Contact
Jason Watkins

Our Ref
P2108447JC04V03

Pages
2 + Attachments

18 June 2025

Great River NSW Pty Ltd
Att: The Directors
By email

Dear Sirs,

Flood Impact Statement – Section 4.55 Modification to Approved Subdivision at 14-98 Old Castlereagh Road, Penrith, NSW

1 Introduction

Martens & Associates Pty Ltd (**Martens**) have prepared this flood impact statement to support a s 4.55 modification application to be submitted to Penrith City Council (the **Council**) proposing amendments to Development Application DA 9876 (the **DA**) approved on 31 March 2022 for a 93 lot community title subdivision of 14 – 98 Old Castlereagh Road, Castlereagh, NSW (the **Site**).

The proposed modifications are shown on the proposed development plans (Attachment 1) and consist of an amalgamation of a number of lots, reducing the total number of lots at the site from 93 to 71, and associated minor alterations to the internal road layout and earthworks.

2 Flooding Considerations

The following reports relevant to flood risk management at the Site were approved as part of the DA (the **Approved Reporting**) (Attachment 2):

1. Amended Flood Emergency Response Plan Version 6.2 prepared by Molino Stewart Pty Ltd dated March 2022.

2. Flood Evacuation Report (Draft) prepared by Molino Stewart Pty Ltd dated 5 November 2021.

The Approved Reporting noted the following in respect of flood risk management:

1. The 1% Annual Exceedance Probability (**AEP**) flood level for the Site was 25.0 mAHD. We note that the modelling more recently documented in the Hawkesbury-Nepean River Flood Study (June 2024) prepared by Infrastructure NSW estimates the 1% AEP flood to be 26.0 mAHD.

2. In the event occupants are onsite during a major flood event, evacuation is the primary emergency response.

3. Sufficient road capacity is available for Site occupants to evacuate safely and evacuate without adversely impacting the evacuation outcomes of the larger subsector.

4. Each business within the Site will need to develop its own flood emergency response plan consistent with the overarching approach and principles documented in the Approved Reporting.

In respect of the Proposed Modification, we note there will be no changes to the approved site population or traffic generation, and no additional earthworks below the 1% AEP flood level. Hence the development as proposed to be modified:

1. Does not materially alter required flood risk management on the Site.

2. Will not cause offsite flood impacts as the proposed earthworks are located entirely above the 1% AEP flood level.

3. Remains consistent with the Approved Reporting.

If you require any further information, please do not hesitate to our offices.

For and on behalf of

Martens & Associates Pty Ltd

Dr Daniel Martens

LLB(Hons1), BSc(Hons1), MEngSc, PhD, FIEAust, CPEng, NER, RPEQ, APEC Eng, IntPE(Aus)

Director, Principal Engineer

Attachment 1: Proposed Development Plans

NEPEAN BUSINESS PARK PENRITH

DEVELOPMENT APPLICATION

DRAWING SCHEDULE

DRAWING NUMBER	DESCRIPTION
200044-09-DA-C01.01	COVER SHEET AND DRAWING SCHEDULE
200044-09-DA-C01.21	GENERAL NOTES AND LEGENDS SHEET 1
200044-09-DA-C01.22	GENERAL NOTES AND LEGENDS SHEET 2
200044-09-DA-C01.31	STAGING PLAN
200044-09-DA-C01.41	GENERAL ARRANGEMENT PLAN
200044-09-DA-C01.81	SUBDIVISION PLAN
200044-09-DA-C01.91	COMMUNITY TITLE SUBDIVISION PLAN
200044-09-DA-C03.01	EROSION AND SEDIMENTATION CONTROL PLAN
200044-09-DA-C03.21	EROSION AND SEDIMENTATION CONTROL DETAILS
200044-09-DA-C04.01	BULK EARTHWORKS CUT AND FILL PLAN
200044-09-DA-C04.21	BULK EARTHWORKS CUT AND FILL SECTONS
200044-09-DA-C05.01	SITEWORKS AND STORMWATER MANAGEMENT PLAN SHEET 1
200044-09-DA-C05.02	SITEWORKS AND STORMWATER MANAGEMENT PLAN SHEET 2
200044-09-DA-C05.03	SITEWORKS AND STORMWATER MANAGEMENT PLAN SHEET 3
200044-09-DA-C05.04	SITEWORKS AND STORMWATER MANAGEMENT PLAN SHEET 4
200044-09-DA-C07.01	ROAD LONGITUDINAL SECTIONS
200044-09-DA-C11.01	PAVEMENT, SIGNAGE AND LINEMARKING PLAN
200044-09-DA-C13.01	STORMWATER LONGSECTIONS SHEET 1
200044-09-DA-C13.02	STORMWATER LONGSECTIONS SHEET 2
200044-09-DA-C14.01	SITEWORK DETAILS
200044-09-DA-C14.11	COUNCIL DETAILS SHEET 1
200044-09-DA-C14.12	COUNCIL DETAILS SHEET 2
200044-09-DA-C14.13	COUNCIL DETAILS SHEET 3
200044-09-DA-C14.14	COUNCIL DETAILS SHEET 4
200044-09-DA-C18.01	STORMWATER DETAILS SHEET 1
200044-09-DA-C18.02	STORMWATER DETAILS SHEET 2
200044-09-DA-C22.01	CATCHMENT PLAN
200044-09-DA-C25.01	TURNING PATH PLAN

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

ISO 9001 QUALITY · ISO 14001 ENVIRONMENT · ISO 45001 SAFETY

Scale: 0 100 200 300 400m — SCALE 1:4000 @A1

North: N

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Scale: 1:4000
First Issue Date: 04/12/2024
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Revision: 3

DATE PLOTTED: 26 February 2025 4:27 PM BY: - JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C01.01 COVER SHEET AND DRAWING SCHEDULE.dwg

SURVEY

1. THE EXISTING SITE CONDITIONS SHOWN ON THE FOLLOWING DRAWINGS HAVE BEEN SUPPLIED BY REGISTERED SURVEYORS TO PROVIDE A BASIS FOR DESIGN. THE USE OF THIS SURVEY BASE DOES NOT GUARANTEE THE ACCURACY OR COMPLETENESS OF THE SURVEY BASE OR ITS SUITABILITY AS A BASIS FOR CONSTRUCTION DRAWINGS.
1. SHOULD DISCREPANCIES BE ENCOUNTERED DURING CONSTRUCTION BETWEEN THE SURVEY DATA AND ACTUAL FIELD DATA, CONTACT THE DESIGN ENGINEER.
2. THE RELATIONSHIP OF IMPROVEMENTS TO BOUNDARIES ARE DIAGRAMMATIC ONLY. WHERE DISTANCES TO BOUNDARIES ARE CRITICAL THEY SHOULD BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION BY FURTHER SURVEY.

LEGEND

BM	BENCHMARK
CL	CENTRELINE OF ROAD
EB	EDGE OF BITUMEN
HYD	HYDRANT
HW	HEADWALL
IK	INVERT OF KERB
IL	INVERT LEVEL
LK	LIP OF KERB
PP	POWER POLE
SMH	SEWER MANHOLE
SV	STOP VALVE
TEL	TELSTRA PIT
TK	TOP OF KERB
TOW	TOP OF WALL
VC	VEHICLE CROSSING
WELL	MONITORING WELL

GENERAL

1. ALL WORKS TO BE CONSTRUCTED IN ACCORDANCE WITH PENRITH CITY COUNCIL STANDARDS.
2. PENRITH CITY COUNCIL STANDARD DETAILS TO BE USED WHERE POSSIBLE.
3. UTILITY ADJUSTMENTS AT DEVELOPERS EXPENSE.
4. CONDUITS TO BE PLACED WHERE REQUIRED BY THE RELEVANT AUTHORITIES.
5. SUBSOIL DRAINAGE LINES AND FLUSHING POINTS AT MAXIMUM 60m CENTRES SHALL BE INSTALLED BEHIND ALL KERBS.
6. A MINIMUM OF 3m OF SUBSOIL LINE SHALL BE LAID INTO UPSTREAM SIDE OF ALL DRAINAGE PITS.

EXISTING SERVICES LEGEND

EXISTING

OVERHEAD ELECTRICAL — e o/h

COMMUNICATIONS — c

SEWER — s

POTABLE WATER — pw

PROPOSED

WATER RISING MAIN (DESIGN BY OTHERS) — W

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DIAL 1100 BEFORE YOU DIG

EXISTING SERVICES

1. ALL UTILITY SERVICES INDICATED ON THE DRAWINGS ORIGINATE FROM SUPPLIED DATA, THEREFORE THEIR ACCURACY AND COMPLETENESS IS NOT GUARANTEED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO DETERMINE AND CONFIRM THE LOCATION AND LEVEL OF ALL EXISTING SERVICES PRIOR TO THE COMMENCEMENT OF ANY WORK. ANY DISCREPANCIES SHALL BE REPORTED TO THE SUPERINTENDENT. CLEARANCES SHALL BE OBTAINED FROM THE RELEVANT SERVICE AUTHORITY.
2. CARE TO BE TAKEN WHEN EXCAVATING NEAR EXISTING SERVICES. NO MECHANICAL EXCAVATIONS ARE TO BE UNDERTAKEN OVER ALL LIVE SERVICES. HAND EXCAVATION ONLY IN THESE AREAS.
3. THE CONTRACTOR SHALL PROTECT AND MAINTAIN ALL EXISTING SERVICES THAT ARE TO BE RETAINED IN THE VICINITY OF THE PROPOSED WORKS. ANY AND ALL DAMAGE TO THESE SERVICES AS A RESULT OF THESE WORKS SHALL BE REPAIRED BY THE CONTRACTOR UNDER THE DIRECTION OF THE SUPERINTENDENT, AND AT NO EXTRA COST.
4. THE CONTRACTOR SHALL ALLOW IN THE PROGRAM FOR ADJUSTMENT (IF REQUIRED) OF EXISTING SERVICES IN AREAS AFFECTED BY WORKS.
5. THE CONTRACTOR SHALL ALLOW IN THE PROGRAM FOR THE CAPPING OFF, EXCAVATION AND REMOVAL (IF REQUIRED) OF EXISTING SERVICES IN AREA AFFECTED BY WORKS UNLESS DIRECTED OTHERWISE ON THE DRAWINGS OR BY THE SUPERINTENDENT.
6. THE CONTRACTOR SHALL ENSURE THAT AT ALL TIMES SERVICES TO ALL BUILDINGS NOT AFFECTED BY THE WORKS ARE NOT DISRUPTED.
7. PRIOR TO COMMENCEMENT OF ANY WORKS THE CONTRACTOR SHALL GAIN APPROVAL OF THE PROGRAM FOR THE RELOCATION AND/OR CONSTRUCTION OF TEMPORARY SERVICES AND FOR ANY ASSOCIATED INTERRUPTION OF SUPPLY.
8. THE CONTRACTOR SHALL CONSTRUCT TEMPORARY SERVICES TO MAINTAIN EXISTING SUPPLY TO BUILDINGS REMAINING IN OPERATION DURING WORKS TO THE SATISFACTION AND APPROVAL OF THE SUPERINTENDENT. ONCE DIVERSION IS COMPLETE AND COMMISSIONED THE CONTRACTOR SHALL REMOVE ALL SUCH TEMPORARY SERVICES AND MAKE GOOD TO THE SATISFACTION OF THE SUPERINTENDENT.
9. PRIOR TO ANY DEMOLITION, EXCAVATION OR CONSTRUCTION A THOROUGH SEARCH OF ALL SERVICE AUTHORITIES SHOULD BE MADE TO DETERMINE THE POSSIBLE LOCATION OF ANY FURTHER UNDERGROUND SERVICES.
10. AUTHORITY PLANS GENERALLY SHOW ONLY THE PRESENCE OF CABLES AND PLANT AND DO NOT WARRANT OR GUARANTEE THAT SUCH PLANS ARE ACCURATE. DO NOT ASSUME DEPTH OR ALIGNMENT OF CABLES OR PLANT AS THESE VARY SIGNIFICANTLY. THE CONTRACTOR HAS A DUTY OF CARE WHEN EXCAVATING NEAR EXISTING SERVICES AND PLANT. BEFORE USING MACHINE EXCAVATORS SERVICES MUST FIRST BE PHYSICALLY EXPOSED BY SOFT DIG POTHOLING TO IDENTIFY IT'S LOCATION.
11. THE CONTRACTOR IS TO UNDERTAKE A DIAL-BEFORE-YOU-DIG SEARCH PRIOR TO ANY EXCAVATION AND MAINTAIN A CURRENT SET ON-SITE DURING EXCAVATION WORKS.
12. THE LOCATIONS OF UNDERGROUND SERVICES SHOWN IN THIS SET OF DRAWINGS HAVE BEEN PLOTTED FROM SURVEY INFORMATION AND SERVICE AUTHORITY INFORMATION. THE SERVICE INFORMATION HAS BEEN PREPARED ONLY TO SHOW THE APPROXIMATE POSITIONS OF ANY KNOWN SERVICES AND MAY NOT BE AS CONSTRUCTED OR ACCURATE.ENSPIRE SOLUTIONS CAN NOT GUARANTEE THAT THE SERVICES INFORMATION SHOWN ON THESE DRAWINGS ACCURATELY INDICATES THE PRESENCE OR ABSENCE OF SERVICES OR THEIR LOCATION AND WILL ACCEPT NO LIABILITY FOR INACCURACIES IN THE SERVICES INFORMATION SHOWN FROM ANY CAUSE WHATSOEVER.
13. CONTRACTORS SHALL TAKE DUE CARE WHEN EXCAVATING ONSITE INCLUDING HAND EXCAVATION WHERE NECESSARY. CONTRACTORS ARE TO CONTACT THE RELEVANT SERVICE AUTHORITY PRIOR TO COMMENCEMENT OF EXCAVATION WORKS. CONTRACTORS ARE TO UNDERTAKE A SERVICES SEARCH, PRIOR TO COMMENCEMENT OF WORKS ON SITE. SEARCH RESULTS ARE TO BE KEPT ON SITE AT ALL TIMES.
14. THE WORKS WILL BE UNDERTAKEN IN A STAGED MANNER AS OUTLINED IN THE STAGING PLAN. HOWEVER, THE SEQUENCE OF STAGING MAY VARY AND WILL NOT NECESSARILY FOLLOW A SEQUENTIAL ORDER.
15. THE WORKS WILL INCLUDE ALL SERVICES, INCLUDING BUT NOT LIMITED TO SEWER, WATER, POWER, NBN, FIRE MAINS, SPRINKLER MAINS AND ASSOCIATED INFRASTRUCTURE TO SERVICE THE LOTS.

EARTHWORKS

1. AT THE COMMENCEMENT OF THE CUT AND FILLING OPERATIONS FOR BULK EARTHWORKS A GEOTECHNICAL ENGINEER IS TO VISIT THE SITE & CONFIRM THE SUITABILITY OF THE METHODOLOGY OF ACHIEVING THE REQUIRED BUILDING PLATFORMS AND COMPACTION REQUIREMENTS. SUBSEQUENTLY, THE HEAD CONTRACTOR IS TO CONFIRM, IN WRITING TO THE DESIGNING CIVIL & STRUCTURAL ENGINEERS, THAT THE METHODOLOGY APPROVED AT THE TIME OF THE GEOTECHNICAL ENGINEERS VISIT WAS MAINTAINED DURING ALL THE BULK EARTHWORKS PROCESS.
2. WHERE FILLING, STRUCTURAL SLABS OR PAVEMENTS ARE REQUIRED, PROOF ROLL THE EXPOSED NATURAL SURFACE WITH A MINIMUM OF TEN PASSES OF A SMOOTH DRUM VIBRATING ROLLER (MINIMUM STATIC WEIGHT OF 10 TONNES) TO DETECT THEN REMOVE SOFT SPOTS (AREAS WITH MORE THAN 2mm MOVEMENT UNDER ROLLER) IN THE PRESENCE OF THE SUPERINTENDENT. THE CONTRACTOR IS TO ALLOW TO REMOVE AND REPLACE A PROVISIONAL QUANTITY OF UNSUITABLE SUBGRADE MATTER. THE UNDERLYING GEOTECHNICAL GROUND CONDITIONS WILL BE REHABILITATED AS NECESSARY TO SUPPORT FUTURE BUILDING USE IN ACCORDANCE WITH THE GEOTECHNICAL ENGINEERS REQUIREMENTS.
3. ALL SOFT, WET OR UNSUITABLE MATERIAL IS TO BE REMOVED AS DIRECTED BY THE SUPERINTENDENT AND REPLACED WITH APPROVED MATERIAL SATISFYING THE REQUIREMENTS LISTED BELOW.
4. EXCAVATED MATERIAL IS NOT TO BE USED AS STRUCTURAL FILL UNLESS APPROVED BY THE GEOTECHNICAL ENGINEER.

   THE CONTRACTOR IS TO PROVIDE CERTIFICATES VERIFYING THE QUALITY OF IMPORTED MATERIAL FOR THE SUPERINTENDENTS APPROVAL.
5. ALL FILL MATERIAL SHALL BE PLACED IN MAXIMUM 200mm THICK LAYERS AND COMPACTED AT OPTIMUM MOISTURE CONTENT (+ OR - 2%) TO ACHIEVE A DRY DENSITY DETERMINED IN ACCORDANCE WITH AS1289 E3.1 OF NOT LESS THAN THE FOLLOWING STANDARD MINIMUM DRY DENSITY IN ACCORDANCE WITH AS1289 E5.1.1.1:

LOCATION	COMPACTION REQUIREMENT
UNDER BUILDING SLABS	98% SMDD
LANDSCAPED AREAS	95% SMDD
ROADS & PAVED AREAS	98% SMDD

6. FOR NON COHESIVE MATERIAL, COMPACT TO NOT LESS THAN

UNDER ROAD	80% DENSITY
OTHER AREA	75% DENSITY

7. THE CONTRACTOR IS TO ALLOW FOR COMPACTION TESTING BY NATA REGISTERED LABORATORY FOR PLATFORMS AND FILL LAYERS IN ACCORDANCE WITH THE LATEST VERSION OF AS3798 - FOR TYPE 1 OPERATIONS (MINIMUM 3 TESTS PER LAYER).
8. FREQUENCY OF COMPACTION TESTING SHALL NOT BE LESS THAN:
   A. 1 TEST PER 200m^3 OF FILL PLACED PER 300mm LAYER OF FILL
   B. 3 TESTS PER VISIT
   C. 1 TEST PER 1000m² OF EXPOSED SUBGRADE
   D. TESTING SHALL BE "LEVEL 1" UNDERTAKEN IN ACCORDANCE WITH AS1398.
10. WHERE TEST RESULTS ARE BELOW THE SPECIFIED COMPACTION, RECOMPACT AND RETEST UNTIL SPECIFIED COMPACTION STANDARD IS ACHIEVED.
11. ALLOW FOR EXCAVATION IN ALL MATERIALS AS FOUND U.N.O. NO ADDITIONAL PAYMENTS WILL BE MADE FOR EXCAVATION IN WET OR HARD GROUND.
12. WHERE THERE IS INSUFFICIENT EXCAVATED MATERIAL SUITABLE FOR FILLING OR SUBGRADE REPLACEMENT, THE CONTRACTOR IS TO ALLOW TO IMPORT FILL. IMPORTED FILL SHALL COMPLY WITH THE FOLLOWING:
   A. MAXIMUM SIZE 50mm. PASSING 75 MICRON SIEVE (<25%).
   B. PLASTICITY INDEX BETWEEN 2-15% AND CBR>8.
   C. FREE FROM ORGANIC AND PERISHABLE MATTER.
13. REFER TO THE SITE SPECIFIC GEOTECHNICAL REPORT FOR GENERAL REQUIREMENTS ON SITE PREPARATION AND RE-USE OF EXISTING SITE MATERIAL AS ENGINEERED FILL.
14. THE CONTRACTOR SHALL PROGRAM THE EARTHWORKS OPERATION SO THAT THE WORKING AREAS ARE ADEQUATELY DRAINED DURING THE PERIOD OF CONSTRUCTION. THE SURFACE SHALL BE GRADED AND SEALED OFF TO REMOVE DEPRESSIONS, ROLLER MARKS AND SIMILAR WHICH WOULD ALLOW WATER TO POND AND PENETRATE THE UNDERLYING MATERIAL. ANY DAMAGE RESULTING FROM THE CONTRACTOR NOT OBSERVING THESE REQUIREMENTS SHALL BE RECTIFIED AT THEIR COST.
15. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO ENSURE AND MAINTAIN THE INTEGRITY OF ALL SERVICES, CONDUITS AND PIPES DURING CONSTRUCTION, SPECIFICALLY DURING THE BACKFILLING AND COMPACTION PROCEDURE. ANY AND ALL DAMAGE TO NEW OR EXISTING SERVICES AS A RESULT OF THESE WORKS SHALL BE REPAIRED BY THE CONTRACTOR AT NO EXTRA COST.

STORMWATER DRAINAGE NOTES

1. STORMWATER DESIGN CRITERIA:
   (A) ANNUAL EXCEEDANCE PROBABILITIES (AEP):
   5% MINOR (PIPED) NETWORK
   1% MAJOR (OVERLAND FLOW) SYSTEM
   (B) RAINFALL INTENSITIES:
   ARR 1987 RAINFALL FROM BUREAU OF METEOROLOGY WEBSITE
   (C) HYDROLOGIC METHOD:
   DRAINS / 12D WITH ILSAX METHOD
2. PIPES 375 DIA. AND LARGER TO BE REINFORCED CONCRETE CLASS '2' APPROVED SPIGOT AND SOCKET WITH RUBBER RING JOINTS. U.N.O.
3. PIPES 300 DIA AND LESS SHALL BE DWV GRADE (CLASS SN8) uPVC WITH SOLVENT WELDED JOINTS.
4. EQUIVALENT STRENGTH FRC PIPES MAY BE USED.
5. ALL PIPES ARE TO BE UNIFORMLY SUPPORTED ALONG THE LENGTH OF THE BARREL BY SUITABLE FILL MATERIAL.
6. PIPES WITH SOCKETS SHALL BE LAID IN BEDDING WHERE SUITABLE RECESSES HAVE BEEN PROVIDED TO ENSURE PIPES DO NOT BEAR ON THEIR SOCKETS.
7. ALL STORMWATER DRAINAGE LINES UNDER PROPOSED BUILDING SLABS TO BE uPVC PRESSURE PIPE PN6. ENSURE ALL VERTICALS AND DOWNPIPES ARE uPVC PRESSURE PIPE, GRADE 6 FOR A MIN OF 3.0m IN HEIGHT.
8. PIPES TO BE INSTALLED TO TYPE HS2 SUPPORT IN ACCORDANCE WITH AS 3725 (2007) IN ALL CASES BACKFILL TRENCH WITH SAND TO 300mm ABOVE PIPE. WHERE PIPE IS UNDER PAVEMENTS BACKFILL REMAINDER OF TRENCH TO UNDERSIDE OF PAVEMENT WITH SAND OR APPROVED GRANULAR MATERIAL COMPACTED IN 150mm LAYERS TO MINIMUM 98% STANDARD MAXIMUM DRY DENSITY IN ACCORDANCE WITH AS 1289 5.2.1. (OR A DENSITY INDEX OF NOT LESS THAN 75).
9. REFER TO AS/NRS 3725:2007 TABLE B1 FOR REQUIRED FILL DEPTHS ABOVE PIPE BARREL PRIOR TO USE OF COMPACTION MACHINERY OR TRAVERSING OF PIPES BY GENERAL SITE EQUIPMENT.
10. WHERE WORKING METHODS REQUIRE HIGHER CLASS PIPE, THE CONTRACTOR SHALL REFER TO AS 3725 (2007) TO DETERMINE THE APPROPRIATE PIPE CLASS. PROPOSED PIPE CLASS SHALL BE REVIEWED BY ENSPIRE SOLUTIONS PRIOR TO INSTALLATION.
11. ALL INTERNAL WORKS WITHIN PROPERTY BOUNDARIES ARE TO COMPLY WITH THE REQUIREMENTS OF AS/NZS 3500.3:2015.
12. PRECAST PITS MAY BE USED EXTERNAL TO THE BUILDING SUBJECT TO APPROVAL BY ENSPIRE SOLUTIONS.
13. ENLARGERS, CONNECTIONS AND JUNCTIONS TO BE PREFABRICATED FITTINGS WHERE PIPES ARE LESS THAN 300 DIA.
14. WHERE SUBSOIL DRAINS PASS UNDER FLOOR SLABS AND VEHICULAR PAVEMENTS, UNSLOTTED uPVC SEWER GRADE PIPE IS TO BE USED.
15. CARE IS TO BE TAKEN WITH LEVELS OF STORMWATER LINES. GRADES SHOWN ARE NOT TO BE REDUCED WITHOUT APPROVAL.
16. GRATES AND COVERS SHALL CONFORM TO AS 3996.
17. ALL BOX CULVERTS SHALL BE STRUCTURALLY DESIGNED BY THE MANUFACTURER AND DELIVERED TO SITE AS FIT FOR PURPOSE.
18. AT ALL TIMES DURING CONSTRUCTION OF STORMWATER PITS, ADEQUATE SAFETY PROCEDURES SHALL BE TAKEN TO ENSURE AGAINST THE POSSIBILITY OF PERSONNEL FALLING DOWN PITS.
19. ALL EXISTING STORMWATER DRAINAGE LINES AND PITS THAT ARE TO REMAIN ARE TO BE INSPECTED AND CLEANED. DURING THIS PROCESS ANY PART OF THE STORMWATER DRAINAGE SYSTEM THAT WARRANTS REPAIR SHALL BE REPORTED TO THE SUPERINTENDENT/ENGINEER FOR FURTHER DIRECTIONS.

KERBS

1. ALL KERBS, GUTTERS, DISH DRAINS AND CROSSINGS TO BE CONSTRUCTED ON 175mm GRANULAR BASECOURSE COMPACTED TO MINIMUM 95% MODIFIED DRY DENSITY (AS 1289 5.2.1).
2. EXPANSION JOINTS (E.J) TO BE FORMED FROM 10mm COMPRESSIBLE FOAM FILLER BOARD FOR THE FULL DEPTH OF THE SECTION AND CUT TO PROFILE. EXPANSION JOINTS TO BE LOCATED AT DRAINAGE PITS, ON TANGENT POINTS OF CURVES AND ELSEWHERE AT MAX 12m CENTRES EXCEPT FOR INTEGRAL KERBS WHERE THE EXPANSION JOINTS ARE TO MATCH THE JOINT LOCATIONS IN THE SLABS.
3. WEAKENED PLANE JOINTS TO BE MIN 3mm WIDE AND LOCATED AT 3m CENTRES EXCEPT FOR INTEGRAL KERBS WHERE THE WEAKENED PLANE JOINTS ARE TO MATCH THE JOINT LOCATIONS IN THE SLABS.
4. EXISTING ALLOTMENT DRAINAGE PIPES ARE TO BE BUILT INTO THE NEW KERB AND GUTTER WITH 100mm DIA HOLE OR IN ACCORDANCE WITH LOCAL AUTHORITY REQUIREMENTS.
5. IN THE REPLACEMENT OF KERB AND GUTTER :-
   EXISTING ROAD PAVEMENT IS TO BE SAWCUT 600mm U.N.O FROM THE LIP OF GUTTER. UPON COMPLETION OF THE NEW KERB AND GUTTER NEW BASECOURSE AND SURFACE TO BE LAID 600mm WIDE U.N.O.

CONCRETE

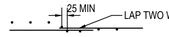
1. THIS SECTION REFERS TO CIVIL CONCRETE WORKS AND DOES NOT INCLUDE BUILDINGS OR BRIDGE STRUCTURES.
2. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH AS 3600 CURRENT EDITION WITH AMENDMENTS, EXCEPT WHERE VARIED BY THE CONTRACT DOCUMENTS.
3. CONCRETE QUALITY;
   ALL REQUIREMENTS OF THE CURRENT ACSE CONCRETE SPECIFICATION DOCUMENT 1 SHALL APPLY TO THE FORMWORK, REINFORCEMENT AND CONCRETE UNLESS NOTED OTHERWISE.

ELEMENT	AS 3600 F'c MPa AT 28 DAYS	SPECIFIED SLUMP	NOMINAL AGG. SIZE	MAX 56 DAY DRYING SHRINKAGE
KERBS AND PATHS	25	60	20	650um
PITS AND VEHICULAR PAVEMENTS	32	80	20	650um

4. CONCRETE PROPERTIES FOR SLABS AND BEAMS SHALL BE VARIED FROM NORMAL CLASS AS FOLLOWS:
   A. MINIMUM CEMENT CONTENT 250kg/m3
   B. MAXIMUM 56 DAY SHRINKAGE STRAIN = AS NOMINATED ABOVE
   C. PRIOR TO COMMENCEMENT CONCRETE SUPPLIER TO PROVIDE DRYING SHRINKAGE TEST RESULTS FROM PRODUCTION ASSESSMENT AS EVIDENCE THAT SPECIFIED DRYING SHRINKAGE LIMITS CAN BE ACHIEVED USING NORMAL MIX DESIGN.
5. CEMENT TYPE SHALL BE (ACSE SPECIFICATION) TYPE SL
6. PROJECT CONTROL TESTING SHALL BE CARRIED OUT IN ACCORDANCE WITH AS 1379.
7. NO ADMIXTURES SHALL BE USED IN CONCRETE UNLESS APPROVED IN WRITING BY THE DESIGN ENGINEER.
8. CLEAR CONCRETE COVERS SHALL BE (UNO):

ENVIRONMENT	COVER
A. SURFACES OF MEMBERS CAST AGAINST, AND IN CONTACT WITH THE GROUND	50mm
B. SURFACES OF MEMBERS CAST AGAINST, AND IN CONTACT WITH THE GROUND SEPARATED BY MEMBRANE	40mm
C. SURFACES OF MEMBERS IN ABOVE GROUND EXTERIOR ENVIRONMENTS	40mm
D. SURFACES OF MEMBERS IN INTERIOR ENVIRONMENTS	20mm

9. ALL REINFORCEMENT SHALL BE FIRMLY SUPPORTED ON MILD STEEL PLASTIC TIPPED CHAIRS, PLASTIC CHAIRS OR CONCRETE CHAIRS AT NOT GREATER THAN 1m CENTRES BOTH WAYS. BARS SHALL BE TIED AT ALTERNATE INTERSECTIONS.
10. THE FINISHED CONCRETE SHALL BE A DENSE HOMOGENEOUS MASS, COMPLETELY FILLING THE FORMWORK, THOROUGHLY EMBEDDING THE REINFORCEMENT AND FREE OF STONE POCKETS.
11. FABRIC SHALL BE LAPPED IN ACCORDANCE WITH THE FOLLOWING DETAIL:

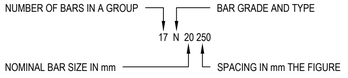


FOLLOWING THE FABRIC SYMBOL SL IS THE REFERENCE NUMBER FOR FABRIC TO AS 1304.

12. ALL PENETRATIONS TO HAVE 2/N12 TRIMMER BARS TOP AND BOTTOM TO EACH FACE U.N.O. EXTEND TRIMMERS 700 BEYOND PENETRATION.
13. FORMWORK CLASS SHALL BE IN ACCORDANCE WITH AS380.
14. SURFACE FINISHES:

ELEMENT	FORMWORK CLASS
STORMWATER PIT	OFF FORM
PAVEMENTS	MACHINE FLOAT/BROOM FINISHED
KERBS	STEEL FLOAT/TROWEL

15. REINFORCEMENT SYMBOLS:
    N DENOTES GRADE 450 N BARS TO AS 1302 GRADE N
    R DENOTES 230 R HOT ROLLED PLAIN BARS TO AS 1302
    SL DENOTES HARD-DRAWN WIRE REINFORCING FABRIC TO AS 1304



REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale:

North:

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Project: NEPEAN BUSINESS PARK
PENRITH

Scale:

First Issue Date: 04/12/2024

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Title: GENERAL NOTES AND LEGENDS
SHEET 1

Size: A1

Datum: AHD

Project Number/Drawing Number: 200044-09-DA-C01.21

Revision: 2

DATE PLOTTED: 26 February 2025 4:27 PM BY: - JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C01.21-C01.22 GENERAL NOTES AND LEGENDS.dwg

SITEWORKS

1. ALL WORKS TO BE IN ACCORDANCE WITH LOCAL AUTHORITY REQUIREMENTS, SPECIFICATIONS AND AUSTRALIAN STANDARDS. CONFLICTS SHALL BE REFERRED TO THE SUPERINTENDENT FOR DIRECTION.
2. CONTRACTOR MUST VERIFY ALL DIMENSIONS AND EXISTING LEVELS ON SITE PRIOR TO COMMENCEMENT OF WORK. ANY DISCREPANCIES TO BE REPORTED TO THE DESIGN ENGINEER.
3. THE CONTRACTOR IS TO DESIGN, OBTAIN APPROVALS AND CARRY OUT REQUIRED TEMPORARY TRAFFIC CONTROL PROCEDURES DURING CONSTRUCTION IN ACCORDANCE WITH RMS AND LOCAL AUTHORITY REGULATIONS AND REQUIREMENTS.
4. THE CONTRACTOR IS TO OBTAIN ALL AUTHORITY APPROVALS AS REQUIRED.
5. RESTORE ALL PAVED, COVERED, GRASSED AND LANDSCAPED AREAS TO THEIR ORIGINAL CONDITION ON COMPLETION OF WORKS.
6. ON COMPLETION OF ANY TRENCHING WORKS, ALL DISTURBED AREAS SHALL BE RESTORED TO THEIR ORIGINAL CONDITION, INCLUDING KERBS, FOOTPATHS, CONCRETE AREAS, GRAVEL, GRASSED AREAS AND ROAD PAVEMENTS.
7. THE CONTRACTOR SHALL ARRANGE ALL SURVEY SETOUT TO BE CARRIED OUT BY A REGISTERED SURVEYOR.
8. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING LEVELS ON SITE PRIOR TO LODGMENT OF TENDER AND ON SITE WORKS. THE PRICE AS TENDERED SHALL BE INCLUSIVE OF ALL WORKS SHOWN ON THE TENDER PROJECT DRAWINGS. ADDITIONAL PAYMENTS FOR WORKS SHOWN ON THE TENDER PROJECT DRAWINGS WILL NOT BE APPROVED.
9. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE ENGINEERING PLANS AND SPECIFICATIONS, AND ANY OTHER WRITTEN INSTRUCTIONS THAT MAY BE ISSUED RELATING TO DEVELOPMENT OF THE SUBJECT SITE.
10. 14. THESE PLANS SHALL BE READ IN CONJUNCTION WITH ALL APPROVED DRAWINGS AND SPECIFICATIONS PREPARED BY OTHER PROJECT CONSULTANTS.
11. 10. DO NOT OBTAIN DIMENSIONS BY SCALING THE DRAWINGS. ALL DIMENSIONS ARE IN MILLIMETERS (mm) AND ALL LEVELS ARE IN METERS (m), UNO. ALL LEVELS ARE TO AUSTRALIAN HEIGHT DATUM (AHD).
12. 11. IN CASE OF DOUBT OR DISCREPANCY REFER TO THE DESIGN ENGINEER AND SUPERINTENDENT FOR CLARIFICATION OR CONFIRMATION PRIOR TO THE COMMENCEMENT OF CONSTRUCTION. OTHERWISE THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE COST OF REMEDIATION WORKS.
13. 12. WHERE NEW WORKS ABUT EXISTING THE CONTRACTOR SHALL ENSURE THAT A SMOOTH EVEN PROFILE, FREE FROM ABRUPT CHANGES IS OBTAINED.
14. THE CONTRACTOR SHALL COMPLY WITH ALL STATUTORY AND INDUSTRIAL REQUIREMENTS FOR PROVISION OF A SAFE WORKING ENVIRONMENT INCLUDING TRAFFIC CONTROL.
15. THE CONTRACTOR SHALL ENSURE THAT AT ALL TIMES ACCESS TO ALL BUILDINGS ADJACENT THE WORKS IS NOT DISRUPTED.
16. WHERE NECESSARY THE CONTRACTOR SHALL PROVIDE SAFE PASSAGE OF VEHICLES AND/OR PEDESTRIANS THROUGH OR BY THE SITE.
17. WHERE NOTED ON THE DRAWINGS THAT WORKS ARE TO BE CARRIED BY OTHERS, (eg. ADJUSTMENT OF SERVICES), THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE CO-ORDINATION OF THESE WORKS.
18. ALL VARIATIONS TO SPECIFIED PRODUCTS OR DESIGNS SHALL BE REFERRED TO THE DESIGN ENGINEER IN WRITING FOR APPROVAL.
19. ANY EXISTING TREES WHICH FORM PART OF THE FINAL LANDSCAPING PLAN WILL BE PROTECTED FROM CONSTRUCTION ACTIVITIES BY:
    - A. PROTECTING THEM WITH BARRIER FENCING OR SIMILAR MATERIALS INSTALLED OUTSIDE THE DRIP LINE
    - B. ENSURING THAT NOTHING IS NAILED TO THEM
    - C. PROHIBITING PAVING, GRADING, SEDIMENT WASH OR PLACING OF STOCKPILES WITHIN THE DRIP LINE EXCEPT UNDER THE FOLLOWING CONDITIONS:
        - C.a. ENCROACHMENT ONLY OCCURS ON ONE SIDE AND NO CLOSER TO THE TRUNK THAN EITHER 1.5 METRES OR HALF THE DISTANCE BETWEEN THE OUTER EDGE OF THE DRIP LINE AND THE TRUNK, WHICH EVER IS THE GREATER
        - C.b. A DRAINAGE SYSTEM THAT ALLOWS AIR AND WATER TO CIRCULATE THROUGH THE ROOT ZONE (E.G. A GRAVEL BED) IS PLACED UNDER ALL FILL LAYERS OF MORE THAN 300 MILLIMETRES DEPTH
        - C.c. CARE IS TAKEN NOT TO CUT ROOTS UNNECESSARILY NOR TO COMPACT THE SOIL AROUND THEM.
20. EPA AND COUNCIL REQUIREMENTS MUST BE ADHERED TO REGARDING THE LEVEL OF NOISE AND WORKING HOURS, TO ENSURE THAT RESIDENTS AND OTHER APPLICABLE NEIGHBOURS TO THE SITE ARE NOT DISTURBED UNREASONABLY. THE GENERATION OF NOISE MUST BE MINIMISED.

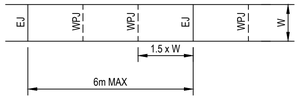
PAVEMENTS

1. ALL PAVEMENT MATERIALS SHALL COMPLY WITH CURRENT RTA SPECIFICATIONS. PROVIDE MECHANICAL ANALYSIS FOR EACH BATCH OF PAVEMENT MATERIAL TO ENSURE CONFORMITY.
2. COMPACTION STANDARDS:
    - A) BASE: 98% MODIFIED MAXIMUM DRY DENSITY
    - B) SUBBASE: 95% MODIFIED MAXIMUM DRY DENSITY
3. THE CONTRACTOR SHALL CONFIRM THE DESIGN CBR WITH A MINIMUM OF 3 TESTS TAKEN AT SUBGRADE LEVEL. WHERE DISCREPANCY IS FOUND, CONTACT THE DESIGNING ENGINEER.
4. ALLOW FOR COMPACTION TESTING BY NATA REGISTERED LABORATORY FOR: BASE LAYER, SUBBASE LAYER, SUBGRADE IN ACCORDANCE WITH THE LATEST VERSION OF AS3798 FOR PAVEMENTS. ALLOW FOR AT LEAST TWO SUCCESSFUL COMPACTION TESTS IN EACH LAYER.
5. MATCH NEW PAVEMENT LAYERS NEATLY AND FLUSH WITH EXISTING WHERE REQUIRED.
6. KEY NEW BASE AND SUBBASE LAYERS INTO EXISTING WITH 150mm WIDE STEPS. ASPHALTIC CONCRETE WAERING COURSE IS TO EXTEND 150mm (MIN) PAST BASECOURSE INTERFACE.
7. TRENCHES THROUGH EXISTING ROAD AND CONCRETE PAVEMENTS SHALL BE SAWCUT TO FULL DEPTH OF CONCRETE AND A MIN 50mm IN BITUMINOUS PAVING.
8. ALL ASPHALTIC CONCRETE (AC) WORK TO BE PREPARED AND CARRIED OUT IN ACCORDANCE WITH GOOD ASPHALTIC PAVING PRACTICE AS DESCRIBED IN AS2734-1994 "ASPHALT (HOT-MIXED) PAVING - GUIDE TO GOOD PRACTICE" AND CURRENT RMS SPECIFICATIONS (R116).
9. WHERE NOMINATED, THE CONTRACTOR SHALL ALLOW FOR ALL COMPONENTS OF PROPRIETARY JOINTING SYSTEMS INCLUDING FIXING, TEMPLATES & PEGGING TO ENSURE THAT ALL DOWEL BARS REMAIN IN THE CORRECT ALIGNMENT AND POSITION.
10. ALL BASECOURSE MATERIAL SHALL BE IGNEOUS ROCK QUARRIED MATERIAL TO COMPLY WITH R.M.S. FORM 3051, COMPACTED TO MINIMUM 98% MODIFIED DENSITY IN ACCORDANCE WITH AS 1289 5.2.1 FREQUENCY OF COMPACTION TESTING SHALL NOT BE LESS THAN 1 TEST PER 50m^3 OF BASECOURSE MATERIAL PLACED.
11. ALL SUB-BASE COURSE MATERIAL SHALL BE IGNEOUS ROCK QUARRIED MATERIAL TO COMPLY WITH R.M.S. FORM 3051, AND COMPACTED TO MINIMUM 95% MODIFIED DENSITY IN ACCORDANCE WITH A.S 1289 5.2.1 FREQUENCY OF COMPACTION TESTING SHALL NOT BE LESS THAN 1 TEST PER 50m^3 OF SUB-BASE COURSE MATERIAL PLACED.
12. AS AN ALTERNATIVE TO THE USE OF IGNEOUS ROCK AS A SUB-BASE MATERIAL IN (9) A CERTIFIED RECYCLED CONCRETE MATERIAL COMPLYING WITH R.M.S. FORM 3051 WILL BE CONSIDERED. SUBJECT TO MATERIAL SAMPLES AND APPROPRIATE CERTIFICATIONS BEING PROVIDED TO THE SATISFACTION OF THE DESIGN ENGINEER.
13. SHOULD THE CONTRACTOR WISH TO USE A RECYCLED PRODUCT THIS SHALL BE CLEARLY INDICATED IN THEIR TENDER AND THE PRICE DIFFERENCE BETWEEN AN IGNEOUS PRODUCT AND A RECYCLED PRODUCT SHALL BE CLEARLY INDICATED.

PAVEMENT JOINTS

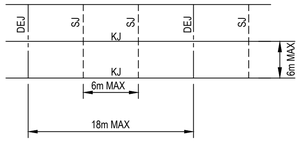
PEDESTRIAN PAVEMENTS

1. ALL PEDESTRIAN PAVEMENTS ARE TO BE JOINTED AS FOLLOWS U.N.O ON THE DESIGN DRAWINGS.
2. EXPANSION JOINTS ARE TO BE LOCATED WHERE POSSIBLE AT TANGENT POINTS OF CURVES AND ELSEWHERE AT MAX. 6.0m CENTRES.
3. WEAKENED PLANE JOINTS ARE TO BE LOCATED AT A MAX. SPACING OF 1.5 x WIDTH OF THE PAVEMENT.
4. WHERE POSSIBLE JOINTS SHOULD BE LOCATED TO MATCH KERBING AND OR ADJACENT PAVEMENT JOINTS.
5. TYPICAL PEDESTRIAN PAVEMENT JOINT DETAIL.



VEHICULAR PAVEMENTS

6. ALL VEHICULAR PAVEMENTS TO BE JOINTED AS FOLLOWS U.N.O ON THE DESIGN DRAWINGS.
7. TIED KEYED CONSTRUCTION JOINTS SHOULD GENERALLY BE LOCATED LONGITUDINALLY AT A MAX OF 6.0m CENTRES
8. SAWN JOINTS SHOULD GENERALLY BE LOCATED LATERALLY AT A MAX OF 6.0m CENTRES WITH DOWELED EXPANSION JOINTS AT MAX 30.0m CENTRES
9. TYPICAL VEHICULAR PAVEMENT JOINT DETAIL.



10. PROVIDE 10mm EXPANSION FOAM BETWEEN NEW CONRETE WORKS AND EXISTING STRUCTURES.
11. LOCAL AUTHORITY REQUIREMENTS SHALL TAKE PRECEDENCE WITHIN THE PUBLIC ROAD RESERVE.
12. DOWELS TO BE PLACED ON PROPRIETARY CRADLES TO ENSURE CORRECT SPACING AND ALIGNMENT.

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale:

North:

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
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Project: NEPEAN BUSINESS PARK
PENRITH

Title: GENERAL NOTES AND LEGENDS
SHEET 2

Scale:

First Issue Date: 04/12/2024

Size: A1

Datum: AHD

Status: FOR APPROVAL
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Project Number/Drawing Number: 200044-09-DA-C01.22

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DATE PLOTTED: 26 February 2025 4:27 PM BY: JOSEPH SHELAYMOON

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REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client

NEPEAN BUSINESS PARK

Scale

0 50 100 150 200m

SCALE 1:2000 @A1

North

N

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Project
NEPEAN BUSINESS PARK
PENRITH

Title
STAGING PLAN

Scale
1:2000

First Issue Date
04/12/2024

Size
A1

Datum
AHD

Status
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Project Number/Drawing Number
200044-09-DA-C01.31

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3

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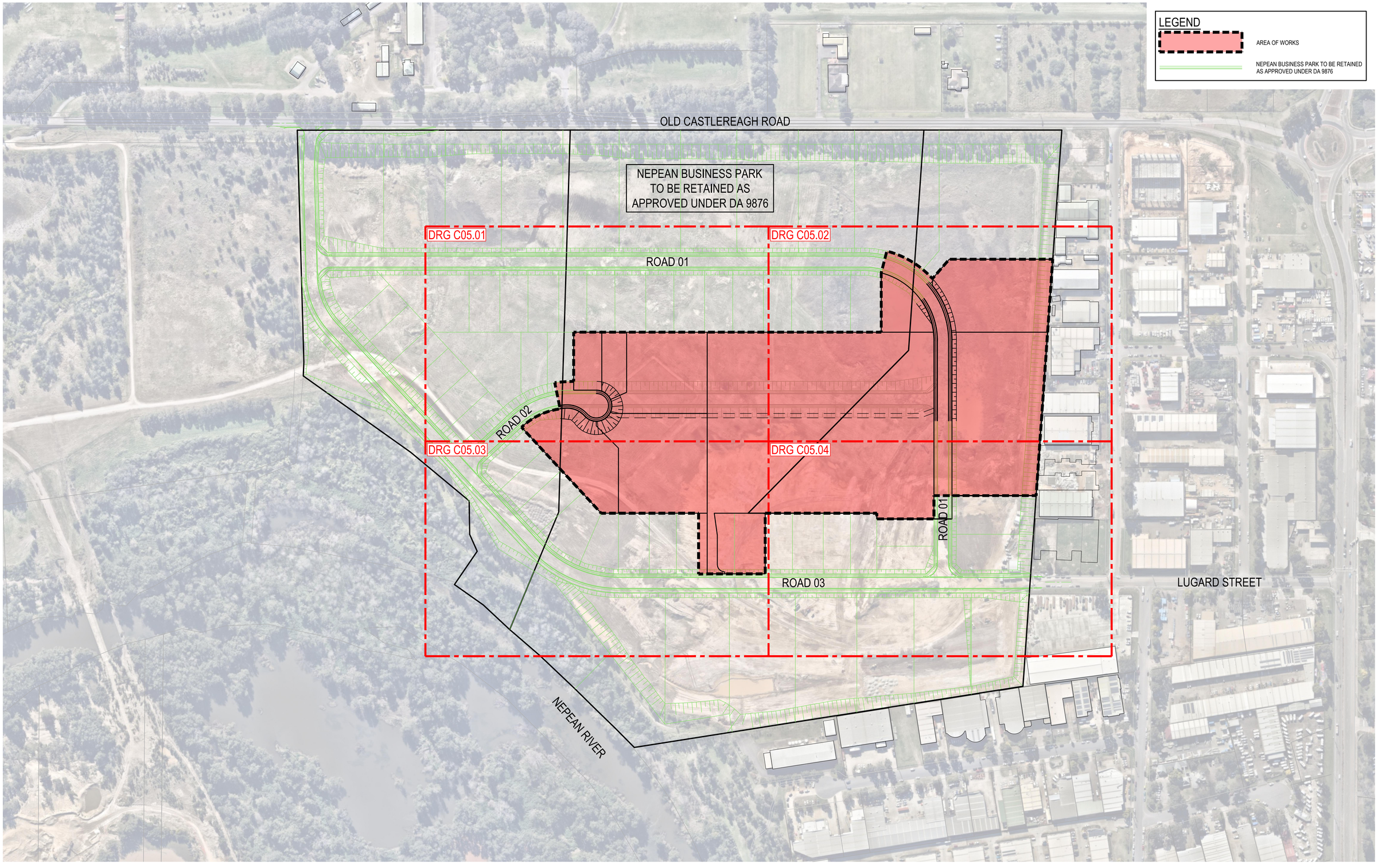

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 50 100 150 200m — SCALE 1:2000 @A1

North

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: GENERAL ARRANGEMENT PLAN

Scale: 1:2000
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

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OLD CASTLREAGH ROAD

NEPEAN BUSINESS PARK
TO BE RETAINED AS
APPROVED UNDER DA 9876

ROAD 01

ROAD 02

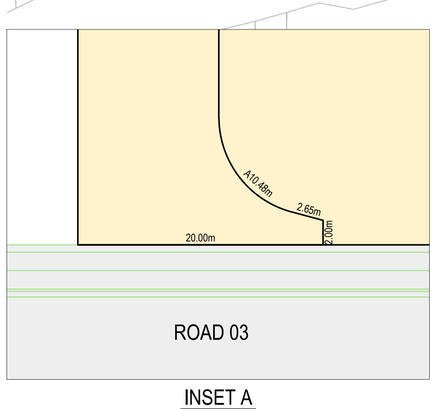
ROAD 03

LUGARD STREET

EASEMENT TO DRAIN
WATER 5m WIDE

SEE INSET A

81 2114.39m²
82 2032.89m²
83 8831.69m²
12 2847.34m²
11 10170.24m²
10 19020.69m²
9
8
23 54352.04m²
38 7320.94m²
37 12042.13m²
48 3770.37m²
27
26



INSET A
SCALE 1:250

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
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Client: NEPEAN BUSINESS PARK

Scale
0 5 10 15 20 25m
SCALE 1:250 @A1
0 50 100 150 200m
SCALE 1:2000 @A1

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: SUBDIVISION PLAN

Scale: AS SHOWN
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
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Project Number/Drawing Number: 200044-09-DA-C01.81
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3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 50 100 150 200m — SCALE 1:2000 @A1

North

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: COMMUNITY TITLE SUBDIVISION PLAN

Scale: 1:2000
First Issue Date: 04/12/2024

Size: A1
Datum: AHD

Status: FOR APPROVAL
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Project Number/Drawing Number: 200044-09-DA-C01.91

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NEPEAN BUSINESS PARK TO BE RETAINED AS APPROVED UNDER DA 9876

ROAD 01

ROAD 02

ROAD 03

ROAD 01

LUGARD STREET

LEGEND

- SEDIMENT FENCE (SD 6-8)
- SEDIMENT TRAP FOR KERB INLET (ON GRADE - SANDBAG)
- SEDIMENT TRAP FOR KERB INLET (AT LOW POINT - SANDBAG)
- GEOTEXTILE INLET FILTER (SD 6-12)

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
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1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 20 40 60 80 100m — SCALE 1:1000 @A1

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: EROSION AND SEDIMENTATION CONTROL PLAN

Scale: 1:1000
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
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Project Number/Drawing Number: 200044-09-DA-C03.01

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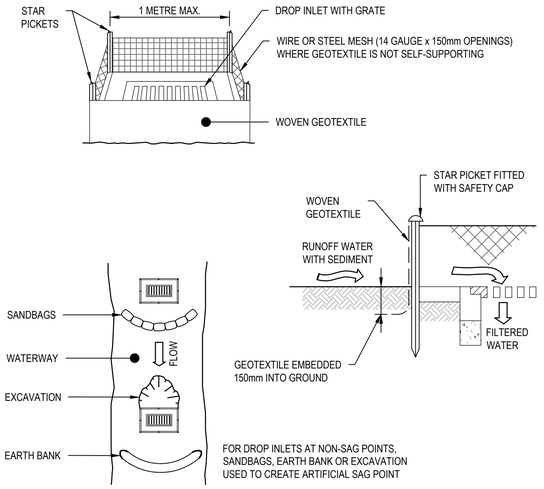
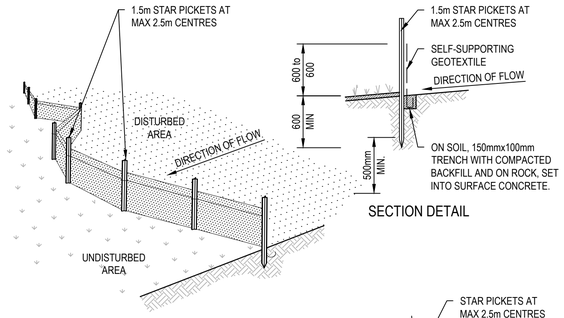


CONSTRUCTION NOTES

1. FABRICATE A SEDIMENT BARRIER MADE FROM GEOTEXTILE OR STRAW BALES.
2. FOLLOW STANDARD DRAWING 6-7 AND STANDARD DRAWING 6-8 FOR INSTALLATION PROCEDURES FOR THE STRAW BALES OR GEOFABRIC. REDUCE THE PICKET SPACING TO 1 METRE CENTRES.
3. IN WATERWAYS, ARTIFICIAL SAG POINTS CAN BE CREATED WITH SANDBAGS OR EARTH BANKS AS SHOWN IN THE DRAWING.
4. DO NOT COVER THE INLET WITH GEOTEXTILE UNLESS THE DESIGN IS ADEQUATE TO ALLOW FOR ALL WATERS TO BYPASS IT.

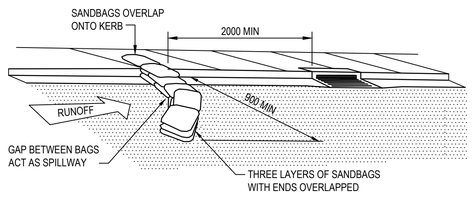
GEOTEXTILE INLET FILTER (SD 6-12)



CONSTRUCTION NOTES

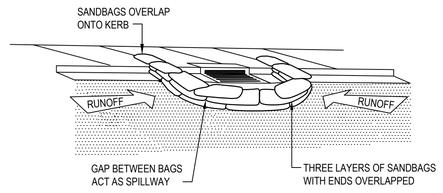
1. CONSTRUCT SEDIMENT FENCES AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DRAWING TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION. THE CATCHMENT AREA SHOULD BE SMALL ENOUGH TO LIMIT WATER FLOW IF CONCENTRATED AT ONE POINT TO 50 LITRES PER SECOND IN THE DESIGN STORM EVENT, USUALLY THE 10-YEAR EVENT.
2. CUT A 150mm DEEP TRENCH ALONG THE UPSLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
3. DRIVE 1.5 METRE LONG STAR PICKETS INTO GROUND AT 2.5 METRE INTERVALS (MAX) AT THE DOWNSLOPE EDGE OF THE TRENCH. ENSURE ANY STAR PICKETS ARE FITTED WITH SAFETY CAPS.
4. FIX SELF-SUPPORTING GEOTEXTILE TO THE UPSLOPE SIDE OF THE POSTS ENSURING IT GOES TO THE BASE OF THE TRENCH. FIX THE GEOTEXTILE WITH WIRE TIES OR AS RECOMMENDED BY THE MANUFACTURER. ONLY USE GEOTEXTILE SPECIFICALLY PRODUCED FOR SEDIMENT FENCING. THE USE OF SHADE CLOTH FOR THIS PURPOSE IS NOT SATISFACTORY.
5. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 150mm OVERLAP.
6. BACKFILL THE TRENCH OVER THE BASE OF THE FABRIC AND COMPACT IT THOROUGHLY OVER THE GEOTEXTILE.

SEDIMENT FENCE (SD 6-8)



SEDIMENT TRAP FOR KERB INLET (ON GRADE - SANDBAG)

NOT TO SCALE



SEDIMENT TRAP FOR KERB INLET (AT LOW POINT - SANDBAG)

NOT TO SCALE

NOTE

REFER TO APPROVED DA 9876 FOR OVERALL SEDIMENT CONTROL AND SEDIMENT BASINS DETAILS.

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale:

North:

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK PENRITH

Title: EROSION AND SEDIMENTATION CONTROL DETAILS

Scale:

Date: 04/12/2024

Size: A1

Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C03.21

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CUT AND FILL VOLUMES

1. REFER SPECIFICATION NOTES FOR GENERAL EARTHWORKS REQUIREMENTS.
2. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH COUNCIL/RELEVANT AUTHORITY SPECIFICATIONS AND DETAILS.
3. NO ALLOWANCE HAS BEEN MADE FOR BULKING FACTORS. NOTE ALL VOLUMES DEPICTED ARE SOLID VOLUMES ONLY AND MAY NOT REFLECT DETAILED EARTHWORKS.
4. NO ALLOWANCE HAS BEEN MADE FOR DETAILED EARTHWORKS. ie SERVICE TRENCHING, DETAILED EXCAVATION AND THE LIKE.
5. ESTIMATED EARTHWORKS VOLUMES REPRESENT ANALYSIS BETWEEN APPROVED BULK SURFACE UNDER DA 9876 AND BULK EARTHWORKS DESIGN LEVEL. BULK EARTHWORKS LEVELS INCLUDE ROAD BOXING AND ALLOWS FOR NO TOP SOIL.
6. EARTHWORKS VALUES AS FOLLOWS:

   6.1. CUT: 2,116m^3
   6.2. FILL: 10,355m^3
   6.3. BALANCE: 8,239m^3 (APPROX.)

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Client: NEPEAN BUSINESS PARK

Scale: 0 50 100 150 200m — SCALE 1:2000 @A1

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: BULK EARTHWORKS CUT AND FILL PLAN

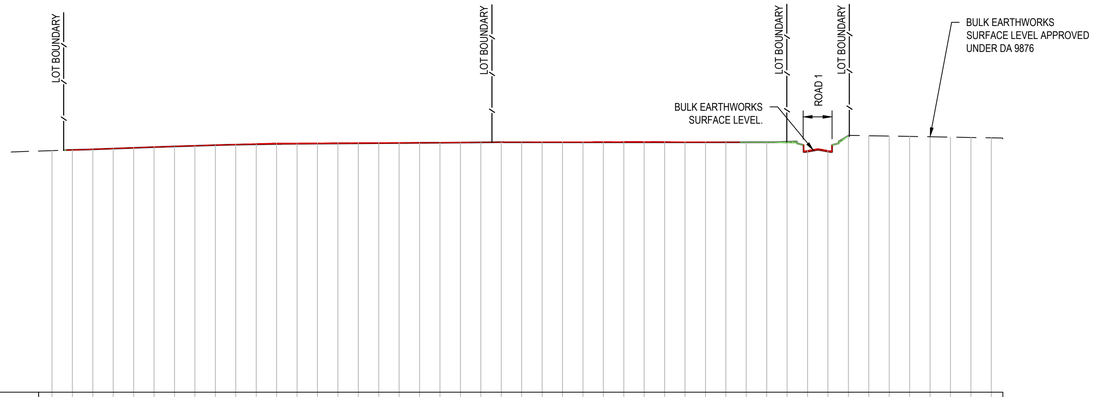
Scale: 1:2000
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C04.01
Revision: 3

DATE PLOTTED: 26 February 2025 4:29 PM BY : JOSEPH SHELAYMOON

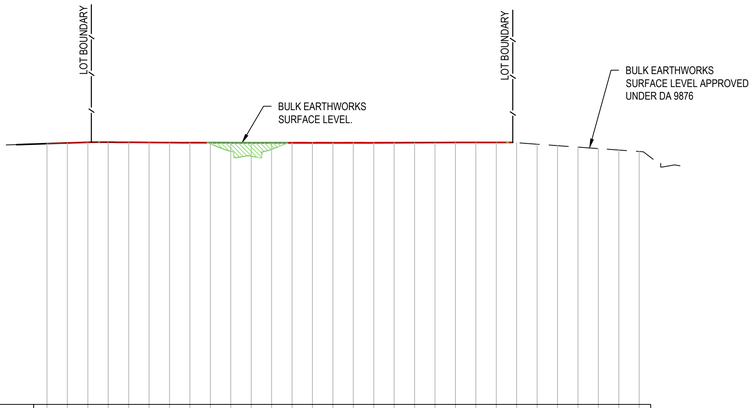
CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C04.01 BULK EARTHWORKS CUT AND FILL PLAN.dwg



DATUM RL 10.0

CHAINAGE	APPROVED BULK SURFACE LEVEL UNDER DA 9876	PROPOSED BULK SURFACE LEVEL
0.00	29.72	
10.00	29.77	29.77
20.00	29.83	29.82
30.00	29.89	29.88
40.00	29.95	29.94
50.00	30.01	30.01
60.00	30.07	30.06
70.00	30.12	30.11
80.00	30.17	30.17
90.00	30.22	30.21
100.00	30.28	30.24
110.00	30.32	30.26
120.00	30.33	30.27
130.00	30.34	30.29
140.00	30.34	30.30
150.00	30.35	30.31
160.00	30.36	30.32
170.00	30.37	30.34
180.00	30.37	30.35
190.00	30.38	30.36
200.00	30.39	30.37
210.00	30.40	30.39
220.00	30.40	30.40
230.00	30.41	30.40
240.00	30.42	30.40
250.00	30.42	30.40
260.00	30.43	30.40
270.00	30.44	30.40
280.00	30.44	30.40
290.00	30.45	30.40
300.00	30.44	30.40
310.00	30.43	30.40
320.00	30.42	30.40
330.00	30.41	30.40
340.00	30.40	30.40
350.00	30.39	30.40
360.00	30.34	30.43
370.00	29.72	29.63
380.00	29.73	29.64
390.00	30.92	30.93
400.00	30.93	
410.00	30.90	
420.00	30.87	
430.00	30.85	
440.00	30.82	
450.00	30.79	
460.00	30.76	

SECTION A
C04.01
HORIZONTAL SCALE 1:1500@A1
VERTICAL SCALE 1:250@A1



DATUM RL 9.0

CHAINAGE	APPROVED BULK SURFACE LEVEL UNDER DA 9876	PROPOSED BULK SURFACE LEVEL
0.00	30.28	30.28
10.00	30.34	30.34
20.00	30.39	30.39
30.00	30.40	30.40
40.00	30.39	30.39
50.00	30.39	30.38
60.00	30.38	30.36
70.00	30.38	30.36
80.00	30.25	30.35
90.00	29.65	30.35
100.00	29.25	30.35
110.00	29.82	30.34
120.00	30.37	30.34
130.00	30.37	30.34
140.00	30.37	30.34
150.00	30.37	30.34
160.00	30.37	30.34
170.00	30.37	30.35
180.00	30.37	30.36
190.00	30.37	30.37
200.00	30.37	30.37
210.00	30.37	30.37
220.00	30.37	30.37
230.00	30.35	
240.00	30.23	
250.00	30.11	
260.00	29.99	
270.00	29.87	
280.00	29.76	
290.00	29.64	

SECTION B
C04.01
HORIZONTAL SCALE 1:1500@A1
VERTICAL SCALE 1:250@A1

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale
0 5 10 15 20 25m
SCALE 1:250 @A1
0 50 100 150m
SCALE 1:1500 @A1

North

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135 enspiresolutions.com.au

Project: NEPEAN BUSINESS PARK
PENRITH

Title: BULK EARTHWORKS CUT AND FILL SECTONS

Scale: AS SHOWN
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

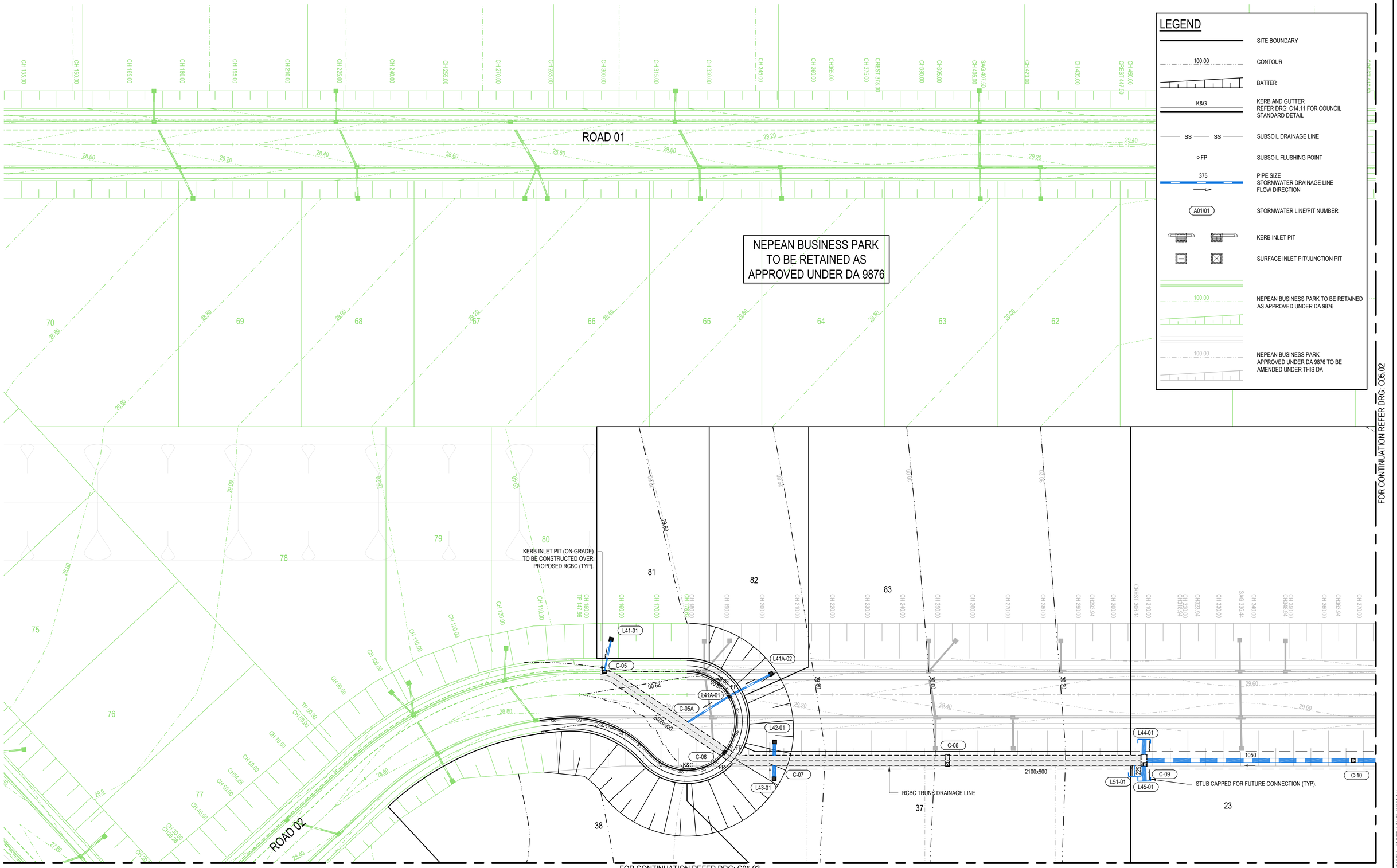
Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C04.21

Revision: 2

DATE PLOTTED: 26 February 2025 4:29 PM BY: JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C04.21 BULK EARTHWORKS CUT AND FILL SECTIONS.dwg



REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 10 20 30 40 50m — SCALE 1:500 @A1

North

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135 enspiresolutions.com.au

Project: NEPEAN BUSINESS PARK
PENRITH

Title: SITEWORKS AND STORMWATER MANAGEMENT PLAN
SHEET 1

Scale: 1:500
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

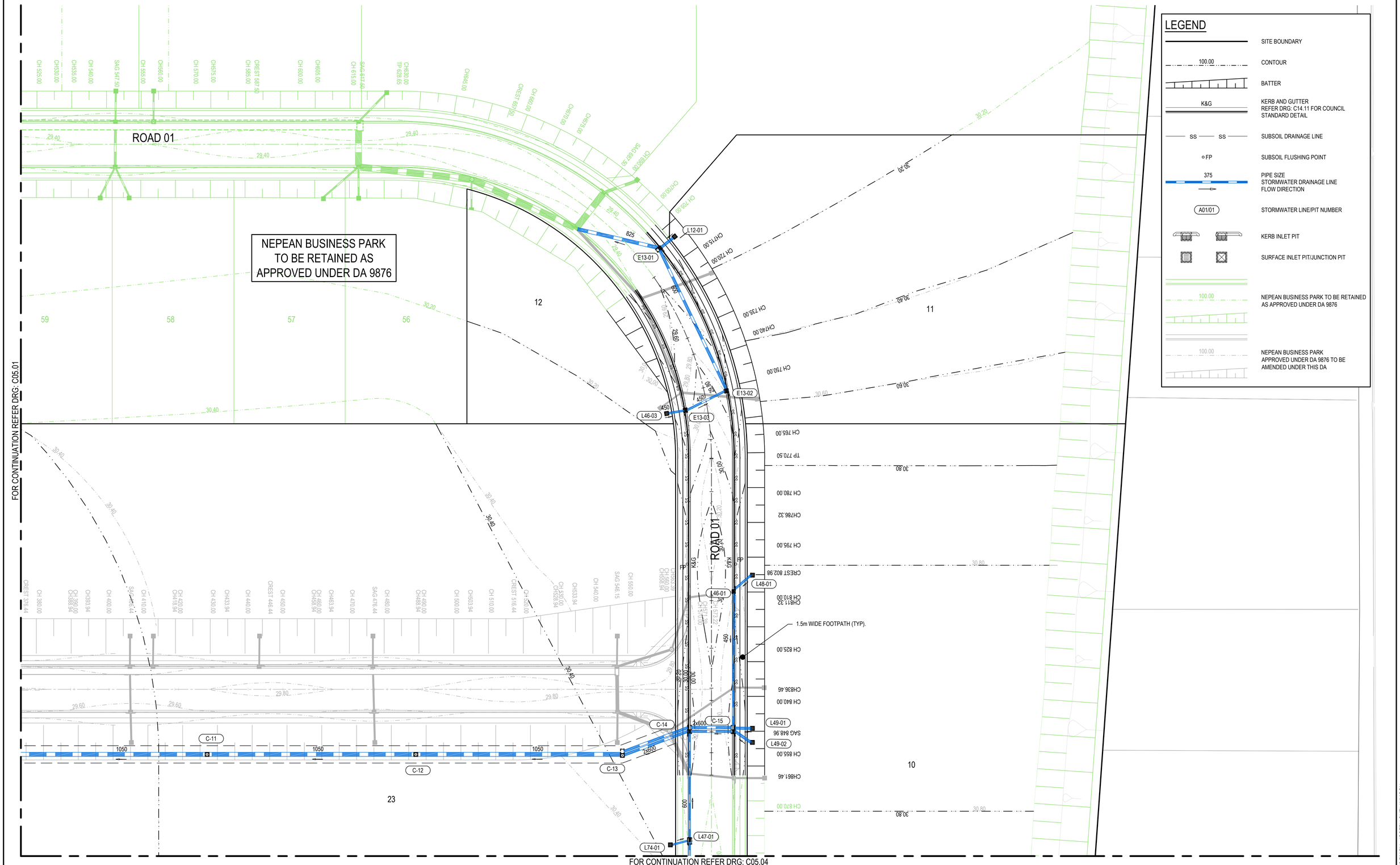
Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C05.01

Revision: 3

DATE PLOTTED: 26 February 2025 5:08 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C05.01-C05.04 SITEWORKS AND STORMWATER MANAGEMENT PLAN.dwg



LEGEND

- SITE BOUNDARY
- 100.00 — CONTOUR
- BATTER
- K&G — KERB AND GUTTER REFER DRG: C14.11 FOR COUNCIL STANDARD DETAIL
- SS — SS — SUBSOIL DRAINAGE LINE
- FP — SUBSOIL FLUSHING POINT
- 375 — PIPE SIZE STORMWATER DRAINAGE LINE FLOW DIRECTION
- A01/01 — STORMWATER LINE/PIT NUMBER
- KERB INLET PIT
- SURFACE INLET PIT/JUNCTION PIT
- 100.00 — NEPEAN BUSINESS PARK TO BE RETAINED AS APPROVED UNDER DA 9876
- 100.00 — NEPEAN BUSINESS PARK APPROVED UNDER DA 9876 TO BE AMENDED UNDER THIS DA

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 10 20 30 40 50m — SCALE 1:500 @A1

North

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: SITEWORKS AND STORMWATER MANAGEMENT PLAN
SHEET 2

Scale: 1:500
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

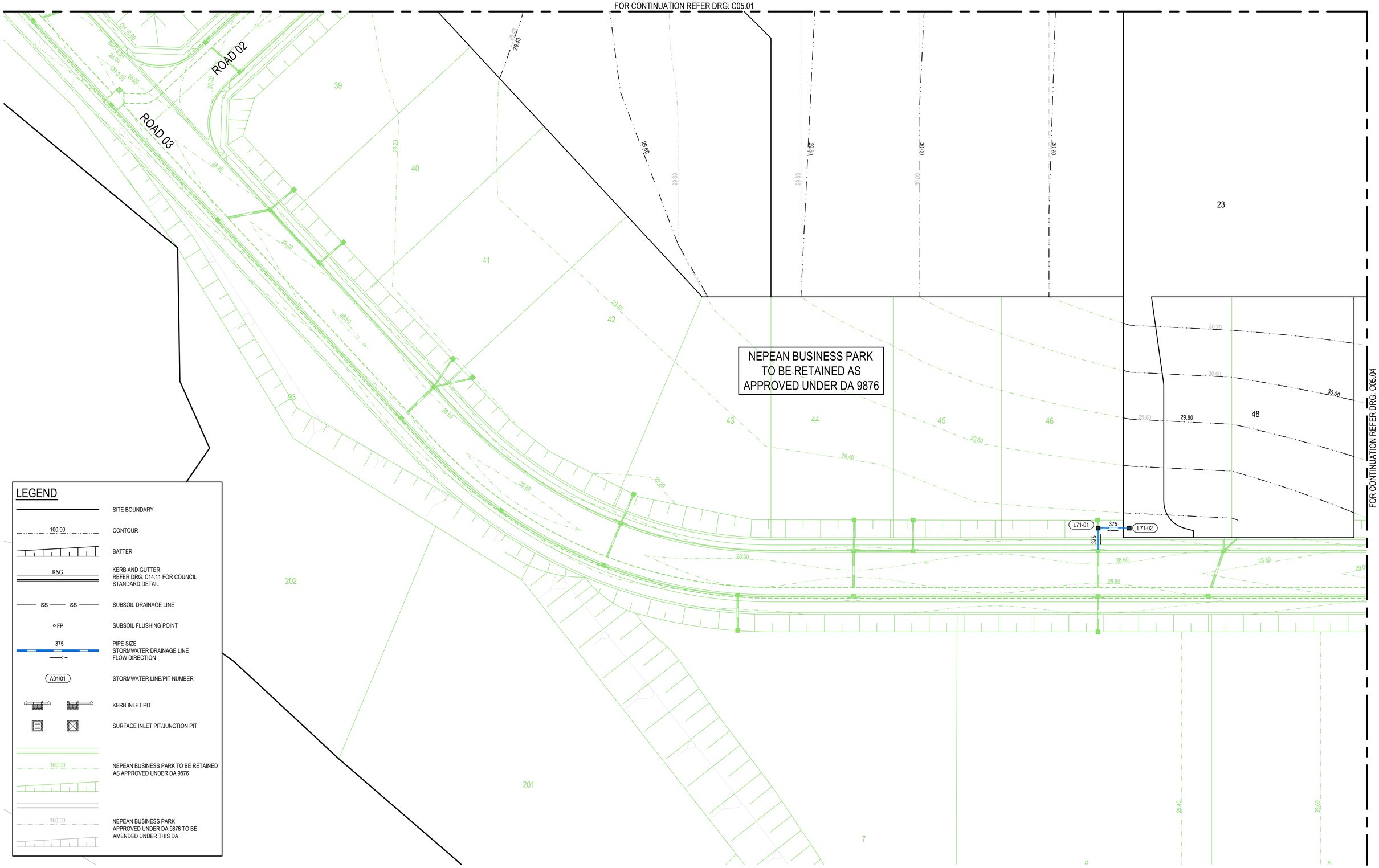
Project Number/Drawing Number: 200044-09-DA-C05.02

Revision: 2

DATE PLOTTED: 26 February 2025 4:29 PM BY: JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C05.01-C05.04 SITEWORKS AND STORMWATER MANAGEMENT PLAN.dwg

FOR CONTINUATION REFER DRG: C05.01



LEGEND

- SITE BOUNDARY
- 100.00 — CONTOUR
- BATTER
- K&G — KERB AND GUTTER REFER DRG: C14.11 FOR COUNCIL STANDARD DETAIL
- SS — SS — SUBSOIL DRAINAGE LINE
- FP — SUBSOIL FLUSHING POINT
- 375 — PIPE SIZE STORMWATER DRAINAGE LINE FLOW DIRECTION
- A01/01 — STORMWATER LINE/PIT NUMBER
- KERB INLET PIT
- SURFACE INLET PIT/JUNCTION PIT
- 100.00 — NEPEAN BUSINESS PARK TO BE RETAINED AS APPROVED UNDER DA 9876
- 100.00 — NEPEAN BUSINESS PARK APPROVED UNDER DA 9876 TO BE AMENDED UNDER THIS DA

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 10 20 30 40 50m — SCALE 1:500 @A1

North

Enspire Solutions Pty Ltd
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Project: NEPEAN BUSINESS PARK
PENRITH

Title: SITEWORKS AND STORMWATER MANAGEMENT PLAN
SHEET 3

Scale: 1:500
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C05.03

Revision: 2

DATE PLOTTED: 26 February 2025 4:29 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C05.01-C05.04 SITEWORKS AND STORMWATER MANAGEMENT PLAN.dwg

FOR CONTINUATION REFER DRG: C05.02

FOR CONTINUATION REFER DRG: C05.03

NEPEAN BUSINESS PARK
TO BE RETAINED AS
APPROVED UNDER DA 9876

ROAD 01

ROAD 03

L75-01 L47-02 L47-03 L50-01 450

LEGEND

- SITE BOUNDARY
- 100.00 CONTOUR
- BATTER
- K&G — KERB AND GUTTER REFER DRG: C14.11 FOR COUNCIL STANDARD DETAIL
- SS — SS SUBSOIL DRAINAGE LINE
- FP SUBSOIL FLUSHING POINT
- 375 PIPE SIZE STORMWATER DRAINAGE LINE FLOW DIRECTION
- A01/01 STORMWATER LINE/PIT NUMBER
- KERB INLET PIT
- SURFACE INLET PIT/JUNCTION PIT
- 100.00 NEPEAN BUSINESS PARK TO BE RETAINED AS APPROVED UNDER DA 9876
- 100.00 NEPEAN BUSINESS PARK APPROVED UNDER DA 9876 TO BE AMENDED UNDER THIS DA

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 10 20 30 40 50m — SCALE 1:500 @A1

North

Enspire Solutions Pty Ltd
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Project: NEPEAN BUSINESS PARK
PENRITH

Title: SITEWORKS AND STORMWATER MANAGEMENT PLAN
SHEET 4

Scale: 1:500
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

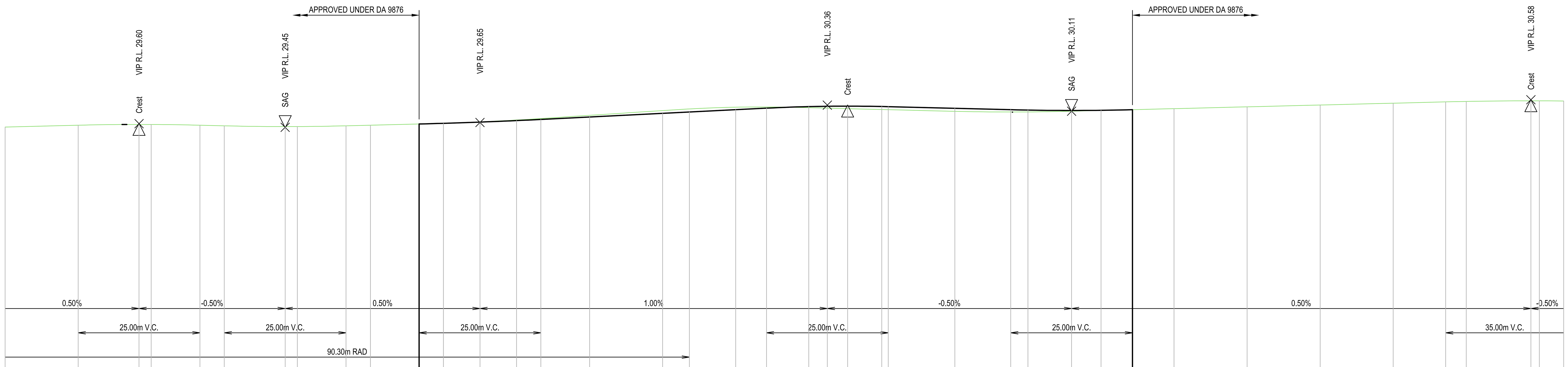
Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C05.04

Revision: 2

DATE PLOTTED: 26 February 2025 4:29 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C05.01-C05.04 SITEWORKS AND STORMWATER MANAGEMENT PLAN.dwg



DATUM RL 17.0

CHAINAGE	APPROVED DA 9876 SURFACE LEVEL	PROPOSED FINISHED SURFACE LEVEL
630.00	29.46	
645.00	29.54	
657.50	29.57	
660.00	29.57	
670.00	29.54	
675.00	29.51	
687.50	29.48	
690.00	29.48	
700.00	29.51	
705.00	29.54	
715.00	29.59	29.59
720.00	29.62	29.62
727.50	29.68	29.67
735.00	29.75	29.73
740.00	29.81	29.77
750.00	29.94	29.87
765.00	30.14	30.02
770.50	30.21	30.08
780.00	30.28	30.17
786.32	30.29	30.24
795.00	30.26	30.30
798.82	30.24	30.32
802.98	30.22	30.32
810.00	30.18	30.31
811.32	30.18	30.30
825.00	30.11	30.23
836.46	30.08	30.17
840.00	30.08	30.16
848.96	30.11	30.14
855.00	30.14	30.15
861.46	30.17	30.17
870.00	30.22	
885.00	30.29	
900.00	30.37	
915.00	30.44	
925.77	30.50	
930.00	30.52	
943.27	30.54	
945.00	30.54	
950.00	30.53	

ROAD 01 LONGITUDINAL SECTION

SCALE 1:500 HORI
SCALE 1:100 VERT

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale
H: 0 10 20 30 40 50m
V: 0 2 4 6 8 10m
SCALE: H:1:500 V:1:100 @A1

North

enspire
Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135
enspiresolutions.com.au

Project: NEPEAN BUSINESS PARK PENRITH

Title: ROAD LONGITUDINAL SECTIONS

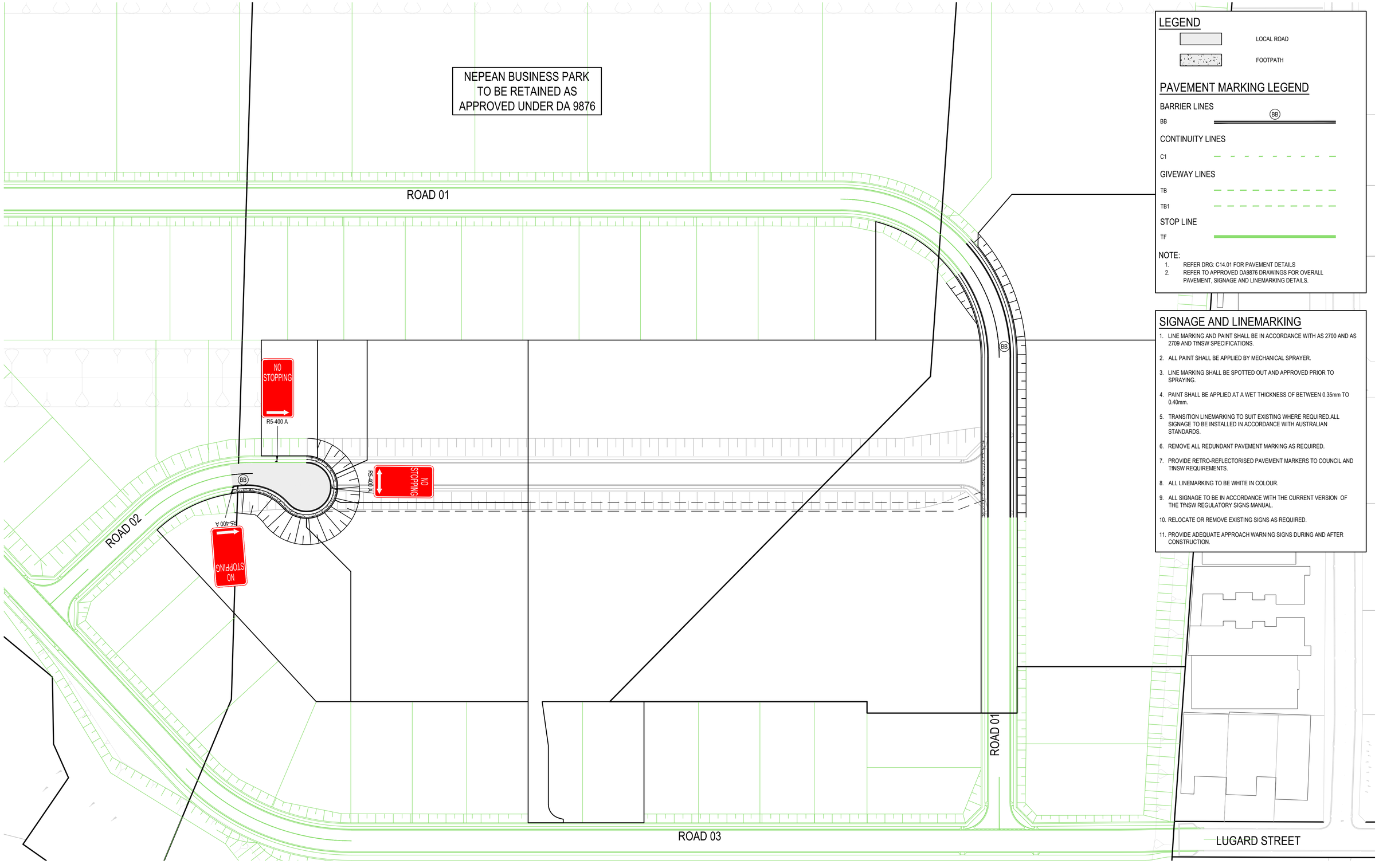
Scale: AS SHOWN
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C07.01
Revision: 2

DATE PLOTTED: 26 February 2025 4:29 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C07.01 ROAD LONGITUDINAL SECTIONS.dwg



LEGEND

LOCAL ROAD

FOOTPATH

PAVEMENT MARKING LEGEND

BARRIER LINES

BB

CONTINUITY LINES

C1

GIVEWAY LINES

TB

TB1

STOP LINE

TF

NOTE:

1. REFER DRG: C14.01 FOR PAVEMENT DETAILS
2. REFER TO APPROVED DA9876 DRAWINGS FOR OVERALL PAVEMENT, SIGNAGE AND LINEMARKING DETAILS.

SIGNAGE AND LINEMARKING

1. LINE MARKING AND PAINT SHALL BE IN ACCORDANCE WITH AS 2700 AND AS 2709 AND TINSW SPECIFICATIONS.
2. ALL PAINT SHALL BE APPLIED BY MECHANICAL SPRAYER.
3. LINE MARKING SHALL BE SPOTTED OUT AND APPROVED PRIOR TO SPRAYING.
4. PAINT SHALL BE APPLIED AT A WET THICKNESS OF BETWEEN 0.35mm TO 0.40mm.
5. TRANSITION LINEMARKING TO SUIT EXISTING WHERE REQUIRED.ALL SIGNAGE TO BE INSTALLED IN ACCORDANCE WITH AUSTRALIAN STANDARDS.
6. REMOVE ALL REDUNDANT PAVEMENT MARKING AS REQUIRED.
7. PROVIDE RETRO-REFLECTORISED PAVEMENT MARKERS TO COUNCIL AND TfNSW REQUIREMENTS.
8. ALL LINEMARKING TO BE WHITE IN COLOUR.
9. ALL SIGNAGE TO BE IN ACCORDANCE WITH THE CURRENT VERSION OF THE TfNSW REGULATORY SIGNS MANUAL.
10. RELOCATE OR REMOVE EXISTING SIGNS AS REQUIRED.
11. PROVIDE ADEQUATE APPROACH WARNING SIGNS DURING AND AFTER CONSTRUCTION.

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 20 40 60 80 100m — SCALE 1:1000 @A1

North

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135
enspiresolutions.com.au

Project: NEPEAN BUSINESS PARK
PENRITH

Title: PAVEMENT, SIGNAGE AND LINEMARKING PLAN

Scale: 1:1000

First Issue Date: 04/12/2024

Size: A1

Datum: AHD

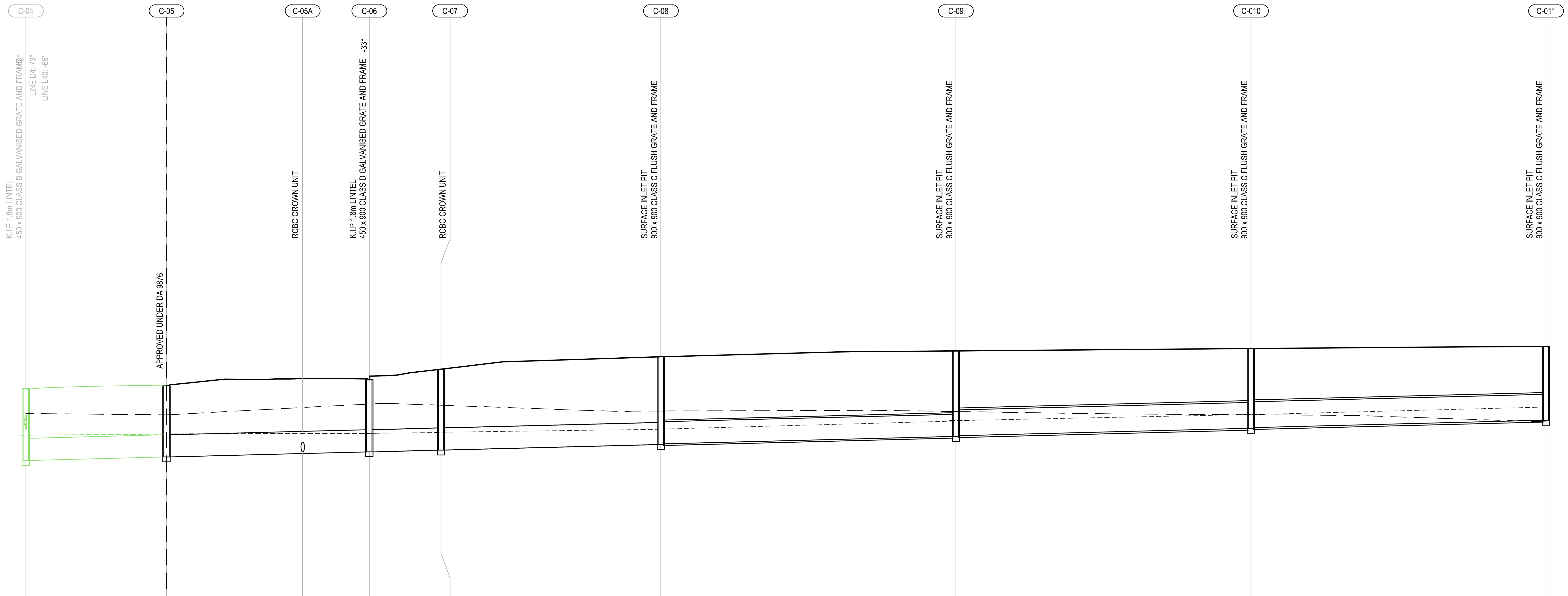
Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C11.01

Revision: 3

DATE PLOTTED: 26 February 2025 4:29 PM BY: JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C11.01 PAVEMENT, SIGNAGE AND LINEMARKING PLAN.dwg



Segment	PIPE GRADE (%)	PIPE SIZE (mm)	PIPE VELOCITY (m/s)	Q - PIPE FLOW (L/s)	Length
C-04 – C-05		2400x900 - RCBC	Vf = 1.82	Q = 3926	L = 28.60
C-05 – C-05A	G = 0.35%	2400x900 - RCBC	Vf = 2.22	Q = 3957	L = 27.68
C-05A – C-06	G = 0.35%	2400x900 - RCBC	Vf = 2.22	Q = 3957	L = 13.56
C-06 – C-07	G = 0.35%	2400x900 - RCBC	Vf = 2.33	Q = 4017	L = 14.57
C-07 – C-08	G = 0.35%	2100x900 - RCBC	Vf = 2.35	Q = 3074	L = 44.72
C-08 – C-09	G = 0.35%	2100x900 - RCBC	Vf = 2.49	Q = 3124	L = 60.00
C-09 – C-010	G = 0.5%	1050 - RCP CLASS 2	Vf = 2.11	Q = 986	L = 60.00
C-010 – C-011	G = 0.50%	1050 - RCP CLASS 2	Vf = 2.16	Q = 942	L = 60.00

	C-04	C-05	C-05A	C-06	C-07	C-08	C-09	C-010	C-011
DATUM RL	13.0	13.0							
5% AEP H.G.L.	26.81	26.85 26.86 26.86	26.88	26.88 26.89 26.89	26.92 26.93 26.93	27.05 27.06 27.06	27.38 27.40 27.40	27.65 27.65 27.65	27.95 27.95
FINISHED SURFACE LEVEL	28.70	28.81	29.10	29.06	29.49	29.99	30.23	30.33	30.41
NATURAL SURFACE LEVEL	27.69	27.63	27.93	28.07	28.03	27.79	27.77	27.64	27.35
PIPE INVERT LEVEL	25.78	25.92 25.92	26.03 26.03	26.08 26.11	26.16 26.16	26.32 26.35	26.56 26.59	26.89 26.92	27.22
DEPTH TO INVERT	2.92	2.89 2.89	3.07	2.98 2.95	3.33 3.33	3.67 3.64	3.67 3.64	3.44 3.41	3.19
CO-ORDINATED SETOUT									
CHAINAGE	138.00	166.60	194.28	207.84	222.41	267.13	327.13	387.13	447.13

LINE C

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale
H: 0 10 20 30 40 50m
V: 0 2 4 6 8 10m
SCALE: H:1:500 V:1:100 @A1

North

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Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135
enspiresolutions.com.au

Project: NEPEAN BUSINESS PARK PENRITH

Title: STORMWATER LONGSECTIONS SHEET 1

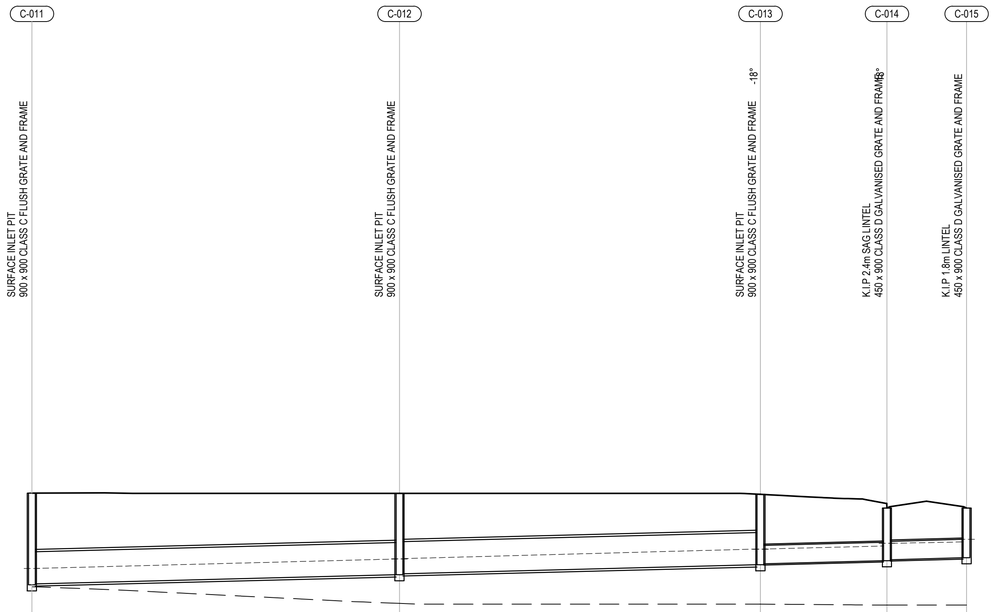
Scale: AS SHOWN
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C13.01
Revision: 3

DATE PLOTTED: 26 February 2025 4:29 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C13.01-C13.02 STORMWATER LONGSECTIONS.dwg



PIPE GRADE (%)	G = 0.50%	G = 0.50%	G = 0.50%	G = 0.50%	
PIPE SIZE (mm)	1050 - RCP CLASS 2	1050 - RCP CLASS 2	(2x)600 - RCP CLASS 2	(2x)600 - RCP CLASS 2	
PIPE VELOCITY (m/s)	Vf = 2.23	Vf = 2.34	Vf = 1.91	Vf = 1.69	
Q - PIPE FLOW (L/s)	Q = 905	Q = 924	Q = 929	Q = 889	
DATUM RL	15.0				
5% AEP H.G.L.	27.95 27.95	28.26 28.26	28.58 28.58	28.87 29.00	29.03 29.09
FINISHED SURFACE LEVEL	30.41	30.40	30.37	29.95	29.92
NATURAL SURFACE LEVEL	27.35	26.81	26.79	26.75	26.75
PIPE INVERT LEVEL	27.22 27.25	27.55 27.58	27.87 27.90	28.00 28.03	28.09
DEPTH TO INVERT	3.19 3.16	2.85 2.82	2.50 2.47	1.95 1.92	1.83
CO-ORDINATED SETOUT					
CHAINAGE	447.13	507.13	566.05	586.70	599.80
	L = 60.00	L = 58.92	L = 20.65	L = 12.10	

LINE C

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: H: 0 10 20 30 40 50m; V: 0 2 4 6 8 10m; SCALE: H:1:500 V:1:100 @A1

North

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
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Project: NEPEAN BUSINESS PARK
PENRITH

Title: STORMWATER LONGSECTIONS
SHEET 2

Scale: AS SHOWN
First Issue Date: 04/12/2024

Size: A1
Datum: AHD

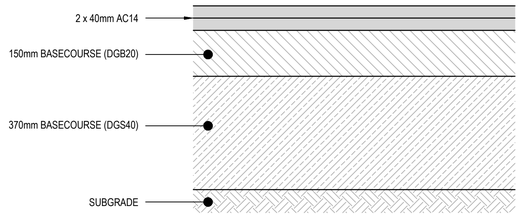
Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C13.02

Revision: 2

DATE PLOTTED: 26 February 2025 4:29 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C13.01-C13.02 STORMWATER LONGSECTIONS.dwg

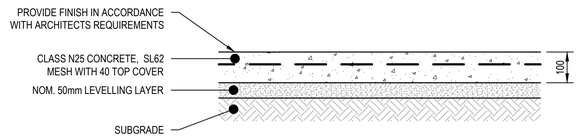


PRIVATE LOCAL ROAD

SCALE 1:10

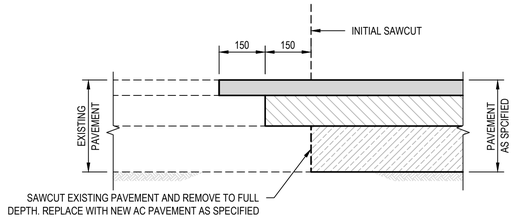
NOTES:

1. MIN CBR 4.0% (CONTRACTOR TO CONFIRM ONSITE).
2. DESIGN LOADING = $5x10^6$ ESA's
3. PRIME AND TACK COAT BASECOURSE SURFACE PRIOR TO PLACEMENT OF AC WEARING COURSE.



FOOTPATH

SCALE 1:10



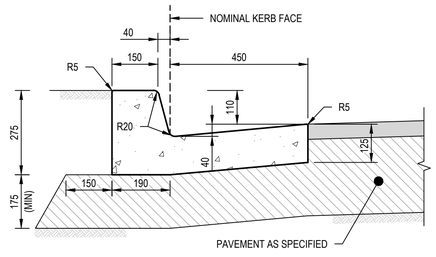
FLEXIBLE PAVEMENT INTERFACE DETAIL

NEW TO EXISTING

SCALE 1:10

NOTE:

TACK COAT EXISTING PAVEMENT BASE AND AC INTERFACE PRIOR TO PLACEMENT OF NEW AC WEARING COURSE.



KERB AND GUTTER (K&G)

SCALE 1:10

NOTE:

PROVIDE TOOL JOINTS AT MAX. 3.0m CTRS.

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 200 400 600 800 1000mm — SCALE 1:10 @A1

North

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135 enspiresolutions.com.au

Project: NEPEAN BUSINESS PARK
PENRITH

Title: SITEWORK DETAILS

Scale: 1:10

First Issue Date: 04/12/2024

Size: A1

Datum: AHD

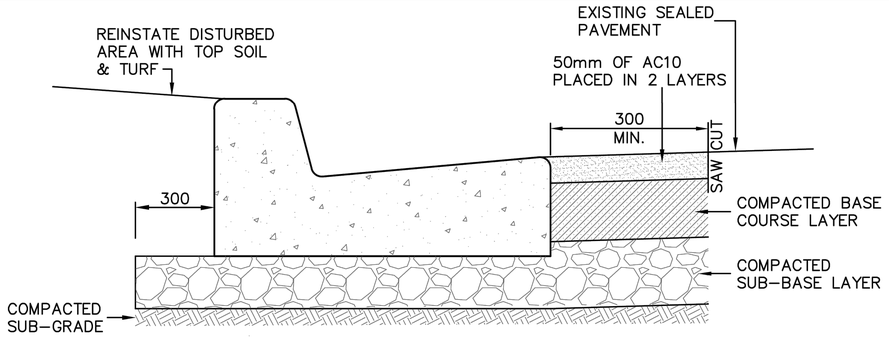
Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C14.01

Revision: 2

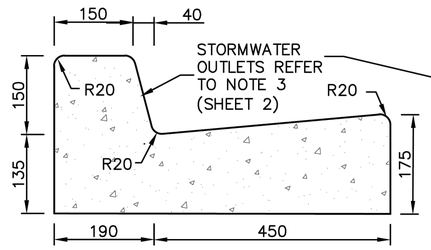
DATE PLOTTED: 26 February 2025 4:29 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C14.01 SITEWORK DETAILS.dwg

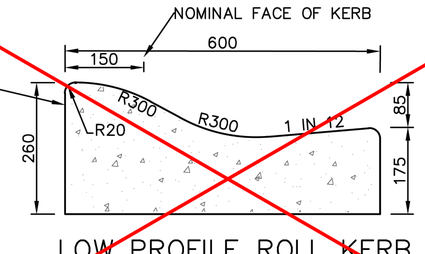


TYPICAL KERB & GUTTER RECONSTRUCTION

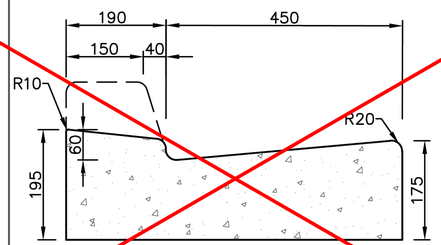
REFER NOTE 6 (SHEET 2)



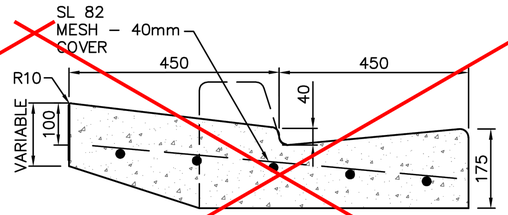
KERB & GUTTER



LOW PROFILE ROLL KERB



DRIVEWAY LAYBACK – RESIDENTIAL



DRIVEWAY LAYBACK – COMMERCIAL & INDUSTRIAL AND LOW LEVEL RESIDENTAIL

DRAWN:	STANDARD KERB & GUTTER, LAYBACKS & DISH CROSSING SHEET 1 OF 2	APPROVED:
PENRITH CITY COUNCIL		PLAN No: SD1003/1

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale:

North:

enspire
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ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK PENRITH

Title: COUNCIL DETAILS SHEET 1

Scale: A1

First Issue Date: 04/12/2024

Datum: AHD

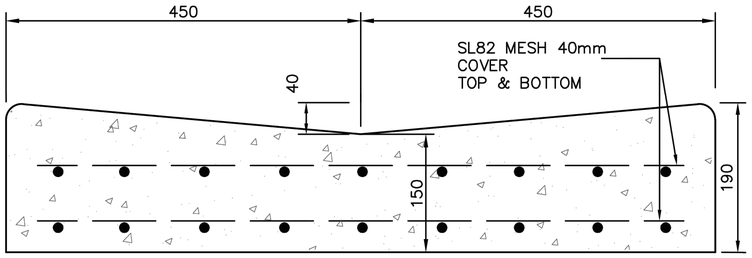
Status: FOR APPROVAL NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C14.11

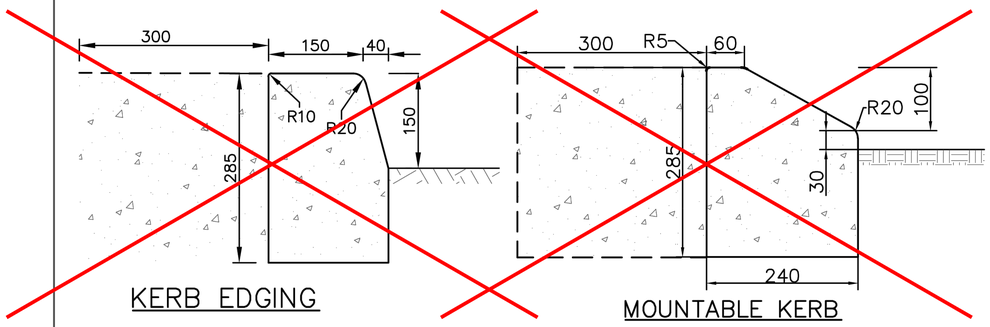
Revision: 2

DATE PLOTTED: 26 February 2025 4:29 PM BY: - JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C14.11-C14.14 COUNCIL DETAILS.dwg



REINFORCED DISH CROSSING



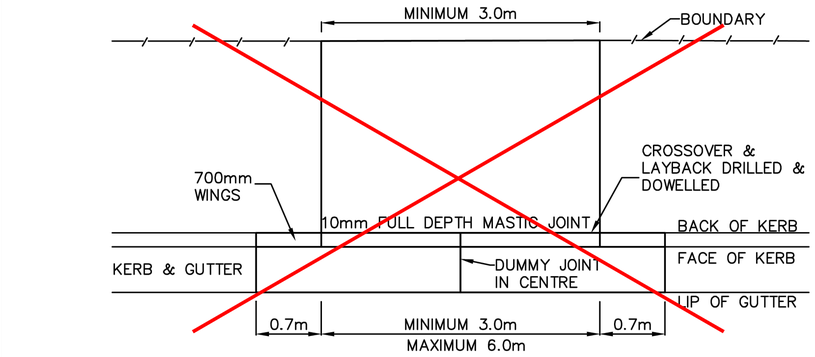
KERB EDGING

MOUNTABLE KERB

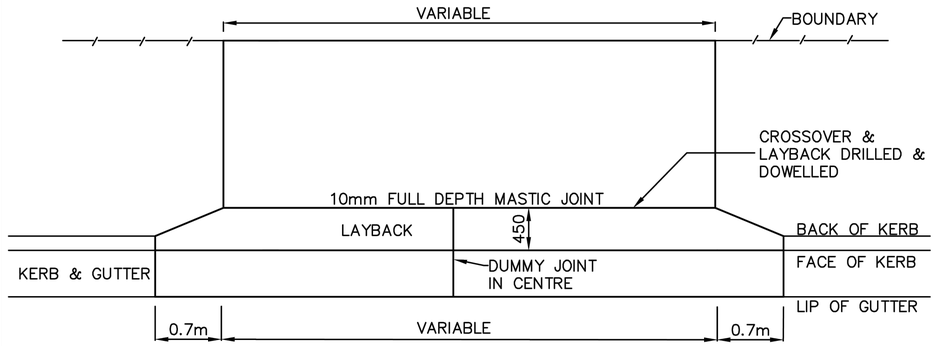
NOTES

1. CONCRETE COMPRESSIVE STRENGTH (F'c) AT 28 DAYS, TO BE 25MPa FOR KERB & GUTTER AND DISH CROSSINGS.
2. ROAD SUB–BASE SHALL BE EXTENDED 300mm BEHIND BACK OF KERB WITH THE THICKNESS TO BE NOT LESS THAN THE ROAD PAVEMENT SUB–BASE THICKNESS.
3. GALVANIZED STEEL OR SIMILAR APPROVED STORMWATER KERB ADAPTORS THE FULL HEIGHT OF THE KERB SHALL BE USED. THE KERB OUTLETS ARE TO MATCH THE PROFILE OF THE KERB. SEE SPECIFICATION
4. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE STATED.
5. ALL EXPOSED EDGES TO BE ROUNDED TO 20mm RADIUS UNLESS SHOWN OTHERWISE
6. SPECIFICATIONS FOR RECONSTRUCTION WORKS TO BE DETERMINED BY COUNCIL'S ENGINEER.
7. SERVICE CONDUIT LOCATIONS SHALL BE MARKED ON KERB FACE WITH AN APPROVED TOOL OR AS OTHERWISE DIRECTED.

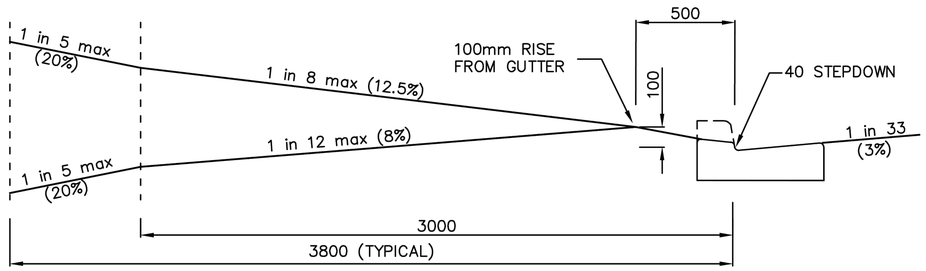
DRAWN:	STANDARD KERB & GUTTER, LAYBACKS & DISH CROSSING SHEET 2 OF 2	APPROVED:
PENRITH CITY COUNCIL		PLAN No: SD1003/2



RESIDENTIAL



INDUSTRIAL/COMMERCIAL



VEHICULAR CROSSING PROFILE – HIGH & LOW LEVEL

DRAWN:	TYPICAL VEHICULAR CROSSOVER	APPROVED:
PENRITH CITY COUNCIL		PLAN No: SD1004

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale:

North:

Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK
PENRITH

Title: COUNCIL DETAILS
SHEET 2

Scale:

First Issue Date: 04/12/2024

Size: A1

Datum: AHD

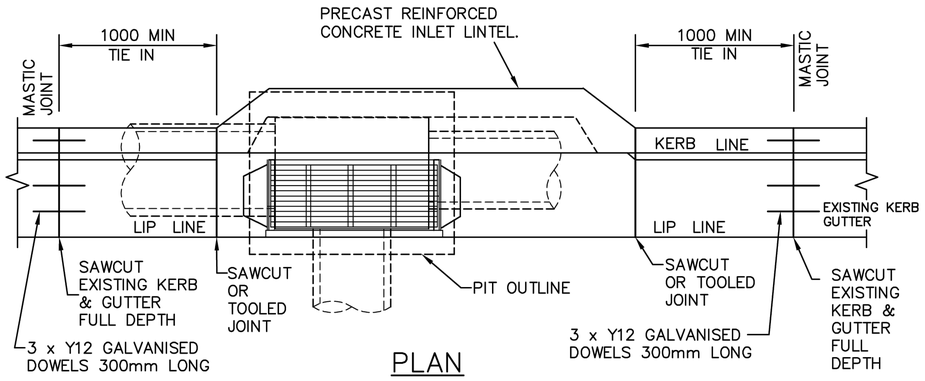
Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C14.12

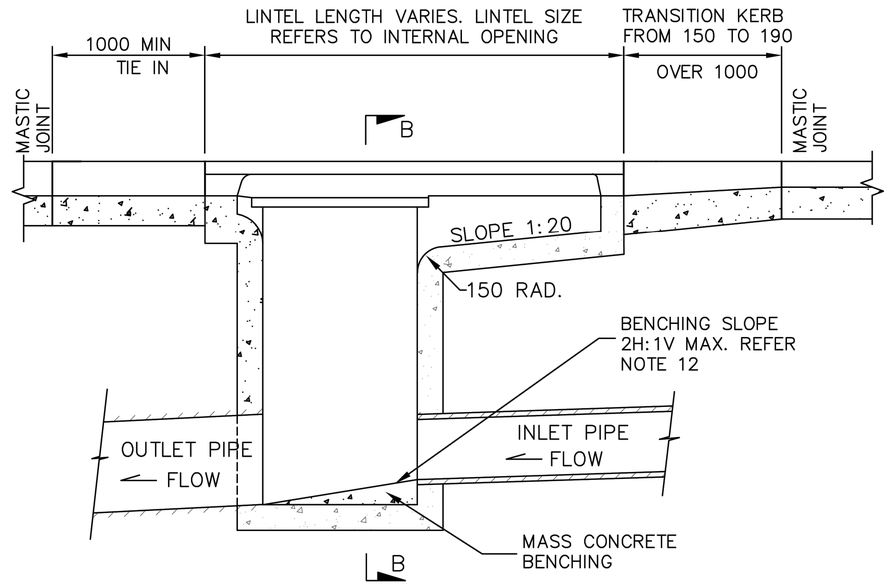
Revision: 2

DATE PLOTTED: 26 February 2025 4:30 PM BY: JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C14.11-C14.14 COUNCIL DETAILS.dwg

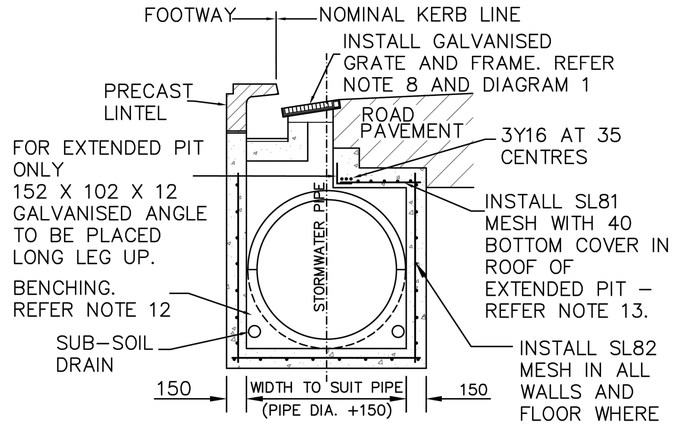


PLAN

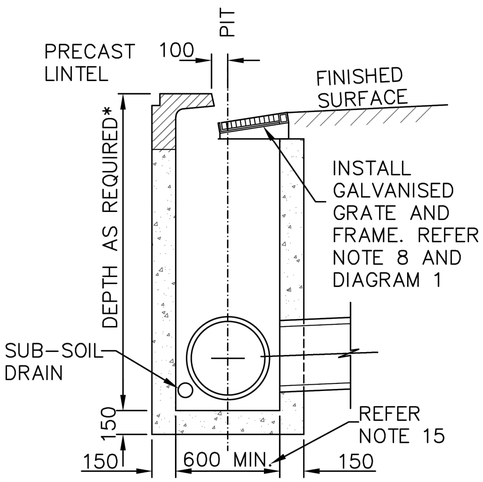


SECTION

DRAWN: M.WARDA	KERB INLET PIT SHEET 1 OF 3	APPROVED:
PENRITH CITY COUNCIL		PLAN No: SD2001/1



SECTION B – B
EXTENDED PIT CHAMBER
REFER NOTE 11.



SECTION B – B
STANDARD PIT

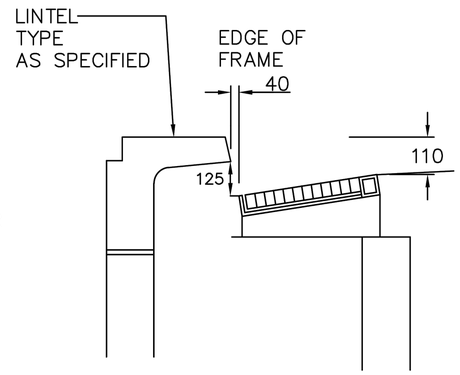


DIAGRAM 1
GRATE INSTALLATION TOLLERENCE

DRAWN: M.WARDA	KERB INLET PIT SHEET 2 OF 3	APPROVED:
PENRITH CITY COUNCIL		PLAN No: SD2001/2

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale:

North:

enspire
Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK
PENRITH

Title: COUNCIL DETAILS
SHEET 3

Scale:

First Issue Date: 04/12/2024

Size: A1

Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-09-DA-C14.13

Revision: 2

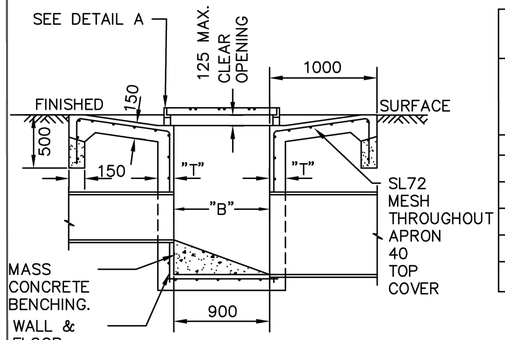
DATE PLOTTED: 26 February 2025 4:30 PM BY : JOSEPH SHELAYMOON

CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C14.11-C14.14 COUNCIL DETAILS.dwg

NOTES

1. CONCRETE TO BE 25MPa AT 28 DAYS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE
3. WHERE DEPTH OF PIT EXCEEDS 1500, WALLS AND BOTTOM TO BE REINFORCED IN ALL DIRECTIONS WITH SL82 MESH AT 40 COVER TO INSIDE FACE WITH N12 CORNER BARS 300 LEGS AT 400 CENTRES. PITS DEEPER THAN 2000 SHALL BE DESIGNED AND THE CONSTRUCTION CERTIFIED BY A PROFESSIONAL STRUCTURAL ENGINEER.
4. TRIMMER BARS TO BE PROVIDED AROUND PIPES GREATER THAN 750 DIAMETER (SEE SD2003).
5. SAG PITS TO HAVE LINTEL LOCATED CENTRALLY OVER PIT.
6. BACKFILL ADJACENT TO PITS TO BE APPROVED GRANULAR MATERIAL.
7. A 3000 LENGTH OF APPROVED "FILTER FABRIC" WRAPPED 100 DIA SUB-SOIL DRAIN IS TO BE PROVIDED AND CONNECTED THROUGH THE UPSTREAM PIT WALL AT THE INVERT LEVEL OF THE UPSTREAM PIPE.
8. PIT GRATE AND FRAME TO BE "WELDLOK" GG51-D GULLY GRATE WITH SKIRTED BASE OR EQUIVALENT FOR ALL ROADS, FITTED WITH A LOCKABLE "J" BOLT OR EQUIVALENT. FOR SAG PITS, USE WELDLOK GG SB 94 SD GULLY GRATE OR EQUIVALENT.
9. APPROVED STEP IRONS SHALL BE PROVIDED WHERE THE PIT EXCEEDS 1000 IN DEPTH. THEY SHALL BE LOCATED AS DIRECTED AND STAGGERED TO GIVE 300 SPACING VERTICALLY AND 300 SPACING HORIZONTALLY.
10. THE CENTRE LINES OF INTERSECTING PIPES ARE TO MEET AT THE DOWNSTREAM FACE OF THE PIT WHERE POSSIBLE.
11. WHERE ENTERING PIPE EXCEEDS 450 IN DIAMETER, PIT CHAMBER TO BE EXTENDED AS PER SECTION B-B 'EXTENDED PIT CHAMBER'.
12. FLOOR OF PIT TO BE BENCHED TO MID POINT OF OUTLET PIPE WHERE OUTLET PIPE GREATER THAN 600 DIAMETER.
13. WHERE EXTENDED CHAMBER WIDTH EXCEEDS 1200, ROOF REINFORCEMENT TO BE DESIGNED BY A PROFESSIONAL STRUCTURAL ENGINEER.
14. CONTRACTOR TO ENSURE CLEARANCE BETWEEN LINTEL AND OPENED GRATE. REFER DIAGRAM 1.
15. WHERE DEPTH OF PIT IS GREATER THAN 1200, INTERNAL WIDTH OF PIT TO BE INCREASED TO 900x900 FOR FULL DEPTH BELOW PAVEMENT.
16. LIFTING LUGS TO BE FILLED AFTER INSTALLATION.

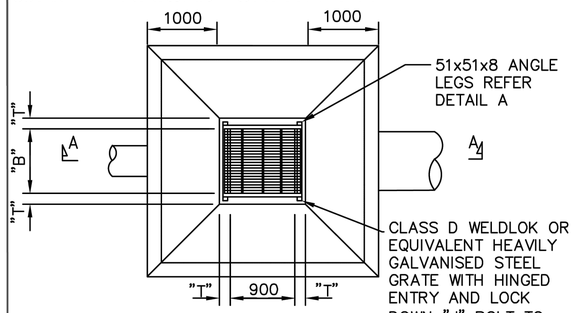
DRAWN: M.WARDA	KERB INLET PIT SHEET 3 OF 3	APPROVED:
PENRITH CITY COUNCIL		PLAN No: SD2001/3

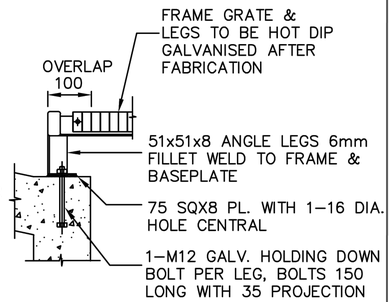


SECTION A – A
RAISED GRATE PIT

PIT DIMENSIONS & MESH			
LARGEST PIPE CONNECTED TO PIT	INTERNAL PIT DIMENSION "B"	WALL THICKNESS DIMENSION "T"	MESH (WALLS eg. & FLOOR ONLY)
UP TO 525	900	150	SL72
UP TO 750	900	150	SL72
825–900	1000	150	SL72
1050–1200	1400	150	SL82
1350	1550	200	SL82
1500	1700	200	SL102

- PITS DEEPER THAN 1.2m SHALL BE 900X900mm INSIDE DIMENSION.
- NOTWITHSTANDING THE ABOVE TABLE, PITS DEEPER THAN 2000mm INVERT OF GUTTER TO INVERT OF PIT SHALL BE STRUCTURALLY DESIGNED & CERTIFIED.





DETAIL A – CONNECTION OF RAISED GRATE TO PIT

TYPICAL DETAIL SURFACE INLET PIT TO SUIT PIPES UP TO 1500mm DIA.

NOTES.

1. ALL CONCRETE TO BE MINIMUM 25MPa UNLESS OTHERWISE NOTED.
2. APPROVED STEP IRONS SHALL BE PROVIDED WHERE THE PIT EXCEEDS 900mm IN DEPTH. THEY SHALL BE LOCATED AS DIRECTED AND STAGGERED TO GIVE 300mm SPACING VERTICALLY AND 300mm SPACING HORIZONTALLY. LOCATE HINGES OF GRATES TO SUIT STEP IRONS.
3. GRATES MUST BE CLASS D.
4. ALL CONCRETE WORK TO BE A MINIMUM OF 150mm THICK.
5. MASS CONCRETE BENCHING TO PIPE CENTRELINE MUST BE PROVIDED AS INDICATED.
6. WHERE SITE CONDITIONS DICTATE, THE SUPERVISING ENGINEER MAY INCLINE THE PIT TOPS TO AN UPPER LIMIT OF 1 VERT. IN 4 HORIZ. NO ALTERATION TO REINFORCEMENT IS REQUIRED, HOWEVER, THE ENTIRE PIT ROOF (AND ACCOMPANYING APRONS) ARE TO REMAIN PLANAR.
   eg.

7. ALL DIMENSION ARE IN mm UNLESS OTHERWISE NOTED.

DRAWN: W.KONG	STANDARD GRATED SURFACE INLET PITS	APPROVED:
PENRITH CITY COUNCIL		PLAN No: SD2002

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale:

North:

enspire
Enspire Solutions Pty Ltd
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ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK PENRITH

Title: COUNCIL DETAILS SHEET 4

Scale:

First Issue Date: 04/12/2024

Size: A1

Datum: AHD

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION

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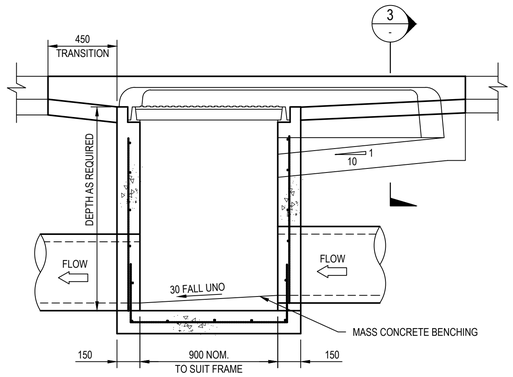
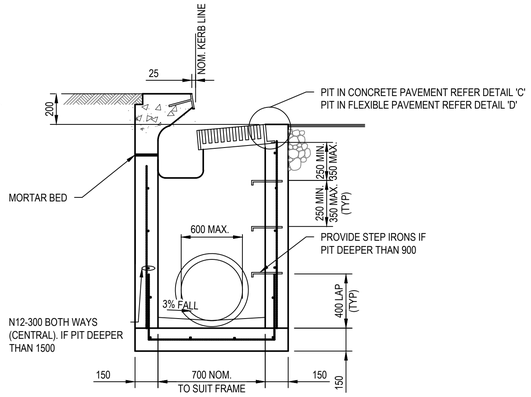
Revision: 2

DATE PLOTTED: 26 February 2025 4:30 PM BY: JOSEPH SHELAYMOON

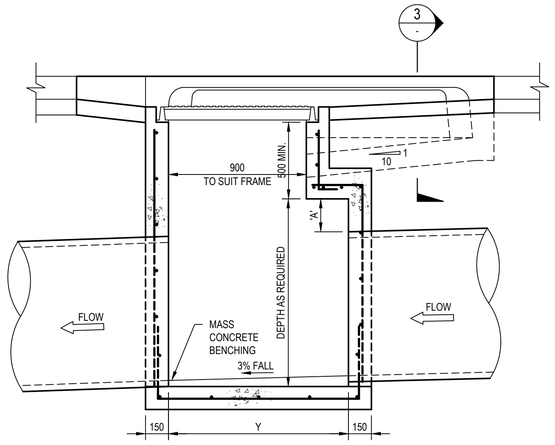
CAD File: P:\200044 NepeanBusinessPark\D-Civil\09-S4.55 DA Update\Drawings\6-DACC\200044-09-DA-C14.11-C14.14 COUNCIL DETAILS.dwg



SECTION 1 -
SCALE 1:20



SECTION 2 -
SCALE 1:20



SECTION 1 -
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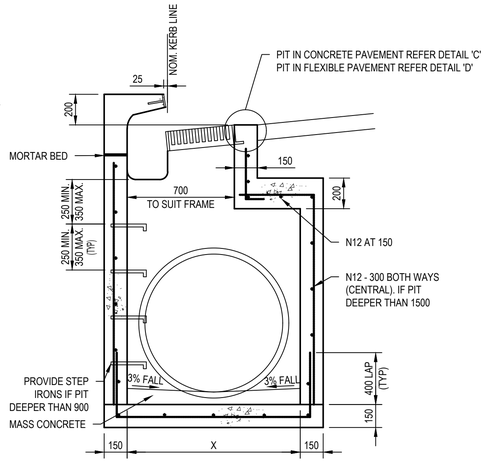

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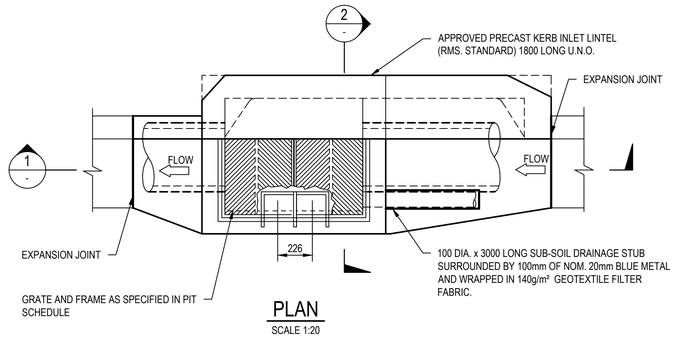

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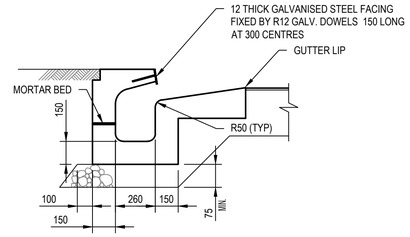

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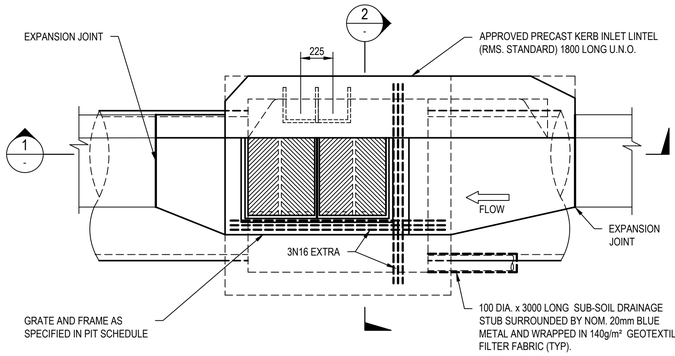

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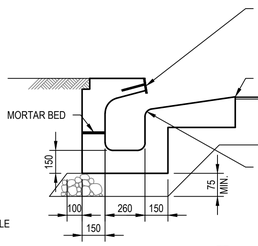

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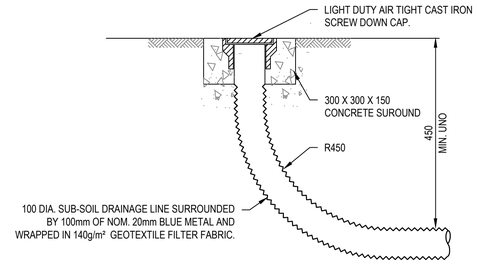

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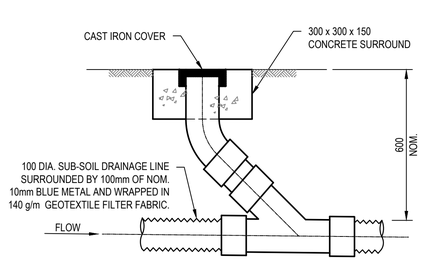

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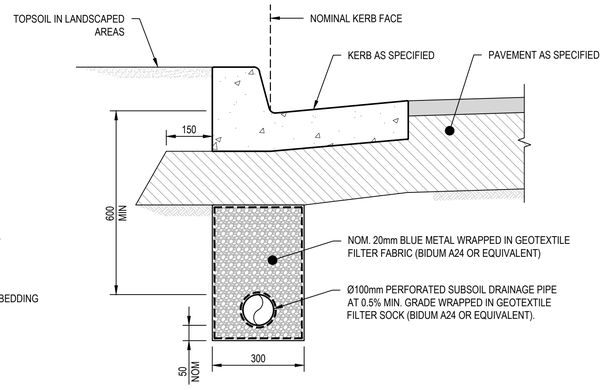
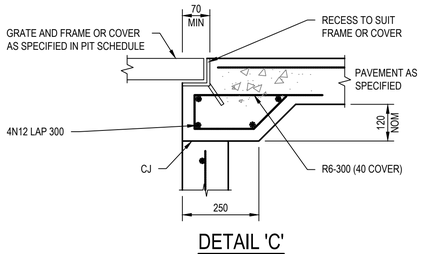
PIPE AND FITTINGS MAY BE USED



SUBSOIL DRAINAGE BEHIND KERBS
SCALE 1:10

NOTE:
BRING RISER TO SURFACE BEHIND KERB.



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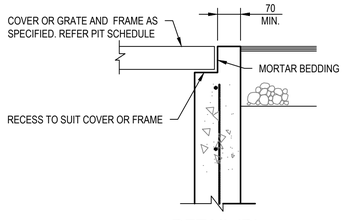

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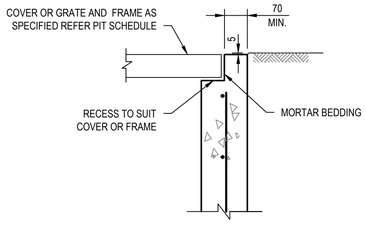

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1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

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SCALE 1:10 @A1
0 0.5 1 1.5 2m
SCALE 1:20 @A1

North

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Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK
PENRITH

Title: STORMWATER DETAILS
SHEET 1

Scale: AS SHOWN
First Issue Date: 04/12/2024
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Datum: AHD

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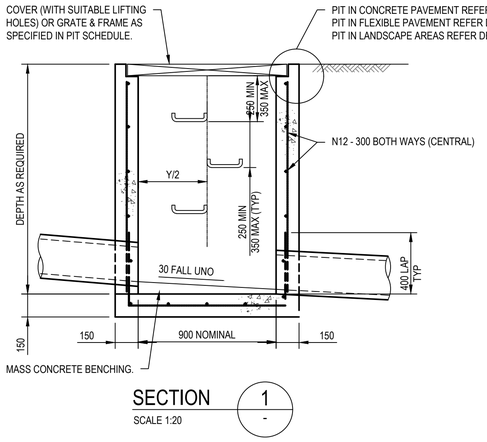

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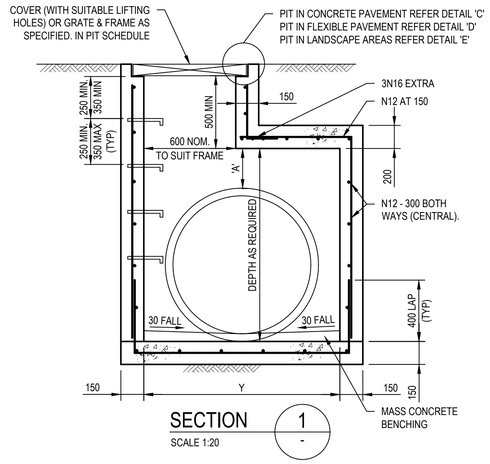

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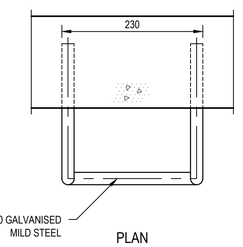

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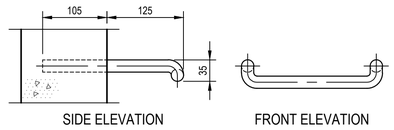
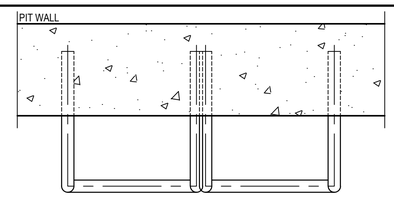


STEP IRON DETAIL

SCALE 1:5



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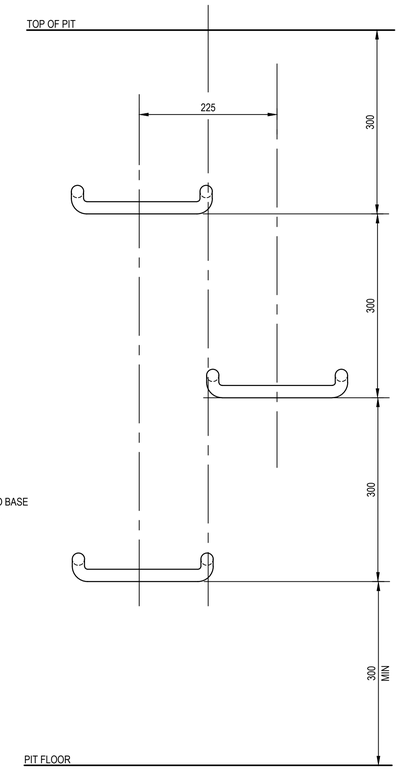

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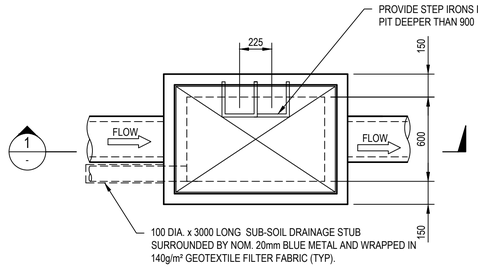
SCALE NTS



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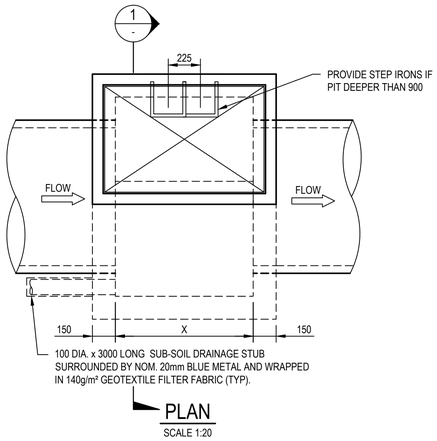

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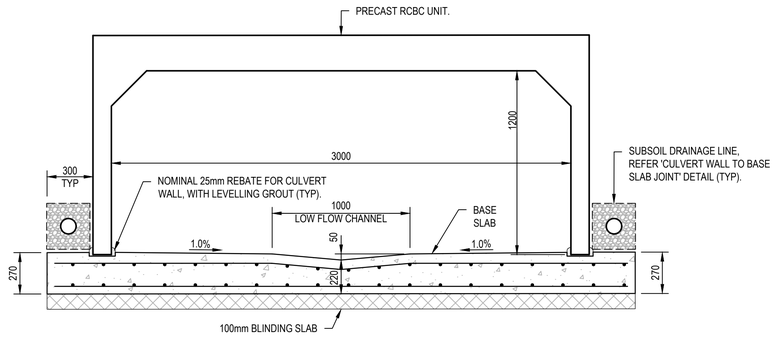

TYPICAL CULVERT AND BASE SLAB DETAIL

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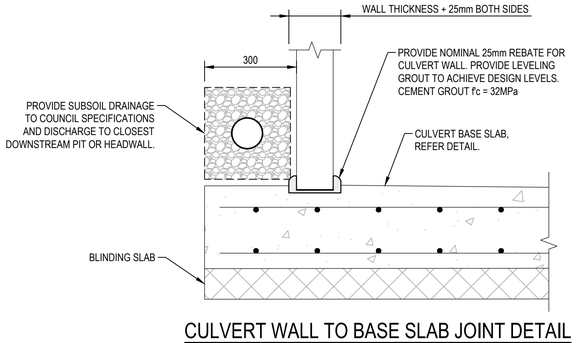

CULVERT WALL TO BASE SLAB JOINT DETAIL

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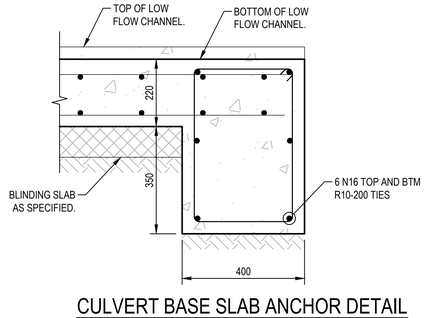

CULVERT BASE SLAB ANCHOR DETAIL

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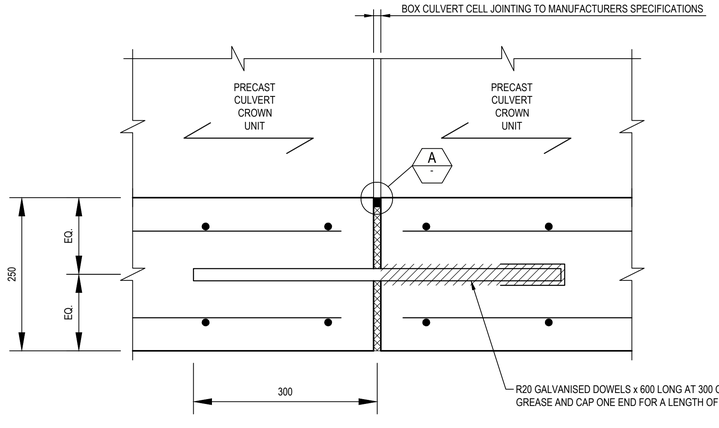

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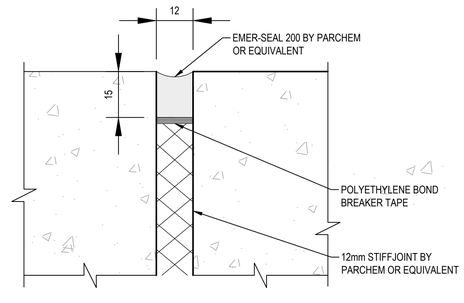

DETAIL A -

N.T.S

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1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 0.2 0.4 0.6 0.8 1m — SCALE 1:10 @A1; 0 0.5 1 1.5 2m — SCALE 1:20 @A1

North

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Project: NEPEAN BUSINESS PARK PENRITH

Title: STORMWATER DETAILS SHEET 2

Scale: AS SHOWN

First Issue Date: 04/12/2024

Size: A1

Datum: AHD

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Revision: 2

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2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 50 100 150 200m — SCALE 1:2000 @A1

North

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: CATCHMENT PLAN

Scale: 1:2000
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

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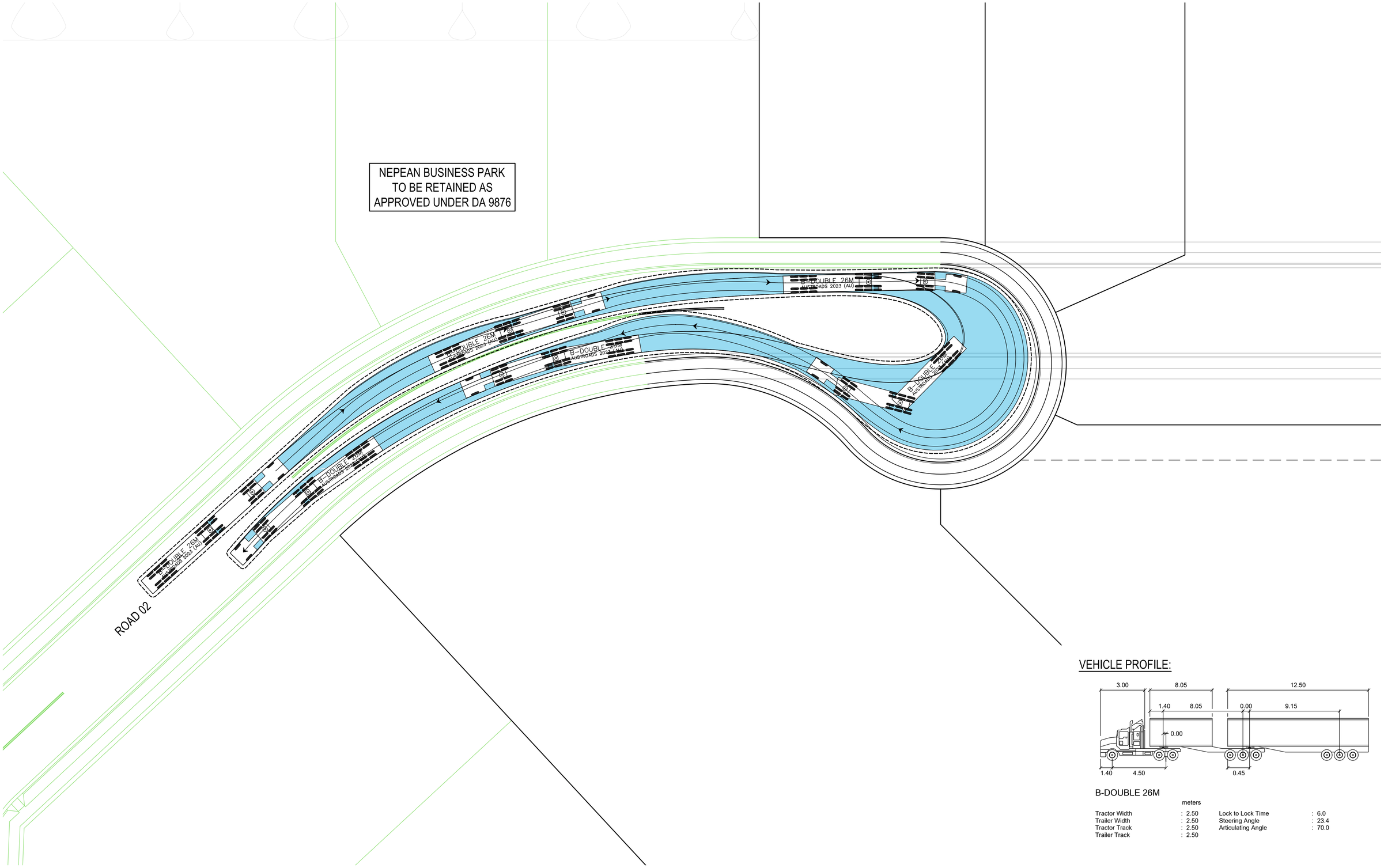
NEPEAN BUSINESS PARK
TO BE RETAINED AS
APPROVED UNDER DA 9876



VEHICLE PROFILE:

B-DOUBLE 26M

meters

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Trailer Width	: 2.50	Steering Angle	: 23.4
Tractor Track	: 2.50	Articulating Angle	: 70.0
Trailer Track	: 2.50		

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
3	26/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
2	24/02/2025	ISSUED FOR DEVELOPMENT APPLICATION	JSH	AL		MKH
1	04/12/2024	ISSUED FOR DEVELOPMENT APPLICATION	DK	AL		MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 5 10 15 20 25m — SCALE 1:250 @A1

North

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Project: NEPEAN BUSINESS PARK
PENRITH

Title: TURNING PATH PLAN

Scale: 1:250
First Issue Date: 04/12/2024
Size: A1
Datum: AHD

Status: FOR APPROVAL
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Project Number/Drawing Number: 200044-09-DA-C25.01
Revision: 3

DATE PLOTTED: 26 February 2025 4:30 PM BY : JOSEPH SHELAYMOON

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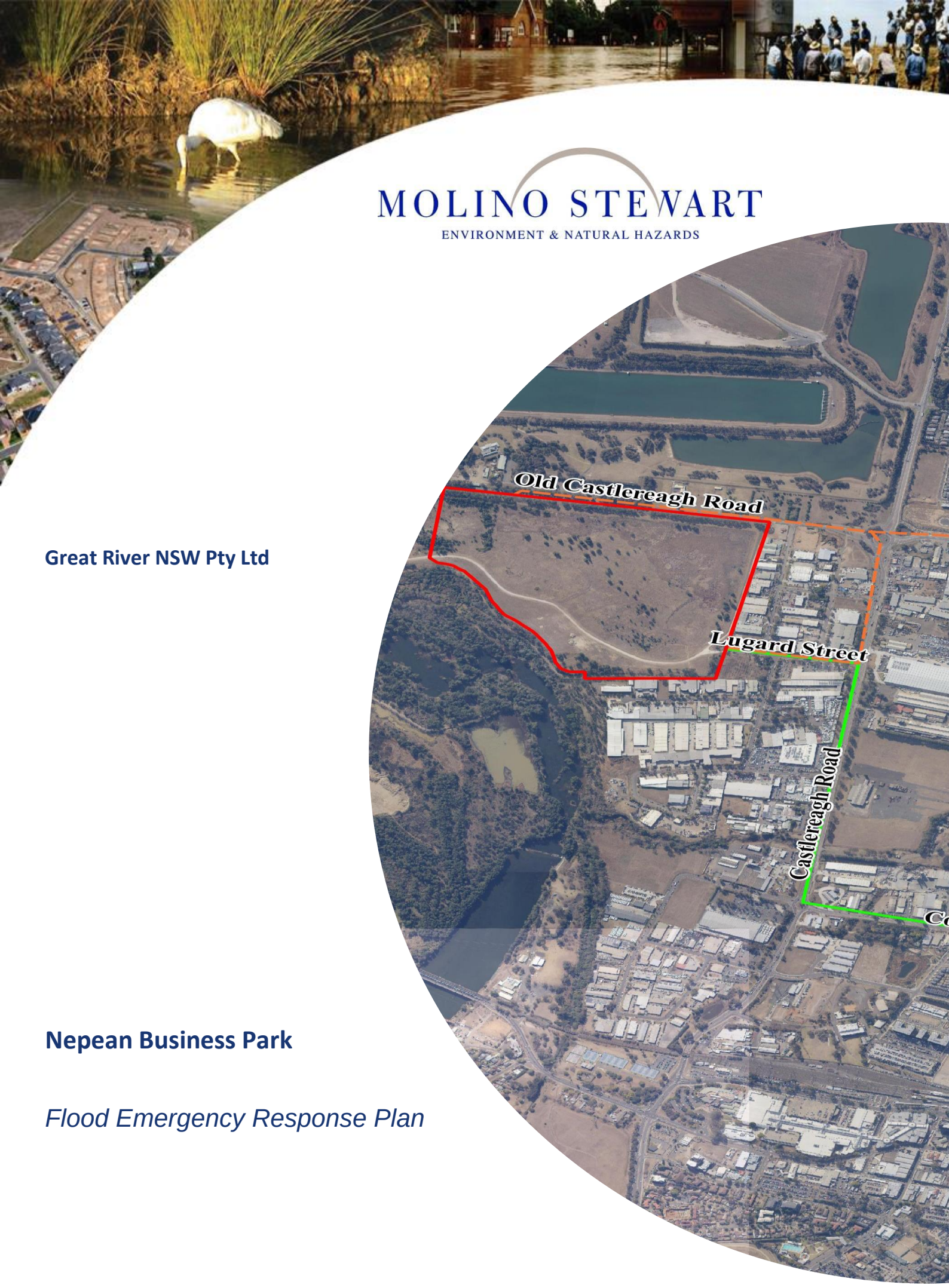
Attachment 2: Approved Reporting

MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS



Great River NSW Pty Ltd

Nepean Business Park

Flood Emergency Response Plan

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Nepean Business Park

FLOOD EMERGENCY RESPONSE PLAN

for

Great River NSW Pty Ltd

by

Molino Stewart Pty Ltd
ACN 067 774 332

MARCH 2022

MOLINO STEWART PTY LTD ABN 95 571 253 092 ACN 067 774 332
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MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

DOCUMENT CONTROL

Document Reference	1080 Nepean Business Park Flood Emergency Response Plan draft 6.2
Project	Nepean Business Park
Document Type	Flood Emergency Response Plan
Author	Steven Molino

REVISION HISTORY

Date	**Version**	**Name**	**Comments**
28/11/2018	1.0	Steven Molino	Draft for client comment
14/12/2018	1.1	Steven Molino	Final
02/12/2020	2.1	Steven Molino	Minor changes to reflect revised layout
11/12/2020	2.2	Steven Molino	Incorporating client comments
14/12/2020	3.0	Steven Molino	Final
12/9/2020	4.0	Steven Molino	Additional information on evacuation modelling
4/11/2021	5.0	Steven Molino	Removal of evacuation modelling & update of flood levels
5/11/2021	5.1	Steven Molino	Final
6/12/2021	5.2	Steven Molino	Insertion of additional actions
1/3/2022	6.1	Steven Molino	Revised Draft
2/3/2022	6.2	Steven Molino	Revised Draft

DOCUMENT APPROVAL

For Molino Stewart	
Name	Steven Molino
Position	Principal
For Great River NSW Pty Ltd	
Name	The Directors
Position	

CONTENTS

APPENDICES

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1 INTRODUCTION

1.1 BACKGROUND

In January 2017, the NSW Government published the State Environmental Planning Policy (Penrith Lakes Scheme) Amendment 2017. Amongst other things, this zoned an area in the south of Penrith Lakes as Employment.

A development application was submitted for a proposed subdivision of this land into light industrial lots within a Community Title scheme.

Clause 33 of the SEPP states that:

(3) Development consent must not be granted for development on land zoned Employment, Residential or Tourism unless the consent authority is satisfied that the development will not adversely affect the safe and effective evacuation of the land and the surrounding area.

This Flood Emergency Response Plan (FERP) has been prepared by Molino Stewart Pty Ltd on behalf of Great River NSW Pty Ltd. The FERP, of which evacuation is only one aspect, sets out how the development will be prepared for flooding and what actions will be taken before, during and after a flood to manage the safety of those on site and to ensure this is done in a way which is compatible with the safe evacuation of the surrounding areas.

This FERP is an overarching plan for the whole precinct and provides a level of detail appropriate to planning and response at a precinct level. Each individual business and body corporate within the precinct will need to develop its own detailed FERP which is consistent with this precinct FERP.

1.2 SITE DETAILS

1.2.1 Locality

The site is located in Penrith and is situated between Castlereagh Road to the east and Nepean River to the west. The location is referred to as the Nepean Business Park and is shown in Figure 1.

The site covers approximately 49 hectares and is located within the NSW SES Penrith North (A) flood evacuation subsector within the Penrith North flood evacuation sector.

1.2.2 Site Layout

Figure 2 shows the indicative layout plan for the proposed subdivision. It consists of a total of 93 lots ranging in size from 2,006m^2 to 20,236m^2 and a community title lot of 4 m^2. It will have road access from Lugard Street in the east and Old Castlereagh Road in the north. It will have an internal ring road network.

1.2.3 Topography and Drainage

The precinct is situated in one of a series of floodplains formed by the topography within the Hawkesbury-Nepean valley. After exiting the Fairlight Gorge, the Nepean River expands into a wider channel with a broad floodplain at Regentville and then flows past Penrith on the east bank of the River and Emu Plains on the west bank. A sharp bend in the river and a narrowing of the channel downstream of Emu Plains creates a constriction which is responsible for the flooding of the Penrith and Emu Plains floodplain.

The precinct is on the outside of this bend at a level of around 26m AHD compared to the normal river level which is at about 12m AHD. Development approval has already been granted to fill the site and that will increase the levels across the site to between 27m AHD and 30.5m AHD.

Boundary Creek enters the River from the east about 650m south of the precinct.

Figure 1: Location of Nepean Business Park

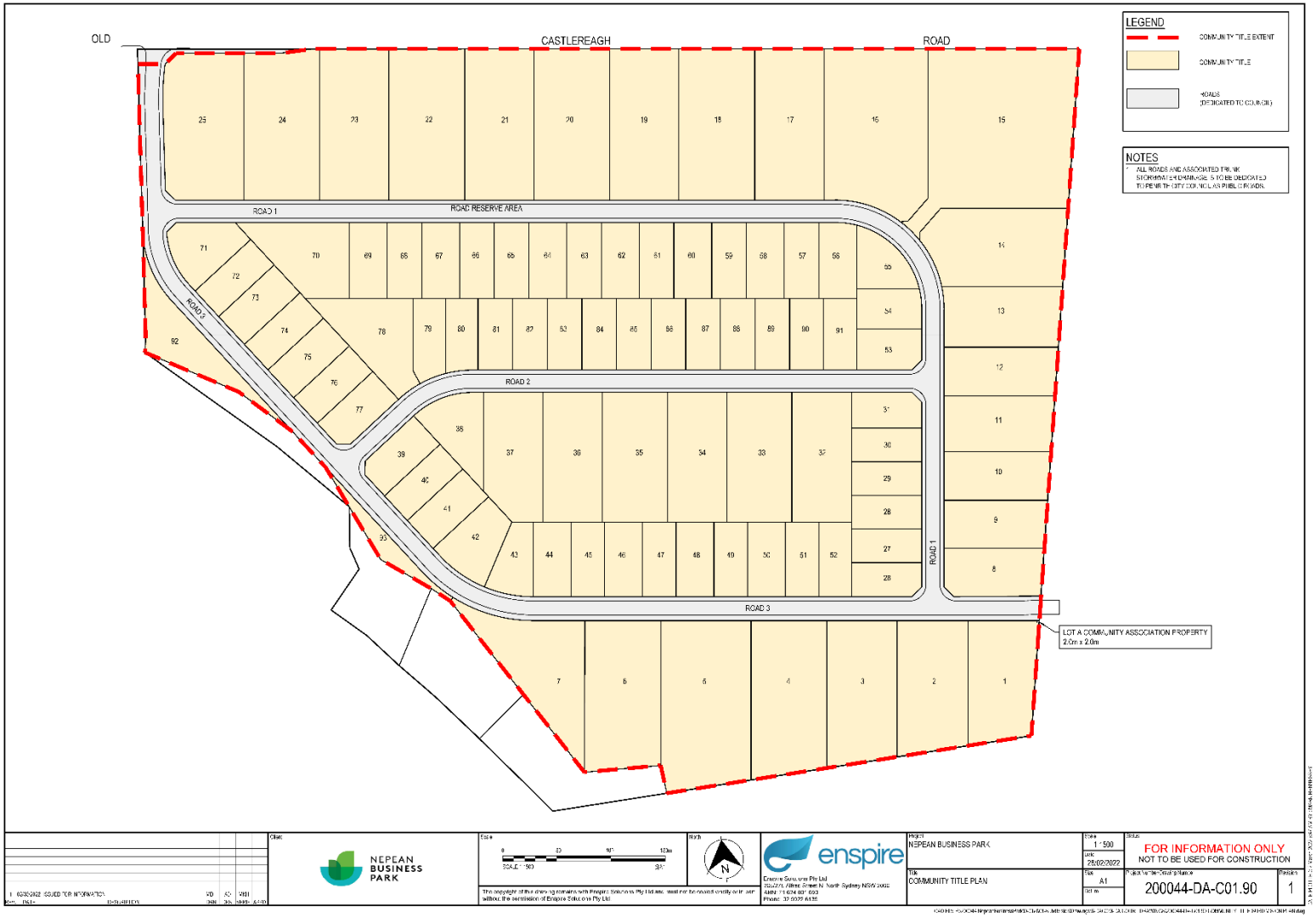

Figure 2: Indicative Layout Plan for Nepean Business Park

2 FLOOD RISKS

2.1 FLOOD GENERATING WEATHER

Coastal areas of eastern Australia mostly receive flooding rains from so-called "east coast lows" that develop from time to time over the adjacent Tasman Sea. These are intense depressions off the coast and can produce thunderstorm activity associated with troughs.

Depressions can develop at any time of year, but are most likely when sea surface temperatures are high and the air is humid. Therefore, these events usually occur in the summer months and over the first half of the year.

Flooding can also be a winter-spring phenomenon, associated with unusually frequent or active extra-tropical depressions and fronts. However, some major events have occurred in the summer half-year as systems of tropical origin extend or move south. Flooding over inland areas is usually associated with southward-moving tropical systems, but in the cooler months, may occur when well-developed cloud bands extend across the interior from the oceans north and northwest of Australia.

All of the above weather can result in extended rainfall events which can cause flooding in the Nepean River or in Boundary Creek or both.

Flooding is more prevalent in a La Nina year when rainfall is significantly greater than the average rainfall.

Rainfall patterns are also dependant on weather patterns that occur throughout the year. Thunderstorms, which generally occur during the summer, can result in localised flooding, which could impact on the site.

Sydney has experienced severe thunderstorms in the past and because large expanses of the urban area are paved, much of the rainfall becomes flood run-off. This could result in localised flooding of Boundary Creek but is unlikely to be the cause of flooding in the Nepean River.

The Hawkesbury-Nepean Valley has been flooded in numerous large rainfall events, although the March 2021 flood at Penrith was the first major flood in 30 years. In summary, there are many different weather events which could cause flooding at the site and this could happen at any time of year.

2.2 FLOOD PROBABILITIES

Flood probability can be expressed in more than one way. For example, a flood may be described as having a 1 in 100 year average recurrence interval (ARI). This means that over many thousands of years, a flood of this magnitude would occur on average once in 100 years. This does not mean that a flood of this size only occurs once every 100 years. It is possible to have floods of this size in consecutive years or even two in the same year. This happened in several locations in Queensland and Victoria in 2010 and 2011.

Another way of expressing flood probability is in terms of average exceedance probability (AEP). A 1 in 100 year ARI flood has roughly a 1 in 100 AEP. That is, each year and every year it has a 1 in 100 or 1% chance of being reached or exceeded. This is perhaps a more helpful way of thinking about flood probabilities.

This document will refer to flood probabilities in terms of chance per year. Each and every year a 1 in 100 chance per year flood has a 1 in 100 chance of being equalled or exceeded in that year.

A flood with a 1 in 100 chance per year has about a 1 in 2 chance of being reached or exceeded in the average person's lifetime, the same probability of tossing a coin and getting a head.

Bigger floods can and do occur. There were several floods with greater than a 1 in 100 chance per year experienced in Eastern Australia in early 2011. Some reached levels which have a 1 in 1,000 (0.1%) chance per year.

A flood with a 1 in 500 chance per year has about a 1 in 6 chance of being reached or exceeded in the average person's lifetime, the same as tossing a die and getting a 6.

The largest flood that can occur is referred to as the Probable Maximum Flood (PMF). Although it has a very low probability of occurring in any one year (about a 1 in 100,000 chance per year

at Penrith), events approaching a PMF have been recorded.

Flooding may occur at any time of year and at any time of day. There is no seasonality associated with flooding in Sydney and an event could occur during hours of operation for commercial premises on the site.

2.3 FLOODING ON THE SITE

2.3.1 Nepean River

The largest flood on record in the Hawkesbury-Nepean valley occurred in 1867 when the river level reached 26.9 metres Australian Height Datum (AHD) at Victoria Bridge at Penrith. This flood is estimated to have between a 1 in 200 and a 1 in 500 chance of occurrence in any year. A PMF event would reach a level of approximately 32.8 metres AHD at Victoria Bridge. Table 1 outlines the history of recorded floods in the valley.

Sediment within the Fairlight Gorge in the Nepean River upstream of Penrith shows that prior to European settlement at least one flood reached or exceeded the level of a flood with about a 1 in 1,000 chance per year level of 27.6 metres AHD at Penrith. The most recent floods in the Hawkesbury-Nepean Valley have ranged been 1 in 5 and 1 in 50 chance of occurrence per year flood levels. The March 2021 flood peaked at 24.2m AHD.

To place these probabilities in context, some of the rivers in Victoria which flooded in 2011 experienced floods with a 1 in 200 chance per year level, while flooding in Lismore NSW in 2022 exceeded a 1 in 500 flood level. Some catchments in Queensland experienced floods in 2011 that have been reported to have had about a 1 in 1,000 chance of occurrence per year.

Flood waters from the Nepean River would initially back up Boundary Creek, eventually flooding Castlereagh Road and cutting the evacuation route south of the site. As the water level continues to rise it would break the river banks and enter the existing industrial estate immediately south of the site.

Further flood rises would result in the water to the south eventually flowing around the east of the precinct and cutting off its access via Lugard Street. At the same time the water backing up in Boundary Creek would have crossed Andrews Road, cutting off that evacuation route. Once water overtops Lugard Street it would flow through the industrial estate to the north and cut Old Castlereagh Road which is at a lower level.

Eventually the river overtops the banks adjacent to the site and begins flooding the site.

2.3.2 Flood Levels

The Penrith gauge is just upstream of Victoria Bridge which itself is upstream of Penrith Weir. The precinct is 700m downstream of the weir. This means that the water level at the gauge is higher than the water level at the site.

Table 1 shows the full range of flood levels which could affect the site. The table shows three levels. The first is the peak gauge level at Victoria Bridge for the corresponding flood probability (note that historically the gauge was set arbitrarily with a zero reading at 14.139m AHD). The second level is the corresponding peak height above sea level (m AHD) for that gauge reading. The third level is the peak level at the precinct which would be reached for a flood of that probability.

The 1 in 100 chance per year flood would reach a peak of 25.8m AHD at the gauge and about 25.0m AHD adjacent to the precinct. The entire Precinct is at or above 27.0m AHD and so would not be directly affected by the flood. However, as shown in Figure 3 its evacuation route along Castlereagh Road would be cut by floodwaters backing up Boundary Creek. The road has a low point of 24.2m AHD at the creek crossing and would be covered by 0.6m of water at this location.

Table 1: Flood history in the Hawkesbury-Nepean valley

Chance per year	Peak gauge level at Victoria Bridge (m)	Peak flood level at Victoria Bridge, Penrith (m AHD)[1]	Peak flood level in river at the Precinct (m AHD)[2]	Year equalled or exceeded[1]
1 in 5	5.5	19.6	18.1	1986, 1962, 1955, 1950, 1943, 1934, 1922, 1895, 1894,
1 in 10	7.2	21.3	20.0	1988, 1975, 1949, 1916, 1898
1 in 20	9.2	23.3	22.2	2021, 1990, 1978, 1964, 1961, 1956, 1952, 1904
1 in 50	10.7	24.8	23.9	No record
1 in 100	11.7	25.8	25.0	No record
1 in 200	12.4	26.5	25.7	1867
1 in 500	13.0	27.1	26.5	No record
1 in 1,000	13.4	27.5	26.9	At least once before 1788
1 in 2,000	14.3	28.4	27.8	No record
1 in 5,000	15.3	29.4	29.0	No record
PMF	18.7	32.8	32.6	No record

1. Source – Hawkesbury Nepean Valley Regional Flood Study Final Report (WMAwater, 2019)
2. Source – flood model outputs provided by WMAWater.

A flood would have to exceed the 1 in 1,000 chance per year level of 26.9m AHD at the site and reach 27.0m AHD before the lowest parts of the site began to flood through water backing up into the internal drainage system and onto the lowest parts of roads.

All of the building floor levels will be at least 0.8m above the 1 in 2,000 chance per year level of 27.8m AHD and most would be above the 1 in 5,000 chance per year flood level of 29.0m AHD. The PMF peak level at the gauge is 32.8m AHD and estimated to be 32.6m AHD at the precinct. The whole precinct would therefore be flooded with the lowest parts of the site flooded to a depth of 5.6m but no ground floor levels being flooded to a depth of more than 5m.

Figure 3: 1 in 100 chance per year flood levels

Note that the above figure is sourced from the Nepean River Flood Study which has slightly higher 1 in 100 chance flood levels than the Hawkesbury Nepean Valley Regional Flood Study which has been relied upon in this FERP. The flood planning level for the site has been based on the Nepean River flood study levels as these are what have been adopted by Penrith City Council.

2.3.3 Rate of Flood Rise

The rate at which this water rises will vary depending on how big the flood is and how quickly the rain is falling. A simulation of 20,000 different rainfall distributions and intensities show that 99.7% of floods take more than 10 hours to rise from 17.0m AHD to 24.0m AHD at the Penrith gauge, most take more than 24 hours (Figure 4). The NSW SES plans its vehicular evacuation of the Hawkesbury Nepean Valley around a minimum of about 10 hours at Penrith.

It should also be noted that the peak at the site will occur a little while after the flood has peaked at Victoria Bridge because of the time it takes the flood peak to travel downstream from the bridge.

2.3.4 Critical Levels

There are several levels associated with the Nepean Business Park which are critical to the safety of people and the protection of property. They are:

- 24.2m AHD – the lowest point along Castlereagh Road which is the lowest evacuation route for the site. All vehicles should leave the precinct before flooding reaches this level at Castlereagh Road. This has between a 1 in 20 and 1 in 50 chance of occurring per year.
- 25.4m AHD – the lowest point on Lugard Street. When flooding exceeds this level adjacent to the precinct, exiting the precinct by car or on foot in this direction becomes dangerous. Water would flow north from this point and cut Old Castlereagh Road which is at a lower level. Andrews Road would also be cut by water backing up Boundary Creek. Once this level is reached safe evacuation routes from the site are effectively cut. This has less than a 1 in 100 chance of occurring per year.
- 27.0m AHD – the lowest point within the precinct. At this level floodwaters enter the precinct directly from the river via the internal drainage system. This has about a 1 in 1,000 chance of occurring per year and would cut the internal roads
- 28.5m AHD – water might start to enter the lowest lying buildings on site. This is has between a 1 in 2,000 and 1 in 5,000 chance of occurrence per year.
- 30.5m AHD – the highest ground level within the precinct would flood. This has between a 1 in 5,000 and 1 in 100,000 chance of occurring per year

Floor levels in each of the buildings within the precinct vary and details of those should be provided in each respective flood response plan. All will have mezzanine floors or first floors which are above the reach of the PMF. An extreme flood could isolate the precinct for up to three days.

2.3.5 Emergency Response Classification

The NSW SES has developed a classification system for areas within floodplains which determines whether those who fail to evacuate by car:

- have safe walking access to a flood free area
- would be isolated and/or overwhelmed by rising floodwaters

The Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities (DECC, 2007) provides details of the classification system.

According to this classification system the precinct is a Low Flood Island (LFI). This is an area whose evacuation routes get cut before the area begins to flood but as floodwaters rise the whole area can be inundated.

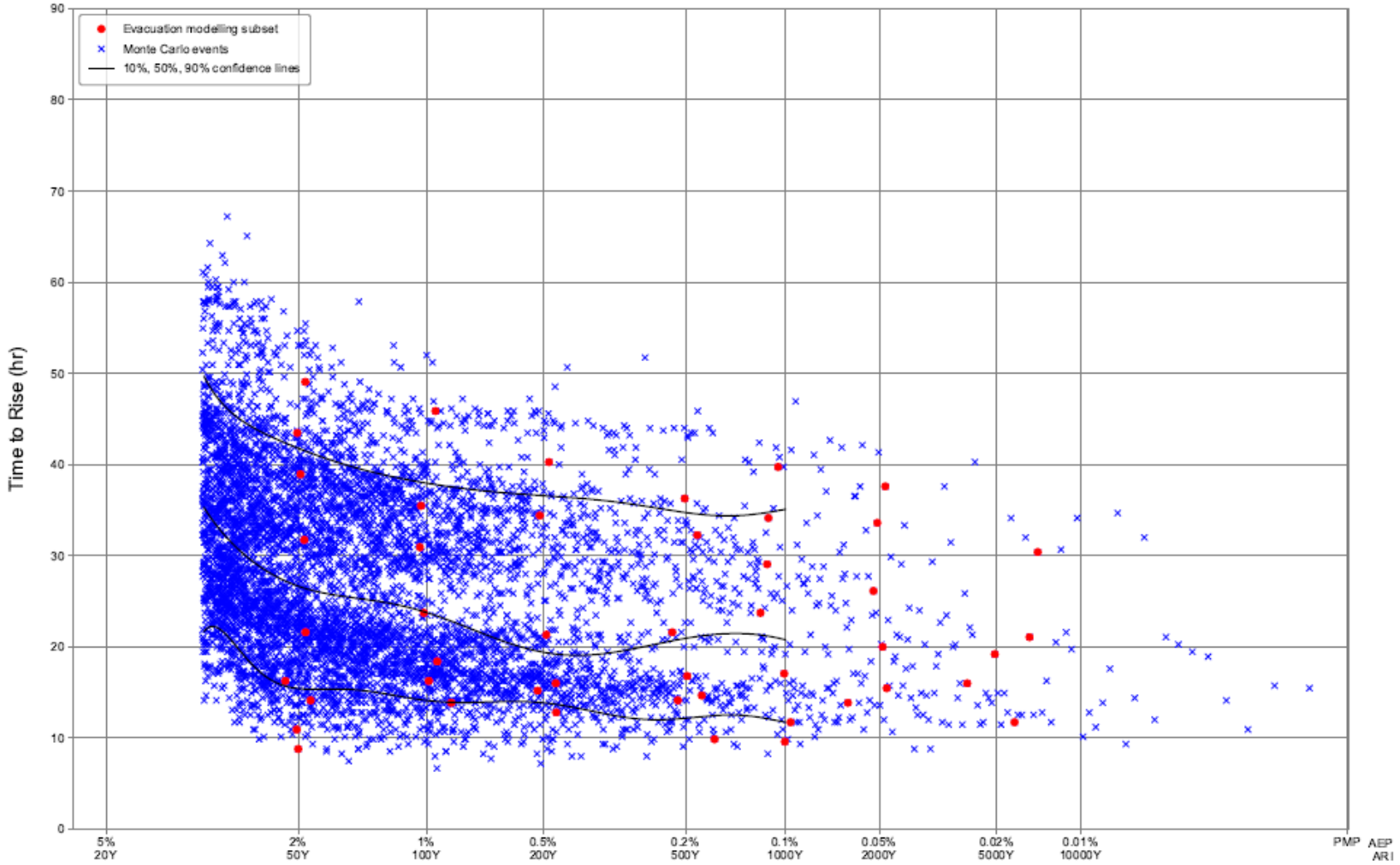

Figure 4: Time to rise between 17.0m and 24.0m AHD at the Penrith Gauge (source, WMA Water, 2019)

3 PRECINCT FERP

3.1 EMERGENCY RESPONSE PHILOSOPHY

This FERP recognises that protection of life is of critical and primary importance.

The protection of all lives is the first priority, the comfort of workers and customers is second, the protection of property is third and the continuity of business operations, while of lesser priority, should not be overlooked.

While this FERP recognises the need for developers, owners and operations managers at premises within the precinct to consider financial implications, this will not be consciously done to the detriment of protecting life. It is incumbent on the developers, owners and operations managers to take all necessary measures outside of this FERP to manage the financial risks which flooding poses to their property and assets.

It should also be recognised that for this site there is an extremely low probability (less than 1 in 2,000 chance per year) of floodwaters entering buildings but a moderate probability (about 1 in 50 chance per year) of evacuation routes being cut and the site being isolated for days.

Therefore, the proposed response to a flood is the evacuation of the entire precinct without spending time protecting building contents from flood damage. This FERP for the Nepean Business Park must be consistent with the NSW SES Flood Emergency Plan for the Hawkesbury Nepean Valley and the proposed Penrith Lakes Early Warning System when it becomes available.

3.2 NSW SES FLOOD EMERGENCY PLAN

The NSW SES flood response strategy for the Hawkesbury Nepean Valley is set out in its Hawkesbury Nepean Flood Emergency Sub Plan (2020). It involves evacuating all residential, business and other premises that are at risk of flooding and directing evacuees towards Sydney Olympic Park. It is expected that most evacuees will find their own temporary accommodation with friends and relatives or at commercial accommodation outside of the floodplain. Those who cannot, will be assisted at Sydney Olympic Park.

To achieve orderly and timely evacuation, the NSW SES has divided the floodplain into sectors and subsectors with designated evacuation routes.

The Precinct is located within the Penrith North A subsector within the Penrith North Sector. This subsector includes the existing industrial estates to the east and south. This subsector would evacuate either south along Castlereagh Road before heading east along Coreen Avenue and other streets to The Northern Road or north on Castlereagh to Andrews Road and east The Northern Road. All evacuation traffic on The Northern Road heads south.

The subsector and evacuation routes are shown in Figure 5.

3.3 FLOOD RESILIENCE FEATURES

The development will include the following flood resilience features:

- all internal roads will be above the 1 in 1,000 chance per year flood level
- all building floors will be above the 1 in 2,000 chance per year flood level
- all buildings will be provided with a refuge above the PMF
- all buildings will be designed and constructed to remain structurally stable in PMF
- the Community Association will implement a vehicle monitoring system which is triggered during a flood alert which ensures vehicle numbers on site do not exceed 1,000 for the duration of that flood alert period
- early evacuation of site is based on a forecast flood level lower than that which would cut evacuation routes and would give at least an additional three hours for early evacuation. Earlier evacuation can be undertaken if

directed by NSW SES, or following the adoption of the Penrith Lakes Scheme Flood Response Guideline when it becomes available

- a Community Association is co-ordinating flood risk management

3.4 EVACUATION

Because the precinct is a low flood island it is imperative that it is evacuated before its evacuation routes are cut by flooding. The NSW SES nominated evacuation routes for the site is south on Castlereagh Road then east on Coreen Avenue or east on Old Castlereagh Road and east on Andrews Road. Andrews Road may remain open for a few hours longer than Castlereagh Road heading south. Andrews Road provides the shortest vehicular route to flood free land.

Andrews Road is recommended as the pedestrian evacuation route as it provides the shortest route from the precinct to flood free land and will remain open the longest. It is about a 2.5km from most locations in the precinct to the section of Andrews Road which is above the reach of the PMF. This would take about 30 minutes to walk at a brisk walking pace or about one hour at a strolling pace. Pedestrian evacuation is only recommended should vehicular evacuation not be possible.

The evacuation routes are shown in Figure 6.

3.5 ROLES AND RESPONSIBILITIES

This FERP is an overarching FERP for the precinct which provides important information on flood levels, flood warnings, evacuation triggers, evacuation routes and actions to take before during and after a flood. The following sets out roles and responsibilities in relation to the maintenance and implementation of the FERP.

3.5.1 Agencies

Within the flood emergency response context, the Bureau of Meteorology has responsibility for forecasting rainfall and river levels and issuing flood warnings and forecasts.

The NSW SES is the lead agency for flood emergency response and will issue evacuation warnings and evacuation orders for the Hawkesbury Nepean Valley including the Penrith North A subsector of which Nepean Business Park is part. The NSW SES also carries out rescue and resupply for those who are stranded by floodwaters.

This FERP and the premises specific FERPs include actions to ensure that people within Nepean Business Park do not need to be rescued or resupplied and therefore are not reliant upon the NSW SES other than for it to issue evacuation warnings and orders for Penrith North A subsector.

3.5.2 Community Association

The maintenance and implementation of this FERP is the responsibility of the Community Association.

The Community Association will appoint a Chief Flood Warden and sufficient Deputy Flood Wardens such that there is at least one Flood Warden on duty at all times.

The Community Association will provide sufficient financial resources to implement the FERP including by way of appointing contractors, or employing staff, appointing and train flood wardens, subscribing to flood and weather warning services and installing and maintaining equipment for the proper implementation of the FERP.

The responsibilities of the Community Association may change following the adoption of the Penrith Lakes Scheme Flood Response Guideline when it becomes available.

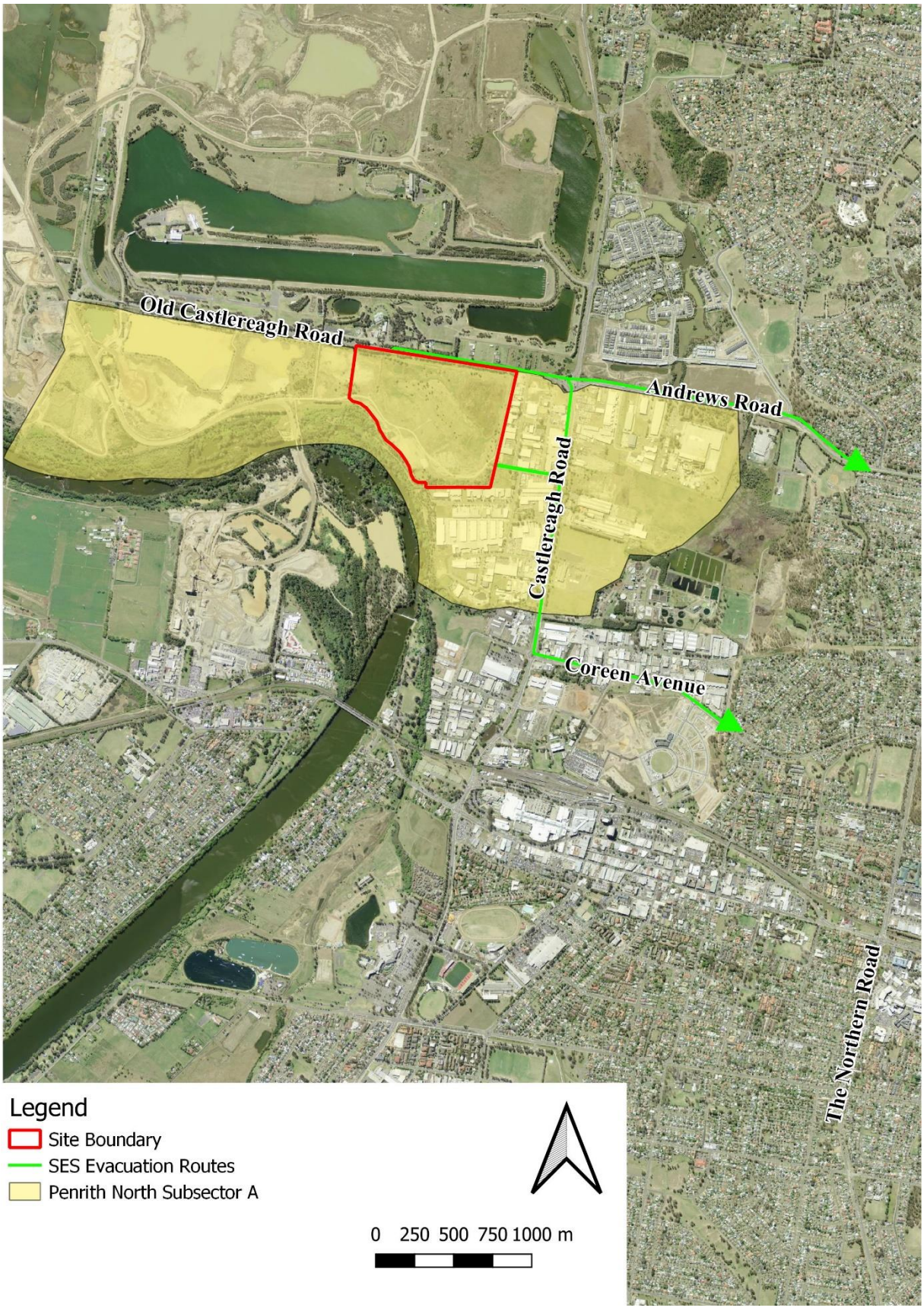

Figure 5: Vehicle evacuation routes for the Penrith North Subsector

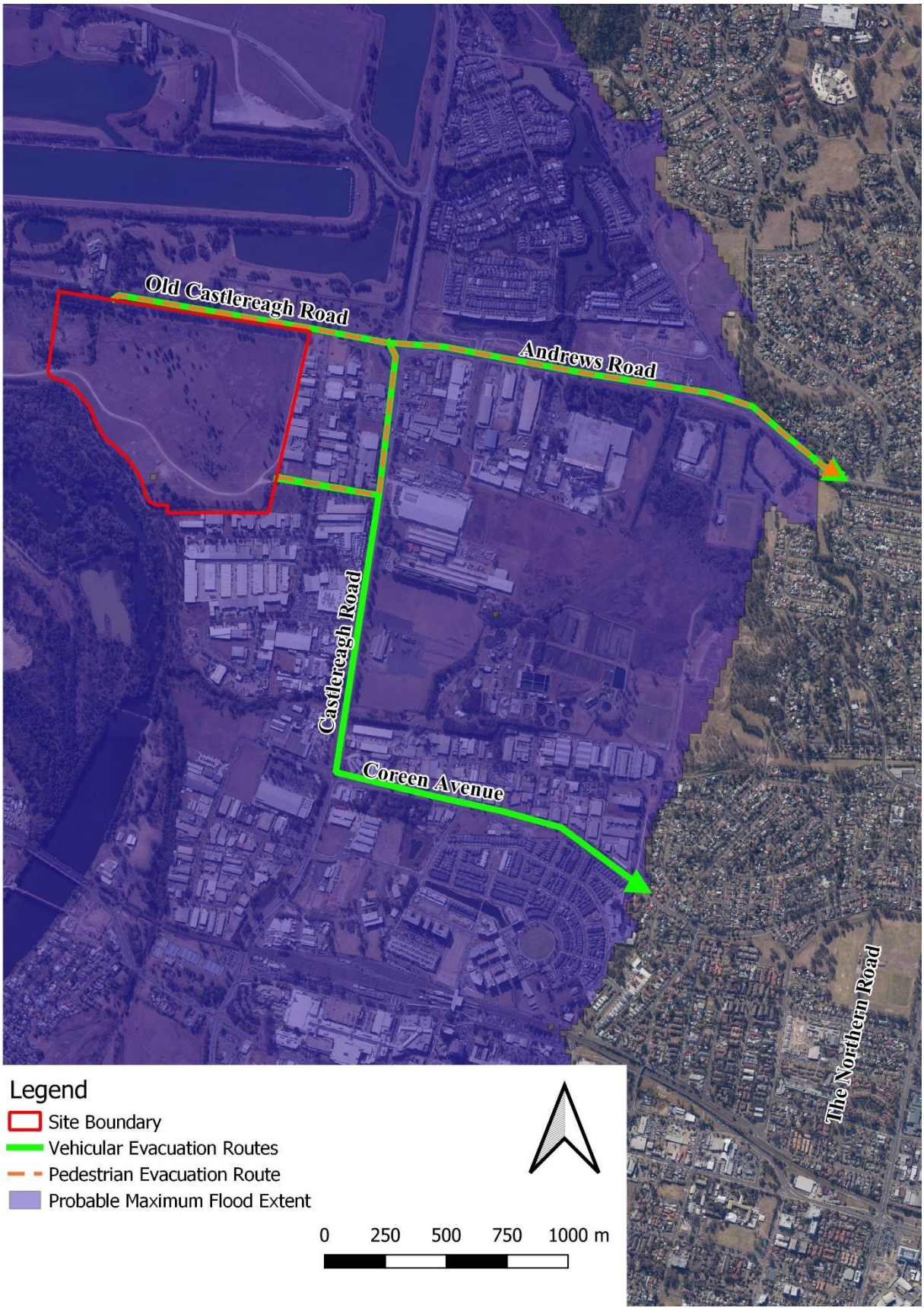

Figure 6: Evacuation Routes

3.5.3 Chief Flood Warden

The Chief Flood Warden will be either contracted to or employed by the Community Association but may have duties other than those of the Chief Flood Warden.

Chief Flood Warden will:

- Become familiar with the flood emergency response procedures set out in the FERP.
- Appoint sufficient Deputy Flood Wardens such that there will be a Chief or Deputy Flood Warden on duty (not necessarily on site) at all times
- Organise training for themselves and Deputy Flood Wardens in the maintenance of the flood warning system and the implementation of the flood emergency response procedures set out in this FERP
- Monitor weather forecasts and flood warnings daily
- Monitor Nepean River flood levels daily through the Bureau of Meteorology website
- Ensure any alerts from a flood and weather warning service are sent directly to the Chief Flood Warden and Deputy Flood Wardens
- Ensure the Chief Flood Warden, the Deputy Flood Wardens and the Flood Wardens know how to monitor and interpret weather warnings, rainfall forecasts and river levels
- Ensure the supply and maintenance all of the equipment necessary to implement the FERP
- Maintain the Emergency Contact List in Appendix B of this report
- Maintain the Business Contact List in Appendix C of this report
- Keep a soft and hard copy of the FERP readily accessible to the Flood Wardens and Deputy Flood Wardens at all times
- Implement this FERP in the event of a flood
- Direct Deputy Flood Wardens to implement various aspects of this FERP, as required
- Liaise with emergency service organisations and other external stakeholders as required
- Review the FERP every 5 years or following a flood which triggers evacuation
- Report annually, and as requested, to the Community Association on implementation and maintenance of the FERP
- Provide new business with a copy of this FERP and brief them on the flood evacuation procedures

The responsibilities of the Chief Flood Warden may change following the adoption of the Penrith Lakes Scheme Flood Response Guideline when it becomes available.

3.5.4 Deputy Flood Wardens

The Deputy Flood Wardens will:

- Become familiar with the flood emergency response procedures set out in the FERP
- Follow the procedures set out in this FERP in the event of a flood
- Fulfil the role of the Chief Flood Warden in the absence of the Chief Flood Warden

3.5.5 Businesses

Each of the businesses within the precinct will need to development its own FERP which is consistent with the overarching FERP but which deals with the specifics of that business.

Each of the premises in the Precinct will have a management structure, either individual business management or strata management. The specific roles and responsibilities within each business with regard to flood emergency response will need to be determined by each of those organisations.

Each of these premises will need to have someone who is responsible for maintaining and implementing their FERP such as monitoring river heights, ensuring basic measures are in place, training staff in flood response procedures, and issuing the necessary warnings when the river reaches the relevant trigger levels (see Section 3.6.3b).

For each individual building FERP this management structure must be identified,

documented and flood responsibilities allocated to personnel with appropriate seniority.

No reliance will be placed upon the New South Wales State Emergency Service or Penrith City Council's emergency resources in the development or implementation of individual FERPs other than relying on the SES to issue evacuation warnings and orders for Penrith North A subsector or any other responsibilities identified following the adoption of the Penrith Lakes Scheme Flood Response Guideline when it becomes available.

3.5.6 Visitors

Visitors will follow the directions of Flood Wardens during a flood response operation.

3.6 FORECASTS AND WARNINGS

3.6.1 Bureau of Meteorology

Monitoring the weather forecasts and warnings will be an integral step in managing the flood risk of the Nepean Business Park. This will be critical to being able to evacuate the site before flooding cuts evacuation routes.

The Bureau of Meteorology (BoM) has forecast rainfall maps which can be used to estimate the amount of rain expected to fall over the next eight and four days, as well as the next 24 hours. This information is available at: www.bom.gov.au/jsp/watl/rainfall/pme.jsp.

NSW Weather Warnings are issued by the Bureau of Meteorology and can be found at the following link: www.bom.gov.au/nsw/warnings/.

The Bureau will also provide specific warnings for flooding in the Nepean River.

There are five potential warnings of relevance to the precinct which operators and managers will need to be alert to. They are:

- Severe Weather Warnings for the Sydney Metropolitan Area or Western Sydney – these are an alert to possible flooding in Boundary Creek
- Flash Flood Warnings for the Sydney Metropolitan Area or Western Sydney – these are an alert to possible flooding in Boundary Creek.
- A Flood Watch for the Nepean River – this is a heads up that flood producing rainfall is forecast within the catchment and flooding may eventuate
- A General Flood Warning for the Nepean River – this is a warning that minor, moderate or major flooding is expected on the Nepean River but it is too early to forecast specific levels
- A Quantified Flood Warning for the Nepean River at Penrith. This will include a forecast flood height and the time at which that height is expected to be reached. It may also include information on whether further flood rises are expected, whether that forecast is expected to peak or whether the river level is falling.

The Bureau of Meteorology also has rainfall gauges which show the amount of rainfall that has fallen in the previous 24 hour period and stream gauges which indicate water heights. These can be monitored at: www.bom.gov.au/australia/flood/.

There are several gauges in the region that are relevant to flood prediction and warning. The most relevant for the precinct is the Penrith gauge at Victoria Bridge and flood response actions for the Precinct should principally be determined by forecasts related to this gauge.

Gauge readings at Warragamba Dam, Camden Weir and Wallacia Weir will be indicative of flood behaviour upstream of Penrith and would be indicative of expected flood behaviour at Penrith some hours later. The data on the website is updated every hour or so.

The radar service on the BoM website also shows current rainfall location and intensities. The radar station to be used for the site would be the Sydney radar at:

http://www.bom.gov.au/products/IDR713.loop.shtml.

It also needs to be remembered that it is the forecast level at the Penrith gauge, not the observed level at the gauge, which needs to be used to trigger evacuation of the Precinct because it is the time it takes to reach the forecast level which is needed to effect evacuation.

3.6.2 Nepean River Flood Categories

The BoM has set minor, moderate and major flood levels for the Nepean River at Penrith based on the impacts that flooding would have. These are set out in Table 2 as both the gauge levels (which is what BoM will report and forecast to) and the corresponding elevations at both the gauge and the site. The site flood levels are lower than the gauge flood levels because the site is downstream of Penrith Weir where the river level drops. It should also be remembered that the flood will peak at the site a little after it does at the gauge because the water takes time to travel from the gauge to the site.

Table 2: Penrith Flood Classes

Class	Penrith Gauge (m)	Penrith (m AHD)	Site* (m AHD)
Minor	3.9	18.0	16.5
Moderate	7.9	22.0	20.8
Major	10.4	24.5	23.6

* estimate only

Provisions and Requirements for Flood Warning in New South Wales (NSW SES, 2019) states that for floods forecast to exceed 8.9m at the Penrith gauge, 6 hours warning will be provided by BoM and for those exceeding 11.3m AHD at Penrith, 8 hours warning will be provided. These warning times are based on the flood travel times from upstream rainfall and stream gauges to the Penrith gauge and are independent of the rate of rise of the flood.

3.6.3 Alerts and Responses

Taking all of the preceding information into account, the following flood alerts, triggers and responses have been adopted for Nepean Business Park.

These may be superseded by those detailed in the Penrith Lakes Scheme Flood Response Guideline when it becomes available.

Level 1 Alert: Basic preparedness – Bureau of Meteorology issues either a:

- Severe Weather Warning for the Sydney Metropolitan Area or Western Sydney; or
- Flash Flood Warning for the Sydney Metropolitan Area or Western Sydney

Level 2 Alert: Prepare for potential closure of Precinct – Bureau of Meteorology issues either a:

- Flood Watch for the Nepean River; or
- Generalised Minor Flood Warning for the Nepean River:

Level 3 Alert: Prepare for closure of premises

Bureau of Meteorology issues either a:

- Generalised Moderate Flood Warning for the Nepean River; or
- Forecast that the river level at Penrith will exceed 8m (22.1m AHD).

Level 4 Alert: Close premises and evacuate

Bureau of Meteorology issues either a:

- Generalised Major Flood Warning for the Nepean River
- Forecast that the river level at Penrith will exceed 8.9m (23.0m AHD).

OR

The NSW SES issues an evacuation order

Level 5 Alert: Shelter on Site

- The River is flooding Lugard St

3.6.4 Closure and Evacuation Procedures

Flooding can occur at any time of any day and it is unlikely that many, if any, of the premises within the precinct will be open 24hrs per day, seven days per week. In fact, most business premises are closed for 60-70% of the time.

It will therefore be important that FERPs for individual businesses acknowledge their operating hours and have different responses for when they are open compared to when they are closed.

It is also noted that premises may close between a Level 2 alert being issued and a Level 3 alert being issued. It may be prudent to

close the premises at the end of the day when a Level 2 alert is issued and not reopen until it is clear that major flooding is not likely to occur.

While this FERP documents that there is likely to be several hours between when an evacuation order is given and when the evacuation route is cut, delaying evacuation should be avoided. The evacuation planning is done on the assumption that everyone will start leaving when the evacuation order is given. If everyone delays their evacuation until the business would otherwise be closing for the day there may be insufficient time for everyone in the subsector to safely evacuate.

If individual business FERPs include procedures for protecting property from flood damage (e.g. moving plant, equipment and stock off site or into higher parts of the building) these should be triggered at a Level 2 alert and not at the Level 3 alert.

If people fail to evacuate from buildings by vehicle or on foot before the precinct is isolated, they should contact NSW SES then stay within the highest part of the building until and the “all-clear” has been given. Sheltering on site should only be a last resort if evacuation has failed because the precinct could be isolated for up to three days, there is unlikely to be power, telecommunications or safe water supply and flood depths and velocities could cause buildings to fail.

4 MANAGEMENT ACTIONS

The management actions listed below are also provided in a Flood Actions Checklist in Appendix A. This is a generic list for the precinct and should be edited and supplemented to reflect the specific needs of each premises.

Each premises will be obliged to establish, implement and maintain a FERP consistent with this overarching FERP through a legally enforceable mechanism such as a DA condition or covenant on title.

The following actions may be superseded by those detailed in the Penrith Lakes Scheme Flood Response Guideline, when it becomes available.

4.1 BEFORE A FLOOD

Trigger for action: Always

- Each building will be provided with a refuge area within the building above the PMF level which is capable of safely accommodating site personnel for the duration that the building might be isolated by PMF floodwaters. This is to be a refuge of last resort in the event of evacuation failure.
- The Community Association will appoint a Chief Flood Warden and sufficient Deputy Flood Wardens such that there is at least one Flood Warden on duty at all times
- The Community Association will provide sufficient financial resources to employ staff, appoint and train flood wardens, subscribe to flood and weather warning services and install and maintain equipment for the proper implementation of the FERP.
- The Chief Flood Warden will be familiar with the flood emergency response procedures set out in the FERP.
- The Chief Flood Warden will appoint sufficient Deputy Flood Wardens such that there will be a Chief or Deputy Flood Warden on duty (not necessarily on site) at all times
- The Chief Flood Warden will organise training for themselves and Deputy Flood Wardens in the maintenance of the flood warning system and the implementation of the flood emergency response procedures set out in this FERP
- The Chief Flood Warden or delegate will monitor weather forecasts and flood warnings daily
- The Chief Flood Warden or delegate will monitor Nepean River flood levels daily through the Bureau of Meteorology website
- The Chief Flood Warden will ensure any alerts from a flood and weather warning service are sent directly to the Chief Flood Warden and Deputy Flood Wardens
- The Chief Flood Warden will ensure the Chief Flood Warden, the Deputy Flood Wardens and the Flood Wardens know how to monitor and interpret weather warnings, rainfall forecasts and river levels
- The Chief Flood Warden will ensure the supply and maintenance all of the equipment necessary to implement the FERP
- The Chief Flood Warden will maintain the Emergency Contact List in Appendix B of this report
- The Chief Flood Warden will maintain the Business Contact List in Appendix C of this report
- The Chief Flood Warden will keep a soft and hard copy of the FERP readily accessible to the Flood Wardens and Deputy Flood Wardens at all times
- Each business will develop and maintain detailed emergency procedures consistent with this precinct FERP and that takes into account any additional risks associated with the particular development.
- Each business owner will ensure all management, staff, and temporary employees likely to be in the Precinct at any time will be made aware of the possibility of flooding and the emergency procedures to be followed if a flood were to occur. This will be done by including flood procedures during staff inductions.
- The business procedures will also include clear responsibilities for management and staff in the event of a flood, and back up resources should key personnel not be present.

- The business management will maintain an emergency contacts list to advise the various emergency services and essential staff of the actions in train on the site. A suggested format for these details and other necessary contact details is provided in Appendix B – this will need to be completed by each business.
- A staff contact list will be created for each business and kept up-to-date in electronic AND hard copy format in the business offices on site.
- Management will appoint a staff member and alternates as flood wardens to monitor weather forecasts, current and predicted rainfall, flood warnings and the local gauge readings to ensure that any design features or equipment required to implement the FERP are in working order. They may delegate some duties to other staff and must have provision for suitable back-ups.
- Each business will subscribe to a flood alert service such as EWN or the equivalent to receive flood warnings direct to management and flood wardens.
- The Chief Flood Warden will review this FERP for currency and appropriateness every five years or when there are changes to the NSW SES Hawkesbury Nepean Flood Sub Plan or the Penrith Lakes Early Warning System
- Each business will review its FERP when this FERP is updated.

4.2 WHEN A FLOOD IS LIKELY

4.2.1 Alert Level 1 – Basic Preparedness

Trigger for action: **Bureau of Meteorology issues severe weather warnings or flash flooding warnings for the Sydney Metropolitan area or Western Sydney**

The Chief Flood Warden will:

- Ensure all emergency contact details within the FERP are up to date
- Ensure there are Deputy Flood Wardens rostered for duty for the foreseeable duration of the potential flood event
- Remind Deputy Flood Wardens of the procedures in this FERP
- Monitor weather and flood warnings every 8 hours

The manager or delegate responsible at each business will ensure that:

- there is a hard copy of the FERP on site
- all emergency contact details within the FERP are up to date
- all staff have been trained in the flood emergency procedures
- contact details are available for:
  - all staff who will be rostered on for the next week; and
  - all clients or customers that have appointments for the next week.
  - All deliveries which are expected in the next week
- forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every four hours and advise management accordingly.

4.2.2 Alert Level 2 – Prepare for potential precinct closure

Trigger for action: **Bureau of Meteorology issues either a Flood Watch for the Nepean River**

OR

a Minor flood warning for the Nepean River at Penrith

The Duty Flood Warden will:

- Implement the vehicle monitoring system
- Ensure that vehicle numbers on site are reduced to less than 1,000 vehicles over the next four hours, with no further vehicle entry unless they are collecting people from site or leaving immediately.
- Remind business managers that they should have implemented their business specific FERP
- Monitor forecasts, warnings and rainfall/stream gauges and local conditions on the site at least every two hours and advise management accordingly.

Each business manager or delegate responsible will ensure that:

- there is a hard copy of the FERP on site
- all emergency contact details within the FERP are up to date
- all staff have been trained in the flood emergency procedures
- contact details are available for:
  - all staff who will be rostered on for the next week; and
  - all clients or customers that have appointments for the next week.
  - All deliveries which are expected in the next week
- forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every two hours and advise management accordingly.

4.2.3 *Alert Level 3* – Prepared for closure of premises

Trigger for action: Bureau of Meteorology issues either a Moderate Flood Warning for the Nepean River

OR

forecasts that the river level at Penrith will exceed 8m (22.1m AHD)

Each business manager or delegate responsible will ensure that:

- staff that are rostered on for that week are notified of the possibility of flooding and reminded of actions and procedures to follow should evacuation be required.
- all organisations/patrons booked to use any facility within the Precinct are notified of the possibility of its closure should floodwaters continue to rise.
- consideration is given to cancelling appointments and deliveries and closing the business until flood threat has passed
- any movable objects owned by each development which are external to the building are either secured to prevent them from floating away or are brought inside the building. This includes objects such as garbage bins, storage containers or external furniture.
- forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every two hours and advise management accordingly.

4.3 DURING A FLOOD

4.3.1 *Alert Level 4* – Close and Evacuate to The Northern Road

Trigger for action: When the Bureau of Meteorology issues either a Major Flood Warning for the Nepean River

OR

forecasts that the river level at Penrith will exceed 8.9m (23.0m AHD)

OR

The NSW SES issues an evacuation order

Each business manager or delegate responsible will:

- Advise staff that are not on the premises that the business is expected to be isolated by flooding and is closing and for them not to come to work until further notice.
- cancel all appointments and deliveries until the flood threat has passed
- direct staff on site to leave and proceed to their homes via The Northern Road.
- direct staff on site who are not able to travel to their homes to travel to the Sydney Olympic Precinct at Homebush.
- direct anyone present who does not have private transport to travel with those who do have private transport.
- sweep the premises following evacuation to ensure that all have left the site, all floatable infrastructure is safely and securely stored and power, water and other utilities are turned off as necessary.

4.3.2 *Alert Level 5* – Shelter on Site

Trigger for action: When floodwaters are over Lugard Street

- shelter in the building until flooding has passed
- contact NSW SES on 132 500 (if possible) and advise of your situation

4.4 AFTER A FLOOD

Trigger for action: When emergency services give the all clear to return

- No owners, tenants or staff will be allowed to return to the site while flooding is still occurring or has recently occurred.
- Owners, tenants and staff can return to the site only after the all clear has been given by emergency services or Council when the flood emergency has passed.
- Where necessary, the Community Association will organise for the site to be appropriately cleaned and utilities checked by professionals before any re-use of the site if floodwaters have entered the site.
- Before site clean up and repair, a hazard assessment will be undertaken, safe work methods statements prepared and personal protective equipment supplied consistent with the known hazards which can be associated with floods:
  - Slips, trips and falls;
  - Sharp debris;
  - Venomous animals; and
  - Contaminated water and sediments.
- When evacuation has been triggered, the Community Association will organise a de-brief with business owners and operators in the precinct and may invite emergency services and/or Council staff to participate. The flood event and response procedures, including the use of the FERP and individual FERPs, will be reviewed to identify changes required or considered beneficial to the operation of the plan.
- Changes may be made to the FERPs and the requirements for future emergency evacuation should the review identify any improvements which may be made.

5 REFERENCES

Advisian, 2018 *Nepean River Flood Study – Final* Prepared for Penrith City Council

DECC, 2007 *Guideline Flood Emergency Response Classification of Communities* Version 1.01 25-10-2007

NSWSES, 2019, *Provisions and Requirements for Flood Warning in New South Wales Supplementary Document to the State Flood Plan v2.0* November, 2019

NSWSES, 2020 *Hawkesbury Nepean Flood Plan*

WMAWater, 2019 *Hawkesbury-Nepean Valley Regional Flood Study – Final Report* Prepared for Infrastructure NSW

APPENDIX A – FLOOD ACTIONS CHECKLIST

Stage	Trigger for action	Action	Who is responsible	What is needed
Before A Flood				
	Always	Each building will be provided with a refuge area within the building above the PMF level which is capable of safely accommodating site personnel for the duration that the building might be isolated by PMF floodwaters. This is to be a refuge of last resort in the event of evacuation failure.	Building owner	
		The Community Association will appoint a Chief Flood Warden and sufficient Deputy Flood Wardens such that there is at least one Flood Warden on duty at all times.	Community Association	
		The Community Association will provide sufficient financial resources to employ staff, appoint and train flood wardens, subscribe to flood and weather warning services and install and maintain equipment for the proper implementation of the FERP.	Community Association	FERP, financial resources
		The Chief Flood Warden will be familiar with the flood emergency response procedures set out in the FERP.	Chief Flood Warden	FERP
		The Chief Flood Warden will appoint sufficient Deputy Flood Wardens such that there will be a Chief or Deputy Flood Warden on duty (not necessarily on site) at all times.	Chief Flood Warden	
		The Chief Flood Warden will organise training for themselves and Deputy Flood Wardens in the maintenance of the flood warning system and the implementation of the flood emergency response procedures set out in this FERP.	Chief Flood Warden	FERP
		The Chief Flood Warden or delegate will monitor weather forecasts and flood warnings daily.	Chief Flood Warden	Smartphone/tablet/computer with internet access, subscription to a weather warning service
		The Chief Flood Warden or delegate will monitor Nepean River flood levels daily through the Bureau of Meteorology website.	Chief Flood Warden	Smartphone/tablet/computer with internet access

Stage	Trigger for action	Action	Who is responsible	What is needed
		The Chief Flood Warden will ensure any alerts from a flood and weather warning service are sent directly to the Chief Flood Warden and Deputy Flood Wardens.	Chief Flood Warden	Subscription to a weather warning service
		The Chief Flood Warden will ensure the Chief Flood Warden, the Deputy Flood Wardens and the Flood Wardens know how to monitor and interpret weather warnings, rainfall forecasts and river levels.	Chief Flood Warden	Smartphone/tablet/computer with internet access, subscription to a weather warning service
		The Chief Flood Warden will ensure the supply and maintenance all the equipment necessary to implement the FERP.	Chief Flood Warden	FERP
		The Chief Flood Warden will maintain the Emergency Contact List in Appendix B of this report.	Chief Flood Warden	Emergency Contact List (Appendix B of FERP)
		The Chief Flood Warden will maintain the Business Contact List in Appendix C of this report.	Chief Flood Warden	Business Contact List (Appendix C of FERP)
		The Chief Flood Warden will keep a soft and hard copy of the FERP readily accessible to the Flood Wardens and Deputy Flood Wardens at all times.	Chief Flood Warden	FERP
		Each business will develop and maintain detailed emergency procedures consistent with this precinct FERP and that takes into account any additional risks associated with the particular development.	Business Manager	FERP
		Each business owner will ensure all management, staff, and temporary employees likely to be in the Precinct at any time will be made aware of the possibility of flooding and the emergency procedures to be followed if a flood were to occur. This will be done by including flood procedures during staff inductions.	Business Owner	Up-to-date induction procedures with flooding information
		The business procedures will also include clear responsibilities for management and staff in the event of a flood, and back up resources should key personnel not be present.	Business Manager	FERP

Stage	Trigger for action	Action	Who is responsible	What is needed
		The business management will maintain an emergency contacts list to advise the various emergency services and essential staff of the actions in train on the site. A suggested format for these details and other necessary contact details is provided in Appendix B – this will need to be completed by each business.	Business Manager	Hard and soft copies of contact details
		A staff contact list will be created for each business and kept up-to-date in electronic AND hard copy format in the business offices on site.	Business Manager	Hard and soft copies of staff contact details
		Management will appoint a staff member and alternates as flood wardens to monitor weather forecasts, current and predicted rainfall, flood warnings and the local gauge readings to ensure that any design features or equipment required to implement the FERP are in working order. They may delegate some duties to other staff and must have provision for suitable back-ups.	Business Manager & appointed Flood Wardens	Staff members designated as Flood Wardens
		Each business will subscribe to a flood alert service such as EWN or the equivalent to receive flood warnings direct to management and flood wardens.	Business Manager	Warning service subscription
		The Chief Flood Warden will review this FERP for currency and appropriateness every five years or when there are changes to the NSW SES Hawkesbury Nepean Flood Sub Plan or the Penrith Lakes Early Warning System.	Chief Flood Warden	FERP, NSW SES Hawkesbury Nepean Flood Sub Plan, Penrith Lakes Scheme Flood Response Guideline
		Each business will review its FERP when this FERP is updated.	Business Manager	FERP

Stage	Trigger for action	Action	Who is responsible	What is needed
When a Flood is Likely				
	Level 1 Alert: BOM issues severe weather warnings or flash flood warnings for Sydney Metropolitan Area or Western Sydney	Ensure all emergency contact details within the FERP are up to date	Chief Flood Warden	FERP (Appendix B)
		Ensure there are Deputy Flood Wardens rostered for duty for the foreseeable duration of the potential flood event	Chief Flood Warden	
		Remind Deputy Flood Wardens of the procedures in this FERP	Chief Flood Warden	FERP
		Monitor weather and flood warnings every **eight** hours	Chief Flood Warden	Smartphone/tablet/computer with internet access, subscription to a weather warning service
		Ensure there is a hard copy of the FERP on site	Business Manager	FERP
		Ensure all emergency contact details within the FERP are up to date	Business Manager	FERP (Appendix B)
		Ensure all staff have been trained in the flood emergency procedures	Business Manager	A list of staff and their responsibilities and training for those staff members
		Check that contact details are available for: – all staff who will be rostered on for the next week; and – all clients or customers that have appointments for the next week. – All deliveries which are expected in the next week	Business Manager	Contact details
		Ensure that forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every **four** hours and advise management accordingly.	Business Manager	Smartphone/tablet/computer with internet access,

				subscription to a weather warning service
	Level 2 Alert: BOM issues a Flood Watch for the Nepean River OR BOM issues a minor flood warning for Nepean River at Penrith	Implement the vehicle monitoring system	Duty Flood Warden	Vehicle monitoring system
		Ensure that vehicle numbers on site are reduced to less than 1,000 vehicles over the next two hours, with no further vehicle entry unless they are collecting people from site or leaving immediately.	Duty Flood Warden	Vehicle monitoring system
		Remind business managers that they should have implemented their business specific FERP	Duty Flood Warden	FERP
		Monitor forecasts, warnings and rainfall/stream gauges and local conditions on the site at least every **two** hours and advise management accordingly.	Duty Flood Warden	Smartphone/tablet/computer with internet access, subscription to a weather warning service
		Ensure there is a hard copy of the FERP on site	Business Manager	FERP
		Ensure all emergency contact details within the FERP are up to date	Business Manager	FERP (Appendix B)
		Ensure all staff have been trained in the flood emergency procedures	Business Manager	A list of staff and their responsibilities and training for those staff members
		Check that contact details are available for: – all staff who will be rostered on for the next week; and – all clients or customers that have appointments for the next week. – All deliveries which are expected in the next week	Business Manager	Contact details
		Ensure that forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every **two** hours and advise management accordingly.	Business Manager	Smartphone/tablet/computer with internet access, subscription to a weather warning service

	Level 3 Alert: BoM issues a moderate flood warning for Nepean River OR BoM forecasts the river gauge level at Penrith to exceed 8m (22.1m AHD)	Ensure that staff that are rostered on for that week are notified of the possibility of flooding and reminded of actions and procedures to follow should evacuation be required.	Business Manager or appointed Flood Wardens	Contact details
		Ensure all organisations/patrons booked to use any facility within the Precinct are notified of the possibility of its closure should floodwaters continue to rise.	Business Manager or appointed Flood Wardens	Contact details
		Ensure consideration is given to cancelling appointments and deliveries and closing the business until flood threat has passed	Business Manager or appointed Flood Wardens	Contact details
		Ensure any movable objects owned by each development which are external to the building are either secured to prevent them from floating away or are brought inside the building. This includes objects such as garbage bins, storage containers or external furniture.	Business Manager or appointed Flood Wardens	Means of securing floating objects
		Ensure forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every **two** hours and advise management accordingly.	Business Manager or appointed Flood Wardens	Smartphone/tablet/computer with internet access, subscription to a weather warning service

During a Flood				
	Alert Level 4: BoM forecasts Penrith gauge level is expected to exceed 8.9m (23.0m AHD) OR BoM issues a major flood warning for Nepean River is issued OR NSW SES issues an evacuation order	Advise staff that are not on the premises that the business is expected to be isolated by flooding and is closing and for them not to come to work until further notice.	Business Manager or appointed Flood Wardens	Contact details
		Cancel all appointments and deliveries until the flood threat has passed.	Business Manager or appointed Flood Wardens	Contact details
		Direct staff on site to leave and proceed to their homes via The Northern Road.	Business Manager or appointed Flood Wardens	Motor vehicles
		Direct staff on site who are not able to travel to their homes to travel to the Sydney Olympic Precinct at Homebush.	Business Manager or appointed Flood Wardens	Motor vehicles
		Direct anyone present who does not have private transport to travel with those who do have private transport.	Business Manager or appointed Flood Wardens	Motor vehicles
		Sweep the premises following evacuation to ensure that all have left the site, all floatable infrastructure is safely and securely stored and power, water and other utilities are turned off as necessary.	Business Manager or appointed Flood Wardens	

	Alert Level 5: When floodwaters are over Lugard Street	Shelter in the building until flooding has passed	Business Manager or appointed Flood Wardens	
		Contact NSW SES on 132 500 (if possible) and advise of your situation	Business Manager or appointed Flood Wardens	Telephone

After a Flood				
	When emergency services give the all clear to return	No owners, tenants or staff will be allowed to return to the site while flooding is still occurring or has recently occurred.	Business Manager or Strata Manager	N/A
		Owners, tenants and staff can return to the site only after the all clear has been given by emergency services or Council when the flood emergency has passed.	Business Manager or Strata Manager	Contact details for owners, tenants and staff
		Where necessary, the Community Association will organise for the site to be appropriately cleaned and utilities checked by professionals before any re-use of the site if floodwaters have entered the site.	Community Association	Utilities contacts
		Before site clean up and repair, a hazard assessment will be undertaken, safe work methods statements prepared and personal protective equipment supplied consistent with the known hazards which can be associated with floods: • Slips, trips and falls • Sharp debris • Venomous animals • Contaminated water and sediments	Community Association	WHS representative to perform assessment with correct SWMS and PPE.
		When evacuation has been triggered, the Community Association will organise a de-brief with business owners and operators in the precinct and may invite emergency services and/or Council staff to participate. The flood event and response procedures, including the use of the FERP and individual FERPs, will be reviewed to identify changes required or considered beneficial to the operation of the plan.	Community Association	FERP and information on what occurred

		Changes may be made to the FERPs and the requirements for future emergency evacuation should the review identify any improvements which may be made.	Community Association	FERP

APPENDIX B – EMERGENCY CONTACTS LIST

Name	Organisation	Role	Contact
	Body Corporate	Site Manager	???
	Business subject of FERP	General Manager	???
	Emergency Services	Fire/ambulance/police	000
	State Emergency Service	SES Local Controller	132 500
	Bureau of Meteorology	NSW Flood Warning Centre	(02) 9296 1511
	Nepean Hospital	Emergency Department	(02) 4734 2000
	Endeavour Energy	Electricity Supply	131 003
	Sydney Water	Water & Sewerage	13 20 90
		Gas Supply	
		Telecommunications	
		Waste Disposal	

MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

Great River NSW Pty Ltd

Nepean Business Park

Flood Evacuation Report

Draft

Nepean Business Park
Flood Evacuation Report
Draft

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Document Approval

For Molino Stewart	
Name	Steven Molino
Position	Principal
For Great River NSW Pty Ltd	
Name	The Directors
Position	

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1 | Introduction

1.1 Background

In 1979 the NSW Government reached an agreement with a consortium of resource companies which gave them permission to extract sand and gravel from the alluvial floodplain of the Nepean River, approximately 3 km north of the Penrith City Centre. That consortium is the Penrith Lakes Development Corporation (PLDC).

The requirements for closure of the extraction operations include the creation of recreational lakes, regional parkland and some urban development. Work on the recreational lakes was partially completed with the creation of the Regatta Lake which was used for rowing, canoeing and kayaking events at the 2000 Olympics and is used for recreation and competition today. Resource extraction was completed in 2015 and final landform shaping across the whole of the Penrith Lakes Scheme will be completed by early 2020.

In January 2017, the NSW Government published the State Environmental Planning Policy (Penrith Lakes Scheme) Amendment 2017. Amongst other things, this zoned an area in the south of Penrith Lakes as Employment.

A development application has been submitted for a proposed subdivision of this land into light industrial lots.

Clause 33 of the SEPP states that:

(3) Development consent must not be granted for development on land zoned Employment, Residential or Tourism unless the consent authority is satisfied that the development will not adversely affect the safe and effective evacuation of the land and the surrounding area.

1.2 This Report

This Flood Evacuation Report has been prepared by Molino Stewart Pty Ltd on behalf of Great River NSW Pty Ltd (the proponent) to assess the capacity of the proposed development to be evacuated in the event of a significant flood on the Hawkesbury Nepean River and whether that evacuation can be effected without adverse impacts on the safe and effective evacuation of surrounding areas.

It provides an overview of flooding in the Hawkesbury Nepean Valley and the flood evacuation plans of NSW State Emergency Service (NSW SES). It explains how the subject site is affected by flooding and where it fits within the NSW SES evacuation plans. It presents the NSW SES method for estimating evacuation capacity of urban areas and applies that method to the proposed development and surrounding areas. The report provides significant detail about the assumptions and inputs which have been used to undertake the evacuation modelling and explains the outcomes of that modeling.

2| Flooding Context

2.1 The Hawkesbury Nepean River

The Hawkesbury-Nepean catchment covers approximately 21,000 square kilometres. The catchment is located on the eastern side of the Great Dividing Range and almost completely surrounds the Sydney Basin. The Hawkesbury-Nepean catchment extends from almost 50 kilometres south of Goulburn, almost 10 kilometres to the west of Lithgow and as far as approximately 30 kilometres north of Putty.

The Nepean River's headwaters are at the top of the escarpment west of Wollongong and the river flows in a generally northerly direction past Camden and Wallacia before being joined by the Warragamba River which enters from the west just downstream of Wallacia. It continues north past Penrith and Emu Plains before being joined by the Grose River which enters from the west at Yarramundi. At this point the river changes names and becomes the Hawkesbury River. It turns more north-easterly as it flows past North Richmond, Richmond, Windsor, Pitt Town and Wilberforce. South Creek enters from the south just downstream of Windsor and then the Colo River enters from the west further downstream. The McDonald River enters from the north just upstream of Wisemans Ferry at which point the river turns south east and flows into Broken Bay at Brooklyn.

2.1.1 Flooding in the Hawkesbury-Nepean valley

The Hawkesbury-Nepean floodplain is actually a series of floodplains formed by the topography within the Valley. Most of these can be seen in *Figure 1*.

The first of these floodplains is around Camden but that is not relevant to this particular investigation. The second of these floodplains is created where the Nepean River leaves a narrow and steep gorge at Bents Basin before entering the Fairlight Gorge, another steep and narrow gorge, downstream of Wallacia. The Fairlight Gorge constricts flow which results in the flooding of a narrow floodplain between the two gorges. This is mostly agricultural land but includes the small town of Wallacia. It too has limited relevance to this investigation.

After exiting the Nepean Gorge the river expands into a wider channel with a broad floodplain at Regentville and then flows past Penrith on the east bank of the River and Emu Plains on the west bank. A sharp bend in the river and a narrowing of the channel downstream of Emu Plains creates another constriction which is responsible for the flooding of the Penrith and Emu Plains floodplain. it is on this floodplain that the subject site sits.

As the Nepean River reaches Windsor, the normal river level is close to sea level and the river is slightly tidal. Downstream of Windsor, the river flows into the narrow Sackville Gorge. It is approximately 100 kilometres by river from Windsor to the Tasman Sea

The constriction caused by the Sackville Gorge and the fact that there is little fall over the last 100 kilometres combine to cause the floodwaters to flow out of the floodplain much more slowly than they are flowing in. This bottleneck can result in flooding up to 26 metres above sea level on the floodplain between Yarramundi and Sackville. This type of flooding is analogous to a bathtub where the inflow from the tap is far greater than the outflow from the drain plug.

This also causes floodwaters to flow back up the River's tributaries, particularly South Creek, Rickabys Creek and Eastern Creek. Backwater flooding up South Creek and Eastern Creek can extend as far as St Marys and Quakers Hill and it takes several days for this ponded water to flow out to sea.

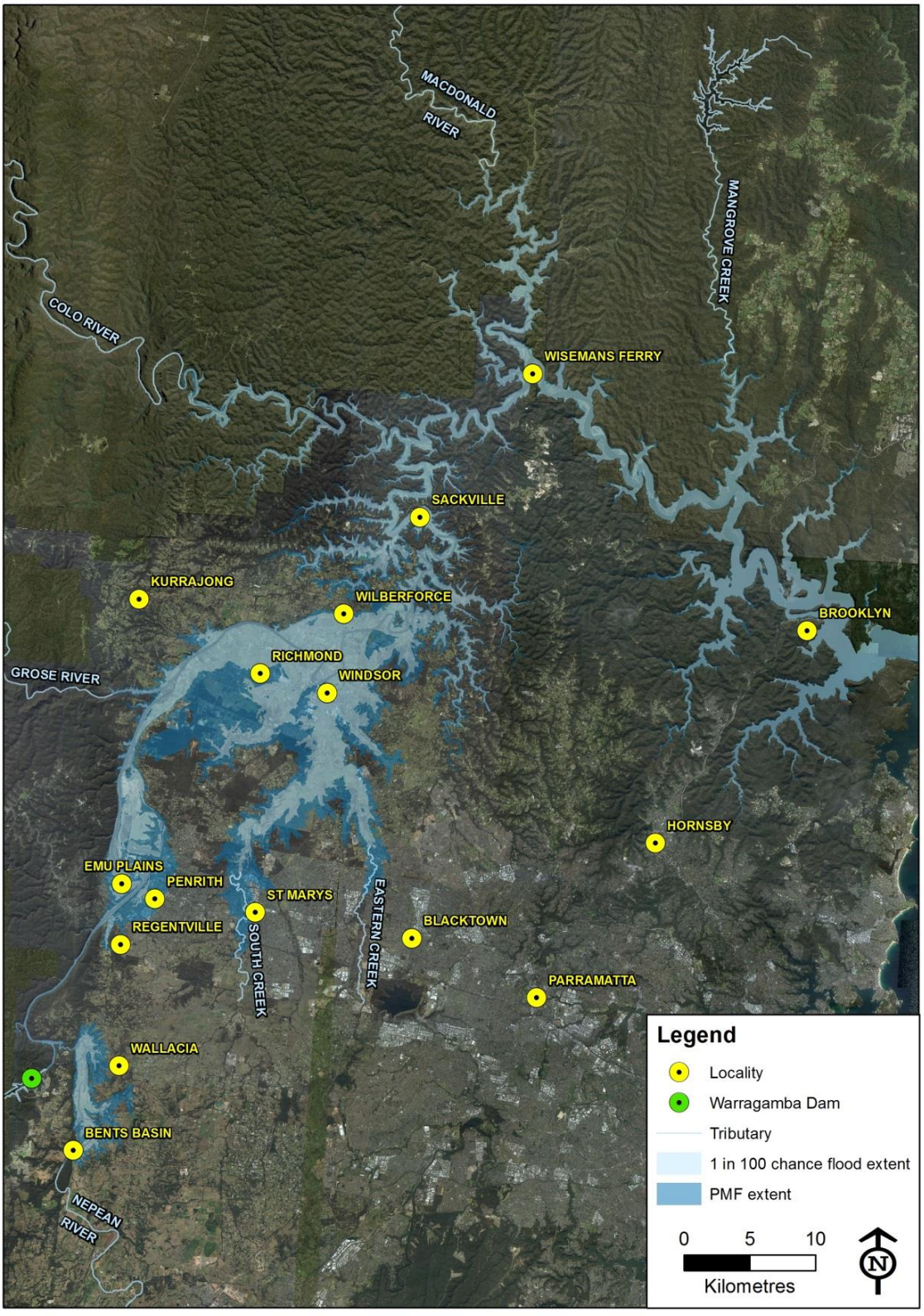

Figure 1: Hawkesbury-Nepean Floodplains

While flooding of this floodplain does not directly affect the site, some of the traffic evacuating from this floodplain would be directed south towards Penrith and the potential for it to converge with traffic evacuating from the site and its surrounds needs to be considered.

There are several smaller floodplains downstream of Sackville but they too are not relevant to this investigation.

2.2 Flooding at the Site

2.2.1 Locality

The site is located in Penrith and is situated between Castlereagh Road to the east and Nepean River to the west. The location is referred to as the Nepean Business Park and is shown in Figure 2.

The site covers approximately 49 hectares. Figure 3 shows the indicative layout plan for the proposed subdivision. It consists of a total of 93 lots ranging in size from 2,006m^2 to 20,236m^2. It will have road access from Lugard Street in the east and Old Castlereagh Road in the north. It will have an internal ring road network.

2.2.2 Topography and Drainage

A sharp bend in the river and a narrowing of the channel downstream of Emu Plains creates a constriction which is responsible for the flooding of the Penrith and Emu Plains floodplain. The precinct is on the outside of this bend and will have a minimum ground level of around 27m AHD compared to the normal river level which is at about 12m AHD.

Boundary Creek enters the River from the east about 650m south of the precinct.

2.2.3 Flood Models

There are three computer flood models which have been developed which provide flood information relevant to the site.

(a) The Rubicon model

This was developed in the 1980s by WMAWater for Sydney Water and covers the whole of the Hawkesbury Nepean River from downstream of Warragamba Dam to Brooklyn. It is a one dimensional model which uses more than 350 cross sections along the river and across the floodplain to estimate flows and levels and then interpolates between those cross sections to create flood surfaces. It does not represent features on the floodplain such as bridges and culverts particularly well. This model was most recently updated and its outputs reported in 2019 (WMAwater, 2019). It is being used by Infrastructure NSW (INSW) to estimate the costs and benefits of flood mitigation options for the Hawkesbury Nepean Valley.

(b) The RMA2 model

The RMA2 model is a two dimensional flood model of the Nepean River between Regentville and Yarramundi and uses upstream inflow hydrographs provided by the Rubicon model. This model was developed by Advisian for Penrith City Council and was most recently updated in 2018 (Advisian, 2018). Penrith City Council has been using this model to set its flood planning levels and determine the impacts of development on the floodplain. It includes details of floodplain features.

(c) The TUFLOW model

The TUFLOW model is a two dimensional flood model which was prepared by BMT for the Penrith Lakes Development Corporation to design the landforms in Penrith Lakes. Water Technology subsequently took this model and incorporated floodplain features such as bridges and culverts which are outside of Penrith Lakes and it was calibrated to the RMA2 model.

The peak flood levels of given probabilities do not find agreement between the three models for all events but is not necessarily problematic for evacuation modelling which is more concerned with rates of flood risk. The flood levels which are cited in this report are generally taken from the Rubicon model because this is the model which NSW SES has been using for the past 30 years to inform its evacuation planning. However, at the time that the evacuation analysis reported here was being undertaken, access to the Rubicon model outputs were not available and so the TUFLOW model was used to estimate relative evacuation trigger levels and cutoff timings across the Penrith floodplain.

As will be explained later, it was also necessary to estimate relative timings of evacuations from the Hawkesbury floodplain around Richmond and Windsor. For that purpose an RMA 2 model of the Hawkesbury River developed by Advisian for Hawkesbury City Council was used.

2.2.1 Nepean River

The largest flood on record in the Hawkesbury-Nepean valley occurred in 1867 when the river level reached 26.9 metres Australian Height Datum (AHD) at Victoria Bridge at Penrith. This flood is estimated to have between a 1 in 200 and a 1 in 500 chance of occurrence in any year. A PMF event would reach a level of approximately 32.1 metres AHD at Victoria Bridge.

Sediment within the Fairlight Gorge in the Nepean River upstream of Penrith shows that prior to European settlement at least one flood reached or exceeded the level of a flood with about a 1 in 1,000 chance per year level of 27.6 metres AHD at Penrith. The most recent floods in the Hawkesbury-Nepean Valley have ranged been 1 in 5 and 1 in 50 chance of occurrence per year flood levels. The March 2021 flood peaked at 24.2m AHD.

To place these probabilities in context, some of the rivers in Victoria which flooded in 2011 experienced floods with a 1 in 200 chance per year level, while some catchments in Queensland experienced floods in 2011 that have been reported to have had about a 1 in 1,000 chance of occurrence per year.

Flood waters from the Nepean River would initially back up Boundary Creek, eventually flooding Castlereagh Road and cutting the evacuation route south of the site. As the water level continues to rise it would break the river banks and enter the existing industrial estate immediately south of the site.

Further flood rises would result in the water to the south eventually flowing around the east of the precinct and cutting off its access via Lugard Street. At the same time the water backing up in Boundary Creek would have crossed Andrews Road, cutting off that evacuation route. Once water overtops Lugard Street it would flow through the industrial estate to the north and cut Old Castlereagh Road which is at a lower level.

Eventually the river overtops the banks adjacent to the site and begins flooding the site.

Figure 2: Location of Nepean Business Park

Figure 3: Indicative Layout Plan for Nepean Business Park

2.2.2 Flood Levels

The Penrith gauge is just upstream of Victoria Bridge which itself is upstream of Penrith Weir. The precinct is 700m downstream of the weir. This means that the water level at the gauge is higher than the water level at the site.

Table 1 shows the full range of flood levels which could affect the site. The table shows three levels. The first is the peak gauge level at Victoria Bridge for the corresponding flood probability (note that historically the gauge was set arbitrarily with a zero reading at 14.139m AHD). The second level is the corresponding peak height above sea level (m AHD) for that gauge reading. The third level is the peak level at the precinct which would be reached for a flood of that probability.

The 1 in 100 chance per year flood would reach a peak of 25.8m AHD at the gauge and about 25.0m AHD adjacent to the precinct. The entire Precinct is at or above 27.0m AHD and so would not be directly affected by the flood. However, as shown in Figure 4 its evacuation route along Castlereagh Road would be cut by floodwaters backing up Boundary Creek. The road has a low point of 24.2m AHD at the creek crossing and would be covered by 0.6m of water at this location.

Table 1: Flood history in the Hawkesbury-Nepean valley

Chance per year	*Peak gauge level at Victoria Bridge (m)*	*Peak flood level at Victoria Bridge, Penrith (m AHD)[1]*	*Peak flood level in river at the Precinct (m AHD)[2]*
1 in 5	5.5	19.6	18.1
1 in 10	7.2	21.3	20.0
1 in 20	9.2	23.3	22.2
1 in 50	10.7	24.8	23.9
1 in 100	11.7	25.8	25.0
1 in 200	12.4	26.5	25.7
1 in 500	13.0	27.1	26.5
1 in 1,000	13.4	27.5	26.9
1 in 2,000	14.3	28.4	27.8
1 in 5,000	15.3	29.4	29.0
PMF	18.7	32.8	32.6

1. Source – Hawkesbury Nepean Valley Regional Flood Study Final Report (WMAwater, 2019)
2. Source – flood model outputs provided by WMAWater.

A flood would have to exceed the 1 in 1,000 chance per year level of 26.9m AHD at the site and reach 27.0m AHD before the lowest parts of the site began to flood through water backing up into the internal drainage system and onto the lowest parts of roads.

The PMF peak level at the gauge is 32.8m AHD and estimated to be 32.6m at the precinct. The whole precinct would therefore be flooded with the lowest parts of the site flooded to a depth of 5.6m.

Figure 4: 1 in 100 chance per year flood levels

Note that the above figure is sourced from the Nepean River Flood Study (Advisian, 2018) which has slightly higher 1 in 100 chance flood levels than the Hawkesbury Nepean Valley Regional Flood Study (WMAWater, 2019).

2.2.3 Critical Levels

There are several levels associated with the Nepean Business Park which are critical to the safety of people and the protection of property. They are:

- 23.0m AHD – the forecast flood level at Penrith gauge which has been selected in this modelling as the evacuation trigger level for the Nepean Business Park and other premises within the Penrith North A subsector. This level has slightly better than a 1 in 20 chance of occurring per year.
- 24.2m AHD – the lowest point along Castlereagh Road which is the primary evacuation route for the site. All vehicles should leave the precinct before flooding reaches this level at Castlereagh Road. This has between a 1 in 20 and 1 in 50 chance of occurring per year.
- 25.4m AHD – the lowest point on Lugard Street. When flooding exceeds this level adjacent to the precinct, exiting the precinct by car or on foot in this direction becomes dangerous. Water would flow north from this point and cut Old Castlereagh Road which is at a lower level. Andrews Road would also be cut by water backing up Boundary Creek. Once this level is reached safe evacuation routes from the site are effectively cut. This has less than a 1 in 100 chance of occurring per year.
- 27.0m AHD – the lowest point within the precinct. At this level floodwaters enter the precinct directly from the river via the internal drainage system. This has about a 1 in 1,000 chance of occurring per year
- 30.5m AHD – the highest ground level within the precinct would flood. This has between a 1 in 5,000 and 1 in 100,000 chance of occurring per year

Floor levels in each of the buildings within the precinct vary and details of those should be provided in each respective flood response plan. Some may have mezzanine floors or first floors which are above the reach of the PMF. An extreme flood could isolate the precinct for up to three days.

2.2.1 Rate of Flood Rise

The rate at which this water rises will vary depending on how big the flood is and how quickly the rain is falling as well as the temporal and spatial distribution of the rainfall. For the purposes of evacuation modelling in this analysis, the 72 hour design PMF was used because this would result in the maximum number of vehicles evacuating and, of the design flood events which were available, this was the fastest rising event other than the 24 hour design PMF.

It should also be noted that the peak at the site will occur a little while after the flood has peaked at Victoria Bridge because of the time it takes the flood peak to travel downstream from the bridge.

3| Emergency Management Context

3.1 Hawkesbury Nepean Flood Emergency Sub Plan

The NSW SES has developed the Hawkesbury Nepean Flood Emergency Sub Plan (2020) which sets out response and recovery arrangements for flooding in the Hawkesbury Nepean Valley from Wallacia to Brooklyn. It includes an evacuation plan for the Hawkesbury Nepean Valley in the event that it is impacted by significant flooding.

The NSW SES has divided potentially flood affected areas into emergency response sectors and subsectors (Figure 5), which are controlled by the local NSW SES offices in the region. Flood response is managed on a subsector by subsector basis.

During a major flood, the Hawkesbury Nepean Flood Emergency Sub Plan makes provision for the evacuation of all populations which are at risk of being inundated as well as provision for evacuating those who may become isolated by floodwaters and would later need to be rescued if they are not evacuated.

The evacuation plan designates predetermined evacuation road routes for each sector as shown in (Figure 6).

Most evacuees are expected to find alternative accommodation outside of the floodplain themselves but those who cannot do so will be directed to Homebush Sports Precinct for processing and the provision of temporary accommodation.

3.2 Sectors & Routes Relevant to this Investigation

Nepean Business Park is within the Penrith North Sector which has The Northern Road Route as its designated evacuation route. This links to the Great Western Highway (GWH) and the M4 Western Motorway (M4) which would take evacuees east towards Homebush.

As can be seen from Figure 6, there are several evacuation routes which converge with The Northern Road Route and The Northern Road Route is not the only evacuation route feeding onto the M4.

Evacuation of Nepean Business Park will be triggered before most other subsectors in the Penrith area. However, if flooding continues to rise evacuation of other parts of the Penrith North Sector as well as parts of the Emu Plains, Penrith and Penrith South sectors may need to take place. Some of these share evacuation routes with Nepean Business Park and the potential for evacuation traffic to converge must be considered.

Also, areas further north including Richmond, Richmond Lowlands, Londonderry, Bligh Park, Windsor Downs and Windsor sectors may need to evacuate at the same time as Penrith Lakes and some of that traffic may be heading towards The Northern Road Route at the same time as traffic from the Penrith North and Penrith sectors.

Nine main areas which need to be evacuated are relevant to this investigation. They are:

- Richmond/Richmond Lowlands – all evacuees would be directed south on the Castlereagh Route to The Northern Road then onto the Great Western Highway (GWH)
- Londonderry – all evacuees would be directed south on the Londonderry Road Route to The Northern Road then onto the GWH
- Windsor – some evacuees would be directed south to The Northern Road then onto the GWH.
- Bligh Park/Windsor Downs - some evacuees would be directed south on the Llandilo Road Route to The Northern Road then onto the GWH.
- South Creek A – some of this evacuates west onto The Northern Road and then onto the GWH

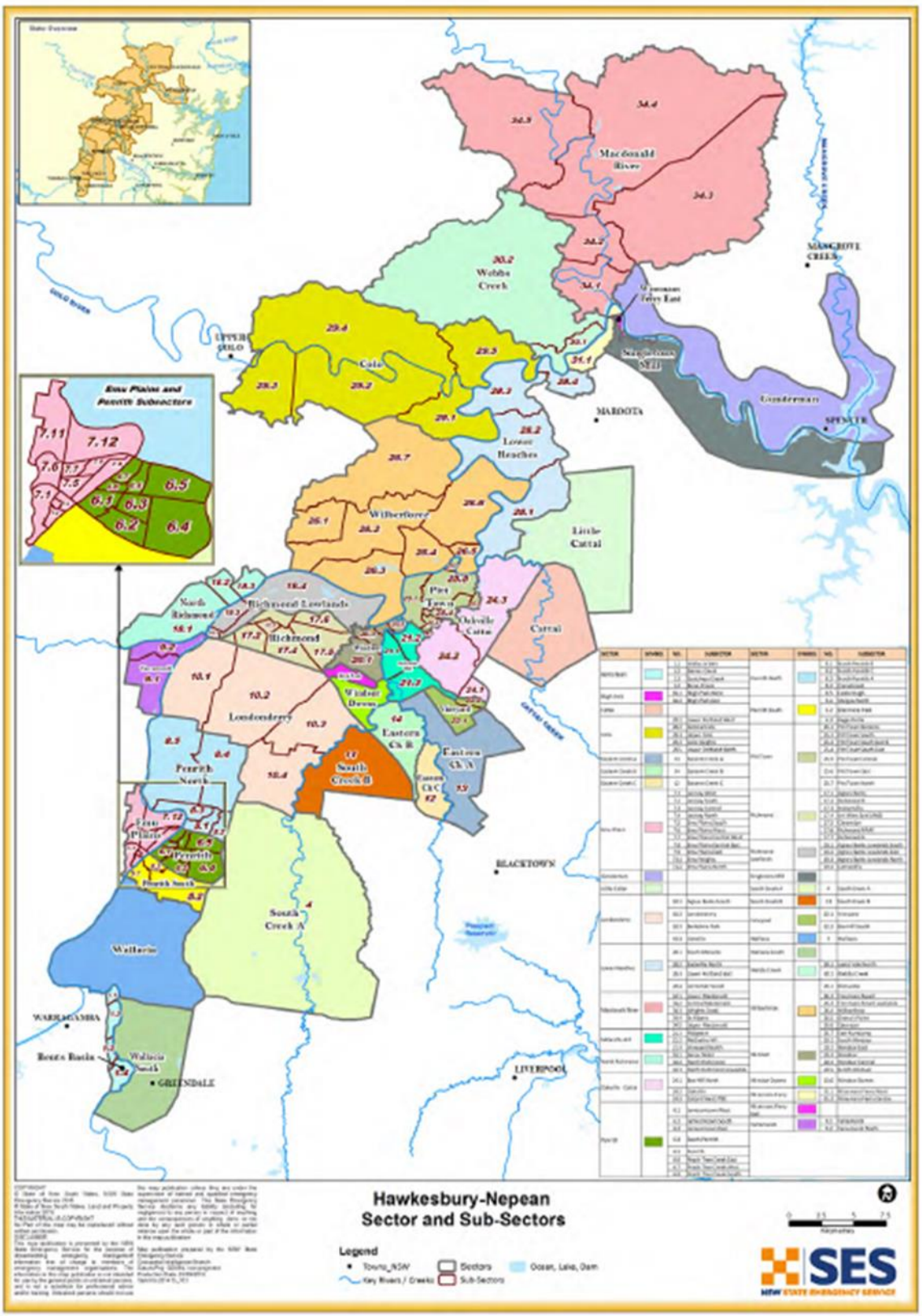

Figure 5: Hawkesbury Nepean Evacuation Sectors and Subsectors (NSW SES, 2020)

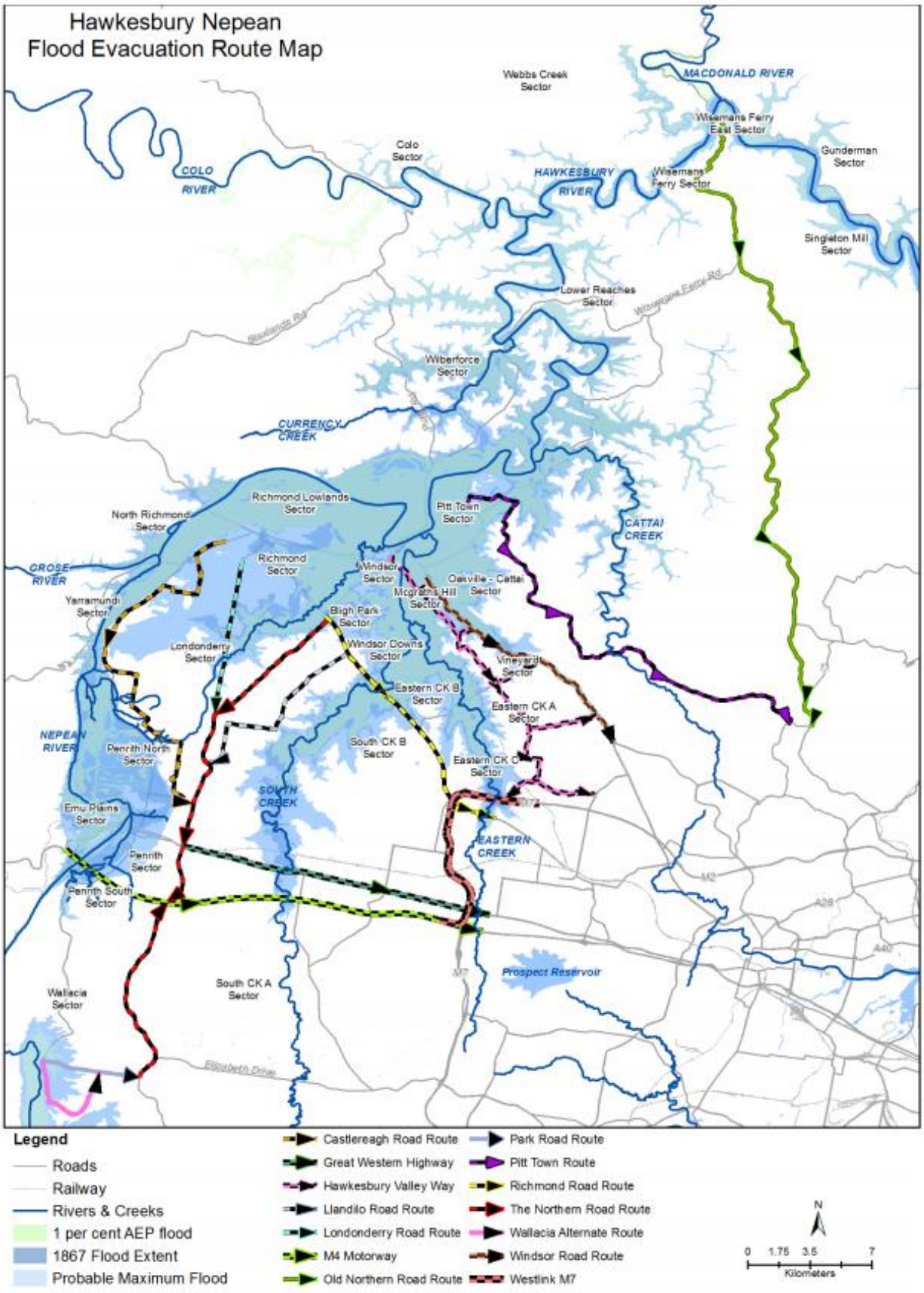

Figure 6: Hawkesbury Nepean Evacuation Routes (NSW SES, 2020)

- Penrith North - all evacuees would be directed east to The Northern Road then onto the M4
- Penrith - some evacuees would be directed east to The Northern Road and onto the M4 while the remainder are evacuated onto Mulgoa Road and the M4
- Penrith South – some evacuees would be directed onto Mulgoa Road and then onto the M4
- Emu Plains – all would be evacuated onto the M4

While each subsector has a designated primary evacuation route, some subsectors have secondary evacuation routes which may be utilised by the evacuees and/or the SES during the event, particularly if there are incidents causing delays on the primary route.

The clearest way to explain the sharing of evacuation routes and the potential for convergence of evacuation traffic from different subsectors is to start with the M4 and work back through the system.

3.3 Evacuation onto the M4

Traffic from the Emu Plains Sector west of the Nepean River enters the M4 via an on ramp at Russell Street. This on ramp only has a single lane so evacuation traffic from this Sector would take up the capacity of a single eastbound lane on the M4 (Figure 7). There are some areas of Emu Plains and Emu Heights whose evacuation routes may be cut off early or who may not be able evacuate in time via Russell Street and they may be directed along Old Bathurst Road to the Great Western Highway at Blaxland. From here they would be directed east to the M4 where why would become part of the traffic stream evacuating from Emu Plains.

Some of the premises in the Penrith South Sector and some in the Penrith Sector would evacuate along Mulgoa Road from the north and the south to the M4. Although multiple lanes would converge at the Mulgoa Road on ramp, this too is only a single lane on ramp so evacuation traffic from Mulgoa Road would be restricted to a single stream of traffic entering the M4. At this point the M4 has three eastbound lanes but in essence the streams of evacuation traffic from Emu Plains and Mulgoa Road evacuees would take up the capacity of two of those lanes when both traffic streams are evacuating simultaneously (Figure 7).

The final stream of evacuation traffic arriving at the M4 would come via The Northern Road. The on ramp from The Northern Road to the M4 is also a single lane. This means that only a single stream of traffic from The Northern Road can enter the M4 and this would occupy the capacity of the third lane on the M4 when this traffic stream is using the M4 at the same time as Mulgoa Road and Emu Plains Traffic (Figure 7).

3.4 Evacuation onto the Great Western Highway

In recognition of the capacity constraints that the on ramp from the Northern Road to the M4 creates, and the fact that evacuation traffic from further west (Emu Plains and Mulgoa Road) could be taking up two lanes of the M4, the NSW SES proposes that the two east bound lanes of the Great Western Highway take evacuation traffic from The Northern Road when possible. Specifically, paragraphs 8.4.5 and 8.4.6 of Chapter 4, Volume 3 of the SES Plan states:

"The Exit Point for the Route is the intersection of Parker Street and the Great Western Highway, Kingswood.

However, the Exit Point may be extended from the intersection of the Great Western Highway and Parker Street, Kingswood to the intersection of The Northern Road Kingswood, and the M4 Western Motorway at South Penrith depending on traffic conditions and if the Emu Plains Sector is also being evacuated." (NSW SES, 2020)

These two lanes are also shown in (Figure 7).

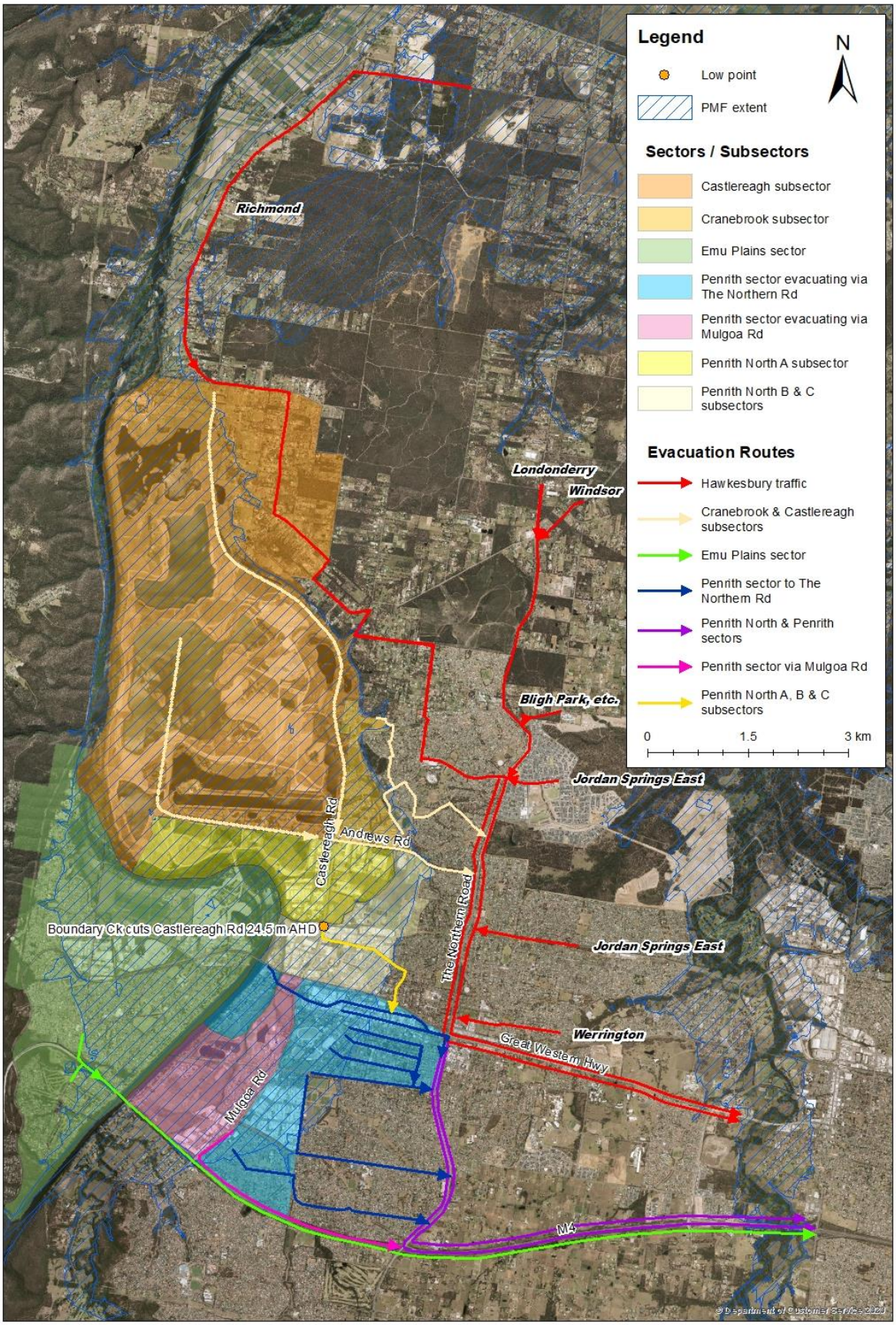

Figure 7: Evacuation Routes to Great Western Highway and M4

3.5 The Northern Road

There are currently two southbound lanes on The Northern Road from Borrowdale Way at Cranebrook to Copeland Street at Werrington and then three lanes south from there to the M4.

Four streams of traffic from the Hawkesbury floodplain (Richmond, Windsor, Londonderry, Bligh Park/Windsor Downs Llandilo) may need to evacuate south along The Northern Road, entering at various points where it is only two lanes wide (Figure 7). The timing of evacuation from these subsectors will be triggered by forecast river levels at Windsor gauge.

Similarly, development in Jordan Springs East and Werrington can be flooded by Hawkesbury floodwaters backing up South Creek and therefore these evacuations will also be triggered by forecast levels at Windsor and will need to evacuate onto The Northern Road where it is two lanes wide (Figure 7).

Evacuation traffic from all of the Penrith North sector and part of the Penrith sector will need to evacuate onto The Northern Road. Their evacuation will be triggered by forecast levels at Penrith gauge.

3.6 Penrith Sector

The Penrith Sector includes several subsectors. Most of those which are west of Mulgoa Road would evacuate onto Mulgoa and then onto the M4. Those which are east of Mulgoa Road have several streets available to them which can take them to The Northern Road (Figure 7). Most of these areas have a rising road route up to The Northern Road and a large road network in which to queue between the peak of the PMF level and The Northern Road.

The exception is Peach Tree Creek West subsector which includes Nepean Avenue and Ladbury Avenue and their connecting streets. This subsector is a low flood island because their evacuation route can be cut by the Nepean River backing up Peach Tree Creek and cutting Ladbury Avenue near its intersection with the Great Western Highway.

3.7 Penrith North Sector

Penrith North Sector has five subsectors (Figure 7). Penrith North A subsector includes Nepean Business Park and its evacuation route is south on Castlereagh Road, east on Coreen Avenue before turning right onto Lemongrove Road, left onto Macquarie Avenue, over the railway line of the Evans Street Bridge, left onto Henry Street which merges into North Street and then High Street and then it would turn right onto The Northern Road and south towards the M4.

Penrith North A is a low flood island because its evacuation route can get cut by the Nepean River backing up Boundary Creek and first cutting Castlereagh Road south of the subsector and the continuing on to cut Andrews Road east of the sector. Penrith North A therefore must be evacuated before the river cuts Castlereagh Road at the Boundary Creek crossing.

Penrith North B is the industrial area between Boundary Creek and the railway line as well as the new residential development at Thornton. It too evacuates onto Coreen Ave and takes the same route as Penrith North A to The Northern Road and the M4.

Penrith North C is east of Penrith North B and is mostly residential land at higher elevation. It also evacuates on the same route and Penrith North A and B.

Castlereagh subsector includes Penrith Lakes and some rural properties to the north of Penrith Lakes. These evacuate along Castlereagh Road or Old Castlereagh Road onto Andrews Road and then south on The Northern Road.

Cranebrook subsector includes the old Cranebrook village as well as the newer development at Waterside. The NSW SES plan has these evacuating via Andrews Road onto The Northern Road but

there is a better evacuation route which they can take along Greygums Road and Sherrington Road which reduces the chance of traffic queues being overtaken by rising floodwaters.

4| Evacuation Modelling

4.1 Timeline Evacuation Model

The NSW SES has developed the Timeline Evacuation Model (TEM) as an empirical means of consistently estimating the ability of people to safely evacuate by motor vehicle from floodplains (Opper et al, 2009). It takes into account the time people take to accept a warning, act upon the warning and travel along an evacuation route which may face delays due to incidents along the route. It then compares this estimated "Time Required" with the estimated "Time Available". The Time Available is derived from information about warning times, flood travel times and flood rates of rise.

The TEM was born out of the 1997 Hawkesbury-Nepean Floodplain Management Strategy, where the NSW SES applied conventional time line project management to the flood evacuation problem. It became apparent that this approach provided a clear and concise method for examining the evacuation process.

Since that time, the approach has been refined into a model that can be easily applied to different developments. The TEM has been used widely within NSW by both the NSW SES and consultants in evacuation planning, with the scale of the model ranging from small sub divisions to towns of tens of thousands of people.

The primary goal of the TEM is to compare the time required for evacuation with the time available for evacuation. This can be represented by the equation:

Surplus Time = Time Available – Time Required

or:

ST=TA-TR

Where the Time Available exceeds the Time Required there can be greater confidence that a community can evacuate safely by motor vehicle. Where the Time Required exceeds the Time Available it is unlikely that everyone will be able to evacuate safely by motor vehicle in all floods.

4.1.1 Estimating the Time Required

The time required (TR) can be described by the equation

TR = WAF + WLF + TT + TSF

Where:

- **Warning Acceptance Factor (WAF)** accounts for the delay between receiving an evacuation order and acting upon it. The NSW SES recommends a value of one hour.
- **Warning Lag Factor (WLF)** is an allowance for the time taken by occupants to prepare for evacuation. The NSW SES recommends a value of one hour.
- **Travel Time (TT)** is defined as the number of hours taken for all of the evacuating vehicles to pass a point given the road capacity. The NSW SES recommends an assumed road capacity of 600 vehicles per hour per lane. Therefore if an evacuation generates 1,200 vehicles and the evacuation route has one lane, then the travel time is two hours. If there are two lanes the travel time is reduced to one hour.
- **Traffic Safety Factor (TSF)** is added to the travel time to account for any delays that occur along the evacuation route. This includes potential for incidents such as vehicle accidents or breakdowns, fallen trees or power lines or water across the road. The NSW SES has developed

a table of traffic safety factors, where the safety factor is proportional to the travel time, ranging from one hour to three and a half hours (Table 2).

Table 2: Traffic Safety Factors

Travel Time TT (hrs)	Traffic Safety Factor TSF (hrs)
0 to 3	1.0
>3 to 6	1.5
>6 to 9	2.0
>9 to 12	2.5
>12 to 15	3.0
>15	3.5

The time needed to disseminate an evacuation order also needs to be considered. Generally, the NSW SES will broadcast the order by several means but will also initiate door knocking of the target premises. The model assumes that the evacuation order is not received at a property until it is door knocked and that at any one time there will be properties at different stages of the evacuation sequence.

However, this is only true if the number of door knocking teams available is equal to the number that would produce enough traffic to keep the evacuation route at full capacity. Should the number of door knocking teams available be less than this optimal number, then the travel time must be modified to account for this. If more door knockers are provided than the optimal number then the rate of traffic generation will exceed the road capacity and traffic queues will form until no more premises evacuate.

These TEM concepts are illustrated diagrammatically in Figure 8.

4.1.1 Estimating Time Available

The time available is usually the time from when an Evacuation Order is issued by the NSW SES to when the lowest point on the evacuation route is cut by floodwaters. The ability to estimate this time for use in the TEM will be very dependent on the quality of available flood data and the type of warning products which the Bureau of Meteorology (BoM) is able to provide.

In the case of the Nepean River, the Provisions and Requirements for Flood Warning in New South Wales (NSW SES, 2019) states that for floods forecast to exceed 8.9m at the Penrith gauge, 6 hours warning will be provided and at 11.3m AHD at Penrith, 8 hours warning will be provided.

The timing of such a forecast is called the Quantitative Precipitation Forecast (QPF) Limit and is the minimum time (in advance) that the flood height can be forecast with a high level of certainty. It uses gauging of rainfall and upstream river levels. This forecasting is not simply forecasting the peak height but any particular height being reached or exceeded. A QPF limit of six or eight hours has therefore been assumed in the evacuation modelling for the precinct and the surrounding areas on the Nepean floodplain around Penrith, depending on the forecast gauge level at Penrith.

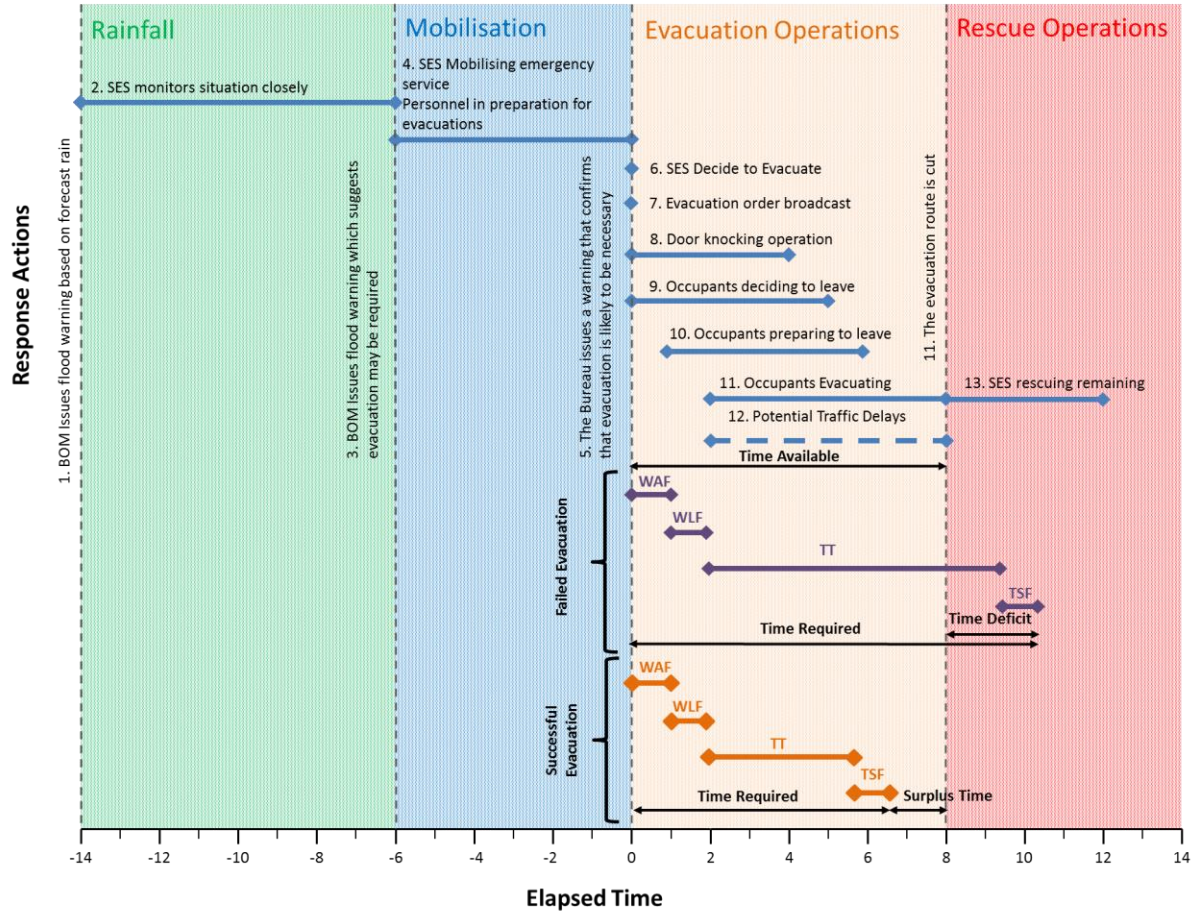

Figure 8: NSW SES Timeline Evacuation Model Concept

Any flood can be represented by a hydrograph at specified points along a river. A hydrograph plots how the water level goes up and down over time. Because the TEM is interested in the minimum time which is likely to be available, and there will be limited data about the possible rates of rise of floods, the PMF hydrograph is usually used for these steps. The 72 hour PMF hydrographs for Penrith and Windsor were available for use in the evacuation modelling of the precinct and have therefore been relied upon.

This does not mean that the TEM is only estimating the time available in a PMF. Modelled design floods and even records of actual floods only represent one possible rate of rise for a flood to reach a particular peak. Floods with peaks smaller than a PMF could rise at rates approaching that of a PMF, particularly in the range in which evacuation needs to take place which is often well below the flood peak.

4.1.2 Other Considerations

In keeping with the principles of the NSW Floodplain Development Manual (DECC, 2005), the results of the TEM calculations must be considered within a risk framework and merits-based decisions need to be made as to the appropriateness or otherwise of modelled evacuation arrangements for existing and proposed developments.

The following highlight some of the issues which need to be considered beyond the results provided by the TEM.

- **Traffic Convergence:** While each community, development or precinct must be evaluated individually to determine whether full evacuation is possible, it must be recognised that the

evacuation traffic from several locations may be directed to the same road and therefore the potential for traffic convergence to affect completion of the evacuation must be considered.

- **Safety Margins:** Any surplus time calculated through the timeline evacuation modelling can be considered to be a safety margin should any of the model assumptions prove to be non-conservative.
- **Consequences of Evacuation Failure:** There are many reasons why vehicular evacuation may fail. It therefore must be acknowledged that some, or all, of the evacuees will be unable to evacuate by motor vehicle. The probability and consequences of such a failure must come into consideration when determining the appropriateness of a new development. The Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities (DECC, 2007) provides some guidance in this regard. The classification system determines whether those who fail to evacuate by car:
    - have safe walking access to a flood free area
    - would be isolated and/or overwhelmed by rising floodwaters
- **Sensitivity of Variables:** Default values for many of the variables used in the TEM have been determined by the NSW SES. It is expected that any application of the TEM will utilise these default values, except where it can be clearly justified to use alternative values. Other variables will be derived from available flood modelling, census data, council records and development details. There may need to be assumptions made in selecting values from this data for use in the TEM. The sensitivity of the TEM to these assumptions should be tested to ensure that any conclusions drawn from using the model are robust.

4.2 Evacuation Modelling for Nepean Business Park

The NSW SES recognises that evacuation of a development may not necessarily occur in isolation as other nearby developments may also have to evacuate at the same time. In the Hawkesbury Nepean floodplain there are multiple subsectors evacuating onto shared evacuation routes.

The Hawkesbury Nepean Valley Flood Management Taskforce is currently developing a dynamic evacuation model for the Hawkesbury Nepean Valley but it is not available for others to use.

Molino Stewart has created a flood evacuation model for the Penrith floodplain which also accounts for evacuation traffic from other parts of the Hawkesbury Nepean Valley. This modelling has been used to evaluate evacuation for the Nepean Business Park.

It uses inputs and assumptions provided by INSW and NSW SES and is consistent with the calculations used as the basis for the NSW SES TEM. The following sections explain in detail the inputs and assumptions used in the modelling.

4.2.1 Evacuation Routes

The regional evacuation routes for each sector as set out in the Hawkesbury Nepean Flood Emergency Sub Plan (2020) and shown in (Figure 6) were generally used. The Penrith North Sector evacuates onto The Northern Road.

There was one slight amendment to the regional evacuation route from Richmond which was used in the modelling. The detail of the Castlereagh Road Route in Figure 6 takes Richmond, Richmond Lowlands and Agnes Banks South evacuation traffic from Castlereagh Road to The Northern Road through several roads including Laycock Street and Andrews Road. These latter two roads were also the NSW SES proposed evacuation routes of the old Cranebrook township off Cranebrook Road and the new development at Waterside which are both part of the Cranebrook subsector. Our modelling clearly showed that if Richmond traffic is evacuating at the same time as traffic from the Penrith floodplain, then the Richmond traffic would block the evacuation of these other two developments and most of the vehicles would not be able to leave the houses, let alone leave the floodplain.

We therefore changed the evacuation routing in this area to ensure that Richmond traffic did not block the access of these two townships to The Northern Road. Even though their evacuation would be blocked by Richmond traffic when they reached the Northern Road, there would be sufficient road length for vehicles to queue above the PMF until all of the Richmond traffic had passed. The alternative evacuation routes are shown in Figure 9.

This modification has no real impacts on the evacuation of the Penrith North A subsector and the Nepean Business Park because it does not change the quantum of traffic already on The Northern Road when Penrith North A needs to merge onto The Northern Road.

The model was set up to focus on the evacuation traffic travelling south on The Northern Road which would then evacuate east either on The Great Western Highway or the M4 Motorway. Traffic evacuating on Richmond Road, Hawkesbury Valley Way, Windsor Road, Pitt Town Road and the Old Northern Road were excluded from the model because they do not converge with traffic evacuating from the Penrith floodplain.

There are three lanes heading east on the M4 east of The Northern Road but there is only a single lane on ramp from The Northern Road onto the M4. During discussions with NSW SES and Transport for NSW while building this evacuation model, they indicated that upgrading of this on ramp would increase its future capacity.

Traffic from the Emu Plains Sector west of the Nepean River would enter the M4 on a single lane on ramp from Russell Street so the modelling assumed that the Emu Plains traffic would take up one of the lanes on the M4. Similarly, traffic evacuating from the Penrith Sector and Penrith South Sector via Mulgoa Road would have a single lane entry onto the M4 and the model assumed all of this traffic would evacuate onto one lane on the M4.

The model was therefore set up with:

- Two lanes heading south on The Northern Road from Borrowdale Way to the M4 (it is noted that since the modelling was undertaken The Northern Road has been widened and there are now three lanes heading south on The Northern Road from Copeland Street to the M4)
- Two lanes heading east on the Great Western Highway from The Northern Road
- A two lane on ramp from The Northern Road heading east onto the M4
- Two lanes heading east on the M4 from The Northern Road with one of those lanes shared with the traffic coming from Mulgoa Road

All other roads were designated as single lane roads in the model.

The assumed evacuation route for Penrith North A, Penrith North B and Penrith North C subsectors was:

- Castlereagh Road to Coreen Avenue
- East on Coreen Avenue to Lemongrove Road
- South on Lemongrove Road
- South on Macquarie Avenue
- South on Evans Street
- East on Henry Street
- East on High Street
- South on The Northern Road
- East on M4

Figure 9: Alternative Evacuation Routing for Richmond, Cranebrook and Waterside

The route from Coreen Avenue to The Northern Road is shown in Figure 10. It also shows traffic from further north on The Northern Road being diverted east on The Great Western Highway. The modelling shows that this is necessary to prevent traffic evacuating from the Hawkesbury Floodplain (particularly Richmond) blocking the evacuation of traffic evacuating from the Penrith floodplain. The modelling suggests this is necessary under the existing scale of development on the floodplains, irrespective of any future growth.

It was assumed Penrith Lakes (Castlereagh Subsector) would evacuate to The Northern Road via Andrews Road and all subsectors in Penrith East of Mulgoa Road would evacuate to The Northern Road on the many streets which provide right turn provisions into The Northern Road.

There is also traffic evacuating from the new suburb of Jordan Springs East and the established suburb of Werrington which both enter the Northern Road from the east. These are both part of the South Creek A subsector.

Figure 11 is a summary of all of the key roads leading into and out of The Northern Road in the modelling.

Table 3 is a summary of the evacuation routes used in the model for each sector and subsector.

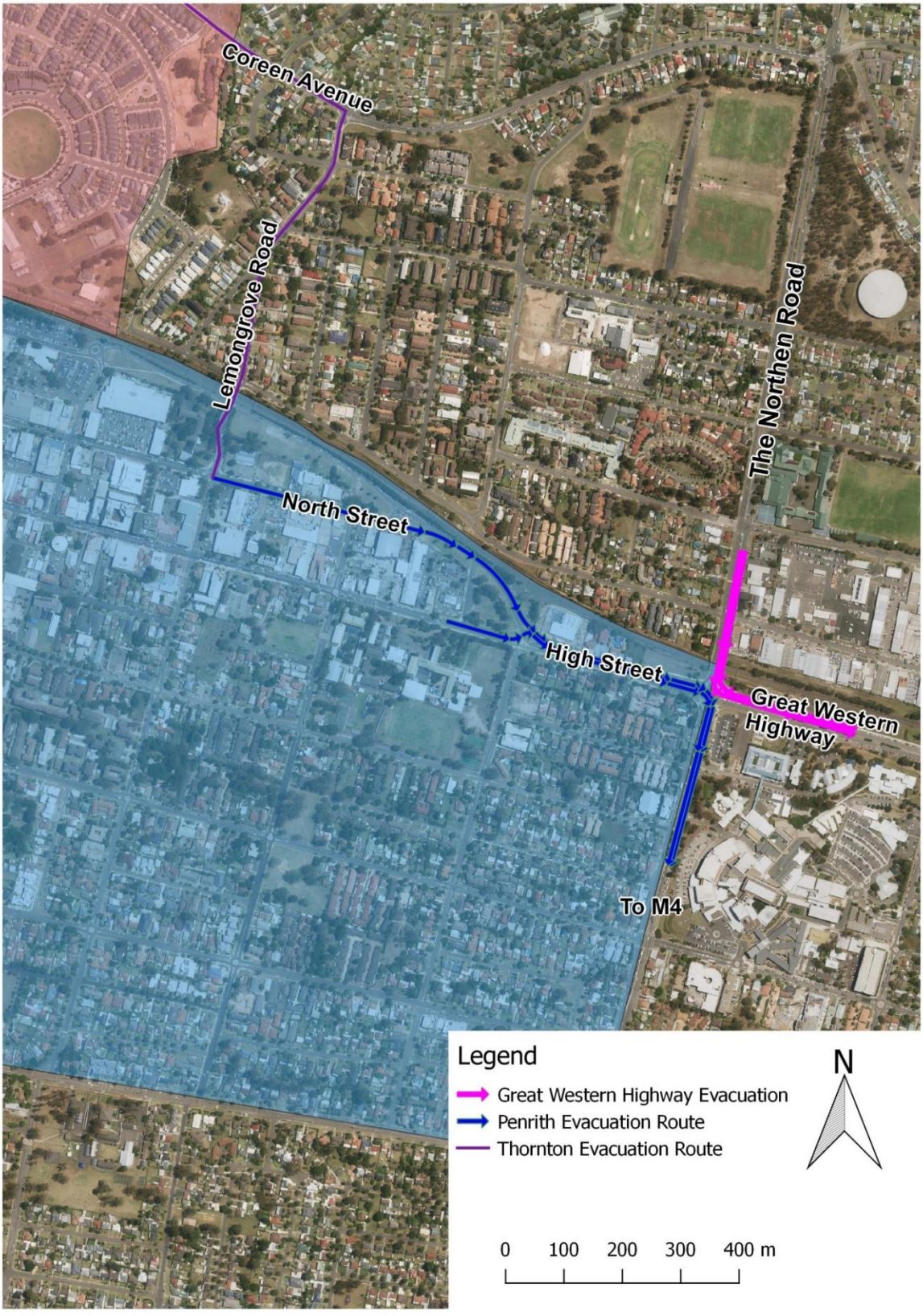

Figure 10: Modelled traffic arrangements at the intersection of The Northern Road and Great Western Highway

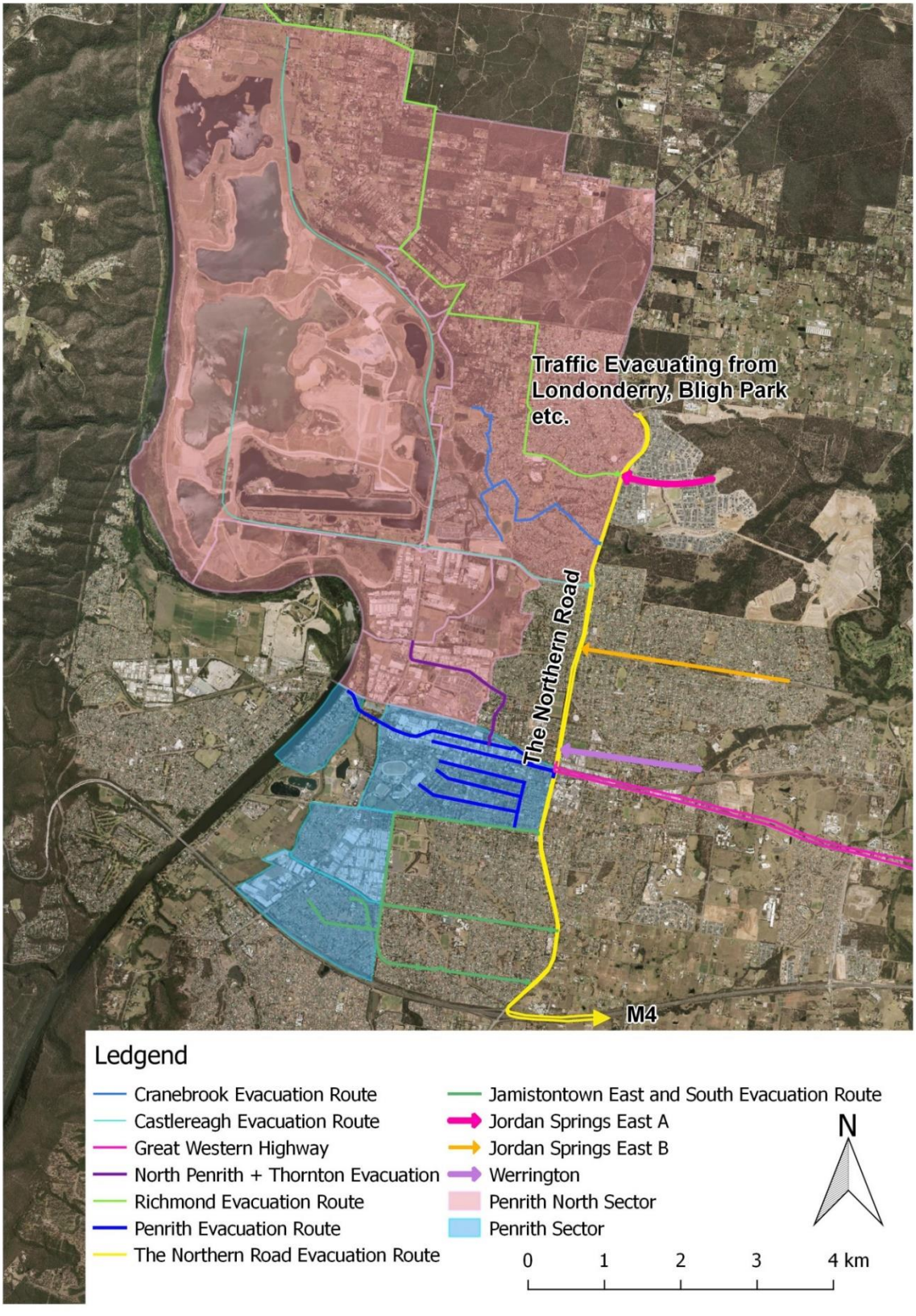

Figure 11: Routes Leading to and from The Northern Road

Table 3: Evacuation routes used in LSM for subsectors evacuating to the Northern Road

Sector	Subsectors	Route
Richmond	All	South on Castlereagh Road, east along the Agnes banks detour (The Driftway, Jockbet Rd and Wiltshire Rd), south along Castlereagh Road, east along Hinxman Road, south along Sheredan Road, east onto east Wilchard Road, south onto Church Street, east onto Church Lane, south onto Cranebrook Road, east onto Vincent Road, south onto Grays Lane, east onto Hindmarsh Street, south onto Laycock Street, east onto Borrowdale Way
Richmond Lowlands	All	
Londonderry	Agnes Banks South	
Londonderry	Londonderry	Local roads to The Northern Road
Londonderry	Berkshire Park and Llandilo	Local roads to Llandilo Road
Bligh Park	Bligh Park	Richmond Road until cut by flooding on South Creek, then Llandilo Road, west on Fourth Avenue, south onto Terrybrook Road, west along Ninth Avenue
Windsor Downs	Windsor Downs	
Penrith North	Castlereagh	Castlereagh Rd to Andrews Rd
Penrith North	Cranebrook	Boundary Rd, Laycock St, Greygums Rd, McHenry Rd, Sherringham Rd
Penrith North	Waterside Green	Laycock St, Greygums Rd, McHenry Rd, Sherringham Rd
Penrith North	North Penrith A	Castlereagh Rd, Coreen Ave, Lemongrove Rd, Macquarie Ave, Evan St, Henry St, High St
Penrith North	North Penrith B	Castlereagh Rd, Coreen Ave, Lemongrove Rd, Macquarie Ave, Evan St, Henry St, High St
Penrith North	North Penrith C	Coreen Ave, Lemongrove Rd, Macquarie Ave, Evan St, Henry St, High St
Penrith	Peach Tree Creek West	Nepean Ave, Great Western Highway
Penrith	Penrith	Great Western Highway or High St or, Jamison Rd, or Lethbridge St or Derby St or Stafford St to Jamison Rd
Penrith	Jamisontown East (Residential + Commercial east of Mulgoa Road)	Jamison Rd or York Rd to Maxwell Rd
Penrith	Jamisontown South (Residential east of Mulgoa Road)	Glenbrook St or Thurwood Ave to Ikin St, to York Rd, to Tukara Rd
South Creek A	Jordan Springs East	Wianamatta Pkwy, Lakeside Pde to either Jordan Springs Blvde or Greenwood Pkwy
South Creek A	Werrington	Victoria St, Copeland St

4.2.2 Vehicle Numbers

The Hawkesbury Nepean Valley Flood Management Taskforce provided projected traffic estimates for the Year 2041. These were provided by the Taskforce in 2016 and were the most up to date estimates available when the modelling was first done in 2018. These estimates were at a Sector level and were the totals of all residential and commercial vehicles which would be evacuating in a worse case scenario. They are presented in Table 4. No explanation has been provided by the Taskforce as to how these were estimated nor what a worse case scenario represents.

Table 4: Taskforce Estimates of Evacuating Vehicles in Sectors used in Evacuation Modelling

Sector	**Total Vehicles 2041[1]**
Bligh Park	6,100
Londonderry	3,800
Penrith	17,400
Penrith North[2]	13,900
Richmond	12,900
Richmond Lowlands	240
Windsor	9,800
Windsor Downs	990
Total	**65,130**

1. Numbers were rounded by the Taskforce
2. Includes estimated 5,000 dwellings at Penrith Lakes

As traffic coming from the Hawkesbury was all coming to The Northern Road along routes which led from sectors it was not necessary to allocate Hawkesbury vehicle numbers according to subsectors in the modelling.

Furthermore, Windsor, Bligh Park and Windsor Downs have alternative evacuation routes to The Northern Road. For the purpose of the modelling it was assumed that 50% of the Windsor traffic would evacuate along The Northern Road. It was further assumed that the first 3,000 vehicles from Bligh Park and Windsor Downs would evacuate along Richmond Road until backwater flooding of South Creek forced the remaining 4,090 vehicles to evacuate along The Northern Road.

Based on approved development at Jordan Springs East it was assumed that there would be 2,667 vehicles evacuating from Jordan Springs East. The Werrington traffic was estimated using existing development numbers and an estimate of future development potential based on current zonings. A total of 2,400 vehicles evacuating from Werrington was included in the modelling.

It was necessary to breakdown the vehicles into subsectors in the Penrith and Penrith North sectors.

A Molino Stewart team used high resolution aerial photography of the floodplain from 2011 to plot the location of every individual residential, commercial and industrial building in the floodplain within a Geographic Information System (GIS).

Google Earth Street View was used to classify buildings as residential, commercial or industrial. It was also use to count letter boxes on properties to estimate the number of dwellings in multi-unit dwellings.

Dwelling counts were compared with 2011 Census data, where Census statistical areas were fully within the floodplain, and were found to be within 5% in the Penrith floodplain.

It was recognised that there had been further residential development on the floodplain since 2011 when the Census data was collected and the airphotos were taken. Of particular interest to this

study were the developments at Waterside and Thornton which are both in the North Penrith Sector and which were both only partly developed. To account for these two developments, subdivision plans were obtained for the ultimate development of both and dwellings were assigned to each lot whether it was currently developed or not. In the case of Thornton this included several high rise apartment buildings with multiple dwellings in each. In this way the model accounted for foreseeable future development.

Similarly, it was recognised that planning approval had been granted to redevelopment of the Penrith Panthers site. The commercial premises and dwelling numbers from the planning proposal were used to assign dwellings and vehicles to that site.

In agreement with the NSW SES in 2014, it was assumed that there would be two (2) vehicles evacuating from each business address identified within each sector. Note that the number of business addresses is not the same as the number of buildings because there are some businesses with multiple buildings and some buildings with multiple businesses. The number of businesses addresses was provided by the NSW SES from data collected by Geoscience Australia. These were distributed in the model equally to each non-residential building.

Similarly, in agreement with NSW SES, the number of residential vehicles at each dwelling was estimated in two different ways:

- For existing dwellings and future residential development (Waterside and Thornton) the average number of vehicles per dwelling for that subsector from the 2011 Census data was used
- For any proposed dwellings for Penrith Lakes it was assumed that there will be 1.8 vehicles per dwelling

These were distributed evenly to each residential building in the model.

Future development to 2041 was accounted for using projections provided by the Department of Planning, Penrith City Council and Hawkesbury City Council in 2013.

When the Hawkesbury Nepean Valley Flood Management Taskforce provided projected traffic estimates for the Year 2041 in 2016, two different approaches were taken for distributing those vehicles in the Penrith North and Penrith sectors.

In the Penrith Sector, the number of vehicles per building in the original model was simply multiplied by 2.5 and distributed evenly across all buildings. This resulted in the total number of vehicles evacuating from the sector being equal to that estimated by the Hawkesbury Nepean Valley Flood Management Taskforce.

In the Penrith North sector only subsectors Penrith North A and Penrith North B have significant numbers of business premises. Geoscience Australia estimated that there were 384 business addresses in the Penrith North A subsector and 442 business premises in the Penrith North B subsector. On the basis of two evacuating vehicles per business premises there would be 768 and 884 vehicles evacuating from Penrith North A and Penrith North B respectively.

The 2014 vehicle estimate method had 4,586 vehicles evacuating from Penrith North sector compared to the 13,900 vehicles in the taskforce estimate. However, the former did not include any vehicles evacuating from Penrith Lakes and the latter accounted for 5,000 dwellings at Penrith Lakes. When that difference is accounted for there was a difference of 314 vehicles and it was assumed that because there was development in progress in Subsector B that these vehicles would all be in Subsector B.

With regard to Penrith Lakes it was assumed, for the purposes of modelling for Nepean Business Park, that any development at Penrith Lakes would either be:

- recreational or tourism development which would be evacuated early and would not contribute to regional evacuation traffic; or
- would be urban development based on a capacity limit determined by separate modelling of road infrastructure upgrades.

Accordingly, the number of vehicles included in each of the Penrith North subsectors for modelling the evacuation capacity for the proposed employment lands precinct are set out in Table 5.

Table 5: Estimates of Evacuating Vehicles in Penrith North Subsectors used in Evacuation Modelling

subsector	**Total Vehicles 2041**
8.1 Penrith North B	2,663
8.2 Penrith North C	0
8.3 Penrith North A	768
8.4 Cranebrook	1,404
8.5 Castlereagh	65[1]
Total	**4,900**

1. excludes new development at Penrith Lakes

4.2.3 Evacuation Triggers

Evacuation of the Penrith and Penrith North Sectors will be triggered by flood levels and forecasts in the Nepean River at Penrith. Evacuation of the Richmond, Richmond Lowlands, Londonderry, Windsor, Bligh Park, Windsor Downs and South Creek A sectors will be triggered by flood levels and forecasts in the Hawkesbury River at Windsor.

The BoM has set minor, moderate and major flood levels for the Nepean River at Penrith based on the impacts that flooding would have. These are set out in Table 6 as both the gauge levels (which is what BoM will report and forecast to) and the corresponding elevations at both the gauge and the Nepean Business Park. Note that historically the gauge was set arbitrarily with a zero reading at 14.139m AHD. The site flood levels are lower than the gauge flood levels because the site is downstream of Penrith Weir where the river level drops. It should also be remembered that the flood will peak at the site a little after it does at the gauge because the water takes time to travel from the gauge to the site.

Table 6: Penrith Flood Classes

Class	Penrith Gauge (m)	Penrith (m AHD)	Site* (m AHD)
Minor	3.9	18.0	16.5
Moderate	7.9	22.0	20.8
Major	10.4	24.5	23.6

* estimate only

Provisions and Requirements for Flood Warning in New South Wales (NSW SES, 2019) states that for floods forecast to exceed 8.9m at the Penrith gauge, 6 hours warning will be provided by BoM and for those exceeding 11.3m AHD at Penrith, 8 hours warning will be provided. These warning times are based on the flood travel times from upstream rainfall and stream gauges to the Penrith gauge and are independent of the rate of rise of the flood.

The Hawkesbury Nepean Flood Emergency Sub Plan (NSW SES, 2020) provides details as to when and by what means evacuation warnings and orders will be issued. Most of the means of disseminating these evacuation orders are by broadcast methods and broadcasting would be done on a subsector or sector basis, depending on the flood forecasts. The Nepean Business Park would be covered by the broadcast messages which covers the rest of the subsector. The extent of development within a subsector has no impact on the demand on NSW SES resources for orders disseminated by these means.

Although the Nepean and Hawkesbury Rivers are one and the same river and floodwaters that pass Penrith will flow to Windsor, it is more helpful for evacuation modelling purposes to think of them as two different rivers with semi-independent flood behaviours. This is because the spatial and temporal distribution of rainfall varies from flood to flood and there is a wide range of relative timings of evacuation trigger levels being reached at Penrith and Windsor. This means the relative timings of evacuations from the sectors which these two rivers affect can vary from flood to flood.

To be conservative, it was assumed that the first of the traffic evacuating from Richmond would arrive on The Northern Road at the same time that the first subsector in the Penrith floodplain evacuates to The Northern Road. The relative timing of the evacuation of other sectors triggered by levels at Windsor was based on the timing of their evacuation triggers being reached relative to each other on a 72hr PMF design flood hydrograph. A slower rising flood would see their arrival on The Northern Road more spread out than the timing which was modelled and would result in less traffic congestion.

For the purposes of evacuation modelling it was assumed that Richmond evacuation would be triggered when it was forecast that the river would reach 13.5m AHD at Windsor, simply to give the existing vehicles enough time to evacuate before their evacuation route was cut by a flood rising as fast as a 72hr PMF. Evacuation from the other sectors was based on a forecast of when their evacuation routes would be cut. The triggers timings relative to the Windsor hydrograph are provided in Table 7.

Table 7: Relative Timings for Evacuation from Sectors to the North

SES Subsector	**Evacuation Via**	**Evacuation commences (hours)[1]**
Richmond and Richmond Lowlands Sectors and Agnes Banks South Subsector	Castlereagh Road and The Northern Road	24.5
Windsor Sector	The Northern Road	26
Londonderry Subsector	Londonderry Road and The Northern Road	24.5
Bligh Park Sector, Windsor Downs Sector, Berkshire Park Subsector, and Llandilo Subsector	Llandilo Road and The Northern Road	32

1. Time first vehicles on evacuation route relative to Windsor flood hydrograph

While it is possible that local flooding of South Creek could require the evacuation of some dwellings in Jordan Springs East and Werrington, this would only be a relatively small number of dwellings. Far more would need to evacuate if an extreme flood on the Hawkesbury River backed up South Creek into these areas.

Unlike traffic from the North, which is mostly entire population centres evacuating once it is known the evacuation route will be cut but floodwaters will keep rising, only those parts of Werrington and Jordan Springs East which are forecast to be flood affected need to evacuate at any one time. However, it will be the same flood hydrograph at Windsor which triggers both evacuation traffic from the north and evacuation traffic from Werrington and Jordan Springs East. The South Creek A triggers are summarised in Table 8.

Table 8: Jordan Springs East and Werrington Evacuation Timings Vehicle Evacuation Distribution

Trigger Level (mAHD)	***19.7***	***20***	***21***	***22***	***23***	***24***	***25***	***26***
Approx. Chance per year (1 in X)	500	750	1,500	2,000		5,000		70,000
Evacuation commences (hours)[1]	35	35	37	39	42	45	49	55

1. Time first vehicles on evacuation route relative to Windsor flood hydrograph

The subsectors in Penrith North have their initial evacuation triggered either by the lowest lying building forecast to be flooded or a low point on the evacuation route forecast to be flooded as summarised in Table 9. However, in the case of Penrith North B, the initial trigger for both residential and non- residential properties is the lowest building flooding but there is a low point on Coreen Avenue which the non-residential vehicles must pass before it is cut. Then the land rises quite steeply so there was a series of triggers set for different bands of development within this subsector. These are summarised in Table 10.

Similarly, in the Penrith Sector there were initially triggers for each subsector but most of the subsectors have rising road access so their evacuation can be staggered based on updated flood forecasts. The triggers used in the model for these subsectors are summarised in Table 11 and Table 12.

All of the timings in the following tables are based on a 72hr PMF design flood hydrograph at Penrith and a six hour warning time for levels between 23.0 and 25.4m AHD and eight hours warning for levels above 25.4m AHD. They also assume that the NSW SES would issue an evacuation order only when it is forecast that the subsector will be affected by flooding. However, there is the opportunity to gain additional evacuation time if evacuation is triggered by the forecast of a level lower than that which would impact on the subsector.

For example, Penrith North A subsector would have its evacuation route cut when it is forecast that a flood will reach a level of 24.4m AHD at Penrith gauge. As this level is between 23.0m AHD and 25.4m AHD there would be six hours warning available and therefore six hours in which to evacuate. However, it would be possible to trigger evacuation based on a forecast of 23.0m AHD and in a flood rising as fast as the 72 hour design PMF this would provide an additional three hours in which to evacuate.

An evacuation trigger or 24.4m AHD would have a chance of occurrence each year a bit more frequently than 1 in 50. Dropping the trigger to 23.0m AHD would increase the frequency to something a bit more frequent than 1 in 20 per year. This frequency of evacuation is unlikely to be a significant inconvenience and cost to businesses. This is particularly so when it is considered that if a

business is open 60 hours per week, then it is actually closed 64% of the time and would not have to evacuate people from site if an evacuation is called when it is already closed.

Discussions with NSW SES indicate that it is contemplating an early trigger for this subsector. Accordingly, a trigger of 23.0m AHD was used for the Penrith North A subsector in the modelling.

Table 9: Low points triggering evacuation of subsectors within the Penrith North Sector

SES Subsector	Low Point Type	Low Point Location	Low Point Ground Level (m)	Inundated at (hours)	Height at Penrith Gauge (m)	Evacuation Triggered at (hours)
North Penrith A	Road Cut	Castlereagh Rd (Boundary Ck)	24.2	16	24.4	10
North Penrith B (Commercial and Industrial)	Building Inundated (Commercial and Industrial)	Coombes Dr (Boundary Ck)	24.0	16	24.4	10
North Penrith B (Residential - Thornton)	Building Inundated (Residential)	Northeast corner of development	25.0	22	26.2	14
North Penrith C	Building Inundated	Western edge	27	27		19
Penrith Lakes	Development flooded	1% flood level	21.7	27		14*
Waterside	Building Inundated (Residential)	Fulmar Way	21.7	24	26.5	16
Castlereagh	Road Cut	Castlereagh Rd (near Smith Rd)	17.4	19.5	25.5	11.5
Cranebrook	Building Inundated (Residential)	Sardam Ave	20.8	25.5	26.8	17.5
* Evacuation of Penrith Lakes is triggered when a flood equal to, or exceeding, a 1% Average Exceedance Probability (AEP) flood is forecast at the Penrith Gauge.						

Table 10: Staged trigger levels for evacuation of Penrith North B subsector within the Penrith North Sector

Ground Levels (m AHD)		24-26	26-27	27-28	>28
Warning Trigger time (hr)	Commercial	10.0	14.0	14.0	14.0
	Residential	10.0	16.0	21.5	27.0

Table 11: Low points triggering evacuation of subsectors within the Penrith Sector

SES Subsector	Low Point Type	Low Point Location	Low Point Ground Level (m AHD)	Inundated at (hours)	Height at Penrith Gauge (m)	Evacuation Triggered at (hours)
Peach Tree Creek West	Road Cut	Ladbury Avenue (near High Street)	23.6	15	24.0	9.0
Penrith	Building Inundated (Residential)	Corner of Mulgoa Road and Rodley Avenue	26.8	25	26.8	17.0
Jamisontown East	Building Inundated (Residential)	Corner of Mulgoa Road and Jamison Road	27.5	27.5	27.3	19.5
Jamisontown South	Building Inundated (Residential)	Snowden Street (near Fairfield Place)	28.4	29.5	27.8	21.5

Table 12: Staged trigger levels for evacuation of Penrith, Jamisontown East and Jamisontown South subsectors within the Penrith Sector

Ground Levels (m AHD)		26.5-27.5	27.5-28.5	28.5-29.5	29.5-30.5	>30.5
Warning Trigger time (hr)	Penrith	18.0	20.5	22.5	26.5	34.5
	Jamisontown East	18.0	20.5	22.5	24.0	24.0
	Jamisontown South	18.0	20.5	22.5	26.5	29

4.2.4 Evacuation Timing and Capacities

The model used the evacuation sequencing recommended by the NSW SES in its Timeline Evacuation Model viz:

Warning Acceptance Factor – one hour

Warning Lag Factor – one hour

Travel Time – each lane of the roads on the evacuation routes can flow at 600 vehicles per hour per lane

Traffic Safety Factor – as per the NSW SES recommended values in Table 2.

It was also assumed that within each subsector the warning would be disseminated at a rate which would generate a constant flow of 600 vehicles per hour from the subsector.

5| Evacuation Modelling Results

The model was run using the assumptions and inputs as set out in Section 4.2. A detailed analysis of evacuation of Nepean Business Park was undertaken at four levels:

- Penrith North A subsector
- Penrith North Sector
- Penrith Floodplain
- Hawkesbury Nepean Valley

5.1 Penrith North A Subsector Evacuation

The results of the application of the TEM to Penrith North A subsector in isolation are presented in Table 13. This indicates that there is 4.3 hours surplus time for the existing subsector traffic.

Table 13: Application of TEM to Penrith North A Subsector

Development Name:	Penrith North A	
Date:		11/09/2021
Calculation ID:	PNA Existing	
Notes:	Current Development evacuating along Castlereagh Road and Coreen Avenue	
Data Type	**Input Data**	**Data Source**
Residential		
Number of Dwellings	0	
Vehicles Per Dwelling		
(OR) Total Number of Residential Vehicles		
percentage of census respondents not reporting		
Residential Vehicles	0	Calculated
Commercial		
Number of Business Premises	384	Goescience Australia 2014
Vehicles Per Business	2	As agreed with NSW SES 2014
(OR) Total Number of Commercial Vehicles		
Commercial Vehicles	768	Calculated
Total Vehicles (TV) = residential + commercial	768	Calculated
Evacuation Route		
Number of Lanes	1	Coreen Avenue
Evacuation Route Capacity (RC) (veh/hr)	600	Calculated
Evacuation Timing (hrs)		
Warning Acceptance Factor (WAF)	1	SES recommended value
Warning Lag Factor (WLF)	1	SES recommended value
Travel Time (TT) = TV/RC	1.3	Calculated
Traffic Safety Factor (TSF)	1	SES recommended value
Total Time Required to evacuate (TR)	4.3	Calculated
Time Available (hrs)		
BOM Forecast Time	6	Provisions and Requirements for Flood Warning in New South Wales (NSW SES, 2019)
Early warning at 23.0 v 24.4m AHD at Penrith Gauge	3	allowance for rise from 23.0 to 24.4 in 72hr PMF
Total Time Available (TA)	9	Calculated
Surplus Time (ST) = TA-TR	**4.7**	Calculated
	2832	spare capacity
Flood Emergency Response Classification	Low Flood Island	

Key
Development specific data which needs to be inputted
SES recommended values
Calculated Outputs

The surplus evacuation time could be taken up with additional vehicles as part of the Nepean Business Park development. Table 13 suggests that more than 2,800 additional evacuating vehicles could be accommodated within the available evacuation time giving a total of 3,600 vehicles evacuating from the subsector. However, this would increase the time that vehicles are on the road and therefore the TSF would increase to 1.5hours and only 3,300 vehicles in total would be able to evacuate.

While the NSW SES and the Hawkesbury Nepean Taskforce have not revealed how they have estimated the total number of vehicles which need to evacuate from the Hawkesbury Nepean floodplain, work on other projects with NSW SES suggests that travel to work data has been used to estimate the number of cars which would need to evacuate from non-residential premises. It is further understood that if the person driving the car lives in the floodplain, their evacuation is included in the residential vehicle count and not in the non-residential vehicle count and only those people who drive to work and live outside of the floodplain are counted for the purposes of calculating evacuating non-residential vehicles.

For example, if 40% of the workforce at Nepean Business Park live within the floodplain (e.g. Richmond, Windsor or a floodprone part of Penrith) then only 60% of the vehicles on site contribute to the evacuation traffic. Therefore, if Nepean Business Park can accommodate 2,532 additional evacuating vehicles, it can accommodate 4,220 vehicles on site. Furthermore, if say only 80% of the workforce drive a car to work, then there would be capacity to accommodate a workforce of 5,275 at Nepean Business Park.

5.2 Penrith North Sector Evacuation

As previously explained, Penrith North A subsector is one subsector in the Penrith North sector (see Figure 7 for the location of all the subsectors and their evacuation routes). It shares an evacuation route with the neighbouring Penrith North B subsector. Another subsector which also shares part of the same evacuation route is the Penrith North C subsector Figure 5. On the other hand, Cranebrook subsector includes Cranebrook village and Waterside and evacuates via Andrews Road onto The Northern Road. Finally, the Castlereagh subsector covers the whole of the Penrith Lakes Scheme and a handful of rural properties immediately to its north. This subsector would also evacuate via Andrews Road to The Northern Road.

The following subsections consider how the Penrith North A evacuation traffic would interact with the evacuation traffic from these other subsectors were it to be fully developed to a 3,300 evacuating vehicle capacity

5.2.1 Coreen Avenue

The evacuation modelling for the Nepean Business Park considered whether the evacuation traffic from Penrith North A subsector would be sharing evacuation routes with evacuation traffic from the other subsectors as the same time. Penrith North A and Penrith North B have the same evacuation trigger which is an earlier evacuation trigger than any of the other subsectors in the Penrith North Sector. However, Penrith North B is different to Penrith North A in that it has a generally rising evacuation route to high ground and its evacuation is only triggered because some low lying business may flood. Its evacuation can progress as the floodwaters rise. Coreen Avenue does get cut at the 20 hour time step at a low point about 200m east of Castlereagh Road and any premises west of that point must evacuate before that time. Therefore, for the purposes of the evacuation modelling, it was assumed that Penrith North B would not be given an early evacuation trigger but would simply get 6 hours warning to evacuate.

Subsector A on the other hand is a flood island which must evacuate before Boundary Creek cuts Castlereagh Road, its evacuation must be completed before that occurs. Therefore, traffic evacuating from Penrith North A can only use the road network for nine hours unless it has to queue

at a point of convergence with other evacuation traffic. Furthermore, if the delays for evacuation commencement and completion from the NSWSES TEM are taken into account, vehicles from Penrith North A would be occupying evacuation routes for a maximum of six hours at the assumed evacuation route capacity of 600 vehicles per lane per hour.

The residential areas of Penrith North B are east of the low point on Coreen Avenue and at a higher elevation and so their evacuation would be triggered at a later time. The ground elevation increases heading east until the subsector merges into Penrith North C which continues to rise to the east. It is expected that evacuation orders for parts of the residential areas of Penrith North B and C will be issued progressively as flood forecasts are revised upwards rather than unnecessarily evacuating people prematurely before it is known that their properties are likely to flood. Based on the data provided by INSW, a total of 1,779 residential vehicles were included in the model for these two subsectors.

Using the TEM, it is estimated that the travel time for the Penrith North B non-residential vehicles will be less than 1.5hrs and for all of the residential vehicles evacuating along Coreen Avenue it would be just under 3hrs. Figure 12 shows the relative timing of the evacuation of all three subsectors assuming full development of Penrith North A to its evacuation capacity and an evacuation trigger when 23.0m AHD is forecast at Penrith gauge.

As Figure 12 shows, the evacuation of some of the non-residential parts of Penrith North B may need to be delayed to ensure all of Penrith North A is evacuated but even if Penrith North B does not start evacuating until Penrith North A is isolated, there would be enough time for the whole subsector to evacuate before the low point in Coreen Avenue is flooded.

Similarly, all of the residential areas have sufficient time to fully evacuate before they are threatened by floodwaters. In the case of these areas which have continually rising evacuation routes there would be a choice to delay evacuation orders for the residential properties or issue them as soon as it is forecast dwellings may flood and allow traffic to queue on the evacuation routes when evacuation traffic merges with that from Penrith North B non-residential premises.

The application of the NSWSES TEM at this scale shows that there is sufficient time for the modelled vehicle numbers to evacuate before their evacuation routes are cut or they are overtaken by floodwaters.

5.2.2 The Northern Road

The evacuation traffic using Coreen Avenue would turn right onto Lemongrove Road, left onto Macquarie Avenue, over the railway line of the Evans Street Bridge, left onto Henry Street which merges into North Street and then High Street and then it would turn right onto The Northern Road and south towards the M4. This route is shown in Figure 13.

This route has a single lane until it reaches North Street where it widens to two lanes. Once the upgrade of The Northern Road is complete there will be three lanes from High Street heading south to the M4. North of the High Street intersection, The Northern Road narrows to two lanes southbound for a short section. Therefore, unless that section of road is widened to three lanes, there will be no more than two lanes of evacuation traffic coming from that direction. As the traffic coming from Coreen Avenue is only a single lane of traffic, Northern Road would have no capacity issues if traffic from Coreen Avenue is arriving at the same time as traffic from the other parts of Penrith North Sector as it would be three lanes of traffic merging onto three lanes of traffic on The Northern Road.

Where the congestion would occur is where The Northern Road enters the M4 as there is a single lane on ramp to head east. The relative timing of all of the subsectors in Penrith North sector is shown in Figure 14. Each colour in the graphic represents a different lane on The Northern Road.

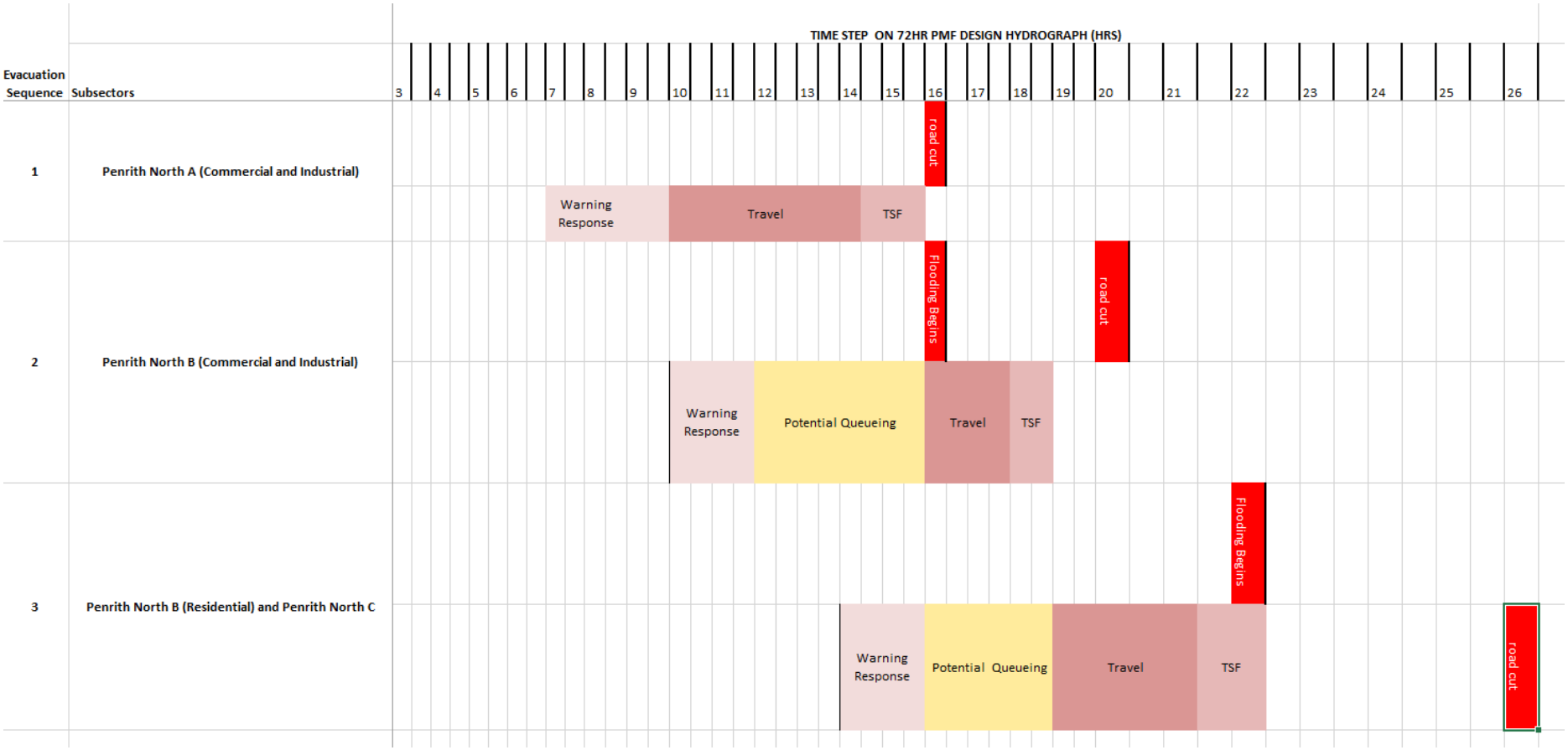

Figure 12: Evacuation Timing of Subsectors Using Coreen Avenue

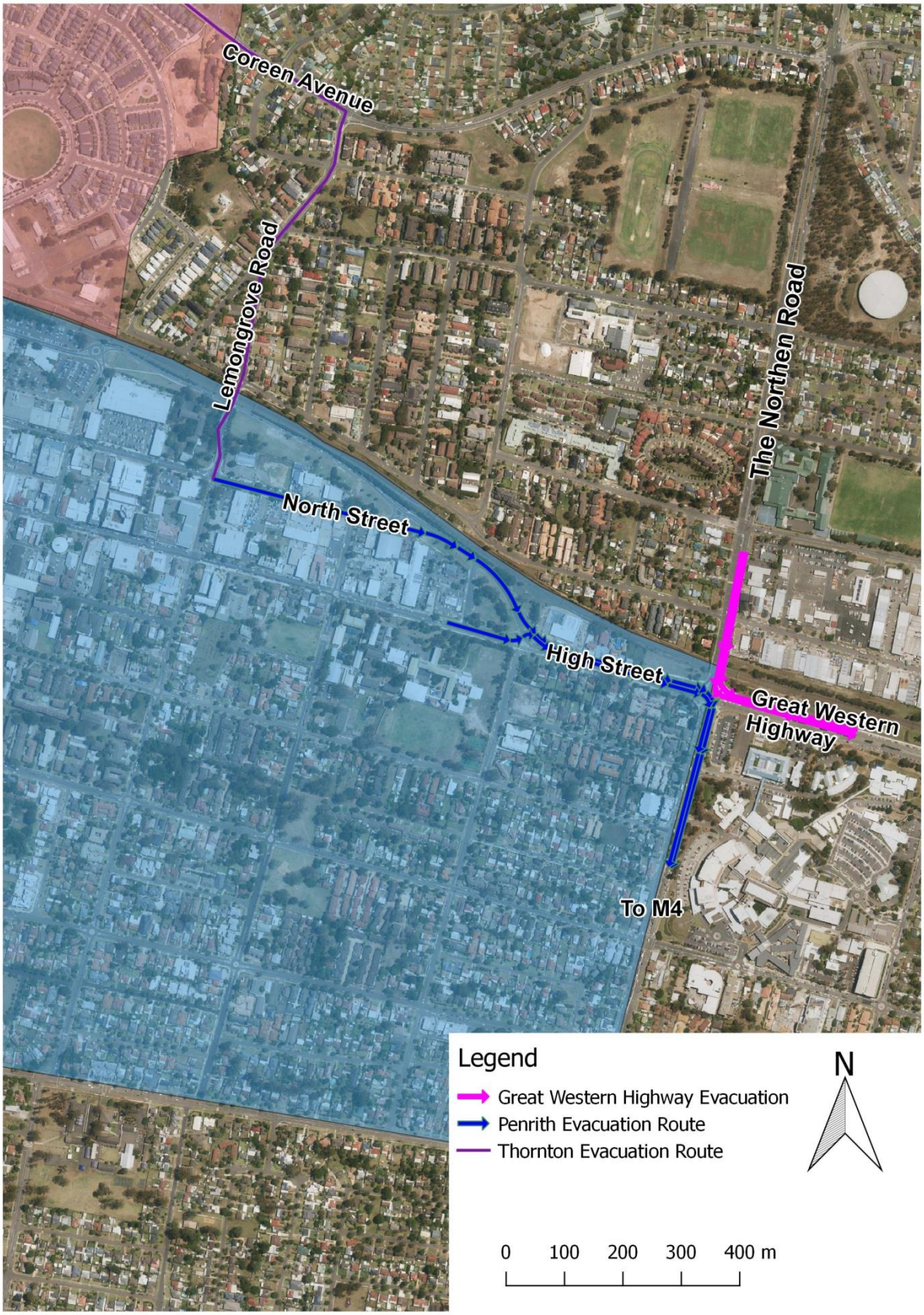

Figure 13: Route from Coreen Avenue to The Northern Road

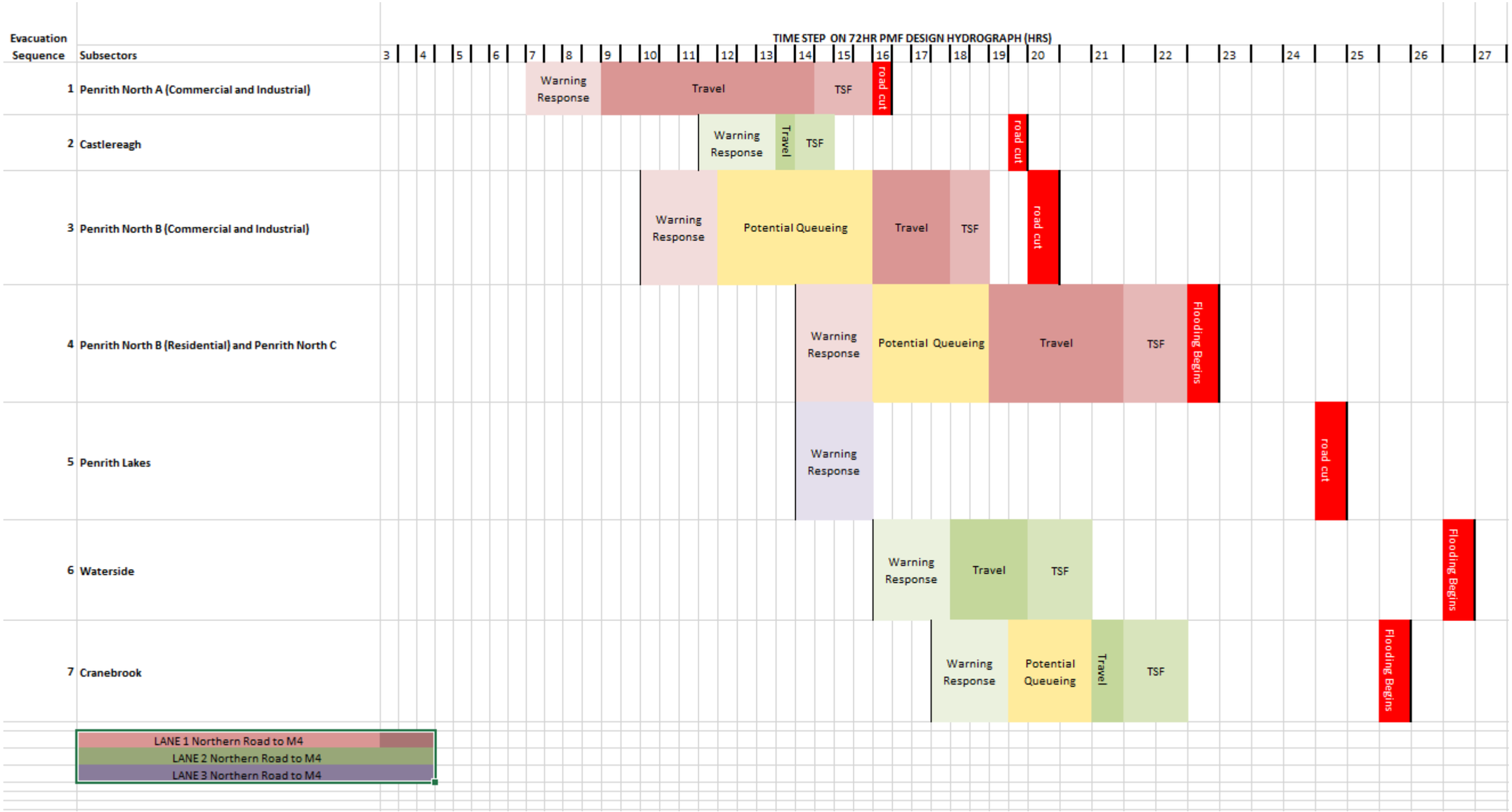

Figure 14: Evacuation Timing of Penrith North Subsectors

As explained previously, the evacuation of Penrith North A has to be completed before t=16 hours when Boundary Creek cuts Castlereagh Road. Figure 14 shows that only Penrith Lakes and Castlereagh have evacuation triggers earlier than that time step and, when the two-hour delay for evacuation commencement in the TEM is taken into account, Penrith Lakes traffic will not start using The Northern Road until after Penrith North A has finished evacuating (Figure 14). In the case of Castlereagh, Table 5 shows that there are only about 65 vehicles having to evacuate. If these vehicles had to queue while merging with Penrith North A traffic at the M4 the queue would be less than 400m long and would be able to be accommodated. If the capacity of the one lane on ramp is increased then there may be no queueing.

If Penrith North B traffic has to wait for Penrith North A to evacuate, this will increase the duration that Penrith North B and Penrith North C are using The Northern Road, and therefore the M4 on ramp, at the same time as other Penrith North evacuation traffic. However, even if the maximum four hours that Penrith North A could potentially use The Northern Road causes a flow on traffic queuing impact, that would amount to a maximum of 2,400 vehicles queueing. At a length of 6m per vehicle that would a queue length of 14,400 km in total but as The Northern Road is three lanes it would be about 4.8km long. The Northern Road between Andrews Road and the M4 is 6km long and therefore could accommodate this length of queueing above the PMF if required.

When the evacuation modelling for Nepean Business Park was being undertaken in 2018 the only development approved at Penrith Lakes was the existing recreational developments. For the purposes of the evacuation modelling, it was assumed that events at those venues would be cancelled when a flood watch was issued or a minor flood was forecast and they would either not be used or would have evacuated earlier than any of the existing urban development. As shown in Table 9 and Figure 14, future development at Penrith Lakes would not be using The Northern Road until Penrith North A had finished evacuating. The scale of development which can be evacuated from Penrith Lakes would depend on the nature of the development and any proposed road upgrades.

5.3 Penrith Floodplain Evacuation

The flooding which triggers evacuation of Penrith North sector may trigger evacuation of other sectors on the Penrith Floodplain. These include the Emu Plains sector which includes all flood prone areas west of the Nepean River and the Penrith Sector which includes those areas east of the river between the M4 and the Western Rail Line.

The Emu Plains sector evacuates onto the M4 and, because it only has a single on ramp onto the M4, it cannot take up more than a single lane of the M4's eastbound capacity. Similarly, the subsectors between the Nepean River and Mulgoa Road can evacuate via Mulgoa Road onto the M4. Here too there is only a single lane on ramp so this traffic will only take up a single lane of the M4 for flood evacuation. As the M4 has three eastbound lanes at The Northern Road, it was assumed in the modelling that one lane of the M4 would be available for evacuation traffic coming from The Northern Road and so Emu Plains and Mulgoa Road evacuation traffic were not included in the model.

There was one subsector west of Mulgoa Road which the model assumed would evacuate onto the M4. That was Peach Tree Creek West because it would evacuate onto the Great Western Highway and it might be easier to direct that traffic directly east. It could just as easily head south on Mulgoa Road to the M4. It makes little difference because it has to evacuate early to avoid having its evacuation route cut at Ladbury Avenue and commences evacuation much earlier than the other subsectors in the Penrith sector. While it will be evacuating at the same time as Penrith North A, it only has a few hundred vehicles and can complete its evacuation within 30 minutes. This can either be accommodated by a short queue on The Northern Road or the additional capacity of the on ramp.

The other Penrith subsectors which were assumed in the modelling to evacuate onto The Northern Road were Penrith subsector and those parts of Jamisontown East and Jamisontown South which are east of Mulgoa Road. These are all shown in Figure 15. As can be seen, each has several roads leading to The Northern Road. They all have rising road access as well as significant areas between the PMF extent and The Northern Road where vehicles can safely queue above the PMF. Their evacuation triggers are generally later than those in the Penrith North Sector and they would not be evacuating at the same time as Penrith North A.

Figure 16 shows the sequencing of the evacuation of these sectors at the same time as those from Penrith North. It indicates that there would be some queueing but this would not crease significant problems because these subsectors have:

- rising road access
- large areas which are only reached at the end of a PMF many hours after evacuation would triggers for their lower areas
- multiple roads out and extensive road networks above the PMF but west of The Northern Road in which vehicles can safely queue.

5.4 Hawkesbury Nepean Valley Evacuation

Flooding on the Nepean River which triggers evacuation on the Penrith Floodplain is likely to also trigger evacuation on the Hawkesbury Floodplain further downstream where the Nepean River becomes the Hawkesbury River at the Grose River junction. The Hawkesbury Nepean Flood Emergency Sub Plan (NSWSES, 2020) proposes that the whole of the Richmond and Richmond Lowlands sectors and the Agnes Banks South, Londonderry, Llandilo and Berkshire Park subsectors all evacuate south onto The Northern Road. It also proposes that some of the Windsor Sector and the Bligh Park and Windsor Downs subsectors evacuate onto The Northern Road. This effectively means that there are several streams of traffic all converging onto The Northern Road from the Hawkesbury.

Vehicles numbers supplied by INSW in 2016 suggest that in the order of 25,000 vehicles from the Hawkesbury may need to use The Northern Road for flood evacuation, more than half of these would be from Richmond alone. As the traffic from Richmond would be reaching The Northern Road on a single lane, the 13,900 vehicles from Richmond would be on the road for more than 23 hours at a rate of 600 vehicles per hour per lane. Applying the NSWSES TEM would add a total of two hours for the warning acceptance factor and the warning lag factor and 3.5 hours for the traffic safety factor. This sector is a low flood island so it must evacuate before its evacuation route is cut. This would mean this sector would need a warning time in excess of 28.5 hours. The Hawkesbury Nepean Flood Emergency Sub Plan indicates that a maximum of 15 hours warning time is available. That is insufficient warning time for the number of vehicles which needed to evacuate from Richmond in 2014 (about 9,000).

Whether these vehicles would be using The Northern Road at the same time as the evacuation traffic from Penrith would depend on the temporal and spatial distribution of rainfall in a particular flood. Any floodwaters at Penrith would flow down to the Hawkesbury but would take several hours to do so. Furthermore, the Grose River and South Creek contribute to Hawkesbury flooding and the relative timing of those flows could either add to the peak at Windsor or simply prolong it.

Figure 15: Evacuation Routes of Penrith Subsectors

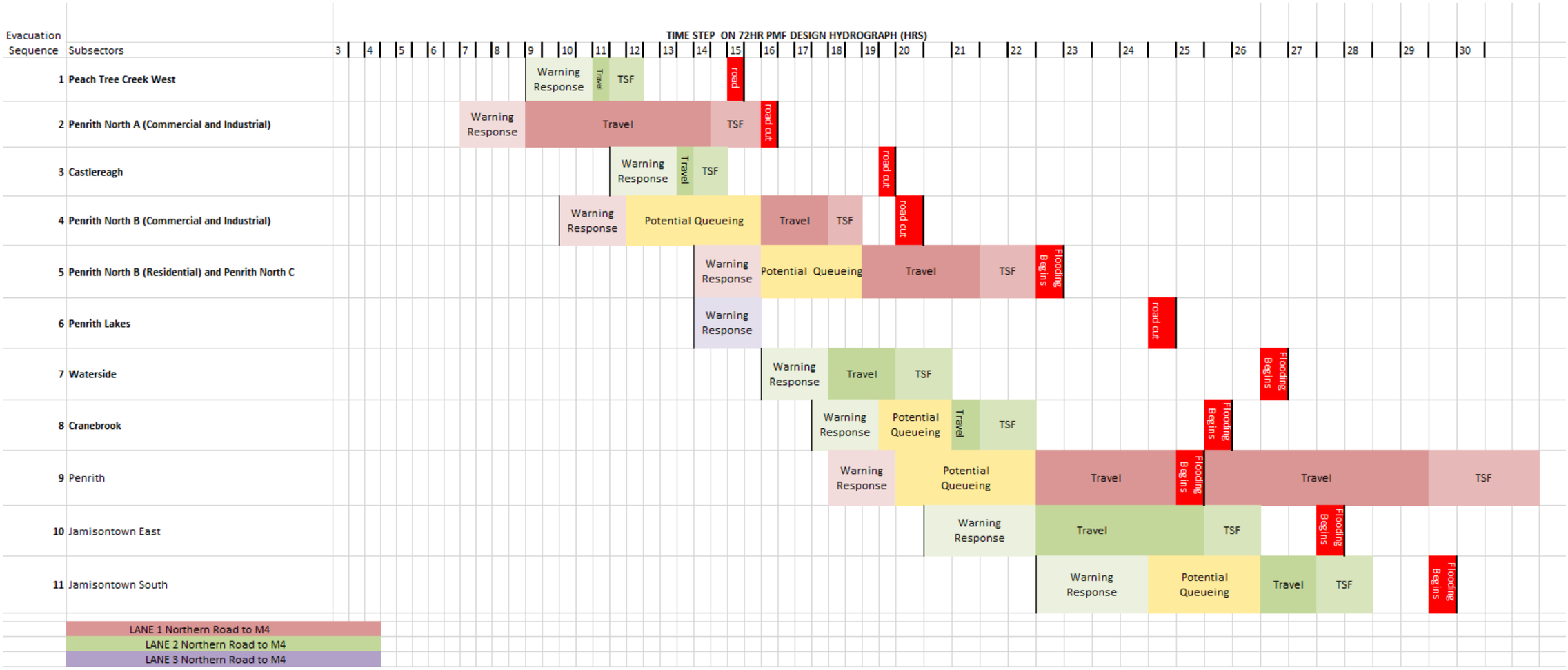

Figure 16: Evacuation Timing of Penrith North and Penrith Subsectors

Finally, a flood exceeding and event with a 1 in 50 chance per year would be needed to trigger significant evacuation from the Penrith floodplain while a flood with a peak closer to the 1 in 20 chance per year event would do the same in the Hawkesbury.

To be conservative, the modelling assumed that the first of the Hawkesbury evacuation traffic would arrive on The Northern Road at the same time as the first of the Penrith Traffic. However, the congestion which would be caused by this possibility was recognised by NSWSES and INSW and they advised that to minimise either Penrith traffic blocking evacuation of the Hawkesbury or Hawkesbury traffic blocking evacuation of Penrith, they were proposing to separate the two streams of traffic at The Northern Road and Great Western Highway intersection. The Hawkesbury traffic would turn east from The Northern Road onto the Great Western Highway while the Penrith Sector and Penrith North A, B and C subsector traffic would head south on The Northern Road. The separation of these traffic streams at this intersection is shown in Figure 13.

With this separation of the traffic streams, evacuation traffic from Penrith North A subsector traffic would have no impacts on evacuation of traffic from the Hawkesbury Floodplain because the traffic streams would never converge.

5.5 Sensitivity Testing

With any modelling it is appropriate to consider the sensitivity of the outputs to the model's assumptions and inputs.

It would be fair to say that most, but not all, of the assumptions used in the modelling, including those recommended by the NSW SES, are conservative and so the modelling results presented in this report present a worst case, extremely low probability scenario.

While it is important to understand the worst possible case when undertaking analyses with regard to loss of life, when evacuation consequences are inconvenient rather than fatal, more likely outcomes can be tolerated.

The following observations are made with regard to the sensitivity of the model outputs to changing key parameters.

(a) Flood Behaviour

It has been assumed that the flood at Penrith and the flood at Windsor will be rising as fast as a 72 hour PMF. While it is possible that floods smaller than a PMF could rise as quickly as a PMF, the assumed rate of rise is at the upper end of the scale with regard to rates of rise.

INSW has commissioned a Monte Carlo analysis of different temporal spatial rainfall distributions across the catchment which has generated 20,000 flood hydrographs. Figure 17 compares the time the Nepean River takes to rise from 18.1m AHD to 24.5m AHD at Penrith gauge for the 20,000 events and the 72 hour design PMF.

It is estimated that the design flood used in this evacuation modelling rises faster than more than 99% of the modelled events. Therefore, there is a very low probability that evacuation will be necessary in advance of a flood rising faster than the one used in the modelling.

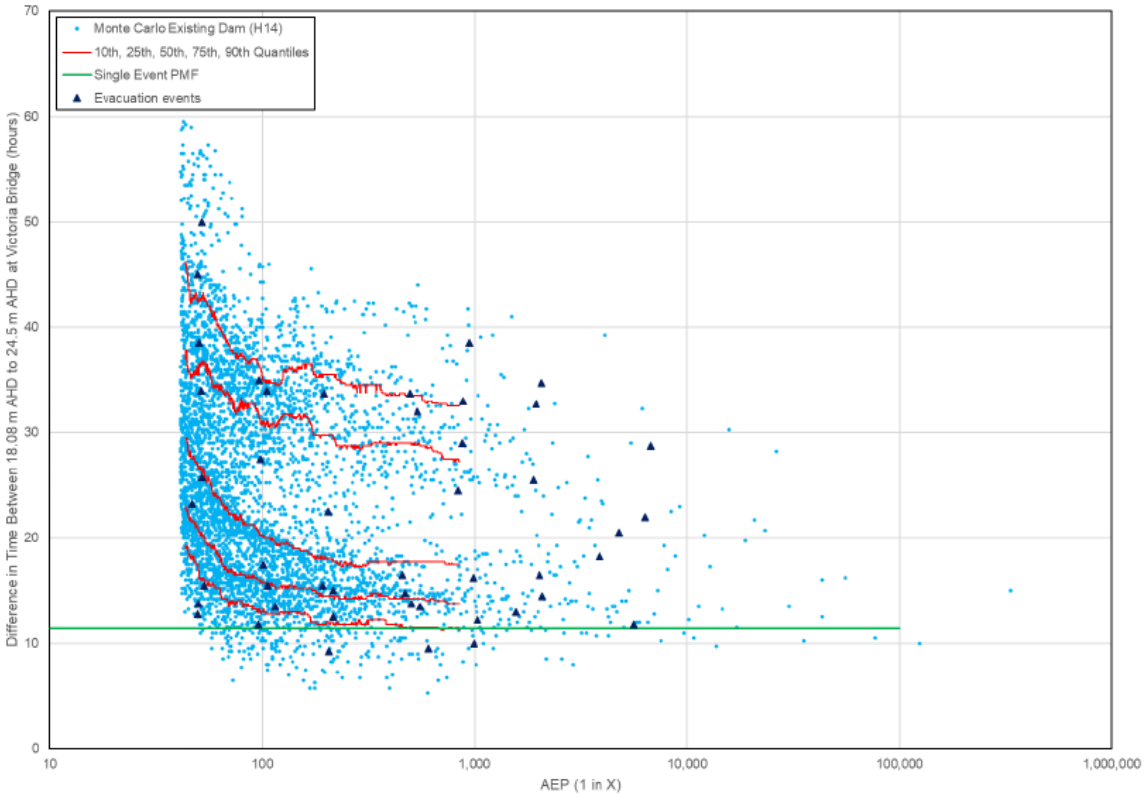

Figure 17: Comparison of 72 hour design PMF rate of rise with other events (source: WMAWater by email)

Furthermore, even if a faster rising flood were used in the evacuation modelling it would not make a significant difference to the outcomes for the following reasons:

a) The NSW SES publication *Provision of and Requirements for Flood Warning* states that the target warning lead time for the Penrith Gauge up to levels of 25.4m AHD is 6hrs. It defines the Target Warning Lead Time as the minimum lead time what will be provided before the height or the flood class level is exceeded. It makes no statements about this being dependent on the rate of rise of the flood because presumably it is dictated by the travel time of fallen rain and river flows from the upstream gauge locations to Penrith whereas the rate of rise is determined by the amount of rain which has fallen. Therefore, the warning time available to Penrith North A subsector is a minimum of 6hrs regardless of the rate of rise of the flood.

b) The rate of rise is only relevant to two aspects of the evacuation modelling:
   i. When a lower trigger level is selected to trigger evacuation then the benefit of this in terms of increased warning time will be less if the rate of rise is faster. For example, we have used a forecast level of 23.0m AHD instead of 24.4m AHD to trigger evacuation of Penrith North A. At the rate of rise which we have used this provides an extra three hours to evacuate. The fastest rising flood which the NSWSES has used in its own evacuation modelling takes about 9 hours to rise 6.5m compared to the 11 hours used in the modelling in this report. event. In the time taken to rise from 23.0m AHD to 24.4m AHD this would make about a 30 minute or 300 vehicle difference in the modelling.
   ii. It compresses the total time in which the evacuation of the whole floodplain takes place. This means that there is more overlap between the evacuation of successive subsectors, more queueing and therefore more potential for vehicles not to be able

to evacuate before being overtaken by floodwaters. However, the rates of rise in the graph are the rates up to 24.5m AHD. This is the trigger level for Penrith North B which is one of the first subsectors to evacuate. Evacuation of subsequent sectors is triggered at higher forecast flood levels. As the river rises it spreads out more and the rate of rise decreases. This is certainly seen in the hydrograph used in this report with the average rate of rise dropping from 0.5m/hr up to 24.5m AHD to less than 0.3m/hr by the time it exceeds 25m AHD. Therefore the difference in timing is likely to diminish in the phase of flooding when most evacuation is taking place.

Any slower rate of rise than that used in the modelling would provide more time for evacuees to depart and result in less risk of evacuees being trapped.

(b) Number of Premises Evacuating

The Taskforce or NSW SES have not revealed how they have estimated the number of premises that need to evacuate and out modelling has simply applied the vehicle numbers supplied. It is our understanding that the number of existing residential premises have been counted but for estimating future residential dwelling numbers it is possible that it has assumed infill development to the maximum extent permissible under existing zonings. This would mean duplexes and granny flats on every property which is of sufficient size and the construction of town houses on large blocks. This is likely to be a significant overestimate of the number of future dwellings if this is what has been done.

The 2016 Census indicates that dwellings in the floodplain had an average occupancy rate of about 90% on Census night. That means that when a flood occurs about 10% of the dwellings could be unoccupied and therefore not have to evacuate. If this discounting has not been applied then the modelling is overestimating the number of evacuating residential vehicles by about 10%.

The number of premises evacuating in the modelling is therefore likely to represent an upper limit.

(c) Number of Evacuating Vehicles

The numbers of vehicles per dwelling have been derived from Census data and while the number of vehicles per person has been increasing in Australia, the number of people per dwelling has been declining. It is therefore unlikely that the number of vehicles per dwelling would continue to increase substantially, particularly considering that Penrith, Windsor and Richmond are well serviced by public transport.

It is much harder to estimate the number of vehicles evacuating from business premises and the method used by INSW for estimating numbers has not been explained. However, it is now understood that INSW used Journey to Work Data released by the Transport Performance and Analytics (TPA), which is based on the 2011 Census of Population and Housing. It provides data at the Travel Zone geographical scale and includes data on the Origin Travel Zones (OTZ), Destination Travel Zones (DTZ) and mode of transport for every employee across NSW. Exactly how INSW used this data to assign non-residential vehicles to each subsector is still not clear.

On average, most business premises are unoccupied for more than 60% of the time so it is unlikely that all businesses and all dwellings will have to evacuate simultaneously. Furthermore, from the time that the first evacuation order is given to the time that the first evacuation order for the final subsector in Penrith is give is about 15 hours which is nearly two work shifts. It would be reasonable to assume that after the first 8 hours of a flood there would be no non-residential premises evacuating because they would have been told not to come to work when a mass evacuation is taking place.

Again, this supports the idea that the number of vehicles being used in the model is an upper bound number.

(d) Probability of Evacuation Numbers

It has also been assumed that a PMF will occur and therefore everyone will need to evacuate. A smaller flood peak will mean that fewer less people will need to be evacuated.

A forecast flood level as low as 15m would trigger evacuation of the whole of the Windsor and Bligh Park Sectors as well as low lying dwellings in the Richmond, Richmond Lowlands and Londonderry Sectors. This would have about a 1 in 40 AEP but should it become apparent, as the flooding develops, that a 1 in 100 AEP level will not be reached then the evacuation can be called off. Even then parts of the Londonderry Sector would not have to evacuate unless it were forecast that flooding would go even higher.

In other words, there is a about a 1 in 100 chance per year that as many as about 12,000 vehicles will have to evacuate from the northern sectors but less than a 1 in 1,000 chance per year that about 29,000 vehicles would need to evacuate.

In Penrith the probabilities of vehicles having to evacuate are even less, not only because larger floods are needed to trigger evacuation but there are also less areas which have their evacuation routes cut early in a flood and so areas can be evacuated gradually as flood forecasts are revised upwards.

Table 14: Probability of vehicles having to evacuate

Flood level probability (chance per year 1 in x)	**Flood Level at Penrith Gauge (m AHD)**	**Subsector**	**Evacuation trigger level at Penrith Gauge (m AHD)**	**Total Vehicles in Sector**	**Cumulative maximum vehicles evacuating**
20	23.5				
		Peach Tree Creek West	24	568	568
		Penrith North A	24.4	1,800*	2,368
		Penrith North B Commercial and Industrial	24.4	1,198	3,566
50	24.8				
		Castlereagh	25.5	163	3,729
100	25.9				
		Penrith North B Residential	26.2	3,663	7,392
200	26.5	Waterside	26.5	2,830	10,222
		Cranebrook	26.8	680	10,902
		Penrith	26.8	10,268	21,170
500	27.1				
		Jamisontown East	27.3	3,580	24,750
1,000	27.6				
		Jamisontown South	27.8	1,228	25,978
2,000	28.7				

Table 14 shows the probability of the various evacuation trigger levels being reached at Penrith Gauge for each of the subsectors in the Penrith and Penrith North sectors. It shows that in a 1 in 100 AEP flood less than 4,000 vehicles would need to evacuate. This would reach about 10,000 in a 1 in

200 AEP event because of the most recently approved developments of Waterside and Thornton having to evacuate. Close to a 1 in 500 AEP event would be needed before more than 12,000 vehicles would need to evacuate.

Although the table indicates that a 1 in 500 AEP flood would trigger the evacuation of Penrith Subsector, only the lowest lying parts would need to evacuate in such an event. The remainder of the 10,000 vehicles which need to evacuate from this sector would only need to do so if flooding continued to rise. The same would be the case with Jamisontown East and Jamisontown South with the last of the vehicles only having to evacuate from these three subsectors were a PMF forecast.

In the case of Bligh Park a flood with about a 1 in 200 AEP would need to be forecast for the whole sector to have to evacuate and for Richmond it would need to be forecast to reach about a 1 in 1,000 AEP flood level.

(e) Traffic Convergence

Not only would a 1 in 1,000 AEP event be needed for anywhere near the modelled number of vehicles to have to evacuate, but the relative timing of the evacuation of the two floodplains would have to coincide to create the maximum number of converging vehicles. It is understood that the Monte Carlo analysis may give some insight into the chance of that occurring but the results of that study were not available at the time of writing.

For all of the vehicles to use the road a PMF would be needed which has a probability approaching 1 in 100,000 chance per year. The probability of the worst possible coincident traffic convergence on The Northern Road during such an event would be something less probable than 1 in 100,000.

(f) Flood Warning Times

The warning times used to guide evacuation triggers in the model are the minimum times which the Bureau of Meteorology is willing commit to based on observed fallen rain and measured stream gauging. In a real event there may be longer warning times available, particularly if rainfall forecasts are taken into consideration.

(g) Warning Dissemination Time

The modelling assumes all houses are doorknocked to receive an evacuation order. It does not make any allowance for people receiving an evacuation order by electronic broadcast, direct contact from neighbours, friends or relatives, or by observing others evacuating nearby. While they may receive the message more quickly than assumed it is unlikely that the majority will receive it more slowly and so the capacity of evacuation routes is unlikely to be underutilised because of slower warning dissemination than assumed in the model.

(h) Departure Delays

The two hour delay between people receiving an evacuation order and actually leaving is a NSW SES recommendation. While post-flood surveys Molino Stewart has undertaken for the NSW and Victorian SES suggest that is about the right order of magnitude for people who evacuate, those same surveys suggest that the vast majority of residents do not evacuate at all when ordered to do so. Most would probably await the arrival of floodwaters at their doorstep before leaving and then it would be too late for vehicular evacuation and, for those who get isolated by floodwaters, too late for pedestrian evacuation.

Were this to occur in Richmond, Windsor and Bligh Park then hardly any traffic would arrive from these areas on The Northern Road. Were it to happen in Penrith, most people would be able to walk directly to higher ground with the exception of Peach Tree Creek West and Waterside. In either case it would result in considerable less evacuation traffic on the roads.

(i) Route Capacities

Free flowing roads have a capacity of 1,200 vehicles per hour per lane or more and on motorways it can approach 1,800. A rate of 600 vehicles per hour per lane is conservatively low and is the rate recommended for modelling the departure of vehicles from car parks. It is unlikely that the rate will be significantly less than this.

(j) All Traffic Heads East on M4

Not all evacuees will want to head east on the M4 and Great Western Highway. Some will be able to find temporary accommodation with friends or relatives in flood free areas off The Northern Road but above the reach of the PMF in suburbs such as Londonderry, Llandilo, Mount Pleasant, South Penrith, Jordan Springs, Cambridge Park, Werrington and Orchard Hills. Indeed, many who are evacuating from business premises may live in those suburbs. Likewise, many evacuees will be able to head west on the M4 because that is where they live or it is where they can readily find temporary accommodation with friends or relatives. In this regard the assumed number of vehicles converging on The Northern Road and the M4 is likely to be an overestimate.

6| Summary and Conclusions

This report set out the flooding and evacuation planning context of the Hawkesbury Nepean Valley and how that informed evacuation modelling of the proposed development and Nepean Business Park.

The evacuation modelling which was undertaken used:

- evacuating vehicle numbers provided by The Hawkesbury Nepean Valley Flood Management Taskforce
- evacuation timing assumptions as set out in the Hawkesbury Nepean Flood Emergency Sub Plan (NSW SES, 2020)
- flood warning times as published in the Provisions and Requirements for Flood Warning in New South Wales (NSW SES, 2019)
- evacuation sectors and routes as set out the Hawkesbury Nepean Flood Emergency Sub Plan (NSW SES, 2020) with some route modifications which are necessary to ensure that Richmond evacuation traffic does not prevent the timely evacuation of the Nepean floodplain under current conditions regardless of any development proposals for the subject site or its surrounds
- a 72hr PMF flood event which rises more quickly than 99% of floods
- the worst possible coincident arrival on The Northern Road of Hawkesbury and Nepean floodplain evacuation traffic

The modelling shows that:

- Richmond and other Hawkesbury evacuation traffic must be sent east on the Great Western Highway before it converges with traffic evacuating onto The Northern Road from the Nepean floodplain otherwise it will compromise the safe evacuation of existing Penrith development regardless of what development takes place at Nepean Business Park.
- these is sufficient road capacity for development to take place at Nepean Business Park and if evacuation is triggered when it is forecast that the Nepean River will reach 23.0m at Penrith then more than 2,500 vehicles could evacuate from the site in the time available and this would translate to even more vehicles on site when the origin of the vehicles is taken into consideration.
- there is sufficient road capacity for any queuing caused by the evacuation of Nepean Business Park to occur above the reach of floodwaters
- almost all of the modelling assumptions are very conservative and there is likely to be significantly more capacity to evacuate than the modelling suggests.

7 | References

Advisian, 2018 *Nepean River Flood Study – Final* Prepared for Penrith City Council

DECC, 2007

NSWSES, 2019, *Provisions and Requirements for Flood Warning in New South Wales Supplementary Document to the State Flood Plan v2.0* November, 2019

NSWSES, 2020 *Hawkesbury Nepean Flood Plan*

WMAWater, 2019 *Hawkesbury-Nepean Valley Regional Flood Study – Final Report* Prepared for Infrastructure NSW