360 environmental

Cardinia Gold Project

Surface Water Assessment Report

Prepared for

Kin Mining NL

May 2021

people planet professional

Document Reference	Revision	Prepared by	Reviewed by	Admin Review	Submitted to Client	
					Copies	Date
4557AA_Rev0	Internal Draft	NC	DT		1-electronic	07/05/2021
4557AA_Rev1	Client Draft	DT	FJ	LI	1-electronic	13/05/2021
4557AA_Rev2	Client Final	NC	DT	LI	1-electronic	14/05/2021

Disclaimer

Executive Summary

Kin Mining NL (the Client) commissioned 360 Environmental Pty Ltd (360 Environmental) to undertake surface water assessment (hydrological and hydraulic modelling) of the Kyte, Lewis Phase 4 (Lewis) and the associated waste dump (the site) (shown in **Figure 1**) within the Cardinia Gold Project. Kin required a surface water assessment of the site to support a new Mining Proposal at Cardinia.

A hydrological and a 2-dimensional (2D) hydraulic model and an accompanying surface water assessment report were prepared to assist with assessing the flood risk for the proposed pits and the waste dump. A comprehensive site walkover was carried out to evaluate the site location, topography, overland flow paths, soils, and land cover as an initial step. The modelling was completed to determine the flood risk and conceptualise a layout and height of the flood protection embankments for a 0.1% Average Exceedance Probability (AEP) rainfall event. In addition, 1% AEP and 10% AEP events were simulated to determine the flood spread in a "baseline" scenario, i.e. current scenario. The modelling was completed in two stages. In the first stage, hydrological catchments and rainfall-runoff were assessed and modelled based on the existing topography. The catchment runoff hydrographs were then added to a 2D hydraulic model as boundary conditions to evaluate flood risk resulting from 0.1%, 1% and 10% AEP rainfall events.

The model results suggested that the Lewis pit will be flooded in all three events. The waste dump will only be marginally affected on the western side. The flood protection embankments were applied to the model to protect the Lewis pit and the waste dump. Their layout and height were investigated for a flood event resulting from a 0.1% AEP rainfall. It was determined that both the pit and the waste dump could be protected. The maximum velocity at the edge of a waste dump in a 0.1% AEP event was less than 0.3 m/s, and the maximum depth does not exceed 0.15 m; at this speed and depth, a flood protection embankment is not warranted. A layer of rip-rap rocks could be sufficient to protect the waste dump from erosion, although it may not be required either. The Lewis pit will require a flood protection embankment, approximately 1,100 m long and no more than 1.8 m high. The height was determined by taking the maximum flood depth of 1.3 m and adding a 0.5 m freeboard margin of safety.

The model's sensitivity has been assessed by simulating variations to 2D model mesh resolution, overland flow wave approximation and floodplain resistance. Following the sensitivity testing, a 0.1% AEP rainfall design event was simulated to produce flood maps. It was further used for assessing flood protection embankments for the Lewis pit and the waste dump. The flows passing the waste dump were further analysed for velocities to inform the selection of adequate erosion protection of the waste dump western slope.

Catchment delineation and model schematisation were based on the LiDAR data provided by Kin. Kin further provided a preliminary design of the pits and the waste dump. These may be subject to further changes, which would require reconsideration of the outcomes of this assessment.

Table of Contents

List of Tables

List of Plates

List of Figures (out of text)

1 Introduction

1.1 Background and Purpose

Kin Mining NL (the Client) proposes extending operations at the existing Cardinia Gold Project site. The Cardinia mine site is located approximately 28 km east-northeast of Leonora and 650 km northeast of Perth, in the Goldfields-Esperance region of Western Australia.

The Client engaged 360 Environmental Pty Ltd (360 Environmental) to undertake a surface water assessment of the Kyte, Lewis Phase 4 (Lewis) and the associated waste dump (the site) within the Cardinia Gold Project.

The overall Cardinia Gold Project comprises the following mining areas:

- Kyte (proposed for near-term development)
- Bruno (starter pit mined previously)
- Lewis and Lewis South (one existing pit and multiple future pits, pit 4 being proposed for near-term development)
- Rangoon (future proposal)
- Helens North and Helens South (future proposal)
- Cardinia Hill (future proposal)
- Hobby (future proposal).

The site location and proposed infrastructure layout are shown in **Figure 1**.

The Client required a surface water assessment of the site to support a new Mining Proposal at Cardinia to cover the Kyte and Lewis 4 pits.

1.2 Description of Study Area

1.2.1 Climate

The site is located within the Goldfield-Esperance region of Western Australia, which has an arid to semi-arid climate with sweltering summers and cool winters.

The closest Bureau of Meteorology (BOM) station to the site is the Leonora station (BOM station 012046). The station has recorded average annual precipitation from 1991 – 2020 of 290 mm, with the months of January to March recording the highest monthly rainfalls.

Temperatures vary from a maximum of approximately 37°C in January to a minimum of 6°C in July. The long term climatic average rainfall minimum and maximum temperatures are shown in **Plate 1**.

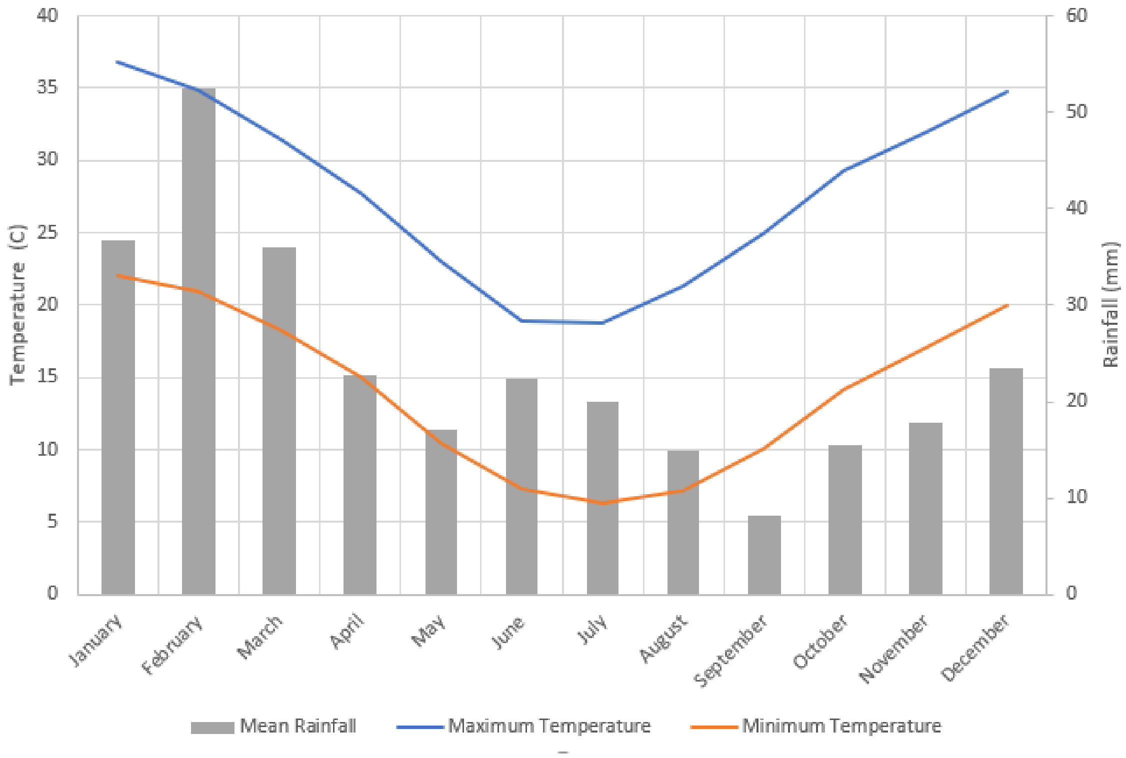


Plate 1: Average climate at Leonora 1991-2020 (BOM station 012046)

1.2.2 Topography

Low undulating plains characterise the topography of the area. The maximum elevation of the study area was approximately 465 m Australian Height Datum (AHD), and the minimum elevation of the site was approximately 390 m AHD.

The site slopes from north to south. Lewis and Kyte pits lie at approximately 410 m AHD within a broad flat valley, with the proposed waste dump, on a slightly elevated ridgeline that separates the two distinct watercourses that traverse the site. The topography of the site is shown in **Figure 2**.

1.2.3 Soil Types

Soil land system mapping, shown in **Figure 3**, indicates the area to be covered in a range of different soil land system; however, all have similarities which includes:

- Gently undulating plains with some breakaways and ridges
- Sandy, gravelly soils of varying compositions
- Lower plains supporting acacia and mulga shrublands, grasses, and halophytic shrublands.

1.2.4 Groundwater

The site lies within the Combined – Fractured Rock West – Alluvium aquifer, within the Raeside groundwater sub-area and the Goldfields groundwater area.

1.2.5 Surface Water

The Department of Water and Environmental Regulations (DWER) Hydrographic Catchments Database (DWER 2018) shows that the site lies within the Raeside-Ponton catchment within the Salt Lake Basin of the Western Plateau Division.

The site lies within a flood plain that carries water via a dendritic drainage pattern of minor non-perennial watercourses, as shown in **Figure 4**. There are two main channels and a third minor channel that convey water through the site. The ultimate flow path is from north to south. The main channel flows to the east of Lewis pit, and a second system flows to the west of the waste dump. A third minor channel conveys water to the southeast of the active mining area between administration buildings and the camp, with all channels ultimately draining to a floodplain south of Leonora-Laverton Road.

1.3 Previous Modelling and Reports

Several surface water assessment studies were carried out for the Cardinia Gold Project (sometimes referred to as the Leonora Gold Project) since May 2015. The most relevant studies and reports describing the previous modelling of the area include:

- MWH (2015); Leonora Gold Project – Surface Water Assessment
- MWH now part of Stantec (2017); Leonora Gold Project - Phase 1: Surface Water Assessment
- MWH now part of Stantec (2017); Leonora Gold Project: Phase 2 Surface Water Assessment.

Those previous reports have limited relevance to the current extent of operations at Cardinia.

1.4 Scope of Work

This study focused on building a 2-dimensional (2D) hydraulic model of Kyte, Lewis, and the associated waste dump floodplain. The model area covers that shown in **Figure 5**.

The 2D Model served to carry out a surface water assessment to assess the site's flood risk. It further assisted in determining the flood protection embankment location and height to protect the future mining pits.

The specific steps in executing this project were:

- Project initiation, including data collation and initial review
- Site visit
- Hydrological analysis of the contributing catchment, including:
    - Sub-catchment delineation

  - Estimation of the design rainfall and critical duration
  - Analysis of the range of annual exceedance probability (AEP) events, including 10% AEP (a 10-year average recurrence interval (ARI) event), 1% AEP (a 100-year ARI event), and 0.1% AEP (a 1000-year ARI event) using the latest Australian Rainfall and Runoff (ARR) guidelines.
- Development of a 2D hydraulic model to simulate the overland flow hydrodynamics and support the flood risk assessment
- Sensitivity testing to assess the model result's sensitivity to uncertainties in various model inputs, such as model computational grid resolution, and Manning's roughness
- Scenario simulations to evaluate concept-level mitigation measures to protect mine infrastructure
- Flood inundation mapping, in particular, to demonstrate that the waste dump is not in a flood zone and to identify the need for pit protection to prevent unacceptable flood risk
- Reporting.

2 Model Components

2.1 Surface Water Catchments

The study area catchments were delineated using the Hydrologic Engineering Centre Hydrological Modelling System (HEC-HMS) software. The topography used as an input to delineate the catchment was obtained from the Elevation and Depth database on Foundation Spatial Data Framework (Geoscience Australia, 2020). The topography data source is the SRTM-derived Hydrological 1 Second DEM Version 1.0.

The 30 m DEM was used for catchment delineation because the Client-supplied 0.1 m DEM did not cover the full extent of the upstream catchments.

HEC-HMS delineated 15 sub-catchments upstream of the Lewis pit that forms the main watercourse, which intersects the site. A further, nine sub-catchments were delineated upstream of the waste dump, including the secondary watercourse to the west side. An additional four sub-catchment were delineated upstream of the camp to the southeast of the active mining area.

The sub-catchment areas are shown in **Table 1**.

Table 1: Delineated Catchment Areas

Catchment	Lewis	Waste Dump	Camp
1	6.61	20.43	6.07
2	4.58	10.29	2.36
3	3.53	12.84	2.47
4	9.53	7.23	0.76
5	6.62	10.21	
6	5.32	9.68	
7	5.37	6.18	
8	5.37	0.55	
9	3.48	26.13	
10	0.63		
11	1.22		
12	2.14		
13	7.31		
14	4.19		
15	4.61		
Total	**70.51**	**103.54**	**11.66**

The modelled sub-catchments and reaches are shown in **Plate 2**.

2.2 Runoff Estimation Method - RORB

The runoff routing model RORB (Laurenson and Mein, 1983) was used to estimate catchment runoff for several design rainfall events. RORB is widely used in Australia and is a well-known rainfall-runoff and streamflow routing model.

A RORB model was built to include all the catchments upstream of the proposed 2D model domain.

Plate 2 below shows the modelled catchments. It further highlights the stream network (dark blue lines) to route the catchment runoff towards the 2D model domain.

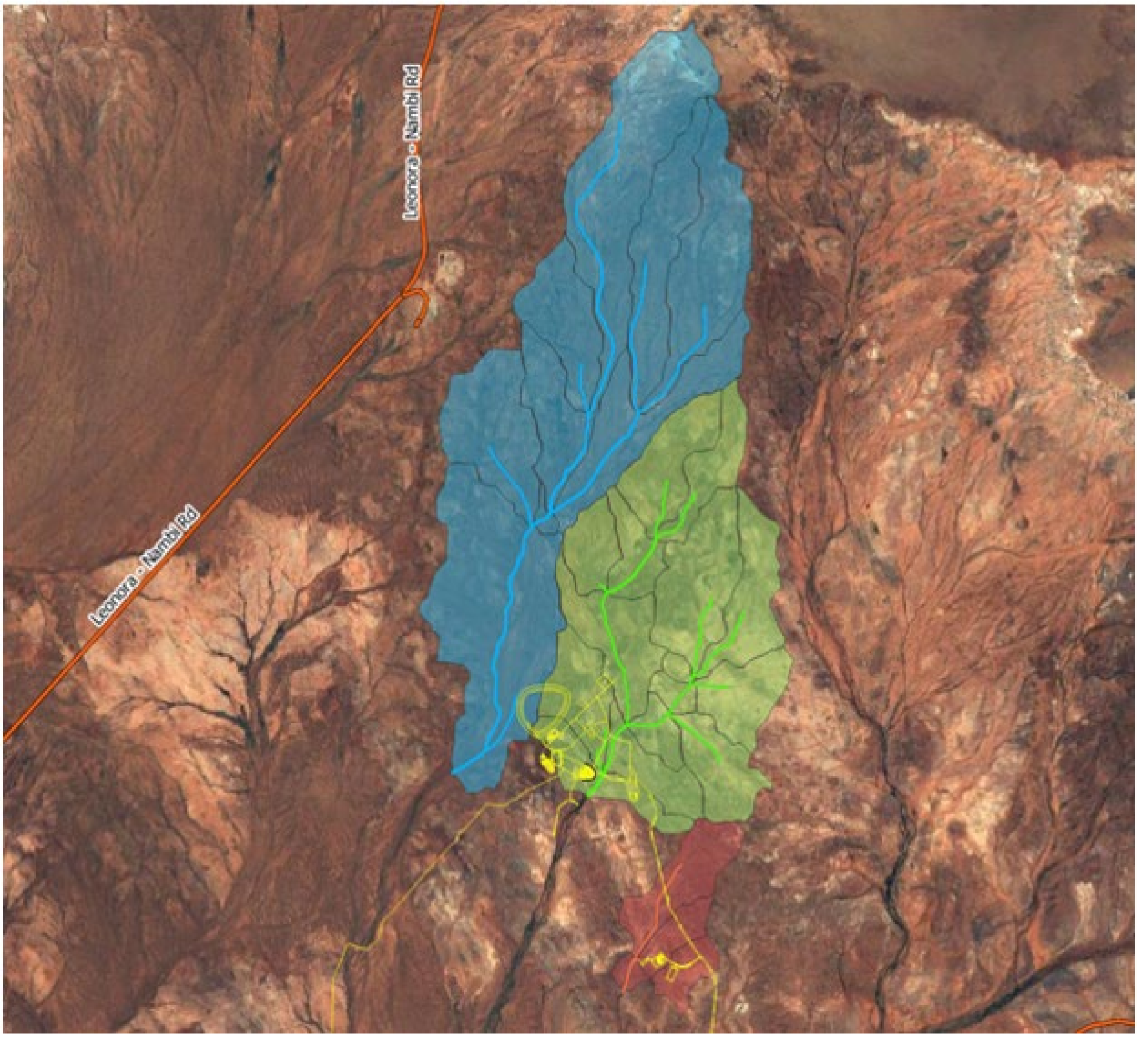


Plate 2: RORB Model Catchments (Blue-Waste Dump, Green-Lewis, Pink-Camp)

The calculated runoff from all four sub-catchments was used as the upstream inflow boundary for the 2D flood model. The details of the 2D flood model are described in Section 2.3.

A non-linear storage routing procedure performs the routing of a hydrograph in RORB based on continuity and a storage function:

$$S = 3600*K*Q^m$$

Where S is the storage (m^3), Q is the outflow discharge (m^3/s), m is dimensionless exponent, and K is a dimensional empirical coefficient.

Model parameters K and m are critical inputs into the RORB hydrological model and represent the hydrological response of a catchment. The coefficient K is formed as the product of two factors: $K = K_c*K_r$, where K_c is an empirical coefficient application to the catchment and stream network, and K_r is a dimensionless ratio, the relative delay time applicable to individual reach storage.

The K was calculated as follows:

$$K_c = 2.2A^{0.5}(Q_p/2)^{0.8-m}$$

where A is the catchment area (km^2), and Q_p is the peak runoff discharge (m^3/s). The m value was set as 0.8, which is the default and recommended value for Australia. When m = 0.8, K_c depends on the catchment area alone.

K_r is calculated in the Model as follows:

$$K_r = F*(L/d_{av})$$

where L is the length of reach represented by storage, d_{av} is the average flow distance in the channel network (calculated in the Model), and F is a factor depending upon the type of reach. As all the modelled reaches are represented as a 'natural channel', F is 1.0.

K depends on an empirical coefficient K_c that needs to be calculated.

Initial infiltration loss (IL) and continuing infiltration loss (CL) were adopted using ARR Book 5 (Geoscience Australia, 2019) and the recommended values within the Arid Region where there is a lack of available information. Therefore, median values were selected.

Table 2 below summarises the hydrological parameters used for the three catchments.

Table 2: Catchment Characteristics and RORB Model Parameters

Parameter/Catchment	Lewis	Waste Dump	Camp
Initial Loss (mm)	37.5	37.5	37.5
Continuing Loss (mm/hr)	2.7	2.7	2.7
K_c	8.52	8.52	8.52

2.2.1 Design Rainfall

Design rainfall used for runoff estimation is based on the Bureau of Meteorology (BoM) Design Rainfall Data System 2016 (BoM, 2020). The database provides rainfall depths and intensities for a wide range of various events rainfall. In the RORB model, 10%, 1%, and 0.1% average exceedance probability (AEP) rainfall events were modelled.

The ARR 2019 guidelines recommend that multiple temporal patterns are to be considered when conducting runoff analysis. The Design Areal Temporal Patterns have been used for runoff and flow estimation, as obtained from the ARR Datahub (ARR, 2020).

The site study area is within the Rangelands Aerial Reduction Factor (ARF) Region. The parameters obtained from the ARR Datahub were used in the assessment (ARR, 2020) for the Waste Dump catchment. ARFs were applied for the Waste Dump catchment because the catchment areas are larger than 75 km^2 (Laurenson, EM and R.G. Mein, 1983). For the remaining two catchments, i.e. Lewis and Camp, ARFs were not accounted for.

2.2.2 Climate Change

Climate change is expected to impact the rainfall intensities, increasing the risk of flooding over time at many locations in Australia.

The Interim Guideline for Climate Change is a component of the ARR Guidelines (Geoscience Australia 2019). It provides designers that utilise ARR with an approach to consider the implications of climate change. At the same time, further research is undertaken to inform on critical uncertainties.

The CSIRO and BOM developed a Climate Futures web tool that focuses on climate change predictions based on Natural Resource Management (NRM) clusters (as shown in **Plate 3**).

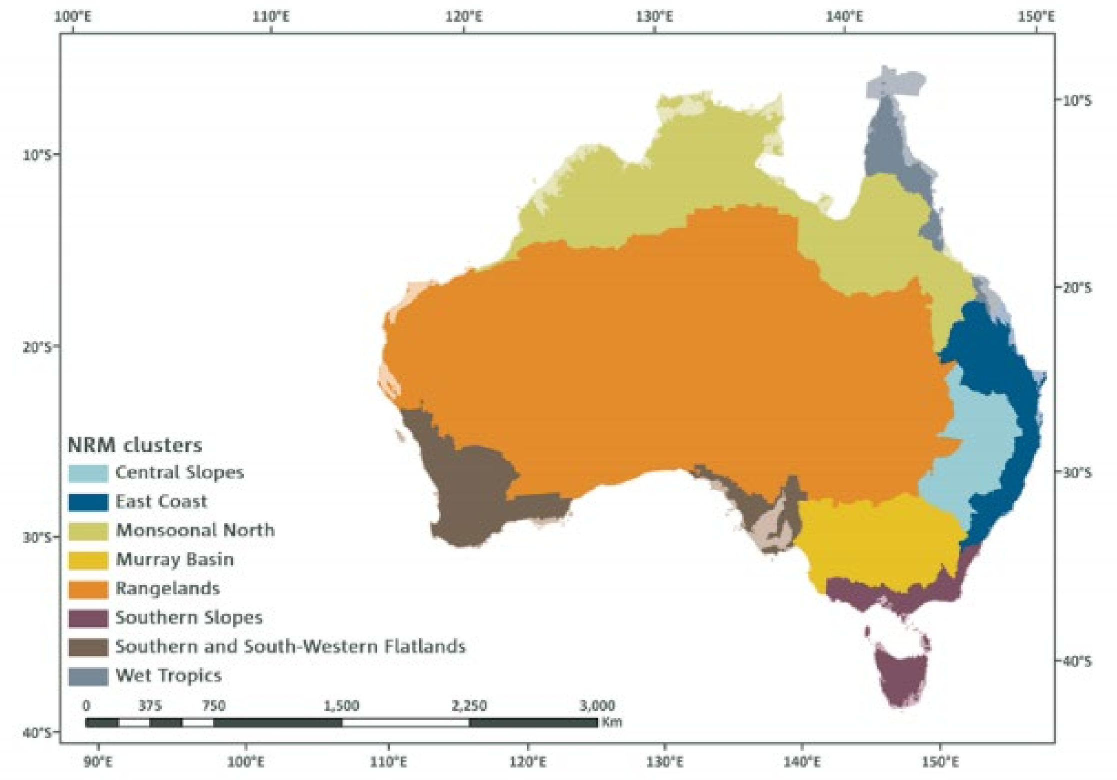


Plate 3: Climate Futures NRM clusters

The site lies within the Rangelands NRM cluster, where the projected outcomes of climate change include:

- High confidence in a decrease in winter rainfall, with changes to summer rainfall possible
- High confidence in the future increase in the intensity of extreme rainfall events

- Increased drought periods
- An increase in average temperatures in all seasons.

The scope of the Interim Guidelines has been limited to projected changes in rainfall intensity because there is little available information available on projected changes to rainfall temporal patterns, antecedent rainfall and baseflow.

The Interim Guidelines are designed to be applied to rainfall intensities within the range of probability of one exceedance per year and 50% to 1% AEP events (ARR 2019).

Given that any proposed flood measures for the site will be designed for the 0.1% AEP event, no account has been made within the modelling for the Interim Guidelines for Climate Change scenarios.

2.2.3 Results

A RORB model was simulated for 10%, 1%, and 0.1% AEP design events with durations ranging between 6 and 72 hours. The critical durations for various AEP events are highlighted in **Table 3.**

Table 3: Critical Storm Durations

Catchment/Critical Duration (hr)	10% AEP	1% AEP	0.1% AEP
Lewis	48	18	18
Waste Dump	48	18	18
Camp	48	18	18

The peak flows at the outlet of each hydrological Model are detailed in **Table 4.** The flow hydrographs at these locations were used as boundary conditions for the 2D hydraulic model. For a 50% AEP rainfall, the infiltration losses exceeded the total precipitation; hence there was no runoff.

Table 4: RORB Model Results

Catchment/Discharge (m^3/s)	10% AEP	1% AEP	0.1% AEP
Lewis	39.77	128.7	252.9
Camp	4.97	17.9	37.5
Waste Dump	68.32	232.7	499.7

2.3 Hydraulic Modelling

2.3.1 Choice of Software

Hydraulic modelling was carried out to estimate the flood extent within site and identify the overland flow paths and flood hazards. It was further used to test the flood protection options to protect the open pits and the waste dump from flooding.

HEC-RAS software, release 5.0.7 of the Hydrologic Engineering Centre – a division of the Institute for Water Resources, US Army Corp of Engineers, was selected to carry out this work. It is a fully dynamic 2D software package.

2.3.2 Model Extent

The model extent was determined based on the results of the preliminary rain-on-grid model simulations. The overland flow paths have revealed the size of the area that contributes to flows towards the site. The model domain includes the significant inflow from the upstream catchments simulated using RORB and then added to the 2D Model as an upstream boundary condition.

Figure 5 shows the 2D model domain. The modelled grid comprises of a squared mesh with computational cells resolution of 30 m x 30 m, at an outer perimeter, and a higher resolution 15 m x 15 m within the inner perimeter. The computational mesh resolution was chosen in consideration of the resolution of the available terrain information, and sensitivity tests carried out, discussed further in **Section 2.3.3**.

2.3.3 Topography

The Client provided the topography used as an input to create a 2D flood model. The topography data source is a 0.1 m high-resolution GeoTIFF image derived from the LiDAR information obtained for the Cardinia project area. The provided terrain information uses the Projection MGA Zone 50 in HEC-RAS and is presented in **Figure 2.**

2.3.4 Boundary Inflows

Three boundary inflows were included in the 2D hydraulic Model, two external and one internal boundary condition. Two boundaries were placed at the locations where the major rivers enter the model domain. The remaining internal boundary condition was used to simulate runoff flows potentially affecting the proposed camp location.

These boundary inflows were assumed to represent the runoff from the RORB hydrological model. The hydrograph represents the accumulated runoff from the upstream catchments, which have a total area of approximately 225 km^2.

Table 5 outlines the catchment areas that contribute to the upstream boundary inflow.

Table 5: Upstream Catchment Areas

Catchments	Area (km^2)
Lewis	72.7
Camp	11.7
Waste Dump	140

2.3.5 Downstream Boundary Conditions

The downstream boundary condition was set as 'normal depth' because there are unlikely to be significant tailwater effects in the broad unobstructed floodplain.

The 'normal depth' boundary condition allows water to freely 'leave' the model area.

2.3.6 2D Model Surface Roughness

ARR 2019 Guidelines provide valid Manning's *n* ranges for different land-use types. Typical land use types and associated Manning's *n* roughness value ranges are summarised in **Table 6.**

Table 6: Manning's n Ranges

Land Use Type	Manning's *n*
Open pervious areas, minimal vegetation (grassed)	0.03 – 0.05
Open pervious areas, moderate vegetation (shrubs)	0.05 – 0.07

Manning's n value of 0.06 was adopted within the 2D model domain based on the site visit and aerial imagery. Similar Manning's n values were used in the Goldfields Region. The Manning's roughness used provides a conservative estimate of flood depths. It indirectly accounts for any local obstructions that may not be well captured within the 2D model terrain information.

A more detailed, spatially distributed Manning's roughness map may be used for better representing the variability of the roughness within the model domain. However, following the site visit and the desktop investigation of the aerial images, it was concluded that using a constant Manning's roughness value is warranted.

Sensitivity tests were carried out (see Section 3) to estimate how different Manning's roughness values may have on the computed flood depths.

3 Model Sensitivity Testing

Sensitivity testing was performed on the model using the parameters of Manning's roughness, computation wave approximation, computational gird size and timestep. Varying these parameters allowed for the optimisation of the model runtimes against model performance. The results of this analysis are discussed in the section below.

3.1 Manning's Roughness

The model was run with Manning's roughness varying from 0.05 to 0.07. The modelling results produced an insignificant difference in maximum flood depth; therefore, Manning's roughness was held at 0.06.

3.2 Computational Wave Approximation

The model was run using the diffusive and full momentum wave approximation of the shallow water equations.

Diffusive wave approximation assumes that the inertial terms in the equations are significantly less than the gravity, friction, and pressure terms. Therefore, the diffusive wave is accurately described as a non-inertial wave. That means that the diffusive wave approximation should not be used when significant backwater effects are expected or slow propagating flood waves.

The full momentum method is recommended for models subject to dynamic flood waves such as dam breaks, sudden expansions and contractions, wave propagation analysis, or multiple structures or backwater conditions.

Given the site conditions and the fact that the diffusive wave method is computationally quicker to run, it was proposed that the diffusive wave method would be suitable.

However, a sensitivity analysis was run using the full momentum method. The water depth results were extracted from several randomly chosen points within site.

The results of the computational wave approximation methods are shown in **Table 7**.

Table 7: Full Momentum vs Diffusive Wave Comparison

Comparison Point	Full momentum Depth (m)	Diffusive Wave Depth (m)	Difference (m)
1	0.86	0.87	0.01
2	0.68	0.67	0.01
3	1.85	1.79	0.06
4	0.64	0.64	0.00
5	0.97	0.95	0.02
6	0.04	0.04	0.00
7	0.77	0.71	0.06
12	0.59	0.59	0.00

Comparison Point	Full momentum Depth (m)	Diffusive Wave Depth (m)	Difference (m)
13	0.68	0.68	0.00
16	0.80	0.80	0.00
17	0.25	0.25	0.00
20	0.82	0.82	0.00
22	0.80	0.79	0.01
23	0.47	0.47	0.00
24	1.77	1.76	0.01
40	0.89	0.89	0.00
41	0.14	0.16	0.02
42	0.36	0.37	0.01
43	0.45	0.45	0.00

The diffusive wave vs full momentum analysis resulted in a maximum difference in modelled depth of 0.06m in a 0.1% AEP event. The runtime for the model, however, was reduced from 36 to 12 hours. Therefore, the diffusive wave method was selected for further analysis.

3.3 Computational Grid Size

Various computational grid sizes were run to test the sensitivity of the modelled results to grid size and to optimise the model runtimes against model performance. The modelled results of the computational grid size sensitivity analysis are shown in **Table 8**.

Table 8:Compational Grid Size Comparison

Comparison Point	5m – 30m Depth (m)	10m – 30m Depth (m)	15m – 30m Depth (m)	Difference (m)
1	0.87	0.87	0.87	0
2	0.67	0.67	0.67	0
3	1.79	1.78	1.78	0.01
4	0.64	0.63	0.63	0.01
5	0.95	0.94	0.94	0.01
6	0.04	0.03	0.03	0.01
7	0.71	0.70	0.70	0.01
12	0.59	0.58	0.58	0.01
13	0.68	0.68	0.68	0
16	0.80	0.79	0.79	0.01
17	0.25	0.25	0.25	0
20	0.82	0.82	0.82	0
22	0.79	0.78	0.78	0.01

Comparison Point	5m – 30m Depth (m)	10m – 30m Depth (m)	15m – 30m Depth (m)	Difference (m)
23	0.47	0.47	0.47	0
24	1.76	1.76	1.76	0
40	0.89	0.88	0.88	0.01
41	0.16	0.16	0.16	0
42	0.37	0.37	0.37	0
43	0.45	0.45	0.45	0

The maximum difference between the 5 m and 15 m 2D grid size for the high-resolution 2D domain was 0.01 m. Increasing the computation grid size from 5m to 15 m reduced the runtime for the model from 12 hours to 40 minutes. Therefore, the final grid size used was a 15 m resolution grid size for the high-resolution 2D domain and a 30 m grid size for the remaining 2D domain.

3.4 Timestep

The final model parameter that was tested for sensitivity was the time step. The model results shown in Section 3.1 and Section 3.2 were derived using a 1 second and 6-second timestep, respectively.

The timestep was increased to 15 seconds with no change in the resulting flood depth at the comparison points. However, for flood protection testing, the time step was reduced to 10 seconds to avoid any potential numerical instabilities in the model. The effect this change had on model run times was negligible.

4 Model Simulations

4.1 Existing Scenario

Plate 4 show the maximum flood depths for the Lewis pit and the waste dump in the 0.1% AEP event.

The maximum modelled flood depth is approximately 13.4 m which reflects the flooding of the Lewis pit. The maximum flood depth within the main channel that transects the site east of Lewis pit is between approximately 1 and 2 m.

Similarly, the maximum depth of the watercourse which transects the site west of the waste dump has a modelled flood depth of approximately 1 – 2 m. The flood depth where the waterway intersects the base of the proposed waste dump is approximately 0.1 m.

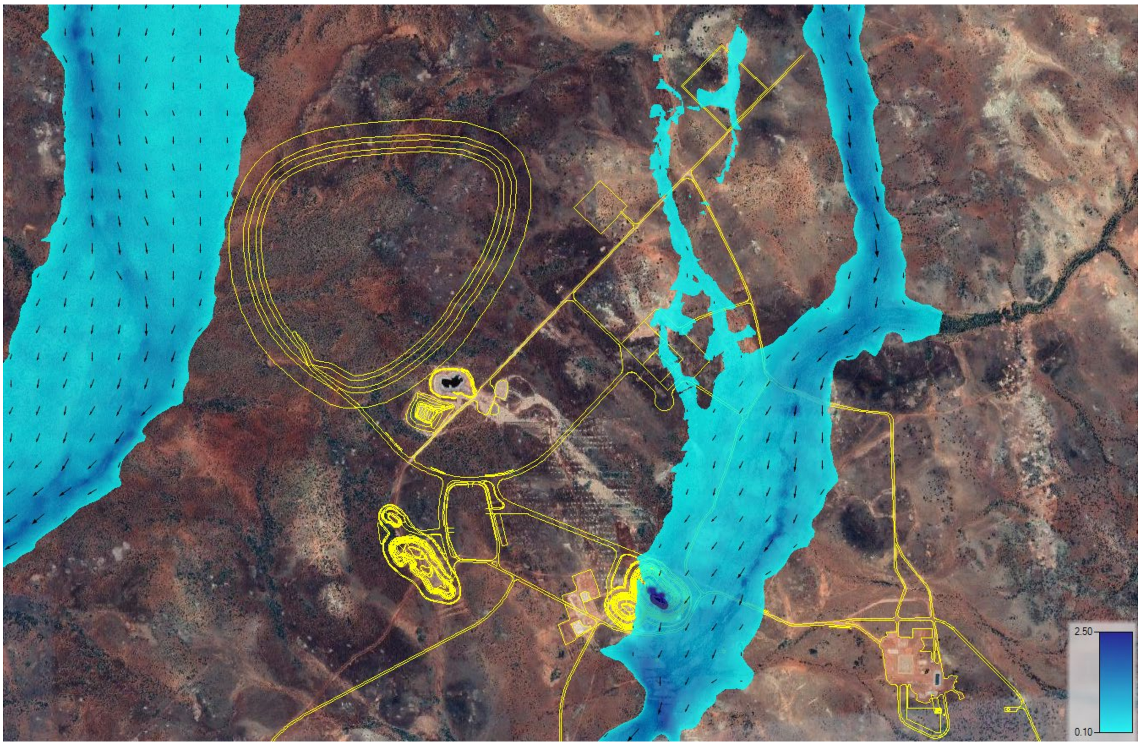


Plate 4: Flood Depth 0.1% AEP

Plate 5 show the flood depth for the camp in the 0.1% AEP event.

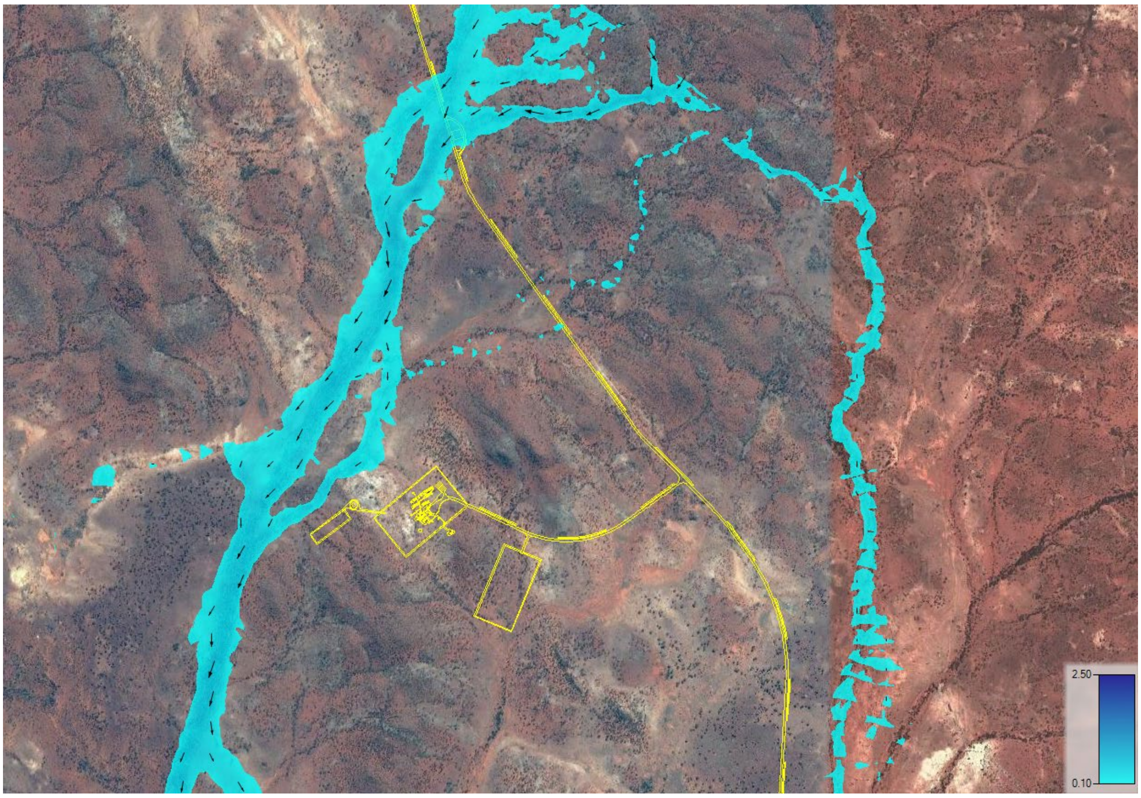


Plate 5: Flood Depth Camp 0.1% AEP

As the camp is not inundated with floodwater in the 0.1% AEP event, no further analysis was completed for the Camp catchments.

Plate 6 show the flood velocities for the Lewis pit and the waste dump in the 0.1% AEP event

The main watercourse that transects the site east of Lewis pit has maximum flood velocities in the range of 1 to 1.5 m/s. The watercourse that flows west of the waste dump has maximum modelled velocities in the range of 1 to 1.25 m/s.

Flood velocities at the base of the waste dump were modelled as approximately 0.3 m/s.

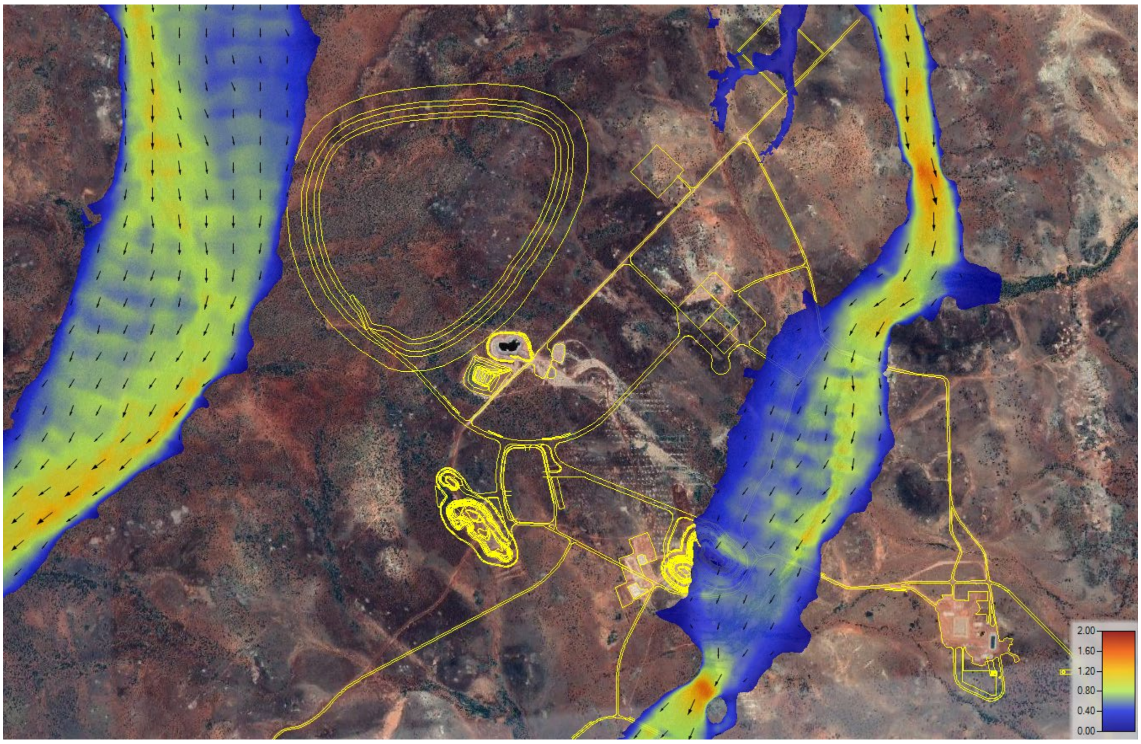


Plate 6: Flood Velocity 0.1% AEP

Figures 6 and **7** show the maximum flood depths and flood velocities for the Lewis pit and the waste dump in the 1% AEP event. **Figure 8** shows the hazard map for the 1% AEP event.

The maximum modelled flood depth is approximately 13 m which reflects the flooding of the Lewis pit. The maximum flood depth within both channels that transect the site are between approximately 1 – 1.5 m, with some small pockets at approximately 2 m.

The flood extent for the western watercourse does not extend as far as the foot of the waste dump, providing an approximate 10m buffer to the base.

Flood velocities in the main channel, east of Lewis pit, were modelled as approximately 1 to 1.25 m/s. Flood velocities in the channel west of the waste dump were approximately 0.7 to 1 m/s.

Figures 9 and **10** show the maximum flood depths and flood velocities for the Lewis pit and the waste dump in the 10% AEP event. **Figure 11** shows the hazard map for the 10% AEP event.

The maximum modelled flood depth is approximately 13 m which reflects the flooding of the Lewis pit. The maximum flood depth within both channels that transect the site is between approximately 0.5 – 1 m, with some small pockets at approximately 1.5 m depth.

The flood extent for the western watercourse does not extend as far as the foot of the waste dump, providing an approximate 10 m buffer to the base.

Flood velocities in the main channel, east of Lewis pit, were modelled as approximately 0.9 to 1.1 m/s. Flood velocities in the channel west of the Waste dump were approximately 0.7 to 1 m/s.

4.2 Flood Protection Scenario

The safety of people, property and the environment are of significant importance in flood management. Flood risk is a function of the probability of a flood event and its consequences. Consequences are related to the hazard of flooding and the vulnerability of the receptor.

The safety of humans can be compromised when exposed to flows that exceed their ability to remain to stand and or traverse a waterway. On the other hand, the property can be affected by floodwater inundating infrastructure that is not water-compatible or built to withstand high-velocity flood flows, damage structural integrity, or washes away structures. Flood hazard information, therefore, is crucial in defining areas for planning and future development.

Flood hazard represents the product of depth and velocity (D x V) in line with ARR Revision Report 10: Appropriate Safety Criteria for People (Engineers Australia, 2010). The hazard ratings are summarised in **Table 9.**

Table 9: Flood Hazard Regimes for Adults

D*V (m^2/s)	Adults
0 – 0.4	Low Hazard
0.4 – 0.6	Moderate Hazard (Dangerous to some)
0.6 – 0.8	Significant Hazard (Dangerous to most)
0.8 – 1.2	Extreme Hazard (Dangerous to all)

The flood hazard in a 0.1% AEP existing scenario event is shown in **Plate 7.**

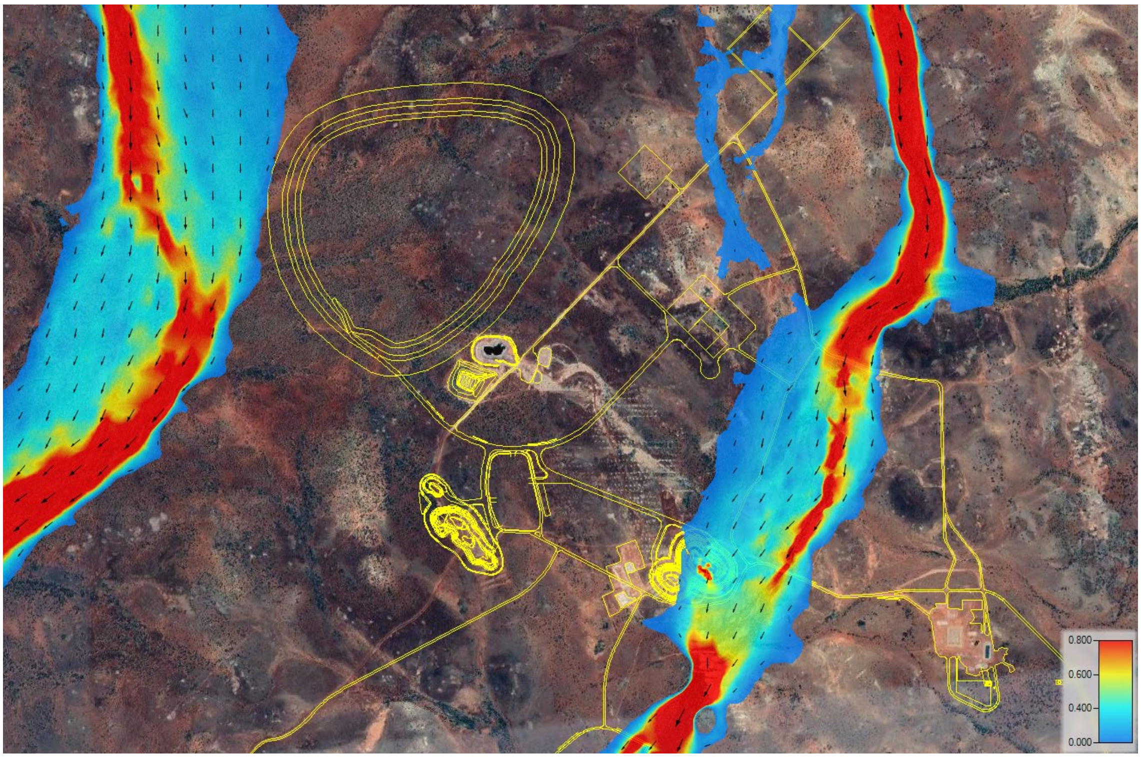


Plate 7: Flood Hazard 0.1% AEP

As shown in **Plate 7,** the flood hazard is extreme throughout the majority of both channels during the 0.1% AEP event, except for small areas of the eastern channel.

Flood protection measures are proposed for the Lewis pit. It is suggested that a flood protection bund is built around the eastern half of the pit, as shown in **Plate 8** to **10**.

Due to the minor encroachment that the flood has on the waste dump, it is proposed that a layer of rip-rap rocks could be sufficient to protect the waste dump from erosion, although it may not be required either.

No flood protection measures are proposed for the camp.

For Lewis pit, a flood protection embankment that measures 1.8 m high is proposed.

Plate 8 show the flood depth around the Lewis pit after the inclusion of the proposed flood protection embankment. The maximum flood depth at the toe of the flood protection embankment is approximately 1.30 m.

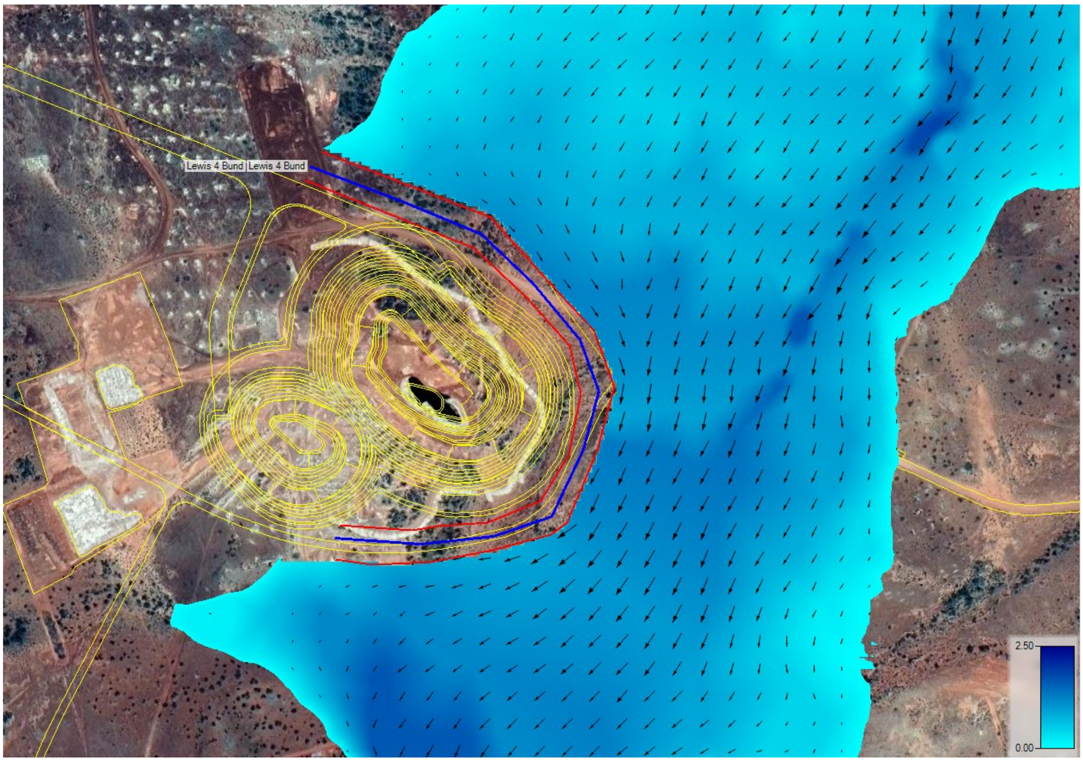


Plate 8: Flood Depth Lewis Pit Protected 0.1% AEP

Plate 9 show the flood velocity around the flood protection embankment at the Lewis pit. The maximum flood velocity at the toe of the flood protection embankment is approximately 0.9 m/s.

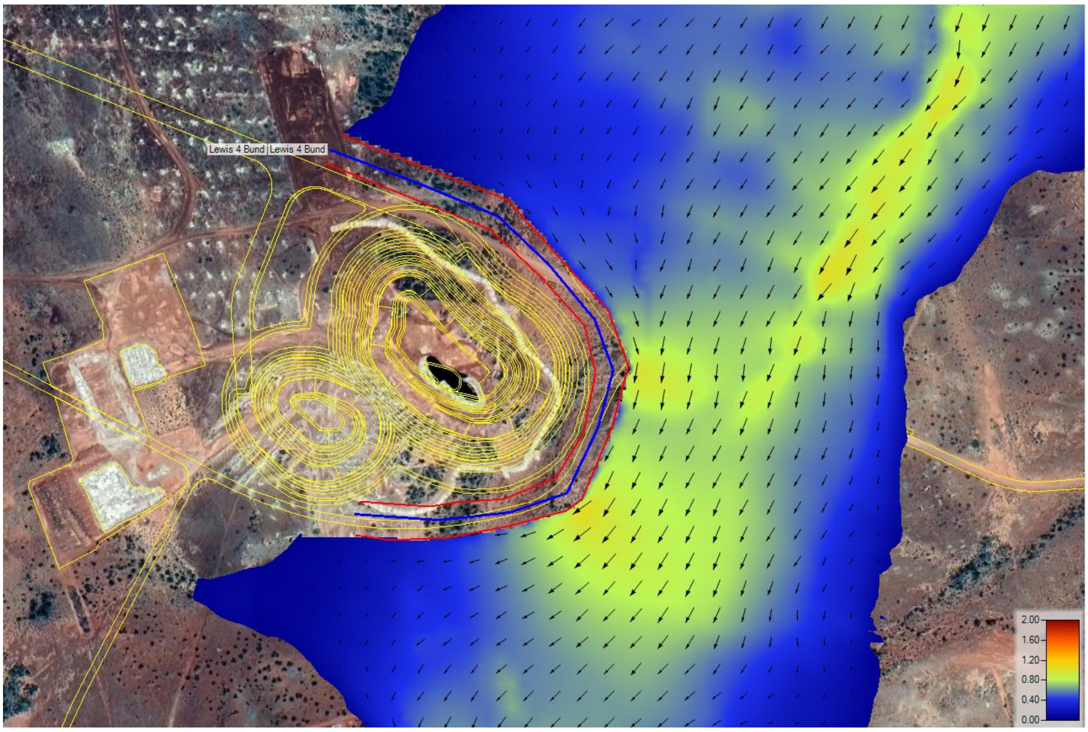


Plate 9: Flood Velocity Lewis Flood Protection 0.1% AEP

Plate 10 show the flood hazard around the flood protection embankment at the Lewis pit. The flood hazard is extreme along the eastern side of the flood protection embankment adjacent to the main channel. The maximum flood hazard is approximately 0.87 m^2/s.

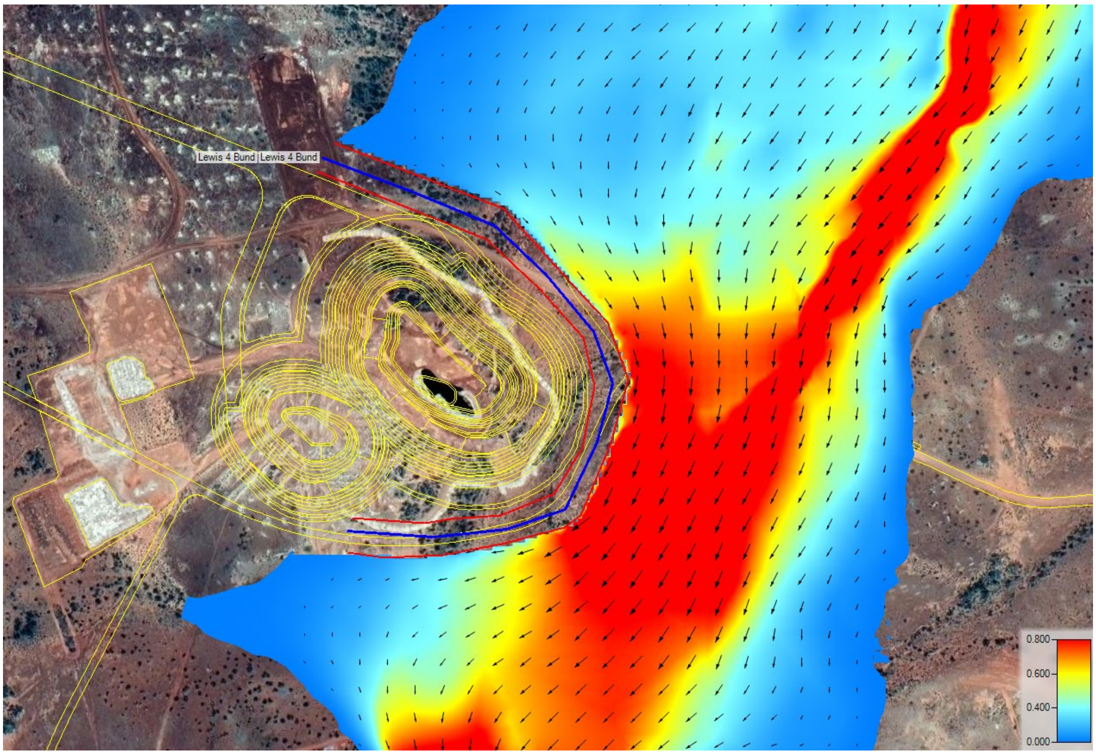


Plate 10: Flood Hazard Lewis Pit Flood Protection 0.1% AEP

5 Quality Assurance

As a part of the internal quality assurance (QA) process at 360 Environmental, integrity checks have been made throughout the modelling process to ensure quality in both the computational Model and the outputs.

Detailed checks were performed during the model build, sensitivity testing, and options run phases to ensure the models were set up correctly. The outputs produced are sensible and without evidence of any significant numerical instabilities.

6 Summary and Recommendations

6.1 Summary

The production of the flood maps and investigating flood protection measures for the Lewis 4, Kyte, and the associated waste dump have involved developing both a hydrological model and a hydraulic model.

The 2D hydraulic Model has been built using the most recent data. Calibration and validation information was non-existent; hence sensitivity tests were carried out to estimate the variability in model predictions. Realistic model parameters (primarily resistance values) have been used, and the model performance is considered acceptable.

Several different temporal pattern storms were simulated using ARR 2019 ensemble storm events to determine the critical storm duration and representative storm pattern.

The 2D hydraulic model was then simulated using the inputs from the hydrological simulation.

A 0.1m DEM (0.1 x 0.1m cell resolution) was used to create a 2D hydraulic model used for the flood hazard assessment. The Client provided the high-resolution GeoTIFF image that was used to source the elevation information. Model sensitivity analysis returned an acceptable convergence in monitoring results using a 15/30m computational grid size derived from the 0.1m DEM.

A detailed analysis of Manning's surface roughness was not undertaken. Sensitivity tests were carried out to determine the effect different Manning's roughness values have on the results. A constant roughness across the domain was adopted.

The model schematisation, choice of parameters and interface between the hydrological and hydraulic models, is crucial in increasing confidence in model predictions. Simple models are great, easy to set up, update, use and analyse. But a model and everything else should be as simple as possible but not simpler (Albert Einstein, 1950).

Whilst every effort was made to make the model as simple as possible to reduce both build time and run time, the ultimate aim in creating the model was to make it as simple as possible while still retaining the models' ability to be used as a tool for the designing, optimising and managing complex stormwater systems into the future.

6.2 Recommendations

The flood risk management strategy should typically be developed, considering the following:

- Outside of the 0.1% AEP flood extent:
  - A preferred location for buildings and permanent infrastructure
  - Facilities and permanent infrastructure are to be flood-proofed by adding 0.5 m freeboard on top of the 0.1% AEP flood elevation.

- Low hazard zone (flood hazard 0.0 – 0.4):
  - Suitable for water-compatible land uses.

The above flood risk management relies on the following definitions:

- Flood-proofed: designing infrastructure to limit the damage caused by water inundation, such as:
  - Use of water-tolerant construction materials
  - Installation of electrical fixings and fixtures 0.5m above the 0.1% AEP flood event
  - Fitting of anti-back-flow devices on toilets.
- Water-compatible land uses, such as:
  - A temporary infrastructure that can be moved in advance of a flood
  - An infrastructure that the temporary water inundation would not damage.

As more detailed designs for landforms, pits and infrastructure become available, they should be incorporated into the model to improve model accuracy.

The access roads to the site, roadside swales and cross drainage infrastructure were designed for a 10% AEP storm event (Lindsay Dynan, 2019). This model can be used to investigate potential impacts less frequent events may have on the road infrastructure, such as the time to inundation.

In future flood events, it is recommended that efforts be made to record high flow extents in the vicinity of the pits and the waste dump. Peak flood extent should be recorded (e.g. by aerial/satellite photography and ground truth surveys). Observations should also be made of flows and blockages at all major structures. This will allow model calibration using empirical evidence to improve the models' ability to predict flood extents and depths in the future as the project expands.

Lastly, keeping this model 'alive' and continuously updated and improved is a cost-effective way of maintaining a useful tool for further optimising the designs in the Cardinia Gold Project area and preventing the Client from reinvesting funds in new model developments that may not be warranted in the future.

7 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

In the preparation of this report, 360 Environmental has relied upon documents, information, data, and analyses ("client's information") provided by the Client and other individuals and entities. In most cases where Client's information has been relied upon, such reliance has been indicated in this report. Unless expressly set out in this report, 360 Environmental has not verified that the Client's information is accurate, exhaustive, or current and the validity and accuracy of any aspect of the report including, or based upon, any part of the Client's information is contingent upon the accuracy, exhaustiveness, and currency of the Client's information. 360 Environmental shall not be liable to the Client or any other person in connection with any invalid or inaccurate aspect of this report where that invalidity or inaccuracy arose because the Client's information was not accurate, exhaustive, and current or arose because of any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to 360 Environmental.

Aspects of this report, including the opinions, conclusions, and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions, and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

Subject to the terms of the contract between the Client and 360 Environmental, copying, reproducing, disclosing, or disseminating parts of this report is prohibited (except to the extent required by law) unless the report is produced in its entirety including this page, without the prior written consent of 360 Environmental.

8 References

Geoscience Australia 2019; Australian Rainfall and Runoff - A Guide to Flood Estimation

Geoscience Australia 2019, Australian Rainfall and Runoff Revision Projects - Project 10 Appropriate Safety Criteria for People, Stage 1 Report P10/S1/006

ARR Datahub 2019, Australian Rainfall and Runoff (available at https://data.arr software.org/)

Laurenson, EM and R.G. Mein 1983, RORB – Version 3 Runoff Routing Program Programmer Manual

Bureau of Meteorology 2021, Climate statistics for Australian locations, available at http://www.bom.gov.au [accessed 9 April 2021]

Department of Water and Environmental Regulation 2019; Water Information Reporting (available at http://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx)

Department of Water and Environmental Regulation 2018; Hydrographic Catchments Database

MWH 2015; Leonora Gold Project - Surface Water Assessment

MWH now part of Stantec 2017; Leonora Gold Project - Phase 1: Surface Water Assessment

MWH now part of Stantec 2017; Leonora Gold Project: Phase 2 Surface Water Assessment

US Army Corps of Engineers 2016; HEC-RAS Analysis System User’s Manual, Version 5.0.7

US Army Corps of Engineers 2020; HEC-HMS User’s Manual, Version 4.7.1

Figures

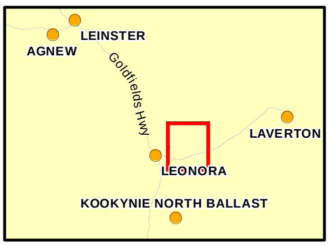
Legend

- Infrastructure
- State Road
- Local Roads

0 1,750 3,500 5,250
Meters
1:170,000 @ A4
N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



Powered By SLIP ENABLER

- LOCALITY MAP SOURCED FROM LANDGATE 2020
- OTHER DATA SOURCED LANDGATE 2020
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2020
(© Western Australian Land Information Authority 2020)

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID			DATE
4557			12/05/2021
HORIZONTAL DATUM AND PROJECTION			
GDA 1994 MGA Zone 51			
CREATED	CHECKED	APPROVED	REVISION
LF	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 1
Site Location

K:\Projects\10. WAM\4557 Cardinia Surface Water Assessment\4557 F01 Site Location.mxd

Legend

- State Road
- Local Roads
- Infrastructure

30m DEM (elevation mAHD)

High : 561.756

Low : 288.686

0 1,750 3,500 5,250

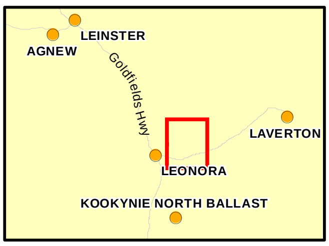
Meters

1:170,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



Powered By SLIP ENABLER

- LOCALITY MAP SOURCED FROM LANDGATE 2020
- OTHER DATA SOURCED LANDGATE 2020
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2020
(© Western Australian Land Information Authority 2020)

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

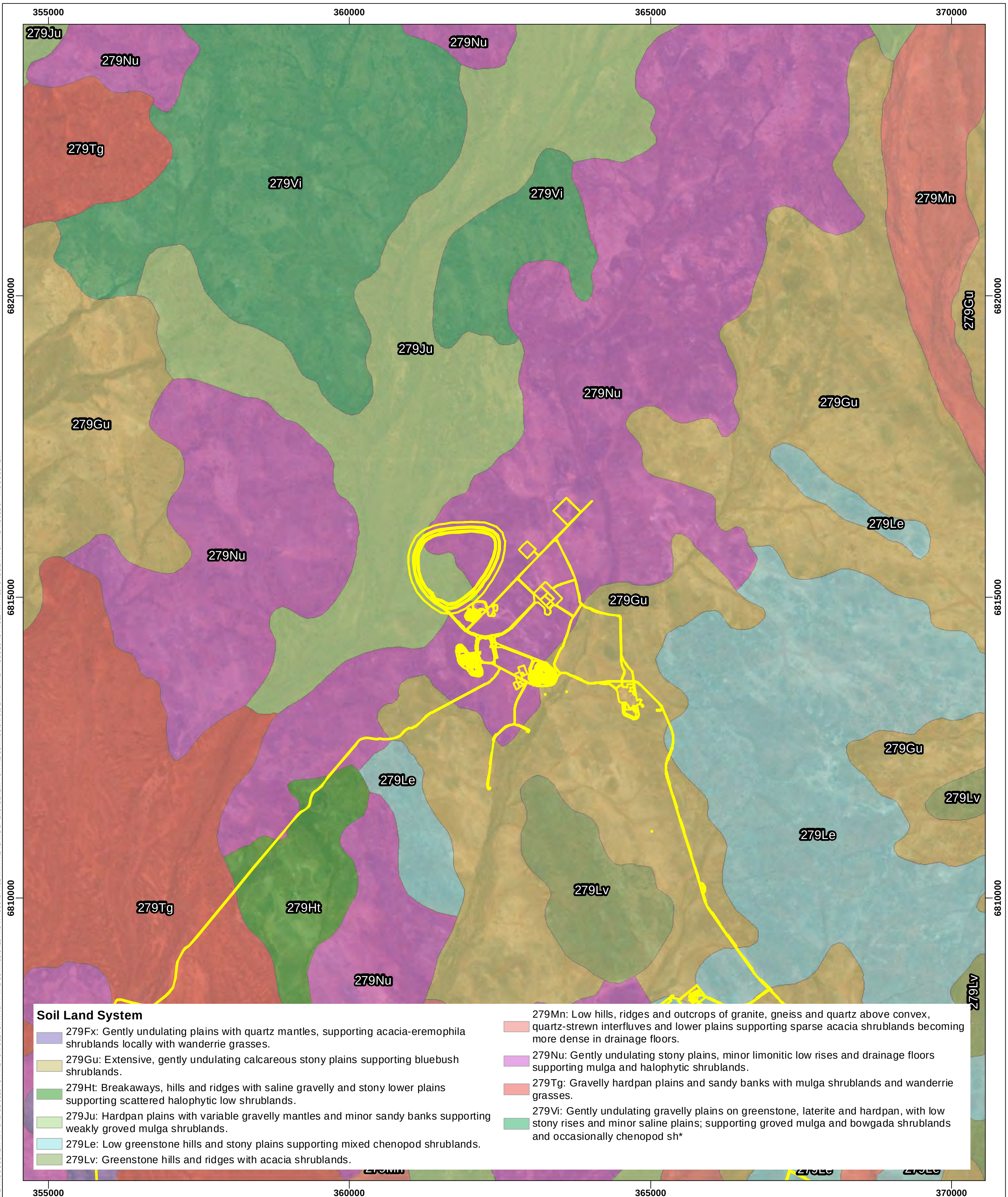
CREATED	CHECKED	APPROVED	REVISION
LF	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 2
Site Topography

K:\Projects\11. CSS\3855 Vasse Dawson 4B and 5A\4557 F02 Site Topography.mxd



Legend

Infrastructure

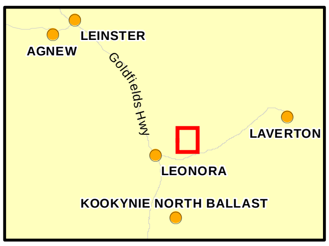
Powered By SLIP ENABLER

- LOCALITY MAP SOURCED FROM LANDGATE 2020
- OTHER DATA SOURCED LANDGATE 2020
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2020
(© Western Australian Land Information Authority 2020)

0 890 1,780 2,670 N
Meters
1:85,000 @ A4

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

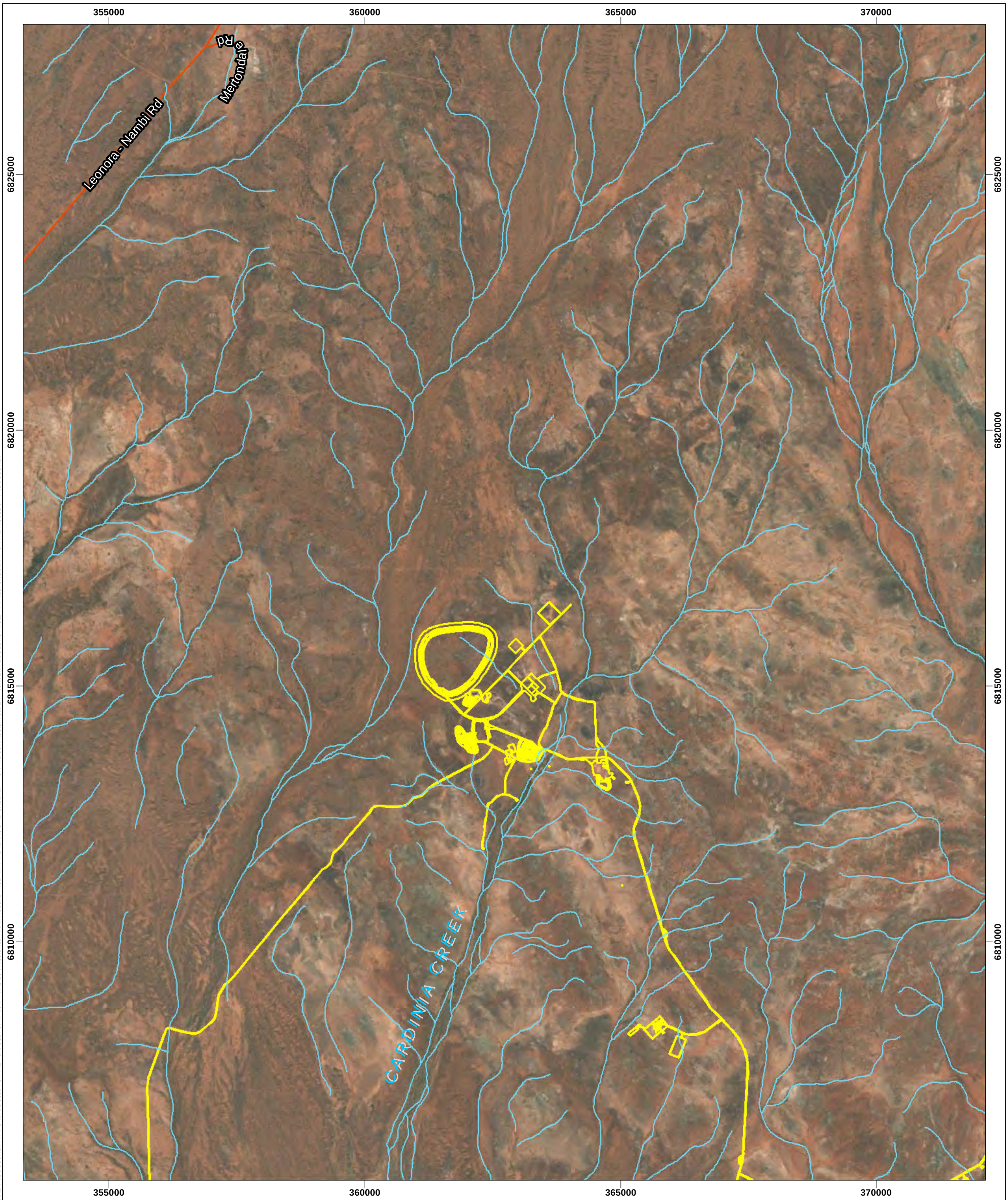
CREATED	CHECKED	APPROVED	REVISION
LF	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 3
Soil Types

K:\Projects\10. WAM\4557 Cardinia Surface Water Assessment\4557 F03 Soils.mxd



Legend

- Local Roads
- Infrastructure

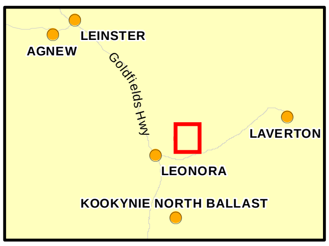
Hydrography

- Watercourse - minor, perennial

0 1,000 2,000 3,000
Meters
1:100,000 @ A4
N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



Powered By SLIP ENABLER

- LOCALITY MAP SOURCED FROM LANDGATE 2020
- OTHER DATA SOURCED LANDGATE 2020
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2020
(© Western Australian Land Information Authority 2020)

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

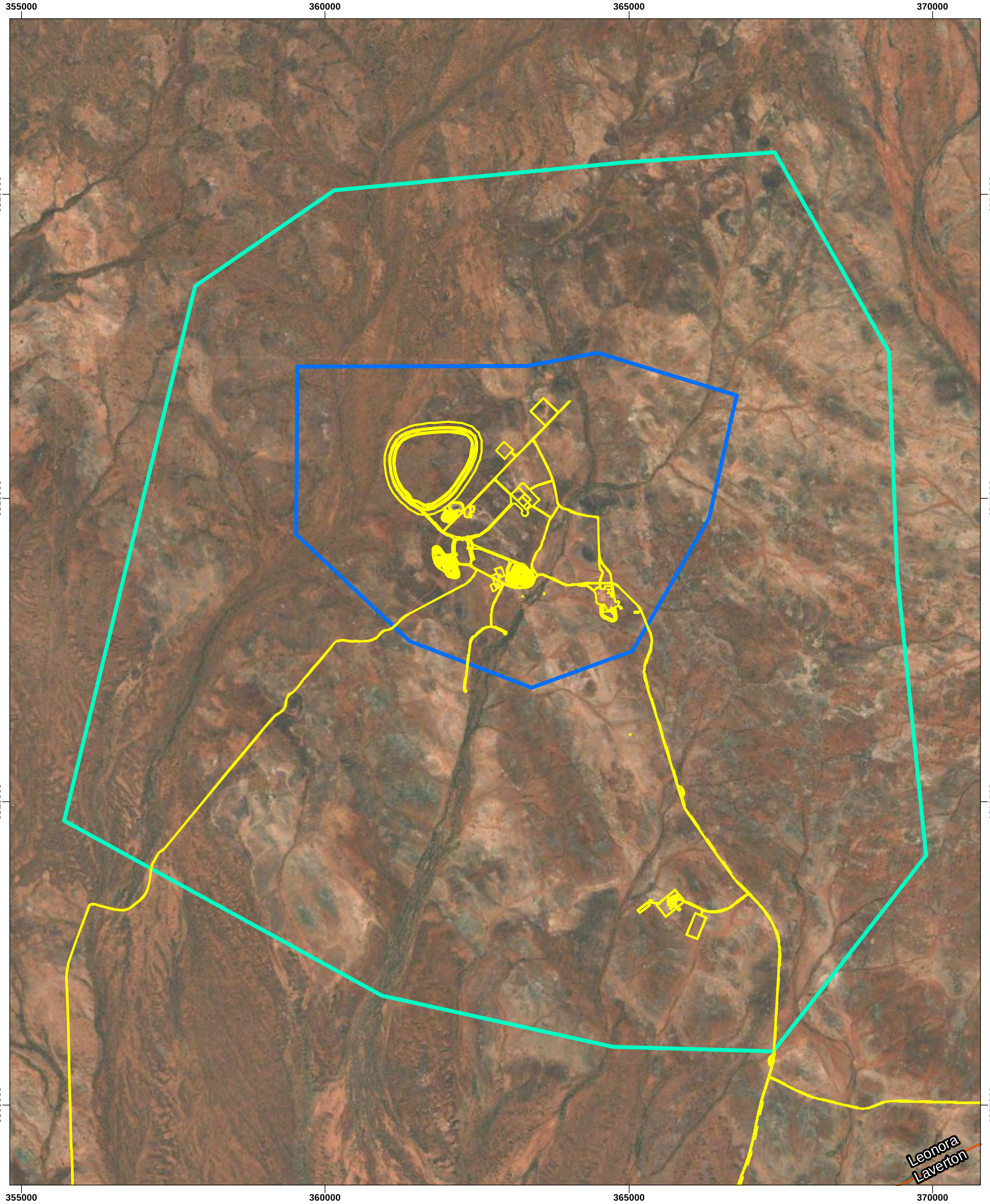
CREATED	CHECKED	APPROVED	REVISION
LF	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 4
Watercourses

K:\Projects\10. WAM\4557 Cardinia Surface Water Assessment\4557 F04 Hydrology.mxd



Legend

- State Road
- Infrastructure
- 2D High Resolution Model Domain
- 2D Model Domain

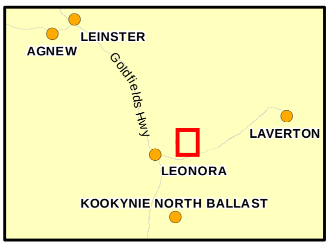
Powered By SLIP ENABLER

- LOCALITY MAP SOURCED FROM LANDGATE 2020
- OTHER DATA SOURCED LANDGATE 2020
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2020
(© Western Australian Land Information Authority 2020)

0 890 1,780 2,670
Meters
1:85,000 @ A4
N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	13/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 51

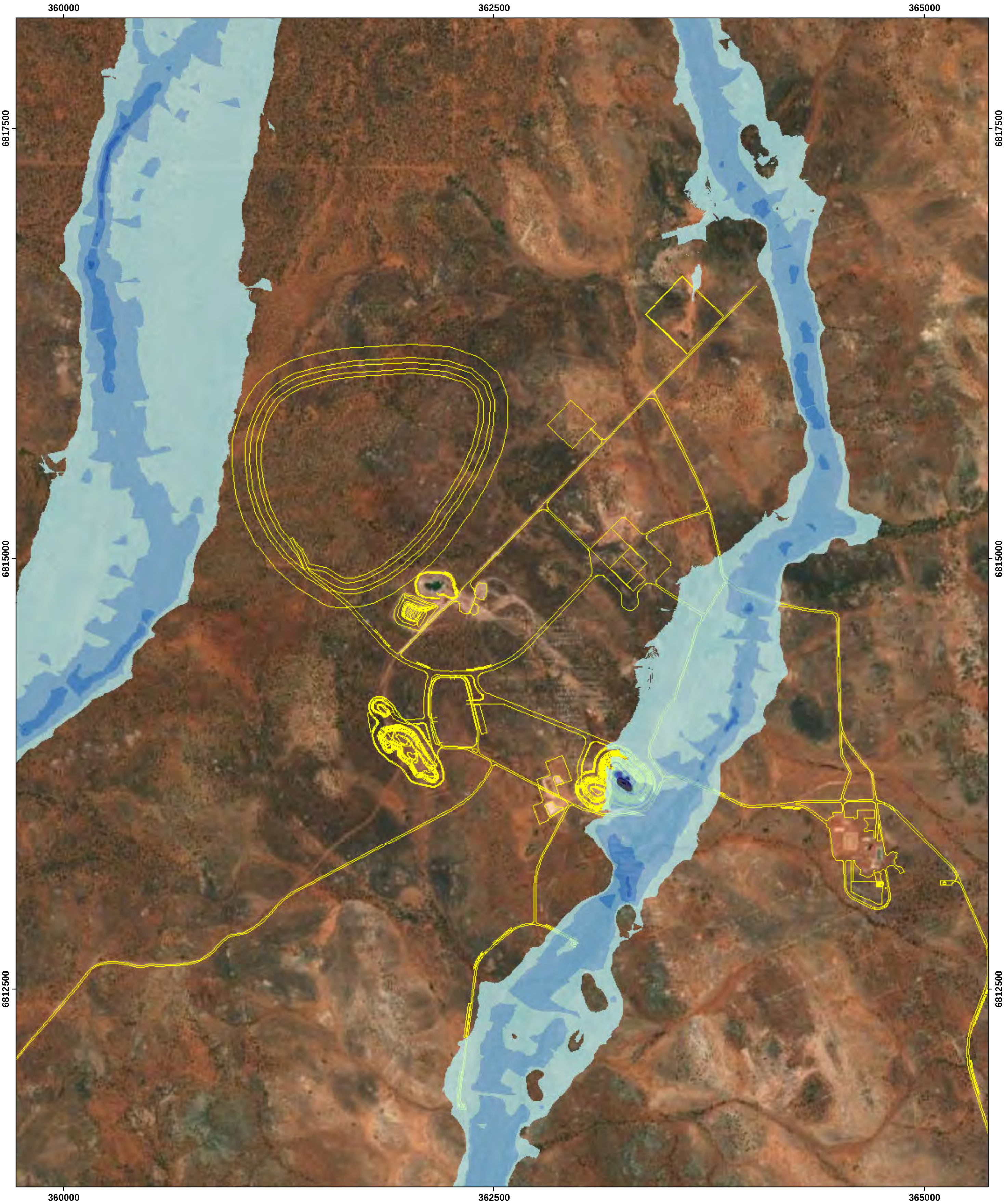
CREATED	CHECKED	APPROVED	REVISION
LF	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 5
2D Model Domain

K:\Projects\10. WAM\4557 Cardinia Surface Water Assessment\4557 F05 Model Domains.mxd



Legend

Infrastructure - Stage 1

1% AEP Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- >2.5

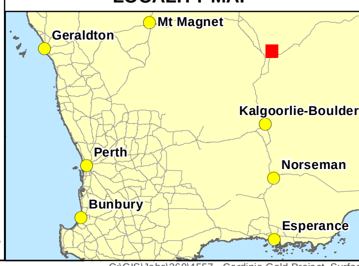
0 250 500 1,000 Metres

Scale: 1:30,041 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



- LOCALITY MAP SOURCED FROM LANDGATE 2006
- AERIAL PHOTOGRAPHY OPEN SOURCED

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

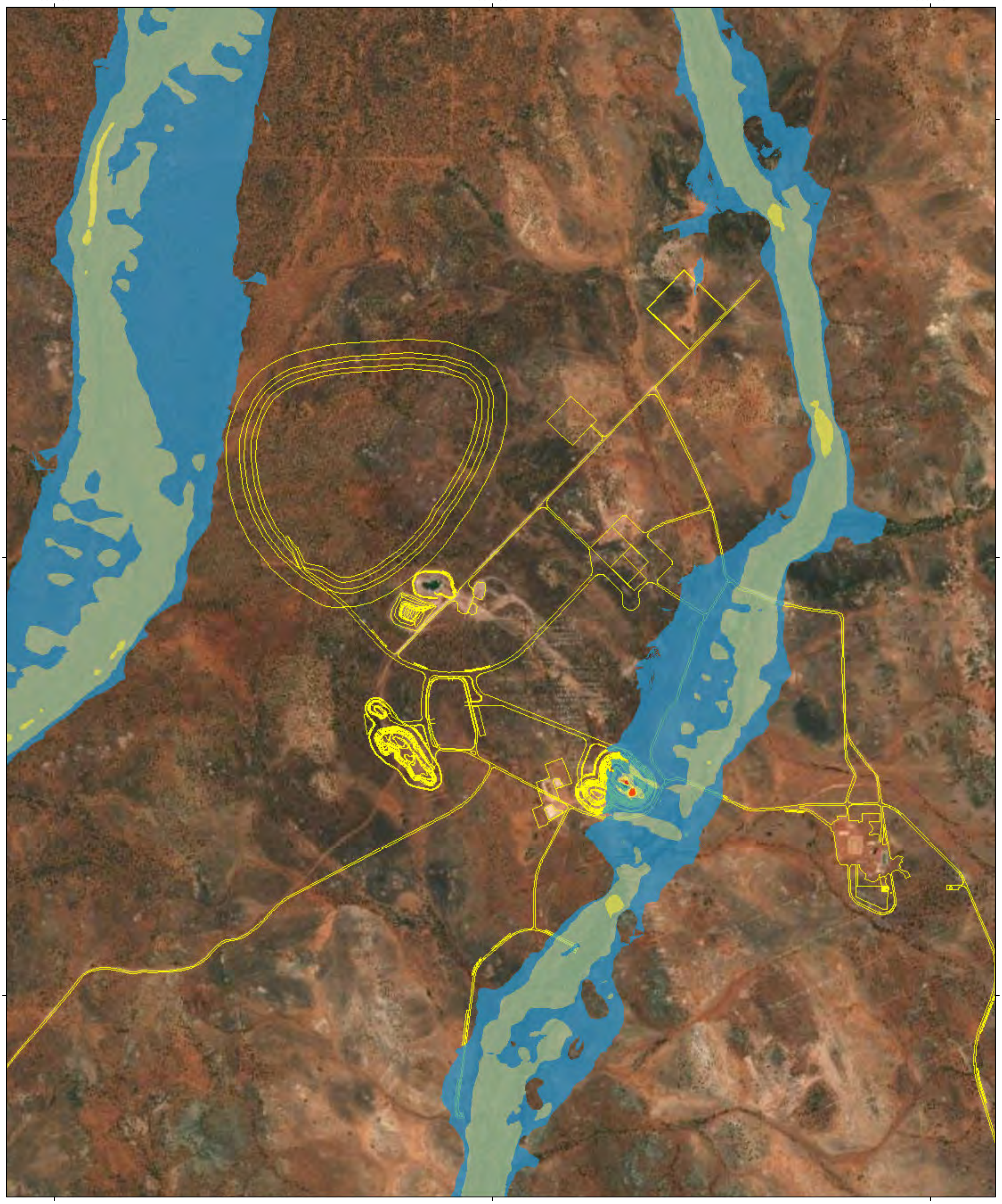
CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 6
1% Flood Depth

C:\GIS\Jobs\360\4557 - Cardinia Gold Project, Surface Water Assessment\Figures\4557_F06 1 Percent Flood Depth_210512.mxd



Legend

Infrastructure - Stage 1

0.1% AEP Flood Velocity (m^2/s)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- >2.0

- LOCALITY MAP SOURCED FROM LANDGATE 2006
- AERIAL PHOTOGRAPHY OPEN SOURCED

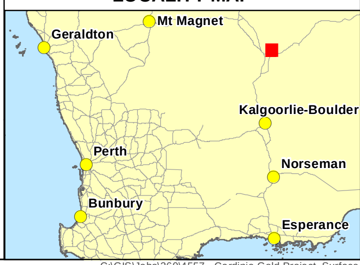
0 250 500 1,000 Metres

Scale: 1:30,041 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

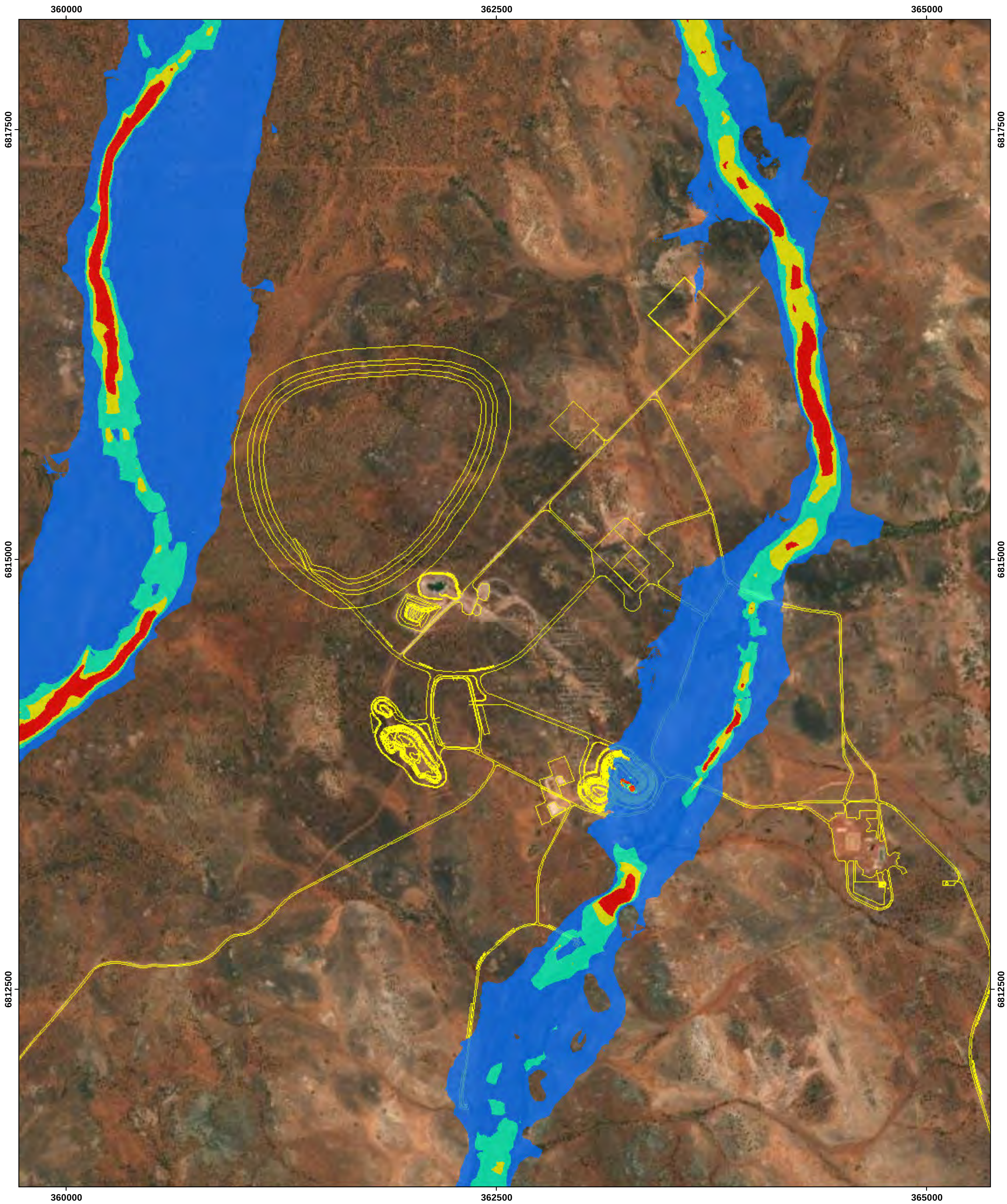
CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 7
1% Flood Velocity

C:\GIS\Jobs\360\4557 - Cardinia Gold Project, Surface Water Assessment\Figures\4557_F07 1 Percent Flood Velocity_210512.mxd



Legend

Infrastructure - Stage 1

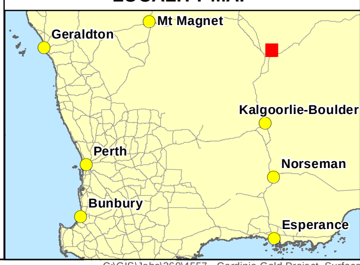
Depth x Velocity (m^2/s)

- 0.0 - 0.4 Low
- 0.4 - 0.6 Moderate
- 0.6 - 0.8 Significant
- >0.8 Extreme

0 250 500 1,000 N
Metres
Scale: 1:30,041 @ A4

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



- LOCALITY MAP SOURCED FROM LANDGATE 2006
- AERIAL PHOTOGRAPHY OPEN SOURCED

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

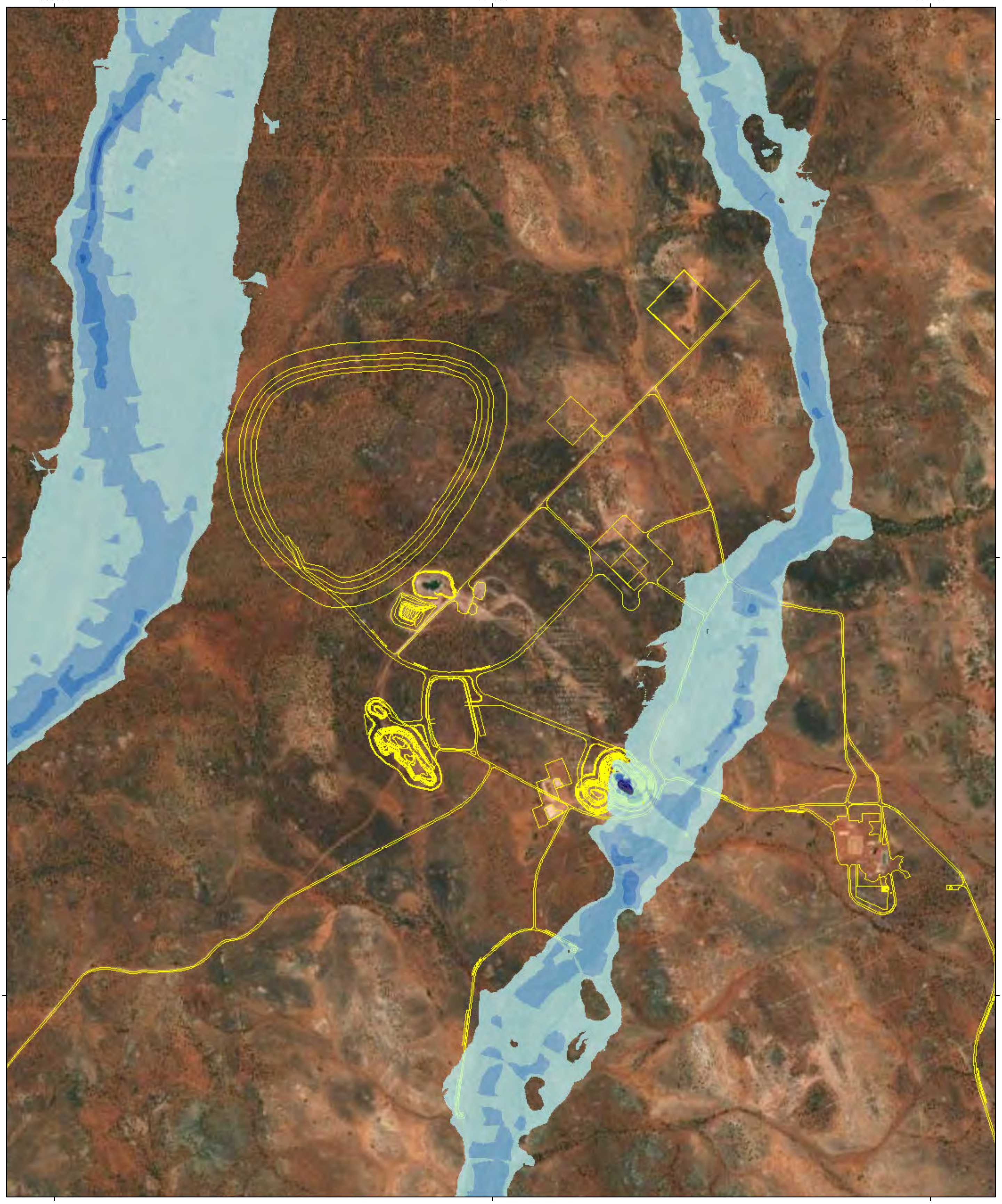
CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 8
1% Flood Hazard

C:\GIS\Jobs\360\4557 - Cardinia Gold Project, Surface Water Assessment\Figures\4557_F08 1 Percent Flood Hazard_210512.mxd



Legend

Infrastructure - Stage 1

10% AEP Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- >2.5

0 250 500 1,000

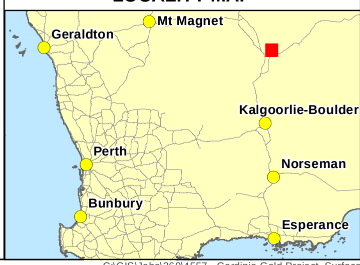
Metres

Scale: 1:30,041 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



- LOCALITY MAP SOURCED FROM LANDGATE 2006
- AERIAL PHOTOGRAPHY OPEN SOURCED

360 environmental

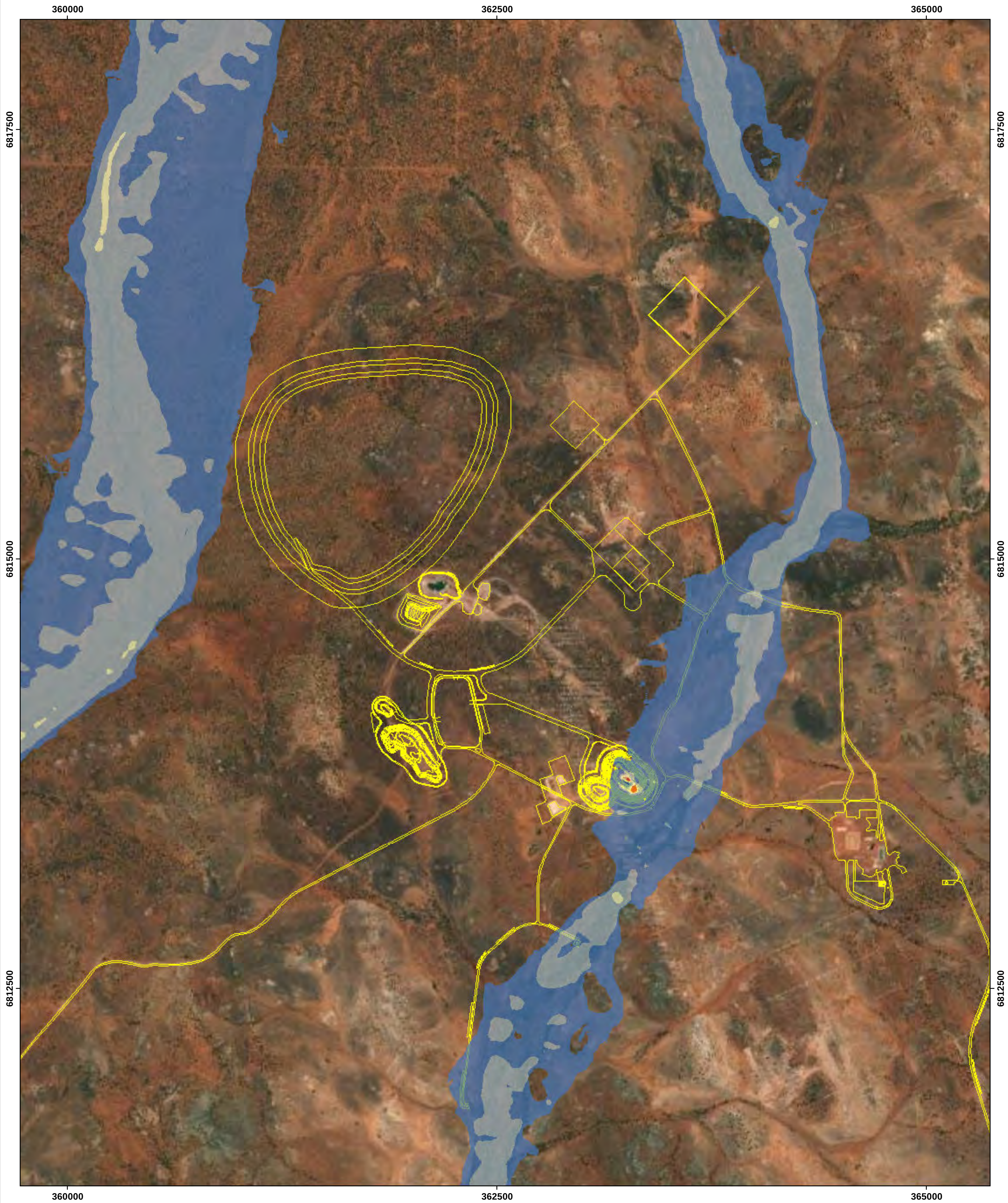
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE		
4557	12/05/2021		
HORIZONTAL DATUM AND PROJECTION			
GDA 1994 MGA Zone 50			
CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 9
10% Flood Depth



Legend

Infrastructure - Stage 1

10% AEP Flood Velocity (m^2/s)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- >2.0

- LOCALITY MAP SOURCED FROM LANDGATE 2006
- AERIAL PHOTOGRAPHY OPEN SOURCED

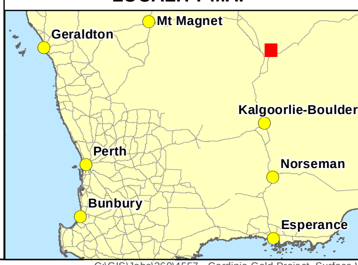
0 250 500 1,000

Metres

Scale: 1:30,041 @ A4

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

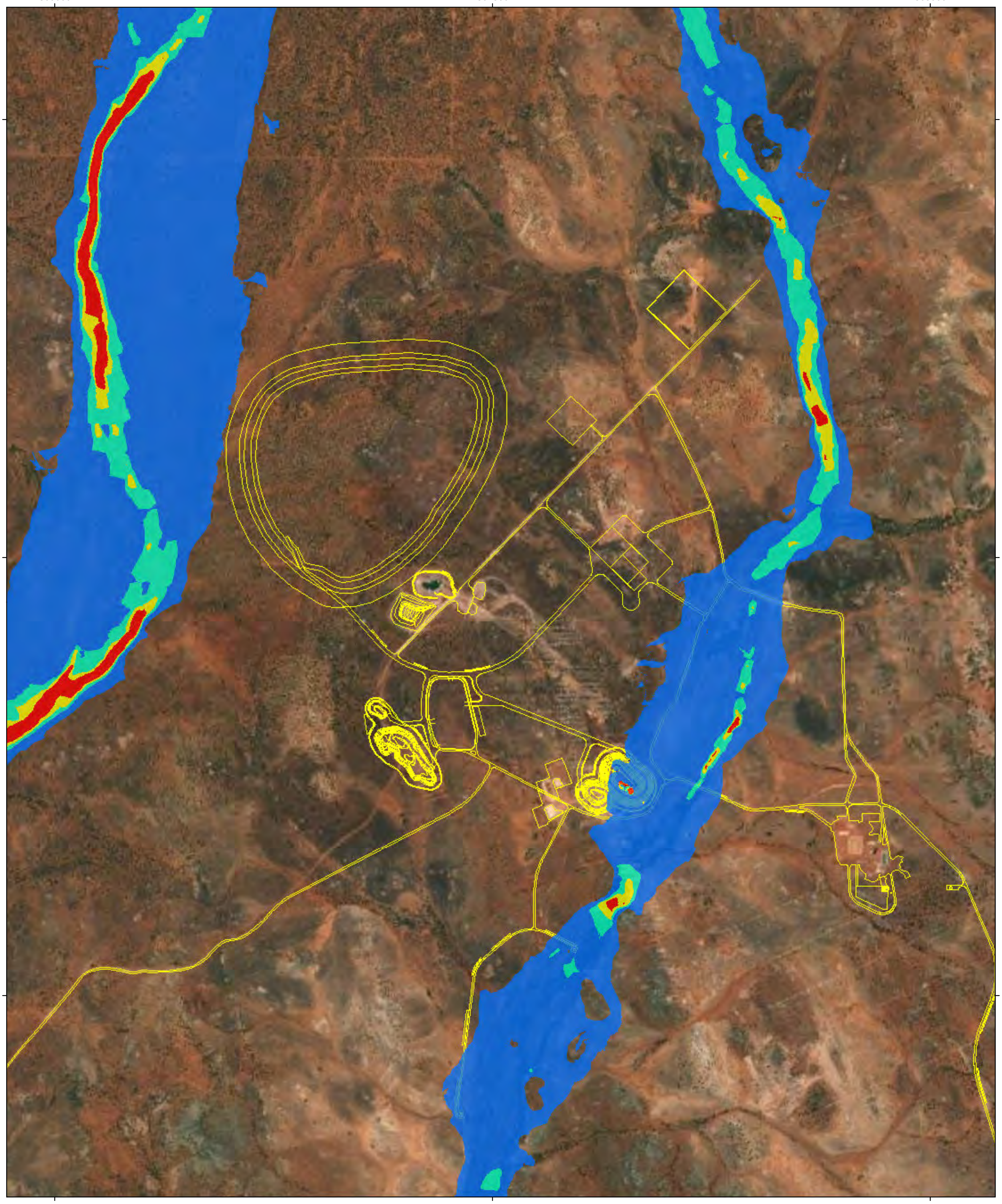
CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 10
10% Flood Velocity

C:\GIS\Jobs\360\4557 - Cardinia Gold Project, Surface Water Assessment\Figures\4557_F10 10 Percent Flood Velocity_210512.mxd



Legend

Infrastructure - Stage 1

Depth x Velocity (m^2/s)

- 0.0 - 0.4 Low
- 0.4 - 0.6 Moderate
- 0.6 - 0.8 Significant
- >0.8 Extreme

- LOCALITY MAP SOURCED FROM LANDGATE 2006
- AERIAL PHOTOGRAPHY OPEN SOURCED

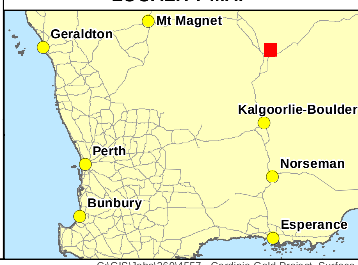
0 250 500 1,000 Metres

Scale: 1:30,041 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

PROJECT ID	DATE
4557	12/05/2021

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	NC	DT	0

Kin Mining NL
Cardinia Gold Project

Cardinia
Surface Water Assessment

Figure 11
10% Flood Hazard

C:\GIS\Jobs\360\4557 - Cardinia Gold Project, Surface Water Assessment\Figures\4557_F11 10 Percent Flood Hazard_210512.mxd

360 environmental

10 Bermondsey Street West Leederville WA 6007 **t** (+618) 9388 8360 **f** (+618) 9381 2360
PO BOX 14, West Perth WA 6872
w 360environmental.com.au **e** admin@360environmental.com.au

● people ● planet ● professional