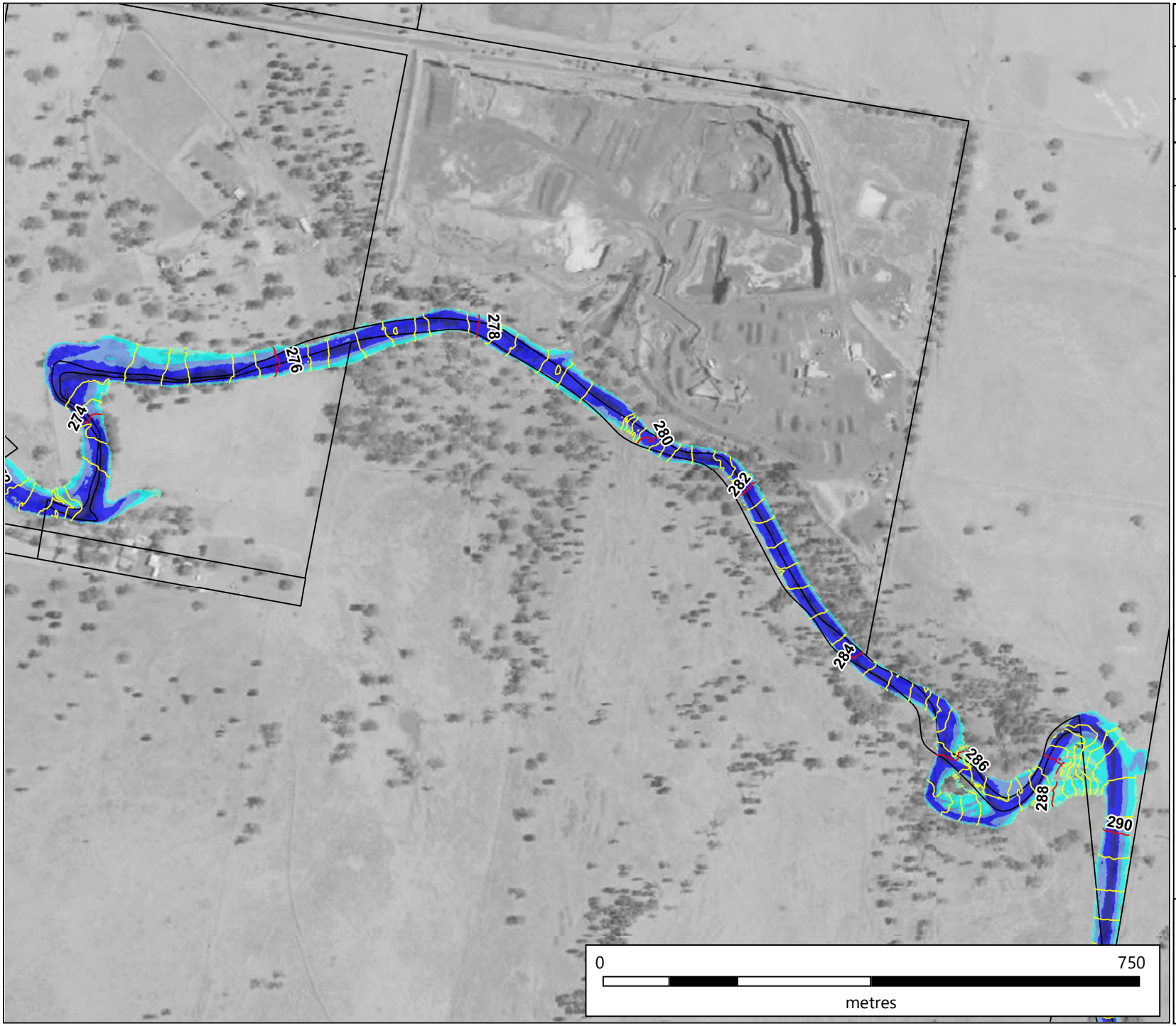

FIGURE NUMBER:	**5**
PROJECT: **DUBBO QUARRY - FLOOD STUDY**	
PROJECT NUMBER:	**190036**
SCENARIO:	**EXISTING CONDITIONS**
EVENT:	**20% AEP**
TITLE: **FLOOD DEPTH AND LEVELS**	

Flood Depth (m)

- < 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 to 3.0
- > 3.0

Major Flood Level Contours (2.0m Spacing)

Minor Flood Level Contours (0.25m Spacing)

Cadastral Boundaries

N W E S

grc HYDRO

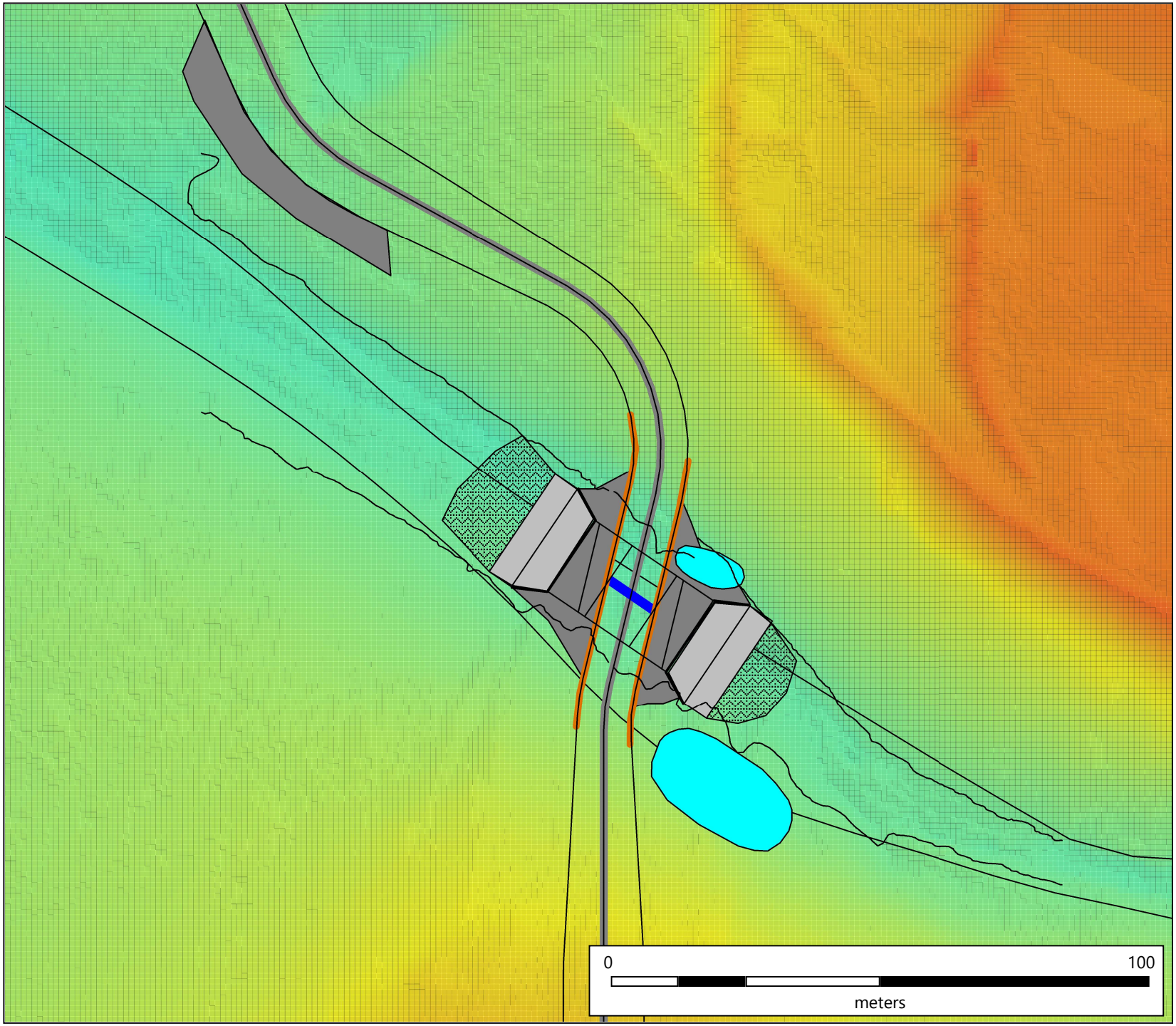

FIGURE NUMBER:	6
PROJECT:	**DUBBO QUARRY - FLOOD STUDY**
PROJECT NUMBER:	**190036**
SCENARIO:	**PROPOSED CONDITIONS**
EVENT:	

TITLE: **2D HYDRAULIC MODEL SETUP**

- Proposed Road
- Road Embankment
- Culvert Base Slab
- Grading
- Culvert Barrels Centreline
- Berm
- Sediment basin

N
W E
S

grc HYDRO

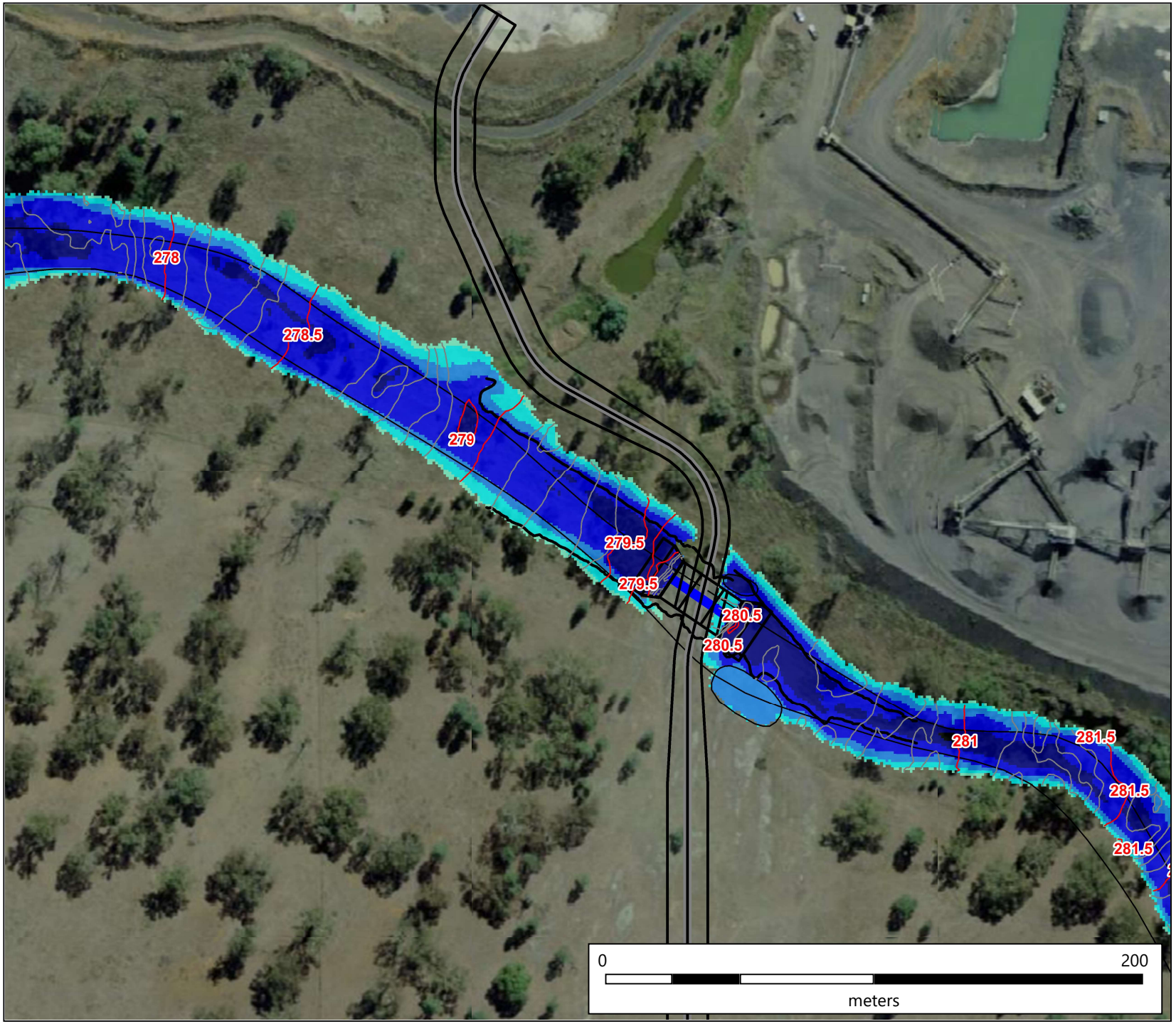

FIGURE NUMBER:	7
PROJECT:	**DUBBO QUARRY - FLOOD STUDY**
PROJECT NUMBER:	**190036**
SCENARIO:	**PROPOSED CONDITIONS**
EVENT:	**20% AEP**
TITLE:	**FLOOD DEPTH AND LEVELS**

Proposed Road

Culvert Barrels Centreline

Flood depth (m)

- < 0.1
- 0.1 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- > 3.0

Major Flood Level Contour (0.5m Spacing)

Minor Flood Level Contour (0.1m Spacing)

N W E S

grc HYDRO

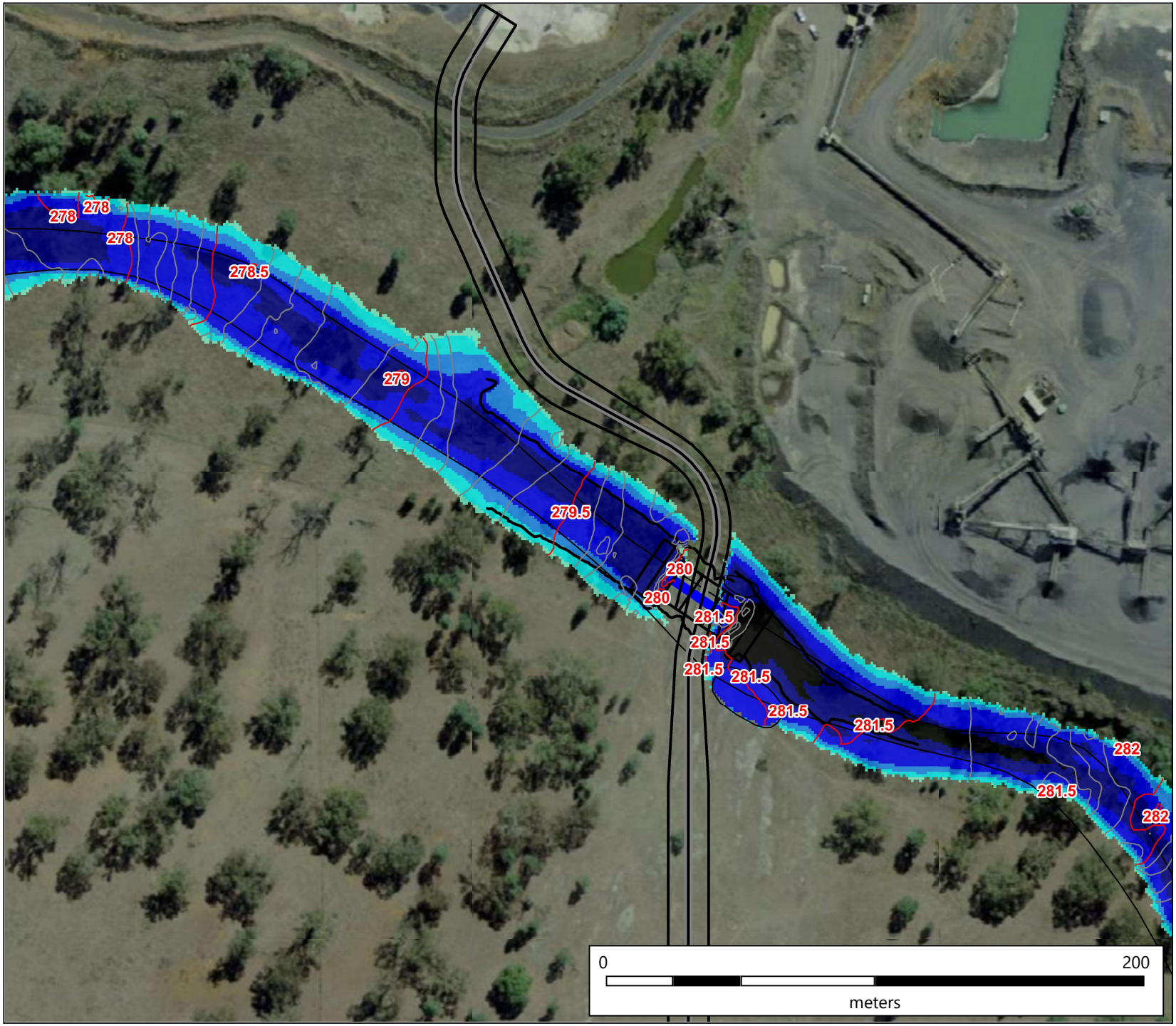

FIGURE NUMBER:	8
PROJECT:	DUBBO QUARRY - FLOOD STUDY
PROJECT NUMBER:	190036
SCENARIO:	PROPOSED CONDITIONS
EVENT:	10% AEP
TITLE:	FLOOD DEPTH AND LEVELS

Proposed Road

Culvert Barrels Centreline

Flood depth (m)

- < 0.1
- 0.1 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- > 3.0

Major Flood Level Contour (0.5m Spacing)

Minor Flood Level Contour (0.1m Spacing)

N W E S

grc HYDRO

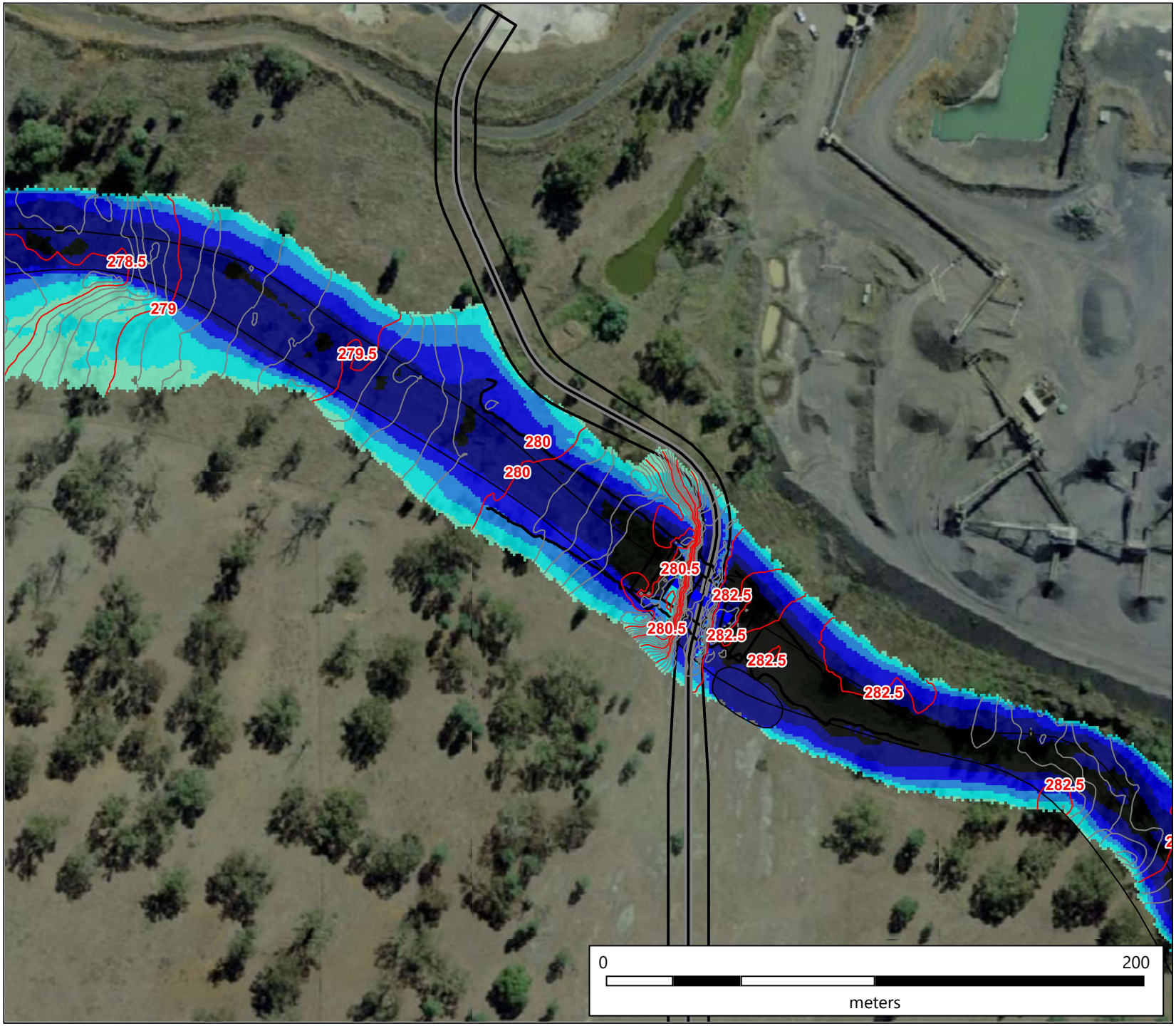

FIGURE NUMBER:	9
PROJECT:	DUBBO QUARRY - FLOOD STUDY
PROJECT NUMBER:	190036
SCENARIO:	PROPOSED CONDITIONS
EVENT:	1% AEP
TITLE:	FLOOD DEPTH AND LEVELS

Proposed Road

Culvert Barrels Centreline

Flood depth (m)

- < 0.1
- 0.1 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- > 3.0

Major Flood Level Contour (0.5m Spacing)

Minor Flood Level Contour (0.1m Spacing)

N W E S

grc HYDRO

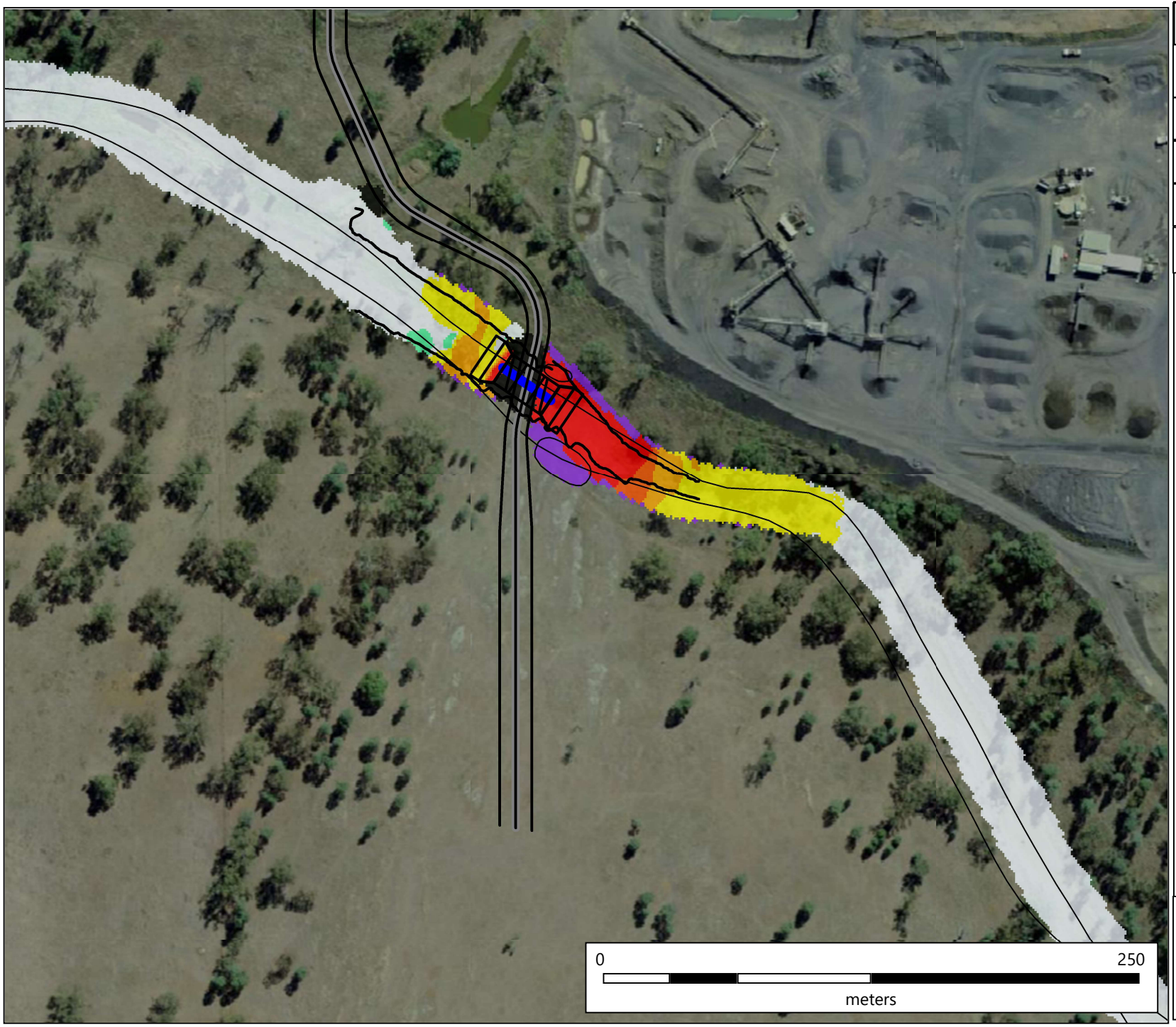

FIGURE NUMBER:	**10**
PROJECT: **DUBBO QUARRY - FLOOD STUDY**	
PROJECT NUMBER:	**190036**
SCENARIO:	**PROPOSED CONDITIONS**
EVENT:	**20% AEP**
TITLE: **FLOOD IMPACT**	

Proposed Road

Culvert Barrels Centreline

Change In Flood Level (m)

- No Impact
- 0.01 to 0.5
- 0.5 to 1
- 1 to 2
- >2.0

- No Longer Flooded
- Newly Flooded

N W E S

grc HYDRO

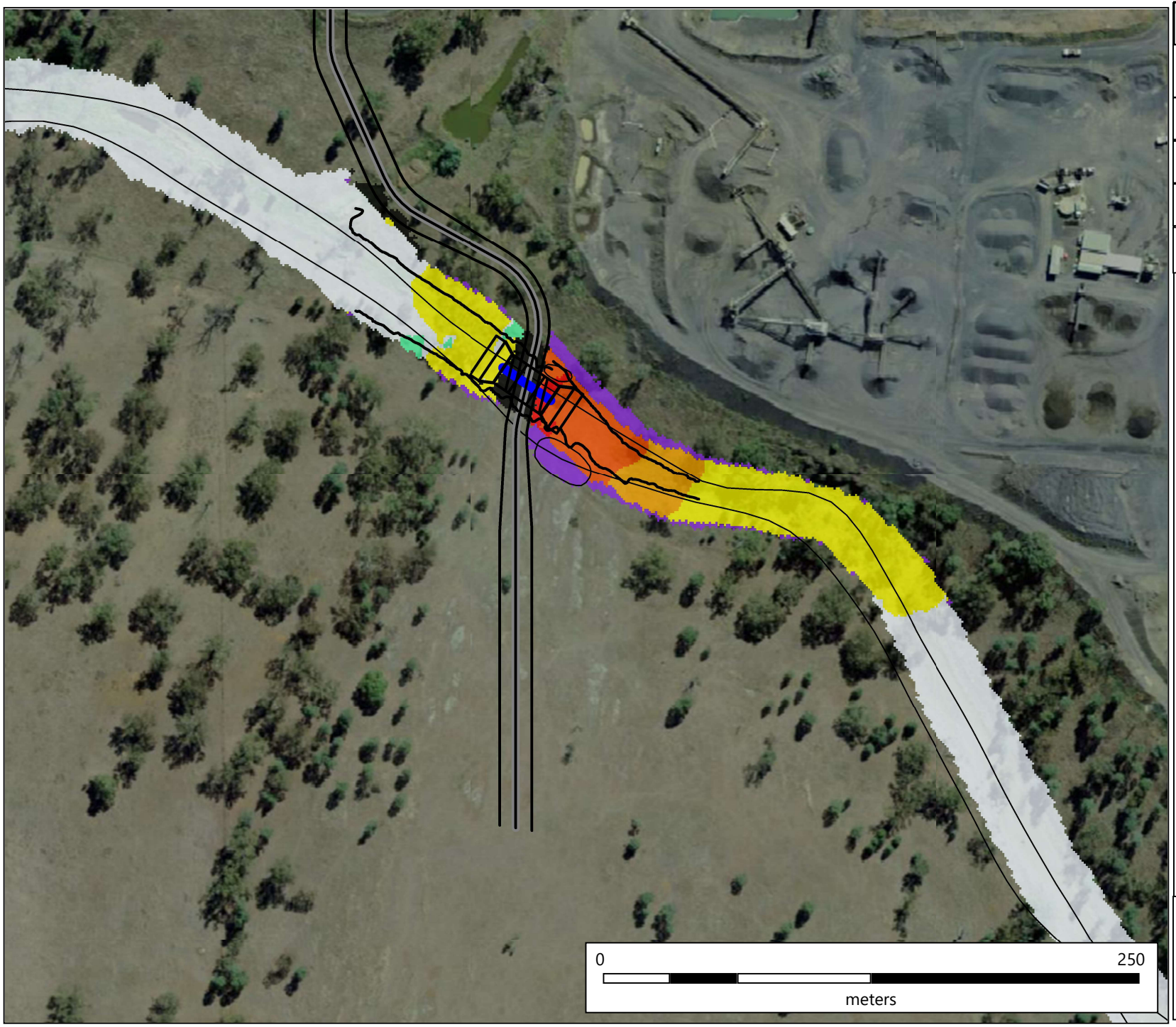

FIGURE NUMBER:	**11**
PROJECT:	**DUBBO QUARRY - FLOOD STUDY**
PROJECT NUMBER:	**190036**
SCENARIO:	**PROPOSED CONDITIONS**
EVENT:	**10% AEP**
TITLE:	**FLOOD IMPACT**

Proposed Road

Culvert Barrels Centreline

Change In Flood Level (m)

- No Impact
- 0.01 to 0.5
- 0.5 to 1
- 1 to 2
- >2.0

- No Longer Flooded
- Newly Flooded

N W E S

grc HYDRO

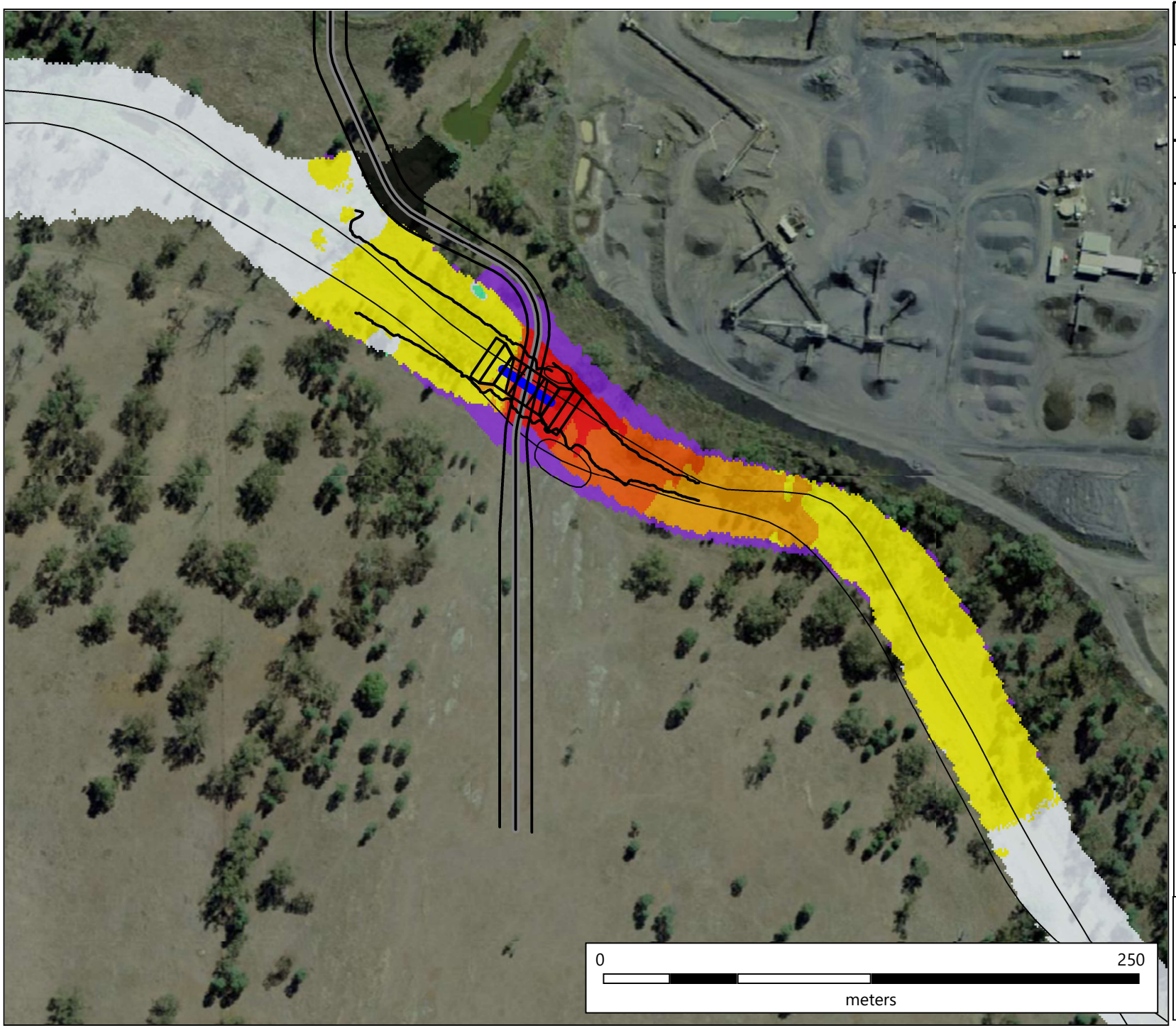

FIGURE NUMBER:	**12**
PROJECT: **DUBBO QUARRY - FLOOD STUDY**	
PROJECT NUMBER:	**190036**
SCENARIO:	**PROPOSED CONDITIONS**
EVENT:	**1% AEP**
TITLE: **FLOOD IMPACT**	

Proposed Road

Culvert Barrels Centreline

Change In Flood Level (m)

- No Impact
- 0.01 to 0.5
- 0.5 to 1
- 1 to 2
- >2.0

- No Longer Flooded
- Newly Flooded

N W E S

grc HYDRO

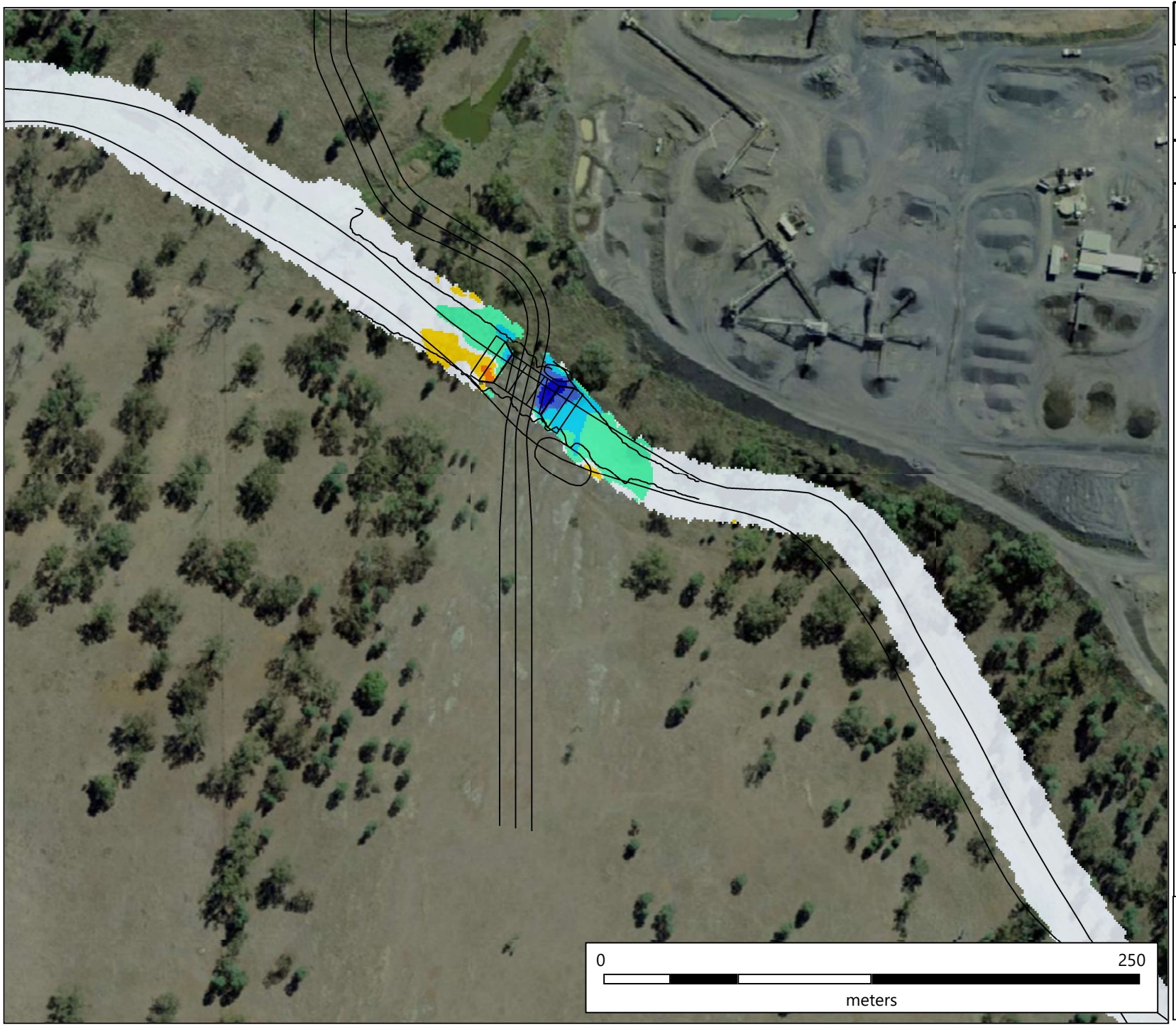

FIGURE NUMBER:	13
PROJECT:	DUBBO QUARRY - FLOOD STUDY
PROJECT NUMBER:	190036
SCENARIO:	PROPOSED CONDITIONS
EVENT:	20% AEP
TITLE :	VELOCITY IMPACT

Change in Peak Velocity (m/s)

- < -3
- -3 to -2
- -2 to -1
- -1 to -0.2
- No Impact
- 0.2 to 1
- 1 to 2
- 2 to 3
- > 3

N
W E
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grc HYDRO

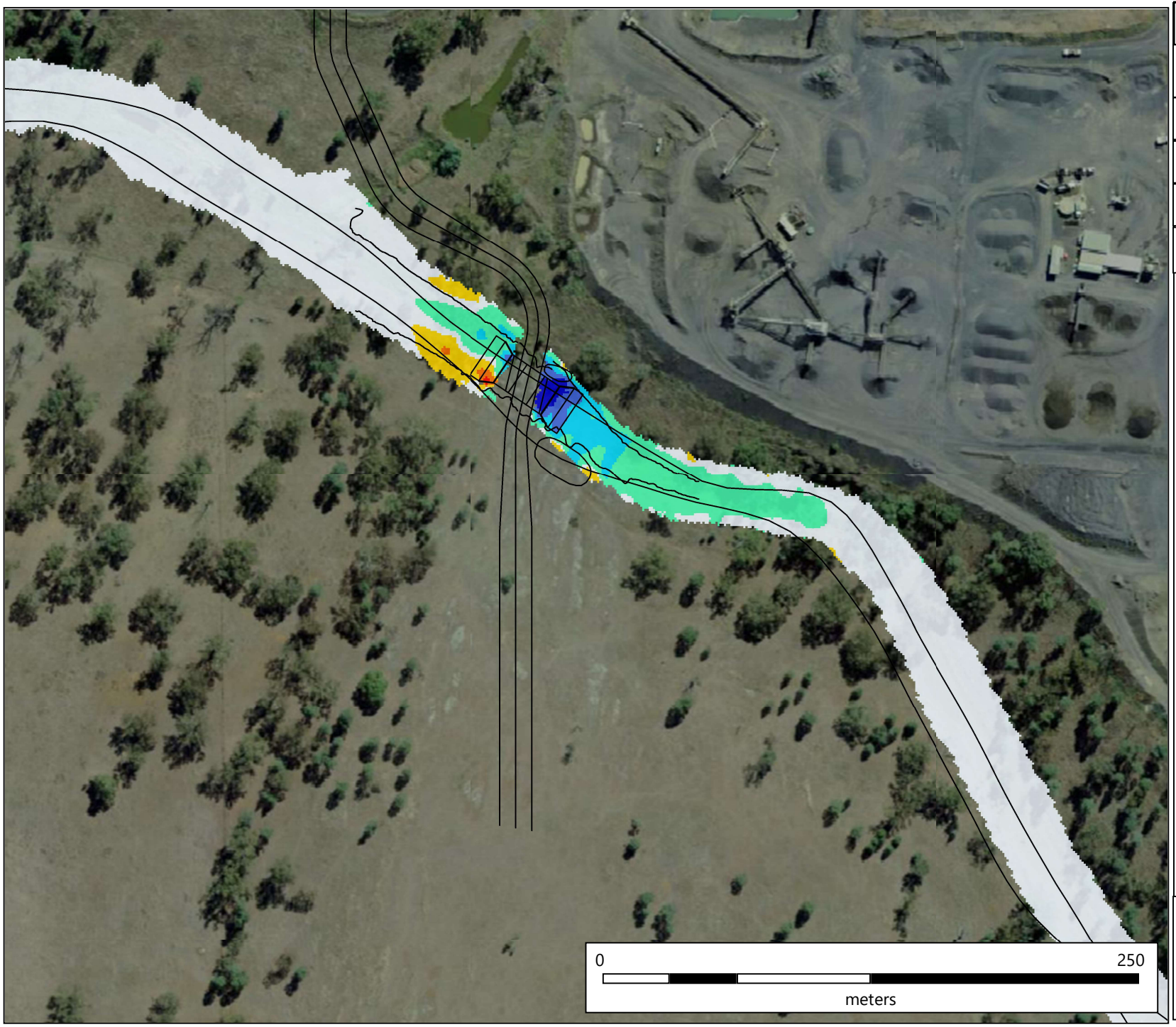


FIGURE NUMBER:	14
PROJECT:	DUBBO QUARRY - FLOOD STUDY
PROJECT NUMBER:	190036
SCENARIO:	PROPOSED CONDITIONS
EVENT:	10% AEP
TITLE	VELOCITY IMPACT

Change in Peak Velocity (m/s)

- < -3
- -3 to -2
- -2 to -1
- -1 to -0.2
- No Impact
- 0.2 to 1
- 1 to 2
- 2 to 3
- > 3

N
W E
S

grc HYDRO

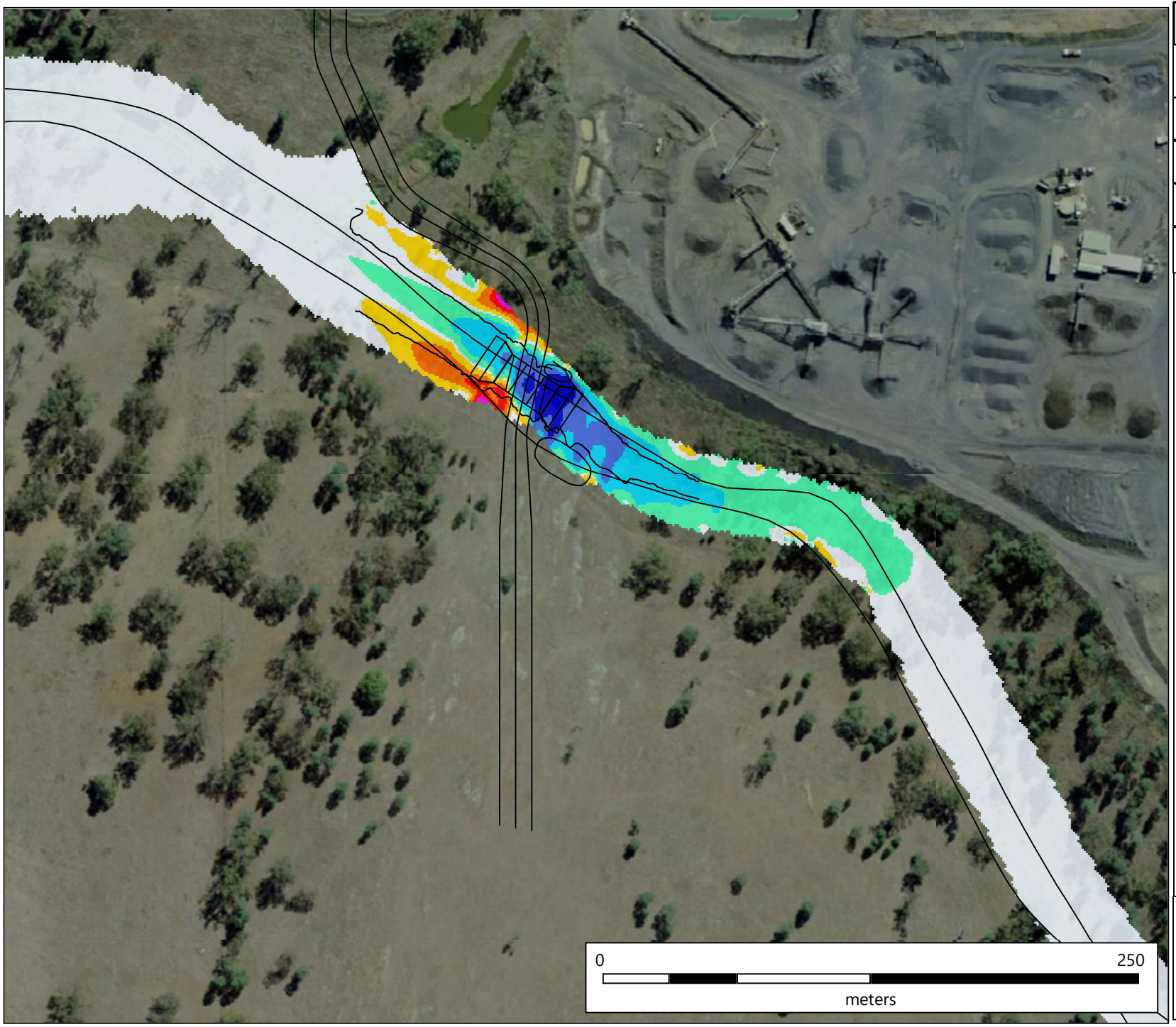


FIGURE NUMBER:	15
PROJECT:	DUBBO QUARRY - FLOOD STUDY
PROJECT NUMBER:	190036
SCENARIO:	PROPOSED CONDITIONS
EVENT:	1% AEP
TITLE	VELOCITY IMPACT

Change in Peak Velocity (m/s)

- < -3
- -3 to -2
- -2 to -1
- -1 to -0.2
- No Impact
- 0.2 to 1
- 1 to 2
- 2 to 3
- > 3

N
W E
S

grc HYDRO

ATTACHMENT A – IDF DESIGN RAINFALL DEPTHS

Australian Government
Bureau of Meteorology

Location

Label: Not provided

Latitude: -32.282 [Nearest grid cell: 32.2875 (S)]

Longitude: 148.657 [Nearest grid cell: 148.6625 (E)]

IFD Design Rainfall Depth (mm)

Issued: 04 July 2019

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	1.90	2.14	2.92	3.47	4.02	4.77	5.37
2 min	3.20	3.62	4.98	5.92	6.86	8.07	8.99
3 min	4.42	5.00	6.86	8.15	9.44	11.1	12.4
4 min	5.53	6.24	8.53	10.1	11.7	13.8	15.5
5 min	6.50	7.33	10.0	11.9	13.8	16.3	18.2
10 min	10.1	11.4	15.5	18.4	21.3	25.3	28.5
15 min	12.5	14.1	19.1	22.7	26.3	31.4	35.4
20 min	14.2	16.0	21.8	25.9	30.1	35.8	40.4
25 min	15.6	17.6	23.9	28.5	33.0	39.3	44.4
30 min	16.7	18.8	25.7	30.6	35.5	42.2	47.6
45 min	19.2	21.7	29.7	35.3	41.0	48.7	54.8
1 hour	21.0	23.8	32.6	38.7	45.0	53.3	59.9
1.5 hour	23.7	26.8	36.8	43.8	50.7	60.0	67.2
2 hour	25.8	29.2	40.0	47.5	55.0	65.0	72.7
3 hour	29.0	32.8	44.8	53.2	61.5	72.5	81.1
4.5 hour	32.7	36.9	50.2	59.4	68.6	81.0	90.6
6 hour	35.6	40.1	54.4	64.3	74.1	87.6	98.2
9 hour	40.3	45.2	61.0	71.9	82.8	98.1	110
12 hour	43.9	49.2	66.0	77.8	89.5	106	120
18 hour	49.3	55.1	73.7	86.7	99.7	119	136
24 hour	53.3	59.5	79.4	93.4	108	129	147
30 hour	56.5	62.9	83.9	98.8	114	138	157
36 hour	59.0	65.7	87.7	103	119	144	165
48 hour	62.8	70.0	93.5	110	128	155	179
72 hour	67.7	75.6	102	120	140	171	197
96 hour	70.8	79.3	107	128	149	182	209
120 hour	73.2	82.1	112	133	156	190	218

144 hour	75.1	84.4	115	138	162	196	225
168 hour	76.8	86.5	119	142	167	202	230

Note:
The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

This page was created at **16:26 on Thursday 04 July 2019 (AEST)**

ATTACHMENT B – ARR DATA HUB RESULTS

ATTENTION: This site was updated recently, changing some of the functionality. Please see the changelog (./changelog) for further information

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	148.657
Latitude	-32.282
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Interim Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show
Baseflow Factors	show

Data

River Region

Division	Murray-Darling Basin
River Number	22
River Name	Macquarie-Bogan Rivers

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^{b} - \mathrm{c}\log_{10}Duration\right)Duration^{-d} + eArea^{f}Duration^{g}\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
Central NSW	0.265	0.241	0.505	0.321	0.00056	0.414	-0.021	0.015	-0.00033

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26\ \mathrm{x}\ 10^{-3}\ \mathrm{x}\ Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141\ \mathrm{x}\ Area^{0.213}\ \mathrm{x}\ 10^{-0.021\frac{(Duration-180)^{2}}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	5634.0
Storm Initial Losses (mm)	33.0
Storm Continuing Losses (mm/h)	2.0

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/CS.zip)

code	CS
Label	Central Slopes

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_CS.zip)

code	CS
arealabel	Central Slopes

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-32.282&longitude=148.657&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	04 July 2019 04:11PM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	1.4 (0.060)	1.1 (0.034)	0.9 (0.024)	0.7 (0.016)	0.6 (0.011)	0.5 (0.008)
90 (1.5)	0.7 (0.027)	1.1 (0.029)	1.3 (0.029)	1.5 (0.029)	1.0 (0.016)	0.6 (0.009)
120 (2.0)	0.9 (0.032)	1.0 (0.026)	1.1 (0.023)	1.2 (0.021)	1.5 (0.023)	1.7 (0.024)
180 (3.0)	1.2 (0.038)	1.1 (0.025)	1.0 (0.020)	1.0 (0.016)	1.1 (0.016)	1.3 (0.015)
360 (6.0)	1.0 (0.026)	2.3 (0.043)	3.2 (0.049)	4.0 (0.054)	7.9 (0.090)	10.8 (0.110)
720 (12.0)	0.0 (0.000)	2.6 (0.040)	4.4 (0.056)	6.1 (0.068)	9.3 (0.088)	11.8 (0.098)
1080 (18.0)	0.0 (0.000)	0.7 (0.009)	1.1 (0.013)	1.5 (0.015)	4.6 (0.038)	6.9 (0.051)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)	3.2 (0.025)	5.6 (0.038)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.4 (0.003)	0.7 (0.004)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	14.2 (0.599)	10.3 (0.316)	7.7 (0.198)	5.2 (0.115)	9.5 (0.178)	12.7 (0.213)
90 (1.5)	12.7 (0.472)	13.6 (0.370)	14.2 (0.325)	14.8 (0.292)	16.7 (0.279)	18.2 (0.270)
120 (2.0)	15.5 (0.533)	16.7 (0.417)	17.4 (0.367)	18.1 (0.330)	20.9 (0.321)	22.9 (0.315)
180 (3.0)	13.8 (0.421)	15.2 (0.340)	16.2 (0.304)	17.1 (0.278)	21.8 (0.300)	25.3 (0.312)
360 (6.0)	13.0 (0.323)	21.4 (0.393)	26.9 (0.418)	32.2 (0.435)	40.5 (0.462)	46.7 (0.476)
720 (12.0)	8.1 (0.165)	16.5 (0.250)	22.0 (0.283)	27.4 (0.306)	41.9 (0.394)	52.8 (0.440)
1080 (18.0)	4.3 (0.079)	9.6 (0.130)	13.0 (0.150)	16.4 (0.164)	26.5 (0.222)	34.0 (0.251)
1440 (24.0)	0.5 (0.009)	4.8 (0.060)	7.6 (0.081)	10.3 (0.096)	18.1 (0.140)	24.0 (0.163)
2160 (36.0)	0.0 (0.000)	2.4 (0.028)	4.0 (0.039)	5.6 (0.047)	9.4 (0.065)	12.3 (0.075)
2880 (48.0)	0.0 (0.000)	1.2 (0.012)	1.9 (0.017)	2.6 (0.021)	7.4 (0.048)	11.0 (0.062)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	1.4 (0.008)	2.4 (0.012)

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	35.8 (1.509)	28.4 (0.873)	23.5 (0.607)	18.8 (0.418)	35.9 (0.673)	48.7 (0.813)
90 (1.5)	33.7 (1.257)	45.0 (1.222)	52.4 (1.198)	59.6 (1.174)	67.2 (1.119)	72.9 (1.084)
120 (2.0)	33.1 (1.136)	40.9 (1.024)	46.1 (0.970)	51.0 (0.928)	64.6 (0.993)	74.7 (1.027)
180 (3.0)	48.4 (1.477)	49.4 (1.102)	50.0 (0.940)	50.6 (0.823)	63.1 (0.870)	72.5 (0.893)
360 (6.0)	27.1 (0.675)	41.7 (0.765)	51.3 (0.798)	60.6 (0.817)	83.8 (0.957)	101.3 (1.031)
720 (12.0)	22.2 (0.451)	38.5 (0.583)	49.3 (0.633)	59.6 (0.666)	82.7 (0.776)	99.9 (0.832)
1080 (18.0)	16.1 (0.292)	27.4 (0.372)	34.9 (0.402)	42.0 (0.421)	62.6 (0.524)	78.1 (0.576)
1440 (24.0)	10.9 (0.183)	18.1 (0.227)	22.8 (0.244)	27.4 (0.254)	46.5 (0.359)	60.9 (0.413)
2160 (36.0)	3.7 (0.056)	12.3 (0.140)	18.0 (0.175)	23.5 (0.197)	35.8 (0.248)	45.0 (0.272)
2880 (48.0)	5.4 (0.077)	10.1 (0.108)	13.2 (0.120)	16.2 (0.127)	26.3 (0.169)	33.8 (0.189)
4320 (72.0)	0.2 (0.003)	4.2 (0.041)	6.9 (0.057)	9.4 (0.067)	22.1 (0.129)	31.6 (0.160)

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	RCP 4.5	RCP6	**RCP 8.5**
2030	**0.972 (4.9%)**	0.847 (4.2%)	**1.052 (5.3%)**
2040	**1.225 (6.2%)**	1.127 (5.7%)	**1.495 (7.6%)**
2050	**1.452 (7.3%)**	1.406 (7.1%)	**1.971 (10.1%)**
2060	**1.653 (8.4%)**	1.685 (8.6%)	**2.480 (12.9%)**
2070	**1.827 (9.3%)**	1.963 (10.1%)	**3.023 (15.9%)**
2080	**1.974 (10.1%)**	2.241 (11.6%)	**3.599 (19.2%)**
2090	**2.095 (10.8%)**	2.518 (13.1%)	**4.208 (22.8%)**

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2019_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	**50**	**20**	**10**	**5**	**2**	**1**
60 (1.0)	19.3	12.1	12.2	13.9	12.3	9.3
90 (1.5)	19.2	12.3	11.2	11.2	9.8	7.8
120 (2.0)	18.7	12.4	11.3	11.6	9.8	7.1
180 (3.0)	17.9	12.7	11.8	12.6	10.3	7.0
360 (6.0)	19.4	13.4	11.8	10.7	8.8	4.8
720 (12.0)	21.2	14.8	13.2	11.7	10.2	5.4
1080 (18.0)	23.3	17.7	16.8	15.9	13.3	7.6
1440 (24.0)	25.2	20.0	19.2	19.1	15.5	7.4
2160 (36.0)	27.1	21.7	21.1	21.8	18.5	9.9
2880 (48.0)	27.2	22.1	21.9	23.9	19.6	14.6
4320 (72.0)	28.1	23.9	25.1	27.4	22.7	16.6

Layer Info

Time Accessed	04 July 2019 04:11PM

Version	2018_v1
Note	As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

Baseflow Factors

Downstream	9529
Area (km2)	19380.5058911
Catchment Number	9605
Volume Factor	0.14291
Peak Factor	0.034415

Layer Info

Time Accessed	04 July 2019 04:11PM
Version	2016_v1

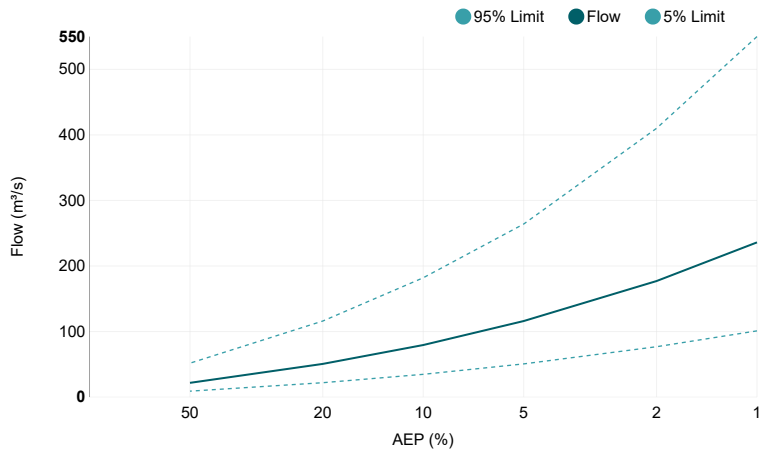
Download TXT (downloads/fd17ba7a-49f8-4be9-800d-685a1f2d50a7.txt)

Download JSON (downloads/271e5cf2-6b6e-4172-afec-1d388baae37c.json)

Generating PDF... (downloads/2f7dad18-f3eb-4a3a-85b7-384b7c5ba54d.pdf)

ATTACHMENT C – RFFE MODEL RESULTS

Results | Regional Flood Frequency Estimation Model



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	21.7	9.00	51.7
20	50.6	21.9	116
10	79.4	34.7	182
5	116	50.6	264
2	177	76.8	410
1	236	101	550

Statistics

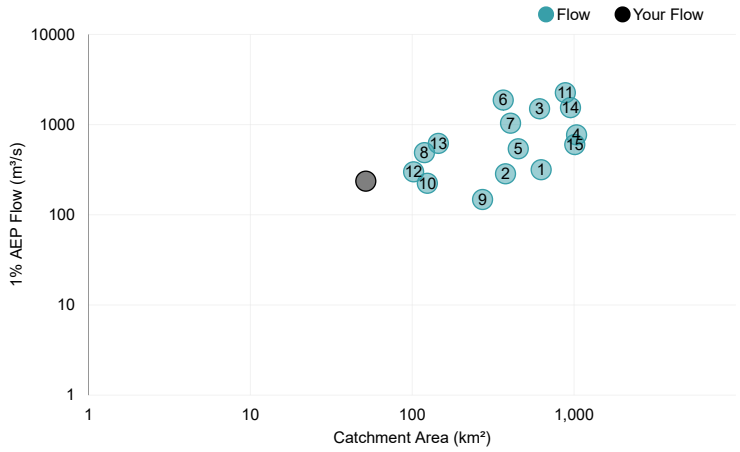
Variable	Value	Standard Dev
Mean	3.034	0.523
Standard Dev	1.016	0.109
Skew	0.076	0.026

Note: These statistics come from the nearest gauged catchment. Details.

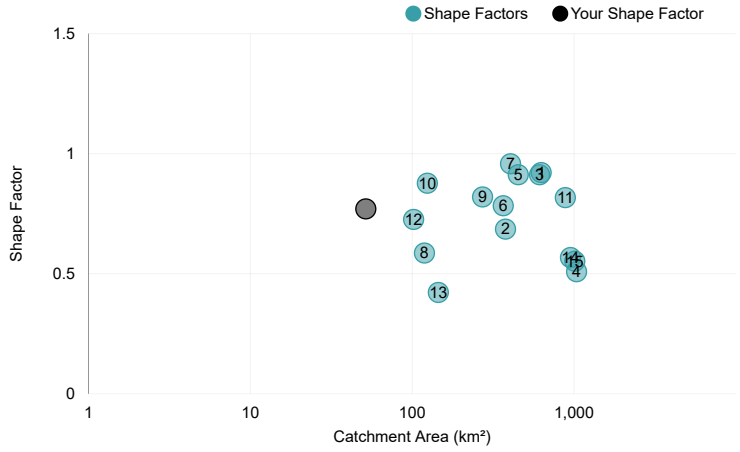
Correlation		
1.000		
-0.330	1.000	
0.170	-0.280	1.000

Note: These statistics are common to each region. Details.

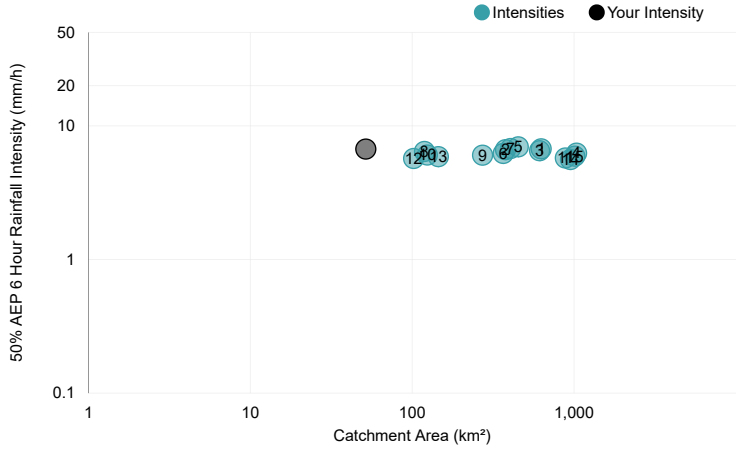
1% AEP Flow vs Catchment Area



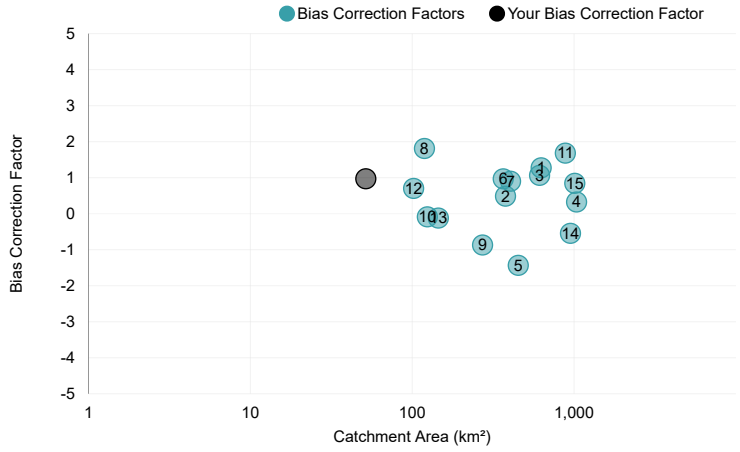
Shape Factor vs Catchment Area



Intensity vs Catchment Area



Bias Correction Factor vs Catchment Area



Download

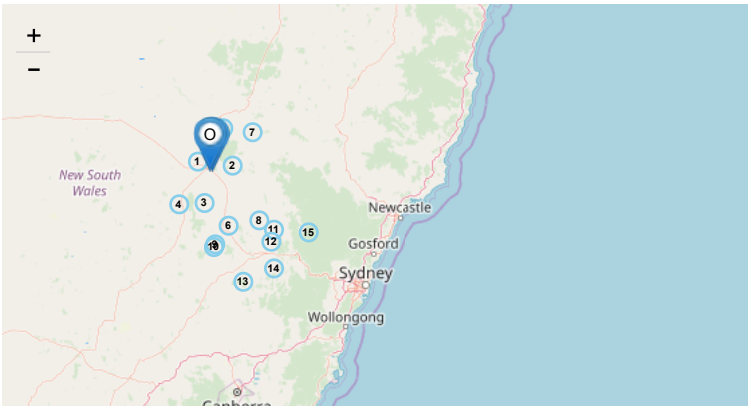
TXT Nearby JSON

Input Data

Date/Time	2019-07-04 17:15

Input Data

Catchment Name	Catchment1
Latitude (Outlet)	-32.282
Longitude (Outlet)	148.657
Latitude (Centroid)	-32.292
Longitude (Centroid)	148.715
Catchment Area (km^2)	51.67
Distance to Nearest Gauged Catchment (km)	24.36
50% AEP 6 Hour Rainfall Intensity (mm/h)	6.702953
2% AEP 6 Hour Rainfall Intensity (mm/h)	14.483112
Rainfall Intensity Source (User/Auto)	Auto
Region	East Coast
Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	0.77
Interpolation Method	Natural Neighbour
Bias Correction Value	0.97



Method by Dr Ataur Rahman and Dr Khaled Haddad from Western Sydney University for the Australian Rainfall and Runoff Project. Full description of the project can be found at the project page (http://arr.ga.gov.au/revision-projects/project-list/projects/project-5) on the ARR website. Send any questions regarding the method or project here (mailto:admin@arr-software.org).

ENGINEERS AUSTRALIA (http://www.engineersaustralia.org.au)

WESTERN SYDNEY UNIVERSITY (http://www.uws.edu.au)

ATTACHMENT D – ARR2019 BLOCKAGE ASSESSMENT

BLOCKAGE ASSESSMENT FORM ARR2019

STUDY AREA: EUMOLOGO CREEK - DUBBO

DEBRIS TYPE / MATERIAL / L_{10} / SOURCE AREA

Debris Type/Material	L_{10}	Source Area	How Assessed
Floating	3 m	Vegetation	Satellite Inspection
Non-floating	Silty Clay/Sand	High erosion hazard.	Satellite Inspection

DEBRIS AVAILABILITY (HML) – *for the selected debris type/size and its source area*

Availability	Typical Source Area Characteristics	Notes
High	• *Dense forest, thick vegetation, extensive canopy, difficult to walk through with considerable fallen limbs, leaves and high levels of floor litter.* • *Streams with boulder/cobble beds and steep bed slopes and banks showing signs of substantial past bed/bank movements.* • *Arid areas, where loose vegetation and exposed loose soils occur and vegetation is sparse.* • *Urban areas that are not well maintained and/or old paling fences, sheds, cars and/or stored loose material etc., are present on the floodplain close to the water course.*	
Medium	• *State forest areas with clear understory, grazing land with stands of trees* • *Source areas generally falling between the High and Low categories.*	**Non-floating: Area has a high level of soil erosion hazard.** **Floating trees, bushes and shrubs**
Low	• *Well maintained rural lands and paddocks, with minimal outbuildings* • *Streams with moderate to flat slopes and stable beds and banks.* • *Arid areas where vegetation is deep rooted and soils resistant to scour* • *Urban areas that are well maintained with limited debris present in the source area.*	

DEBRIS MOBILITY (HML) - *for the selected debris type/size and its source area*

Mobility	Typical Source Area Characteristics	Notes
High	• *Steep source area with fast response times and high annual rainfall and/or storm intensities and/or source areas subject to high rainfall intensities with sparse vegetation cover.* • *Receiving streams that frequently overtop their banks.* • *Main debris source areas close to streams*	
Medium	• *Source areas generally falling between the High and Low categories.*	**Non-floating: velocities around 2.5 m/s in the 5-year event determine mobility of creek bed material** **Floating: dry shrubs have relatively high mobility**
Low	• *Low rainfall intensities and large, flat source areas.* • *Receiving streams that Infrequently overtop their banks.* • *Main source areas well away from streams*	

DEBRIS TRANSPORTABILITY (HML) - *for the selected debris type/size and stream characteristics*

Transportability	Typical Transporting Stream Characteristics	Notes
High	• *Steep bed slopes (> 3%).and/or high stream velocity (V>2.5m/sec)* • *Deep stream relative to vertical debris dimension (D>0.5L10)* • *Wide streams relative to horizontal debris dimension. (W>L10)* • *Streams relatively straight and free of constrictions/snag points.* • *High temporal variability in maximum stream flows*	**Non -floating: high velocity (>2.5m/s) in the 5y event** **Floating: high velocity (>2.5m/s) in the 5y event**
Medium	• *Streams generally falling between High and Low categories*	
Low	• *Flat bed slopes (< 1%).and/or low stream velocity (V<1m/sec)* • *Shallow stream relative to vertical debris dimension (D<0.5L10)* • *Narrow streams relative to horizontal debris dimension. (W<L10)* • *Streams meander with frequent constrictions/snag points.* • *Low temporal variability in maximum stream flows*	

SITE BASED DEBRIS POTENTIAL 1%AEP (HML) - *for the selected debris type/size arriving at the site*

Debris Potential	Combinations of the Above (any order)	Notes
High	*HHH or HHM*	
Medium	*MMM or HML or HMM or HLL*	**MMH for both floating and not floating Debris**
Low	*LLL or MML or MLL*	

AEP ADJUSTED SITE DEBRIS POTENTIAL (HML) - *for the selected debris type/size*

Event AEP	At Site 1% AEP Debris Potential			AEP Adjusted at Site Debris Potential	
	High	Medium	Low	FLOATING	NON-FLOATING
AEP > 5% (frequent)	*Medium*	*Low*	*Low*	**low**	**Low**
AEP 5% - AEP 0.5%	*High*	*Medium*	*Low*	**medium**	**medium**
AEP < 0.5%	*High*	*High*	*Medium*	**High**	**High**

MOST LIKELY DESIGN INLET BLOCKAGE LEVEL (B_{DES}%) *for the selected debris type/size*

Control Dimension Inlet Width W (m)	At Site 1% AEP Debris Potential		
	High	Medium	Low
$W < L_{10}$	*100%*	*50%*	*25%*
$W \geq L_{10} \leq 3L_{10}$	*20%*	*10%*	*0%*
$W > 3L_{10}$	*10%*	*0%*	*0%*

Event AEP	Bdes% Floating	Bdes% Non-Floating
AEP > 5% (frequent)	*0%*	*0%*
AEP 5% - AEP 0.5%	*10%*	*0%*
AEP < 0.5%	*20%*	*10%*

BARREL BLOCKAGE

The following tables are only relevant to sites subject to a significant debris load of sediment. Where inlet blockage and barrel blockage are both likely, the blockage producing the greatest impact on flood behaviour should be used in design.

LIKELIHOOD OF SEDIMENT BEING DEPOSITED IN WATERWAY (HML)

Peak Velocity through Structure (m/s)	Particle Type				
	Clay/Silt	Sand	Gravel	Cobbles	Boulders
>= 3	*L*	*L*	*L*	*L*	*M*
1.0 to 3	***L***	***L***	*L*	*M*	*M*
0.5 to 1	*L*	*L*	*L*	*M*	*H*
0.1 to 0.5	*L*	*L*	*M*	*H*	*H*
< 0.1	*L*	*M*	*H*	*H*	*H*

MOST LIKELY DEPOSITIONAL BLOACKAGE LEVELS – B_{DES}%

Likelihood that deposition will occur	AEP Adjusted Debris Potential		
	High	Medium	Low
High	*100%*	*60%*	*25%*
Medium	*60%*	*40%*	*15%*
Low	*25%*	*15%*	*0%*

Event AEP	Bdes% Non-Floating
AEP > 5% (frequent)	*0%*
AEP 5% - AEP 0.5%	*15%*
AEP < 0.5%	*25%*

ESTIMATED BLOCKAGE LEVELS – B_{DES}%

Event AEP	Bdes% fLOAT	Bdes% Non-float	Bdes% Final
AEP > 5% (frequent)	*0%*	*0%*	*0%*
AEP 5% - AEP 0.5%	*10%*	*15%*	*15%*
AEP < 0.5%	*20%*	*25%*	*25%*

Appendix B

Water balance method statement

B.1 Overview

A water balance model was developed for the existing and proposed operations water management systems. The objectives of the model were to estimate the volume of water that is captured by the water management system and used for dust suppression and site discharge volumes.

B.2 Modelling approach

The water balance model was developed in GoldSim version 12.1 (GoldSim Technologies 2017). The model applies a continuous simulation methodology that assesses the performance of the modelled water management system under a range of rainfall and evaporation sequences. The model was created by representing the water cycle as a series of elements, each containing pre-set rules and data, that were linked together to simulate the interaction of these elements. Key features of the model are described below:

- The model runs on a daily time-step and requires daily rainfall and evaporation rates as model inputs. The model results are available on a daily time step but are reported as annual averages to simplify the results presentation.
- The model runs as a continuous simulation and applies a long term (101 year) rainfall record that includes a wide range of embedded dry and wet periods as well as major flood events. The model results are processed to provide a statistical representation of the performance of each surface water management system, under a full range of climatic conditions.
- Results are presented in flow chart format for typical dry (10th Percentile), median (50th Percentile) and wet (90th Percentile) years. Select results such as dam overflows are also presented as summary charts.

The model was broadly parametrised to approximate anecdotal information provided by Holcim.

B.3 Model assumptions

This section details the assumptions applied to the water balance model.

a Climatic data

To facilitate a comprehensive assessment of a range of climatic conditions, a 101-year simulation period was adopted for the water balance model based on the available rainfall record. This simulation period applies the daily rainfall record that is described in Section 3.3.

b Calculation of runoff

The SIMHYD rainfall / runoff model was applied to simulate the rainfall runoff response from the catchments within the quarry's surface water management system. SIMHYD is one of the most used rainfall runoff models in Australia and has been extensively tested using data from across Australia (Chiew, 2005).

Each water management dam catchment was delineated into material types that reflected soil hydrologic groups consistent with *Managing Urban Stormwater: Volume 1* (Landcom 2004). A runoff model for each soil group was parameterised to best represent the 5-day runoff coefficients presented in Table F2 (Landcom 2004). The Eastern watercourse was parameterised independently to achieve an average annual runoff rate reflective of the maximum harvestable rights calculator (DPIE) at 0.6 ML/ ha.

The annual average runoff coefficient achieved for each runoff model type is presented in Table B.1.

Table B.1 SIMHYD model runoff coefficients

Soil hydrologic group (Landcom 2004)	Representative material types on site	Annual runoff coefficient
Type A	Stockpiles	0.22
Type B	Vegetated batters, farmland	0.33
Type D	Pit floor, compacted road base, hard stand etc.	0.51

It is noted that SIMHYD calculates runoff on a daily time step, as a function of soil moisture storage. Hence, C_v for any given rainfall event will generally be below the long term average C_v during dry conditions (due to the soils being dry before the event) and above the long term average C_v during wet conditions when the soils are close to saturated before the event. This represents the effects of antecedent soil moisture conditions when calculating daily runoff.

c Process water demands

The process water demands documented in Section 4.1.4 were applied equally to all scenarios. Haul road dust suppression demands were calculated on a daily time step by applying the following equation:

$$DSupp(t) = ((Evap(t) - Rain(t)) + LossFactor) \times (Area \times 10)$$

A daily loss factor of 1 mm/day and an application area of 0.6 Ha produced a good representation of the anecdotal application rates that are reported in Table 4.2. For the proposed operations model, the application area was increased to 0.98 ha, representing the additional area of haul road connecting to the SEA.

Plant water use was applied at a constant rate of 70 kL/day in the water balance model.

d Water management dams

The water management dams shown on each of the model results figures in Sections 4 and 5 were included in the model for each scenario, where the stated volumes in the relevant figures are consistent with the modelled volume. The level/storage characteristics for each dam were estimate by EMM from LiDAR levels, aerial photos and information provided by Holcim.

e Evaporation losses

Evaporation losses occur from all water storages. The model calculates evaporation losses on a daily timestep as a function of:

- Evaporation rates – daily pan evaporation extracted from SILO was included in the model. A Pan Coefficient of 0.9 was applied to all evaporation loss calculated from the water management dams.
- Dam surface area – is a function of the dam volume and the surface area/volume properties of the storage. The surface area is calculated at each daily time step based on the storage volume and estimated area characteristics for each storage.

f Groundwater exchange

The groundwater exchange relationship applied to the model is outlines in detail in the Water Addendum (Water RtS Appendix A).

g Irrigation

Irrigation was only applied to the model when the following conditions were met during a model timestep:

- capacity was available in the soil moisture storage component of the SIMHYD catchment model representing the rehabilitation area; and
- the current PET rate exceeded the current rainfall rate.

The irrigation applied was limited to the minimum of the soil moisture storage capacity and the difference of PET and rainfall. Applied irrigation was added to the next timestep of the SIMHYD model in addition to rainfall to ensure the irrigation amount was not lost from the model processes.

h Water transfers

Water transfers between storages, demands and sources are controlled using transfer rules that are based on storage levels, demand requirements and source availability. It was assumed that all pumps on site were limited to 25 L/s capacity.

Appendix C

Eulomogo Creek crossing EIS concept design

pitt&sherry

Dubbo Quarry Continuation Project

Eulomogo Creek - Concept Options Report

Prepared for
Holcim

Client representative
Luke Edminson

Date
08 May 2020

Rev A

Table of Contents

List of figures

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Appendices

Prepared by — Frazer McCloy		**Date — 08/05/2020**
Reviewed by — Russel Odendaal		**Date — 08/05/2020**
Authorised by — David Crowe		**Date — 08/05/2020**

Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
A	Draft	F. McCloy	R.Odendaal	D. Crowe	08/05/2020

1. Introduction

Holcim has engaged pitt&sherry to undertake concept designs for a crossing structure over Eulomogo Creek. This forms part of the Dubbo Quarry Continuation Project, involving the development of a new resource extraction area to the South of the existing quarry boundary. The Dubbo Quarry is located on Sheraton Road, and the proposed crossing location is demonstrated in Figure 1 below.

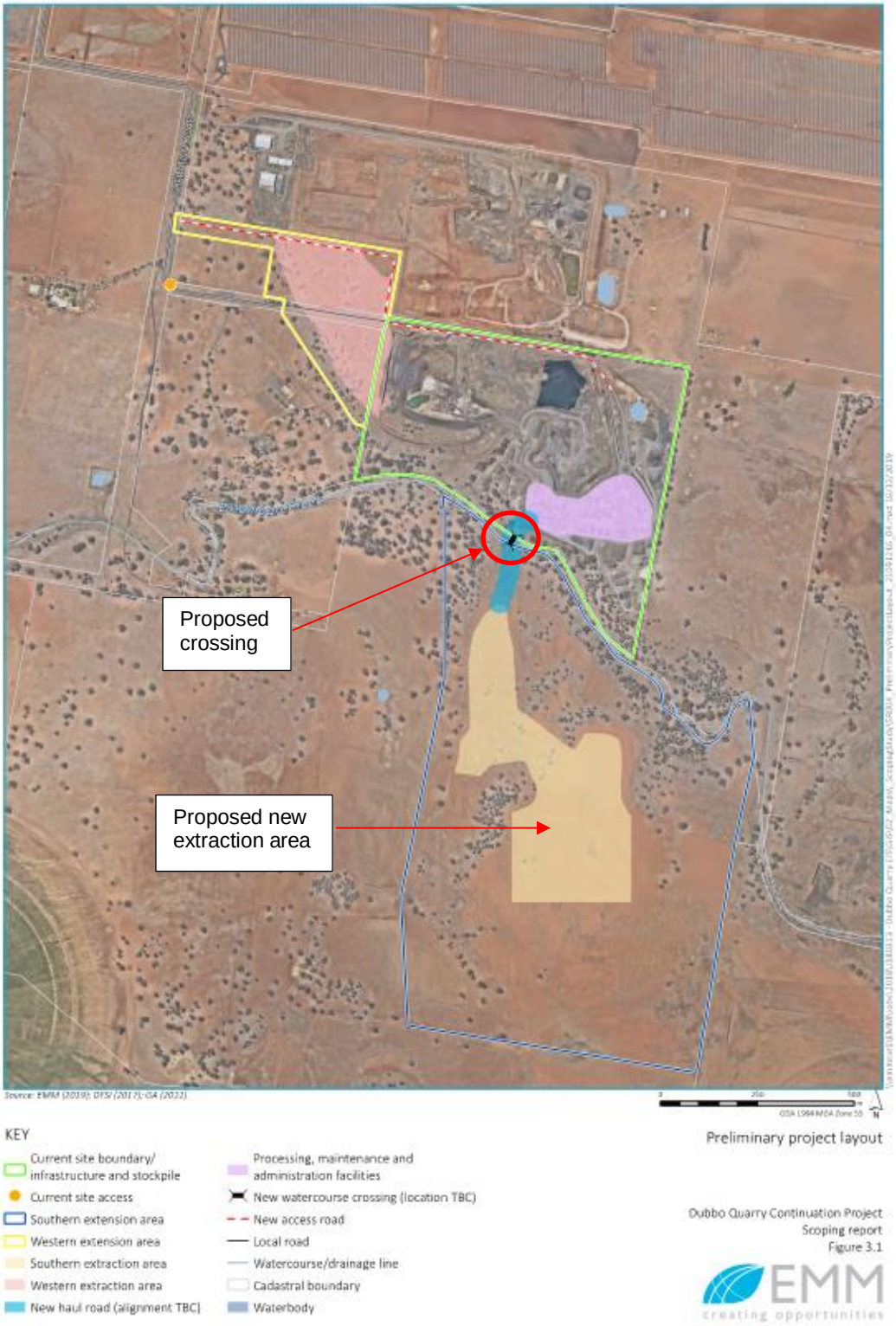


Figure 1: Dubbo Quarry Location

2. Design Development

The concept designs were developed taking into consideration the available site information, design criteria as well as the known site constraints. Details of these considerations are outlined below.

2.1 Available Information

2.1.1 Site Inspection

As part of the scope, pitt&sherry undertook a site inspection on the 19 December 2019. Russel Odendaal (pitt&sherry – Senior Bridge Engineer) along with Luke Edminson (Holcim – Planning & Environmental Manager) and Alasdair Webb (Holcim – Dubbo Quarry Manager) inspected the site to obtain key dimensions, photographs and site layouts for the proposed crossing. The site inspection indicated the proposed crossing would need to be between 15-20m span and require a skew to tie into the indicative haul road geometry.

2.1.2 Client Supplied

Client supplied information has been included in Appendix A. The client supplied the following information to inform the concept design:

- Project Area Location (Figure 1.1 - SR001_ProjectAreaLocation_20191216_03);
- Project Site (Figure 1.2 - SR002_ProjectSite_21091216_04);
- Surrounding Environment (Figure 2.1 - SR003_SurroundingEnvironment_21091216_03);
- Preliminary Project Layout (Figure 3.1 - SR004_PreliminaryProjectLayout_21091216_04); and
- Environmental Constraints (Figure 5.1 - SR005_PreliminaryEnvironmentalConstraints_20191216_03).

2.1.3 pitt&sherry obtained

pitt&sherry obtained the following information to inform the concept design:

- Nearmap high resolution Imagery; and
- LIDAR Data – GIS at 1m accuracy.

2.2 Design Criteria

2.2.1 Design Standards

The following standards were used in preparation of the concept design:

- AS5100:2017 – Bridge Design;
- AS/NZS 3725:2007- Design for Installation of Buried Concrete Pipes;
- AS/NZS 4058:2007- Precast Concrete Pipes;
- AS 1597:2013 - Precast Reinforced Concrete Box Culverts; and
- Recognised standard 19 (August 2019) – Design and construction of mine roads.

2.2.2 Design Loading

Concept design of the Eulomogo Creek Crossing considered the following design loading:

- Vertical loads in accordance with AS5100.2:2017, including dead loads, superimposed dead loads and vehicle loads; and
- CAT 796C with provisions for future CAT777 Dump Truck.

No other design loading, including hydraulic and horizontal earth pressure loading has been considered at this stage.

2.2.3 Design Geometrical Requirements

- Haul road width = 10m over crossing; and
- Haul road width = 15m elsewhere.

2.2.4 Design Structural Preferences

Holcim confirmed that culvert type structures are preferred and that a bridge option should not be considered.

2.3 Site Constraints

2.3.1 Environmental

Protected Trees – EMM environmental has provided details of protected tree species Blakley's Red Gum which are located nearby to the proposed crossing. The design has been developed to minimise the required footprint and removal of trees where possible.

Riparian Corridor – The proposed crossing has been developed considering the Department of Primary Industries Office of Water – Guidelines for watercourse crossing on waterfront land.

2.3.2 Geotechnical

The site inspection identified high lying rock strata below the proposed crossing. The design has been developed to minimise the need to excavate any rock material.

2.3.3 Hydraulic and Hydrological

The design has been developed to maintain the creek function and flow with minimal disturbance where possible.

2.4 Assumptions & Limitations

The following assumptions and limitations have been considered in the concept design:

- The details shown are conceptual and should be confirmed during the detailed design process;
- The haul road has been shown indicatively and is subject to detailed design;
- Hydrological and hydraulic modelling to be undertaken to confirm hydraulic conditions required and scour protection. No modelling has been undertaken to date;
- An assessment by NSW government department of water required for watercourse crossing;
- No geotechnical information about the site is currently available. It is assumed the material below the culvert crossing has sufficient strength for the required bearing capacity;

- Engineers costs estimates are based on concept details and subject to detailed design. They are indicative costs for the crossing structures only and do not include any allowance for approach works and haul road construction; and
- The culvert is located in a non-aggressive environment for durability of the concrete. This should be confirmed by soil and groundwater testing during detailed design.

3. Concept Options

3.1 Crossing General Arrangement

Two concept design options have been developed to determine the most effective design to span across Eulomogo Creek. Both concept options consider utilisation of a precast concrete culvert to facilitate access to the proposed southern extraction area. The culverts are proposed to span 16.41m between the Eulomogo Creek banks. The culvert cells are parallel to the flow of the creek, with the haul road skewed at 20° to enable minimal impact and disturbance to the adjacent land and creek, whilst retaining a safe travel path for haul road users.

Both concept options consider concrete lined safety berms either side of a 10m wide haul road carriageway. The safety berms are 1.4m in height above the carriageway and are intended to safely deflect any vehicle crossing the culvert away from the edge of the road. Safety berms are included in lieu of bridge barriers due to the large vehicles expected to utilise the structure.

The proposed culvert options include a concrete pavement, as well as a concrete lining covering the safety berms and fill material above culvert cells to provide increased flood immunity. In the event of culvert overtopping, the concrete lining and pavement will provide the structure with a physical barrier to mitigate the impact of roadway scour. The haul road allows for a 3% crossfall to allow for drainage of the culvert surface. 150mm diameter scuppers are provided at 1m centres along the safety berms to enable drainage through the safety berms and to prevent water pooling.

Rip-rap is proposed either side of the culvert apron slabs to provide scour protection to the culvert structure. The rip-rap extends across the width of the apron slab and consists of a downturn transverse to the creek flow to prevent undermining of the apron slab.

General arrangements of the proposed design are provided on drawing NC19061-SK001. A section view of the culvert carriageway surface is presented in Figure 2.

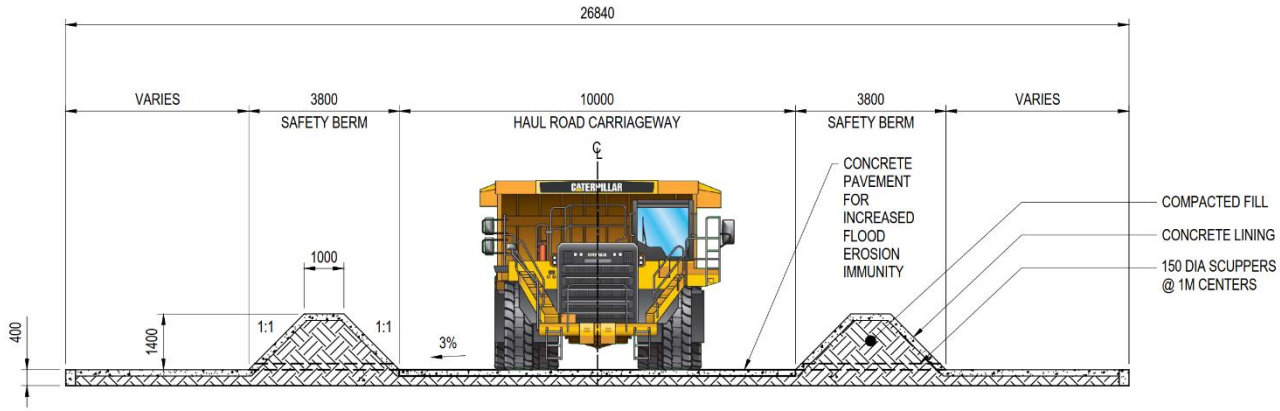


Figure 2: Culvert Carriageway General Arrangement

3.2 Option 1 – Precast Concrete Pipes

Option 1 consists of a 5-cell precast pipe culvert to span the proposed section of Eulomogo Creek. The solution comprises of pipe culvert units with an internal diameter of 2.1m. The pipe culvert units are encased with compacted fill

and are spaced at approx. 3.1m centres. Reinforced concrete wingwalls surround the pipe cells which are supported by a compacted fill pipe bedding. A typical section view of the pipe culvert solution along the haul road centreline is presented in Figure 3. Concept design drawings of option 1 are presented in drawing NC19061-SK002 included in Appendix B.

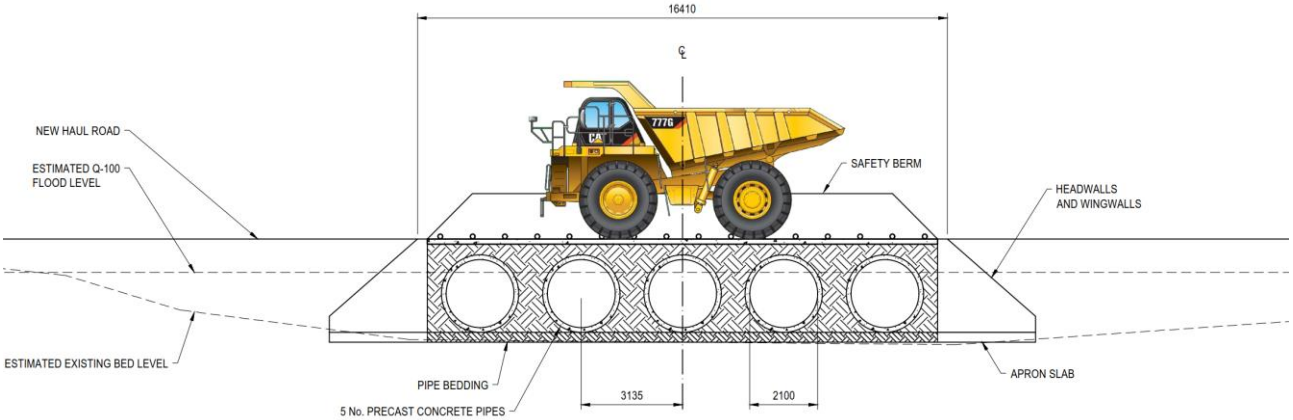


Figure 3: Option 1 Typical Section

Engineers cost estimates have been developed for this option. They have been based on precast unit pricing supplied by Holcim and industry rates for required items. Estimates for the cost of detailed design, contractor preliminaries, contractor margin and an allowance for risk contingency have been included. A detailed breakdown of the pricing estimates has been included in Appendix C. Due the concept nature of the scheme an upperbound and lowerbound cost estimate has been produced, which is indicated in Table 1 below.

Table 1: Option 1 Engineers Cost Estimate

Lowerbound	Upperbound
$ 729,000	$ 1,199,000

3.3 Option 2 – Precast Concrete Box Culverts

Option 2 consists of a 5-cell precast box culvert to span the proposed section of Eulomogo Creek. The solution comprises of 3 no. precast concrete box culvert cells with 2 no. precast concrete link slabs bridging between the box cells. The box culvert units are 1.2m long and have a 3m internal width and 2.1m internal height. Similarly, the link slab units are 1.2m long and with a span of 3m. The box culvert units are encased by reinforced concrete wingwalls and supported by a reinforced concrete base slab. A typical section view of the box culvert solution along the haul road centreline is presented in Figure 4. Concept design drawings of option 2 are presented in drawing NC19061-SK002 included in Appendix B.

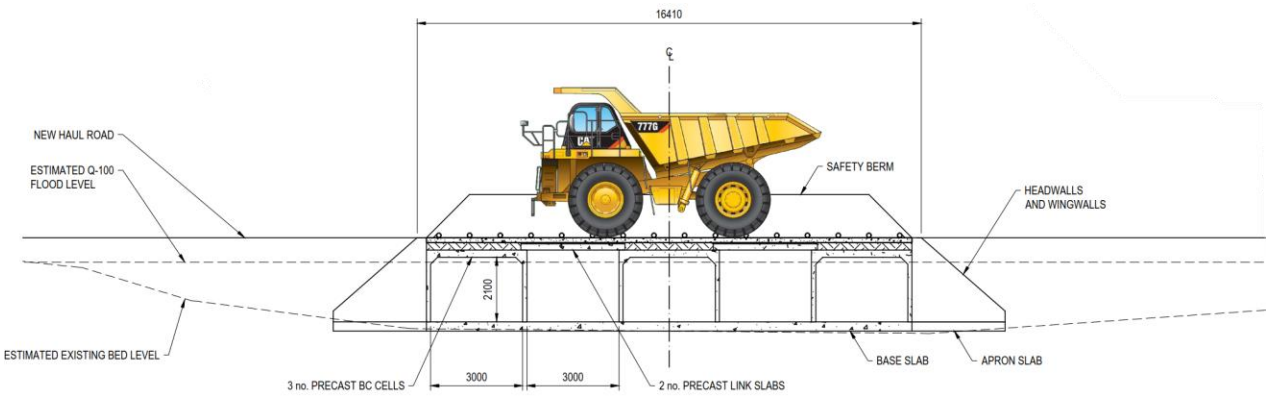


Figure 4: Option 2 Typical Section

Engineers cost estimates have been developed for this option. They have been based on precast unit pricing supplied by Holcim and industry rates for required items. Estimates for the cost of detailed design, contractor preliminaries, contractor margin and an allowance for risk contingency have been included. A detailed breakdown of the pricing estimates has been included in Appendix C. Due the concept nature of the scheme an upperbound and lowerbound cost estimate has been produced, which is indicated in Table 2 below.

Table 2: Option 2 Engineers Cost Estimate

Lowerbound	Upperbound
$ 1,180,000	$ 1,940,000

4. Multi-criteria Analysis

To assess and compare the identified options, a multi-criteria analysis (MCA) has been undertaken. This analysis has been performed to identify the best crossing option. In the MCA, each option is scored against the five criteria, and the scores tallied to identify the preferred option. Scores are provided on a scale of 1 (worst) to 5 (best).

Scoring for the criteria is also weighted to consider more significant criteria as agreed with Holcim, shown in Table 3. The results of the MCA are provided in Table 4. The 'Cost' criteria of the MCA take into consideration the engineers cost estimates developed for each option. These have been included in Appendix C for further information.

Table 3: Multi criteria analysis weightings

Criteria	Weighting
Design Life	5%
Environmental Impact	20%
Safety	5%
Hydraulic Performance	10%
Cost	60%

Table 4: MCA Scoring

Criteria for Comparison	Option 1 – Precast Concrete Pipes	Option 2 – Precast Concrete Box Culverts
Design Life	5	5
Environmental Impact	4	3
Hydraulic Performance	3	5
Safety	4	4
Cost	5	3
Overall Weighted Rank	**4.6**	**3.3**

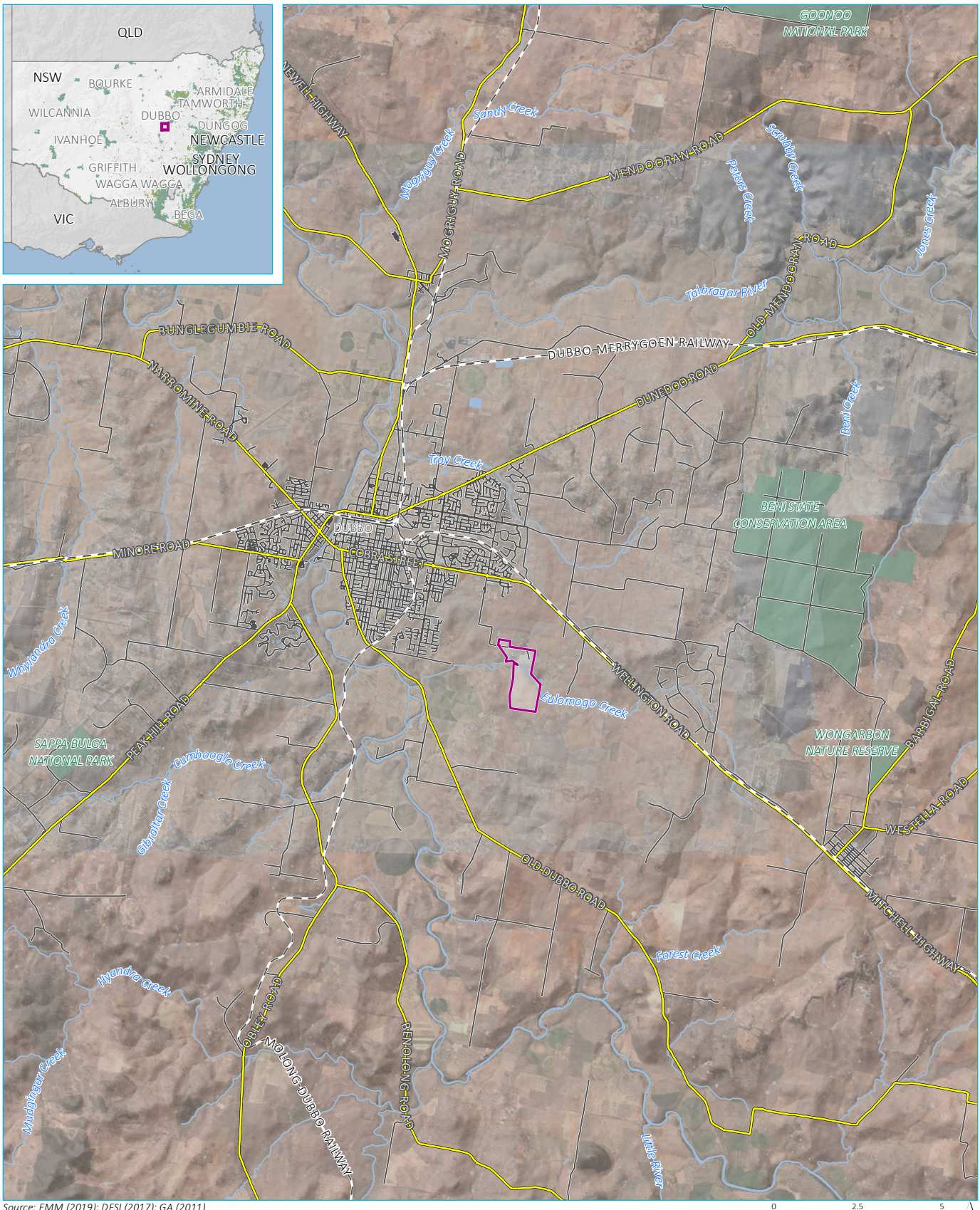
5. Conclusions & Recommendations

Concept design options were explored for the Eulomogo Creek Crossing, proposed to provide access to the southern extension area of the Holcim Dubbo Quarry. Based on an initial review of the client's criteria and the site-specific information, it was determined that a precast concrete culvert solution would best achieve the design intent. The presented options consisted of precast concrete box culvert and precast concrete pipe culvert.

Given the results of the MCA, which explored the design life, environmental impact, safety and cost of each option, it is apparent that the precast concrete pipe culvert solution (Option 1) is the best option to span the Eulomogo Creek. The presented option provides an increased benefit in terms of environmental impact and cost in comparison to the precast concrete box culvert solution. The precast concrete pipe culvert solution (Option 1) has an engineer's cost estimate between $729,000 - $ 1,199,000 compared to the precast concrete box culvert (Option 2) with an engineer's cost estimate between $ 1,180,000 - $ 1,940,000. It is therefore recommended that Holcim adopt the precast concrete pipe solution (Option 1) for the Eulomogo Creek Crossing.

Client Supplied Information

Appendix A



Source: EMM (2019); DFSI (2017); GA (2011)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

\\emmsvr1\EMMJobs\2018\J180313 - Dubbo Quarry EIS\GIS\02_Maps_ScopingStudy\SR001_ProjectAreaLocation_20191216_03.mxd 16/12/2019

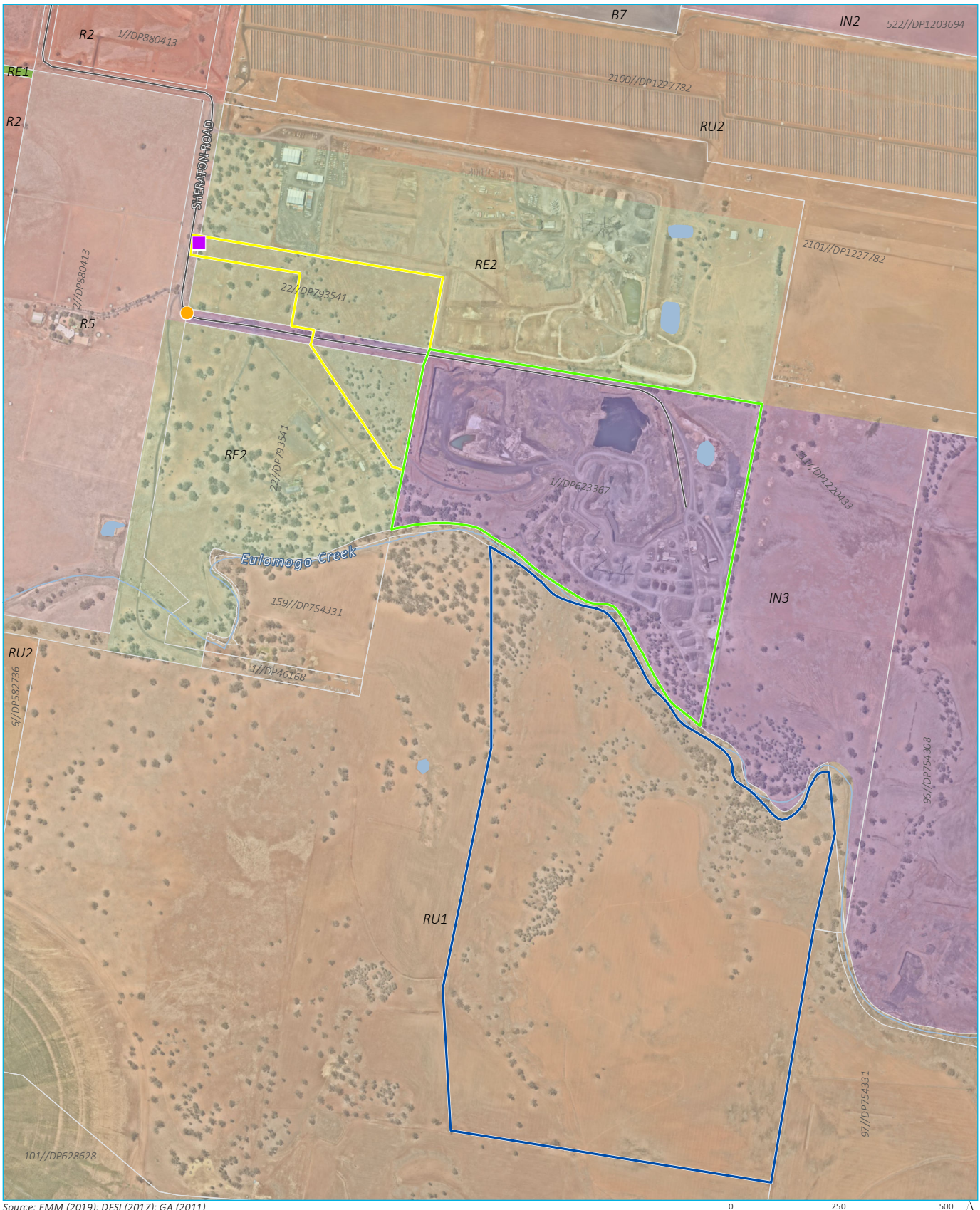
KEY

- Project area
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- NPWS reserve
- State forest
- Waterbody

Project location

Dubbo Quarry Continuation Project
Scoping report
Figure 1.1

EMM
creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

\\emmsvr1\EMMJobs\2018\J180313 - Dubbo Quarry EIS\GIS\02_Maps_ScopingStudy\SR002_ProjectSite_21091216_04.mxd 16/12/2019

KEY

Project site

Current site boundary/ infrastructure and stockpile

Current site access

Southern extension area

Western extension area

Proposed future site access

Local road

Watercourse/drainage line

Cadastral boundary

Waterbody

Land zoning

B7 Business park

IN2 Light industrial

IN3 Heavy industrial

R2 Low density residential

R5 Large lot residential

RE1 Public recreation

RE2 Private recreation

RU1 Primary production

RU2 Rural landscape

Dubbo Quarry Continuation Project
Scoping report
Figure 1.2

EMM
creating opportunities

Source: EMM (2019); DFSI (2017); GA (2011)

0 1 2 km

GDA 1994 MGA Zone 55

N

\\emmsvr1\EMM\Jobs\2018\J180313 - Dubbo Quarry EIS\GIS\02_Maps_ScopingStudy\SR003_SurroundingEnvironment_21091216_03.mxd 16/12/2019

KEY

- Current site boundary/ infrastructure and stockpile
- Current site access
- Southern extension area
- Western extension area
- Proposed future site access
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- Waterbody

Surrounding environment

Dubbo Quarry Continuation Project
Scoping report
Figure 2.1

EMM
creating opportunities

Source: EMM (2019); DFSI (2017); GA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

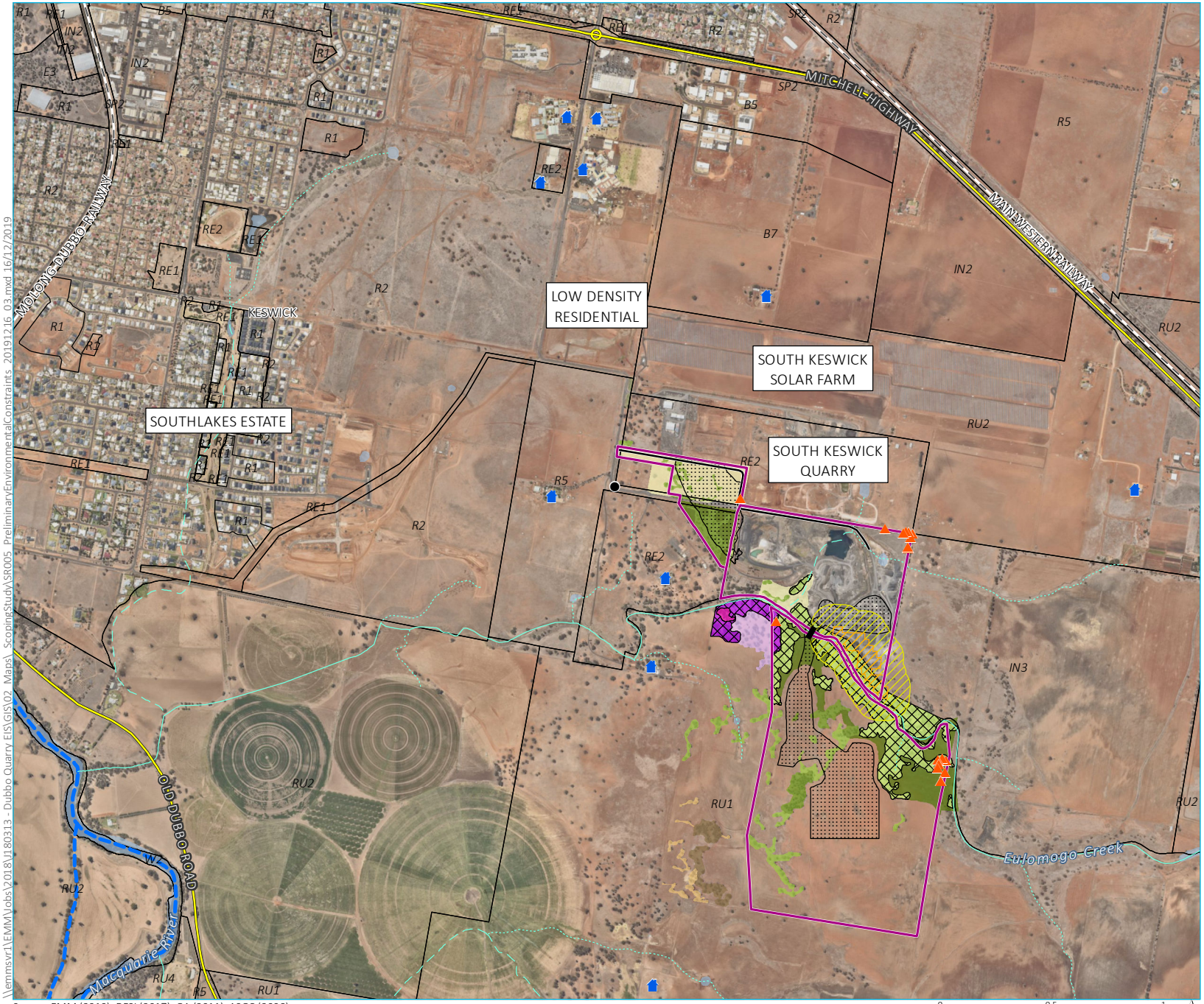
- Current site boundary/ infrastructure and stockpile
- Current site access
- Southern extension area
- Western extension area
- Southern extraction area
- Western extraction area
- New haul road (alignment TBC)
- Processing, maintenance and administration facilities
- New watercourse crossing (location TBC)
- New access road
- Local road
- Watercourse/drainage line
- Cadastral boundary
- Waterbody

Preliminary project layout

Dubbo Quarry Continuation Project
Scoping report
Figure 3.1

EMM creating opportunities

\\emmsvr1\EMMJobs\2018\J180313 - Dubbo Quarry EIS\GIS\02_Maps_ScopingStudy\SR004_PreliminaryProjectLayout_21091216_04.mxd 16/12/2019



KEY

- Project area
- Current site access
- New watercourse crossing (location TBC)
- New access road
- Indicative project disturbance area

Existing environment

- Rail line
- Main road
- Waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 9th order

- Receptor
- Aboriginal heritage site

Bushfire prone land

- Vegetation category 1
- Vegetation category 2
- Exotic grassland
- EPBC listed CEEC

Plant community type

81 - Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion

- Moderate (medium)
- Moderate (poor)

201 - Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion

- Moderate (medium)

435 - White Box - White Cypress Pine shrub grass hills woodland in the Brigalow Belt South Bioregion and Nandewar Bioregion

- Moderate (medium)
- Moderate (poor)

599 - Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion

- Moderate (medium)
- Moderate (poor)
- Moderate (other)
- Moderate (DNG)

Land zoning

B5 - Business Development
B7 - Business Park
E3 - Environmental Management
IN2 - Light Industrial
IN3 - Heavy Industrial
R1 - General Residential
R2 - Low Density Residential
R5 - Large Lot Residential
RE1 - Public Recreation
RE2 - Private Recreation
RU1 - Primary Production
RU2 - Rural Landscape
RU4 - Primary Production Small Lots
SP2 - Infrastructure
W2 - Recreational Waterways

Source: EMM (2019); DFSI (2017); GA (2011); ASGC (2006)

0 0.5 1 km

GDA 1994 MGA Zone 55

N

\\emmsvr1\EMM\Jobs\2018\J180313 - Dubbo Quarry EIS\GIS\02 Maps\ ScopingStudy\SR005 PreliminaryEnvironmentalConstraints 20191216 03.mxd 16/12/2019

Preliminary environmental constraints

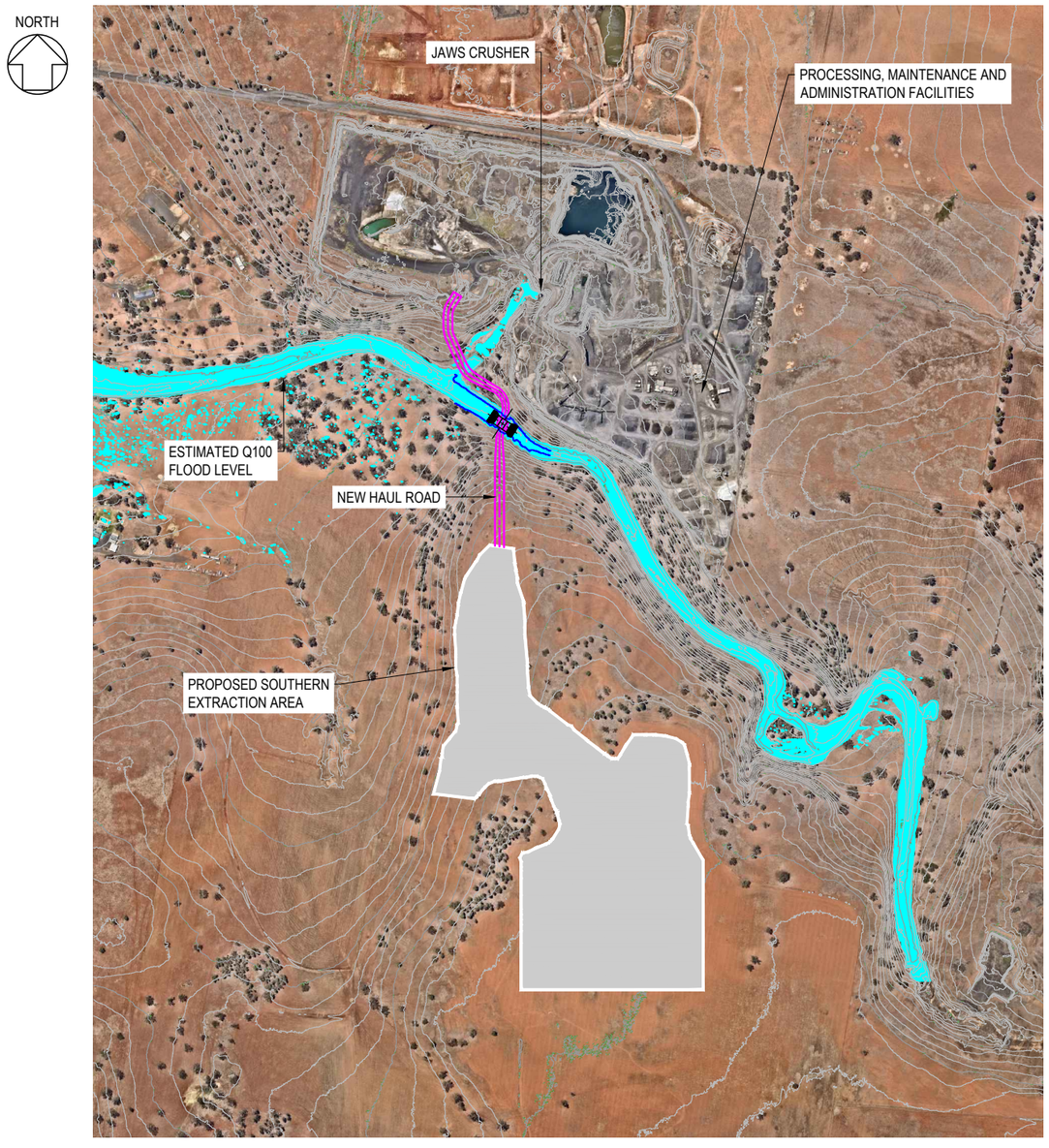
Dubbo Quarry Continuation Project
Scoping report
Figure 5.1

DRAFT

EMM creating opportunities

Concept Drawings

Appendix B



SITE ARRANGEMENT
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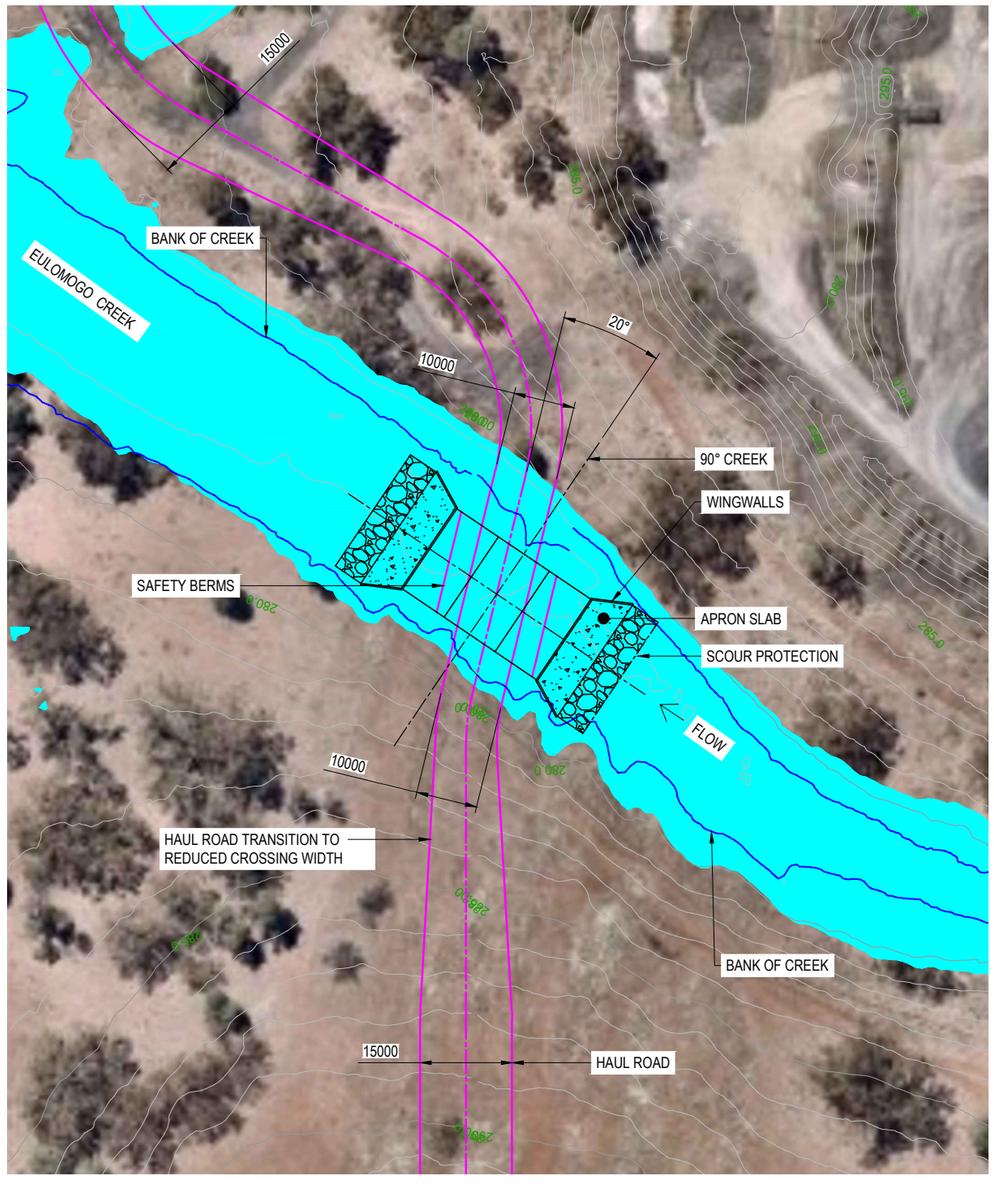

CROSSING ARRANGEMENT
SCALE 1:1000

REFERENCE FILES ATTACHED: NC19061_dubbo_DEM_Contours_Existing_2d; NC19061_estimated_Q100_flood_level

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
B	CONCEPT DESIGN	D.BRANCH		R.ODENDAAL	05-05-20
A	CONCEPT DESIGN	D.BRANCH		R.ODENDAAL	03-02-20

APPROVED
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SIGNED
DATE

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CLIENT: HOLCIM
PROJECT: DUBBO QUARRY CONTINUATION PROJECT
STATUS: CONCEPT

DRAWING TITLE: GENERAL ARRANGEMENT SKETCH SHEET 1 OF 3
DATUMS: AHD / MGA
CLIENT No. -
DRAWING No. NC19061-SK001
REVISION B
May. 5, 20 - 13:46:36 Name: NC19061-SK001.dwg Updated By: David Branch

GENERAL NOTES

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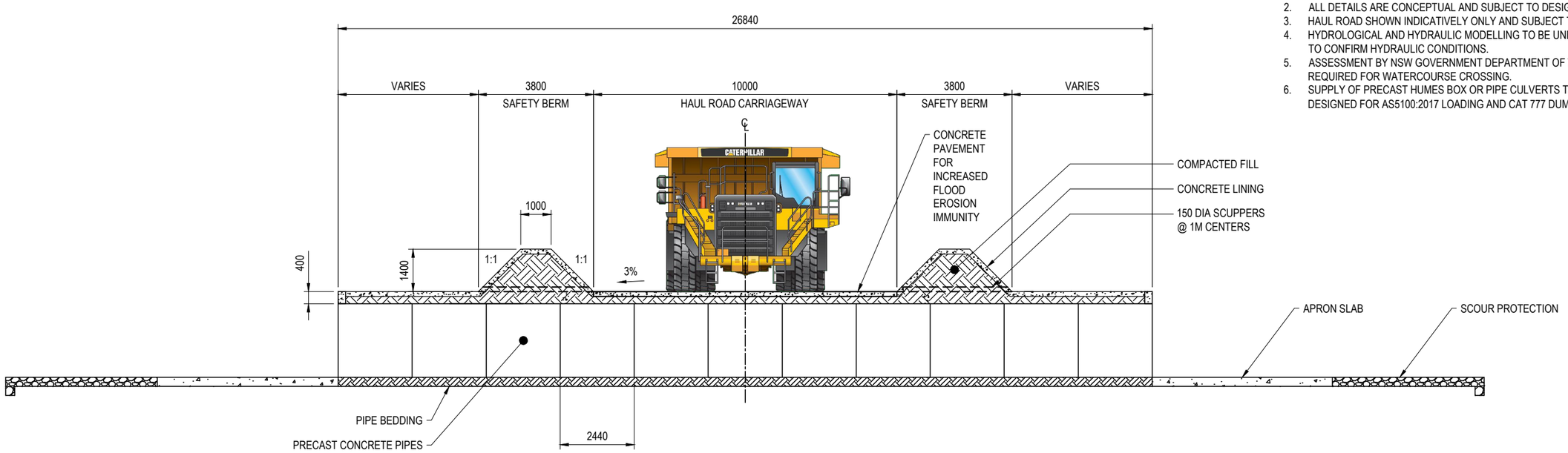
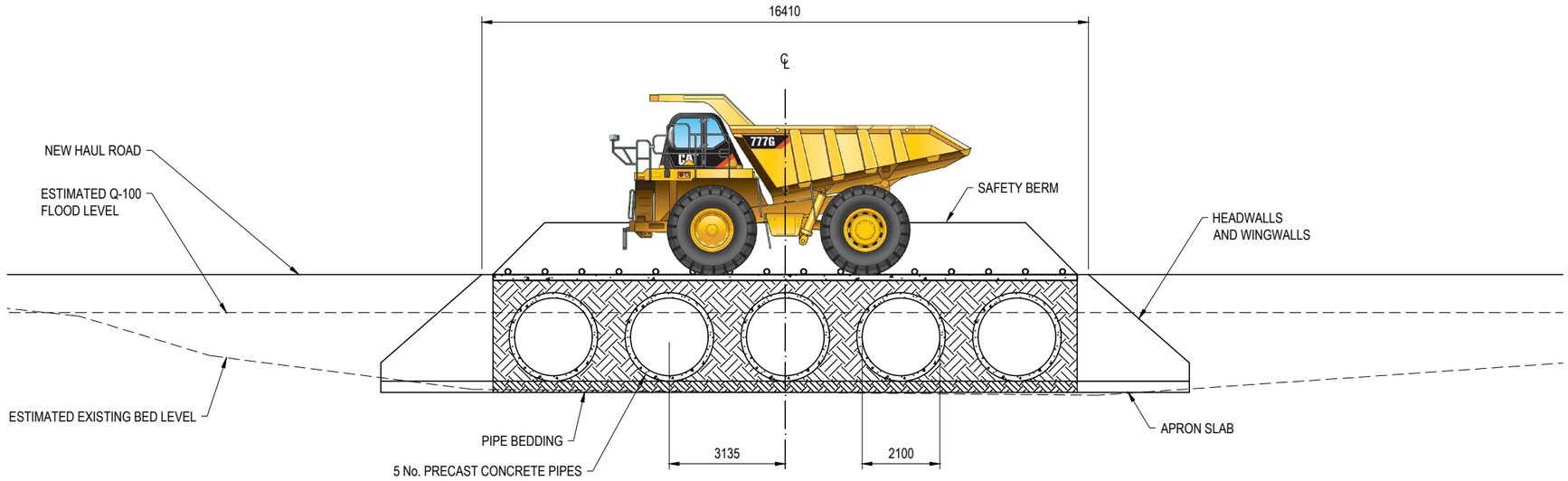
2. ALL DETAILS ARE CONCEPTUAL AND SUBJECT TO DESIGN.
3. HAUL ROAD SHOWN INDICATIVELY ONLY AND SUBJECT TO DESIGN.
4. HYDROLOGICAL AND HYDRAULIC MODELLING TO BE UNDERTAKEN TO CONFIRM HYDRAULIC CONDITIONS.
5. ASSESSMENT BY NSW GOVERNMENT DEPARTMENT OF WATER REQUIRED FOR WATERCOURSE CROSSING.
6. SUPPLY OF PRECAST HUMES BOX OR PIPE CULVERTS TO BE DESIGNED FOR AS5100:2017 LOADING AND CAT 777 DUMP TRUCK.



TYPICAL SECTION ALONG CL OF CULVERT

SCALE NTS



TYPICAL SECTION ALONG CL OF ROAD

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REFERENCE FILES ATTACHED:

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A	CONCEPT DESIGN	D.BRANCH		R.ODENDAAL	03-02-20

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CLIENT: HOLCIM

PROJECT: DUBBO QUARRY CONTINUATION PROJECT

STATUS: CONCEPT

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DATUMS: AHD

CLIENT No. -

DRAWING No. NC19061-SK002

REVISION B

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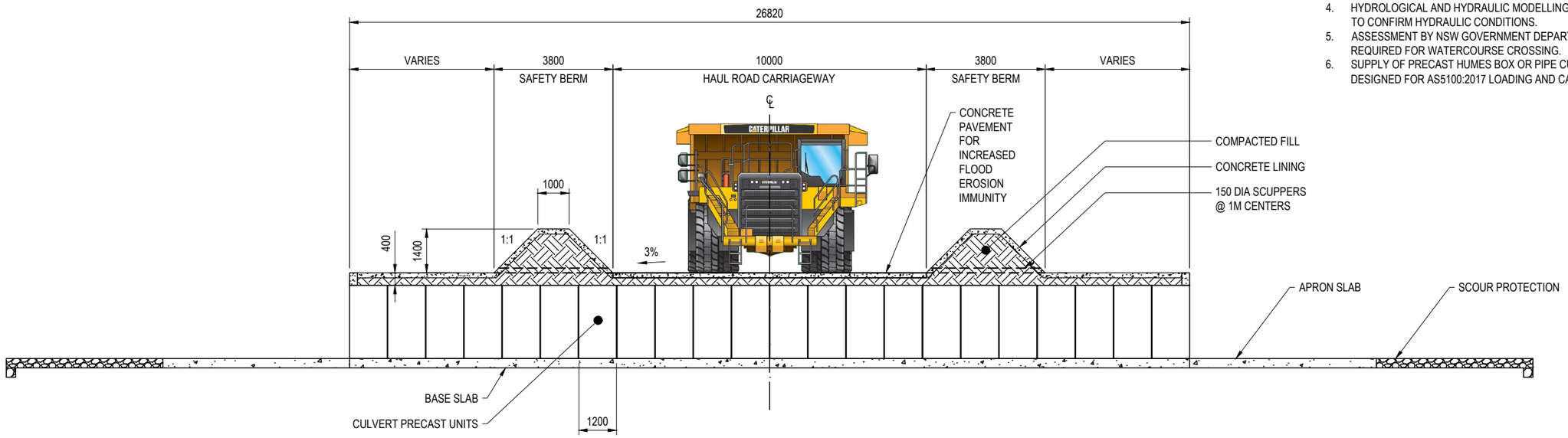
5. ASSESSMENT BY NSW GOVERNMENT DEPARTMENT OF WATER REQUIRED FOR WATERCOURSE CROSSING.
6. SUPPLY OF PRECAST HUMES BOX OR PIPE CULVERTS TO BE DESIGNED FOR AS5100:2017 LOADING AND CAT 777 DUMP TRUCK.



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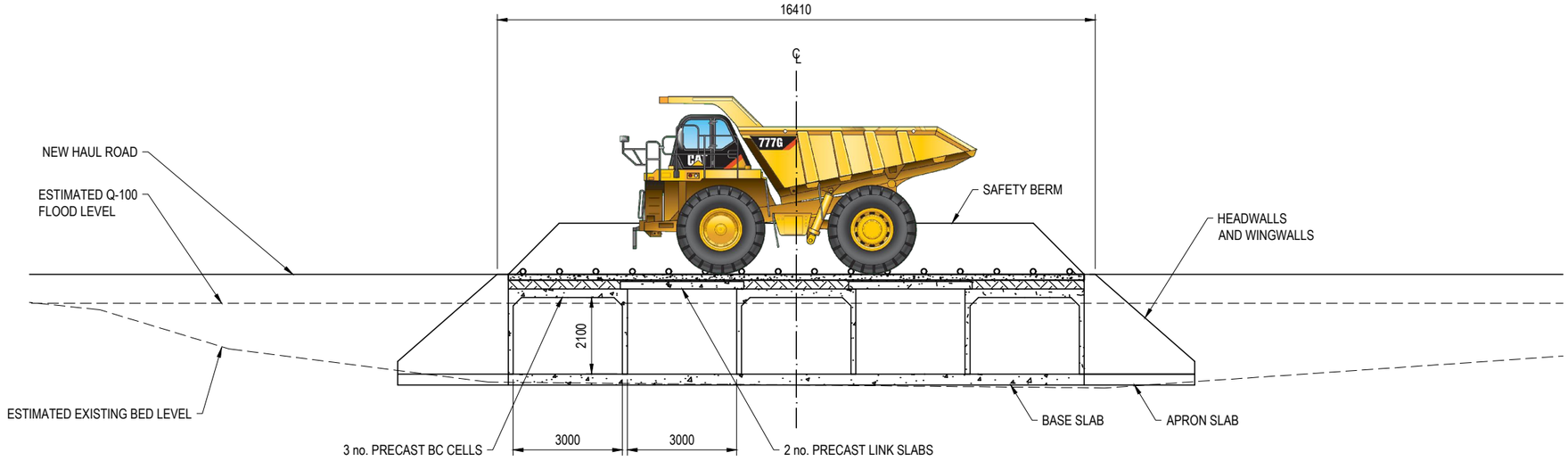

TYPICAL SECTION ALONG CL OF ROAD
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CLIENT: HOLCIM
PROJECT: DUBBO QUARRY CONTINUATION PROJECT
STATUS: CONCEPT

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DATUMS: AHD
CLIENT No. -
DRAWING No. NC19061-SK003
REVISION B
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Engineers Cost Estimates

Appendix C

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PIPE CULVERT LOWERBOUND

Code	Descritption	Quantity	Unit	Rate (adjusted)	Total
1.0	**GENERAL EARTHWORKS**				
1.0.1	**EARTHWORKS, EXCAVATION**				
	Excavation for wingwalls, base slab, apron slab, all materials	27	cum	$ 23	$ 612
1.0.2	**BLINDING CONCRETE**				
	N20 Blinding concrete, 50 mm nominal thickness across base slab and apron slabs	17	sqm	$ 414	$ 6,955
1.0.3	**SELECT FILL**				
	Granular fill on top of culverts	132	cum	$ 59	$ 7,836
	Safety berm	84	cum	$ 59	$ 4,977
	Pipe bedding	130	cum	$ 59	$ 7,707
	Wingwall fill	268	cum	$ 59	$ 15,917
	Fill around pipes	547	cum	$ 59	$ 32,441
2.0	**CULVERT STRUCTURE**				
2.0.1	**CONCRETE**				
	Concrete Class S40 apron slabs	101	cum	$ 234	$ 23,567
	Concrete Class S40 wingwalls	6	cum	$ 234	$ 1,403
	Concrete Class S40 headwalls	19	cum	$ 234	$ 4,445
	Concrete Class 6 precast pipe	70	units	$ 2,800	$ 194,767
	Concrete pavement, including mesh	164	sqm	$ 95	$ 15,646
	Safety Berm Lining	192	sqm	$ 95	$ 18,306
2.0.2	**SCOUR PROTECTION**				
	Rockfill scour protection	70	cum	$ 95	$ 6,665
2.0.3	**BAR REINFORCEMENT**				
	Steel reinforcing bar in apron slabs	20	t	$ 2,515	$ 50,698
	Steel reinforcing bar in wingwalls	1.2	t	$ 2,515	$ 3,018
	Steel reinforcing bar in headwalls	3.8	t	$ 2,515	$ 9,563
2.0.4	**FORMWORK**				
	Class F2 formwork to edge of apron slab	14	sqm	$ 220	$ 3,082
	Class F2 formwork to wingwalls	30	sqm	$ 233	$ 6,980
	Class F2 formwork to headwalls	26	sqm	$ 233	$ 6,049
	DETAILED DESIGN	7.5%			$ 31,547.52
	CONTRACTOR PRELIMINARIES	40%			$ 168,253.42
	CONTRACTOR MARGIN	10%			$ 42,063.36
	PROJECT CONTINGENCY	10%			$ 66,250
	TOTAL				**$ 728,748**

PIPE CULVERT UPPERBOUND

Code	Description	Quantity	Unit	Rate (adjusted)	Total
1.0	**GENERAL EARTHWORKS**				
1.0.1	**EARTHWORKS, EXCAVATION**				
	Excavation for wingwalls, base slab, apron slab, all materials	27	cum	$ 23	$ 612
1.0.2	**BLINDING CONCRETE**				
	N20 Blinding concrete, 50 mm nominal thickness across base slab and apron slabs	17	sqm	$ 414	$ 6,955
1.0.3	**SELECT FILL**				
	Granular fill on top of culverts	132	cum	$ 59	$ 7,836
	Safety berm	84	cum	$ 59	$ 4,977
	Pipe bedding	130	cum	$ 59	$ 7,707
	Wingwall fill	268	cum	$ 59	$ 15,917
	Fill around pipes	547	cum	$ 59	$ 32,441
2.0	**CULVERT STRUCTURE**				
2.0.1	**CONCRETE**				
	Concrete Class S40 apron slabs	101	cum	$ 234	$ 23,567
	Concrete Class S40 wingwalls	6	cum	$ 234	$ 1,403
	Concrete Class S40 headwalls	19	cum	$ 234	$ 4,445
	Concrete Class 6 precast pipe	70	units	$ 2,800	$ 194,767
	Concrete pavement, including mesh	164	sqm	$ 95	$ 15,646
	Safety Berm Lining	192	sqm	$ 95	$ 18,306
2.0.2	**SCOUR PROTECTION**				
	Rockfill scour protection	70	cum	$ 95	$ 6,665
2.0.3	**BAR REINFORCEMENT**				
	Steel reinforcing bar in apron slabs	20	t	$ 2,515	$ 50,698
	Steel reinforcing bar in wingwalls	1.2	t	$ 2,515	$ 3,018
	Steel reinforcing bar in headwalls	3.8	t	$ 2,515	$ 9,563
2.0.4	**FORMWORK**				
	Class F2 formwork to edge of apron slab	14	sqm	$ 220	$ 3,082
	Class F2 formwork to wingwalls	30	sqm	$ 233	$ 6,980
	Class F2 formwork to headwalls	26	sqm	$ 233	$ 6,049
	DETAILED DESIGN	10%			$ 42,063.36
	CONTRACTOR PRELIMINARIES	70%			$ 294,443.49
	CONTRACTOR MARGIN	10%			$ 42,063.36
	PROJECT CONTINGENCY	50%			$ 399,602
	TOTAL				**$ 1,198,806**

BOX CULVERT LOWERBOUND

Code	Description	Quantity	Unit	Rate (adjusted)	Total
1.0	**GENERAL EARTHWORKS**				
1.0.1	**EARTHWORKS, EXCAVATION**				
	Excavation for wingwalls, base slab, apron slab, all materials	27	cum	$ 23	$ 612
1.0.2	**BLINDING CONCRETE**				
	N20 Blinding concrete, 50 mm nominal thickness across base slab and apron slabs	39	cum	$ 414	$ 16,065
1.0.3	**SELECT FILL**				
	Granular fill on top of culverts	132	cum	$ 59	$ 7,836
	Safety berm	84	cum	$ 59	$ 4,977
	Wingwall fill	268	cum	$ 59	$ 15,917
2.0	**CULVERT STRUCTURE**				
2.0.1	**CONCRETE**				
	Concrete Class S40 base slab	132	cum	$ 234	$ 30,870
	Concrete Class S40 apron slabs	101	cum	$ 234	$ 23,567
	Concrete Class S40 wingwalls	6	cum	$ 234	$ 1,403
	Concrete Class S40 headwalls	2	cum	$ 234	$ 539
	Concrete Class S50 precast box culvert units	66	units	$ 3,756	$ 247,896
	Concrete Class S50 precast link slab units	44	units	$ 2,606	$ 114,664
	Concrete pavement, including mesh	164.1	sqm	$ 95	$ 15,646
	Safety Berm Lining	192	sqm	$ 95	$ 18,306
2.0.2	**SCOUR PROTECTION**				
	Rockfill scour protection	70.4	cum	$ 95	$ 6,665
2.0.3	**BAR REINFORCEMENT**				
	Steel reinforcing bar in base slab	26	t	$ 2,515	$ 66,407
	Steel reinforcing bar in apron slabs	20.2	t	$ 2,515	$ 50,698
	Steel reinforcing bar in wingwalls	1	t	$ 2,515	$ 3,018
	Steel reinforcing bar in headwalls	0.5	t	$ 2,515	$ 1,160
	Steel reinforcing bar in link slab	13.2	t	$ 2,515	$ 33,195
2.0.4	**FORMWORK**				
	Class F2 formwork to edge of base and apron slab	37	sqm	$ 220	$ 8,144
	Class F2 formwork to wingwalls	30	sqm	$ 233	$ 6,980
	Class F2 formwork to headwalls	26	sqm	$ 233	$ 6,049
	DETAILED DESIGN	7.5%			$ 51,000
	CONTRACTOR PRELIMINARIES	40%			$ 272,245.52
	CONTRACTOR MARGIN	10%			$ 68,061.38
	PROJECT CONTINGENCY	10%			$ 107,192
	TOTAL				**$ 1,179,113**

BOX CULVERT UPPERBOUND

Code	Description	Quantity	Unit	Rate (adjusted)	Total
1.0	**GENERAL EARTHWORKS**				
1.0.1	**EARTHWORKS, EXCAVATION**				
	Excavation for wingwalls, base slab, apron slab, all materials	27	cum	$ 23	$ 612
1.0.2	**BLINDING CONCRETE**				
	N20 Blinding concrete, 50 mm nominal thickness across base slab and apron slabs	39	cum	$ 414	$ 16,065
1.0.3	**SELECT FILL**				
	Granular fill on top of culverts	132	cum	$ 59	$ 7,836
	Safety berm	84	cum	$ 59	$ 4,977
	Wingwall fill	268	cum	$ 59	$ 15,917
2.0	**CULVERT STRUCTURE**				
2.0.1	**CONCRETE**				
	Concrete Class S40 base slab	132	cum	$ 234	$ 30,870
	Concrete Class S40 apron slabs	101	cum	$ 234	$ 23,567
	Concrete Class S40 wingwalls	6	cum	$ 234	$ 1,403
	Concrete Class S40 headwalls	2	cum	$ 234	$ 539
	Concrete Class S50 precast box culvert units	66	units	$ 3,756	$ 247,896
	Concrete Class S50 precast link slab	44	units	$ 2,606	$ 114,664
	Concrete pavement, including mesh	164.1	sqm	$ 95	$ 15,646
	Safety Berm Lining	192	sqm	$ 95	$ 18,306
2.0.2	**SCOUR PROTECTION**				
	Rockfill scour protection	70.4	cum	$ 95	$ 6,665
2.0.3	**BAR REINFORCEMENT**				
	Steel reinforcing bar in base slab	26	t	$ 2,515	$ 66,407
	Steel reinforcing bar in apron slabs	20.2	t	$ 2,515	$ 50,698
	Steel reinforcing bar in wingwalls	1	t	$ 2,515	$ 3,018
	Steel reinforcing bar in headwalls	0.5	t	$ 2,515	$ 1,160
	Steel reinforcing bar in link slab	13.2	t	$ 2,515	$ 33,195
2.0.4	**FORMWORK**				
	Class F2 formwork to edge of base and apron slab	37	sqm	$ 220	$ 8,144
	Class F2 formwork to wingwalls	30	sqm	$ 233	$ 6,980
	Class F2 formwork to headwalls	26	sqm	$ 233	$ 6,049
	DETAILED DESIGN	10%			$ 68,000.16
	CONTRACTOR PRELIMINARIES	70%			$ 476,429.66
	CONTRACTOR MARGIN	10%			$ 68,061.38
	PROJECT CONTINGENCY	50%			$ 646,553
	TOTAL				**$ 1,939,658**

Dubbo Quarry Continuation Project

Eulomogo Creek - Concept Options Report

Contact

Russel Odendaal
0412 032 802
rodendaal@pittsh.com.au

Pitt & Sherry (Operations) Pty Ltd
ABN 67 140 184 309

Phone 1300 748 874
info@pittsh.com.au
pittsh.com.au

Located nationally —
Melbourne
Sydney
Brisbane
Hobart
Launceston
Newcastle
Devonport
Wagga Wagga

Appendix B

Government correspondence

Patrick Carolan

From: Brian Gardoll
Sent: Monday, 30 March 2020 11:13 AM
To: Mark Campbell
Cc: Alasdair Webb; Tess Davies; Claire Burnes; Nick Bartho
Subject: Re: Holcim's Dubbo Quarry - surface water licensing
Attachments: Holcim application - Section R.pdf; Dubbo Quarry Council Consent.pdf

Hi Mark

Thank you for your review. In response to your dot points please see the following comments;

- Yes agreed, the application is in the name of Holcim (Australia) Pty Ltd.
- As you have suggested please find attached a completed Section R.
- Please also find attached a copy of the consent granted by Dubbo City Council.
- Your concurrence with 136 ML is noted and action will now proceed to secure this volume.
- Noted re your contact with NRAR.

Regards
Brian

Brian Gardoll
Associate Director Water Regulation

T 02 4907 4800
M 0409 151 596
www.emmconsulting.com.au

From: Mark Campbell <Mark.Campbell@waternsw.com.au>
Date: Monday, 30 March 2020 at 8:59 am
To: Brian Gardoll <bgardoll@emmconsulting.com.au>
Cc: Alasdair Webb <alasdair.webb@lafargeholcim.com>, Tess Davies <tdavies@emmconsulting.com.au>, Claire Burnes <cburnes@emmconsulting.com.au>, Nick Bartho <nbartho@emmconsulting.com.au>
Subject: RE: Holcim's Dubbo Quarry - surface water licensing

Thanks Brian,

We have undertaken a review of the application and provide the following comments;

- The application should be lodged in the name of Holcim (Australia) Pty Ltd as the owner of Lot 222 DP 1247780.
- The type of work should be completed at Section R as this best describes the type of work to be authorised (run off harvesting dam). Section S refers to in river storages which are regarded as works on third order or higher streams.
- Are you able to provide a copy of the consent granted for the quarry?
- The volume of water to be sourced to cover the water captured is confirmed as 136 ML.
- I have also left a message with Tim Baker from NRAR just to find out if they have had any prior involvement in the surface water side of this development.

Regards
Mark

From: Brian Gardoll <bgardoll@emmconsulting.com.au>
Sent: Thursday, 12 March 2020 11:32 AM
To: Mark Campbell <Mark.Campbell@waternsw.com.au>
Cc: Alasdair Webb <alasdair.webb@lafargeholcim.com>; Tess Davies <tdavies@emmconsulting.com.au>; Claire Burnes <cburnes@emmconsulting.com.au>; Nick Bartho <nbartho@emmconsulting.com.au>
Subject: RE: Holcim's Dubbo Quarry - surface water licensing

Hi Mark

Further to my email 22 January and your response 31 January, please now find attached a water supply Work Approval application lodged on behalf of Holcim (Australia) Pty Ltd.

In relation to water take, EMM reviewed your suggestion to consider the Dam Reliability Factor (DRF) to assess the final volume require to be traded. However as discussed, that method was developed to match dam size against catchment area to prevent over or under sizing of farm dams and is not appropriate for the quarry site. Please confirm your acceptance of our extrapolation of the MHRDC calculation, provided on 22 January, as the method for determining the volume required being 136 ML. Once confirmed EMM will assist the client to enter the water market to acquire entitlement in the Maryvale Geurie Creek water source.

We also reviewed the 1st order stream to the north that you mentioned. It is our understanding that this stream no longer contributes to quarry inflows due to developments in that area, however this will be confirmed during on-site inspection.

Thank you for your attention to this issue.

Regards
Brian

Brian Gardoll
Associate Director Water Regulation

T 02 4907 4800
M 0409 151 596
www.emmconsulting.com.au

From: Mark Campbell <Mark.Campbell@waternsw.com.au>
Sent: Friday, 31 January 2020 2:49 PM
To: Brian Gardoll <bgardoll@emmconsulting.com.au>
Subject: RE: Holcim's Dubbo Quarry - surface water licensing

Hi Brian,

Thanks for your email. We have had a preliminary look at the calculations and methodology for assessing the volume that may require trading, to account for the water captured within the quarry. I

It appears that the catchment area (hatched in figure 3.1) does not include the catchment area of the 1st order stream that also enters the quarry site from the north. The 1st order stream from the east is mapped as flowing through the Holcim quarry site into Eulomogo Creek. Whilst the stream enters the pit site immediately after flowing through the small dam, the catchment area within the quarry site should also be included when assessing the required volume. The MHRDC of the quarry site would be excluded from that overall volume.

The dam reliability factor (DRF) may also be used to determine a final volume that is required to be traded. The DRF is essentially an adaption of the concept of “critical storage period” which has been used in the design of dams since the 1960s. For this location the DRF has been calculated as 1.50. As an example in this location a 100 ML dam would

need to trade in a volume of 66.6 ML (100 ML divided by calculated DRF of 1.50). This methodology will need to be assessed to see if it is applicable for this proposal.

Please note that a work approval only will be required, as the use component of the quarry is not required to be authorised under our legislation [exempt under Part 3 division 2 subdivision 2 35 (a)] of the Water Management (General) Regulation 2018.

We would appreciate your comments on our preliminary assessment, and welcome a further discussion on the proposal.

Kind Regards
Mark

Mark Campbell
Senior Water Regulation officer
Customer Assessment & Approvals
Customer & Community (North).

9 Commercial Avenue,
PO Box 1018
DUBBO, NSW 2830
T: 02 6841 2042
E:mark.campbell@waternsw.com.au

From: Brian Gardoll <bgardoll@emmconsulting.com.au>
Sent: Wednesday, 22 January 2020 2:39 PM
To: Mark Campbell <Mark.Campbell@waternsw.com.au>
Cc: Claire Burnes <cburnes@emmconsulting.com.au>
Subject: Holcim's Dubbo Quarry - surface water licensing

Hi Mark

As indicated previously, Holcim Pty Ltd have engaged EMM to assist in determining the appropriate licensing of surface water that is incidentally captured within their quarry operation.

To this end EMM have undertaken some preliminary assessment of the catchment and developed a methodology to calculate a reasonable volume to licence, through entering the water market.

To initiate discussions please find attached the following documents;

- A draft memo introducing the issue, a runoff calculation method and an opportunity to secure entitlement,
- A diagram of the relevant catchment,
- A MHRDC calculation for the locality, as a starting point, and
- An suggested extrapolation of the MHRDC calculation for licensing purposes.

Please note this is not an attempt to seek exemption under the Harvestable Rights provisions, but using the harvestable rights methodology as an accepted precedent.

Please treat this material as draft to assist discussion and not for circulation.

Regards
Brian

Brian Gardoll
Associate Director Water Regulation

creating opportunities

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Connect with us

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Appendix G
Addendum visual impact assessment

EMM
creating opportunities

Dubbo Quarry Continuation Project

Visual Impact Assessment: Addendum

Prepared for Holcim (Australia) Pty Ltd
June 2022

EMM Sydney
Ground floor, 20 Chandos Street
St Leonards NSW 2065

T 02 9493 9500
E info@emmconsulting.com.au

www.emmconsulting.com.au

Dubbo Quarry Continuation Project

Visual Impact Assessment: Addendum

Report Number
J210189 RP#VIA
Client
Holcim (Australia) Pty Ltd
Date
28 June 2022
Version
v1 Draft

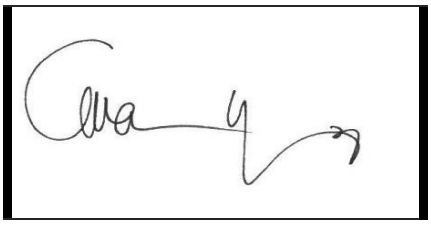
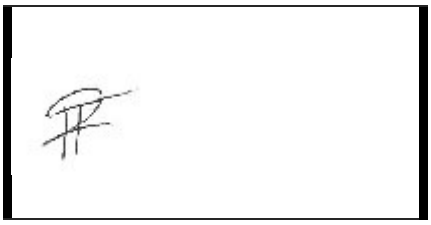
Prepared by	Approved by
	
Allan Young	**Rachael Thelwell**
National Technical Leader, Urban and Regional Planning	Associate Environmental Planner

Table of Contents

1 Introduction

1.1 Context

This Visual Impact Assessment (VIA) Addendum is a supplementary study to the findings of the Visual Impact Assessment chapter in the Dubbo Quarry Continuation Project Environmental Impact Statement (EIS) (EMM 2021).

1.2 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements (SEARs) for this project remain unchanged and are stated to be (with respect to visual impacts) as stated in Table 1.1

Table 1.1 SEARs requirement - Visual

SEARs requirement
Visual - including a detailed assessment of the likely visual impacts of the development (before, during and post-mining) on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to any new landform.

1.3 Purpose and methodology

The purpose and method for preparing this VIA Addendum are the same as those presented in Section 6.16 of the EIS (EMM 2021).

The VIA examines the effect of the project in terms of visual impact on local residences and other locations where a line of sight to the project is feasible and where people may place a value on the existing visual landscape. The assessed viewing locations include destinations such as tourist sites and vantage points, or similar settings where the view is an integral component of the experience.

The methodology is consistent with the *Guidelines for Landscape and Visual Impact Assessment* (Landscape Institute and the Institute of Environmental Management and Assessment (LI&IEMA) 2013).

1.4 Existing environment

There has been one major visual change to the host environment (eg new structures which may influence a viewshed) since the VIA was prepared for the EIS. The landholding associated with the adjacent quarry, owned and operate by MAAS, includes areas to the north and east of the Holcim Quarry. In February 2021, Dubbo City Council granted approval for the construction of a concrete batching plant and associated buildings in the eastern area of the MAAS land. Refer to Figure 1.1.

Those works, notably a 10 metre (m) high (60 m x 30 m) shed and 22 m high batching plant with cement silos, are now constructed and form a significant feature in the visual landscape.

This will, to some extent, alter the viewshed for many of the identified sensitive receptors; however, the receptors to the north and east will experience the more pronounced additional element in the host environment.

It is also noted that Holcim has, under the authorisation of its existing consent at the site, removed processing plant from the top of the existing quarry and installed mobile processing plant in the existing pit. This has reduced the cumulative effect of plant and other structures within the visual landscape.

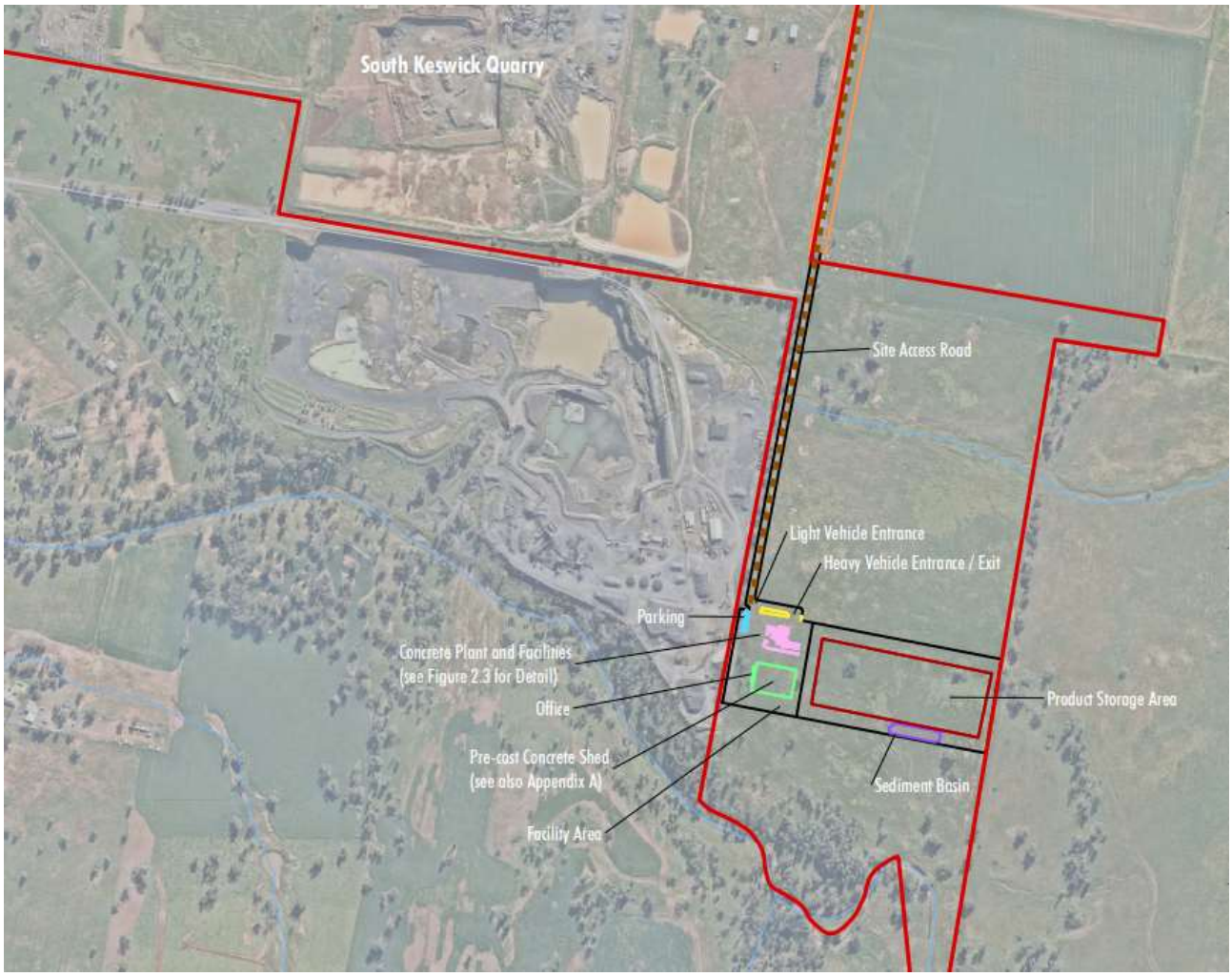


Figure 1.1 Concrete batching plant and associated works

Source: Statement of Environmental Effects (Umwelt 2020)

1.5 The findings of the EIS VIA

The VIA prepared for the EIS ('the EIS VIA') considered the likely visual impact of the proposed works at a range of potential sensitive receptor locations within a 3 km radius of the proposed quarry development.

The elements of the project with visual effects were noted to include the quarry pits/void, bund walls, existing built infrastructure and proposed surface infrastructure.

The EIS VIA found that there are three existing rural residences within the area of theoretical visibility that will have high or moderate visual impacts resulting from the project. At these residences, the visual impacts are

associated with the proposed voids and bunding, and to a lesser extent with the proposed and existing surface infrastructure.

For all other existing rural residences, the impact was assessed to be low or non-existent, due to both viewing distance and the presence of intervening structures and vegetation.

The EIS VIA noted the potential for future urban and large lot residential development to the west of the existing quarry. Impacts to future residences were not able to be quantified; however, it was identified that, in anticipation of some future potential interaction, the early establishment of visual impact mitigation measures, such as tree plantings for visual screening, is a sensible and pragmatic risk management initiative. The EIS for the proposed quarry development includes a commitment to establish planting.

The EIS VIA found that the project would have low to nil visual impacts to other sensitive receptors including community facilities, major tourism sites, function centres, public vantage points, and visually sensitive lands.

2 Proposed amendments to the project

2.1 Background to project amendments

The (then) Department of Planning, Industry and Environment (DPIE) wrote to Holcim on 15 March 2021 requesting responses to the matters raised by NSW Government agencies, Dubbo Regional Council (the Council) and the community that were received during the public exhibition of the EIS.

The Submissions Report addressed most of the issues raised in advice and submissions received on the project (SSD-10417), as well as further technical studies and stakeholder and community engagement activities that Holcim has carried out since the conclusion of the EIS exhibition.

Holcim is now preparing an Addendum Submissions Report which identifies project changes in response to submissions received.

2.2 Proposed amendments

The following sub-sections briefly identify the further proposed project amendments which are relevant to the consideration of visual impact.

2.2.1 Expanded extraction area within East Pit

Since the EIS was submitted in January 2021, extraction of the existing East Pit has continued under the quarry's existing development consent. To access available resources and maintain operation of the quarry until the project can be approved, extraction within the East Pit will continue in a southern direction.

A revised future extraction boundary for the East Pit has been estimated assuming extraction continues up to mid-2022 (approximately 12 months) at a rate of 500,000 tpa, though the actual East Pit boundary at the time of project commencement may vary depending on when project approval is obtained, and the rate of extraction during this period.

2.2.2 Change to processing area location and upgrade of plant

The area to the south of the East Pit was previously the location of the quarry's processing plant which is now decommissioned and removed. Holcim has instead installed mobile processing plant inside the pit. Continued extraction within the East Pit will require the mobile plant to be replaced by modular plant. The key difference from a visual perspective is that the modular plant will be approximately 3 m to 4 m higher than the mobile plant.

The new plant location (ie within the pit) will continue to be the location of the processing plant for the duration of the project.

The location of the processing plant within the quarry pit will have several supplementary changes to quarry operations. These are as follows:

- haul truck routes will be slightly modified to travel from the Southern Extraction Area (SEA) or Western Extraction Area (WEA) to the in-pit processing area;
- conveyors may be installed along haul truck routes between the SEA, WEA and the in-pit processing area as an alternative to truck haulage. If conveyors are installed, the primary jaw crusher may be located within the SEA or WEA to allow crushing of rock prior to being loaded onto conveyors;

- an additional excavator (similar to the one currently on-site) will be used to load material into the primary crusher; and
- an additional stockpile area will be located adjacent to the new processing area.

2.2.3 Changes to construction activities

The construction of a 4 m high bund on the western boundary of the WEA was initially proposed in the EIS to provide amenity benefits including visual. Further assessment has been undertaken and determined that this bund would provide no significant visual amenity benefit and would result in negative visual amenity impacts until it is rehabilitated. Therefore, this bund is no longer proposed to be constructed under the project. Construction of the amenity bund around the SEA will remain a part of the project.

3 Sensitive receptors

The sensitive receptors remain unchanged since the preparation of the EIS VIA.

The identified sensitive receptors and their sensitivity ranking for the WEA are listed in Table 3.1.

The identified sensitive receptors and their sensitivity ranking for the SEA are listed in Table 3.2.

Table 3.1 WEA - Sensitive receptor locations and sensitivity ranking

No.	Nearest road	Sensitivity	Reason / Notes
R1	Sheraton Road	High	Distance is ~240 m; Some vegetation filtering
R2	Sheraton Road	Moderate	Distance is ~600 m; Some vegetation filtering
R3	Sheraton Road	Moderate	Distance is~520 m; Some vegetation filtering
R4	Wellington Road (A32)	Low	Distance is ~770 m; Solar array obscuring
R5	Lidscomb Road	Low	Distance is ~1.6 km; Vegetation obscuring
R6a	Old Dubbo Road	Low	Distance is ~2.3 km; Structures and vegetation obscuring
R6b	Old Dubbo Road	Low	Distance is ~2.4 km; Structures and vegetation obscuring
R7	Angle Park Road	Nil	Distance is~3.1 km; Outside area of theoretical visibility
R8	Angle Park Road	Nil	Distance is ~3.1 km; Outside area of theoretical visibility
R9	Sheraton Road	Low	Distance is~1.3 km; Vegetation and structures obscuring
R10	Sheraton Road	Low	Distance is~1.5 km; Other structures obscuring
R11	Sheraton Road	Low	Distance is~1.2 km; Vegetation and structures obscuring
R12	Sheraton Road	Low	Distance is ~1.5 km; Other structures obscuring
R13	Wellington Road (A32)	Nil	Distance is ~1.4 km; Outside area of theoretical visibility
R14	Lidscomb Road	Low	Distance is ~1.6 km; Predominantly obscured by solar array
R15	Lidscomb Road	Low	Distance is ~1.8 km; Partly obscured by solar array; Vegetation filtering
R16	Basalt Road	Low	Distance is ~1.7 km; Vegetation and structures obscuring
R17	Sheraton Road	Low	Distance is ~400 m (office only); Vegetation and structures obscuring
R18	Argyle Avenue	Low	Distance is ~1.5 km; Vegetation obscuring
R19	Stream Avenue (future)	Low	Distance is ~1.3 km; Vegetation obscuring
R20	Angle Park Road	Low	Distance is ~ 3.4 km; Vegetation filtering
R21	Angle Park Road	Low	Distance is ~ 3.5 km; Vegetation and structures obscuring
R22	Basalt Road	Low	Distance is ~2 km; Vegetation filtering
R23	Sheraton Road	Low	Distance is ~550 m; Vegetation and structures obscuring

Table 3.2 SEA - Sensitive receptor locations and sensitivity ranking

No.	Nearest road	Sensitivity	Reason / Notes
R1	Sheraton Road	Low	Distance is ~700 m; Vegetation filtering
R2	Sheraton Road	Moderate	Distance is ~600 m; Some vegetation filtering
R3	Sheraton Road	Low	Distance is~1.3 km; Vegetation filtering
R4	Wellington Road (A32)	Low	Distance is ~1.7 km; Solar array obscuring
R5	Lidscomb Road	Low	Distance is ~1.6 km; Vegetation obscuring
R6a	Old Dubbo Road	Low	Distance is ~1.7 km; Topography and vegetation obscuring
R6b	Old Dubbo Road	Low	Distance is ~1.7 km; Topography and vegetation obscuring
R7	Angle Park Road	Nil	Distance is ~1.9 km; Outside area of theoretical visibility
R8	Angle Park Road	Nil	Distance is ~1.9 km; Outside area of theoretical visibility
R9	Sheraton Road	Low	Distance is~2.5 km; Vegetation and structures obscuring
R10	Sheraton Road	Nil	Distance is~2.7 km; Outside area of theoretical visibility
R11	Sheraton Road	Low	Distance is~2.5 km; Vegetation and structures obscuring
R12	Sheraton Road	Nil	Distance is ~2.7 km; Outside area of theoretical visibility
R13	Wellington Road (A32)	Low	Distance is ~2.1 km; Topography and solar array obscuring
R14	Lidscomb Road	Low	Distance is ~1.9 km; Predominantly obscured by solar array
R15	Lidscomb Road	Low	Distance is ~1.9 km; Vegetation filtering
R16	Basalt Road	Low	Distance is ~1.9 km; Vegetation and structures obscuring
R17	Sheraton Road	Low	Distance is ~1.2 km (office only); Vegetation and structures obscuring
R18	Argyle Avenue	Low	Distance is ~2.2 km; Vegetation obscuring
R19	Stream Avenue (future)	Low	Distance is ~2.1 km; Vegetation obscuring
R20	Angle Park Road	Low	Distance is ~ 2 km; Vegetation filtering
R21	Angle Park Road	Low	Distance is ~ 2.1 km; Vegetation and structures obscuring
R22	Basalt Road	Low	Distance is ~1.6 km; Vegetation obscuring
R23	Sheraton Road	Low	Distance is ~1.6 km; Vegetation and structures obscuring

4 Visual impact

This VIA examines the project revisions which may have a visual effect.

4.1.1 Expanded extraction area within East Pit

The extension of the area of extraction at the existing East Pit will tend to shift the pit boundary (ie the edge of the excavation void) eastwards.

For those sensitive receptors to the east – specifically residential dwellings in Lidscomb Road and Basalt Road – the proposed eastward transition of the East Pit will have a negligible (ie nil) visual impact. This is due to the oblique angle of likely viewers at ground level and it is noted that other factors, such as the solar farm infrastructure and intervening vegetation largely obscure any line of sight in any case.

Sensitive receptors to the west of the quarry, which may have a filtered view of the eastern wall existing pit will receive a neutral impact. There is some benefit arising from the greater distance between the receptors and the pit wall, but this is considered negligible in terms of visual impact.

4.1.2 Change to processing area location and upgrade of plant

The area to the south of the East Pit was previously the location of the quarry's processing plant which is now decommissioned and removed. Holcim has instead installed mobile processing plant inside the pit. Continued extraction within the East Pit will require the mobile plant to be replaced by modular plant. The key difference from a visual perspective is that the modular plant will be approximately 3 m to 4 m higher than the mobile plant.

The new plant location (ie within the pit) will continue to be the location of the processing plant for the duration of the project.

The location of the modular processing plant within the quarry pit will have several supplementary changes to quarry operations. These are as follows:

- haul truck routes will be slightly modified to travel from the Southern Extraction Area (SEA) or Western Extraction Area (WEA) to the in-pit processing area;
- conveyors may be installed along haul truck routes between the SEA, WEA and the in-pit processing area as an alternative to truck haulage. If conveyors are installed, the primary jaw crusher may be located within the SEA or WEA to allow crushing of rock prior to being loaded onto conveyors;
- an additional excavator (similar to the one currently on-site) will be used to load material into the primary crusher; and
- an additional stockpile area will be located adjacent to the new processing area.

The VIA in the EIS considered the range of structures in situ at the existing approved facility.

The indicative heights for selected prominent (existing and approved) structures are:

- offices – 2.8 m and 3.6 m;
- amenities building – 3.3 m;

- workshop – 7.4 m;
- primary bin – 9 m;
- crushing plant – 17 m;
- pre-coat plant conveyor – 7.4 m; and
- pug mill silo – 10.5 m.

There is no known record of any complaint regarding loss of visual amenity due to the presence of the structures, plant and equipment.

For those sensitive receptors to the east – specifically residential dwellings in Lidscomb Road and Basalt Road – the proposed change to the processing area has a neutral visual outcome. Any prior viewshed which may have included surface infrastructure or in-pit plant (as previously approved under the existing consent) will experience negligible change to those elements.

These changes to the operational arrangement for the quarry are not likely to generate any material visual effect and, therefore, remain rated as a low visual impact.

i Mobile plant

The modular plant to be installed in the existing pit during the period of additional extraction in the East Pit could include machinery such as conveyors and bin feeders which tend to have maximum heights ranging from 8 m to 12 m. The pit depth is 6 m to 7 m below the surrounding natural ground level.

Elements of the plant may, therefore, protrude above the rim of the pit and, therefore, be visible. The uppermost components such as conveyors do not, however, represent a feature with any bulk or scale. The majority of the plant remains below the rim of the pit.

ii Use of conveyor system

The project has been amended to include the option of installing a conveyor system between the SEA and WEA and the in-pit processing plant.

The conveyor system will generally be situated close to the quarry pit floor and would not be visible above the rim of the pit. The conveyor system would travel outside of the quarry pits in the vicinity of Eulomogo Creek where it will follow the haul road and creek crossing. This area is also a landscape which remains generally vegetated as a riparian corridor and is in topographic terms generally lower than surrounding land. Refer to Photograph 4.1.

There are very limited opportunities for a line of sight between a receptor and proposed works in this location.

The visual impact is rated as nil.

Photograph 4.1 Eulomogo Creek

Source: Holcim

4.1.3 Changes to construction activities

The EIS VIA included bunds (4m high) of which there was one proposed to the west of the quarry void, and one to the south. The bunds were not proposed as a specific mitigation measure to address visual impact.

The construction of amenity bunds on the western boundary of the WEA is no longer proposed as part of the project. It will be replaced by a safety berm (approximately 1 m high) along the same perimeter area. The safety berm introduces a very minor visual element at ground level.

The EIS VIA noted that the previously proposed amenity bund itself (in the absence of any plantings or screening) created a moderate visual impact for sensitive receptors to the west of the quarry. This change, therefore, represents a positive revision from the perspective of visual amenity.

To the extent that the removal of the bunds enables a potential line of sight to face of the pit, it is noted that the proposed continued extraction of the East Pit will increase the distance between sensitive receptors to the west of the quarry and the pit wall, which will move at least 100 m further away over time. The viewshed for rural residences immediately to the west of the quarry will remain filtered by intervening vegetation. The visual impact of this proposed amenity bund is, therefore, rated as low.

The proposed bund at SEA is unchanged and, therefore, is not re-assessed.

5 Mitigation measures

Noting that most of the proposed changes achieve either a slight improvement in visual impact or are neutral in terms of visual impact, and that most are rated as low impact, the proposed mitigation measures are limited to the following.

The construction of the safety berm (in place of the proposed acoustic amenity bund) reduces the visual impact but nevertheless can be further mitigated though the planting of ground cover on the safety berms (subject to this being an acceptable arrangement from the perspective of berm safety performance).

The haul roads and conveyor system, where they extend into more elevated areas, can be screened by the planting of trees along the verges of the road/conveyor. This will also filter any distant light spill from operations or vehicle movement during night hours.

6 Conclusion

Broadly, the proposed changes (in aggregate) reduce the overall visual impact of the proposed works.

The set-back distances to most receptors and the presence of exiting vegetation both ensure that elements introduced to the visual landscape have a diminished effect.

Where impacts persist, these are rated as low, and there are opportunities to further reduce any light spill or visual intrusion by the planting of screening vegetation on the site.

Appendix H

Updated mitigation measures table

EMM
creating opportunities

Table H.1 Mitigation measures

Aspect	Measures
Noise and blasting	Noise and vibration mitigation measures will be implemented in accordance with a Noise and Blasting Management Plan.
	Construction:
	Construction mitigation measures to address noise generation from work practice methods and plant and equipment suggested in the NVIA include:
	• work practice methods:
	– regular reinforcement (such as toolbox talks) of the need to minimise noise;
	– review and implementation of feasible and reasonable mitigation measures to reduce noise;
	– limiting the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
	– developing routes for the delivery of materials and parking of vehicles to minimise noise;
	– where possible, avoiding the use of equipment that generates impulsive noise; and
	– notifying potentially affected residents prior to the commencement of works;
	• plant and equipment:
	– where possible, choose quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
	– operate plant and equipment in the quietest and most efficient manner; and
	– regularly inspect and maintain plant and equipment to minimise noise level increases, to ensure that all noise attenuation devices are operating effectively.
	Operation:
	The noise mitigation measures identified in Table 2.2 of the Supplementary NIA will be implemented.
	Blasting:
	The project will adopt good industry practice blast management including real time monitoring of all blasts. It is noted that blasting is generally undertaken no more than once per week and that blast criteria adopted herein are applied to all development, including relatively larger scale mining operations where blasting occurs daily through the year. The BMP will include blasting design considerations to minimise the potential for flyrock. Reference to the contractor's drill and blast management plan would be included in the proposed Blast Management Plan for the project.
Air quality	**Legislative requirements**
	The quarry will continue to comply with the POEO requirements as follows:
	• as a scheduled activity under the POEO regulations, the quarry operates under EPL 2212 issued by the EPA and is required to comply with requirements including emission limits, monitoring and pollution-reduction programmes (PRPs). The EPL may be updated and changed overtime;
	• the quarry does not feature significant odour-generating emission sources and is, therefore, unlikely to generate odorous emissions; and
	• no large-scale open burning is performed on-site.
	Best practice dust control
	From the data considered in the AQIA, it has been concluded that the most significant sources of particulate matter emissions from the project's operations are associated with material handlings, hauling and wind erosion. To manage particulate matter emissions from the quarry's existing and proposed operations, a range of mitigation measures and management practices are required.

Table H.1 Mitigation measures

Aspect	Measures
	Measures implemented at the quarry and included in the emissions estimation (where emission reduction factors exist) for both the existing and proposed scenarios include: • water sprays at conveyor transfer points; • scrapers used to clean conveyor belts; • cyclone and water injection on drills; • design blasts to minimise numbers needed per year; • minimising truck and dozer travel speeds; • ensure dozer routes are kept moist with the use of water carts; • minimising trucks and front-end-loader (FEL) drop heights; • watering of exposed areas where practical; • watering unpaved haul routes; • paved haul routes; • bunds in the SEA and WEA; • partial and full rehabilitation; and • watering at coal crusher screen. In addition to the above measures, Table 5.5 of Appendix E provides an overview of relevant applicable best practice dust control management measures as listed in the NSW Coal Benchmarking Study: International Best Practice to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining (the Best Practice Report) (Katestone 2011). If required during operation of the project, Holcim will consider: • the use of larger water cart or an increased number of water carts, to achieve the commitment of Level 2 watering (corresponding to a 75% control) on unpaved roads; and • further mitigation measures to reduce wheel-generated dust on unpaved roads. This may include installation of ground sprinkler systems or the use of chemical dust suppressants. Potential measures to manage fly ash stored at the site include: • locating stockpile(s) away from water courses and within impervious areas; • administration of chemical suppressors on stockpiles where required; and • fly ash to be ordered on an as needs basis and minimising the amounts of fly ash stored where possible.
Biodiversity	**Offsets** A total of 132 ecosystem credits are required to offset the residual impacts of the project, comprising 127 credits from vegetation communities and 5 credits from paddock trees. 76 **Biodiversity management measures**

Impact	Action and outcome	Responsibility	Timing
Direct impact/ prescribed impact			
Clearing of native vegetation	Avoiding and minimising clearing impacts where possible. Clearing limits will be clearly marked to prevent clearing beyond the extent of the disturbance area. Tree clearing and disturbance will be limited to the disturbance area. Appropriate signage such as 'No Go Zone' or 'Environmental Protection Area' will be installed.	Construction site manager.	Prior to and during vegetation clearing.

Table H.1 Mitigation measures

Aspect	Measures			
		The locations of 'No Go Zones' will be included in site inductions.		
	Clearing of hollow bearing trees/habitat trees, resulting in fauna injury and mortality	Limiting removal of trees (including dead trees) to that required within the disturbance area during the installation of project infrastructure. A clearing procedure will be implemented during the clearing of the disturbance area, as follows: preclearance surveys will be completed to determine if any nesting birds are present; and a suitably trained fauna handler will be present during hollow-bearing tree (including dead hollow-bearing trees) clearing to rescue and relocate displaced fauna if found on-site. Appropriate exclusion fencing will be installed around trees and woodland to be retained within the disturbance area during construction in accordance with Standards Australia (2009).	Construction site manager and suitably trained fauna handler.	Prior to and during tree clearing.
	Vehicle collision with fauna	Reduced speed limits where vehicle access tracks neighbour undisturbed areas will be considered in the CEMP.	Construction site manager	During construction and operation.
	Disturbance of river/creek beds and banks during crossing construction (including construction of creek crossings).	An erosion and sediment control (ESC) plan will be prepared in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom 2004) prior to commencement of construction. Disturbed areas will be stabilised and rehabilitated as soon as possible to reduce the exposure period. Source controls, such as mulching, matting and sediment fences, will be utilised where appropriate. A specific creek crossing sub-plan will be included as part of the CEMP.	Construction site manager.	Design stage, during vegetation clearing and construction.
	Indirect impact			
	Transfer of weeds and pathogen to and from site.	Appropriate wash down facilities will be available to clean vehicles and equipment prior to arrival and when leaving site.	Construction site manager.	Design stage, during vegetation clearing and construction.
	Artificial lighting impacting fauna behaviour	Lighting will comply with Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting.	Construction site manager.	During construction and operation.

Table H.1 Mitigation measures

Aspect	Measures
Aboriginal heritage	**Management of identified sites within the survey area**
	Avoidance is proposed for three sites: DQ-IF2, DQ-OS1 and DQ-OS2 (refer Figure 6.6 of the EIS). The three sites will be protected by a semi-permanent or permanent boundary fence around the visible extent of the sites and/or the PAD areas to avoid inadvertent impacts.
	The isolated artefact from Aboriginal site DQ-IF1 will be relocated by a qualified archaeologist and RAP representatives prior to any impacts for the site.
	Special procedures
	Special procedures will be implemented if ancestral remains or new sites are discovered during extraction works. These procedures are detailed in Appendix G and summarised below.
	In the event that known or suspected human remains are encountered, the following procedure will be followed as soon as the suspected remains are discovered:
	• all work in the immediate vicinity will cease and the site supervisor notified;
	• the NSW Police and the State coroner to be notified;
	• contact Heritage NSW for advice on identification; and
	• if it is determined that the skeletal material is of Aboriginal ancestry, the RAPs will be contacted and consultative arrangements will be made to discuss ongoing care or reinterment of the remains.
	In the event of discovery of new Aboriginal sites within the development footprint, the following procedure will be followed:
	• the immediate vicinity (an approximate 20 m buffer from the visible extent of the site) will be secured to protect the find;
	• an archaeologist and select RAPs to determine the significance of the object(s); and
	• any new sites must be registered in the AHIMS database.
	In the event that newly identified sites will be impacted by the project and cannot be avoided, they will be managed in a manner commensurate with the assessed significance, consistent with the management measures provided for the identified sites similar.
	Aboriginal Heritage Management Plan
	An Aboriginal Heritage Management Plan will be developed in consultation with DPE, the RAPs and Heritage NSW. It will provide detail of:
	• all Aboriginal sites identified during the archaeological investigation for the project;
	• management measures and their progress towards completion;
	• measures to ensure ongoing consultation and involvement of project RAPs;
	• protocols for newly identified sites;
	• protocols for educating staff and contractors of their obligations relating to Aboriginal cultural heritage values through a site induction process;
	• protocols for suspected human skeletal materials;
	• protocols for the ongoing care of salvaged Aboriginal objects; and
	• provisions for review and updates for the AHMP.
Historical heritage	All workers and contractors will be informed of their obligations under the NSW *Heritage Act 1977*. If any potentially significant heritage items are uncovered during the course of the works, the Heritage Council of NSW and relevant Commonwealth department will be contacted for advice.

Table H.1 Mitigation measures

<table>
<tr><th>Aspect</th><th>Measures</th></tr>
<tr><td>Surface water</td><td>All surface water management will be constructed in accordance with the methods recommended in Managing Urban Stormwater: Volume 1 (Landcom 2004) and Volume 2E (for mines and quarries) (DECC 2008).</td></tr>
<tr><td></td><td>Holcim will continue monitoring water quality and levels in groundwater and surface water in the water storages and Eulomogo Creek.</td></tr>
<tr><td></td><td>A water management plan will also be prepared which details the management measures that will be implemented to manage quarry groundwater inflows and to monitor surface water levels and water quality.</td></tr>
<tr><td></td><td>The proposed surface and groundwater monitoring program described in the Water RtS (Appendix D) is to be implemented.</td></tr>
<tr><td></td><td>Holcim will consult with DPE Water and NRAR on optimal locations for the proposed sediment basins near Eulomogo Creek and detailed design of the creek crossing.</td></tr>
<tr><td></td><td>Contingency measures to address excess water within the water management system are provided in the below table
Contingency measures
<table>
<tr><th>Trigger</th><th>Contingency measure</th></tr>
<tr><td>Groundwater inflows exceed existing WAL allocations.</td><td>If practical, maintain higher water levels in pit sumps to reduce groundwater inflows.
Acquire additional WAL entitlements.</td></tr>
<tr><td>The water management system is in surplus and discharges from the East Pit are required frequently, outside of significant wet weather events.</td><td>Irrigation activities can be expanded to include the proposed bund walls around the WEA and SEA, new rehabilitation areas established progressively during the project life and unused haul roads. This would substantially increase water use.
There is potential for Holcim to supply water to nearby irrigators for beneficial use.</td></tr>
</table></td></tr>
<tr><td>Groundwater</td><td>The potential for detrimental impacts to groundwater quality from a contamination event will be mitigated through standard construction environmental management including:</td></tr>
<tr><td></td><td>• development and implementation of an OEMP which would detail relevant procedures, including but not limited to:</td></tr>
<tr><td></td><td>– plant and equipment refuelling;</td></tr>
<tr><td></td><td>– vehicle wash down and/or cement truck washout; and</td></tr>
<tr><td></td><td>– notification requirements to the EPA for incidents that cause material harm to the environment;</td></tr>
<tr><td></td><td>• development and implementation of a site-specific spill management plan as part of the OEMP; and</td></tr>
<tr><td></td><td>• all fuels and combustible liquids will be managed and handled in accordance with AS 1940 The storage and handling of flammable liquids, the WH&S Act and Regulation and the Storage and Handling of Dangerous Goods – Code of Practice 2005 (WorkCover 2005).</td></tr>
<tr><td>Land resources</td><td>Soil inventory</td></tr>
<tr><td></td><td>The details of the quality and distribution of soil materials able or unable to support plant growth will guide material handling processes (ie stripping, stockpiling, sorting and amelioration) and eventual rehabilitation of disturbed areas. The LSCA notes that effective soil management is imperative to successful rehabilitation, and post mining land use objectives.</td></tr>
<tr><td></td><td>The fertility of the topsoil materials has generally been assessed as moderate to high; however, handling and stockpiling could easily degrade the fertility of these soils.</td></tr>
</table>

Table H.1 Mitigation measures

Aspect	Measures
	To assist with soil management, a summary of the estimated growth media volumes is provided in Table 12 of the LSCA. It is noted that bulk earthworks and handling of materials has the potential to mix different soil layers and materials and either improve, or degrade, the quality of materials as growth media. Landloch recommends that, should growth media be salvaged from these areas, it may be useful and cost-effective to undertake more detailed survey work to delineate soils and allow the segregation of undesirable materials during stripping
	Contamination
	To manage any potential contamination impacts associated with the construction and operation of the project, a construction environmental management plan (CEMP) should be prepared to address applicable provisions under the POEO Act. Work, health and safety controls to prevent exposure of construction workers to contamination would be implemented in accordance with the requirements of the *Work Health and Safety Act 2011* and the *Work Health and Safety Regulation 2017*. As well as typical environmental management measures, other components of the CEMP would include: • an unexpected finds protocol, including procedures to identify and manage contamination, if encountered; • procedures for the handling and storage of waste including contaminated materials; • surface water management and sediment and erosion control; • requirements for the storage of dangerous goods and other materials; and • decommissioning requirements, including remediation and rehabilitation if necessary. To manage spills and leaks associated during the operation of the project, spill containment measures will be installed in permanent operational facilities where there is a risk of impact from spills. Site management activities would be documented in an OEMP prepared for the project.
Rehabilitation	**Erosion and sediment control**
	The following erosion and sediment control measures will be implemented to mitigate erosion risk and predicted rates:
	• implementation of progressive erosion and sediment control plans for individual areas to ensure sediment erosion risks are identified and appropriately managed and mitigated;
	• dispersive soils will be treated with gypsum during the stripping process to improve electrochemical stability and such parameters as ESP and EMP;
	• a sump will be excavated into the floor of the SEA to collect runoff during the rehabilitation phase and until 60% of soil surface has been retained; and
	• implementation of sowing techniques for the revegetation of the final landforms.
	Post-closure monitoring
	Rehabilitation monitoring to assess rehabilitation progress will be undertaken annually during operation and every 5 years once rehabilitation has commenced (or less if the rehabilitation criteria have been met). Post-rehabilitation, review of the monitoring frequency will be undertaken based on the performance of the revegetation and an appropriate monitoring frequency determined.
	Rehabilitation monitoring will identify areas requiring maintenance and identify and address deviations from the expected. Rehabilitation areas will be assessed against performance indicators and regularly inspected for the following aspects:
	• evidence of any erosion or sedimentation;
	• success of initial establishment cover;
	• natural regeneration of improved pasture;
	• weed infestation (primarily noxious weeds, but also where rehabilitation areas are dominated by other weed);
	• integrity of drainage, erosion and sediment control structures; and
	• general stability of the rehabilitation areas.

Table H.1 Mitigation measures

Aspect	Measures
	Monitoring techniques will include photographic monitoring and soil sampling in established transects or quadrants within the rehabilitation areas. Specific monitoring within grazing and also native woodland and riparian rehabilitation areas will be undertaken such as indicators of grazing productivity and rapid ecological assessment techniques.
	Post-closure maintenance
	Where monitoring has identified that rehabilitation criteria has not been met, maintenance works may be undertaken and include:
	• re-seeding and, where necessary, re-soiling and/or the application of specialised treatments;
	• use of materials such as composted mulch to areas with poor vegetation establishment;
	• replacement of drainage controls if they are found to be inadequate for their intended purpose, or compromised by vegetation or wildlife; and
	• de-silting or repair of sediment control structures.
	Maintenance works will also be carried out to target specific issues, like weeds management, the upkeep of access tracks and public safety.
	The spreading of noxious weeds could impact the success of revegetation and will be controlled through the following measures:
	• herbicide spraying or scalping weeds;
	• post-closure use of rehabilitated areas as a working farm, with associated management practices; and
	• rehabilitation inspections to identify potential weed infestations.
	Access tracks may be required to facilitate the revegetation and ongoing maintenance of rehabilitation areas. These tracks will be kept to a practical minimum and will be designed prior to the completion of the project. Controls will be implemented to minimise the potential for impacts on public safety and may include maintenance of fencing and warning signs around areas that have the potential to cause harm and that are accessible to the public. As pit walls will be rehabilitated to a safe and stable gradient permanent bunding is not anticipated to be required, safe and stable gradients will be further addressed in the management plans, post approvals. Additionally, any large rocks within the pit walls that pose a safety risk post-rehabilitation will be removed and relocated.
	Management and closure plans
	A RMP will be developed to provide a structured and documented process for managing and improving rehabilitation activities at the quarry. The plan will serve as a process map for interdepartmental administration of rehabilitation activities within the quarry planning and implementation. The RMP will include a weed management plan.
Traffic and transport	**Driver's Code of Conduct**
	Holcim will implement a Driver's Code of Conduct to facilitate the future safe site operations for all the quarry trucks traffic using Sheraton Road, in combination with all the other road users (including school buses) and pedestrian traffic.
	The Code of Conduct will be required to be read and signed/agreed to by all truck drivers operating to and from the quarry and will address all relevant road safety and traffic management measures such as, compliance with all rules and regulations, vehicle speeds, driver behaviour near schools, residential and shopping areas, courtesy to other road users, fatigue management, drug and alcohol testing, checking vehicles and covering loads, the appropriate use of compression braking, procedures for accidents and breakdowns, procedures for oversize vehicles accessing the site, and procedures for monitoring and compliance.
	Outgoing heavy vehicle movements from the site will be suspended during 3.15 pm–3.45 pm on school days.

Table H.1 Mitigation measures

<table>
<tr><th>Aspect</th><th>Measures</th></tr>
<tr><td></td><td>Road pavement maintenance</td></tr>
<tr><td></td><td>A road maintenance agreement for Sheraton Road will be discussed with the DRC.</td></tr>
<tr><td></td><td>Stakeholder engagement</td></tr>
<tr><td></td><td>Further meetings of the CCC will continue to address traffic and road safety related matters.</td></tr>
<tr><td>Social</td><td>The proposed mitigation and management strategies for potential social impacts are summarised in the below table.
Summary of mitigation and management strategies for identified social risks
<table>
<tr><th>Impact</th><th>Description of social risk</th><th>Proposed mitigation and management strategies</th><th>Responsibility</th></tr>
<tr><td rowspan="8">Way of life</td><td>Access to adequate employment (ongoing).</td><td>Local participation strategy and plan and provision of training and upskilling opportunities for workers.</td><td>Holcim
Truck contractors</td></tr>
<tr><td>Access to adequate employment (short-term).</td><td>Local participation strategy and plan.</td><td>Holcim
Construction contractors</td></tr>
<tr><td>Noise from truck movements causing amenity issues.</td><td>Continued maintenance of community grievance mechanism.</td><td>Holcim</td></tr>
<tr><td>Noise from quarry operations causing amenity issues.</td><td>Development of community and stakeholder engagement strategy that includes provisions for residents affected by noise.
Continued maintenance of community grievance mechanism.</td><td>Holcim
Contractors</td></tr>
<tr><td>Dust causing amenity issues.</td><td>Continued maintenance of community grievance mechanism.</td><td>Holcim
Contractors</td></tr>
<tr><td>Voids and bunding affecting visual amenity.</td><td>Development of community and stakeholder engagement strategy that includes provisions for residents affected by visual changes from voids and bunding.
Continued maintenance of community grievance mechanism.</td><td>Holcim</td></tr>
<tr><td>Land rehabilitation.</td><td>Inclusion of local stakeholders in the rehabilitation and closure planning and implementation process.</td><td>Holcim</td></tr>
<tr><td>Culture impacts</td><td>Destruction of culturally significant Indigenous artefacts.</td><td>Development and implementation of AHMP, including avoidance measures and unexpected finds and discovery protocols.</td><td>Holcim
Contractors</td></tr>
<tr><td>Health and community well-being</td><td>Public safety issues due to truck movements through school zones.</td><td>Implementation of Driver’s Code of Conduct continued engagement in the form of the CCC and a grievance mechanism.</td><td>Holcim
Dubbo Regional Council
Representatives of schools located along Sheraton Road
South Keswick Quarry</td></tr>
</table></td></tr>
</table>

Table H.1 Mitigation measures

Aspect	Measures			
		Dust exacerbating health related issues.	Include information about air quality in any updates provided to the local community as part of Holcim's community and stakeholder engagement strategy. Continued maintenance of community grievance mechanism.	Holcim Contractors
	Surrounding	Discharge of water from the quarry into Eulomogo Creek.	Implementation of water management strategy.	Holcim
	Personal and property rights	Land rehabilitation.	Inclusion of local stakeholders in the rehabilitation and closure planning and implementation process.	Holcim
	Fears and aspirations	Contributions to continued economic growth and development of the local area and the region.	Operation of the Dubbo Quarry Continuation Project and liaison with Dubbo Regional Council for economic opportunities.	Holcim
	The community grievance mechanism will be formalised with contact details provided on Holcim's website and records of community correspondence kept at the quarry.			
	A monitoring and management framework will be developed to ensure that the identified social impacts are monitored over time to measure the effectiveness or otherwise of the proposed mitigation and management measures, including changing conditions and trends in the local and regional areas over the same period. This will:			
	• track progress of mitigation and management strategies;			
	• access actual project impacts against predicted impacts;			
	• identify how information will be captured for reporting to impacted stakeholders including landholders, communities and government on progress and achievements;			
	• provide key performance indicators, targets and outcomes;			
	• identify responsible parties; and			
	• describe mechanisms for ongoing adaptation of management measures when and if required.			
Hazard	Hazard related procedures and plans currently implemented at the quarry will continue to operate under the project.			
	Appropriate safety barriers and signage will be placed within the pit to direct vehicles and ensure separation of quarry operations from vehicle movements.			

Table H.1 Mitigation measures

<table>
<tr><th>Aspect</th><th>Measures</th></tr>
<tr><td>Bushfire</td><td>The table below provides a summary of recommendations to achieve compliance with the relevant requirements for PBP for bush fire protection for asset protection zones, construction standards, access, water supply, provision of services, and emergency management.
Summary of recommended management measures
<table>
<tr><th>Mitigation element</th><th>Objectives</th></tr>
<tr><td>Asset protection zones</td><td>APZs are provided commensurate with the construction of the building.
A defendable space is provided.
Vegetation is managed within asset protection zones in perpetuity.</td></tr>
<tr><td>Property access</td><td>Safe access to/from the public road system is provided for firefighters providing property protection during a bushfire and for occupant egress for evacuation;
Firefighting vehicles are provided with safe, all-weather access to structures and hazard vegetation.
The capacity of access roads is adequate for firefighting vehicles.
There is appropriate access to water supply.</td></tr>
<tr><td>Water supply</td><td>Adequate services of water for the protection of buildings during and after the passage of bushfire are provided.
Water supply requirements for firefighting are designed in accordance with the relevant Australian Standards and PBP.</td></tr>
<tr><td>Other services</td><td>Location of electricity services limits the possibility of ignition of surrounding bush land or the fabric of buildings.
Location and design of gas services will not lead to ignition of surrounding bushland or the fabric of buildings.</td></tr>
<tr><td>Construction standards</td><td>The proposed building can withstand bush fire attack in the form of embers, radiant heat and flame contact.</td></tr>
<tr><td>Landscaping</td><td>Landscaping is designed and managed to minimise flame contact and radiant heat to buildings, and the potential for wind-driven embers to cause ignitions.</td></tr>
<tr><td>Potential ignition sources</td><td>To provide for the storage of hazardous materials away from the hazard wherever possible.</td></tr>
<tr><td>Bushfire management plan (including emergency management)</td><td>A BFMP for the construction and operation of the project, will provide details for the ongoing management and maintenance of bushfire protection measures.
The BFMP should include a bushfire emergency management and evacuation plan to provide suitable emergency and evacuation (and relocation) arrangements for occupants of the development.</td></tr>
</table></td></tr>
<tr><td>Visual</td><td>Consultation with rural residences R2 and R3 in regard to the overall moderate visual impacts of the project will inform the need for additional design solutions, mitigation measures, or interventions to reduce the level of visual impact.
Additional tree plantings will be undertaken within the project area between the western disturbance boundary and the boundary with Lot 221.</td></tr>
</table>

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