

Ref: 16026.04\_160705\_IPD\_REP\_Dampier Drainage Design & Cost Estimate Report

08 July 2016

Mr. Arqum Hayat City of Karratha Welcome Road Karratha WA 6714

Dear Argum,

# DAMPIER DRAINAGE PRELIMINARY DESIGN AND COST ESTIMATE REPORT

The Dampier Stormwater Management Study (DSMS) was completed by GHD in 2015. In it a suite of recommendations was made to better manage the local flooding issues. Based on this report the City of Karratha has commissioned WISE/IPD to undertake preliminary designs for the open drain remediation, culvert upgrades and crossover reinstatements for the preparation of a detail cost estimate. The following presents the design philosophy and costings for the above scope of work.

#### 1. Design Philosophy

The Dampier Stormwater Management Study (DSMS) has made a number of assumptions to establish the hydraulic model. Among these are the typical geometries of the open drains, culvert sizes and locations as well as the identification of the unapproved rear accesses. The DSMS however did not report the assumed invert levels within the hydraulic model for both the open drains and the culverts. To overcome this lack of information we have adopted the control points at the various outfalls (that is the invert levels of the natural streams where the last culvert discharges into). From these points the open drains are graded upstream to establish the other invert levels.

As well as achieving the hydraulic capacities, the design approach also took into consideration the constructability and cost implications. Specifically, the design examined the efficiencies of the infrastructure assets. For example, the design has adopted reinforced concrete pipes (RCP) as the preferred culverts over the reinforced box culverts (RBC). This is due to the ease of constructing the DN600 pipes over its larger counterpart. In addition, the large number of units required would give this preference the economy of scale needed to achieve a lower unit cost. The commonly used DN600 is also more readily available and thus making it more price competitive.

#### 1.1 Open Drain Remediation

The DSMS has recommended a geometry of 1.5m deep drain with 15m top width. Whilst the 1.5m depth can generally be achieved, the top width were constrained by the drainage reserves itself. Where there is sufficient drainage reserve, a 15m top width has been provided for. Where the drainage reserve is constrained, the road reserve has been utilized to maximize the cross sectional area and thereby the drainage capacity. This approach of utilizing road reserves to convey major storm events is a commonly accepted approach under best practice.

The terrain within the catchment is generally steep thereby creating a potential for scouring and sediment transport. To minimize this effect, all drains have been designed with a longitudinal grade of 2% or less. Where the open drain bends significantly, rock pitching have been placed at the bends to again minimize the effects of scouring.

#### 1.2 Culvert Upgrades

In comparing the RPC and RBC it was noted that almost 90% of the RPC is of a singular size (DN600). By adopting the RCP would therefore benefit from economy of scale as well as being able to achieve a higher degree of efficiencies (repeatable work). Additionally, the design attempts to minimize the depth of installation in order to avoid the extent of rock excavation. This will not only reduce the amount of work required (excavation) but also the cost (excavation and removal of rocks). On this basis the minimum cover for Class 4 RCP culverts has be established to be 400mm.

The culverts have been graded to match the upstream and downstream invert levels of the open drain where possible. Instances where this is not possible the open drain will need to be regraded locally to match.

Headwalls at both the up and downstream ends are to be install and rock pitching is to be extended 2m from the concrete apron to prevent scouring.

#### 1.3 Crossover Reinstatement

Two crossover improvement options were assessed. Whilst cost is an important criteria ongoing maintenance and minimizing flow impediments to the open drain also formed part of the consideration.

From a cost perspective the culvert option will require 2 x DN600 or more for approximately 65% of the crossovers. The cost for the culvert installation alone has been assessed to be approximately 40% higher than the floodway option. This is considered cost prohibitive due to the number of crossovers involved.

It is understood that the open drain has been modelled both in terms of its flow as well as its storage capacity. The culvert option would not only impede flows but also reduces the available storage volume. Adopting the culvert option would therefore change the intent of the open drain's function.

From a maintenance perspective, less efforts are required to maintain floodway crossovers than those of culvert crossovers. Debris washed down from upstream could cause blockages to the crossover culverts, thus resulting in localized flooding. In addition, the batters from the rear accesses is likely to be eroded over time which would require periodic reinstatement.

For the above reasons it is proposed that all crossovers be reinstated using the floodway option.

#### 2. Cost Estimate

#### 2.1 Construction Sequence

The cost estimate prepared under this report is based on a logical sequence of work. That is, we have assumed that the open drain remediation has been completed prior to culvert upgrades. Once these two activities have been completed the crossover reinstatements can be carried out. This approach aims to reduce the amount work required and thereby achieving a high level of cost efficiencies.

#### 2.2 Assumptions

The construction rates prepared under this cost estimate is based on a number of assumptions. These are as follows:

#### Preliminaries:

- The preliminaries associated with typical contract of \$2M or more is between 8% to 10% of the total cost. However, as we anticipate the Dampier drainage remediation to be undertaken as a multi-stage contract, we have increased the preliminaries to 12.5% to reflect the smaller value.
- Preliminaries as a minimum includes:
  - Mobilisations and demobilisations of plants and resources
  - Establishing and maintaining site compounds and facilities
  - Prepare various management plans including OSH, traffic, environmental, noise, dust etc.
  - OHS compliance
  - Insurances
  - Survey and setout
  - Supervision
  - Security
  - BCITF levy

#### Open Drain Remediation:

- No geotechnical investigations were undertaken. GHD however noted that the soils up to 1.5m in depth are likely to be imported fill (sand). As such the cost estimate has assumed 10% of excavated material to be rock.
- Rocks from excavation and those at surface are to be stockpile and then replaced upon completion of re-grading the drain.
- Excavated material other than rocks can be distributed locally.
- Demolished pavements within the encroachment area are to be disposed off-site. Assumed disposal location is within 5km from site.
- Fencing and other structures (patios etc) removed within the encroachment area are to be stockpiled on the respective lot. No costs have been allocated to reinstall the fencing or structures.

#### Culvert Upgrade:

- Open trenching is used.
- Existing roads have been assumed to consisted of a 400mm pavement.
- Allowances for 500mm of rocks to be excavated within the length of trenches.
- Rocks from excavation are to be replaced within the re-graded open drain.
- Multiple twin-barrel headwalls will be cut and mortar joined on site to form four or more barrel headwalls.

#### Crossover Reinstatement:

- Concrete apron for the crossover only extends over the open drain. The remaining sections within the drainage and road reserves are to be constructed from compacted road gravel.
- For economy of scale it has been assumed that each crossover reinstatement contract will have a minimum of 25 crossovers.

#### 2.3 Bill of Ouantities

The bill of quantities has been prepared based on the preliminary design drawings and the assumptions stated above.

#### 2.4 Cost Estimate

The table below is a summary of the cost estimate prepared based on the preliminary design. It should be noted that the rates have been obtained from similar work within the region. These rates may change from the time of this report as a result of changing market conditions and the vagaries of tendering.

Item	Descriptions	Costs
1.0	Construction	
1.1	Preliminaries	603,000
1.2	Open Drain Remediations	2,713,000
1.3	Culvert Upgrades	1,485,000
1.4	Crossover Reinstatements	696,000
1.5	Provisionals	464,000
2.0 Fees and Charges		
2.1	Design & Contract Superintendance	269,000
2.2	Geotechnical Investigation	80,000
2.3	Surveying	65,000
3.0	Contingency	597,000
	Total	6,972,000

### 3. Remediation Program

The extent and severity of flooding reported in the DSDM of the varies from sub-catchment to sub-catchment. In term of the properties affected, sub-catchment 1a and 2 are most notable (refer to Plan 100). It is therefore recommended that these sub-catchments be prioritized ahead of others in the remediation programme.

Within the 2 priority sub-catchments, work should proceed in an orderly manner from downstream to upstream with open drains to be completed first, followed by culvert upgrades and crossover reinstatements.

On this basis it is envisaged that there are works 4 packages (sub-catchments) for the Dampier Drainage Remediation Programme.

#### 4. Recommendations

To complete the final detail design for construction purposes, it is recommended that the assumptions in GHD's hydraulic model be cross-checked. Specifically, the invert levels of the open drains as well as the culverts needs to be verified.

Additionally, in order to de-risk the extent of rock assumed in the costs estimate, a geotechnical investigation is recommended to quantify the volume undertaken as part of the final detail design.

We trust the above is satisfactory however please do not hesitate to contact the undersigned should you require any further information or clarification.

Yours sincerely,

Dan Luong

Principal

Infrastructure Planning & Development

IP&D Pty Ltd

### Appendix 1 - Bill of Quantities

### **DAMPIER DRAINAGE BILL OF QUANTITIES**

ITEM	DESCRIPTION	QTY	UNIT	RATE	COSTS
1	PRELIMINARIES	4,894,528	Item	12.5%	611,816
_	TREMINARIES	4,054,520	псш	12.570	011,810
2	OPEN DRAIN REMEDIATION				2,713,198
2.1	Strip and clear drainage corridor				2,713,130
	a) Remove, stockpile and replace rocks	14,789.6	m3	53.56	792,116
	b) Remove and disposed of existing hardstands and crossovers.	11,092.2	m3	43.93	487,325
	c) Remove and stockpile structure (fencing, carport, etc)	5,083.0	m2	26.50	134,699
2.2	Excavate and respread of insitu material	122,014.2	m3	8.25	1,006,617
2.3	Grade and shape open drain	101,659.5	m2	1.93	195,695
2.4	Proof roll site	101,659.5	m2	0.45	45,747
2.5	Quality Assurance as specified, including				,.
	a) Dilapidation survey	5.0	day	3,500.00	17,500
	a) Compaction testing	1.0	item	8,000.00	8,000
	c) Final inspection	1.0	item	3,000.00	3,000
	d) As constructed survey and documentation.	1.0	item	22,500.00	22,500
				,	,
3	CULVERT UPGRADE				1,485,229
3.1	Removal of existing pavement	280.3	m3	43.93	12,315
3.2	Excavation and backfill to depths shown;				
	a) 0-2m	1,414.4	m	128.47	181,707
	a) Extra over for excavating in rock	851.3	m3	53.56	45,595
	a) Replace rock in open channels	851.3	m3	63.90	54,402
	b) Import sand for bedding	851.3	m3	89.90	76,535
	Extra over for excavating in existing road reserve	279.6	m	290.71	81,282
3.3	Remove existing drainage	865.8	m	171.72	148,676
3.4	Supply and lay Class 4 RCP pipework				
	a) DN450	115.7	m	305.84	35,386
	b) DN600	1,248.3	m	306.97	383,186
	b) DN1050	50.4	m	674.72	34,006
3.5	Supply and install culvert hadwalls				
	a) 1 x barrel	24.0	ea	2,025.00	48,600
	b) 2 x barrel	34.0	ea	3,075.00	104,550
	c) 4 x barrel	8.0	ea	6,765.00	54,120
	d) 7 x barrel	2.0	ea	13,530.00	27,060
3.6	Reinstate asphaltic pavement	622.9	m2	118.84	74,022
3.7	Reinstate concrete kerbing	51.3	m	61.61	3,161
3.8	Reinstate 2m wide footpaths	51.3	m	265.65	13,628
3.9	Remove and reinstate existing driveway/carport				
	a) Culvert 61	1.0	item	25,000.00	25,000
	b) Culvert 336	1.0	item	70,000.00	70,000
3.1	Quality Assurance as specified, including				
	a) Final inspection	1.0	item	2,500.00	2,500
	b) As constructed survey and documentation.	1.0	item	9,500.00	9,500
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4	CROSSOVER REINSTATEMENT  Trim betters to tip in with desirage corridor	2 240 5		0.40	696,101
4.1	Trim batters to tie-in with drainage corridor	2,219.5	m2	8.18	18,156
4.2	Construct floodway crossover	2 240 5	2	46.04	27 505
	a) Construct 100mm compacted gravel within road reserve	2,219.5	m2	16.94	37,595
	b) Construct 100mm unreinforced concrete (32MPa)	5,178.9	m2	120.75	625,350
4.3	Quality Assurance as specified, including	1.0	:4	2 500 00	2 500
	a) Final inspection	1.0	item	2,500.00	2,500
	b) As constructed survey and documentation.	1.0	item	12,500.00	12,500
Е	PROVISIONALS				464.077
5 5.1	Traffic Management	18.0	woole	11,639.34	464,077
5.1		18.0 500.0	weeks	11,639.34 53.56	209,508
	Extra over for excavating in rock		m3		26,780
5.3	Replace rock in open channels	500.0	m3	63.90	31,952
5.4	Remove and disposed of existing hardstands and crossovers.	250.0	m2	43.93	10,984
5.5 5.6	Demolish and stockpile structure (fencing, carport, etc)  Dust management	250.0 28.0	m2	26.50 4.579.61	6,625
5.7	Works directed by superintendent	1.0	weeks	4,579.61 50,000.00	128,229 50,000
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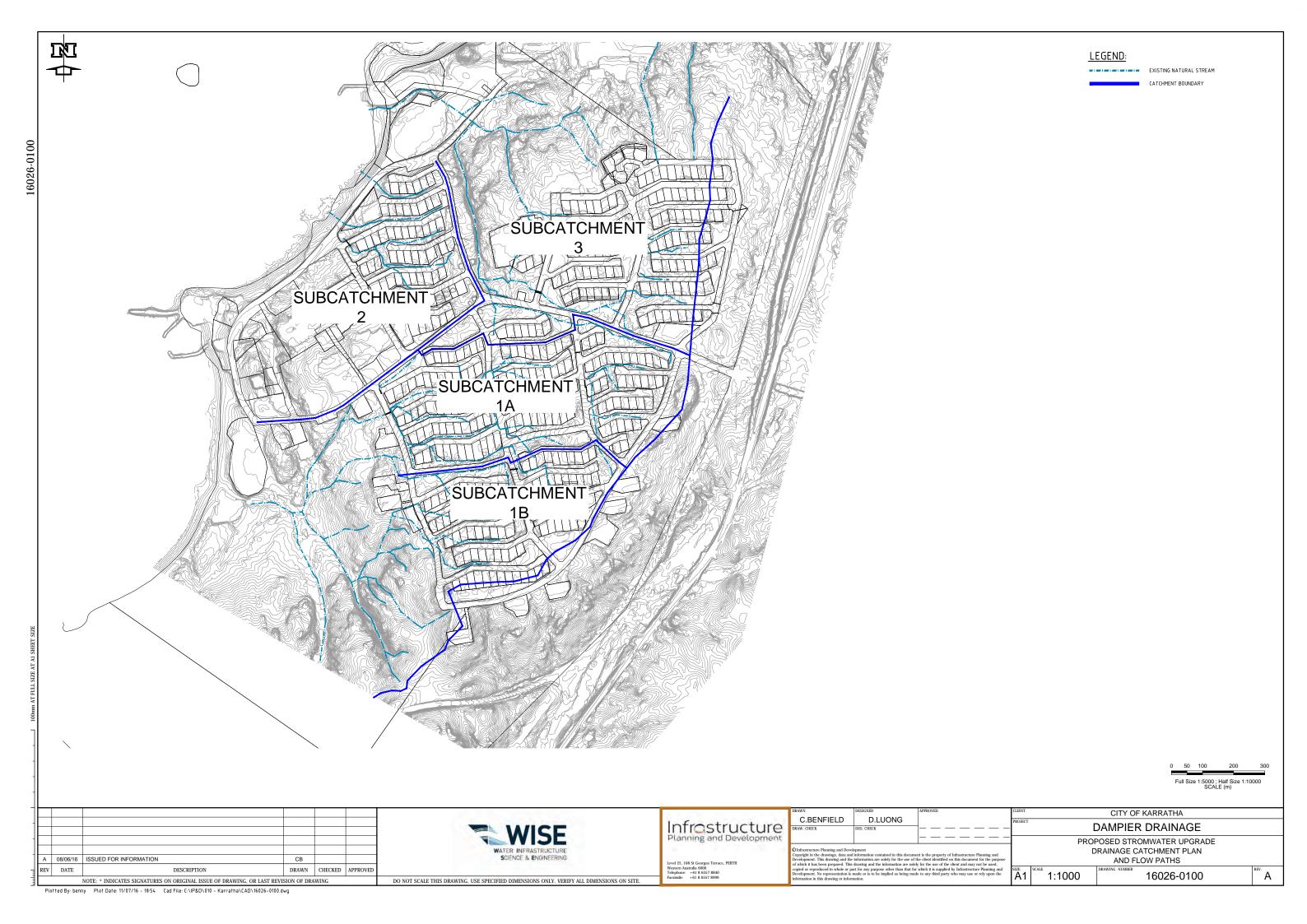
### Appendix 2 - Preliminary Design

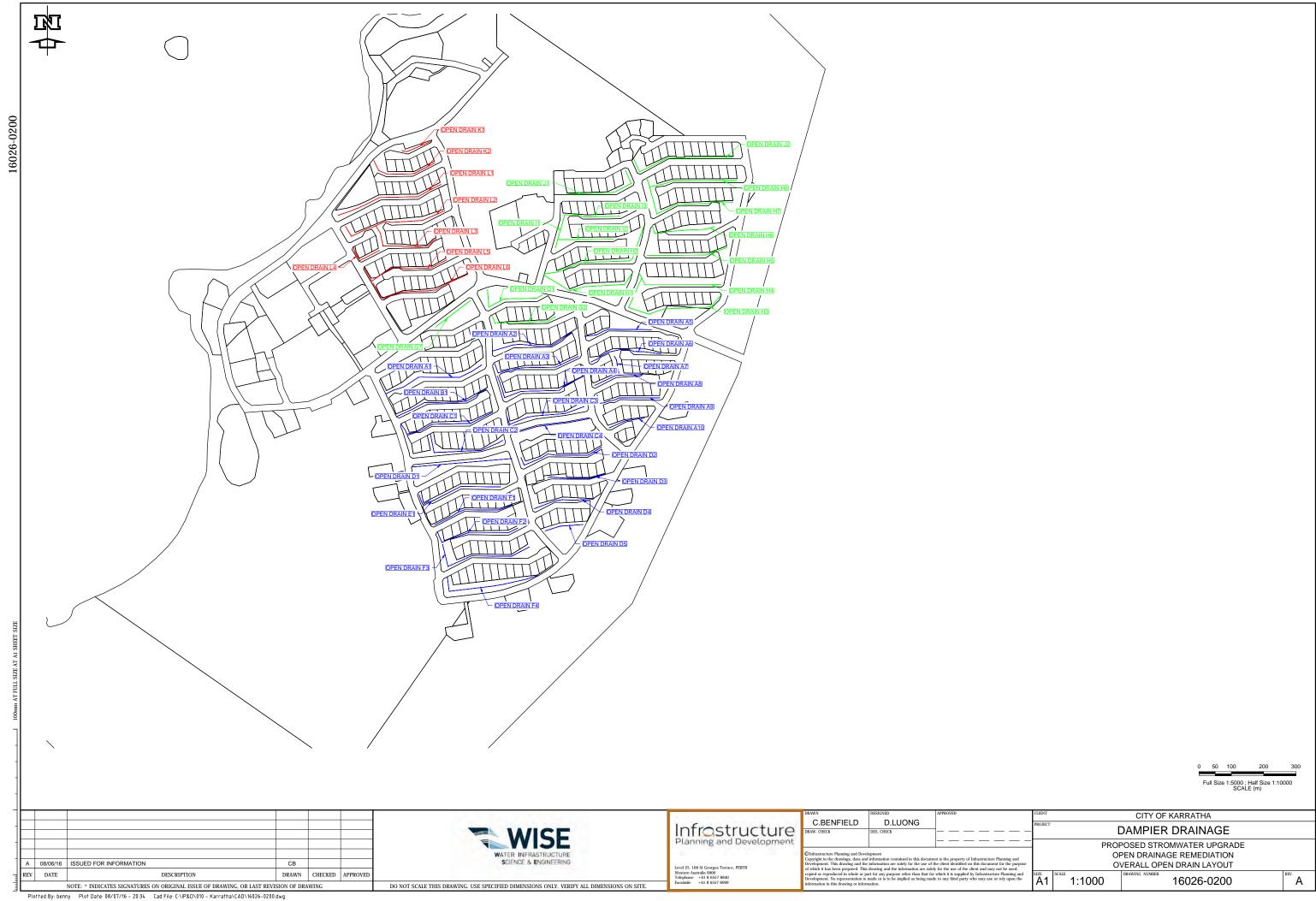
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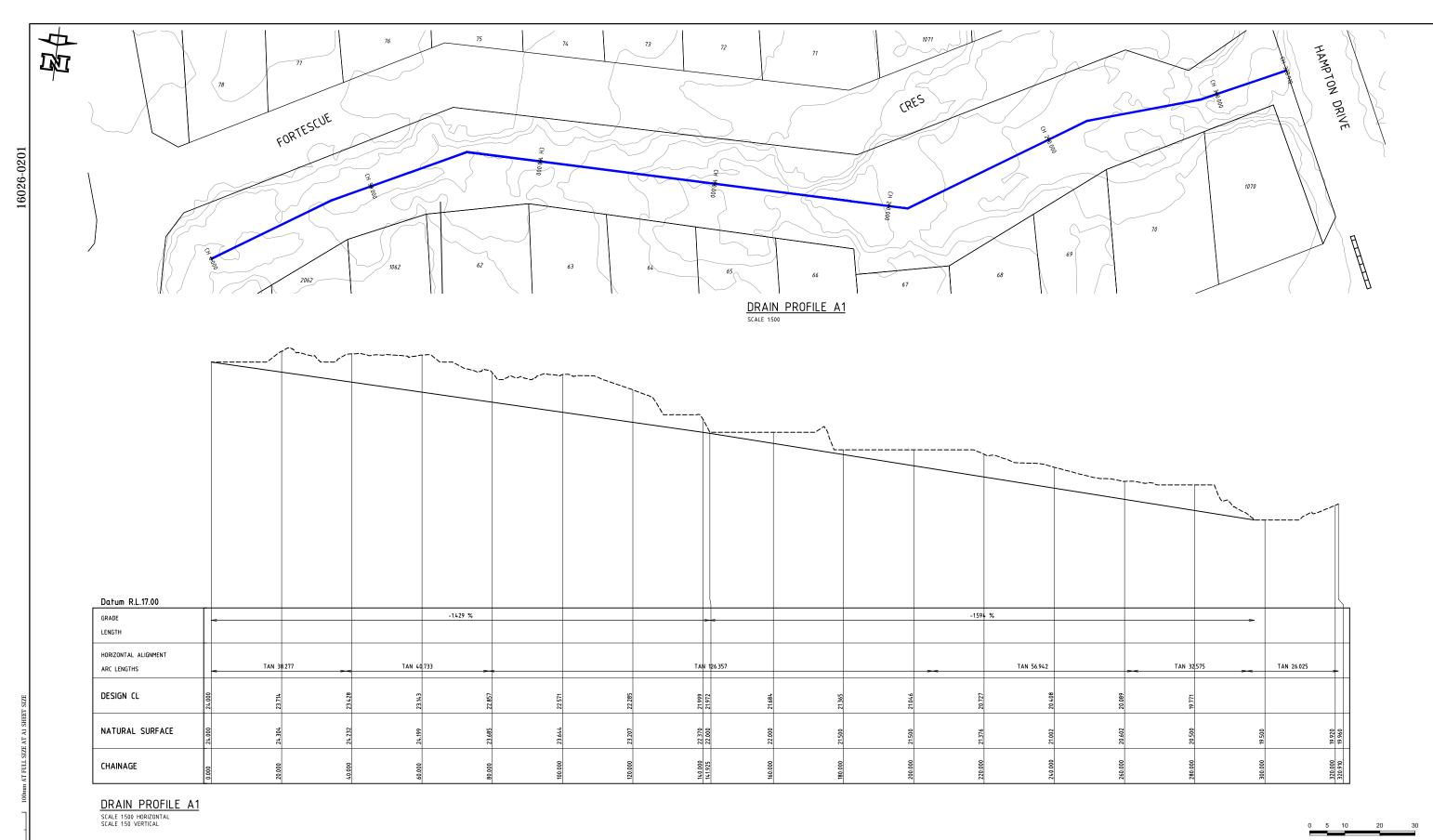
Plans 200 – 299 Open Drain Remediation

Plans 300 – 310 Culvert Upgrade

Plans 400 – 405 Crossover Reinstatement







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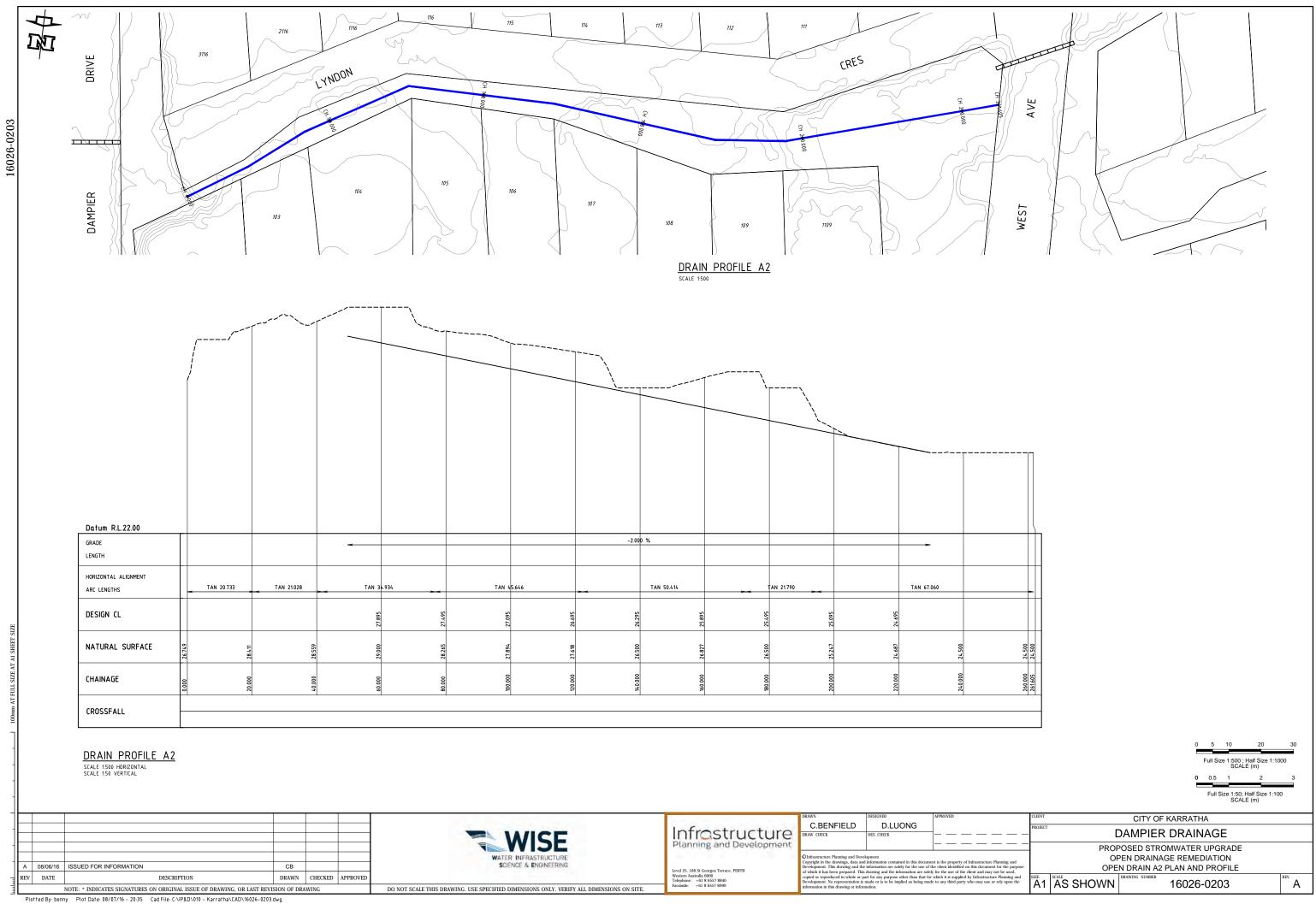
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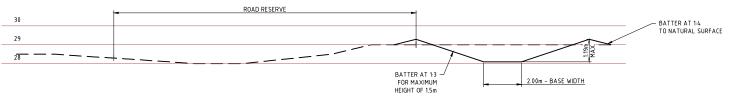
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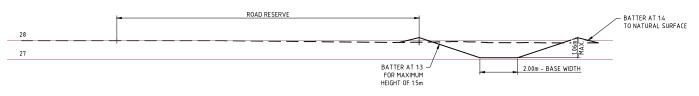
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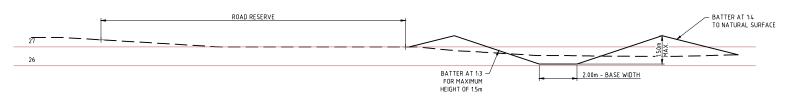




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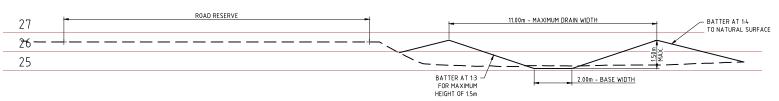


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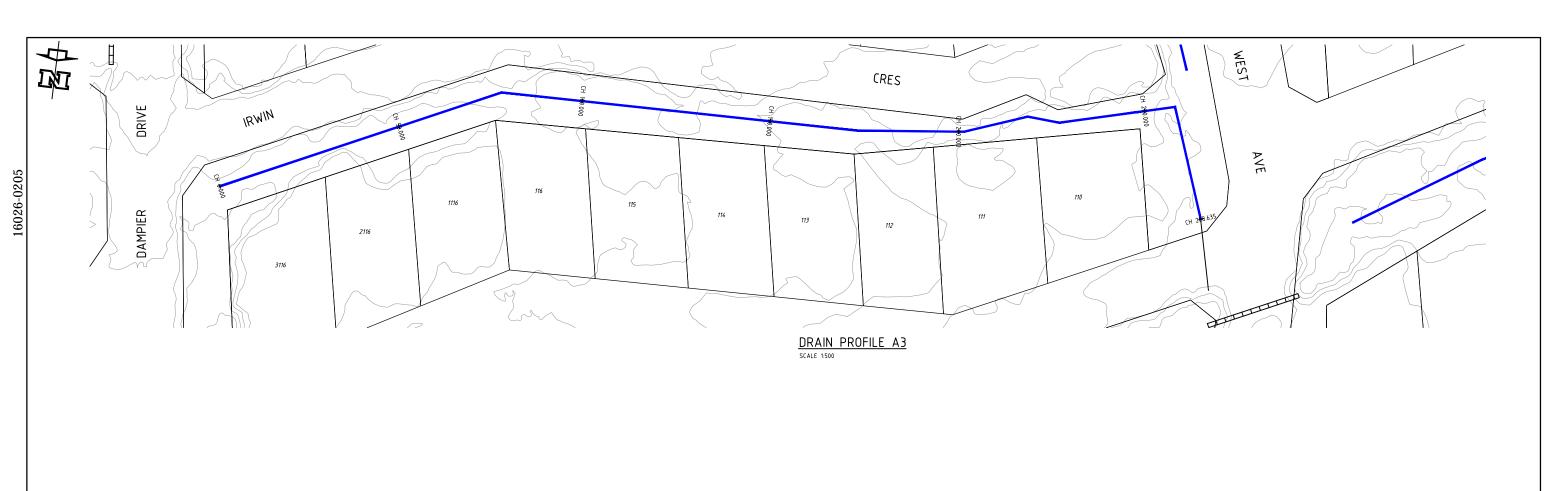
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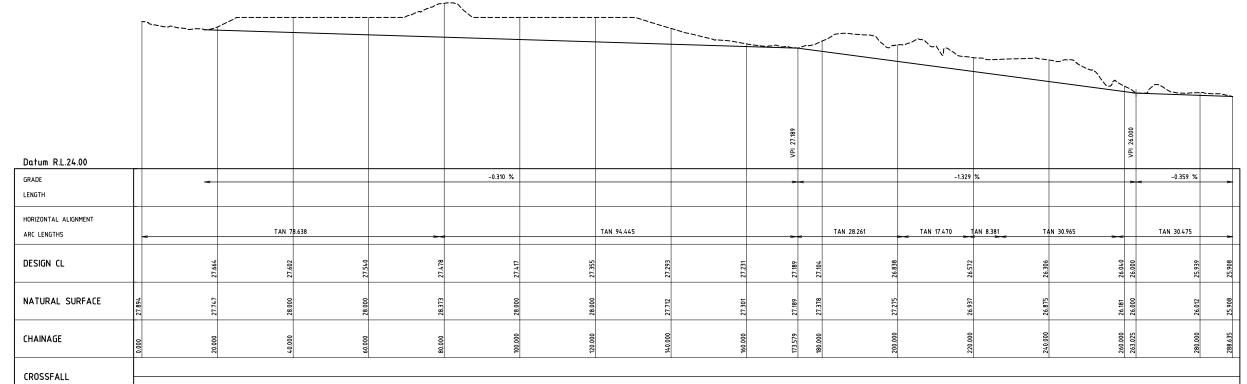
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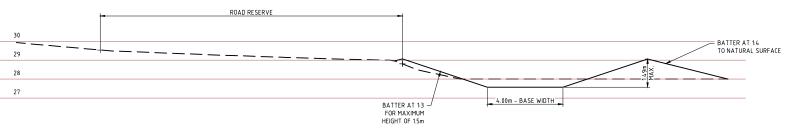
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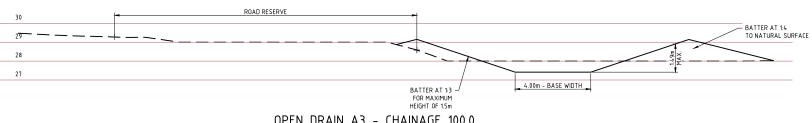
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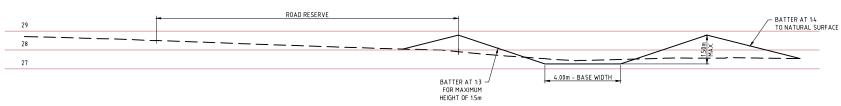
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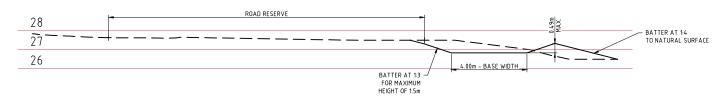
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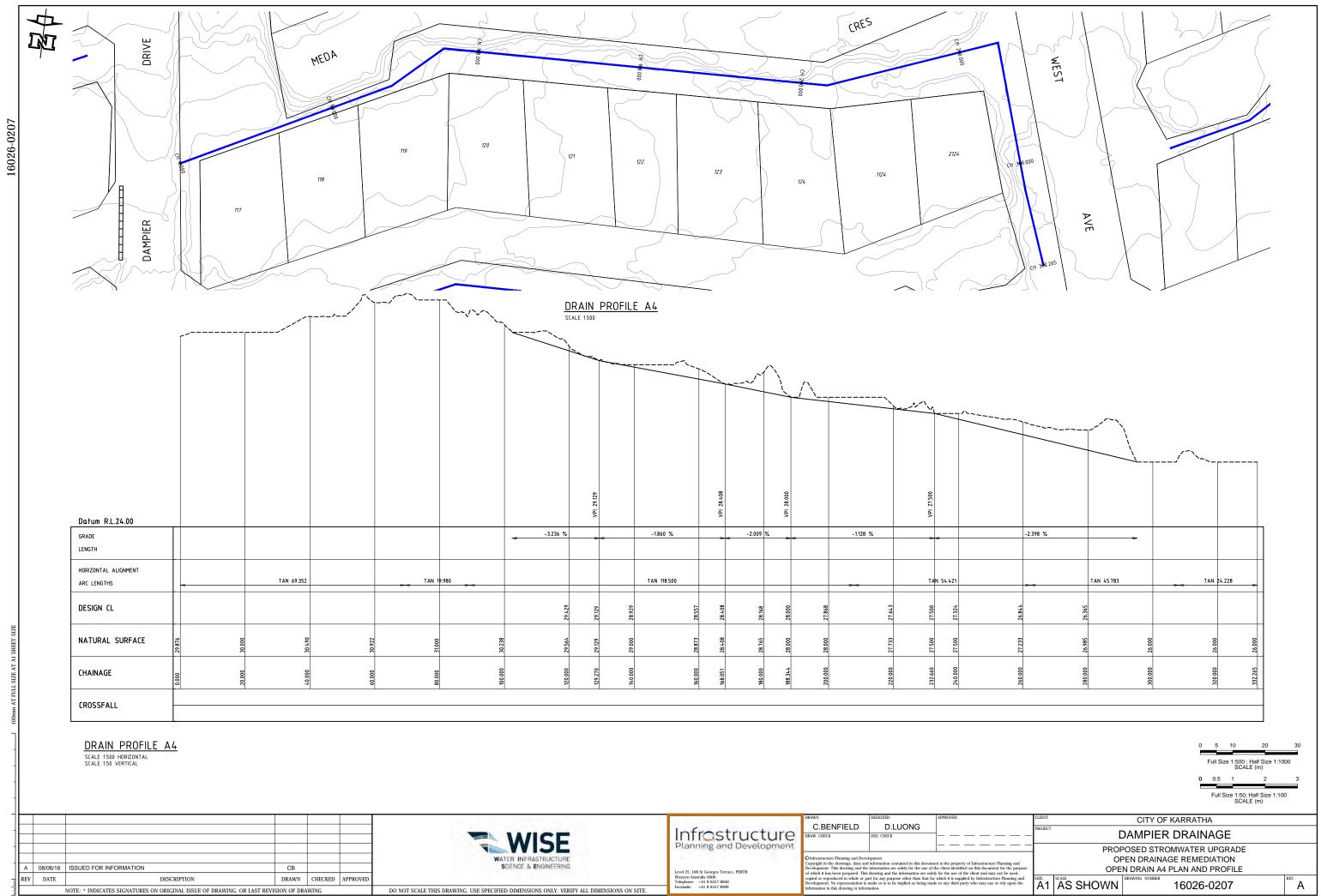
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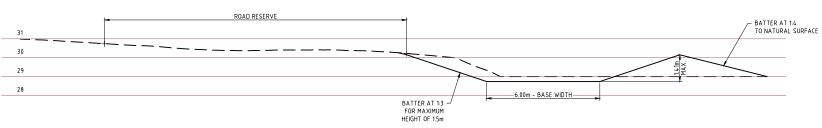


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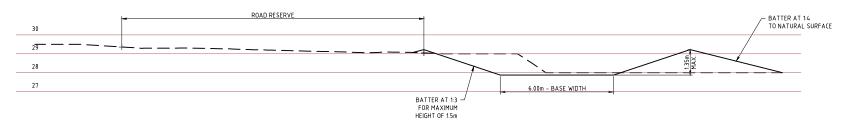


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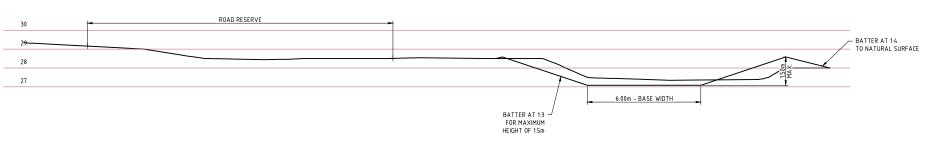




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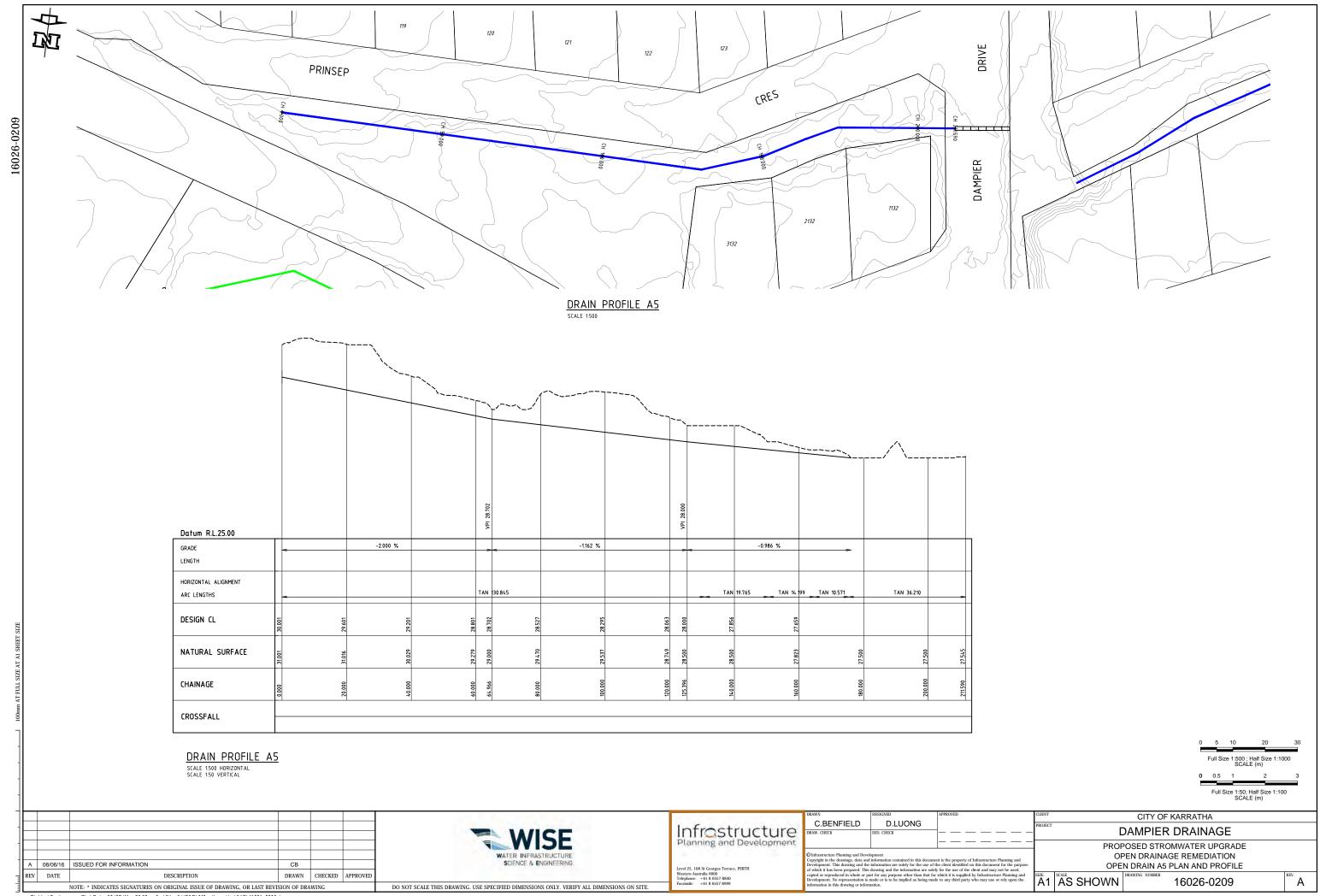


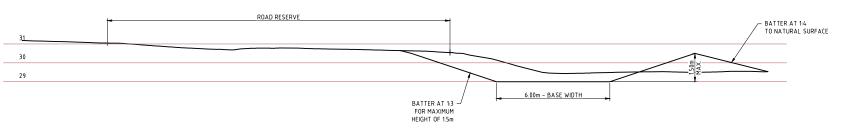
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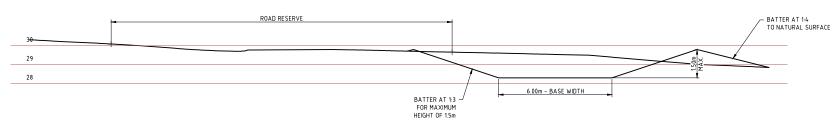
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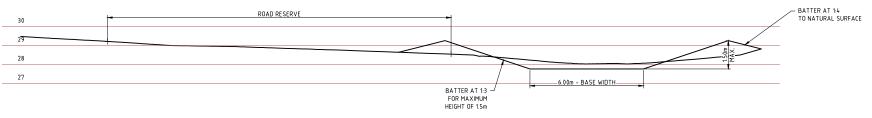




# OPEN DRAIN A5 CHAINAGE 50.0 SCALE 1:100



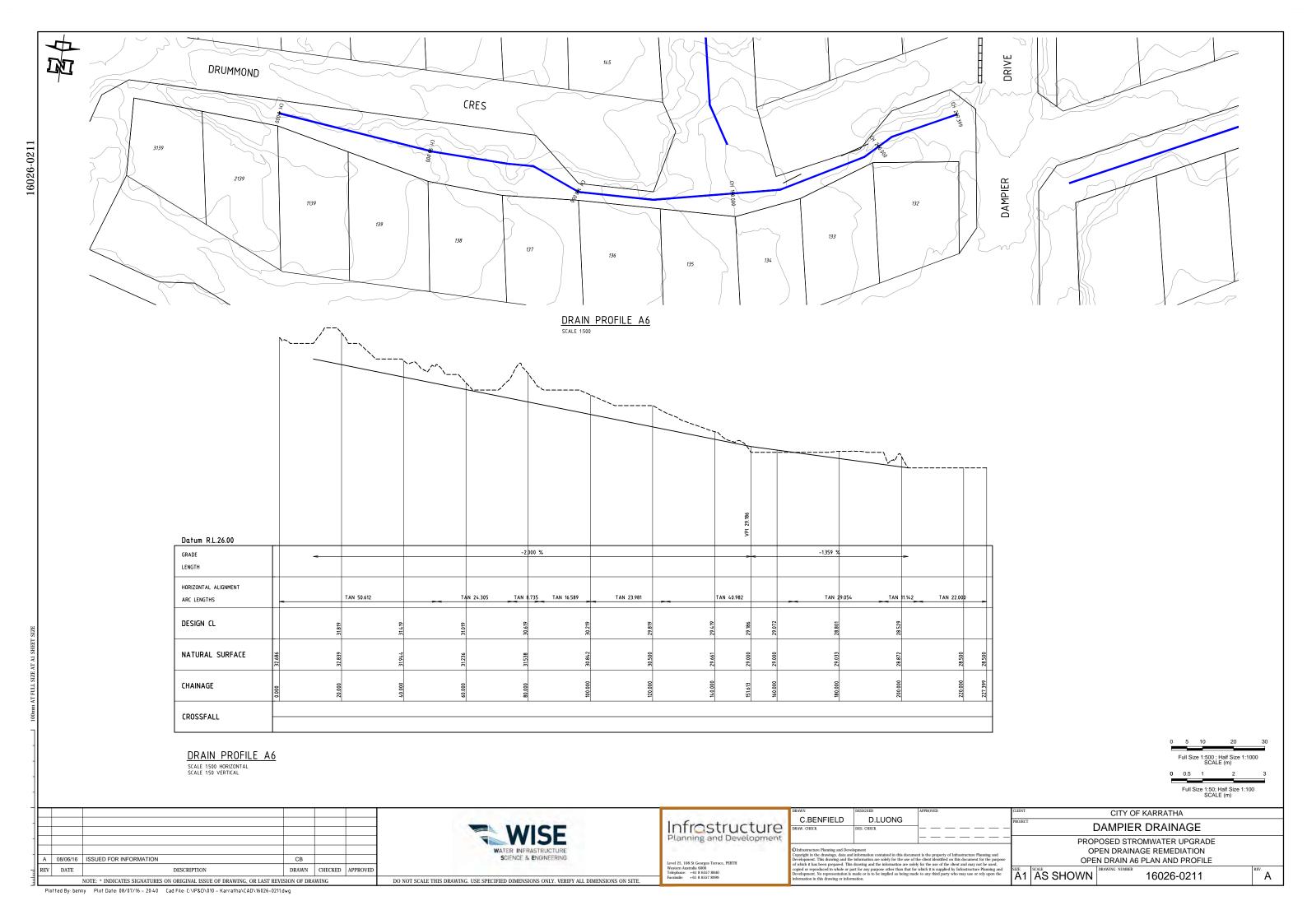
# OPEN DRAIN A5 CHAINAGE 100.0 SCALE 1:100

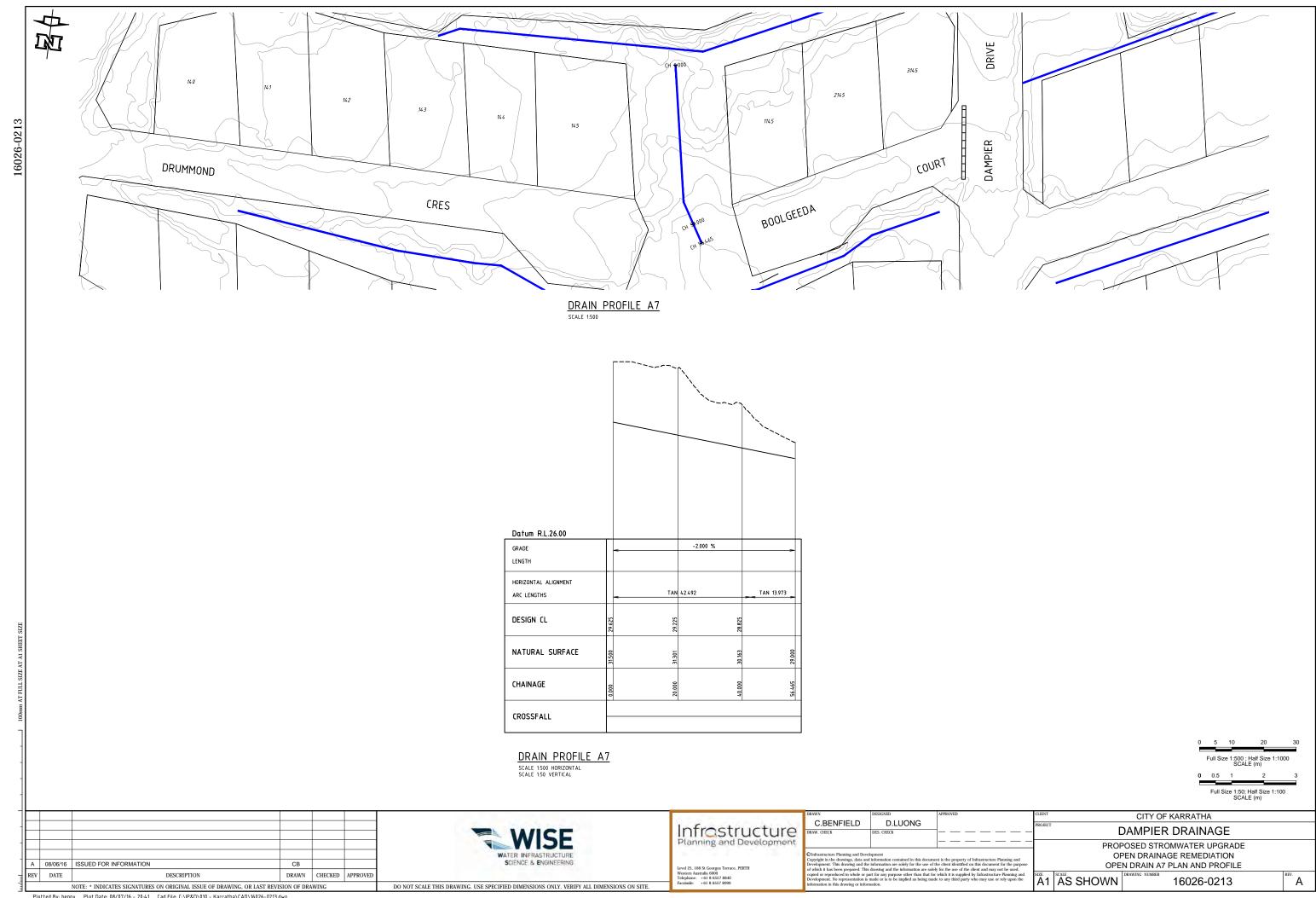


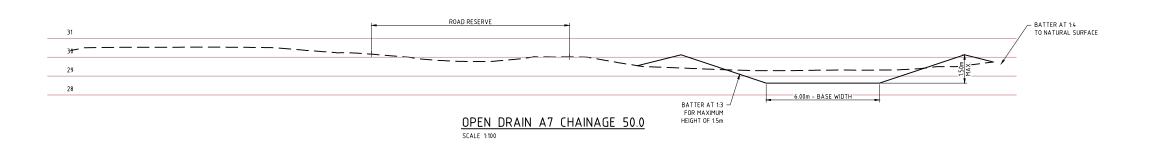
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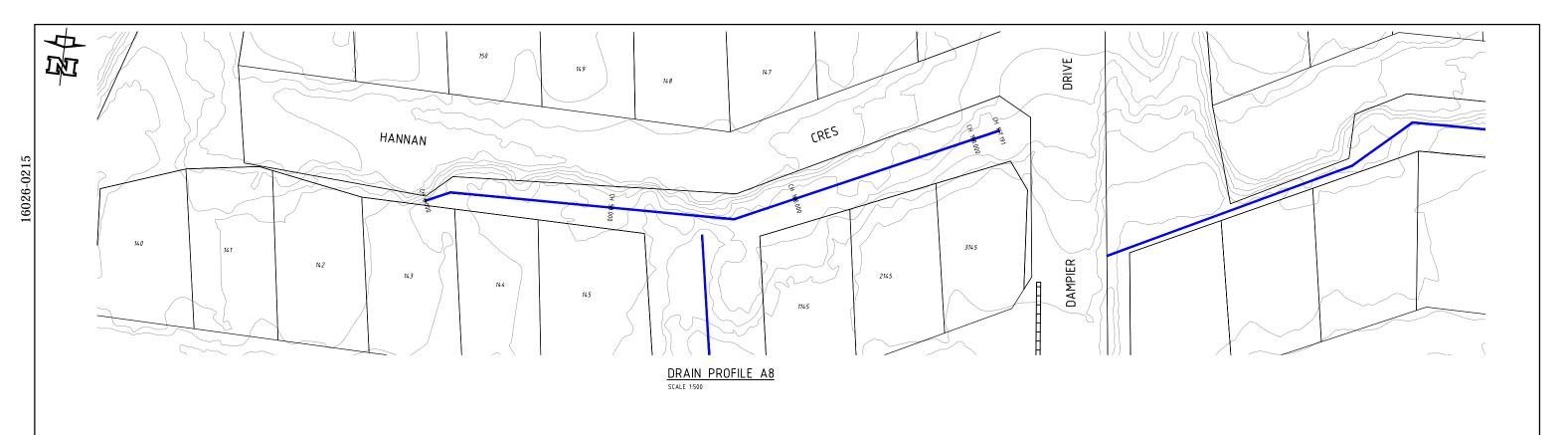


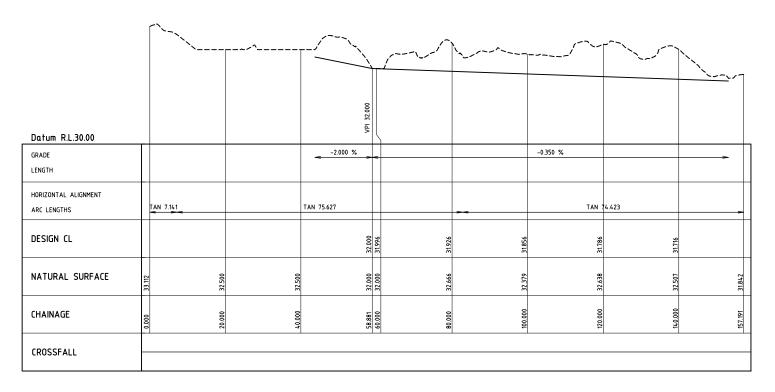




Full Size 1:100; Half Size 1:200 SCALE (m)







### DRAIN PROFILE A8

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL Full Size 1:500; Half Size 1:1000 SCALE (m)

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Full Size 1:50; Half Size 1:100 SCALE (m)

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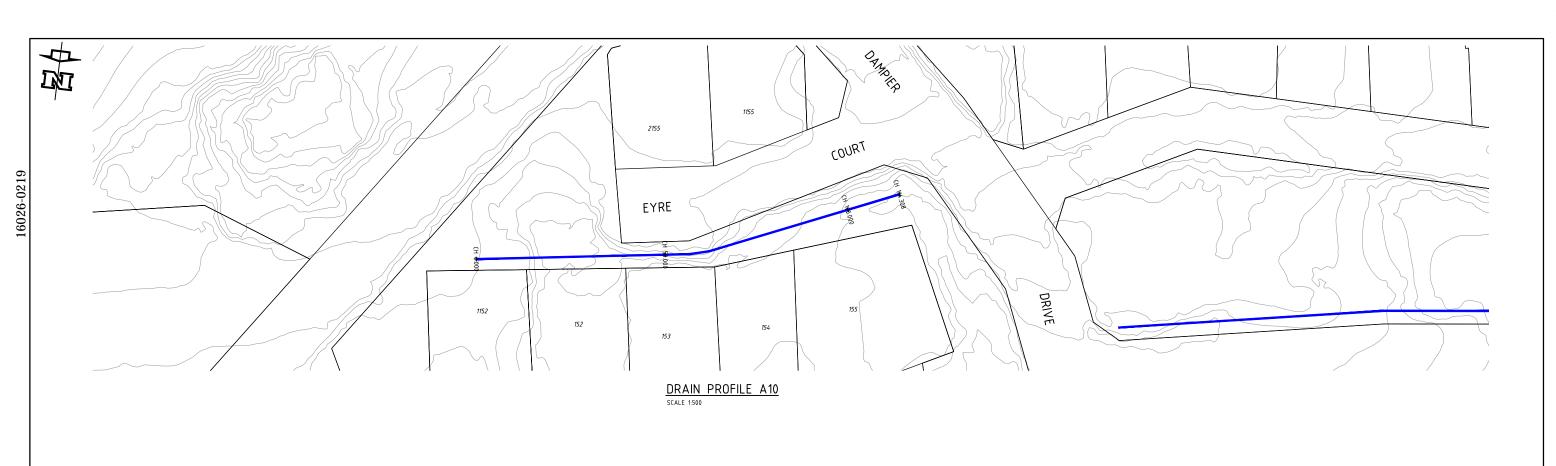
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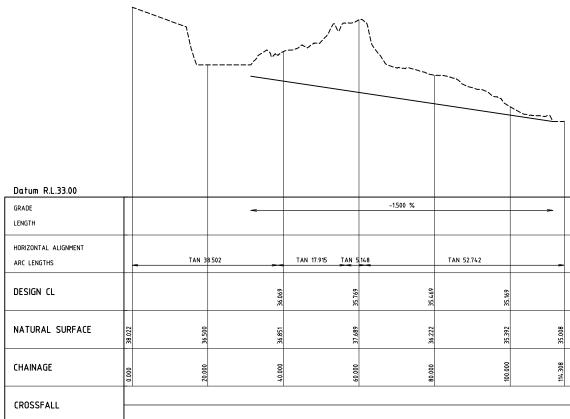
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### DRAIN PROFILE A10

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

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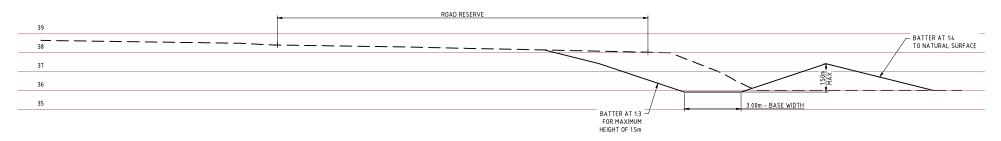


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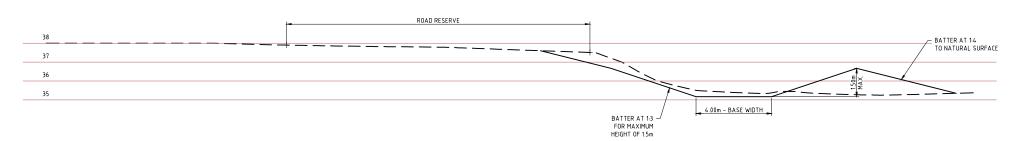
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# OPEN DRAIN A10 CHAINAGE 50.0 SCALE 1:100



# OPEN DRAIN A10 CHAINAGE 100.0 SCALE 1:100



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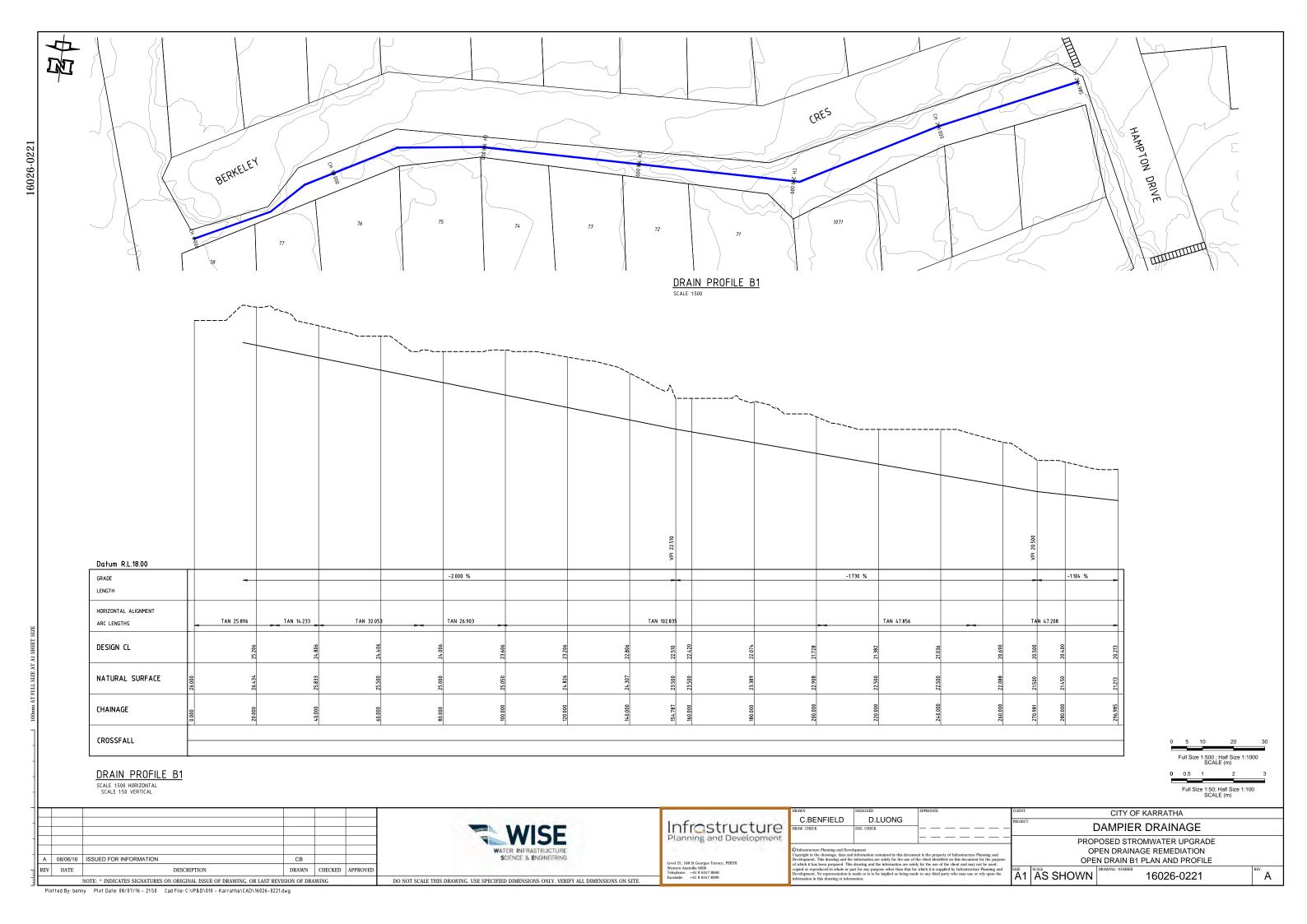
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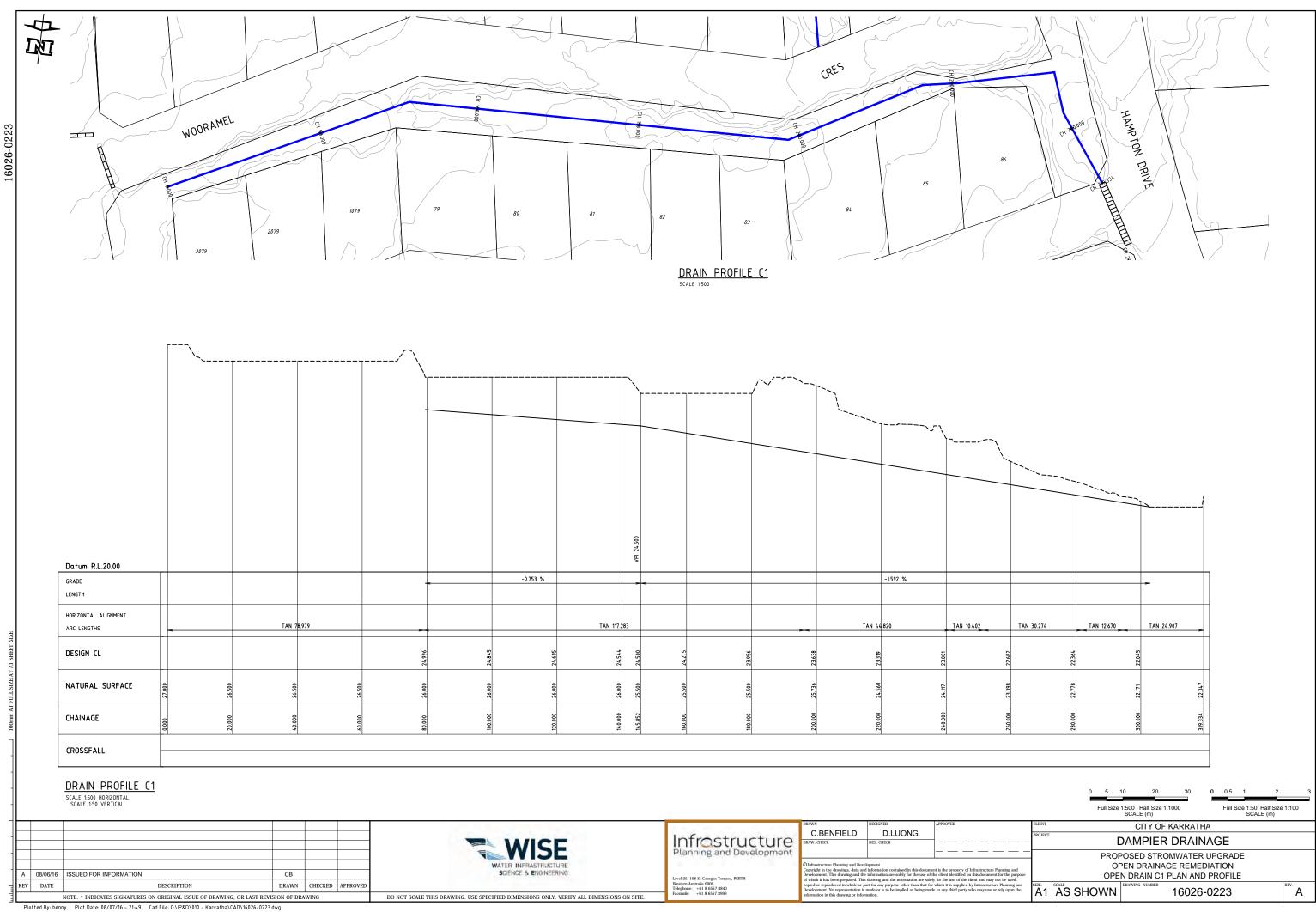
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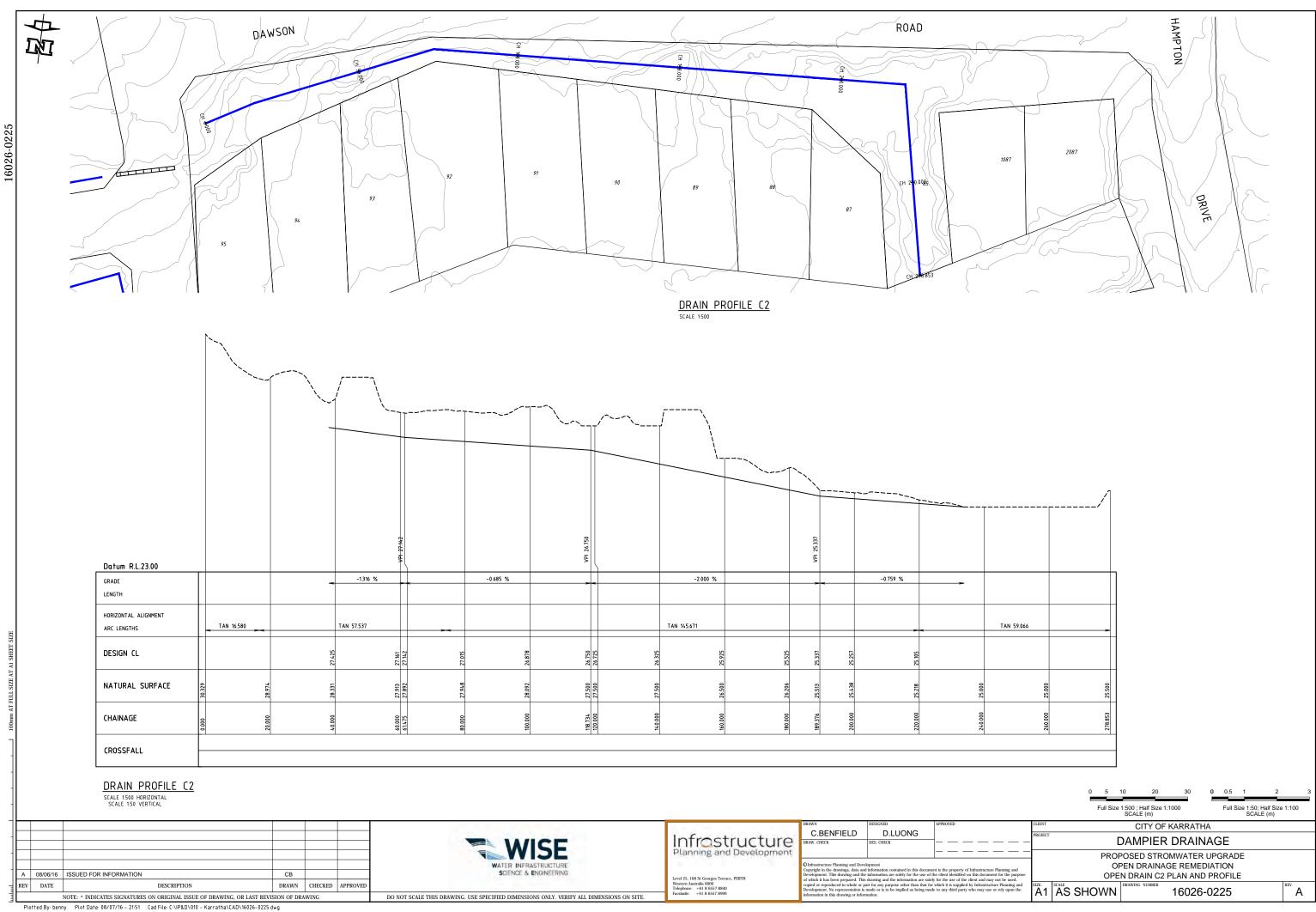
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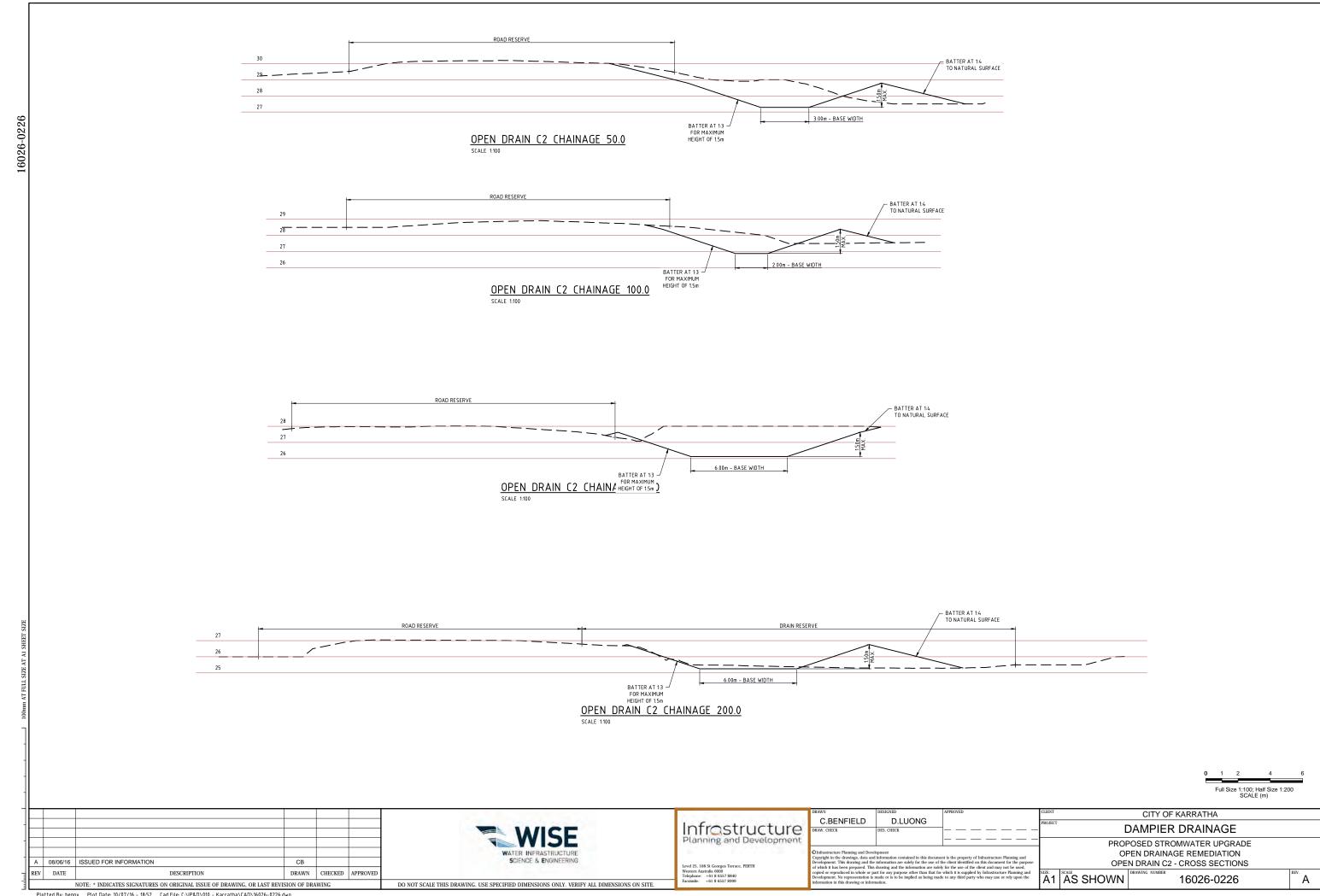
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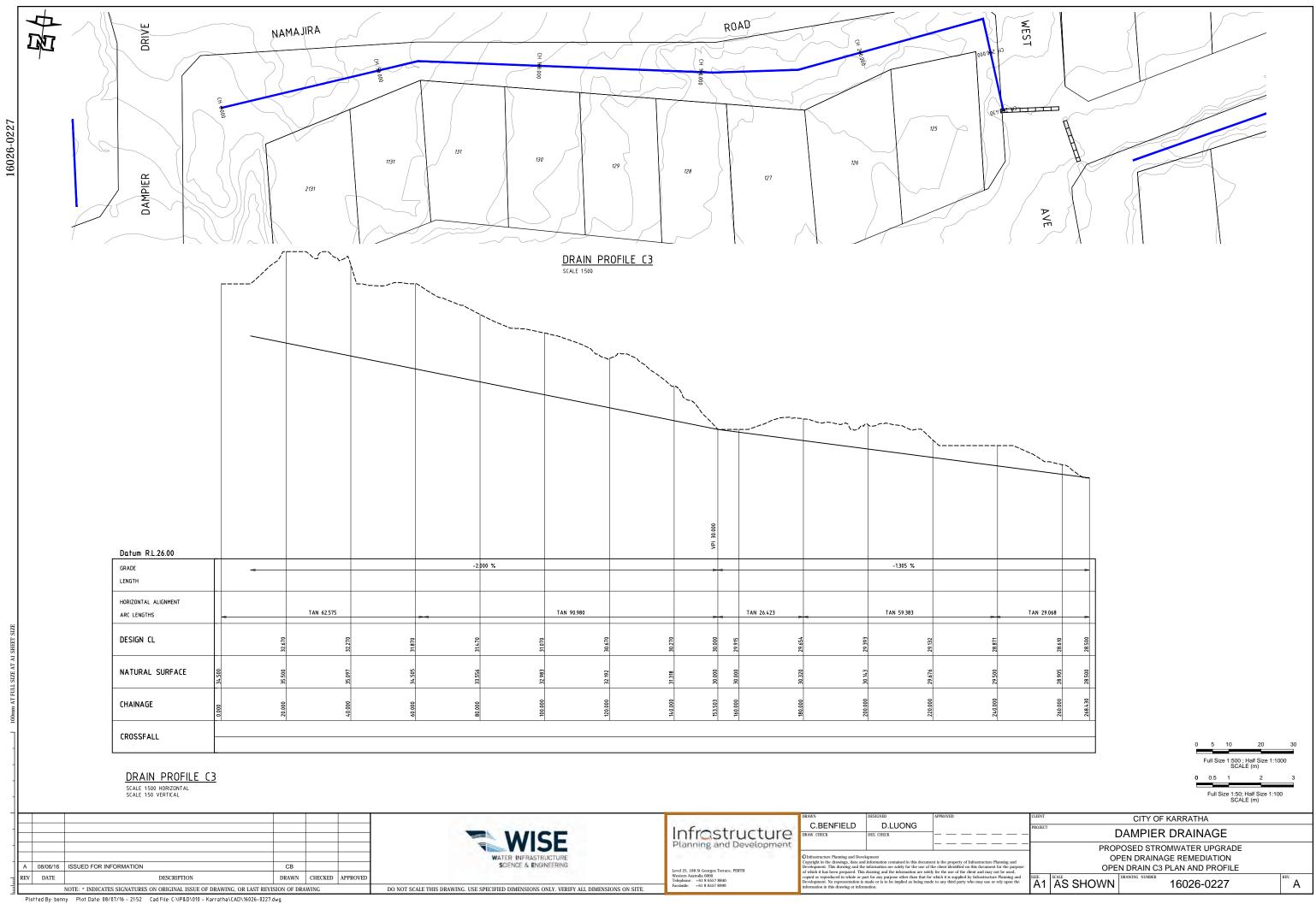
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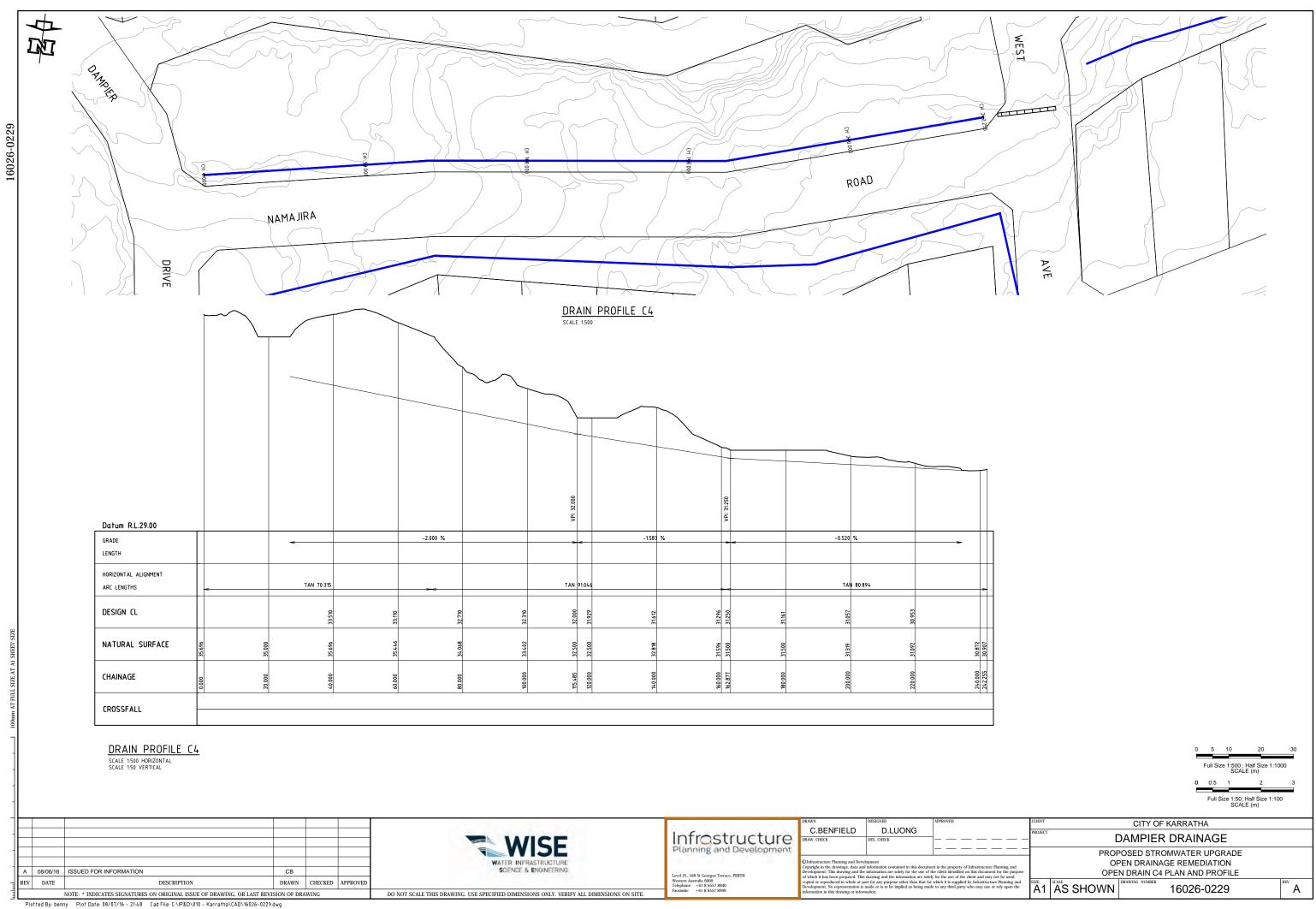


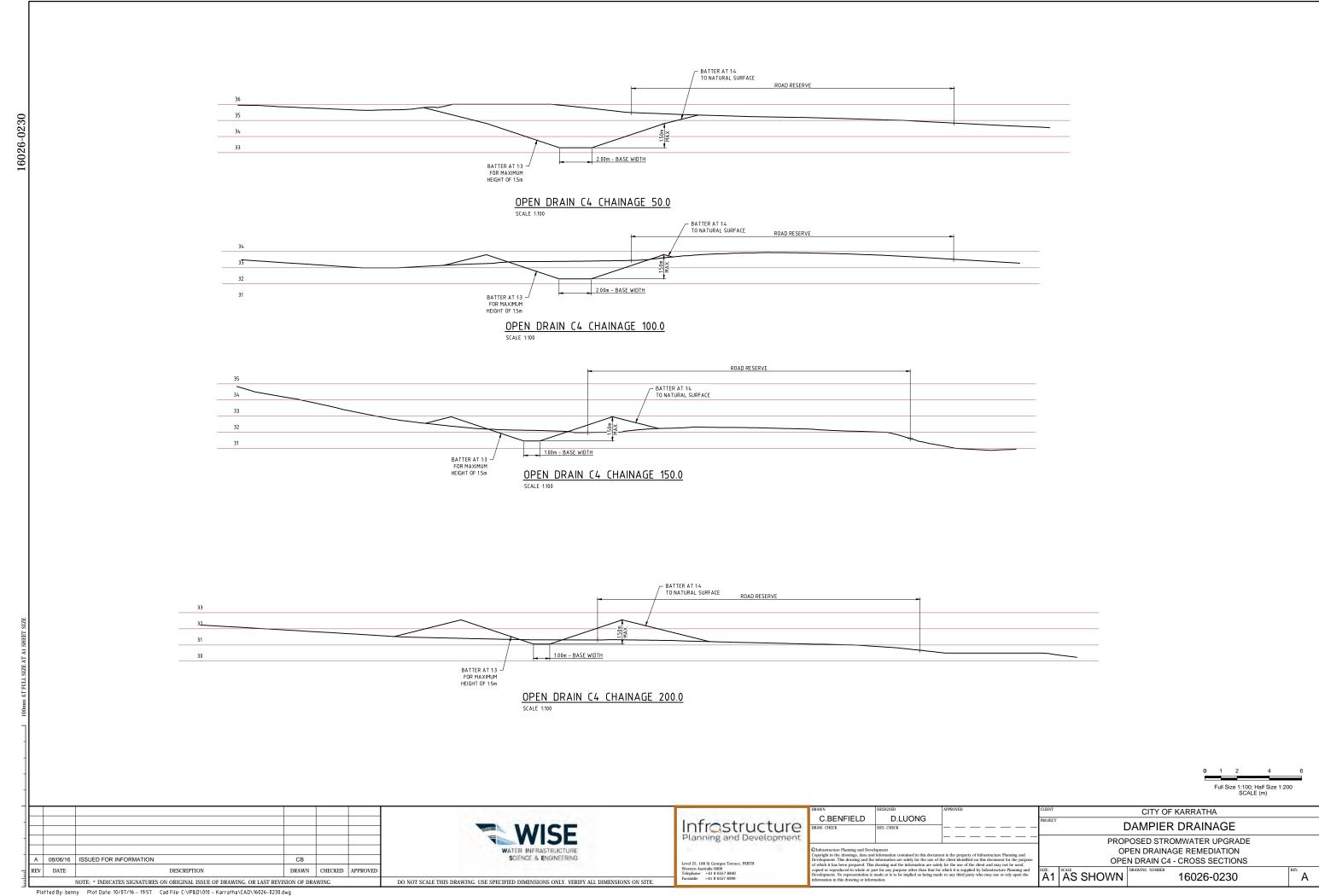


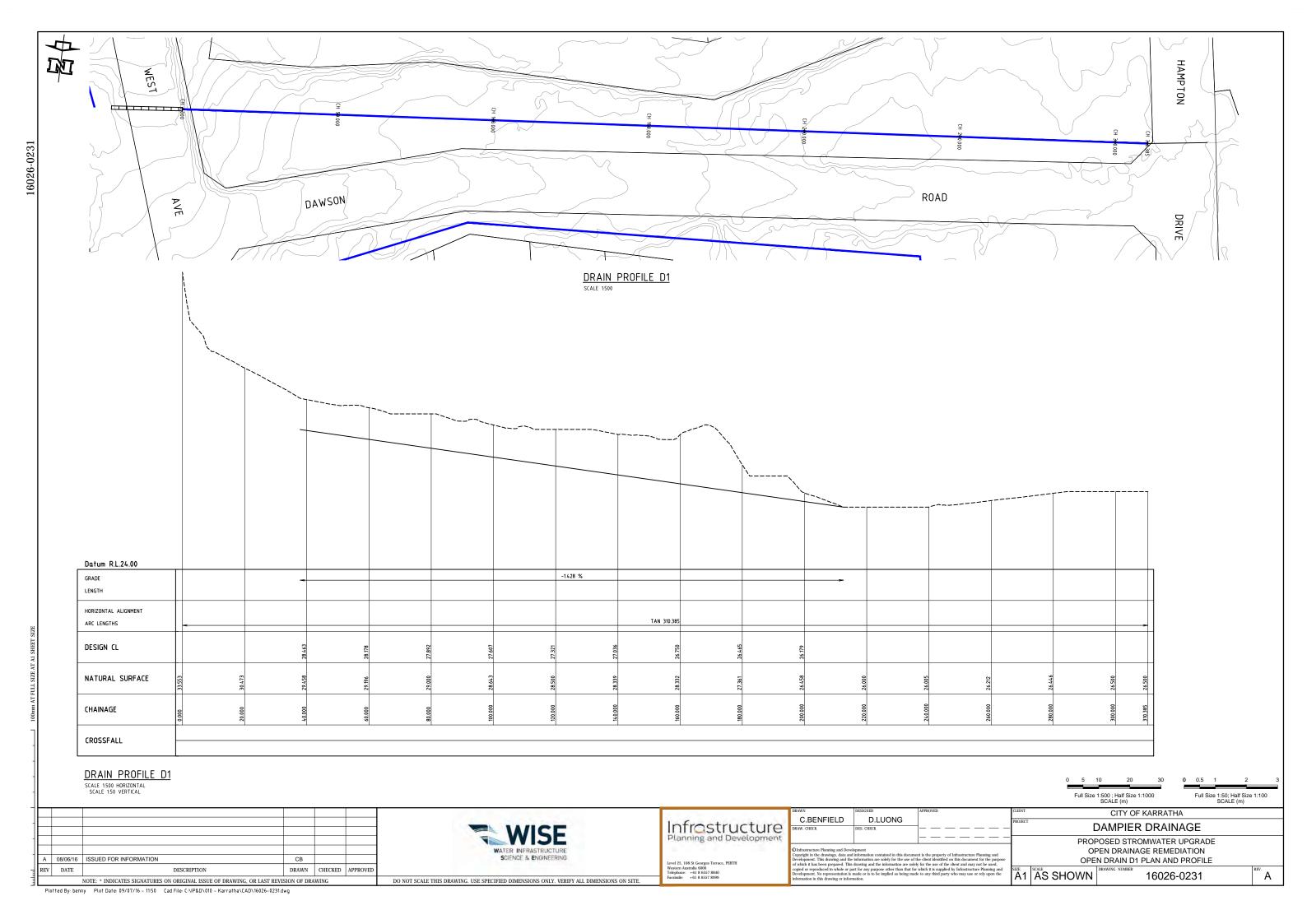


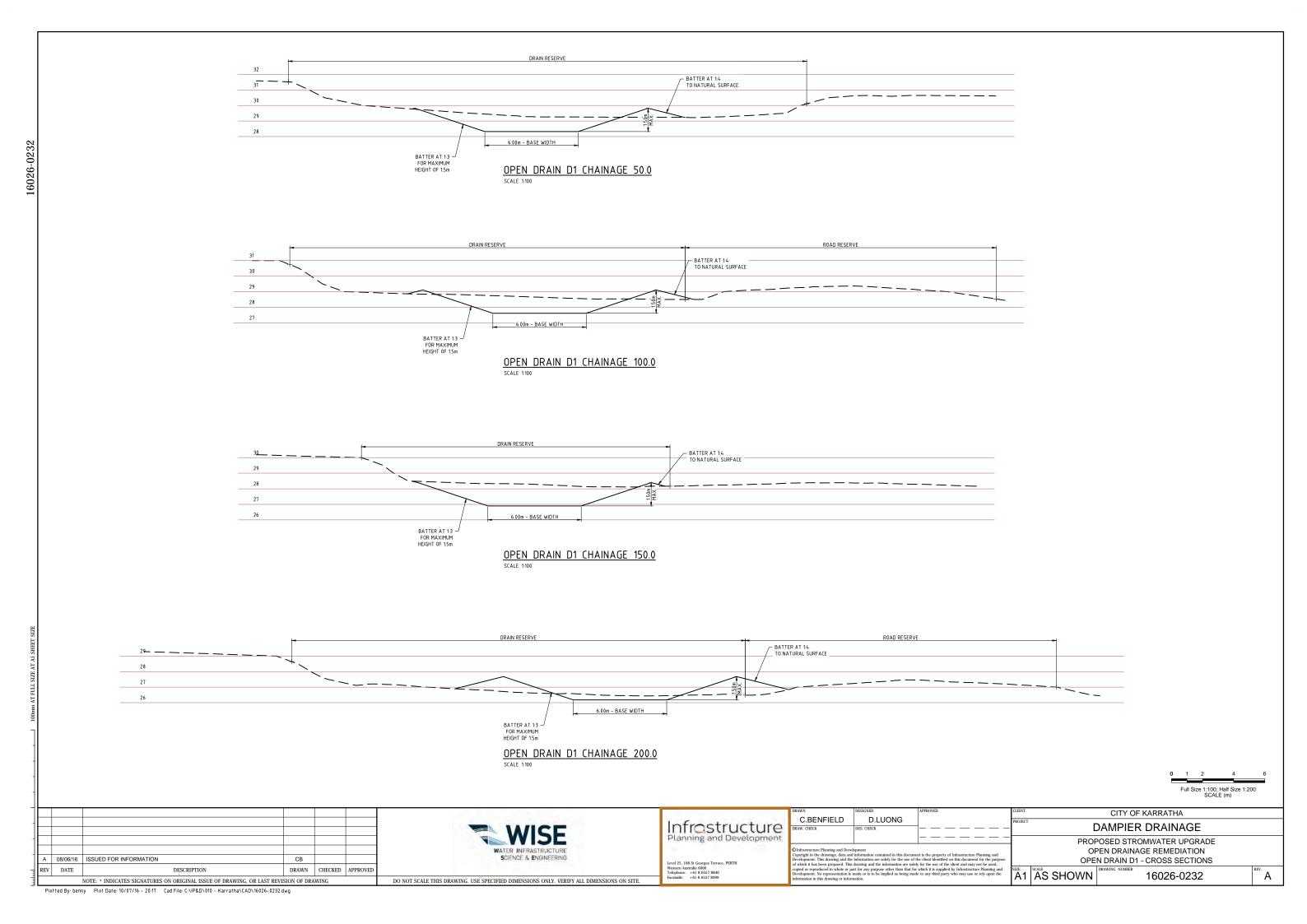


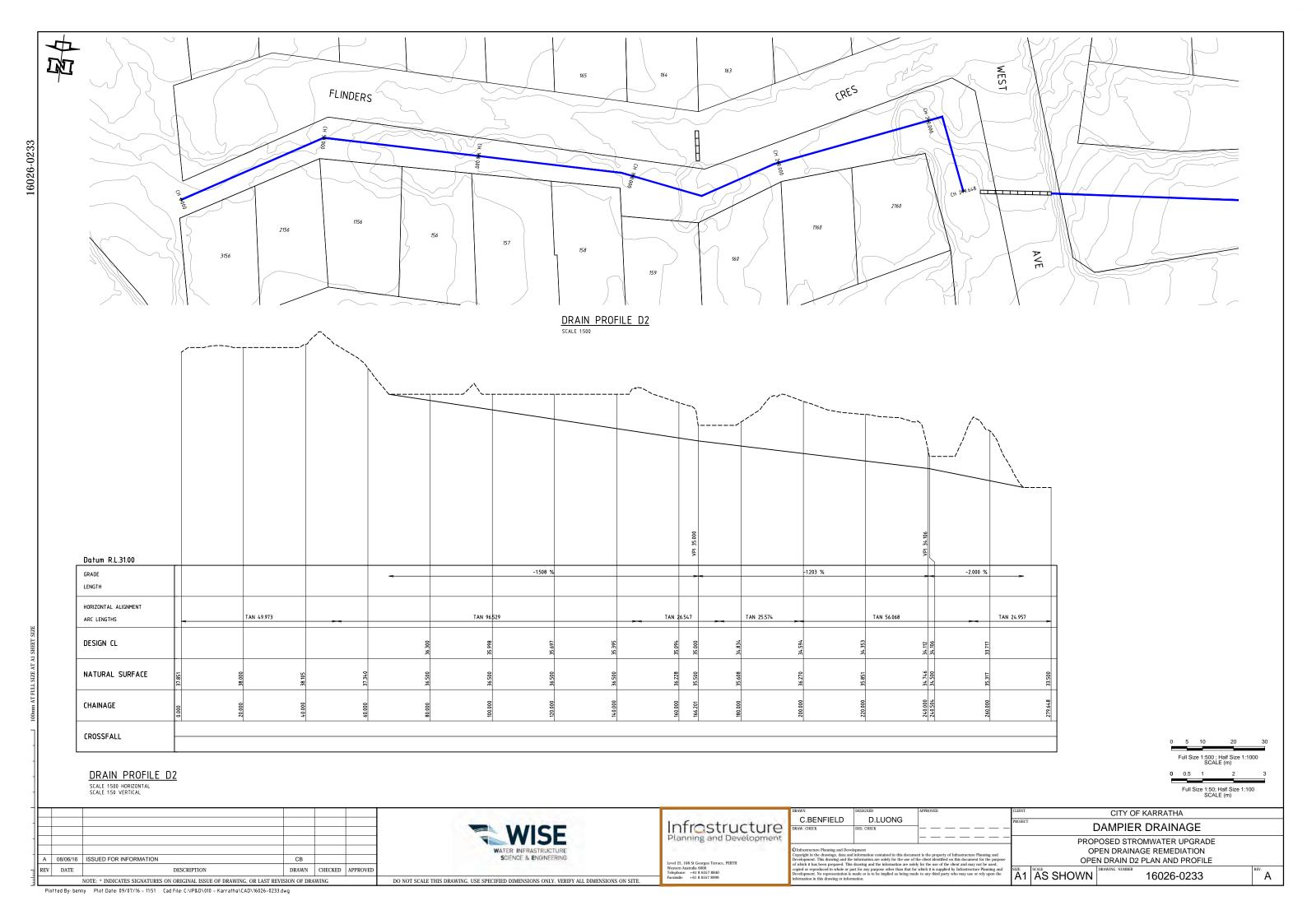


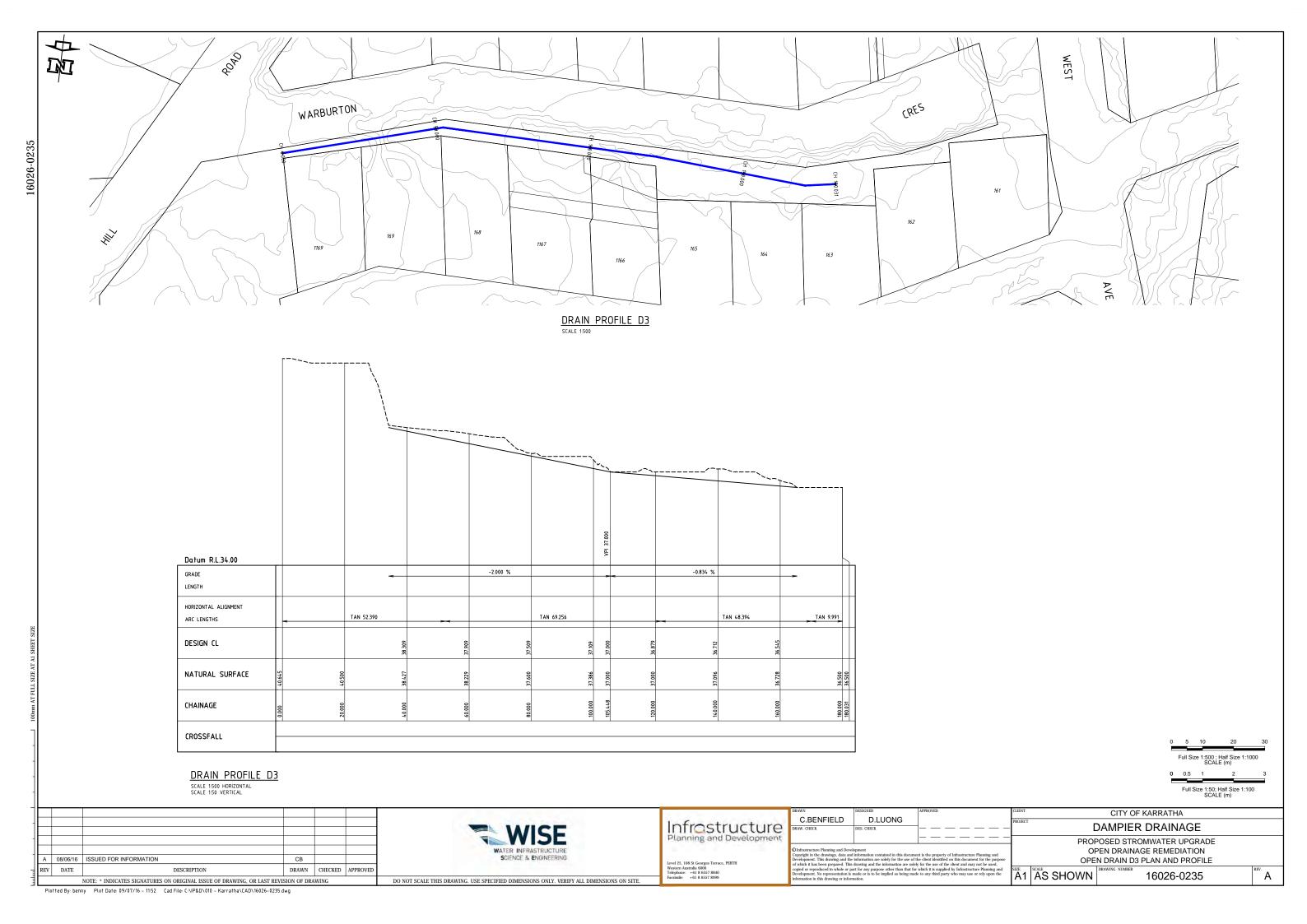


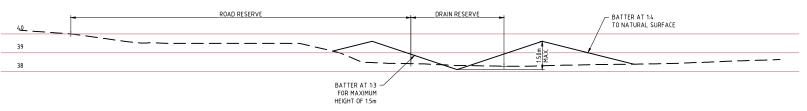




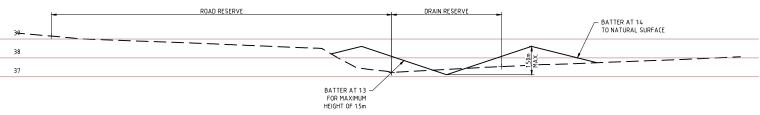




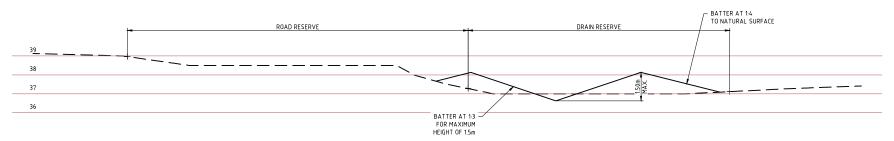




# OPEN DRAIN D3 CHAINAGE 50.0 SCALE 1:100



# OPEN DRAIN D3 CHAINAGE 100.0 SCALE 1:100



# OPEN DRAIN D3 CHAINAGE 150.0 SCALE 1:100



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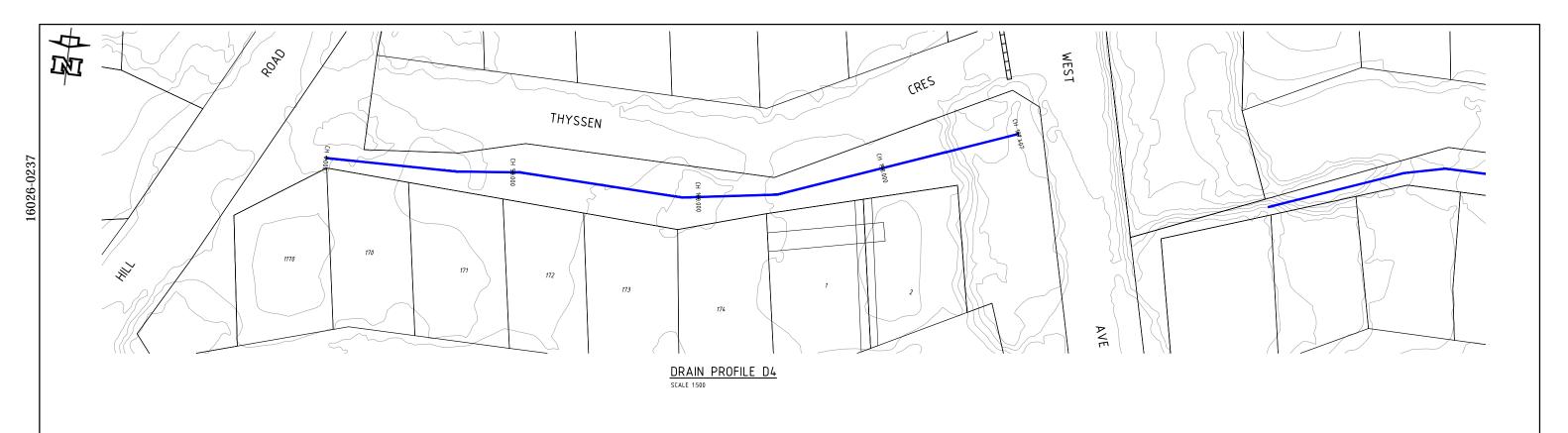


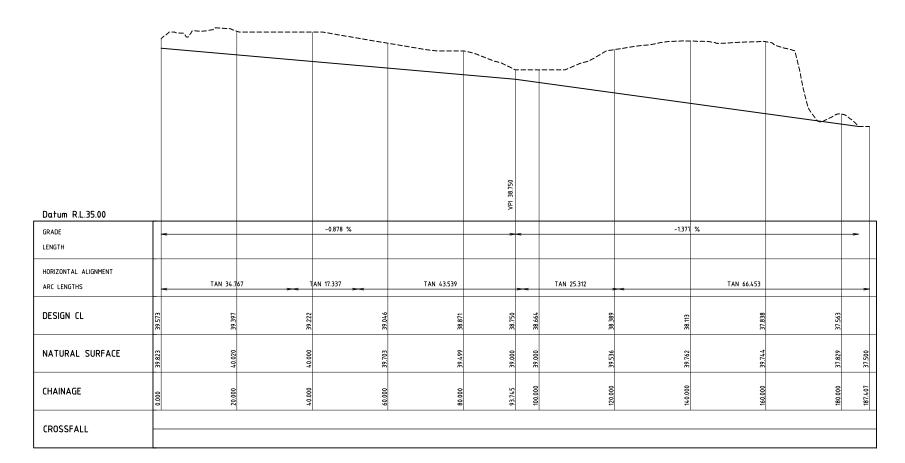
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#### DRAIN PROFILE D4

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

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C.BENFIELD D.LUONG

Full Size 1:50; Half Size 1:100 SCALE (m) CITY OF KARRATHA

Full Size 1:500 ; Half Size 1:1000 SCALE (m)

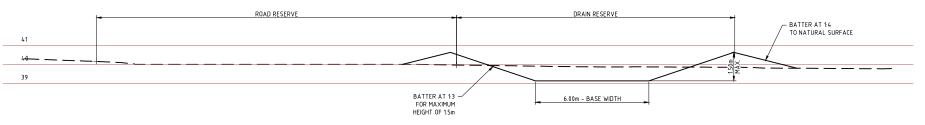
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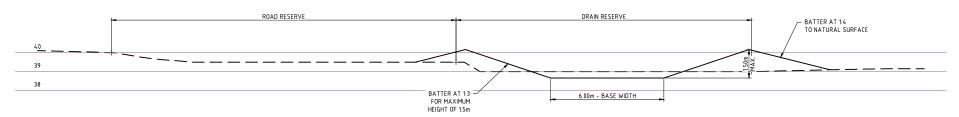
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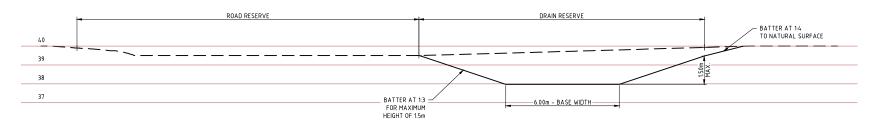
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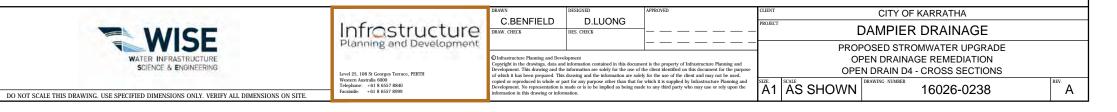
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#### OPEN DRAIN D4 CHAINAGE 100.0



#### OPEN DRAIN D4 CHAINAGE 150.0

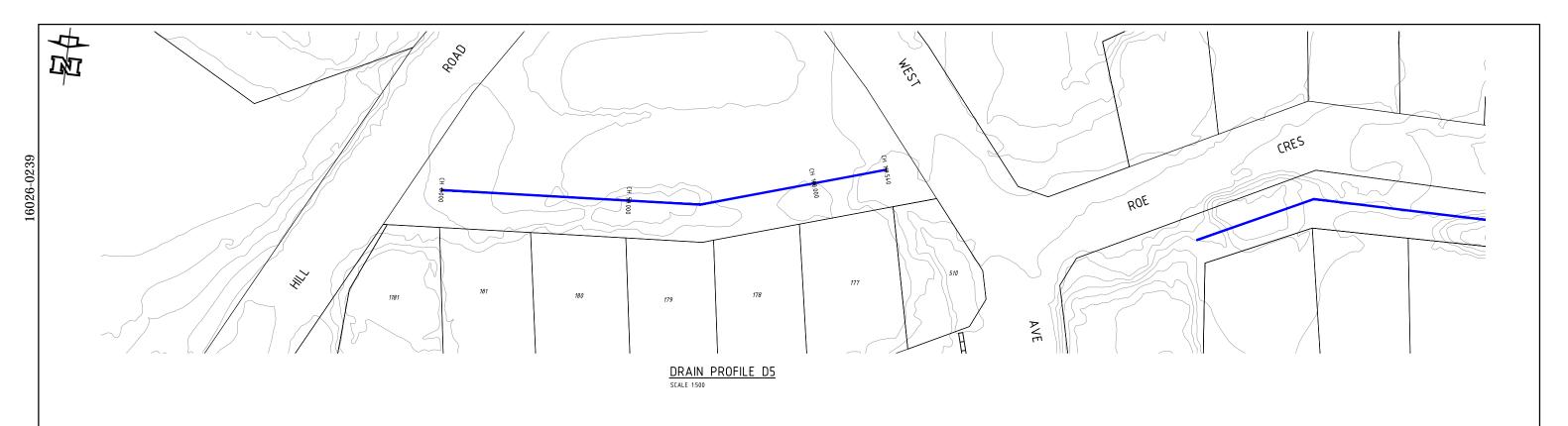


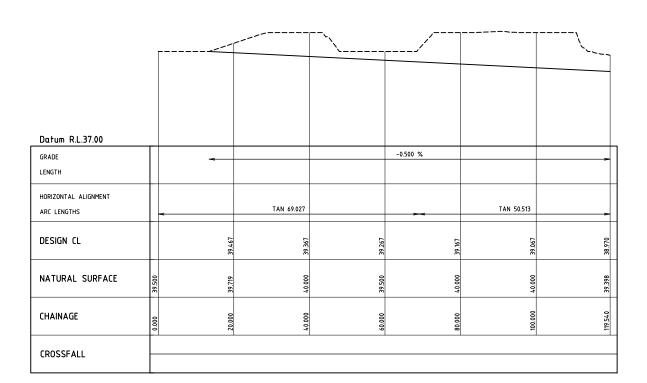
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# DRAIN PROFILE D5 SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

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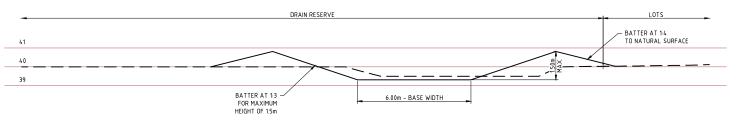
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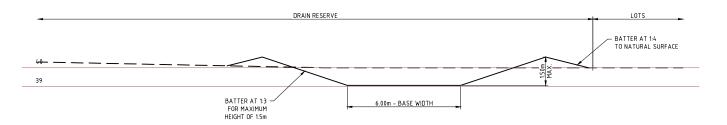
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# OPEN DRAIN D5 CHAINAGE 50.0 SCALE 1:100

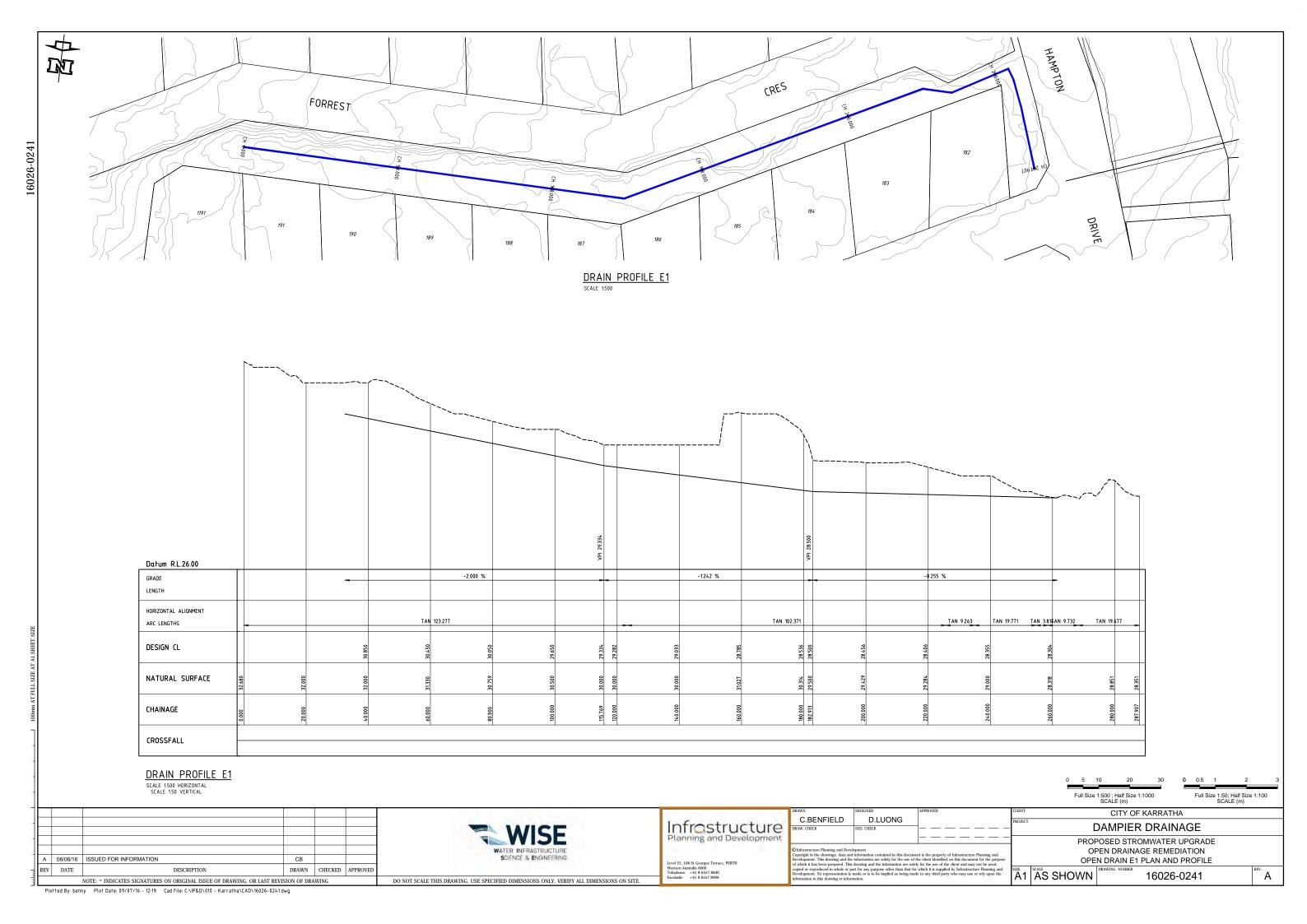


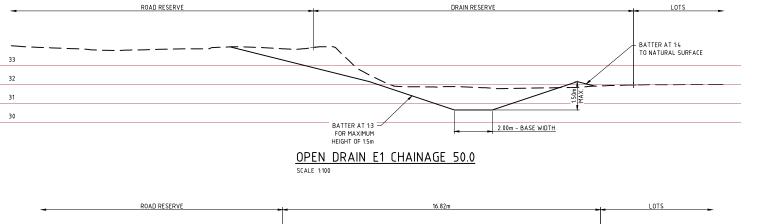
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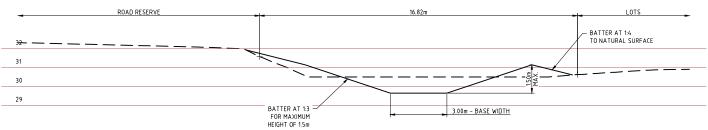


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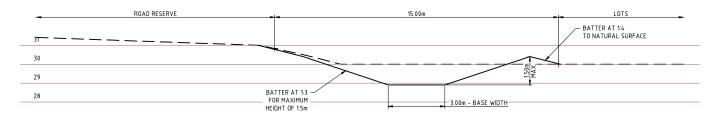
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#### OPEN DRAIN E1 CHAINAGE 100.0



## OPEN DRAIN E1 CHAINAGE 150.0 SCALE 1:100

ROAD RESERVE

15.12m

LOTS

BATTER AT 1.4
TO NATURAL SURFACE

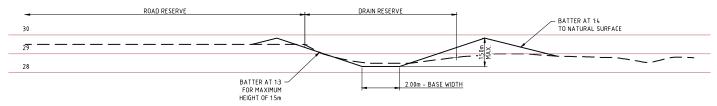
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BATTER AT 1.3
FOR MAXIMUM
HEIGHT OF 1.5m

3.00m - BASE WIDTH

## OPEN DRAIN E1 CHAINAGE 200.0 SCALE 1.100



### OPEN DRAIN E1 CHAINAGE 250.0

CALE 1:100

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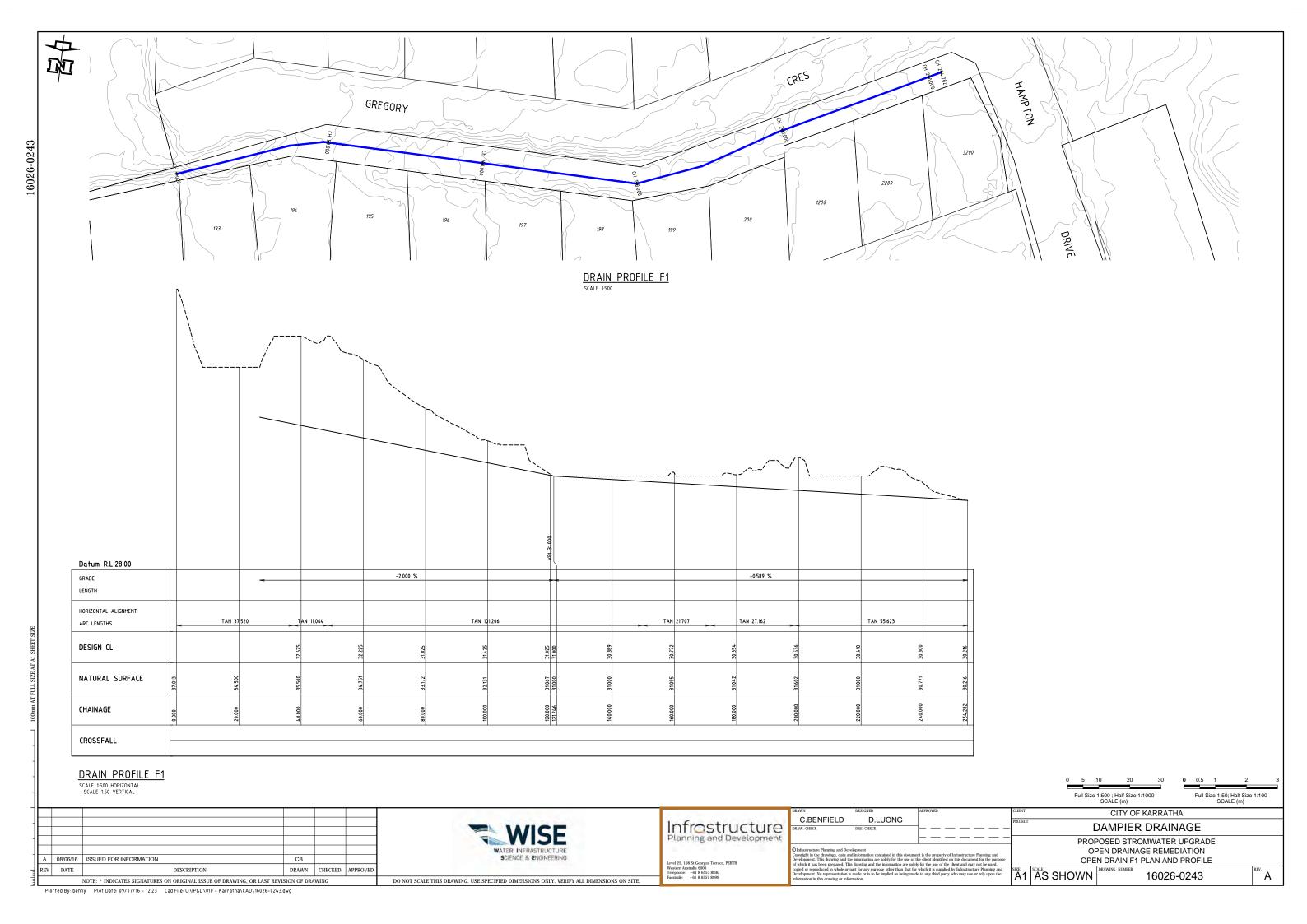
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	CITY OF KARRATHA	
CT .	DAMPIER DRAINAGE	

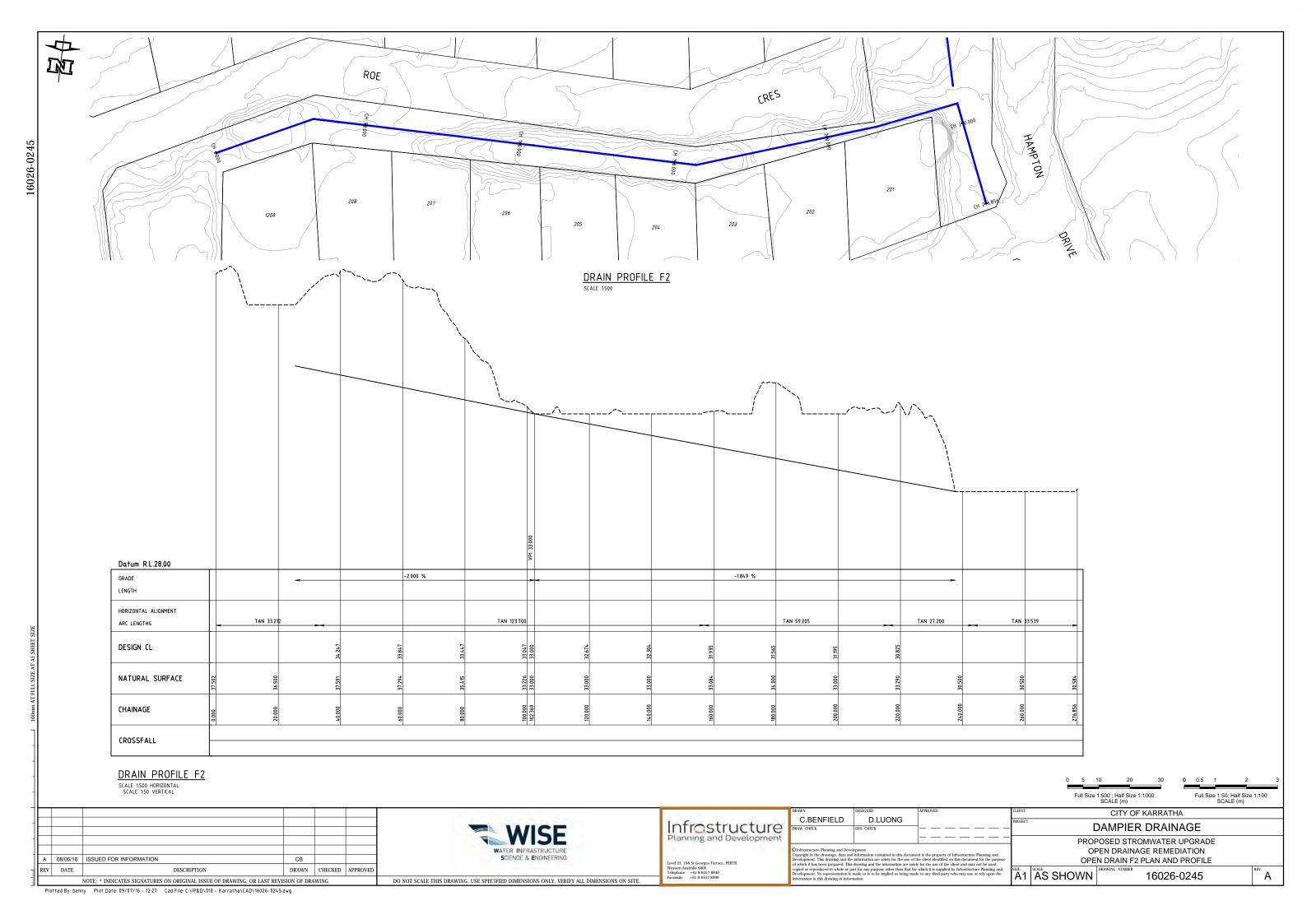
PROPOSED STROMWATER UPGRADE
OPEN DRAINAGE REMEDIATION
OPEN DRAIN E1 - CROSS SECTIONS

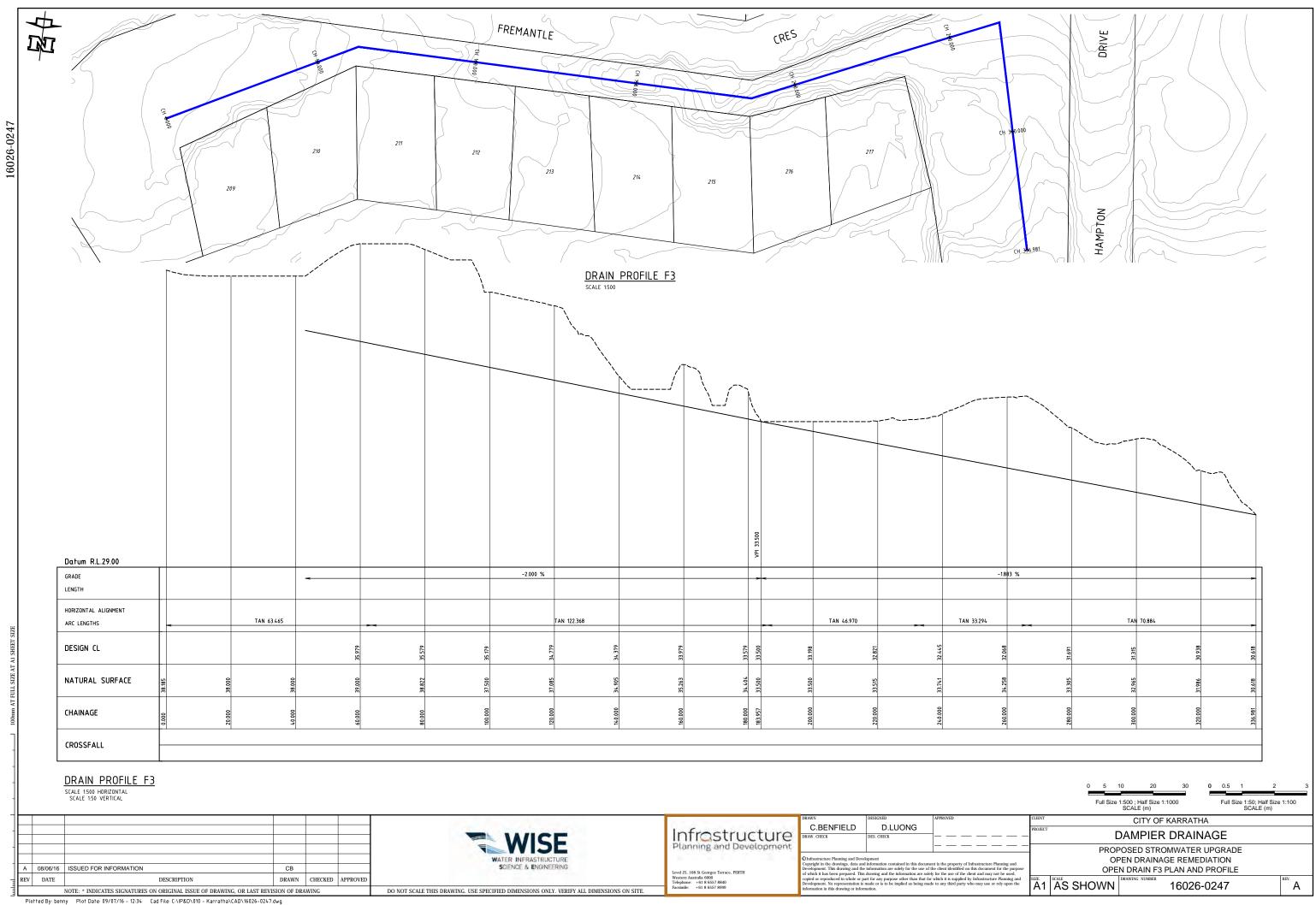
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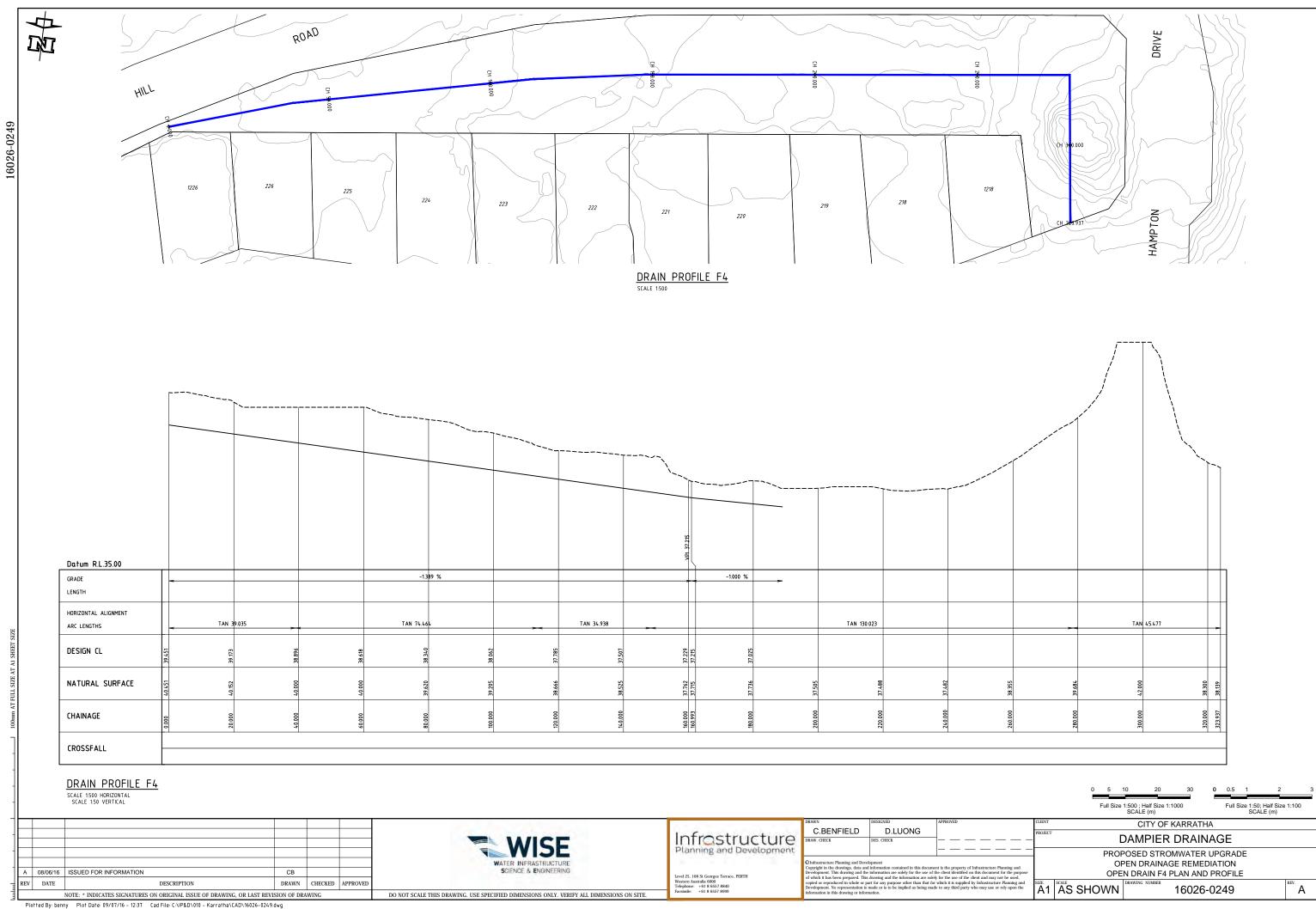
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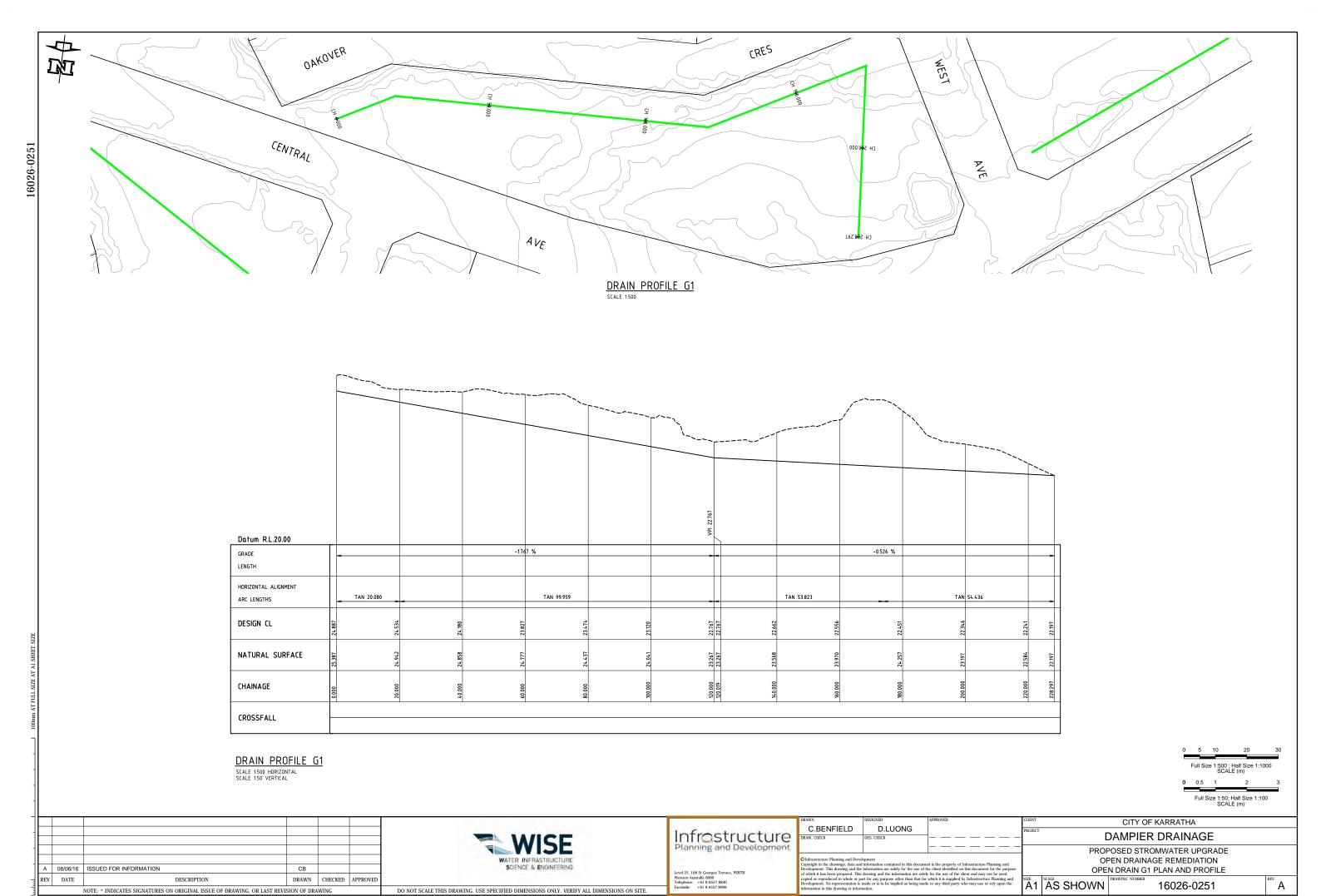
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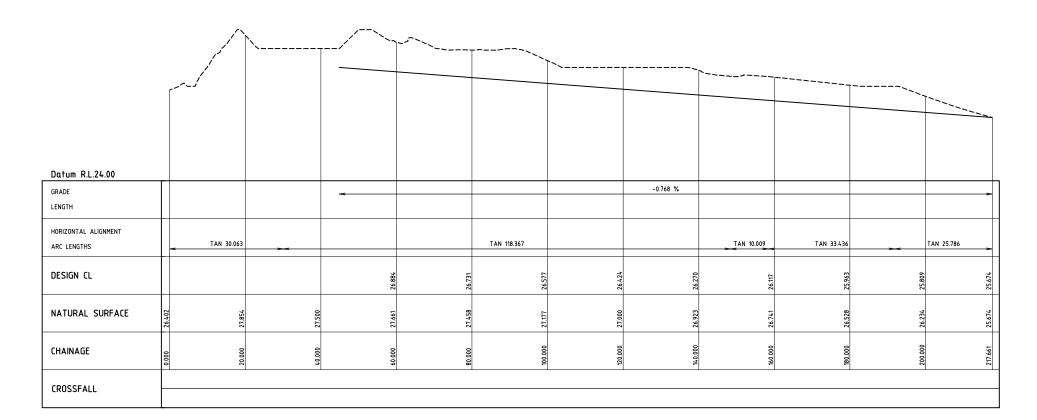












DRAIN PROFILE G2

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

Full Size 1:500 ; Half Size 1:1000 SCALE (m) Full Size 1:50; Half Size 1:100 SCALE (m)

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CITY OF KARRATHA DAMPIER DRAINAGE PROPOSED STROMWATER UPGRADE OPEN DRAINAGE REMEDIATION OPEN DRAIN G2 PLAN AND PROFILE A1 AS SHOWN

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### CITY OF KARRATHA DAMPIER DRAINAGE PROPOSED STROMWATER UPGRADE OPEN DRAINAGE REMEDIATION

Full Size 1:100; Half Size 1:200 SCALE (m)

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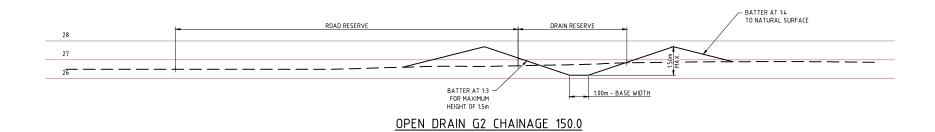
OPEN DRAIN G2 - CROSS SECTIONS

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2.00m - BASE WIDTH OPEN DRAIN G2 CHAINAGE 100.0 SCALE 1:100

- BATTER AT 1:4 TO NATURAL SURFACE

- BATTER AT 1:4 TO NATURAL SURFACE



BATTER AT 1:3 — FOR MAXIMUM HEIGHT OF 1.5m

BATTER AT 1:3 — FOR MAXIMUM HEIGHT OF 1.5m

ROAD RESERVE

BATTER AT 1:3 -FOR MAXIMUM HEIGHT OF 1.5m

OPEN DRAIN G2 CHAINAGE 50.0 SCALE 1:100

- BATTER AT 1:4 TO NATURAL SURFACE DRAIN RESERVE

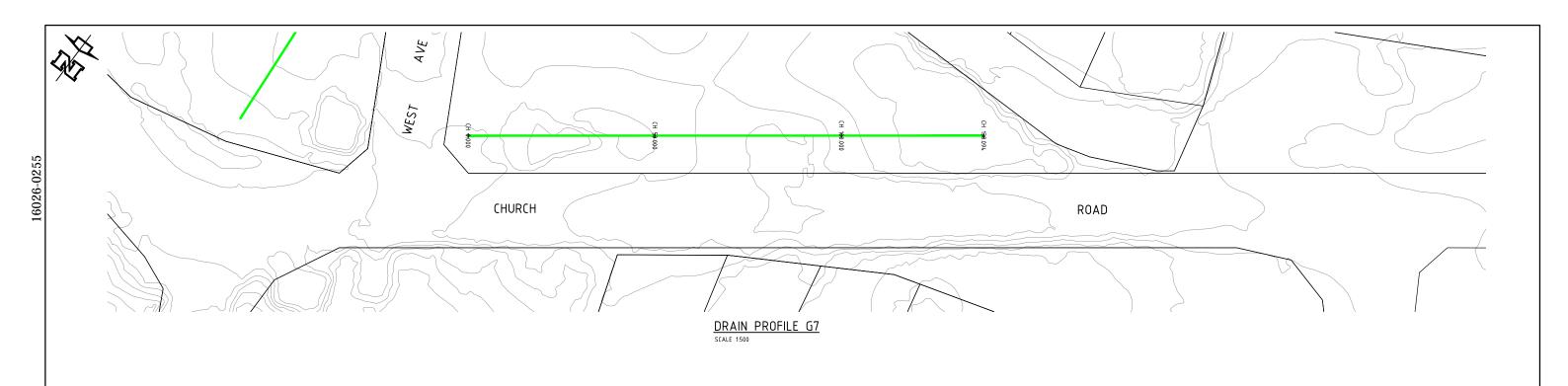
DRAIN RESERVE

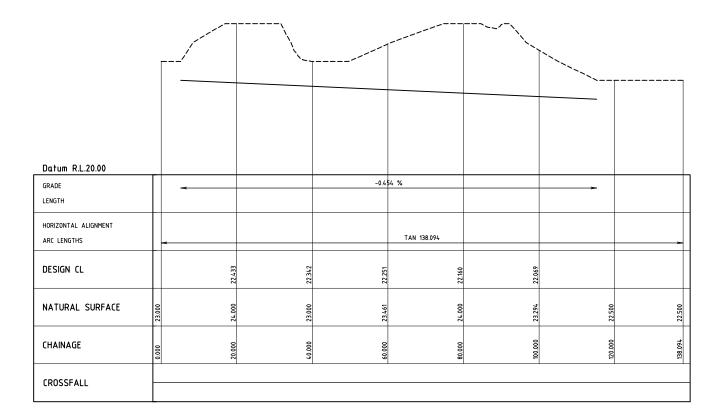
DRAIN RESERVE

2.00m - BASE WIDTH

OPEN DRAIN G2 CHAINAGE 200.0

6.00m - BASE WIDTH





DRAIN PROFILE G7

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL 0 5 10 20 30

Full Size 1:500 ; Half Size 1:1000
SCALE (m)

0 0.5 1 2 3

Full Size 1:50; Half Size 1:100
SCALE (m)

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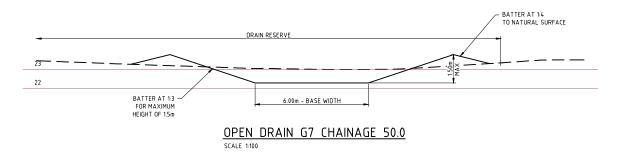
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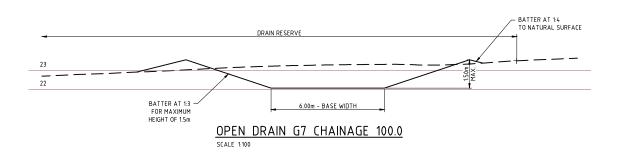
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Full Size 1:100; Half Size 1:200
SCALE (m)

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CLIENT	CITY OF KARRATHA		
PROJECT	DAMPIER DRAINAGE		
	PROPOSED STROMWATER UPGRADE OPEN DRAINAGE REMEDIATION		

OPEN DRAIN G7 - CROSS SECTIONS

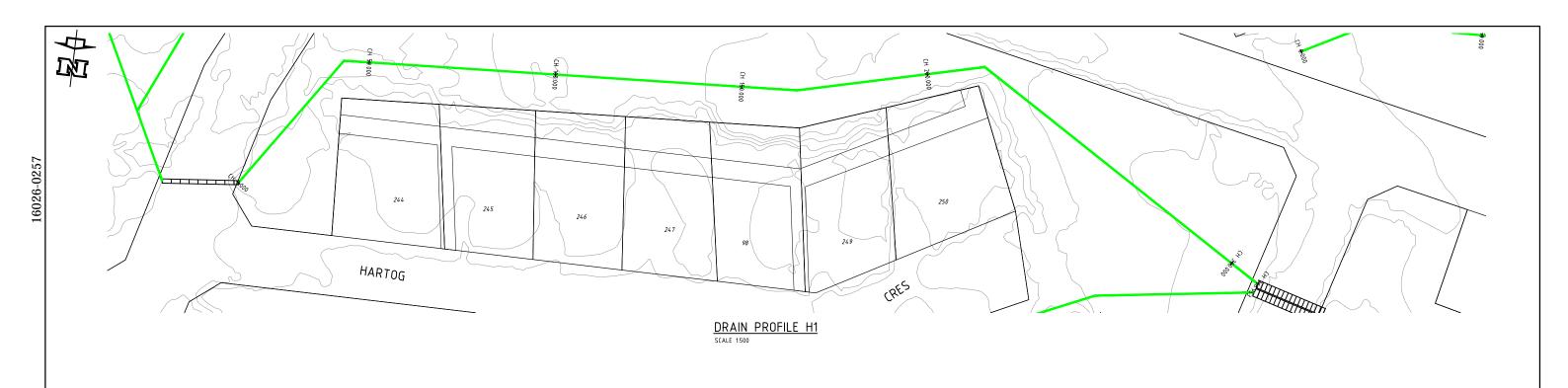
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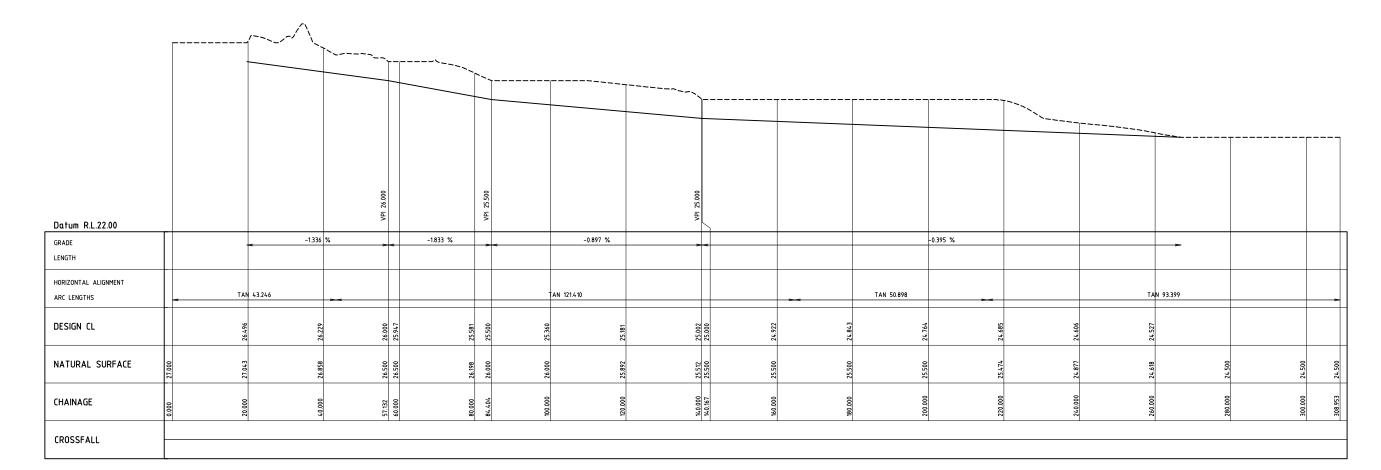
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OPEN DRAIN G7 - CROSS SECTIONS

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DRAIN PROFILE H1

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL Full Size 1:500 ; Half Size 1:1000 SCALE (m)

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Full Size 1:50; Half Size 1:100 SCALE (m)

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PROJECT

DAMPIER DRAINAGE

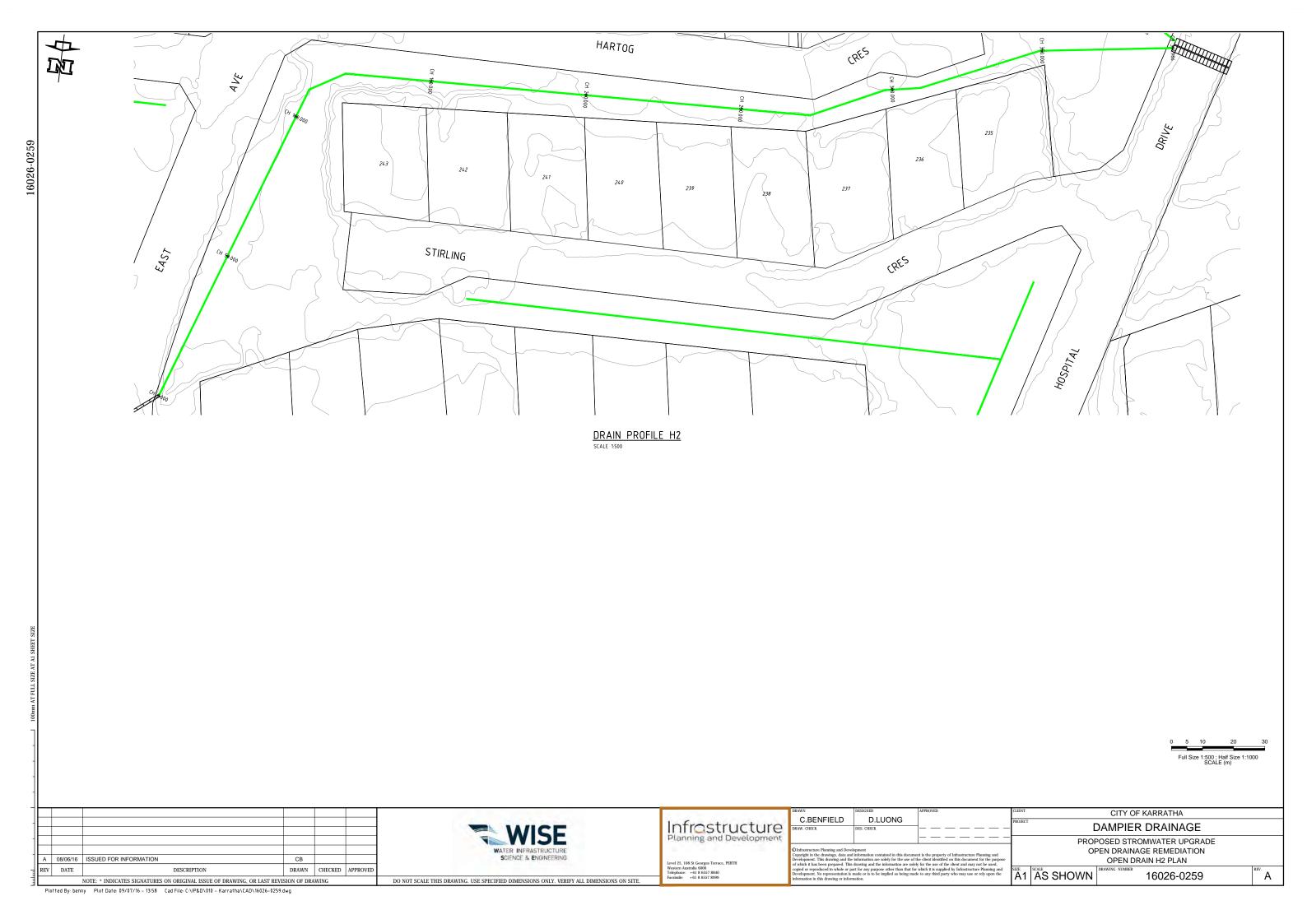
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OPEN DRAIN H1 PLAN AND PROFILE

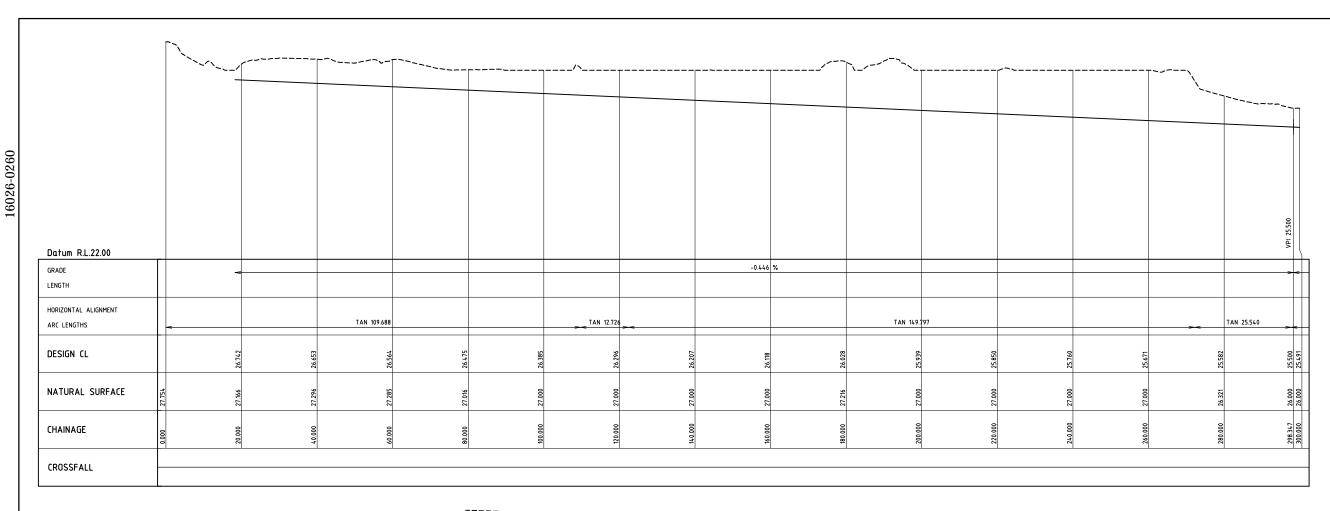
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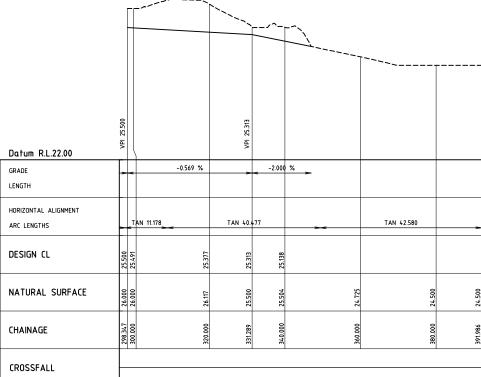
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#### DRAIN PROFILE H2

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL



#### DRAIN PROFILE H2

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

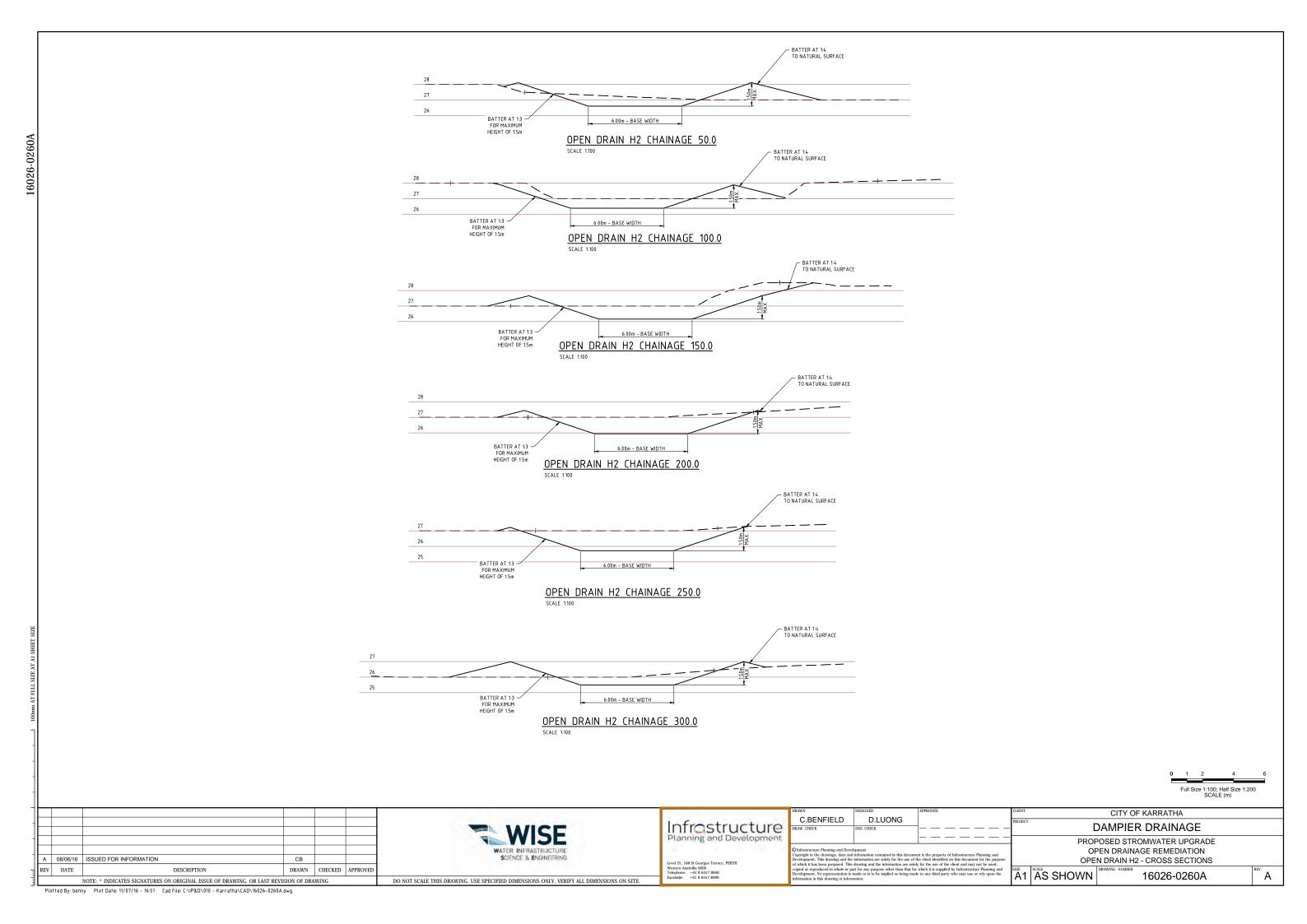
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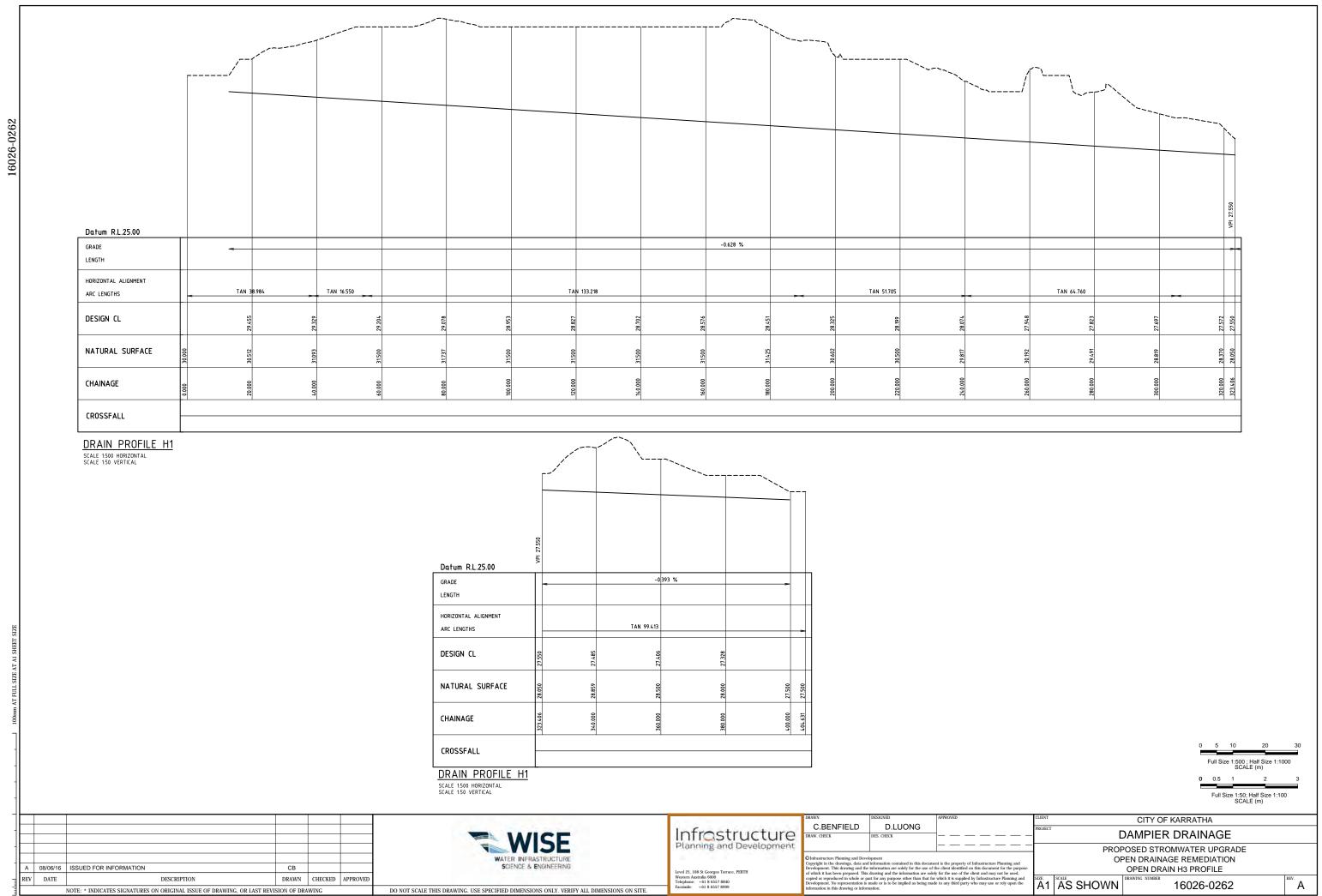
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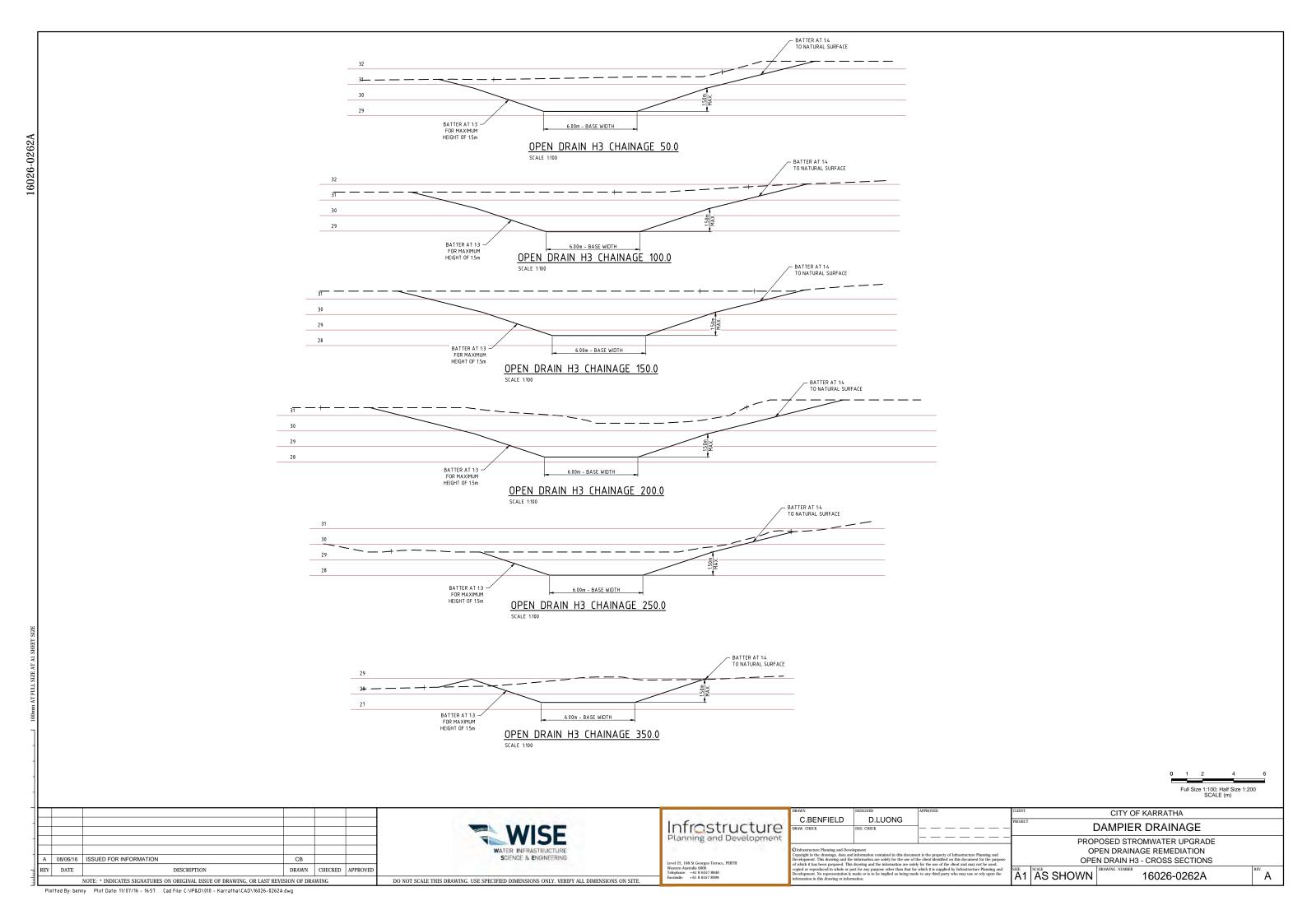
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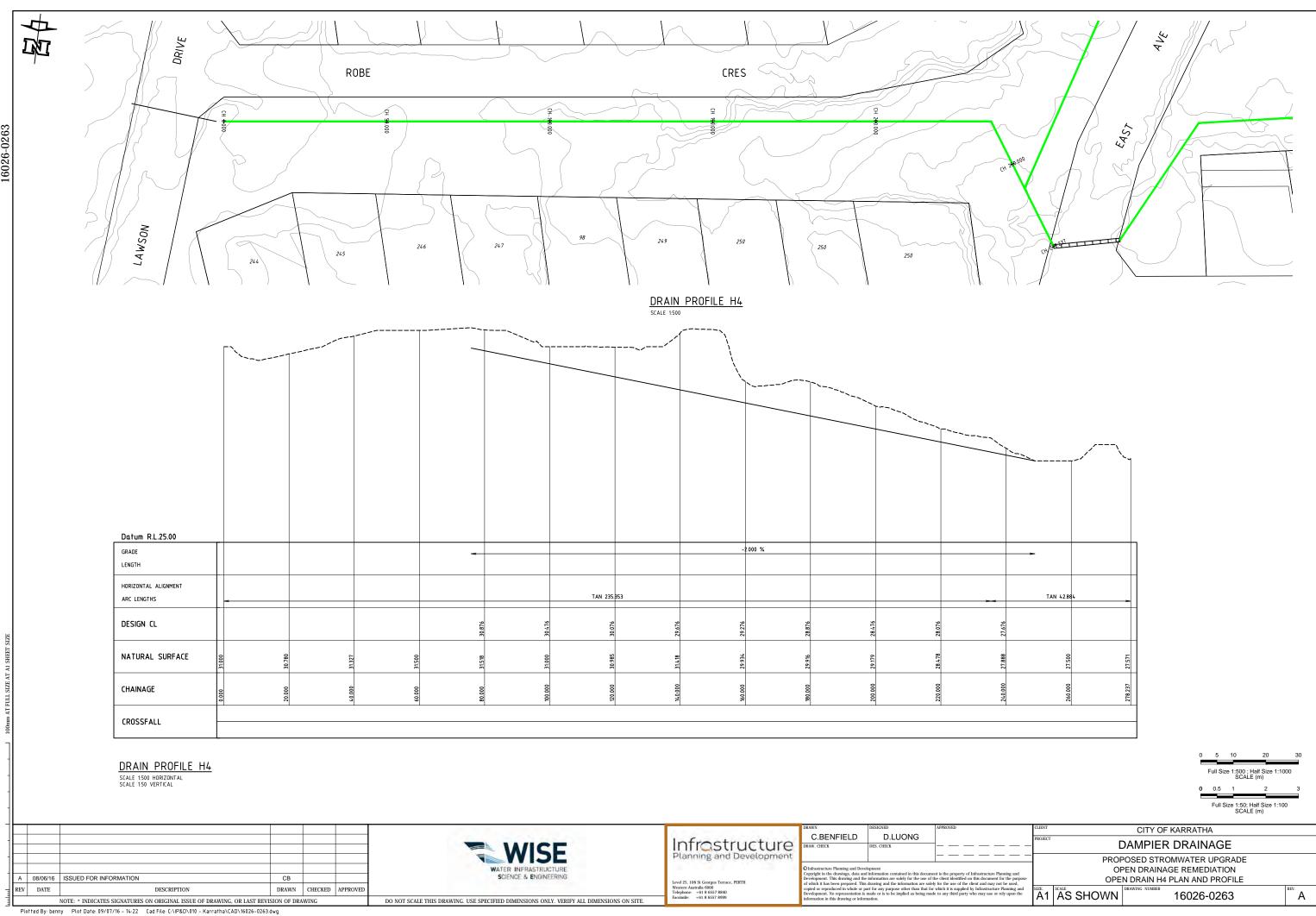
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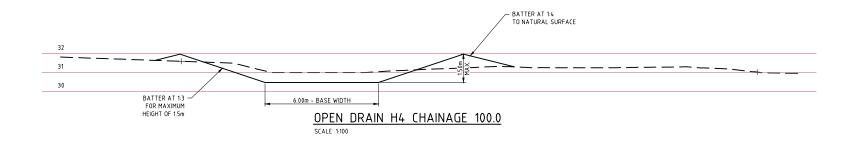


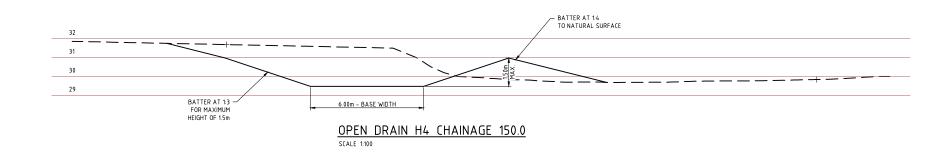


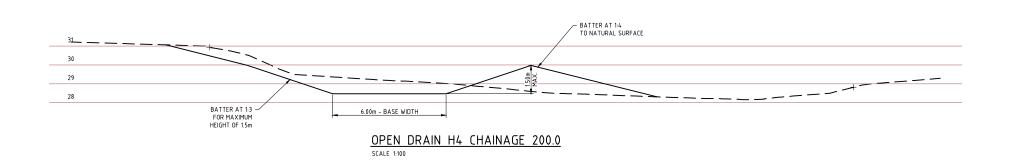














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CITY OF KARRATHA

DAMPIER DRAINAGE

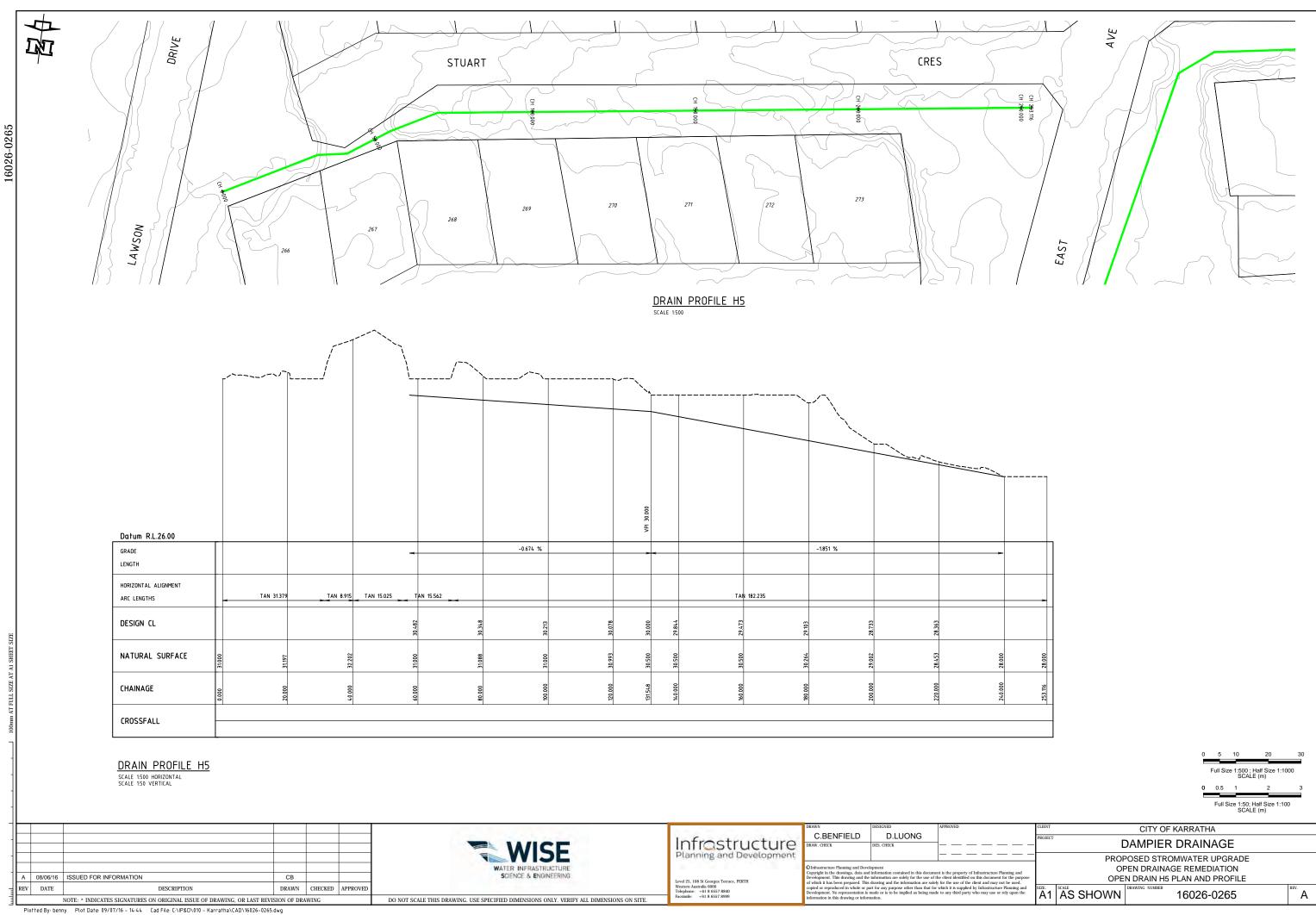
PROPOSED STROMWATER UPGRADE

OPEN DRAINAGE REMEDIATION

OPEN DRAIN H4 - CROSS SECTIONS

OPEN DRAINAGE REMEDIATION
OPEN DRAIN H4 - CROSS SECTIONS

SIZE. | SCALE | DRAWING NUMBER | 16026-0264







C.BENFIELD D.LUONG

CITY OF KARRATHA DAMPIER DRAINAGE

PROPOSED STROMWATER UPGRADE OPEN DRAINAGE REMEDIATION OPEN DRAIN H5 - CROSS SECTIONS

Full Size 1:100; Half Size 1:200 SCALE (m)

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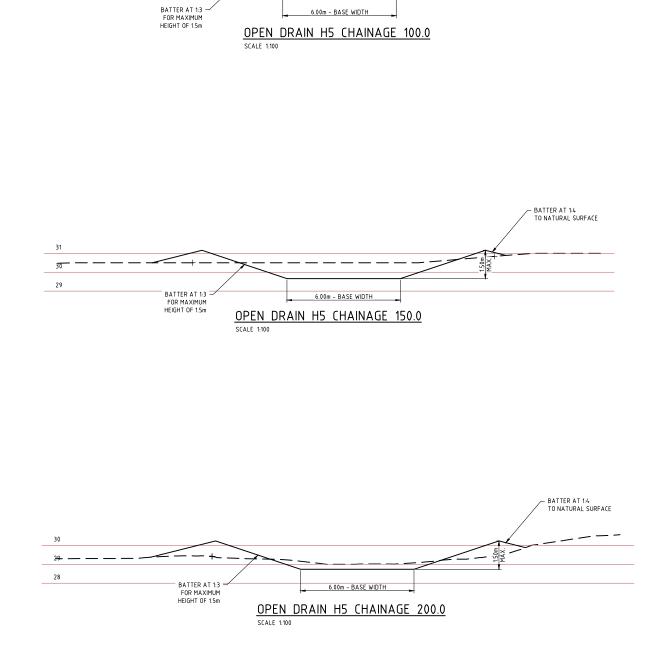
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DESCRIPTION

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DRAIN PROFILE H6

SCALE 1:500 HORIZONTAL
SCALE 1:50 VERTICAL

Full Size 1:500 ; Half Size 1:1000 SCALE (m) Full Size 1:50; Half Size 1:100 SCALE (m)

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	PROJECT		DAMPIER DRAINAGE			
	PROPOSED STROMWATER UPGRADE					
nd	OPEN DRAINAGE REMEDIATION					
urpose d.	OPEN DRAIN H6 PLAN AND PROFILE					
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Full Size 1:100; Half Size 1:200 SCALE (m)

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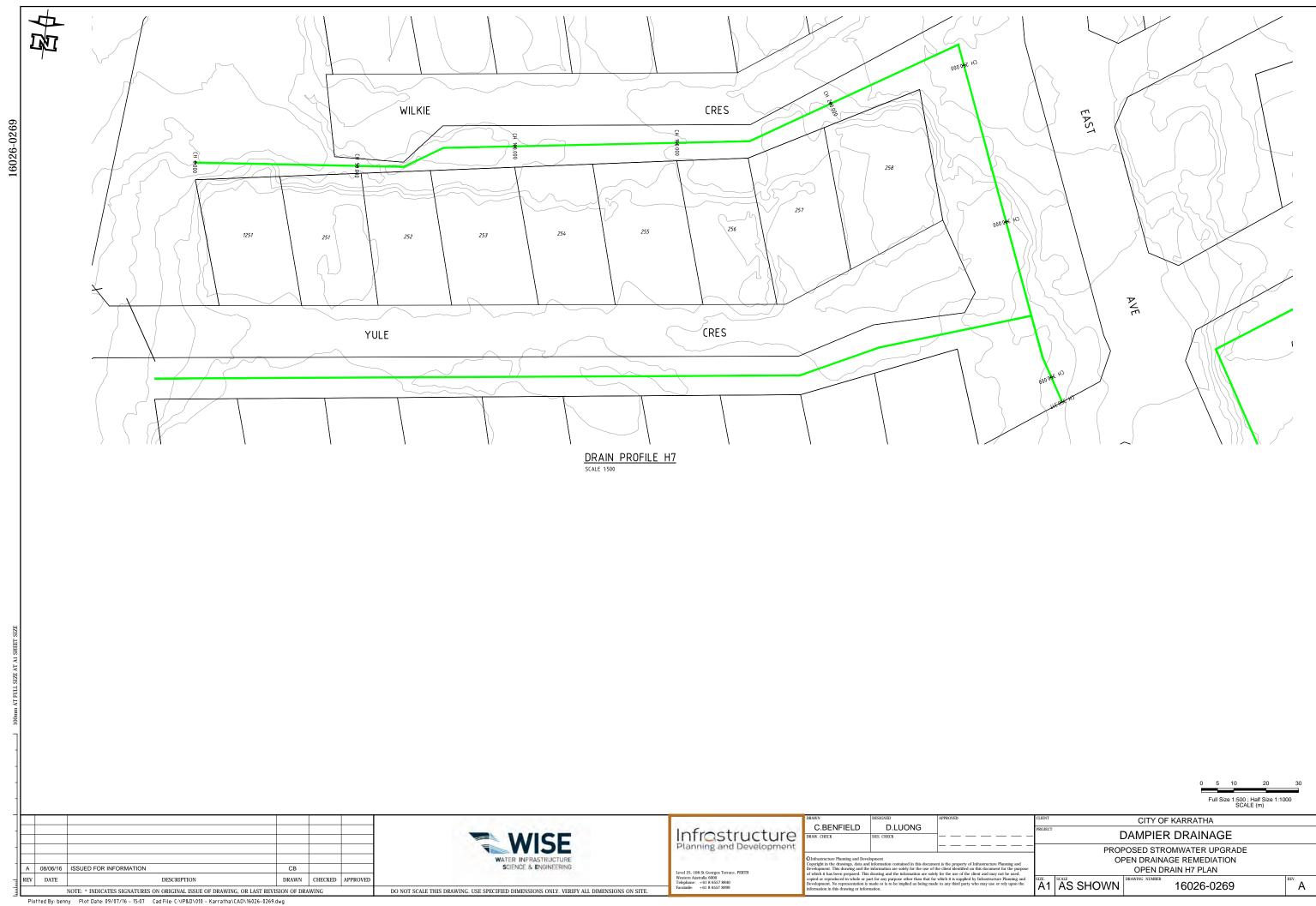
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DAMPIER DRAINAGE

PROPOSED STROMWATER UPGRADE OPEN DRAINAGE REMEDIATION OPEN DRAIN H6 - CROSS SECTIONS

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#### DRAIN PROFILE H7

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

DRAIN PROFILE H7

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL 0 5 10 20 30

Full Size 1:500; Half Size 1:1000

SCALE (m)

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Full Size 1:50; Half Size 1:100

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ENT	CITY OF KARRATHA	
JECT	DAMPIER DRAINAGE	
	PROPOSED STROMWATER UPGRADE	
	OPEN DRAINAGE REMEDIATION	

OPEN DRAINAGE REMEDIATION
OPEN DRAIN H7 PROFILE
SIZE.
A1 AS SHOWN DRAWING NUMBER
16026-0270

#### DRAIN PROFILE H8

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL 0 5 10 20 30

Full Size 1:500 ; Half Size 1:1000
SCALE (m)

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Full Size 1:50: Half Size 1:100
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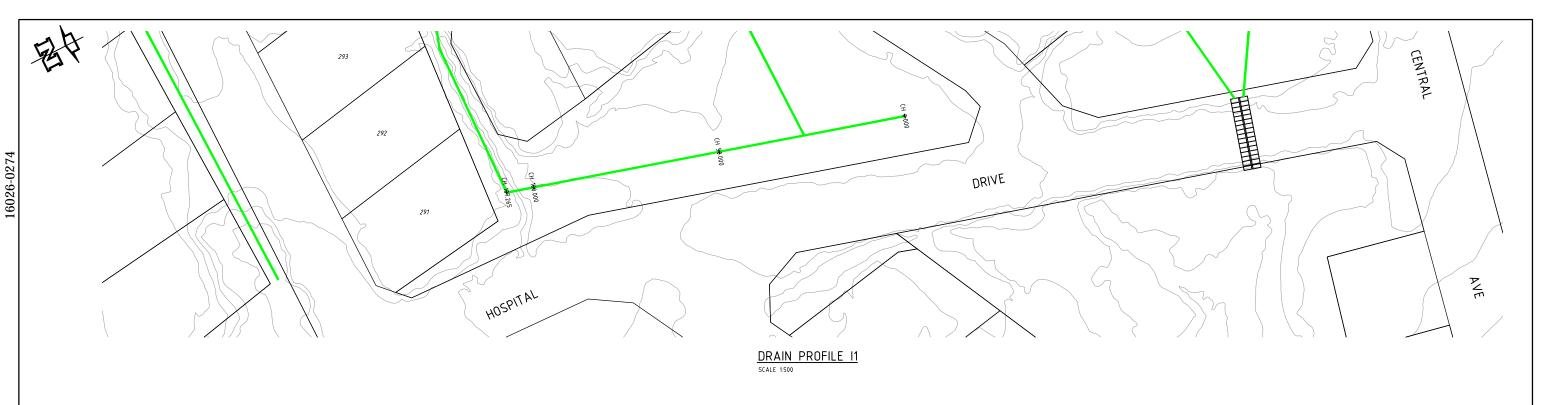
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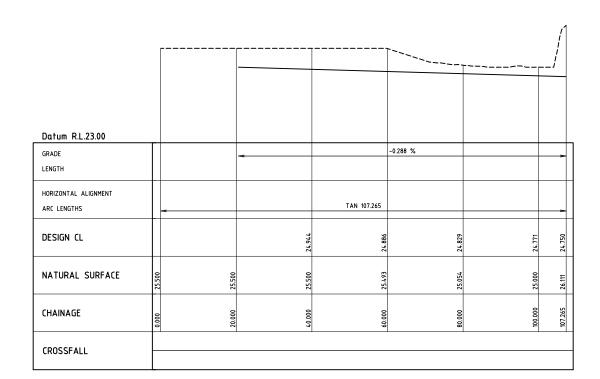
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	CLIENT	CITY OF KARRATHA				
DAMPIER DRAINAGE						
PROPOSED STROMWATER UPGRADE						
	OPEN DRAINAGE REMEDIATION					
	OPEN DRAIN H8 PLAN AND PROFILE					
	SIZE. AS SHOWN DRAWING NUMBER 16026-0272					





DRAIN PROFILE 11

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

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C.BENFIELD D.LUONG

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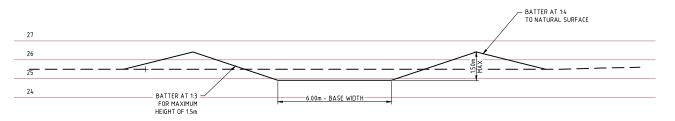
CLIENT CITY OF KARRATHA

PROJECT DAMPIER DRAINAGE

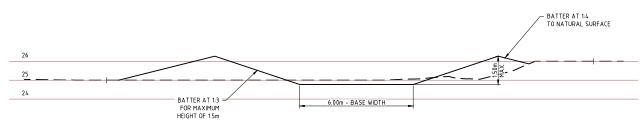
PROPOSED STROMWATER UPGRADE
OPEN DRAINAGE REMEDIATION
OPEN DRAIN 11 PLAN AND PROFILE

SIZE AT AS SHOWN DRAWING NUMBER 16026-0274

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## OPEN DRAIN 11 CHAINAGE 50.0 SCALE 1:100



OPEN DRAIN 11 CHAINAGE 100.0 SCALE 1:100

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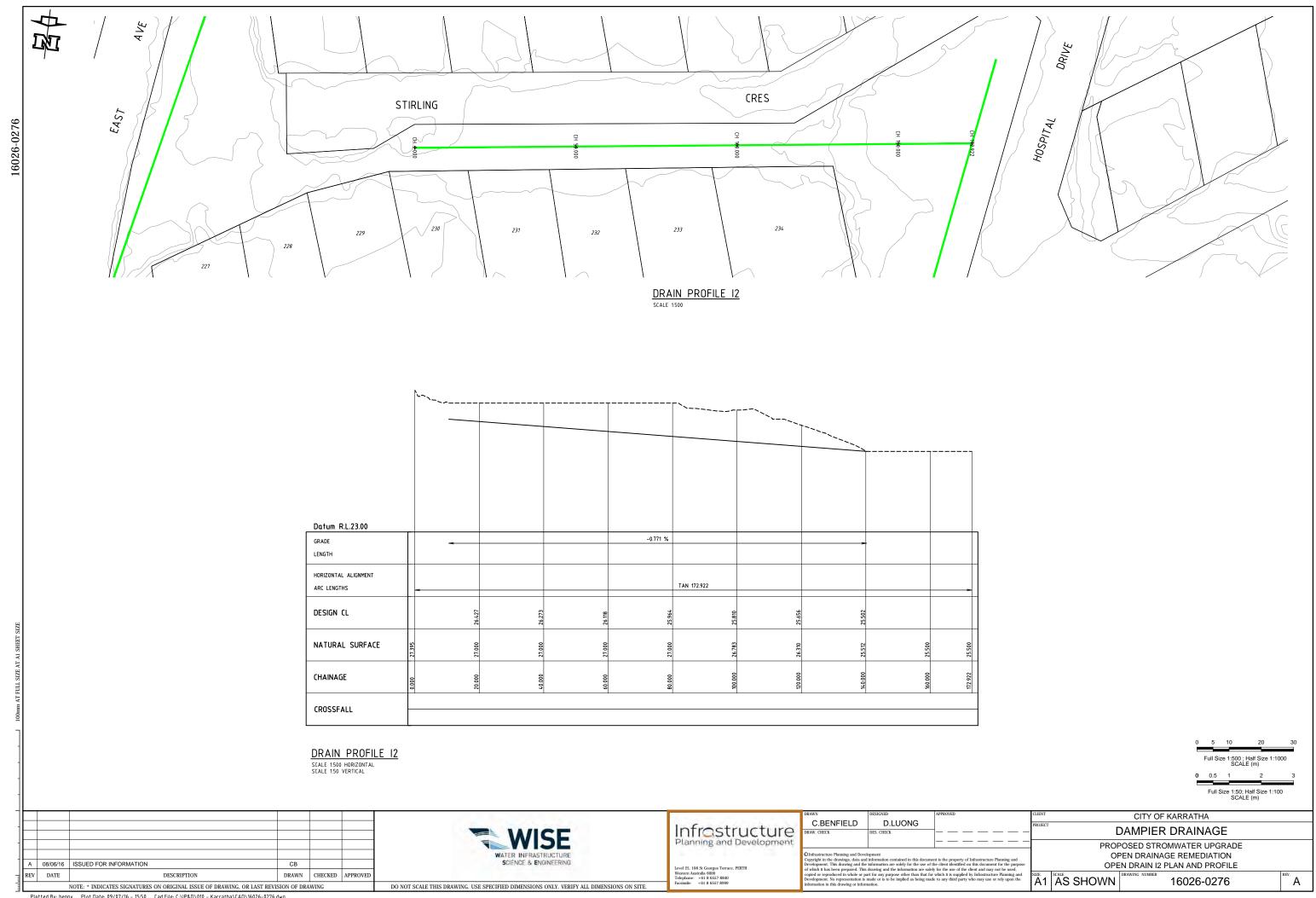
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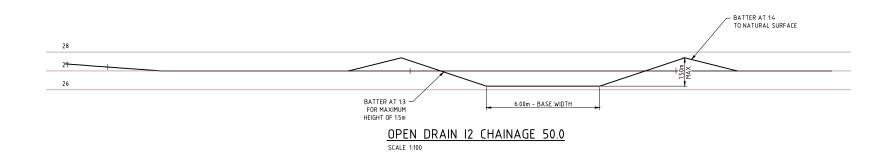
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OPEN DRAIN 11 - CROSS SECTIONS

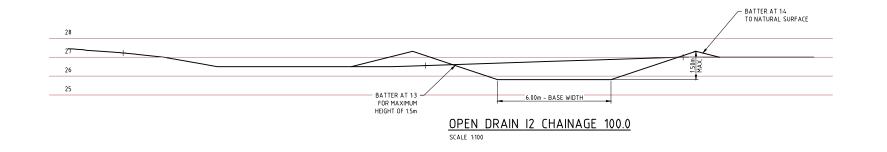
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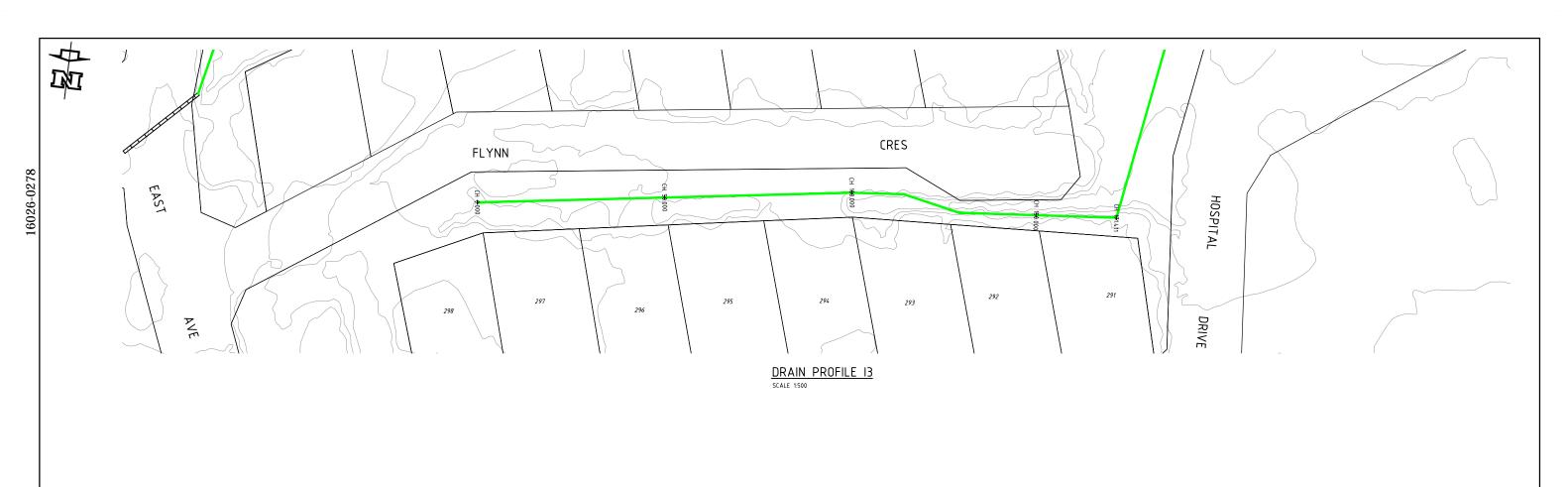
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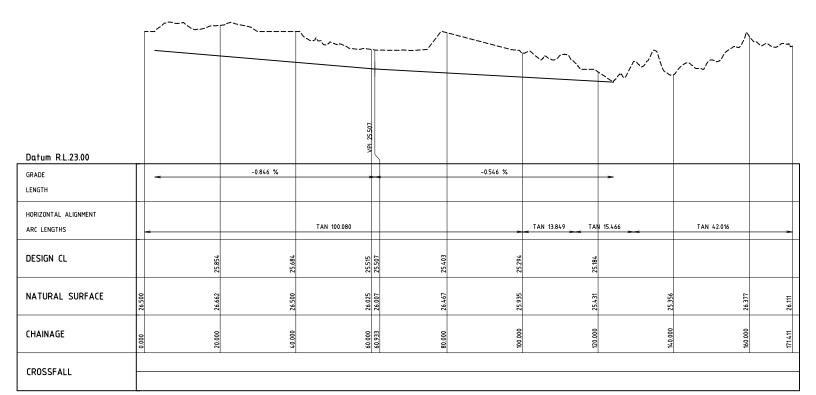
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OPEN DRAINAGE REMEDIATION
OPEN DRAIN 12 - CROSS SECTIONS

SIZE A1 AS SHOWN DRAWING NUMBER 16026-0277





#### DRAIN PROFILE 13

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Full Size 1:50; Half Size 1:100 SCALE (m)

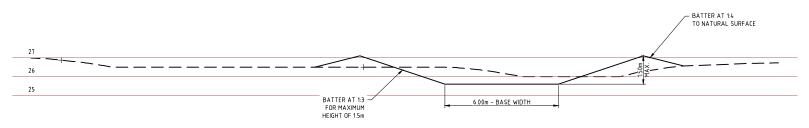
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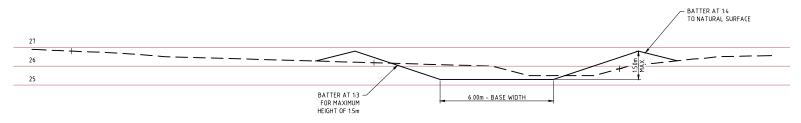
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## OPEN DRAIN 13 CHAINAGE 50.0 SCALE 1:100



OPEN DRAIN 13 CHAINAGE 100.0 SCALE 1:100

Full Size 1:100; Half Size 1:200 SCALE (m)

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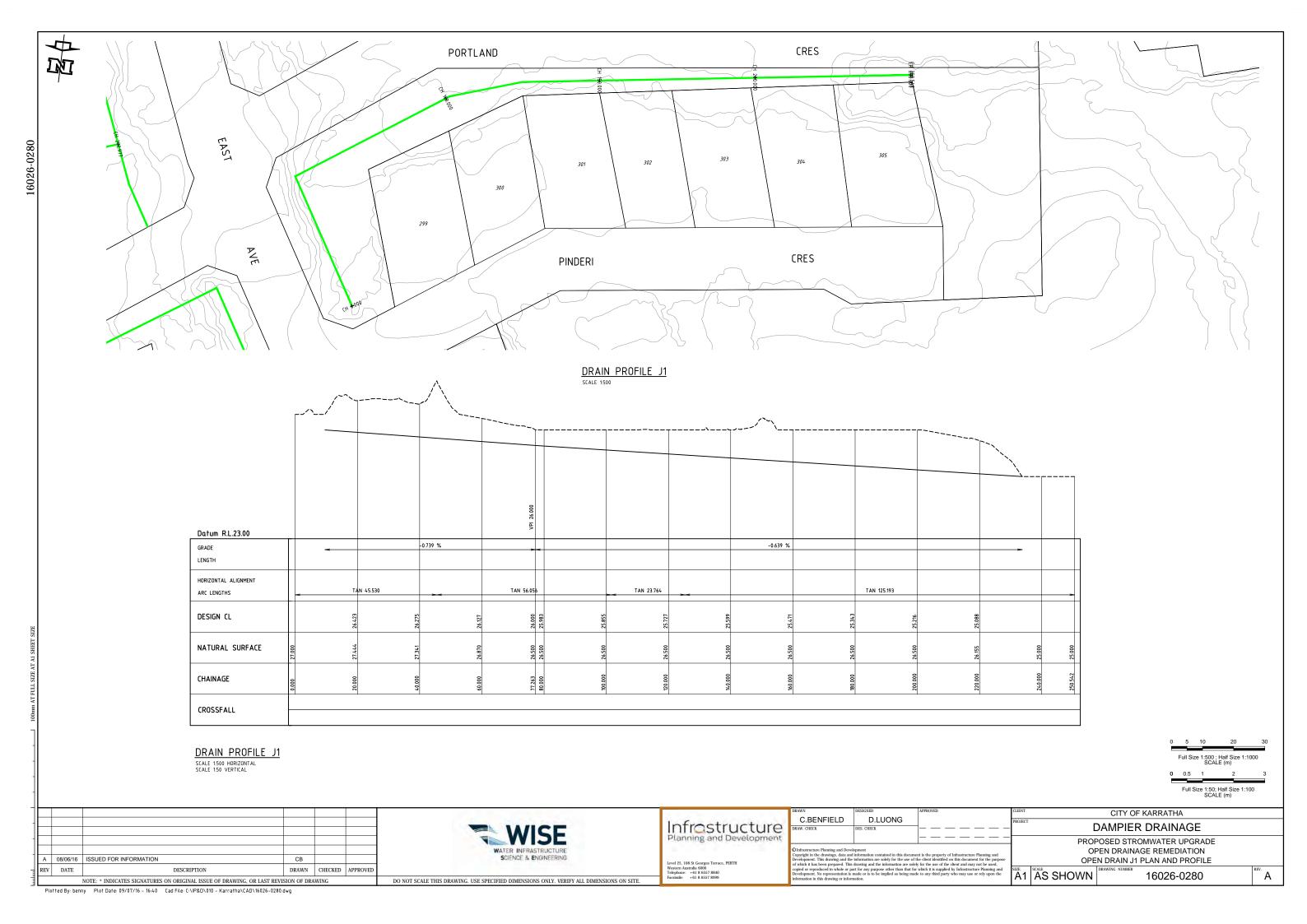
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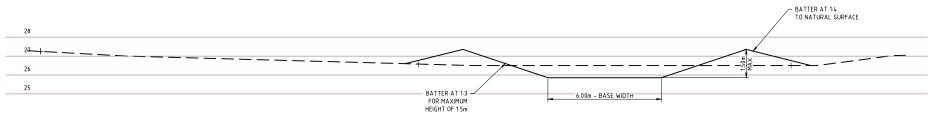
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OPEN DRAIN 13 - CROSS SECTIONS A1 AS SHOWN

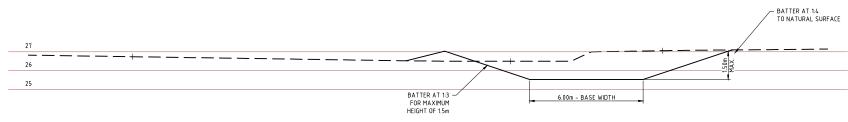
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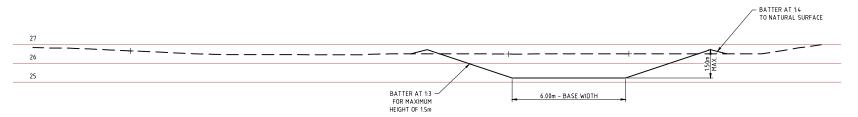




## OPEN DRAIN J1 CHAINAGE 100.0 SCALE 1:100



## OPEN DRAIN J1 CHAINAGE 150.0 SCALE 1:100

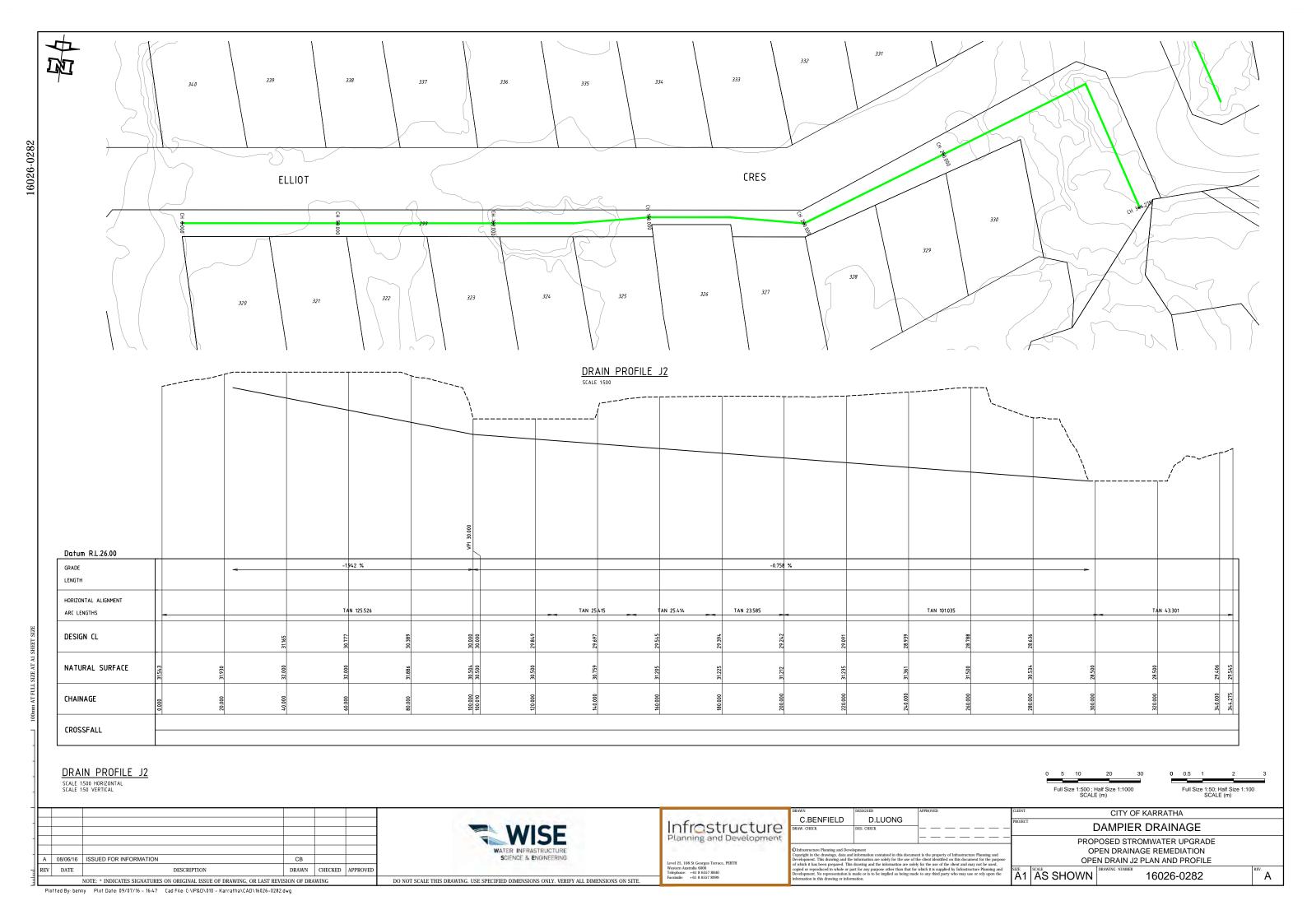


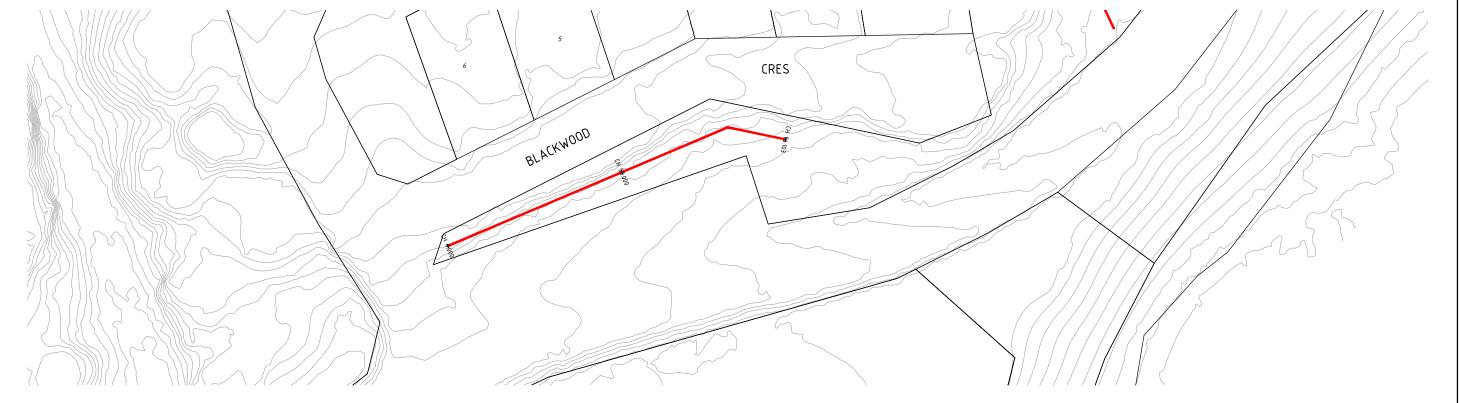
## OPEN DRAIN J1 CHAINAGE 200.0 SCALE 1:100



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RI	V DATE	DESCRIPTION	DRAWN CHECKED	APPROVED		Western Australia 6000 Telephone: +61 8 6557 8840	copied or reproduced in whole or part for any purpose other than that for Development. No representation is made or is to be implied as being ma	or which it is supplied by Infrastructure Planning and ade to any third party who may use or rely upon the	A1 AS SHOWN	16026-0281
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### DRAIN PROFILE K1

Datum R.L.6.00 -1.386 % -2.000 % GRADE LENGTH HORIZONTAL ALIGNMENT TAN 80.491 TAN 15.612 ARC LENGTHS DESIGN CL NATURAL SURFACE CHAINAGE CROSSFALL

#### DRAIN PROFILE K1

SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

Full Size 1:500 ; Half Size 1:1000 SCALE (m)

Full Size 1:50; Half Size 1:100 SCALE (m)

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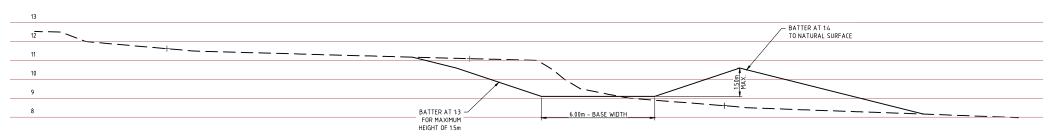
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C.BENFIELD D.LUONG

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## OPEN DRAIN K1 CHAINAGE 50.0 SCALE 1:100

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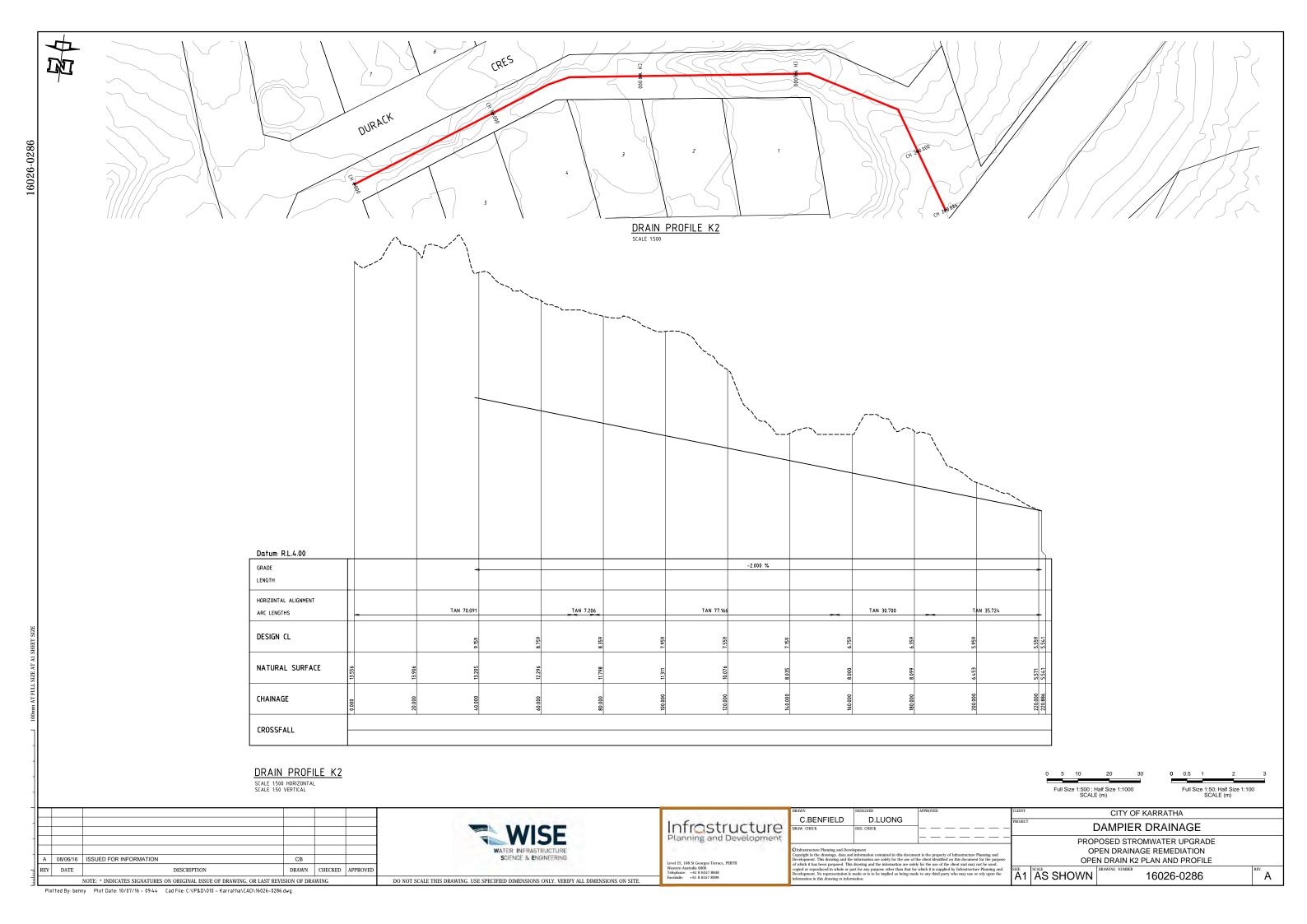
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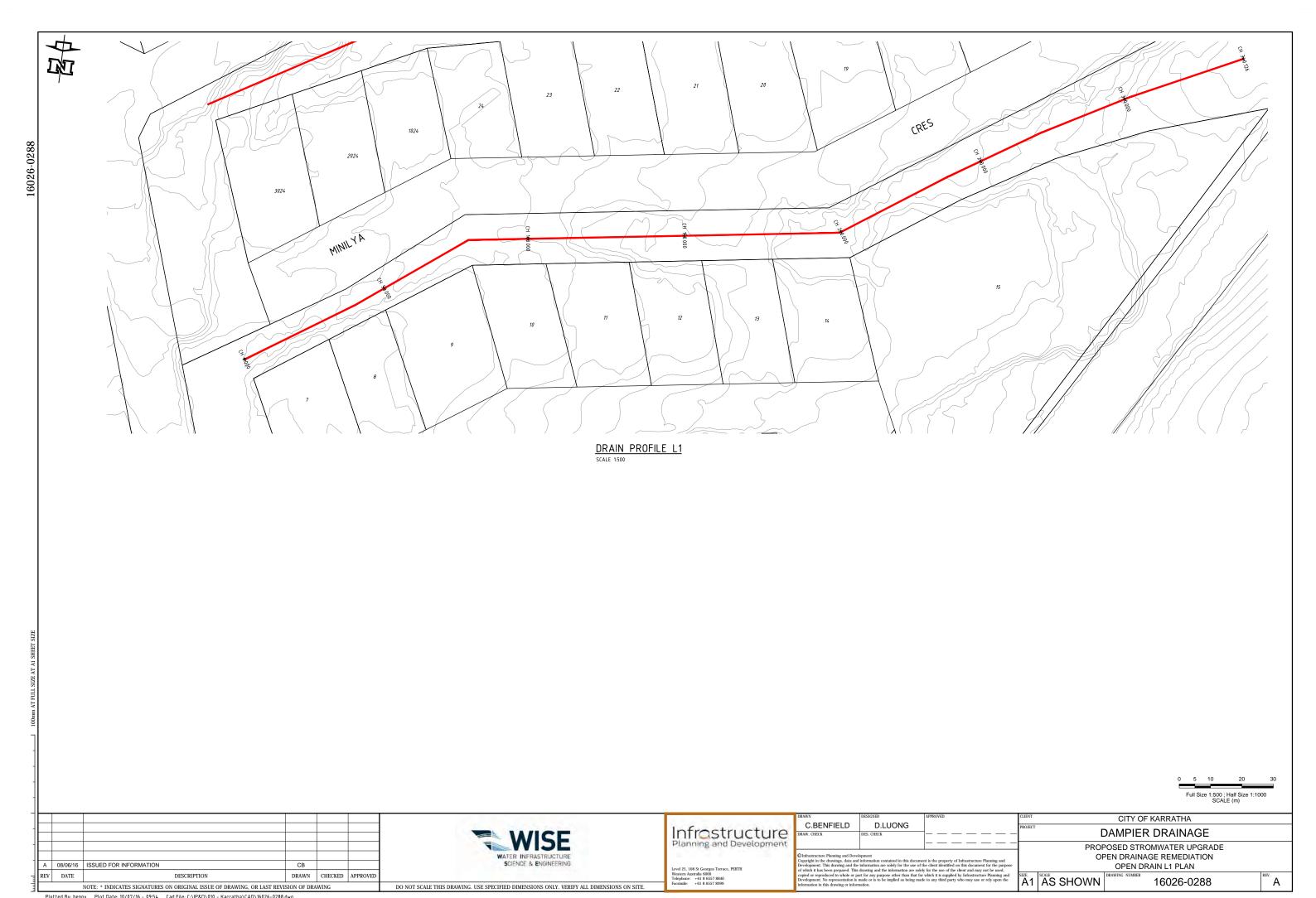
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PROPOSED STROMWATER UPGRADE OPEN DRAINAGE REMEDIATION OPEN DRAIN K1 - CROSS SECTIONS

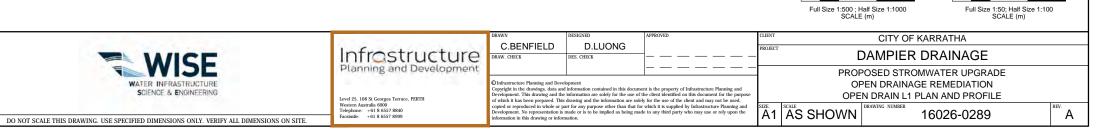
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Datum R.L.2.00 -2.000 % GRADE LENGTH HORIZONTAL ALIGNMENT TAN 39.009 TAN 42.033 TAN 118.382 TAN 39.220 TAN 32.929 TAN 30.761 ARC LENGTHS DESIGN CL NATURAL SURFACE 340.000 CHAINAGE CROSSFALL DRAIN PROFILE L1 SCALE 1:500 HORIZONTAL SCALE 1:50 VERTICAL

WATER INFRASTRUCTURE SCIENCE & ENGINEERING



DESCRIPTION

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Full Size 1:500 ; Half Size 1:1000 SCALE (m)

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D.LUONG

C.BENFIELD

CITY OF KARRATHA DAMPIER DRAINAGE PROPOSED STROMWATER UPGRADE OPEN DRAINAGE REMEDIATION OPEN DRAIN L2 PLAN A1 AS SHOWN 16026-0291 Α

Datum R.L.4.00 -2.000 % GRADE LENGTH HORIZONTAL ALIGNMENT TAN 76 678 TAN 94.808 TAN 18.181 TAN 48.982 TAN 22.137 TAN 44.703 TAN 35.747 ARC LENGTHS DESIGN CL NATURAL SURFACE CHAINAGE CROSSFALL DRAIN PROFILE L2

SCALE 1.500 HORIZONTAL
SCALE 1.500 VERTICAL

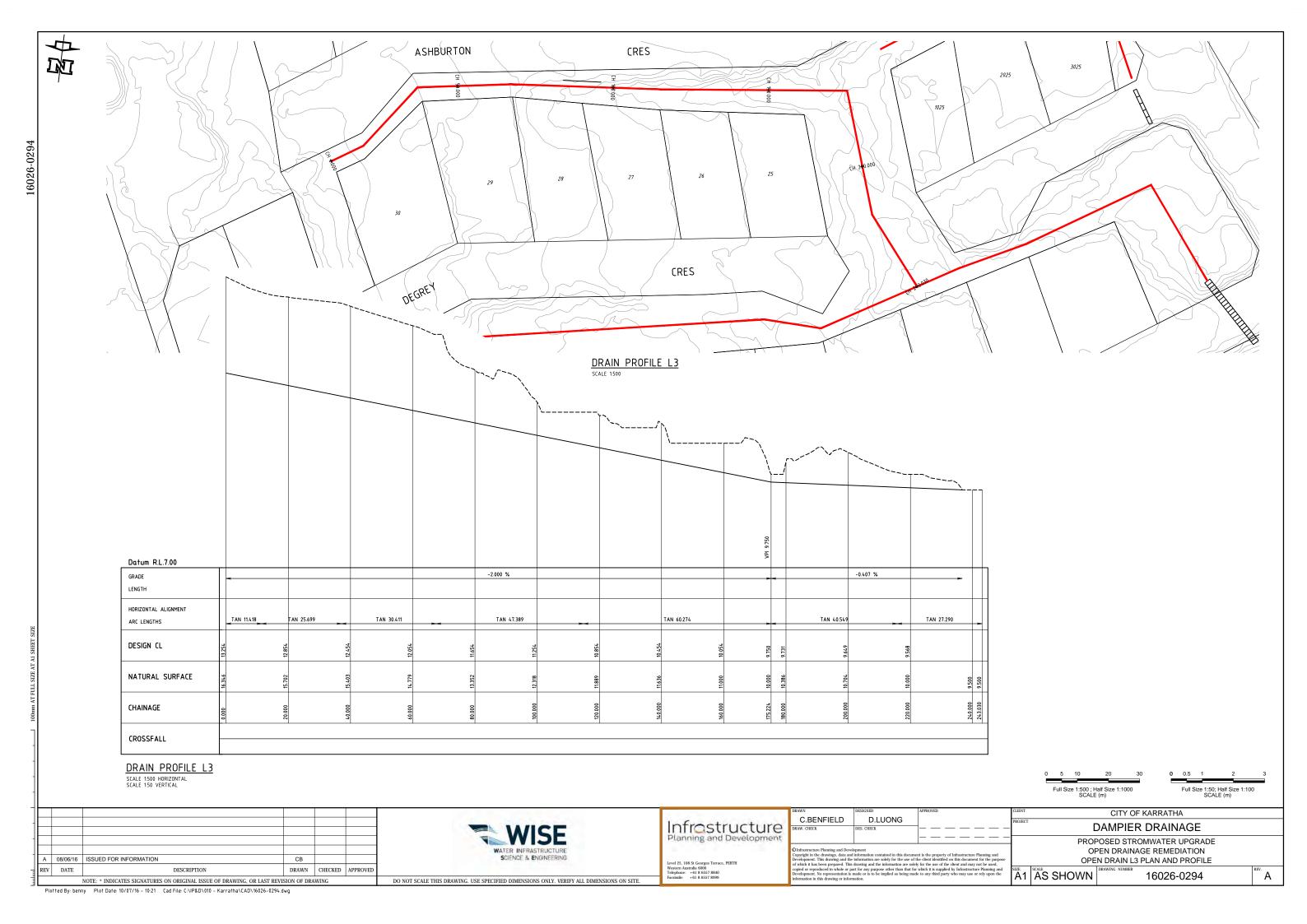
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-	Western Australia 6000 Telephone: +61 8 6557 8840 Facsimile: +61 8 6557 8999	copied or reproduced in whole or p	art for any purpose other than that for made or is to be implied as being made	r which it is supplied by Infrastructure Planning and de to any third party who may use or rely upon the	A1	AS SHOWN	DRAWING NUMBER 16026	6-0292	REV.

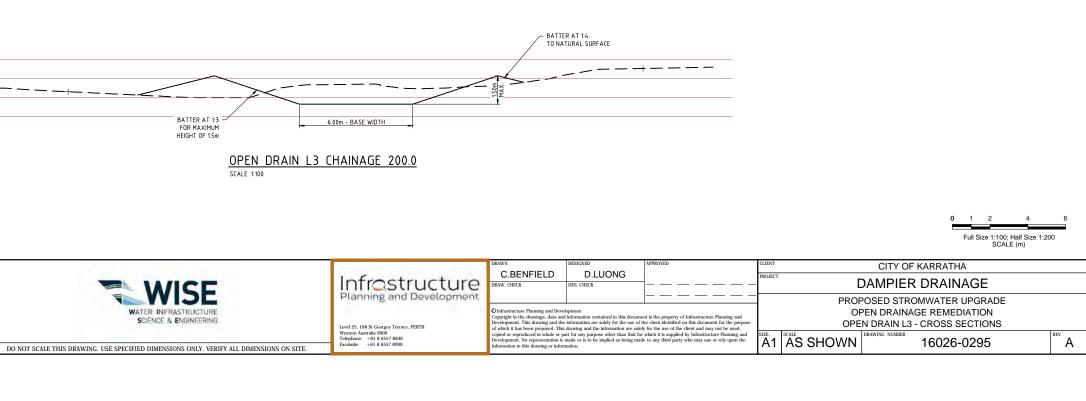
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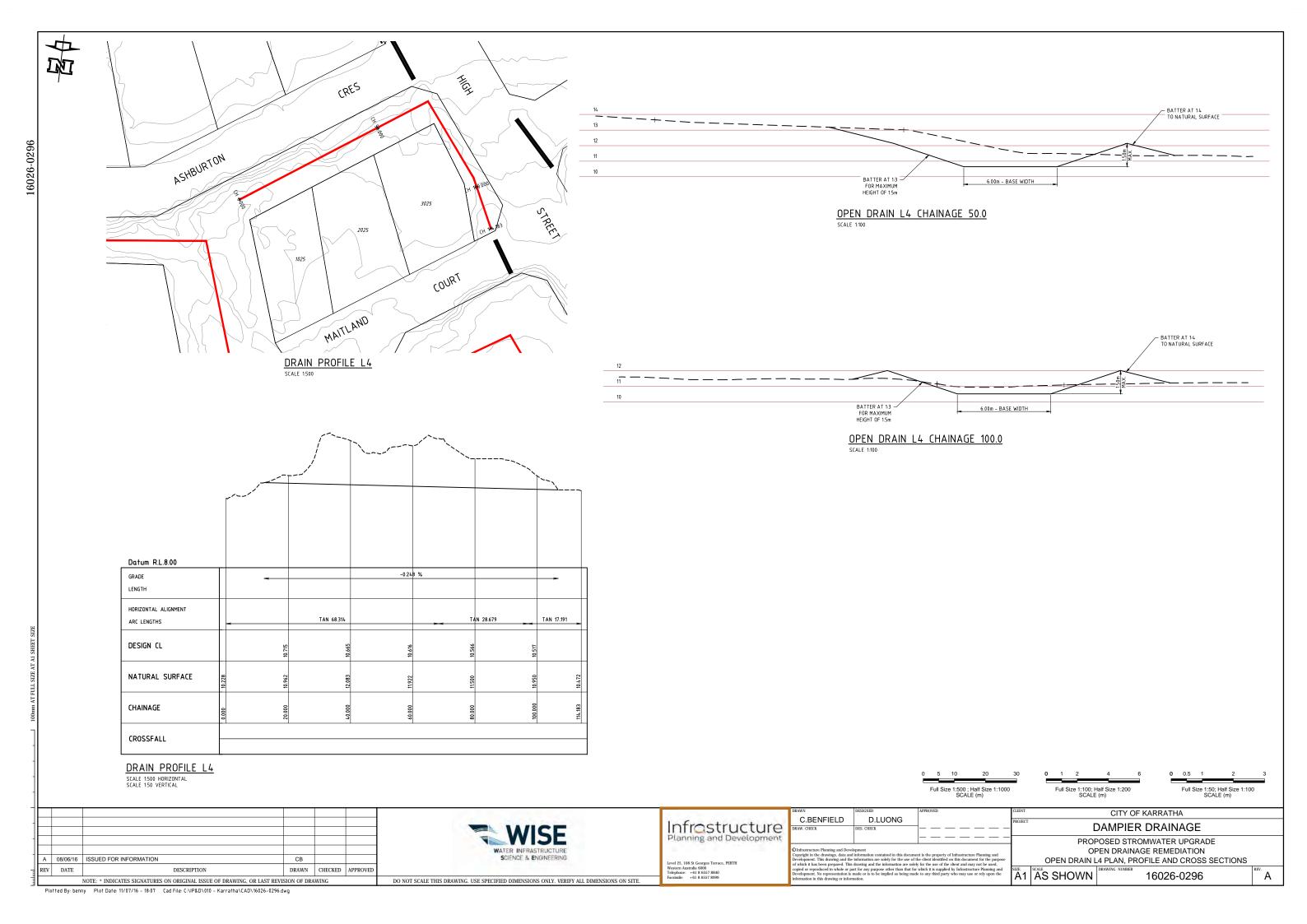
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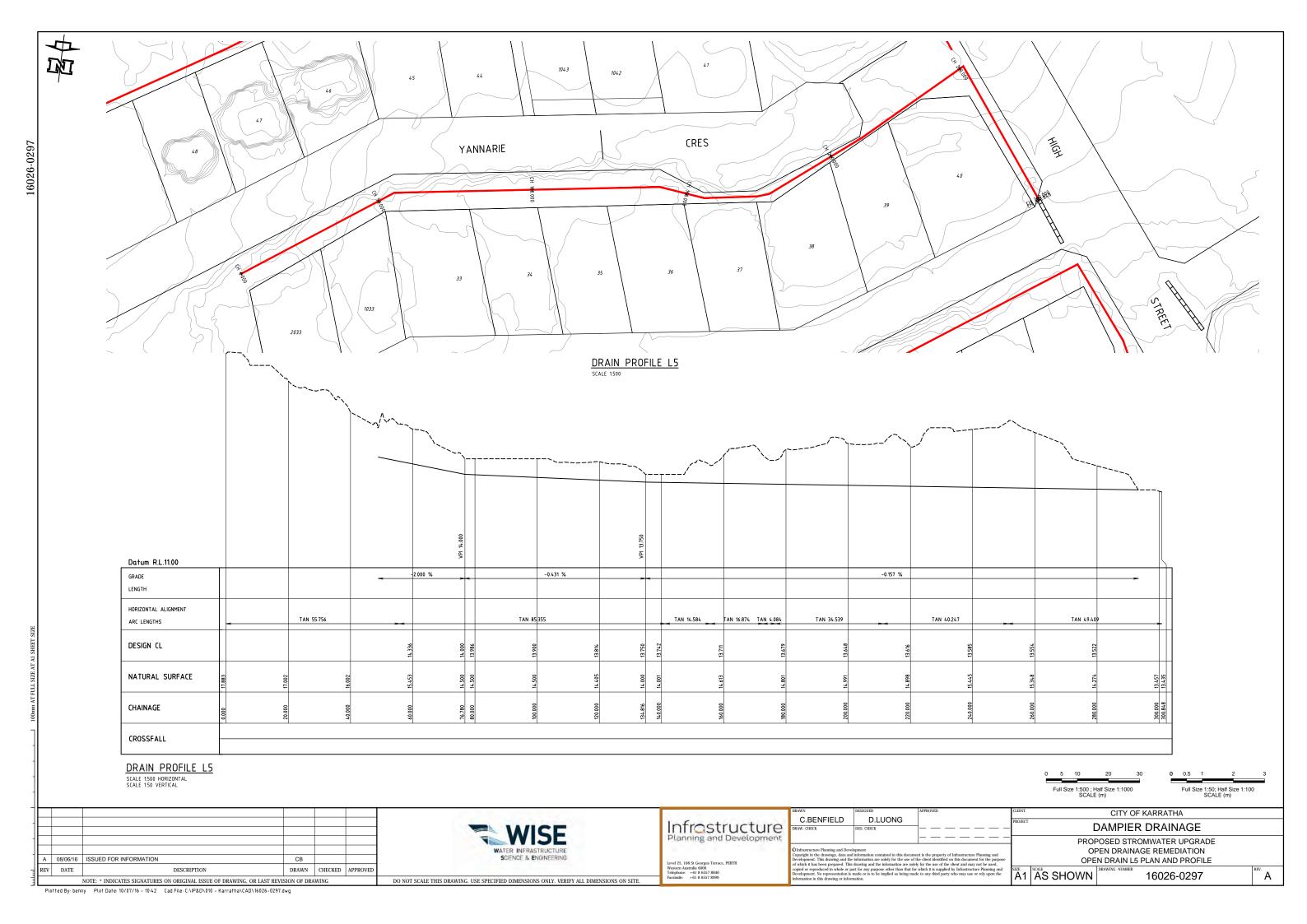
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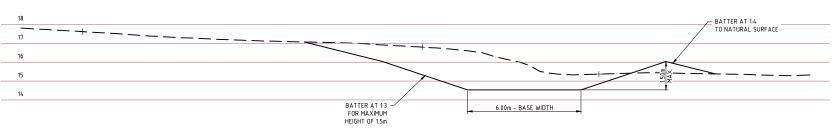
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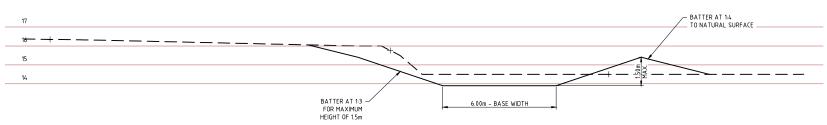
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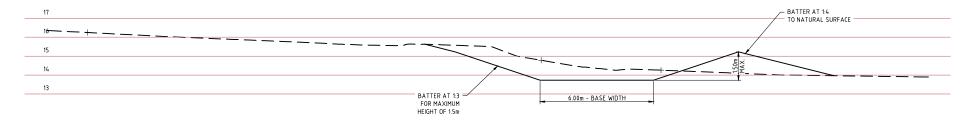




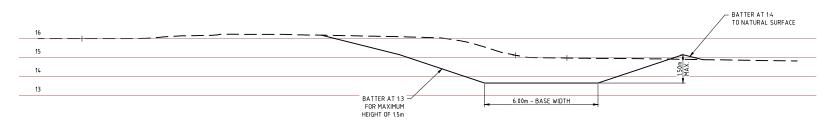
# OPEN DRAIN L5 CHAINAGE 50.0 SCALE 1:100



### OPEN DRAIN L5 CHAINAGE 100.0 SCALE 1:100



## OPEN DRAIN L5 CHAINAGE 150.0 SCALE 1:100



### OPEN DRAIN L5 CHAINAGE 200.0 SCALE 1:100

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VVIDE	Planning and Development						POSED STROMWATER UPGRADE	
WATER INFRASTRUCTURE SCIENCE & ENGINEERING		Olnfarstructure Planning and Development Copyright in the drawings, data and information contained in this document is the property of Infrastructure Planning and Development. This drawing and the information are solely for the use of the client identified on this document for the purpose		OPEN DRAINAGE REMEDIATION OPEN DRAIN L5 - CROSS SECTIONS				
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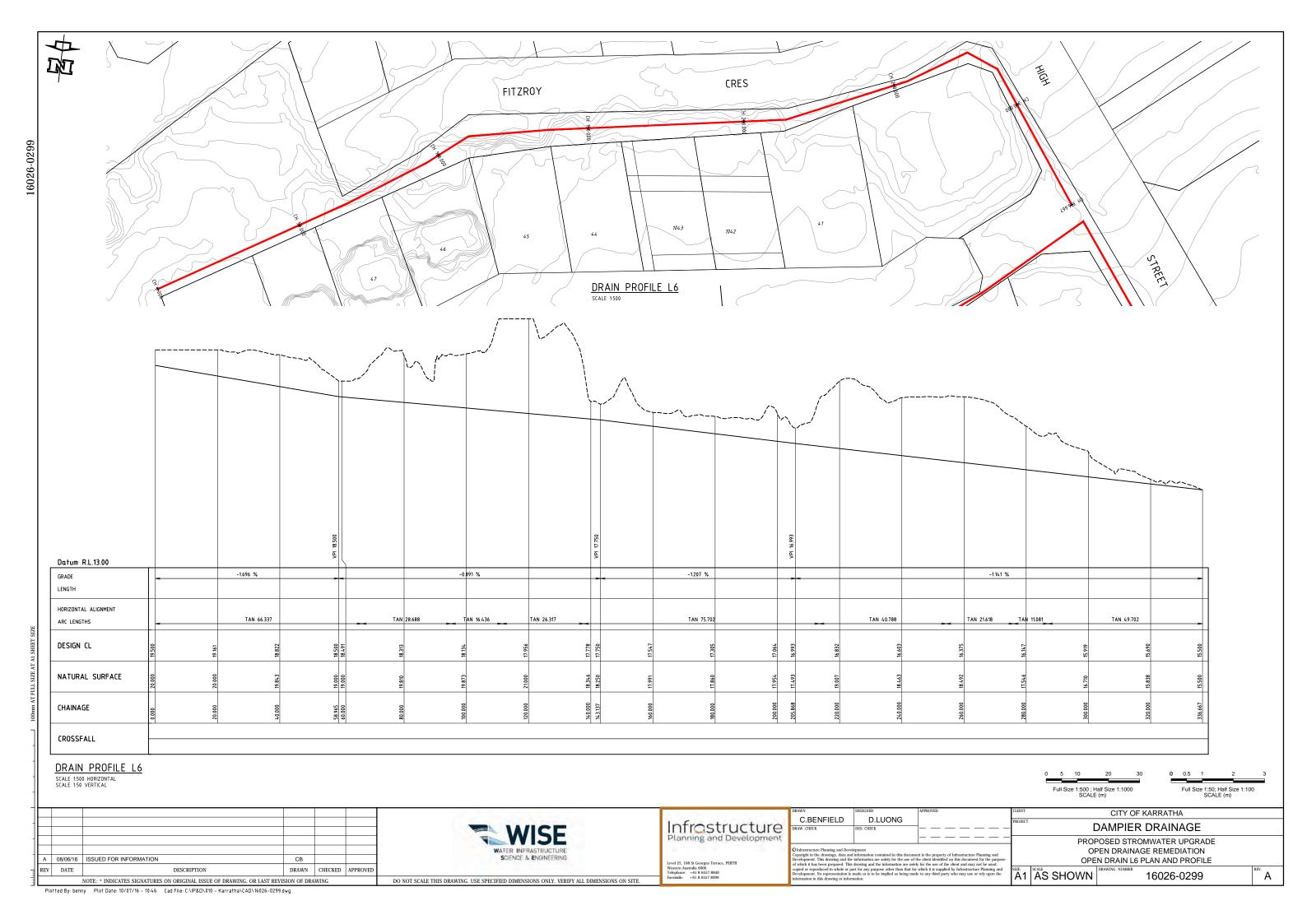
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DESCRIPTION

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## C.BENFIELD D.LUONG

**CULVERT SCHEDULE:** 

LOCATION

LAWSON DVE / YULE CRES

YULE CRES

HAMPTON DVE

HAMPTON DVE

HOSPITAL DVE

MINILYA CRES

MAITLAND CRT

ASHBURTON CRES

YANNARIE CRES

PATTERSON CRES

BOOLGEEDA CRT

BOOLGEEDA CRT

THYSSEN CRES

BERKELEY CRES

HARDY CRES

LYNDON CRES

ASHBURTON CRES

WOORAMEL CRES

FLINDERS CRES

EAST AVE / WILKIE CRES

EAST AVE / HARTOG CRES

DAMPIER DVF / CENTRAL AVE

DAMPIER DVE / PRINSEP CRES

HAMPTON DVE / DAWSON RD

WEST AVE / LYNDON CRES

WEST AVE / NAMATJIRA RD

WEST AVE / WOORAMEL CRES

HUON ST

NEILSEN CRT

LAWSON DVE / ROBE CRES

LAWSON DVE / ROBE CRES

WEST AVE

HAMPTON DVE / LOCKYER CRES

WORKS DESCRIPTION

INSTALL NEW 1xØ600mm CLASS 4 RCP

INSTALL NEW 1xØ600mm CLASS 4 RCP

INSTALL NEW 1xØ600mm CLASS 4 RCP

INSTALL NEW 4xØ600mm CLASS 4 RCP

INSTALL NEW 4xØ600mm CLASS 4 RCP

INSTALL NEW 4xØ600mm CLASS 4 RCP

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Full Size 1:5000 ; Half Size 1:10000 SCALE (m)

Α

NAME

CULVERT No. 336

CULVERT No. 318

CULVERT No. 319

CULVERT No. 334

CULVERT No. 335

CULVERT No. 323

CULVERT No. 206

CULVERT No. 332

CULVERT No. 333

CULVERT No. 2

CULVERT No. 4

CULVERT No. 5

CULVERT No. 6

CULVERT No. 10

CULVERT No. 18

CULVERT No. 21 CULVERT No. 25

CULVERT No. 29

CUI VERT No. 34

CULVERT No. 36

CULVERT No. 39

CULVERT No. 40

CULVERT No. 49

CULVERT No. 57

CULVERT No. 59

CULVERT No. 61

CULVERT No. 63

CULVERT No. 62

CULVERT No. 64

CULVERT No. 65

CULVERT No. 67

CULVERT No. 68

CULVERT No. 69

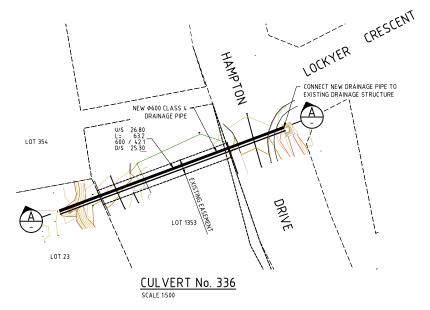
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CITY OF KARRATHA DAMPIER DRAINAGE

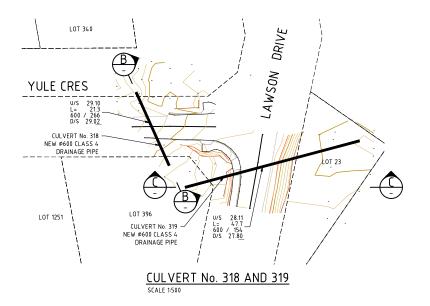
PROPOSED STROMWATER UPGRADE CULVERT UPGRADE OVERALL CULVERT LAYOUT

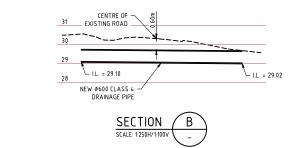
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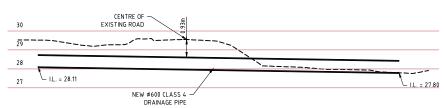
# CULVERT No. 25 - CULVERT No. 318 CULVERT No. 2 ULVERT No. 18 CULVERT No. 64 CULVERT No. 5 - CULVERT No. 332 CULVERT No. 29 CULVERT No. 6 - [CULVERT No. 333] CULVERT No. 40 CULVERT No. 63 CULVERT No. 65 CULVERT No. 334 & 335 CULVERT No. CULVERT No. 59 1



CENTRE OF — EXISTING ROAD









### DIAL BEFORE YOU DIG www.1100.com.au The Essential First Step

CENTRE OF \_\_ EXISTING ROAD

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NEW Ø600 CLASS 4 -DRAINAGE PIPE

SECTION



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SECTION

C.BENFIELD	D.LUONG		PROJECT
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information in this drawing or inform	lauon.		, , , ,

- ALL WORKS SHALL BE CARRIED OUT TO THE REQUIREMENTS OF THE LOCAL AUTHORITY, WHERE
  THEIR REQUIREMENTS ARE IN CONFLICT WITH WHAT IS SHOWN ON THE DRAWINGS, THE
  CONTRACTOR SHALL OBTAIN DIRECTION FROM THE SUPERINTENDENT PRIOR TO PROCEEDING WITH THE CONSTRUCTION.
- THE CUNSTRUCTION.

  2. THE CONTRACTOR SHALL COMPLY WITH LOCAL AUTHORITY CONDITIONS IN REGARDS TO SAND-ORIFT, STABILISATION AND THE REQUIREMENT OF WATER CARTS TO MINIMISE DUST BLOW TO NEIGHBOURING PROPERTIES.

  3. THE CONTRACTOR SHALL PROTECT AND MAINTAIN EXISTING TREES, POWER LINES, POLES AND
- 3. THE CONTRACTOR SHALL PROTECT AND MAINTAIN EXISTING TREES, POWER LINES, POLES AND OTHER SERVICES ALLONG EXISTING ROADS AT ALL TIMES.

  4. THE CONTRACTOR SHALL ALLOW FOR AND CARRY OUT STABILISATION OF ALL EARTHWORKED AREAS INCLUDING ROAD VERGES, AND ANY DISTURBED AREAS USING HYDROMULCH WITHOUT SEED, UNLESS OTHERWISE DIRECTED OR DISCUSSED WITH THE SUPERINTENDENT ON SITE.

  5. ALL LEVELS SHALL BE BASED ON BENCHMARKS AS SUPPLIED BY SURVEYOR.

  6. CONTRACTOR SHALL LOCATE ALL EXISTING SERVICES, PRIOR TO WORKS COMMENCING AND DEDUCTED FOR THE MAINTAIN OF THE
- PROTECT FOR THE DURATION OF THE WORKS. ANY DAMAGE TO SERVICES IS THE RESPONSIBILITY OF THE CONTRACTOR TO REPAIR IN ACCORDANCE WITH THAT SERVICE AUTHORITY REQUIREMENTS. ANY DETAILS OF EXISTING SERVICES SHOWN ON THE DRAWINGS ARE INDICATIVE ONLY.
- ARE INDICATIVE ONLY.
  ALL PIPES SHALL BE (LASS (4) REINFORCED CONCRETE (RR.)) UNLESS OTHERWISE NOTED.
  THE CONTRACTOR SHALL NOTIFY THE SUPERINTENDENT WHERE 400mm MINIMUM COVER IS NOT
- A CHIEVEL).

  9. CONTRACTOR SHALL CONTACT SUPERINTENDENT PRIOR CONSTRUCTION, WHEN AN INCORRECT INVERT LEVEL OR GRADE IS FOUND. (INVERT LEVELS OVER-RIDE GRADES GIVEN)

  10. DRAINAGE PIPES SHALL BE PILED AND KEELED WHERE THEY CROSS ABOVE SEWER LINES. THE
- PILE AND KEEL DETAIL SHALL BE AS ADOPTED BY THE WATER CORPORATION.

  11. BACKFILL SHALL BE PLACED AND COMPACTED IN LIFTS NOT EXCEEDING 300mm. CONTRACTOR SHALL NOTIEY SUPERINTENDENT PRIOR TO COMMENCING NEXT LIFT. ALL COMPACTION MUST BE TO 95% MMDD.
- 12. THE CONTRACTOR SHALL PROVIDE 'AS-CONSTRUCTED' INFORMATION FOR DRAINAGE IN COMPLIANCE WITH THE LOCAL AUTHORITY'S LATEST REQUIREMENTS.

#### LEGEND:

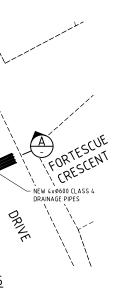
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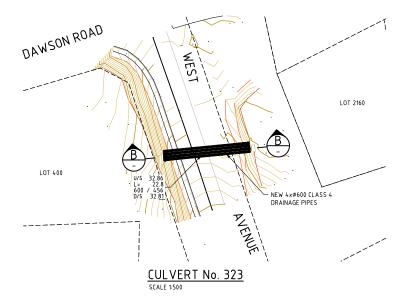
PROPOSED DRAINAGE ROAD KERBING

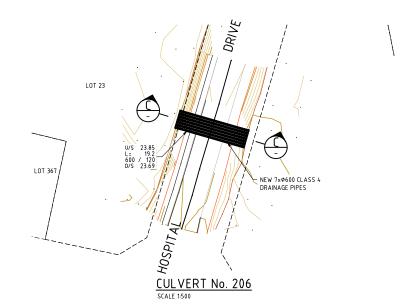
PIPE CLASS UPSTREAM INVERT LEVEL PIPE LENGTH PIPE DIAMETER / PIPE GRADE DOWNSTREAM INVERT LEVEL

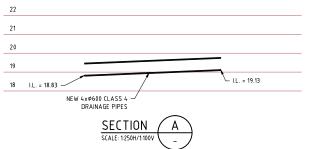
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CITY OF KARRATHA DAMPIER DRAINAGE PROPOSED STROMWATER UPGRADE CULVERT UPGRADE SHEET 1 OF 10 1:1000 16026-0301 Α









CONTRACTOR TO CONFIRM EXISTING DRAINAGE INFRASTRUCTURE AND REPORT TO SUPERINTENDENT PRIOR TO CONSTRUCTION

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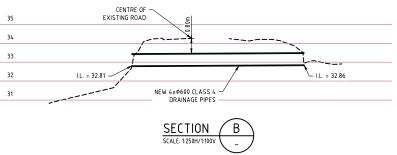
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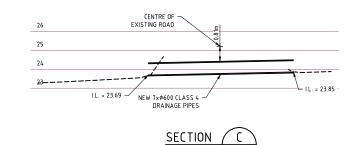
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SECTION B

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WATER INFRASTRUCTURE
SCIENCE & ENGINEERING

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Western Australia 6000
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Fassimile: +101 8 6357 8899

DRAWN	DESIGNED	APPROVED	CLIENT			CITY OF	KARRATHA
C.BENFIELD DRAW. CHECK	D.LUONG DES. CHECK		PROJECT			DAMPIER	DRAINAGE
					PROF	POSED STRO	MWATER UPGRADE
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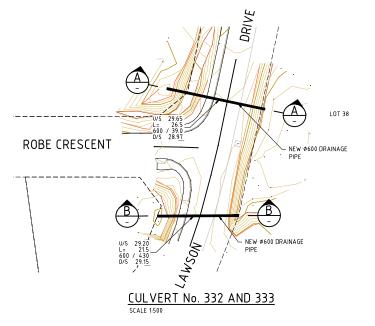
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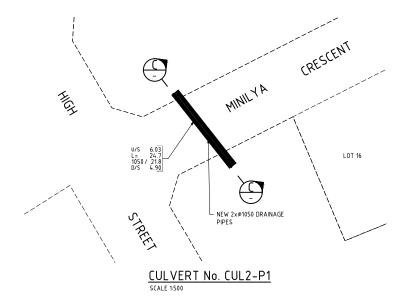
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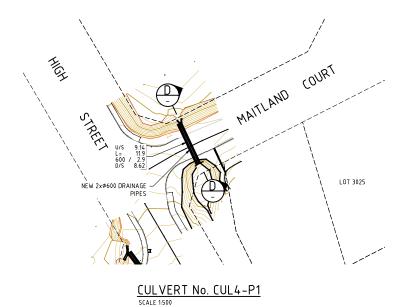


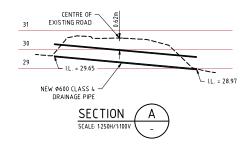
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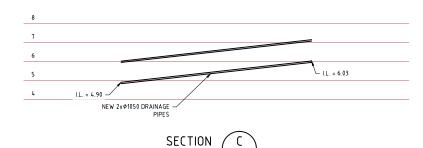
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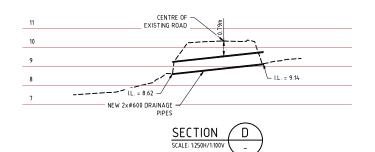


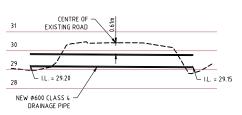














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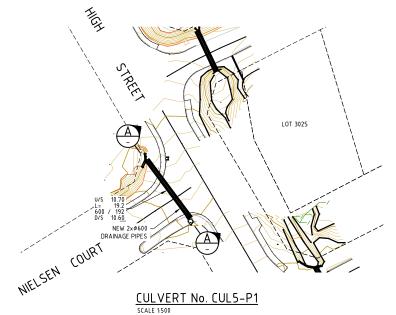
CITY OF KARRATHA

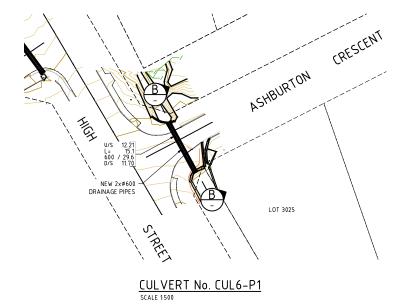
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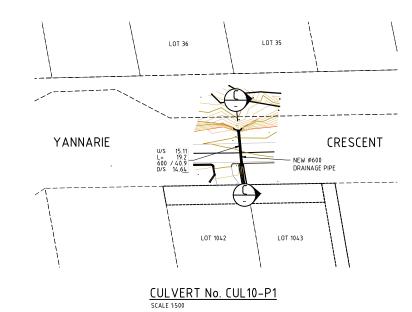
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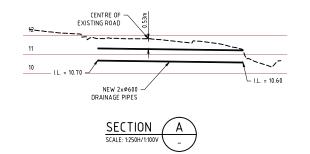


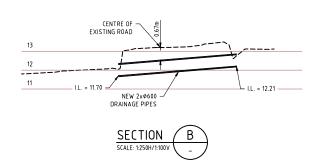


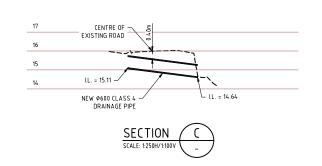


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CITY OF KARRATHA	
DAMPIER DRAINAGE	
PROPOSED STROMWATER UPGRADE	
CULVERT UPGRADE	
SHEET 4 OF 10	

16026-0304

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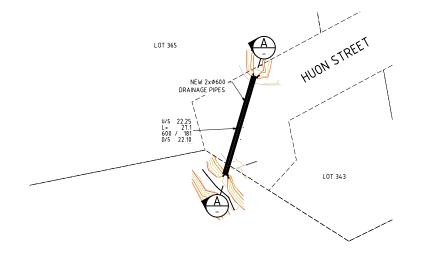


CITY OF KARRATHA DAMPIER DRAINAGE PROPOSED STROMWATER UPGRADE CULVERT UPGRADE SHEET 5 OF 10

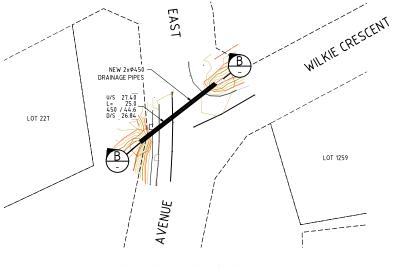
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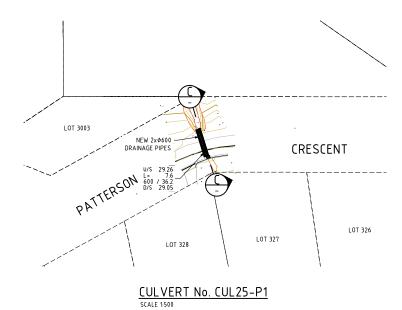
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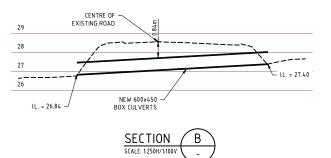


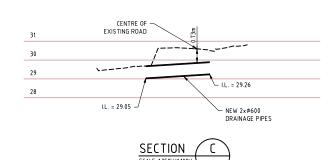
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└ I.L. = 22.25 NEW 2xØ600 -DRAINAGE PIPES I.L. = 22.10 -SECTION

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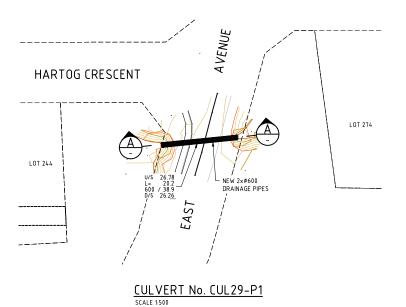


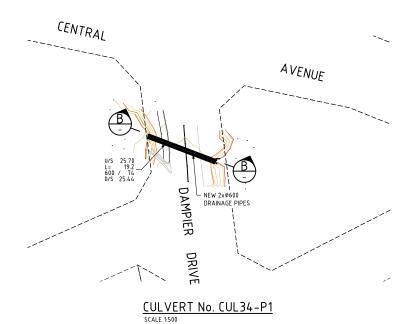


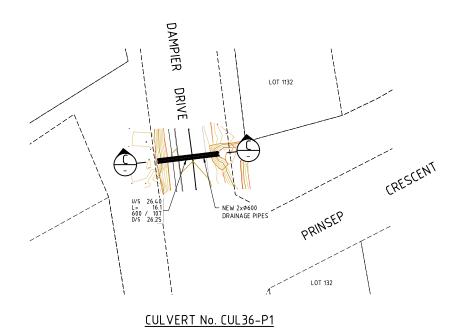
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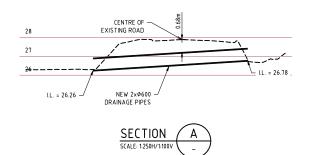
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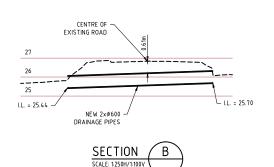


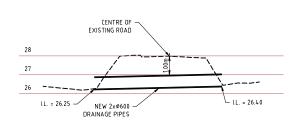












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CITY OF KARRATHA DAMPIER DRAINAGE

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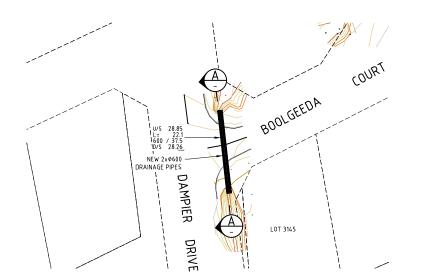
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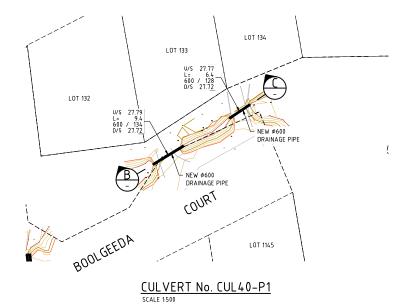
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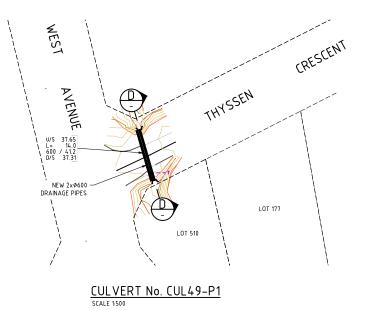
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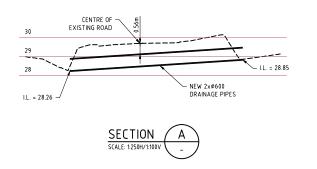
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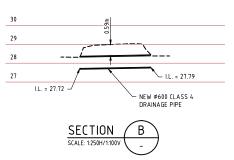






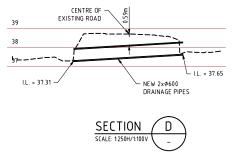


CULVERT No. CUL39-P1



SECTION SCALE: 1:250H/1:100V





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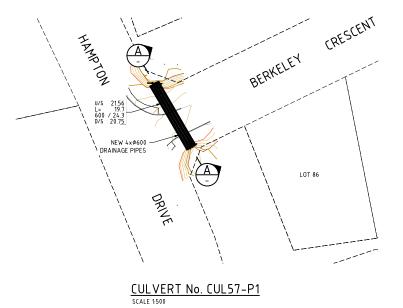
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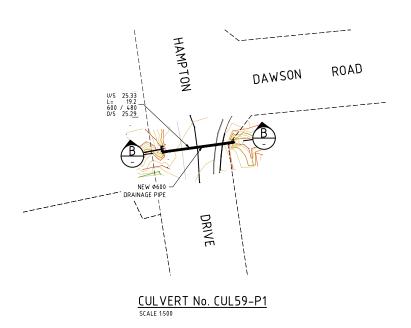
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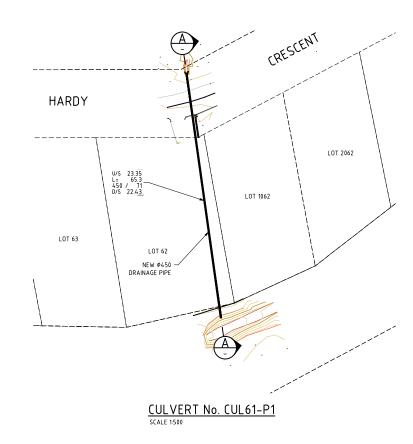
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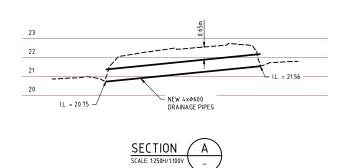
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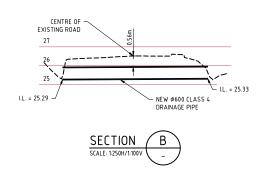


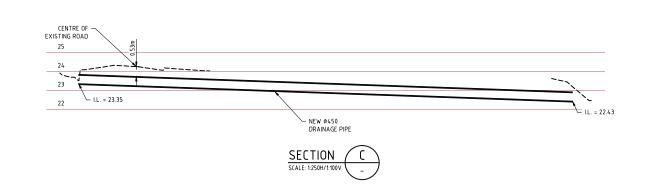














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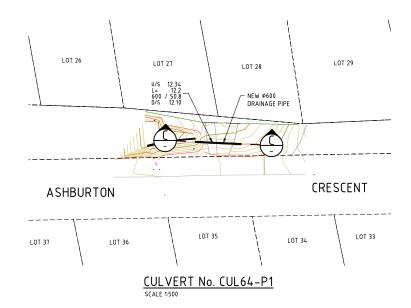


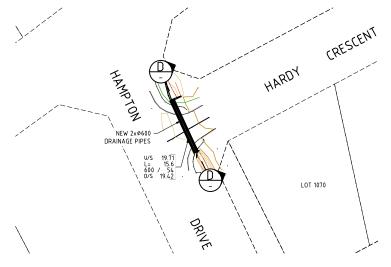
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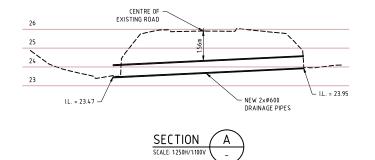
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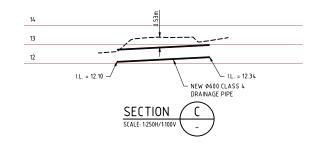
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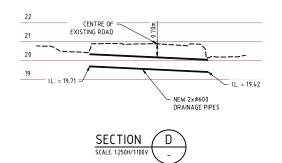


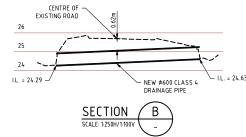


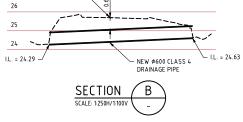
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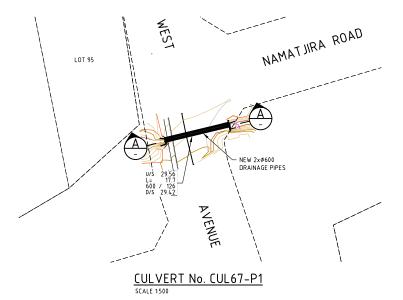
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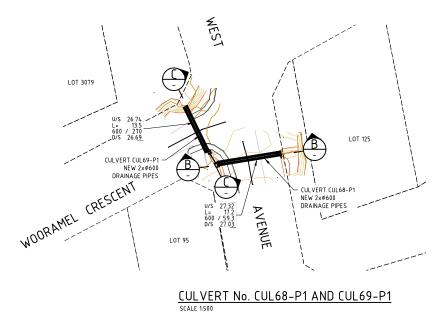
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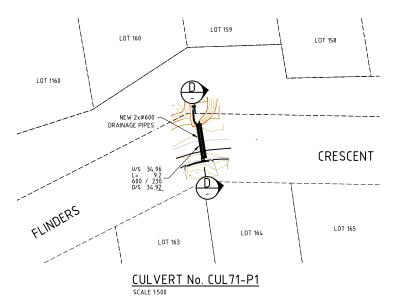
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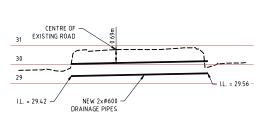
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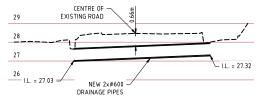




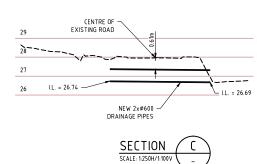


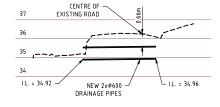
















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REV	DATE	DESCRIPTION DRAWN	CHECKED APPROVED		Western Australia 6000 Telephone: +61 8 6557 8840	copied or reproduced in whole or Development. No representation is	part for any purpose other than that f s made or is to be implied as being m	or which it is supplied by Infrastructure Planning and ide to any third party who may use or rely upon the	A1 SCALE 1:10	00 DRAWING NUMBER 16026-0310
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D.LUONG

CITY OF KARRATHA DAMPIER DRAINAGE PROPOSED STROMWATER UPGRADE

1:1000

CROSS OVER UPGARDE CROSS OVER LAYOUT PLAN - SHEET 1 OF 5

16026-0400

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C.BENFIELD

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D.LUONG

C.BENFIELD

CITY OF KARRATHA

DAMPIER DRAINAGE

PROPOSED STROMWATER LIPGRA

PROPOSED STROMWATER UPGRADE CROSS OVER UPGARDE CROSS OVER LAYOUT PLAN - SHEET 2 OF 5

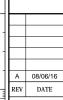
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C.BENFIELD D.LUONG

PROPOSED STROMWATER UPGRADE CROSS OVER UPGARDE CROSS OVER LAYOUT PLAN - SHEET 3 OF 5

CITY OF KARRATHA

DAMPIER DRAINAGE

Full Size 1:1000 ; Half Size 1:2000 SCALE (m)

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PROPOSED STROMWATER UPGRADE CROSS OVER UPGARDE CROSS OVER LAYOUT PLAN - SHEET 5 OF 5

Full Size 1:1000 ; Half Size 1:2000 SCALE (m)

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