Government of **Western Australia**
Department of **Finance**

PLANNING AND DEVELOPMENT ACT 2005
METROPOLITAN REGION SCHEME
APPLICATION FOR APPROVAL TO COMMENCE DEVELOPMENT

DA Application No.:	DA1991 ED0017
Applicant:	Carabiner Architects
Lot Number:	502
Plan/Diagram	428804
CT Volume/Folio:	LR3177/963
Street Address:	3 Bushman Glade, Byford
Owner:	State of Western Australia
Development Description:	Two-storey, multidisciplinary community health facility.
Application Received:	28 April 2025

The Department of Finance (Department), under delegation from the Western Australian Planning Commission, has received a development application under the Metropolitan Region Scheme for the above proposed works.

The proposed works are public works by a public authority in accordance with section 6 of the *Planning and Development Act 2005* and section 2 of the *Public Works Act 1902.* Accordingly, approval under the local planning scheme is not required.

Plans and documentation relating to the proposed works are attached. The Department intends to determine the application within 60 days from the date of lodgement. Please provide any information, comment or recommended conditions pertinent to this application by 5 pm on 9th June 2025. If your response cannot be provided in that period, please provide an interim reply advising of the reasons for the delay and the date by which a completed response will be made, or if you have no comments to offer.

The provision of any comments or recommendation within 14 calendar days would be greatly appreciated.

The referral response should be sent via email to: referrals@finance.wa.gov.au.

Should you have any queries or wish to discuss this application further, please contact the undersigned via email at referrals@finance.wa.gov.au or telephone of (08) 6551 1483.

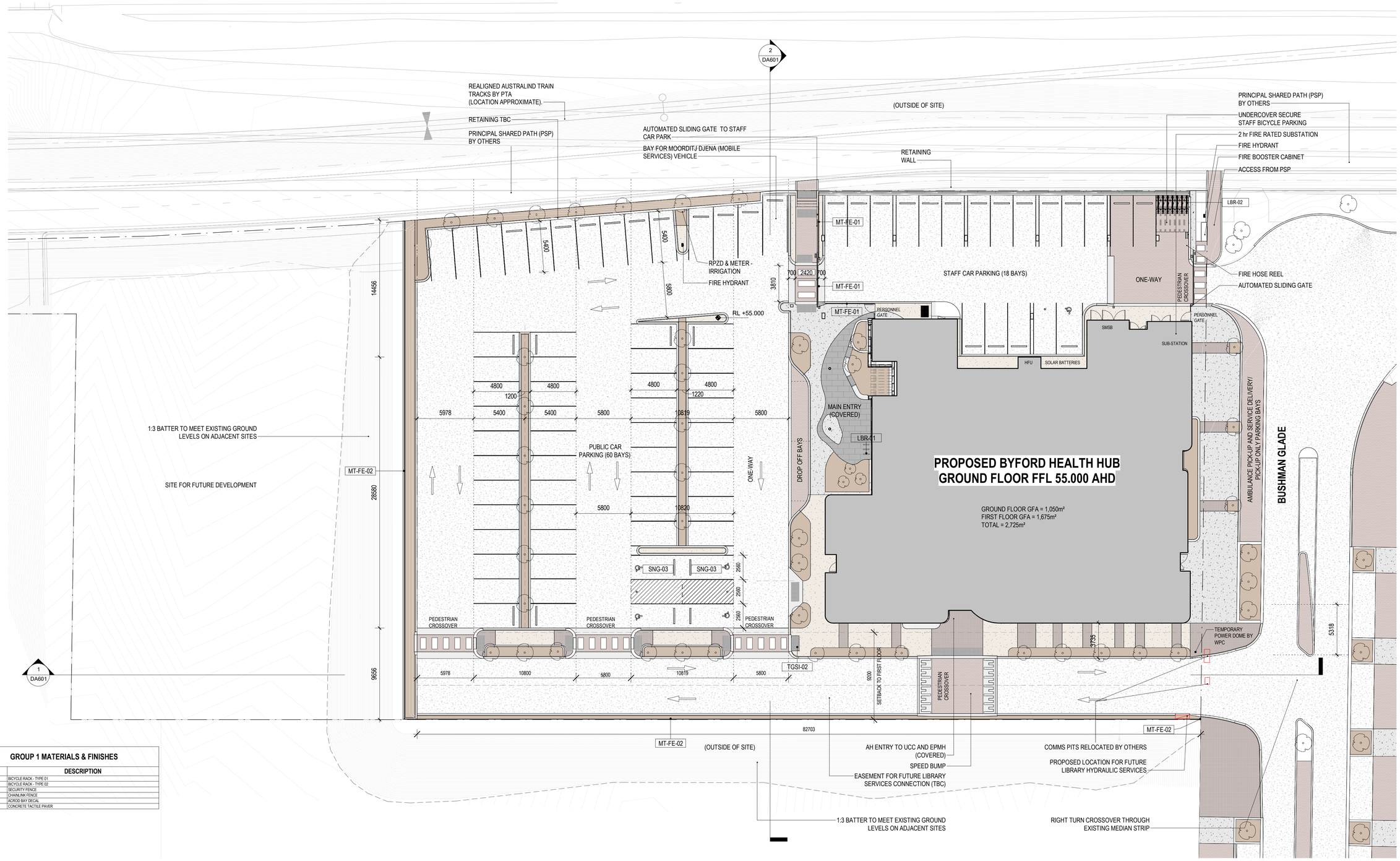
Your faithfully

Susan Cowling

Susan Cowling
Manager Planning
Statutory Planning and Asset Policy
Department of Finance

28 April 2025

Locked Bag 11, Cloisters Square WA 6850
Telephone (08) 6551 1000
WA.gov.au



GROUP 1 MATERIALS & FINISHES	
ABBRV.	DESCRIPTION
LBR-01	BICYCLE RACK - TYPE 01
LBR-02	BICYCLE RACK - TYPE 02
MT-FE-01	SECURITY FENCE
MT-FE-02	CHAINLINK FENCE
SNG-03	ACROD BAY DECAL
TGSI-02	CONCRETE TACTILE PAVER

1 SITE PLAN
1 : 200

2368 DEVELOPMENT APPLICATION DA101 | SITE PLAN / B | 1 : 200 @ A1 | 31/03/2025

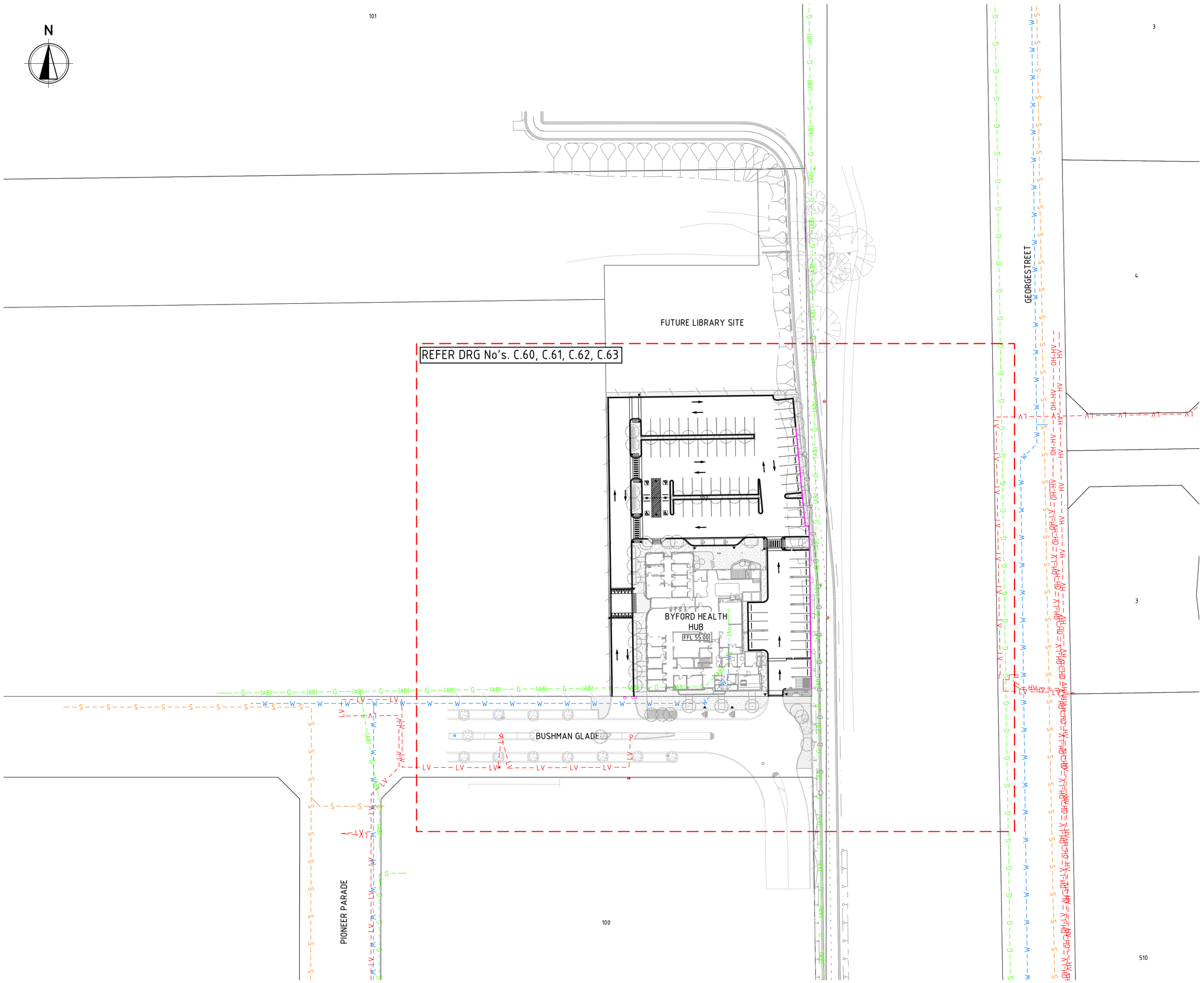
BYFORD HEALTH HUB

1:200 0 5m
SCALE AS MARKED @A1 SIZE

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NOTES

1. DO NOT SCALE DRAWINGS.
2. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
3. CONTRACTOR MUST VERIFY ALL DIMENSIONS AND LEVELS PRIOR TO THE COMMENCEMENT OF WORKS. ANY DISCREPANCIES ARE TO BE REPORTED TO THE SUPERINTENDENT AND INSTRUCTION SOUGHT.
4. CONTRACTOR TO VERIFY SERVICES IN THE VICINITY OF ALL EXCAVATION/DRAINAGE WORKS PRIOR TO THE COMMENCEMENT OF THE WORKS. SERVICES INFORMATION SHOWN ON THE DRAWINGS ARE INDICATIVE ONLY AND MAY NOT BE COMPLETE.
5. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.
6. REFER TO CIVIL DESIGN REPORT FOR DETAILED SITE PREPARATION REQUIREMENTS.
7. REFER TO THE LANDSCAPE ARCHITECT'S DRAWINGS FOR ALL TREE LOCATIONS AND PROTECTION REQUIREMENTS. TREES SHOWN AS REFERENCE ONLY.

LEGEND

- CADASTRAL BOUNDARY
- FUTURE CADASTRAL BOUNDARY

EXISTING SERVICES

- DRAINAGE
- GAS
- GAS - ABANDONED
- POWER - HIGH VOLTAGE
- POWER - LOW VOLTAGE
- POWER - OVERHEAD HIGH VOLTAGE
- POWER - OVERHEAD LOW VOLTAGE
- SEWER
- WATER

WARNING
BEWARE OF UNDERGROUND/OVERHEAD SERVICES. THE LOCATIONS OF UNDERGROUND/OVERHEAD SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

BEFORE YOU DIG www.byda.com.au

REV	DATE	DESCRIPTION	
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM

REVISIONS

Perth *Office—*
Level 19, Kings Square 1
556 Wellington St, Perth WA 6000
P / +61 8 6364 3300
E / info@bgeeng.com
bgeeng.com—

BG&E DOCUMENT No: P24020

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Department of **Finance**
Buildings and Contracts

CIVIL

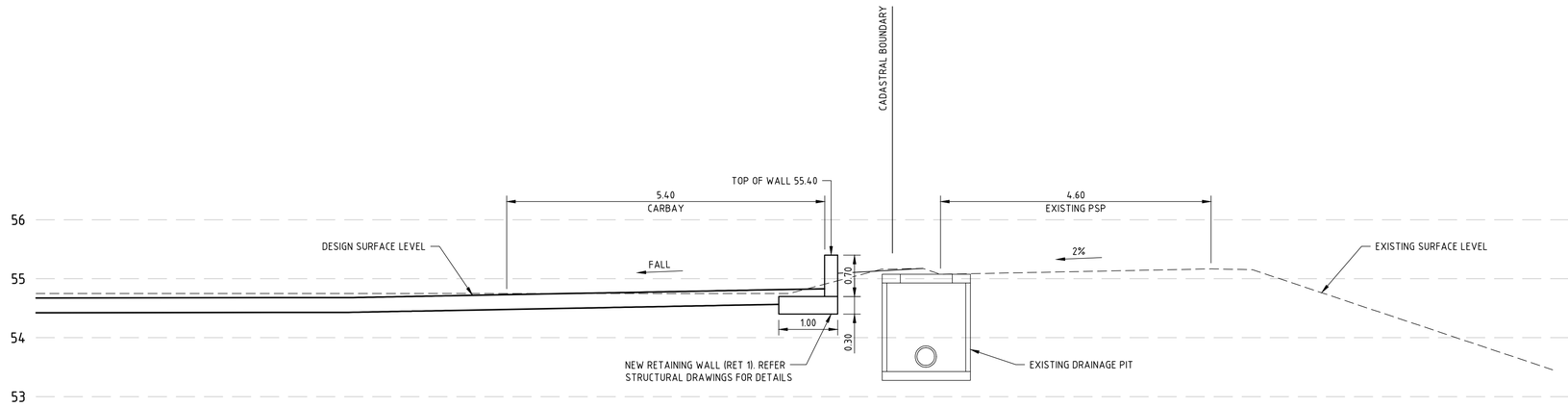
BYFORD HEALTH HUB
MAIN WORKS
SITE PLAN

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE 1:500		DATE 12.08.24	DRAWING No. C.55 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

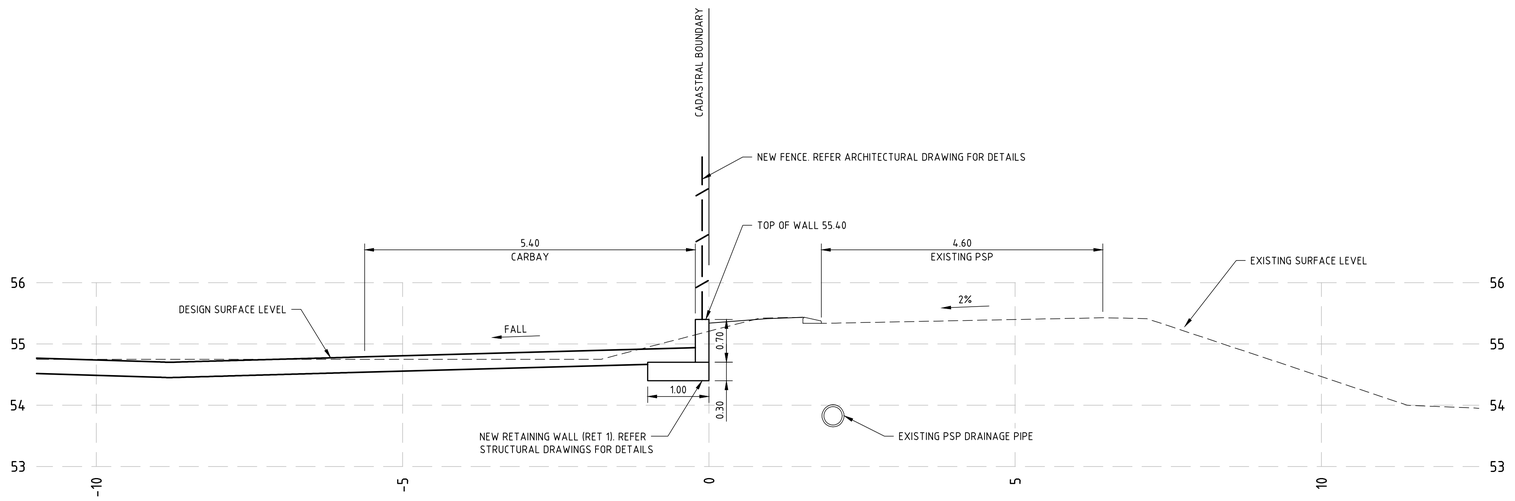
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DO NOT AMEND MANUALLY

NOTES

1. DO NOT SCALE DRAWINGS.
2. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.



SECTION 1 / C.61
SCALE 1:50



SECTION 2 / C.61
SCALE 1:50

0 0.5 1.0 1.5 2.0 2.5 3.0m
SCALE 1:50 AT A1 SIZE

REV	DATE	DESCRIPTION	
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM
REVISIONS			RVD

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bgeeng.com—

BG&E DOCUMENT No: P24020

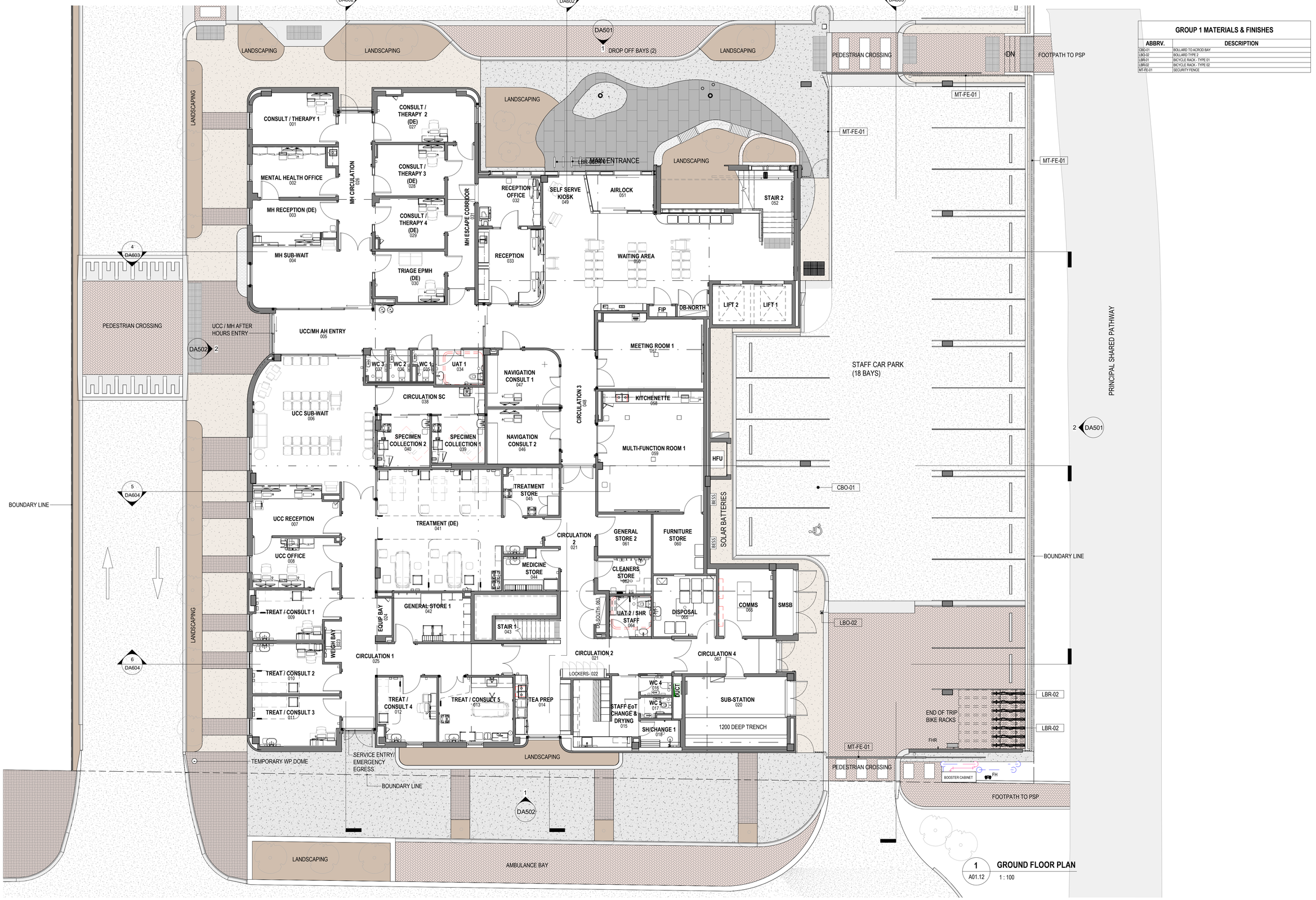
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Buildings and Contracts

CIVIL

BYFORD HEALTH HUB
MAIN WORKS
CROSS SECTIONS

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CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE 1:50		DATE 17.10.24	DRAWING No. C.67 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

THIS IS A CADD DRAWING
DO NOT AMEND MANUALLY



GROUP 1 MATERIALS & FINISHES

ABBRV.	DESCRIPTION
CBO-01	BOLLARD TO ACROD BAY
LBO-02	BOLLARD TYPE 2
LBR-01	BICYCLE RACK - TYPE 01
LBR-02	BICYCLE RACK - TYPE 02
MT-FE-01	SECURITY FENCE

1 GROUND FLOOR PLAN A01.12 — 1 : 100

2368 DEVELOPMENT APPLICATION **BYFORD HEALTH HUB**

DA201 | GROUND FLOOR PLAN / B | 1 : 100 @ A1 | 31/03/2025

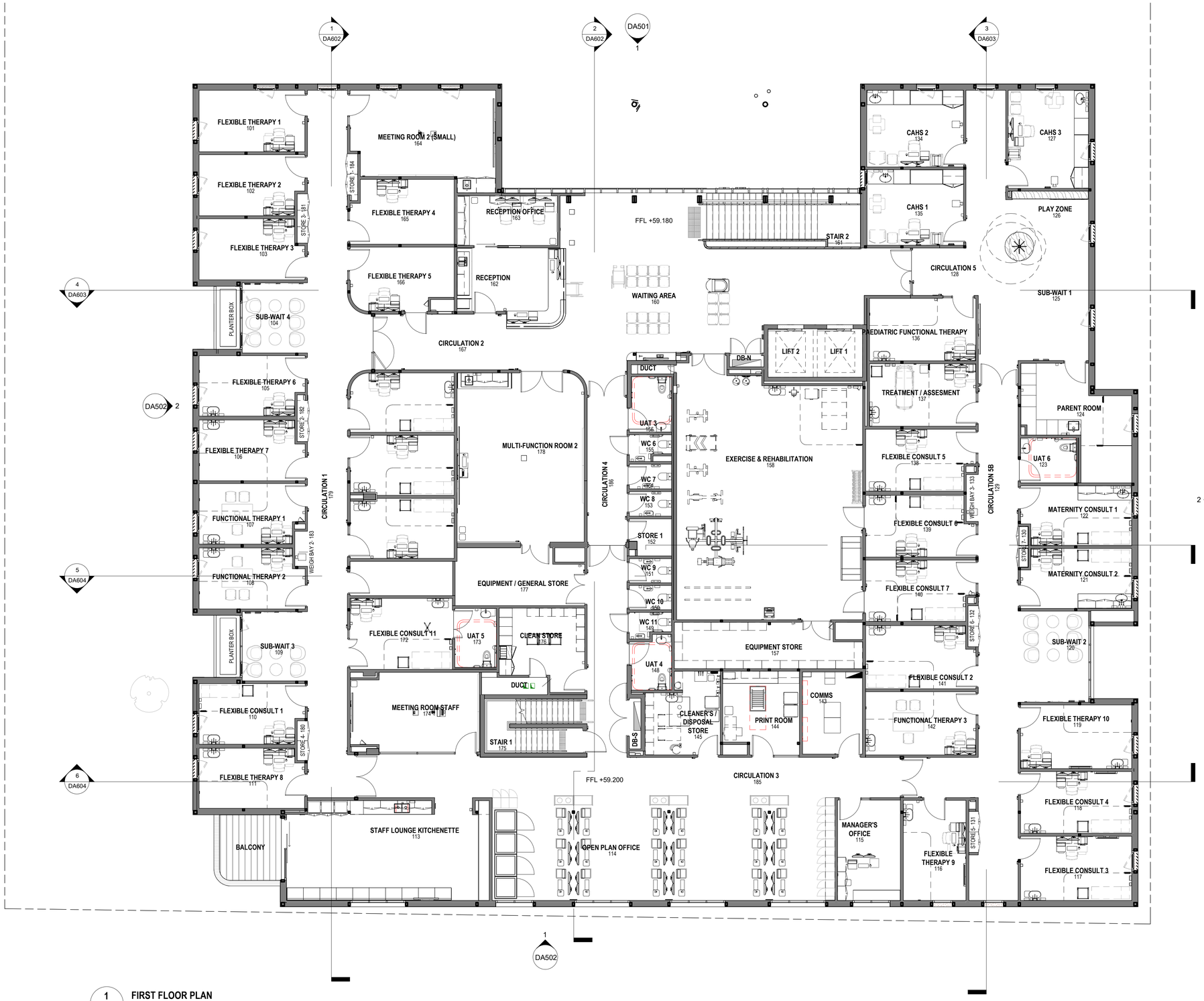
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SCALE AS MARKED @A1 SIZE

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1 A05.01 **FIRST FLOOR PLAN**
1 : 100

2368 DEVELOPMENT APPLICATION DA202 | FIRST FLOOR PLAN / B | 1 : 100 @ A1 | 2/04/2025

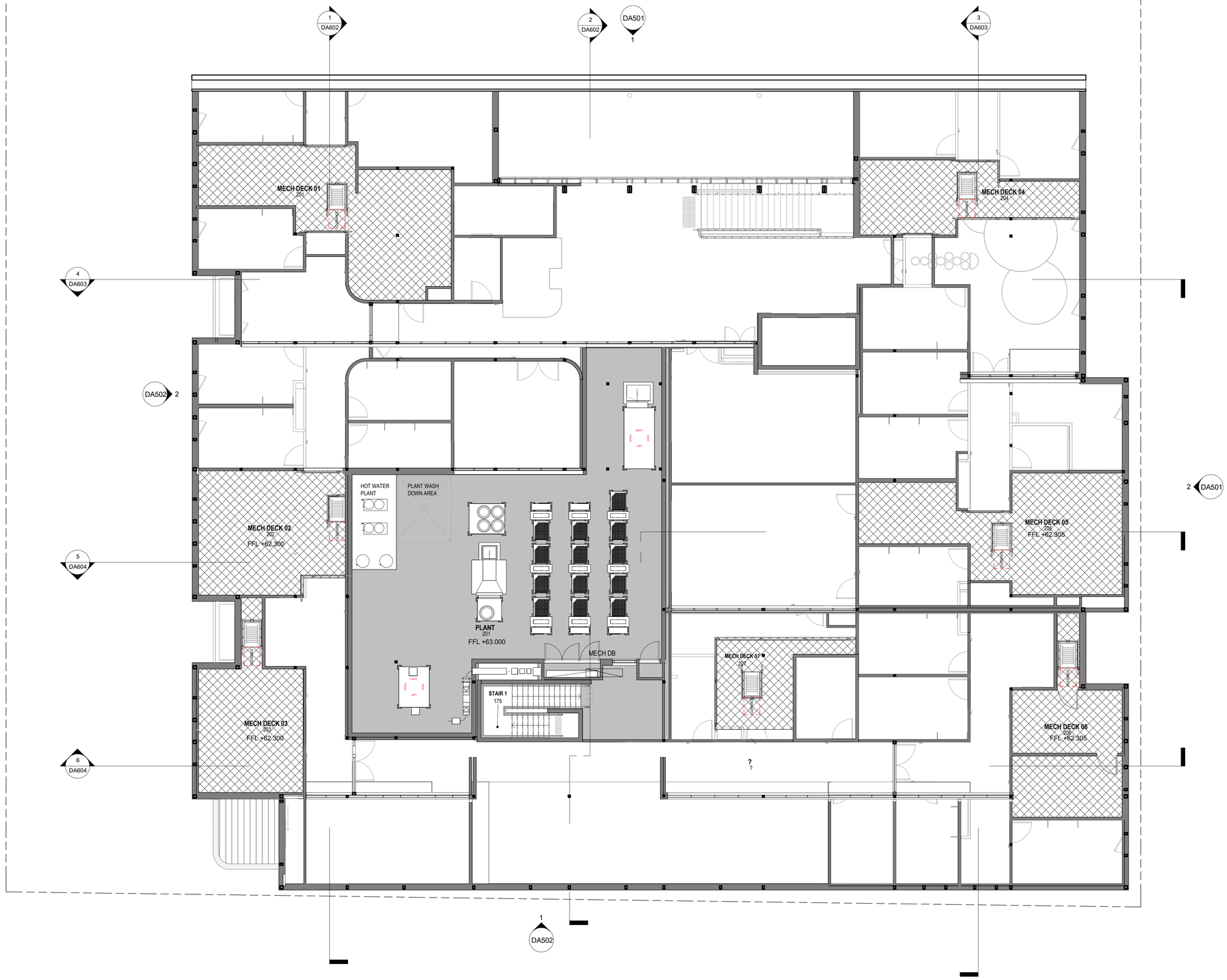
BYFORD HEALTH HUB

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SCALE AS MARKED @A1 SIZE

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1 PLANT DECK PLAN
1 : 100

2368 DEVELOPMENT APPLICATION DA203 | PLANT DECK PLAN / B | 1 : 100 @ A1 | 2/04/2025

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1:5 0 0.10m
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CEILING LEGEND	
TYPE	DESCRIPTION
	80mm UNDERSLAB INSULATION
CE-01	FLUSH PLASTERBOARD CEILING, SQUARE SET
CE-01a	FLUSH PLASTERBOARD CEILING, P50 SHADOWLINE
CE-02	WET AREA FLUSH PLASTERBOARD CEILINGS, SQUARE SET
CE-02a	WET AREA FLUSH PLASTERBOARD CEILINGS, P50 SHADOWLINE
CE-03	PERFORATED PLASTERBOARD CEILING, SQUARE SET
CE-04	1200 x 600mm MINERAL FIBRE CEILING TILES, SQUARE SET EDGE TRIM
CE-05	PRE-FINISHED COMPRESSED FIBRE CEMENT SOFFIT LINING
CE-06	METAL SHEET SOFFIT LINING
CE-07	TIMBER CEILING WITH INSULATION OVER
CE-07	TIMBER SLAT CEILING WITH BLACK SCRIM AND INSULATION OVER

1 / A01.12 **GROUND FLOOR REFLECTED CEILING PLAN**
1 : 100

2368 DEVELOPMENT APPLICATION DA301 | RCP GROUND FLOOR / B | 1 : 100 @ A1 | 2/04/2025

BYFORD HEALTH HUB

1:100 0 2.5m
SCALE AS MARKED @A1 SIZE

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CEILING LEGEND	
TYPE	DESCRIPTION
	140mm UNDERSLAB INSULATION
CE-01	FLUSH PLASTERBOARD CEILING, SQUARE SET
CE-01a	FLUSH PLASTERBOARD CEILING, P50 SHADOWLINE
CE-02	WET AREA FLUSH PLASTERBOARD CEILINGS, SQUARE SET
CE-02a	WET AREA FLUSH PLASTERBOARD CEILINGS, P50 SHADOWLINE
CE-03	PERFORATED PLASTERBOARD CEILING, SQUARE SET
CE-04	1200 x 600mm MINERAL FIBRE CEILING TILES, SQUARE SET EDGE TRIM
CE-08	TIMBER SLAT CEILING WITH BLACK SCRIM AND INSULATION OVER
CE-09	EXTERIOR GRADE TIMBER SLAT CEILING WITH BLACK SCRIM AND INSULATION OVER
CE-10	EXTERIOR GRADE TIMBER CEILING WITH INSULATION OVER
CE-11	FIRE-RATED FLUSH PLASTERBOARD CEILING
SB-01	15mm PLYWOOD BARRIER CEILING TO UNDERSIDE OF PURLINS



1 A05.01 **FIRST FLOOR CEILING PLAN DA**

1 : 100

2368 DEVELOPMENT APPLICATION

BYFORD HEALTH HUB

DA302 | RCP FIRST FLOOR / B | 1 : 100 @ A1 | 2/04/2025

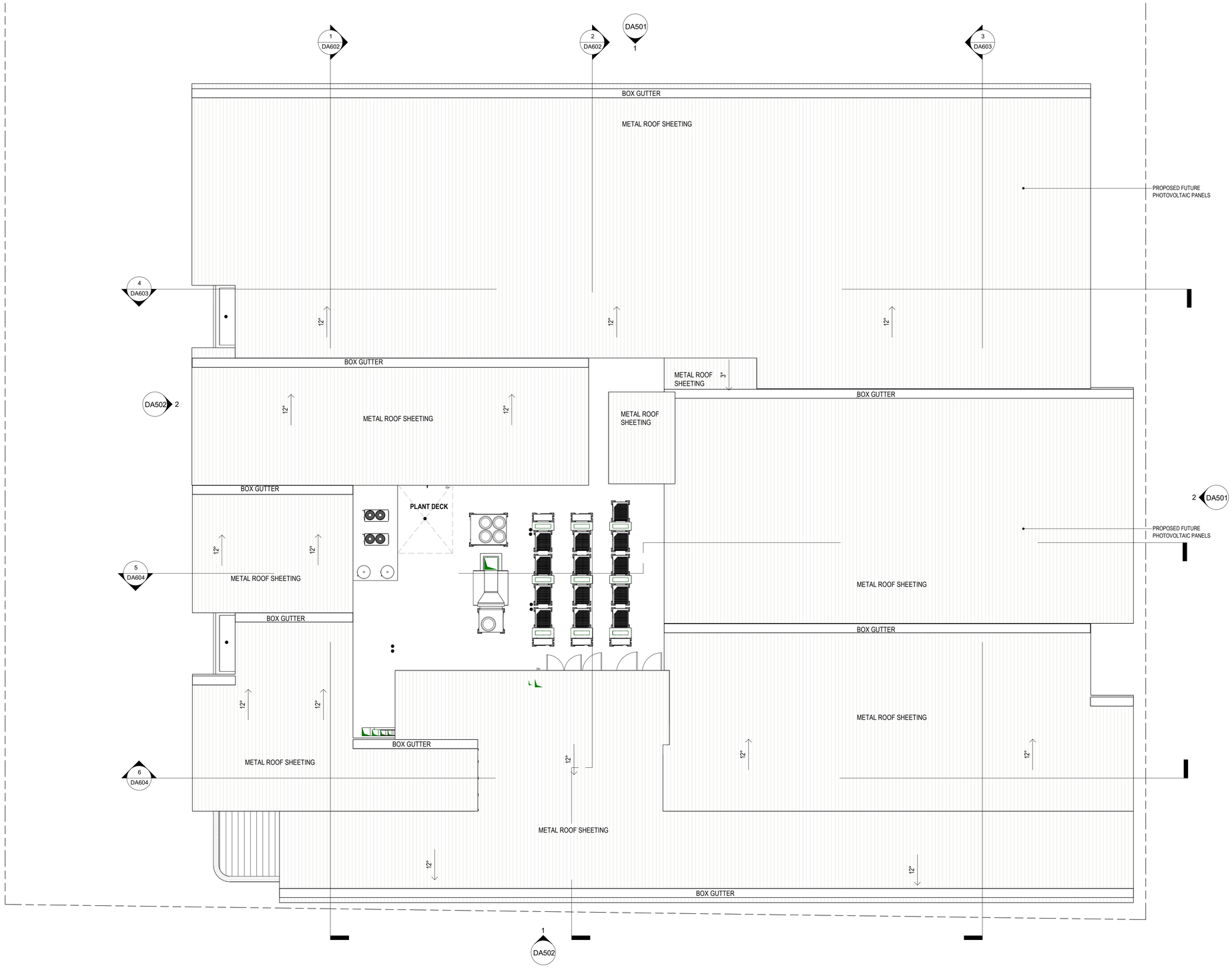
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SCALE AS MARKED @A1 SIZE

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1 ROOF PLAN
1 : 100

2368 DEVELOPMENT APPLICATION DA401 | ROOF PLAN / B | 1 : 100 @ A1 | 2/04/2025

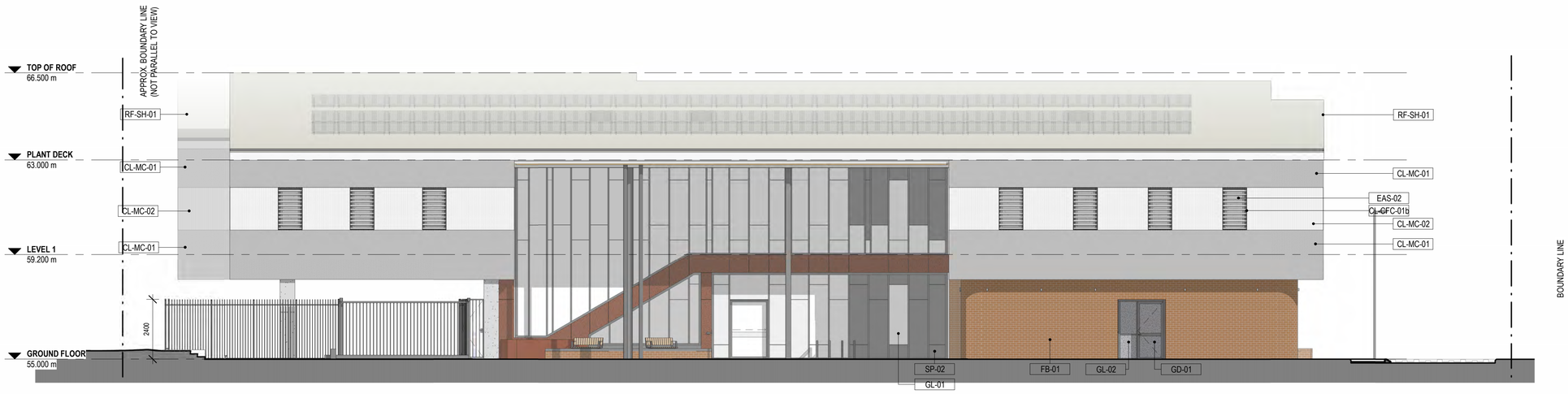
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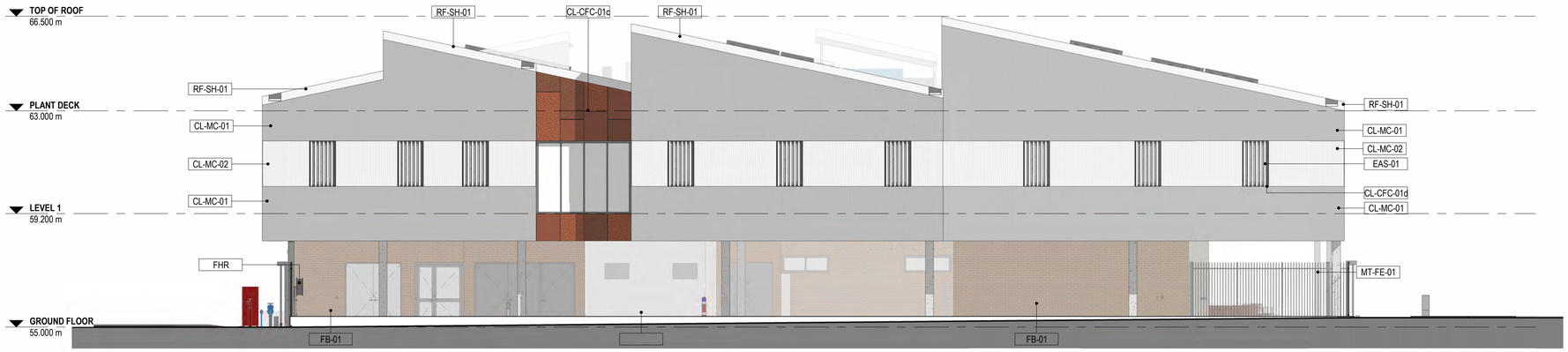
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1 DA201 **NORTH ELEVATION**
1 : 100

GROUP 1 MATERIALS & FINISHES

ABBRV.	DESCRIPTION
CL-CFC-01b	COMPRESSED FIBRE CEMENT - COLOUR B
CL-CFC-01c	COMPRESSED FIBRE CEMENT - COLOUR C
CL-CFC-01d	COMPRESSED FIBRE CEMENT - COLOUR D
CL-MC-01	METAL SHEET CLADDING TYPE 1
CL-MC-02	METAL SHEET CLADDING TYPE 2
EAS-01	ALUMINIUM WINDOW SCREEN VERTICAL
EAS-02	ALUMINIUM WINDOW SCREEN HORIZONTAL
FB-01	FACE BRICK - 01
FHR	FIRE HOSE REEL
GD-01	SINGLE ALUMINIUM FRAMED GLAZED DOOR
GL-01	EXTERNAL GLAZING TYPE 1 - DOUBLE GLAZED
GL-02	EXTERNAL GLAZING TYPE 1 - DOUBLE GLAZED - WITH TRANSLUCENT FILM ON INNER PANE
MT-FE-01	SECURITY FENCE
RF-SH-01	ROOF SHEETING - METAL DECK SHEETING 01
SP-02	SPANDREL TYPE 02



2 A01.14 **EAST ELEVATION**
1 : 100

2368 DEVELOPMENT APPLICATION DA501 | BUILDING ELEVATIONS / B | 1 : 100 @ A1 | 2/04/2025

BYFORD HEALTH HUB

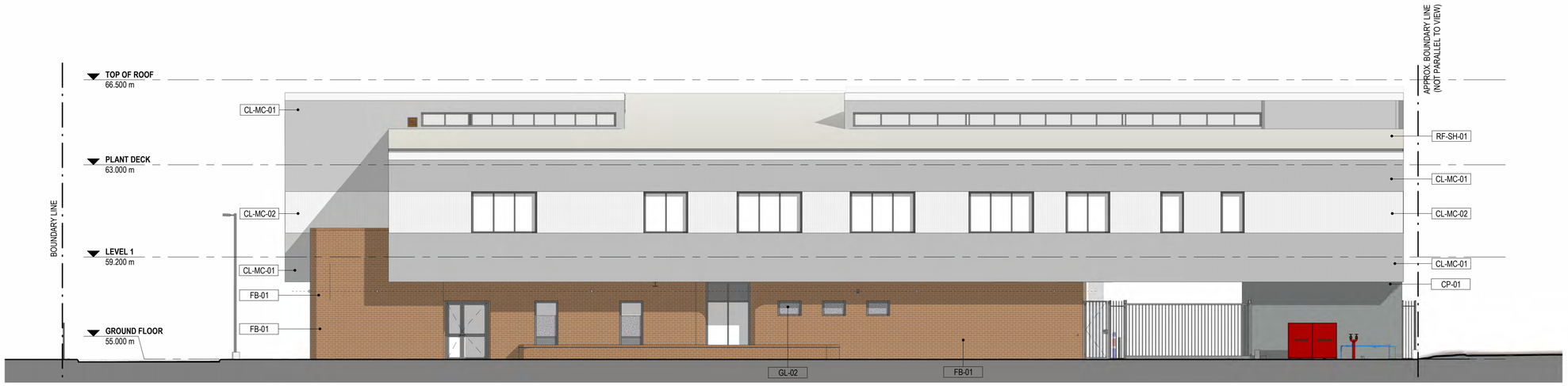
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SCALE AS MARKED @A1 SIZE

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GROUP 1 MATERIALS & FINISHES

ABBRV.	DESCRIPTION
CL-CFC-01a	COMPRESSED FIBRE CEMENT - COLOUR A
CL-CFC-01b	COMPRESSED FIBRE CEMENT - COLOUR B
CL-CFC-01c	COMPRESSED FIBRE CEMENT - COLOUR C
CL-MC-01	METAL SHEET CLADDING TYPE 1
CL-MC-02	METAL SHEET CLADDING TYPE 2
CP-01	CONCRETE PANEL
FB-01	FACE BRICK - 01
GL-02	EXTERNAL GLAZING TYPE 1 - DOUBLE GLAZED - WITH TRANSLUCENT FILM ON INNER PANE
RF-SH-01	ROOF SHEETING - METAL DECK SHEETING 01



1 DA201 **SOUTH ELEVATION**
1 : 100



2 DA201 **WEST ELEVATION**
1 : 100

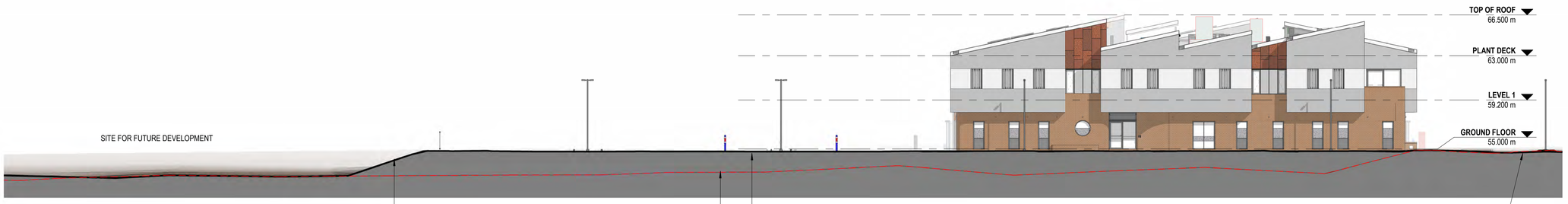
2368 DEVELOPMENT APPLICATION
BYFORD HEALTH HUB

DA502 | BUILDING ELEVATIONS 2 / B | 1 : 100 @ A1 | 2/04/2025

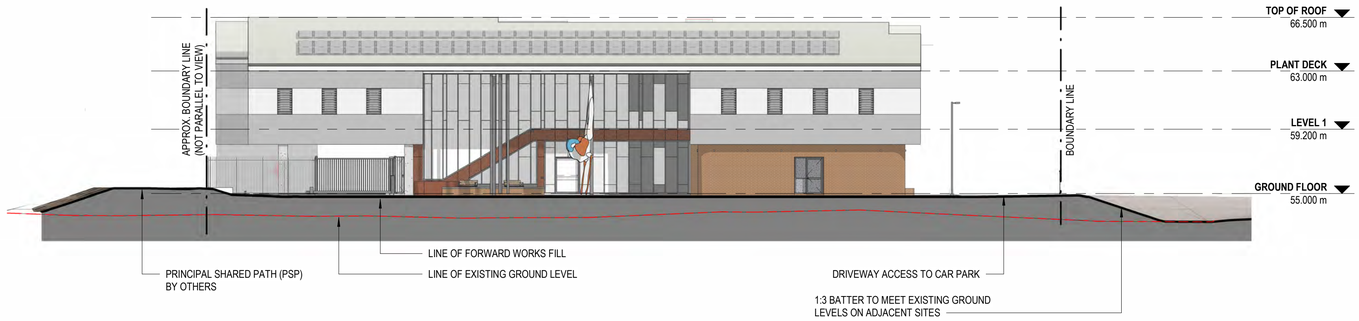
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SCALE AS MARKED @A1 SIZE

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1 DA101 **SITE SECTION**
1 : 200



2 DA101 **SITE SECTION**
1 : 200

2368 DEVELOPMENT APPLICATION
BYFORD HEALTH HUB

DA601 | SITE SECTIONS / B | 1 : 200 @ A1 | 2/04/2025

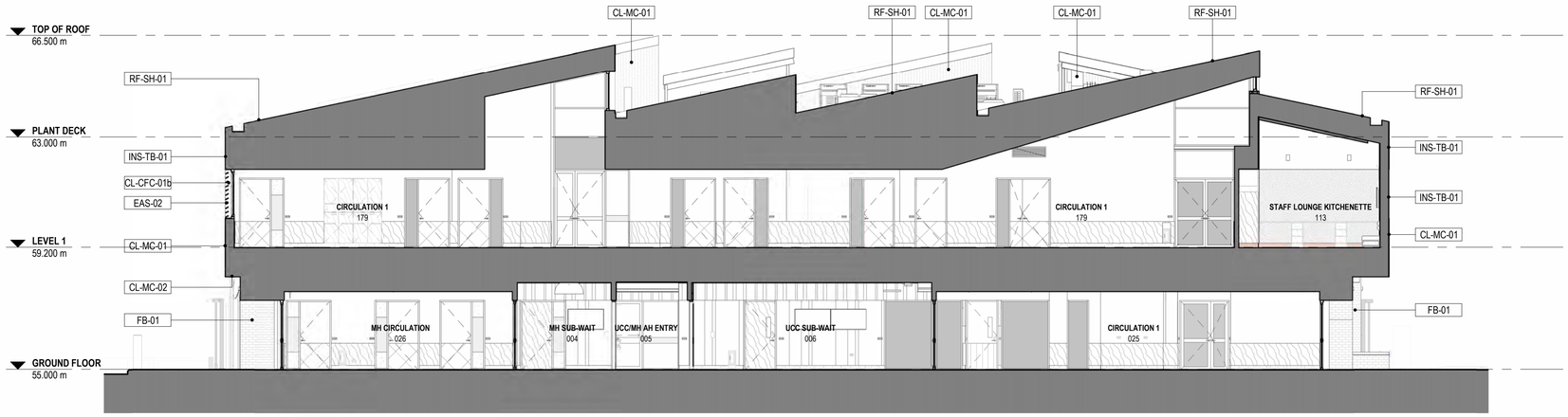
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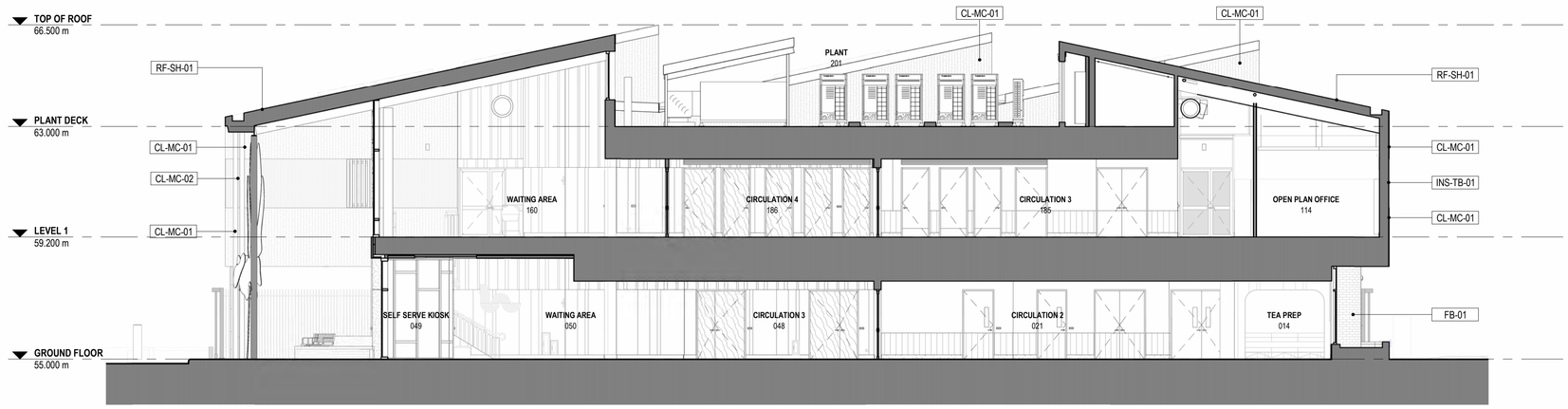
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GROUP 1 MATERIALS & FINISHES

ABBRV.	DESCRIPTION
CL-CFC-01b	COMPRESSED FIBRE CEMENT - COLOUR B
CL-MC-01	METAL SHEET CLADDING TYPE 1
CL-MC-02	METAL SHEET CLADDING TYPE 2
EAS-02	ALUMINIUM WINDOW SCREEN HORIZONTAL
FB-01	FACE BRICK - 01
INS-TB-01	THERMAL BREAK - WALL
RF-SH-01	ROOF SHEETING - METAL DECK SHEETING 01



1 DA201 **SECTION 1**
1 : 100



2 DA201 **SECTION 2**
1 : 100

2368 DEVELOPMENT APPLICATION DA602 | SECTIONS / B | 1 : 100 @ A1 | 2/04/2025

BYFORD HEALTH HUB

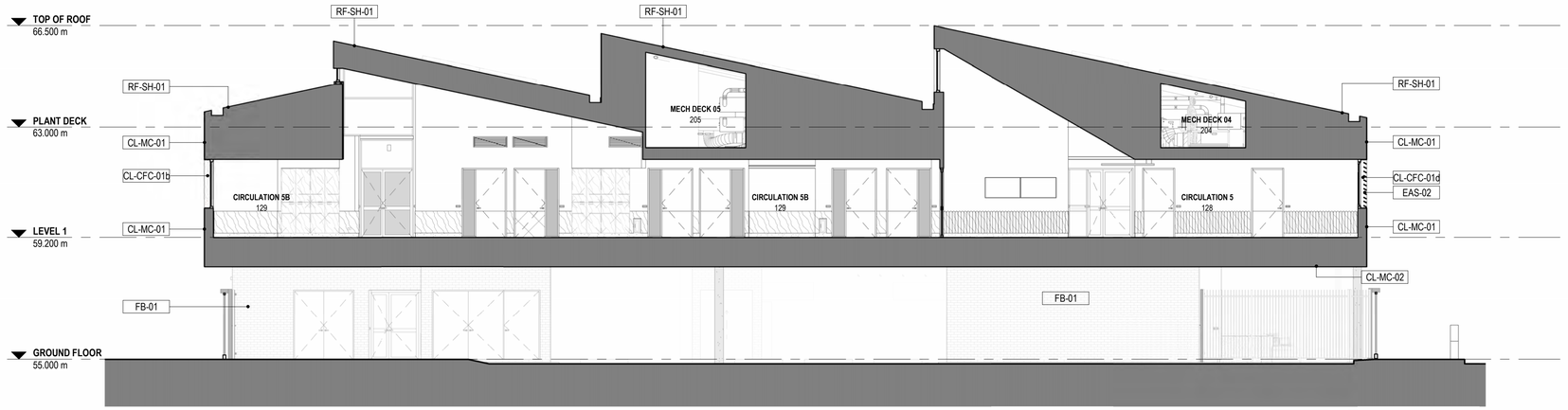
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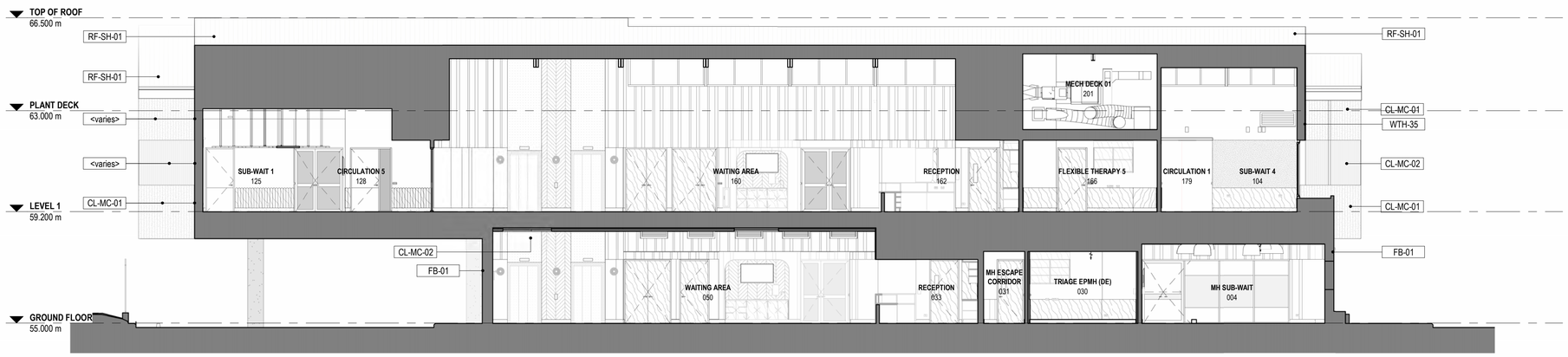
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GROUP 1 MATERIALS & FINISHES

ABBRV.	DESCRIPTION
<varies>	
CL-CFC-01b	COMPRESSED FIBRE CEMENT - COLOUR B
CL-CFC-01d	COMPRESSED FIBRE CEMENT - COLOUR D
CL-MC-01	METAL SHEET CLADDING TYPE 1
CL-MC-02	METAL SHEET CLADDING TYPE 2
EAS-02	ALUMINIUM WINDOW SCREEN HORIZONTAL
FB-01	FACE BRICK - 01
RF-SH-01	ROOF SHEETING - METAL DECK SHEETING 01
WTH-35	35mm TOP HAT



3 DA201 — **SECTION 3**
1 : 100



4 DA201 — **SECTION 4**
1 : 100

2368 DEVELOPMENT APPLICATION DA603 | SECTIONS / B | 1 : 100 @ A1 | 2/04/2025

BYFORD HEALTH HUB

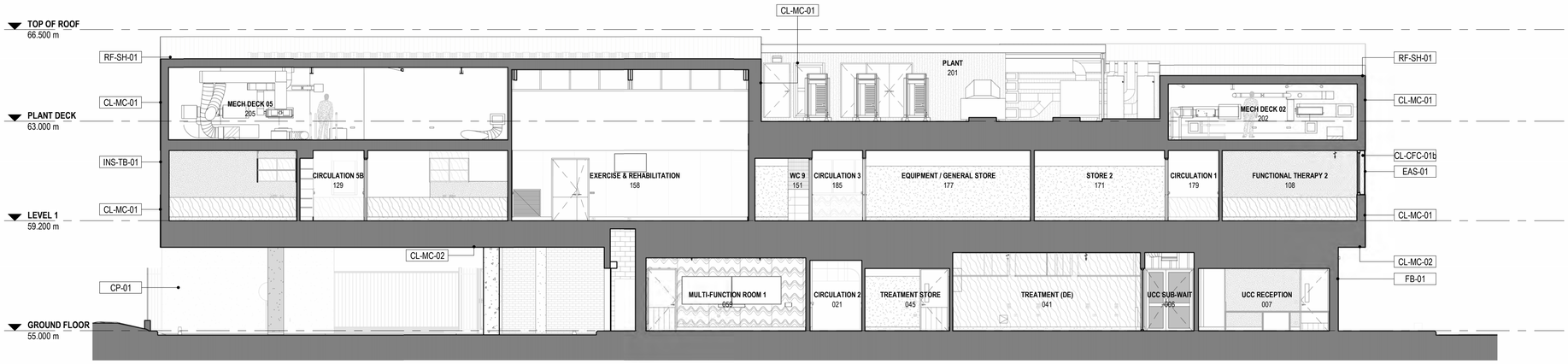
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SCALE AS MARKED @A1 SIZE

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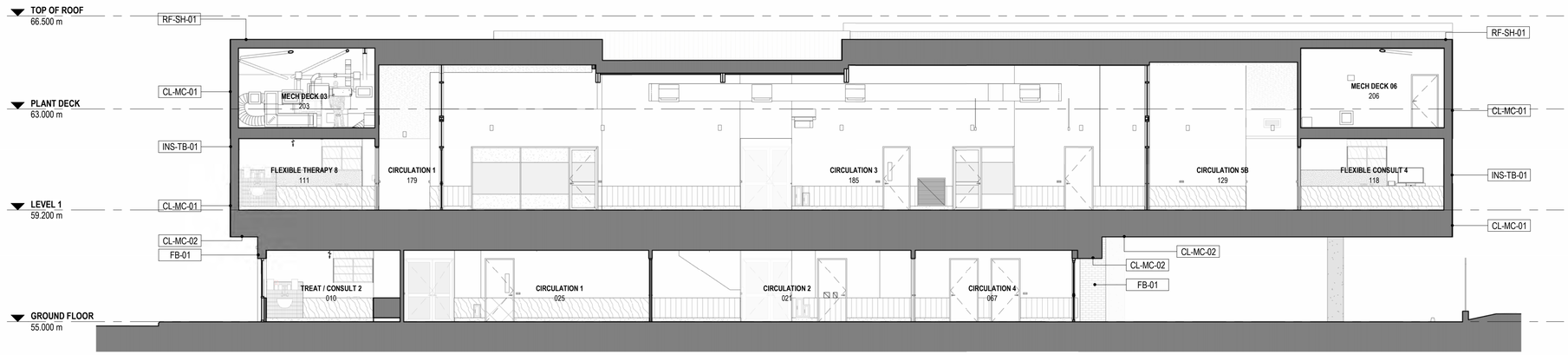
carabiner

GROUP 1 MATERIALS & FINISHES

ABBRV.	DESCRIPTION
CL-CFC-01b	COMPRESSED FIBRE CEMENT - COLOUR B
CL-MC-01	METAL SHEET CLADDING TYPE 1
CL-MC-02	METAL SHEET CLADDING TYPE 2
CP-01	CONCRETE PANEL
EAS-01	ALUMINIUM WINDOW SCREEN VERTICAL
FB-01	FACE BRICK - 01
INS-TB-01	THERMAL BREAK - WALL
RF-SH-01	ROOF SHEETING - METAL DECK SHEETING 01



5 DA201 **SECTION 5**
1 : 100



6 DA201 **SECTION 6**
1 : 100

2368 DEVELOPMENT APPLICATION DA604 | SECTIONS / B | 1 : 100 @ A1 | 2/04/2025

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1:100 0 2.5m
SCALE AS MARKED @A1 SIZE

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NORTH ARRIVAL



NORTH-EAST ARRIVAL



NORTH-WEST ARRIVAL



SOUTH ARRIVAL

2368 DEVELOPMENT APPLICATION DA700 | 3D IMAGES / A | @ A1 | 19/02/2025

BYFORD HEALTH HUB

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NORTH ENTRY



AFTER HOURS UCC / MH ENTRY WEST ARRIVAL



WEST FACADE

2368 DEVELOPMENT APPLICATION DA701 | 3D IMAGES / A | @ A1 | 19/02/2025

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PROJECT: Byford Health Hub – Main Works Development Approval
SUBJECT: Design Statement - SPP 7.3

1. Context and Character

The proposed development is broadly consistent with the Byford Town Centre Civic Master Plan developed by the Shire of Serpentine-Jarrahdale, dated July 2022.

Features of the site master plan include a north-south pedestrian thoroughfare for future connection to the Byford Train Station, a centrally located car park that can be extended to include additional bays when the Shire develops the northern portion of the site, north-facing main entry and reception plus west-facing secondary entry for discrete and after-hours public access.

The immediate surrounding built environment is characterised by a mix of established and recent development and presents a unique character for the area, taking in consideration the following aspects:

- Currently the surrounding area is heavily vehicle oriented, with large car parking areas and buildings and uses which are destinational in nature.
- There have been recently developed streetscapes such as Bushman Glade which begin to enhance the local scale pedestrian environment.
- The buildings in the area are all within a 1-2 storey scale and utilise pitched roof or pitched facade details.
- Structures situated on corners tend to have more articulation to act as landmarks for these areas.
- The overall colour and material palette of the area emphasises the character of Byford between old and new.
- Colours are primarily deep reds and browns which create a sense of sitting within the natural environment, emulating the red earth and bushland.
- This has been further enhanced by the use of materials that are focused around stone, brick and wooden textures.
- Built form retains sight lines to the surrounding natural landscape and the hills as a backdrop.

The design proposal for the BHH builds on the developing built-form and landscape context of the precinct.

Proposed materials include a textured brick base that references the earth tones of the landscape and the adjacent buildings, with lightweight profiled metal cladding above that reflects the sky and tree canopy and references traditional building materials used in the old and new town centres.

The building form is a contemporary interpretation of the pitched roof form that is predominant in the town centre and is designed to break down the building bulk to a human scale that feels welcoming to the public. The specific saw-tooth form incorporates south-facing highlight windows to bring natural light deep into the large first-floor footprint.

A broad, open and welcoming north-facing entry zone incorporates a sheltered outdoor waiting zone and enables a visual connection between indoor and outdoor public realms.

Location



Context

Existing



Context

Built Form Character

- Excerpt from Byford Town Centre Civic Master Plan 2022



Lemas Corner Feature- Building Materials and Colours



Formal Blackburn Road (southern site access)



East edge - Rail Corridor and Old Town Interface



Recent Development - rear Coles interface



Activity and views of natural context

2.4 BUILT FORM CHARACTER

The immediate surrounding built form is characterised by a mix of established and recent development and presents a unique character for the area.

FORM AND SCALE

Currently the surrounding area is heavily vehicle oriented, with large car parking areas and buildings and uses which are destinational in nature.

There have been recently developed streetscapes such as Blackburn Road which begin to enhance the local scale pedestrian environment.

The buildings in the area are all within a 1-2 storey scale and utilise pitched roof or pitched facade details. Structures situated on corners tend to have more articulation to act as landmarks for these areas.

MATERIALS AND AESTHETIC

The overall colour and material palette of the area emphasises the character of Byford between old and new.

Colours are primarily deep reds and browns which create a sense of sitting within the natural environment, emulating the red earth and bushland.

This has been further enhanced by the use of materials which are focused around stone, brick and wooden textures.

Built form retains sight lines to the surrounding natural landscape and the hills as a backdrop.

Context

Natural Character

- Excerpt from Byford Town Centre Civic Master Plan 2022

2.5 NATURAL CHARACTER

The site is located on former cleared farmland and has largely been cleared of tall trees except for on the edges adjacent to the rail. This has resulted in a horizontal outlook with a long horizon to the distance. Whilst this will change as the town centre develops there are elements of this horizontal form that can be captured and reflected on the site.

Although the site is former cleared farmland there is still a natural aesthetic across the site. This stems from the water channel along the northern edge of the site and contributes to the lush green setting particularly along this edge. This lush green water interface helps to cool the site down and is a characteristic that should be integrated in future development.

The rail corridor on the eastern edge contains a number of trees and shrubs and provides a clear edge condition.



Horizontal scale



Natural Setting



Water Feature/ Living stream



Long Horizon

Context

Existing Features


View to Undeveloped Land


View to Roundabout


View to Shopping Centre


View to Railway System


View to Shopping Centre

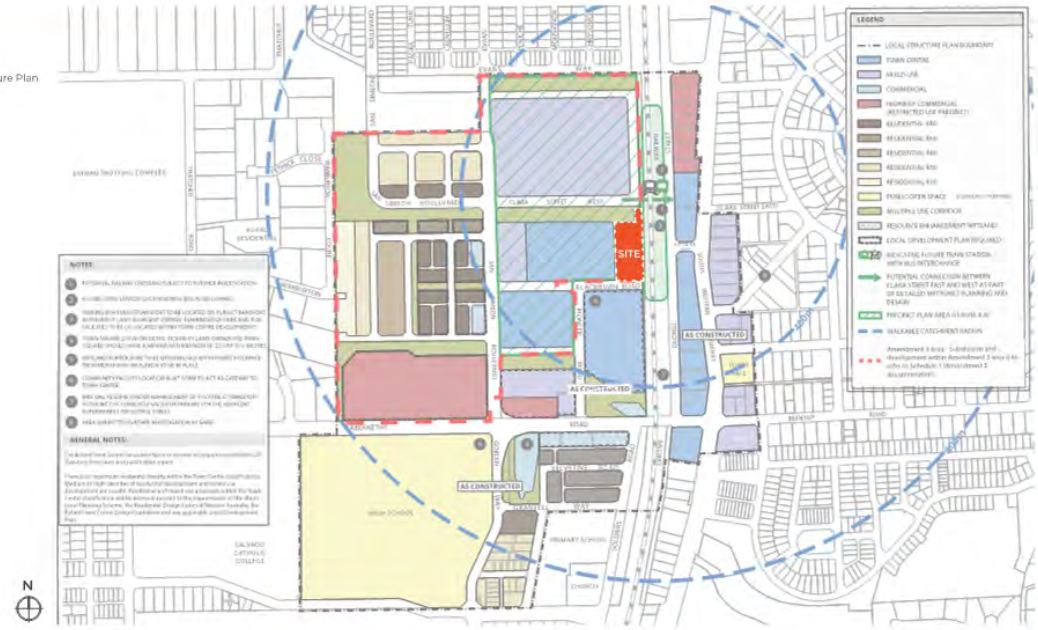

View to Paving



Context

Town Masterplan

- Excerpt from Byford Local Structure Plan 2015



Context

Byford Train Station

- Excerpts from Byford Station Development Application 2023









Context

Town Masterplan

- Excerpt from Byford Town Centre Civic Master Plan 2022

4.1 RECOMMENDATIONS

The case studies have provided key insights which have formed the following recommendations. These are focussed around three main categories.

BUILT FORM

Utilise the built form to highlight entry points to the library and health hub with:

- An elevated roof line to offer shade and manipulate volumes to expand views
- Double height entries to provide a sense of scale and highlight access
- Large entries with glass facades which encourage natural light and views to surrounding nature

ACTIVITY

Include a mix of uses which are co-located to increase community amenity by:

- Allowing for diversity internally within the buildings and exploring the opportunity for further activation with commercial functions
- Locating play areas with other community functions to provide activation and passive surveillance

OPEN SPACE & LANDSCAPE

Create a variety of experiences within open spaces to provide for diverse community requirements by:

- Including a mix of play elements for a wide age group
- Providing pedestrian connections to the wider town centre
- Designing all open spaces to be accessible

Integrate local character and heritage through the concept via:

- Materials, native planting and visual narrative
- Exploring the history, heritage and meaning of places on and around the site

Integrate landscape into the context and connect interiors to exteriors by:

- Creating entry points which integrate with the external landscape context. Carry the planting and material themes through to the interior
- Utilising artwork to integrate culture and community into the site
- Integrating landscape to soften large expanses of built form



Byford Health Hub – Proposed Development



Landscape Quality

The landscape design seeks to reflect the existing character of the local Byford Town Centre, while creating a sense of comfort, safety and entry experience to the Byford Health Hub.

An avenue of tree planting along the entry driveway will provide afternoon shade along the main pedestrian path that connects the Health Hub with the existing Byford Town Centre. A combination of brick paving, exposed aggregate paving and low seating walls, with native trees and planting creates a sophisticated yet inviting setting for visiting members of the community and remains sensitive to the local Byford aesthetic. Feature exotic trees are proposed to highlight key entry locations to the Byford Health Hub and a selection of shade tolerant species have been selected for use in the areas which are covered by the architectural forms. The landscape on the western side of the development needs to consider bushfire management and shall be maintained to a low threat standard. All trees and planting within this project shall be irrigated.

MATERIALITY

- Feature brick paving bands, reflect the existing paving character in the Byford Town Centre. The banding within the Byford Health Hub precinct
- reflects the architecture and creates a sense of rhythm along the pedestrian path.
- Exposed aggregate paving is proposed as the main paving material. This provides a textural, robust surface that is easy to maintain and ages well.
- Trafficable unit paving is proposed to the dedicated raised pedestrian areas. A warm blend of brick paving has been selected to tie into the proposed
- hardworks palette and broader area.
- A built-in brick and rammed earth seating wall element with an of the shelf seat will provide opportunities for seating within the BHH main entry
- area. Seats will have backs and arm rests to ensure that they are user friendly and comfortable for all patrons.
- Bike racks are proposed to be located within the BHH entry area. The bike rack shall be an of-the shelf propriety item that can be powdercoated
- to match the architectural intent. Bike racks have been located under the architectural roof form to provide as much cover and protection from the
- elements as possible.
- Exotic deciduous trees will be used to highlight building entry points. Their deciduous nature will allow winter sun to brighten and warm the northern
- entry area.
- Low and medium ground covers, shrubs and native trees are to compliment and soften the built form through a variety of textures and colours.
- Where planting is proposed in areas of high shade, shade tolerant species have been selected to suit the conditions.

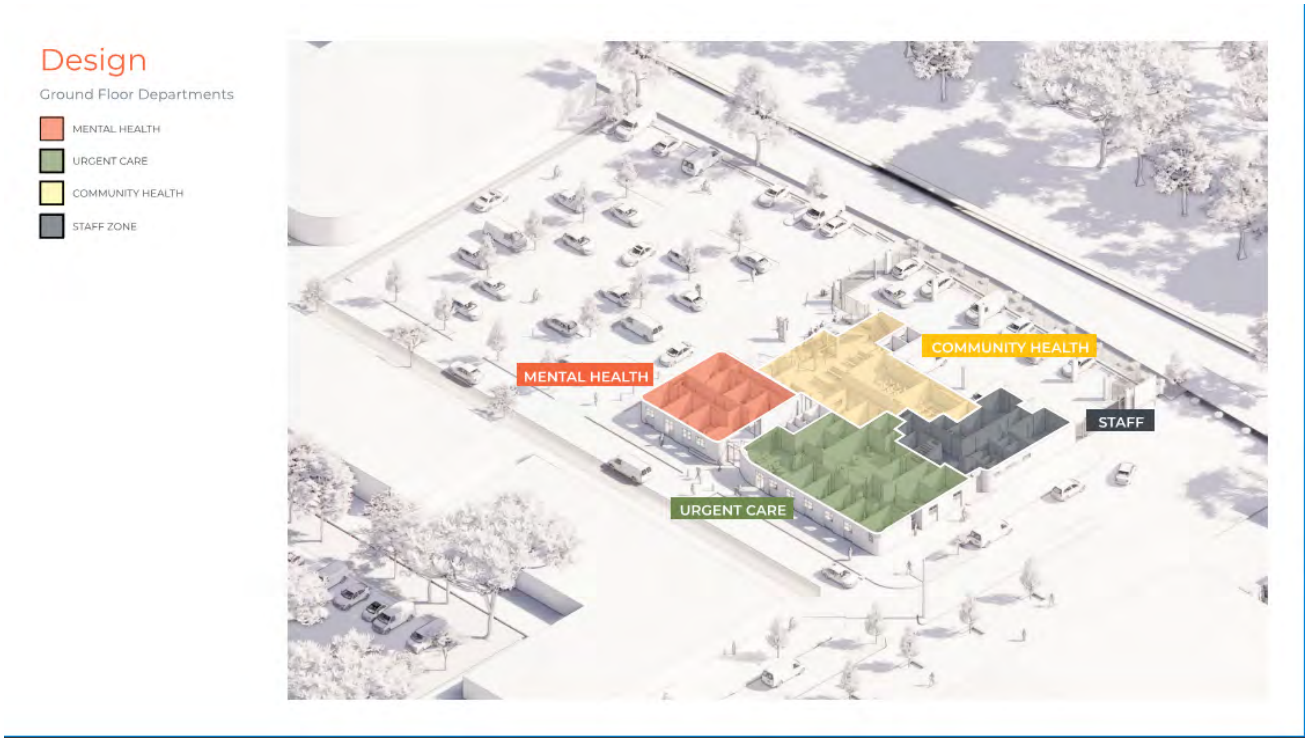
Refer Landscape Report for details.

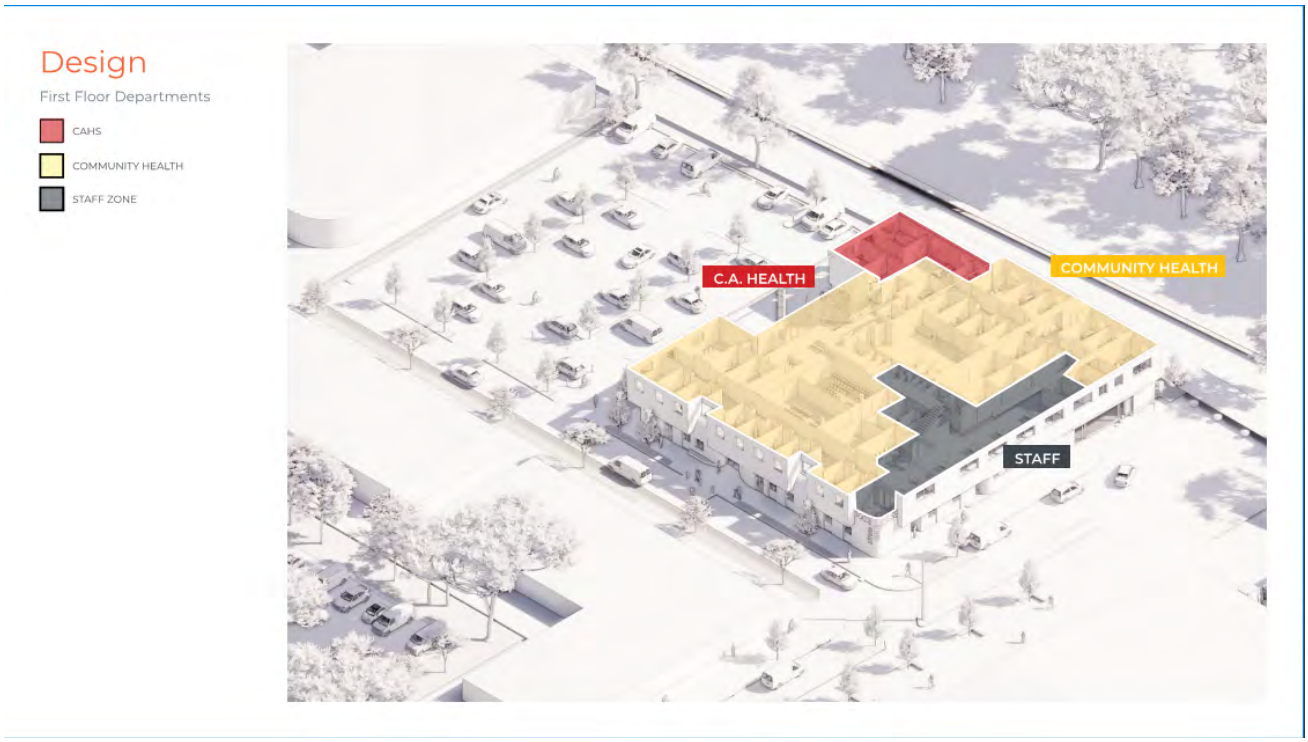
Built Form and Scale

The development of a 2-storey building abutting Bushman Glade is consistent with the Byford Town Centre Master Plan. The bulk is broken down by articulation of the facades in plan and in section. The saw-tooth roof form further breaks down the scale of the building and reflects the pitched-roof character of the Byford Town Centre.

Functionality and Build Quality

The building layout has been developed through a rigorous process of consultation to address the bespoke requirements of the specialist functions of the Health Hub, balanced with a need to maintain flexibility and adaptability.





Materials are selected for durability and low maintenance, as well as tactility. Face brick at ground level reinforces human scale for pedestrian experience.

Sustainability

The development will satisfy the briefed requirements of Department of Finance TG040, which exceeds "Deemed to Satisfy" requirements of NCC 2022. A specialist sustainability consultant, Full Circle Design Services, has been engaged to guide and monitor compliance with TG040.

Full Circle
Design Services

Executive Summary

This report provides FCDS sustainable design review of the proposed Byford Health Hub. The project has targeted a 'Best Practice' sustainable design outcome, as determined through a self-assessment against the Green Star Buildings credits and benchmarks.

By FCDS analysis, the project is expected to achieve around 39 points, just over the 5-Star target. This includes 28 points which are considered design additions above standard practice. There are an additional 7 points which could be included, requiring finalised material and plant selections and three which could be added to the project.





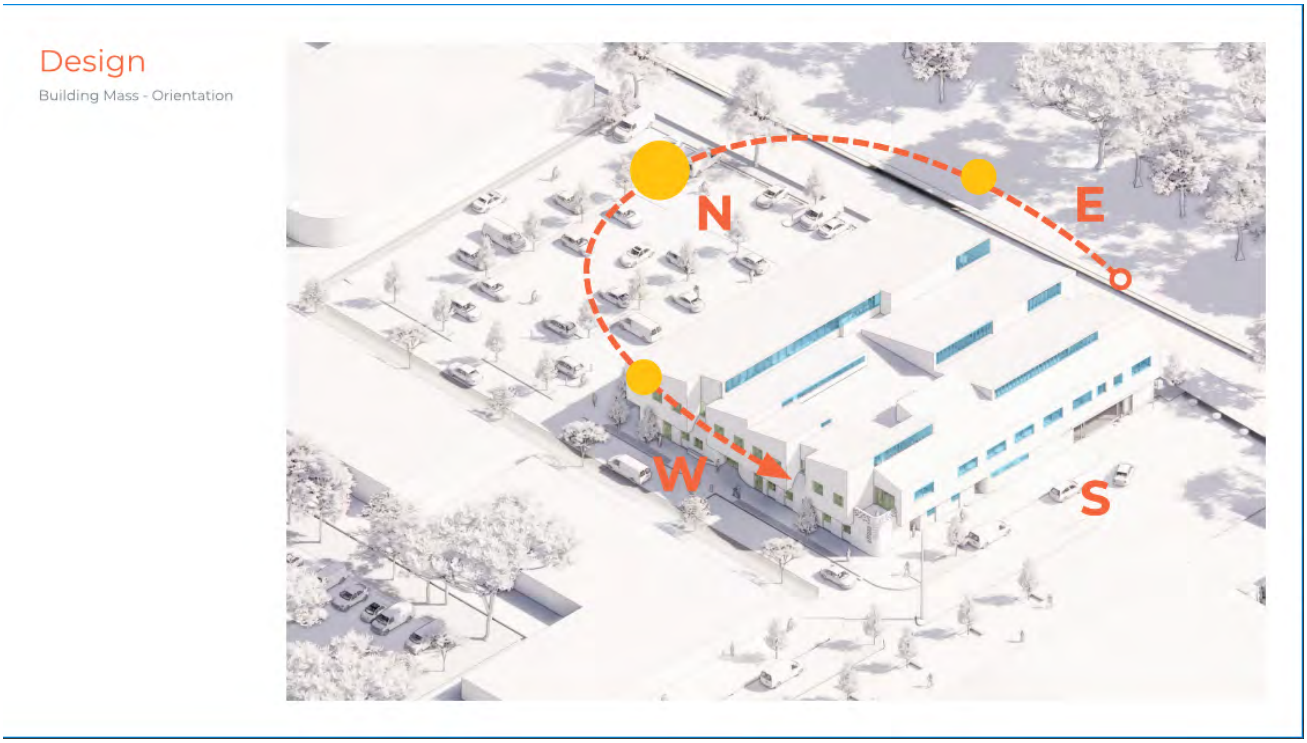
Compliance with the requirements of TG040, includes Green Star certification, however, due to budget pressures, the project team have elected to forgo formal certification, with simplified reporting and analysis in lieu. The key project inclusions are as follows:

- On site PV generation, 60kW and Batteries ~$125,000
- Lighting system Upgrades ~$50,000
- Air Quality testing at completion ~$5,000
- Sophisticated metering system ~$15,000
- Independent Commissioning Agent ~$40,000
- Building envelope pressure testing ~$15,000
- Carbon offsets for refrigerant ~$15,000
- Staff shower and change facilities ~$20,000

The project could achieve three extra points through provision of EV chargers and a sustainable transport plan.

Amenity

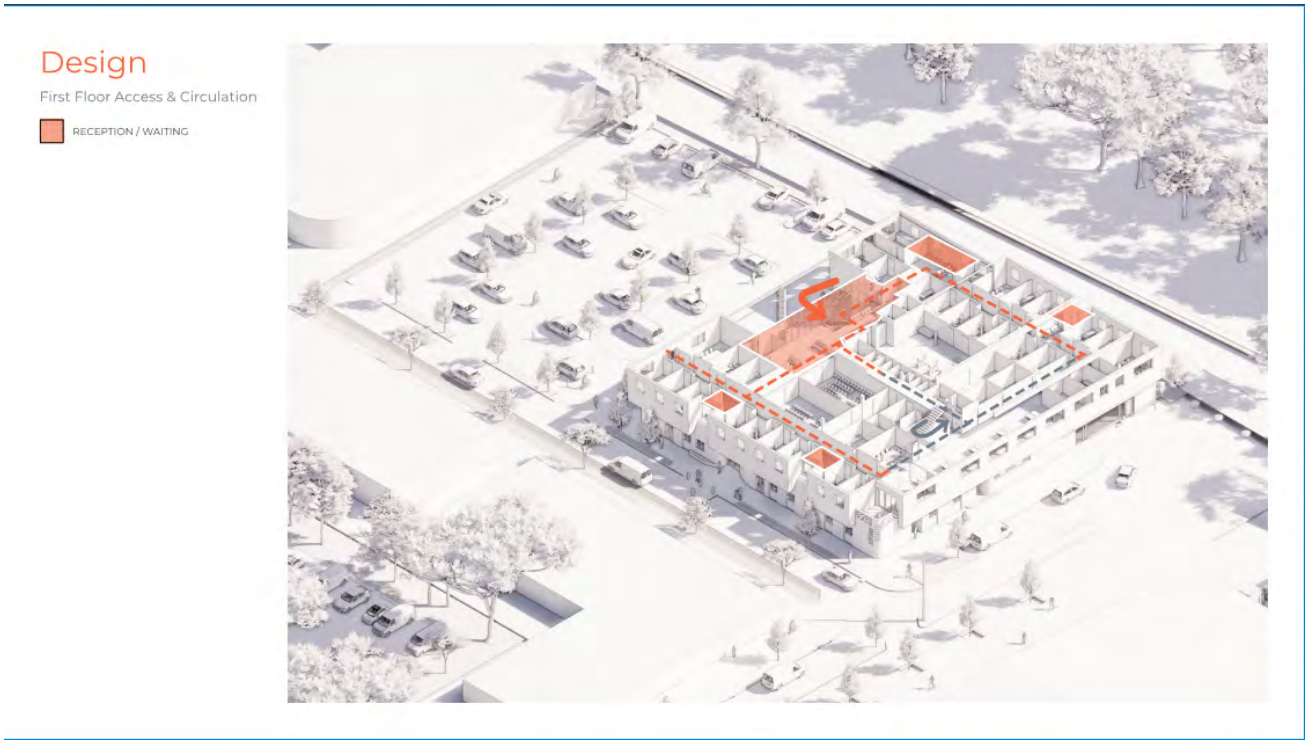
The design provides significant natural light and outlook throughout. Generous circulation and waiting zones with high quality acoustic treatments and easy wayfinding all contribute to an environment where staff and visitors alike will feel comfortable and safe.



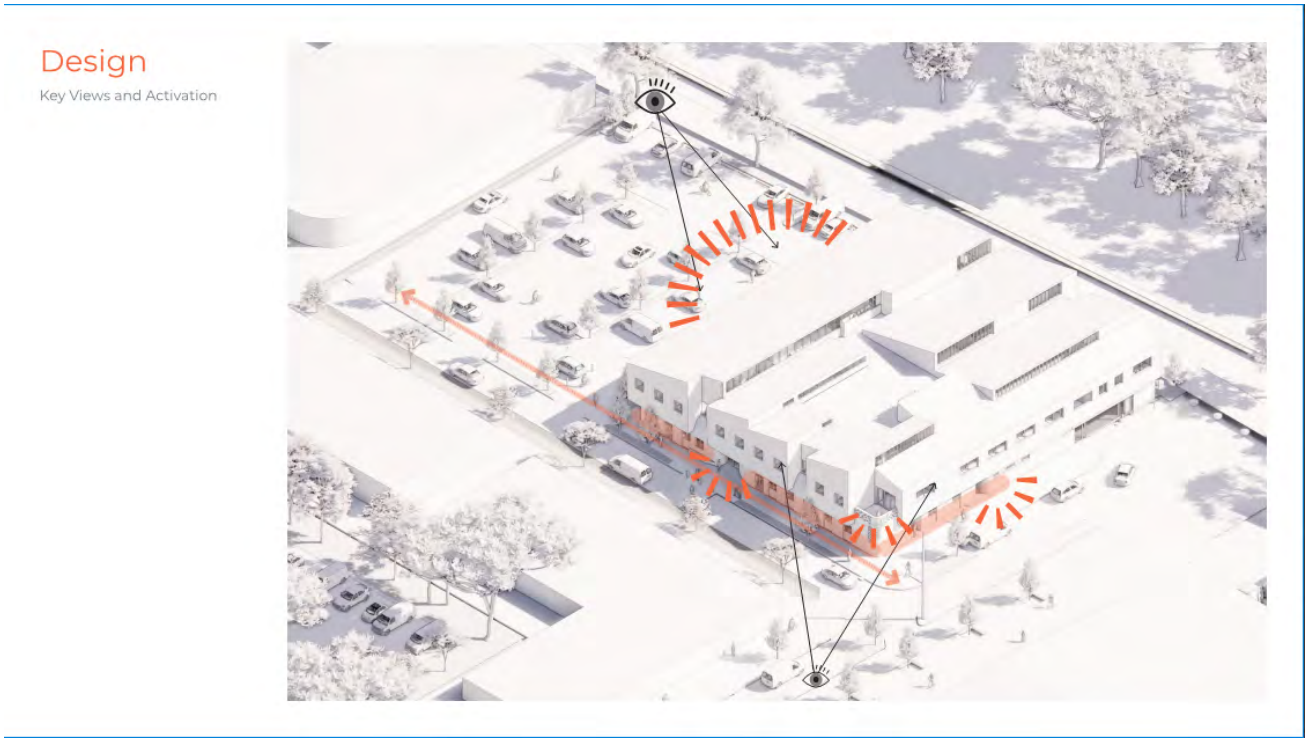
Legibility

The northern aspect, facing the car park and train station, incorporates an expansive double-volume covered entry zone that is clear and inviting. A more discrete visitor entry is available on the west elevation, immediately adjacent to the main pedestrian pathway and car park entry. This entry is used for after-access to the urgent care facility, and for discrete direct access to the community mental health area.





The south west corner of the building is a feature of the building and will incorporate signage to clearly identify the building to oncoming vehicles.



Safety

Facades are activated to provide passive surveillance along pedestrian routes. Visibility is unobstructed with no deep reveals that could be used as hiding places.

Traffic flows in one direction past the northern entry of the building to streamline drop-off and pick-up, and to simplify vehicle movements making pedestrian crossing safer.

Community

The site master plan includes a north-south pedestrian spine that will eventually connect Bushman Glade and associated retail hub with the train station and planned library to the north. The pedestrian spine is generously wide and heavily planted with trees to provide a natural shade canopy.

The perimeter of the Health Hub building incorporates seating benches to encourage people to dwell and engage. The main entry area on the north includes a large iconic sculpture by renowned artist Jon Tarry, seating, and a sensory garden element.





Aesthetics

The aesthetics of the Byford Health Hub are derived from a careful design response to functional requirements and context, resulting in a composition that delivers appropriate scale, interesting and tactile materiality, an open and engaging facade, and an enhanced landscape setting.





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Byford Health Hub – Main Works

Development Approval – Planning Report

22nd April 2025

Document Control

Version	Date	Prepared	Approved	Description
1.0	22-4-2025	SC	DK	Issued DoF for DA

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Introduction

This development application is being submitted by Carabiner Architects, on behalf of the East Metropolitan Health Service (EMHS), Department of Health for the Forward Works for the Byford Health Hub (BHH) project.

The BHH is a fully funded State Government election commitment to deliver a 'one-stop-shop' for services that are delivered within the Hub itself, as well as connecting to complimentary services delivered throughout the community. The BHH will support access to services across a range of providers and will present an opportunity for local service providers (existing and new) to hire space in a contemporary building, ideally located, and with flexible options to suit their needs.

A forward works component was approved in December 2024 to assist in preparing the site to facilitate the development of the full BHH project and meeting critical project timeframes. The proposed Stage 1 forward works include the levelling and battering of the site together with amendments to Bushman Glade to facilitate future access to the BHH site. Stage 1 works have commenced and are expected to be finalised in September 2025.

The main works component, the subject of this application, involves the construction of a two-storey multidisciplinary community health facility to service the wider Byford community

The value of the Stage 2 main works is $21.195 million and is scheduled for completion late 2026.

Public Works

The proposed development is to be undertaken as a public work under the *Public Works Act 1902*. DoF and EMHS as public authorities are exempt under Section 6 of the *Planning and Development Act 2005* from the requirement to obtain development approval for public works under the Local Planning Scheme.

The Section 6 exemption does not extend to the requirements of a Region Planning Scheme and as such, a development approval under the Metropolitan Region Scheme (MRS) is required for the proposed works.

Under recently introduced planning reforms, public works were removed from the Development Assessment Panel system. Consequently, the Western Australian Planning Commission (WAPC) is now the responsible authority for the determination of development applications for public works regardless of value.

Site Details

Location

The BHH is located on Lot 103, 3 Bushman Glade in Byford within the Shire of Serpentine-Jarrahdale (the Shire) **(Attachment A – Location Plan)**.

The BHH is bound by the railway reserve to the east, vacant land to the west, the future Byford train station car park to the north and a Coles supermarket to the south.

Ownership & Tenure

The site is Crown Reserve 54697 and is described as Lot 502 on Deposited Plan 428804. The current Reserve purpose is for *health, hospital and allied purposes*, with a Management Order to the EMHS **(Attachment B – Certificate of Title)**.

Site Description

Lot 502 is approximately 4,575 m^2 in size, and the site is vacant, relatively flat and cleared of any significant vegetation. Stage 1 forward works to remove existing fencing and cul-de-sac head with associated carriageway, achieve a consistent finished ground level across the site and construction of new road carriageway and associated works to Bushman Glade commenced and expected to be completed in May 2025.

The eastern side boundary abuts onto Public Transport Authority (PTA) land which is currently under development to accommodate the new Byford Train Station, which is due to commence operations in 2025. A Principal Shared Path (PSP) acts as the interface with PTA land.

Proposed Development

The BHH is a two-storey community health building comprising of multiple consulting rooms, multi-purpose areas and support facilities. It is expected to accommodate a maximum of 60 staff and 90 patients.

The complete scope of works for the Stage 2 main works, as shown in **Attachment C**, will involve:

- Construction of a new two storey 2,725m^2 multidisciplinary community health facility including primary health care, mental health, child and adolescent health, aged and disability support, allied health and other community health and social services.
- End of trip facilities for staff members, including the provision of changing facilities, lockers and undercover and secured staff bicycle parking.
- Provision of a 60 bay public carpark, inclusive of 4 accessible bays, and a further 18 bay staff carpark including 1 accessible bay, 2 short term drop off bays and an ambulance pick-up and service delivery bay along Bushman Glade.
- Comprehensive landscaping across the site including around the building, shade trees within the carpark and perimeter native planting strips.
- Construction of a fire booster cabinet along Bushman Glade.
- Installation of retaining and garrison style fencing along the eastern side boundary.

On completion of the BHH the finished floor level at ground level will be RL55m.

Stormwater drainage management has been designed to cater for the 1 in 10-year ARI utilising the Shire of Serpentine-Jarrahdale's stormwater pipe network and including water sensitive urban design principles incorporating green infrastructure and permeable surfacing. The critical duration for the 100-year ARI event has been considered, with storage cells with capacity to hold 426m^3 located under the carpark **(Attachment D – Geotechnical Report)**.

The proposed finished development levels of carpark areas will fall away from the eastern and southern boundaries with the PTA PSP and Bushman Glade respectively.

Site Considerations

Environment

Flora & Fauna

Vegetation value and fauna habitat were assessed by Emerge Associates in support of the Stage 1 forward works DA, with existing vegetation noted as being degraded or completely degraded and with little value for retention, whilst no significant fauna habitat identified. The site has been subsequently cleared and filled as part of forward works with no vegetation remaining onsite.

No significant impacts on vegetation or fauna are anticipated as a result of these works.

Contamination

The site is not listed on the Department of Water & Environmental Regulation (DWER) Contaminated Sites Database; however, this does not preclude the possibility that contamination exists.

Standard measures will be included as part of the works contract to ensure any excavated material will be managed and disposed of appropriately.

Geomorphic Wetlands

The site is on the edge of an identified Multiple Use Wetland as identified by the Department of Biodiversity, Conservation and Attractions (DBCA). Multiple Use Wetlands are considered to be degraded and can be considered for land use and development purposes.

The Stage 1 forward works will result in an appropriate development level above ground and surface water considerations and will follow development levels for surrounding areas that have been previously developed.

Acid Sulphate Soils

The western portion of the site is classified as being at a 'medium to low' risk of Acid Sulphate Soils (ASS). The site has been filled to an appropriate level for future development and to match surrounding developed areas, no specific issues are anticipated in relation to ASS.

Public Transport Authority Requirements

Consultation with the PTA has been ongoing through the design process for the BHH project, including integration of the PTA's PSP works, resulting in the eastern boundary of the site being modified to accommodate the PSP works. As a result,

the PSP works and the proposed BHH forward works will be integrated appropriately **(Attachment E)**. It is anticipated that the PSP works will be completed by September 2025, providing a pedestrian connection to the future train station once the BHH is operational.

PTA have advised that there are no special requirements for works in proximity to the rail reserve at this stage as there are no tracks in place.

A risk assessment for the project as a whole has been submitted to PTA, with no objections received.

PSP works are currently underway on the eastern boundary of the site. These works are due to be completed prior to the opening of the BHH, providing a suitable pedestrian connection. The site plan for the main works component contemplates the suitability of connection between the BHH and PTA PSP with those works outside of the development area will be completed under PTA authority.

The BHH will have no adverse impact on pedestrian connectivity with the Byford Train Station.

ATCO Gas Pipeline

There is an ATCO Gas pipeline in the vicinity of the site that was recently relocated from the eastern boundary of the site to the other side of the railway reserve in George Street. ATCO Gas have confirmed that the old pipeline alignment has been decommissioned, and the new pipeline in George Street is now commissioned and is in use.

ATCO gas has also advised that given the proposed development is over 50m from the pipeline, no objections or issues were identified.

Traffic & Parking

A Traffic Impact Assessment completed by Shawmac, dated 17 January 2025, completed in accordance with the Western Australian Planning Commission TIA guidelines, indicates that the proposal is consistent with the strategic planning intent for the site, noting no major concerns with capacity.

Two crossovers are proposed to the east and west boundaries of the site, with eastern side allowing for egress only, whilst the western side allowing for both ingress and egress. Appropriate crossover approval from the Shire of Serpentine-Jarrahdale will be required; however, advice from the Shire indicates no objection to placement and design for the identified crossover locations.

Provision of a 60 bay public carpark, inclusive of 4 accessible bays, and a further 18 bay staff carpark including 1 accessible bay, 2 short term drop off bays and an ambulance pick-up and service delivery bay along Bushman's Glade is provided for.

There are no specific parking requirements under the MRS; however, the TIA notes that the parking provision is adequate to accommodate given the development that proximity to public transportation routes, inclusive of the Byford Train Station, reciprocal parking availability at the adjacent shopping precinct and future community library, connection to the pedestrian and cycle network and provision of end of trip facilities for staff.

The TIA concluded it is likely the development will facilitate higher rates of non-car mode share resulting in a low moderate impact on peak hour traffic flows which can be accommodated within the existing capacity of the road network.

Planning Framework

Metropolitan Region Scheme

The site is zoned Urban under the Metropolitan Region Scheme (MRS). The zoning is considered suitable for the proposed BHH, and forward works.

Matters to be considered

As a public work, the proposal is to be considered and assessed under clause 43 of the MRS which requires the decision maker to have regard to the following factors when determining a development application:

***Table 1**: Assessment against clause 43 of the MRS*

Matters to be considered by the Commission	Consideration
(a) the purposes and aims of this Scheme and any relevant local planning schemes in operation within the metropolitan region;	The site is zoned 'Urban' under the MRS and the proposed works are consistent with the zoning under the MRS.
(b)(i) any relevant proposed amendment to this Scheme or proposed replacement Scheme for which advertising has commenced under section 43 of the Act;	No current MRS amendment process.
(b)(ii) any relevant proposed local planning scheme or proposed amendment to a local planning scheme for which advertising has commenced under section 84 of the Act;	The proposed development is to be undertaken as a public work under the *Public Works Act 1902*. DoF and EMHS as public authorities are exempt under Section 6 of the *Planning and Development Act 2005* from the requirement to obtain development approval for public works under the Local Planning Scheme.
(c) any State planning policy (SPP);	SPP 5.4: Road and Rail Noise, SPP 3.7: Planning in Bushfire Prone Areas and SPP7.0: Design of the Built Environment are addressed under Part 5.3.
(d) any environmental protection policy approved under the EP Act;	Appropriate environmental investigation completed in support of the Stage 1 forward works development application.
(e) any policy or strategy of the Commission, including any region planning scheme policy or district structure plan that is in force;	The Byford town centre is identified as a 'District Activity Centre' under the *Perth and Peel at 3.5 million: South Metropolitan Sub-Regional Planning Framework*. The proposal seeks to provide fundamental multidisciplinary community health services within an activity

	centre inclusive of existing commercial operations and future and community/ civic services. The proposal is consistent with the regional planning framework.
(f) any policy adopted by the Government	The provision of the BHH is consistent with the *State Public Health Plan for Western Australia 2024-2029* which seeks the promotion of community health servicing.
(g) the local government's local planning strategy in respect of a local planning scheme, as endorsed by the Commission under the Planning and Development (Local Planning Schemes) Regulations 2015 regulation 15(1) and amended from time to time;	The proposed development complies with the strategic and statutory planning intent for the site as the site is part of the Byford Town Centre.
(h) for reserved land, the public purpose for which the land is reserved;	MRS Reserve for Public Purposes: health, hospital and allied purposes. Management Order to the benefit of the EMHS. The development is consistent with the reserve purpose.
(i) the conservation of any place that is a heritage-protected place;	N/A – no identified heritage.
(j) the compatibility of the development with its setting;	The development is located within a District Activity Centre, characterised by mixed uses including commercial and civic services. The site is well serviced with a number of transportation options including private travel, public transportation or active travel outcomes. The BHH is considered to be highly compatible with its setting.
(k) any social issues that may affect the amenity of the locality;	N/A
(l) the cultural significance of any place or area affected by the development;	No identified cultural heritage.
(m) the likely effect of the proposal on the natural environment and any means that are proposed to protect, or to mitigate impacts on, the natural environment;	Appropriate environmental investigation completed in support of the Stage 1 forward works development application. Stormwater will be appropriately managed on site to consider the 1-in-100 ARI event. The western portion of the site is classified as being at a 'medium to low' risk of Acid Sulphate Soils (ASS). The site has been filled to an appropriate level for future development and to match surrounding developed areas, no

	specific issues are anticipated in relation to ASS. Appropriate measures have been undertake to consider the impact of the proposal on the natural environment.
(n) whether the land to which the application relates is unsuitable for the proposal because it is, or is likely to be, subject to flooding, tidal inundation, subsidence, landslip, bush fire or other similar risk;	The site is partially located within a Bushfire Prone Area. A BAL assessment has identified that the BHH will be within a BAL-29 area or less. A Bushfire Management Plan has been submitted that appropriately manages risk. The land parcel is considered suitable for the development of the BHH.
(o) the preservation of the amenity of the locality;	Located within a District Activity Centre; the BHH is appropriately located so as not to impact on amenity within a town centre precinct featuring commercial and civic uses.
(p) the relationship of the proposal to development of adjoining land or on other land in the locality, including, but not limited to, the likely effect of the height, bulk, scale, orientation and appearance of the proposal;	The development has been designed to take advantage of the evolving public transportation network with key active transport elements, such as secured bicycle parking, incorporated into accessible area to key public transport nodes (Byford Train Station). The building has been sited to take advantage of the significant frontage along Bushman Glade, with parking sleeved behind the building. The building height is consistent with a town centre development.
(q) whether the proposed means of access to and egress from the site are adequate and whether adequate provision has been made for the loading, unloading, manoeuvring and parking of vehicles;	Proposal includes two crossover points onto Bushman Glade. Loading bay included on Bushman Glade. Onsite parking available for 60 customer vehicles and 18 staff parking bays.
(r) the amount of traffic likely to be generated by the proposal, particularly in relation to the capacity of the road system in the locality and the probable effect on traffic flow and safety;	TIA includes investigation of traffic numbers noting that traffic relating to the BHH will have a low medium impact on the local road network.
(s) whether public transport services are necessary and, if so, whether they are available and adequate for the proposal;	Site is in close proximity to the Byford Train Station, which is due to commence operation is 2025. Additionally, there are two existing PTA bus services servicing the site.
(t) whether public utility services are available and adequate for the proposal;	Site is currently serviced by private water service. Public utility services will be available on gazettal of Bushman Glade (expected by

	mid-2025) with the private water service transferred to the Water Corporation.
(u) whether adequate provision has been made for access for pedestrians and cyclists (including end of trip storage, toilet and shower facilities);	Appropriate provision of end of trip facilities including staff showers, lockers and secured bicycle storage to the east of the site included.
(v) whether adequate provision has been made for access by disabled persons;	Appropriate consideration has been made for accessibility as per AS1428.1.
(w) whether adequate provision has been made for the landscaping of the land to which the application relates and whether any trees or other vegetation on the land should be preserved	Comprehensive landscaping across the site including around the building, shade trees within the carpark and perimeter native planting strips, as per landscape concept drawings provided with the DA package.
(x) whether the proposal is likely to cause soil erosion or land degradation	Appropriate measures for retaining, landscaping and stormwater management are proposed to ensure no negative impact on soil erosion or land degradation.
(y) the potential loss of any community service or benefit resulting from the development approval;	Nil. The proposal will result in significant benefit to health care for the Byford community.
(z) any relevant submissions received on the application;	Addressed during the processing of the development application.
(za) any recommendations received from a local government under clause 37(3);	Consultation with the Shire of Serpentine-Jarrahdale has been ongoing, with design considering the installation of the future Byford Library to the north of the development area.
(zb) consultation under clause 44(1);	Pre-consultation with PTA and DPLH completed with key concerns addressed within final design proposal. The main consideration related to connectivity to the PSP to the Byford Train Station. Whilst direct connection points fall outside of the scope of the development site, the internal pedestrian network has been designed to facilitate an appropriate connection.
(zc) any advice of the Trust under clause 45(4);	N/A – site not located within lands under the authority of the Swan and Canning River Trusts.
(zd) any other development consideration the Commission considers relevant.	No additional issues.

Local Planning Scheme & Strategy

The subject site is zoned 'Urban Development' in the Shire's Local Planning Scheme No. 2 (LPS2).

The Byford Town Centre Local Structure Plan (BTCLSP) was endorsed by the WAPC in June 2018 and identifies the site as 'Town Centre'. The Town Centre classification is intended to incorporate a mixture of land uses including retail, restaurants and cafes, leisure and entertainment, commercial offices, civic and community uses, including a Town Square, childcare facilities, consulting rooms and medical suites, residential development and open space.

The development of the BHH is considered consistent with the intent of the Town Centre classification under the BTCLSP.

State Planning Policies

State Planning Policy 5.4 – Road and Rail Noise

The subject site is within the 100m trigger distance for passenger railways. The intent of the Policy (SPP5.4) is to minimise adverse impacts of road and rail noise on development within the specified trigger distance. SPP5.4 applies a performance-based approach to the management and mitigation of transport noise, including the setting of noise targets, to achieve objectives.

Noise impact has been considered within an acoustic report; the 'Architectural Acoustics Design Development' report undertaken by Gabriels Hearne Farrell (**Attachment F**) has examined material and design outcomes, noting that forecast noise levels are below noise targets indicated within SPP5.4.

The forecast noise levels are consistent with the requirements of SPP5.4 with existing design and material elements satisfying policy outcomes.

State Planning Policy 3.7 – Planning in Bushfire Prone Areas

A portion of the site is located within a designated bushfire prone area and compliance with State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7) and supporting Guidelines for Planning in Bushfire Prone Areas is required.

The proposal has been considered against the policy measures, with a Bushfire Management Plan (dated 10 December 2024) prepared to assess risk and mitigation measures. The BAL assessment indicates a BAL-29 rating with the development being constructed to address the risk rating (**Attachment G – Bushfire Management Plan**).

State Planning Policy 7.0 – Design of the Built Environment

*State Planning Policy 7: Design of the Built Environment (*SSP 7) is the lead planning policy that elevates the importance of design quality, and sets out the principles, processes and considerations which apply to the design of the built environment in Western Australia, across all levels of planning and development.

SPP7 establishes a set of ten 'Design Principles', providing a consistent framework to guide the design, review and decision-making process for planning proposals. **Attachment H** provides an assessment against the ten design principles of SPP7.0.

Pre-Lodgement Engagement

Shire of Serpentine-Jarrahdale

Consultation with the Shire in regard to the BHH project has been ongoing in relation to the land acquisition process and the BHH facility itself. A Crown subdivision was recently completed excising the necessary land tenure to accommodate the BHH with the remainder of the land intended to be developed for the future Byford library.

During the consideration of the Stage 1 forward works Development Application, the Shire indicated that appropriate PSP connection to the adjacent PTA land be addressed. PSP works are currently underway on the eastern boundary of the site. A temporary footpath is not considered necessary and would be a duplication of the PSP works. These works are due to be completed prior to the opening of the BHH, providing a suitable pedestrian connection. The site plan for the main works component contemplates the suitability of connection between the BHH and PTA PSP with those works outside of the development area will be completed under PTA authority.

The Shire has provided its general support for the project though provided specific commentary relating to design outcomes, indicating built form guidelines in the guise of Local Planning Policy 3.8 (LPP3.8) for the Byford Town Centre. The Shire's comments indicated that the proposal is non-compliant with LPP3.8 with respect to the use of non-permitted material and failure to satisfy "contemporary rural town" characterisation.

As a 'public work' the development should have due regard to, but is otherwise exempt, from the local government planning framework. Reviewing the objectives of LPP3.8, which identifies a number of vision statements and principles, it is noted that whilst specific materials are encouraged, materiality is not prohibited. The design incorporates natural materials, such as the use of timber, within public internal spaces of the building, whilst external material design is influenced by the greater rural material characteristics commonly utilised in the rural landscape within Serpentine-Jarrahdale.

The Shire's concerns were further discussed with an acknowledgement of the commonality of materials within the rural landscape, and that the project design is consistent with the vision and objectives of the LPP. The Shire expressed support for further examination through a design review process coordinated by the Government Architect of Western Australia.

Department of Planning, Lands & Heritage

Consultation with officers from DPLH has been ongoing in relation to the two-stage DA process, as well as the project itself.

No specific issues or concerns have been raised by DPLH officers.

Conclusion

This proposal to facilitate the Stage 2 main works for the BHH is being submitted to meet critical project timelines for the delivery of the BHH, which is a critical Stage Government priority project. The State Government has committed to the delivery of the BHH as an election commitment and the project is fully funded.

Overall, the Shire is supportive of the Stage 2 main works and consultation will remain open and ongoing through project development.

Having regard to the above, the application clearly demonstrates the suitability of the proposed development to the site. Accordingly, it is requested that the application is considered favourably by the WAPC.

Bushfire Management Plan Coversheet

Site address:	3 Bushman Glade, Byford						
Site visit:	Yes	✓	No				
Date of site visit:	Day	08	Month	August	Year	2024	
Report author or reviewer:	Kathy Nastov						
Not accredited		Level 1 BAL assessor		Level 2 practitioner		Level 3 practitioner	✓
BPAD accreditation number:	27794	Accreditation expiry: Month	August	Year	2025		
Bushfire management version number:	V1.4						
Bushfire management plan date:	10 December 2024						

If one or more of the following responses are yes, then these should be automatically referred to DFES.	Yes	No
Strategic planning is required to address SPP 3.7 and the Guidelines		✓
The application is a vulnerable land use		✓

If one or more of the following responses are yes, and the decision-maker requires input from DFES, then the application can be referred.	Yes	No
The BAL rating has been calculated by a method other than Method 1 as prescribed by AS 3959		✓
An outcomes-based approach has been submitted to demonstrate compliance with the bushfire protection criteria		

Note: If a subdivision or development application meets all the acceptable solutions and does not otherwise trigger a referral as listed above, seeking advice from DFES on SPP 3.7 or other matters is at the discretion of the decision-maker.

The information provided within this bushfire management plan, to the best of my knowledge, is true and correct:

Signature of report author or reviewer:		Date	10-Dec-24

BUSHFIRE PRONE PLANNING

Byford Health Hub

Bushfire Management Plan

(PREPARED FOR PLANNING APPLICATION ASSESSMENT PURPOSES)



Compiled in accordance with State Planning Policy 3.7 Bushfire and the Planning for Bushfire Guidelines

Lot 103, 3 Bushman Glade Byford

Shire of Serpentine Jarrahdale

Development Application - Commercial/Industrial Development

10 December 2024

Job Reference No: 230699

BPP GROUP PTY LTD T/A BUSHFIRE PRONE PLANNING

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Version	Status/Details	Date
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DISTRIBUTION					
Destination		Version	No. Copies	Hard Copy	Electronic Copy
Person	Email				
Ahmed Salam	ahmads@caribiner.com.au	1.4		☐	☒

Limitations: The protection measures that will be implemented based on information presented in this Bushfire Management Plan are minimum requirements and they do not guarantee that buildings or infrastructure will not be damaged in a bushfire, persons injured, or fatalities occur either on the subject site or off the site while evacuating.

This is substantially due to the unpredictable nature and behaviour of fire and fire weather conditions. Additionally, the correct implementation of the required protection measures (including bushfire resistant construction) and any other required or recommended measures, will depend upon, among other things, the ongoing actions of the landowners and/or operators over which Bushfire Prone Planning has no control.

All surveys, forecasts, projections and recommendations made in this report associated with the proposed development are made in good faith based on information available to Bushfire Prone Planning at the time. All maps included herein are indicative in nature and are not to be used for accurate calculations.

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STATEMENT OF PURPOSE – THE **'PLANNING'** BUSHFIRE MANAGEMENT PLAN

EXPLANATORY INFORMATION

SITE/USE PLANNING

This BMP is produced to present the information necessary for a planning proposal's assessment against the State's bushfire planning requirements. The developed information is to inform and assist decision-making authorities, planners, landowners/proponents and referral agencies in their implementation WA's State Planning Policy 3.7 Bushfire – and where relevant, any supplementary provisions of a local planning scheme or policy.

Policy Document Versions Applied in This BMP	State Planning Policy 3.7 Bushfire (SPP 3.7)	November 2024	Planning for Bushfire Guidelines (supporting SPP 3.7	November 2024

> The Stated Intent of SPP 3.7 is to *implement effective, risk based land use planning and development which in the first instance avoids bushfire risk, but where unavoidable, manages and/or mitigates the risk to people, property and infrastructure to an acceptable level. The preservation of life and the management of bushfire impact are paramount.*

SITE OPERATIONS

This BMP is not an 'operational' BMP for property and operations management. Such a BMP would apply additional and more specific bushfire protection measures to more comprehensively reduce the level of risks associated with a bushfire event. These being the potential loss of life, injury, or destroyed or damaged assets which results in personal loss and economic loss.

However, this 'planning' BMP does establish certain responsibilities for the implementation and maintenance of the bushfire protection measures that are considered the minimum for bushfire planning decision making.

BUSHFIRE RESISTENT CONSTRUCTION

This 'planning' BMP is not required to consider the requirement to construct certain buildings, in designated bushfire prone areas, to the standard corresponding to the Bushfire Attack Level (BAL) they are subject to. This requirement is dealt with under the State Building Act 2011/Building Regulations 2012 and the referenced Building Code of Australia.

DETERMINED BUSHFIRE ATTACK LEVEL (BAL) RATINGS AND CONSTRUCTION – CAUTION!

For construction purposes a determined (not indicative) BAL rating is required to be known and a BAL Certificate produced for submission with a building application. This establishes the construction design and materials that are to be complied with in accordance with AS 3959 Construction in bushfire prone areas (as amended) and/or NS 300 NASH Standard Steel Framed Construction in Bushfire Areas (as amended).

This 'planning' BMP cannot necessarily determine a BAL rating that will apply to a future building. All variables required for that calculation may not be known at the assessed stage of planning. For example, actual location of a building footprint on a lot and/or any classified vegetation that will remain, at the time of construction, within the lot or on neighbouring lots.

This 'planning' BMP is only required to identify if a viable sized building can be located on a lot and be subject to a BAL rating not exceeding BAL-29, based on certain allowable assumptions. This is a planning requirement not a building requirement and a BAL contour map can be used to illustrate this information as an 'indicative' BAL rating.

> Be aware that typically you cannot derive the determined BAL rating for a future building(s) on a specific lot from a BAL contour map (when presented in a BMP prepared for planning approval purposes). This is only possible in limited circumstances.
>
> Planning assessment requirements are different to building assessment requirements. Refer to explanatory information above and Appendix B1 for additional information.

1 THE PLANNING PROPOSAL

1.1 Details, Plans and Maps

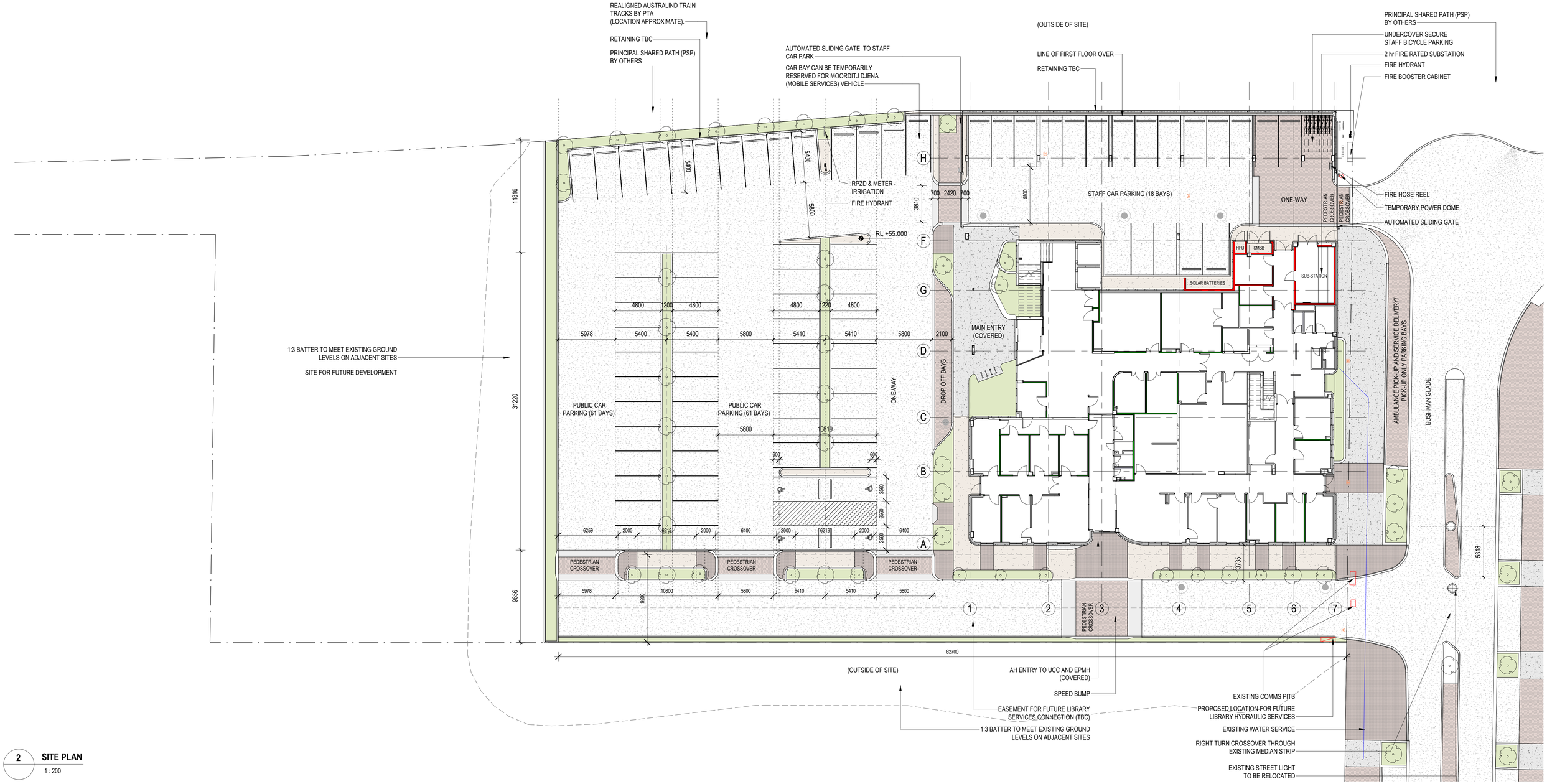
SUBJECT LAND AND PROPONENT (LANDOWNER)		
The Subject Land / Site	Lot 103, 3 Bushman Glade, Byford (and Crown Reserve 53923)	
Total Area of Subject Land / Site	7000 m^2	
Proponent	East Metropolitan Health Service (EMHS)	
Entity Commissioning Production of the BMP	Ahmad Salman (Caribiner)	
THE PLANNING PROPOSAL STAGE AND TYPE		
Strategic Planning Document	☐	N/A
Structure Plan	☐	N/A
Subdivision Application	☐	N/A
Development Application	☑	Construction of a habitable building that is subject to bushfire planning requirements.
DESCRIPTION		
Proposed construction and development of a new two-storey, contemporary and multidisciplinary health facility. The Byford Health Hub (BHH) will accommodate a range of accessible, local, community-based health and social care services for different population age groups and health conditions (see Figure 1.1.1). It is understood that the northern side of the lot will be cleared and considered for future development as a carpark and library. This BMP, however, only addresses the Byford Health Hub development. ***Any changes to the layout or lot boundaries will require a revised BMP to be carried out.*		
EXPLANATORY INFORMATION Note: A habitable building is defined in the *Planning and Development (LPS) Regulations 2015* to mean: A permanent or temporary structure on land that: (a) Is fully or partially enclosed; and (b) Has at least one wall of solid material and a roof of solid material; and (c) Is used for a purpose that involves the use of the interior of the structure by people for living, working, studying or being entertained.		
The Primary Proposed Construction		
Type(s)	New Building(s)	
NCC Classification	Class 5 (office building - professionals)	
Development Type for Assessment Against the Bushfire Protection Criteria		
Development Commercial and Industrial	Construction of or addition to, a habitable building for commercial or industrial uses. *[Guidelines s7]*	

Assessment Supporting Details:

We have had advice from a building certifier that the Byford Health Hub can be classified as class 5A as the majority of the rooms are Medical Consulting Rooms as opposed to a 'Health-care building'(Class 9a) which is defined under the NCC as being ''a building whose occupants or patients undergoing medical treatment generally need physical assistance to evacuate the building during an emergency and include –

a) A public or private hospital; or
b) A nursing home or similar facility for sick or disabled persons needing full-time care; or
c) A clinic, day surgery or procedure unit where the effects of the predominant treatment administered involve patients becoming non-ambulatory and requiring supervised medical care on the premises for some time after the treatment.''

As this is a day use facility with no surgical procedures and people are able to evacuate unassisted, it is not considered a Vulnerable Land Use or Class 9 building.



2 SITE PLAN
1 : 200

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ALL DIMENSIONS SHALL BE VERIFIED ON SITE BEFORE PROCEEDING WITH THE WORK. RELEVANT PARTY SHALL BE NOTIFIED IN WRITING OF ANY DISCREPANCIES.

THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS, REPORTS AND DRAWINGS.

THE DRAWINGS SHALL NOT BE USED FOR CONSTRUCTION UNLESS ENDORSED 'FOR CONSTRUCTION' AND AUTHORISED FOR ISSUE.

No.	Date	Revision / Issued To	By
I	28/10/2024	ISSUED TO CONSULTANTS	
H	10/10/2024	ISSUED TO CONSULTANTS	
G	09/10/2024	ISSUED FOR INFORMATION	
F	04/10/2024	ISSUED TO CONSULTANTS	
E	13/09/2024	ISSUED TO CONSULTANTS	
D	12/09/2024	ISSUED FOR WESTERN POWER REVIEW	
C	03/09/2024	ISSUED TO CONSULTANTS	
B	29/08/2024	ISSUED FOR CLIENT REVIEW	
A	05/08/2024	ISSUED TO CONSULTANTS	

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Department of **Finance**

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PRELIMINARY
NOT FOR CONSTRUCTION

N

DEPARTMENT OF FINANCE PROJ. No. 2368

BYFORD HEALTH HUB
Project Address

SITE PLAN

DRAWN	CG	DESIGNED DK	REDUCTION 1:100 0 2.5m
CHECKED	CG	PRINCIPAL CARABINER	
APPROVED	AS		
SCALE 1 : 200@ A1		DATE PRINTED 29/10/2024 8:52:20 AM	DRAWING No. A01.01 REV No. I
DF PROJ No. XXXXX		DF FILE No. XXXXX	

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Figure 1.2

Proposed Development

Lot 103 on Plan 414923, Area : 7,000 sq m
Bushman Glde
BYFORD
SHIRE OF SERPENTINE - JARRAHDALE

------ LEGEND -----

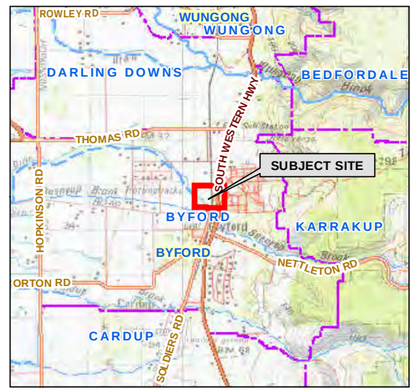
- Subject Site
- Other Lots
- Hydrant

Proposed

- Health Hub
- Principal Shared Path (PSP) by PTA

0 20 40 60 80 100
Metres

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : January 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 2/12/2024
Map updated by: Ian Ross 2/12/2024
A3 Scale 1:1,750

BUSHFIRE PRONE PLANNING

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Map Document Path / Name: K:\Projects\Jobs 2023\230699 - Byford Health Hub (BMP) RFQ 3 Aug\Mapping\MXD\230699_Fig1-2_DEV_Byford Health Hub.mxd

Figure 1.3

Location Plan

Lot 103 on Plan 414923, Area : 7,000 sq m
Bushman Glde
BYFORD
SHIRE OF SERPENTINE - JARRAHDALE

SUBJECT SITE

HILBERT
DARLING DOWNS
WUNGONG
BEDFORDALE
BYFORD
OAKFORD
KARRAKUP
CARDUP
Jarrahdale State Forest
Cardup Nature Reserve
Wungong Brook
Beenyup Brook
Cardup Brook
Kevin Murphy Trail
Oscar Bruns Reserve
Sunrays Park
Bill Hicks Reserve
Marri Grove Primary School
West Byford Primary School
Byford Trotting Training Complex
Beenyup Brook Reserve
Byford Bowling Club
BYFORD BFB
Byford Secondary College
Salvado Catholic College
Byford John Calvin School
Briggs Park Byford BMX Track
Brickwood Reserve
Cardup Brook
DALRAY CT
WUNGONG-SOUTH RD
SOUTH WESTERN HWY
MASTERS RD
COMIC COURT CCT
TONKIN HWY
HOPKINSON RD
THOMAS RD
BRIGGS RD
MALARKEY RD
ALEXANDER RD
LINTON ST NORTH
LARSEN RD
GEORGE ST
NINKA LANE
MALUA LANE
ABERNETHY RD
THATCHER RD
CORBEL LANE
BEENYUP RD
DUNDATHA DR
OLD BRICKWORKS RD
ADMIRAL RD SOUTH
TOURMALINE BVD
DOLEY RD
BULLOCK DR
TURNER RD
NETTLETON RD
ORTON RD
SOLDIERS RD
COOPERAGE ST
BARGE DR
LEAVER WAY
CARDUP SIDING RD
KILN RD
BOURNBROOK AV

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Metres

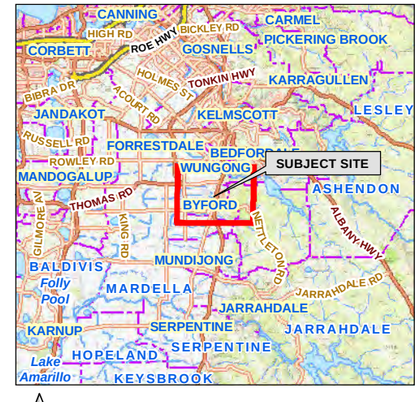
------ LEGEND ------

- Subject Site
- Locality / Suburb
- Bush Fire Brigade

Reserves
- Reserves

Legislated Lands and Waters
- Crown Freehold - DBCA Managed
- Nature Reserve
- Conservation Park
- State Forest
- Bush Forever

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : January 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 3/04/2024
Map updated by: Ian 3/04/2024
A3 Scale 1:25,000

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Map Document Path / Name: K:\Projects\Jobs 2023\230699 - Byford Health Hub (BMP) RFQ 3 Aug\Mapping\MXD\230699_Fig1-3_LOC_Byford Health Hub.mxd

1.2 Identification of the Requirement to Apply SPP 3.7

1.2.1 The Initial Trigger to Give SPP 3.7 Due Regard

A PLANNING AND A BUILDING APPLICATION IS TO BE SUBMITTED TO THE LOCAL GOVERNMENT FOR DETERMINATION
The proposed development is for the construction and/or use of a building and the local government is the decision maker. A development application must be submitted, and due regard will be given to SPP 3.7 in accordance with the following triggers. The local government determination is made under: • The Planning and Development Act 2005, its relevant subsidiary legislation (e.g. Regulations) and associated State Planning Policies; and • The local government's Local Planning framework (i.e. Strategy / Scheme and Policy as applicable) that establishes approved variations and additions to the above legislation. The Planning and Development (Local Planning Schemes) Regulations 2015, Schedule 2 Part 10A – Bushfire risk management, in summary establishes: 1. If the proposed development is: (a) The construction or use, or construction and use, of a single house or ancillary dwelling on a lot or lots with a total area of 1,100 m^2 or more; or (b) The construction or use, or construction and use, of (i) a habitable building other than a single house or ancillary dwelling; or (ii) a specified building; and (c) Is not the use of a dwelling as hosted or unhosted short-term rental accommodation (STRA) which is specifically excluded; and 2. The development site is wholly or partly within a designated bushfire prone area (Map of Bushfire Prone Areas), requiring the developer to have prepared a BAL assessment for the development site: then 3. Where the pre-development (before the establishment of an APZ), calculated bushfire attack level of the development site is BAL-40 or BAL-FZ, then the developer must have development approval to commence any development on the development site.
Assessment Supporting Details: None required

1.2.2 The Assessment Triggers Established by SPP 3.7/Guidelines

EXPLANATORY INFORMATION

Note:

'Development' means the development or use of any land, including (a) any demolition, erection, construction, alteration of or addition to any building or structure on the land (b) the carrying out on the land of any excavation or other works (Planning and Development Act 2005, Part1, s.4; and

'Development Site' means that part of a lot on which a building that is the subject of development stands or is to be constructed - Planning and Development (LPS) Regulations 2015, s.78A.

For development applications, the triggers for the application of State Planning Policy 3.7 Bushfire (SPP 3.7) established in the Planning for Bushfire Guidelines (Guidelines) – at the start of Sections 6 - 8 - are aligned with the current version of the LPS Regulations 2015. Consequently, these will be applied in this BMP.

The triggers for the application of (SPP 3.7) established by SPP 3.7 Part 4 will not be applied in their entirety in this BMP for the following reason:

As of 18 November 2024, SPP 3.7 contains 'development application' triggers that are not yet established by the current version (3 November 2024) of the deemed provisions of the LPS Regulations 2015, Schedule 2, Part 10A – Bushfire risk management.

ASSESSMENT TRIGGERS		
	REQUIREMENTS ESTABLISHED BY SPP 3.7 AND THE GUIDELINES	APPLICABLE
1	THE LAND SUBJECT TO THE PLANNING PROPOSAL IS: ➢ Designated bushfire prone and 'Area 1 (Urban)' on the Map of Bushfire Prone Areas (refer to Figure 1.4). OR	No
	➢ Designated bushfire prone and 'Area 2' on the Map of Bushfire Prone Areas (refer to Figure 1.4).	Yes
	AND	
2	THE PLANNING PROPOSAL WILL: ➢ Result in the intensification of development (or land use); OR	Yes
	➢ Result in an increase of visitors, residents or employees; OR	Yes
	➢ Adversely impact or increase the bushfire risk to the subject or surrounding site(s).	No
	AND	
3	THE PLANNING PROPOSAL IS A: ➢ (Source: SPP 3.7, Part 4) A strategic planning proposal for which the subject site is within the designated Area 2 on the Map of Bushfire Prone Areas and is exposed to a Bushfire hazard Level above LOW from vegetation on and/or external to the site. [note: there is no requirement for strategic planning proposals within BPA Area 1 (Urban) to apply SPP 3.7.] OR	No
	➢ (Source: SPP 3.7, Part 4) A structure plan (where lot layout and/or the internal road network is known), that has or will have the subject site exposed to a Bushfire Attack Level (BAL) rating above BAL-LOW.	No

	OR	
	➢ (Source: SPP 3.7, Part 4) A subdivision application that has or will have the subject site exposed to a Bushfire Attack Level (BAL) rating above BAL-LOW.	No
	OR	
	➢ (Source: SPP 3.7, Part 4) A development application for construction of a habitable building (single house or ancillary dwelling) on a lot more than 1,100 m^2, which is not connected to reticulated water and where the development site(s) has a BAL rating above BAL-LOW.	No
	OR	
	➢ (Source: SPP 3.7, Part 4) A development application for construction of a habitable building (single house or ancillary dwelling) on a lot more than 1,100 m^2, which is connected to reticulated water and where the development site(s) has a radiant heat impact exceeding 29kW/m^2 (BAL-40 or BAL-FZ).	No
	OR	
	➢ (Source: SPP 3.7, Part 4) A development application for construction of a habitable building (other than a single house or ancillary dwelling) on a lot more than 1,100 m2, which is connected to reticulated water and where the development site(s) has a radiant heat impact exceeding 29kW/m2 (BAL-40 or BAL-FZ).	Yes
	OR	
	➢ (Source: SPP 3.7, Part 4) A development application for construction and/or use of a habitable building (other than a single house or ancillary dwelling), for a vulnerable land use and where the development site(s) has a BAL rating above BAL-LOW.	No
	OR	
	➢ (Source: SPP 3.7, Part 4) A development application for construction and/or use of a caravan park, nature-based park or camping ground (whether it contains a habitable building(s) or not), and where the development site(s) has a BAL rating above BAL-LOW.	No

Assessment Supporting Details:

None required

1.2.3 Assessment Exemptions Identified

EXPLANATORY INFORMATION	
The following situations provide for an exemption from the application of SPP 3.7/Guidelines. They are established by the noted sources and are being identified as evidence that that they have been considered. Their relevance to the planning proposal is explained if applicable.	
EXEMPTION SCENARIOS	**APPLICABLE**
➢ (Source: LPS Regulations 2015 Part 10A - Bushfire risk management) Does not apply to land where there is no existing local planning scheme or where a local planning scheme has ceased to have legal effect.	No
➢ (Source: Guidelines s1.2.1) For a structure plan or subdivision application, for proposed lot(s) that: • Are not designated as bushfire prone; • Or where there is no increase in the development potential and therefore no intensification of land use or bushfire risk, such as a boundary realignment, that does not restrict the ability to establish or maintain an APZ; and • does not restrict vehicular access/egress to any existing or future habitable building.	No
➢ (Source: Guidelines s1.2.1) - For incidental non- habitable buildings or structures located not less than six metres from the habitable building, including but not limited to private garages, carports, patios, storage sheds, outbuildings, swimming pools, spa pools and fences.	No
➢ (Source: Guidelines s1.2.1) - For a change of use, minor renovations, extensions, alterations, improvements or repair of an existing habitable building where: ▪ The application does not result in an increase of occupants onsite; and/or ▪ There is no increase in the bushfire risk, such as an extension being further away from the bushfire hazard, or the extension does not restrict vehicular access or the provision of water for the development.	No
Assessment Supporting Details: None required	

Figure 1.4

Bushfire Prone Area

Lot 103 on Plan 414923, Area : 7,000 sq m
Bushman Glde
BYFORD
SHIRE OF SERPENTINE - JARRAHDALE

SUBJECT SITE

BYFORD BFB

------ LEGEND ------

- Subject Site
- Other Lots
- Bush Fire Brigade
- Hydrant

Proposed Building

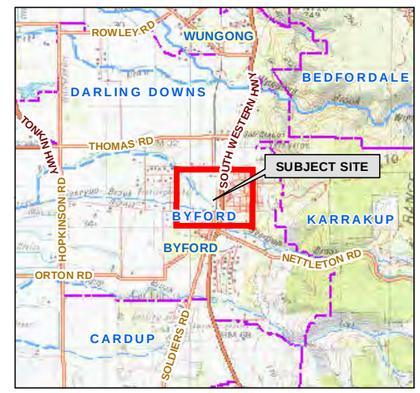
- Health Hub

Bushfire Prone Area OBRM_023

- Bushfire Prone Area 2

0 50 100 150 200 250
Metres

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : January 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 10/12/2024
Map updated by: Ian Ross 10/12/2024
A3 Scale 1:5,000

BUSHFIRE PRONE PLANNING

Disclaimer and Limitation: This map has been prepared for bushfire management planning purposes only. All depicted areas, contours and any dimensions shown are subject to survey. Bushfire Prone Planning does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence arising from relying on any information depicted.

Map Document Path / Name: K:\Projects\Jobs 2023\230699 - Byford Health Hub (BMP) RFQ 3 Aug\Mapping\MXD\230699_Fig1-4_BPA_Byford Health Hub.mxd

1.3 Required '**Bushfire Planning**' Assessments and Documents

INFORMATION **PRESENTED IN THIS 'PLANNING' BMP (OR THE BEP)** - PROVIDED TO ACCOMPANY **THE PROPONENT'S** PLANNING SUBMISSION						
The requirements are established by SPP 3.7 Part 4, Guidelines Section 1.2, 4.4, 5.5, 6.4, 7.2, and 8.3. The column identifying applicable requirements for the subject planning proposal is highlighted green.		Strategic Planning Document		Structure Plan / Subdivision Application		Development Application
Required Information	Details	Map of Bushfire Prone Areas Designation				
		Area 1 (Urban)	Area 2	Area 1 (Urban)	Area 2	Areas 1 & 2
Environment - Identification of environmental, biodiversity or conservation values on the subject site(s)	Presented in the BMP. When relevant, how proposal siting and design avoids and/or minimises clearing of native vegetation to achieve bushfire protection measures is identified.	BUSHFIRE PLANNING ASSESSMENTS ARE NOT REQUIRED	✓	✓	✓	✓
BLA - Broader Landscape Assessment	Presented in the BMP and considers proposal location suitability. Provides an understanding of vegetation extent, potential for landscape scale bushfire, road network and suitable destinations within the area up to 2 km from the planning proposal.		✓	N/A	✓	N/A
BHL - Bushfire Hazard Level Assessment (pre-development)	Presented in BMP when relevant. Can include detail of treatments required to achieve BHL of moderate and/or low.		✓	-	-	-
BAL - Bushfire Attack Level Assessment	Results to be presented in the BMP in BAL contour map format as a requirement and in table format as an additional option.		-	✓	✓	-
	Results to be presented in the BMP in table format and/or BAL contour map format – dependant on which is more efficient and effective at presenting the results (e.g. BAL contour map for multiple buildings).		-	-	-	✓
BPC - Assessment against the relevant Bushfire Protection Criteria (E1 – E4)	Presented in BMP. Strategic planning will necessarily focus on Element 1: Location. Can demonstrate compliance using acceptable solutions and/or an outcomes-based approach.		✓	✓ NOT E1	✓	✓ NOT E1
BEP - Bushfire Emergency Plan	Provided as a separate document or an addition / modification to an existing BEP or site Emergency Management Plan.		N/A	N/A	N/A	Vulnerable Land Uses Only
LMP – Landscape Management Plan	Provided as a separate document or an addendum to the BMP when required					

1.4 Other Documents Relevant to Preparing the BMP

EXPLANATORY INFORMATION
This section identifies any known assessments, reports or plans that have been conducted and prepared previously, or are being prepared concurrently, and are relevant to the subject planning proposal. They may have implications for the assessment of bushfire hazard threats and the identification and implementation of the bushfire protection measures that are established by this BMP.

RELEVANT DOCUMENTS					
Document	Relevant	Exists	To Be Concurrently Developed	Copy Provided by Proponent / Developer	Title
Structure Plan	No	No	N/A	N/A	-
Bushfire Management Plan	No	No	N/A	N/A	-
Preliminary bushfire advice (may include a BAL contour map)	No	Yes	N/A	Yes	-
Bushfire Emergency Plan	No	No	N/A	N/A	-
Bushfire Risk Report	No	No	N/A	N/A	-
Environmental Asset or Vegetation Survey	Yes	Yes	N/A	Yes	Environmental, Heritage and Bushfire Assessment
Refer to Section 2.1 for details.					
Landscape Management Plan	Yes	Yes	Select.	Select.	Landscape Concept Plan
Refer to Section 2.3 for details.					
Revegetation Plan	No	No	N/A	N/A	-

2 ENVIRONMENTAL CONSIDERATIONS – NATIVE VEGETATION

EXPLANATORY INFORMATION

Some bushfire prone areas also have high biodiversity values. SPP3.7 objective 5.4 prioritises the retention of native vegetation for biodiversity conservation, environmental protection and landscape amenity.

Clearing or modification of native vegetation for the purpose of land use or development is assessed under State Planning Policy 2: Environment (SPP 2), State Planning Policy 2.8: Bushland policy for the Perth Metropolitan Region (SPP 2.8) and relevant environmental legislation. A key objective of these polices is to avoid development that may result in unacceptable environmental damage.

Any 'modification' or 'clearing' of vegetation to reduce bushfire risk is considered 'clearing' under the *Environmental Protection Act 1986* (EP Act) and requires a clearing permit under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (Clearing Regulations) – unless for an exempt purpose.

Clearing native vegetation is an offence, unless done under a clearing permit or the clearing is for an exempt purpose. Exemptions are contained in the EP Act or are prescribed in the Clearing Regulations (note: these exemptions do not apply in environmentally sensitive areas).

The *Department of Water and Environmental Regulation* (DWER) is responsible for issuing 'clearing' permits and the framework for the regulation of clearing. Approvals under other legislation, from other agencies, may also be required, dependent on the type of flora or fauna present.

Local Planning Policy or Local Biodiversity Strategy: Natural areas that are not protected by the above Act and Regulation (or any other National or State Acts) may be protected by a local planning policy or local biodiversity strategy. Permission from the local government will be required for any modification or removal of native vegetation in these Local Natural Areas (LNA's). Refer to the relevant local government for detail.

For further Information refer to Native vegetation clearing permits | Western Australian Government, the Planning for Bushfire Guidelines (as amended) and the Bushfire and Vegetation Factsheet - WAPC, Dec 2021.

2.1 Biodiversity or Conservation Values Identified

EXPLANATORY INFORMATION

The required information, relevant to bushfire planning and informing the production of this BMP, is sourced and presented as indicated below.

Note that where a 'desktop' assessment has been conducted, this should not be considered a replacement for a full Environmental Impact Assessment. It is a summary of potential biodiversity or conservation values at the subject site, inferred from information contained in public available datasets and/or reports, which are only current to the date of last modification.

The information provided in the BMP should be considered indicative where the subject site has not previously been subject to a site-specific environmental assessment by an appropriate professional.

The required information is sourced from the environmental/planning consultant report developed for the subject site and provided to the bushfire consultant (details below when applicable). The information it contains is not repeated in this BMP as it will accompany the planning submission. The implications for the subject planning proposal and this BMP are stated below when relevant.	Yes - Fully

Environmental Heritage and Bushfire Assessment Byford Health Hub (June 2023).

There are no identified Bush Forever sites, no threatened or priority flora species recorded within the site, fauna habitat values in the site are limited and no cockatoo breeding areas therefore environmental factors are unlikely to impact the application of the Bushfire Protection Criteria and this BMP. The site is highly disturbed and as a dense cover of non-native vegetation.

The required information is sourced by the bushfire consultant as a 'desktop' assessment from publicly available data bases and/or a local government's local biodiversity strategy or local planning strategy. When applicable, this information is presented on the following pages of this BMP.	N/A



Figure 2.1

Environmental Considerations

Lot 103 on Plan 414923, Area : 7,000 sq m
Bushman Glde
BYFORD
SHIRE OF SERPENTINE - JARRAHDALE

------ LEGEND -----

- Subject Site
- Bush Fire Brigade
- Hydrant

Proposed
- Health Hub

- Reserves

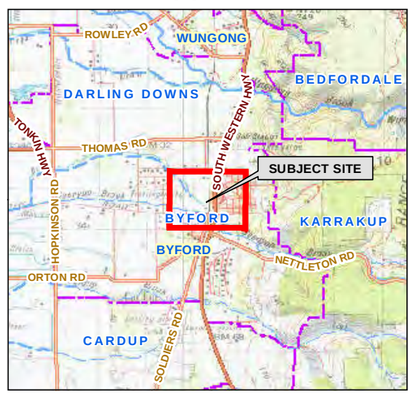
Environmentally Sensitive
- Threatened Ecological

Clearing
- Clearing Regulations

Geomorphic
- Palusplain

0 50 100 150 200 250
Metres

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : January 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 2/12/2024
Map updated by: Ian Ross 2/12/2024
A3 Scale 1:5,000

BUSHFIRE PRONE PLANNING

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Map Document Path / Name: K:\Projects\Jobs 2023\230699 - Byford Health Hub (BMP) RFQ 3 Aug\Mapping\MXD\230699_Fig2-1_ENV_Byford Health Hub.mxd

2.2 Response of the Planning Proposal to Protection of Native Vegetation

The protection of native vegetation is to be prioritised by avoiding areas that would require clearing or modification of native vegetation, specifically for the purpose of bushfire mitigation (BMP Manual, November 2024 DPLH).

SOLUTIONS APPLIED TO MINIMISE NATIVE VEGETATION REMOVAL / MODIFICATION	
Clearing and/or modification of native vegetation is proposed and necessary.	Unlikely
The vegetation that is required to be removed all seems to be non-native shrubs and grass. If native species are required to be removed, approval will be required.	
Conservation Response	
The proposal reserves native vegetation for conservation, recreation or environmental protection purpose. These can include ecological linkage, local natural area, waterway, or foreshore area or wetland buffer.	No
Siting / Design / Construction Responses	
Reduction in the proposed intensification of land use or development potential.	Not required
Containing or clustering areas of intensification of land use to reduce clearing requirements.	Not required
Consideration of locating proposed development to have greater initial vegetation separation distances from bushfire hazards by utilising non-vegetated interfaces.	Not required
Modification or redesign of the proposed areas of intensification of land use to avoid areas with high environmental, biodiversity or conservation values.	Not required
The proposal has applied a reduction in the intensification of land use or development potential (e.g. reduced lot yield or smaller building footprints), to ensure the retention of greater areas of native vegetation while achieving the required vegetation separation distances to limit exposure to unacceptable levels of potential bushfire impact.	Not required
The proposal situates required non-vegetated elements (e.g. footpaths, paved areas, roads, parking, open drainage channels, and major services delivery installed in common corridors), between bushfire hazards and elements at risk – to effectively achieve required vegetation separation distances with less vegetation clearing and/or modification.	Not required
The proposal applies building envelopes, and these have located to minimise the requirement to clear and/or modify native vegetation.	Not required
The proposal utilises the clustering habitable buildings to reduce requirements for native vegetation clearing and/or modification.	Not required
The proposal aligns roads and pathways to work around trees and other vegetation, preserving their ecological values.	Not required
The proposal establishes requirements for the construction of building(s) to satisfy the requirements corresponding to higher BAL ratings to ensure a reduced vegetation separation distance requirement.	Not required

2.3 Vegetation Management Plans with Implications for the BMP

EXPLANATORY INFORMATION

This section identifies the area(s) of land (supporting vegetation), within or near the subject site (i.e. onsite or offsite) to which one or more of the following descriptions applies:

1. Area(s) subject to a LANDSCAPE PLAN THAT RESULTS IN RELEVANT ELEMENTS AT RISK BEING EXPOSED TO A LOW BUSHFIRE THREAT LEVEL from existing or planned area(s) of vegetation and establishes the following management actions:

    (a) To apply landscaping design (including the modification and/or establishment of plants/shrubs/trees), that will enable the area(s) to be excluded from classification under AS 3959 BAL determination methodology;

    (b) To actively manage the area(s) to maintain the low bushfire threat level in perpetuity. Thereby ensuring the applicable bushfire protection measures, applied in accordance with the BMP, remain effective;

    (c) To achieve and maintain the low threat state through using a combination of mechanisms including:

        (i) Minimising vegetation fuel loads through design and ongoing management;

        (ii) Using low flammability and/or higher moisture content species;

        (iii) Incorporating non-vegetated elements; and

    (d) To identify the entity responsible for ensuring the landscape plan is complied with in perpetuity and when required, will contain written confirmation of their acceptance of the responsibility.

2. Area(s) subject to a LANDSCAPE PLAN THAT RESULTS IN RELEVANT ELEMENTS AT RISK BEING EXPOSED TO A REDUCED BUSHFIRE THREAT LEVEL from existing or planned area(s) of vegetation and establishes the following management actions:

    (a) To apply landscaping design involving the removal and/or modification of existing vegetation that will enable the area(s) to be classified as a lower threat class under AS 3959:2018 BAL determination methodology;

    (b) To actively manage the area(s) to maintain the reduced bushfire threat level in perpetuity. Thereby ensuring the applicable bushfire protection measures, applied in accordance with the BMP, remain effective;

    (c) To identify the entity responsible for ensuring the landscape plan is complied with in perpetuity and when required, will contain written confirmation of their acceptance of the responsibility.

3. Area(s) subject to a REVEGETATION PLAN THAT MAY RESULT IN RELEVANT ELEMENTS AT RISK BEING EXPOSED TO AN ADDITIONAL BUSHFIRE HAZARD AND/OR AN INCREASED BUSHFIRE THREAT LEVEL from an existing area(s) of vegetation and establishes the following information:

    (a) The location of the areas to be revegetated (as distinct from natural regeneration which is accounted for in the vegetation classification under AS 3959 BAL determination methodology); and

    (b) A description of the planned design regarding density and species of plants/shrubs/trees to inform the bushfire consultant's classification of the vegetation under AS 3959:2018 BAL determination methodology.

2.3.1 Landscape Management Plan – Low Bushfire Threat Level

PLANNED LANDSCAPING – LOW BUSHFIRE THREAT LEVEL			
The proposed development has (or requires) a landscape plan that results in relevant elements at risk being exposed to a low Bushfire Threat Level from existing or planned area(s) of vegetation.			Yes
Assessment Details			Relevant
An area of land that is to be subject to a Landscape Management Plan is within the subject site (onsite).			Yes
An area of land that is to be subject to a Landscape Management Plan is outside the subject site (offsite).			Maybe
The landscape management plan is a required bushfire protection measure established by the relevant acceptable solution of the bushfire protection criteria (Guidelines). [Development proposals for vulnerable land uses require a landscape management plan]			No
The landscape plan is recommended as a bushfire protection measure by the bushfire consultant for the reasons identified in the 'Additional Bushfire Protection Measures of this BMP.			No
The area of land subject to the landscape management plan will be excluded from classification under AS 3959 (as amended) BAL determination methodology as it will achieve and maintain a low bushfire threat state in perpetuity.			Yes
Responsibility for Ongoing Management of the Landscaped Area			Yes
Landscaped Area	Persons / Agency	A Requirement Exists for Written Authority and/or Agreement to Remove/Modify/Manage Vegetation	
Onsite	Landowner (Department of Finance)	No	
Offsite	Landowner (Public Transport Authority) & Department of Finance	No	
An approved landscape management plan and/or written confirmation exists and is provided to demonstrate that agencies responsible for the ongoing management understand and support the vegetation classification assigned to the subject area and its resulting ongoing management implications on the agency.			Yes
A written authority and management agreement exists and is provided to demonstrate an arrangement between adjoining landowners as to the responsibility for establishment and ongoing management of the defined area of land subject to a Landscape Management Plan.			Yes
An agreement between Department of Finance and Public Transport authority exists to maintain the Public Shared Path and the area either side (a total of 8 metres from the edge of the BHH building) as non-vegetated or low threat (see Appendix E).			
Identification of the Area(s) of Land Subject to a Landscape Management Plan			
The car park within the subject site is subject to a Landscape Concept Plan. It is essential that these areas are continually managed to low threat by the subject site landowner. Either side of the Principle Shared Path (PSP) may be subject to landscaping. If so a Landscaping Management Plan will be required to be developed and it will be required to be managed to low threat by the Public Transport Authority.			
Location of the Landscape Concept Plan and Agreement for Reference			
The Landscape Concept Plan for the Byford Health Hub is a separate document. The agreement between Department of Finance and Public Transport authority to maintain the Public Shared Path and the area either side as non-vegetated or low threat is referenced in Appendix E.			

Implications for the BMP
All planned landscaping areas have been classified as excluded post-development and contribute to the Planning BAL-29 APZ.

2.3.2 Landscape Management Plan – Reduced Bushfire Threat Level

PLANNED LANDSCAPING – REDUCED BUSHFIRE THREAT LEVEL	
The proposed development has (or requires) a landscape plan that results in relevant elements at risk being exposed to a reduced Bushfire Threat Level from existing or planned area(s) of vegetation.	No

2.3.3 Revegetation Plan – Additional Bushfire Hazard

PLANNED REVEGETATION – ADDITIONAL BUSHFIRE HAZARD	
The proposed development has (or requires) a Revegetation Plan that may result in relevant elements at risk being exposed to an additional Bushfire Hazard and/or an increased Bushfire Threat Level from existing or planned area(s) of vegetation.	No

3 THE BUSHFIRE HAZARD – POTENTIAL IMPACT - LANDSCAPE AND VEGETATION DATA

3.1 Bushfire Attack Level (BAL) Assessment Summary (Contour Map Format)

EXPLANATORY INFORMATION

BUSHFIRE ATTACK LEVELS (BAL) - UNDERSTANDING THE RESULTS

The potential transfer (flux/flow) of radiant heat from the bushfire to a receiving object is measured in kW/m^2. The AS 3959:2018 BAL determination methodology establishes the ranges of radiant heat flux that correspond to each bushfire attack level. These are identified as BAL-LOW, BAL-12.5, BAL-19, BAL-29, BAL-40 and BAL-FZ.

The bushfire performance requirements for certain classes of buildings are established by the Building Code of Australia (Vol. 1 & 2 of the NCC). The BAL will establish the bushfire resistant construction requirements that are to apply in accordance with AS 3959:2018 - *Construction of buildings in bushfire prone areas* and the NASH Standard – *Steel framed construction in bushfire areas (NS 300 2021),* whose solutions are deemed to satisfy the NCC bushfire performance requirements.

DETERMINED BAL RATINGS

A BAL Certificate can be issued for a determined BAL. A BAL can only be classed as 'determined' for an existing or future building/structure when:

1. It's final design and position on the lot are known and the stated separation distance from classified bushfire prone vegetation exists and can justifiably be expected to remain in perpetuity; or

2. It will always remain subject to the same BAL regardless of its design or position on the lot after accounting for any regulatory or enforceable building setbacks from lot boundaries as relevant and necessary (e.g., R-codes, restrictive covenants, defined building envelopes) or the retention of any existing classified vegetation either onsite or offsite.

If the BMP derives determined BAL(s), the BAL Certificate(s) required for submission with building applications can be provided, using the BMP as the assessment evidence.

INDICATIVE BAL RATINGS

A BAL Certificate cannot be issued for an indicative BAL. A BAL will be classed as 'indicative' for an existing or future building/structure when the required conditions to derive a determined BAL are not met.

This class of BAL rating indicates what BAL(s) could be achieved and the conditions that need to be met are stated.

Converting the indicative BAL into a determined BAL is conditional upon the currently unconfirmed variable(s) being confirmed by a subsequent assessment and evidential documentation. These variables will include the future building(s) location(s) being established (or changed) and/or classified vegetation being modified or removed to establish the necessary vegetation separation distance. This may also be dependent on receiving approval from the relevant authority for that modification/removal.

BAL RATING APPLICATION – PLANNING APPROVAL VERSUS BUILDING APPROVAL

1. Planning Approval: SPP.3.7 establishes that where BAL- LOW to BAL-29 will apply to relevant future construction (or existing structures for proposed uses), the proposed development may be considered for approval (dependent on the other requirements of the relevant policy measures being met). That is, BAL40 or BAL-FZ are not acceptable on planning grounds (except for certain limited exceptions).

   Because planning is looking forward at what can be achieved, as well as looking at what may currently exist, both determined and indicative BAL ratings are acceptable assessment outcomes on which planning decisions can be made (including conditional approvals).

2. Building Approval: The Building Code of Australia (Vol. 1 & 2 of the NCC) establishes that relevant buildings in bushfire prone areas must be constructed to the bushfire resistant requirements corresponding to the BAL rating that is to apply to that building. Consequently, a determined BAL rating and the BAL Certificate is required for a building permit to be issued - an indicative BAL rating is not acceptable.

INTERPRETATION OF THE BAL CONTOUR MAP

The BAL contour map is a diagrammatic representation of the results of the bushfire attack level assessment.

The map presents different coloured contours extending out from the areas of classified vegetation. Each contour represents a set range of radiant heat flux that potentially will transfer to an exposed element (building, person or other defined element), when it is located within that contour.

Each of the set ranges of radiant heat flux corresponds to a different BAL rating as defined by the AS 3959:2018 BAL determination methodology.

The width of each shaded BAL contour will vary dependant on both the BAL rating and the relevant parameters (calculation inputs) for the subject site. Their width represents the minimum and maximum vegetation separation distances that correspond to each BAL rating (refer to the relevant table below for these distances).

The areas of classified vegetation to be considered in developing the BAL contours, are those that will remain at the intended end state of the subject development once earthworks, clearing and/or landscaping and re-vegetation have been completed. Variations to this statement that may apply include:

- Both pre and post development BAL contour maps are produced; and/or
- Each stage of a development is assessed independently.

CAUTION: Be aware that you should not use a BAL contour map to determine a BAL rating for a building application and future bushfire construction requirements – except when the conditions of the lot and its surrounds are such that a building located anywhere on the lot would not be subject to a different rating or the contour map has been developed for a single lot and the building location is known. (Refer to Appendix B1 for additional information.

Otherwise, determining a BAL rating will require an assessment of the specific lot, the known building design and location, the existing bushfire prone vegetation surrounding both and potentially other site specific variables.

3.1.1 BAL Determination Methodology and Location of Data and Results

LOCATION OF DATA & RESULTS					
BAL Determination Methodology		Location of the Site Assessment Data			Location of the Results
AS 3959:2018	Applied to Assessment	Classified Vegetation and Topography Map(s)	Calculation Input Variables		Assessed Bushfire Attack Levels and/or Radiant Heat Levels
			Summary Data	Detailed Data with Explanatory and Supporting Information	
Method 1 (Simplified)	Yes	Figure 3.1	Table 3.2	Appendix A1	Table 3.1 Table 3.3 / BAL Contour Map

3.1.2 BAL Ratings Derived from the Contour Map

Table 3.1: Indicative and determined BAL(s) for future buildings/structures on the proposed lots.

BUSHFIRE ATTACK LEVEL FOR FUTURE BUILDINGS / STRUCTURES ON STATED LOT [1]		
Lot No. 103	Future Buildings / Structure	
	Indicative BAL [2]	Determined BAL [2]
Byford Health Hub	BAL-29	N/A

[1] The assessment data used to derive the BAL ratings is sourced from Table 3.1 and Figure 3.2 'BAL Contour Map'.

[2] Refer to the start of Section 3 for an explanation of indicative versus determined BAL ratings.

3.1.3 Site Assessment Data Applied to Construction of the BAL Contour Map(s)

RELEVANT CLASSIFIED VEGETATION	
Identification of Classified Vegetation that is Relevant to the Production of the BAL Contour Map(s)	Relevant Vegetation Map
The relevant vegetation will be all areas of classified vegetation that exist at the time of the site assessment – both within the subject site (onsite) and external to the subject site (offsite).	Figure No.3.1
The relevant vegetation for the post-development BAL contour map will be any area of classified vegetation - both within the subject site (onsite) and external to the subject site (offsite) - that will remain at the intended end state of the subject development once earthworks, any clearing and/or landscaping and re-vegetation have been completed.	Figure No.3.2
Supporting Assessment Details: None required.	

Table 3.2: Calculation inputs applied to deriving the vegetation separation distances corresponding to different levels of potential radiant heat transfer.

DATA APPLIED TO CALCULATE THE SITE SPECIFIC VEGETATION SEPARATION DISTANCES CORRESPONDING TO POTENTIAL RADIANT HEAT TRANSFER LEVELS [1]													
Applied BAL Determination Method		METHOD 1 - SIMPLIFIED PROCEDURE (AS 3959:2018 CLAUSE 2.2)											
The Calculation Input Variables - Corresponding to the Applied BAL Determination Method [2]													
Methods 1 and 2		Method 1			Method 2								
Vegetation Classification		FDI	Effective Slope		Site Slope	FFDI or GFDI	Flame Temp.	Elevation of Receiver	Flame Width	Fireline Intensity	Flame Length	Modified View Factor	
			Applied Range	Measured									
Area	Class		degree range	degrees	degrees		K	metres	metres	kW/m	metres	% Reduction	
1	(A) Forest	80	Upslope or flat 0	flat 0	-	-	-	-	-	-	-	-	
2	(B) Woodland	80	Upslope or flat 0	flat 0	-	-	-	-	-	-	-	-	
3	(D) Scrub	80	Upslope or flat 0	flat 0	-	-	-	-	-	-	-	-	
4	(G) Grassland	80	Downslope >0-5	d/slope 1	-	-	-	-	-	-	-	-	
5	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	-	-	-	-	-	-	
6	Excluded cl 2.2.3.2(e & f)	N/A	N/A	N/A	-	-	-	-	-	-	-	-	

Note 1: The values used to indicate levels of potential radiant heat transfer (from fire in bushfire prone vegetation to exposed elements at risk), will be stated in subsequent tables as either as a bushfire attack level (BAL) and/or as kilowatts per square metre (kW/m2), as relevant to the application of the value and the type and use of the element at risk.

Note 2: All data and information supporting the determination of the classifications and values stated in this table is presented in Appendix A. Where the values are stated as 'default' these are either the values stated in AS 3959:2018, Table B1 or the values calculated as intermediate or final outputs through application of the equations of the AS 3959:2018 BAL determination methodology. They are not values derived by the assessor.

Table 3.3: Vegetation separation distances corresponding to the stated levels of potential radiant heat transfer.

THE CALCULATED (SITE SPECIFIC) VEGETATION SEPARATION DISTANCES CORRESPONDING TO THE STATED LEVEL OF POTENTIAL RADIANT HEAT TRANSFER (METRES) [1]									
Vegetation Classification		Maximum Radiant Heat Transfer (Flux)							
		>40 kW/m²	40 kW/m²	29 kW/m²	19 kW/m²	12.5 kW/m²	N/A [2]	10 kW/m²	2 kW/m²
		Bushfire Attack Levels							
Area	Class	BAL-FZ	BAL-40	BAL-29	BAL-19	BAL12.5	BAL-LOW		
1	(A) Forest	<16	16-<21	21-<31	31-<42	42-<100	>100	-	-
2	(B) Woodland	<10	10-<14	14-<20	20-<29	29-<100	>100	-	-
3	(D) Scrub	<10	10-<13	13-<19	19-<27	27-<100	>100	-	-
4	(G) Grassland	<7	7-<9	9-<14	14-<20	20-<50	>50	-	-
5	(G) Grassland	<6	6-<8	8-<12	12-<17	17-<50	>50	-	-
6	Excluded cl 2.2.3.2(e & f)	-	-	-	-	-	-	-	-

Note 1: The calculated results are illustrated in Figure 3.2 as a BAL Contour Map and/ or additional defining lines as necessary. All applied calculation input variables are presented in Table 3.2. A copy of the radiant heat calculator output for each area of classified vegetation is presented in Appendix A3.

Note 2: The BAL-LOW rating does not represent a maximum level of radiant heat transfer. The rating is applied when the separation distance is at least 100m from all classified vegetation except Grassland, for which 50m applies.

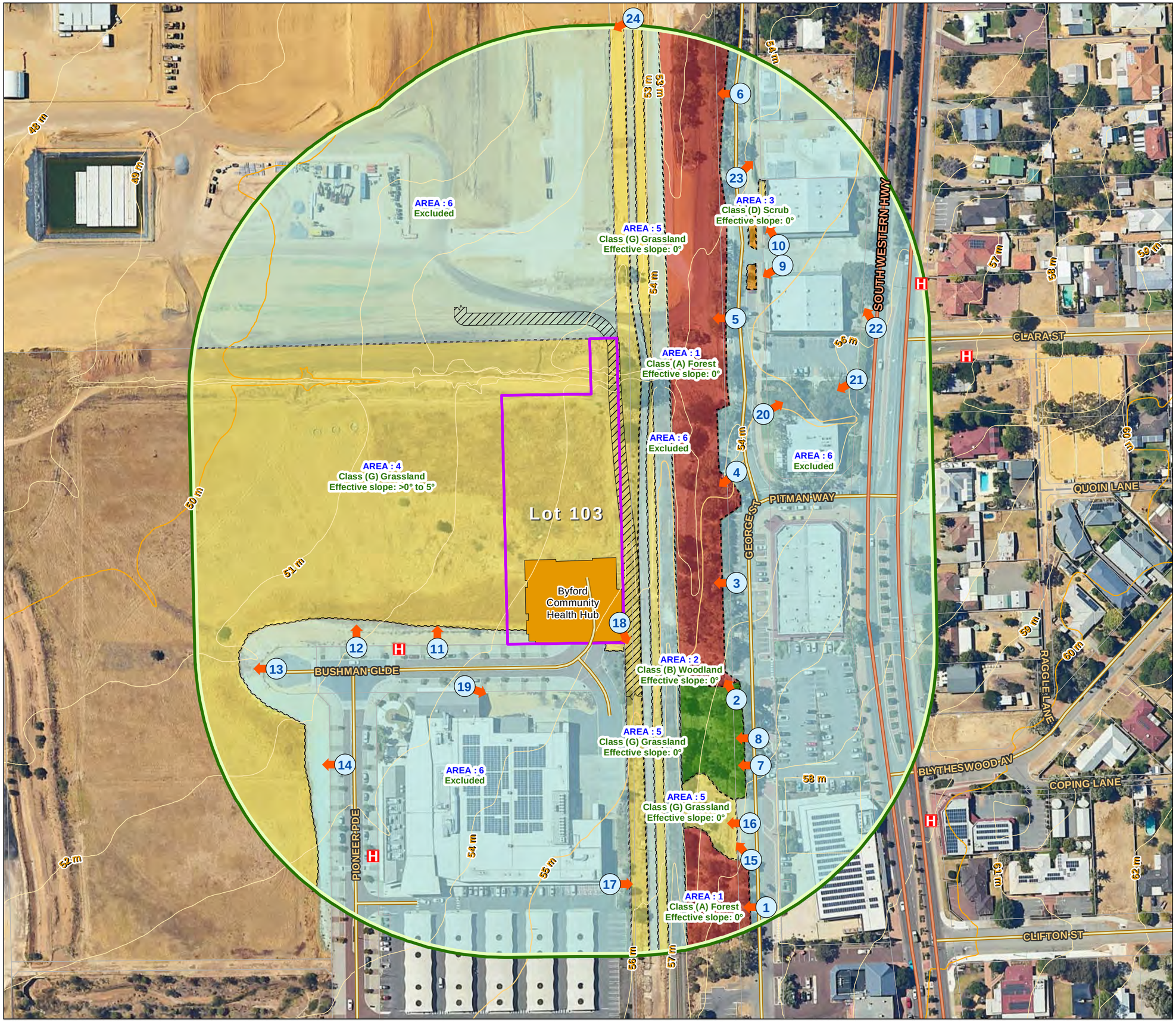


Figure 3.1

Classified Vegetation & Topography (Existing)

Lot 103 on Plan 414923, Area : 7,000 sq m
Bushman Glde
BYFORD
SHIRE OF SERPENTINE - JARRAHDALE

------ LEGEND ------

- Subject Site
- Other Lots
- Photo & Direction
- Hydrant

Proposed

- Health Hub
- Principal Shared Path (PSP) by PTA

150m Vegetation Assessment

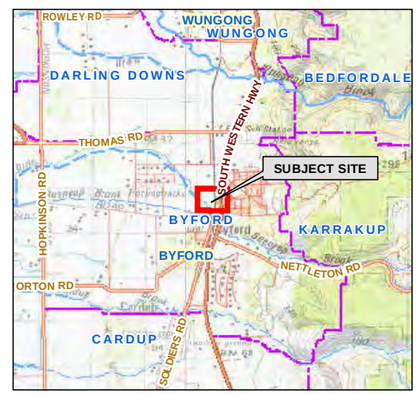
- 150m from Subject Site

Classified Vegetation

- Class (A) Forest
- Class (B) Woodland
- Class (D) Scrub
- Class (G) Grassland
- Excluded 2.2.3.2 {f}

0 20 40 60 80
Metres

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : January 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 4/12/2024
Map updated by: Ian Ross 4/12/2024
A3 Scale 1:1,750

BUSHFIRE PRONE PLANNING

Disclaimer and Limitation: This map has been prepared for bushfire management planning purposes only. All depicted areas, contours and any dimensions shown are subject to survey. Bushfire Prone Planning does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence arising from relying on any information depicted.

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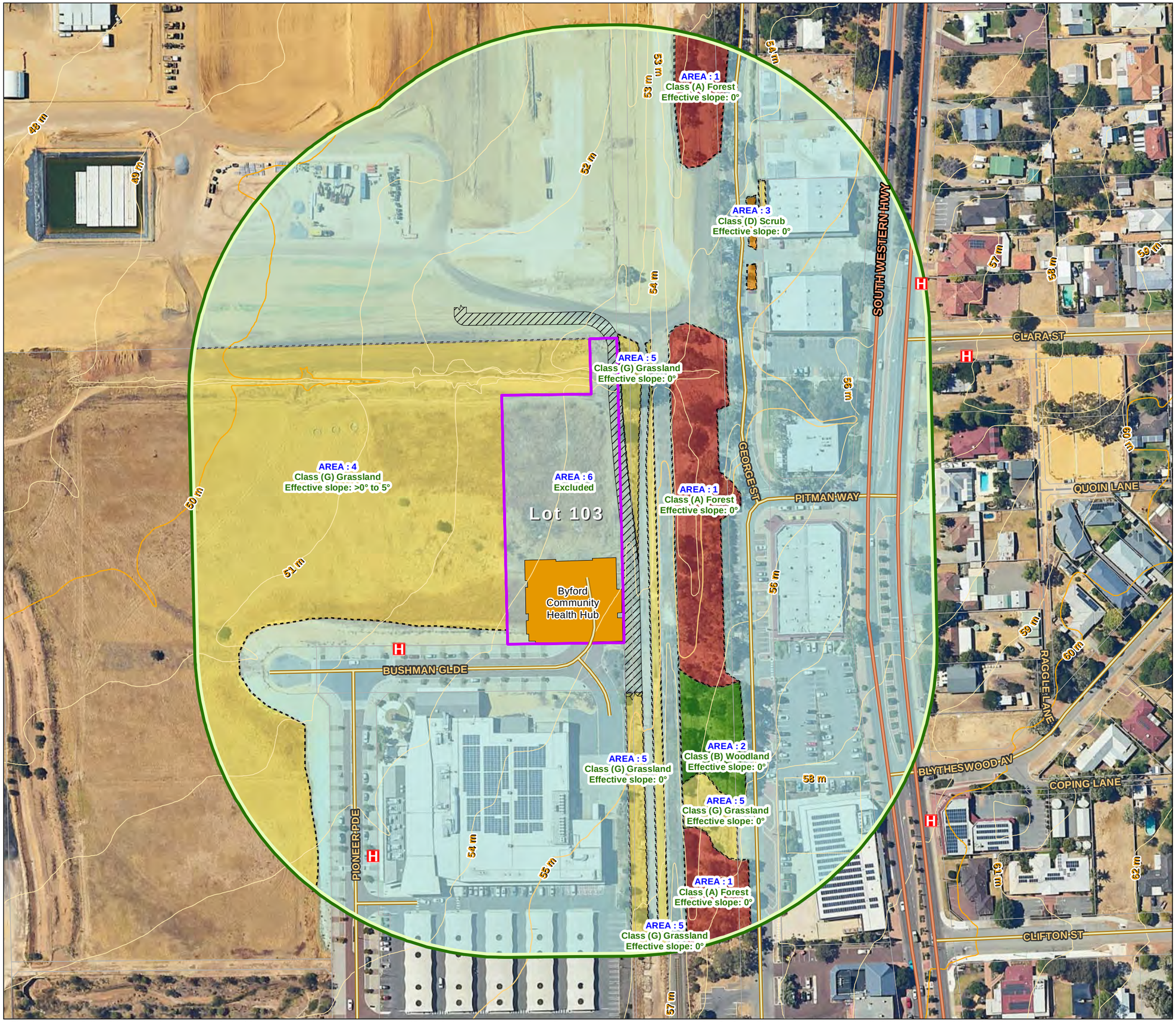


Figure 3.1.1

Classified Vegetation & Topography (Post Development)

Lot 103 on Plan 414923, Area : 7,000 sq m
Bushman Glde
BYFORD
SHIRE OF SERPENTINE - JARRAHDALE

------ LEGEND -----

- Subject Site
- Other Lots
- Hydrant

Proposed

- Health Hub
- Principal Shared Path (PSP) by

150m Vegetation Assessment

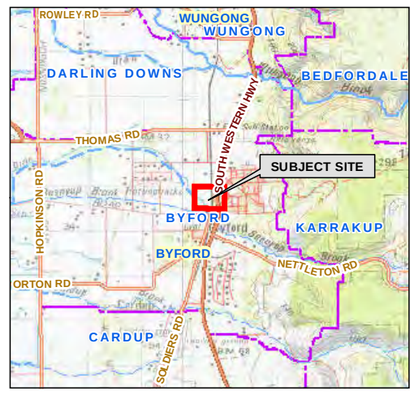
- 150m from Subject Site

Classified

- Class (A) Forest
- Class (B) Woodland
- Class (D) Scrub
- Class (G) Grassland
- Excluded 2.2.3.2 {f}

0 20 40 60 80
Metres

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : January 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 4/12/2024
Map updated by: Ian Ross 4/12/2024
A3 Scale 1:1,750

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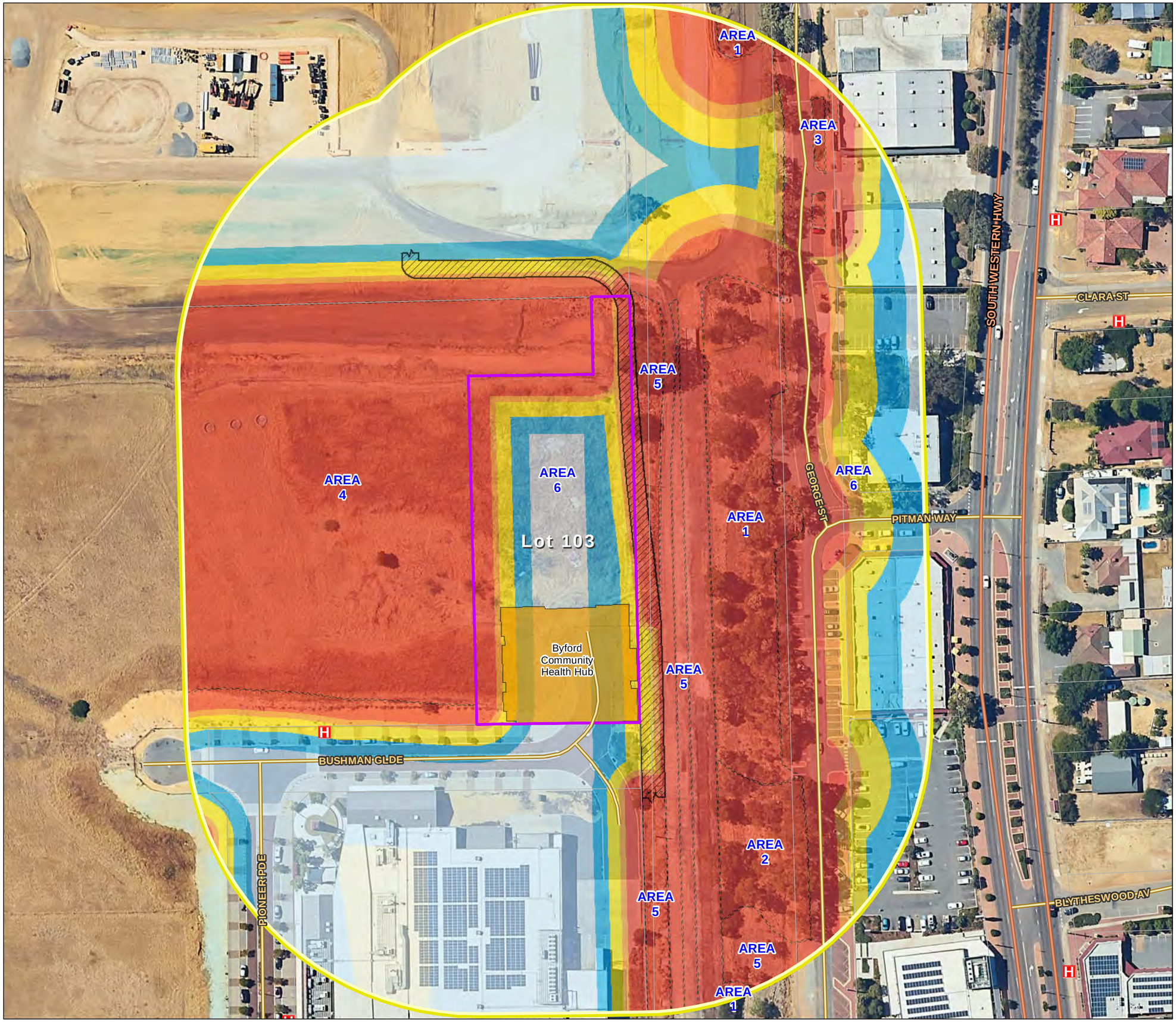


Figure 3.2

BAL Contour Map (Post Development)

Lot 103 on Plan 414923, Area : 7,000 sq m
Bushman Glde
BYFORD
SHIRE OF SERPENTINE - JARRAHDALE

------ LEGEND ------

- Subject Site
- Other Lots
- Hydrant

Proposed

- Health Hub
- Principal Shared Path (PSP) by PTA

100m Vegetation Assessment

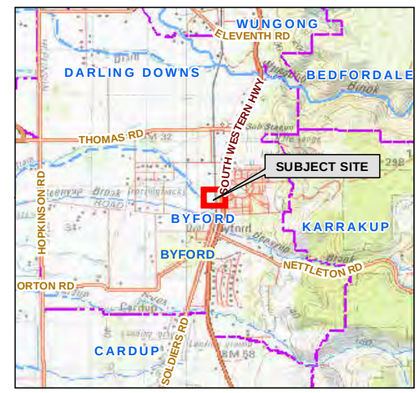
- 100m from Subject Site

Indicative Bushfire Attack

- BAL FZ
- BAL 40
- BAL 29
- BAL 19
- BAL 12.5
- BAL LOW
- Classified Vegetation Boundary

0 20 40 60 80
Metres

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : January 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 2/12/2024
Map updated by: Ian Ross 2/12/2024
A3 Scale 1:1,250

BUSHFIRE PRONE PLANNING

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Map Document Path / Name: K:\Projects\Jobs 2023\230699 - Byford Health Hub (BMP) RFQ 3 Aug\Mapping\MXD\230699_Fig3-2_BAL_POST_Byford Health Hub.mxd

4 ASSESSMENT AGAINST THE BUSHFIRE PROTECTION CRITERIA (BPC)

EXPLANATORY INFORMATION

The bushfire protection criteria (BPC) consist of five elements each focussed on a primary set of bushfire protection measures considered by the Department of Planning, Lands and Heritage / the Western Australian Planning Commission, as the most important to be considered in land use planning.

[Note: the additional primary bushfire protection measure of bushfire construction requirements that are to apply to certain classes of habitable buildings in WA (corresponding to their assessed Bushfire Attack Level) - is implemented through the process of applying the Building Code of Australia (Volumes 1 and 2 of the National Construction Code) in accordance with WA building legislation – not through any planning legislation].

The elements of the BPC are Location (applicable to strategic and structure plan/subdivision planning stages), and Siting and Design, Vehicular Access and Water Supply (applicable to all planning stages and land uses).

The BPC establish a set of acceptable solutions that are considered a 'deemed to comply' pathway to satisfying intent, objectives and outcomes of State Planning Policy 3.7 Bushfire (SPP 3.7).

When all applicable acceptable solutions cannot be met, the use of the alternative pathway of an outcomes-based approach is available. In brief, this involves the development of a merit based case, specific to the planning proposal, that potentially involves the use of innovative, alternative and or additional bushfire protection measures and addressing the level of risks associated with a bushfire event. This is then presented to the decision-maker for their discretionary decision.

The requirement to prepare a Bushfire Emergency Plan (BEP) for vulnerable land uses is an additional bushfire protection measure established by SPP 3.7. This is to be produced as a separate standalone operational document. However, some requirements identified in the BEP may necessarily incorporated into this BMP and the responsibilities it creates.

4.1 Local Government Variations to Apply

EXPLANATORY INFORMATION

1. Local governments may add to or modify the acceptable solutions contained within the Guidelines, through regional or local variations that form part of a local planning strategy and/or local planning scheme to recognise special local or regional circumstances that reinforce the SPP 3.7 objectives and outcomes (via a scheme amendment or special control area).

   This could include acceptable solutions that address topography, vegetation or climate to the satisfaction of the Western Australian Planning Commission (WAPC) that the modifications comply with the corresponding SPP 3.7 objectives and outcomes. (Planning for Bushfire Guidelines, s. 3.4, 2024).

2. Under the relevant state legislation (LPS Regulations 2015), SPP 3.7 does not apply to hosted or unhosted short-term rental accommodation. However, the local government under its Local Planning framework (i.e. Strategy / Scheme and Policy as applicable), may require that certain bushfire protection measures or variations to the measures (the bushfire protection criteria), established by SPP 3.7 and the Guidelines, are to be applied.

Endorsed regional or local variations to the acceptable solutions apply to the assessments against the Bushfire Protection Criteria for the planning proposal?	No
The proposed land use for hosted or unhosted short-term rental accommodation, and the local government requires certain bushfire protection measures, contained within the BPC, to be applied, that under the LPS Regulations 2015, would otherwise not be required?	No

4.2 Assessment Summary

HOW THE REQUIRED BUSHFIRE PLANNING OUTCOMES OF SPP 3.7 ARE ACHIEVED FOR THE PLANNING PROPOSAL		
DEVELOPMENT – COMMERCIAL AND INDUSTRIAL		
The Bushfire Protection Criteria (BPC) Elements and Acceptable Solutions	Compliance Pathway Applied and Assessment Outcome	
	Deemed to Comply	Outcomes-Based Approach
	Requires Compliance with All Applicable Acceptable Solutions	Expert Opinion Identifies Achieving the Required SPP 3.7 Outcomes can be Demonstrated [1]
E2: SITING AND DESIGN	Fully Compliant	Achieving the required element outcome is demonstrated using the acceptable solutions
A2.1a Siting and design	Fully Compliant	
A2.1b Siting in an area with a radiant heat impact exceeding 29 kW/m² (BAL-40 or BAL-FZ)	Not Applicable	
A2.2 Asset Protection Zone (APZ)	Fully Compliant	
A2.3 Clearing of native vegetation	Fully Compliant	
A2.4 Storage of hazardous, flammable and/or combustible materials	Not Applicable	
E3: VEHICULAR ACCESS	Fully Compliant	Achieving the required element outcome is demonstrated using the acceptable solutions
A3.1 Private Driveways	Fully Compliant	
E4: WATER SUPPLY	Fully Compliant	Achieving the required element outcome is demonstrated using the acceptable solutions
A4.1 Water supply	Fully Compliant	
Note 1: Assessment details addressing the criteria established by SPP 3.7 cl. 7.5, are provided in the following section when this compliance pathway is applied.		

4.3 Development – Commercial and Industrial – BPC 7 Assessment Statements

4.3.1 Element 2: Siting and Design

ELEMENT 2: SITING AND DESIGN (DEVELOPMENT - COMMERCIAL/INDUSTRIAL)					
All details of acceptable solution requirements are established in the Planning for Bushfire Guidelines (Guidelines) – WA Department of Planning, Lands and Heritage (DPLH, as amended). When relevant, the 'Bushfire Management Plan Guidance for the Dampier Peninsula' (DPLH, 2021 Rev B), is also referenced.					
O2	State Planning Policy 3.7 Bushfire - Outcomes to be Achieved				
	SPP 3.7, 6.2: Ensure siting and design solutions: • Manage or mitigate the bushfire risk to people, property and infrastructure; and • Avoid, or where unavoidable, minimises the clearing of native vegetation.				
E2	Statement for Compliance with Element E1 – The Deemed to Comply Pathway				
	The planning proposal is fully compliant with all applicable acceptable solutions and therefore achieves the required outcomes of this element.				
	Alternative Pathway Applied to Achieve SPP 3.7 Outcomes				
	N/A				
ACCEPTABLE SOLUTIONS - ASSESSMENT STATEMENTS					
Check Box Legend:	☑ Relevant & met	☒ Relevant & not met	⃠ Not relevant		
A2.1a Siting and design		Applicable:	Yes	Compliant:	Yes
☐ ☐ ⃠	BPC 7 establishes A2.1a is applicable to the planning stage and land use. However, A2.1b provides an additional acceptable solution (dealing with the same protection measure), that establishes a higher level of radiant heat impact that will be considered for planning approval, if it can be satisfactorily demonstrated that the allowable constraints apply to the subject development site. For the subject planning proposal, A2.1a is not applicable as A2.1b can be satisfactorily applied.				
☑ ☐ ☐	Every habitable building achieves a radiant heat impact not exceeding 29 kW/m² (BAL-29).				
Assessment Supporting Details: The proposed BHH building will be sited in an area that will be subject to BAL-29 upon completion of required vegetation modification and insertion of the Principal Shared Path. Refer to Appendix 1.2 for supporting site assessment details and required works. A part of the development site is subject to radiant heat levels corresponding to the BAL-40 and BAL-FZ ratings, this is addressed by development design.					
A2.1b Siting in an area with a radiant heat impact exceeding 29 kW/m² (BAL-40 or BAL-FZ)		Applicable:	No	Compliant:	-
☐ ☐ ⃠	BPC 7 establishes A2.1b is applicable to the planning stage and land use. However, A2.1a provides an additional acceptable solution that addresses the same protection measure of siting. For the subject planning proposal, A2.1b is not applicable as A2.1a can be complied with.				

☐ ☐ ⊘ The commercial or industrial habitable building(s) is sited with a radiant heat impact exceeding 29 kW/m² (BAL-40 or BAL-FZ) and is unable to establish an APZ in accordance with A2.2. However, meeting all of the following established requirements allows consideration for approval.

☐ ☐ ⊘ The lot was created prior to 2015; and

☐ ☐ ⊘ There are demonstrated site characteristics and/or biodiversity or conservation values that prevent the achievement of a radiant heat impact not exceeding 29 kW/m2 (BAL-29); and

☐ ☐ ⊘ It is demonstrated that the reduction of the building footprint or a redesign to manage or mitigate the risk, is not practical or appropriate; and

☐ ☐ ⊘ The vegetation immediately surrounding the building(s) can and will be managed as defendable space in accordance with Appendix B.2, Table 9 – APZ technical requirements.

Assessment Supporting Details:

The proposed BHH building will be sited in an area that will be subject to BAL-29.

A2.2 Asset Protection Zone (APZ)	Applicable:	Yes	Compliant:	Yes

EXPLANATORY INFORMATION

Refer to Appendix B1 for an explanation of what an APZ is and its purpose and the factors determining the dimensions of the 'Planning BAL-29' APZ, the 'BAL Rating' APZ, the 'Local Government' APZ and the 'Required' APZ which is to be established and maintained by the eventual landowner.

The following assessment of the acceptable solution is applying the dimensions of the 'Planning BAL-29' APZ to provide evidence of the planning proposals ability, or not, to achieve the minimum vegetation separation distances considered acceptable under State Planning Policy 3.7 Bushfire (i.e. those corresponding to BAL-29 for the site conditions).

Note: The 'Planning BAL-29' APZ is not necessarily the dimensions of the APZ that should be physically implemented and maintained by the eventual landowner surrounding a habitable building. Rather, these dimensions should correspond to the buildings determined BAL rating. Caution! - the 'planning' function of this BMP means that it is not determining the actual BAL rating that will apply to future building works (although it can in limited circumstances).

Where a habitable building(s) cannot be wholly within an area with a radiant heat impact not exceeding 29 kW/m² (BAL-29) in its pre-development state, an indicative APZ is to be provided and meet the following requirements for width, location and management:

☑ ☐ ☐ APZ Width: The APZ, when measured from any external wall or supporting post or column, is of sufficient size to ensure the radiant heat impact of a bushfire does not exceed 29 kW/m² (BAL-29) to any part of the building, in all circumstances.

☐ ☐ ⊘ APZ Location – Option 1: The indicative 'Planning BAL-29' APZ can be contained solely within the boundaries of the lot.

☑ ☐ ☐ APZ Location – Option 2: The indicative 'Planning BAL-29' APZ cannot be contained solely within the boundaries of the lot. However, the relevant vegetation on the adjoining land / lot(s) is, and will continue to be, on an ongoing basis in perpetuity, low threat as per:

- Clause 2.2.3.2 of AS 3959 (including non-vegetated land such as a sealed or unsealed road, or a water body); or
- The requirements of the Guidelines Appendix B.2, Table 9 – APZ technical requirements; or
- The alternative standard in the local planning scheme (when it exists).

☑ ☐ ☐	APZ Management: The APZ can and will be managed in accordance with the requirements of Guidelines, Appendix B.2, Table 9 – APZ technical requirements, or the alternative standard in the gazetted local planning scheme (when it exists).

Assessment Supporting Details:

The ability to establish the 'Planning BAL-29' APZ dimensions is illustrated in Figure 3.2 Onsite vegetation will be required to be modified and/or removed (see figure 3.1.1), for which the appropriate authority will be required (refer to Section 2 of this BMP).

A2.3 Clearing of native vegetation	Applicable:	Yes	Compliant:	Yes

☑ ☐ ☐	The development avoids, or where unavoidable, minimises the clearing of native vegetation.

Assessment Supporting Details:

No native vegetation is required to be removed or managed.

A2.4 Storage of hazardous, flammable and/or combustible materials	Applicable:	No	Compliant:	-

☐ ☐ ⊘	The proposed land use does not include the storage of hazardous, flammable and/or combustible materials as part of its ongoing day to day operations. Therefore, A2.6 is not applicable to the subject planning proposal.
☐ ☐ ⊘	The proposed land use will include the storage of hazardous, flammable and/or combustible materials as part of its ongoing day to day operations. These will be a quantity that trigger the requirement for a licence under the *Dangerous Goods Safety Act 2004* or the *Environmental Protection Act 1986*. Consequently, the requirements under the above legislation will establish the storage requirements and therefore A2.6 is not applicable to the subject planning proposal.
☐ ☐ ⊘	The proposed development will include the storage of hazardous, flammable and/or combustible materials as part of its ongoing day to day operations. These are not at a quantity that trigger the requirement for a licence under the *Dangerous Goods Safety Act 2004* or the *Environmental Protection Act 1986*. Consequently, the following established storage area requirements can and will be applied.
☐ ☐ ⊘	The storage area is subject to a radiant heat impact not exceeding 29 kW/m^2 (BAL-29); and
☐ ☐ ⊘	The construction of the storage area is non-combustible and shields the materials to reduce their exposure to radiant heat from the bushfire to levels significantly lower than 29 kW/m^2 and prevents the entry of debris and embers; and
☐ ☐ ⊘	The construction of the storage area limits to the degree necessary and practical, the escape of sources of ignition from the stored materials into bushfire prone vegetation.

4.3.2 Element 3: Vehicular Access

ELEMENT 3: VEHICULAR ACCESS (DEVELOPMENT - COMMERCIAL/INDUSTRIAL)	
All details of acceptable solution requirements are established in the Planning for Bushfire Guidelines (Guidelines) – WA Department of Planning, Lands and Heritage (DPLH, as amended). When relevant, the 'Bushfire Management Plan Guidance for the Dampier Peninsula' (DPLH, 2021 Rev B), is also referenced. The technical construction requirements for access types and components are established in the Guidelines Appendix B.3, Table 10 (certain information is copied and presented in Appendix C of this BMP). The local government will advise the proponent where different requirements are to apply and when any additional specifications such as those for signage and gates are to apply. These are included in the appendix if requested by the local government.	
O3	State Planning Policy 3.7 Bushfire - Outcomes to be Achieved
	SPP 3.7, 6.3: Ensure the design and capacity of vehicular access and egress provide: • For efficient and effective evacuation to a suitable destination(s) and/or • As a contingency measure for vulnerable land uses, an on-site shelter, where demonstrated appropriate, as a last resort option.
E3	Statement for Compliance with Element E1 – The Deemed to Comply Pathway
	The planning proposal is fully compliant with all applicable acceptable solutions and therefore achieves the required outcomes of this element.
	Alternative Pathway Applied to Achieve SPP 3.7 Outcomes
	N/A

ACCEPTABLE SOLUTIONS - ASSESSMENT STATEMENTS				
Check Box Legend:	☑ Relevant & met	☒ Relevant & not met	⃠ Not relevant	
A3.1 Private driveways	Applicable:	Yes	Compliant:	Yes
☑ ☐ ☐	The subject lot is serviced by reticulated water and the private driveway is no greater than 70 metres in length between the most distant external part of the habitable building and the public road. For these conditions, no private driveway technical requirements are prescribed by the Guidelines. All the following established requirements do not need to be met.			
☐ ☐ ⃠	The private driveway meets the technical requirements (Guidelines Appendix B3, Table 10) for minimum horizontal clearance (6 metres) or where not required to comply with the Guidelines width, it meets the requirements of the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision; and			
☐ ☐ ⃠	The private driveway meets the technical requirements (Guidelines Appendix B3, Table 10) for minimum vertical clearance (4.5 metres), minimum weight capacity (15 tonnes - includes bridges, culverts) and minimum inner radius of road curves (8.5 metres); and			
☐ ☐ ⃠	The private driveway meets the technical requirements (Guidelines Appendix B3, Table 10) for the gradients of different surfaces and dips; and			

☐ ☐ ⊘	Passing bays can and will be installed every 200 metres with a minimum length of 20 metres and a minimum additional carriageway width of 2 metres i.e. the combined carriageway width of the passing bay and constructed private driveway will be a minimum 6 metres; and
☐ ☐ ⊘	The turnaround area / head requirements (Guidelines, Figure 30) can and will be complied with and will be located within 30 metres of the residential building (Guidelines Figure 38).
Assessment Supporting Details: It is recommended that driveways meet public road standards as the development is for public use.	

4.3.3 Element 4: Water Supply

ELEMENT 4: WATER SUPPLY (DEVELOPMENT - COMMERCIAL/INDUSTRIAL)	
All details of acceptable solution requirements are established in the Planning for Bushfire Guidelines (Guidelines) – WA Department of Planning, Lands and Heritage (DPLH, as amended). When relevant, the 'Bushfire Management Plan Guidance for the Dampier Peninsula' (DPLH, 2021 Rev B), is also referenced.	
O4	State Planning Policy 3.7 Bushfire - Outcomes to be Achieved
	SPP 3.7, 6.4: Ensure that sufficient water is available and accessible for emergency services, to enable people, property and infrastructure to be defended from bushfire.
E4	Statement for Compliance with Element E1 – The Deemed to Comply Pathway
	The planning proposal is fully compliant with all applicable acceptable solutions and therefore achieves the required outcomes of this element.
	Alternative Pathway Applied to Achieve SPP 3.7 Outcomes
	N/A

ACCEPTABLE SOLUTIONS - ASSESSMENT STATEMENTS				
Check Box Legend:	☑ Relevant & met	☒ Relevant & not met	⃠ Not relevant	
A4.1 Water supply	Applicable:	Yes	Compliant:	Yes

☑ ☐ ☐	Evidence is provided that a reticulated water supply, available for firefighting purposes, exists or can be provided. Hydrant connection(s) will be provided in accordance with the specifications established by the relevant water supply authority (refer also to hydrant location information in Appendix D of this BMP).
☐ ☐ ⃠	The subject site will have a reticulated water supply but is in an area designated as Area 2 on the Map of BPA and/or the local government area has known issues with water supply or pressure. The proposed development will adopt the Guidelines recommendation to provide water supply tank(s) and fittings dedicated to firefighting purposes that satisfy the construction and design requirements established in Appendix B4: Water Supply.
☐ ☐ ⃠	The subject site is serviced by reticulated water. However, the distance from the public road (along which the fire hydrant is located) to the farthest part of the habitable building is greater than 70 metres, exceeding the reach of a hose reel. A water supply tank will be installed within the lot in accordance with the relevant requirements of Guidelines, Appendix B4: Water Supply.
☐ ☐ ⃠	The provision of or the specifications of a reticulated water supply cannot be met. Evidence is provided that a sufficient, sustainable and accessible non-reticulated water supply, dedicated to firefighting purposes, can and will be provided in accordance with the specifications established in the Guidelines, Appendix B4: Water Supply.
☐ ☐ ⃠	The planning proposal is for commercial/industrial development. For each habitable building a water supply, dedicated to firefighting purposes, will be stored in tanks at 10,000 litres of water per 1,500 m^2 of floor area up to 50,000 litres in total.

☐ ☐ ⊘	The above ground water supply tank(s), dedicated to firefighting purposes (and tank stand(s) when applicable), will be constructed of non-combustible material and as necessary, will comply with AS/NZS 3500.1(as amended). This includes not using the same water supply for both domestic use and firefighting purposes. If a combined use tank(s) is to be used, it will separate the storage compartments in accordance with the provisions of the standard (i.e. internal installation of double partition walls).
☐ ☐ ⊘	The planning proposal is for a commercial/industrial land use. The tank(s) water outlet connection fitting will be 125 mm Storz.
☐ ☐ ⊘	All above-ground, exposed water supply pipes and fittings will be metal and positioned facing away from the source of bushfire hazard and/or shielded against potential bushfire impact – to allow access by emergency services.
☑ ☐ ⊘	The planned provision of the water supply tank(s) will consider locations relative to the bushfire hazard. Location of the tank(s) and management of vegetation will ensure vegetation will not exist over or against the tank(s) and that sufficient separation exists to limit the potential bushfire impact. Due consideration will also be given to the provision of sufficient separation from vegetation and/or shielding for the protection of firefighters accessing the water supply.
☐ ☐ ⊘	An unobstructed, hardened ground surface, for emergency services vehicle access, can and will be installed within 4 metres of the water supply outlet (refer to Figure 39, Guidelines).
☐ ☐ ⊘	It is proposed for a water supply tank outlet(s) is to be remote from the tank, the local government and DFES will have been consulted regarding the application and location. The determined requirements are presented as an Addendum in this BMP.
☐ ☐ ⊘	Planned below ground water supply tank(s), dedicated to firefighting purposes, will have at least a 200 mm diameter access hole – or a suitable inspection opening - to allow tankers or emergency services vehicles to refill direct from the tank, with the outlet location clearly marked on the surface. As necessary, the tanks(s) will comply with AS/NZS 3500.1 (as amended).
☐ ☐ ⊘	The subject site is in a non-reticulated area. The planning proposal adopts the recommendation contained in Guidelines, Appendix B4: Water supply, that where pumping equipment is installed it will be powered by means other than the electricity network such as an appropriately powered and capacity petrol/diesel or onsite generator/electricity, driven pump, and be shielded against potential bushfire impact.
☐ ☐ ⊘	The planning proposal intends that a suitable static water supply is to be provided by a dam or river that complies with the DFES guidelines for acceptable sources of water for firefighting purposes. Evidence is provided that: • Demonstrates that the water level will be maintained above the top of the highest fire brigade suction point; and • Approval has been obtained from the decision maker in consultation with the emergency services and is presented as an Addendum in this BMP.

Assessment Supporting Details:

A hydrant 50m to the South West of the existing lot as indicated on Figure 1.2.

[Refer to additional technical requirement information contained in Appendix D]

5 RESPONSIBILITY CHECKLISTS

EXPLANATORY INFORMATION

This section of the BMP sets out the responsibilities of the relevant entity or person for:

- The initial implementation of the required bushfire protection measures and their timing; and
- The ongoing maintenance of the required bushfire protection measures to ensure their effectiveness.

5.1.1 Developer / Landowner Responsibilities Prior to Building and Operation

TABLE 6.2(A) REQUIRED BUSHFIRE PROTECTION MEASURES - IMPLEMENTATION ACTIONS (SUBJECT TO COMPLIANCE CHECK TO BE CONDUCTED BY A BUSHFIRE CONSULTANT)	
1	Prior to occupancy/operation establish the 'Required' Asset Protection Zone (APZ) around habitable buildings (and other structures as required) to satisfy: • The minimum required dimensions established in Appendix B1; and • The standards established by the *Guidelines for planning in bushfire prone areas,* DPLH, 2021 v1.4, Schedule 1; or • The standards established for an Asset Protection Zone (APZ) by the relevant local government's requirements set out in a section 33 notice under the Bush Fires Act 1954 (annual firebreak/fuel load notice); or • An alternative standard in a gazetted local planning scheme. If native vegetation is required to be modified or removed, ensure that approval has been received from the relevant authority (refer to the applicable local government for advice).
2	Clearing and/vegetation modification to be undertaken in accordance with requirements established by the BMP. If native vegetation is required to be modified or removed, ensure that approval has been received from the relevant authority (refer to the applicable local government for advice).
3	Clear at least 8 metres of vegetation for the installation of the Principal Shared Path (PSP) on the PTA reserve that borders the eastern boundary of the development as per the designs in Appendix E.

TABLE 6.2(C) REQUIRED BUSHFIRE PROTECTION MEASURES - IMPLEMENTATION ACTIONS (NOT SUBJECT TO COMPLIANCE CHECK)	
1	Prior to relevant building work, inform the builder of the existence of this approved Bushfire Management Plan (BMP). The plan identifies that the development site is within a designated bushfire prone area and states the indicative (or determined) BAL rating(s) that may (or will) be applied to buildings/structures. A BAL assessment report may be required to confirm determined ratings and will be required when ratings are indicative. BAL certificates will need to be issued to accompany building applications. The BMP may also establish, as an additional bushfire protection measure, that construction requirements to be applied will be those corresponding to a specified higher BAL rating. Compliance with the Building Code of Australia (Volumes 1 and 2 of the National Construction Code), will require certain bushfire resistant construction requirements be applied to residential buildings in bushfire prone areas (i.e., Class 1, 2 and 3 and associated Class 10a buildings and decks). Other classes of buildings may also be required to comply with these construction when established by the relevant authority or if identified as an additional bushfire protection measure within the BMP. The deemed to satisfy solutions that will meet the relevant bushfire performance requirements are found in AS 3959 – Construction of Building in Bushfire Prone Areas (as amended) and the NASH Standard - Steel Framed Construction in Bushfire Areas (as amended).

5.1.2 Landowner / Operator Responsibilities – Ongoing Management

TABLE 6.3 REQUIRED BUSHFIRE PROTECTION MEASURES – ONGOING MANAGEMENT ACTIONS	
1	Maintain the 'Required' Asset Protection Zone (APZ) around habitable buildings (and other structures as required) to satisfy: • The minimum required dimensions established in Appendix B1; and • The standards established by the *Guidelines for planning in bushfire prone areas,* DPLH, 2021 v1.4, Schedule 1; or • The standards established for an Asset Protection Zone (APZ) by the relevant local government's requirements set out in a section 33 notice under the Bush Fires Act 1954 (annual firebreak/fuel load notice); or • An alternative standard in a gazetted local planning scheme.
2	Maintain any areas nominated to be modified, cleared or revegetated in accordance with the vegetation classification and management standards as specified in the BMP and/or Landscape Management Plan.
3	Comply with the Shire of Serpentine Jarrahdale Fire Hazard Reduction Notice issued under s33 of the Bush Fires Act 1954. Check the notice annually for any changes.
4	Ensure that builders engaged to construct dwellings/additions and/or other relevant structures on the lot, are aware of the existence of this approved Bushfire Management Plan (BMP). The plan identifies that the development site is within a designated bushfire prone area and states the indicative (or determined) BAL rating(s) that may (or will) be applied to buildings/structures. A BAL assessment report may be required to confirm determined ratings and will be required when ratings are indicative. BAL certificates will need to be issued to accompany building applications. Compliance with the Building Code of Australia (Volumes 1 and 2 of the National Construction Code), will require certain bushfire resistant construction requirements be applied to residential buildings in bushfire prone areas (i.e., Class 1, 2 and 3 and associated Class 10a buildings and decks). The deemed to satisfy solutions that will meet the relevant bushfire performance requirements are found in AS 3959 – Construction of Building in Bushfire Prone Areas (as amended) and the NASH Standard - Steel Framed Construction in Bushfire Areas (as amended). As an additional bushfire protection measure, other classes of buildings may also be required to comply with these construction requirements when established by the relevant authority or if identified as an additional bushfire protection measure within the BMP. The BMP may also establish that construction requirements to be applied will be those corresponding to a specified higher BAL rating. When applicable, these requirements will be identified in Section 5.7.
5	Ensure all future buildings the landowner has responsibility for, are designed and constructed in full compliance with: • The bushfire resistant construction requirements of the Building Code of Australia (Volumes 1 and 2 of the National Construction Code), as established by the Building Regulations 2012 (WA Building Act 2011); and • Any additional bushfire protection measures this Bushfire Management Plan has established are to be implemented.

	Ensure the ongoing implementation of the BMP, including providing successive landowners with a copy of the BMP and making them aware of the responsibilities it contains.

APPENDIX A: DETAILED BAL ASSESSMENT DATA AND SUPPORTING INFORMATION

A1: BAL Assessment Inputs Common to the Method 1 and Method 2 Procedures

A1.1: FIRE DANGER INDICES (FDI/FDI/GFDI)

When using Method 1 the relevant FDI value required to be applied for each state and region is established by AS 3959:2018, Table 2.1. Each FDI value applied in Tables 2.4 – 2.7 represents both the Forest Fire Danger Index (FFDI) and a deemed equivalent for the Grassland Fire Danger Index (GFDI), as per Table B2 in Appendix B. When using Method 2, the relevant FFDI and GFDI are applied.

The values may be able to be refined within a jurisdiction, where sufficient climatological data is available and in consultation with the relevant authority.

Relevant Jurisdiction:	WA	Region:	Whole State	Method 1	Applied FDI:	80
				Method 2	Applied FFDI:	N/A
					Applied GFDI:	N/A

A1.2: VEGETATION ASSESSMENT AND CLASSIFICATION

Vegetation Types and Classification

In accordance with AS 3959:2018 Clauses 2.2.3 and C2.2.3.1, all vegetation types within 100 metres of the 'site' (defined as "the part of the allotment of land on which a building stands or is to be erected"), are identified and classified. Any vegetation more than 100 metres from the site that has influenced the classification of vegetation within 100 metres of the site, is identified and noted. The maximum excess distance is established by AS 3959: 2018 Clause 2.2.3.2 and is an additional 100 metres.

Classification is also guided by the Visual Guide for Bushfire Risk Assessment in WA (WA Department of Planning February 2016) and any relevant FPA Australia practice notes.

Modified Vegetation

The vegetation types have been assessed as they will be in their natural mature states, rather than what might be observed on the day. Vegetation destroyed or damaged by a bushfire or other natural disaster has been assessed on its expected re-generated mature state. Modified areas of vegetation can be excluded from classification if they consist of low threat vegetation (refer to Appendix B) and that any required active management can be expected to continue in perpetuity, and this can be adequately justified.

The Influence of Ground Slope

Where significant variation in effective slope exists under a consistent vegetation type, these will be delineated as separate vegetation areas to account for the difference in potential bushfire behaviour, in accordance with AS 3959:2018 Clauses 2.2.5 and C2.2.5.

THE INFLUENCE OF VEGETATION GREATER THAN 100 METRES FROM THE SUBJECT SITE	
Vegetation area(s) within 100m of the site whose classification has been influenced by the existence of bushfire prone vegetation from 100m – 200m from the site:	None
Assessment Statement:	No vegetation types exist close enough, or to a sufficient extent, within the relevant area to influence classification of vegetation within 100 metres of the subject site.

VEGETATION AREA 1				
Classification	A. FOREST			
Types Identified	Open forest A-03	Low open forest A-04		
Exclusion Clause	N/A			
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees
Justification:	Eucalyptus species (Marri and Jarrah most common) ranging from 10 to 15 metres in height, with mixed understorey consisting of native and invasive shrubs and grasses.			
Post Development Assumptions:	Vegetation reasonably assumed to remain as it in perpetuity.			



PHOTO ID: 1



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PHOTO ID: 4

	
PHOTO ID: 5	PHOTO ID: 6

VEGETATION AREA 2				
Classification	B. WOODLAND			
Types Identified	Woodland B-05 Low woodland B-07			
Exclusion Clause	N/A			
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees
Justification:	Eucalyptus species (Marri and Jarrah most common) ranging from 10 to 15 metres in height, with an invasive grass understorey.			
Post Development Assumptions:	Vegetation reasonably assumed to remain as it in perpetuity.			



PHOTO ID: 7



PHOTO ID: 8

VEGETATION AREA 3				
Classification	D. SCRUB			
Types Identified	Open scrub D-14			
Exclusion Clause	N/A			
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees
Justification:	Scrub under 6m in height. Unmanaged road verge classified as worst-case scenario.			
Post Development Assumptions:	Vegetation reasonably assumed to remain as it in perpetuity. This area potentially could be managed in better condition in the future. Offsite vegetation is classified as worst-case scenario.			



PHOTO ID: 9



PHOTO ID: 10

VEGETATION AREA 4				
Classification	G. GRASSLAND			
Types Identified	Open tussock G-23 Dense sown pasture G-25			
Exclusion Clause	N/A			
Effective Slope	Measured	d/slope 1 degrees	Applied Range (Method 1)	Downslope >0-5 degrees
Justification:	Grassland up to 0.5m in height, with a few scattered bushes (mostly introduced species).			
Post Development Assumptions:	Offsite vegetation cannot be altered or removed by subject site landowner. Onsite vegetation within the lot boundary will be completely removed for development. Onsite or Offsite vegetation where the proposed Principal Shared Path is to be installed will be completely removed for development.			



PHOTO ID: 11



PHOTO ID: 12



PHOTO ID: 13



PHOTO ID: 14

VEGETATION AREA 5				
Classification	G. GRASSLAND			
Types Identified	Closed tussock grassland G-21	Dense sown pasture G-25		
Exclusion Clause	N/A			
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees
Justification:	Grassland up to 0.5m in height, with a few scattered bushes (mostly introduced species).			
Post Development Assumptions:	Vegetation reasonably assumed to remain as it in perpetuity. Onsite or Offsite vegetation, at least 8 metres on the eastern side of the development, where the proposed Principal Shared Path is to be installed, will be completely removed for development, and replaced with a paved path that will prevent regrowth (see figure 1.2) with possible low threat landscaping either side of the path.			



PHOTO ID: 15



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VEGETATION AREA 6				
Classification	N/A			
Types Identified	N/A			
Exclusion Clause	2.2.3.2 (e) non-vegetated areas and (f) low threat vegetation - high moisture content.			
Effective Slope	Measured	N/A	Applied Range (Method 1)	N/A
Justification:	Non vegetated areas include sealed public roads, car parks, shopping centres and buildings. Low threat vegetation includes small, reticulated lawns, gardens and roadside verges with native species managed to a minimal fuel state.			
Post Development Assumptions:	Low threat vegetation is reasonably expected to remain in low threat state in perpetuity.			



PHOTO ID: 19



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PHOTO ID: 23	PHOTO ID: 24

A1.3: EFFECTIVE SLOPE

EXPLAINING THE ASSESSMENT METHODOLOGY APPLIED BY BUSHFIRE PRONE PLANNING

DEFINITION: Effective slope is "the slope under that classified vegetation which most influences the bushfire attack" (AS 3959:2018, Clause 1.5.11).

"The effective slope under the classified vegetation is not the same as the average slope for the land surrounding the site of the proposed building. The effective slope is that slope which most significantly influences bushfire behaviour" (AS 3959:2018, Clause CB4).

The slope is described as upslope, flat or downslope when viewed from an exposed element (e.g., building) and looking towards the vegetation. It is measured in degrees.

[Note: Additional relevant guidance provided by AS 3959:2018 and NSW RFS, Planning for Bushfire Protection (2019) is incorporated into the applied assessment methodology and is presented at the end of this explanation.]

COMPOUND SLOPES UNDER VEGETATION AND DETERMINING SLOPE SIGNIFICANCE

Non-Linear Slopes: When the slope of ground under the vegetation out to the distance to be assessed (100 m or further if necessary), is not a straight line or nearly straight line slope, then it is made up of several different slopes i.e., it is a compound slope. The different slope angles and lengths must be factored into the determination of the effective slope value to be applied. Different slopes will potentially influence the bushfire rate of spread and intensity, both increasing and decreasing it.

Significant Slope: The AS 3959:2018 bushfire attack level determination methodology, with default inputs, models a fully developed bushfire. Therefore, a 'significant' slope is one that will significantly influence bushfire behaviour. To be 'significant' the length of the slope must be 'sufficient' to support a fully developed fire on that slope. The angle of a significant slope could be the determined effective slope for the area of classified vegetation if it is the one that 'most influences the bushfire attack'.

Sufficient Slope Length: Is a slope that will, as a minimum, allow the entire flame depth (flaming zone) of a fully developed fire (100m flame width) to exist on that slope.

The expected flame depth of a fully developed bushfire is a function of the length of time the flaming phase will exist on a section of the fuel bed (the 'residence time') and the bushfire's 'rate of spread'. For a given rate of spread, longer residence times result in greater flame depths. Greater flame depths are correlated with greater flame temperatures and greater flows of radiant heat.

The primary factors that will increase the residence time are:

- Heavier fine fuel loads of grass, leaf litter, twigs, bark etc less than 6mm in width and existing within the surface and near surface layers (and elevated fuel layers when contiguous with the base layers); and
- A greater percentage of larger fine fuels within the fuel load.

The primary factors that increase the rate of spread (apart from fire weather factors), include finer fuels, drier fuels, horizonal continuity of fuel and steeper upward ground slope in the direction of fire travel.

Example values:

- Residence Time: Grassfire 5 – 15 seconds, Forest fire 25 -50 seconds.
- Rate of Spread: Grassfires of a few km/hr are considered fast moving, 5-10 km/hr is common and fastest in the order of 25km/hr. Forest fire typically recorded in metres/hour with 1-1.5 km/hr being considered fast moving and fastest in the order of 3–4 km/hr.
- Flame Depth: More typically, a few metres for grasses to tens of metres for forest fires.

An Isolated Slope: For scenarios where there is a single significant slope (based on the above criteria) additional consideration would need to be given to the time and distance consumed by a bushfire still in its 'developing' phase. This will require due consideration be given to how it is potentially ignited i.e., from a single or multiple points, as this will influence the time and distance required to fully develop. For such scenarios, a normally significant slope may not be sufficiently long. It may be necessary to determine the potential bushfire impact more accurately by

justifying the application of a lesser effective slope, or a lower threat vegetation classification, or calculating a reduced head fire width (using short fire run modelling).

Determined Effective Slope: Only a 'significant' slope can potentially be the effective slope by itself. In which case, for a defined area of classified vegetation area, the worst significant slope under that vegetation is to apply.

The table below presents Bushfire Prone Planning's considerations applied to assessing short and/or compound slopes in determining the effective slope.

Slope Length (m)	Considered a Significant Slope	Considerations in Determining the Effective Slope
< 5	No	Where these short slopes exist as part of a compound slope under an area of classified vegetation, they can be ignored as they will not influence the fire behaviour in that vegetation.
5-20	No	These slopes will have a range of influence on fire behaviour from very little to a degree of influence that must be accounted for to some extent by the determined effective slope that is applied (i.e., with a greater length apply to a greater extent). But the actual slope of these shorter slopes is likely not to be applied as it is not a 'significant' length.
20-30	Maybe	The same considerations applied to the 5-20m slope lengths should be applied here. However, more justification would need to be presented to support their assessment as not being 'significant' slopes. For these slope lengths, consideration must be given more broadly to the potential level of risks associated with a bushfire event in this location. The risk level will be a function of the bushfire hazard threat levels (direct attack mechanisms) within the immediate and broader assessment area as influenced by local topography, vegetation extents and types and the exposure and vulnerability of persons and/or buildings/structures to these threats. Higer risk levels require greater precaution meaning these slopes should be considered 'significant', and vice versa. Consider the potential for a bushfire on adjoining or nearby land be a source of ignition and/or pre-heating to vegetation on the subject slope. Consider if vegetation on the slope is likely be ignited by a single ignition point or is multipoint ignition possible from bushfire an adjoining slopes or the surrounding area. Single point ignition will require a fire to travel further before being fully developed (DFES considers less than 100m fire runs may be considered a short fire run for forest, woodland and scrub vegetation classifications, RFS NSW applies 150m). Isolated slopes of this length are less likely to be considered significant as compared to when part of a compound slope.
>30	Yes	Likely to always be a significant slope unless isolated (i.e., exists alone) – in which case, justifying the application of a lesser effective slope, or a lower threat vegetation classification, or calculating a reduced head fire width, are approaches that may need to be applied.

BPP Approach - Slope Variation Within Areas of Vegetation

When multiple 'significant' slope lengths with large differences in degrees of effective slope (or different applicable slope ranges when AS 3959:2018 Method 1 is applied), exists under a single vegetation classification, these will be delineated as separate vegetation areas of classified vegetation to account for the difference in potential bushfire behaviour and impact, in accordance with AS 3959:2018 clauses 2.2.5 and C2.2.5.

Effective Slope Variation Due to Multiple Development Sites

When the effective slope, under a single area of bushfire prone vegetation, will vary significantly relative to multiple proposed development sites (exposed elements), then the effective slopes corresponding to each of the different

locations, are separately identified. The relevant (worst case) effective slope is determined in the direction corresponding to the potential directions of fire spread towards the subject building(s).

AS 3959:2018 EFFECTIVE SLOPE DETERMINATION - GUIDANCE

The Standard presents a broad set of guidance statements that indicate the intent of deriving an effective slope value for use in calculations, rather than detailing the 'in the field' determination process. These include:

- Highlighting the importance of the value by stating "The slope of the land under the classified vegetation has a direct influence on the rate of fire spread, the severity of the fire and the ultimate level of radiant heat flux" (Clause C2.2.5). [Note: A common rule of thumb is that for every 10 degrees of upslope, a fire will double its rate of spread if moving in the direction of the prevailing wind].
- It may be necessary to consider the slope under the classified vegetation for distances greater than 100 m in order to determine the effective slope for that vegetation classification.
- "Where there is more than one slope within the classified vegetation, each slope shall be individually assessed, and the worst case Bushfire Attack Level shall apply" (Clause 2.2.5).

NSW RFS 2019, PLANNING FOR BUSHFIRE PROTECTION - APPENDIX A1.5 - ADDITIONAL DETERMINATION GUIDANCE

- "In identifying the effective slope - it may be found that there are a variety of slopes covering different distances within the vegetation. The effective slope is considered to be the slope under the vegetation which will most significantly influence the bushfire behaviour for each aspect. This is usually the steepest slope. In situations where this is not the case, the proposed approach must be justified".
- "Vegetation located closest to an asset may not necessarily be located on the effective slope".

SITE ASSESSMENT DETAILS - EXPLANATION & JUSTIFICATION

The effective slopes determined from the site assessment are recorded in Table 3.2 of this Bushfire Management Plan.

A1.4: SEPARATION DISTANCE

Measuring

The separation distance is the distance in the horizontal plane between the receiver (building/structure or area of land being considered) and the edge of the classified vegetation (AS 3959:2018, clause 2.2.4)

The relevant parts of a building/structure from which the measurement is taken is the nearest part of an external wall or where a wall does not exist, the supporting posts or columns. Certain parts of buildings are excluded including eaves and roof overhangs.

The edge of the vegetation, for forests and woodlands, will be determined by the unmanaged understorey rather than either the canopy (drip line) or the trunk (AS 3959:2018, clause C2.2.5).

Measured Separation Distance as a Calculation Input

If a separation distance can be measured because the location of the building/structure relative to the edge of the relevant classified vegetation is known, this figure can be entered into the BAL calculation. The result is a determined BAL rating.

Assumed Separation Distance as a Calculation Input

When the building/structure location within the lot is not known, an assumed building location may be applied that would establish the closest positioning of the building/structure relative to the relevant area of vegetation.

The assumed location would be based on a factor that puts a restriction on a building location such as:

- An established setback from the boundary of a lot, such as a residential design code setback or a restrictive covenant; or
- Within an established building envelope.

The resultant BAL rating would be indicative and require later confirmation (via a Compliance Report) of the building/structure actual location relative to the vegetation to establish the determined BAL rating.

Separation Distance as a Calculation Output

With the necessary site specific assessment inputs and using the AS 3959:2018 bushfire modelling equations, the range of separation distances that will correspond to each BAL rating (each of which represents a range of radiant heat flux), can be calculated. This has application for bushfire planning scenarios such as:

- When the separation distance cannot be measured because the exact location of the exposed element (i.e., the building, structure or area), relative to classified vegetation, is yet to be determined.

  In this scenario, the required information is the identification of building locations onsite that will correspond to each BAL rating. That is, indicative BAL ratings can be derived for a variety of potential building/structure locations; or

- The separation distance is known for a given building, structure or area (and a determined BAL rating can be derived), but additional information is required regarding the exposure levels (to the transfer of radiant heat from a bushfire), of buildings or persons, that will exist at different points within the subject site.

The calculated range of separation distances corresponding to each BAL rating can be presented in a table and/or illustrated as a BAL Contour Map – whichever is determined to best fit the purpose of the assessment.

For additional information refer to the information boxes in Section 3 'Bushfire Attack Levels (BAL) - Understanding the Results and Section 3.2. 'Interpretation of the BAL Contour Map'.

SITE ASSESSMENT DETAILS - EXPLANATION & JUSTIFICATION

For the subject development/use the applicable separation distances values are derived from calculations applying the assessed site data. They are an output value, not an input value and therefore are not presented or justified in this appendix.

The derived values are presented in Section 3, Table 3.1 and illustrated as a BAL contour map in Figure 3.2.

APPENDIX B: ADVICE - ONSITE VEGETATION MANAGEMENT - THE APZ

THE ASSET PROTECTION ZONE (APZ)

The APZ is an area surrounding a building/structure that is not vegetated and/or the retained or planted vegetation can be considered low threat based on flammability or moisture content characteristics or is actively managed to maintain minimal fuel loads. The primary objectives of establishing an APZ are:

1. Ensure a reduction in the exposure of the building/structure to bushfire direct attack mechanisms (threats) of flame contact, radiant heat transfer and ember attack, by establishing appropriate separation from the bushfire prone vegetation. The required APZ dimensions will be dependent on site specific conditions and the use of the site;
2. Ensure a reduction in the exposure of the building/structure to bushfire indirect attack mechanisms (threats) by:
    - Preventing surface fire spreading to the building/structure;
    - Minimising the potential for tree strike; and
    - Limiting the potential for consequential fire to impact the building/structure by eliminating, reducing and/or shielding consequential fire fuels. These fuels include accumulated debris, stored combustible/flammable items and constructed combustible items. Consequential fire, typically ignited by embers, is the primary cause of building loss in a bushfire event; and
3. To provide a defendable space for firefighting activities.

The Appendix B2 of the Guidelines provide guidance and requirements for meeting these objectives might be met (also refer to Appendix B2 in this BMP).

B1: The Asset Protection Zone (APZ) - Dimension and Location Requirements

PLANNING APPLICATION REQUIREMENTS VERSUS LANDOWNER IMPLEMENTATION REQUIREMENTS

ONE IDENTIFIES THE ABILITYOF DEVELOPMENT TO LIMIT EXPOSURE TO CERTAIN BUSHFIRE THREATS TO AN ACCEPTABLE LIMIT AND THE OTHER ESTABLISHES WHAT IS TO BE PHYSICALLY IMPLEMENTED SURROUNDING BUILDINGS/STRUCTURES

THE 'PLANNING BAL-29' APZ

For planning approval purposes, an assessment against the Bushfire Protection Criteria (Guidelines) is conducted. Element 2: Siting and design, essentially establishes that the APZ must be of sufficient size to ensure the radiant heat impact of a bushfire on existing or future habitable buildings (as applicable) does not exceed 29kW/m2 (BAL-29).

The APZ must be able to be maintained in a low threat state and satisfy the following:

Dimensions: The minimum dimensions of the 'Planning BAL-29' APZ are those that will ensure the potential radiant heat impact on the relevant buildings does not exceed 29 kW/m^2. These dimensions will vary dependent on the site specific conditions.

Location: The 'Planning BAL-29' APZ dimensions must not extend past lot boundaries onto land the landowner has no responsibility for or control over. Limited exceptions include:

- When adjoining land is not vegetated (e.g., built out, roads, carparks, drainage systems, rock, water body etc.);
- When adjoining land does or will contain low threat vegetation (refer to Appendix B) and it can be justified that enforceable mechanisms are in place to ensure the APZ status of this land will exist in perpetuity. Such areas of land include:
    - Publicly managed areas of vegetation (e.g., public open space, recreation grounds/areas and services installed in a common section of land). For certain situations, evidence of an entity's

enforceable requirement to manage these areas to the required standard would be included in either the BAL Assessment Report or Bushfire Management Plan;

- Land on a neighbouring lot that is/will be part of the required APZ surrounding buildings/structures on that lot, and/or required firebreak, and for which the owner of that lot has a recognised responsibility to implement and maintain.
- Adjoining land for which a formalised and enforceable authority and responsibility is created for the owner of the lot on which development is proposed, or another third party, to manage vegetation in perpetuity, on land they do not own. This is not common, and the necessary evidence of the responsibility would be included in the BAL Assessment Report or Bushfire Management Plan.

KEY POINT

The 'Planning BAL-29' APZ dimensions are not necessarily those that must be physically implemented and maintained by a landowner. Implementation requirements may be different (see 'Determined BAL Rating APZ' below).

The purpose of identifying the ability of proposed development to apply the 'Planning BAL-29' APZ dimensions is solely to inform decision makers as to the ability of the proposed building works to limit exposure to certain bushfire threats (flame contact, radiant heat transfer and ember attack), to the extent represented by a BAL-29 rating.

Note for certain vulnerable land uses, evidence of the ability to implement a larger APZ may be required to inform planning decisions. These include dimensions corresponding to radiant heat impact levels of 10 kW/m² and/or 2 kW/m² and calculated using a flame temperature of 1200 K – rather than 29kW/m² at 1090 K.

THE 'DETERMINED BAL RATING' APZ

The dimensions associated with the 'Determined BAL Rating APZ' are derived for the specific site conditions and are to be physically implemented and maintained by the landowner. The rating also establishes the bushfire construction requirements for any new building works which results in the built resilience to bushfire threats corresponding to their distance from the bushfire hazard. Variations of these dimensions will only exist as the result of either:

- A requirement presented within an associated Bushfire Management Plan to increase the size of the APZ as part of an alternative solution, and which is subsequently approved by the decision maker; or
- A directive of the relevant Local Government through their annual Firebreak/Hazard Reduction Notice (see below) that results in a larger dimension.

The applicable 'determined' BAL rating is stated in the BAL Assessment Data section of the BAL Assessment Report or Bushfire Management Plan (when it is possible to be a 'determined' rather than 'indicative' value).

If an 'indicative' or 'conditional' rather than a 'determined' BAL rating is stated, the corresponding separation distances (dimensions) are just informative. Confirmation that the stated BAL rating (or a different rating) will apply, is still subject to either certain physical requirements being met or approval from relevant authorities for native vegetation removal is obtained (refer to explanatory information in Section 3).

Dimensions: The minimum dimensions of the 'BAL Rating APZ' will be those associated with the 'determined' BAL rating for the relevant buildings/structures and stated in the following Table B1.

Note for certain vulnerable land uses and relevant buildings/areas, the 'BAL Rating' APZ dimensions may be replaced with dimensions corresponding to the specific radiant heat impact levels of 10 kW/m² and 2 kW/m² and calculated using a flame temperature of 1200K– rather than 29kW/m² at 1090 K.

Location: As for the 'Planning BAL-29' APZ.

THE 'LOCAL GOVERNMENT' APZ

Certain Local Government's state the dimensions of the APZ that must be established surrounding buildings in their annual Firebreak/Hazard Reduction Notice. For certain vegetation/sites, based on environmental considerations, they may also establish a maximum allowable dimension, typically that corresponding to a BAL-29 rating.

THE 'REQUIRED' APZ

The dimensions associated with the 'Required' APZ are to be established and maintained by the landowner within the subject lot and surrounding the subject buildings/structures. The 'Required APZ' will be appropriately depicted in Reports and Plans on the Property Bushfire Management Statement when it is required to be included.

Dimensions: The 'Required APZ' dimensions are the minimum distances away from the subject building/structure that the APZ must extend towards each relevant area of classified vegetation (note: a distance may also be a maximum distance when relevant as an environmental constraint). These distances are stated in the following Table B1.

The dimensions to implement are determined by:

A. Those associated with the 'Determined BAL APZ' for the subject building(s) when distances are greater than 'B' below (except when 'B' has established a maximum distance); or

B. The 'Local Government' APZ' derived from their Firebreak/Hazard Reduction Notice when distances are greater than 'A' above, other than when a maximum distance is established, in which case this will apply; or

C. A combination of 'A' and 'B' as they may apply to different areas of classified vegetation.

Location: As for the 'Planning BAL-29' APZ.

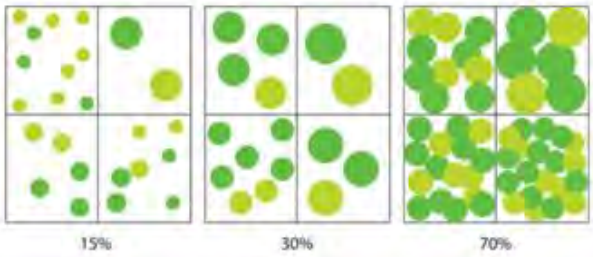
Table B1: The APZ dimensions required to be implemented and maintained by the landowner.

DETERMINATION OF **THE** 'REQUIRED' **APZ DIMENSIONS TO BE** IMPLEMENTED AND MAINTAINED BY LANDOWNER WITHIN THEIR LOT										
Relevant Buildings(s)	Vegetation Classification [Refer to Fig 3.1]		Minimum Required Separation Distances from Building to Vegetation (metres)							
			Established by the 'BAL Rating' APZ Dimension					Established by the "Local Government' APZ Dimension		The 'Required' APZ Dimensions [see note]
			Determined Radiant Heat Impact	Stated 'Indicative' or 'Conditional' BAL				Firebreak / Hazard Reduction Notice	Maximum Allowed	
	Area	Class		BAL-29	BAL-19	BAL-12.5	BAL-LOW			
Byford Health Hub	1	(A) Forest	BAL-FZ	21	31	42	100	20	N/A	20m on the north side; to the lot boundary on the south, east, and west sides.
	2	(B) Woodland		14	20	29	100	20		
	3	(D) Scrub		13	19	27	100	20		
	4	(G) Grassland		9	14	20	50	20		
	5	(G) Grassland		8	12	17	50	20		
	6	Excluded cl 2.2.3.2(e & f)		-	-	-	-	-		
Note: The 'Required' APZ Dimension corresponding to each area of vegetation is the greater of the 'BAL Rating' or the 'Firebreak/Hazard Reduction Notice' APZ dimensions - unless a local government maximum distance(s) is established as a result of their environmental assessment of the subject site. The area of the APZ will also be limited to the subject lot boundary unless otherwise justified in this Report/Plan. Final determination of the dimensions will require that any indicative or conditional BAL becomes a 'Determined' BAL.										
Comments: The 20 m indicated under the Firebreak / Hazard Reduction Notice is set out by the *Shire of Serpentine Jarrahdale Fire Hazard Reduction Notice 2023-24.*										

B2: APZ Technical Requirements Established by the Guidelines (DPLH/WAPC)

Within the Guidelines the APZ requirements are established in Appendix B2: Siting and Design. This includes Table 9 reproduced below.

Table 9: Asset Protection Zone (APZ) technical requirements

OBJECT	REQUIREMENT
Fences within the APZ	Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Appendix F of AS 3959)
Fine fuel load (combustible, dead vegetation matter less than 6 mm in thickness)	• Should be managed and removed on a regular basis to be maintained as low threat vegetation • Should be maintained at less than two tonnes per hectare (on average) • Mulches should be non-combustible such as stone, gravel, shells, rock or crushed mineral earth or wood mulch more than five millimetres in thickness.
Trees* (more than 6 m in height)	• Trunks at maturity should be a minimum distance of six metres from all elevations of the building • Branches at maturity should not touch or overhang a building or powerline • Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. • Canopy cover within the APZ should be less than 15 per cent of the total APZ area • Tree canopies at maturity should be at least 5 m apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided the total canopy cover within the APZ does not exceed 15 per cent and is not connected to the tree canopy outside the APZ. **Tree canopy cover – ranging from 15 to 70 per cent at maturity** 
Shrub* and scrub* (0.5 m to 6 m in height). Shrub and scrub more than 6 m in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings • Should not be planted in clumps more than five square metres in area • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground cover* (less than 0.5 m in height. Ground cover more than 0.5 m in height is to be treated as shrub)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above • Can be located within two metres of a structure but three metres from windows or doors if more than 100 mm in height.
Grass	• Grass should be maintained at a height of 100 mm or less, at all times • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.
Defendable space	Within three metres of each wall or supporting post of a habitable building; the area is kept free from vegetation but can include ground cover, grass and non- combustible mulches as prescribed above.
Liquid petroleum gas cylinders	• Should be located on the side of a building farthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building • The pressure relief valve should point away from the house • No flammable material within six metres from the front of the valve • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

Notes:
** Plant flammability, landscaping design and maintenance should be considered – refer to following explanatory notes*

Fine fuel load is the combustible, dead or dry vegetation matter on the ground, near ground, or elevated. Fine fuel includes grass, leaves, bark and twigs less than six millimetres in diameter that ignite readily and are burnt rapidly when dry.

Fine fuel should be maintained at less than 2t/ha. 100gm/m² equates to 1t/ha. To estimate a fuel load (in t/ha), collect the dry fine fuel from a representative one square meter and weigh (in grams using kitchen scales) and multiply the weight by 0.01.

Shrub* and scrub* (0.5 metres to six metres in height). Shrub and scrub >6 metres in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings. • Should not be planted in clumps >5 square metres in area. • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground covers* (<0.5 metres in height. Ground covers >0.5 metres in height are to be treated as shrubs)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above. • Can be located within two metres of a structure, but three metres from windows or doors if >100 millimetres in height.
Grass	• Grass should be maintained at a height of 100 millimetres or less, at all times. • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.
Defendable space	• Within three metres of each wall or supporting post of a habitable building, the area is kept free from vegetation, but can include ground covers, grass and non-combustible mulches as prescribed above.
LP Gas Cylinders	• Should be located on the side of a building furthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building. • The pressure relief valve should point away from the house. • No flammable material within six metres from the front of the valve. • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

** Plant flammability, landscaping design and maintenance should be considered – refer to explanatory notes*

B3: APZ Technical Requirements Established by the Local Government

Refer to the firebreak / hazard reduction notice issued annually (under s33 of the Bushfires Act 1954) by the relevant local government. It may state Standards that vary from those established by the Guidelines and that have been endorsed by the WAPC in accordance with Section 3.4 of the Guidelines.

A copy of the applicable notice is not included here as they are subject to being reviewed and modified prior to issuing each year. Refer to ratepayers' notices and/or the local government's website for the current version.

B4: Vegetation Excluded from Classification & Ensuring Continued Low Threat Status

EXPLANATORY NOTES

When applying AS 3959:2018 BAL determination methodology, vegetation adjoining or adjacent to the subject site can be excluded from classification based on being 'low threat'. To maintain this status, certain requirements must continue to be met in accordance with the below extract from AS3959:2018. Refer to the 'Classified Vegetation and Topography Map' for the relevant low threat areas associated with the subject site.

Determination of 'low threat' vegetation is based on factors such as:

- Proximity to the subject site
- Small areas of vegetation
- Low flammability
- High moisture content
- Low fuel load

Aside from a naturally occurring low fuel load, vegetation maintained in a minimal fuel condition through active management can be excluded. The associated key requisite is that the active management can be expected to continue in perpetuity, and this can be adequately justified.

Acceptable forms of justification typically involve supportable evidence or the existence of an enforceable mechanism. Examples of enforceable mechanisms include:

- Requirements established by a Section 33 (Bush Fires Act 1954) notice issued by a local government;
- An appropriate and enforceable agreement between relevant parties (which may involve additions to land titles); and
- For public open space, written evidence that the land manager e.g., local government or State Government Department, agrees to maintain the public open space in a low threat state in perpetuity.

2.2.3.2 *Exclusions—Low threat vegetation and non-vegetated areas*

The following vegetation shall be excluded from a BAL assessment:

(a) Vegetation of any type that is more than 100 m from the site.

(b) Single areas of vegetation less than 1 ha in area and not within 100 m of other areas of vegetation being classified vegetation.

(c) Multiple areas of vegetation less than 0.25 ha in area and not within 20 m of the site, or each other or of other areas of vegetation being classified vegetation.

(d) Strips of vegetation less than 20 m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 m of the site or each other, or other areas of vegetation being classified vegetation.

(e) Non-vegetated areas, that is, areas permanently cleared of vegetation, including waterways, exposed beaches, roads, footpaths, buildings and rocky outcrops.

(f) Vegetation regarded as low threat due to factors such as flammability, moisture content or fuel load. This includes grassland managed in a minimal fuel condition, mangroves and other saline wetlands, maintained lawns, golf courses (such as playing areas and fairways), maintained public reserves and parklands, sporting fields, vineyards, orchards, banana plantations, market gardens (and other non-curing crops), cultivated gardens, commercial nurseries, nature strips and windbreaks.

NOTES:

1 Minimal fuel condition means there is insufficient fuel available to significantly increase the severity of the bushfire attack (recognizable as short-cropped grass for example, to a nominal height of 100 mm).

2 A windbreak is considered a single row of trees used as a screen or to reduce the effect of wind on the leeward side of the trees.

APPENDIX C: TECHNICAL REQUIREMENTS FOR VEHICULAR ACCESS

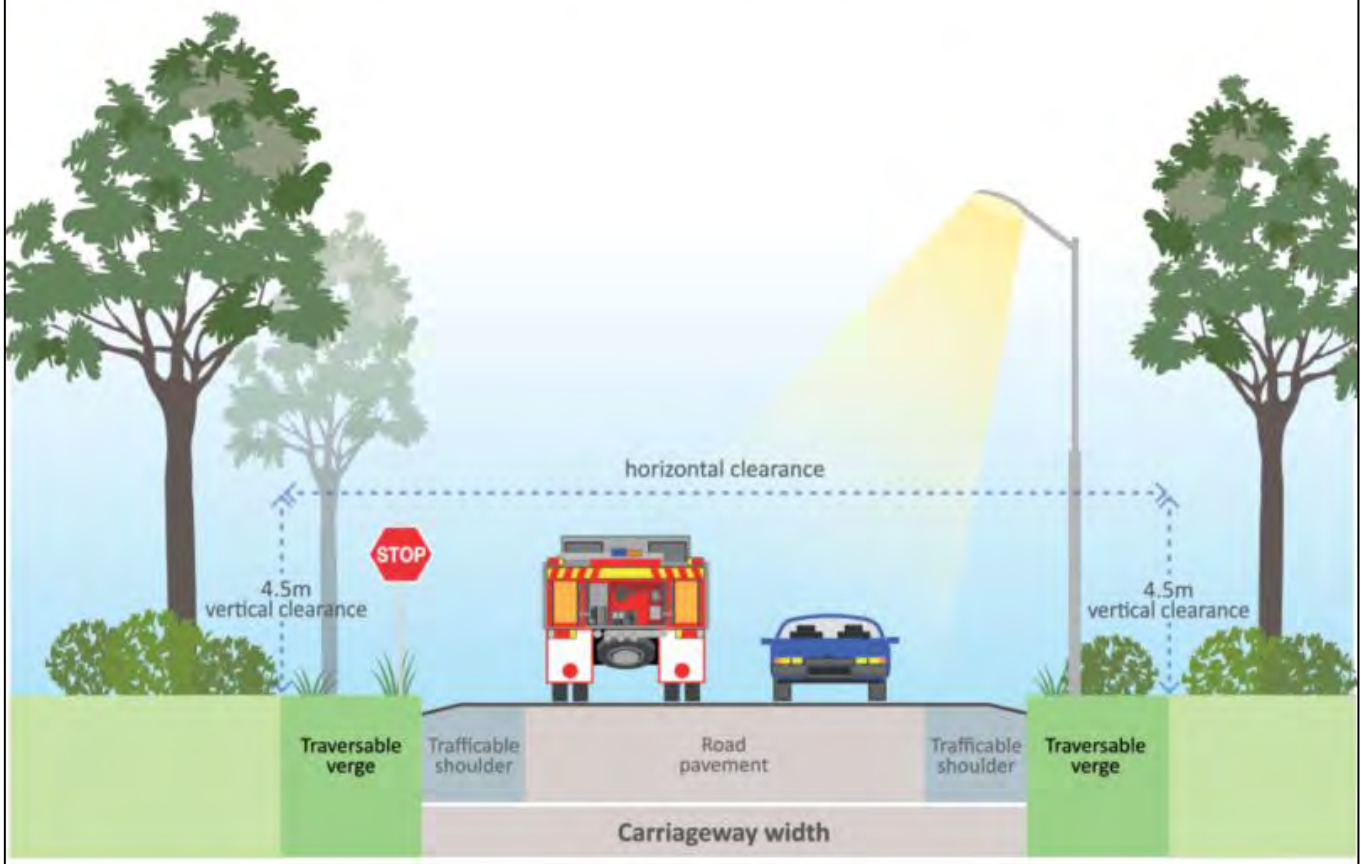
The Planning for Bushfire Guidelines (DPLH/WAPC) (as amended), can be sourced online and establishes:

- In sections 5 to 8, The vehicular access acceptable solutions (corresponding to a planning stage and land use type), that will achieve the required outcomes of State Planning Policy Bushfire 3.7 (SPP 3.7): and
- In Appendix B3, the vehicular access components technical requirements and general considerations.

Common requirements are presented in this appendix. Reference the Guidelines for specific requirements.

ROAD COMPONENT TERMINOLOGY

Figure 26: Area encompassing horizontal clearance and vertical clearance



Horizontal clearance: The carriageway width (including the road pavement and trafficable shoulder) and traversable verge that provides for the movement and parking of vehicles and area required by emergency services to operate. Infrastructure and vegetation within the traversable verge should be frangible, however, non-frangible items can occur providing they do not restrict vehicular movement in the event of an emergency.

VEHICULAR ACCESS TECHNICAL REQUIREMENTS

Table 10: Vehicular access technical requirements

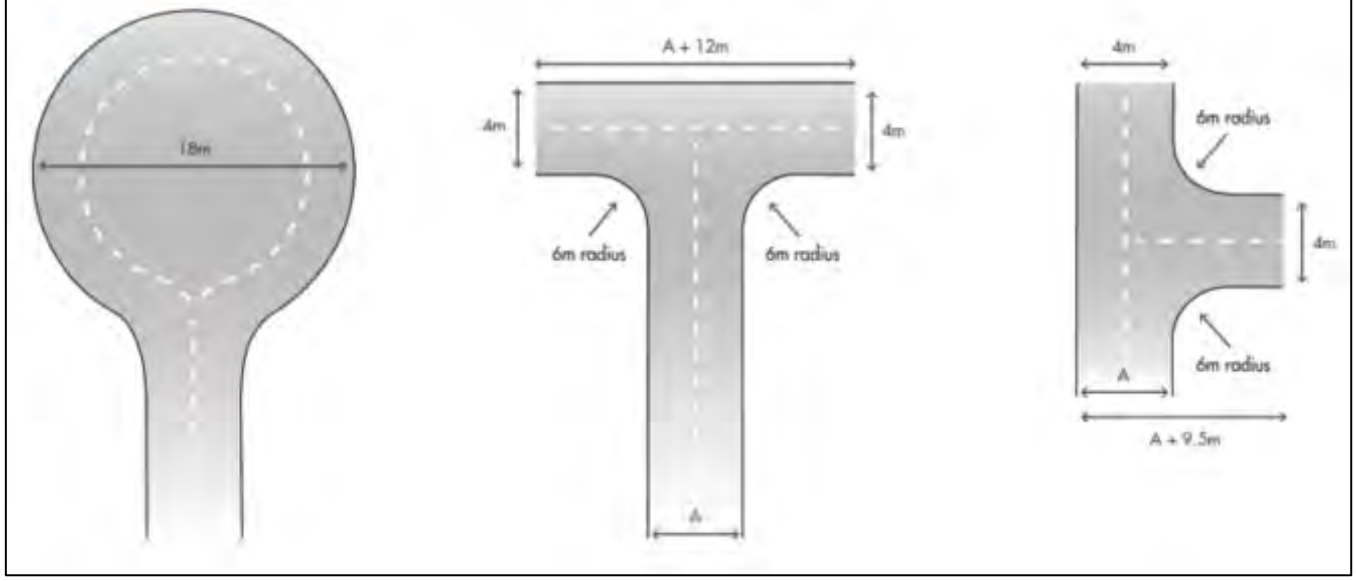
	1		2		3		4		5	
TECHNICAL REQUIREMENTS	**PERIMETER ROADS**		**PUBLIC ROADS**		**EMERGENCY ACCESS WAY[3]**		**FIRE SERVICE ACCESS ROUTE[3]**		**BATTLE-AXE & PRIVATE DRIVEWAYS[1]**	
MAP OF BUSH FIRE PRONE AREAS DESIGNATION	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**
Minimum horizontal clearance (metres)	12	8	See note 5		10	6	10	6	6	
Minimum vertical clearance (metres)	4.5									
Minimum weight capacity (tonnes)	15									
Maximum grade unsealed road[2]	See note 5		See note 5		1:10 (10% or 6°)					
Maximum grade sealed road[2,4]					1:7 (14.3% or 8°)					
Maximum average grade sealed road					1:10 (10% or 6°)					
Minimum inner radius of road curves (metres)					8.5					

Notes:

1. Driveways and battle-axe legs to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision where not required to comply with the widths in this Appendix or the Guidelines.
2. Dips must have no more than a 1 in 8 (12.5% - 7.1 degrees) entry and exit angle.
3. To have crossfalls between 3 per cent and 6 per cent.
4. For sealed roads only the maximum grade of no more than 1 in 5 (20 per cent) (11.3 degrees) for no more than 50 metres is permissible, except for short constrictions to 3.5 metres for no more than 30 metres in length where an obstruction cannot be reasonably avoided or removed.
5. As outlined in the Institute of **Public Works Engineering Australasia (IPWEA) subdivision guidelines, Liveable Neighbourhoods, Austroads Standards** Main Roads standard, supplement, policy or guideline and/or any applicable or relevant local government standard or policy.

TURN-AROUND AREA – DESIGN REQUIREMENTS

Figure 30: Design requirements for a turn-around area



APPENDIX D: TECHNICAL REQUIREMENTS FOR FIREFIGHTING WATER SUPPLY

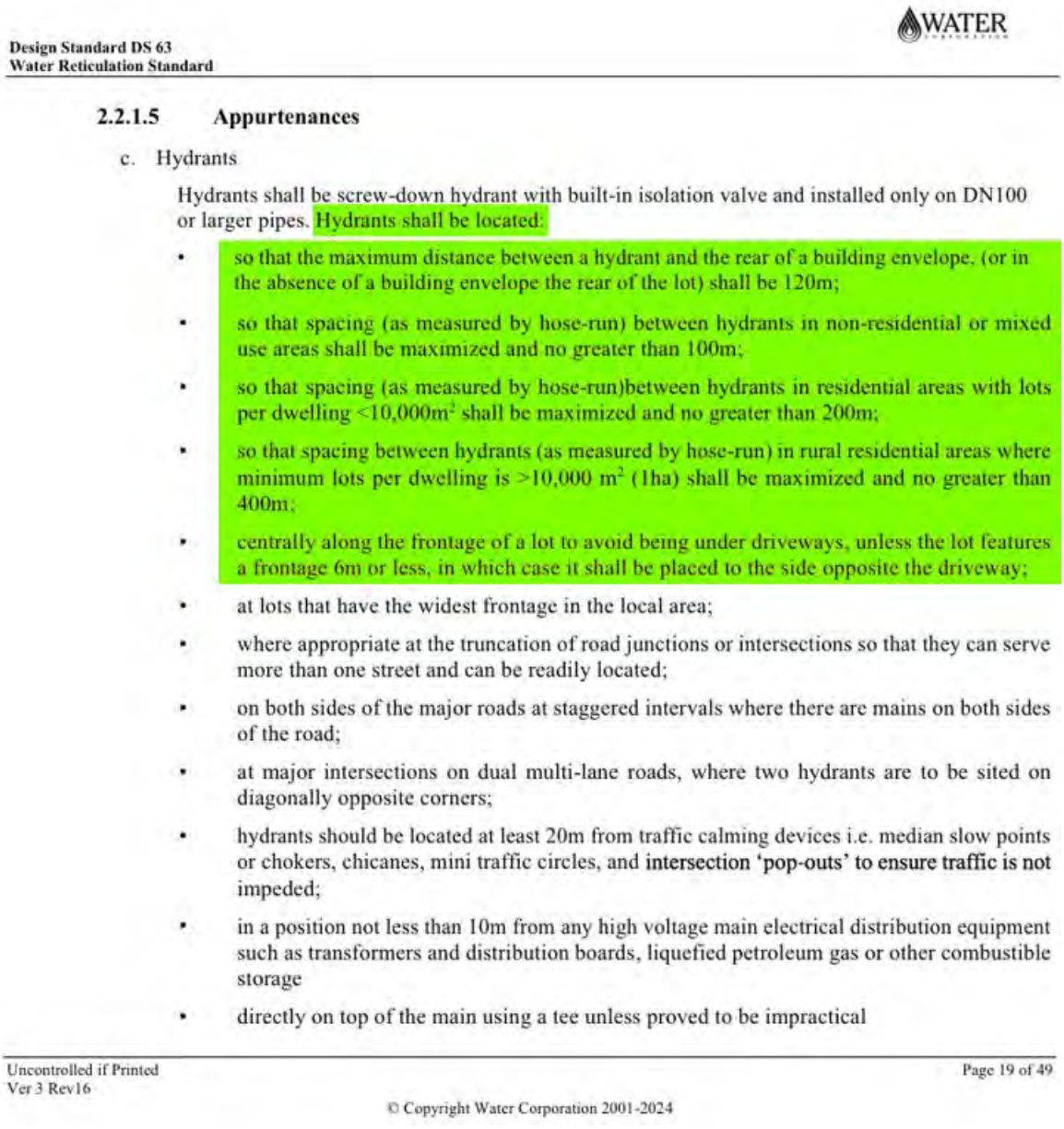
The Planning for Bushfire Guidelines (DPLH/WAPC) (as amended), can be sourced online and establishes:

- In sections 5 to 8, The water supply acceptable solutions (corresponding to a planning stage and land use type), that will achieve the required outcomes of State Planning Policy Bushfire 3.7 (SPP 3.7): and
- In Appendix B4, the water supply technical requirements and general considerations.

The information provided in this Appendix is additional to that provided in the Guidelines. It includes:

- For reticulated water supply, the hydrant location specifications established by the WA Water Corporation (Design Standard DS 63), as dependant on land use type and relevant to bushfire planning assessments (highlighted). Note: the maximum distance from a hydrant to the rear of a lot/building is generally interpreted as not applicable to large lot sizes where the maximum distance becomes an impractical limitation i.e., typically rural residential areas; and
- Images of example installations of acceptable water supply tanks and outlet fittings.

D1: Hydrant Location in Reticulated Areas



Design Standard DS 63
Water Reticulation Standard

2.2.1.5 Appurtenances

c. Hydrants

Hydrants shall be screw-down hydrant with built-in isolation valve and installed only on DN100 or larger pipes. Hydrants shall be located:

- so that the maximum distance between a hydrant and the rear of a building envelope. (or in the absence of a building envelope the rear of the lot) shall be 120m;
- so that spacing (as measured by hose-run) between hydrants in non-residential or mixed use areas shall be maximized and no greater than 100m;
- so that spacing (as measured by hose-run)between hydrants in residential areas with lots per dwelling <10,000m² shall be maximized and no greater than 200m;
- so that spacing between hydrants (as measured by hose-run) in rural residential areas where minimum lots per dwelling is >10,000 m² (1ha) shall be maximized and no greater than 400m;
- centrally along the frontage of a lot to avoid being under driveways, unless the lot features a frontage 6m or less, in which case it shall be placed to the side opposite the driveway;
- at lots that have the widest frontage in the local area;
- where appropriate at the truncation of road junctions or intersections so that they can serve more than one street and can be readily located;
- on both sides of the major roads at staggered intervals where there are mains on both sides of the road;
- at major intersections on dual multi-lane roads, where two hydrants are to be sited on diagonally opposite corners;
- hydrants should be located at least 20m from traffic calming devices i.e. median slow points or chokers, chicanes, mini traffic circles, and intersection 'pop-outs' to ensure traffic is not impeded;
- in a position not less than 10m from any high voltage main electrical distribution equipment such as transformers and distribution boards, liquefied petroleum gas or other combustible storage
- directly on top of the main using a tee unless proved to be impractical

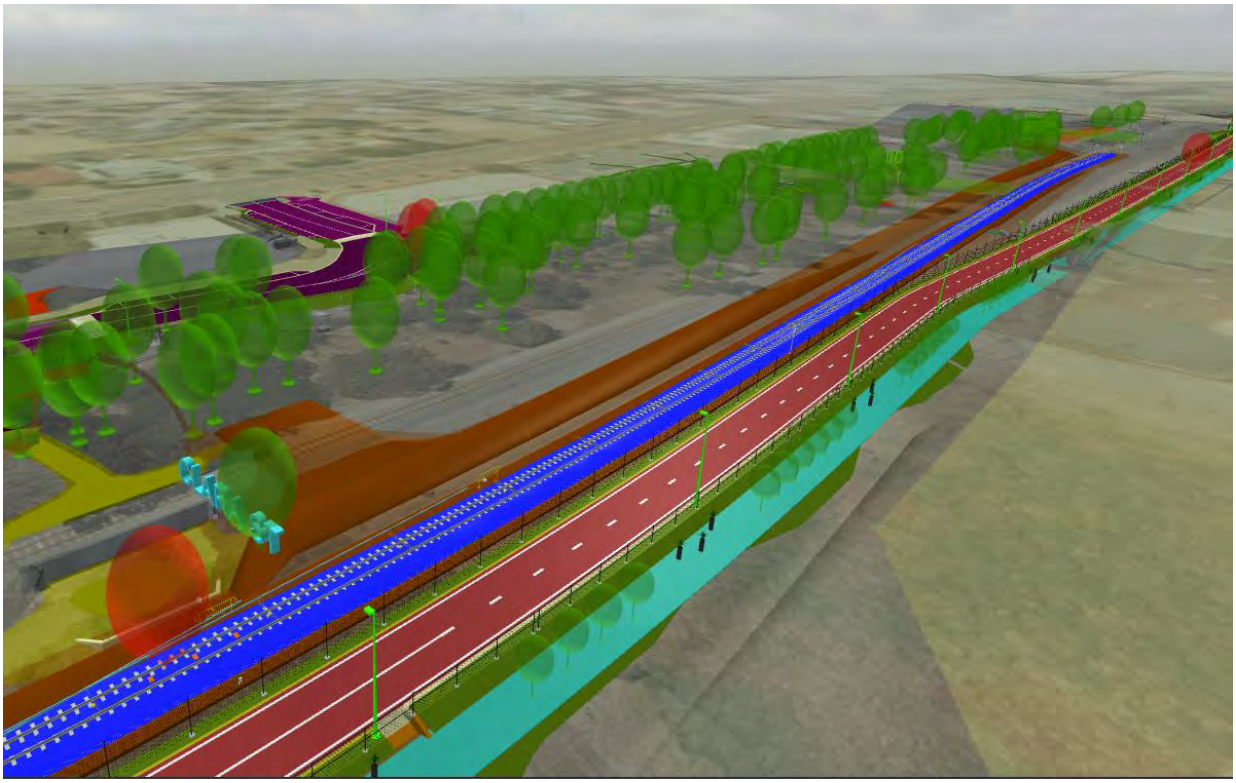
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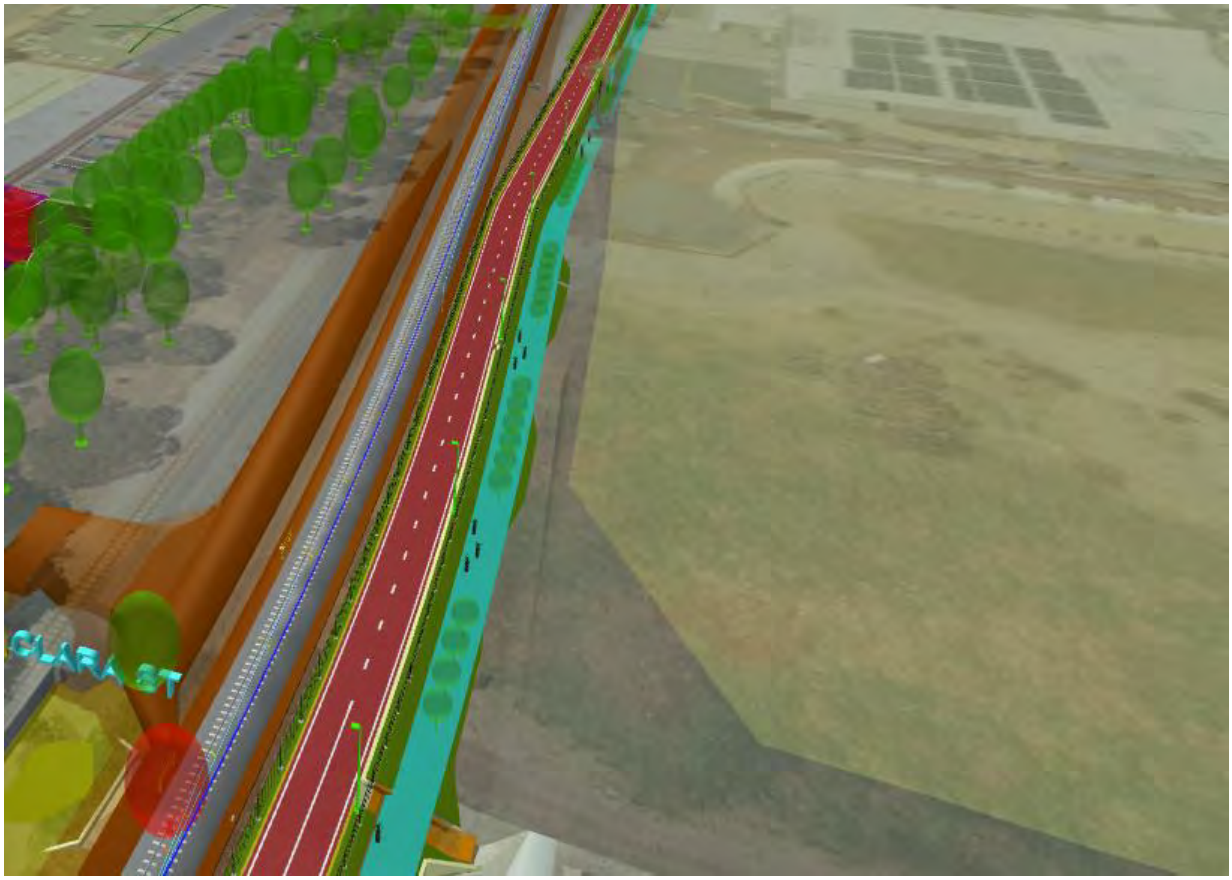
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APPENDIX E: PRINCIPAL SHARED PATH (PSP) DESIGN

It has been agreed upon by Perth Transport Authority (PTA) and the East Metropolitan Health Service (EMHS)that a Principal Shared Path (PSP) will be installed partly on PTA land and partly on EMHS land. This will involve clearing at least 8m of land on the eastern side of the proposed BHH building. It will be the responsibility of both parties to ensure 8m to the east of the building will remain as non-vegetated or low threat vegetation in perpetuity. See initial PSP designs below.





GABRIELS HEARNE FARRELL

ARCHITECTURAL ACOUSTICS DESIGN DEVELOPMENT

BYFORD HEALTH HUB
BLACKBURN ROAD, BYFORD

Rev A - 31st January 2025



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Report Version	Author	Notes	Date
PDP Report	Michael Ferguson		01st May 2024
PDP Report - Rev A	Michael Ferguson	Update to remove GS certification	21st May 2024
PDP Report - Rev B	Michael Ferguson	Change to building classification	4th June 2024
SD Report	Michael Ferguson		9th August 2024
DD Report	Michael Ferguson		6th December 2024
DD Report - Rev A	Michael Ferguson	Include generic comment on products	31st January 2025

Association of Australasian Acoustical Consultants

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1. INTRODUCTION

This Acoustic Report extends the guidance given in the earlier Schematic Design stage, focusing on the architectural acoustic considerations for the Design Development stage of the proposed Byford Health Hub, situated on Blackburn Road, Byford.

This report addresses the specific acoustic challenges and solutions relevant to the project's current design phase, such as acoustic separation between spaces, impact noise transmission reverberation control, and services noise control.

The report is based on the architectural documentation received 28th November, 2024.

This report offers recommendations on specific brands and products for potential inclusion in the architectural documentation. However, it is not a formal specification and should be regarded solely as general guidance on suitable materials. In accordance with the Department of Finance's guidelines, all materials incorporated into the final documentation and specifications must be stated as *"a similar product, equivalent in function, quality, etc., subject to the approval of the Superintendent's Representative."* This the responsibility of the documentation team.

2. ENVIRONMENTAL ACOUSTICS

2.1 Noise Intrusion

2.1.1 *Traffic Noise*

The proposed development is located within relatively minor suburban streets of Byford. Based on expected traffic flows and distances to major roads, we do not currently have any significant concerns regarding potential traffic noise intrusion.

2.1.2 *Rail Noise & Vibration*

Previous correspondence and reporting have been undertaken regarding the immediately adjacent Australind Train line. For more details on this, refer to our PDP report.

In summary, due to the infrequent nature of rail events currently proposed to go past the project site, recommended upgrades to the building fabric are as follows:

- External glazing – Minimum sound reduction of R_w 37 (glass and frame performance). This can be achieved by using 12.5mm Oceania QLam Hush glass in a fixed commercial frame.
- External light-weight wall – Minimum sound reduction of R_w 58 (e.g. 12mm compressed fibre-cement cladding + top-hats + 92mm steel studs with R2.5 90mm fibreglass + 2 layers of 13mm plasterboard.
- The external window on the East façade of each Consulting Room will not exceed 3.6m^2 in area,

Preliminary calculations are indicating that with the above constructions allowed for, the internal noise levels in habitable rooms should remain below the recommended L_{Amax} 50 dB(A) for a train pass-bys. This is also on the assumption that the new Australind trains in development are no louder than the existing trains that these calculations are based off.

Regarding potential vibration intrusion (and associated structure-borne noise), we have received correspondence from the PTA that estimates the following:

- Ground Borne Vibrations 102 dB
- Ground Borne Noise 41 dB

The above values are therefore predicted to fall under the recommended criteria set out in the Byford Rail Extension Design Report R30-SLR-RPT-NV-540-00007 for a commercial building, of L_{vSmax} 112 dB and L_{ASmax} 45 dB respectively, and assuming no critical medical equipment is present.

Based on the available information, we do not anticipate a need for vibration isolation. However, it is important to note that this assessment is based on modelled data. As indicated in our initial PDP report, it would be advisable for the client to consider potential vibration risks and implement mitigation measures through direct measurements once the train network is operational. Additionally, provisions for vibration isolation should be considered by the design team during the documentation phase of the project.

2.2 Noise Emissions

2.2.1 *Environmental Noise Criteria*

The noise emissions from the facility must comply with the Environmental Protection (Noise) Regulations 1997. The Regulations describe a procedure for establishing the Assigned Levels, based on the traffic flow and land zoning within a 100m radius and 450m radius outer circle, relevant to the reference receiver premises.

As indicated in Image 01 below, there is approximately 33% commercial properties within the outer circle, and approximately 43% in the inner circle. There is also approximately 3% industrial properties (train station) within the outer circle. There is also a major road within the outer circle.

Based on this information the Assigned Noise Level's applicable to this development is +6 dB(A).



Image 01 - Influencing Factor Radii

The calculated Assigned Levels for receiver properties adjacent to this site are set out below in Table 01 below.

Type of premises receiving noise	Time of day	Assigned Noise Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises; highly sensitive area. (i.e. within 15m of a residential building)	0700 to 1900 hours Monday to Saturday	51	61	71
	0900 to 1900 hours Sunday and public holidays	46	56	71
	1900 to 2200 hours all days	46	56	61
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays.	41	51	61
Commercial Premises	All hours	60	75	80

Table 01 - Assigned Noise Levels for Adjacent Receiver Positions

The sound level parameters used for the various environmental noise criteria are described below, based on an assessment period of 15 minutes up to 4 hours:

L_{A10} is the 'A' weighted noise level which is not to be exceeded for more than 10% of the time, e.g. for more than 10 minutes in 100 minutes. This is the parameter relevant to most HVAC equipment, and emissions from other longer term noise sources that run for extended duration (such as exhaust fans, cooling towers, condensing units, etc.).

L_{A1} is the 'A' weighted noise level which is not to be exceeded for more than 1% of the time, e.g. for more than 1 minute in 100 minutes, or up to 24 minutes in 4 hours. This is the parameter relevant to noise sources that only occur occasionally, for short durations, (e.g. fire pump / generator testing, etc.).

L_{Amax} is the 'A' weighted noise level for individual events, which is not to be exceeded at any time.

2.2.2 *Adjustments for Noise Character*

Regulation 9(3) requires that the noise emission must be free of annoying characteristics, namely tonality (e.g. whining, droning), modulation (like a siren), and impulsiveness (e.g. thumping). Where noise emissions do exhibit the above noise characteristics, an adjustment is made to the measured/calculated noise level:

Tonality	5dB is added to the measured level
Modulation	5dB is added to the measured level
Impulsiveness	10dB is added to the measured level

Where the noise emission is music the following adjustments to the measured noise levels apply:

Impulsiveness not present	10dB is added to the measurement level
Impulsiveness present	15dB is added to the measurement level

The above adjustments only apply where the noise character is audible and measurable the noise receiver. Typically mechanical units have a +5 dB penalty applied to predicted levels, music has a +10 dB penalty, and general crowd noise is free from penalties.

2.2.3 *Impact on Project*

At mentioned above, potential items for noise to neighbours are as follows:

- Mechanical units, particularly those installed in the rooftop plant deck
- Noise emission from Fire Pumps and Generators during regular testing and maintenance runs.

Each relevant noise source is discussed below.

<u>Mechanical Units</u>

All mechanical noise from the site must achieve compliance with the Regulations. If the centre is proposed to operate after 10pm with after hour care, compliance with the L_{A10} night level of no greater than 36 dB(A) at any noise sensitive receiver position (once taking into account penalties for tonality).

Fortunately the majority of the surrounding properties appears to be commercial in nature, which therefore requires a noise level of no greater than 55 dB(A), once allowing for penalties.

Based on the noise level information and documentation provided by the mechanical consultant, compliance with the Regulations appears to be achieved at all times of the day. If the project team is aware of any neighbouring residential or other noise sensitive (e.g. child care centres) then we must be advised so that the assessment can be updated.

At this stage no further action is required.

<u>Fire Pumps & Generators</u>

Whilst the noise emissions from fire pumps are not required to achieve compliance during an emergency, the potential noise emissions during the regular testing of the equipment must comply with the Regulations. As this testing is typically run for a short duration, this is assessed against a less stringent L_{A1} criteria.

At this stage the project documentation appears to not require a dedicated fire pump. Should this be included in the later stages we must be notified.

Generators on the other hand still have regular testing, however they are not run during an emergency. Due to this generators typically must comply with the more stringent L_{A10} criteria based on run times.

As per the fire pumps above, there does not appear to be any generators currently proposed on the project. Again, we must be notified should this change as compliance with the Environmental Regulations has bene difficult in the past for non "life safety" projects such as this.

3. ACOUSTIC RATED WALLS

To achieve the required level of acoustic isolation between spaces, wall construction with the appropriate Weighted Sound Reduction Index (R_w) performance should be provided. The colour marked-up plan appended to this report (Appendix A) indicates the minimum required acoustic performance of the internal walls, based on the *Wall Types* set out in Table 1 below. The minimum recommended R_w ratings are based on what we understand has been fit-for-purpose on similar previous projects.

Changing the type of plasterboard to a fire rated, sound rated, or impact rated plasterboard will also increase the speech privacy achieved. This can be investigated for cost implications and feasibility where required.

Wall Type	Acoustic Performance	Lightweight Partition	Masonry / Concrete
Type W1 Blue	≥ R_w 42	1 layer 13mm plasterboard 76mm stud frame, 75mm insulation in cavity. 1 layer 13mm plasterboard	90mm masonry rendered both sides *OR* 110mm masonry (no render)
Type W2 Green	≥ R_w 46	2 layers 13mm plasterboard 76mm stud frame, 75mm insulation in cavity. 1 layer 13mm plasterboard	110mm masonry rendered both sides *OR* 150mm special performance brick (no render)
Type W3 Red	≥ R_w 50	2 layers 13mm plasterboard 76mm stud frame, 75mm insulation in cavity. 2 layers 13mm plasterboard	150mm special performance brick rendered both sides *OR* Cavity Masonry wall
Type W4 Yellow / Pink Dashed	≥ R_w 55	2 layers of 13 mm Fyrchek *Rondo Quiet Stud* (92 mm) 90mm insulation in cavity 2 layers of 13 mm Fyrchek	Cavity Masonry wall 90mm masonry - rendered 50mm cavity with no ties 90mm masonry - rendered
Type W5 Yellow	Hydraulic / Discontinuous	1 layer of 13 mm Plasterboard with a minimum 20mm discontinuous gap to the adjacent wall 64mm stud frame, 75mm insulation in cavity	All services to be mounted to hydraulic wall and separated from adjacent wall.

Table 02 – Acoustic Wall Types

GABRIELS HEARNE FARRELL PTY LTD
UNIT 3/2 HARDY ST SOUTH PERTH WA 6151 PH – (08) 9474 5966

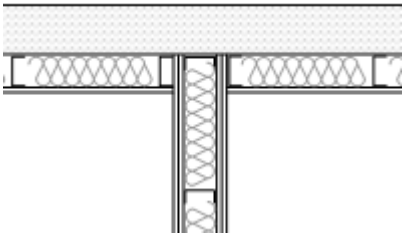
Notes:

- It is essential that fibre insulation provided in stud-framed construction be specified to have density ≥10.8 kg/m^3. It is recommended that 75mm glasswool partition batts are used. If polyester insulation is desired, utilise Martini MAB 14/75 insulation.
- Direct stick plasterboard on masonry walls is not an acoustic equivalent to render. A significant reduction is acoustic rating is likely to result where this lining is applied.
- Stud sizing is based upon acoustics and estimated partition height limits. This must be confirmed by structural and we must be advised before any changes are made.
- Note if 92mm studs are used and impact resistant (or equivalent density) plasterboard is specified for the project, then the above lightweight walls type can have the total number of layers reduced by one i.e. Rw 50 can be achieve with 1 x 13mm impact pb, 92mm stud with 90mm insulation, and 2 x 13mm impact pb.

The minimum wall performance specified on the attached marked-up plans should provide an acceptable level of acoustic separation, provided the ambient noise level in each space complies with AS 2107:2016. If the actual ambient noise levels are too low (i.e. less than the *satisfactory* noise levels stipulated in AS 2107:2016), the specified performance for walls may not be adequate.

3.1 Junction of Wall and External Façade / Glazing

3.1.1 *External Façade*



The junction of an internal partition and an external lightweight façade can be a noticeable acoustic weakness in the overall separating system from one room to another. This is due to the limited acoustic performance of this internal lining of the external façade creating a flanking noise path. It is critical that this junction is upgraded to meet the acoustic performance of the partition wall.

Typically this is achieved by continuing the internal partition through the internal lining of the external wall, through to the external concrete/masonry leaf. This can be seen in the above plan diagram. If this cannot be constructed then the number of internal layer of plasterboard (on the external wall) may need to be increased to maintain the over system performance e.g. 2 layers of plasterboard to all internal linings.

External Mullions

Where internal partition systems meet and external mullion, it is critical that the acoustic separation is not downgraded by the lightweight aluminium mullion typically present in these types of facilities. Ideally the plasterboard of the separating partition system is to be extended out to the external glazing, covering each side of the window mullion (see Option 01 in the following section of this report).

If this cannot be achieved then depending on the performance of the separating partition system it is plausible that the window mullion itself can be acoustically upgraded. Typically this is achieved via the installation of mass loaded vinyl and steel plating adhered to the side face of each side of the window mullion, with sealing of any junctions with flexible mastic type sealants. Details of this can be provided where required.

External Glazing

On this project there are some areas where internal partitions meet external glazing elements. In order to maintain the performance of the internal separating partition the detailing of this junction is critical. Below are two recommended options for detailing:

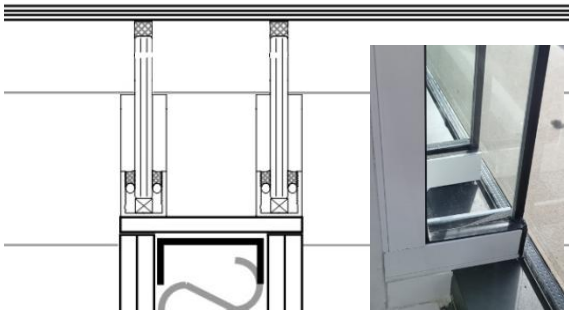
Option 01

Our preference is for the plasterboard of the internal partition to be continued out and sealed to the external glazing. This will require the cutting out of the plasterboard around the window sill, as seen in the image below.



Option 02

In some circumstances the detailing provided in Option 01 can be difficult due to either the façade movement, or aesthetically where mullions are not present. Another option to maintain this partition performance is to provide an acoustic double glazed detail with 12.5mm VLam Hush or equivalent in separate glazing channels, sealed to both the partition and the external glazing.



It should be noted however that Option 02 may not be feasible for rooms with a separating partition above R_w 50. In these instances we would require the partition system to be continued through to the external glazing, like in Option 01.

General Note

It is critical that other flanking paths typically observed in these areas do not downgrade the acoustic performance of the separating partition. Typical weaknesses include window sills, continuous skirting boards or linear grill systems, roller blind bulkheads, etc. It is our current assumption that any of the aforementioned acoustic weaknesses can be resolved by the separating partition extending through these elements i.e. window sills and existing linear grills can be cut and separating partitions extended through to meet the external façade.

If this cannot be undertaken then the acoustic separation will be significantly compromised. The client must be made aware of this limitation if pursued.

4. OPERABLE WALLS

It must be noted that whilst operable walls provide flexibility in terms of use of space, they do not provide a high level of acoustic isolation. Unfortunately operable walls cannot provide the same level of acoustic isolation as a high performance permanent stud framed or masonry wall.

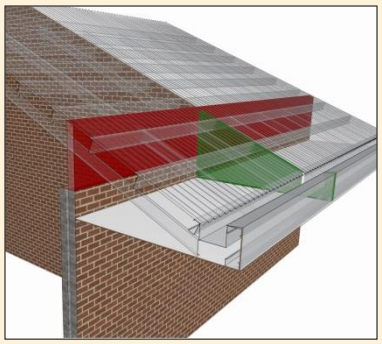
At this stage the current documentation does not appear show any operable walls. If this changes through the design of the project we can provide advice accordingly, with particular care taken to the details of the surrounding wall elements.

5. FULL-HEIGHT WALLS

Many of the walls in this project need to be taken full-height right up to the underside of the roof sheeting above. This is required to control room-to-room noise transmission via the ceiling space.

It is assumed that all external perimeter walls are documented as full height construction with fully sealed eaves. If this is not the case we **must** be notified so that appropriate advice can be provided. Otherwise, acoustic flanking via the eave space between rooms can become a significant problem.

It is important that all perimeter open eaves are closed off with a full height wall detail. This can either be achieved via the perimeter wall continuing up to the underside of the roof sheeting above (red area in the adjacent image), or by continuing the separating partition walls out to the edge of the eave lining (green area in adjacent image).



Full height walls are compulsory around spaces that contain perforated ceilings, given that perforated ceilings do not act as a barrier to noise transmission. The required full height walls are clouded in red on the attached plans. It is critical that an air-tight seal is achieved where the walls meet the underside of the roof sheeting / floor slab above:

- For stud framed walls, the plasterboard sheeting must push up against the Anticon roof insulation. The plasterboard sheeting must be cut around the purlins, with the resultant gaps sealed with a non-setting flexible sealant (similar to how a fire wall would be detailed).
- For masonry walls, stud framed construction can be used between the top of the masonry wall and the underside of the roof insulation to create full height walls. The stud framed construction must be as per the table of Wall Types above, correlating with the colours on the marked-up plans.

It is important that the portions of full height wall above ceiling level are not compromised by mechanical and electrical services. Some issues to consider include:

- Avoid having mechanical ductwork penetrating full height walls. Where this is unavoidable, ensure an air-tight flexible seal is achieved around the duct at the wall penetration. This is often achieved by inserting high density fibreglass insulation into the small gap around the mechanical duct, then installing steel angles in front of the gaps to cover the insulation. Further information can be provided where required.
- Avoid having cable trays passing through full height walls. Where this is unavoidable, special detailing is required to ensure an air-tight seal is achieved at the penetration. If cable trays must pass through full height walls, the best location for the penetration is above the door to the room in the ceiling space. We can provide a schematic detail for this penetration, if required.
- Cable trays must not pass through walls rated at or above R_w 50. Where this is unavoidable the cable tray must stop before the wall with cables being bundled, passed through conduits and sealed through the wall penetration. Conduits must not be more than 50mm individually.

5.1 Partial Full Height Walls

In some areas of the proposed development the attenuation provided by the Mineral Fibre Tile Ceiling and insulation outlined in Section 8 of this report will be adequate. However where Consulting Rooms requiring higher levels of privacy (or video conferencing rooms) face on to one another this flanking path is recommended to be upgraded with a partial full height wall construction.

In areas clouded blue, a single layer of plasterboard continued up to the floor slab / roof sheeting above can be installed (on only one side of the stud framework). All penetration through here must be adequately sealed. Alternatively to the layer of plasterboard, a suitably installed Baffleblock / Martini Flankguard system should also provide adequate acoustic attenuation through this ceiling flanking path.

6. INTERNAL DOORS

Acoustically, doors form the weakest link in a wall system. It follows that special attention to the performance and detailing of doors is required.

Where a basic level of noise control is required, doors should be provided with full perimeter rubber acoustic seals (frame seals and drop seals such as Raven RP10 & RP38 or Raven RP126 & RP78). The door itself should be either 38mm solid core or 10.38mm laminated glass in a high quality metal frame.

Note – A 38mm solid core door with seals will achieve a transmission loss performance of around R_w 28 to 30. This is noticeably lower performance than the wall types detailed in Section 3. As such, speech privacy is not possible even though an acoustically sealed door. Door grilles negate the acoustic performance of doors and must not be used in solid core doors. If 'Return Air' is required, it should be via acoustic air-transfer ducts, not door grilles.



The locations where it is recommended that acoustically sealed solid core or glazed doors be implemented are indicated on the attached marked-up plans (doors coloured in solid red).



If possible it is recommended that doors on to critical areas are upgraded to a 50mm solid core door. This thicker door will provide an increased level of privacy and is particularly relevant where the distances between entry doors cannot be maximised, or doors open onto noise sensitive rooms from public spaces. Higher quality acoustic seals are also typically recommended on these doors e.g. Raven RP10 & RP38's.

Note some doors on the marked-up floor plans have been recommended for the acoustic upgrade to 50mm doors. This is based on discussions with the project Architect as well as previous projects, however this upgrade should be considered for all areas where an increased level of acoustic privacy is desired.

6.1 Sliding Doors

It should be noted that generally sliding doors do not achieve the same degree of acoustic performance compared to sealed solid swing doors. To achieve a similar rating requires use of engineered acoustic sliding system, which can unfortunately come with a related increase in cost.

We recommend the acoustic rating of the selected system to match at least that of a sealed door in the same location, with is typically in the order of R_w 30. A range of proprietary acoustic rated sliding doors have been developed by Lotus Folding Walls & Doors Pty Ltd, or Glyde Architectural Acoustic Systems. It is critical that details of any proposed system are reviewed such that full perimeter acoustic seals can be confirmed.

7. INTERNAL GLAZING

A minimum of 10.38mm laminated glass is recommended throughout all internal glazing. 10.38mm laminated glass within an aluminium frame will achieve around R_w 32 performance. Unfortunately this will not provide speech privacy nor will it render typical activity noise 'inaudible' within adjacent rooms.

Whilst this arrangement has typically been used in the past, the client must be made aware of this limitation. Due to this limitation it is recommended that glazing is removed or significantly reduced in size where speech privacy is a concern.

Further to the above information we have been advised that the project it is our understanding that the State Government TG040 Technical Guideline *"Environmentally Sustainable Design Guideline for Non-Residential Government Buildings"*, may be applied to this project. One of the criteria to achieve compliance with the GreenStar minimum criteria is achieving the minimum acoustic separation.

The specific details of this are outlined in Section 15 of this report, however in summary if the acoustic credits are to be claimed for this project then 10.5mm VLam Hush glass will be required for internal glazing. Note this only applies to "regularly occupied areas", which to our understanding glazing to general corridors do not require this upgrade.

8. CEILINGS

All large, multi-occupancy spaces require acoustically absorbent ceilings for the purpose of reverberation control. This is necessary such that compliance with Australian Standard 2107 is achieved. The acoustically absorbent ceilings should achieve a minimum Noise Reduction Coefficient (NRC) of 0.75. The attached marked-up plan identifies the recommended ceilings for this project, based on the ceiling types below.

8.1 Acoustically Absorbent Ceilings



Acoustically absorbent ceilings are recommended to any multi-occupancy spaces in order to control reverberation. Without acoustically absorbent ceilings, the reverberation will not be compliant with Australian Standard 2107:2016, and the spaces will be perceived as 'noisy'. The selected acoustically absorbent ceiling must be specified to achieve a minimum Noise Reduction Co-efficient (NRC) of 0.75. Options include:

Perforated plasterboard with a minimum of 75mm glasswool insulation over, including,

- Boral Echostop 12mm Square Hole or 13.5mm Round Holes
  https://www.usgboral.com/content/dam/USG_Boral/Brochures/Internal%20Linings/Final%2013467_Echostop_PDS_LR.pdf
- Vogl seamless perforated plasterboard – VF8/18R, VF12/25R, VF15/30R, VF12/20/66R, VF8/18Q, VF12/25Q, and VF5/82/15.4SL
  http://www.decorsystems.com.au/products/#/seamless-perforated-plasterboard/

Perforated/slotted timber ceilings, with 75 mm glasswool insulation over, including,

The selected product must have a percentage of perforations of at least 18%. Suppliers include:

- Supawood
  http://supawood.com.au/
- DecorPly from Décor Systems
  http://www.decorsystems.com.au/products/#/perforated-acoustic-panels/

Perforated/slotted fibre-cement ceilings, with 75 mm glasswool insulation over, including,

The selected product must have a percentage of perforations of at least 18%. Suppliers include:

- DecorLux from Décor Systems
  http://www.decorsystems.com.au/products/perforated-fibre-cement/
- Cemintel
  http://ceilingdistributors.com.au/wpcproduct/cemintel-perforated-fibre-cement-panels/

NOTE – Perforated ceilings must only be painted using rollers. Spray application of paint is not permitted as this will clog the perforations and reduce the acoustic performance of the system. Therefore if colours other than white are specified a specific "colour-through" type plasterboard may be required in order to continue the finished ceiling colour inside the perforations. Otherwise the white core of the plasterboard material is likely to be clearly visible when viewed on an angle across the room.

Further to the above, it is important to note that when applying coloured paint to perforated ceilings, it is advisable to use a roller with a short nap and avoid overloading it with paint. Excessive paint or a roller with a long nap can cause the paint to unevenly fill the perforations, resulting in a mottled appearance. Therefore, it is preferable to apply multiple thin coats rather than a single thick coat.

8.2 Mineral Fibre Tile Ceilings



Mineral fibre tile ceilings can act as an acoustically absorbent surface to reduce reverberation time (and therefore increase speech privacy, particularly in open plan areas) as well as act as a limited barrier between rooms. In typical office spaces, if the mineral fibre tile selected has a CAC (barrier) performance of at least 40, then with the addition of ceiling insulation each side, a full height wall is no longer required. However this will only maintain the acoustic separation between rooms separated by a 'green' rated

partition system, and unfortunately due to the higher levels of speech privacy required on this project these areas are minimal. It should be noted though that a lower rated CAC performance may have an impact on the type of full height barrier required, as per Section 5 of this report.

It is also critical that the specified acoustic tile has a minimum NRC performance of at least 0.70.

For any new mineral fibre tiles, a recommended product is the Armstrong Ultima+ MFT's with fibreglass insulation of at least 75mm thickness over. Note **do not** specify the Ultima **OP** tiles, as these are designed for open plan spaces only and provide minimal barrier performance.

It is also strongly recommended that square edge tiles are used as these form a far better seal to the head track of the partitions. An angled tegular edge tile will not maintain the recommended acoustic performance. Alternatively partitions can penetrate the ceiling systems by approximately 100mm if tegular edges are preferred for aesthetic purposes.

8.3 Flush Plasterboard Ceilings



Plasterboard ceilings should be 13mm with cornice to walls, to form an effective acoustic seal around the perimeter of the space. For acoustic purposes at least 75mm insulation must be provided over. Ideally light fittings should be surface mounted to avoid downgrading the acoustic barrier integrity of the plasterboard. This is because most flush plasterboard ceilings are required to act as a barrier to room-to-room flanking sound transmission via the roof spaces.

9. FLOORS

9.1 Impact on Hard Flooring - As Noise Source Within a Space

Noise of footfall / hard soled shoes and general impact noise from furnishing on hard flooring can be significant within a space. In relatively reverberant spaces this can create a noticeably noisy environment.

Furniture movement on hard flooring can also be a particular concern, (e.g. chairs/stools on vinyl flooring). Carpet is the most effective method of dampening this noise at the source, however we understand this is not practical in some environments. Acoustically absorbent ceilings are recommended to all areas with hard floors, with the possible exception of rooms requiring a flush finish due to health or security considerations.

In spaces where hard wearing (typically acoustically reflective) flooring is required, the extent of acoustic absorption in these ceiling zone should be maximised as far as is practical. Wherever practical, we strongly recommend that flush perimeter borders be reduced to an absolute minimum, or deleted altogether, in order to maximise the effective area of acoustic absorption. Typically we recommend a minimum absorptive area of at least 80% of the room floor area.

9.2 Impact Transmission to Spaces Below Hard Floors

Impact noise transmission through the floor systems is dependent upon the floor covering and impact isolation treatments above the floor slab / lightweight structure. Where carpet is used, the impact noise transmission associated with foot-fall and furniture movement will be adequately controlled. However, hard floor finishes need to be considered in terms of impact noise transmission.

Where a tiled, vinyl or timber floor is used, it is strongly recommended that a proprietary rubber acoustic underlay. Examples of suitable acoustic underlays include:

- Regupol Sonus Multi 4.5
- 5mm Embelton Impacta-Mat, or similar approved

Alternatively, a vinyl product with an inbuilt impact isolation layer can be used. An examples of this material is Tarkett Tapiflex Excellence.

This is particularly relevant to any rooms that have impact noise present e.g. Exercise and Rehabilitation room. Whilst carpet is the preferred material floor these rooms we understand this may not be practical for the intended room use.

Within the rehab room itself it is recommended that any equipment that has structure-borne noise potential be provided with a suitable acoustic underlay between the unit and the floor slab e.g. rubberised matting under treadmills. Rubberised flooring for any free weight areas is also recommended.

9.3 Airborne Noise Transmission

For floors slab separating general purpose spaces, 150mm concrete with suspended mineral fibre tile ceilings below is generally adequate to control vertical room-to-room airborne sound transmission.

9.4 Stairs

All stairs are to be mass concrete, which is acoustically beneficial to reduce impact noise transmission. Lightweight framed stairs are prone to generating significant structure-borne / impact noise, particularly when used by groups, or when a person 'bounds' up or down.

10. SPECIALIST AREAS

10.1 General Flexible Therapy

The updated Design Development ceiling plans are now showing large flush plasterboard margins in all rooms. In smaller rooms this creates a significant drop in acoustic absorption, which typically requires additional wall absorption to compensate for the loss on the ceiling plane.

Additional absorption can be in the form of 25mm Autex Quietspace or similar, to be applied in all rooms with flush margins. Generally allowances should be made for approximately 10% of the floor area of the room, to be as evenly distrusted as possible.

10.2 Virtual Consult Rooms

Rooms that are regularly used for teleconferencing are generally recommended to have both a lower background noise level and reverberation time to meet AS 2107 recommended criteria. The lower background and higher vocal effort usually associated with these activities also typically requires a higher acoustic separation between the rooms.

Since the Schematic design stage it appears that these rooms have been relabelled as general Flexible Therapy rooms. We understand the desire for flexibility, however if the intent is to provide some rooms where the majority of use is video consulting, then the below rain noise barrier should be considered, along with higher rated acoustic separation in the form of R_w 55 walls i.e. Wall Type 4 in Table 02, and at least 50% of the available wall area in each room to be covered with 25mm Autex Quietspace or similar approved acoustic absorption.

10.2 Rain Noise

To control the intrusion of rain noise to an adequate level, the typical construction in an office type environment is:

- Colorbond roof sheeting
- Min 75mm foil faced Anticon insulation, compressed between the roof sheeting and purlins
- Mineral Fibre Tile ceilings with a CAC performance of minimum 40, with minimum 75mm fibreglass over

Where perforated ceilings are proposed on the upper floor then additional measures of attenuation may be warranted. Typically this is only applied to private office spaces and meeting / boardrooms, with foyer / waiting areas deemed acceptable to have a higher level of intrusion allowed.

Where a higher degree of noise intrusion is required e.g. video conference rooms etc. then either an additional plasterboard barrier can be installed underneath the roof purlins, or the ceiling material can be increased to have a higher barrier performance e.g. 2 layers of flush plasterboard with insulation over. If flush plasterboard ceilings are used then reverberation control should still be considered in habitable rooms.

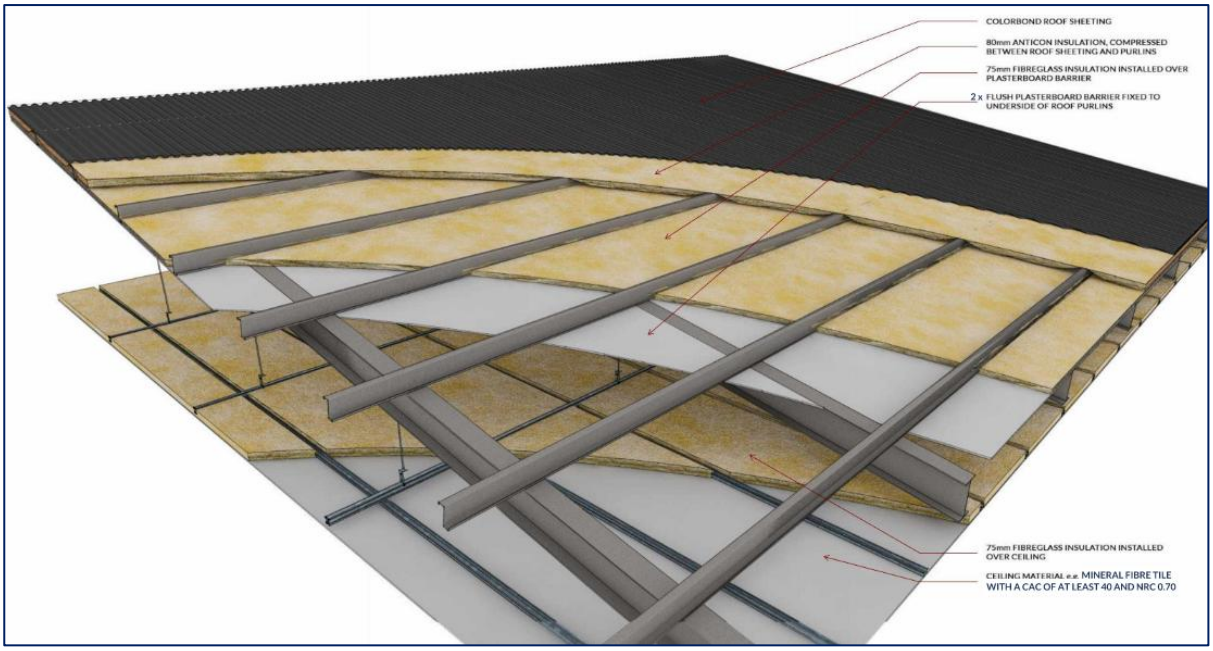


Image 01 - Rain Noise Barrier, if required for Noise Sensitive Rooms

10.3 Isolated Sub-Station Slab

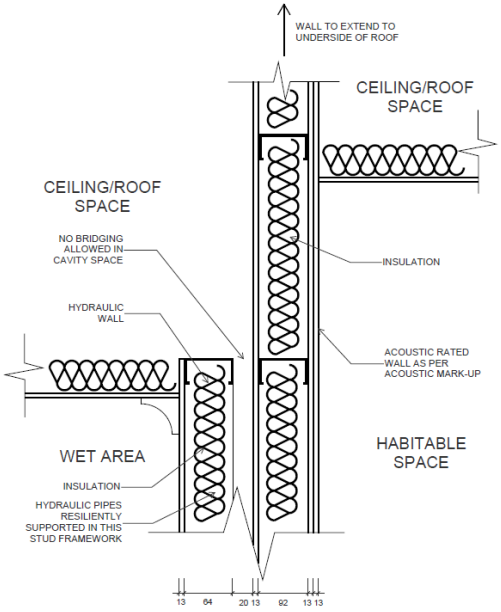
Although the Transformer Room is located on the ground floor, there is still the potential for structure-borne noise transmission from electrical units travelling to the levels above. Due to this, it is recommended that a separate slab with a discontinuous gap around the perimeter of the room is documented. Flexible sealant with an Ableflex insert is permissible to be specified to fill the cavity space.

11. HYDRAULIC SERVICES

11.1 Hydraulic Walls

Structure-borne noise generated by water supply pipes, waste pipes, and hydraulic fittings can radiate noise into adjoining areas. The hydraulic fittings and lines must be carefully considered in terms of their impact on adjoining noise sensitive areas. These walls can also be beneficial in areas where noise generating activities are proposed on benchtops adjacent to noise sensitive spaces.

Based on our review of the project documentation we would recommend that sacrificial hydraulic walls are constructed where nominated on the marked-up floor plans (yellow lines). These are to be constructed of a 64mm stud frame with a single layer of 13mm plasterboard and 75mm fibreglass in the cavity space. The sacrificial framework should incorporate a minimum 20mm discontinuous construction from the adjacent partition. Only the main partition needs to extend to the underside of the roof sheeting, if indicated on the marked-up floor plans provided.



11.2 Hydraulic Services

Any hydraulic services, such as waste pipes and rain water pipes, located adjacent to or above habitable spaces must be wrapped in an acoustic lagging material such as Pyrotek 4525c. Double wrapping is to occur over critical spaces, such as focus rooms or meeting rooms.

11.3 Hand Dryers & Roll Holders

Similar to cisterns, ideally these items should not be located on walls common to noise sensitive spaces. Where this must occur onto particularly sensitive spaces, we recommend a structurally discontinuous wall system to reduce structure-borne transmission.

We strongly recommend hand dryers not be incorporated into wet areas where adjacent areas may be affected by breakout noise. If this is of a concern then dedicated acoustic lobbies or fully sealed entry doors will need to be considered. Breakout via single doors will otherwise be very noticeable, particularly if undercut.

11.4 General Hydraulic Guidelines

Hydraulic systems shall be selected and installed for quiet operation. The following guidelines represent good acoustic practice and are provided to assist in achieving the noise and vibration criteria established above. It is not intended as a complete specification for acoustic control of hydraulic services. This is addressed by the hydraulic consultant in the hydraulic specification for this project.

Of particular note are any services from the upper floor toilet areas running above habitable ceiling spaces below. It is strongly recommended that these are wrapped in loaded vinyl such as Pyrotek 4525.

a) *Supply Pressure*
It is important that domestic hot and cold water is not supplied at excessive pressure. This results in excessive noise being generated at taps, shower mixing valves and toilet valves. The water should be supplied at the minimum pressure to provide satisfactory flow of water to basins etc. The maximum pressure recommended is:

   i. 340 KPa for main distributor lines, and
   ii. 240 KPa for floor feed lines.

b) *Pipe Velocities*
Hot and cold water reticulation velocities should not exceed 1.2 m/s in pipes up to 50 mm in diameter. This applies to pipe-works in walls common to noise sensitive spaces.

c) *Water Supply Ring Mains*
These pipes shall not pass over noise sensitive (ambient noise criteria < 40 dB(A). If this cannot be avoided, then the pipes shall be resiliently fixed and wrapped in Pyrotek 4525.

d) *Pipe Fixings*
All reticulation pipework within the building particularly in plumbing ducts, and suspended ceilings contiguous to noise sensitive and public spaces should be installed so that it is neither in contact with nor rigidly fastened to structural or architectural elements of the building. All pipework including hot and cold water reticulation should be properly supported by resilient pipe hangers e.g. *Binder* clips. Alternatively for smaller diameter pipes, use 13mm closed cell nitrile rubber between pipe and clamp can be used.

Reticulation pipework in vertical plumbing ducts should be connected to the wall on the service side of the plumbing duct. Pipes must not be in contact with the wall on the habitable side of the duct. If required wrap pipework in a closed cell nitrile rubber, e.g. Bradflex.

All local supply pipework embedded in walls is to be fastened and fully grouted. Pipework shall not be embedded into walls directly connected to adjacent noise sensitive spaces unless vertical vibration isolation is incorporated in the construction between the valves and the adjacent area, e.g. cavity walls with no ties.

e) *Pipe Penetrations*
All pipework penetrating building walls should be installed in steel pipe sleeves with 10 to 15 mm fibreglass packing between the pipe and the sleeve to minimise transmission of hydraulic vibration from the pipe into the structure. Plumbing pipes shall be fully isolated from the building structure

f) *Bends*
Use radial bends in preference to 90° elbows.

g) *Water Hammer*
The water supply system shall be designed to be free of water hammer.

12. ELECTRICAL SERVICES

This section establishes general guidelines for within this project for the general installation of electrical equipment.

12.1 Light Fittings in Acoustic Barrier Ceilings

Where ceilings are designed to provide sound transmission loss performance (i.e. non-perforated materials), special care is required in the location of recessed light fittings. Recessed light fluorescent light fitting are recommended to be solid metal boxes designed to maintain the design sound reduction performance of the ceiling. Open recessed down lights are not permitted.

12.2 Back to Back Power Points

Standard electrical switch boxes must not be installed in a back-to-back arrangement within any of the acoustically rated walls (i.e. walls with an R_w rating greater than 40). If back-to-back switch boxes are unavoidable, then fire/acoustic rated switch boxes must be used, such as those manufactured by Promat, Clipsal, and HPM.

Standard electrical switchboxes can be used where they offset horizontally by a minimum of 300 mm as well as a vertical stud being located between the two boxes.

For walls rated R_w 55 and above we recommend the specification of fire/acoustic rated wall boxes, as well as locating a stud between GPO's on the same wall i.e. offsetting by no less than 300mm as well as acoustic boxes.

12.3 Penetrations

All electrical penetrations through walls are to be packed with fibreglass insulation fully sealed on both sides of the wall with acoustic sealant.

13. MECHANICAL SERVICES

13.1 Indoor Design Sound Levels - AS/NZS 2107:2016

The duct-borne noise and noise from any Fan Coil Units should comply with the design sound levels for the following spaces, as established in Australian Standard AS/NZS 2107:2016 *"Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors"*. Relevant design values are summarised below:

	Recommended Ambient Design Sound Level	
Type of Space	*Lower Range*	*Upper Range*
Administration - Open Plan	40 dB(A)	45 dB(A)
Administration - Private Offices	40 dB(A)	45 dB(A)
Administration - Executive Offices	35 dB(A)	40 dB(A)
Counselling / Interview Rooms	40 dB(A)	45 dB(A)
Video Consult Rooms	30 dB(A)	40 dB(A)
Conference / Boardrooms	35 dB(A)	45 dB(A)
Public / Waiting Areas / Corridors	40 dB(A)	50 dB(A)
Reception Areas	40 dB(A)	45 dB(A)
Staff Breakout Areas	40 dB(A)	45 dB(A)
Toilets	50 dB(A)	55 dB(A)

Table 03 – AS 2107:2016 Design Sound Levels

Design to control duct-borne noise (room noise levels) and appropriate equipment selection is responsibility of the Mechanical Services Design Consultant.

13.2 Maintaining Acoustic Isolation

In areas requiring acoustic isolation it is essential that any mechanical ductwork and air transfer systems do not downgrade the acoustic performance of the architectural barrier systems provided. This is particularly relevant for areas where the ceilings are used as a return air plenum.

All penetrations through the walls and barrier ceilings are to be fully sealed and provided with appropriate acoustic attenuation treatment. Where required comment on details provided can be made.

13.3 Noise Intrusion from Mechanical Equipment

Noise intrusion from mechanical equipment located in the ceiling space can be problematic. An assessment has been undertaken based on the provided noise level information and documentation by the mechanical consultant. Below are the results of this review.

13.3.1 *Mech Deck Areas*

There are multiple locations around the project's upper floor where fan coil units are located within the ceiling space in groups. Based on the noise levels provided and the recommended ceiling types, noise intrusion to the habitable spaces below appears to meet AS2107 noise levels.

This is on the basis of all ceilings below plant decks being either Mineral Fibre Tile ceilings (with a CAC performance of no less than 40, and fibreglass insulation over), or flush plasterboard. If perforated ceilings are located within 4m of any plant deck then we must be notified so that a review can be undertaken.

13.3.2 *High Level Windows*

The proposed development has many high level windows throughout the project. Some of these windows overlook the plant deck, where the external noisy equipment is located.

Calculations have been undertaken to determine the glazing required to limit noise intrusion to AS2107 levels. Based on this information, 12.5mm VLam Hush glass or equal approved is recommended for any fixed glass overlooking plant areas. This is to achieve an acoustic rating of no less than R_w 36.

If thermal double glazing is required for thermal purposes (i.e. an air gap of approximately 12mm), then one pane of glass must be at least 10.38mm laminated glass.

13.4 Mechanical Plant – Vibration

All dynamic elements of building services must incorporate suitable vibration isolation from the building structure to reduce vibration transmission to the building elements, which can result in structure-borne noise.

All condensing units, fan coil units, pipework, ductwork and all associated mechanical equipment shall be selected and installed for quiet and vibration free operation such that regenerated / structure-borne noise does not exceed the design sound levels set out in AS 2107.

14. SOUND MASKING SYSTEMS

As noted previously, the background noise level in office spaces and counselling rooms plays a critical role in the speech privacy achieved by any separating partition system. The lower the background noise level the more audible any speech intrusion will be from adjacent spaces.

In a typical office type environment the air-conditioning / computer fans are enough to create a reasonable background noise level relative to the recommended AS2107 levels. However if the office mechanical systems are particularly quiet, or have significant periods without operation, then additional masking noise may be required to maintain a minimum background / ambient noise level.

At this stage it is recommended that masking systems are considered for any areas where speech privacy is considered critical, such as the mental health area. Whilst still recommended throughout the project if possible, it is not normally installed in general consulting rooms from the outset. If the mechanical systems are particularly quiet due to the efficiency of the final building, then masking systems may need to be retrofitted in specific areas of concern. It is our understanding that it is reasonably practical to retrofit masking systems after practical completion if required.

15. GREENSTAR TG040 REQUIREMENTS

It is our understanding that the State Government TG040 Technical Guideline *"Environmentally Sustainable Design Guideline for Non-Residential Government Buildings"*, may be applied to this project. The following advice is in accordance with meeting the intent of this guideline, however it is not intended for full certification purposes. Details of this can be discussed as required.

The following advice should be read in conjunction with the above recommendations. Whilst the majority of above advice is likely to cover compliance with the GreenStar credits, some areas require a higher level of acoustic separation for GreenStar compliance, and some walls are recommended to be beyond that required for GreenStar compliance.

The current GreenStar Buildings guidelines contains 2 credits points available for providing acoustic comfort to the building occupants. These credits are claimable based upon the building acoustics applicable to the class of development, as follows:

Project Type	Maximum Internal Noise Levels	Minimum Internal Noise Levels	Acoustic Separation	Impact Noise Transfer	Reverberation Control	Requirement for 2 points
Residential (Class 2, 3 & 9a)	•		•	•		2/3
Healthcare	•		•	•	•	3/4
Schools	•	•	•	•	•	3/5
Fit-Out (commercial)	•	•	•	•	•	4/5
Fit-Out (retail)	•		•	•	•	3/4
Base build (commercial)	•		•			2/2
Base build (retail)	•		•			2/2
Sport & Leisure	•		•	•	•	3/4
Industrial	•		•			2/2

Table 04 – Green Star Building Requirements for Acoustic Comfort

We have assumed that the project is to be deemed **Fit-Out (commercial)**. Therefore, the applicable requirements to achieve the 2 acoustic credits is a minimum of **four** of the following criteria:

- Maximum Internal Noise Levels
- Minimum Internal Noise Levels
- Acoustic Separation
- Impact Noise Transfer
- Reverberation Control

If required, an additional "Acoustic Comfort Strategy" can be provided upon final testing and submission to the GBCA. If the project does not require full certification then final testing and comfort strategy is not normally undertaken.

15.1 Maximum Internal Noise Levels

Internal ambient noise levels in the regularly occupied areas must be no greater than the upper range value relevant to the activity type in each space as recommended in the current Australian Standard AS/NZS 2107:2016 *"Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors"*.

Regularly occupied areas are defined as those continuously occupied or occupied for more than two hours, including living and sleeping areas in Class 2 and 3 developments. Areas that are either transient or accessed intermittently, such as corridors, storage, back of house, or plant rooms, can be excluded. Spaces can also be excluded if the use of the space justifies specific ventilation conditions (e.g. a laboratory), or if the applicable Standard recommends that specialist advice be sought (e.g. a theatre).

Relevant design values for this project are summarised below:

	Ambient Design Sound Level Range		
Type of Space	*Lower Range*	*Upper Range*	*Green Star maximum*
Administration - Open Plan	40 dB(A)	45 dB(A)	45 dB(A)
Administration - Private Offices	40 dB(A)	45 dB(A)	45 dB(A)
Administration - Executive Offices	35 dB(A)	40 dB(A)	40 dB(A)
Counselling / Interview Rooms	40 dB(A)	45 dB(A)	45 dB(A)
Video Consult Rooms	30 dB(A)	40 dB(A)	40 dB(A)
Conference / Boardrooms	35 dB(A)	45 dB(A)	45 dB(A)
Public / Waiting Areas / Corridors	40 dB(A)	50 dB(A)	50 dB(A)
Reception Areas	40 dB(A)	45 dB(A)	45 dB(A)
Staff Breakout Areas	40 dB(A)	45 dB(A)	45 dB(A)
Toilets	50 dB(A)	55 dB(A)	55 dB(A)

Table 05 – AS 2107:2016 Maximum Design Sound Levels for Regularly Occupied Areas

It must also be noted that whilst rain noise is excluded from the internal noise level requirements, it is recommended that this is controlled to the degree practicable. As a minimum our recommendation is that rain noise control is provided by means of Anticon insulation compressed between the roof sheeting and purlins in conjunction with the ceilings outlined in Section 8 of this report.

Roof spacers are not recommended, and if required for thermal performance, compression of at least 50% of the Anticon thickness should be allowed for i.e. 100mm Anticon if 50mm spacers are used.

15.2.1 *Traffic / Rail Noise Intrusion*

During the following stages of this project on-site traffic noise measurements will be undertaken and advice will be provided to ensure that the external glazing to regularly occupied spaces will ensure internal levels fall within the limits above. Based on current documentation and the expected traffic conditions of the surrounding site, this is not expected to the onerous.

Note the above noise levels are an average level over time and that individual noisy vehicles are likely to be audible above the maximums outlined above. The required extent of intrusion for GreenStar compliance is also only covered by an average noise level, therefore intermittent rail noise is of no concern.

15.2.2 *Mechanical Noise Intrusion*

A review of the projects' mechanical documentation has been undertaken, based on its current status and layout. At this stage it appears that potential noise intrusion from mechanical equipment should be below the maximum permissible levels outlined above. It is critical that we are notified to any adjustments to the mechanical design within their system design. The above noise levels should also be specified within the mechanical specifications for potential contractor reselections.

15.2 Minimum Internal Noise Levels

Internal ambient noise levels in the regularly occupied areas must be no less than 5 dB below the lower range value relevant to the activity type in each space as recommended in the current Australian Standard AS/NZS 2107:2016 *"Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors"*.

As mechanical systems are not always operational, without dedicated masking noise installed in all habitable spaces there may be periods when the ambient noise drops below the lower end of the range. Therefore it is generally considered that this criteria is unachievable unless masking noise is provided.

It should be noted that with minimum internal noise levels unlikely to be achievable, all four of the remaining criteria are required to be met to claim the Acoustic credits for this project.

15.3 Acoustic Separation

The project must address noise transmission between enclosed spaces within the regularly occupied areas. It is our understanding this does not apply to walls separating consulting rooms and the like from general corridors as they are not technically "regularly occupied areas". The below requirements are only applicable between habitable spaces. Details about locations needing extra treatment can be provided where required.

Compliance for acoustic separation can be demonstrated via either the Privacy approach, or the Sound Insulation approach. For the purposes of this project we have selected the Sound Insulation methodology, whereby compliance is achieved by means of the specific weighted sound reduction index (R_w) for each wall type.

The minimum R_w performances for the various internal partition systems are as follows:

- At least R_w 45 for all partitions separating enclosed spaces which are:
  - Fixed without a door
  - Glazed partitions without a door*
- At least R_w 40 for all partitions fronting a room from an open plan area
- At least R_w 35 for all partition types that contain a door (in composite with the partition and door ratings)
- At least R_w 50 through floors between occupied spaces. Note for this project there are no floors separating occupied spaces.

*It is at the discretion of the Acoustic Consultant to determine whether an R_w 45 or 35 rating is more applicable when using glazed partitions.

To achieve the above values, wall constructions as per Section 3 of this report can be specified. The majority of walls provided in our recommendations will also cover the above requirements. Regarding the required glazing systems to achieve the above performances, we have previously recommended the following:

- R_w 35 - 10.5mm VLam Hush
- R_w 40 - 10.5mm VLam Hush / 12mm air / 6mm standard glass
- R_w 45 - 10.5mm VLam Hush / 87.5mm air / 6.38mm laminated glass

Full perimeter acoustic seals are required to all doors on habitable spaces, to achieve the minimum acoustic performances. Recommended seals are Raven RP10 & RP38 or Raven RP99 & RP78. Other seals are available on the market however these must be rubberised and adjustable in nature to ensure adequate sealing. Felt type seals are not be used.

15.4 Impact Noise Transfer

Impact noise transfer measured in accordance with ISO 16283-2 through a floor must not exceed L_{nTw} 60 for any habitable rooms.

Carpeted floors on concrete floors slabs will meet the above performance, regardless of the ceilings specified. For harder floor finishes over habitable areas we recommend the following constructions:

Tile Floor finish

This floor construction requires tiles to be installed over an approved acoustic underlay, typically in conjunction with a resiliently suspended (with insulation) flush plasterboard ceiling or Mineral Fibre tile ceiling with a CAC minimum 40. Perforated ceilings below tiled areas are not recommended without additional barriers in place.

Suitable acoustic underlays are Regupol Sonus Multi 4.5mm or Embelton 5mm Impacta-mat.

Glued Timber Floor

The requirements for timber floor finish where floors are adhered to the slab is similar to tiled floor as above. This is in terms of approved acoustic underlay and a resiliently suspended and insulated ceiling construction below the slab. A suitable underlay is either the Regupol 4515 4.5mm underlay or equivalent, or a specific timber flooring system, such as a Sika Acoubond System consisting of a 5mm thick SikaLayer-05 slotted foam underlay and Sikabond-T53 adhesives

Floating Timber Floor

Floating timber floors provide improved acoustic impact isolation performance compared to fully adhered timber floors. A floating timber floor on Regupol 5512 or Dunlop Advantage3 acoustic underlay in combination with minimum 200mm concrete slab should achieve the minimum requirements in terms of impact noise.

It should be noted that floating timber floors are generally associated with higher levels of step noise within the room itself, however there is a direct relationship between higher "step noise" within the room and reduced impact noise transmission to the floor below.

Vinyl Floor Finish

Vinyls or Tarket on Regupol underlay provide significant improved impact isolation performance compared to both timber and tiles on acoustic underlay. These materials should be considered for living type spaces such as kitchens. Site testing indicates that vinyl, Tarket or similar finishes glued to Regupol 4515 over a minimum 200mm concrete slab will provide adequate impact noise isolation to fully comply with the GreenStar requirements. Alternatively use a cushion backed vinyl with a minimum 15dB impact noise reduction as tested in an acoustic laboratory.

General Management of Hard Floor Surfaces

In our experience, a construction that achieves the no greater than L'_{nTw} 60 dB performance, will still result in audible impact noise transmission, particularly for hard floors. Management of impact noise on hard floor surfaces will still be required to reduce potential annoyance to habitable rooms below. The major considerations are:

- Use of soft soled shoes where possible,
- Felt pads under all furniture

15.5 Reverberation Control

Reverberation times in the regularly occupied areas must be below the maximum stated in the 'Recommended Reverberation Times' provided in Table 1 of AS 2107:2016. The applicable times for this project are therefore as follows:

	Recommended Reverberation Times (seconds)		
Type of Space	*Lower Range*	*Upper Range*	*Green Star Requirement*
Administration - Open Plan	minimised		minimised
Administration - Private Offices	0.4	0.6	< 0.6
Administration - Executive Offices	0.4	0.6	< 0.6
Counselling / Interview Rooms	0.3	0.6	< 0.6
Video Consult Rooms	0.2	0.4	< 0.4
Conference / Boardrooms	0.6	0.8	< 0.8
Public / Waiting Areas / Corridors	0.5	1.0	< 1.0
Reception Areas	0.6	0.8	< 0.8
Staff Breakout Areas	0.4	0.6	< 0.6
Toilets	N/A		N/A

Table 06 – AS 2107:2016 Maximum Allowable Reverberation Times for Regularly Occupied Areas

For spaces that require reverberation times be minimised as far as practicable e.g. Open Plan Offices, compliance can be demonstrated by treating 50% of the combined floor ceiling area with an acoustically absorbent material with an NRC of no less than 0.5, or by providing acoustic absorption equivalent to the calculated reverberation time for a space with this extent of acoustic absorption.

Based on these requirements we have the following recommendations:

- Open Plan Offices & Consulting Rooms
  - Full MFT ceiling with an NRC of at least 0.70 and CAC of no less than 40 e.g. Armstrong High NRC / High CAC
  - Carpeted floors throughout
- Multi-Purpose Rooms
  - Full acoustic ceiling, as outlined in Section 8 of this report
- Foyer / Reception Areas
  - Full acoustic ceiling, as outlined in Section 8 of this report

15.6 GreenStar Summary

The above recommendations are provided with the intention of achieving compliance with all four criteria for Commercial Fitout projects, with the assumption that masking noise will not be provided, and thus minimum noise levels will not be achieved.

Further calculations can be undertaken in the following stages of this project should any changes to materials, rooms sizes, or mechanical systems be proposed. At this stage we do not have any significant concerns regarding compliance on any of the four criteria being aimed for.

If you have any queries regarding this information please call the undersigned on 9474 5966.

Regards,

Michael Ferguson
Associate Director *B.IntArch(Hons) M.A.A.S.*



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ATTACHMENTS

- APPENDIX A - Legend for Marked-up Floor Plans
- APPENDIX B - Sealing of Full Height Walls
- APPENDIX C - Hydraulic Wall Detail
- APPENDIX D - Marked-up Floor Plans (x2)

APPENDIX A

LEGEND FOR ACOUSTIC MARK-UPS

Type W1 - ≥ R_w 42 Wall
1 layer 13mm PB / 76mm Stud frame with 75mm fg insulation / 1 layer 13mm PB
90mm masonry – rendered both sides *OR* 110mm masonry (no render)

Type W2 - ≥ R_w 46 Wall
2 layers 13mm PB / 76mm Stud frame with 75mm fg insulation / 1 layer 13mm PB
110mm masonry – rendered both sides *OR* 150mm special perform masonry (no render)

Type W3 - ≥ R_w 50 Wall
2 layers 13mm PB / 76mm Stud frame with 75mm fg insulation / 2 layers 13mm PB
150mm special perform masonry – rendered both sides *OR* back-to-back 90mm masonry

Type W4 - R_w 55+ Wall
2 layers 13mm FRPB / 92mm Quietstud frame with 90mm fg insulation / 2 layers 13mm FRPB
Back-to-back 90mm masonry Note Impact plasterboard can be used in lieu of Fire rated

Full Height Wall, sealed to the Underside of the Roof Sheeting / Floor Slab Above

Partial Full Height Wall i.e. single sheet of plasterboard or Martini Flankguard, sealed to the Underside of the Roof Sheeting / Floor Slab Above

Noise Transmission Flanking Issue Present - Detailing required TBC, likely closing off cavity space or increasing number of layers of internal plasterboard lining

Acoustically Absorbent Ceiling (minimum NRC 0.75) e.g. perforated plasterboard with 75mm fibreglass over

Mineral Fibre Tile Ceiling with min CAC 40 and NRC 0.70 with 75mm fibreglass over e.g. Armstrong Ultima+

Flush Plasterboard Ceiling with 75mm Fibreglass Insulation Over

Rain Noise Barrier as per Section 10 of this report

Solid Door - No door grills allowed

38mm Solid Core Door with Full Perimeter Acoustic Seals

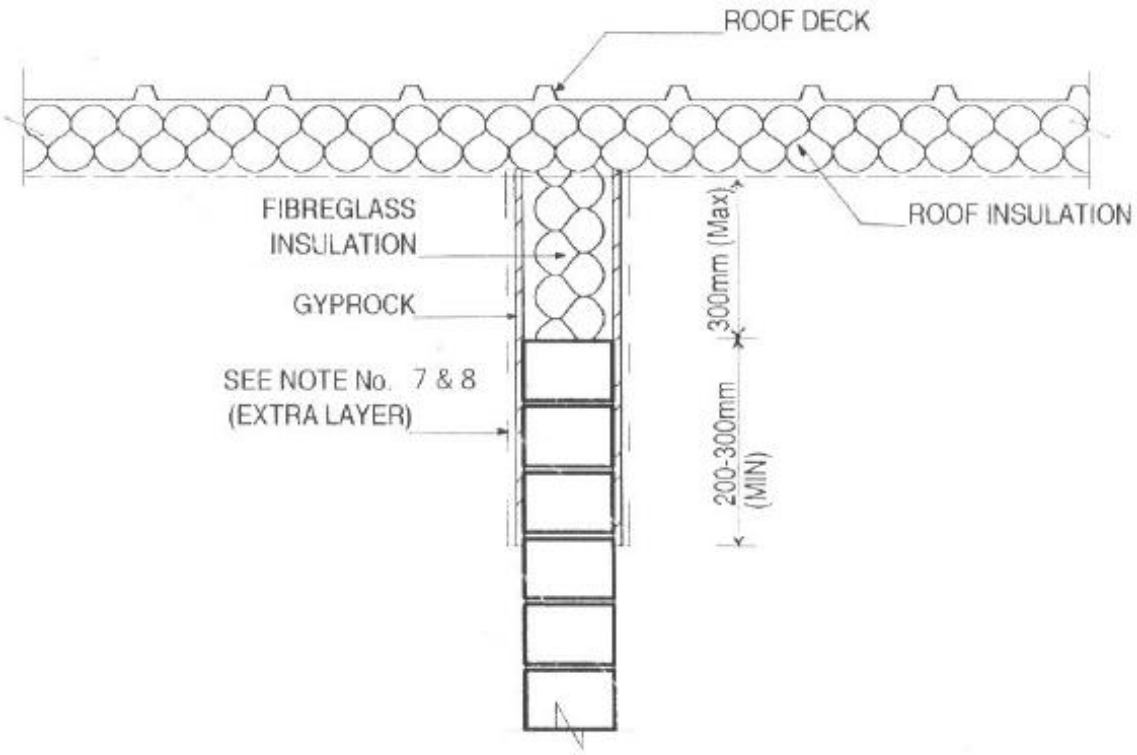
50mm Solid core door with full perimeter acoustic seals. Higher rated door if feasible within budget and operational requirement (i.e. heavier doors) e.g. Spence Sontron Doors.
No door grills permitted.

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APPENDIX B

SEALING OF WALLS TO UNDERSIDE OF ROOF

SCHEMATIC SECTION (N.T.S)



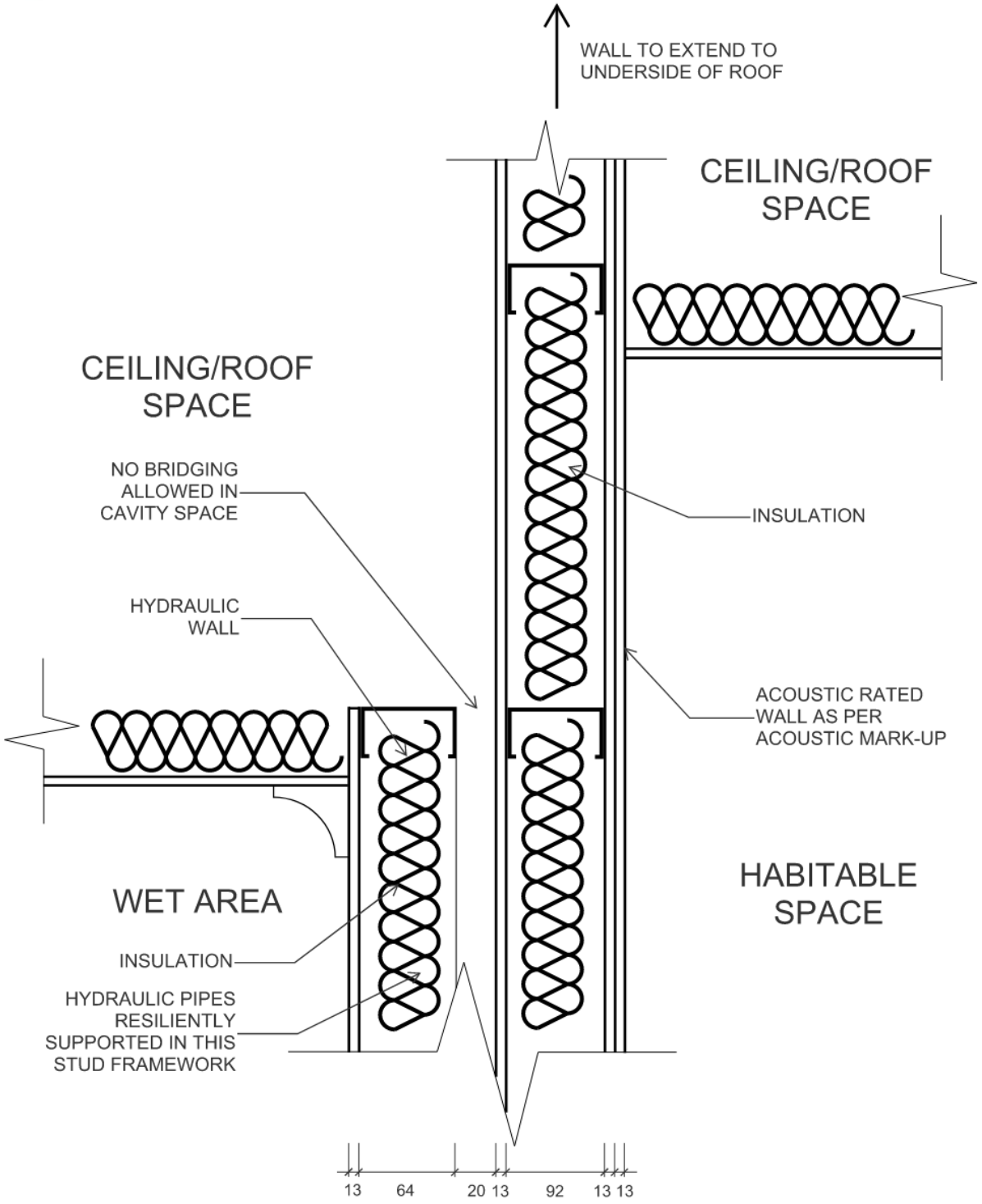
Notes:

1. Concrete or Masonry Walls to be extended to within 100 mm of the underside of purlins or 300 mm of the underside of the roof sheeting – whichever is smaller.
2. All masonry walls above the ceiling are to be bag finished to ensure all bed and perpend joints are fully filled and sealed.
3. Plasterboard to be fixed to walls with a continuous bead of cornice cement along the bottom edge of the Plasterboard, and with 50 mm daubs at 450 mm centres at the top of the wall.
4. Plasterboard sheets to be pushed tight into the insulation blanket under roofing, or fully sealed to exposed roof sheeting.
5. Plasterboard sheets to be neatly cut and sealed in and around purlins, rafters or any other penetrations. All joints to be flush jointed.
6. For 110 mm masonry walls use single 13 mm thick plasterboard on either side of the wall.
7. For double leaf or cavity masonry use double layer 13 mm plasterboard on both sides of the wall. Each layer of plasterboard to be flush jointed, and all joints must be staggered.
8. For any "Party Wall" in an Apartment Project use double layer 13 mm fire rated plasterboard on both sides of the wall. Each layer of plasterboard to be flush jointed, and all joints must be staggered. (Normal fire rating requirements must not be compromised).
9. Fill cavity between plasterboard sheets with 10 to 14 kg/m^3 fibre insulation.

APPENDIX C

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HYDRAULIC WALL SCHEMATIC DETAIL (N-T-S)



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NOTE DOOR BETWEEN OFFICE AND RECEPTION WILL AFFECT PRIVACY ACHIEVED. WE ASSUME NO PRIVATE CONVERSATIONS WITH PUBLIC OCCUR IN THIS OFFICE SPACE

WE UNDERSTAND THE REQUIREMENT FOR A SECONDARY ESCAPE DOOR, HOWEVER THE INCLUSION OF A DOOR IN THIS LOCATION WILL SIGNIFICANTLY IMPACT PRIVACY BETWEEN UCC OFFICE AND ADJACENT TRIAGE ROOM. CONVERSATIONS ARE LIKELY TO BE CLEARLY AUDIBLE

DUE TO LARGE FLUSH PLASTERBOARD CEILING MARGINS, ADDITIONAL WALL ABSORPTION WILL BE REQUIRED TO COMPENSATE FOR LOSS OF MFT'S. EACH TREATMENT / CONSULT ROOM IS TO BE PROVIDED WITH A MINIMUM OF 1.5m2 OF 25mm THICK AUTEX QUIETSPACE OR SIMILAR. LARGER ROOMS MAY REQUIRE ADDITIONAL ABSORPTION

SUBSTATION FLOOR SLAB SHOULD IDEALLY BE POURED SEPARATELY FROM THE MAIN BUILDING SLAB, WITH A DISCONTINUOUS GAP AROUND THE PERIMETER OF THE ROOM. THIS WILL AID WITH ANY POTENTIAL STRUCTURE-BORNE NOISE FROM THE TRANSFORMER, HOWEVER VIBRATION ISOLATION WILL STILL LIKELY BE REQUIRED DIRECTLY UNDER THE UNIT

DENOTES FULL HEIGHT WALLS

DENOTES FULL HEIGHT FIRE RATED WALLS

KEYNOTE LEGEND

ABBRV.	DESCRIPTION
AED-01	WALL RECESSED DEFIBRILLATOR CUPBOARD
BR-01	EXTERNAL BRACING - EXPOSED
CB-01	CONCRETE BENCH SEAT 1
COL-CN	CONCRETE COLUMN
COL	STRUCTURAL COLUMN - GALVANISED
CP-01	CONCRETE PANEL
CP-02	CONCRETE WALL - STAINED
FE-01	FIRE EXTINGUISHER - DRY CHEMICAL ABE
FE-C-01	FIRE EXTINGUISHER CABINET - DRY CHEMICAL ABE
FE-C-02	FIRE EXTINGUISHER CABINET - CO2
HT-01	HOSE TAP
LBO-02	BOLLARD TYPE 2
LBR-01	BICYCLE RACK - TYPE 01
LBS-01	LANDSCAPE BENCH SEAT
MT-FE-01	SECURITY FENCE
SD-01	DOOR CHANNEL DRAIN, 100mm - STAINLESS STEEL
SD-02	DOOR CHANNEL DRAIN, 165mm - STAINLESS STEEL
TGSI-02	CONCRETE TACTILE PAVER

1 GROUND FLOOR - GENERAL ARRANGEMENT
1 : 100

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B	12/09/2024	ISSUED FOR WESTERN POWER REVIEW	
A	03/09/2024	ISSUED TO CONSULTANTS	

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DEPARTMENT OF FINANCE PROJ. No. 2368

BYFORD HEALTH HUB
3 BUSHMAN GLADE
BYFORD, WA 6122

GROUND FLOOR PLAN - GENERAL ARRANGEMENT

DRAWN	CG	DESIGNED DK	REDUCTION 1:100 0 2.5m
CHECKED	CG	PRINCIPAL CARABINER	
APPROVED	AS		
SCALE As indicated@ A1		DATE PRINTED 23/01/2025 1:23:28 PM	DRAWING No. A02.01 REV No. O
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DENOTES FULL HEIGHT WALLS

DENOTES FULL HEIGHT FIRE RATED WALLS

KEYNOTE LEGEND

ABBRV.	DESCRIPTION
CL-FC-01	FC WINDOW SURROUND - RED
CL-FC-02	FC WINDOW SURROUND - ORANGE
CL-FC-03	FC WINDOW SURROUND - PURPLE
FE-01	FIRE EXTINGUISHER - DRY CHEMICAL ABE
FE-02	FIRE EXTINGUISHER - CO2
FE-C01	FIRE EXTINGUISHER CABINET - DRY CHEMICAL ABE
FE-C02	FIRE EXTINGUISHER CABINET - CO2

IF ROOMS ARE TO BE USED FOR VIDEO CONFERENCING THEN ADDITIONAL RAIN NOISE CONTROL MAY BE WARRANTED i.e. BARRIER UNDER PURLINS OR SIMILAR AS RECOMMENDED AT SD STAGE.
SIMILARLY ADDITIONAL WALL ABSORPTION (IN ADDITION TO THE CEILING LOSS COMPENSATION AREA) SHOULD BE INCORPORATED

BASED ON DISCUSSIONS WITH THE PROJECT TEAM, DUE TO THE RAKING CEILINGS THESE AREAS ARE CURRENTLY MARKED-UP AS FLUSH PLASTERBOARD INSTEAD OF MINERAL FIBRE TILES. ADDITIONAL ACOUSTIC ABSORPTION WILL BE REQUIRED EITHER TO THE UNDERSIDE OF THE CEILING OR ON A SIGNIFICANT PORTION OF THE WALLS, POTENTIALLY A COMBINATION OF BOTH

IF PERFORATED TYPE CEILING ARE PROVIDED IN MULTI-FUNCTION ROOMS THEN ADDITIONAL RAIN NOISE CONTROL MAY BE WARRANTED i.e. BARRIER UNDER PURLINS OR SIMILAR. IF MECH UNITS ARE LOCATED IN THE CEILING SPACE THEN BARRIER SHOULD BE INSTALLED BELOW THE UNITS AND ABOVE THE CEILING PLANE

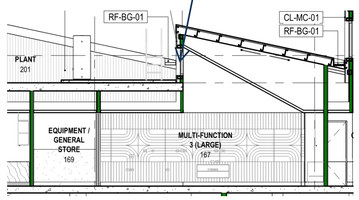
WALLS IN CAHS AREA COULD POTENTIALLY BE UPGRADED DEPENDING ON THE LEVEL OF PRIVACY REQUIRED AND USE OF THE ROOMS i.e. MENTAL HEALTH TYPICALLY HAS Rw 55 WALLS RECOMMENDED

CEILINGS BELOW MECH DECK AREAS THROUGHOUT THE PROJECT ARE NOT TO BE PERFORATED

BASED ON DISCUSSIONS WITH THE PROJECT TEAM, DUE TO THE RAKING CEILINGS THESE AREAS ARE CURRENTLY MARKED-UP AS FLUSH PLASTERBOARD INSTEAD OF MINERAL FIBRE TILES. ADDITIONAL ACOUSTIC ABSORPTION WILL BE REQUIRED EITHER TO THE UNDERSIDE OF THE CEILING OR ON A SIGNIFICANT PORTION OF THE WALLS, POTENTIALLY A COMBINATION OF BOTH

REDUCE TO 'GREEN' IF DOOR INTRODUCED

ANY WINDOW OVERLOOKING THE ROOFTOP PLANT DECK AREA LIKELY TO REQUIRES 12.5mmVLam HUSH GLASS AS A MINIMUM. IF DOUBLE GLAZING IS PROVIDED FOR THERMAL PURPOSES THEN AT LEAST ONE PANE OF GLASS MUST BE 10.38mm LAMINATED GLASS



IMPACT PERFORMANCE OF FLOORING IS RECOMMENDED TO BE CONSIDERED IN REHAB AREA i.e. CUSHION BACKED VINYL FLOORING OR SIMILAR. ALL EQUIPMENT SHOULD BE ISOLATED AS FAR AS PRACTICABLE e.g. RUBBERISED MATTING UNDER TREADMILLS AND THE LIKE.

1 FIRST FLOOR PLAN - GENERAL ARRANGEMENT

1 : 100

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DEPARTMENT OF FINANCE PROJ. No. 2368

BYFORD HEALTH HUB
3 BUSHMAN GLADE
BYFORD, WA 6122

FIRST FLOOR PLAN - GENERAL ARRANGEMENT

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Byford Health Hub

Design Development Report – Civil and Geotech

Prepared for Carabiner

December 2024

Project Number P24020

Document Number P24020-REP-C-0003-B

Revision B

OPPORTUNITIES THROUGH EXCELLENCE

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Document Control					
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A - Draft	06/12/2024	DD Civil & Geotech	Alan Mayahi		
B	29/01/2025	DD Civil & Geotech	Alan Mayahi	Brad Sherlock	Brad Sherlock

1. Introduction

1.1 Description of Project

BG&E was engaged by Carabiner to provide civil design services for Byford Health Hub (the Project). The Project is located in Byford on the south-eastern edge of Perth; a locality plan is provided in Figure 1.1.



Figure 1.1 – Locality Plan

1.2 Scope of Works

The civil scope of the works includes the following components:

- BHH Public Car Parking (approximately 56 parking space).
- Staff Car Parking (approximately 19 parking space).
- Access Roads

The report seeks to:

- Identify the Civil and Geotech design references (standards and guidelines)
- Determine the main Civil and Geotech design issues with consideration for appropriate solutions.
- Design of drainage retention/infiltration network to contain desired storm events.
- Provide commentary regarding construction systems best suited for the project.
- Determine requirements for retaining walls!
- Highlight Civil and Geotech concerns which may cause a cost premium over-and-above typical reference construction cost.

This report should be read in conjunction with the design drawings provided in Appendix A

1.3 Purpose of this Report

This report documents the Roads, Drainage, Earthworks, Pavement, and Civil Design for the Project and captures the following design information.

- BG&E's understanding of the project scope.
- Relevant design standards and criteria.
- Key stakeholders involved in the project.
- Existing site conditions and constraints.
- Design progress including design changes and updates at each stage.
- Departures from design standards or project specifications.
- Constructability considerations.
- Safety in Design.

2. Background

2.1 Existing Conditions

Key site attributes include:

- Site currently zoned Urban Development and indicated as Town Centre in the Byford Town Centre Local Structure Plan.
- Located adjacent to the proposed new METRONET Byford Station with potential for direct pedestrian linkages, and within the heart of the emerging Byford Town Centre; and
- The site has been predominantly cleared and exhibits a relatively flat terrain, necessitating some earthworks. Within the broader Byford structure plan area, two drainage corridors serve as corridors for stormwater runoff originating from the Darling escarpment. These corridors are as follows:
    - **Beenyup Brook**: Positioned to the south of the site, it directs water flow via landscaped drainage swales. The Brook extends to the western section of the site, following a dedicated drainage corridor within a natural environment.
    - **Oaklands Drain**: Runs along a semi-formalized channel towards the east and transitions into a dedicated drainage corridor, exiting the site in the north-western direction.
- The Oaklands drainage line intersects the northern part of the site, necessitating that any development plans facilitate the uninterrupted passage of these water flows through the site.

2.2 Design Inputs

The following documentation is referenced in the body of this report:

- Architectural Drawings by Carabiner
- Geotechnical Engineering Report WAG230321-02 001 R Rev 1 and WAG230321-02-002 L Rev0 (see Appendix C)

2.3 Key Constraints

The health hub is proposed to be constructed as part of the Byford Library and Multi-Agency Centre on the Shire Civic Reserve in the Byford Town Centre. The land boundaries are located on the Shire's Civic Reserve, adjacent to the Byford Village Shopping Centre and directly opposite the future Byford METRONET station.

The site was a pastural land until 2015. Between 2015 and 2016, it is apparent that fill was stockpiled in the northern half of the site, and sand was removed from a localised area in the central portion of site (relatively shallow excavation). It is judged these works were associated with development of the adjacent Byford Shopping Centre and residential lots.

Design flood levels are likely to govern site levels. As discussed in the Geotech Report, The Department of Water is likely to require a minimum site level of RL 52.5 m AHD, which could require about 0.5 m to 2.5 m of imported fill.

Stormwater disposal may be possible into deep imported Permeable Sand fill provided the base of the soak well is at least 0.5 m above the design groundwater level or clayey strata. During overland stormwater events, stormwater must be disposed of offsite. Design groundwater levels are subject to civil design and subsoil drains could be required.

3. Design Basis

3.1 Design Standards, Requirements and Guidelines

The Civil Design is based on the technical references listed in Table 3.1. These technical references are listed in the order of precedence for the event of any inconsistency, ambiguity, or discrepancy between documents.

Table 3.1 – Technical References

Standard or Guideline	Relevant Chapters / Parts
Australian Standards	AS/NZS 3500.2:2021 Amd 1:2021 Plumbing and Drainage AS/NZS 3500.2:2021 Plumbing and Drainage AS 5200.000 – 2006 Technical Specification for Plumbing and Drainage Products. AS 3798-2007/Amdt 1-2008 Guidelines on earthworks for commercial and residential developments AS 3798-2007 Guidelines on earthworks for commercial and residential developments. AS/NZS 2890.1:2004/Amdt 1:2005 Parking facilities - Off-street car parking. AS/NZS 2890.1:2004 Parking facilities - Off-street car parking. All other related Australian standards.
Project General Specification	National Construction Code (NCC); East Metropolitan Health Service Guideline. PTA Guideline – SMP Local authority standards and requirements
Austroads Guide to Road Design (AGRD)	Part 3 – Geometric Design Part 4 – Intersections and Crossings Part 4A – Unsignalized and Signalised Intersections Part 4B – Roundabouts Part 4C – Interchanges Part 5 – Drainage – General and Hydrology Considerations Part 5A – Drainage – General and Hydrology Considerations Part 5B – Drainage – Open Channels, Culverts and Floodways Part 6 – Roadside Design, Safety and Barriers Part 6A – Paths for Walking and Cycling Part 6B – Roadside Environment
Austroads Design Vehicles and Turning Path Templates Guide	Class 3 to 5 trucks
Watercorp Specifications	DS50 – Design and Construction Requirements for Gravity Sewer DN150 to DN600 DS60 Water Supply Distribution Standards DS66 Urban Main Drainage Standards
Pavement Standards	Austroads Part 2 – Pavement Structural Design. Main Roads Western Australia (MRWA, 2013), Engineering Road Note 9.
Relevant proprietary product manuals	As nominated by Contractor

3.2 Design Criteria

The Civil Design has been developed in accordance with the design criteria summarised in Table 3.2, for convenience.

Table 3.2 – Key Design Criteria

Parameter	Value	Reference
Pit & Pipe System	AEP 10%	AGRD Part 5A
Basins and Infiltration Tanks	AEP 1%	AGRD Part 5A

Parameter	Value	Reference
Minimum Pipe Grade	0.33%	AGRD Part 5A
Minimum Pipe Velocity	1 m/s for full pipe 0.8 m/s for 1/3 full pipe	AGRD Part 5A
Minimum Cover	600mm Class 2 400mm Class 4	AGRD Part 5A
Pipe Material and Joints	Reinforced precast concrete pipes w/ rubber ring belled socket joints	AGRD Part 5A
Pipe Class	Minimum Class 2	AGRD Part 5A
Pipe Roughness (Manning's n coefficient)	0.013 (RCP)	Austroads Guide to Road Design, Part 5A, Table 6.4
Cover Load Class	Class D for grated gully inlets Class C for side entry inlets	AGRD Part 5A Section 5.2.8
Pit Blockage (On-grade)	80% - Side Entry 50% - Grated	AGRD Part 5A, Table 5.4
Pit Blockage (Sag)	80% - Side Entry 50% - Grated	AGRD Part 5A, Table 5.4
Freeboard in minor event	150mm	Austroads Part 5 Section 4.7.2
Maximum Width	1.0m in 10% AEP (≤70km/h) 2.0m in 39.35% AEP (Carparks) 0.75m in 63.21% AEP (Busways)	AGRD Part 5A, Table 5.1
Maximum Depth	200mm in 1% AEP	AGRD Part 5A
Maximum Depth Velocity Product	0.4m²/s for pedestrians and vehicles 0.6m²/s for vehicles only	AGRD Part 5A, Table 5.1
Road Roughness (Manning's n coefficient)	0.013	AGRD Part 5A, section 4.7.2

3.3 Design Assumptions and Limitations

The Design has been developed based on the assumptions, qualifications and limitations listed below.

- BG&E's design is reliant upon information provided by the principal and third parties, where listed in Section 2.2. The accuracy of the design is, therefore, limited by the accuracy of this reliance information. BG&E has made no independent verification of this information and assumes no liability for any inaccuracies in or omissions to that information.
- In preparing the Report, BG&E assumes that:
    - Construction of the works for the Project will be undertaken by a competent contractor and in accordance with the requisite standard of care and standards applicable to the work performed.
    - Other consultants and contractors are responsible for performing and coordinating services that do not form part of the Services.
- BG&E makes no warranty, statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use, development or re-development of the site.
- This Report is subject to the conditions and limitations of the site at the time it was prepared. BG&E accepts no responsibility for any changes in site conditions or in the information reviewed that have occurred after this time.
- Inspections undertaken in respect of this Report are limited to [visual inspections] only and are constrained by the particular site conditions, such as the location of buildings, road geometry and structures already in place.

4. Design Details

4.1 Geotechnical Conditions

The geotechnical information was provided by Galt Geotechnics report ref no. WAG230321-02 001 R Rev1 “GEOTECHNICAL STUDY PROPOSED BYFORD HEALTH HUB PART LOT 103, 3 BUSHMAN GLADE BYFORD” dated 20/06/2024, and WAG230321-02-002 L Rev0 for the flexible pavement design, see Appendix C.

The geotechnical information was reviewed to provide inputs into the civil design. The investigation was undertaken to assess subsurface soil and groundwater conditions across the site; and to provide a site classification(s) in accordance with AS 2870-2011; and to assess the appropriate site subsoil class for the site in accordance with AS1170.4-2007.

4.1.1 Subsurface Conditions

The site was found to be underlain by Fill (SAND / Gravelly SAND / Clayey SAND) about 0.7 m to 1.6 m thick, generally over Colluvium (Clayey Sandy GRAVEL / Gravelly Sandy CLAY / Clayey Gravelly SAND), tending to being cemented and rock strength at relatively shallow depth (2 m to 3 m deep).

4.1.2 Groundwater

Groundwater was not encountered during the investigation; however, there is a possibility that water may accumulate or pond at the site due to lower permeability layers.

A review of the Water Register (DWER 2021b) reveals that the site falls within the 'Serpentine' groundwater area, the 'Byford' sub-aquifer, and the Perth-Leederville Confined Aquifer. The superficial aquifer has available allocation, and currently, there are no groundwater licenses allocated for the site vicinity.

The Lower Serpentine Region Groundwater contours (DWER 2021a) indicate that the maximum groundwater level is at 51m AHD, while the minimum level stands at 43m AHD. Considering the topography of the site, the groundwater contour mapping suggests that groundwater is near the ground surface level, potentially seasonally reaching it. Given the low permeability of the soils, it is probable that the site sits above a perched water table. Development activities may likely require groundwater management measures, including subsoil drainage and/or filling. Importantly, the site is not situated within a public drinking water source area (PDWSA).

The site investigation indicates the top of clay underlying surficial sand is at about RL 51.5 m AHD to RL 52.3 m AHD. A possible design groundwater level of about RL 52.8m AHD for design of onsite stormwater disposal systems is recommended. Overland flow must be allowed for when on-site disposal is overwhelmed in flood events.

4.1.3 Acid Sulfate Soils (ASS)

The site risk category is considered Moderate to Low Risk as per the DataWA Acid Sulphate Soil Risk Map, Swan Coastal Plain (DWER-055) of Acid Sulfate soils (ASS) occurring within 3 m of the natural soil surface.

Based on site investigation results, all material to the maximum depth of the investigation is classified as non-acid sulfate soils (NASS). As such, no further investigation or management is required.

4.1.4 Site Classification

Based on AS2870 site classification Either Class S where less than 1 m of sand over in situ clayey soils, or Class A where no less than 1 m of sand over in situ clayey soils. And based on AS1170.4 site subsoil class Ce.

We recommend that inspections be carried out during footing excavations to confirm that conditions exposed are as anticipated.

Site preparation to include GDR6.2.1 Common Measures and GDR6.2.4 Clayey Sites. Extending 1 m beyond the proposed building footprint, common measures are to include excavation to no less than 0.5 m below current ground levels. Remove any uncontrolled fill exposed in excavation if required.

Following proof compaction (GDR6.2.4) at base of excavation, stockpiled excavated material may be reused if on site assessment confirms the material is a ‘Silty Sand Fill’ as defined in GDR8 Approved Fill and Conformance Testing.

4.2 Earthworks

4.2.1 General

The site generally has a flat topography, sloping approximately 1.7% from RL 54.9 m AHD in the South to RL 52 m AHD in the North. Earthworks will primarily involve fill to create a level surface for constructing new buildings and a car park. Opportunities to use excavated materials on-site will be explored in schematic and detailed design phases to minimise material imports.

In this stage and following the Geotech engineer recommendations, bulk earthworks design was carried out, which included minimal fill of less 1 meter in the south-east (highest point of the site) to align with the existing road, and about less than 2 meter in the north-west (lowest point) following the existing ground slope, ensuring a 1% slope toward the existing Oaklands Drain for civil and drainage purposes. Establishing the building sand pads at elevation of approximately RL 54.90 m AHD with finish floor level at 55.00 m AHD.



Figure 4.1 – Earthworks Strategy for the Site

4.2.2 Finished Surface Levels

Finished floor levels (FFL) were set tie in with the existing Bushman Glade to the south. Furthermore, the following criteria were applied when setting FFL's to allow for an efficient, effective and compliant design:

- Drainage Design.
- External roads and cul-de-sac rearrangement with adjust Coles driveway.
- Disability access.

- Minimisation of retaining walls and ramps.
- Vehicle access.
- Future public library.
- Provision of major storm overland flow routes; and
- Servicing.

Refer to design drawings in Appendix A for more details.

4.2.3 Bulk Earthworks

In the earthworks design of the project, particular attention has been given to ensuring that the final bulk earthworks levels are strategically planned to facilitate overland flow and support shallow foundations effectively. By carefully shaping the landscape through excavation and embankment, the natural drainage patterns of the site are enhanced, allowing for efficient surface water runoff and minimizing the risk of water pooling or erosion issues. This approach not only promotes environmental sustainability by preserving the integrity of the land but also contributes to the long-term stability and functionality of the project's infrastructure.

Moreover, in addition to prioritizing efficient overland flow and foundation support, the earthworks strategy has been optimized to consider the minimum necessary volume of excavation and fill for economic reasons. With fill material imported to meet the drainage infiltration conditions, the design aims to strike a balance between meeting performance requirements and minimizing unnecessary earth-moving activities. This cost-conscious approach is promoting a sustainable and economically viable outcome for the project.

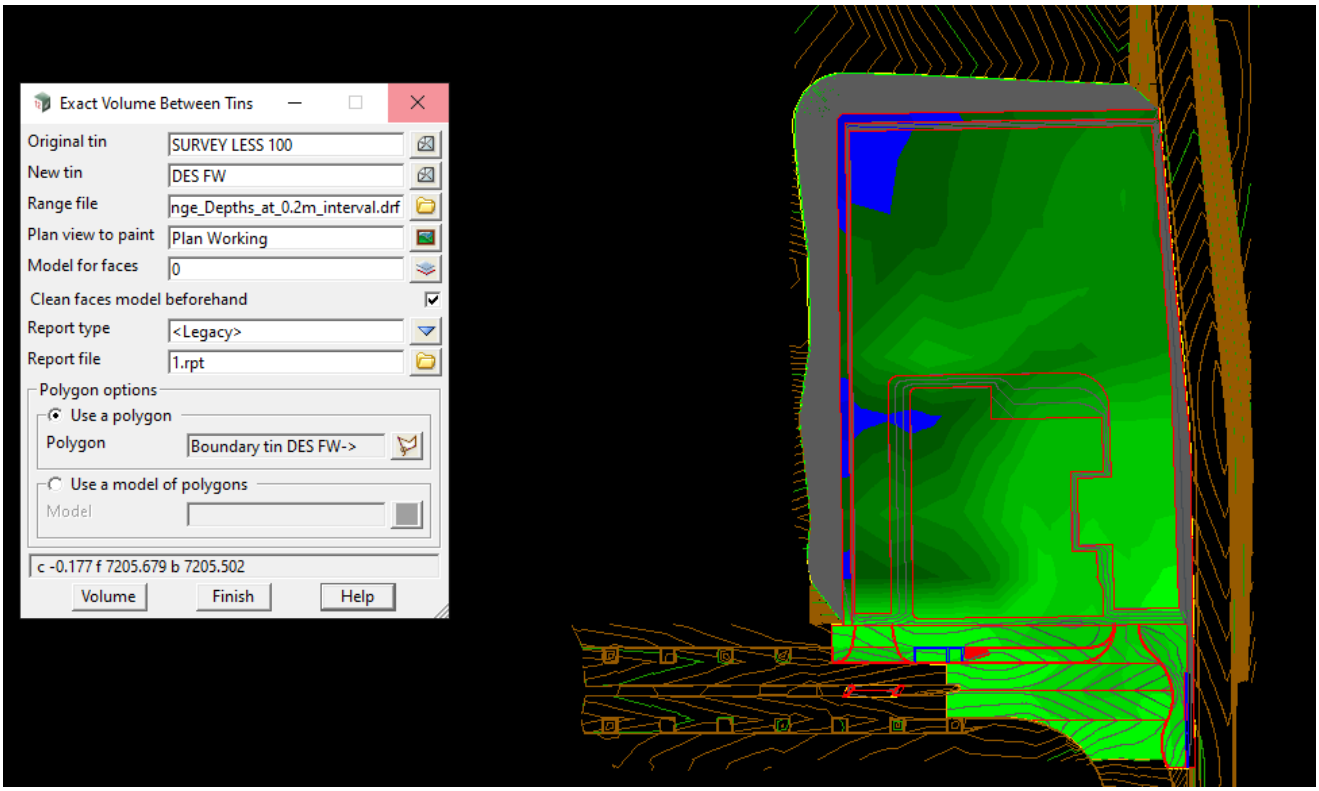


Figure 4.2 – Bulk Earthworks Volumes

4.2.4 Volumes

The following preliminary bulk earthworks volumes have been calculated using survey and preliminary design surfaces. All the earthworks done as part of the Forword Works package, all the levelling provided within the Main Works package (Appendix A) is just to adjust the surface for the pavement and drainage purposes and no cut or fill is required during the Main Works stage.

Earthworks	Volume (m^3)
Cut	$0.00m^3$
Fill	$7205m^3$
Balance	$7205m^3$ of fill required

Table 3 Site Bulk Earthwork Volume

4.2.5 Retaining Walls

Very limited use of retaining wall will be required within the Byford Health Hub development. 1:3 batter was proposed with the northern and western borders of the site. And the proposed finish levels of the site will tie in with the existing Bushman Glade to the south. There is a deference in levels between the site and the adjust newly constructed PSP to the east, this will require a proposed retaining wall build with an average 400mm hight. Refer to structural package for further details on the retaining wall.

4.3 Drainage

The drainage design has been developed based on the previous Concept Drainage Design and shown in the design drawings. In the context of the project's drainage design, adopting a sustainable approach is crucial for ensuring long-term environmental resilience and efficiency. By prioritizing sustainable drainage strategies, such as green infrastructure and permeable surfaces, we can effectively manage stormwater runoff while minimizing the impact on natural water systems. Implementing techniques like rain gardens, and bioswales not only helps to reduce flooding risks but also promotes groundwater recharge and improves water quality by filtering out pollutants.

Drainage for the site has been analysed as follows:

- Provision for stormwater pipe network to cater for the 1 in 10-year ARI.
- Provision for all building and major overland flow routes to cater for flows up to the 100-year ARI.
- Sized accordingly to meet the requirements of both infiltration capacity and storage volume as per the Council requirement to store the 100-year ARI event.

The above criteria complies with the Australian standards and Shire of Serpentine Jarrahdale requirements for commercial lots. The site catchment will cover the carpark (both staff and public carparking), roads, driveways, and the building. The catchment has impervious area of approx. $4800m^2$.

BG&E have undertaken an assessment of the 10%AEP and 1%AEP to recommend storage volumes for critical storm events (1% AEP 24hr storm). In addition, the design has undertaken a sensitivity analysis to understand the impacts of a maximum groundwater level on the drainage system.

The main site stormwater network will accept flows from the roof, hard/soft scape and pavement catchments of the proposed development and discharge into proposed detention tanks. The roofed areas will be collected and discharged into the nearest civil piped drainage connection and subsequently conveyed to the compensating basin.

Due to the presence of high groundwater level the assessment of required storage has been undertaken using PCSump shallow groundwater model as the depth of groundwater to bottom of the drainage tanks is less than 1m.

Galt ground investigation and supplementary information has noted an infiltration rate of 0.2 – 0.6 m/day within the existing soil strata (taken at circa 0.45m below existing levels). Due to the fill volumes on the site and the import of clean sand to raise the levels, the design has used an infiltration rate of 2m/day for horizontal conductivity within the clean sand layer. During the bulk earthworks activity, it is recommended to undertake a field pumping test or insitu infiltration test to confirm that the 2m/day is achieved.

The critical duration for the 100-year ARI event in this vicinity is likely to be 90 minutes. The subsequent stormwater storage volume for the proposed building, carparks, access roads, and paths for the development is estimated to be $430m^3$. The storage will be located beneath the carpark area. Due to the landscape design, the storage was divided into two tanks connected to provide one storage system. Tank A with a storage capacity of 174.5m3 and to the south Tank B with a 251.6m3 of storage.

The storage tanks are trafficable with infiltration. It is proposed to use Graf EcoBloc Maxx Stormwater System or approved equivalent, the cells will be stacked in two layers with a hight of approximately 700mm, with base tank level at RL 53.30.

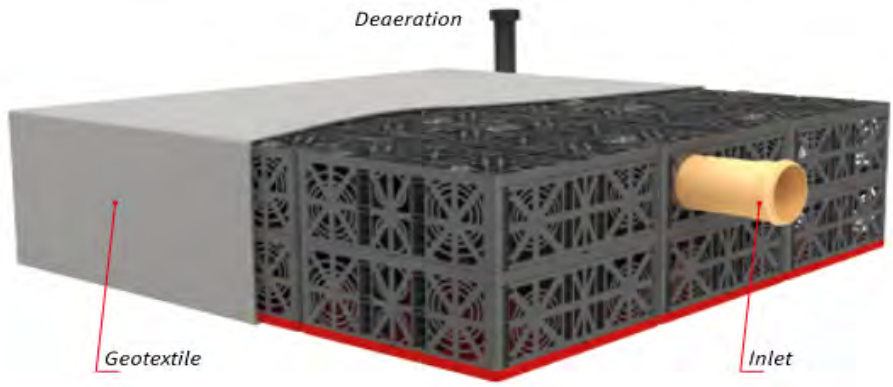


Figure 4.3 – Typical Graf EcoBloc Stormwater System



Figure 4.4 – Typical Graf EcoBloc Under Car Parks

The shape and storage capacity of each tank can be customized on-site to accommodate various needs, such as the prevention of clashes with services, compliance with landscape specifications, or to meet any supplier's conditions. It is essential that any modifications to the tanks receive approval from the engineer to ensure that the overall storage capacity and the base invert levels of the tanks remain unchanged. This guarantees that the functionality and integrity of the system are maintained while allowing for necessary adjustments to meet specific project demands.

In documenting a drainage system BG&E have undertaken an analysis of scenarios to demonstrate impacts of drainage storm events:

Major storm event combined with exceptionally high groundwater table which will further reduce the infiltration rates. In this event the storage tanks will be at capacity and the additional stormwater may result limited localised flooding of the carpark area. It is not recommended to upsize drainage infrastructure for this scenario but rather ensure that critical infrastructure is not impeded by excess water. Areas of limited localised flooding will rescind following the extreme storm event ending and groundwater level rescinding to normal levels.

4.3.1 Subsoil Drainage

A Subsoil drainage system has been designed to drain away subsurface water in order to:

- increase the stability of the ground and footings of the building by inducing a more stable moisture regime and reducing foundation movements due to the variations in the soil moisture content;
- mitigate surface water ponding and waterlogging of soils by controlling groundwater levels;
- alleviate ground water pressures likely to cause dampness in below-ground internal pavements; and/or
- increase soil strength by reducing the moisture content.

The subsoil drainage system has been provided for the building and the surrounding sealed road pavements. The finished levels of the site have been raised approximately 1.5m across the site and as such the existing groundwater levels and proposed design groundwater levels should be well below the proposed pavement layers. However, due to the amount of civil works in the area, the inclusion of the subsoil is an important part for the site to prolong the performance of the building's footings by minimising the risk of softening and rutting for the ground when exposed to heavy loads.

The subsoil drains of 100mm PVC pipes connect to stormwater pits and are generally consistent with the layouts for the site stormwater drains with an intermediate run involving branch subsoil drains. The secondary advantage of the spaced subsoil drainage is to counteract the potential capillary action and drawdown any groundwater away from the footings and pavement layers.

4.4 Roads and Parking

The development will require site access roads including an access road along the south-west corner for light passenger vehicles, emergency service vehicles (up to 30 tonne fire truck) and general service vehicles (deliveries, rubbish pickup etc.).

General light vehicle parking is also proposed to the north of the health hub to include the following:

- Parking areas and other hard standings within the site, including all necessary parking and hard standing area ancillaries such as kerbing, pedestrian ramps, traffic regulatory.
- Roadway and flexible pavements, including subgrade, subbase, basecourse, bituminous and asphalt seals preparation.
- Pedestrian pathway within the site includes all necessary path ancillaries, pedestrian ramps, signs, and line marking.

Furthermore, the existing cul-de-sac and roundabout will be removed as they are located within the site land. A geometric rearrangement will be implemented to maintain the functionality of the roads and accommodate the additional traffic flow expected from the Byford Health Hub.

The revised layout will feature an entrance and exit for the health hub from Bushman Glade to the south, with modifications to the median allowing access for light vehicles. Additionally, a mini roundabout will be added to accommodate turning vehicles, including those as large as a DFES platform truck.

The bulk earthworks and pavement plan has incorporated footpaths and facilities as per the Architectural layout. BG&E have modified levels to accommodate DDA compliance.

The flexible pavements at the site were designed to suit a maximum 30 tonne fire emergency services truck among other heavy service vehicles and light passenger vehicles. The maximum sized fire service truck will comprise an Austroads Class 5 heavy vehicle as shown below:

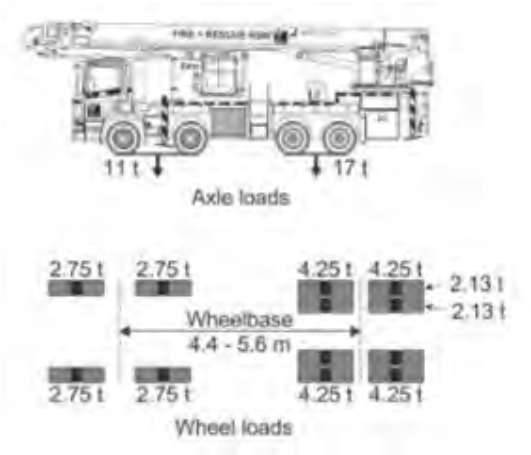


Figure 4.5 – Typical Specialist Fire Emergency Service Vehicle

Considering the expected number of movements of the above vehicle (say no more than 10 movements per year for fire emergencies) and of other heavy service vehicles that will probably traffic the pavement a few times a week such as delivery trucks and rubbish trucks (Austroads Class 3 to 5 trucks), we have assumed a design traffic of 1 x 10^5 Equivalent Standard Axles (ESA) over a design period of 40 years with a project reliability of 95%. More details can be found in the Geotech report Appendix C.

In addition to the above, drainage control measures will be implemented to prevent ponding and moisture ingress into the pavement layers. The finished surfaces of pavements will be suitably shaped to direct storm-water run-off away from the pavements and towards drainage systems

Signage and Pavement marking has been detailed at this stage, refer to design drawings Appendix A.

4.5 Sewer

The proposed site does not have any sewer connection on the immediate fronting of Bushman Glade. The nearest Water Corporation gravity sewer is a 225 PVC that runs along the Pioneer Road on the Southwestern side of the lot and currently servicing the existing Coles Byford Village. This gravity sewer to be extended to the proposed site at 1:300 grade and a site connection be made at IL 50.46.

Full extension details were approved by Water Corp and attached to Appendix A.

4.6 Water

The existing connection pipe is currently available from Blackburn Drive to the south of Byford Health Hub site. The existing water main, identified as 150P-12 that runs along Blackburn Drive and Pioneer Road on the Southwestern side of the lot, provides the existing Coles Byford Village with water.

We anticipate that the water supply to the site will not pose a significant issue based on Water Corporation planning advice. However, further investigation is required to fully understand the capacity of the existing network and determine any additional capacity necessary to accommodate the needs of the New Buildings. This investigation will ensure that the water supply to the site remains sufficient and meets the project's requirements. Refer to hydraulic package for more details.

Appendices

Appendix A
Civil Design Drawings

DRAWING INDEX

DRAWING No.	DRAWING TITLE
C.50	MAIN WORKS COVER SHEET AND DRAWING INDEX
C.51	MAIN WORKS LOCALITY PLAN
C.55	MAIN WORKS SITE PLAN
C.60	MAIN WORKS ROAD LAYOUT
C.61	MAIN WORKS LINEMARKING AND SIGNAGE PLAN
C.62	MAIN WORKS EARTHWORKS PLAN
C.63	MAIN WORKS SPOT LEVELS
C.64	MAIN WORKS DRAINAGE PLAN
C.65	MAIN WORKS PAVEMENT PLAN
C.67	MAIN WORKS CROSS SECTIONS
C.70	MAIN WORKS TYPICAL DETAILS SHEET 1
C.71	MAIN WORKS TYPICAL DETAILS SHEET 2
C.72	MAIN WORKS TYPICAL DETAILS SHEET 3
C.80	MAIN WORKS DRAINAGE DETAILS SHEET 1
C.81	MAIN WORKS DRAINAGE DETAILS SHEET 2
C.82	MAIN WORKS SUBSOIL DETAILS
C.90	MAIN WORKS DRAINAGE PIT SCHEDULE

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BYFORD HEALTH HUB
MAIN WORKS 2024
COVER SHEET AND DRAWING LIST

CIVIL

SET No. TENDER NUMBER VOL. OF

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TENDERS CLOSE:

C.50 A

BYFORD HEALTH HUB
MAIN WORKS



LOCALITY PLAN
SCALE 1:1000

REV	DATE	DESCRIPTION	
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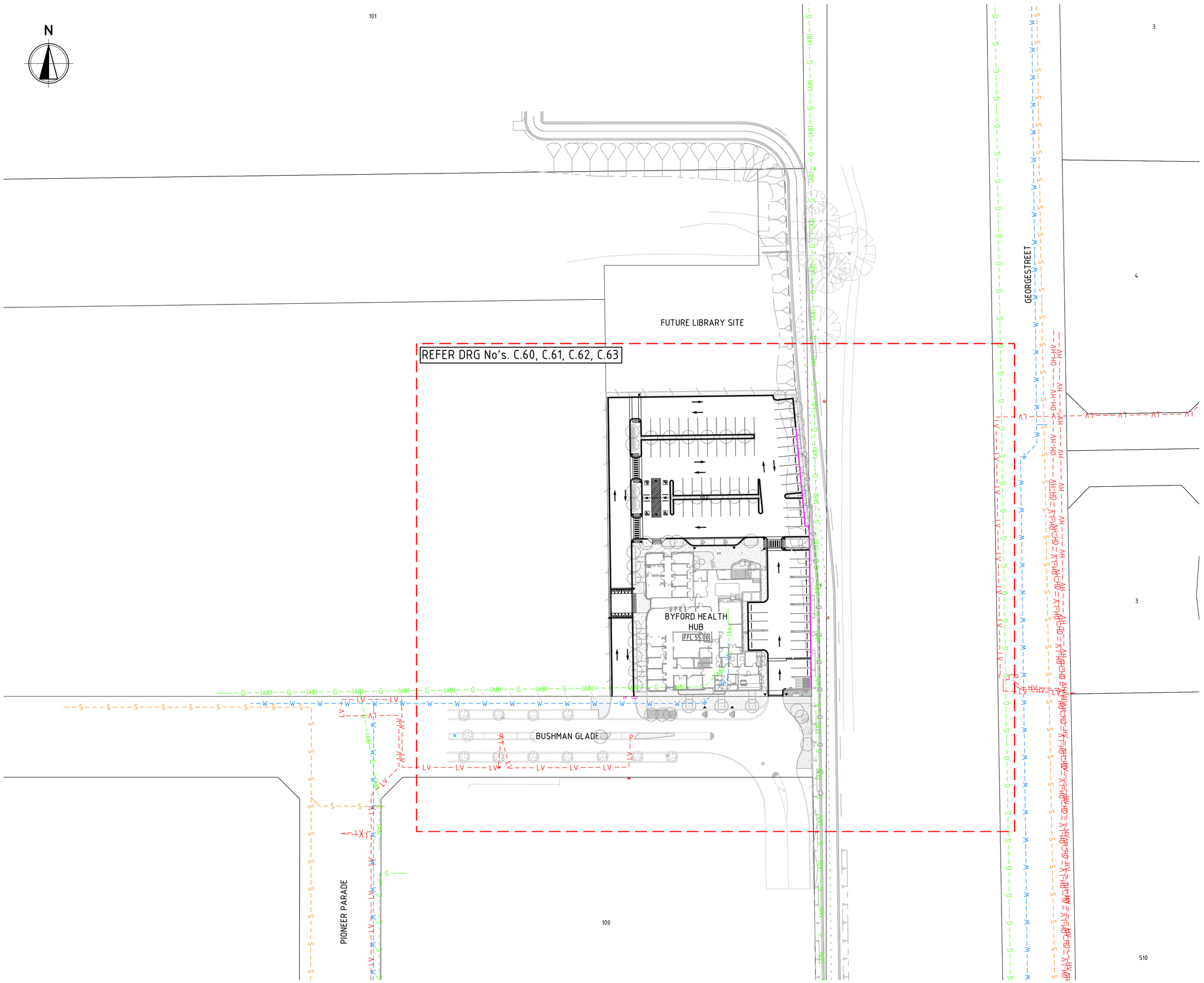
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BYFORD HEALTH HUB
MAIN WORKS
LOCALITY PLAN

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APPROVED CB			
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DF PROJ No. 15618		DF FILE No. 2023/07702	

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SCALE 1:1000 AT A1 SIZE

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LEGEND

- CADASTRAL BOUNDARY
- FUTURE CADASTRAL BOUNDARY

EXISTING SERVICES

- DRAINAGE
- GAS
- GAS - ABANDONED
- POWER - HIGH VOLTAGE
- POWER - LOW VOLTAGE
- POWER - OVERHEAD HIGH VOLTAGE
- POWER - OVERHEAD LOW VOLTAGE
- SEWER
- WATER

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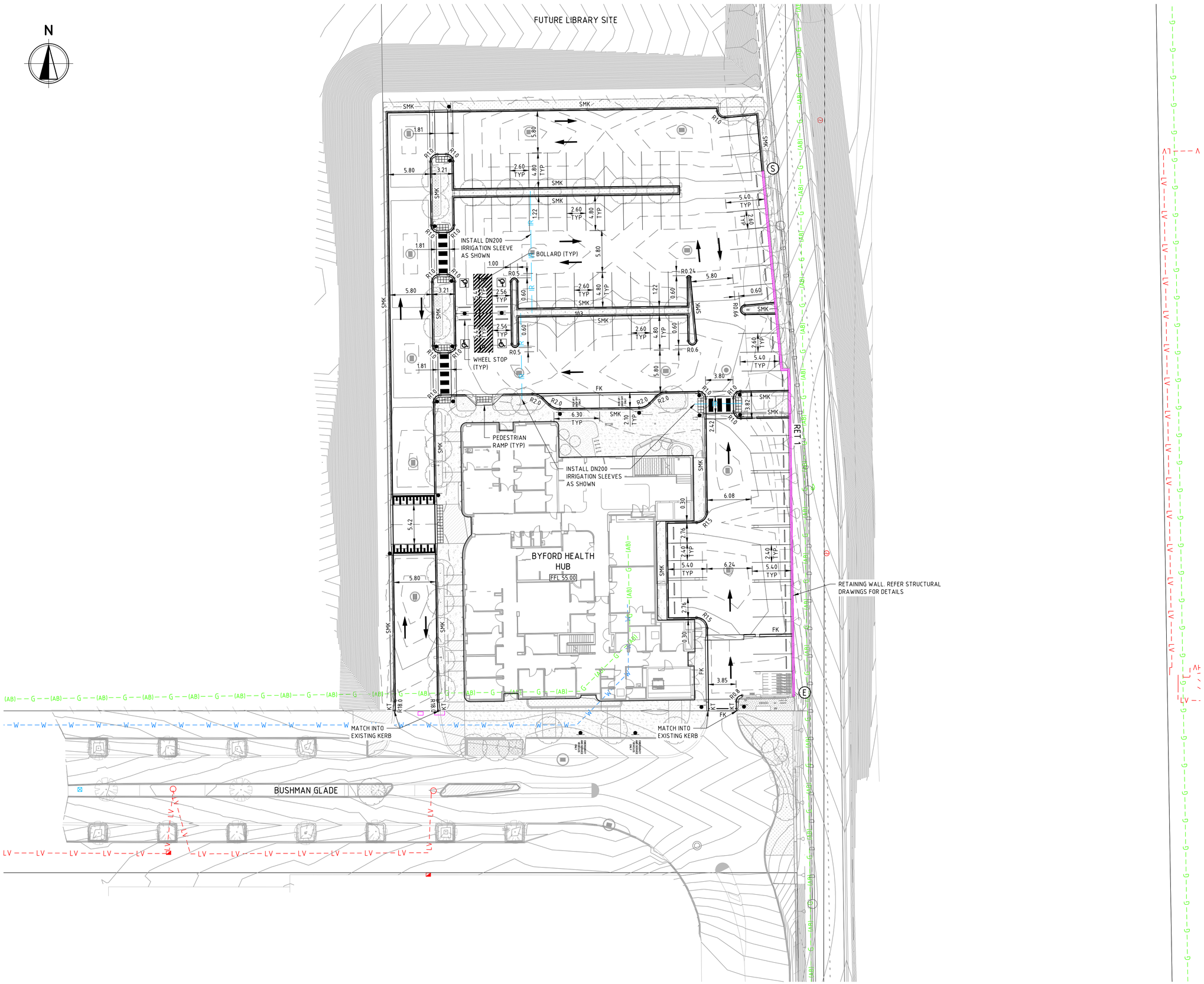
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BYFORD HEALTH HUB
MAIN WORKS
SITE PLAN

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LEGEND

- CADASTRAL BOUNDARY
- FUTURE CADASTRAL BOUNDARY
- MAIN WORKS CONTOURS - MAJOR (1.0m INTERVALS)
- MAIN WORKS CONTOURS - MINOR (0.1m INTERVALS)
- EXISTING CONTOURS - MINOR (0.05m INTERVALS)
- SMK — SEMI-MOUNTABLE KERB
- FK — FLUSH KERB
- KT — KERB TRANSITION
- RETAINING WALL. REFER STRUCTURAL DRAWINGS FOR DETAILS

EXISTING SERVICES

- DRAINAGE
- GAS
- GAS - ABANDONED
- POWER - HIGH VOLTAGE
- POWER - LOW VOLTAGE
- WATER

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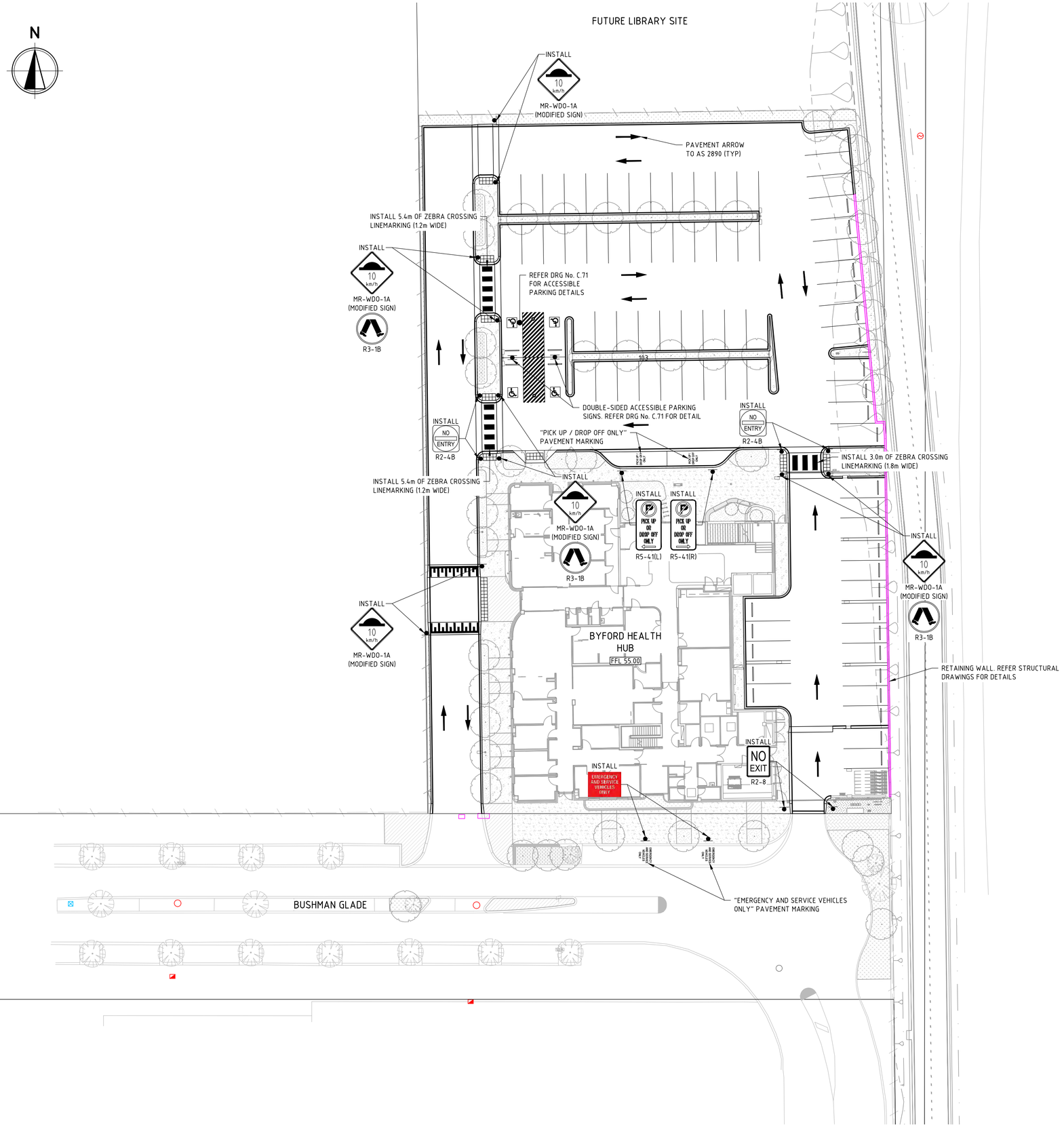
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BYFORD HEALTH HUB
MAIN WORKS
ROAD LAYOUT

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LEGEND

- CADASTRAL BOUNDARY
- FUTURE CADASTRAL BOUNDARY
- RETAINING WALL. REFER STRUCTURAL DRAWINGS FOR DETAILS

0 2.5 5.0 7.5 10 12.5 15m
SCALE 1:250 AT A1 SIZE

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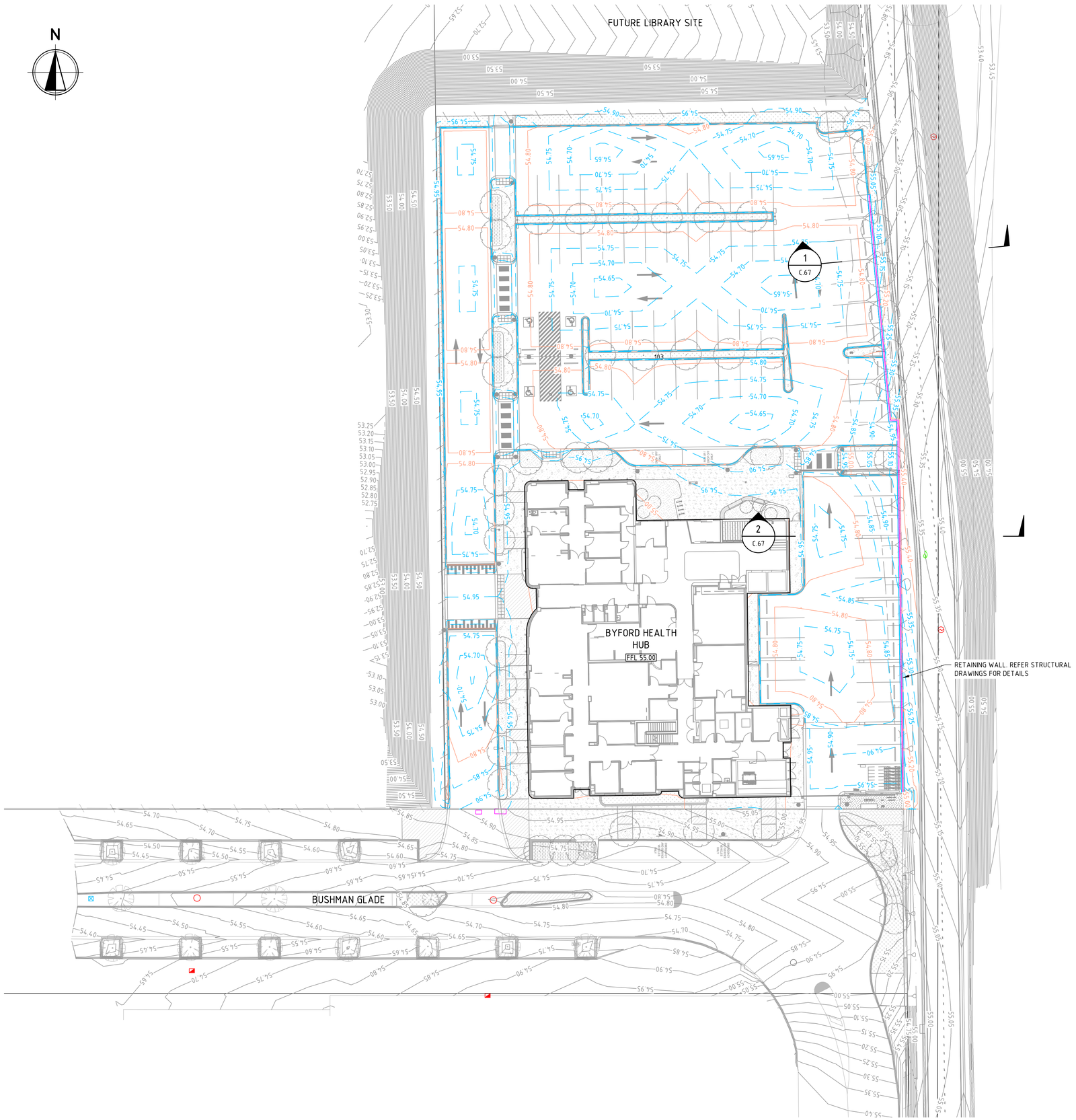
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BYFORD HEALTH HUB
MAIN WORKS
LINEMARKING AND SIGNAGE PLAN

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LEGEND

- CADASTRAL BOUNDARY
- FUTURE CADASTRAL BOUNDARY
- RETAINING WALL. REFER STRUCTURAL DRAWINGS FOR DETAILS
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- 55.05 — MAIN WORKS CONTOURS - MINOR (0.1m INTERVALS)
- 54.85 — EXISTING CONTOURS - MINOR (0.05m INTERVALS)

0 2.5 5.0 7.5 10 12.5 15m
SCALE 1:250 AT A1 SIZE

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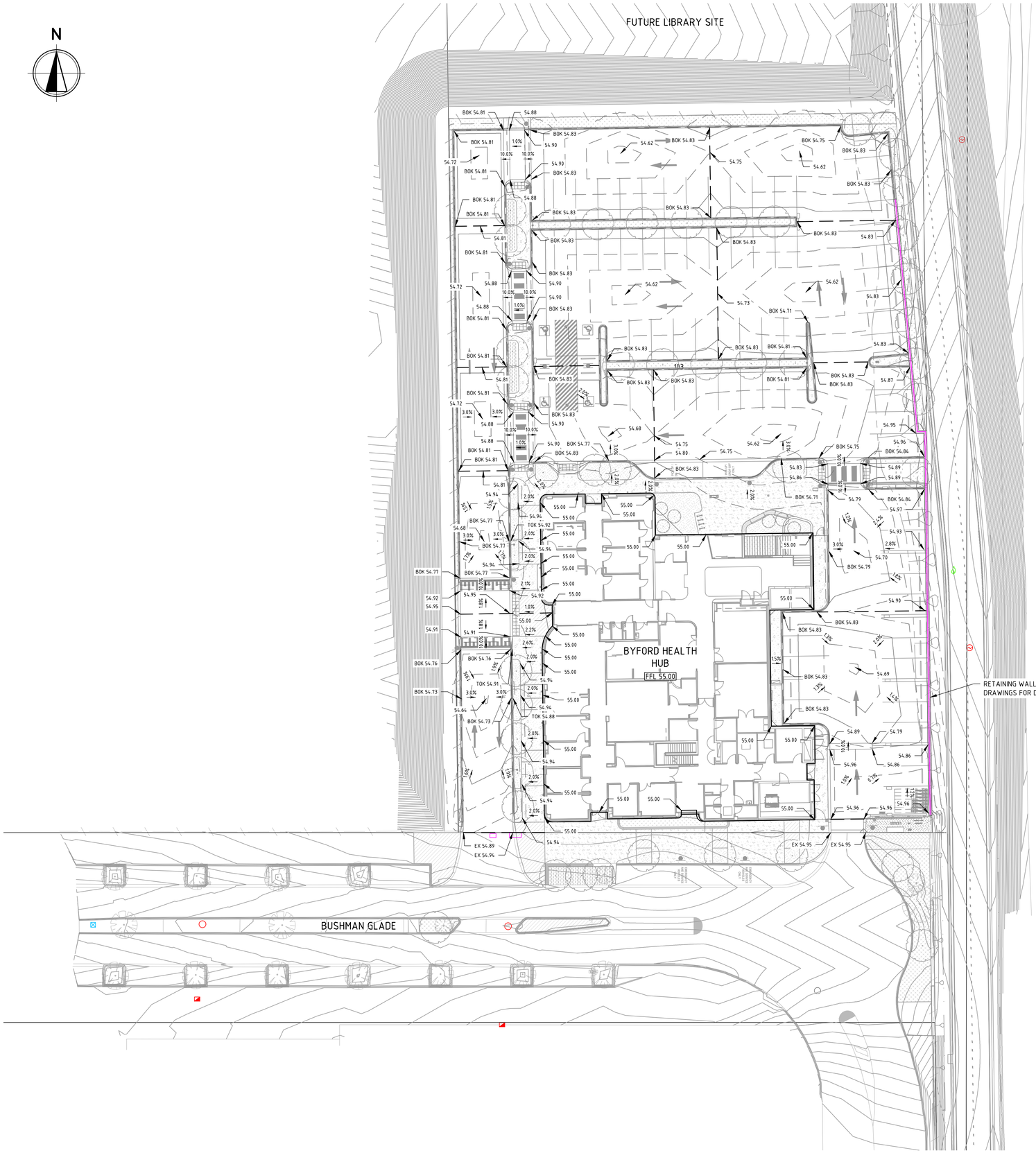
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BYFORD HEALTH HUB
MAIN WORKS
EARTHWORKS PLAN

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LEGEND

- CADASTRAL BOUNDARY
- FUTURE CADASTRAL BOUNDARY
- RIDGE LINE
- MAIN WORKS CONTOURS - MAJOR (1.0m INTERVALS)
- MAIN WORKS CONTOURS - MINOR (0.1m INTERVALS)
- EXISTING CONTOURS - MINOR (0.05m INTERVALS)
- RETAINING WALL. REFER STRUCTURAL DRAWINGS FOR DETAILS

0 2.5 5.0 7.5 10 12.5 15m
SCALE 1:250 AT A1 SIZE

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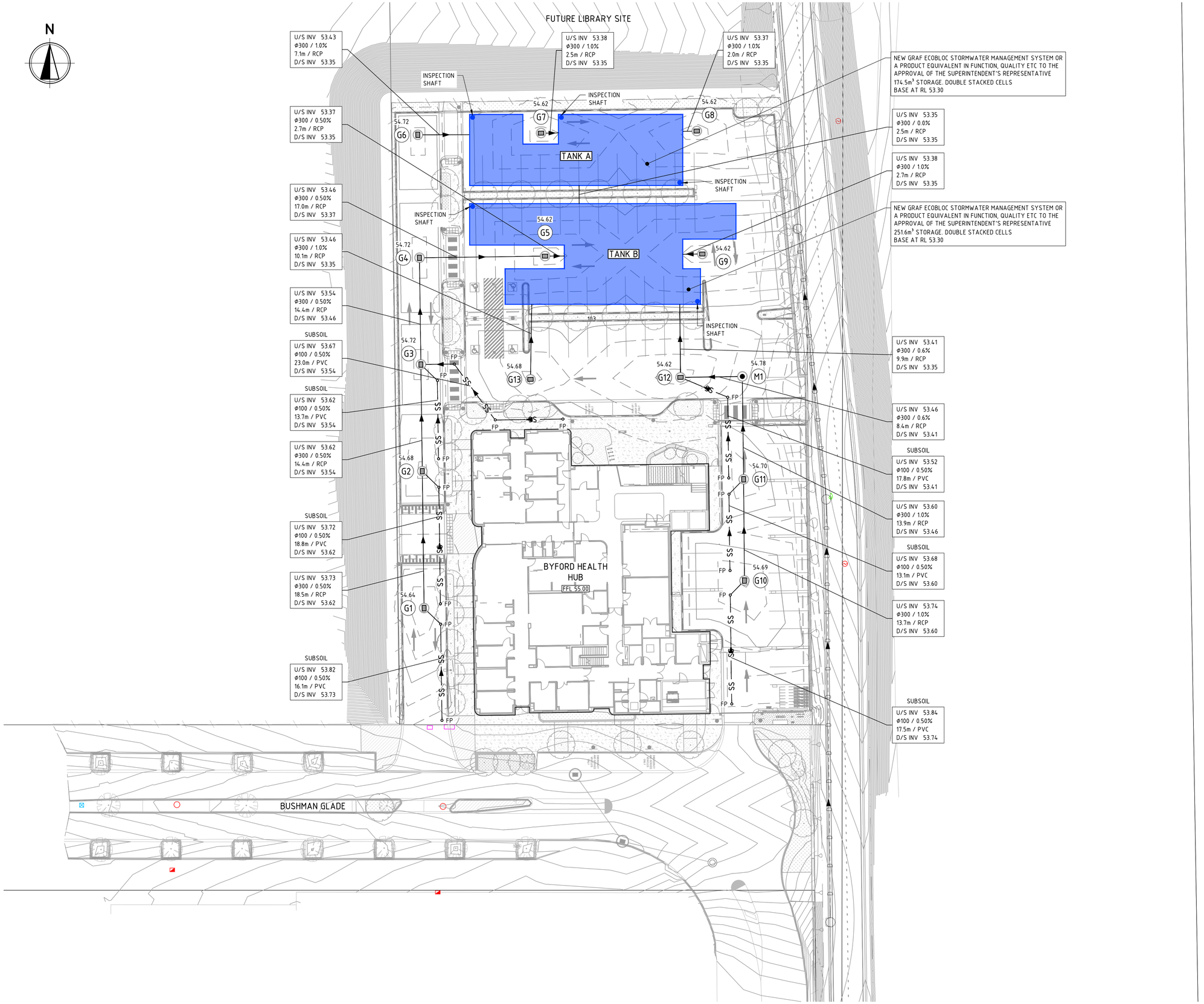
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CIVIL

BYFORD HEALTH HUB
MAIN WORKS
SPOT LEVELS

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APPROVED CB			
SCALE 1:250		DATE 13.08.24	DRAWING No. C.63 A
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0 2.5 5.0 7.5 10 12.5 15m
SCALE 1:250 AT A1 SIZE

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LEGEND

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- FUTURE CADASTRAL BOUNDARY
- MAIN WORKS CONTOURS - MAJOR (1.0m INTERVALS)
- MAIN WORKS CONTOURS - MINOR (0.1m INTERVALS)
- EXISTING CONTOURS - MINOR (0.05m INTERVALS)
- NEW DRAINAGE PIPE WITH FLOW ARROW
- SS → SS — NEW SUBSOIL PIPE WITH FLOW ARROW
- NEW GRATED GULLY PIT
- NEW MANHOLE
- G1 — DRAINAGE STRUCTURE NUMBER
- FP — SUBSOIL FLUSHING POINT
- U/S INV 53.73 / ø300 / 0.50% / 18.5m / RCP / D/S INV 53.62 — DRAINAGE INFORMATION: PIPE - UPSTREAM INVERT, PIPE DIAMETER / GRADE, PIPE LENGTH / MATERIAL, PIPE - DOWNSTREAM INVERT
- NEW DRAINAGE TANK
- D → D — EXISTING DRAINAGE PIPE WITH FLOW ARROW
- EXISTING DRAINAGE PIT

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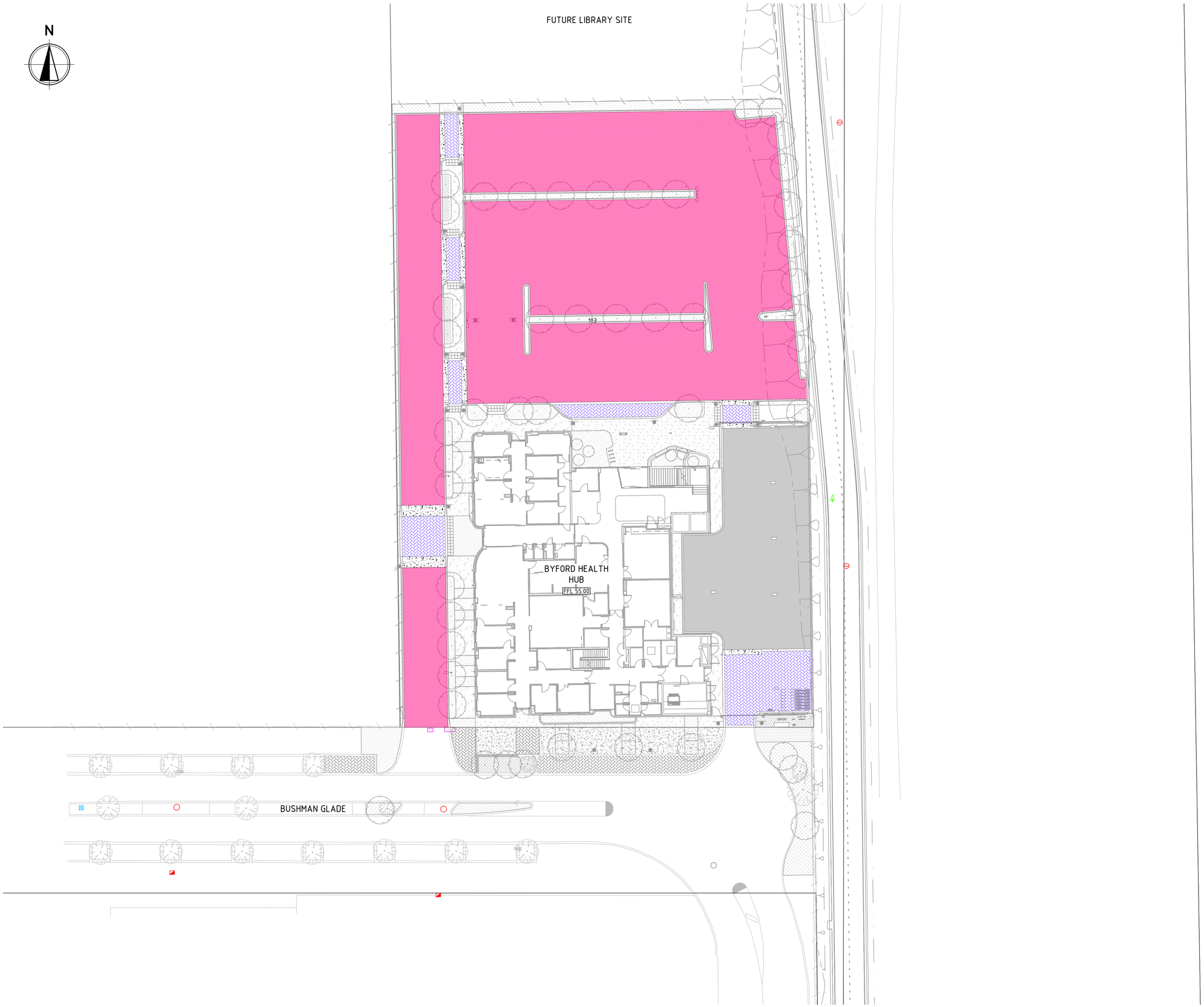
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BYFORD HEALTH HUB
MAIN WORKS
DRAINAGE PLAN

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APPROVED CB			
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0 2.5 5.0 7.5 10 12.5 15m
SCALE 1:250 AT A1 SIZE

NOTES

1. DO NOT SCALE DRAWINGS.
2. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
3. CONTRACTOR MUST VERIFY ALL DIMENSIONS AND LEVELS PRIOR TO THE COMMENCEMENT OF WORKS. ANY DISCREPANCIES ARE TO BE REPORTED TO THE SUPERINTENDENT AND INSTRUCTION SOUGHT.
4. CONTRACTOR TO VERIFY SERVICES IN THE VICINITY OF ALL EXCAVATION/DRAINAGE WORKS PRIOR TO THE COMMENCEMENT OF THE WORKS. SERVICES INFORMATION SHOWN ON THE DRAWINGS ARE INDICATIVE ONLY AND MAY NOT BE COMPLETE.
5. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.
6. REFER TO CIVIL DESIGN REPORT FOR DETAILED SITE PREPARATION REQUIREMENTS.
7. REFER TO THE LANDSCAPE ARCHITECT'S DRAWINGS FOR ALL TREE LOCATIONS AND PROTECTION REQUIREMENTS. TREES SHOWN AS REFERENCE ONLY.

LEGEND

CADASTRAL BOUNDARY

FUTURE CADASTRAL BOUNDARY

RED ASPHALT:
- 30mm WEARING SURFACE 10mm DENSE GRADED RED ASPHALT CLASS 170 BITUMEN
- PRIMER SEAL
- 100mm CRUSHED IGNEOUS ROCK BASECOURSE
- 100mm CRUSHED LIMESTONE SUBBASE
- SAND SUBGRADE CBR 12%

BLACK ASPHALT:
- 30mm WEARING SURFACE 10mm DENSE GRADED BLACK ASPHALT CLASS 170 BITUMEN
- PRIMER SEAL
- 100mm CRUSHED IGNEOUS ROCK BASECOURSE
- 100mm CRUSHED LIMESTONE SUBBASE
- SAND SUBGRADE CBR 12%

TRAFFICABLE BRICK PAVING:
- HEAVY DUTY INTERLOCK PAVERS, MINIMUM 80mm THICK AS SPECIFIED BY LANDSCAPE ARCHITECT, WITH CEMENT BEDDED HEADER COURSE ALONG ALL EDGES
- BEDDING COURSE TO PAVER MANUFACTURER'S DETAILS
- 100mm CRUSHED IGNEOUS ROCK BASECOURSE
- 100mm CRUSHED LIMESTONE SUBBASE
- SAND SUBGRADE CBR 12%

CONCRETE RAMP:
REFER DRG No. C.72 FOR DETAILS

REV	DATE	DESCRIPTION	
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM

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Buildings and Contracts

CIVIL

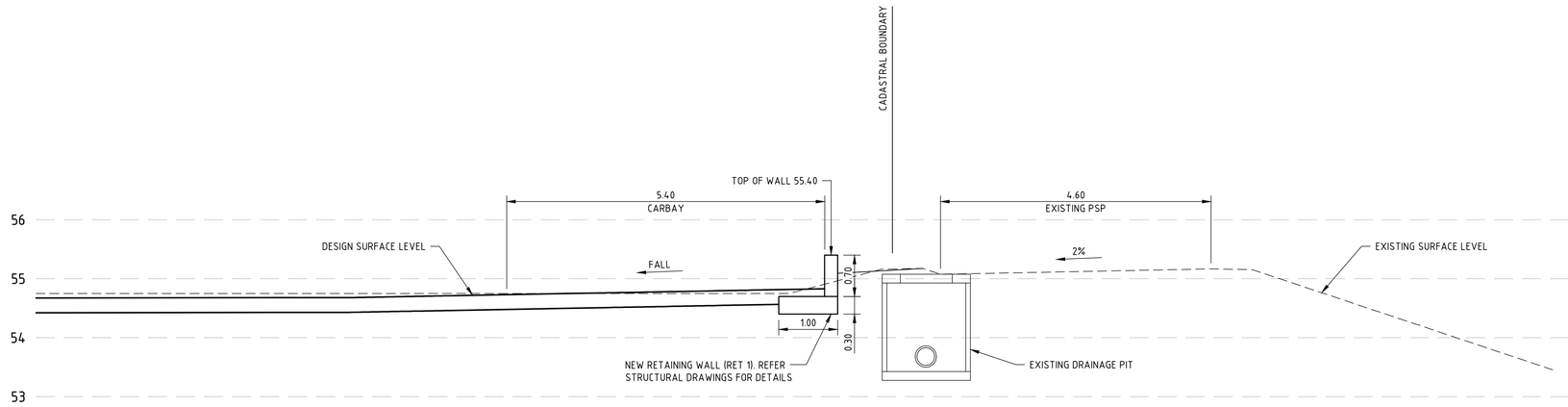
BYFORD HEALTH HUB
MAIN WORKS
PAVEMENT PLAN

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE 1:250		DATE 21.10.24	DRAWING No. C.65 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

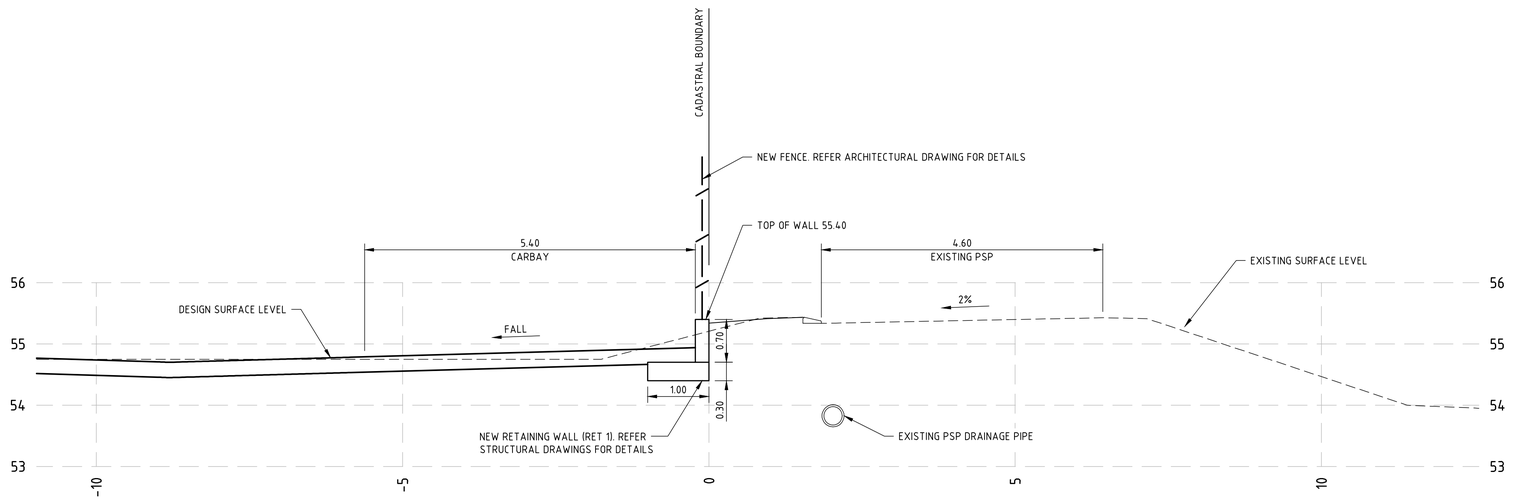
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NOTES

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SECTION 1 / C.61
SCALE 1:50



SECTION 2 / C.61
SCALE 1:50

0 0.5 1.0 1.5 2.0 2.5 3.0m
SCALE 1:50 AT A1 SIZE

REV	DATE	DESCRIPTION	
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM
REVISIONS			RVD

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CIVIL

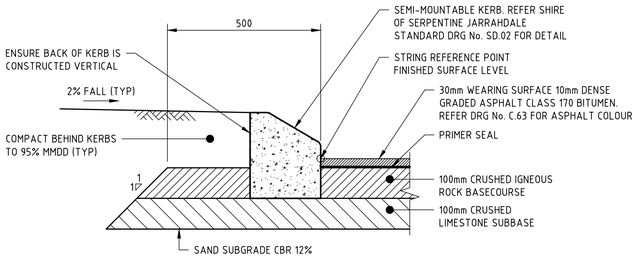
BYFORD HEALTH HUB
MAIN WORKS
CROSS SECTIONS

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE 1:50		DATE 17.10.24	DRAWING No. C.67 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

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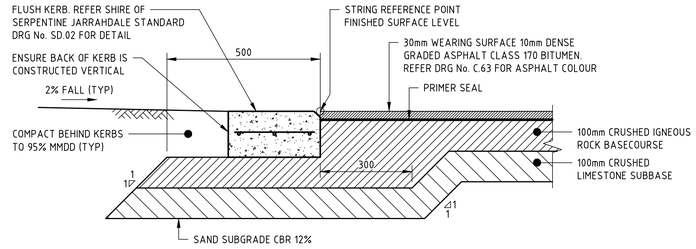
NOTES

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3. CONCRETE CLASS TO BE N32 UNLESS SPECIFIED OTHERWISE.



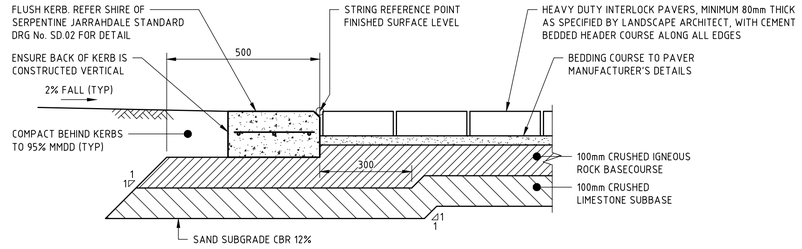
ASPHALT PAVEMENT DETAIL WITH SEMI-MOUNTABLE KERB

SCALE 1:10



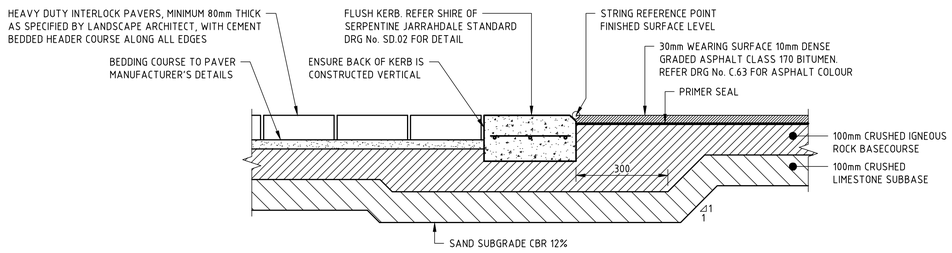
ASPHALT PAVEMENT DETAIL WITH FLUSH KERB

SCALE 1:10



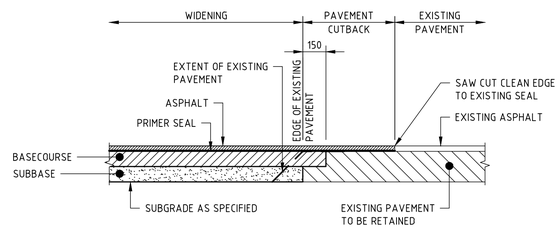
BRICK PAVING DETAIL WITH FLUSH KERB

SCALE 1:10



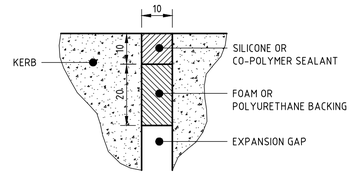
ASPHALT TO TRAFFICABLE BRICK PAVING DETAIL WITH FLUSH KERB

SCALE 1:10



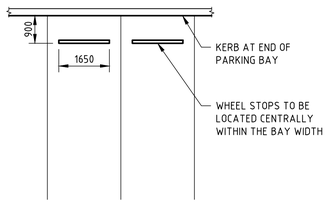
PAVEMENT TIE-IN DETAIL (LONGITUDINAL JOINT)

SCALE 1:20



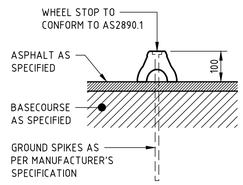
KERB EXPANSION JOINT

SCALE NTS



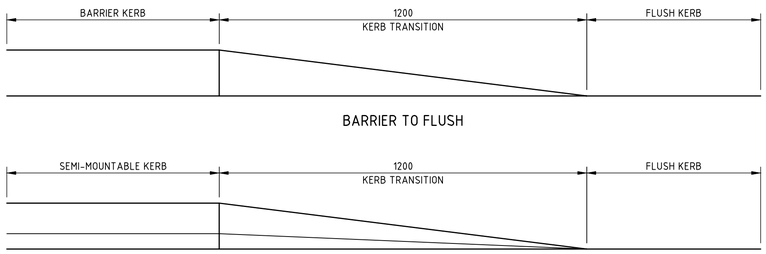
WHEEL STOP

SCALE 1:100



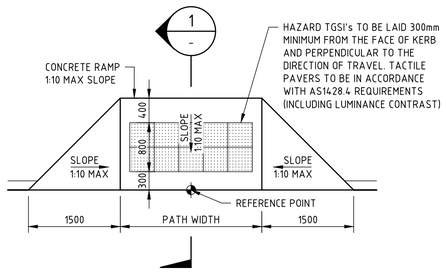
WHEEL STOP DETAIL

SCALE NTS



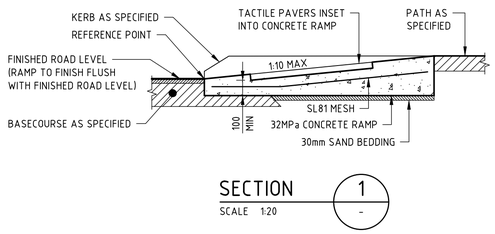
KERB TRANSITION ELEVATION

SCALE 1:10



PEDESTRIAN RAMP

SCALE 1:50



SECTION 1 / -

SCALE 1:20

0 100 200 300 400 500 600mm
SCALE 1:10 AT A1 SIZE

0 0.2 0.4 0.6 0.8 1.0 1.2m
SCALE 1:20 AT A1 SIZE

0 0.5 1.0 1.5 2.0 2.5 3.0m
SCALE 1:50 AT A1 SIZE

0 1 2 3 4 5 6m
SCALE 1:100 AT A1 SIZE

REV	DATE	DESCRIPTION	
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CIVIL

BYFORD HEALTH HUB

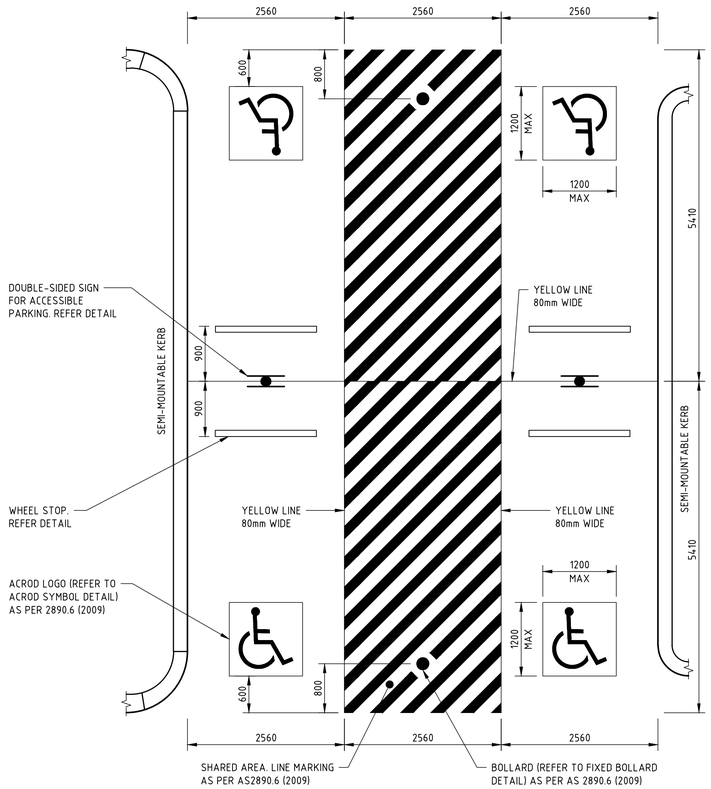
MAIN WORKS
TYPICAL DETAILS
SHEET 1

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE AS SHOWN		DATE 08.10.24	DRAWING No. C.70 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

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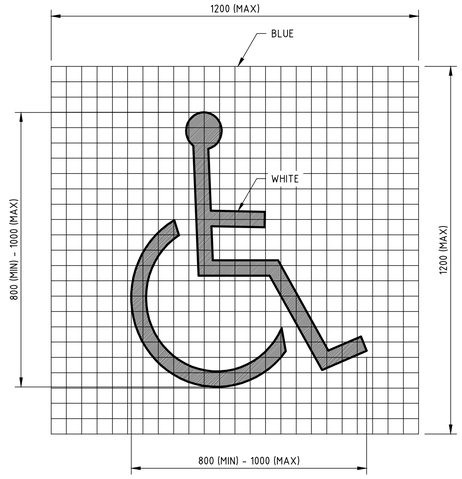
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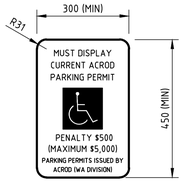
ACCESSIBLE PARKING DETAIL

SCALE 1:50



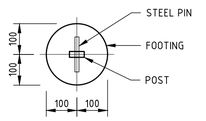
ACROD SYMBOL

SCALE NTS



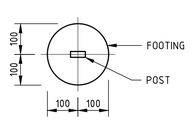
INTERNATIONAL SYMBOL OF ACCESS PARKING SIGN

SCALE NTS



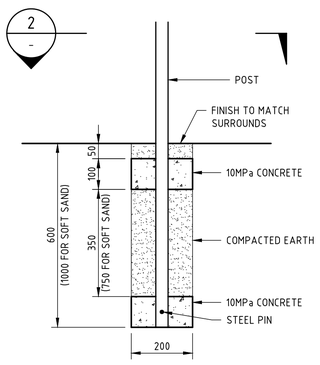
SECTION 2

SCALE 1:10



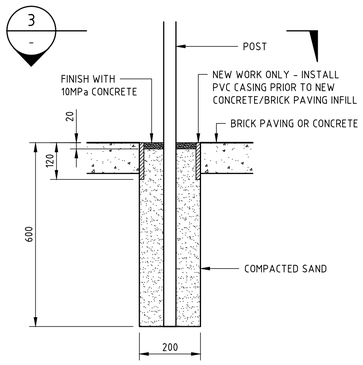
SECTION 3

SCALE 1:10



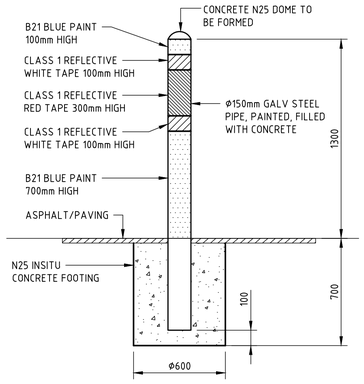
SIGN POST FOOTING DETAIL (IN SOIL AREAS)

SCALE 1:10



SIGN POST FOOTING DETAIL (IN PAVEMENTS, CONCRETE AND HARDSTAND AREAS)

SCALE 1:10



FIXED BOLLARD DETAIL

SCALE 1:20

0 100 200 300 400 500 600mm
SCALE 1:10 AT A1 SIZE

0 0.2 0.4 0.6 0.8 1.0 1.2m
SCALE 1:20 AT A1 SIZE

0 0.5 1.0 1.5 2.0 2.5 3.0m
SCALE 1:50 AT A1 SIZE

REV	DATE	DESCRIPTION	
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM
REVISIONS			RVD

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BYFORD HEALTH HUB

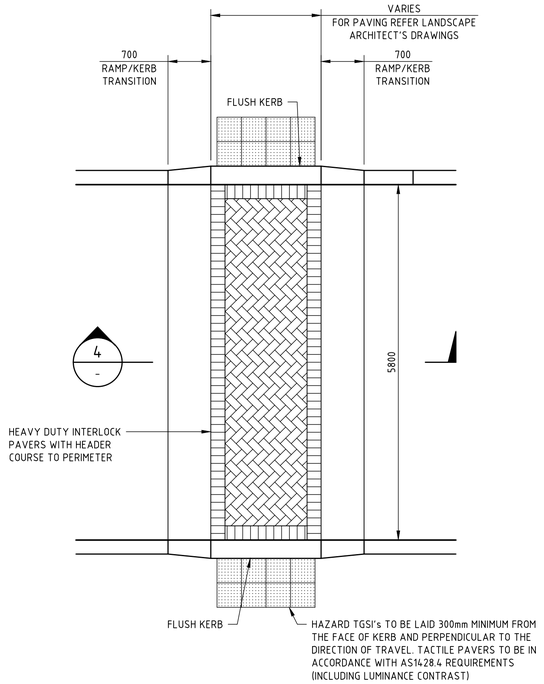
MAIN WORKS
TYPICAL DETAILS
SHEET 2

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE AS SHOWN		DATE 10.10.24	DRAWING No. C.71 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

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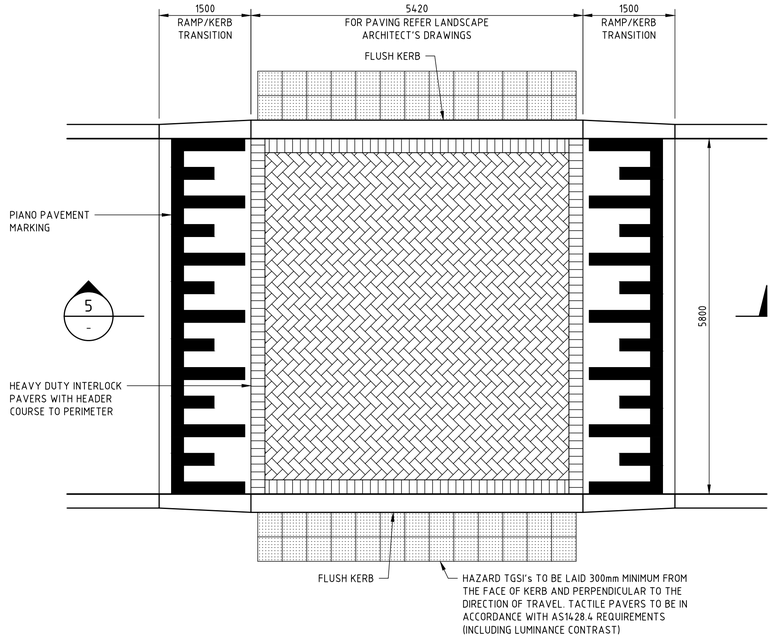
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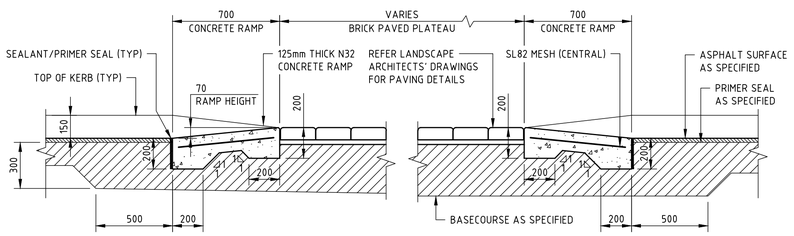
PAVED PEDESTRIAN PLATEAU - TYPICAL

SCALE 1:50



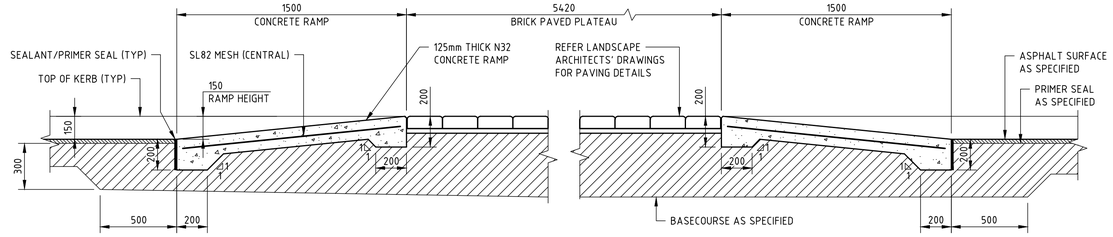
PAVED PEDESTRIAN PLATEAU - WESTERN ROAD

SCALE 1:50



SECTION 4

SCALE 1:20



SECTION 5

SCALE 1:20

0 0.2 0.4 0.6 0.8 1.0 1.2m
SCALE 1:20 AT A1 SIZE

0 0.5 1.0 1.5 2.0 2.5 3.0m
SCALE 1:50 AT A1 SIZE

REV	DATE	DESCRIPTION	
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REVISIONS			RVD

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BYFORD HEALTH HUB

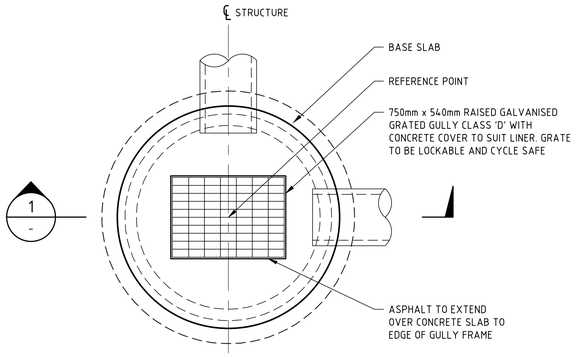
MAIN WORKS
TYPICAL DETAILS
SHEET 3

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE AS SHOWN		DATE 21.10.24	DRAWING No. C.72 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

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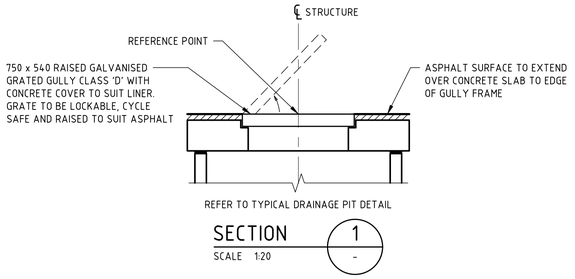
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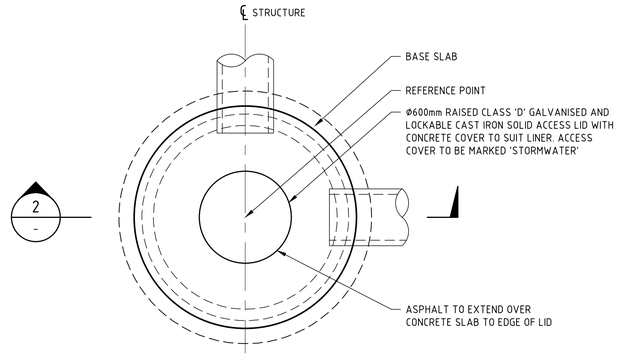
PLAN

SCALE 1:20



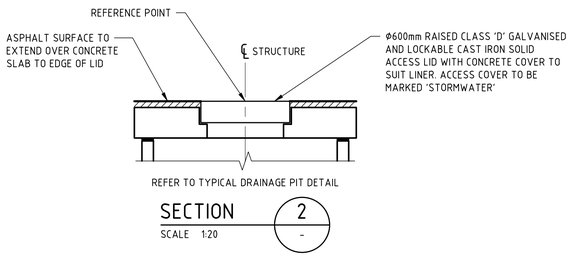
SECTION 1 - SCALE 1:20

GRATED GULLY DETAIL - ASPHALT



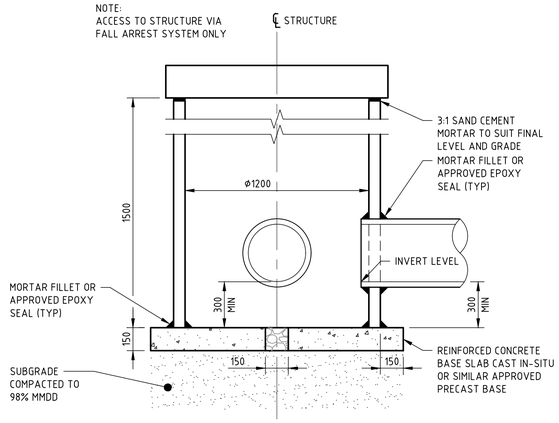
PLAN

SCALE 1:20



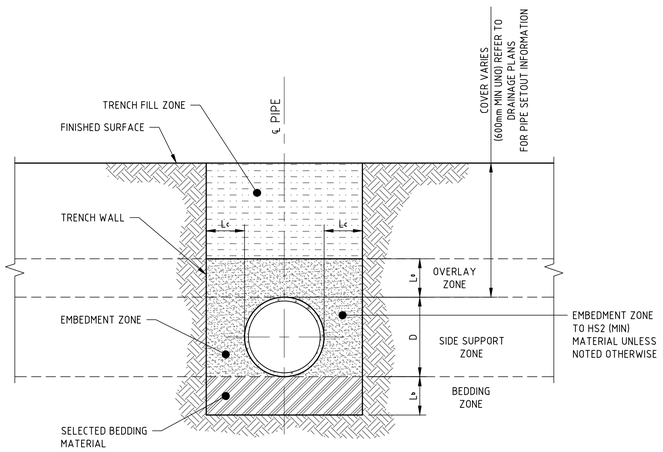
SECTION 2 - SCALE 1:20

MANHOLE DETAIL - ASPHALT



TYPICAL DRAINAGE PIT DETAIL

SCALE 1:20



TRENCH METHOD (TYPICAL)

SCALE NTS

D (LARGEST DIAMETER ALONG PIPE BARREL)	MIN DIMENSION (mm)		
	Lb	Lc	Lo
75 ≤ 150	75	100	100
150 ≤ 300	100	150	150
300 ≤ 450	100	200	150
450 ≤ 900	150	300	150
900 ≤ 1500	150	350	200

0 0.2 0.4 0.6 0.8 1.0 1.2m

SCALE 1:20 AT A1 SIZE

REV	DATE	DESCRIPTION	
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM

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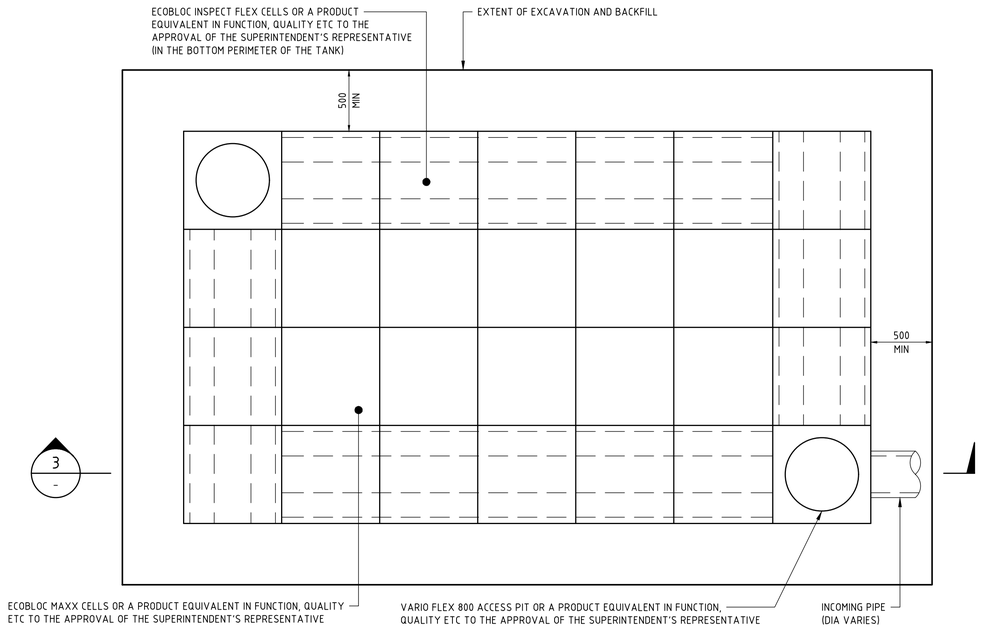
CIVIL

BYFORD HEALTH HUB

MAIN WORKS
DRAINAGE DETAILS
SHEET 1

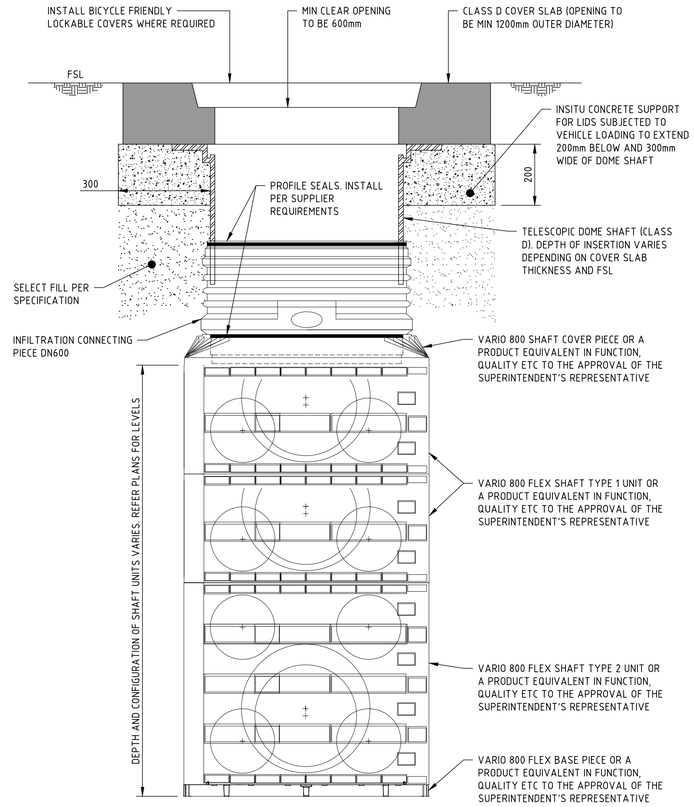
DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE AS SHOWN		DATE 10.10.24	DRAWING No. C.80 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

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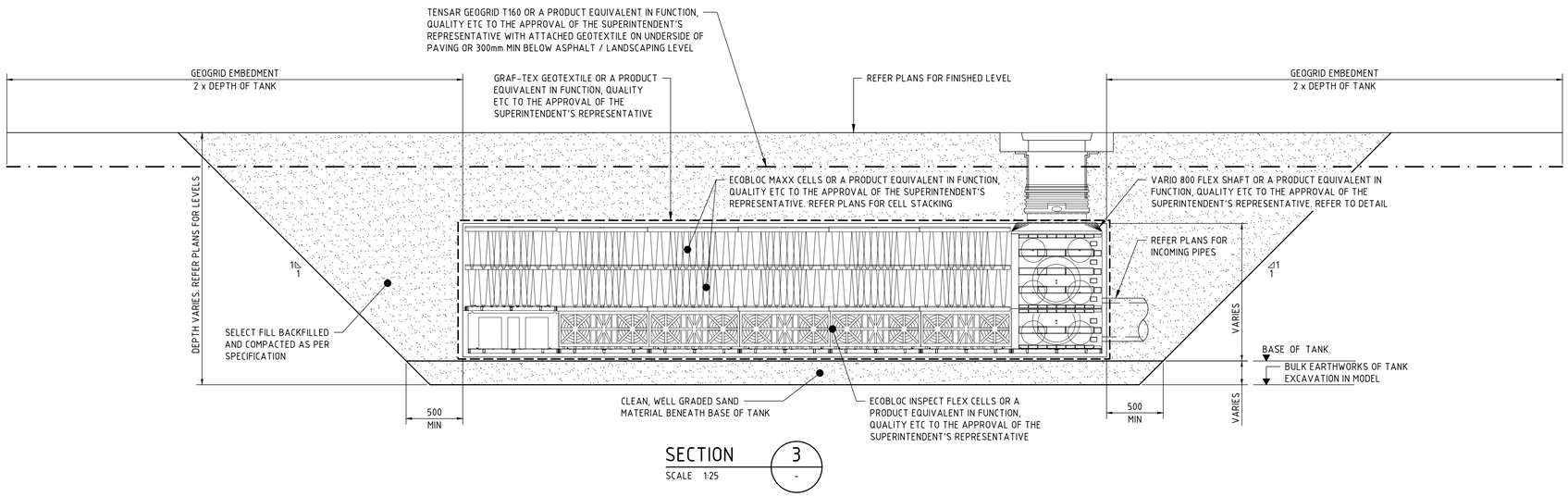
DIAGRAMMATIC DRAINAGE TANK PLAN (BASE LAYER SHOWN)

SCALE 1:25



ACCESS SHAFT TYPICAL DETAIL

SCALE 1:10



SECTION 3 -

SCALE 1:25

NOTES

1. DO NOT SCALE DRAWINGS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
3. TANK SYSTEM TO BE ECOBLOC SYSTEM OR A PRODUCT EQUIVALENT IN FUNCTION, QUALITY ETC TO THE APPROVAL OF THE SUPERINTENDENT'S REPRESENTATIVE.
4. TANK SYSTEM TO BE BEDDED AND BACKFILLED IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS.
5. TANK INSTALLATION TO BE SUPERVISED BY SUPPLIER.

REV	DATE	DESCRIPTION	
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM
REVISIONS			RVD

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556 Wellington St, Perth WA 6000
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CIVIL

BYFORD HEALTH HUB
MAIN WORKS
DRAINAGE DETAILS
SHEET 2

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE AS SHOWN		DATE 10.10.24	DRAWING No. C.81 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

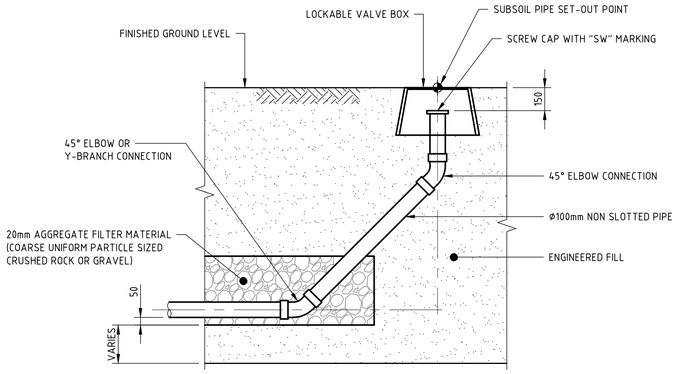
0 100 200 300 400 500 600mm
SCALE 1:10 AT A1 SIZE

0 0.25 0.5 0.75 1.0 1.25 1.5m
SCALE 1:25 AT A1 SIZE

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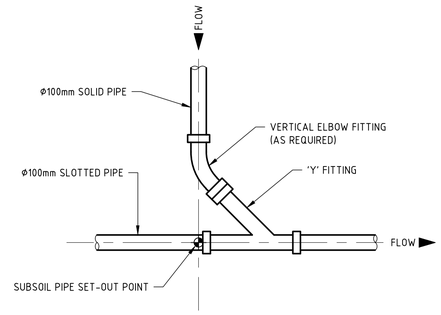
NOTES

1. DO NOT SCALE DRAWINGS.
2. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
3. CONCRETE CLASS TO BE N32 UNLESS SPECIFIED OTHERWISE.



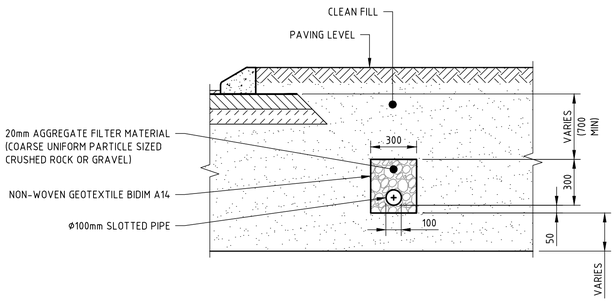
END OF LINE FLUSHING POINT DETAIL - Ø100mm SUBSOIL (TYP)

SCALE 1:20



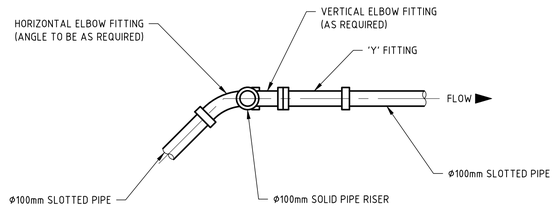
FLUSHING POINT AT BEND DETAIL ELEVATION

SCALE 1:20



SUBSOIL DRAINAGE DETAIL Ø100mm (TYP)

SCALE 1:20



FLUSHING POINT AT BEND PLAN

SCALE 1:20

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BYFORD HEALTH HUB
MAIN WORKS
SUBSOIL DETAILS

DRAWN JS		DESIGNED LG	REDUCTION 0 25
CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE 1:20		DATE 29.11.24	DRAWING No. C.82 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

0 0.2 0.4 0.6 0.8 1.0 1.2m
SCALE 1:20 AT A1 SIZE

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DRAINAGE PIT SCHEDULE

STRUCTURE No.	STRUCTURE TYPE	LINER DIAMETER (mm)	PIT DEPTH (mm)	REFERENCE POINT EASTING	REFERENCE POINT NORTHING	REFERENCE POINT LEVEL	COMMENTS
G1	GRATED GULLY PIT	1200	1500	67925.870	233852.154	54.64	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G2	GRATED GULLY PIT	1200	1500	67925.621	233870.642	54.68	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G3	GRATED GULLY PIT	1200	1500	67925.432	233885.048	54.72	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G4	GRATED GULLY PIT	1200	1500	67925.238	233899.461	54.72	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G5	GRATED GULLY PIT	1200	1500	67942.215	233899.690	54.62	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G6	GRATED GULLY PIT	1200	1500	67925.014	233916.077	54.72	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G7	GRATED GULLY PIT	1200	1500	67941.669	233916.301	54.62	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G8	GRATED GULLY PIT	1200	1500	67962.717	233916.584	54.62	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G9	GRATED GULLY PIT	1200	1500	67963.469	233899.976	54.62	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G10	GRATED GULLY PIT	1200	1500	67969.168	233855.864	54.69	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G11	GRATED GULLY PIT	1200	1500	67969.060	233869.550	54.70	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G12	GRATED GULLY PIT	1200	1500	67960.522	233883.315	54.62	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
G13	GRATED GULLY PIT	1200	1500	67940.242	233883.042	54.68	750 x 540mm RAISED GALVANISED GRATED GULLY CLASS 'D' WITH CONCRETE COVER TO SUIT LINER. GRATE TO BE LOCKABLE AND CYCLE SAFE
M1	MANHOLE	1200	1500	67968.877	233883.428	54.78	ø600mm RAISED CLASS 'D' GALVANISED AND LOCKABLE CAST IRON SOLID ACCESS LID WITH CONCRETE COVER TO SUIT LINER. ACCESS COVER TO BE MARKED 'STORMWATER'

NOTE:
DRAINAGE STRUCTURE EASTINGS, NORTHINGS AND RLs TO BE CONFIRMED AGAINST DIGITAL MODEL PROVIDED PRIOR TO CONSTRUCTION.

REV	DATE	DESCRIPTION	RVD
A	06.12.24	ISSUED FOR DESIGN DEVELOPMENT	AM

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DRAINAGE PIT SCHEDULE

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CHECKED AM		PRINCIPAL	
APPROVED CB			
SCALE NTS		DATE 16.10.24	DRAWING No. C.90 A
DF PROJ No. 15618		DF FILE No. 2023/07702	

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Appendix B
SID Report

SID RISK SCHEDULE

PROJECT TITLE	Byford Health Hub	PROJECT NO:	P24020	REV	A
PREPARED BY:	Alan Mayahi	Document No:	P24020 - CIVIL SID REGISTER-0001		
CHECKED BY:	Alan Mayahi	DATE:	10 April 2024		

Risk No.	Activity / Element	Unwanted Event / Hazard	Potential / Inherent Risk			Designers Action	Residual Risk			Significant Residual Risk	Action Required during design and/or construction phases	Organisation Responsible for Risk Treatment Strategies	By When	Closed out
			Likelihood	Severity	Risk		Likelihood	Severity	Risk					
1	General Construction Activities – Machinery movements to and from site	Person being hit by machinery	C-Possible	5-Critical	H (22)	Item cannot be designed out, however documentation states traffic management requirements	C-Possible	5-Critical	H (22)	Person being hit by machinery on public road	Traffic management proposal to be undertaken and submitted for approval prior to commencement of works. Measures to include pedestrian safety at crossovers and management of site access/egress.	Contractor	At commencement of project	
2	General Construction Activities – Operation of Heavy Machinery	Person being hit or run over by machinery, both public and workers.	C-Possible	5-Critical	H (22)	Works have been designed to limit where possible scope of works. Site security and fencing required during construction works.	C-Possible	5-Critical	H (22)	Members of public gaining access to site UnInducted workers/machine operators	Site security enforcement. Toolbox meetings on safe operation of large machinery. Management of concurrent works limit interaction of machinery and personnel	Contractor	At commencement of project	
3	Earthwork Construction Activities – deep excavation	Person falling in	C-Possible	4-Major	H (18)	Depths of excavations minimised where possible and large excavations placed within forward works contract where possible	C-Possible	4-Major	H (18)	Works at depth still required - risk of excavations not being adequately shored or edge protected	Adequate shoring and protection to deep excavations. Toolbox talks on matter. Signs of deep excavations being placed and area of works protected with barriers/barricades	Contractor	At commencement of project	
4	Earthwork Construction Activities – deep excavation	Collapse of trench	C-Possible	5-Critical	H (22)	Depths of excavations minimised where possible and deep excavations placed within forward works contract where possible	C-Possible	5-Critical	H (22)	Works at depth still required - risk of excavations not being adequately shored	Adequate shoring to deep excavations. Toolbox talks on matter	Contractor	At commencement of project	
5	Construction near or over existing drainage tanks leading to collapse of tanks	Creates crash hazard and/or trip hazard due to collapse of ground	C-Possible	5-Critical	H (22)	Works in the area cannot be designed out. Document location of existing infrastructure clearly on documentation along with information on loading criteria.	C-Possible	5-Critical	H (22)	Works in areas and access in areas cannot be design out, therefore risk remains to be managed.	Identification of the risk areas and loadings criterias in the documentation by the design team should be set out and reviewed by the Contractor in his programming and sequencing of the works. The location of the tank infrastructure is to be set out and delinated on site. The Contractors methodology and safety plan shall include for the mitigation of the risk.	Design Team/Contractor	At commencement of project	
6	Large retaining wall construction without final fencing/balustrade fixing	Person falling from height on completion of wall	C-Possible	5-Critical	H (22)	Specification of security fencing to protect members of public gaining access to site. Identification of risk to contractor	C-Possible	5-Critical	H (22)	Site personnel falling from height/ Members of public gaining access to site	Identification of risk to contractor and specification of site fencing to be maintained throughout handover of works to main contractor. Adequate temporary protection measures to be provided by contractor.	Design Team/Contractor	At commencement of project	
7	Construction near live services	Accidental Contract, Electrification, Explosion	C-Possible	5-Critical	H (22)	Investigation of all existing services as much as possible and limit works in their area. Potholing to confirm approximate depth and size of the utility service	C-Possible	5-Critical	H (22)	Works still required to be undertaken in area of existing services and risk of unknown services	Identification of all known services to be indicated on drawings by design team, with the contractor to locate and mark prior to commencement of works. Contractor to check all information on the location of all underground services through **DYBD** (dial before you dig) and other registered service locators. The contractor's safety plan shall inculde all emergency procedures covering striking of underground services	Design Team/Contractor	At commencement of project	
8	Windborne dust and small particles	Windborne material causing eye injury	C-Possible	3-Moderate	M (13)	Contract documentation incorporates requirements for a Dust Management Plan to be implemented by te Contractor	E-Rare	3-Moderate	L (6)	Material/debris becomes windborne prior to treatment causing eye inury.	Contractor to prepare JSA and specify appropriate PPE	Contractor	At commencement of project	
9	Windborne dust and other fibres	Inhalation leading to respiratory diseases	C-Possible	3-Moderate	M (13)	Contract documentation incorporates requirements for a Dust Management Plan to be implemented by the Contractor	E-Rare	3-Moderate	L (6)	Inhalation leading to respiratory diseases.	Contractor to prepare JSA and specify appropriate PPE	Contractor	At commencement of project	
10	Hazardeous materials not identified during the initial geotechnical investigation and survey of the proposed site	Workers exposed to harzadeous materials leading to injury and/or health problems	C-Possible	3-Moderate	M (13)	Items cannot be designed out, however documented in specificationd and scope of works contract should mitigate if identified in the survey and the geotechnical report	E-Rare	3-Moderate	L (6)	Workers exposed to harzadeous materials leading to injury and/or health problems	Site to be inspected prior to constrcution of works to identify any toxic or hazardeous substances. Should these be discovered, arrangements will be made for their safe removal from from site by approved contactors	Contractor	At commencement of project	

11	Compaction using vibratory machinery	Damage to near-by buildings	C-Possible	4-Major	H (18)	Contract documentation incorporates statement that the contractor shall limit the use of vibratory compaction equipment where possible, limits starting and stopping of equipment to areas away from existing buildings and states that equipment and wave velocity shall be selected to minimise vibrations beyond the construction site.	E-Rare	4-Major	M (10)	Damage to near-by buildings	Contractor to refer to specifications and identify applicable at risk areas.	Contractor	At commencement of project	
12	Access to the construction site	Vehicles impacts on passing traffic resulting in a crash.	D-Unlikely	3-Moderate	M (9)	Item cannot be designed out, however documentation states traffic management requirements	E-Rare	3-Moderate	L (6)	Vehicles impacts on passing traffic resulting in a crash.	Traffic management required at the site's main access gates	Contractor	At commencement of project	
13	Water entering excavations	Increased risk of collapse causing injury	C-Possible	4-Major	H (18)	Contractor documentation requires that the contractor maintain all excavations free from water.	E-Rare	4-Major	M (10)	Rain fills excavation when contractor not on site.	Contractor to refer to and abide by specifications.	Contractor	At commencement of project	
14	Insufficient compaction resulting in an uneven surface	Creates a crash hazard for plant or trip/fall hazard for personnel on foot.	C-Possible	3-Moderate	M (13)	Contract documentation incorporates compaction testing at regular stages of construction.	E-Rare	3-Moderate	L (6)	No signficant residual risk	Contractor to refer to and abide by specifications.	Contractor	At commencement of project	
15	Lowering pipes into trench	Worker hit/crushed whilst guiding plant operator.	C-Possible	4-Major	H (18)	Item cannot be designed out	C-Possible	4-Major	H (18)	Worker hit/crushed whilst guiding plant operator.	The Contractor is to ensure that activity specific risk assessments / JSA's / WMS covering the laying of pipes are prepared and workers inducted / trained in these.	Contractor	At commencement of project	
16	Erosion of earthworks	Creates a trip hazard for personel on foot and unsafe driving conditions for plant anf light vehicles	C-Possible	4-Major	H (18)	Contract documentation requires that the contractor reinstates all avoidable erosion of earthworks	C-Possible	4-Major	H (18)	No significant residual risk	Contractor to refer to and abide by specifications.	Contractor	At commencement of project	
17	Cutting into Concrete/Asphalt	Cutting of pipes / access chambers results in lacerations if workers hit by shattering blades or foreign objects in eye	C-Possible	3-Moderate	M (13)	Item cannot be designed out	C-Possible	3-Moderate	M (13)	Cutting of pipes / access chambers results in lacerations if workers hit by shattering blades or foreign objects in eye	The Contractor shall prepare and implement a Safe Work Practice for Cutting Pipes The Contractor shall endure that workers follow manufacturers operating instructions when using electrical saws or other mechanical equipment to cut pipes. The Contractor shall ensure that all workers use appropriate PPE e.g. gloves, goggles / faceshield.	Contractor	At commencement of project	
18	Unloading pipes	Worker being hit/crushed when unloading pipes.	C-Possible	4-Major	H (18)	Item cannot be designed out	C-Possible	4-Major	H (18)	Worker being hit/crushed when unloading pipes.	The Contractor shall ensure that only workers holding appropriate work licence for dogging are in the area where pipes being unloaded The Contractor shall ensure that only operators who hold relevant and current licenses for operating plant in crane mode can operate and load pipes.	Contractor	At commencement of project	
19	Laying Asphalt	Workers being injuried when working around the hot asphalt	D-Unlikely	3-Moderate	M (9)	Item cannot be designed out	C-Possible	4-Major	H (18)	Workers being injuried when working around the hot asphalt	The Contractor shall ensure that only authorised workers to work in the area where asphalt is being layed. Toolbox talk on safety matter	Contractor	At commencement of project	

Likelihood Rating
A = Almost Certain
B = Likely
C = Possible
D = Unlikely
E = Rare

Severity Rating
4 = Major
5 = Critical

Risk Rating
VH = Very High (23-25)
H = High (15-22)
M = Moderate (7-14)
L = Low (1-6)

Appendix C
Geotechnical Report

Galt GEOTECHNICS

Report on:

GEOTECHNICAL STUDY PROPOSED BYFORD HEALTH HUB PART LOT 103, 3 BUSHMAN GLADE BYFORD

WAG230321-02 001 R Rev1

Submitted to:

BG&E

Level 19, Kings Square 1, 556 Wellington Street

Perth WA 600

20 June 2024

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Figure 1: Site and Location Plan

Appendix A: Site Photographs
Appendix B: Test Pit Reports
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Appendix D: Dynamic Probe Super Heavy (DPSH)
Appendix E: Infiltration Test Results
Appendix F: Geotechnical Laboratory Test Results
Appendix G: Acid Sulfate Soils Test Results

Standard Geotechnical Definitions, Recommendations, Requirements and Limitations

1. INTRODUCTION

This report presents the outcomes of Galt Geotechnics' (Galt's) geotechnical study for the proposed Byford Health Hub development, at 3 Bushman Glade, Byford ("the site").

This report is to be read in conjunction with the appended "Geotechnical Definitions, Recommendations, Requirements and Limitations". 'Clause GDR1', etc. refer to this Appendix, found at the back of this report.

2. KEY FINDINGS

The site was found to be underlain by Fill (SAND / Gravelly SAND / Clayey SAND) about 0.7 m to 1.6 m thick, generally over Colluvium (Clayey Sandy GRAVEL / Gravelly Sandy CLAY / Clayey Gravelly SAND), tending to being cemented and rock strength at relatively shallow depth (2 m to 3 m deep).

Design flood levels are likely to govern site levels. As discussed in Section 9.2, The Department of Water is likely to require a minimum site level of RL 52.5 m AHD.

Stormwater disposal may be possible into deep imported Permeable Sand fill (i.e. assuming the site is raised substantially) provided the base of the soak well is at least 0.5 m above the design groundwater level or clayey strata. During flood events, stormwater must be disposed of offsite. Design groundwater levels are subject to civil design and subsoil drains could be required.

Following site preparation described above, the site is generally considered competent for foundation of the proposed development. Shallow footings could be used. Parameters for piles and dynamically loaded footings are presented in Sections 11.3 and 11.4.

The soils at the site were identified as non-acid sulfate soils (NASS) to the depth tested.

3. SITE DESCRIPTION

Table 1: Summary of Site

Item	Comment
Site Extent	Refer Figure 1
Site Area	Approximate 2,750 m^2
Current Site Surface Levels[1]	About RL 52.5 m AHD at the north west to RL 54.5 m AHD at the south east.
Vegetation	Dense tall grass with occasional shrubs and trees.
Current Land Use	Vacant land
Existing Infrastructure	Adjacent the northern site boundary is a table drain (referred to as '*Oaklands drain d/s George Road (south)*' by the Department of Water)
Site History[2]	The site was a pastural land until 2015. Between 2015 and 2016, it is apparent that fill was stockpiled in the northern half of the site, and sand was removed from a localised area in the central portion of site (relatively shallow excavation). It is judged this works is associated with development of the adjacent Byford Shopping Centre and residential lots.

NOTES:
1. *Site levels based on survey drawing provided.*
2. *Site history based on aerial imagery (Landgate).*

4. PROPOSED DEVELOPMENT

Table 2: Summary of Proposed Development

Item	Comment
Proposed Development	Byford Health Hub – double storey building with associated carparks, access ways and landscaped areas. A public library is being considered in the northern portion of the site (excluded from this study).
Basements Proposed	Nil
Proposed Finished Level	Assumed some filling up to about 2.5 m required so site is no less than 0.5 m above Department of Water flood levels (refer Section 9.2).
Cut/Fill	Assumed cut less than 1 m, and fill of up to about 2.5 m.
Assumed Foundation Type	Slab on ground and shallow footings
Assumed Retaining Walls	Gravity retaining walls typically up to about 1 m high
Assumed Stormwater Disposal	On-site via Soakwells, with overflow to Oaklands Drain during flood events.
Assumed Sewage Disposal	Off-site via local council reticulated sewerage

NOTES: ***1.*** *Proposed development details based on supplied information presented in Appendix B, Supplied Information.*

5. PROJECT OBJECTIVES

The objectives of the study were to:

- Assess subsurface soil and groundwater conditions across the site;
- Assess ground stability and need for ground improvement or removal of unsuitable materials;
- Determine groundwater levels and provide an assessment of likely seasonal variations, including design water table level;
- Advise on short and long term groundwater control as required;
- Assess the site classification in accordance with AS 2870, “Residential Slabs and Footings”;
- Provide recommendation on suitable foundation systems for the proposed development;
- Provide recommendations and geotechnical design parameters for footings;
- Provide recommendations and geotechnical design parameters for the design of pad and raft foundations located including modulus of subgrade reaction for use in dynamic load cases and allowable bearing capacities;
- Provide recommendations for a piled foundation for use in a cantilevered train deflection wall adjacent to the PTA easement;
- Provide recommendations and geotechnical parameters for retaining structures;
- Provide cut and fill batter recommendations;
- Provide an assessment of the sub soil for earthquake design and assess liquefaction potential;
- Provide an assessment of the potential for on-site disposal of storm water;
- Provide recommendations on site preparation requirements, including possible effect on adjacent buildings / roadways/ infrastructure/ services;
- Provide CBR for pavement design;
- Asphalt pavement design and pavement recommendations;
- Provide recommendations for excavation and dewatering requirements (as required) for input to earthworks specification;
- Provide recommendations for fill and material usage; and

- Provide recommendations with regard to any presence of Acid Sulphate Soils on the site and recommend additional studies where necessary.

6. PREVIOUS STUDY

Galt have previously undertaken a due diligence investigation of the site, with the results presented in our report dated 14 December 2023 (Referenced WAG230321-01 001 R Rev0). Test Pit Logs from this study are shown on Figure 1, and included as Appendix B. Laboratory test results from the study are included in Attached Table 1.

7. FIELDWORK

7.1. General

Fieldwork was carried out in the presence of a representative from Galt between the 23 and 25 May 2024 and comprised:

Table 3: Summary of Field Data

Type	Results Appendix	Summary	GDR Clause	Equipment Used	No. Tests	Depth Range (m)
Site Plan	Figure 1	-	-	Hand held GPS[1]	-	-
Photographs	A	-	-	-	-	-
Machine Auger Boreholes (BH)	C	Section 10	GDR3.3	Melvelle drill rig on 4WD utility	4	0.6 - 3.0
Dynamic Probing Super Heavy (DPSH)[3]	D	Section 10	GDR3.6	GRIZZLY tracked rig	4	0.8 - 2.9
Infiltration Tests (It)	E	Section 7.2	GDR3.7	Inverse auger hole	6	0.45 - 0.49
Acid sulfate soil sampling	G	Section 11.5	-	-	10	0 – 3.0

NOTES:

1. *Hand held GPS is accurate to ±5 m.*
2. *DCP Tests carried out adjacent to each test pits.*
3. *CPT and seismic testing were initially attempted, however the soil was too dense / cemented / desiccated for the probe to penetrate any significant depth below the surface. DPSH testing was subsequently undertaken and is presented in this report.*

7.2. Infiltration Test Results

Table 4: Infiltration Test Results

Test Location	Soil Description	Depth (m)	Minimum Unsaturated Hydraulic Conductivity, k_{unsat} (m/day)
BH02 / IT01	FILL: SAND	0.45	0.2
BH03 / IT02	FILL: SAND	0.45	0.6
BH04 / IT03	FILL: SAND	0.49	0.6

NOTES:

1. *Infiltration test method using inverse auger is explained in GDR3.7*

8. LABORATORY TESTING

Table 5: Summary of Laboratory Testing Undertaken

Type	Testing Done?	Results Summary	Results Appendix
Geotechnical Index Tests	Yes	Attached Table 1	F
Geotechnical Chemical Tests	No	-	-

Type	Testing Done?	Results Summary	Results Appendix
Acid Sulfate Soil Tests	Yes	Attached Table 2	G

9. SITE CONDITIONS

9.1. Geology

Table 6: Summary of Geology Mapping

Map Sheet	Map Scale	Mapped Soils	Site Findings[1]
Armadale	1:250K	- (Cs) Sandy CLAY – white-pale to brown, fine to coarse grained, sub-angular to rounded sand, clay of moderate plasticity gravel and silt layers near scarp (most of the site); and - (Csg) Gravelly Sandy CLAY – variable, with lenses of silt and gravel, quartz sand, sub-angular with eolian rounded component, heavy minerals common, gravel rounded, of colluvial origin.	(Topsoil) SAND/Silty SAND; over SAND/Clayey SAND; over Sandy CLAY/ Clayey Sandy GRAVEL, tending to cemented/rock strength with depth

NOTES: ***1.*** *Uncontrolled fill present to around 1 m depth*

9.2. Groundwater and Surface Water

Table 7: Summary of Groundwater and Surface Water Levels

Item	Date	Depth Range (m)	Elevation Range (m AHD)	Comment[1]
Perth Groundwater Atlas	-	-	-	The Perth Groundwater Atlas (1997, 2019) does not extend to subject site.
Department of Biodiversity, Conservation and Attractions database	-	-	-	The site is located within the 'Armadale Palusplain' – seasonally waterlogged flat terrain.
Department of Water (DoW) Byford Town Drainage Report [1]	-	-	5-year ARI flood level of RL 51.80 m AHD, and 100-year ARI flood level of RL 52 m AHD.	Adjacent the northern site boundary is a table drain (referred to as '*Oaklands drain d/s George Road (south)*' by DoW). An indicative floodway width of 40 m is provided by DoW for the 100-year ARI flood event. **Development (i.e. filling, building) within the floodway would require approval from Dow.** For development outside of the floodway, a minimum building floor level of 0.50 metres above the adjacent DFE flood level is recommended.
Site observations	November 2023 & May 2024	-	-	Groundwater was not encountered during our investigation. However, it is possible that water could perch / pond at the site on low permeability layers.
Groundwater – Recommended Design	-	0.5	RL 52.8 m AHD	Our investigation indicates the top of clay underlying surficial sand is at about RL 51.5 m AHD to RL 52.3 m AHD. We suggest a possible design groundwater level of about RL 52.8m AHD for design of onsite stormwater disposal systems (subject to civil design). Overland flow must be allowed for when on-site disposal is overwhelmed in flood events.

Item	Date	Depth Range (m)	Elevation Range (m AHD)	Comment[1]
Surface Water - Recommended Design	-	-	-	To be assessed by project civil engineer. However, no lower than DoW's recommended RL 52.0 m AHD, with floor levels minimum 0.5 m above this.

NOTES: ***1.*** *The Department of Water, Byford Townsite Drainage and Water Management Plan, (2008), Perth, WA*

10. GROUND MODEL

The encountered subsurface conditions can be summarised as comprising:

- **Surficial TOPSOIL SAND** up to 0.1 m thick; overlying
- **UNCONTROLLED FILL: SAND / Gravelly SAND / Clayey SAND (SP - SM)**, fine to coarse grained, sub angular to sub rounded, grey brown, variable fines content (estimated up to about 20 %), up to 5 % cobbles in some zones, trace roots in some zones with gravel size pieced of construction rubble (no ACM), typically medium dense to dense, extending to depths of about 0.7 m to 1.6 m; overlying
- **TP01, TP04 and BH03 to BH04 ONLY: NATURAL SAND (SP - SC),** fine to coarse grained, yellow and grey, with fines, gravelly in some zones typically medium dense to dense; overlying
- **COLLUVIUM Clayey Sandy GRAVEL / Gravelly Sandy CLAY / Clayey Gravelly SAND (SC/GC/CI)**, fine to coarse grained sand, fine to coarse grained gravel, low to medium plasticity fines, orange / brown, some weakly cemented zones, very stiff to hard / medium dense to very dense, extending to refusal depths (inferred tending to cemented soil / rock strength material).

Note: Granular pavement layers in road ways.

Geotechnical design parameters for the generalised subsurface units are described in Table 8.

Table 8: Geotechnical Model Units and Design Parameters

Unit Name	Description	γ_{bulk} (kN/m^3)	ϕ' (°)	c' (kPa)	S_u (kPa)	E_v (MPa)	$E_{v\ SMALL\ STRAIN}$ (MPa)	G_0 (MPa)	ν	k_0	Wall Friction=0		Wall Friction=0.5ϕ	
											k_a	k_p	k_a	k_p
PROPOSED IMPORTED PERMEABLE FILL (refer Section 11)	Proposed unit to raise site above flood levels (not currently present). Could be up to about 2.5 m thick. Unit could possibly allow for onsite disposal of groundwater.	18	35	0	0	50	200	65	0.3	0.43	0.27	3.69	0.24	6.08
PROPOSED RECOMPACTED UNCONTROLLED FILL	Proposed unit to reduce risks associated with insitu uncontrolled fill described below. Material must be assessed during construction, and only be re used if complies with specification for 'Silty Sand Fill' in Section 11.	18	35	0	0	50	200	65	0.3	0.43	0.27	3.69	0.24	6.08
IN SITU UNCONTROLLED FILL SAND / Gravelly SAND / Clayey SAND	Unit description and distribution provided above.	18	-	-	-	-	-	-	-	-	-	-	-	-
NATURAL SAND SAND / Gravelly SAND		18	35	0	0	25 - 50	100 - 200	33 - 65	0.3	0.43	0.27	3.69	0.24	6.08
COLLUVIUM Clayey Sandy GRAVEL / Gravelly Sandy CLAY / Clayey Gravelly SAND		18	32	5	150	25 - 50	100 - 200	33 - 65	0.5	-	-	-	-	-

NOTES:

1. *These units are a generalization of results from individual tests, which should be referred to for more information.*

2. *Conditions at CPT locations below depth of soil sample recovery are inferred (refer to clause GDR3.2)*

3. *Topsoil is not included as a discrete unit.*

4. *For all earth pressure coefficients (retaining wall design) refer to clause GDR11.2 for more detail and interpretation. Unit weights for retaining structure design should be as per GDR11.2 or 1 kN/m^3 greater than the values in the table above.*

γ_{bulk} – bulk unit weight
ϕ' – Internal angle of friction
S_u – undrained shear strength
c'– effective cohesion
E_v – vertical elastic modulus
ν – Poisson's Ratio
k_a – coefficient of active earth pressure (Coulomb – AS4678-2002, Appendix E)
k_p – coefficient of passive earth pressure (Coulomb – AS4678-2002, Appendix E)
k_0 – coefficient of at-rest earth pressure (Jaky)

5. *Strength and stiffness parameters provided for colluvium are likely to be conservative in any cemented horizons, however we do not have deeper testing to establish continuity of any rock-strength zones and provide a judgement on parameters.*

11. GEOTECHNICAL ASSESSMENT

11.1. Summary

Table 9: Summary of Geotechnical Assessment

Type	Clause	Parameter	Comment
Site Suitability	-	-	We consider the site to be geotechnically suitable for the proposed development.
Construction Methodology and Suitability	-		Shallow footings in accordance with AS2870-2011 will be suitable for this site. Mass retaining will be suitable for retaining above groundwater. We understand cantilever walls may be required near the rail reserve due to PTA requirements.
Site Classification (AS2870)	GDR5	**Either Class S** where no less than 1 m of sand over in situ clayey soils, **or Class A** where no less than 1.8 m of sand over in situ clayey soils.	Site preparation as per below. Where 'sand' refers to either **Imported Fill**, **Recompacted Uncontrolled Fill** or **Natural Sand**, as defined in Section 10.
Site Subsoil Class (AS1170.4)	-	Ce	-
Site Preparation	GDR6	-	Site preparation to include **GDR6.2.1 Common Measures** and **GDR6.2.4 Clayey Sites**. Extending 1 m beyond the proposed building footprint, common measures are to include excavation to no less than 0.5 m below current ground levels. Remove any uncontrolled fill exposed in excavation if required. Following proof compaction (GDR6.2.4) at base of excavation, stockpiled excavated material may be reused if on site assessment confirms the material is a '**Silty Sand Fill'** as defined in **GDR8 Approved Fill and Conformance Testing.**
Approved Fill	GDR8	-	In situ soils (excluding surficial topsoil and deeper colluvium) are likely to be suitable for reuse as **Silty Sand Fill**. This material is likely to be relatively impermeable when recompacted which must be considered as part of civil design. It is likely that significant additional fill will be required to raise the site above current levels, If imported **Permeable Sand** is used, it may be possible to dispose of stormwater on site (subject to civil design).
Compaction Control	GDR7	-	NDG is recommended for in situ materials. Imported **Permeable Sand** could be tested with a PSP.
Shallow Footings	GDR9	*Allowable Bearing pressures of 150 kPa to 250 kPa (refer Section 11.2)*	Design tables for shallow footings are presented in Section 11.2. Limited bearing pressures are provided for shallow footings near existing ground level in order to control settlements. Estimated settlements are not considered excessive. 70% of the settlement is expected to occur during construction.
Stormwater Disposal	GDR13	-	Stormwater disposal may be possible into deep imported **Permeable Sand** fill provided the base of the soak well is at least 0.5 m above the design groundwater level or clayey strata. During flood events, stormwater must be disposed of off site (refer Table 7). Design groundwater levels are subject to civil design and subsoil drains could be required.
Earth Pressure Coefficients	GDR11	GDR3.4	Refer Table 8.
Pavement Subgrade CBR	GDR16	CBR = 12 %	For sand subgrades compacted as described above.
Batters	GDR12	1V:2H (temporary) 1V:3H (permanent)	Batter angles apply to units in Table 8 above the water table. Retention below groundwater will require structural retaining elements (i.e. shoring).

11.2. Shallow Footings

Table 10: Isolated Pad Footing Allowable Bearing Pressures and Estimated Settlements

d_e (m)	b (m)	q_{all} (kPa)	s (mm)
0.5	0.5	220	< 5
0.5	1.0	220	5 - 10
0.5	2.0	250	10 - 15
1.0	1.0	250	5 - 10
1.0	2.0	250	10 - 15
1.0	3.0	250	15 - 20

NOTES:

1. *d_e – minimum embedment depth (below finished ground level or floor slab)*
2. *b – Footing breadth (footings assumed approximately square)*
3. *q_{all} – allowable bearing pressure (peak). Limited to keep estimated settlements less than 25 mm. Higher q_{all} may be possible if higher settlements can be tolerated – refer queries to us.*
4. *s – estimated settlement (excludes shrink/swell from site class)*
5. *Refer to GDR9*
6. *Groundwater assumed to be at footing invert level.*
7. *These parameters apply to footings founded at around the current site level or on up to 2.5 m of compacted Approved Fill*

Table 11: Isolated Strip Footing Allowable Bearing Pressures and Estimated Settlements

d_e (m)	b (m)	q_{all} (kPa)	s (mm)
0.5	0.5	150	< 5
0.5	1.0	170	5 - 10
0.5	2.0	220	15 - 20
1.0	1.0	220	10 - 15
1.0	2.0	220	15 - 20
1.0	3.0	220	20 - 25

NOTES:

1. *d_e – minimum embedment depth (below finished ground level or floor slab)*
2. *b – Footing breadth (footings assumed long relative to breadth)*
3. *q_{all} – allowable bearing pressure (peak). Limited to keep estimated settlements less than 25 mm. Higher q_{all} may be possible if higher settlements can be tolerated – refer queries to us.*
4. *s – estimated settlement (excludes shrink/swell from site class)*
5. *Refer to GDR9*
6. *Groundwater assumed to be at footing invert level.*
7. *These parameters apply to footings founded at around the current site level or on up to 2.5 m of compacted Approved Fill*

11.3. Piles

Table 12: Geotechnical Parameters for Axial Loading of CFA Piles (Ultimate)

Unit[2]	Unit Shaft Resistance fs (kPa)	Unit Base Resistance fb (kPa)
PROPOSED IMPORTED COMPACTED PERMEABLE SAND FILL	80	-
PROPOSED RECOMPACTED UNCONTROLLED FILL	80	1,500
NATURAL SAND SAND / Gravelly SAND	80	1,500
COLLUVIUM Clayey Sandy GRAVEL / Gravelly Sandy CLAY / Clayey Gravelly SAND	65	1,300

NOTES:

1. *Refer to GDR10 Piled Foundations for limitations to above parameters.*
2. *Units described in Section 10.*
3. *Colluvium parameters may be conservative in cemented/rock strength horizons, however insufficient data is available to inform greater unit stress parameters.*

11.4. Dynamic Modulus of Subgrade Reaction

Table 13: Dynamic Modulus of Subgrade Reaction for Square Pad Foundations

Square Pad Footing Size	Dynamic Modulus of Subgrade Reaction (kPa/mm)
0.50	370
0.75	220
1.00	150
2.00	75
3.00	60
5.00	50

11.5. Acid Sulfate Soils

Based on results, all material to the maximum depth of the investigation is classified as non-acid sulfate soils (NASS). As such, no further investigation or management is required.

11.6. Further Work

Given the relatively shallow refusals encountered on CPTs and DPSH tests, we do not have data on the engineering characteristics or prevalence of cemented / rock-strength materials at the site. Hence, we cannot comment on excavatability of deeper materials (including pile installation into such materials). Should this become important for design, we consider that additional testing with rotary core drilling would be needed to establish material profiles and parameters. However, available data is considered adequate for the design of shallow footings and small retaining walls.

12. CLOSURE

GALT GEOTECHNICS PTY LTD





Owen Woodland CPEng
Geotechnical Engineer

Tyrone Mardesic CPEng
Geotechnical Engineer

https://galtgeo.sharepoint.com/sites/wag230321/shared documents/02 bge detailed si/03 correspondence/wag230321-02 001 r rev1.docx

Attached Table 1: Summary of Geotechnical Index Test Results

Test Name	Sample Depth (m)	Soil Class (AS1726 2017)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PI (%)	LS (%)
TP01	0.2 – 1.0	SP	36	62	2	30	14	7.0
TP01	1.5 – 2.7	SC	38	46	16	32	16	7.0
TP05	1.2 – 2.6	SC	17	59	34	-	-	-
BH04	0.5 – 0.8	SP/SM	39	51	10	-	-	-

Notes *1. Particle size distribution (by mass)*

Gravel: 2.36 mm – 63 mm *Sand: 0.075 mm – 2.36 mm* *Fines: <0.075 mm*

Figures





Legend

- Site Boundary

Galt Proposed Test Locations

- Borehole
- Borehole / Standpipe
- Dynamic Probing Super Heavy Test

Galt Previous Test Locations

- Test Pit / Dynamic Cone Penetration

N

0 9.5 19 28.5 38 47.5
Meters

NOTES
Aerial Imagery and Cadastre sourced from Landgate/SLIP



SCALE	1:600 (A3)
DRAWN	CED
DATE DRAWN	10/6/2024
CHECKED	–
DATE CHECKED	–
PROJECTION	GDA 1994 MGA Zone 50

Galt Geotechnics Pty Ltd
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CLIENT	**BG&E**
PROJECT	BYFORD HEALTH HUB
LOCATION	3 BUSHMAN GLADE BYFORD
TITLE	SITE & LOCATION PLAN
Job No	WAG230321-02
Fig No	FIGURE 1
Rev	**A**

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Appendices

Appendix A: Site Photographs

Photograph 1: Site Photo



Photograph 2: Site Photo



Photograph 3: Bushman Glade Cul de sac



Appendix B: Test Pit Reports

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS

METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HE	Hand Excavation	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T	Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

►	Water Inflow	▼	Water Level
◄	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

TCR = Total Core Recovery (%) $= \frac{CRL}{TCL} \times 100$

RQD = Rock Quality Designation (%) $= \frac{ALC>100}{TCL} \times 100$

TCL	Length of Core Run
CRL	Length of Core Recovered
ALC>100	Total Length of Axial Lengths of Core Greater than 100 mm Long

METHOD OF SOIL DESCRIPTION
BOREHOLE AND TEST PIT REPORTS

GRAPHIC LOG & SOIL CLASSIFICATION SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES / BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	GM	Silty GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

NOTE: Dual classification given for soils with a fines content between 5% and 12%.

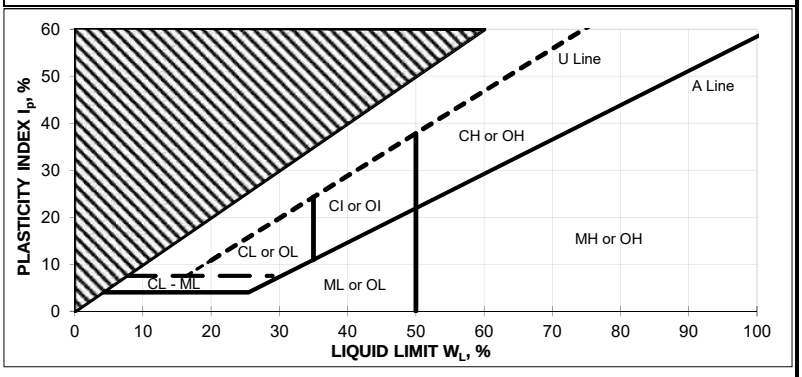
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-2017. Material properties are assessed in the field by visual/tactile methods in combination with field and laboratory testing techniques (where used).

NOTE: AS 1726-2017 defines a fine grained soil where the total dry mass of fine fractions (<0.075 mm particle size) exceeds 35%.

PARTICLE SIZE		
Soil Name		**Particle Size (mm)**
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	19 to 63
	Medium	6.7 to 19
	Fine	2.3 to 6.7
SAND	Coarse	0.6 to 2.36
	Medium	0.21 to 0.6
	Fine	0.075 to 0.21
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY - MODIFIED CASAGRANDE CHART - AS1726-2017



RESISTANCE TO EXCAVATION		
Symbol	**Term**	**Description**
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

MOISTURE CONDITION	
Symbol	**Term**
D	Dry
M	Moist
W	Wet

CEMENTATION	
Cementation	**Description**
Weakly cemented	Soil may be easily disaggregated by hand in air or water
Moderately cemented	Effort is required to disaggregate the soil by hand in air or water

CONSISTENCY		
Symbol	**Term**	**Undrained Shear Strength (kPa)**
VS	Very Soft	0 to 12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very Stiff	100 to 200
H	Hard	>200

ORGANIC SOILS	
Material	**Organic Content % of dry mass**
Inorganic soil	<2%
Organic soil	2% to 25%
Peat	>25%

DENSITY		
Symbol	**Term**	**Density Index (%)**
VL	Very Loose	<15
L	Loose	15 to 35
MD	Medium Dense	35 to 65
D	Dense	65 to 85
VD	Very Dense	>85

REPORT OF TESTPIT: TP01

Job No	: WAG230321-01	Easting	: 0		
Client	: BG&E	Northing	: 0	Logged	: WF
Project	: Byford Health Hub	UTM	:	Logged Date	: 27/11/2023
Location	: 3 Bushman Glade, Byford WA	Drill Rig	:	Checked	: TM
Contractor	: Diggermate	Inclination	: -90 deg	Checked Date	: 12/12/2023

Excavator Attachment	DCP graph	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Remarks	Sample
250mm toothed bucket	SET 9		0	Fill		SP	Fill SAND: yellow, medium dense to dense, fine to medium grained, with fine to medium sized gravel, trace fines, with sub angular to angular gravel, grass and rootlets (topsoil) at surface..	D	MD-D		
	20+R		0.2	Fill		SP-SM	Fill Gravelly SAND: yellow and pale grey, very dense, fine to medium grained, fine to medium sized gravel, about 5 % cobbles.		VD		
			1	Natura		SP-SC	Natural SAND: yellow and pale grey, fine to medium grained, with fines, fines increasing with depth.				
			1.5	Natura		SC	Natural Clayey to gravelly SAND: low plasticity clay, brown orange, fine to medium grained, fine to medium sized gravel, becoming sandy clay at depth, weakly cemented.				
			2				**TP01 refusal at 2.7m (Refusal on clay. Groundwater not encountered.)**				
			3								





REPORT OF TESTPIT: TP02

Job No	: WAG230321-01	Easting	: 0		
Client	: BG&E	Northing	: 0	Logged	: William Feng
Project	: Byford Health Hub	UTM	:	Logged Date	: 27/11/2023
Location	: 3 Bushman Glade, Byford WA	Drill Rig	:	Checked	: TM
Contractor	: Diggermate	Inclination	: -90 deg	Checked Date	: 12/12/2023

Excavator Attachment	DCP graph	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Remarks	Sample
250mm toothed bucket	SET 6		0	Topsoi		SM	Topsoil Silty SAND: brown, fine to medium grained, trace fine to medium sized gravel, about 10% to 15% fines, increasing fines with depth, with organics (grass and rootlets).	D	MD		
	20+R		0.2	Fill		SC	Fill Clayey SAND: low plasticity clay, dark grey and brown, dense to very dense, fine to medium grained, becoming sandy clay at depth, interbedded with clayey sand layers, likely fill to 1m, about 5% cobbles.		D-VD		
			1								
			1.5	Natura		CL-CI	Natural Sandy CLAY: low to medium plasticity, brown orange, fine to medium grained sand, with fine to medium sized gravel, inorganic.		VSt-H		
			2								
			3				**TP02 refusal at 2.8m (Refusal on clay. Groundwater not encountered)**				





Galt

REPORT OF TESTPIT: TP03

Job No	: WAG230321-01	Easting	: 406436.16569848894		
Client	: BG&E	Northing	: 6434908.125365052	Logged	: WF
Project	: Byford Health Hub	UTM	: 50H	Logged Date	: 27/11/2023
Location	: 3 Bushman Glade, Byford WA	Drill Rig	:	Checked	: TM
Contractor	: Diggermate	Inclination	: -90 deg	Checked Date	: 12/12/2023

Excavator Attachment	DCP graph	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Remarks	Sample
250mm toothed bucket	SET 3 6 6 3 11 15 10+R		0.2 0.7 1 2	Topsoi Fill Natura		SP-SM SP-SC CL-CI	Topsoil SAND: brown, fine to medium grained, trace fine sized gravel, with fines / silty, with organic (grass and rootlets). Fill Silty SAND: brown and grey, medium dense to dense, fine to medium grained, increasing fines / becoming clayey at depth. Natural Sandy to gravelly CLAY: low to medium plasticity, orange yellow, fine to medium sized gravel, fine to medium grained sand, inorganic, increasing plasticity with depth.	D	MD MD-D VSt-H		

TP03 refusal at 2.8m (Refusal on clay. Groundwater not encountered.)





REPORT OF TESTPIT: TP04

Job No	: WAG230321-01	Easting	: 0		
Client	: BG&E	Northing	: 0	Logged	: WF
Project	: Byford Health Hub	UTM	:	Logged Date	: 27/11/2023
Location	: 3 Bushman Glade, Byford WA	Drill Rig	:	Checked	: TM
Contractor	: Diggermate	Inclination	: -90 deg	Checked Date	: 12/12/2023

Excavator Attachment	DCP graph	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Remarks	Sample
250mm toothed bucket	SET 3 2 3 9 10 20+R		0 0.2 1 1.5 2 3	Topsoil Fill Natural Natural		SP SP-SC SP-SC GC	Topsoil SAND: brown, fine to medium grained, trace fines, with organics (grass and rootlets). Fill SAND: brown, medium dense, fine to medium grained, with low plasticity clay, trace roots. Natural Gravelly SAND: pale grey, fine to medium grained, fine to medium sized gravel, with fines. Natural Clayey to sandy GRAVEL: low plasticity clay, yellow orange, fine to medium sized, fine to medium grained sand. **TP04 Terminated at 2.9m (Groundwater not encountered.)**	D	MD		





REPORT OF TESTPIT: TP05

Job No	: WAG230321-01	Easting	: 0		
Client	: BG&E	Northing	: 0	Logged	: WF
Project	: Byford Health Hub	UTM	:	Logged Date	: 27/11/2023
Location	: 3 Bushman Glade, Byford WA	Drill Rig	:	Checked	: TM
Contractor	: Diggermate	Inclination	: -90 deg	Checked Date	: 12/12/2023

Excavator Attachment	DCP graph	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Remarks	Sample
250mm toothed bucket	SET			Topsoil		SP-SC	Topsoil Gravelly SAND: grey, fine to medium grained, fine to medium sized gravel, trace to with fines, with organics (grass and rootlets).	D	L-MD		
	SET		0.2								
	2			Fill		SP-SC	Fill Gravelly SAND: grey and brown, dense to very dense, fine to medium grained, fine to medium sized gravel, increasing fines at depth.		D-VD		
	7										
	20+R		1								
			1.2	Natura		GC	Natural Clayey to sandy GRAVEL: low plasticity clay, orange yellow, fine to medium sized, fine to medium grained sand.				
			2								
							TP05 refusal at 2.6m (Refusal on gravel. Groundwater not encountered.)				
			3								





REPORT OF TESTPIT: TP06

Job No	: WAG230321-01	Easting	: 0		
Client	: BG&E	Northing	: 0	Logged	: WF
Project	: Byford Health Hub	UTM	:	Logged Date	: 27/11/2023
Location	: 3 Bushman Glade, Byford WA	Drill Rig	:	Checked	: TM
Contractor	: Diggermate	Inclination	: -90 deg	Checked Date	: 12/12/2023

Excavator Attachment	DCP graph	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Remarks	Sample
250mm toothed bucket	SET		0	Topsoil		SP	Topsoil SAND: grey, fine to medium grained, trace fines, with organics (grass and rootlets).	D	MD		
	3										
	9		0.2	Fill		GP-GC	Fill Gravelly SAND: grey, dense to very dense, fine to medium grained, fine to medium sized gravel, with fines, fines increasing at depth.		D-VD		
	20+R		1								
			1.6	Natura		SC	Natural Clayey to gravelly SAND: low plasticity clay, brown orange, fine to medium grained, fine to medium sized gravel, becoming clayey sandy gravel at depth.				
			2								
							TP06 refusal at 2.2m (Refusal on gravel, Groundwater not encountered.)				
			3								





Appendix C: Borehole Log Reports

METHOD OF SOIL DESCRIPTION
BOREHOLE AND TEST PIT REPORTS

GRAPHIC LOG & SOIL CLASSIFICATION SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES / BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	GM	Silty GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

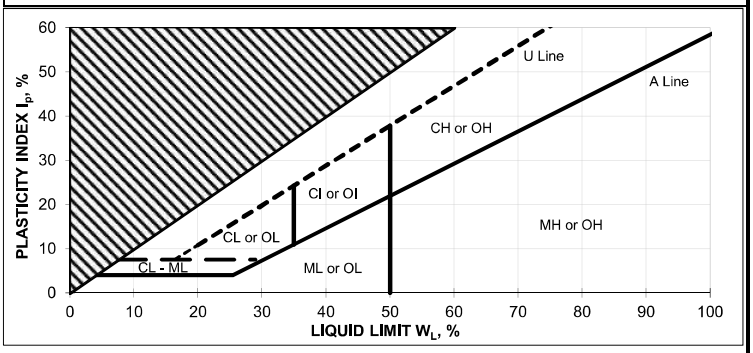
NOTE: Dual classification given for soils with a fines content between 5% and 12%.

SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-2017. Material properties are assessed in the field by visual/tactile methods in combination with field and laboratory testing techniques (where used).
NOTE: AS 1726-2017 defines a fine grained soil where the total dry mass of fine fractions (<0.075 mm particle size) exceeds 35%.

PARTICLE SIZE		
Soil Name		**Particle Size (mm)**
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	19 to 63
	Medium	6.7 to 19
	Fine	2.3 to 6.7
SAND	Coarse	0.6 to 2.36
	Medium	0.21 to 0.6
	Fine	0.075 to 0.21
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY - MODIFIED CASAGRANDE CHART - AS1726-2017



RESISTANCE TO EXCAVATION		
Symbol	**Term**	**Description**
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

MOISTURE CONDITION	
Symbol	**Term**
D	Dry
M	Moist
W	Wet

CEMENTATION	
Cementation	**Description**
Weakly cemented	Soil may be easily disaggregated by hand in air or water
Moderately cemented	Effort is required to disaggregate the soil by hand in air or water

CONSISTENCY		
Symbol	**Term**	**Undrained Shear Strength (kPa)**
VS	Very Soft	0 to 12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very Stiff	100 to 200
H	Hard	>200

ORGANIC SOILS	
Material	**Organic Content % of dry mass**
Inorganic soil	<2%
Organic soil	2% to 25%
Peat	>25%

DENSITY		
Symbol	**Term**	**Density Index (%)**
VL	Very Loose	<15
L	Loose	15 to 35
MD	Medium Dense	35 to 65
D	Dense	65 to 85
VD	Very Dense	>85

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS

METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HE	Hand Excavation	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T	Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

►	Water Inflow	▼	Water Level
◄	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

TCR = Total Core Recovery (%) $= \frac{CRL}{TCL} \times 100$

RQD = Rock Quality Designation (%) $= \frac{ALC>100}{TCL} \times 100$

TCL	Length of Core Run
CRL	Length of Core Recovered
ALC>100	Total Length of Axial Lengths of Core Greater than 100 mm Long

BOREHOLE: BH01

Sheet 1 OF 1

Job Number:	WAG230321-02	**Contractor:**	Galt	**Date:**	23/05/2024
Client:	BG&E	**Drill Rig:**	Melvelle	**Logged:**	FP
Project:	Proposed Health Club	**Inclination:**	-90°	**Checked Date:**	10/06/2024
Location:	3 Bushman Glade, Byford			**Checked By:**	TM

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	E		0.0					SP	FILL: SAND, fine to coarse grained, sub-angular to sub-rounded, with gravel size pieces of construction rubble (no ACM), trace fines	D		
			0.5									
									Hole terminated at 0.60 m Refusal Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION WAG230321-02.GPJ <<DrawingFile>> 10/06/2024 11:57 10.02.00.04 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

BOREHOLE: BH02

Sheet 1 OF 1

Job Number:	WAG230321-02	**Contractor:**	Galt	**Date:**	23/05/2024
Client:	BG&E	**Drill Rig:**	Melville	**Logged:**	FP
Project:	Proposed Health Club	**Inclination:**	-90°	**Checked Date:**	10/06/2024
Location:	3 Bushman Glade, Byford			**Checked By:**	TM

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	E		0.0					SP	SAND: fine to medium grained, sub-angular to sub-rounded, pale grey, with fine to coarse grained, angular to sub-angular gravel, trace organics, trace fines	D		Likely surficial sand layers are fill.
			0.5						Fine to coarse grained, dark grey-brown, gravel is rounded to sub-rounded			
			1.0						Coarse gravel content increases			
			1.5					SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, orange-brown, low plasticity, desiccated, trace fine grained gravel			
			2.0									
			2.5						Hole terminated at 2.20 m Refusal Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION WAG230321-02.GPJ <<DrawingFile>> 10/06/2024 11:57 10.02.00.04 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

BOREHOLE: BH03

Sheet 1 OF 1

Job Number:	WAG230321-02	**Contractor:**	Galt	**Date:**	23/05/2024
Client:	BG&E	**Drill Rig:**	Melvelle	**Logged:**	FP
Project:	Proposed Health Club	**Inclination:**	-90°	**Checked Date:**	10/06/2024
Location:	3 Bushman Glade, Byford			**Checked By:**	TM

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	E		0.0					SP	FILL: SAND, fine to coarse grained, sub-angular to sub-rounded, grey-brown, with gravel sized pieces of building rubble (no ACM), trace fines			
			0.5									
			1.0						Becomes Gravelly SAND			
			1.5					SP	SAND: fine to medium grained, sub-angular to sub-rounded, orange-brown, trace fine grained gravel, trace fines	D		
			2.0									
			2.5									
			3.0						Hole terminated at 3.00 m Refusal Groundwater not encountered			

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION WAG230321-02.GPJ <<DrawingFile>> 10/06/2024 11:57 10.02.00.04 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

BOREHOLE: BH04

Sheet 1 OF 1

Job Number:	WAG230321-02	**Contractor:**	Galt	**Date:**	23/05/2024
Client:	BG&E	**Drill Rig:**	Melvelle	**Logged:**	FP
Project:	Proposed Health Club	**Inclination:**	-90°	**Checked Date:**	10/06/2024
Location:	3 Bushman Glade, Byford			**Checked By:**	TM

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	E		0.0					SP-SM	FILL: Gravelly SAND, fine to coarse grained, sub-angular to sub-rounded, grey/brown, with fines, includes building rubble (no ACM)	D		
			0.5									
			1.0									
			1.5					SP	SAND: fine to medium grained, sub-angular to sub-rounded, trace fines			
			2.0					SC	Clayey SAND: fine to coarse grained, sub-angular to sub-rounded, orange/brown, trace gravel dessicated			
			2.5									
			3.0						Hole terminated at 3.00 m Refusal Groundwater not encountered			

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION WAG230321-02.GPJ <<DrawingFile>> 10/06/2024 11:57 10.02.00.04 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

Appendix D: Dynamic Probe Super Heavy (DPSH)

DPSH01

Sounding : DPSH01
Site : WAG230321-02
Date : 25/05/2024 00:00
Company : galt geotech
User : Chris Harkin
Supervisor : SD
UTM area : 50H
UTM E,N : 406416 | 6434853
Altitude : 48.4 m
Tracking :

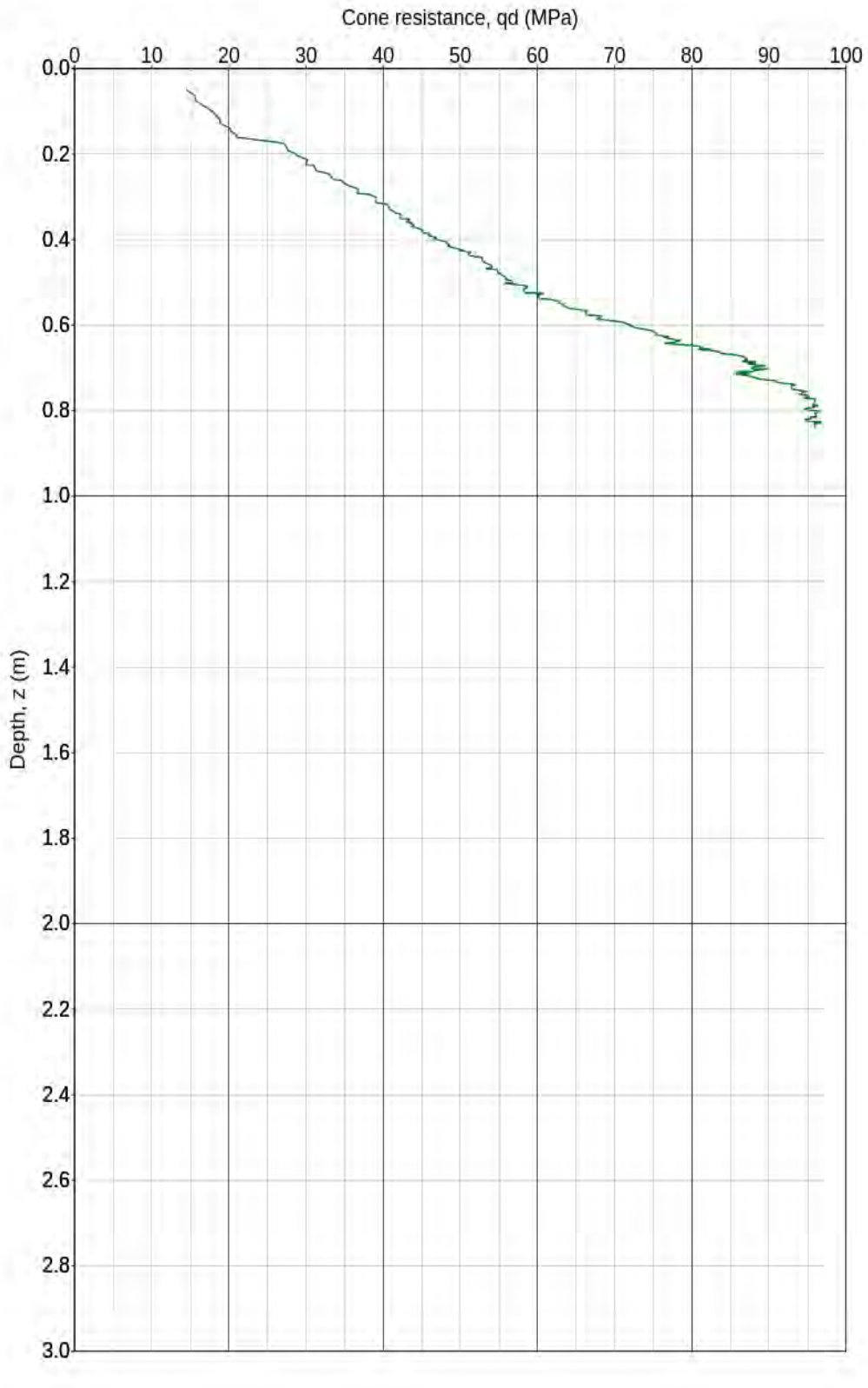
Test

Target depth : 12.0 m
Pre-drilling depth :
Stop condition : Temporary
Reached depth : 0.84 m
Water table : Not found
Stable level :
Unstable level :

Characteristics

Device type : Grizzly
Hammering mode : 63.5 kg
Cone section : 20 cm²

GRIZZLY®



Processing

Smoothing step : 100 mm
Regularization step : 1 mm
Clipping : No

Observation

Refusal @ 0.85m. Collapsed Dry @ 0.70m

DPSH02

Sounding : DPSH02
Site : WAG230321-02
Date : 25/05/2024 00:00
Company : galt geotech
User : Chris Harkin
Supervisor : SD
UTM area : 50H
UTM E,N : 406445 | 6434881
Altitude : 55.5 m
Tracking :

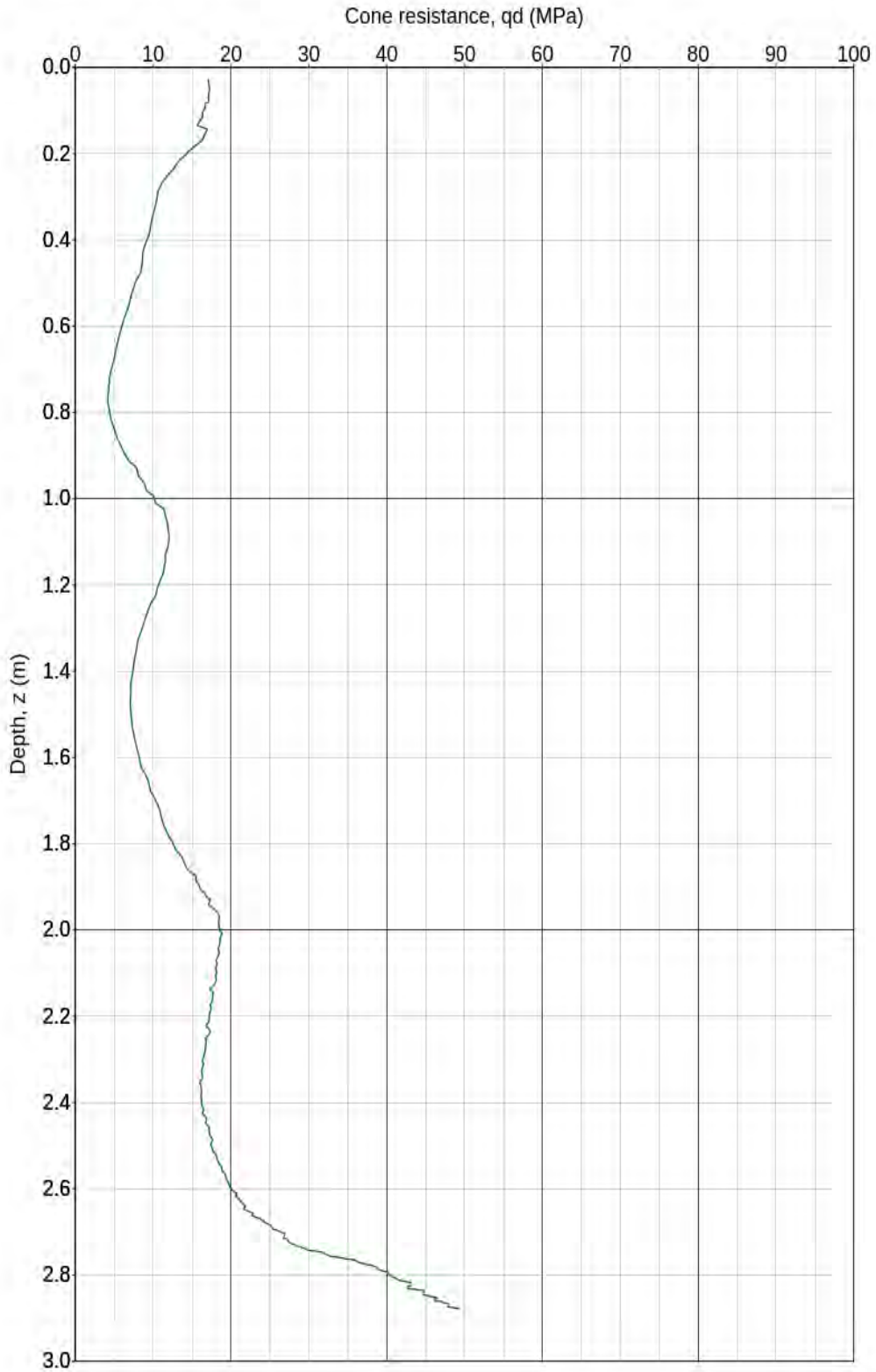
Test

Target depth : 12.0 m
Pre-drilling depth :
Stop condition : Temporary
Reached depth : 2.88 m
Water table : Not found
Stable level :
Unstable level :

Characteristics

Device type : Grizzly
Hammering mode : 63.5 kg
Cone section : 20 cm²

GRIZZLY®



Processing

Smoothing step : 100 mm
Regularization step : 1 mm
Clipping : No

Observation

Refusal @ 2.88m. Dry @ 2.8m

DPSH03

Sounding : DPSH03
Site : WAG230321-02
Date : 25/05/2024 00:00
Company : galt geotech
User : Chris Harkin
Supervisor : SD
UTM area : 50H
UTM E,N : 406419 | 6434877
Altitude : 54.6 m
Tracking :

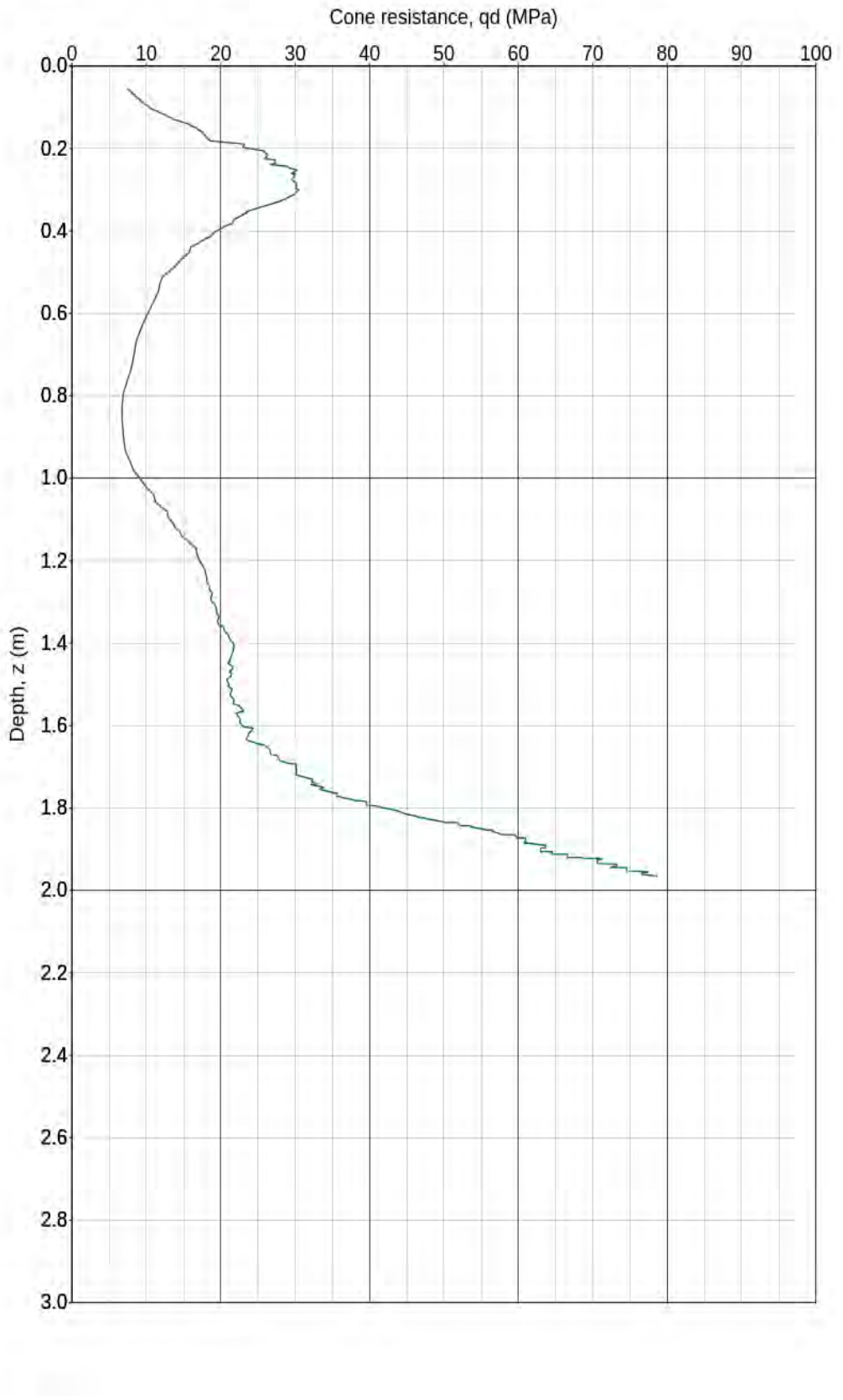
Test

Target depth : 12.0 m
Pre-drilling depth :
Stop condition : Temporary
Reached depth : 1.97 m
Water table : Not found
Stable level :
Unstable level :

Characteristics

Device type : Grizzly
Hammering mode : 63.5 kg
Cone section : 20 cm²

GRIZZLY®



Processing

Smoothing step : 100 mm
Regularization step : 1 mm
Clipping : No

Observation

Refusal @ 1.97m. Collapsed Dry @ 1.8m

DPSH04

Sounding : DPSH04
Site : WAG230321-02
Date : 25/05/2024 00:00
Company : galt geotech
User : Chris Harkin
Supervisor : SD
UTM area : 50H
UTM E,N : 406450 | 6434843
Altitude : 54.6 m
Tracking :

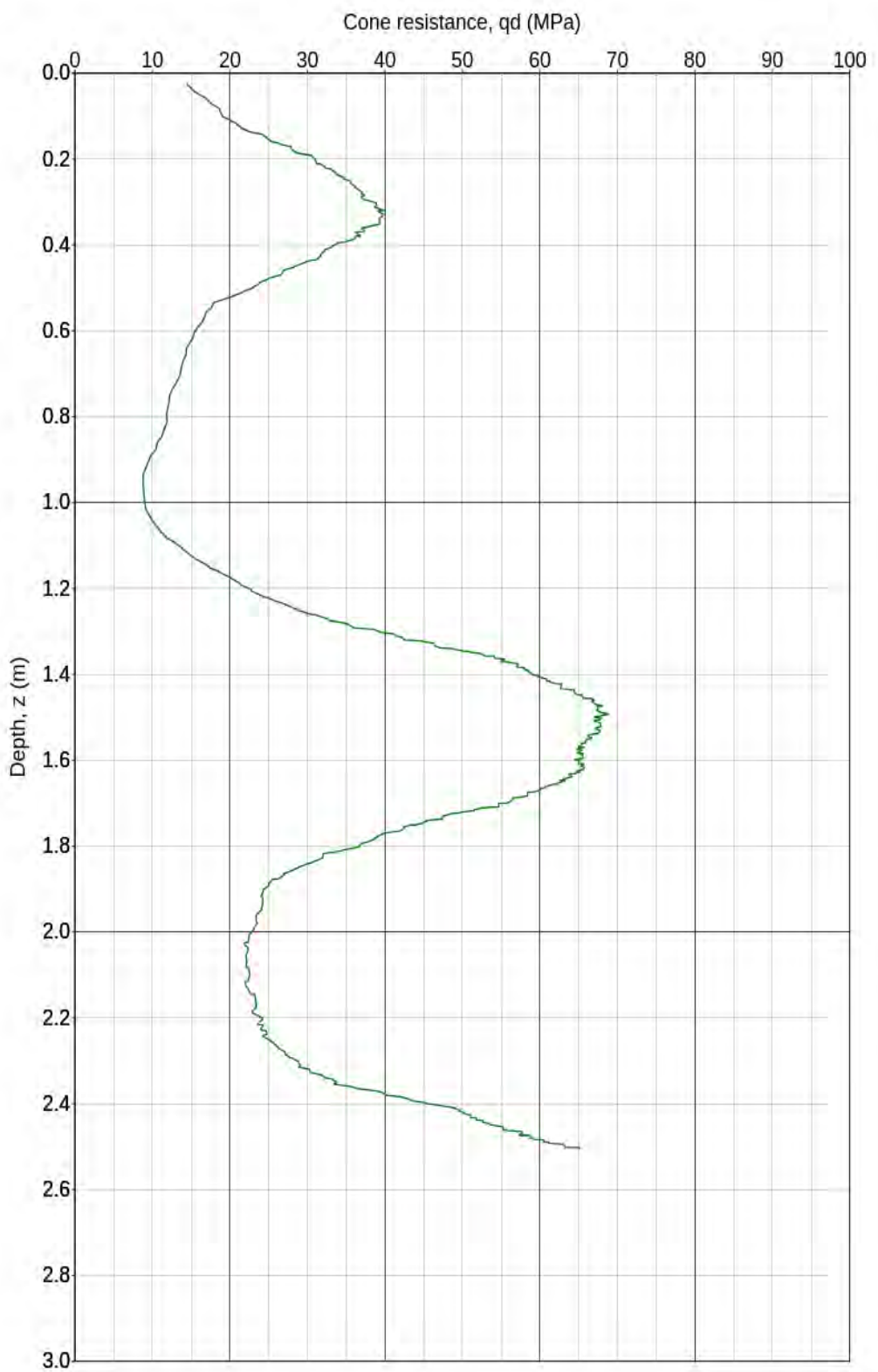
Test

Target depth : 12.0 m
Pre-drilling depth :
Stop condition : Temporary
Reached depth : 2.51 m
Water table : Not found
Stable level :
Unstable level :

Characteristics

Device type : Grizzly
Hammering mode : 63.5 kg
Cone section : 20 cm²

GRIZZLY®



Processing

Smoothing step : 100 mm
Regularization step : 1 mm
Clipping : No

Observation

Refusal @ 2.5m. Collapsed Dry @ 2.1m

Appendix E: Infiltration Test Results

Hydraulic Conductivity Calculation - Inverse Auger Hole Method

Galt Geotechnics

Job No:	WAG230321
Client:	BG&E
Project:	Byford health hub
Location:	3 Bushman Glade
Calc by:	K.sibanda
BH Name:	BH02/IT01
Test Depth:	0.45 m

Spreadsheet author:	ORW	17-Oct-09

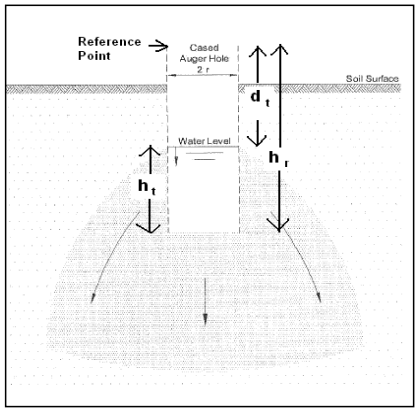
$$K = 1.15r\frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Hydraulic Conductivity		m/s
r	radius of test hole	0.045	m
t	time since start of measurement		s
h_r	reference point height above base	0.55	m
d_t	depth from reference point to water at time t		m
h_t	Water column height at time t		m
h_0	h_t at t=0		m



Test 1

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.402	0.148		
20	0.404	0.146	1.3E-05	1.1
40	0.406	0.144	1.3E-05	1.2
60	0.408	0.142	1.3E-05	1.2
80	0.408	0.142	1.0E-05	0.9
100	0.409	0.141	9.4E-06	0.8
120	0.41	0.14	9.0E-06	0.8
140	0.411	0.139	8.7E-06	0.8
160	0.413	0.137	9.4E-06	0.8
180	0.414	0.136	9.1E-06	0.8
200	0.414	0.136	8.2E-06	0.7
220	0.414	0.136	7.5E-06	0.6
240	0.415	0.135	7.4E-06	0.6
260	0.415	0.135	6.9E-06	0.6
280	0.416	0.134	6.9E-06	0.6
300	0.417	0.133	6.9E-06	0.6
		AVERAGE	9.3E-06	0.8

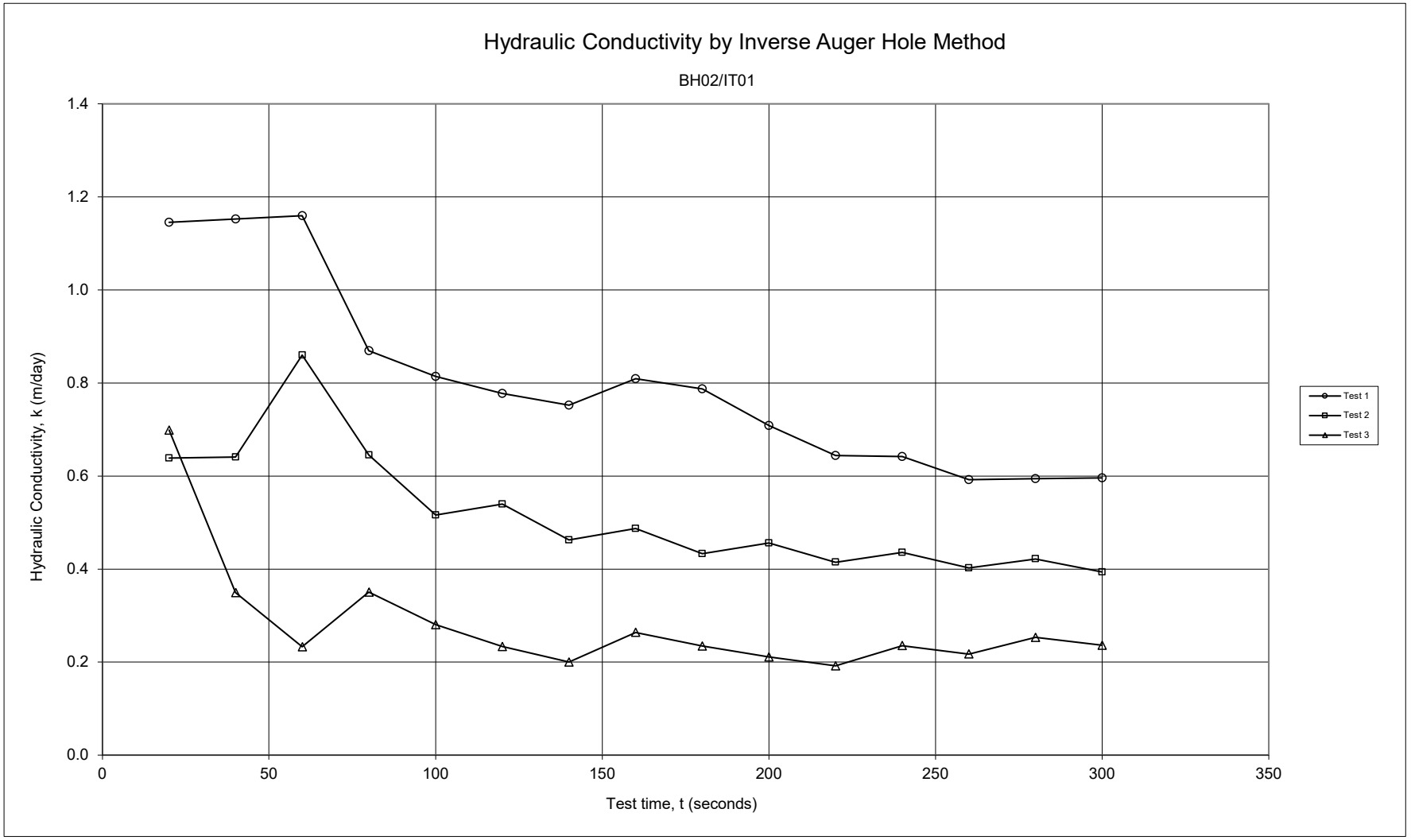
Test 2

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.42	0.13		
20	0.421	0.129	7.4E-06	0.6
40	0.422	0.128	7.4E-06	0.6
60	0.424	0.126	1.0E-05	0.9
80	0.424	0.126	7.5E-06	0.6
100	0.424	0.126	6.0E-06	0.5
120	0.425	0.125	6.2E-06	0.5
140	0.425	0.125	5.4E-06	0.5
160	0.426	0.124	5.6E-06	0.5
180	0.426	0.124	5.0E-06	0.4
200	0.427	0.123	5.3E-06	0.5
220	0.427	0.123	4.8E-06	0.4
240	0.428	0.122	5.0E-06	0.4
260	0.428	0.122	4.7E-06	0.4
280	0.429	0.121	4.9E-06	0.4
300	0.429	0.121	4.6E-06	0.4
		AVERAGE	6.0E-06	0.5

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.433	0.117		
20	0.434	0.116	8.1E-06	0.7
40	0.434	0.116	4.0E-06	0.3
60	0.434	0.116	2.7E-06	0.2
80	0.435	0.115	4.1E-06	0.4
100	0.435	0.115	3.2E-06	0.3
120	0.435	0.115	2.7E-06	0.2
140	0.435	0.115	2.3E-06	0.2
160	0.436	0.114	3.1E-06	0.3
180	0.436	0.114	2.7E-06	0.2
200	0.436	0.114	2.4E-06	0.2
220	0.436	0.114	2.2E-06	0.2
240	0.437	0.113	2.7E-06	0.2
260	0.437	0.113	2.5E-06	0.2
280	0.438	0.112	2.9E-06	0.3
300	0.438	0.112	2.7E-06	0.2
		AVERAGE	3.2E-06	0.3

https://galtgeo.sharepoint.com/sites/WAG230321/Shared Documents/02 BGE Detailed SI/08 Analysis/2024-05-23 KS Perms/WAG230321-02 Perms



https://galtgeo.sharepoint.com/sites/WAG230321/Shared Documents/02 BGE Detailed SI/08 Analysis/2024-05-23 KS Perms/WAG230321-02 Perms

Hydraulic Conductivity Calculation - Inverse Auger Hole Method

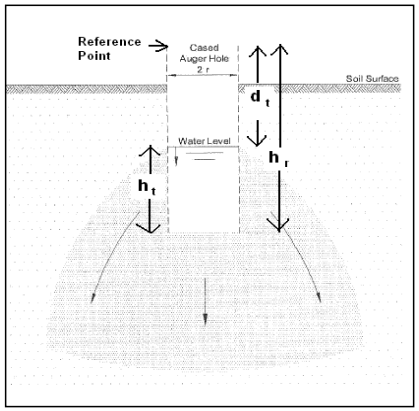
Galt Geotechnics

Job No:	WAG230321
Client:	BG&E
Project:	Byford health hub
Location:	3 Bushman Glade
Calc by:	K.sibanda
BH Name:	BH03/IT02
Test Depth:	0.45 m

Spreadsheet author:	ORW	17-Oct-09

$$K = 1.15r\,\frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114



Spreadsheet Legend

	Required input
	Calculated field
	Comment field
	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Hydraulic Conductivity		m/s
r	radius of test hole	0.045	m
t	time since start of measurement		s
h_r	reference point height above base	0.53	m
d_t	depth from reference point to water at time t		m
h_t	Water column height at time t		m
h_0	h_t at t=0		m

Test 1

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.36	0.17		
20	0.362	0.168	1.2E-05	1.0
40	0.364	0.166	1.2E-05	1.0
60	0.365	0.165	9.9E-06	0.9
80	0.365	0.165	7.4E-06	0.6
100	0.367	0.163	8.3E-06	0.7
120	0.368	0.162	7.9E-06	0.7
140	0.368	0.162	6.8E-06	0.6
160	0.371	0.159	8.3E-06	0.7
180	0.373	0.157	8.7E-06	0.8
200	0.376	0.154	9.8E-06	0.8
220	0.378	0.152	1.0E-05	0.9
240	0.38	0.15	1.0E-05	0.9
260	0.382	0.148	1.0E-05	0.9
280	0.386	0.144	1.2E-05	1.0
300	0.392	0.138	1.4E-05	1.2
		AVERAGE	9.8E-06	0.8

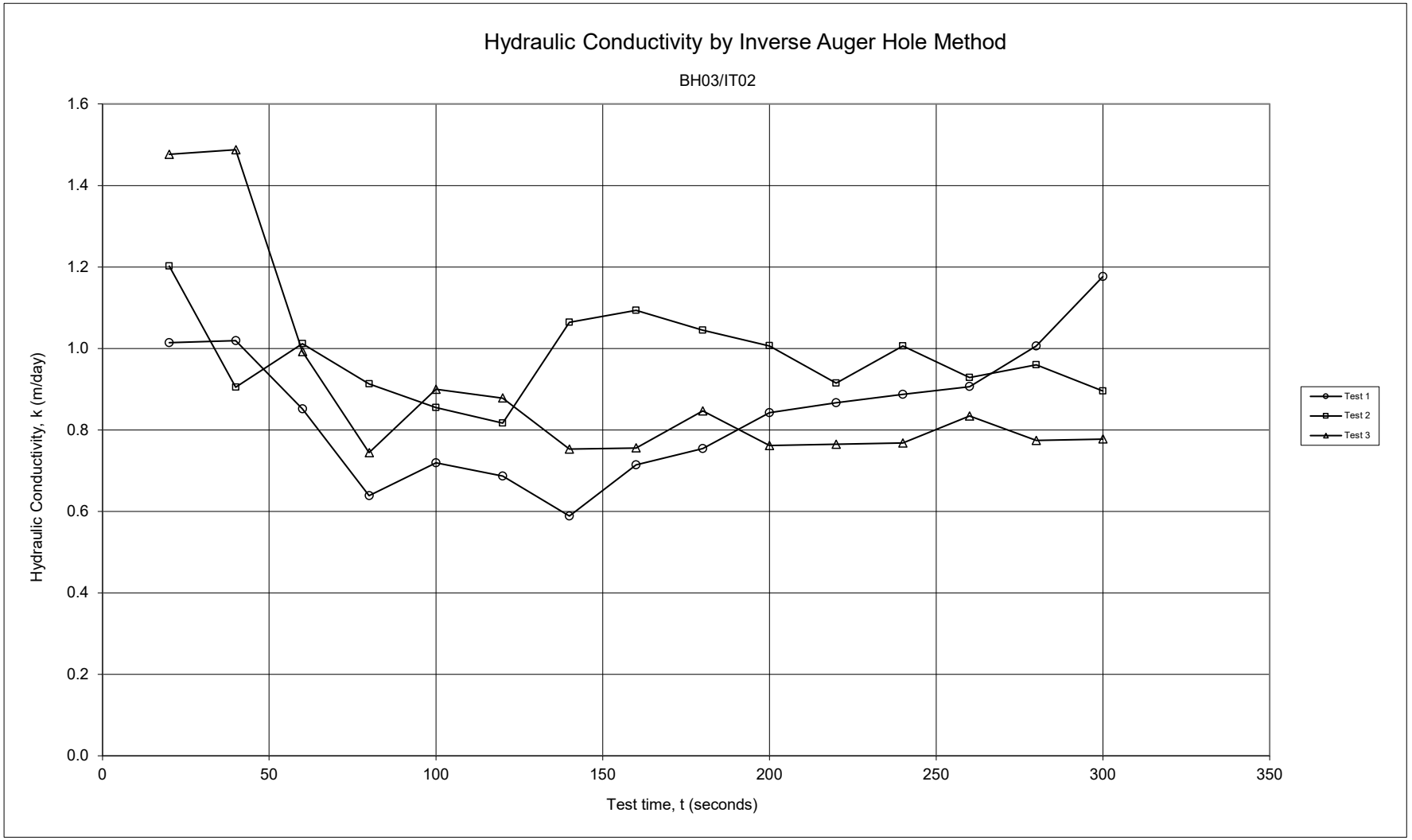
Test 2

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.39	0.14		
20	0.392	0.138	1.4E-05	1.2
40	0.393	0.137	1.0E-05	0.9
60	0.395	0.135	1.2E-05	1.0
80	0.396	0.134	1.1E-05	0.9
100	0.397	0.133	9.9E-06	0.9
120	0.398	0.132	9.5E-06	0.8
140	0.402	0.128	1.2E-05	1.1
160	0.404	0.126	1.3E-05	1.1
180	0.405	0.125	1.2E-05	1.0
200	0.406	0.124	1.2E-05	1.0
220	0.406	0.124	1.1E-05	0.9
240	0.409	0.121	1.2E-05	1.0
260	0.409	0.121	1.1E-05	0.9
280	0.411	0.119	1.1E-05	1.0
300	0.411	0.119	1.0E-05	0.9
		AVERAGE	1.1E-05	1.0

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.42	0.11		
20	0.422	0.108	1.7E-05	1.5
40	0.424	0.106	1.7E-05	1.5
60	0.424	0.106	1.1E-05	1.0
80	0.424	0.106	8.6E-06	0.7
100	0.426	0.104	1.0E-05	0.9
120	0.427	0.103	1.0E-05	0.9
140	0.427	0.103	8.7E-06	0.8
160	0.428	0.102	8.7E-06	0.8
180	0.43	0.1	9.8E-06	0.8
200	0.43	0.1	8.8E-06	0.8
220	0.431	0.099	8.9E-06	0.8
240	0.432	0.098	8.9E-06	0.8
260	0.434	0.096	9.7E-06	0.8
280	0.434	0.096	9.0E-06	0.8
300	0.435	0.095	9.0E-06	0.8
		AVERAGE	1.0E-05	0.9

https://galtgeo.sharepoint.com/sites/WAG230321/Shared Documents/02 BGE Detailed SI/08 Analysis/2024-05-23 KS Perms/WAG230321-02 Perms



https://galtgeo.sharepoint.com/sites/WAG230321/Shared Documents/02 BGE Detailed SI/08 Analysis/2024-05-23 KS Perms/WAG230321-02 Perms

Hydraulic Conductivity Calculation - Inverse Auger Hole Method

Galt Geotechnics

Job No:	WAG230321
Client:	BG&E
Project:	Byford health hub
Location:	3 Bushman Glade
Calc by:	K.sibanda
BH Name:	
Test Depth:	0.49 m

Spreadsheet author:	ORW	17-Oct-09

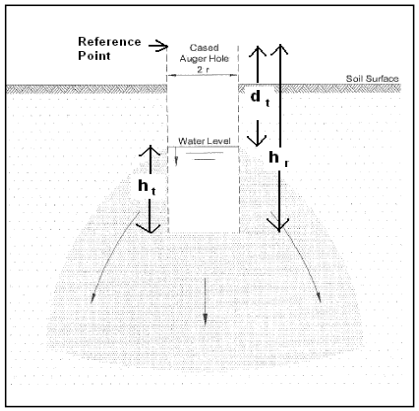
$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Spreadsheet Legend

	Required input
	Calculated field
	Comment field
	Field not used
	Fixed field

Parameter	Description	Value	Units
K	Hydraulic Conductivity		m/s
r	radius of test hole	0.045	m
t	time since start of measurement		s
h_r	reference point height above base	0.53	m
d_t	depth from reference point to water at time t		m
h_t	Water column height at time t		m
h_0	h_t at t=0		m



Test 1

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.36	0.17		
20	0.362	0.168	1.2E-05	1.0
40	0.364	0.166	1.2E-05	1.0
60	0.365	0.165	9.9E-06	0.9
80	0.365	0.165	7.4E-06	0.6
100	0.367	0.163	8.3E-06	0.7
120	0.368	0.162	7.9E-06	0.7
140	0.368	0.162	6.8E-06	0.6
160	0.371	0.159	8.3E-06	0.7
180	0.373	0.157	8.7E-06	0.8
200	0.376	0.154	9.8E-06	0.8
220	0.378	0.152	1.0E-05	0.9
240	0.38	0.15	1.0E-05	0.9
260	0.382	0.148	1.0E-05	0.9
280	0.386	0.144	1.2E-05	1.0
300	0.392	0.138	1.4E-05	1.2
		AVERAGE	9.8E-06	0.8

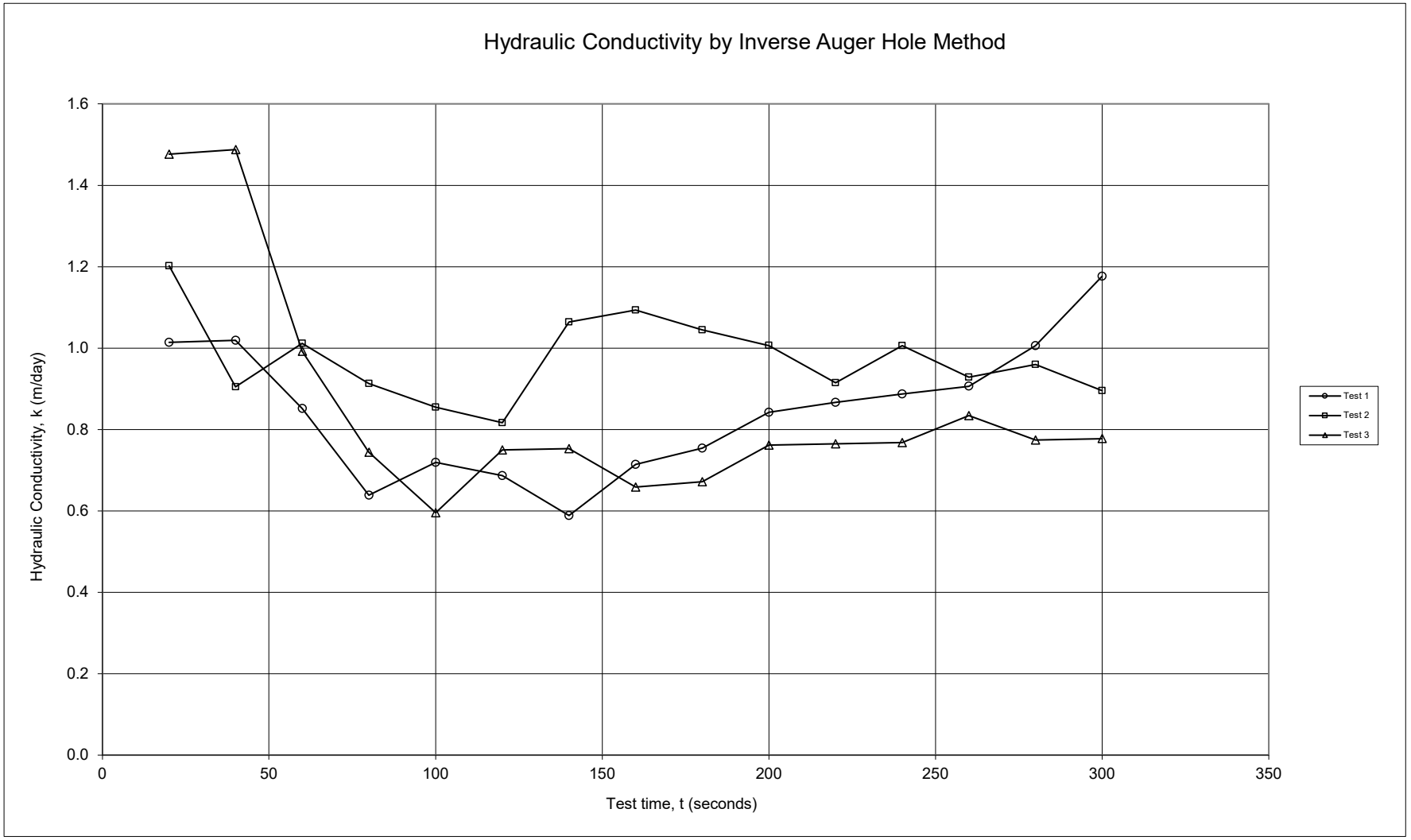
Test 2

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.39	0.14		
20	0.392	0.138	1.4E-05	1.2
40	0.393	0.137	1.0E-05	0.9
60	0.395	0.135	1.2E-05	1.0
80	0.396	0.134	1.1E-05	0.9
100	0.397	0.133	9.9E-06	0.9
120	0.398	0.132	9.5E-06	0.8
140	0.402	0.128	1.2E-05	1.1
160	0.404	0.126	1.3E-05	1.1
180	0.405	0.125	1.2E-05	1.0
200	0.406	0.124	1.2E-05	1.0
220	0.406	0.124	1.1E-05	0.9
240	0.409	0.121	1.2E-05	1.0
260	0.409	0.121	1.1E-05	0.9
280	0.411	0.119	1.1E-05	1.0
300	0.411	0.119	1.0E-05	0.9
		AVERAGE	1.1E-05	1.0

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.42	0.11		
20	0.422	0.108	1.7E-05	1.5
40	0.424	0.106	1.7E-05	1.5
60	0.424	0.106	1.1E-05	1.0
80	0.424	0.106	8.6E-06	0.7
100	0.424	0.106	6.9E-06	0.6
120	0.426	0.104	8.7E-06	0.7
140	0.427	0.103	8.7E-06	0.8
160	0.427	0.103	7.6E-06	0.7
180	0.428	0.102	7.8E-06	0.7
200	0.43	0.1	8.8E-06	0.8
220	0.431	0.099	8.9E-06	0.8
240	0.432	0.098	8.9E-06	0.8
260	0.434	0.096	9.7E-06	0.8
280	0.434	0.096	9.0E-06	0.8
300	0.435	0.095	9.0E-06	0.8
		AVERAGE	9.9E-06	0.9

https://galtgeo.sharepoint.com/sites/WAG230321/Shared Documents/02 BGE Detailed SI/08 Analysis/2024-05-23 KS Perms/WAG230321-02 Perms



https://galtgeo.sharepoint.com/sites/WAG230321/Shared Documents/02 BGE Detailed SI/08 Analysis/2024-05-23 KS Perms/WAG230321-02 Perms

Appendix F: Geotechnical Laboratory Test Results

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

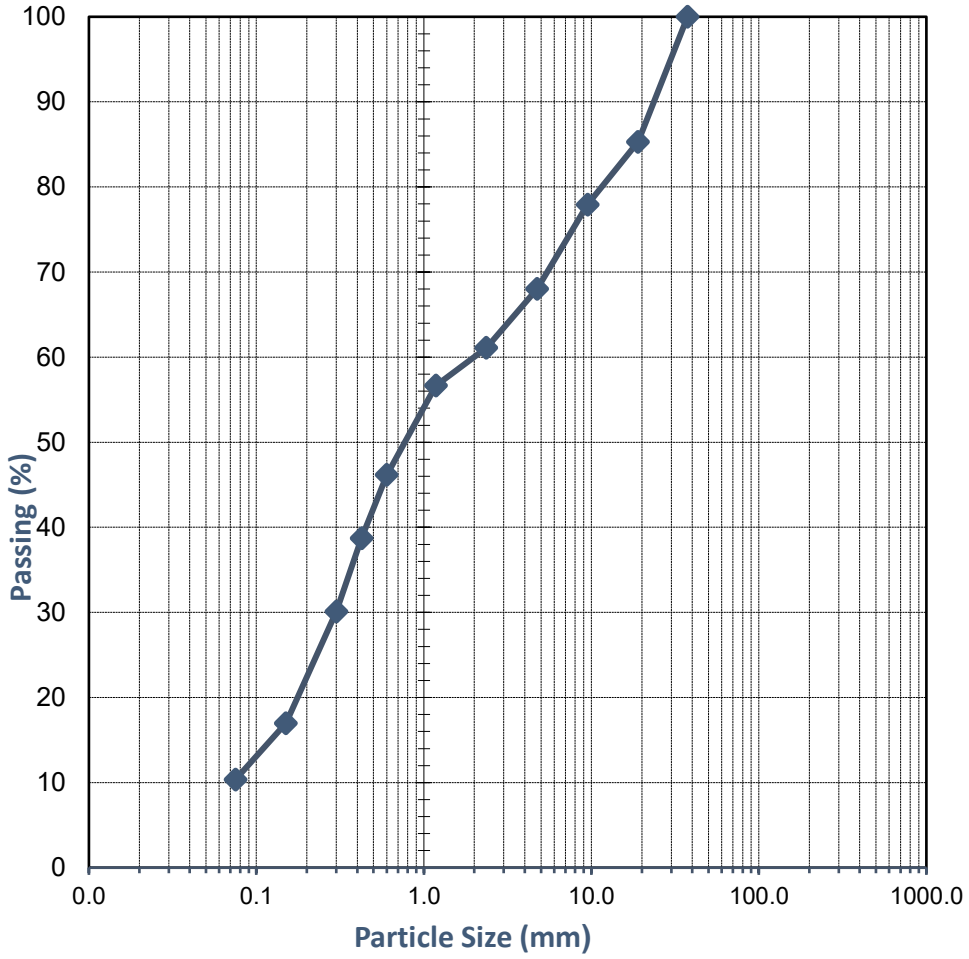
TEST REPORT - AS 1289.3.6.1, *AS 1289.1.1

Client:	BG&E Pty Ltd	*Ticket No.*	S13374
Client Address:	-	*Report No.*	WG24.8513_1_PSD
Project:	Byfrod Health Hub	*Sample No.*	WG24.8513
Location:	3 Bushman Glade, Byford WA	*Date Sampled:*	Not Specified
Sample Identification:	BH04 (0.5-0.8)m	*Date Tested:*	29/05 - 30/05/2024

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	85
9.5	78
4.75	68
2.36	61
1.18	57
0.600	46
0.425	39
0.300	30
0.150	17
0.075	10



*Comments: *AS 1289.1.1- Deviation from standard: Insufficient sample according to test method requirements. NATA accreditation does not cover the performance of this service.*

Approved Signatory:

Name: Cody O'Neill

Date: 30/May/2024

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

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Appendix G: Acid Sulfate Soils Test Results

eurofins | Environment Testing

Certificate of Analysis

Galt Environment P/L
50 Edward Street
Osborne Park
WA 6017

NATA Accredited
Accreditation Number 1261
Site Number 20794

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention: **- ALL SRA/Results**

Report **1100914-S**
Project name BUSHMAN GLADE BYFORD
Project ID WAG230321
Received Date May 24, 2024

Client Sample ID			**BH01/0.5**	**BH02/1.0**	**BH02/1.75**	**BH02/2.0**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**L24-My0069900**	**L24-My0069901**	**L24-My0069902**	**L24-My0069903**
Date Sampled			**May 23, 2024**	**May 23, 2024**	**May 23, 2024**	**May 23, 2024**
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	110	100	120	130
>2mm Fraction	0.005	g	10	12	17	19
Analysed Material	0.1	%	91	89	88	87
Extraneous Material	0.1	%	8.7	11	12	13
Net Acidity (Excluding ANC)						
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Actual Acidity (NLM-3.2)						
pH-KCL (NLM-3.1)	0.1	pH Units	9.4	8.6	8.6	8.6
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	< 2	< 2	< 2	< 2
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	< 0.003	< 0.003	< 0.003	< 0.003
Potential Acidity - Chromium Reducible Sulfur						
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)[S04]	0.005	% S	< 0.005	< 0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	3	mol H+/t	< 3	< 3	< 3	< 3
Extractable Sulfur						
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Retained Acidity (S-NAS)						
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
Acid Neutralising Capacity (ANCbt)						
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	3.9	3.5	2.2	2.5
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	1.3	1.1	0.72	0.79
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	780	700	450	490
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
Net Acidity (Including ANC)						
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Sample Properties						
% Moisture	1	%	1.9	7.3	7.2	8.2

eurofins | Environment Testing

Client Sample ID			BH03/01.0	BH03/1.75	BH03/3.00	BH04/0.25
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L24-My0069904	L24-My0069905	L24-My0069906	L24-My0069907
Date Sampled			May 23, 2024	May 23, 2024	May 23, 2024	May 23, 2024
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	81	81	77	43
>2mm Fraction	0.005	g	67	50	19	22
Analysed Material	0.1	%	55	62	80	67
Extraneous Material	0.1	%	45	38	20	33
Net Acidity (Excluding ANC)						
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Actual Acidity (NLM-3.2)						
pH-KCL (NLM-3.1)	0.1	pH Units	8.2	7.7	6.5	8.7
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	< 2	< 2	< 2	< 2
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	< 0.003	< 0.003	< 0.003	< 0.003
Potential Acidity - Chromium Reducible Sulfur						
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)[S04]	0.005	% S	< 0.005	< 0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	3	mol H+/t	< 3	< 3	< 3	< 3
Extractable Sulfur						
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Retained Acidity (S-NAS)						
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
Acid Neutralising Capacity (ANCbt)						
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	1.2	0.71	N/A	23
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	0.39	0.23	N/A	7.3
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	240	140	N/A	4600
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
Net Acidity (Including ANC)						
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Sample Properties						
% Moisture	1	%	2.8	3.6	6.3	4.0

Client Sample ID			BH04/1.75	BH04/3.00	QC01
Sample Matrix			Soil	Soil	Soil
Eurofins Sample No.			L24-My0069908	L24-My0069909	L24-My0069910
Date Sampled			May 23, 2024	May 23, 2024	May 23, 2024
Test/Reference	LOR	Unit			
Extraneous Material					
<2mm Fraction	0.005	g	57	95	110
>2mm Fraction	0.005	g	47	7.0	38
Analysed Material	0.1	%	55	93	74
Extraneous Material	0.1	%	45	6.9	26

eurofins | Environment Testing

Client Sample ID			BH04/1.75	BH04/3.00	QC01
Sample Matrix			Soil	Soil	Soil
Eurofins Sample No.			L24-My0069908	L24-My0069909	L24-My0069910
Date Sampled			May 23, 2024	May 23, 2024	May 23, 2024
Test/Reference	LOR	Unit			
Net Acidity (Excluding ANC)					
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	< 1	< 1
Actual Acidity (NLM-3.2)					
pH-KCL (NLM-3.1)	0.1	pH Units	8.4	8.5	7.2
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	< 2	< 2	< 2
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	< 0.003	< 0.003	< 0.003
Potential Acidity - Chromium Reducible Sulfur					
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)[S04]	0.005	% S	< 0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	3	mol H+/t	< 3	< 3	< 3
Extractable Sulfur					
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A
Retained Acidity (S-NAS)					
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0
Acid Neutralising Capacity (ANCbt)					
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	1.9	1.1	0.47
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	0.62	0.36	0.15
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	380	230	94
ANC Fineness Factor		factor	1.5	1.5	1.5
Net Acidity (Including ANC)					
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	< 1	< 1	< 1
Sample Properties					
% Moisture	1	%	10	7.3	3.4

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Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Extraneous Material	Brisbane	Jun 02, 2024	6 Week
- Method: LTM-GEN-7050/7070			
Chromium Suite - NASSG (Excluding ANC)	Brisbane	Jun 02, 2024	6 Week
- Method: LTM-GEN-7070 Chromium Reducible Sulfur Suite			
% Moisture	Brisbane	May 24, 2024	14 Days
- Method: LTM-GEN-7080 Moisture			

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Project ID: WAG230321

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Report #: 1100914
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Received: May 24, 2024 3:15 PM
Due: May 31, 2024
Priority: 5 Day
Contact Name: - ALL SRA/Results

Eurofins Analytical Services Manager : Natalie Hill

Sample Detail						Moisture Set	Chromium Suite - NASSG (Excluding ANC)
Brisbane Laboratory - NATA # 1261 Site # 20794						X	X
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH01/0.5	May 23, 2024		Soil	L24-My0069900	X	X
2	BH02/1.0	May 23, 2024		Soil	L24-My0069901	X	X
3	BH02/1.75	May 23, 2024		Soil	L24-My0069902	X	X
4	BH02/2.0	May 23, 2024		Soil	L24-My0069903	X	X
5	BH03/01.0	May 23, 2024		Soil	L24-My0069904	X	X
6	BH03/1.75	May 23, 2024		Soil	L24-My0069905	X	X
7	BH03/3.00	May 23, 2024		Soil	L24-My0069906	X	X
8	BH04/0.25	May 23, 2024		Soil	L24-My0069907	X	X
9	BH04/1.75	May 23, 2024		Soil	L24-My0069908	X	X
10	BH04/3.00	May 23, 2024		Soil	L24-My0069909	X	X
11	QC01	May 23, 2024		Soil	L24-My0069910	X	X
Test Counts						11	11

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Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follow guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013. They are included in this QC report where applicable. Additional QC data may be available on request.
2. Unless otherwise stated, all soil/sediment/solid results are reported on a dry weight basis.
3. Unless otherwise stated, all biota/food results are reported on a wet weight basis on the edible portion.
4. For CEC results where the sample's origin is unknown or environmentally contaminated, the results should be used advisedly.
5. Actual LORs are matrix dependent. Quoted LORs may be raised where sample extracts are diluted due to interferences.
6. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds where annotated.
7. SVOC analysis on waters is performed on homogenised, unfiltered samples unless noted otherwise.
8. Samples were analysed on an 'as received' basis.
9. Information identified in this report with **blue** colour indicates data provided by customers that may have an impact on the results.
10. This report replaces any interim results previously issued.

Holding Times

Please refer to the 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours before sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and despite any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the sampling date; therefore, compliance with these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether, the holding time is seven days; however, for all other VOCs, such as BTEX or C6-10 TRH, the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ppm:** parts per million
µg/L: micrograms per litre	**ppb:** parts per billion	**%:** Percentage
org/100 mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100 mL:** Most Probable Number of organisms per 100 millilitres
CFU: Colony Forming Unit	**Colour:** Pt-Co Units (CU)	

Terms

APHA	American Public Health Association
CEC	Cation Exchange Capacity
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where moisture has been determined on a solid sample, the result is expressed on a dry weight basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples, these are performed on laboratory-certified clean sands and in the case of water samples, these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC represents the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a similar compound to the analyte target is reported as percentage recovery. See below for acceptance criteria.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment; however, free tributyltin was measured, and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 6.0
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should only be used as a guide and may be different when site-specific Sampling Analysis and Quality Plan (SAQP) have been implemented.

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is ≤30%; however, the following acceptance guidelines are equally applicable:

Results <10 times the LOR:	No Limit
Results between 10-20 times the LOR:	RPD must lie between 0-50%
Results >20 times the LOR:	RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range, not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%, VOC recoveries 50 – 150%

PFAS field samples containing surrogate recoveries above the QC limit designated in QSM 6.0, where no positive PFAS results have been reported or reviewed, and no data was affected.

QC Data General Comments

1. Where a result is reported as less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown are not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery, the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results, a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data; thus, it is possible to have two sets of data.

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Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
LCS - % Recovery							
Actual Acidity (NLM-3.2)							
pH-KCL (NLM-3.1)	%	102			80-120	Pass	
Titratable Actual Acidity (NLM-3.2)	%	90			80-120	Pass	
LCS - % Recovery							
Potential Acidity - Chromium Reducible Sulfur							
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)	%	116			80-120	Pass	
LCS - % Recovery							
Extractable Sulfur							
HCl Extractable Sulfur	%	108			80-120	Pass	
CRM - % Recovery							
Actual Acidity (NLM-3.2)							
pH-KCL (NLM-3.1)	%	100			80-120	Pass	
CRM - % Recovery							
Acid Neutralising Capacity (ANCbt)							
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	%	100			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
Net Acidity (Excluding ANC)				Result 1	Result 2	RPD			
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	L24-My0069900	CP	% S	< 0.02	N/A	N/A	30%	Pass	
CRS Suite - Net Acidity - NASSG (Excluding ANC)	L24-My0069900	CP	mol H+/t	< 10	N/A	N/A	20%	Pass	
CRS Suite - Liming Rate - NASSG (Excluding ANC)	L24-My0069900	CP	kg CaCO3/t	< 1	N/A	N/A	30%	Pass	
Duplicate									
Actual Acidity (NLM-3.2)				Result 1	Result 2	RPD			
pH-KCL (NLM-3.1)	L24-My0069900	CP	pH Units	9.4	9.4	<1	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L24-My0069900	CP	mol H+/t	< 2	< 2	<1	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L24-My0069900	CP	% pyrite S	< 0.003	< 0.003	<1	30%	Pass	
Duplicate									
Potential Acidity - Chromium Reducible Sulfur				Result 1	Result 2	RPD			
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)	L24-My0069900	CP	% S	< 0.005	< 0.005	<1	20%	Pass	
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	L24-My0069900	CP	mol H+/t	< 3	< 3	<1	30%	Pass	
Duplicate									
Extractable Sulfur				Result 1	Result 2	RPD			
Sulfur - KCl Extractable	L24-My0069900	CP	% S	N/A	N/A	N/A	30%	Pass	
HCl Extractable Sulfur	L24-My0069900	CP	% S	N/A	N/A	N/A	20%	Pass	
Duplicate									
Retained Acidity (S-NAS)				Result 1	Result 2	RPD			
Net Acid soluble sulfur (SNAS) NLM-4.1	L24-My0069900	CP	% S	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (s-SNAS) NLM-4.1	L24-My0069900	CP	% S	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (a-SNAS) NLM-4.1	L24-My0069900	CP	mol H+/t	N/A	N/A	N/A	30%	Pass	
Duplicate									
Acid Neutralising Capacity (ANCbt)				Result 1	Result 2	RPD			
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	L24-My0069900	CP	% CaCO3	3.9	3.6	7.7	20%	Pass	
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)	L24-My0069900	CP	% S	1.3	1.2	7.7	30%	Pass	
ANC Fineness Factor	L24-My0069900	CP	factor	1.5	1.5	<1	30%	Pass	

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Duplicate									
Net Acidity (Including ANC)				Result 1	Result 2	RPD			
s-CRS Suite - Net Acidity - NASSG (including ANC)	L24-My0069900	CP	% S	< 0.02	< 0.02	<1	30%	Pass	
CRS Suite - Net Acidity - NASSG (Including ANC)	L24-My0069900	CP	mol H+/t	< 10	< 10	<1	30%	Pass	
CRS Suite - Liming Rate - NASSG (Including ANC)	L24-My0069900	CP	kg CaCO3/t	< 1	< 1	<1	30%	Pass	
Duplicate									
Sample Properties				Result 1	Result 2	RPD			
% Moisture	L24-My0069905	CP	%	3.6	3.4	5.1	30%	Pass	
Duplicate									
Net Acidity (Excluding ANC)				Result 1	Result 2	RPD			
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	L24-My0069910	CP	% S	< 0.02	N/A	N/A	30%	Pass	
CRS Suite - Net Acidity - NASSG (Excluding ANC)	L24-My0069910	CP	mol H+/t	< 10	N/A	N/A	20%	Pass	
CRS Suite - Liming Rate - NASSG (Excluding ANC)	L24-My0069910	CP	kg CaCO3/t	< 1	N/A	N/A	30%	Pass	
Duplicate									
Actual Acidity (NLM-3.2)				Result 1	Result 2	RPD			
pH-KCL (NLM-3.1)	L24-My0069910	CP	pH Units	7.2	7.2	<1	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L24-My0069910	CP	mol H+/t	< 2	< 2	<1	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L24-My0069910	CP	% pyrite S	< 0.003	< 0.003	<1	30%	Pass	
Duplicate									
Potential Acidity - Chromium Reducible Sulfur				Result 1	Result 2	RPD			
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)	L24-My0069910	CP	% S	< 0.005	< 0.005	<1	20%	Pass	
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	L24-My0069910	CP	mol H+/t	< 3	< 3	<1	30%	Pass	
Duplicate									
Extractable Sulfur				Result 1	Result 2	RPD			
Sulfur - KCl Extractable	L24-My0069910	CP	% S	N/A	N/A	N/A	30%	Pass	
HCl Extractable Sulfur	L24-My0069910	CP	% S	N/A	N/A	N/A	20%	Pass	
Duplicate									
Retained Acidity (S-NAS)				Result 1	Result 2	RPD			
Net Acid soluble sulfur (SNAS) NLM-4.1	L24-My0069910	CP	% S	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (s-SNAS) NLM-4.1	L24-My0069910	CP	% S	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (a-SNAS) NLM-4.1	L24-My0069910	CP	mol H+/t	N/A	N/A	N/A	30%	Pass	
Duplicate									
Acid Neutralising Capacity (ANCbt)				Result 1	Result 2	RPD			
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	L24-My0069910	CP	% CaCO3	0.47	0.49	3.9	20%	Pass	
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)	L24-My0069910	CP	% S	0.15	0.16	3.9	30%	Pass	
ANC Fineness Factor	L24-My0069910	CP	factor	1.5	1.5	<1	30%	Pass	
Duplicate									
Net Acidity (Including ANC)				Result 1	Result 2	RPD			
s-CRS Suite - Net Acidity - NASSG (including ANC)	L24-My0069910	CP	% S	< 0.02	< 0.02	<1	30%	Pass	
CRS Suite - Net Acidity - NASSG (Including ANC)	L24-My0069910	CP	mol H+/t	< 10	< 10	<1	30%	Pass	
CRS Suite - Liming Rate - NASSG (Including ANC)	L24-My0069910	CP	kg CaCO3/t	< 1	< 1	<1	30%	Pass	

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Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	N/A
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
S01	Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil' multiply 'reported results' x 'wet bulk density of soil in t/m3'
S02	Retained Acidity is Reported when the pHKCl is less than pH 4.5
S03	Acid Neutralising Capacity is only required if the pHKCl if greater than or equal to pH 6.5
S04	Acid Sulfate Soil Samples have a 24 hour holding time unless frozen or dried within that period

Authorised by:

Natalie Hill	Analytical Services Manager
Jonathon Angell	Senior Analyst-Sample Properties
Jonathon Angell	Senior Analyst-SPOCAS



Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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Standard Geotechnical Definitions, Recommendations, Requirements and Limitations

GDR1 ABOUT THIS APPENDIX

These technical notes are to be read with the attached report. These notes contain important information regarding the study in the attached report, and the report cannot be considered in isolation without full reading of these notes.

Where there are conflicts between this appendix and the report text, the report text takes precedence.

Unless noted otherwise, geotechnical investigations are conducted in accordance with AS1726-2017, "Geotechnical site investigations".

Unless noted otherwise, the report does not include any assessment (or implied assessment) of karst risk.

GDR2 DEFINITIONS

The following definitions apply:

- **Approved Fill** – fill that has been assessed and approved by the geotechnical engineer or civil designer for a particular purpose.
- **Bulk Fill** – Controlled fill intended to support future infrastructure, but potentially lacking some engineering properties required for upper fill layers or adjacent to structures, where fill with specific properties may be required. Contrast with Select Fill.
- **Civil Design** – the engineering design of the earthworks including surface water and erosion control and subsurface drainage control (where required) to achieve an earthworked, drained site which is capable of supporting the proposed development (including target site classification to AS2870, where relevant). This design is separate to this geotechnical investigation and is a required element of a site development.
- **Clay** – A component of a soil with particles smaller than 0.002 mm in size.
- **Cohesionless (Non-cohesive) Soil** – A soil mass that has does not hold together at low applied stress levels. The strength of the soil depends solely on friction between particles.
- **Cohesive Soil** – A soil mass that has holds together and can adhere to itself.
- **Collapsible Soil** – a soil with high void ratio that is typically strong when dry but loses strength and consolidates under constant stress when wetted, usually due to loss of soil matric suction or dissolving of a chemical cementing agent.
- **Compaction –** The process of increasing the soil density, typically be mechanical means.
- **Competent Person** – A person who has, through a combination of training, education and experience, acquired knowledge and skills enabling that person to correctly perform a specified task.
- **Consistency** – The stiffness of a cohesive soil, at specific moisture contents, to resist mechanical stress or manipulation (remoulding).
- **Controlled (or engineered) Fill** – Any fill for which engineering properties are controlled during placement. Also referred to as structural fill.
- **Dense –** with respect to sandy soils, at a relatively high density index or dry density ratio, exhibiting better engineering parameters with respect to strength and stiffness than the same material at a lower density index.
- **Density** – A measure of the mass of material per unit volume.
- **Eccentric Load** – a load incorporating either a varying vertical load and/or a horizontal load such that the peak vertical stress exceeds the average vertical stress.
- **Fill** – Any material that has been placed by anthropogenic processes.
- **Fines** – A component of a soil with particles smaller than 0.075 mm in size.
- **Groundwater** – Water located beneath the earth's surface in pore spaces, fractures and voids in soil or rock.
- **Gravel** – A component of a soil with particles between 2.36 mm and 63 mm in size.

- **Heavily Loaded** – in reference to mobile plant, particularly intended for equipment where ground bearing pressures exceed 50 kPa and/or equipment has a high centre of gravity and could be prone to toppling. In reference to buildings/structures, where footing pressures exceed 100 kPa and/or footing dimensions exceed 1 m wide.
- **Hydraulic Conductivity** – ratio of volume flux to hydraulic gradient – a quantitative measure of soil's ability to transmit water when subjected to a hydraulic gradient. k_{sat} – saturated hydraulic conductivity, intended for dewatering assessment, subsoil drainage design and other engineering assessments where saturated soils are relevant. k_{unsat} – unsaturated hydraulic conductivity, intended for design of stormwater disposal elements such as soakwells and infiltration basins, where the base of disposal elements is above the groundwater level.
- **In situ** – In the place and condition in which it exists naturally. May also refer to fill that is present at any site prior to an investigation taking place.
- **Limestone** – A sedimentary carbonate rock. The use of the term does not infer a specific strength, carbonate content or grain size. Refer to GDR4.1 for further detail.
- **Loose** – with respect to sand soils, at a relatively low density index or dry density ratio, typically indicating poorer engineering parameters with respect to strength and stiffness than the same material at a higher density index.
- **Material** – Matter that meets the definitions of 'soil', 'rock', other engineered matter (i.e., concrete, bricks etc.) or non-engineered matter (organics, contaminated refuse, deleterious material).
- **May** – Indicates that the statement is an option.
- **Must** – Indicates that the statement is mandatory.
- **Natural** – In the context of soil or rock, material which is present as a result of natural geological processes and has not been subject to anthropogenic engineering processes (such as filling, excavation, replacement, etc).
- **Organic** – In the context of soil, material derived from living matter, primarily plants.
- **Overconsolidated** – a soil that has been subjected to a greater vertical stress than its current state.
- **Permeable Soil** – soil that meets the civil design permeability requirements to allow relatively rapid flow of water through the soil matrix.
- **Rock** – Any aggregate of minerals and/or materials that cannot be disaggregated by hand in air or water without prior soaking.
- **Sand** – a component of soil with particle size between 0.075 mm and 2.36 mm.
- **Select Fill** – a controlled fill which has been chosen for particular engineering characteristics (such as strength, CBR, grading, permeability, etc), commonly for use as a higher-grade capping layer or adjacent to structures. Contrast with Bulk Fill.
- **Shall** – Indicates that the statement is mandatory.
- **Should** – Indicates that the statement is a recommendation.
- **Silt** – A component of a soil with particles between 0.075 mm and 0.002 mm in size.
- **Soil** – Particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking.
- **Sand** – A component of a soil with particle between 0.075 mm and 2.36 mm in size.
- **Uncontrolled Fill** – Any material that has been deposited by anthropogenic process, which does not meet the definition of 'controlled fill'.

GDR3 GEOTECHNICAL TEST METHODS AND INTERPRETATION

GDR3.1 Test Pit Excavation

Test pit excavations are formed using mechanical excavation equipment (typically an excavator) or hand dug, with the objective of inspecting (or profiling) the soil exposed in the excavation.

Typical limitations on test pit excavations are:

- Limited depth of excavation – typically governed by reach of the excavator arm.
- Cannot be excavated below groundwater in cohesionless soils, due to collapse and water ingress.
- Cannot be excavated through very stiff / very dense soils (i.e., desiccated clays or cemented soils) or most rock.
- Cannot typically obtain rock samples that are suitable for strength testing.

Test pits are usually mechanically excavated with a toothed bucket (intended for excavation in clay or weak rock) or a flat-edged bucket (typically for sands).

When hand-dug test pits are excavated, it is usually for recovery of near-surface soils or inspection of shallow in-ground elements.

We note that where test pits are excavated on a site, they are only ever loosely backfilled during our studies. They must always be located during site preparation works, over-excavated to their full depth and plan extents and re-filled with approved fill in compacted layers.

GDR3.2 Cone Penetration Tests (CPTs)

Cone penetration testing (CPT) is done by Galt or specialist contractors and typically to AS1289.6.5.1. The test involves pushing an instrumented cone into the soil with a hydraulically operated pushing frame. The test measures tip resistance and sleeve friction on the cone, which are then plotted with depth.

We interpret soil types and associated geotechnical soil parameters from CPT data using the following:

Technical Interpretations and International Guides

- Robertson P.K., Campanella R.G., Gillespie D. and Grieg J. (1986). “Use of piezometer cone data”. Proceedings of the ASCE Speciality Conference In Situ ’86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, pp 1263-80, American Society of Civil Engineers (ASCE).
- Robertson, P.K., Cabal K.L. (2016) “Guide to Cone Penetration Testing for Geotechnical Engineering 6th Edition 2015”. Gregg Drilling & Testing, Inc., California.
- Baldi G., Bellotti R., Ghionna V.H., Jamiolkowski M., Lo Presti D. C. (1989) “Modulus of sands from CPTs and DMTs”. Proc. 12th Int. Conf. on SMFE, Rio de Janeiro, Vol 1, p165-170, Balkema, Rotterdam.

Local (Perth and Western Australia) Research, Interpretation and Guides

- Fahey, M., Lehane, B., Stewart, D. (2003) “Soil stiffness for shallow foundation design in the Perth CBD”. Australian Geomechanics Vol. 8 No. 3.
- Main Roads Western Australia (MRWA) (2009) “Structures Engineering Design Manual”. Document 3912/03, Perth.
- Lehane B. (2017). “CPT-Based Design of Foundations”, E.H. Davis Memorial Lecture, Australian Geomechanics, Vol 54. No. 4’ and
- Galt’s in-house correlations between CPT data and other geotechnical testing.

GDR3.3 Borehole Drilling

Boreholes are drilled for sampling of the soil and rock, with a small disturbance footprint. Typical techniques are:

- Auger drilling (hand auger or machine auger) – for recovery of soil at relatively shallow depths only. Cannot penetrate cemented soils or rock.
- Push probe drilling – for recovery of soil at relatively shallow depths and below groundwater. Cannot penetrate cemented soils or rock.
- Air core drilling – for recovery of soil, cemented soil and rock (typically up to high strength rock). Not suited to drilling of very high strength rock.
- Diamond coring (or rotary coring) – for recovery of cemented soil, rock and some soil types (typically not sand). Suited to all strengths of rock.

If used, standard penetration tests (SPTs) are done in accordance with AS1289.6.3.1. Correlations for consistency and density are based on:

- Standards Australia (2016), "HB160-2006, Soils Testing".

GDR3.4 Dynamic Cone Penetrometer (DCP)

The DCP is a hand-held tool for assessing penetration resistance of a soil. This comprises a 16 mm rod equipped with a 20 mm cone, hammered into the ground using a falling 9 kg weight on a 510 mm slide hammer on the top of the rod. This is done in accordance with AS1289.6.3.2 and the blow counts to hammer in the rod are measured in 100 mm penetration increments. Where provided, correlations for consistency and density are based on:

- Standards Australia (2016), "HB160-2006, Soils Testing".

GDR3.5 Perth Sand Penetrometer (PSP)

The PSP is a variation on a DCP and uses a 9 kg weight on a 600 mm slide hammer to hammer in a 16 mm rod with a blunt (square-faced) end. Testing is done in accordance with AS1289.6.3.3, with the following typical variations:

- Testing is often done to a greater depth than the 450 mm covered in the standard.
- Blow counts are sometimes recorded in 150 mm intervals (compared to 300 mm intervals used in the standard) to provide better resolution on the tests.

Where provided, correlations for density are based on:

- Standards Australia (2016), "HB160-2006, Soils Testing".

GDR3.6 Dynamic Probing Super Heavy (DPSH)

The DPSH test involves driving a solid cone (20 cm^2) into the ground using a 63.5 kg hammer falling 760 mm. Testing is done in accordance with EN ISO 22476-2 – Geotechnical engineering – Field testing – Part 2: Dynamic probing – DPSH-B.

Results may be presented as either:

- N10 (No. of blows required for every 100 mm penetration);
- N30 (No. of blows required for every 300 mm penetration); or
- q_d (dynamic tip resistance, analogous to CPT q_c).

GDR3.7 Inverse Auger Hole Infiltration Test (Falling Head, Unsaturated Soil)

Infiltration tests are carried out using the 'inverse auger hole' method described by:

- Cocks, G (2007), "Disposal of Stormwater Runoff by Soakage in Perth Western Australia", Journal and News of the Australian Geomechanics Society, Volume 42 No. 3, pp 101-114

This test is an unsaturated falling head test, in that it is carried out above the groundwater table and is intended to mimic the behaviour of soak wells and similar drainage elements (i.e. soakage basins), which discharge stormwater into an unsaturated medium.

The hole is wetted only for a short period prior to the testing.

The test is usually repeated three times, with the intention that the second and third tests provide similar results (within about 10%-20%). Tests are done over a short duration, typically 2 minutes to 10 minutes. The focus of the testing is generally when the head is low (200 mm or lower), such that the relevant lateral zone is as saturated as the zone directly below the borehole.

The hydraulic conductivity derived from this test is not to be used for applications where saturated hydraulic conductivity is relevant, e.g.:

- Subsoil drainage design; and
- Dewatering estimations.

Based on Galt's in-house research, this method does not completely saturate the soil in any reasonable test length, and thus may not be suitable for assessment of soils at sites where the critical drainage condition is a fully saturated soil (i.e., in areas with high groundwater tables). Our research on sand sites indicates that the test does correlate well with actual soak well performance, in unsaturated sand zones without impermeable zones.

GDR3.8 Guelph Permeameter Test (Constant Head, Quasi-Saturated Soil)

The Guelph permeameter test, conducted in accordance with the constant head test method outlined in Appendix G of AS1547, is a constant-head test in nominally "saturated" soil (in that the test is conducted until a "steady state" is reached). However, we note that this test can only be done above the groundwater table and as such, is in an unsaturated zone. Therefore, the hydraulic conductivity derived from this test should be used with caution and evaluated against other test methods (such as saturated, constant-head permeability testing from laboratory samples, or in situ saturated hydraulic conductivity testing below the groundwater table).

GDR4 GEOLOGICAL UNITS

GDR4.1 Limestone

The term 'Limestone' is used to describe a carbonate rock. Tamala Limestone is the common limestone in Western Australia, and typically comprises cemented quartz and shell fragments cemented together by calcium carbonate.

Limestone can vary significantly across short distances in composition, strength and cementation. Tamala limestones in Western Australia also have known possible geological features including:

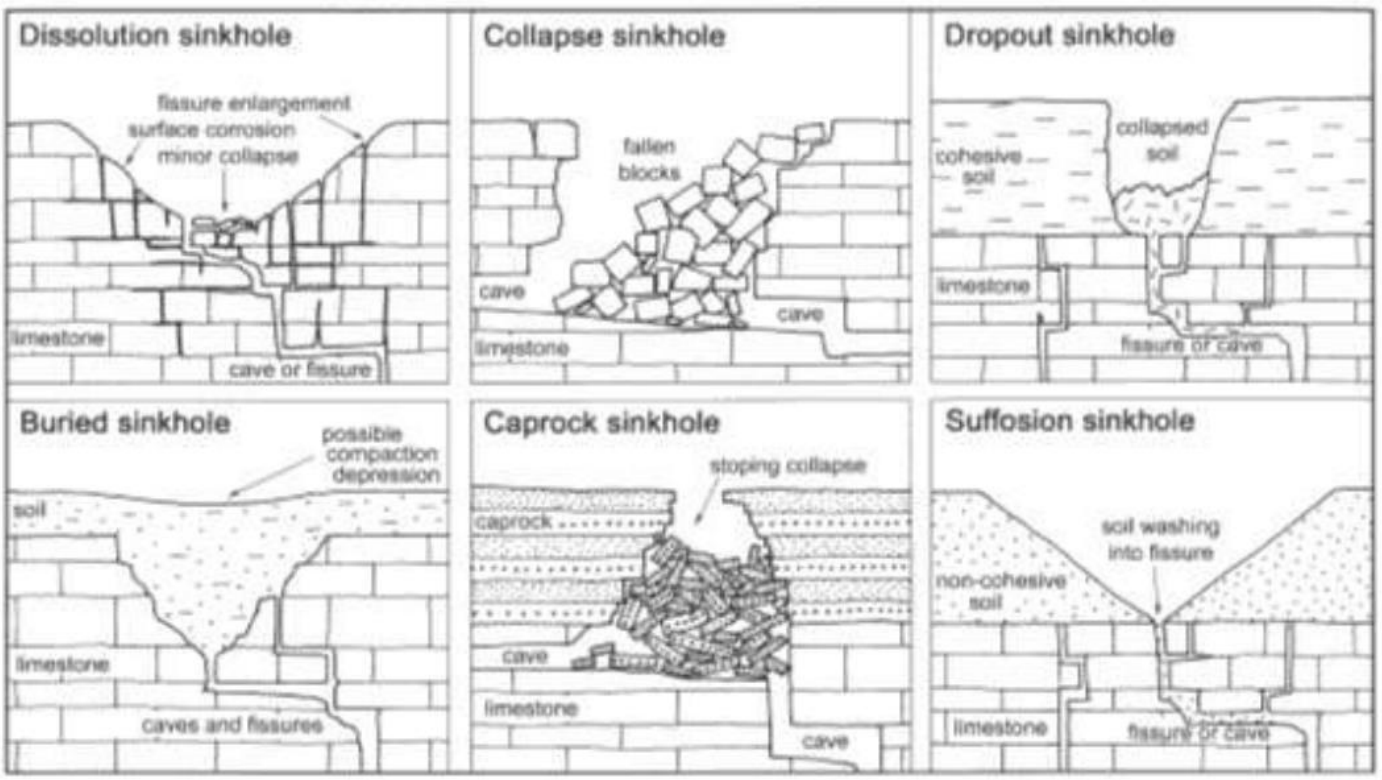
- Caprock/calcrete – The formation of a very hard duricrust, usually due to sun exposure. Caprock may be up to 3 m thick, but typically around 1.5 m thick. Caprock is very difficult to excavate and may require the use of hydraulic rock breakers or rock saws to excavate.
- Solution features/tubes – Often initially formed due to the presence of Eucalypt and Jarrah roots during limestone formation, and often increasing in depth and size due to ongoing weathering. May be up to 500 mm in diameter. These are typically filled with very loose, unconsolidated sand.
- Pinnacles – Pinnacles are usually the limestone that is left around surrounding solution features. Often can comprise very hard limestone/caprock that can be substantially higher than surrounding areas. Pinnacles may have also been formed by surrounding erosion (i.e., wind/water).
- Karst/caves – Karst is caused by the dissolution of limestone, typically where there is interaction in low-lying areas with water and limestone. Karst manifests itself as loose near-surface sand with cavities (caves) in the underlying limestone. This can lead to sinkholes and collapse of overlying structures.

Inline images showing typical pinnacle/solution features and Karstic features follow. These are taken from:

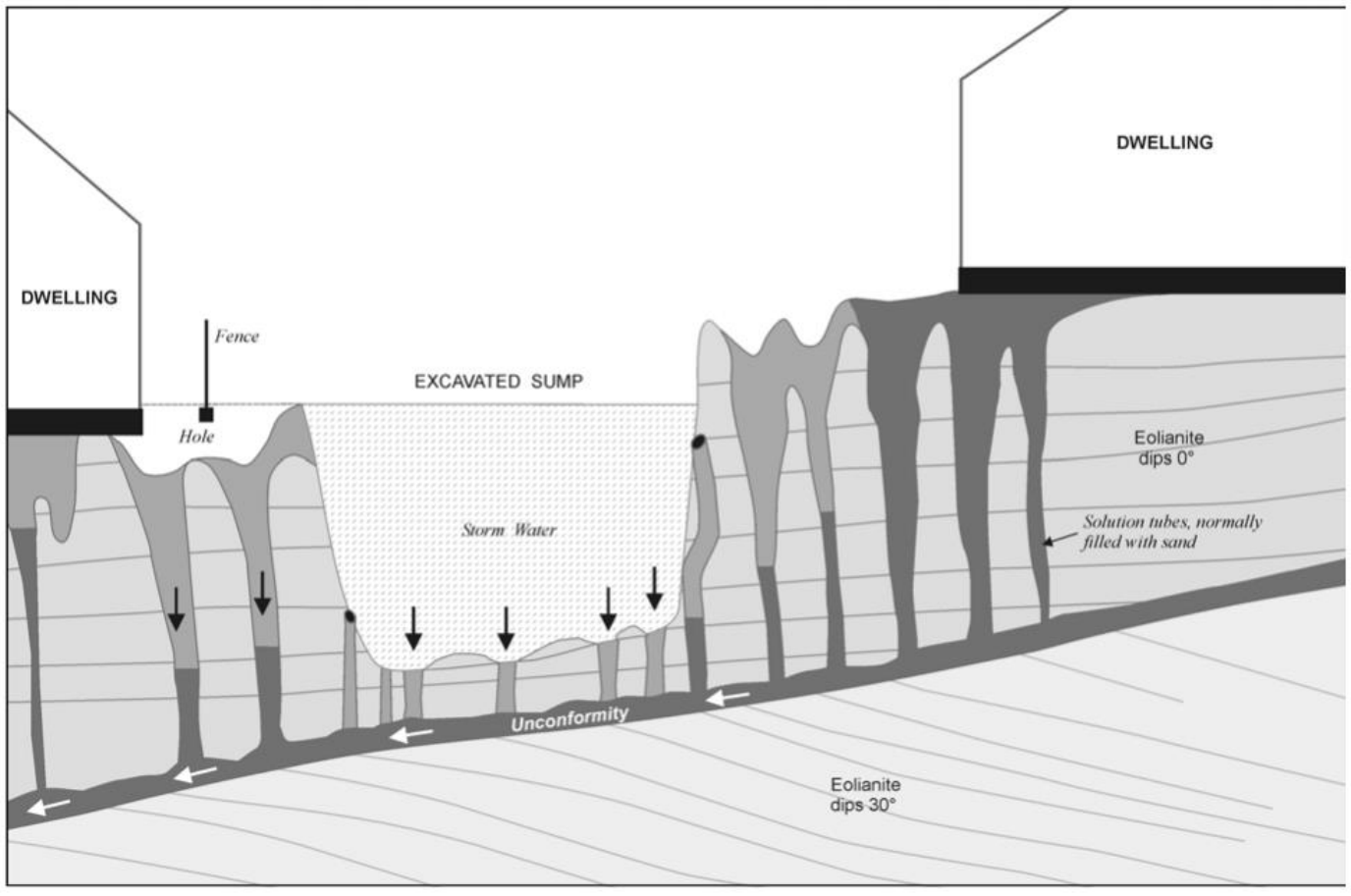
- Gordon, R. (2003). "Coastal Limestones". Australian Geomechanics Vol.38 No. 4, The Engineering Geology of Perth.

- Waltham, A. & Fookes, P. (2003). "Engineering Classification of Karst Ground Conditions: Quarterly Journal of Engineering Geology and Hydrogeology, Vol 36.

Inline Image GDR 1 - Karstic Sinkhole Features from Waltham and Fookes (2003)



Inline Image GDR 2: Pinnacle/Solution Features from Gordon (2003)



GDR4.2 Pindan Sands and Collapsible Soils

In the Western Australian context, Pindan sands are sandy soils present predominantly across the Pilbara and Kimberley regions. Pindan sands are typically:

- Red brown in colour.
- Between 10% and 40% fines.
- Of aeolian origin, usually resulting in unconsolidated in situ conditions (nuclear density gauge testing often indicates these soils have in situ density ratios of 80%-85% of modified maximum dry density).
- Very strong when dry due to high soil suctions in the fine fraction, which create strong bonds between the sand particles.

As the grains are usually held in place by the dry fine fraction, this can lead to:

- very high settlements (i.e., “collapse”) as the grain-to-grain bonds are weakened as matric suction decreases on soaking; and
- loss of vertical and horizontal strength/stiffness as the grain-to-grain bonds weaken.

The risks associate with Pindan sands are usually quantified in terms of the collapse potential/magnitude of possible collapse events.

Other similar soils are present in Western Australia that may exhibit similar collapse potential and may not strictly be Pindan sands (i.e., have other grain-to-grain bonding mechanisms).

GDR5 SITE CLASSIFICATION

Site classification refers to the assessment of a site in reference to AS2870-2011, “Residential slabs and footings”. The method for assessing the site class is outlined in Section 2 of AS2870-2011, which indicates that this may be done by:

- assessing the characteristic surface movement, due to seasonal moisture changes in the soil profile;
- assessing the performance of existing foundations; or
- assessment of the soil profile (where there are deleterious inclusions, landfill, putrescible waste etc.).

The site classifications based on the expected characteristic surface movement are summarised in Table GDR 1.

Table GDR 1: Summary of Site Classifications (AS2870-2011)

Class	Description	Characteristic Surface Movement (y_s)
A	Most sand and rock site with little or no ground movement from moisture change	Not Defined (typically <5 mm)
S	Slightly reactive clay sites with only slight ground movement from moisture changes	0 – 20 mm
M	Moderately reactive clay sites, which may experience moderate ground movements from moisture change	20 – 40 mm
H1	Highly reactive sites, which may experience high ground movements from moisture change	40 – 60 mm
H2	Highly reactive sites, which may experience very high ground movements from moisture change	60 – 75 mm
E	Extremely reactive sites, which may experience extreme ground movements from moisture change	>75 mm
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise	Not Defined

The calculated characteristic surface movement is predominantly based on:

- the reactivity (i.e., the shrink-swell potential) of the soil (and any proposed fill);

- the design depth of soil suction change, which is the maximum expected depth of soil suction change due to seasonal soil moisture changes; and
- the depth to any bedrock and groundwater table.

The design depth of soil suction change for Western Australia has been refined using the Thornthwaite Moisture Index (TMI). We have carried out assessment using the depths as detailed in:

- Hu Y, Saraceni P, Cocks G, Zhou M (2016). "TMI assessment and climate zones in Western Australia". Australian Geomechanics Journal, Vol.51 No.3.
- Hu Y, Raj A, Cocks G, Verheyde F (2019). "Re-assessment of TMI based climate zones in metropolitan Perth, WA". ANZ Geomechanics Conference 2019, Perth Australia.

The design depth of soil suction change for Northern Territory is based on the research presented in:

- Jackson, S (2022), "Thornthwaite moisture index and climate zones in the Northern Territory", Australian Geomechanics Journal, Vol. 57 No. 3.

We highlight that AS2870-2011 does not make any reference to the fines content of a soil when assessing the site classification.

Where a site classification is provided in our reports, it is always predicated on the requirement that the recommended site preparation procedures are carried out.

We also highlight that the footing performance and shrink-swell movements of a site can be impacted by the planting or removal of trees. This should be considered where appropriate, and we refer to the CSIRO BTF 18-2011 "Foundation Maintenance and Footing Performance: A Homeowner's Guide" for further information.

AS 2870 is limited to single and double storey residential buildings with normal shallow footings with a maximum bearing pressure of 100 kPa and is not applicable where development types other than this are proposed.

GDR6 SITE PREPARATION

GDR6.1 General

The intent of the site preparation guidelines provided in the above report are to ensure that the earthworks can be constructed to meet specific requirements, i.e., minimum compaction, fill requirements, removal of unsuitable material etc. The site preparation guidelines are not exhaustive, and on-site conditions may dictate that other preparation measures may be required to meet geotechnical requirements.

GDR6.2 Site Preparation

Site preparation measures outlined in this section relate to bulk earthworks at the site in preparation for the construction of buildings, pavements and other structures.

The preparation of a site in accordance with outlined measures below or those presented in the report text does not imply that the site is suitable for heavily loaded plant or eccentric loads. This is especially applicable for working platforms for mobile plant including cranes, crawlers or the like. The site surface may still not be trafficable for mobile plant. Individual working platform assessments must be done if heavily loaded mobile plant are proposed.

GDR6.2.1 Common Measures

The common measures outlined below are to prepare standard sites in advance of proof compaction, bulk excavation and filling. These measures are applicable to most sites, however the applicability of these measures is stated in the main report.

Table GDR 2: Common Measures

Measure	Commentary
Demolish and remove structures and pavements	Demolish existing structures and pavements, including removal of all buried services and footings and dispose off-site.
Remove demolition debris and other deleterious material	Remove any demolition debris and other deleterious material from site including old footings, slabs, soak wells, buried services, paving and building rubble.
Strip uncontrolled fill (where present)	Strip any uncontrolled fill from the site (where encountered) and, if suitable, stockpile it for potential re-use as non-structural fill. If contaminated, dispose off-site. Refer to the report text for discussions on the presence of detected uncontrolled fill and its composition. It is important to realise that undetected uncontrolled fill may be present between test locations and the absence of its identification in our report does not preclude its presence. If uncontrolled fill is detected during site works, please contact us for inspection and to provide recommendations.
Remove trees	All tree roots must be removed, this may result in significant excavation in places. Where tree roots and stumps are removed, the disturbed soil must be over-excavated and replaced with controlled, compacted fill. Backfilling of over-excavations is discussed in the following sections .
Strip and stockpile topsoil.	Strip and stockpile topsoil from unpaved areas of the site for potential re-use in non-structural applications. The topsoil strip is only necessary to remove roots and we recommend a topsoil strip as necessary to remove all roots from the soil.
Carry out bulk excavation	Excavate to the required level. Stockpile suitable excavated material for potential re-use as fill (the re-use of spoil as fill , if appropriate, is discussed in the report text) and remove unsuitable or excess material off-site.
Batter edges of excavation	Excavations should be battered to a temporary slope as given in the report text where applicable and not in close proximity to adjacent structures etc. If required, construct temporary/permanent retaining walls where batters cannot be accommodated.

By following these measures, the site should have been prepared to a point where topsoil and vegetation has been removed to expose either natural soil or controlled fill. Over-excavation to the required levels may then be required for some projects. Once complete, the site is now ready for proof compaction and filling.

GDR6.2.2 Sand Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by sand.
- No collapsible soils present.
- No deep loose sand.
- Compaction of a loose upper horizon to maximum 1 m depth.
- No shallow groundwater (<1 m deep).
- No limestone or other rock present at shallow depth.
- “Common Measures” outlined in Section GDR6.2.1 have been completed (as required).

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings, pavements and any other settlement-sensitive infrastructure is proposed.

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 3: Sand Site Measures

Measure	Commentary
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must **not** assume that the use of the PSP is appropriate.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with **Approved Fill** as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where fill is required to build up levels, use **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction to achieve the density specified in Section GDR7.1.

In following this method, shallow/surficial loose sand will be compacted, and the site will be filled (where required) in preparation for supporting footings, ground slabs, pavements and the like.

GDR6.2.3 Deep Loose Sand Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by sand.
- Collapsible soils or deep loose sand present (if applicable, this is discussed in the report).
- Over-excavation, compaction and replacement of loose sand required.
- No shallow groundwater (<1 m deep).
- No limestone or other rock present at shallow depth.
- "Common Measures" outlined in Section GDR6.2.1 have been completed.

The greatest depth of compaction that can be achieved with standard compaction equipment (vibrating roller, etc) is around 1 m (for sands). As such, it is necessary to cut down the site level to a point where this compaction can be done to the lowest level needed to be improved.

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings and any other settlement-sensitive infrastructure are proposed. Not typically required for pavement subgrades, however, this is discussed in the report if required.

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 4: Deep Loose Sand Site Measures

Measure	Commentary
Over-excavate to the required depth.	Over-excavate sand soil to the depth stated in the report and, if appropriate (discussed in report) retain it for re-use as fill. Over-excavation is likely to be done in stages depending on the site area available for earthworks. Excavations must be battered to a temporary slope as given in the report text where applicable and not in close proximity to adjacent structures etc. If required, construct temporary/permanent retaining walls where batters cannot be accommodated.
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must **not** assume that the use of the PSP is appropriate.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted **Approved Fill** as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.

Measure	Commentary
Carry out bulk filling	Where fill is required to build up levels (including restoration of the site surface level to the original level), use **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction as specified in Section GDR7.1.

In following this method, deep, loose sand will be compacted to a sufficient depth to reduce settlement impacts and the site will be filled (where required) in preparation for supporting footings, ground slabs, pavements and the like.

GDR6.2.4 Clayey Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by cohesive soils (typically >12% fines, i.e., clayey enough for the fines proportion of the soil to dominate behaviour).
- No collapsible soils present.
- No deep soft soils or organic soils.
- Over consolidated clayey soils present which will not be subject to significant primary or secondary consolidation (settlements expected to be within the limit of typical seasonal movements occasioned by moisture content changes, which would be captured in assignment of an AS2870 site classification).
- No shallow groundwater (<1 m deep)
- No rock present at shallow depth.
- "Common Measures" outlined in Section GDR6.2.1 have been completed.

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings, pavement subgrades and any other settlement-sensitive infrastructure is proposed.

Unless specified otherwise in the report, the **Approved Fill** to be used is **Clay** as outlined in Section GDR8.

Table GDR 5: Clay Site Measures

Measure	Commentary
Moisture condition and proof compact.	Moisture condition and compact the exposed clayey ground to achieve the density specified in Section GDR7.1 ("fine grained soils") to a depth of at least 300 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("fine grained soils") has been achieved to a depth of at least 300 mm. The use of a penetrometer for compaction control of cohesive soils is not an appropriate substitute for in situ NDG testing.
Treat areas of loose or unsuitable material	Any areas of soft clayey soils or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted **Approved Fill**. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where excavations are done into clayey soils (e.g. to treat soft zones, remove root balls and the like), they must not be backfilled filled with sand fill (even where a sand topping layer is proposed). Where fill is required (including backfilling of excavations to remove trees), only use **Approved Fill**, moisture conditioned, placed and compacted in layers of no greater than 300 mm loose thickness. Test moisture and compaction as specified in Section GDR7.1.
Grade completed clayey surface	Surface water control is essential for clayey sites. This also applies to control of infiltrated water into sand topping layers or the like. The surface of clayey ground must be graded at a minimum of 1% crossfall to drain. This is a general recommendation and an appropriate civil design must be done to account for surface and subsoil drainage.
Install sand topping layer	Where a sand topping layer is proposed, this should be done as outlined in Section GDR6.2.5.

These measures do not take into account the objectives of the civil design for the site, particularly with regard to surface water drainage and groundwater control (including clay grading, subsoil drainage, thickness and composition of a sand topping layer and the like). This must be taken into account by the civil designer. General commentary on drainage control measures is presented in Section GDR14.

GDR6.2.5 Sand Topping Layer

Where a sand topping layer is required:

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 6: Sand Topping Layer Measures

Measure	Commentary
Prepare Substrate	Prepare the clayey or other substrate as separately outlined prior to installing the topping layer.
Build up sand topping layer	Build up level to the required level with **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness to achieve the density specified in Section GDR7.1.

For the purposes of achieving the allowable bearing pressures and site classification discussed in the report, it is not necessary to have the bases of slabs and footings in the sand topping layer, i.e. if required, they may extend through the sand topping layer into clayey soil below.

GDR6.2.6 Limestone Sites

The preparation measures outlined below are provided for sites underlain by limestone (refer to Section GDR4.1), meeting the following criteria:

- Site underlain by sand overlying limestone.
- Compaction of a loose upper horizon to maximum 1 m depth, with localised deeper treatments between pinnacles if required.
- No shallow groundwater (<1 m deep)
- “Common Measures” outlined in Section GDR6.2.1 have been completed.

The site preparation measures outlined below are aimed at improvement of the site in preparation for construction of the structures including on-ground slabs, shallow footings, retaining walls and pavements.

Unless specified otherwise in the report, the **Approved Fill** may comprise one of the following as specified in Section GDR8 (the specific selection is subject to the requirements of the civil designer):

- **Permeable Sand** where permeable fill is required
- **General Sand** where permeable fill is not required
- **Mixed Sand/Limestone Fill** where permeable fill is not required

The re-use of any limestone for fill is subject to the requirements of the civil design and discussions in the report text. The use of **Mixed Sand/Limestone Fill** is discussed in Section GDR6.2.7. The preparation measures outlined in Table GDR 7 assume sand fill.

Table GDR 7: Standard Limestone Site Measures (Bulk Earthworks)

Measure	Commentary
Treat zones of loose sand	Where deep loose sand is present (particularly, but not exclusively, between limestone pinnacles), over-excavate to the depth as noted in the report . Sand should be retained for re-use as fill if recommended in the report. Limestone debris and pinnacles should be separated and only re-used if recommended in the report.
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm. Proof compaction of intact limestone is not required.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must not assume that the use of the PSP is appropriate. If refusal to the test method is encountered within the target test depth on limestone and the results to the refusal depth are acceptable, it is not necessary to repeat compaction testing at that location. Compaction control of intact limestone is not required.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted **Approved Fill** as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where fill is required to build up levels, use **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction to achieve the density specified in Section GDR7.1.

These measures do not take into account the specifics of the civil design, including the requirement (if any) for excavatable and/or free draining layers to achieve construction and drainage objectives. The civil design must take precedence and is not specifically considered in this advice.

Soakwells can perform poorly in limestone and specific advice may apply to the installation of soakwells in limestone areas. If not discussed in our report, please contact us for further advice.

Without further consultation with the structural designer, footings for any one structure must not be founded on a mixture of sand and intact limestone. This is due to potential differential settlements between limestone zones (relatively stiff) and soil zones (relatively soft). Where this is the case, the measures outlined in Table GDR 8 must be followed, only with guidance from the structural designer and Galt.

Table GDR 8: Standard Limestone Site Measures (Footing and Slab Preparation)

Measure	Commentary
Excavate and compact for slabs, subgrades, pad or strip footings	Excavate for pad and strip footings. Where a mix of soil and limestone is present below any one structure, one of the following must be done (to be agreed with structural designer and us): ▪ **Over-excavate limestone and replace with compacted soil:** Typically where the foundation largely comprises soil and a relatively small amount of limestone is present. Where footings and slabs are founded partly on soil and partly on limestone, over-excavate the limestone by at least 300 mm below the base of footing or slab and replace the excavated material with compacted **Approved Fill**. ▪ **Remove soil from over limestone and replace with concrete**: Typically where the foundation largely comprises limestone and a relatively small amount of soil is present. Localised zones of sand and mixed sand/limestone rubble must be removed and replaced with lean-mix concrete, e.g. 10 MPa blinding concrete. ▪ **Design the structure to accommodate differential foundation movements:** For example, include construction joints or use a more heavily reinforced footing (subject to the structural designer's requirements).
Test compaction of footing bases, slabs or subgrades.	Compact the exposed bases to achieve the density specified in Section GDR7.1 ("sand"), to a depth of at least 900 mm, or to the depth where limestone is intersected. If refusal to the test method is encountered within the target test depth on limestone and the results to the refusal depth are acceptable, it is not necessary to repeat compaction testing at that location. Compaction control of intact limestone is not required. Remove, replace and compact as required with approved fill any zone not achieving the density specified in Section GDR7.1 ("sand")

GDR6.2.7 Mixed Sand/Limestone Filling

On sites where deemed appropriate by the Civil Design, **Approved Fill** may comprise limestone rubble fill (**Mixed Sand/Limestone**, as specified in Section GDR8).

The preparation measures outlined below are provided for sites meeting the following criteria:

- No shallow groundwater (<1 m deep)
- "Common Measures" outlined in Section GDR GDR6.2.1 have been completed.
- Substrate preparation for the relevant site type has been done in preparation for further filling (as relevant for sand, limestone or clayey sites discussed in the preceding sections).

The site preparation measures outlined below are required prior to construction of structures including on-ground slabs, shallow footings, retaining walls and pavements.

Table GDR 9: Mixed Sand/Limestone Fill Measures

Measure	Commentary
Develop a method specification for the filling	A performance specification is not appropriate for compaction control in **Mixed Sand/Limestone** fill, due to oversize limestone particles and the limitations of test methods. Therefore, a method specification is required. Development of a method specification is discussed in Section GDR7.5. A tentative method specification for **Mixed Sand/Limestone** Fill preparation is also provided.
Carry out bulk filling	Where fill is required to build up levels, use **Approved Fill**, placed and compacted in accordance with the developed method specification.
Maintain Construction Records	As performance testing cannot be done, quality assurance records are limited. Therefore, the parameters mentioned in Section GDR7.5.1 must be kept in a comprehensive record of the earthworks done to the developed method specification. The use of the PSP is possible only to check for loose sand zones between limestone particles. High PSP blow counts, where limestone particles are intersected, are meaningless in terms of assessing density of the prepared fill. The primary means of validation of the earthworks is conformance with the developed method specification.
Install sand topping layer	Where a sand topping layer is proposed, this should be done as outlined in Section GDR6.2.5.

These measures do not take into account the specifics of the civil design, including the requirement (if any) for excavatable and/or free draining layers to achieve construction and drainage objectives. The civil design must take precedence and is not specifically considered in this advice.

Soakwells can perform poorly in limestone fill and specific advice may apply to the installation of soakwells in limestone fill areas. If not discussed in our report, please contact us for further advice.

GDR6.3 Guidance on Sites with Cohesive Soils

Cohesive soils (most commonly, "clayey" soils) require careful moisture conditioning to facilitate compaction. We recommend that the moisture content of the material is between optimum moisture content (OMC) and 2% wet of OMC at the time of placement and compaction. We note that compaction to the densities specified in Section GDR7.1 can be difficult to achieve for clayey material when not appropriately moisture conditioned.

Vibratory padfoot rollers are preferred for compacting cohesive fill to promote proper kneading and interlocking of subsequent layers.

Clayey soils will drain poorly when inundated following rain events and result in saturated conditions that may inhibit compaction of the soil. In general, it is preferable to avoid trying to re-work clayey sites within several days of any substantial rainfall.

We recommend that the surfaces of clayey sites are sealed by compaction (i.e., final compaction should be with a smooth drum roller) and graded to drain (to avoid low spots where water can pond and cause softening) prior to any

rain events. Stripping back of softened materials to expose competent natural or compacted clayey soil is required before continuing earthworks.

If difficulties are experienced during compaction due to water, further advice should be sought from a geotechnical engineer.

GDR6.4 Preparation and Testing of Shallow Footings

It is preferable to dig all footing excavations carefully with a flat-edged bucket to minimise the disturbance of underlying foundation soil.

Where the footing base is disturbed, or compaction is required, this must be done using appropriate compaction equipment particular to the task (as evaluated by the contractor) – typically a 'jumping jack', self-propelled plate compactor or an excavator-mounted plate compactor.

All footing bases must be tested to achieve the density requirements of Section GDR7.1. PSP testing of sand foundations is only applicable where the use of the PSP is specifically approved in the report, otherwise all testing is to be done using the NDG.

Sand Topping Layer - Where a sand topping layer is present over a different soil (i.e., clay, limestone etc.), testing of the density of the sand topping layer is only necessary within the thickness of the sand topping layer. Testing does not need to extend into the underlying compacted substrate, which is separately subjected to compaction control.

Mixed Sand/Limestone Fill – Where mixed sand/limestone fill has been installed to a method specification, no compaction control testing is required, however re-compaction of the base must be done as noted above.

In situ limestone – where in situ limestone (weakly or more cemented limestone, with no sand zones or voids) is present at a footing base and no over-excavation has been done (refer to Section GDR6.2.6 regarding over-excavation of footing bases in limestone), then no compaction control testing is required.

Where loose or soft material is encountered, one of the following actions must be taken:

- Over-excavate the loose / soft layer to expose a suitable layer that does meet the required density (Section GDR7.1) and either:
  - Place and compact Approved Fill (relevant to the appropriate preparation measures outlined in Section GDR6.2) to achieve the required density (Section GDR7.1); or
  - Pouring blinding concrete (f'_c>15 MPa at 28 days) from the competent layer up to the underside of the footing.

All foundations must be assessed by a competent person prior to blinding.

Measures must be taken to minimise moisture changes in clayey foundation soils at the base of footing excavations. Concrete footings are to be poured soon after excavation to minimise the potential for excessive moisture change. The use of a concrete blinding layer following foundation preparation should be considered.

GDR7 COMPACTION AND MOISTURE CONDITIONING

GDR7.1 Requirements

Any soil within the significant founding zone of structures (buildings, slabs, pavements, etc.) must be suitably moisture conditioned and compacted. These soils must be compacted to the requirements as outlined below.

Table GDR 10: Compaction and Moisture Requirements

Soil Description	Soil Particle Limits	Moisture Requirement	Density Requirement (DDR)	Possible QA/QC Test Methods
Sand	<5% fines <5% gravel *Maximum particle size 9.5 mm*	MOMC ±2%	95% MMDD	PSP NDG
Gravel	<5% fines >50% gravel *Maximum particle size 19.0 mm*	MOMC ±2%	95% MMDD	NDG
Clayey/Silty Gravel	5-35% fines >50% gravel *Maximum particle size 19.0 mm*	MOMC ±2%	95% MMDD	NDG
Sand with fines or gravel	5-35% fines; and/or 5-50% gravel *Maximum particle size 19.0 mm*	MOMC ±2%	95% MMDD	NDG Method Specification
Fine grained soils (Clayey or Silty)	>35% fines *Maximum particle size 19.0 mm*	MOMC ±2%; or SOMC ±2%[2]	92% MMDD; or 95% SMDD	NDG Method Specification
Oversize/rubbly soil	Any soils with particles >19.0 mm	MOMC ±2%	95% MMDD (Or equivalent to)	Method Specification Detailed Assessment Based on Specific Material

NOTES:

1. *DDR – Dry Density Ratio*
   MMDD – Modified maximum dry density (AS1289.5.2.1)
   MOMC – Modified optimum moisture content (AS1289.5.2.1)
   SMDD – Standard maximum dry density (AS1289.5.1.1)
   SOMC – Standard optimum moisture content (AS1289.5.1.1)
   PSP – Perth Sand Penetrometer
   NDG – Nuclear Density Gauge
2. *Preferably OMC to OMC +2%, for ease of compaction and producing a homogenous fill*
3. *Test frequencies are specified in Section GDR7.6.*

The soil groups and definitions outlined above are generally based on AS1726-2017. Test methods are discussed in subsequent sections.

GDR7.2 Construction Recommendations

Over-excavation and replacement of loose material must be done where the minimum DDR cannot be achieved.

Fill must be placed in horizontal layers of not greater than 300 mm loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken if compacting in the vicinity of existing structures, such as the adjacent properties. This is particularly important if vibratory compaction is being carried out.

- Tynan (1973), “Ground Vibration and Damage Effects on Buildings”, Australia Road Research Board, Special Report No. 11.

Tynan (1973) provides guidance on the selection of compaction equipment for use adjacent to structures. The distance of influence (i.e., the definition of “vicinity”) will vary depending on the size of compaction plant proposed for use. Where there is concern regarding the impact on nearby structures, a dilapidation study should be done.

Care must be taken when compaction is undertaken when the site surface is within 1 m of the groundwater level, as compaction (particularly with vibration) can draw the water up to the surface. In this instance, consideration should be given to:

- Static rolling only;
- Using a pioneering layer (if possible); or
- Dewatering to keep the water at least 1 m below the surface being compacted.

GDR7.3 Nuclear Density Gauge

Where applicable, a nuclear density gauge (NDG) must be used in accordance with AS1289.5.8.1. NDG tests must be done to a depth of 300 mm or as otherwise indicated in the text of the attached report.

GDR7.4 Perth Sand Penetrometer

Where clean sand is used (<5% fines and <5% gravel), a Perth sand penetrometer (PSP) may be used for compaction control in accordance with AS1289.6.3.3. Refer to the report for recommended blow counts correlating to the specified density.

Where the fines or gravel contents of a sand soil exceed the maximum contents noted above, a PSP must not be used exclusively for compaction control. As a minimum, ongoing confirmation testing with an NDG is required. If not specified in our report, please contact us for further advice regarding test frequencies.

If difficulties are experienced recording the required blow counts, a site-specific PSP correlation should be carried out to determine the PSP blow count correlating to a DDR of 95% MMDD. In addition, a particle size distribution (PSD) test should be carried out to verify that the use of a PSP is suitable for the sands being tested. A site-specific PSP correlation must:

- be done on site;
- use the nuclear density gauge (NDG) to determine density at a minimum of 5 points with varying density to a depth of 300 mm below surface;
- include at least 1 point where the dry density ratio is in excess of 95% MMDD;
- use a calibrated PSP to determine the PSP blow count from 150 mm to 450 mm at each NDG test point; and
- be plotted on a chart of PSP blow count vs DDR.

Only where specifically stated as applicable in the report and where the use of the PSP is relevant as noted above, the following values may be taken as deemed to conform to a dry density ratio of 95% MMDD for the relevant sand type.

Table GDR 11: Deemed-to-comply Values for PSP Results in Perth Sands

Depth Interval (mm)	Bassendean	Tamala	Calcareous
0-150	SET	SET	SET
150-450	7	8	12
450-750	9	10	14
750-1050	11	12	16

NOTES:

1. *Blows per 300 mm interval*
2. *Bassendean Sand is typically a white - grey, low-fines quartz sand found on the eastern part of the Perth coastal plain*
3. *Tamala / Spearwood sand is typically yellow or orange, low-fines quartz sand found on the western part of the Perth coastal plain*
4. *Calcareous sands are typically white or yellow, calcareous sand found in low-lying areas on the western fringe of the Perth coastal plain*

5. *Values derived from Galt experience on PSP correlations done on sites across Perth for the 150-450 mm interval.*

GDR7.5 Method Specifications

GDR7.5.1 General

Where proposed, a method specification should be developed by a geotechnical engineer or similarly qualified person and ratified by us (including a site visit by us). The method specification should be confirmed by the construction of a trial pad or trial area and the compaction methodology should be checked against either:

- density, as assessed using a nuclear density gauge; or
- settlement, as assessed using a dGPS.

Specific advice should be requested for the development of a method specification, taking into consideration the material being compacted.

Method specification compliance should be maintained for all areas on a minimum 20 m grid, with the compliance to include:

- Roller used (weight, style, vibration);
- Water application rate (per lift);
- Layer thickness placed; and
- Number of passes with roller.

GDR7.5.2 Indicative Method Specification – Sand/Limestone Rubble Mix

Where mixed sand/limestone is used as structural fill, a performance specification is not appropriate due to the inaccuracies of standard test methods (NDG/PSP etc.) in this type of material. A method specification can be used instead. The following indicative method specification is provided for evaluation and trial but must be trialled and ratified by us prior to widespread employment on site. The following would be typically adopted:

- Maximum particle size: 250 mm
- Maximum loose layer thickness: 350 mm
- Minimum watering rate: 10 L/m^2/100 mm thickness of loose material (e.g. 35 L/m^2 for a 350 mm thick layer)
- Minimum 8 passes with a vibrating padfoot roller, minimum static weight 10 tonnes.
- The compacted fill must comprise closely packed particles without any significant voids between the larger particles.

GDR7.6 Testing Frequency

After compaction, verify that the required density has been achieved by testing at the base of excavation and through the full depth of any fill, and to a minimum depth of:

- 900 mm where a PSP is used; or
- 300 mm where a NDG is used.

The frequency of testing (when a method specification is not used) should be as follows:

Table GDR 12: Compaction Testing Frequency Requirements

Area	Minimum Testing Frequency	Minimum Tests Per Lot
Proof Compacted Area	1 test per 1,000 m^2 (30 m grid)	2
Structural Fill Outside of Building and Pavement Footprints	1 test per 500 m^3 2 tests per layer *Whichever is greater*	2
Structural Fill Within Building and Pavement Footprints	1 test per 500 m^3 4 tests per layer *Whichever is greater*	4
Spread/Pad Footings	1 test per 9 m^2 per footing	1
Strip Footings/Retaining Wall Foundations	Minimum 2 tests At 5 m centres *Whichever is greater*	2
On-ground slabs, pavements and rafts	Minimum 2 tests At 10 m centres 1 test per 100 m^2 *Whichever is greater*	2

NOTES:

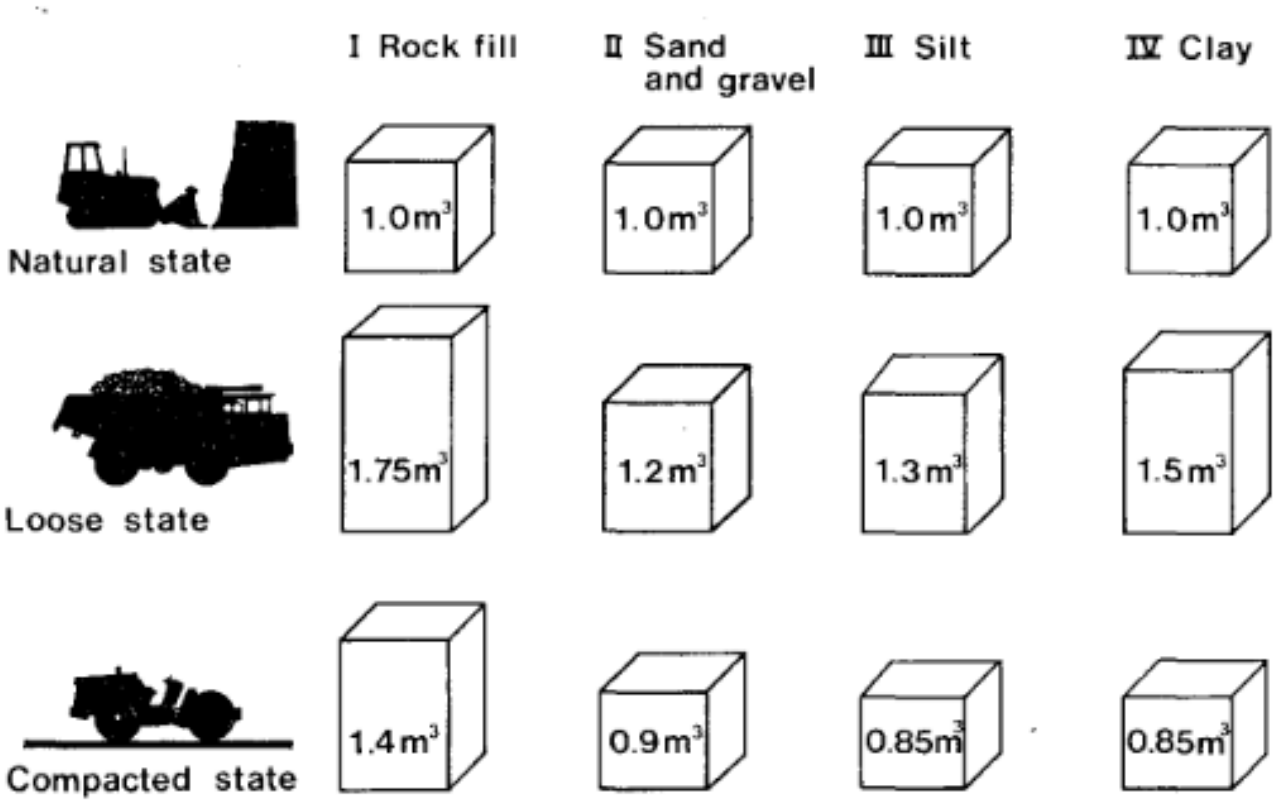
1. *A 'lot' is defined in the context of this section as a section of earthworks that is undertaken in one operation where the equipment, personnel, materials and methodology are consistent throughout the entire process. This would typically be limited to operations done in one day, but this is not mandatory.*
2. *There will frequently be multiple 'lots' in an earthworks process, therefore the number of tests must be adjusted according to the minimum number per lot in this table (where this is more than the frequency specified in 'testing requirements').*

GDR7.7 Bulking and Compaction Factors

All soils will "bulk" when excavated to stockpile, and "compact" when placed from stockpile to earthworks layers. Published bulk and compaction factors are presented below for conventional materials, taken from:

- Forssblad, L (1981), "Vibratory Soil and Rock Fill Compaction", Dynapac Maskin AB

Inline Image GDR 3: Volumes of Different Types of Fill Materials in Natural, Loose and Compacted State



These values are indicative only and will vary according to site specific conditions. The values provided here must not be used for commercial volume estimates or settling disputes regarding volumes.

GDR8 APPROVED FILL AND CONFORMANCE TESTING

Imported fill must comply with the material requirements as stated in AS 3798-2007, “Guidelines on Earthworks for Commercial and Residential Developments”.

Where doubt exists, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

The following table presents recommended material parameters for standard fill types. This does not take account of availability of materials either on site or in the local area. Refer to the report text for specific advice on fill at the subject site.

Table GDR 13: Standard Fill Recommendations

Soil Description	Application	Soil Particle Limits (%)[3]				k_{min}[1] (m/d)	OC[2] (%)	Atterberg Limits		CBR[6] (%)	Test Method[4]
		Fines	Sand	Gravel	Max.			LL (%)	PI (%)		
Permeable Sand	Permeable bulk fill Retaining wall backfill Permeable select fill	≤5	≥90	≤5	9.5	5	≤2	NP	NP	≥12	PSP NDG
General Sand	Bulk fill Select fill (permeability not required)	≤5	≥90	≤5	9.5	N/A	≤2	NP	NP	≥12	PSP NDG
Silty Sand	Bulk fill Select fill	≤35	≥55	≤10	9.5	N/A	≤2	<35	<11	≥12	NDG
Clayey Sand	Bulk fill Select fill	≤35	≥55	≤10	9.5	N/A	≤2	<40	N/A	≥12	NDG
Mixed Sand/Limestone	Bulk fill (permeability not required)	≤5	≥20	≤80	250	N/A	≤2	NP	NP	N/A	NDG Method
Blue Metal Gravel[8]	Retaining wall backfill Drainage trench backfill	≤3	≤5	≥90	37.5	5	≤1	NP	NP	N/A	NDG
Clay[7]	Reinstatement of localised excavations in clay Bulk fill	≥12	Varies	≤30	19	N/A	≤2	Varies			NDG

NOTES:

1. *k_{min} – minimum saturated hydraulic conductivity (AS1289.6.7.1, remoulded to minimum DDR 100% MMDD).*
2. *OC – organic content (Walkley-Black method recommended, AS1289.4.1.1 – not loss on ignition methods)*
3. *% by mass.*
4. *Test method indicates possible compaction control methods for this material.*
   PSP – Perth sand penetrometer (AS1289.6.3.3). Where a PSP is used, a site-specific correlation must be done unless otherwise noted in the report.
   NDG – Nuclear density gauge (AS1289.5.8.1)
   Method – method specification
5. *Atterberg Limits: LL – liquid limit PI – plasticity index NP – non-plastic*
6. *CBR: California bearing ratio (for sand - remoulded to DDR 95% MMDD @ OMC, 4.5 kg surcharge). CBR values may be changed depending on the design pavement requirements.*
7. *"Clay" fill type is included for broad reference only and to illustrate preferred applications, particle size limits and recommended test method. Specific discussion on the use of clayey fills is included in the report text if applicable. Atterberg limit and CBR testing of clayey fills may be required and advice must be sought from us if not stated in the report.*
8. *"Blue metal" gravel refers to single sized, crushed, washed igneous rock gravel used for drainage purposes.*
9. *In the absence of specific test frequencies by the civil designer, the testing shown in Table GDR 14 must be done (highlights in Table GDR 13 show where the test is required).*

Table GDR 14: Conformance Testing Frequency Requirements

Parameter	Frequency (m^3)	Minimum Tests per Source	AS1289 Reference
Particle size distribution	5,000	1	3.6.1
Hydraulic conductivity (permeability)	10,000	2	6.7.1
Organic content	5,000	1	4.1.1
Atterberg limits	5,000	1	3.1.1, 3.2.1, 3.3.1
CBR	10,000	2	6.1.1

NOTES:
1. *Frequency is for the nominal number of cubic metres of compacted fill.*
2. *Unless stated otherwise in the report text, the conformance testing must also be carried out on site-derived materials to confirm suitability.*

GDR9 SHALLOW FOUNDATIONS

GDR9.1 Design

Footings and slabs may be designed in accordance with the assigned site classification in accordance with AS2870-2011. We note that AS2870-2011 is limited to single and double storey residential and commercial developments and may not be strictly applicable.

Where the report provides tables for shallow footing design, custom footings may be designed by the structural engineer using the data provided therein.

GDR9.2 Interpretation of Provided Values

BEARING PRESSURES

All settlement and bearing pressures estimates are provided on the assumption that the site preparation requirements outlined in the report are completed below all structures plus a minimum distance of 1 m beyond the outside edge of any footing or slab. It is essential that the soil below all foundations is appropriately prepared as outlined and meets the relevant compaction requirements.

Allowable bearing pressures for footings of intermediate plan dimensions (to any tabulated) can be interpolated. Footings that have a plan dimension either smaller or larger than those presented in the report will need to be considered individually along with other embedment depths.

Allowable bearing pressures, where provided, are considered to be the upper limit for shallow footings to limit total and differential settlements. Footings carrying eccentric loading, such as below retaining walls, must be assessed separately.

SETTLEMENTS

The reporting of settlements to any precision level is not intended to imply a high accuracy of settlement prediction. Settlements as reported should be considered ‘order of magnitude’.

Estimated settlements represent vertical downwards movement due to loading and do not take into account potential additional movement associated with the characteristic surface movement of the soil (which must be taken in addition to these settlements from loading, refer Section GDR5). The site classification is discussed in the report.

The actual settlement of any proposed structure will depend upon a number of factors including the applied pressures, footing size and base preparation. The estimated settlement(s) provided in this report are for the working bearing pressures as indicated. Differential settlements are likely between footings of similar sizes, loads and elevations (as

stated in the report text). A proportion of the settlement is expected to occur during construction (i.e., during initial loading.

The provided settlement estimates (unless otherwise stated) do not include interaction effects from footings founded near other footings (i.e., groups of footings). Interaction effects will need to be considered if the spacing between adjacent footings is smaller than the dimension of the footings (i.e., the centre-to-centre spacing between footings is less than twice the width of the footing). This could act to double provided settlements, dependent on the footing configuration. Where an assessment of footing groups is required, a more detailed numerical or finite-element modelling analysis would need to be undertaken.

CREEP AND CONSOLIDATION

Creep settlement is an irreversible component of long-term soil settlement caused by sustained vertical stress. Consolidation is a time-dependent irreversible compression in a soil layer caused by a reduction in pore pressure between soil particles. Both creep and consolidation can occur in natural materials as a result of earthworks or the placement of loads on to soil layers. The settlements as presented for short-term loading do not include consideration for creep and consolidation settlements unless specifically stated.

GDR9.3 Raft Foundations

Where moduli of subgrade reactions are provided for the design of raft foundations, we highlight that these are an estimate of the elastic reaction of the soil. The values are provided based on an expected load and loaded area size. Soils are typically non-linear in their response and will have different stiffnesses at different levels of strain and load repetitions. This is due to the physical interaction of soil particles under different levels of stress.

The possibility of a non-linear response must be considered by the designer of any raft foundation.

GDR10 PILED FOUNDATIONS

Piles must be designed and tested in accordance with AS2159-2009, “Piling – Design and Installation”. We use the following interpretation/design methods to provide pile design parameters:

- Franki Africa Pty Ltd (2008) “A Guide to Practical Geotechnical Engineering in South Africa”. 4th ed.
- AFNOR (2012) “NF P 94-262 – Justification des ouvrages géo-techniques, Normes d’application nationale de l’Eurocode 7”, Afnor, Paris, July 2012.
- Lehane, B. (2017) “CPT-Based Design of Foundations”. E.H Davis Memorial Lecture, Australian Geomechanics Vol 54. No. 4.
- Lehane, B. et al. (2020) “A New ‘Unified’ CPT-Based Axial Pile Capacity Design for Drivel Piles in Sand”. Proceedings of the Fourth International Symposium on Frontiers of Offshore Geotechnics.
- Doan., Lehane, B. (2021) “CPT-Based Design Method for Axial Capacities of Drilled Shafts and Cast-in-place Piles.” American Society of Civil Engineers (ASCE), Journal of Geotechnical and Geoenvironmental Engineering.

The pile designer must:

- consider the possible variation in subsurface conditions at each pile location;
- consider any pile group effects based on the final piling configuration;
- assume that the unit shaft resistance in tension is less than 80% of the unit shaft resistance in compression to account for Poisson’s effect in sand;
- ignore pile resistance in the surficial 0.5 m or 1 x pile diameter (whichever is greater), if relevant;

- consider the impact of weak layers underlying stiffer layers (or vice versa) on end bearing capacity; and
- reduce the pile capacity in tension to no greater than 0.8 of the pile capacity in compression.

The piling contractor must:

- make their own assessment on the suitability of their equipment to install any piles at the subject site; and
- carry out or appoint a suitably experienced contractor to test the piles in accordance with AS2159.

Where dynamic or static testing of the piles does not occur, we consider that a design geotechnical reduction factor (ϕg) of 0.4 is applicable for the pile design. If testing of the piles is proposed by the piling contractor, a higher ϕg could be adopted.

Unless otherwise stated, providing pile design parameters does not specifically indicate the driveability of any piles into soil units.

A separate driveability study may be required and must be considered by the pile designer and installer. The given pile design parameters must not be used for driveability assessments as these parameters are likely to be un-conservative.

GDR11 EARTH RETAINING STRUCTURES

GDR11.1 General

Retaining structures may be designed in accordance with AS4678 (2002) “Earth Retaining Structures”. Unless otherwise specifically stated, we recommend that all retaining walls are backfilled with free-draining soil (Permeable Sand or Blue Metal Gravel as defined in Section GDR8).

Where the cohesive soil is used as retaining wall backfill, a suitable, permanent drainage system must be placed behind the wall such that a build-up of pore pressure is prevented. A separator geotextile (Bidim A24, or similar, or heavier) must be used between the interface of any granular backfill and the cohesive soil.

Where drainage is not provided, the retaining wall must be designed to accommodate water pressure behind the wall (10 kPa per metre height).

GDR11.2 Earth Pressure Coefficients and Strength Parameters

Where earth pressure coefficients are provided for retaining walls, the wall designer must make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction. Unless otherwise stated, we have assumed a horizontal ground surface behind and in front of the retaining wall for provided parameters.

GDR11.2.1 Cohesionless Soils

Where cross-referenced for suitability in the report, the following parameters may be adopted for design of earth retaining structures in cohesionless soils (sand and gravel).

Table GDR 15: Retaining Wall Geotechnical Parameters (Cohesionless Soils)

Density	γ (kN/m³)	ϕ' (°)	k_0	Wall Friction=0		Wall Friction=0.5ϕ		Wall Friction=0.67ϕ	
				k_a	k_p	k_a	k_p	k_a	k_p
Very Loose	17	30	0.44	0.33	3.00	0.29	4.81	0.28	5.74
Loose	17	32	0.42	0.31	3.25	0.27	5.55	0.26	6.83
Medium Dense	18	34	0.39	0.28	3.54	0.25	6.47	0.23	8.26
Dense	19	36	0.36	0.26	3.85	0.22	7.63	0.21	10.18
Very Dense (1)	19	38	0.34	0.24	4.20	0.21	9.11	0.20	12.85
Very Dense (2)	19	40	0.31	0.22	4.60	0.19	11.06	0.18	16.73

NOTES:

1. *Earth pressure coefficients are provided in this table for conditions of zero friction between the wall and the soil and with wall friction of 0.5Φ' or 0.67Φ'.*
2. *A horizontal ground surface behind and in front of the wall has been assumed.*
3. *The retaining wall designer should make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction.*
4. *γ – bulk unit weight*
   ϕ' – effective friction angle
   k_a – coefficient of active earth pressure (Coulomb – AS4678-2002, Appendix E)
   k_p – coefficient of passive earth pressure (Coulomb – AS4678-2002, Appendix E)
   k_0 – coefficient of at-rest earth pressure (Jaky)
5. *Maximum fines content 12% for applicability of this table for design purposes.*
6. *Unit weights based on Table D1 of AS4678-2002, for moist bulk weight.*
7. *Friction angle based on Equation D1 and Table D2 of AS4678-2002, based on rounded, moderately graded siliceous sand.*

GDR11.2.2 Cohesive Soils

Where cohesive soils (i.e. clayey or silty soils) are proposed for backfill, geotechnical design parameters may be provided in the form of effective strength and undrained strength parameters. We note that:

- Undrained strength parameters should be used for analysis of short-term stability, or stability under sudden loading of cohesive soils.
- The effective strength parameters should be used for analysis of free-draining soils and the long-term stability of cohesive soils.

Table GDR 16: Retaining Wall Geotechnical Design Parameters (Cohesive Soils – Undrained)

Consistency	γ_b (kN/m³)	c_u (kPa)
Soft	17	12
Firm	18	25
Stiff	19	50
Very Stiff	20	100
Hard	20	200

NOTES:

1. *γ_b – bulk unit weight*
   c_u – undrained cohesion
   $\phi_u = 0°$ (undrained friction angle)
2. *Unit weights based on Table D1 of AS4678-2002*
3. *Undrained cohesion based on lower end of shear strengths as define in AS1726-2017, Table 11*

Table GDR 17: Retaining Wall Geotechnical Design Parameters (Cohesive Soils – Drained)

Fines Content	PI (%)	γ_b (kN/m^3)	ϕ' (°)	c' (kPa)[5]
12-35%	All	19	32	0
>35%	10	20	30	0 – 5
>35%	20	20	26	0 – 5
>35%	30	20	23	0 – 5
>35%	40	20	21	0 – 5

NOTES:

1. *γ_b – bulk unit weight*
   c' – drained cohesion
   ϕ' – effective friction angle
   PI – plasticity index
2. *Unit weights based on Table D1 of AS4678-2002, assuming generally stiff to hard overconsolidated soils.*
3. *For fines contents <35% (silty sand and clayey sand), strength parameters based on:*
   - *Lehane, B. et al (2007) "A Laboratory Investigation of the Upper Horizons of the Perth/Guildford Formation in Perth CBD", Australian Geomechanics Vol 42. No. 3.*
4. *For fines content >35% (sandy clay), strength parameters based on:*
   - *CIVL5503 course notes (2004), "Underground Construction", University of Western Australia*
5. *c' = 0 recommended for long-term design. Table D4 of AS4678 suggests c' up to 5 kPa for 'poor' fine grained soils and 10 kPa for 'average' fine-grained soils. The use of c' for design is subject to the designer's judgement but recommended by us only for temporary works.*

Per AS4678-2002 Appendix E, horizontal earth pressures for frictional-cohesive soils may be calculated in accordance with the Rankine-Bell design model (illustrated in Figure E2 of AS4678). The earth pressures are as follows (Z = depth, all other terms have the meanings given in the above tables):

- Active: $p_a = \gamma Z tan^2\left(45 - \frac{\emptyset}{2}\right) - 2ctan\left(45 - \frac{\emptyset}{2}\right)$
- Passive: $p_p = \gamma Z tan^2\left(45 + \frac{\emptyset}{2}\right) + 2ctan\left(45 + \frac{\emptyset}{2}\right)$

GDR11.3 Design and Construction Considerations

Compaction plant can augment the lateral earth pressure acting on retaining walls. Hand operated compaction equipment is recommended within 2 m of any retaining walls to minimise compaction pressures.

Retaining walls can move and rotate under imposed soil loading resulting in settlement behind the wall. This must be considered in the design and during construction of the retaining walls in order that adjacent infrastructure is not adversely affected.

It is important to note that some ground movement will occur behind any soil retaining system, including gravity retaining walls.

GDR12 EXCAVATIONS, BATTERS AND SLOPES

GDR12.1 Excavatability

Our assessment of the excavatability of rock is based on a combination of:

- Our experience on earthworks and construction projects across Australia; and
- Figure 10 of the revised graphical method of assessing excavatability of rock by:
- Pettifer, G.S. & Fookes, P.G., "A revision of the graphical method for assessing the excavatability of rock", Quarterly Journal of Engineering Geology, 27, pp145-164, 1994.

GDR12.2 Safety

All excavations must be carried out in accordance with:

- Commission for Occupational Safety and Health (2022). “Excavation: Code of Practice”, Department of Mines, Industry Regulation and Safety, 89pp, Perth.

Excavations in cohesionless soils are particularly prone to instability unless support is provided. Care must be exercised in such excavations and appropriate safety measures adopted where necessary, particularly in the vicinity of existing buildings, structures and infrastructure.

The toe of any batter must be at least 500 mm above groundwater (including perched groundwater).

Unless a specific slope stability assessment or retention design has been done, the toe of any excavation should not encroach within a line of 1V:3H to any nearby footings, pavements or other settlement-sensitive structures.

Surcharges (such as structures, plant and soil stockpiles) must not be placed at or close to the crest of unsupported excavations, without a specific slope stability assessment.

A geotechnical engineer must be consulted where there is any doubt regarding the stability or safety of unsupported excavations.

GDR12.3 Batters

Temporary batter slopes provided in the report are subject to the following conditions, unless otherwise stated:

- The maximum slope height is 2 m without specific advice and slope stability analysis.
- The groundwater level for the duration of the excavation must be at least 500 mm below the toe of the slope.
- No surcharges are present in the vicinity of the slope (i.e. must be outside a line of 1V:3H from the toe of the slope).

Unless noted specifically in the report, the following batters may be adopted (maximum height: 2 m):

Table GDR 18: Default Batter Angles

Situation	Material	Batter
Temporary	Cohesionless Soils (Sand/Gravel)	1V:2H
Temporary	Cohesive Soils – Soft	1V:2H
Temporary	Cohesive Soils – Firm, Stiff, Very Stiff or Hard	1V:1H
Temporary	Limestone – Variably Cemented	1V:1H
Temporary	Limestone – Well Cemented	1V:0.5H
Permanent	All Soils	1V:3H
Permanent	Limestone – Variably Cemented	1V:2H
Permanent	Limestone – Well Cemented	1V:1H

Where specified batters cannot be accommodated in the vicinity of existing footings, roads and services, temporary or permanent lateral support will be required.

Specific advice is required for batters higher than 2 m.

Erosion control must be considered for permanent slopes.

Rock slopes must be inspected, and all loose cobbles / boulders removed. Permanent rock slopes may require dentition works or possibly rock catch drains.

GDR12.4 Grouting

Permeation or jet grouting involves injecting a microfine cement into soil to form a grouted soil block (soilcrete) to support excavation and structures. Grouting is typically only effective where the soil has the capacity to "take" the grout and form a uniformly cemented soil mass. Permeation grouting is generally limited to relatively permeable, coarse-grained cohesionless soils (sands and gravels with <5% fines).

If grouting is proposed, we recommend the following:

- Grouting must be carried out by a suitably experienced contractor.
- Only microfine cement grout should be used (not GP or coarse cement blends) to ensure adequate penetration into the soil matrix.
- Grouting should be done on a grid of not greater than 300 m.
- Application rates must be discussed with the contractor.
- The grouted soil mass must have intimate contact with any structures it is intended to support.
- The contractor must satisfy themselves that the proposed grouting can be installed with their equipment and into the subsurface conditions encountered at the site, considering possible obstructions, groundwater, cemented layers, loose sands etc.
- Testing of the grouted soil mass must be done to ensure that the grout has adequately permeated through the soil matrix. This can be done by drilling into the soil mass to ensure the cementation is continuous.

Grouting is most effective on permeable, relatively loose natural sand. Where historical filling or other ground disturbances have occurred, the grouting process can be less effective due to the tendency of grout (or other liquids) to follow more permeable paths / zones through the disturbed soil.

GDR13 STORMWATER DISPOSAL AND DRAINAGE DESIGN

GDR13.1 Groundwater Separation – Controlled Groundwater

These recommendations ONLY apply to where regional controls on groundwater (primarily: subsoil drainage, but also surficial 'main drains') exist, i.e. only to areas where groundwater is actively controlled.

The following reference:

- IPWEA (2016), "Specification: Separation Distances for Groundwater Controlled Urban Development", Institute of Public Works Engineering Australasia

recommends the following separation distances from drainage infrastructure to groundwater:

- Underground infiltration systems: 0 mm from the 50% AEP (annual exceedance probability) phreatic surface.
- Surface infiltration systems (vegetated): 300 mm from the 50% AEP phreatic surface.

The above IPWEA reference also states that performance measures for underground infiltration systems are to have a: *demonstration of acceptable volumetric capacity when groundwater is elevated above base of system and that the groundwater recedes below the invert of the system during mosquito breeding seasons (grated or partially open systems)*.

GDR13.2 Groundwater Separation – Uncontrolled Groundwater

These recommendations apply where regional controls on groundwater levels are not present. For infiltration into soakwells and soakage basins to be the full theoretical value, an adequate separation to groundwater must be achieved, because otherwise performance is hindered by inadequate separation to groundwater or partial submergence of the infiltrative element.

We recommend a minimum separation of 500 mm from the underside of infiltrative elements to maximum groundwater level.

- To average annual maximum groundwater level (AAMGL), where this has been defined for the site; or
- To historical maximum groundwater level, where this has been defined to the site.

GDR13.3 Design Hydraulic Conductivity Values

Where provided, the values of hydraulic conductivity (k) should be considered the maximum/upper limit design values. As discussed in Section GDR3.7, the inverse auger hole test is an unsaturated field test carried out above the groundwater table and, as such, presents the best-case conditions for drainage.

For soak wells in sand, we provide the design value taking into consideration the variability in materials and reduced permeability as a result of:

- Densification of sand during site preparation works; and
- Natural variation in sands.

Design k_{unsat} values provided for soak wells are only appropriate for the design of unsaturated soils where the base of disposal area is at least 500 mm above groundwater and 500 mm above any impermeable layer.

Where design values of k_{unsat} have been provided, clogging of the base of the soakwell / drainage basin has not been considered. Clogging will need to be controlled with maintenance over the life of the soakwell / drainage basin.

For the design of subsoil drains or modelling of saturated soil performance, a k_{sat} value must be given (in the report text) or assessed by laboratory testing (or a combination of field and laboratory testing). Unless specifically stated, k_{unsat} values presented in our report are for unsaturated conditions and intended for design of stormwater disposal elements above groundwater. If no k_{sat} value has been provided, do not use the provided k_{unsat} value for saturated drainage design. Please contact us for further advice.

For saturated or semi-saturated sands, the hydraulic conductivity must be assessed by testing of representative soil samples at a NATA accredited laboratory to determine:

- The modified maximum dry density (MMDD); and
- The constant-head permeability (AS1289.6.7.1) on a sample remoulded to at least 5% greater than the proposed specification density (i.e., sample should be remoulded to 100% MMDD if the earthworks specification requires a density ratio of 95% MMDD).

For saturated or semi-saturated clayey or silty soils, the hydraulic conductivity must be assessed by testing of representative soil samples at a NATA accredited laboratory to determine:

- The standard maximum dry density (SMDD); and
- The falling-head permeability (AS1289.6.7.2) on a sample remoulded to at least 3% greater than the proposed specification density (i.e., sample should be remoulded to 101% SMDD if the earthworks specification requires a density ratio of 98% SMDD).

GDR13.4 Soakwells

In uncontrolled groundwater environments, the base of any soakwell must be the higher of:

- At least 500 mm above the average annual maximum groundwater level (AAMGL).
- At least 500 mm above any low permeability/impermeable layers (clay, rock or otherwise).

In controlled groundwater environments (refer to Section GDR13.1), the base of any soakwell may be 0 mm above the controlled groundwater level at the location of the soakwell (as determined by the civil engineer).

Soak wells must be placed outside a line of 1V:2H extending below the edge of the nearest footing, subject to local council regulations. Discharge from soak wells has been known to promote densification of loose sandy soils, leading to settlements of footings and slabs. Soak wells should be carefully wrapped with geotextile to prevent migration of sand and fines into the soak well.

Where soak wells are proposed to dispose of water within a line of 1V:2H from any basement walls or similar, the walls must be waterproofed to prevent seepage or damp within the basement wall.

In potentially karstic terrain or areas of potentially collapsible soils, soakwells should typically be located 10 m from the nearest footing, slab or pavement.

GDR13.5 Design Groundwater Elevation

Where applicable, a recommended design groundwater elevation will be provided in the report and will be identified as such.

In the absence of a specific statement on design groundwater elevation, **do not assume** that:

- Absence of comments about groundwater indicates an absence of groundwater (in particular, sites that are dry in the dry season to the investigated depth may well become waterlogged in the rainy season).
- Where groundwater depths/levels are noted, that these are fixed (groundwater fluctuations occur over the course of the year and between wetter and drier years).

Where groundwater elevations are likely to be critical for a development (particularly where large-scale subdivision or large developments are proposed with substantial channelling of stormwater into on-site disposal by infiltration), a site-specific hydrology study is likely to be required to confirm design groundwater elevations.

GDR14 DRAINAGE CONTROL

In addition to the site preparation measures outlined for cohesive soils (refer Section GDR6.2.4), careful control of surface water and stormwater is essential to minimise the likelihood of cohesive soils decreasing in strength and affecting the installed infrastructure. These measures include:

- The ground surface of clayey soils should be graded to drain any seepage away from structures and prevent standing water over the cohesive soils. A grade of at least 1% is recommended.
- Pavements should be sealed to minimise water ingress.
- Stormwater disposal swales should be located at least 10 m away from buildings, retaining walls and pavements.
- Runoff from hardstandings and pavements must either be collected and discharged via pipes into discrete locations (via swales or soakage basins) at least 10 m away from structures and pavements or, alternatively, discharged over a wide area, but not allowed to collect and discharge into concentrated areas, particularly near structures and pavements.

- Spoon drains should be used to collect water at the crest of slopes to capture surface runoff and direct it away from running directly down slopes or seeping into the ground behind slopes.

These measures are general in nature only and do not take into account the civil design objectives, which must be addressed separately by the civil designer.

GDR15 DEWATERING

Dewatering may be required for excavations and construction below groundwater or perched groundwater tables. Common dewatering methods are summarised below:

Table GDR 19: Dewatering Recommendations

Material	Recommended Methods
Sandy Soils	Spears Deep Well Point
Impermeable Clay	Sump Pumping

Dewatering spears are typically suitable for small scale excavations below groundwater, with a typical recommendation for spears to be installed at 1 m below the base of any excavation. Dewatering spears may not be suitable where there are impermeable/cemented/strong transition layers, i.e., it may not be possible to extract water near an impermeable layer (rock/clay), or the spear may not be readily driven through a hard clay/cemented layer (i.e., coffee rock).

Sump pumping can be done by grading a clayey excavation to drain (i.e., by using spoon drains), and excavating a sump in the excavation. A sump can typically be backfilled with a blue metal gravel, with a pump wrapped in a geofabric (i.e., Bidim A14 or similar), with disposal of water away from the excavation.

Deep well point dewatering is typically suitable for larger excavations, where there are transitional layers or where the aquifer is confined. It may not be suitable where there are impermeable layers within the profile. It involves the installation of a deep filtered well to a depth required to draw down the groundwater level at the entire site. A deep well dewatering system must be designed by a suitable designer to provide design flow rates, draw down depths etc.

GDR16 PAVEMENT SUBGRADES

Unless otherwise specified, the provided subgrade California bearing ratio (CBR) is not a pavement design, but an assessment of the subgrade as an input into any required pavement designs.

Provided design values are based on the assumption that the relevant site preparation measures are completed for all pavement subgrades, including the use of appropriate approved fill and adequate compaction. We highlight that specific requirements such as those outlined by Main Roads WA (MRWA) or the local council in their construction specifications may have different requirements.

The provided design value is based on laboratory testing (where done), local experience, and the advice as outlined in:

- Main Roads Western Australia (2013). “Engineering Road Note 9 – Procedure for the Design of Road Pavements”. Western Australia Supplement to the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design, East Perth.

Where the subgrade differs from that described in the text, the subgrade CBR must be confirmed.

The performance of any pavement is highly dependent on the surface and subsurface drainage provided (also considering factors like capillary rise from seasonally high groundwater tables). Adequate drainage must be provided to any pavements, and capillary rise must be considered by the designer.

GDR17 SOIL CORROSIVITY AND AGGRESSIVITY

The relevant exposure classifications for concrete and steel piles in soils based on the exposure conditions are presented in Table GDR 20 and Table GDR 21 respectively.

The relevant exposure classifications for concrete in sulfate soils based on the exposure conditions are presented in Table GDR 22.

Table GDR 20: Exposure Classification for Concrete Piles in Soil

Exposure Conditions				Exposure Classification	
Sulfates (expressed as SO_4)[1]		pH	Chlorides in Groundwater (ppm)	Soil Conditions A[2]	Soil Conditions B[3]
In Soil (ppm)	In Groundwater (ppm)				
< 5,000	< 1,000	> 5.5	<6000	Mild	Non-aggressive
5,000 – 10,000	1,000 – 3,000	4.5 – 5.5	6,000-12,000	Moderate	Mild
10, 000 – 20,000	3,000 – 10,000	4 – 4.5	12,000-30,000	Severe	Moderate
> 20,000	> 10,000	< 4	>30,000	Very Severe	Severe

NOTES:
1. *Approximately 100 ppm SO_4 = 80 ppm SO_3*
2. *Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater*
3. *Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater*
4. *Table reproduced from Table 6.4.2(C) of AS2159-2009*

Table GDR 21: Exposure Classification for Steel Piles in Soil

pH	Chlorides		Resistivity (ohm.cm)	Exposure Classification	
	In Soil (ppm)	In Water (ppm)		Soil Conditions A[2]	Soil Conditions B[3]
> 5	< 5,000	< 1,000	> 5,000	Non-aggressive	Non-aggressive
4–5	5,000-20,000	1,000–10,000	2,000 – 5,000	Mildly aggressive	Non-aggressive
3–4	20,000-50,000	10,000–20,000	1,000 – 2,000	Moderately aggressive	Mildly aggressive
< 3	> 50,000	> 20,000	< 1,000	Severely aggressive	Moderately aggressive

NOTES:
1. *1 ppm (parts per million) is equivalent to 1 mg/kg*
2. *Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater*
3. *Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater*
4. *Table reproduced from Table 6.5.2(C) of AS2159-2009*

Table GDR 22: Exposure Classification for Concrete in Sulfate Soils

Exposure Conditions			Exposure Classification	
Sulfates (expressed as SO_4)[1]		pH	Soil Conditions A[2]	Soil Conditions B[3]
In Soil (ppm)	In Groundwater (ppm)			
< 5,000	< 1,000	> 5.5	Mild	Non-aggressive
5,000 – 10,000	1,000 – 3,000	4.5 – 5.5	Moderate	Mild
10, 000 – 20,000	3,000 – 10,000	4 – 4.5	Severe	Moderate
> 20,000	> 10,000	< 4	Very Severe	Severe

NOTES:
1. *Approximately 100 ppm SO_4 = 80 ppm SO_3*
2. *Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater*
3. *Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater*
4. *For disturbed soils, the assumption of soil A conditions where accelerated corrosion is possible should be considered.*
5. *Table reproduced from Table 4.8.1 of AS3600-2018*

GDR18 LIQUEFACTION

Soil liquefaction can occur when loose, granular, Holocene age material below the groundwater table is subjected to a seismic event (typically within 15 m of the ground surface). This can cause a loss of strength and result in vertical and lateral movements of the site surface.

Where a liquefaction analysis is carried out and outlined in the report, this has been done in accordance with consideration to the design earthquake details as presented in AS1170.4-2007:

- The hazard factor is taken from Figure 3.2 (C) and Table 3.2. The Hazard Factor (Z) for Western Australia represents the 1 in 500-year annual probability of exceedance of ground motions measured in gravity (g).
- The probability factor (k_p) is taken from Table 3.1.

Unless otherwise stated, an earthquake magnitude of 7.5 for the south-west of WA is based on research by:

- Dhu T., Sinadinovski C., Edwards M., Robinson D., Jones T., Jones A. (2004) “Earthquake Risk Assessment for Perth, Western Australia”. 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada. Paper No. 2748.

GDR19 EXPECTATIONS OF THE REPORT

The following sections have been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

GDR20 THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

GDR21 DATA PROVIDED BY THIRD PARTIES

Where data is provided by third parties, it will be identified as such in our reports. We necessarily rely on the completeness and accuracy of data provided by third parties in order to draw conclusions presented in our reports. We are not responsible for omissions, incomplete or inaccurate data associated with third party data, including where we have been requested to provide advice in relation to field investigation data provided by third parties.

GDR22 SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques prepared by Galt. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

GDR23 THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

GDR24 CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

GDR25 SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

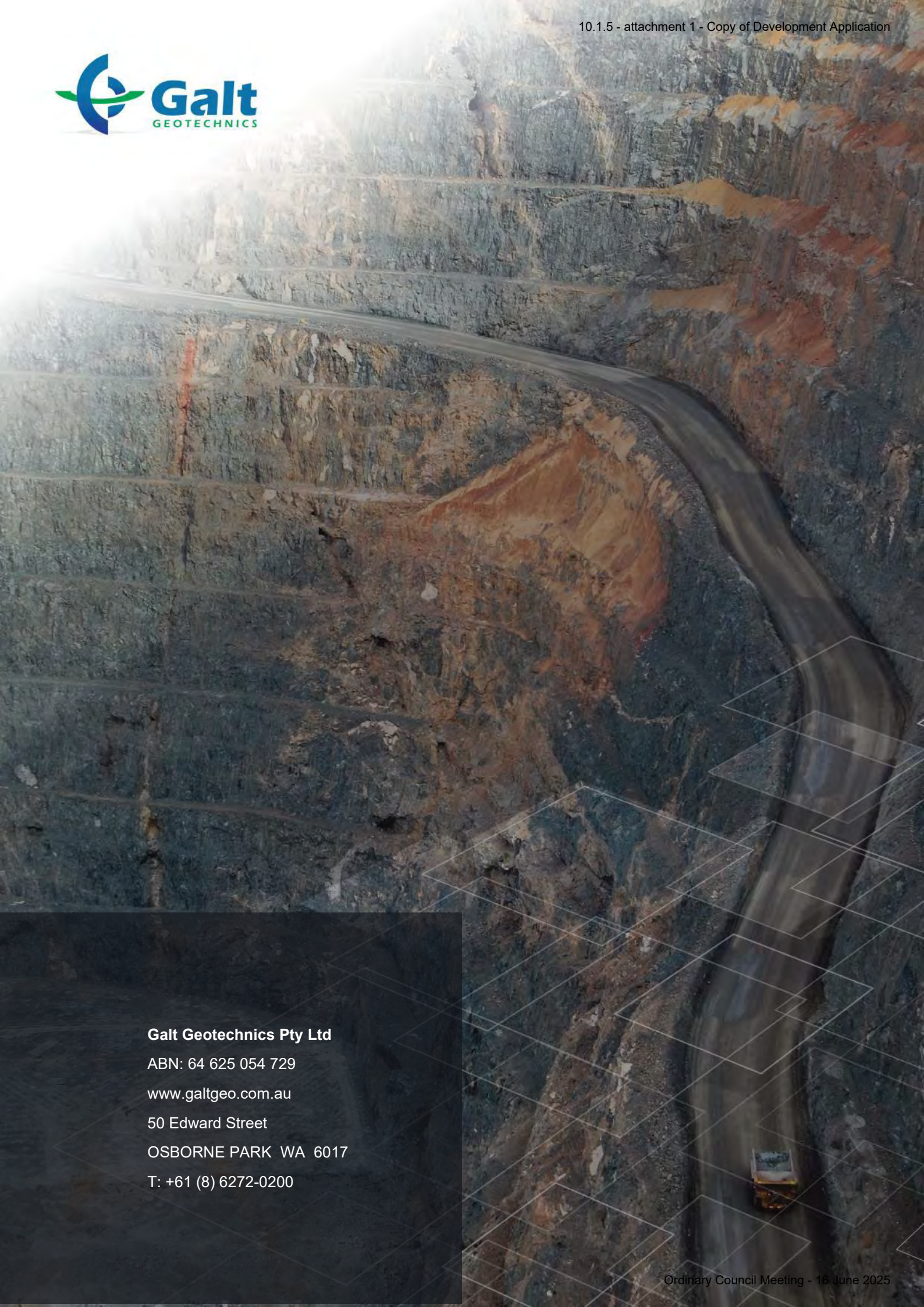
The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

GDR26 ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Geotechnical advice presented in a Galt Environmental report has been provided by Galt Geotechnics under a sub-contract agreement. Similarly, environmental advice presented in a Galt Geotechnics report has been provided by Galt Environmental under a sub-contract agreement.

Unless specifically noted otherwise, no parties shall draw any inferences about the applicability of the Western Australian state government landfill levy from the contents of this document.



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WAG230321-02 002 L Rev0

13 June 2024

BG&E
Level 19, Kings Square 1
556 Wellington Street
PERTH WA 6000

Attention: Alan Mayahi

FLEXIBLE PAVEMENT DESIGN
SITE ACCESS ROADS AND CARPARK FOR BYFORD HEALTH HUB
PART LOT 103, 3 BUSHMAN GLADE, BYFORD

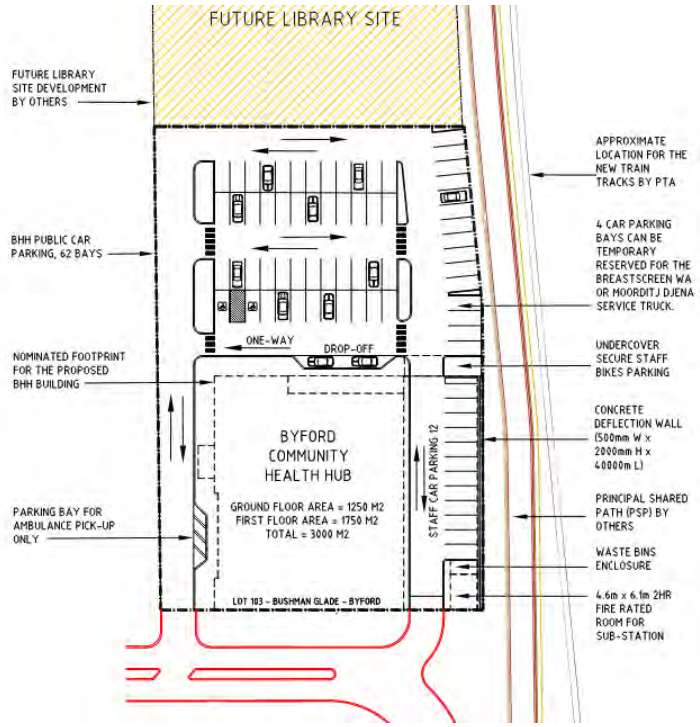
Dear Alan,

1 INTRODUCTION

This letter report presents Galt Geotechnics' (Galt's) flexible pavement design for the site access roads and carpark for the Byford Health Hub on Part Lot 103 Bushman Glade Byford ("the site"). The location of the site relative to the surrounding area is shown on Figure 1.

2 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The proposed surgical centre site covers a plan area of about 2,750 m^2 and the proposed site plan is shown below.



Inline Figure 1: Site Layout of Byford Health Hub

The development will require site access roads including an access road along the western and northern boundary for light passenger vehicles, emergency service vehicles (up to 30 tonne fire truck) and general service vehicles (deliveries, rubbish pickup etc.). General light vehicle parking is also proposed to the north and east of the health hub building.

3 GEOTECHNICAL STUDY

Galt conducted a geotechnical investigation at the site and the outcomes are presented in report WAG230321-02 001 R Rev0. Relevant findings of the investigation are discussed in Section 4.2.

4 FLEXIBLE PAVEMENT DESIGN

4.1 General

The flexible pavement design was conducted in general accordance with the following design guides:

- Austroads (2012) Guide to Pavement Technology Part 2 – Pavement Structural Design.
- Main Roads Western Australia (MRWA, 2013), Engineering Road Note 9.

4.2 Subgrade Evaluation

The Galt investigation was carried out in May 2024 and concluded that the site was underlain by Fill (SAND / Gravelly SAND / Clayey SAND) about 0.7 m to 1.6 m thick, generally over Colluvium (Clayey Sandy GRAVEL / Gravelly Sandy CLAY / Clayey Gravelly SAND), tending to being cemented and rock strength at relatively shallow depth (2 m to 3 m deep).

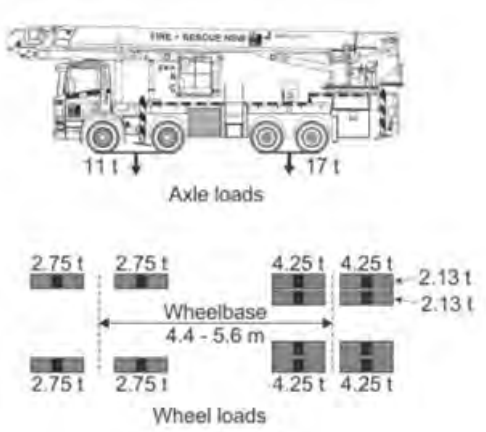
Pad clearance to groundwater and flood levels is required and this will dictate site surface levels. The pad is anticipated to be around 0.3 m to 0.5 m above flood levels as a minimum. Filling of the site is anticipated and permeable sand fill was recommended. On this basis, a design subgrade CBR=12% was provided for compacted sand fill (either in situ or imported fill).

We have assumed this design subgrade CBR in our pavement design.

4.3 Design Traffic

We understand that flexible pavements at the site are to be designed to suit a maximum 30 tonne fire emergency services truck among other heavy service vehicles and light passenger vehicles.

Our experience indicates that the maximum sized fire service truck will comprise an Austroads Class 5 heavy vehicle as shown:



Inline Figure 2: Typical Specialist Fire Emergency Service Vehicle

Considering the expected number of movements of the above vehicle (say no more than 10 movements per year for fire emergencies) and of other heavy service vehicles that will probably traffic the pavement a few times a week such as delivery trucks and rubbish trucks (Austroads Class 3 to 5 trucks), we have assumed a design traffic of 1 x 10^5 Equivalent Standard Axles (ESA) over a design period of 40 years with a project reliability of 95%.

4.4 Summary of Pavement Design

The following flexible pavement design is provided in Table 1 based on our assumptions.

Table 1: Summary of Pavement Design

Pavement Layer	Description	Minimum 4 day Soaked CBR (%)	Specification	Design Thickness (mm)	
				Option 1	Option 2
Wearing Surface	10 mm dense graded asphalt Class 170 bitumen	N/A	IPWEA/AfPa (2023)	30	
Seal	Prime and Seal Refer to Section 4.5 for application rates	N/A	MRWA Specifications 503 & 511	Nominal	
Base	Crushed Igneous Rock Basecourse	100%	MRWA Specification 501	100	185
Subbase	Crushed Limestone Subbase or Class 1 Recycled Roadbase	As per spec.	MRWA Specification 501 (Crushed Limestone) IPWEA/WALGA (2016) for Recycled Roadbase	100	-
Subgrade	SAND	12%	N/A	Modelled as semi-infinite	

Note: The thickness of crushed limestone may need to be increased to 150 mm depending on the particle size distribution of the material for constructability.

Asphalt Fatigue Notes

Mechanistic-empirical analyses of asphalt fatigue was not undertaken as this is not a governing aspect of the pavement design at this traffic loading. The service life of thin asphalt surfacings is typically in the order of 15 years before distress occurs due to environmental effects such as oxidation of the binder. Resurfacing of the pavement before the end of the 40-year design period is required to ensure the pavement performs adequately.

4.5 Seal and Surfacing Designs

4.5.1 Surface Preparation and Priming

Prior to sealing, the surface must be compacted and dried back to produce a dense, evenly textured, tightly bound surface and swept with a rotary broom or similar to remove any surface dust or loose particles. The surface must not show evidence of laminations or ravelling before and after brooming.

The surface must be sealed to waterproof the granular base and provide a strong bond between the basecourse, seal and surfacing. We recommend priming in accordance with MRWA Specification 503 using a prime comprising 40% Class 170 bitumen/60% Medium curing cutter oil applied at a rate of 0.6 L/m^2.

The prime must be applied in dry and warm conditions, with no rainfall forecast within the following 3 days. The prime must be allowed to cure for 3 to 7 days prior to application of the surfacing (subject to assessment of site conditions).

Notwithstanding the given nominal application rates, the prime must be adjusted:

- to ensure a uniform and even coating;
- to account for the porosity of the pavement surface; and
- to account for the pavement moisture content and prevailing conditions.

4.5.2 Preliminary Spray Seal Design below Surfacing

Preliminary seal designs have been performed in general accordance with Austroads AGPT04K-18, MRWA ERN15 (2017) and MRWA Specification 503.

Table 2: Preliminary Seal Design

Seal Type	Aggregate Size (mm)	Binder	Total Binder Application Rate (@ 15°C) L/m^2	Aggregate Spread Rate (m^2/m^3)
Prime	-	Cutback primer	0.6	-
Single/single	7 mm	CRS170/60	1.3	150-200

Assumptions:

The following assumptions have been made and must be reviewed by the sealing contractor:

- Assumed Average Least Dimension (ALD) of 4 mm for the 7 mm aggregate and Flakiness Index (FI) 25-35%.
- No adjustments for surface texture, embedment, or absorption assuming suitable basecourse preparation and priming.
- Design based on no trafficking between prime and seal applications.

4.5.3 Surfacing Selection

The proposed surfacing for the light vehicle carpark is 30 mm thick, 10 mm dense graded asphalt with Class 170 bitumen (50 blow Marshall Density). We recommend adopting the mix design for 10 mm dense graded asphalt in the IPWEA/AfPa (2023) Asphalt Specification. The asphalt must be placed and compacted to a minimum 94.5% of the 50 blow Marshall Density.

The asphalt job mix must be trialled and laboratory tested to ensure it conforms with the specification.

5 PAVEMENTSPECIFICATION AND CONSTRUCTION

5.1 Fill Materials

Imported granular and bituminous pavement materials should meet the requirements of MRWA Specifications including:

- MRWA Specification 501 – Pavements.
- MRWA Specification 503 – Bituminous Surfacing.
- IPWEA/AfPA (2023) – Asphalt Specification.
- IPWEA/WALGA (2016) – Specification for Supply of Recycled Roadbase.
- MRWA Specification 511 – Materials for Bituminous Treatments.

5.2 Compaction and Dryback

It is essential that all granular pavement layers are suitably compacted and dried back. It should be noted that inadequate dry-back of pavement materials is often a cause of premature failures. Compaction and dry back requirements are provided in Table 3.

Table 3: Compaction and Dryback Requirements

Pavement Layer	Minimum DDR	Maximum Moisture Content for Dryback
Crushed Rock Base-course	99% MMDD	60% of MOMC
Recycled Roadbase	98% MMDD	70% of MOMC
Crushed Limestone Subbase	95% MMDD	85% of MOMC
Sand Subgrade	95% MMDD	No dry back required

Note: MOMC – Modified Optimum Moisture Content

Compaction control of pavement materials must be undertaken using a nuclear density meter in accordance with AS1289.5.8.1.

A Perth sand penetrometer (PSP) may be used for compaction control of the sand subgrade provided it is correlated to the minimum required DDR of 95% MMDD.

5.3 Drainage

The pavement designs assume that suitable drainage control measures have been implemented to prevent ponding and moisture ingress into the pavement layers. The finished surfaces of pavements must be suitably shaped to direct storm-water run-off away from the pavements and towards drainage systems.

6 CLOSURE

We draw your attention to Attachment A of this letter report, "Understanding Your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimize risks associated with groundworks for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD





Harry Chambers

Geotechnical/Pavement Engineer

Owen Woodland CPEng

Geotechnical Engineer

Attachments: A – Understanding Your Report

https://galtgeo.sharepoint.com/sites/WAG230321/Shared Documents/02 BGE Detailed SI/03 Correspondence/WAG230296-01 002 L Rev0.docx

ATTACHMENT A

Understanding Your Report

UNDERSTANDING YOUR REPORT

GALT FORM PMP11 Rev4

1. EXPECTATIONS OF THE REPORT

This document has been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

3. DATA PROVIDED BY THIRD PARTIES

Where data is provided by third parties, it will be identified as such in our reports. We necessarily rely on the completeness and accuracy of data provided by third parties in order to draw conclusions presented in our reports. We are not responsible for omissions, incomplete or inaccurate data associated with third party data, including where we have been requested to provide advice in relation to field investigation data provided by third parties.

4. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques prepared by Galt. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

5. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

6. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

7. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

8. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Geotechnical advice presented in a Galt Environmental report has been provided by Galt Geotechnics under a sub-contract agreement. Similarly, environmental advice presented in a Galt Geotechnics report has been provided by Galt Environmental under a sub-contract agreement.

Unless specifically noted otherwise, no parties shall draw any inferences about the applicability of the Western Australian state government landfill levy from the contents of this document.

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Our teams in Australia, New Zealand, South East Asia, the United Kingdom and the Middle East, design and deliver engineering solutions for clients in the Property, Transport, Ports and Marine, Water, Defence, Renewables and Resources sectors.

We collaborate with leading contractors, developers, architects, planners, financiers and government agencies, to create projects for today and future generations.

ABN 67 150 804 603





Transport Impact Assessment

Project:	Byford Health Hub
Client:	Department of Finance c/- Carabiner
Author:	Paul Nguyen
Date:	17th January 2025
Shawmac Document #:	2403008-TIA-001

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1. Introduction

1.1. Proponent

Carabiner have been appointed by the Department of Finance to design and document the proposed Byford Health Hub (BHH) to be located on Bushman Glade in Byford. Shawmac has been engaged to prepare a Transport Impact Assessment to support the development application.

1.2. Scope

This TIA has been prepared in accordance with the WAPC *Transport Impact Assessment Guidelines* (TIA guidelines). According to the TIA guidelines, the key objectives of a TIA are to:

- assess the proposed internal transport networks with respect to accessibility, circulation and safety for all modes, that is, vehicles, public transport, pedestrians and cyclists;
- assess the level of transport integration between the development and the surrounding land uses;
- determine the impacts of the traffic generated by the development on the surrounding land uses; and
- determine the impacts of the traffic generated by the development on the surrounding transport networks.

1.3. Site Location

The site is Lot 103, 3 Bushman Glade in Byford and the local authority is the Shire of Serpentine Jarrahdale. The site location is shown in **Figure 1**.

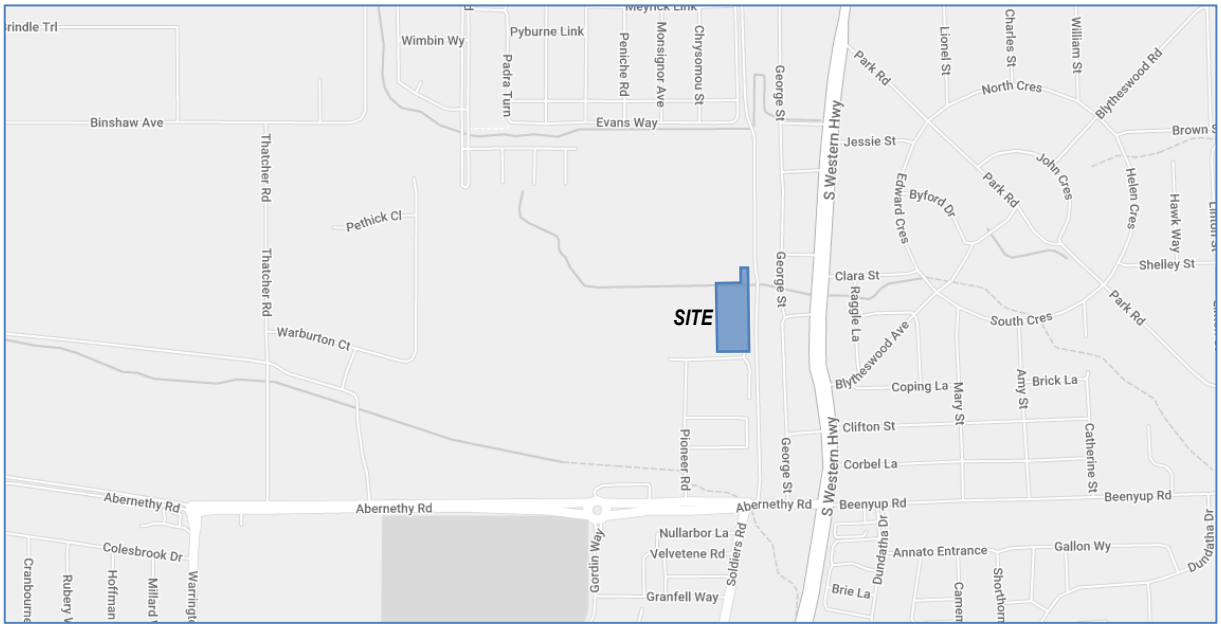


Figure 1: General Site Location

An aerial view of the site is shown in **Figure 2**.



Figure 2: Existing Site (November 2024)

1.4. Proposal

The proposed development is a two-storey community health hub building comprising multiple consulting rooms, multi-purpose areas and supporting facilities. The health hub is expected to accommodate a maximum of 60 staff and 90 patients at any one time.

A future public library is also proposed on the northern portion of the site.

The BHH is estimated to be delivered in late 2026 / early 2027 and the library is indicatively planned for delivery around 2034.

The proposed site plan is shown in **Figure 3**.

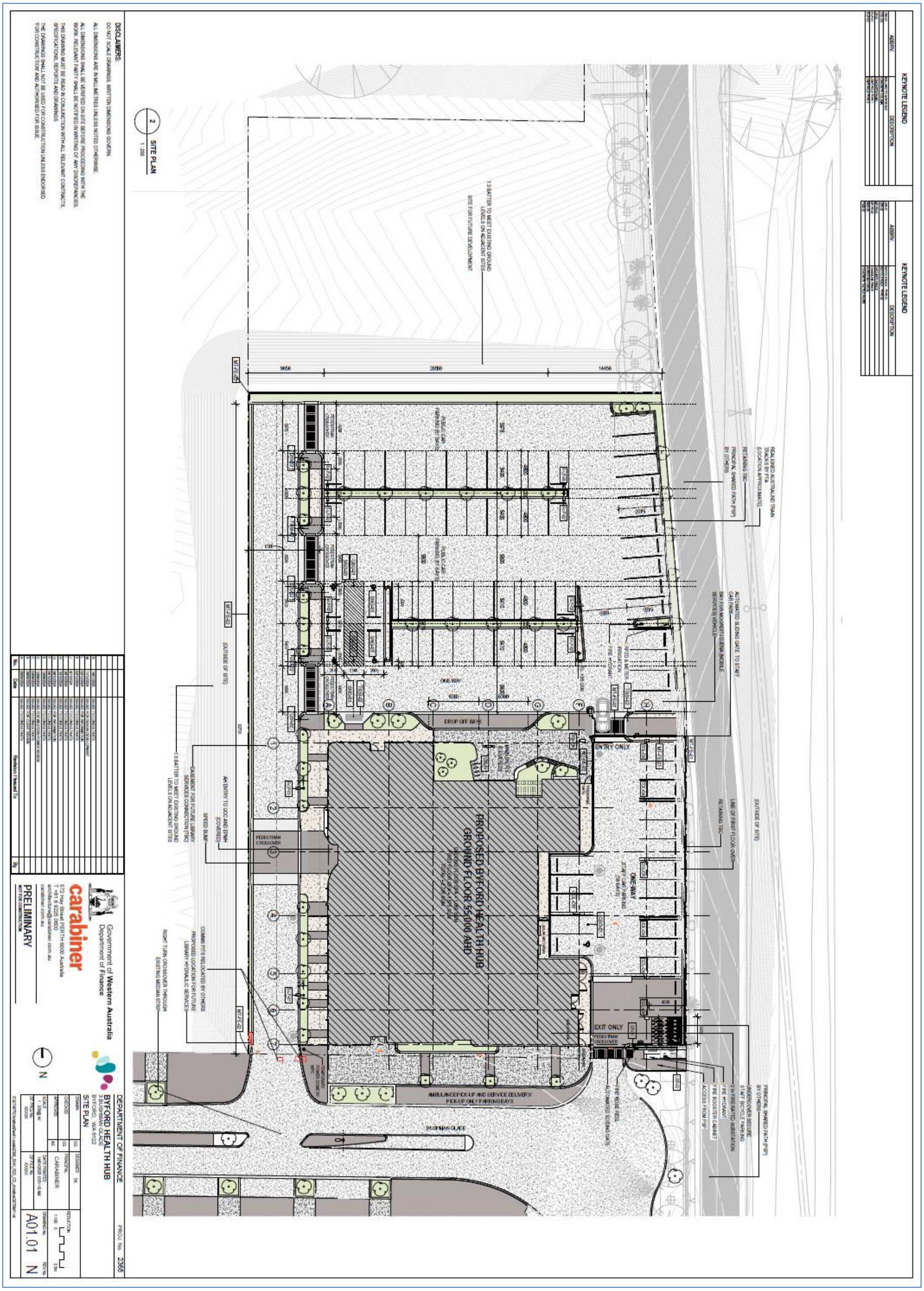


Figure 3: Proposed Site Layout

2. Site and Surrounding Network

2.1. Land Uses

The proposed BHH is located within the Byford Town Centre. The adopted Local Structure Plan (LSP) for the Byford Town Centre as prepared by Rowe Group is shown in **Figure 4**.

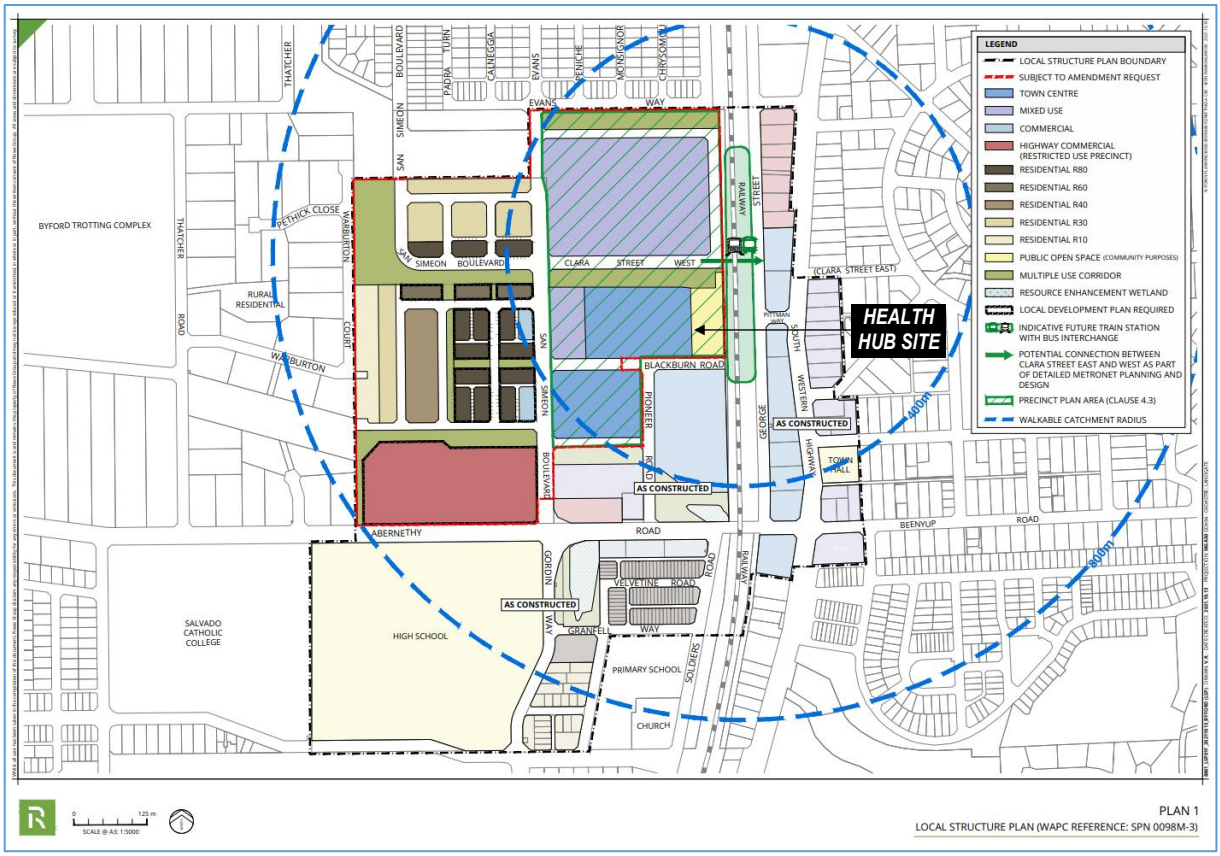


Figure 4: Byford Town Centre Local Structure Plan (Rowe Group, 2021)

The site is currently indicated on the LSP as Public Open Space (Community Purposes) and is subject to the preparation of a precinct plan. The site is also located adjacent to the proposed Byford Railway Station which is currently under construction and indicatively planned for opening in 2025 before the BHH is completed.

2.2. Road Network Layout and Hierarchy

The current layout and hierarchy of the surrounding road network according to Main Roads WA's *Road Information Mapping System* is shown in **Figure 5**.

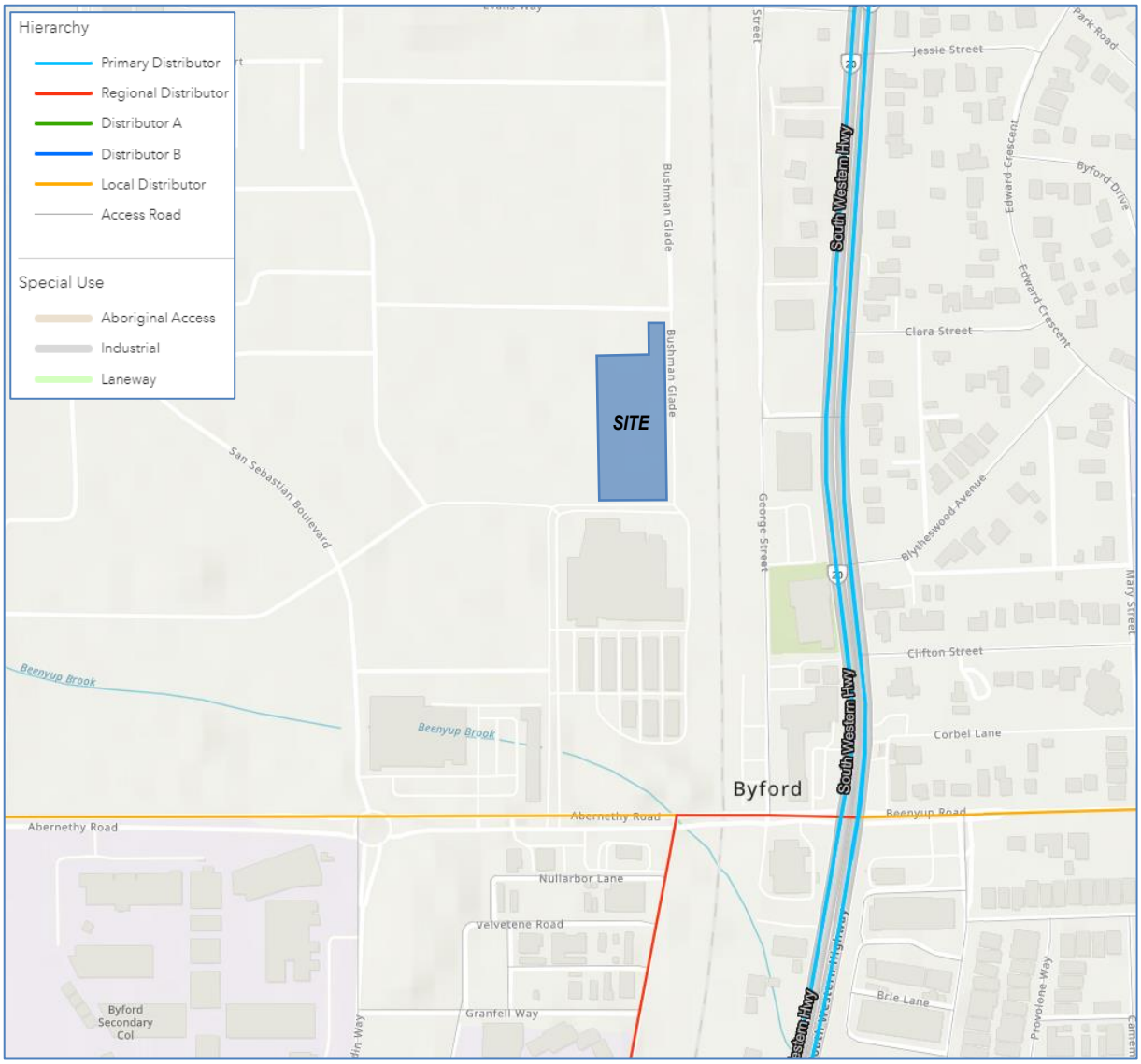


Figure 5: Road Layout and Hierarchy

Pioneer Road and Bushman Glade have not yet been added to the Main Roads WA database. The likely classification of these roads is discussed later.

2.3. Speed Limits

The current speed limits are shown in **Figure 6**.

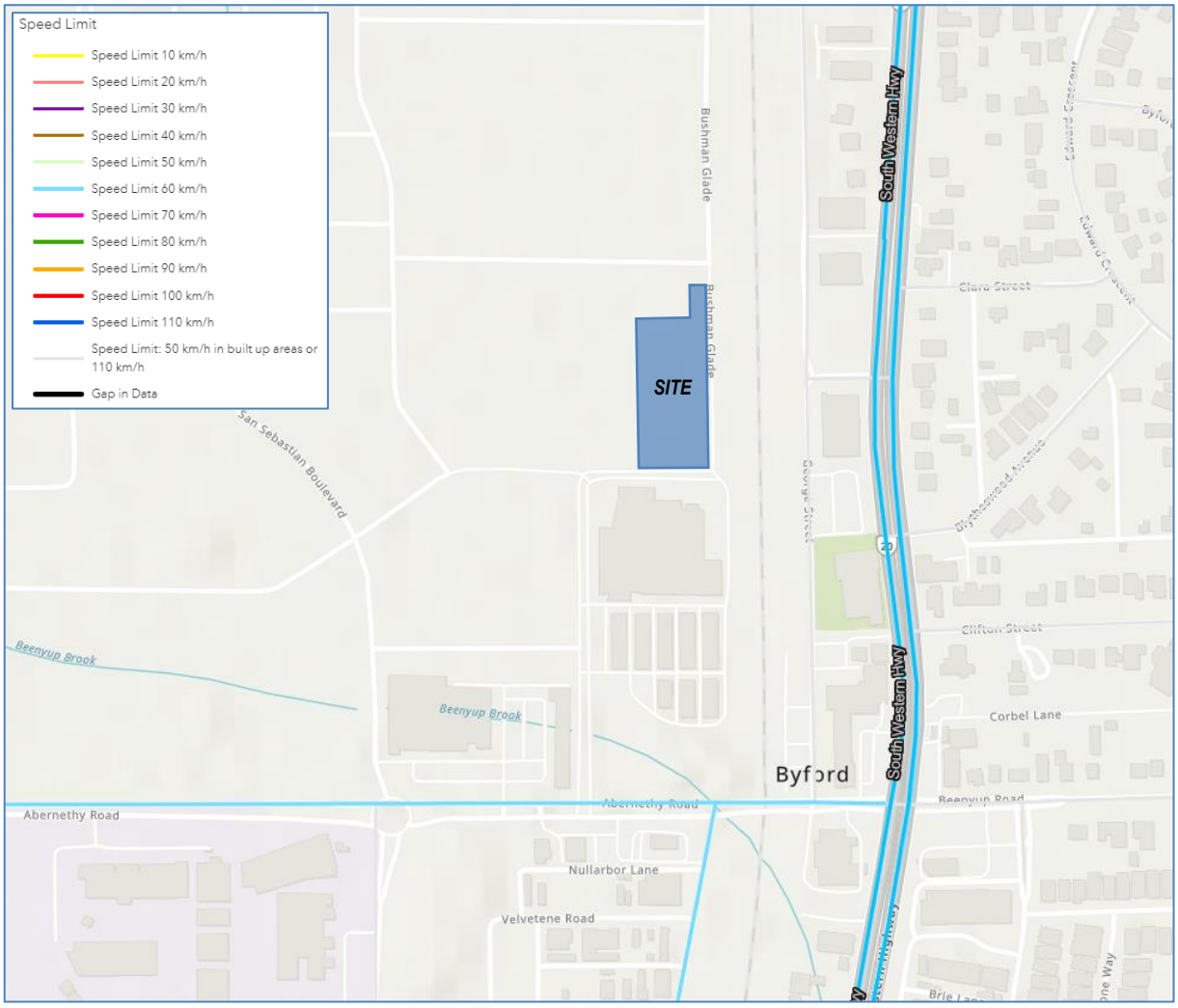


Figure 6: Speed Limits

It is assumed that the default 50km/h speed limit for built up areas applies along Pioneer Road and Bushman Glade.

2.4. Changes to the Surrounding Transport Network

As per the adopted LSP, Bushman Glade / Blackburn Road will be extended west to connect with the future extension of San Simeon Boulevard but will remain as a no through road along the site frontage. Another key change to the road network will be the creation of a new level crossing at Clara Street to the north of the site. However, it is understood that no vehicle access will be provided to the BHH site from the proposed Clara Street West.

A Transport Impact Assessment was prepared by for the LSP by Cardno in 2021. The proposed road layout and hierarchy for the LSP is shown in **Figure 7**. Bushman Glade will be an Access Street and Pioneer Road will eventually be a Neighbourhood Connector A road.

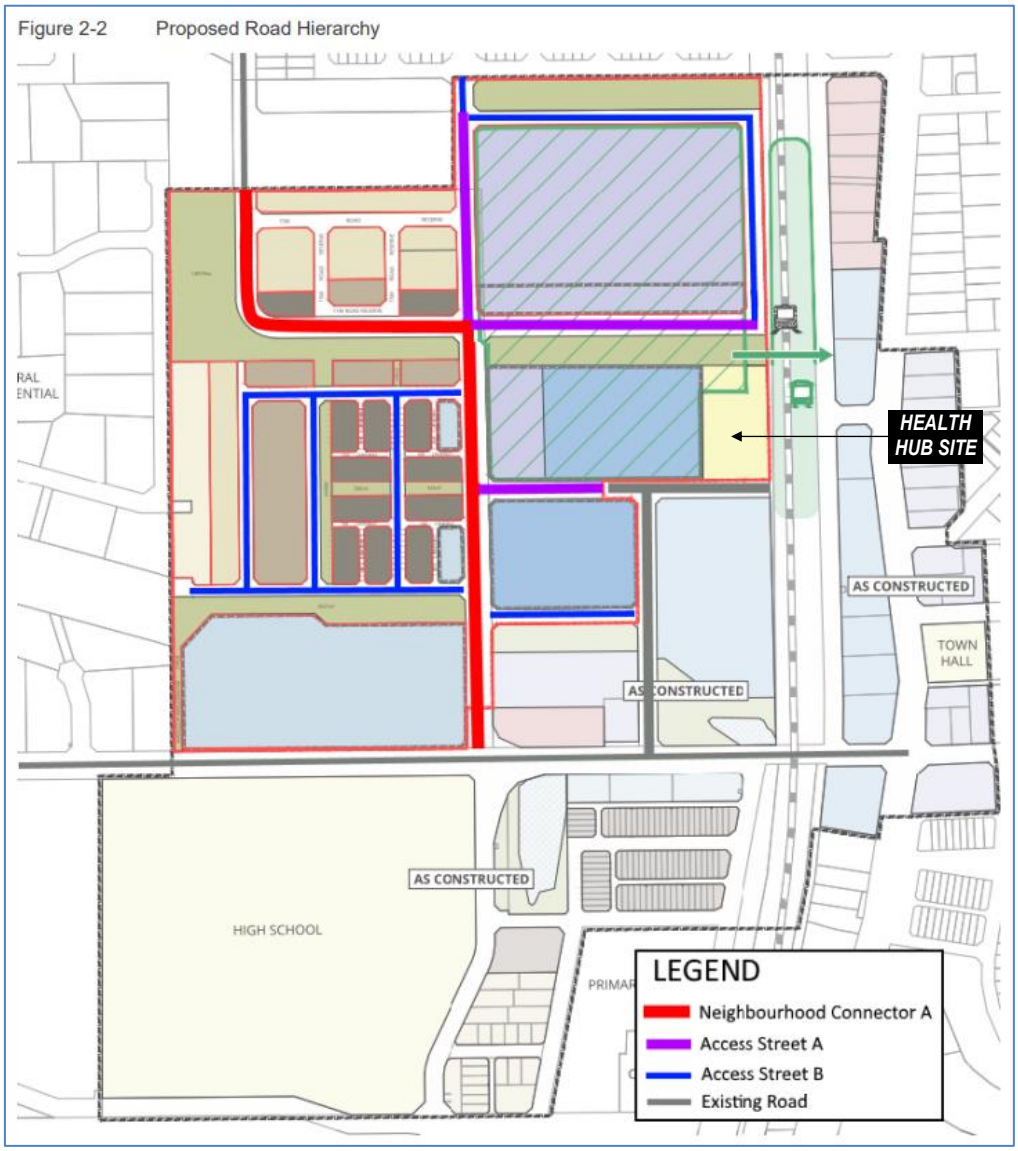


Figure 7: Byford Town Centre – Road Hierarchy (Cardno, 2021)

The projected daily traffic volumes based on full development of the LSP area as modelled by Cardno are shown in **Figure 8**. As shown, the adjacent section of Bushman Glade is predicted to carry 1,500 vehicles per day (vpd).

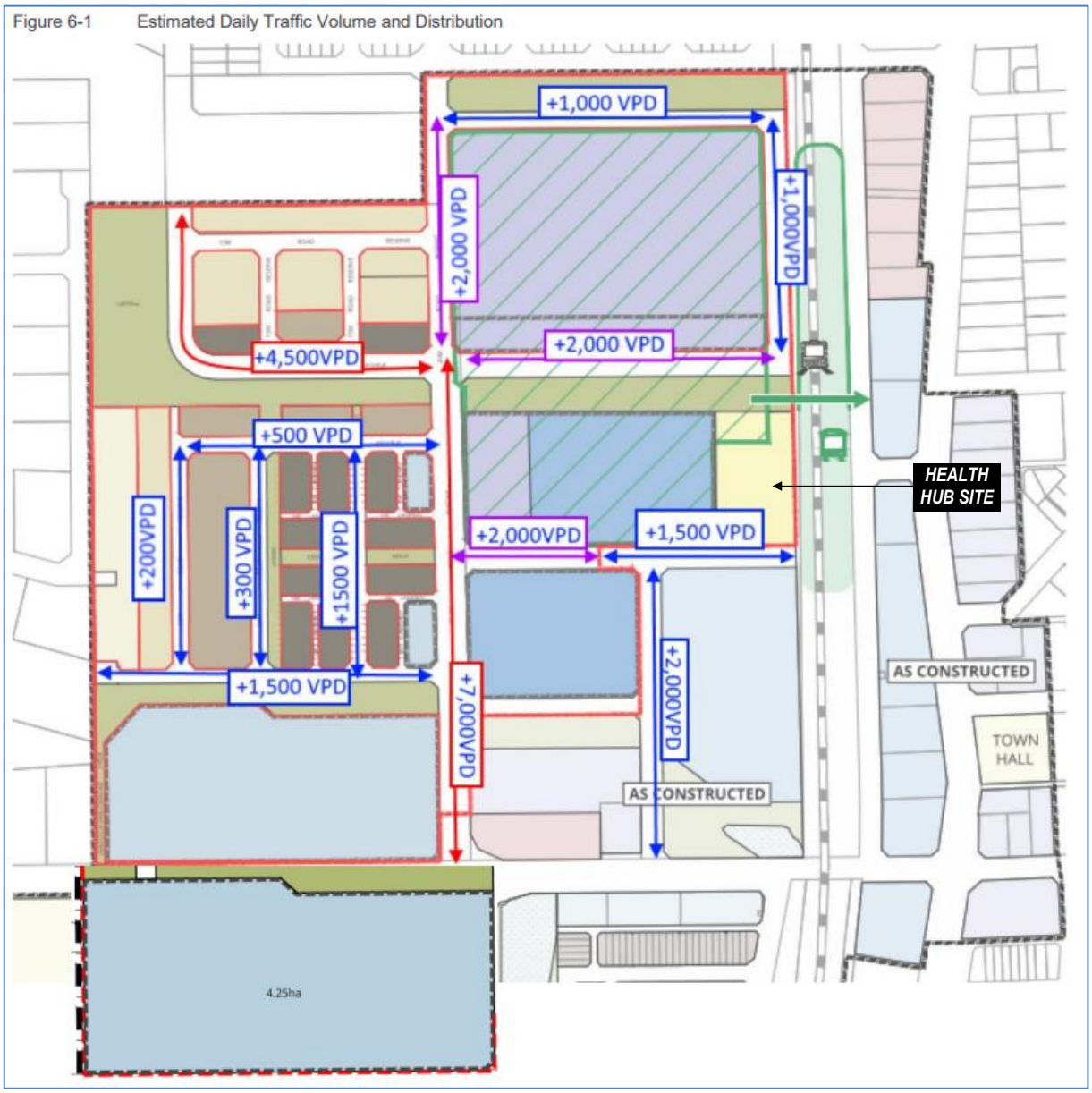


Figure 8: Byford Town Centre – Daily Traffic Volumes (Cardno, 2021)

The Cardno assessment included detailed capacity analysis of the proposed road network and concluded that "Overall the proposed LSP would result in minor impact to the surrounding intersections and road network. However, the impact is within manageable Level of Service and would generally occur during the peak periods only."

3. Traffic Impact Assessment

3.1. Assessment Parameters

Based on the proposed land use, the key periods of assessment will be the weekday morning and afternoon peak hours which are likely to broadly coincide with the road network peaks.

3.2. Traffic Generation

The volume of traffic generated by the proposed BHH has been estimated using trip generation rates from the NSW Government Roads and Maritime Services *Trip Generation Surveys – Medical Centres* (RMS Surveys). The RMS Surveys were undertaken by TEF Consulting in 2015 and compiles traffic and parking generation data of 20 medical centres, including 14 centres in the Greater Metropolitan Sydney Area and 6 centres in Regional NSW. The RMS Surveys concluded that there were low levels of correlation between the number of vehicle trips and independent variable such as floorspace, number of consulting rooms and number of practitioners. This is likely due to various factors such as location, accessibility to non-car modes of transport and ultimately the difference in how each medical centre operates.

As the proposed BHH is located within a town centre, the potential trip generation rate has been estimated using the average trip rate for 5 of the surveyed sites that were also located in town centres. Most are located within reasonable walking distance of bus services but only 1 was located adjacent to a train station. Therefore, the proposed BHH is likely to have a higher non-car mode share and the use of these rates is a worst-case scenario estimate.

The peak trip generation is detailed in **Table 1**. The rates are based on the peak hour of the adjacent road network and the number of consulting rooms / practitioners as this appeared to have the highest level of correlation out of the independent variables.

Table 1: Proposed Development Vehicle Trip Generation

Land Use	Units	Quantity	Generation Rate		Number of Trips	
			AM Peak	PM Peak	AM Peak	PM Peak
Medical Centre	Consulting Rooms	34	1.08	1.52	37	52

As shown, the proposed BHH is predicted to generate approximately 37 vehicle trips during the morning peak hour and 52 during the afternoon peak hour.

According to the WAPC TIA guidelines, an increase of between 10 to 100 peak hour vehicles is considered to have a low to moderate impact and is generally deemed acceptable without requiring detailed capacity analysis.

The estimated 37 to 52 peak hour trips is around the middle of this range and the development is therefore likely to have a low moderate impact and can be accommodated within the existing capacity of the road network.

As mentioned previously, the Cardno assessment for the LSP included detailed capacity analysis of the proposed road network and concluded that “Overall the proposed LSP would result in minor impact to the surrounding intersections and road network. However, the impact is within manageable Level of Service and would generally occur during the peak periods only.”

4. Parking Assessment and Management

4.1. Parking Requirements

According to the Byford Town Centre Local Structure Plan, the minimum parking requirement for non-residential uses within the LSP is 1 bay for every 20m^2 gross leasable area (GLA), less any on-street parking adjoining the site. Based on the proposed 3,000m^2 floor area, the minimum requirement is 150 bays.

Reference has also been made to the Shire's Town Planning Scheme No. 2 (TPS2). The most applicable land use included in *Table 5 – Parking Requirements* of the TPS2 is considered to be *Consulting Rooms* which require 6 spaces for the first practitioner plus 4 spaces for each additional practitioner. The maximum number of practitioners on the site has been estimated to be 34 practitioners based on the number of consultant and treatment rooms listed on the Schedule of Accommodation. For 34 practitioners, the minimum parking requirement would be 138 car bays.

The current plans indicate a provision of approximately 79 car bays which is short of the LSP requirements by 71 bays and short of the TPS2 requirements by 59 bays.

In this instance, the shortfall is considered to be acceptable based on the following reasons:

- The site is located adjacent to the Byford Train Station which is planned to be open in 2025 around the same time as the BHH.
- The site is located within the Byford Town Centre and adjacent to several supermarkets (Coles, Woolworths, Aldi) with ample parking. Many patrons of Byford Health Hub will also visit adjacent businesses before and after their appointments.
- The site will be well connected for pedestrians and cyclists with a proposed Principal Shared Path (PSP) to be constructed along the eastern boundary of the site.
- The development includes bicycle parking for staff and visitors as well as end of trip facilities (lockers, showers and change rooms) for staff.
- Several pick-up and drop-off bays are proposed adjacent to the building to allow patients to be picked up and dropped off by taxi or rideshare services.

4.2. Parking Management

To maximise the efficient use of the available parking and to encourage alternative transport, the following parking management measures are recommended for consideration:

- Encourage staff to walk, cycle, scoot and use public transport as much as possible. They could include subsidised public transport fees or other incentives for staff who do not drive to and from work.
- Allocate the on-site staff parking bays to specific staff members and advise other staff not to use the public parking bays for all day parking.
- Enforce time limits on the public car parking bays to discourage staff from using these bays.
- Prepare and implement a Sustainable Travel Plan (STP) including the above measures and any additional measures to encourage sustainable transport. The STP can be distributed to all staff and reviewed regularly.

5. Access Assessment

5.1. Access Arrangement

Vehicle access to the site is proposed via two crossovers on Bushman Glade as shown in **Figure 9**. As shown, the western end of Bushman Glade will be modified to accommodate the proposed site access and the central median will be modified to restrict inbound right turns at the western access.

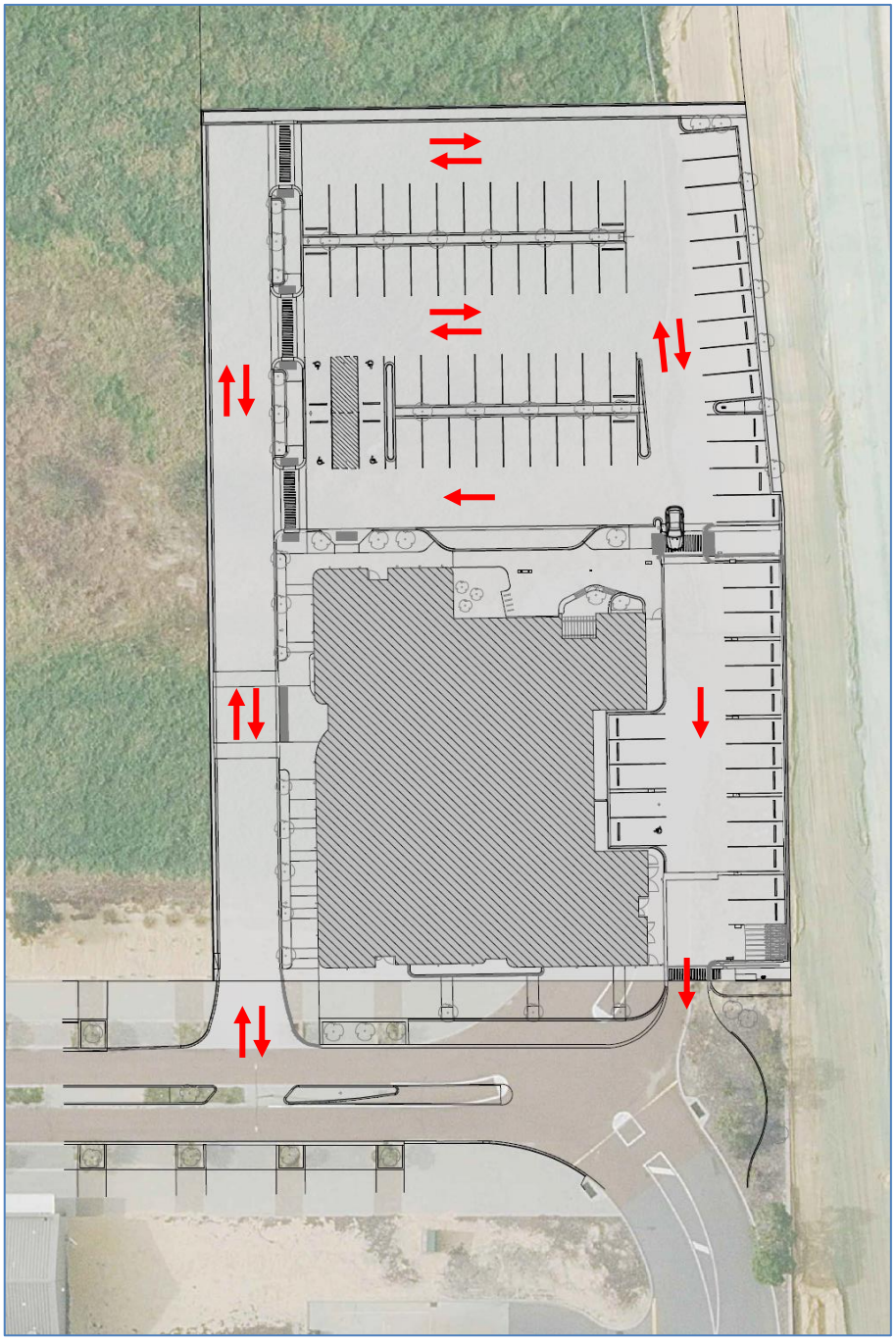
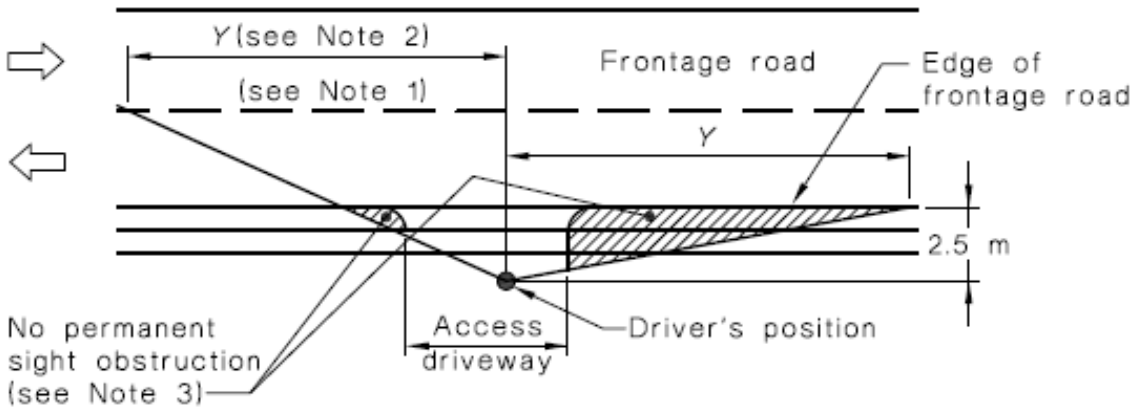


Figure 9: Proposed Access Arrangement

5.2. Access Sight Distance

Sight distance requirements from vehicle exit points are defined in Figure 3.2 of Australian Standard AS2890.1:2004 *Parking facilities Part 1: Off-street car parking* as shown in **Figure 10**.



Frontage road speed (Note 4) km/h	Distance (*Y*) along frontage road m		
	Access driveways other than domestic (Note 5)		Domestic property access (Note 6)
	Desirable 5 s gap	Minimum SSD	
40	55	35	30
50	69	45	40
60	83	65	55
70	97	85	70
80	111	105	95
90	125	130	Use values from 2nd and 3rd columns
100	139	160	
110	153	190	

Figure 10: Sight Distance Requirements

Based on the assumed 50km/h speed limit along Bushman Glade, the minimum required sight distance is 45m. As shown in **Figure 11**, the minimum required sight distance is achieved in both directions at the western exit point.

Vertically, the geometry of the Bushman Glade is relatively flat with no major crests or sags that would impede sight distance.

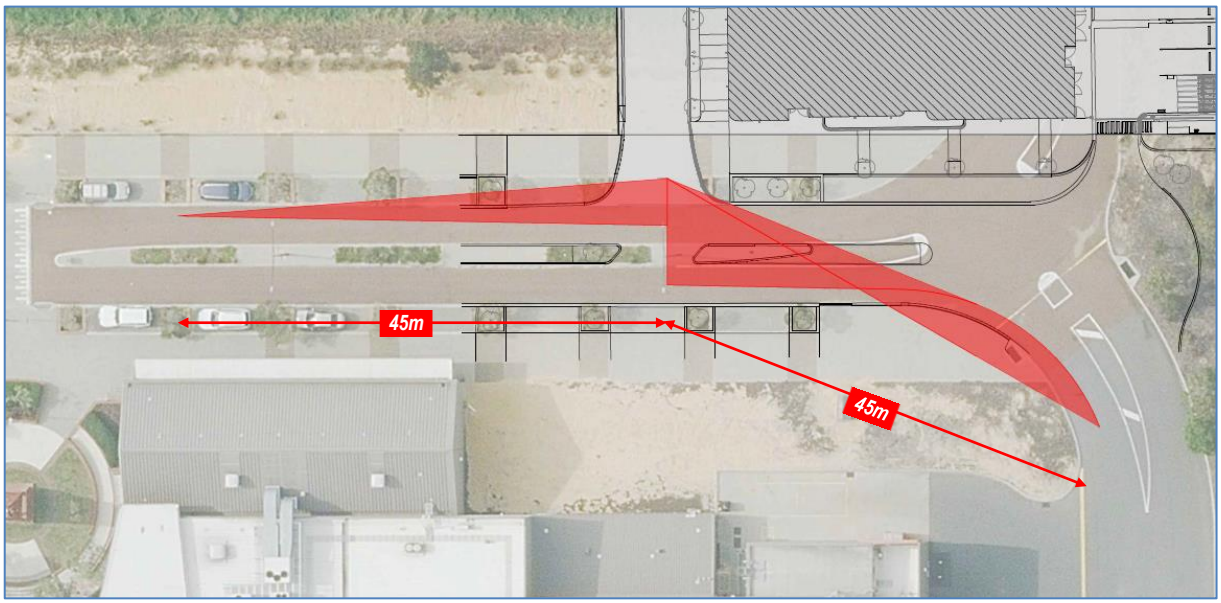


Figure 11: Sight Distance Check

5.3. Service Vehicles

A vehicle swept path analysis has been undertaken to check that the current layout has sufficient room to accommodate the largest vehicle expected to access the site which is a DFES fire appliance. The analysis has been completed in AutoTURN vehicle tracking software using a custom template based on the largest DFES fleet vehicle (9.3m Combination Ladder Platform Truck). It is understood that waste will be collected from the verge along Bushman Glade and so a check has also been completed for a standard 10m long waste vehicle turning around at the proposed cul-de-sac.

The results of the swept path analysis are attached as **Appendix A** and these demonstrate that there is adequate room for the expected service vehicles except that the east splay of the main crossover will need slight widening and the adjacent garden bed set back to accommodate the DFES vehicle turning left out of the site.

The swept path analysis should be updated as the design progresses.

6. Road Safety Assessment

6.1. Crash History

Bushman Glade and Pioneer Road have not been added to the Main Roads WA database and so no crashes have been recorded on the Main Roads WA Reporting Centre.

The proposed development will generate a moderate volume of additional traffic and there is no indication that the development itself will increase the risk of crashes unacceptably.

7. Public Transport Accessibility

7.1. Existing Services

The following public transport services currently operate in the vicinity of the site:

- Transperth Bus Route 252 which operates between Armadale Station and Mundijong via Byford.
- Transperth Bus Route 254 which operates between Armadale Station and Byford via Kardan Boulevard.

The closest stops are on Abernethy Road, approximately 400m walking distance from the site.

As the Byford Town Centre is further developed, there is also likely to be a level crossing at Clara Street which will provide access to additional bus services operating along South Western Highway, including Routes 251 and 253.

As mentioned previously Byford Train Station will be operational in 2025 and it is likely that new or updated bus services will operate from the station.

The existing and planned public transport services are considered to be adequate to meet the expected demand.

8. Pedestrian and Cyclist Demand and Facilities Assessment

8.1. Analysis of Pedestrian / Cycle Networks

The pedestrian network is progressively being developed along with the surrounding area. There are currently wide paved verges along both sides of Bushman Glade and Pioneer Road.

According to the Byford Town Centre LSP, footpaths are to be provide on both sides of all streets within the LSP area and a cycle network made up of dual use paths within multiple-use corridors, on road cycle lanes and shared streets are identified in the Movement Network Plan.

8.2. Bicycle Parking

The Byford Town Centre LSP does not specify bicycle provision. Schedule 4 of the Shire's TPS2 requires a provision of 1 bay per 4 practitioners for a medical centre. Based on 34 practitioners, the development would require 9 bicycle parking spaces.

The current site plan includes a secure enclosure for 7 staff bicycles and another bicycle rack with 4 spaces adjacent to the main entrance for visitors. The bicycle parking provision satisfies the minimum requirements.

9. Conclusion

A preliminary traffic review of the proposed Byford Health Hub concluded the following:

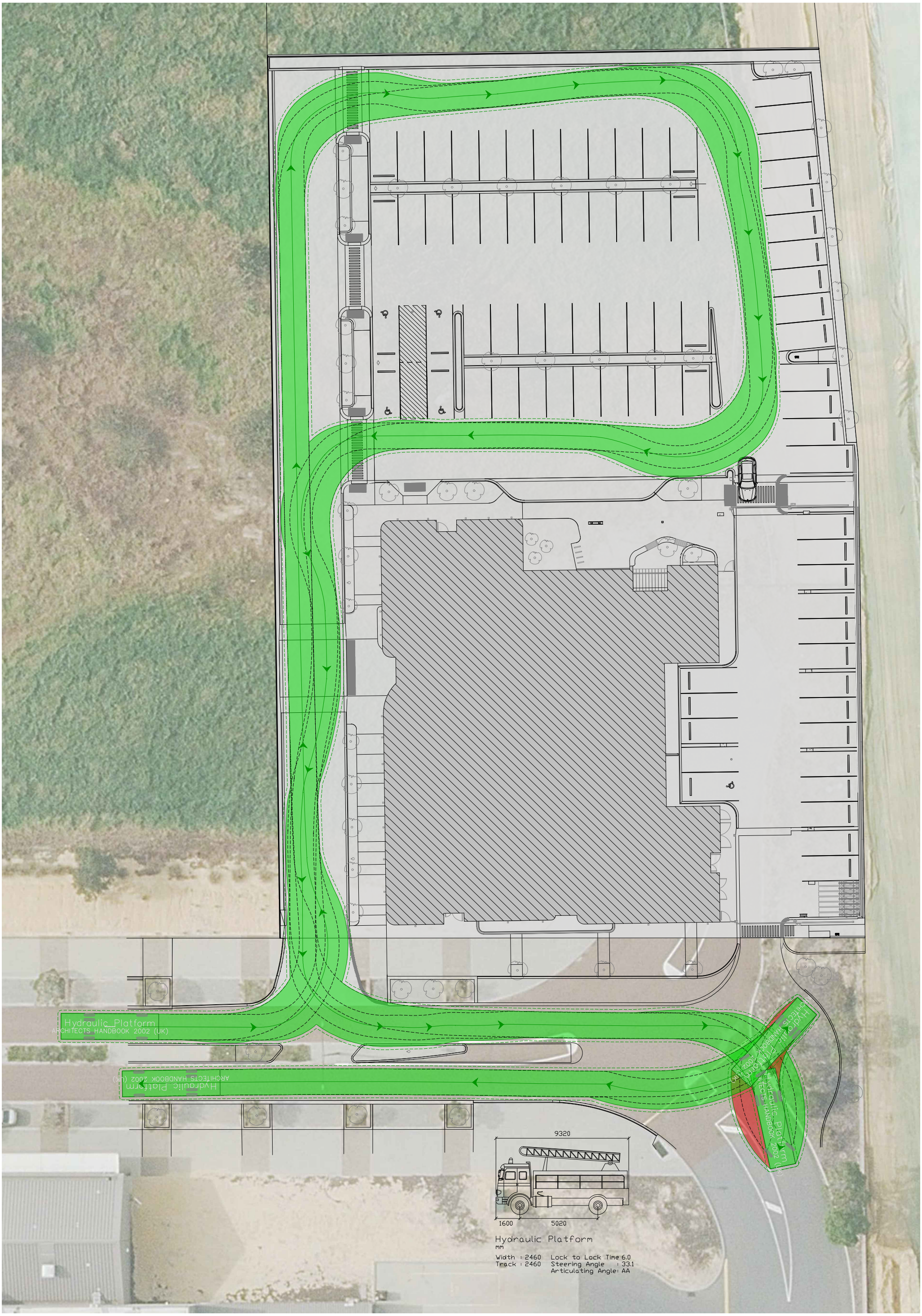
- The proposed BHH appears to be consistent with previous planning for the area.
- The proposed BHH is predicted to generate approximately 37 vehicle trips during the morning peak hour and 52 during the afternoon peak hour.
- According to the WAPC TIA guidelines, an increase of between 10 to 100 peak hour vehicles is considered to have a low to moderate impact and is generally deemed acceptable without requiring detailed capacity analysis. The estimated 37 to 52 peak hour trips is around the middle of this range and the development is therefore likely to have a low moderate impact and can be accommodated within the existing capacity of the road network.
- As mentioned previously, the Cardno assessment for the LSP included detailed capacity analysis of the proposed road network and concluded that "Overall the proposed LSP would result in minor impact to the surrounding intersections and road network. However, the impact is within manageable Level of Service and would generally occur during the peak periods only."
- The current plans indicate a provision of approximately 79 car bays which is short of the LSP requirements by 71 bays and short of the TPS2 requirements by 59 bays.
- In this instance, the shortfall is considered to be acceptable based on the following reasons:
    - The site is located adjacent to the Byford Train Station which is planned to be open in 2025 around the same time as the BHH.
    - The site is located within the Byford Town Centre and adjacent to several supermarkets (Coles, Woolworths, Aldi) with ample parking. Many patrons of Byford Health Hub will also visit adjacent businesses before and after their appointments.
    - The site will be well connected for pedestrians and cyclists with a proposed Principal Shared Path (PSP) to be constructed along the eastern boundary of the site.
    - The development includes bicycle parking for staff and visitors as well as end of trip facilities (lockers, showers and change rooms) for staff.
    - Several pick-up and drop-off bays are proposed adjacent to the building to allow patients to be picked up and dropped off by taxi or rideshare services.
- To maximise the efficient use of the available parking and to encourage alternative transport, the following parking management measures are recommended for consideration:
    - Encourage staff to walk, cycle, scoot and use public transport as much as possible. The could include subsidised public transport fees or other incentives for staff who do not drive to and from work.
    - Allocate the on-site staff parking bays to specific staff members and advise other staff not to

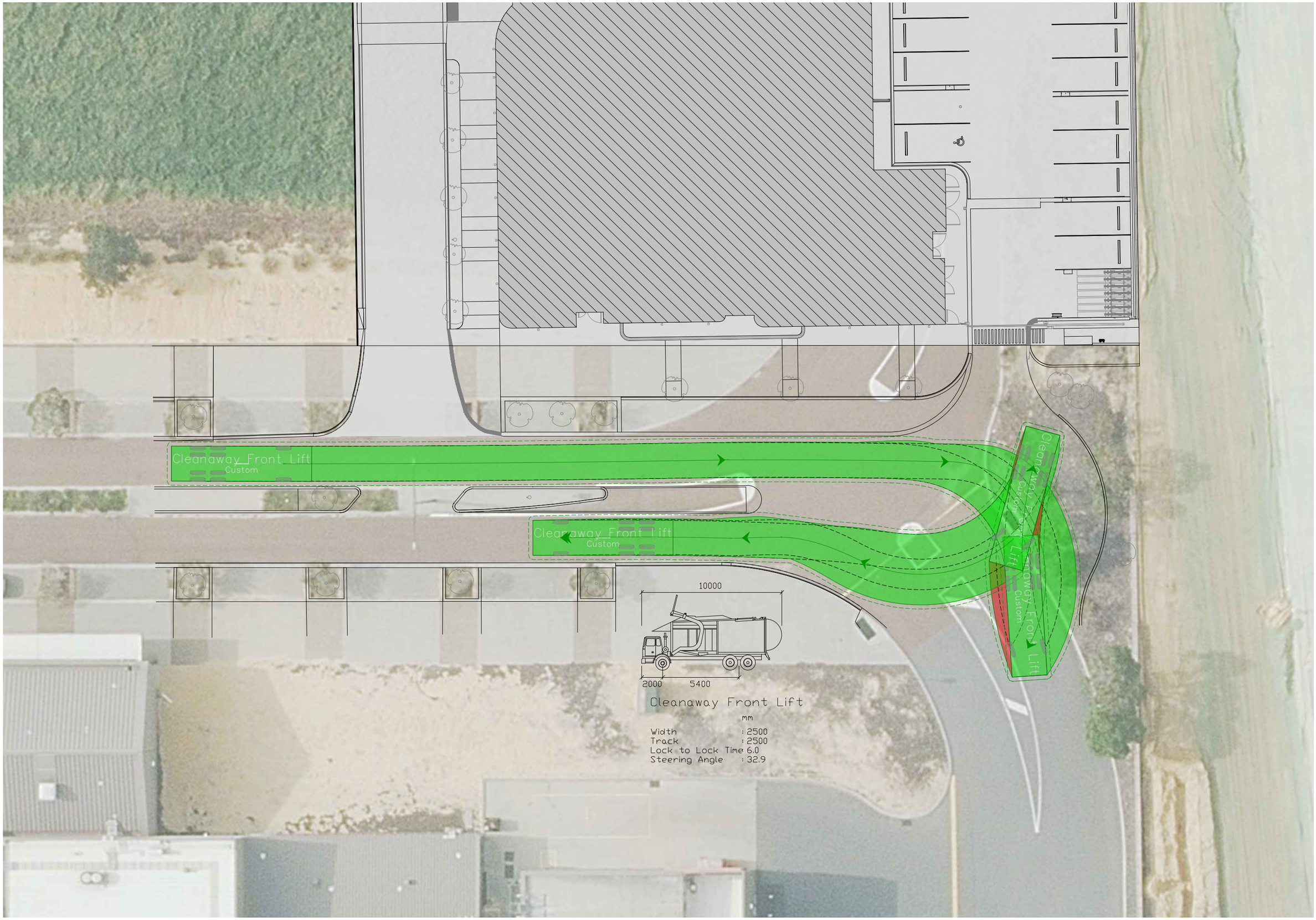
use the public parking bays for all day parking.

- Enforce time limits on the public car parking bays to discourage staff from using these bays.
- Prepare and implement a Sustainable Travel Plan (STP) including the above measures and any additional measures to encourage sustainable transport. The STP can be distributed to all staff and reviewed regularly.

- The western end of Bushman Glade will be modified to accommodate the proposed site access and the central median will be modified to restrict inbound right turns at the western access. The access arrangement is considered to be adequate.
- The minimum required sight distance is achieved in both directions at the western exit point. Vertically, the geometry of the Bushman Glade is relatively flat with no major crests or sags that would impede sight distance.
- A vehicle swept path analysis demonstrate that there is adequate room for the expected service vehicles except that the east splay of the main crossover will need slight widening and the adjacent garden bed set back to accommodate the DFES vehicle turning left out of the site.
- The swept path analysis should be updated as the design progresses.
- Bushman Glade and Pioneer Road have not been added to the Main Roads WA database and so no crashes have been recorded on the Main Roads WA Reporting Centre. The proposed development will generate a low to moderate volume of additional traffic and there is no indication that the development itself will increase the risk of crashes unacceptably.
- The existing and planned public transport services are considered to be adequate to meet the expected demand.
- The pedestrian network is progressively being developed along with the surrounding area. There are currently wide paved verges along both sides of Bushman Glade and Pioneer Road.
- According to the Byford Town Centre LSP, footpaths are to be provide on both sides of all streets within the LSP area and a cycle network made up of dual use paths within multiple-use corridors, on road cycle lanes and shared streets are identified in the Movement Network Plan.
- Based on 34 practitioners, the development would require 9 bicycle parking spaces. The current site plan includes a secure enclosure for 7 staff bicycles and another bicycle rack with 4 spaces adjacent to the main entrance for visitors. The bicycle parking provision satisfies the minimum requirements.

Appendix A – Swept Path Analysis


Hydraulic_Platform
ARCHITECTS HANDBOOK 2002 (UK)
9320
1600
5020
Hydraulic Platform
mm
Width : 2460
Track : 2460
Lock to Lock Time 6.0
Steering Angle : 33.1
Articulating Angle: AA


Cleanaway Front Lift
Custom
Cleanaway Front Lift
Custom
Cleanaway Front Lift
Custom
Cleanaway Front Lift
Custom
10000
2000
5400
Cleanaway Front Lift
mm
Width : 2500
Track : 2500
Lock to Lock Time 6.0
Steering Angle : 32.9