 2243.10 requirements.
Combustible liquids	C1 and C2	Volumes onsite will be limited to AS 2243.10 or AS 1940 requirements. Applicable Australian Standard will be depended on location of usage.
Biological agents	Biological material of PC2 risk category	Limited to biological agents in use or storage for research purposes only
Fire protection	Fire extinguishers, e.g. water, dry chemical, carbon dioxide, etc.	As required throughout as per the requirements of the Australian Standards.

4.2. Summary of Risk due to Identified Hazards

Although there is a large number of identified hazards onsite, overall these hazards can be grouped into the following main categories assuming any incident occurs within the confines of the building;

- Reticulation services line rupture – Depending on the gases being reticulated, fire, explosion, asphyxiation, or varying levels of toxicity to people may result.
- Gas usage – Depending on where the gas usage is occurring or being stored, fire, explosion, asphyxiation, or varying levels of toxicity to people may result.
- Class 3 and 4 chemicals – Depending on where storage or usage is occurring, fire, explosion or varying levels of or varying levels of toxicity to people may result.
- Class 5 chemicals – Depending on where storage or usage is occurring, fire, explosion or varying levels of toxicity to people may result. Final outcomes will be dependent on the type of oxidising agents being used.
- Class 6.1 chemicals – Depending on where storage or usage is occurring, fire or or varying levels of toxicity to people may result.
- Class 8 chemicals – Depending on where storage or usage is occurring, or varying levels of toxicity to people may result. Final outcomes will be dependent on the type of oxidising agents being used.
- Class 7 chemicals – Depending on where storage or usage is occurring, or varying levels of toxicity to people may result. However, these items are radioactive isotopes used for medical research, therefore the expected half-life of these items would be short thus reducing the overall risk.
- Class 9 chemicals – Depending on where storage or usage is occurring, or varying levels of toxicity to people may result. Final outcomes will be dependent on the type of oxidising agents being used.
- Fire extinguishers – Depending on where these items are located for usage, the main risk is rupture of the vessel.
- PC2 biological material – Material of this nature (PC2 risk rating) present moderate individual risk, and limited community risk. They cause human, animal or plant disease but do not pose a serious risk because effective treatment and preventative measures are available and there is limited potential for spread.
- Laboratory, chemical stores and fume cupboard exhausts – Depending on the location from which the exhausted air is being exhausted, or varying levels of toxicity to people may result.

4.3. Hazard Identification and Mitigation

Table 2 below provides a summary of the hazardous incidents identified onsite and potential initial mitigating features which may be implemented to reduce their overall risk outcome.

Table 2: Risk Assessment

Event	Cause/Comment	Possible Consequences	Likelihood of Event
Gas Leak and Storage			
Leak of gas to the atmosphere from reticulated pipe lines outside of the building.	Mechanical impact from vehicles, weld or joint failure, operation error, corrosion, sabotage.	**Moderate** Release gas at high or moderate pressure. If ignition sources are available, then flash fires, explosion or jet fire is possible if gases are flammable.	**Unlikely** All pipes are pressure tested upon commissioning and maintenance schedules are followed, including visual inspection of exposed pipes for corrosion. All piping will be protected within locked risers or enclosures.
Operation error by users resulting in over pressuring the gas line or accidently knocking over cylinders.	Maintenance work, incorrect shutdown of cylinders, installation of incorrect cylinder to gas manifold. Cylinders not being stored in appropriate location/holders.	**Moderate** Release gas at high or moderate pressure. If ignition sources are available, then flash fires, explosion or jet fire is possible for flammable gases. Cylinder head sheers off resulting in a catastrophic release of gas.	**Moderate** Human error and/or user inexperience may result in a human induced event.
Venting of gas	Maintenance work, incorrect shutdown or purging of gas lines.	**Insignificant** Release gas at high or moderate pressure. If ignition sources are available, then flash fires, explosion or jet fire is possible for flammable gases.	**Almost Certain** Any maintenance of work will require system shutdown, pressure release and degassing.
Gas release within laboratories.	Taps being left open accidently.	**Major** Build-up of gas within laboratories causing oxygen depletion / enrichment, elevated levels of toxic gases or flammable mixtures in air.	**Moderate** Human error and/or user inexperience may result in a human induced event.

Cryogenic Liquid Usage / Storage			
Vessel rupture	Mechanical impact from vehicles, weld or joint failure, corrosion, sabotage.	**Catastrophic** Sudden release of cryogenic liquid into neighbouring area causing sudden oxygen depletion / enrichment or toxic gas build-up.	**Unlikely** All vessels are pressure tested upon commissioning and maintenance schedules are followed, including visual inspection of vessels. All vessels will be protected within locked enclosures.
Spillage of vessel contents	Human error, degradation of carrying equipment.	**Catastrophic** Sudden release of cryogenic liquid into neighbouring area causing sudden oxygen depletion / enrichment or toxic gas build-up.	**Unlikely** Human error and/or user inexperience may result in a human induced event.
Chemical Storage / Usage (Classes 3 to 9, excluding 7)			
Accidental spillage or breakage of containers within chemical storage areas.	Human error, shelving failure.	**Minor** Fire or explosion for flammable liquids. Formation of toxic atmospheres in enclosed areas.	**Moderate** Human error and/or user inexperience may result in a human induced event.
Mixing of different chemicals following breakage of containers.	Human error, shelving failure.	**Moderate** Mixing of chemicals may result in undue risk because of unwanted reactions, e.g. fire, explosion, toxic fumes.	**Unlikely** Mixing of chemicals resulting in undue risk would be low because chemicals would be stored within dedicated chemical cabinets or stores.
Accidental spillage of chemical within laboratories.	Human error, shelving failure.	**Minor** Mixing of chemicals may result in undue risk because of unwanted reactions, e.g. fire, explosion, toxic fumes.	**Moderate** Human error and/or user inexperience may result in a human induced event.

Storage or usage of Class 7			
Accidental spillage or breakage of containers within storage areas.	Human error, shelving failure.	**Moderate** Release of radioactive material.	**Unlikely** Human error and/or user inexperience may result in a human induced event. However, radioactive material would be stored onsite in small volumes and within a secondary container.
Accidental spillage of chemical within laboratories.	Human error, shelving failure.	**Moderate** Mixing of chemicals may result in undue risk because of unwanted reactions, e.g. fire, explosion, toxic fumes.	**Rare** Human error and/or user inexperience may result in a human induced event.
Transportation of Dangerous Goods to and from the building			
Accident onsite while goods are being delivered to site	Human error.	**Major** Gas cylinders, cryogenic liquid vessels may become damaged. Breakage of glass containers holding chemicals. Release of toxic, flammable or oxygen depleting gases into the surrounding area.	**Unlikely** The dangerous goods transport company would follow their procedures and protocols which would be in compliance to the ADG Code.
Transportation of Dangerous Goods within the building			
Transportation of gases or cryogenic liquids between building levels resulting contents spillage.	Human error, equipment failure.	**Major** Personal injury or asphyxiation.	**Unlikely** Human error and/or user inexperience may result in a human induced event. However, any human induced event may result in death.

4.4. CALCULATION OF RISK

Risk is the likelihood of any defined adverse outcome. Risk can be defined for any of the final outcomes of an event as detailed in Table 2 by the effect of the consequences coupled with the associated likelihood. As the adverse outcome can take many forms, particularly in the case of effects on the biophysical environment, risks can be expressed in a number of different ways. Within this report, the Risk has been documented in Table 4 using the risk assessment table in Table 3.

Based on the risk assessment results in as detailed in Table 4, result greater than 'LOW' will require further risk mitigating hardware to mitigate any potential adverse event or reduce its impact.

Table 3: Risk Assessment Table

Likelihood \ Consequences	**Insignificant** Minor problem easily handled by normal day to day process.	**Minor** Some disruption possible. Injuries may result, hospitalisation generally not required, can be treated with first aid onsite.	**Moderate** Significant time/resources required. Moderate injuries, may require hospitalisation.	**Major** Operations severely damaged. Sever Injuries.	**Catastrophic** Business survival at risk. Death.
Almost Certain (>90%)	High	High	Extreme	Extreme	Extreme
Likely (50 - 90%)	Moderate	High	High	Extreme	Extreme
Moderate (10 - 50%)	Low	Moderate	High	Extreme	Extreme
Unlikely (3 - 10%)	Low	Low	Moderate	High	Extreme
Rare (<3%)	Low	Low	Moderate	High	High

Table 4: Risk Assessment Outcome

Event	Consequence Rating	Likelihood Rating	Overall Risk	Required Mitigating Strategies
Gas Leak and Storage				
Leak of gas to the atmosphere from reticulated pipe lines outside of the building.	**Moderate**	**Unlikely**	**Moderate**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use of fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Identify hazard zones (as per AS 60079.10.1) and install appropriate electrical fittings complying with the enclosure's classification, i.e. ZONE type, Gas Group, Temperature Class. • Install gas sensors to monitor for oxygen depletion, or the gas being reticulated with automatic shut-off valves connected to the gas sensor. • Install collision bollards to protect the cylinders or piping locations. • Plume modelling required confirming safe dispersion of contaminants.
Operation error by users resulting in over pressuring the gas line or accidently knocking over cylinders.	**Moderate**	**Moderate**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use of fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Identify hazard zones (as per AS 60079.10.1) and install appropriate electrical fittings complying with the enclosure's classification, i.e. ZONE type, Gas Group, Temperature Class. • Install gas sensors to monitor for oxygen depletion, or the gas being reticulated with automatic shut-off valves connected to the gas sensor. • Locate structurally sound cylinder holders within the enclosure with ample space for cylinder movements between cylinder exchanges.

Venting of gas	**Insignificant**	**Almost Certain**	**Low**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use of fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Identify hazard zones (as per AS 60079.10.1) and install appropriate electrical fittings complying with the enclosure's classification, i.e. ZONE type, Gas Group, Temperature Class. • Install gas sensors to monitor for oxygen depletion, or the gas being reticulated with automatic shut-off valves connected to the gas sensor.
Gas release within laboratories.	**Major**	**Moderate**	**Extreme**	• Supply sufficient fresh air (as per AS 1668) to maintain air quality at acceptable levels. • Restrict gas flow at the taps within laboratories to as low as practically possible, refer to AS 2896, AS 4289, etc. whichever most applicable. • Review requirement for gas sensors. • Review hazard zones and implement appropriate safeguards as detailed in AS 60079.10.1.
Cryogenic Liquid Usage / Storage				
Vessel rupture	**Catastrophic**	**Unlikely**	**Extreme**	• Locate vessel as per the requirements of AS 1894. • Ensure pressure release valve is appropriate and working correctly for vessel requirements. • Ensure all separation distances, as per AS 1894, are met. • Direct pressure release valves to areas away from public spaces. • Ensure release valve meets separation requirements as per AS 1894.
Spillage of vessel contents	**Catastrophic**	**Unlikely**	**Extreme**	• For closed vessel which are transporting cryogenic liquids internally, ensure a maximum volume of 250 L dewars are used. • For open vessel, ensure maximum dewar volume is based on risk assessment taking into consideration room volume, fresh air ventilation and volume of cryogenic liquid.

Chemical Storage / Usage (Classes 3 to 9, excluding 7)				
Accidental spillage or breakage of containers within chemical storage areas.	**Minor**	**Moderate**	**Moderate**	• Design chemical storage areas as per the requirements of AS 2243.10, incorporating further requirements from AS 1940, i.e. fire separation, ventilation requirements, etc. • Incorporate minimum firefighting requirements as per AS 1940. • Ensure containment area is designed as per the requirements of AS 1940, thus supplying minimum bunding requirements. • For areas where flammable mixtures may result, ensure hazard zoning as per the requirements of AS 60079.10.1 are incorporated clearly documenting ZONE type, Gas Group, Temperature Class. • Ensure exhaust from chemical storage areas exhaust at an appropriate location, ideal locations may require investigation through AERMOD, AUSPLUME or physical modelling of wind and building infrastructure.
Mixing of different chemicals following breakage of containers.	**Moderate**	**Unlikely**	**Moderate**	• Design chemical storage areas incorporating segregation and separation to minimise unwanted chemical mixing, i.e. Class 3 chemicals to be separated from Class 8 and 6.1. Class 6.1 chemicals to be segregated from Class 8 chemicals.
Accidental spillage of chemical within laboratories.	**Minor**	**Moderate**	**Moderate**	• Ensure appropriate procedures and protocols are implemented to minimise the outcome of the event, e.g. appropriate spill kits, safety showers, eye washes.
Storage or usage of Class 7				
Accidental spillage or breakage of containers within storage areas.	**Moderate**	**Unlikely**	**Moderate**	• Design storage areas as per the requirements of AS 2243.4. • Ensure containment area is designed as per the requirements of AS 2243.4, thus supplying minimum bunding requirements. • For areas where flammable mixtures may result, ensure hazard zoning as per the requirements of AS 60079.10.1 are incorporated clearly documenting ZONE type, Gas Group, Temperature Class.

Accidental spillage of chemical within laboratories.	**Moderate**	**Rare**	**Moderate**	• Ensure appropriate procedures and protocols are implemented to minimise the outcome of the event, e.g. appropriate spill kits, safety showers, eye washes.
Transportation of Dangerous Goods to and from the building				
Accident onsite while goods are being delivered to site	**Major**	**Unlikely**	**High**	• Ensure that all deliveries to site are conducted by approved suppliers who hold all relevant licensing as per the Australian Dangerous Goods Code, Dangerous Goods (Road and Rail Transport) Act 2008 and Dangerous Goods (Road and Rail Transport) Regulation 2014. • Ensure appropriate spill kits are available. • Ensure the design of the loading dock with ample space for ease of truck movements. • Ensure direct route to and from the loading dock for ease of movement. • General transport risks of such materials are handled by the company's safety requirements. Clean up and incident management procedures as per transport company procedures.
Transportation of Dangerous Goods within the building				
Transportation of gases or cryogenic liquids between building levels resulting contents spillage.	**Major**	**Unlikely**	**High**	• Minimise occupant lift usage combined with cryogenic liquid or gases transportation. • Implement lift controls for unattended lift usage. • University of Sydney to develop transportation guidelines for all dangerous goods within the building which are outside of the PC2 laboratories or chemical storage areas. • Transport goods on purposely designed trolleys to securely transport goods.

5. POTENTIAL HAZARDOUS INCIDENTS AND THEIR CONTROLS

As detailed in the risk assessment table above, refer to Table 4, safety management systems have been recommended to reduce the risk from potentially hazardous installations, these mitigating strategies will employ design requirements as detailed in various Australian Standards and a combination of engineered solutions including, hardware and software packages. It is essential to ensure that hardware systems and software procedures used are reliable and of the highest quality in order to ensure safe operation of the facility under all circumstances.

5.1. GENERAL HARDWARE SAFEGUARDS

Hardware safeguards include factors such as laboratory design, layout of equipment and instrumentation, and compliance with relevant codes, technical standards and industry best practice.

All systems handling dangerous goods will comply with the following Acts, Regulations and Codes and Australian Standards in their latest editions. Below are listed some of the most relevant for laboratory design and construction;

- NSW Occupational Health and Safety Act and its associated legislation, such as the Dangerous Goods Regulations, Construction Safety Regulations, etc.
- AS/NZS 2982 Laboratory design and construction.
- AS/NZS 2243.10 Safety in laboratories - Storage of chemicals.
- AS/NZS 2243.3 Safety in laboratories - Microbiological safety and containment.
- AS/NZS 2243.4 Safety in laboratories - Ionizing radiations.
- AS/NZS 2243.5 Safety in laboratories - Non-ionizing radiations—Electromagnetic, sound and ultrasound.
- AS/NZS 1940 The storage and handling of flammable and combustible liquids.
- AS/NZS 1894 The storage and handling of non-flammable cryogenic and refrigerated liquids.
- AS/NZS 4332 The storage and handling of gases in cylinders.
- AS/NZS 1216 Class labels for dangerous goods.
- AS/NZS 60079.10.1 Explosive atmospheres - Classification of areas - Explosive gas atmospheres.
- AS/NZS 60079.17 Explosive atmospheres - Electrical installations inspection and maintenance.

- AS/NZS 60079.14 Explosive atmospheres - Electrical installations design selection and erection.

5.2. Specific Hardware Safeguards

5.2.1. Gas Leak

Australian Standards, (AS 2896, AS 4289, AS 1596, AS 2885), sets out minimum standards for pipelines where flammable, oxidising or non-hazardous gases are reticulated. These codes give detailed requirements for the design, construction and operation of the gas and liquid pipelines for the various classes of gases.

The proposed safeguards for the supply pipelines detailed below. The safeguards have been grouped together under the potential hazardous events associated with the pipeline.

- External Interference – Such interference may be due to collisions from vehicles or sabotage of the piping installation. This potential is minimised through the fact that all reticulated services, e.g. natural gas (which will be buried underground for pipelines at high pressure) or other gases for laboratory use will be clearly labelled and protected by collision bollards or within service risers would mitigate the risk or such events. Further to this, any external installation will be protected by security fencing or within a dedicated secure enclosure.
- Construction Defects / Material Failure – These events may result due to poor workmanship or quality of material. Although gas leaks due to material failure are minimised by initially testing gas lines as per the requirements of AS 4037, including the stability and quality of joints. The potential for gas leaks is further minimised by the installation of pressure release valves which are designed to release pressure at a known level below the breaking point of the pipeline.
- Corrosion of piping – Although corrosion of piping may be possible in the lifetime of the installation. All exposed piping (i.e. piping in risers) would be subject to ongoing monitoring and maintenance regimes as per manufacturer's requirements or as detailed in relevant Australian Standards, e.g. AS 1596.
- Oxygen depletion / Toxic and/or Flammable gas accumulation – In areas where gas accumulation can occur, appropriate oxygen depletion or toxic/flammable gas detection devices are to be installed. An appropriate risk assessment must be conducted to elucidate appropriate sensors, alarming levels and location for installation.

5.2.2. Cryogenic Vessel or Cylinder Rupture / Fall

Australian Standards, AS 1894 and AS 4332, sets out minimum design and construction requirements for these types of enclosures which are to house cryogenic liquids or compressed gases in storage. The proposed safeguards for these enclosures are detailed below when considering potential hazardous events associated with the type of storage.

- External Interference – Such interference may be due to collisions from vehicles or sabotage of the storage area. This potential is minimised through construction of enclosures which are protected by either collision bollards or collision barriers. Further to this, these enclosures will be protected by security fencing or solid construction which will be lockable by a secure gate/door.
- Construction Defects / Material Failure – These events may result due to poor workmanship or quality of material. However, Linde or BOC who supply compressed gases in cylinders or cryogenic cylinders construct and test these items to relevant Australian Standards to confirm the quality of the items and compliance to specifications. Therefore such an event would be unlikely to occur due to ongoing testing. This risk is further reduced by the installation of pressure release valves on cylinders and cryogenic tanks which are set to release gas in the event of pressure build-up.
- Corrosion of cylinders or tanks – Although corrosion of cylinders and tanks is possible over the lifetime of the items, cylinders are pressure tested by the gas supplier to confirm integrity as per their procedures and protocols. The cryogenic tanks will also pressure tested following similar protocols.
- Oxygen depletion / Toxic and/or Flammable gas accumulation – In areas where gas accumulation can occur, appropriate oxygen depletion or toxic/flammable gas detection devices are to be installed. An appropriate risk assessment must be conducted to elucidate appropriate sensors, alarming levels and location for installation.

5.2.3. Chemical Storage, Use, Spills or Fires

Australian Standards, AS 2243 series, AS 1940, AS 4452, AS 3780, sets out storage requirements for dangerous goods; including constructions requirements for chemical stores, ventilation requirements, maximum allowable volumes in storage and in use, recommended procedures to mitigate spills and minimum firefighting requirements.

The proposed safeguards for these storage and usage areas are detailed below when considering potential hazardous events associated with the type of storage or use.

- Human error, spills and vapour generation – For chemicals which are accidently spilt due to human error, e.g. accidental dropping of containers, the resulting solvents which spill onto the floor will generally generate vapours which can be toxic or flammable in nature. A means to mitigate the risk to occupants is to ventilate the area to maintain an environment which is suitable for occupant to implement corrective actions to either clean up the spill or alert others to the incident. As detailed in the standards above, safety devices that are implemented into laboratory or chemical store design are;
    - Emergency buttons to alert security or safety officers.
    - Gas or vapour sensors, which when triggered, alert security or safety officers.
    - Emergency ventilation.
    - Spill kits to aid in clean-up.
- Flammable vapour generation – For areas where flammable liquids are used, spills of these chemicals can generate flammable vapours which can cause flash fires or explosions. However when considering the 'fire triangle', the three items that are required to cause a fire or explosion are oxygen, flammable vapour and an ignition source. The two items above which can be controlled through engineering mitigating devices is flammable vapour and ignition sources. Therefore these areas will be ventilated as per AS 1940 or AS 1668 and all ignition sources will be controlled to meet the requirements of AS 60079.10.1. That is all areas where flammable liquids are used will contain flammable hazardous areas as defined in AS 60079.10.1 and all electrical items which fall within the defined hazard zones will be engineered to meet the requirements of AS 2381 series.
- Fires from spills – All areas where chemicals are being used may possess a small potential for fires. This risk is mitigated through the installation of various firefighting devices as per relevant codes and Australian Standards, these firefighting devices will be;
    - Fire sprinklers.
    - Fire hose reels.
    - Fire extinguishers.
    - Fire blankets.

  Therefore, although a risk of fire is always present there will be a number of mitigating strategies which will be applied to meet BCA requirements such as fire compartmentation, firefighting devices, etc.

5.2.4. Class 7 Chemicals – Spills and Discharges

All class 7 chemical which will be used in this facility will be medical in nature, thus meaning that the majority of these items will possess short half-lives. Further to this procedures and protocols as detailed by ARPANSA will need to be followed prior to relevant licensing to be issued.

The proposed safeguards for safe use and storage of such chemical are detailed in AS 2243.4, where design construction requirements are also detailed.

- Spills – All surfaces where these chemical will be used will be designed so as to be easy to clean and non-absorbent.
- Legislative requirements in relation to design and construction for areas where radioactive materials are used will be adhered to minimise the risk to occupants, neighbouring establishments and general ventilation discharges.

5.2.5. Chemical Vapour Release from the Building

As a scientific building where a number of processes and tasks will generate various vapours which can be toxic or harmful to users, AS 2243 series sets out minimum design and construction requirements for laboratories and how to expel their emissions to minimise the impact and risk to the public. Currently AS 2982 and AS 1668 define how ventilation exhaust is to be discharged into the atmosphere to minimise the impact on the general public and neighbouring building.

The proposed safeguards for safe exhaust discharge are;

- Design exhaust stacks to meet the requirements of AS 1668 meeting minimum separation distances from building fresh air intakes and other openings within the same building or neighbouring buildings.
- Confirm with the Sydney Airport and / or CASA that the building height or exhaust stack discharge heights (i.e. wind turbulence) does not enter Sydney Airport protected airspace thus interfering with the Obstacle Limitation Surface (OLS).
- Conduct plume modelling for stacks emissions to confirm that all contaminants discharged from stacks dilute to acceptable levels to before reaching locations where potential odours may be detected. Such discharge locations will be modified if required to minimise the risk of neighbouring complaints.

5.2.6. NMR and Crystallography Machines

One machine which uses a large volume of cryogenic liquids (e.g. liquid helium and nitrogen) is the NMR machine which is used to ascertain chemical structure through the detection of specific atoms within molecules. Other machines such as the crystallography machine generate X-rays to elucidate molecular structure.

These machines require a stable environment for their functioning correctly and therefore will be housed internally within the building. Although while in use they will generate electromagnetic fields and x-rays, these non-ionising and ionising energies will be contained within their rooms and should pose little to no risk to the public. AS 2243.4 and AS 2243.5 specify design requirements to aid in the shielding of these radiations to protect the occupant within the building. Further to this the manufacturers design specification will also be implemented to aid in the shielding of these radiations while the machines are in use. Note that when not in use, they pose little to no risk to the public.

As the NMR machine will be using a large volume of cryogenic liquid an oxygen depletion gas detection devices are to be installed. An appropriate risk assessment must be conducted to elucidate appropriate sensors, alarming levels and location for installation.

6. Conclusion and Recommendations

In reviewing the new proposal and the conditions as detailed within the ‘Department of Planning’s Hazardous and Offensive Development Application Guidelines - Applying SEPP 33’, CETEC believes that SEPP 33 applies to this proposal and therefore the following conclusions and recommendations have been attained following this risk assessment.

The main hazard associated with the proposed project is associated with the production and handling of biological material with Physical Containment Requirements of Level 2, dangerous goods of Classes 2 to 9 with limited Class 7 items. A number of hazards will always be present onsite due to the nature of work which will be conducted within this building. Although its impact to the internal and external environments will be dependent on volumes present and staff training, the impact from any incident onsite can be further reduced through the implementation of construction requirements as detailed within various Australian Standards, the Building Code of Australia and other local government construction requirements.

As documented in Table 4, the Risk Assessment Outcomes, there are a number of risk scenarios which have been found to be Moderate to Extreme in this assessment (assuming no engineering controls are implemented), however practically it would be expected that the impact to the external environment, i.e. the impact to the neighbouring environment, would be expected to be small given that chemical volumes onsite would be relatively small. Further impacts to the local environment, building occupants and building structure can be further reduced by the implementation of appropriate design requirements as detailed in Table 4. However the major social impact from an incident onsite would be through the injury of staff and/or student within the classrooms or laboratories. Therefore as part of the future design of this building a detailed risk assessment would need to be conducted to elucidate appropriate engineering controls for the building as the preliminary risk assessment above has indicated that a majority of possible hazardous scenarios may eventuate from human error. Therefore where practical through engineering controls, the risk of human error will be designed out through the use of the 'Hierarchy of Hazard Control' pyramid.

Given the early stages of this project, appropriate engineering controls have not been developed or considered. Therefore this report is based on conservative assumptions indicating an inherent risk with the proposed building. However these risks can and will be further reduced through the implementation of construction requirements for laboratory spaces and chemical storage locations as detailed in relevant Australian Standards and through a risk assessment as detailed below.

6.1. Future Detailed Risk Assessment for Risk Minimisation

Although this report documents a number of risks and hazards associated with the identified chemicals which will be used therein. It doesn't risk assess user requirements or chemicals and any other engineering devices that may be required to mitigate the risk associated with the design of the building.

As a number of hazards have been identified that will impose a number of risks onto the design of this building and its users. All of which may result in fires, injury or death if not assessed appropriately to impose restrictions on procedures and protocols, or engineering controls. A further detailed risk assessment will be required as the progression on the design of this building continues.

Although this detailed risk assessment is not part of this report given the early stages of the documentation, a future detailed risk assessment which will identify localised risks within each laboratory will be required in the future to elucidate all engineering controls that will be required to mitigate the risks of fire, asphyxiation, contamination spread, etc. Items to be addressed / assessed within the detailed risk assessment will be;

- Chemical storage (all classes used by the users).
- Laboratory design (the laboratories will need to comply to PC2 requirements).
- Bulk chemical stores (all classes used by users).
- Hazard zones and hazardous atmospheres.
- Contaminant dispersion from stacks.

Therefore a full risk assessment report will be generated for the University of Sydney and designers which will;

- Identify laboratory spaces and confirm design and construction requirements for compliance to AS 2982 and AS 2243.3.
- Review user requirements for the laboratory spaces.
- Identify procedures and protocols which will be implemented within each laboratory.
- Identify laboratories which will use dangerous goods.
- Identify chemical classes which will be required within each laboratory space based on user needs.
- Review chemical requirements and elucidate maximum allowable chemical storage for compliance to AS 2243.10.
- Review gas requirements and elucidate if risk mitigating gas sensors or increased ventilation is required.
- Review flammable goods which will be used onsite and identify hazard zones associated with such usage.

APPENDIX A – PRELIMINARY PLANS

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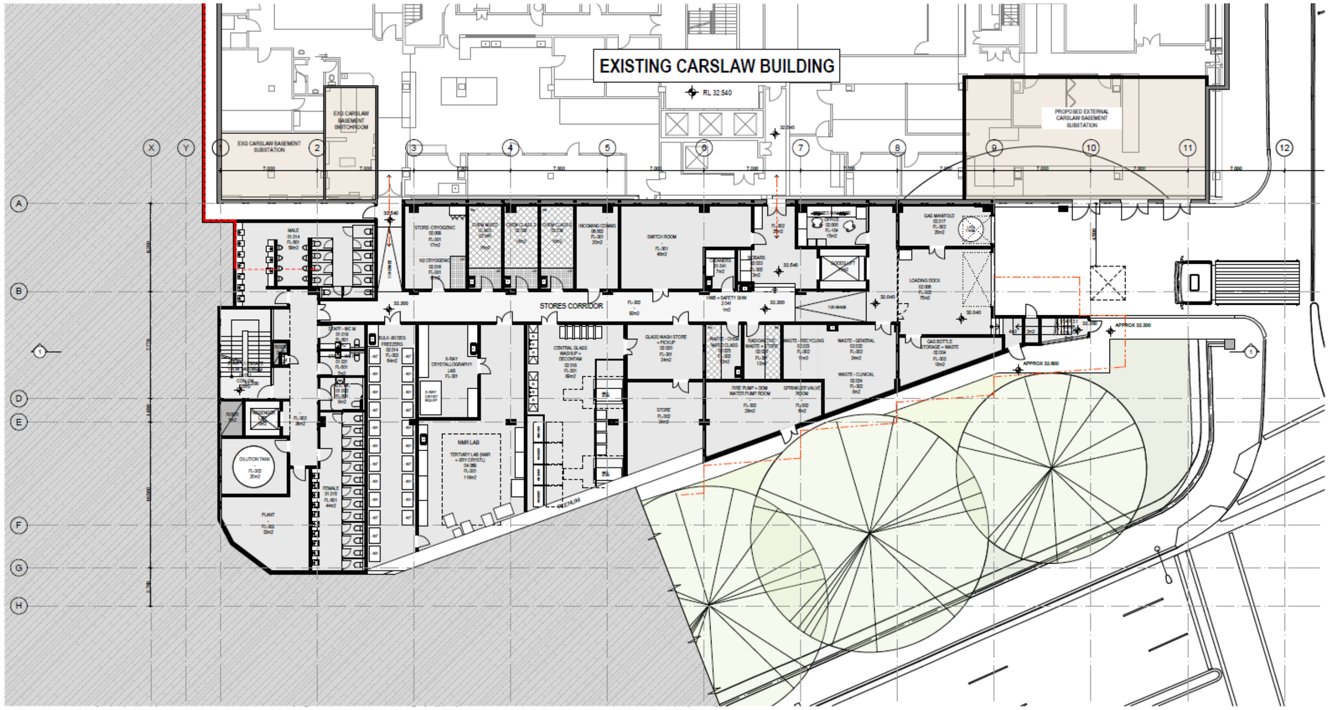
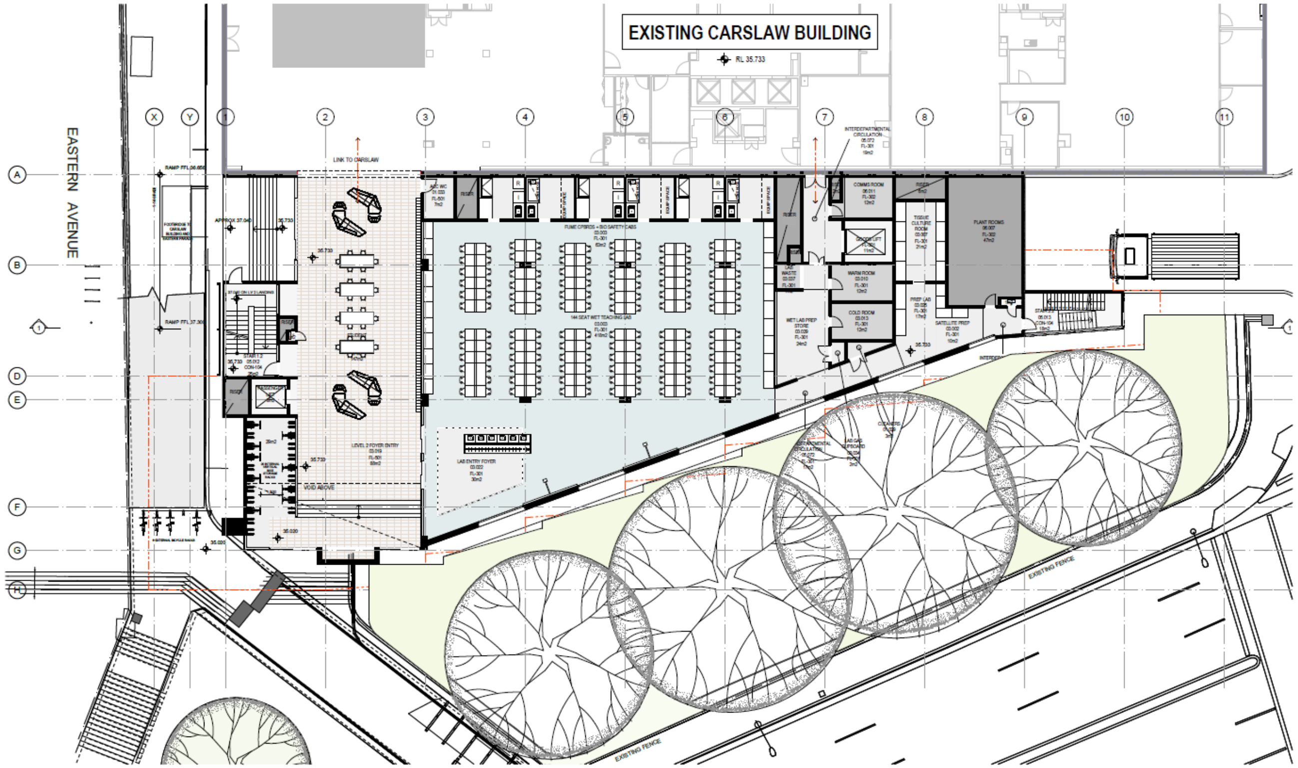


Level 2 (Ground)



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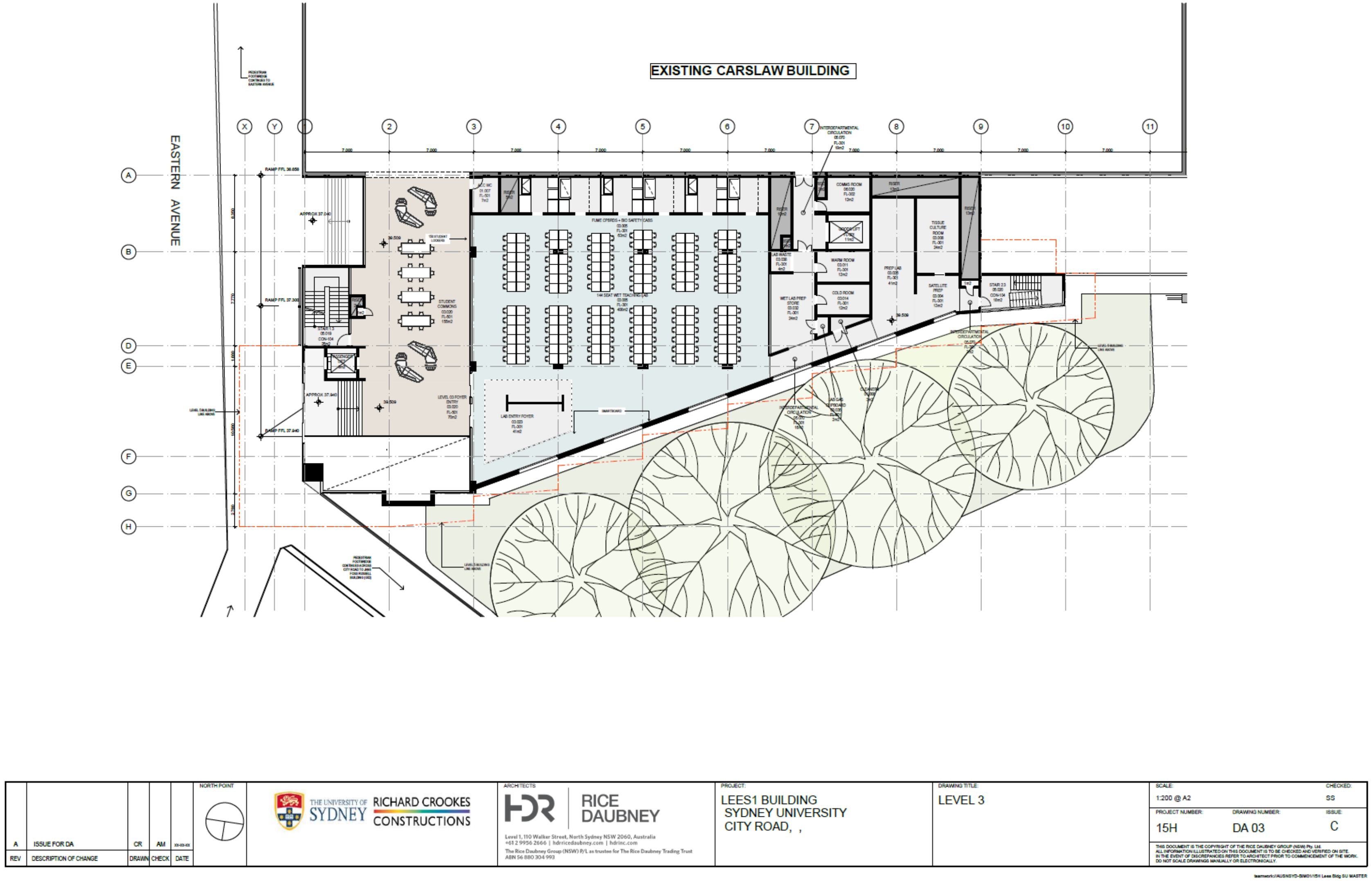
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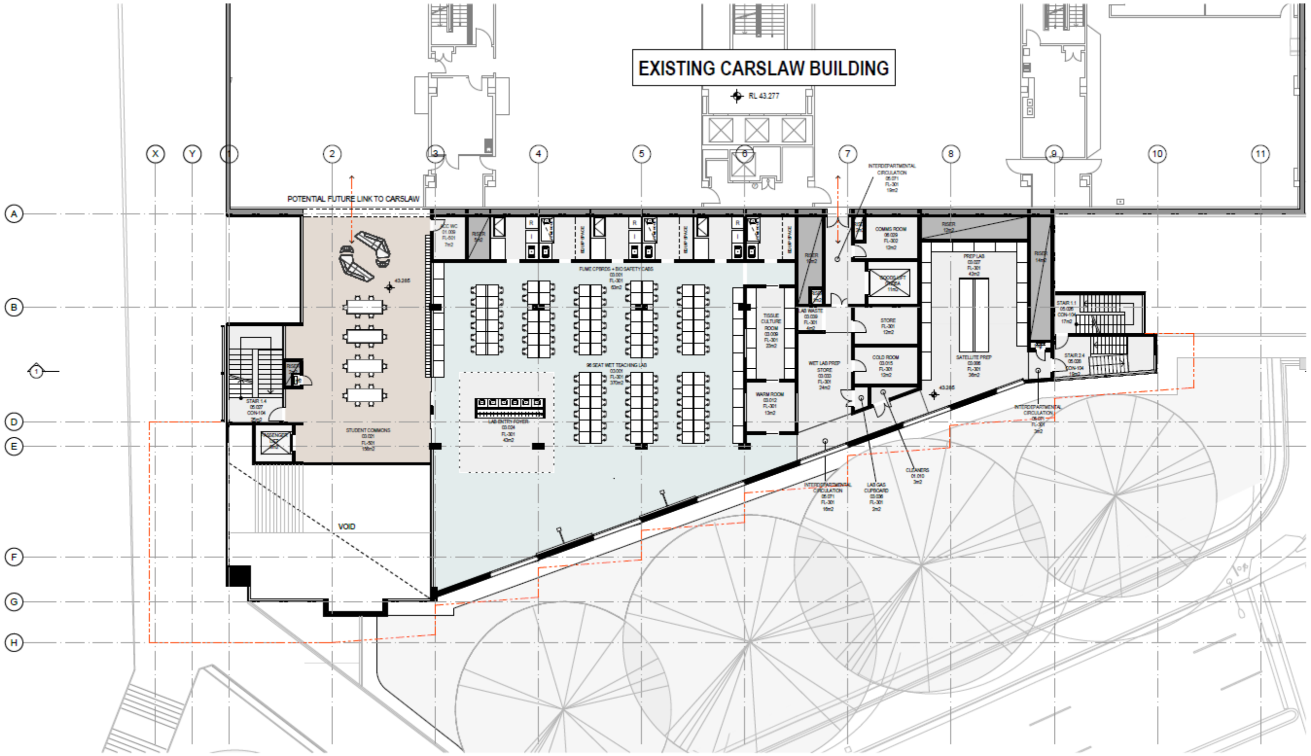
Level 4



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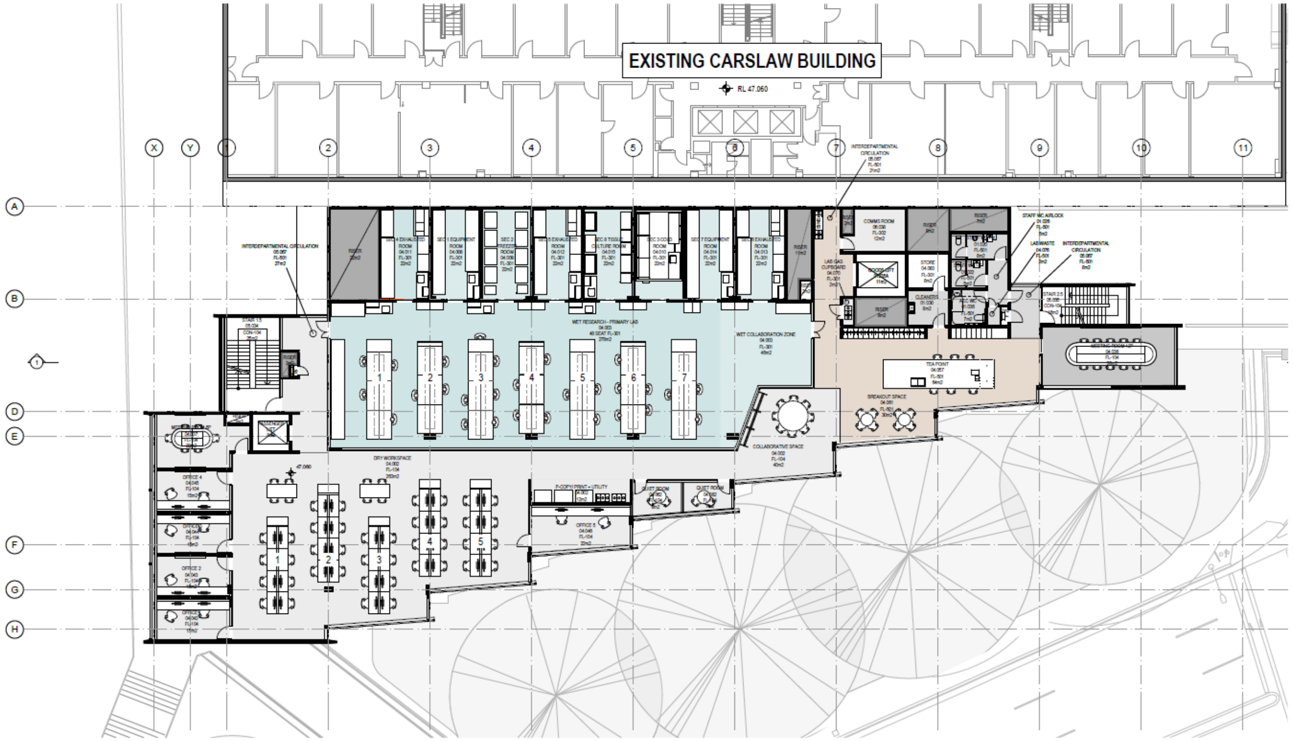

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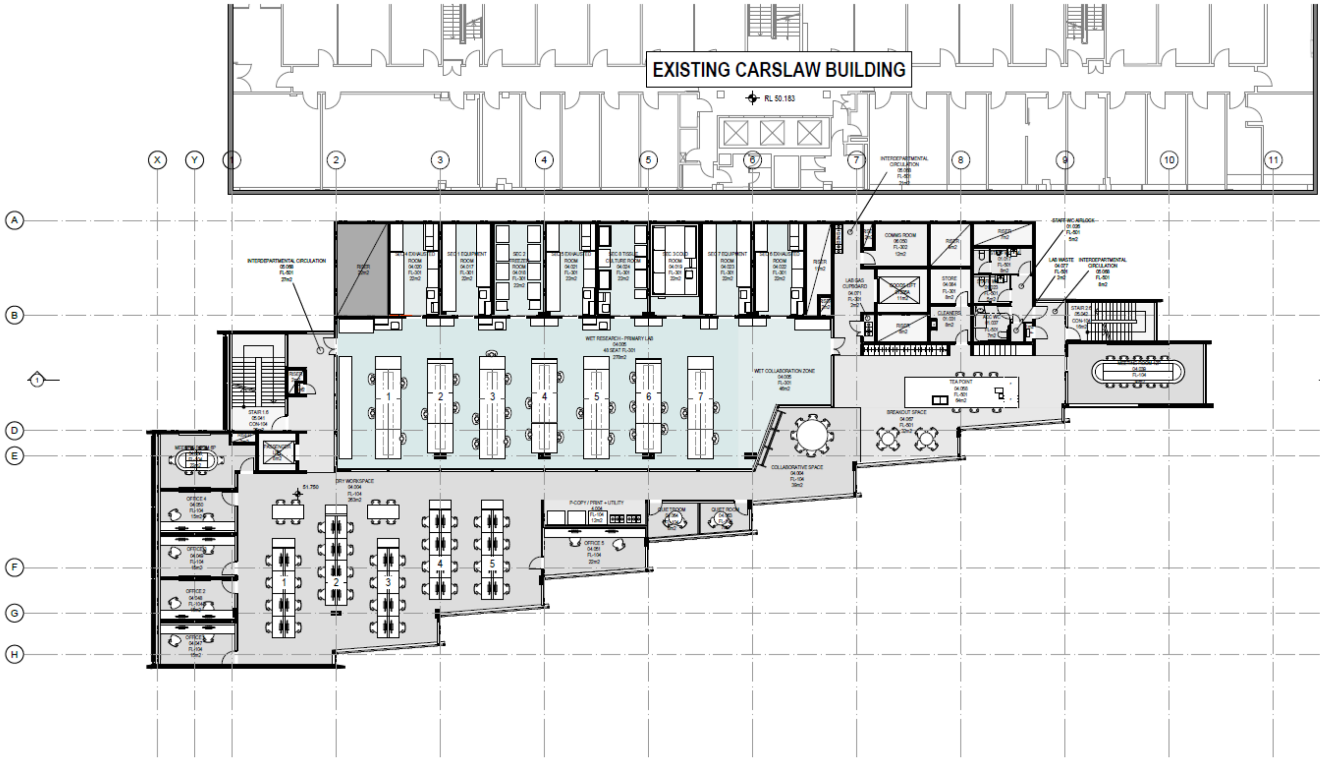

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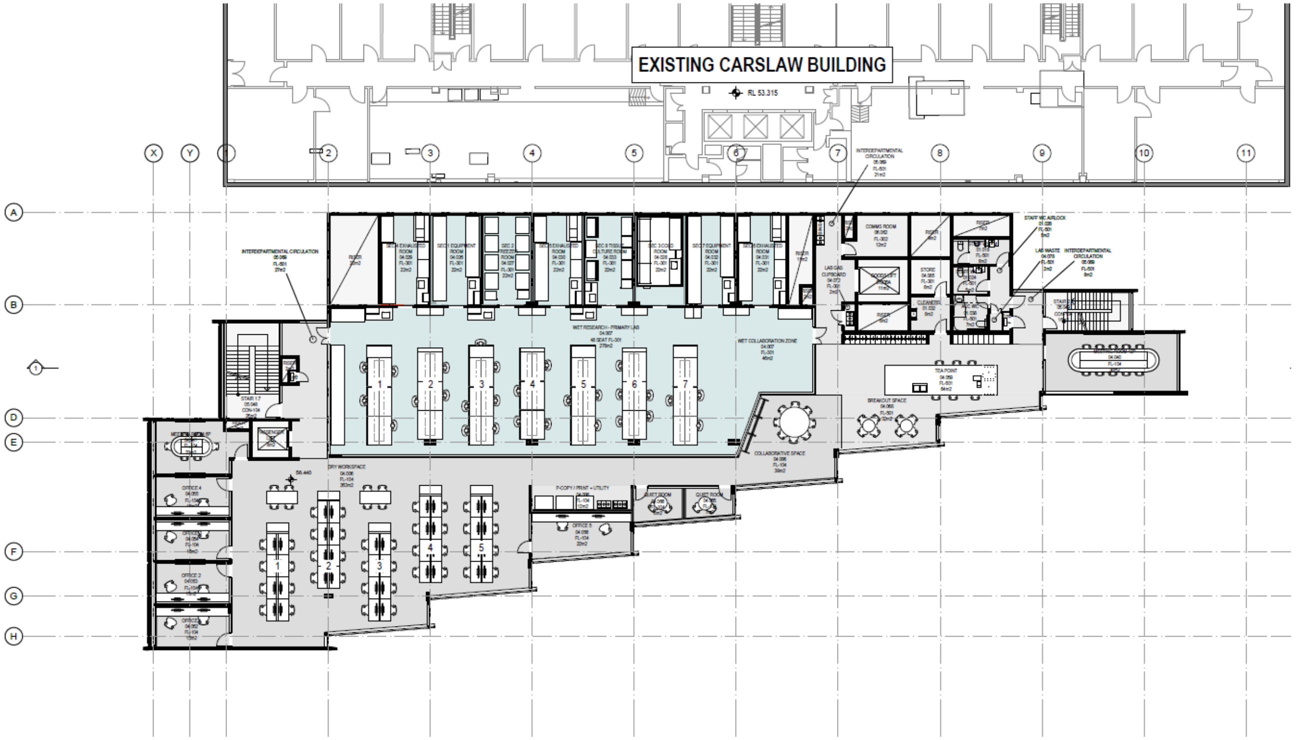

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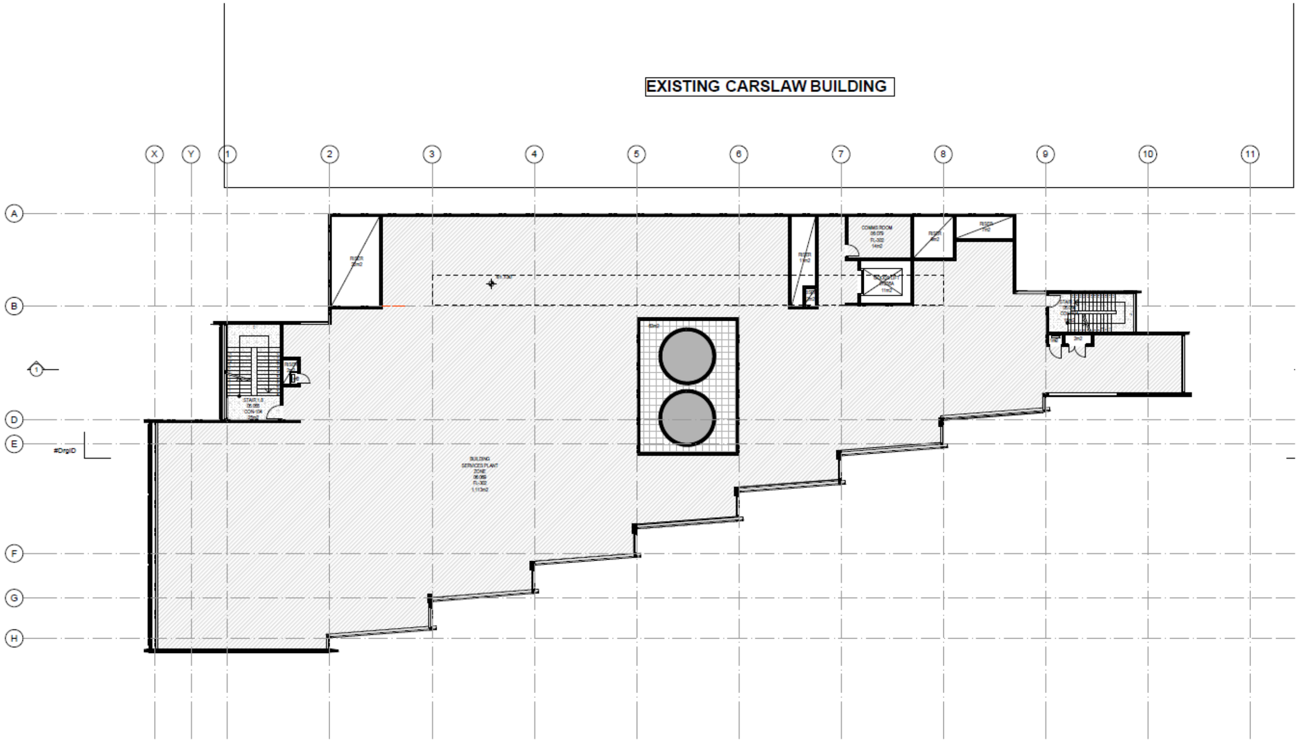

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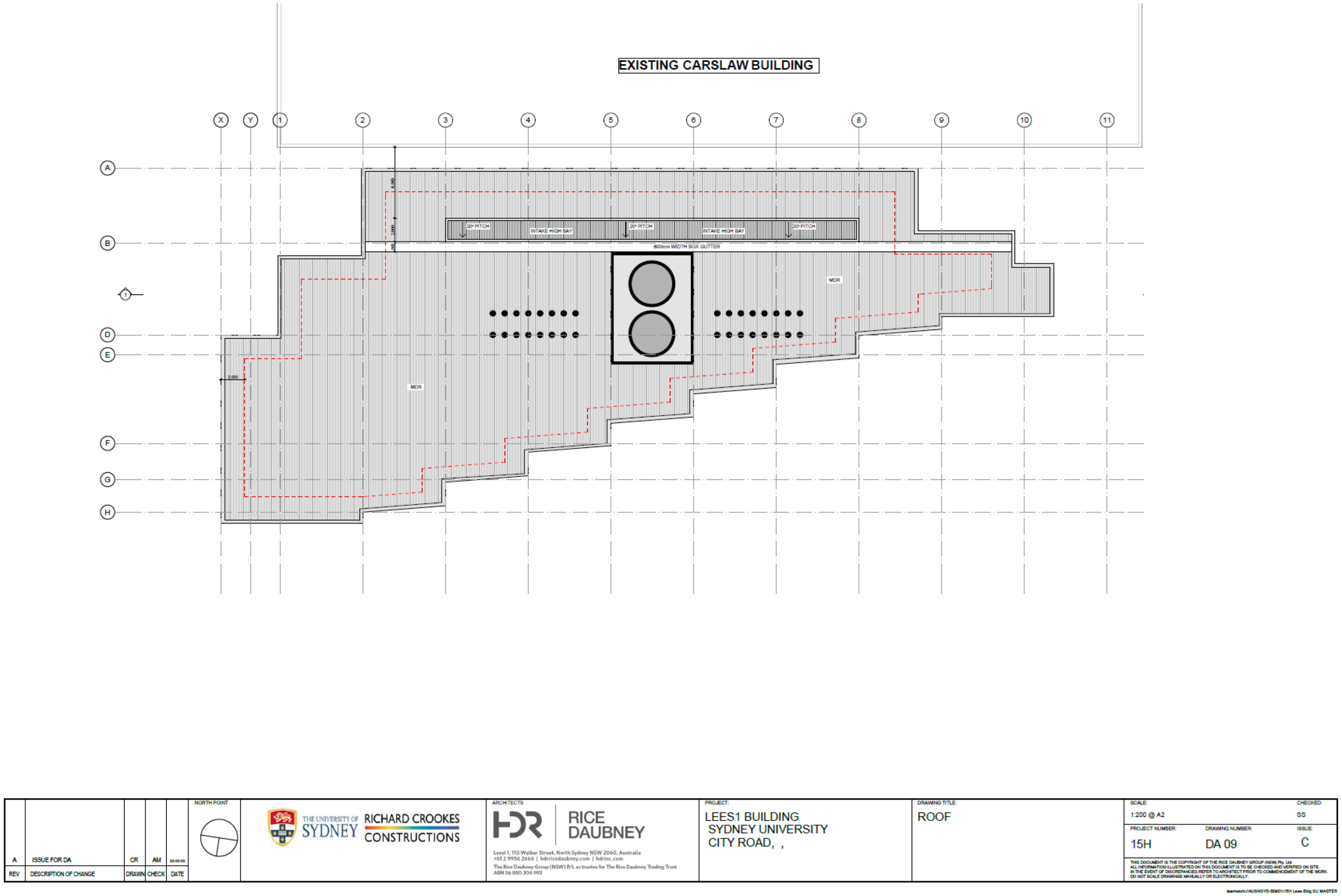
Level 9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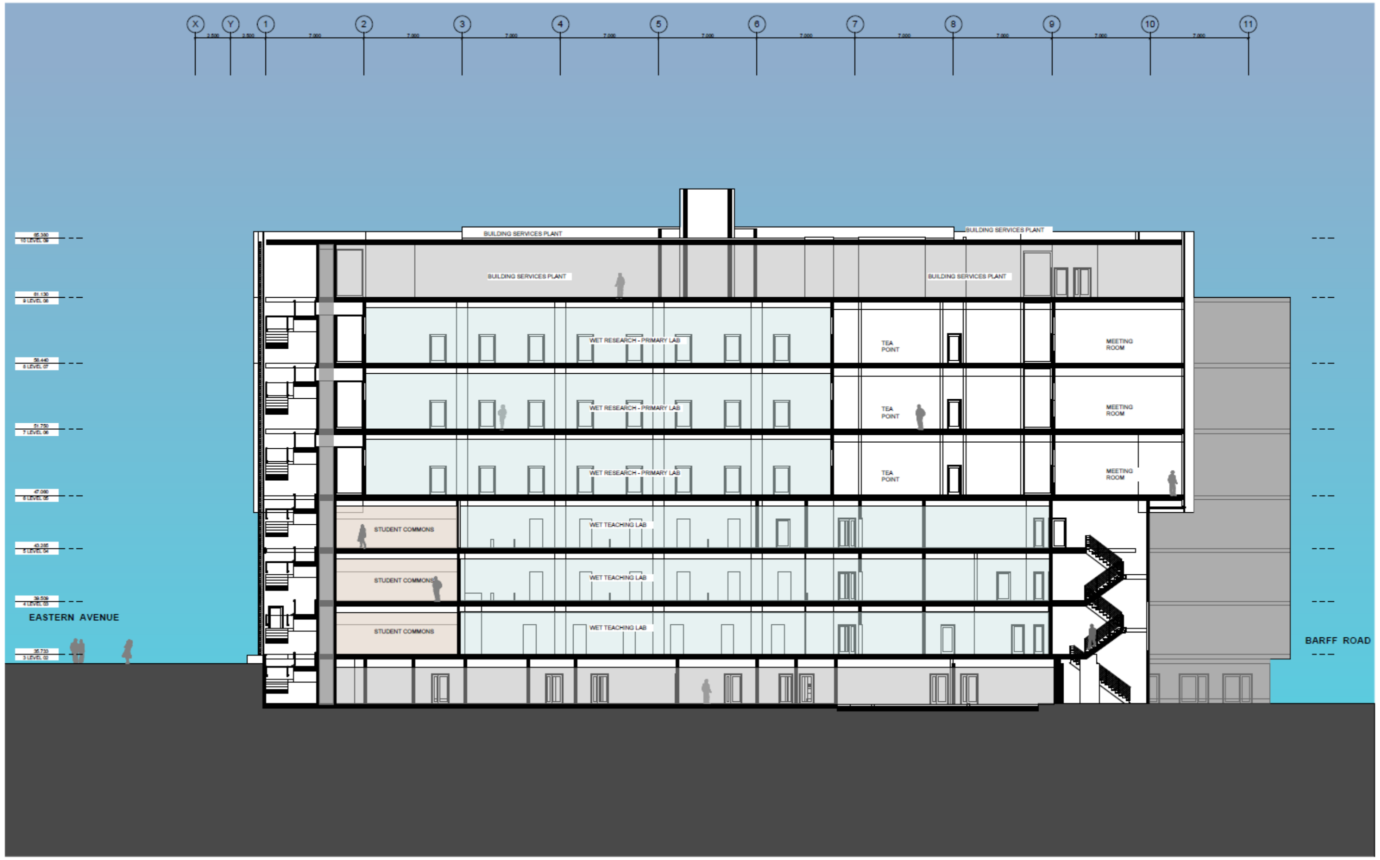

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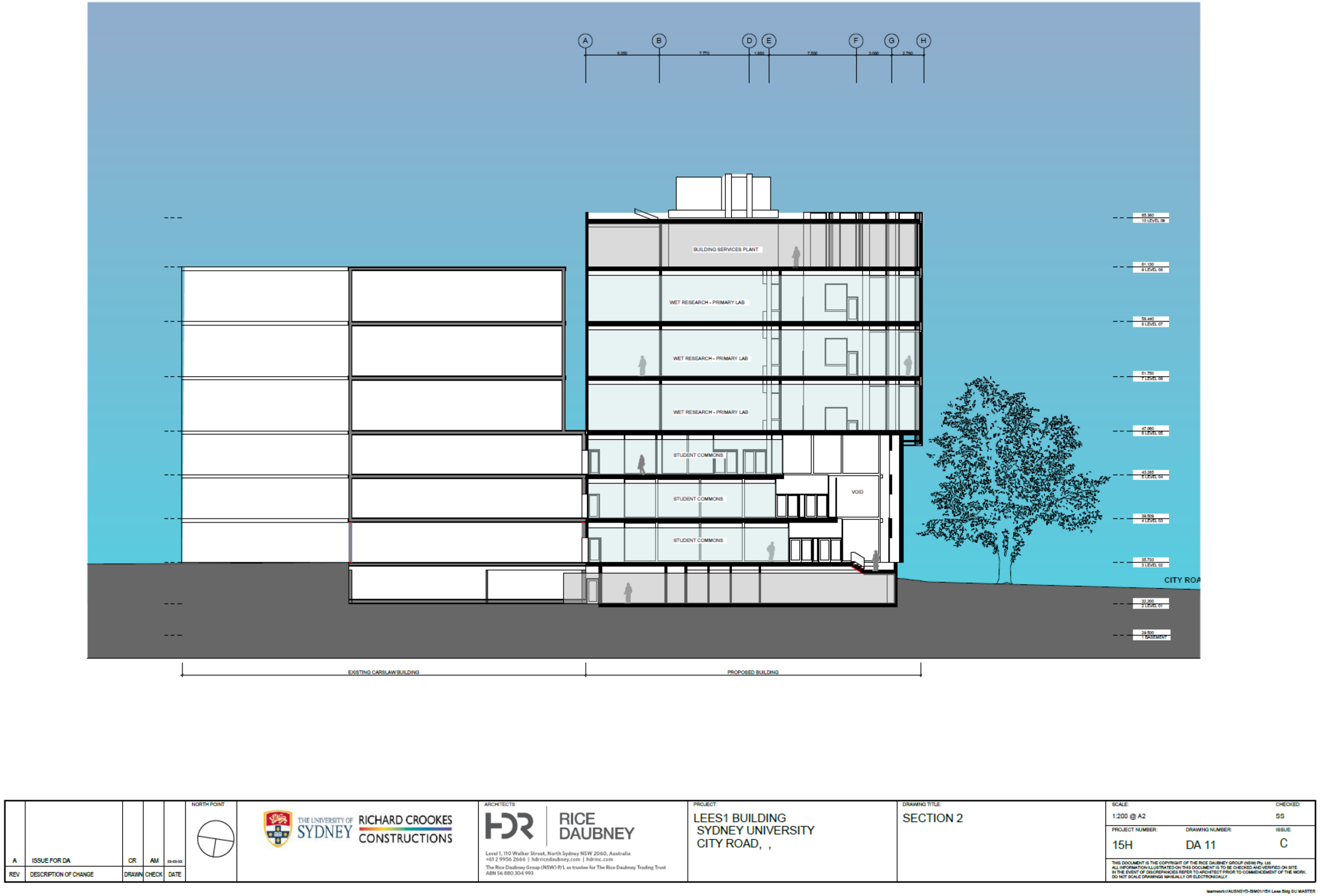
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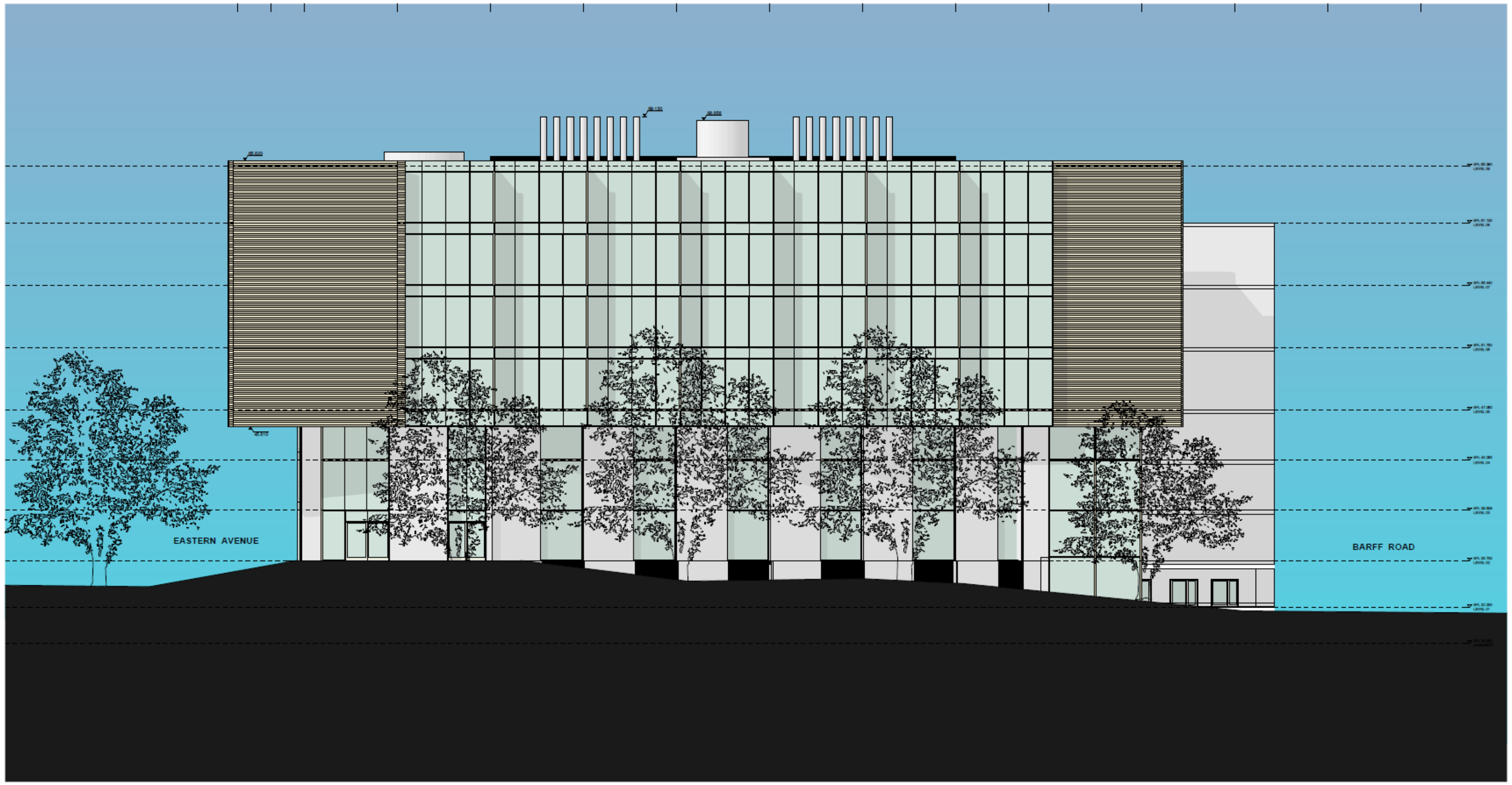

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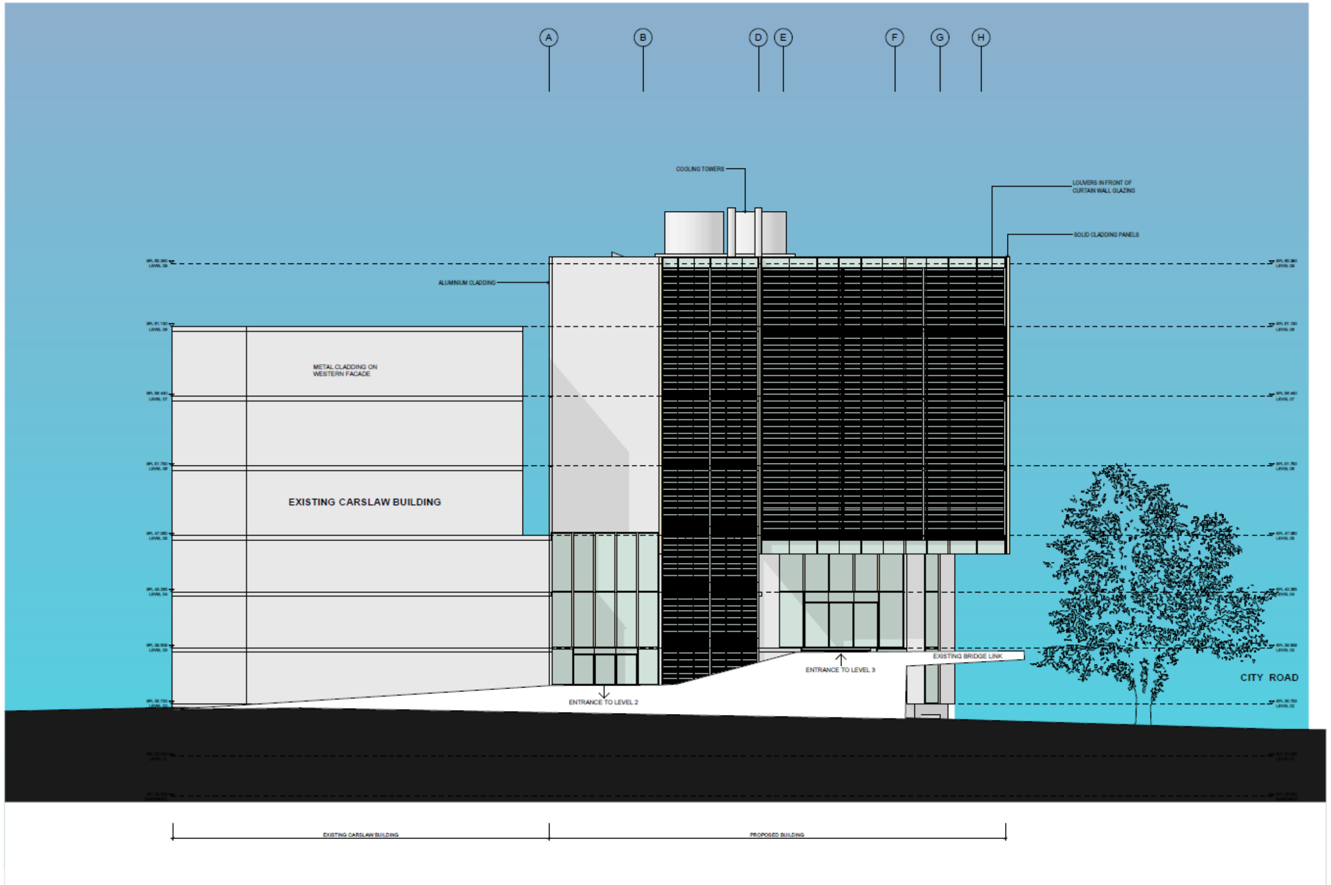

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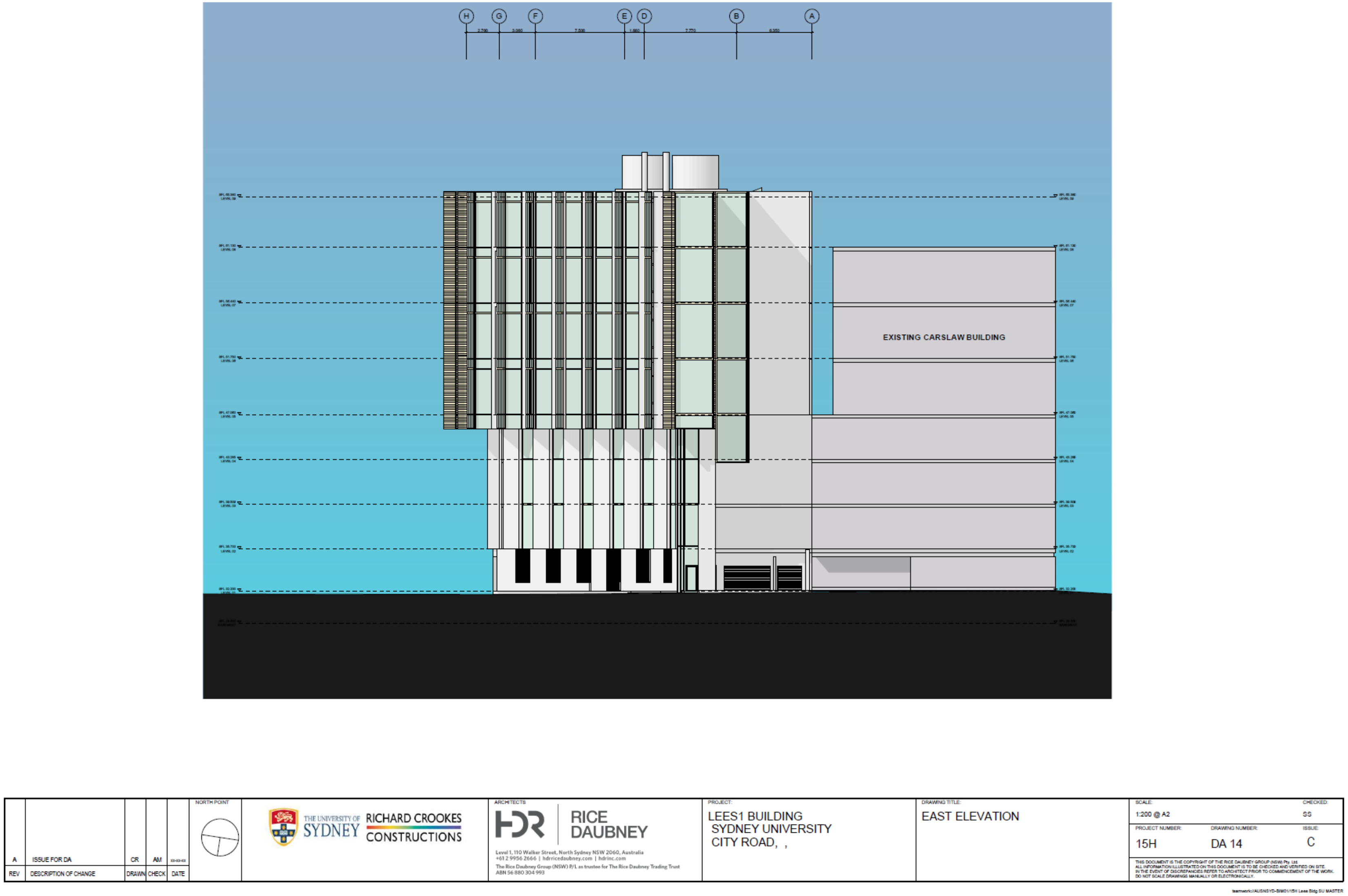

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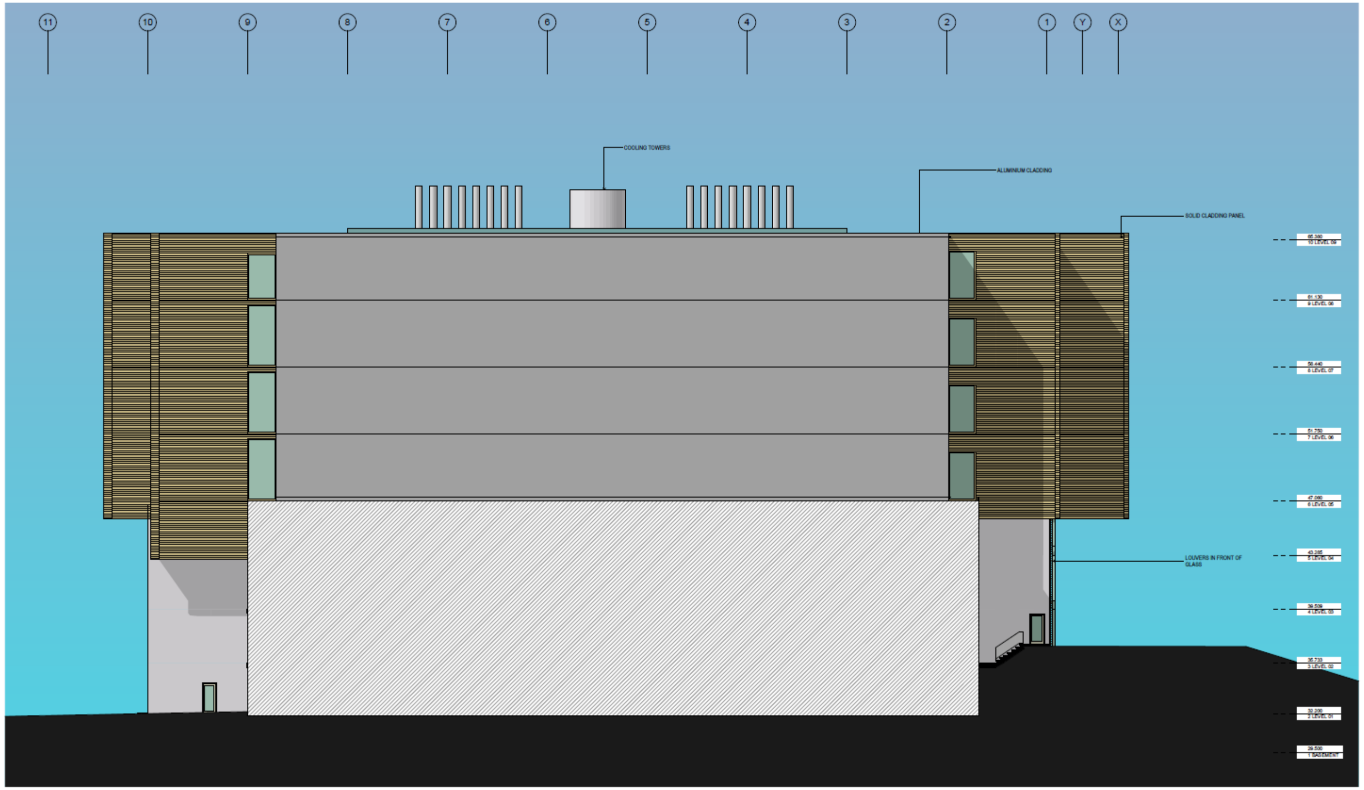

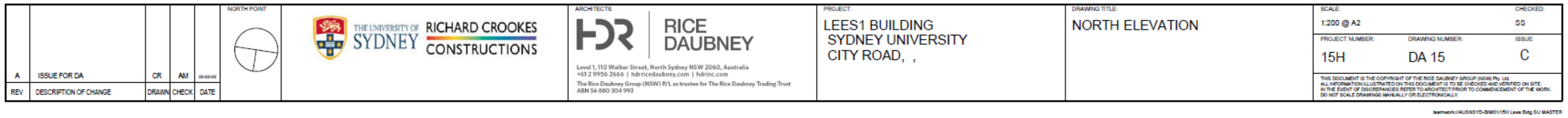

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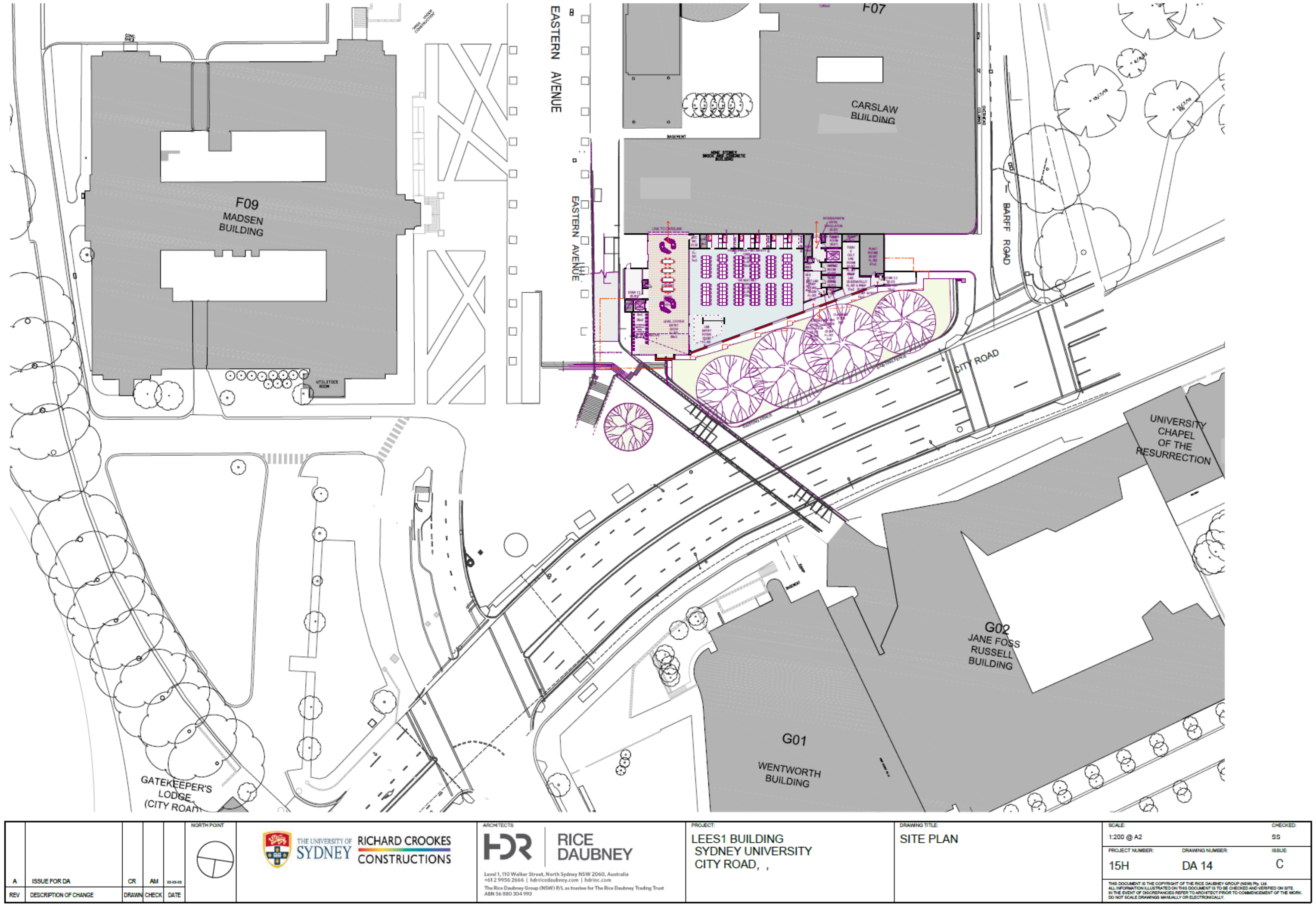
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EASTERN AVENUE
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G02
JANE FOSS RUSSELL BUILDING
G01
WENTWORTH BUILDING
GATEKEEPER'S LODGE (CITY ROAD)
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