REPORT

Winu Final Study

Updated Flood Risk Assessment – Access Route (2 of 2)

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Distribution List

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1.0 INTRODUCTION

Rio Tinto Winu Pty Ltd (Rio Tinto) has commissioned Golder Associates Pty Ltd (Golder) to undertake a flood risk assessment for the main access route to support assessment of the planned 7 Mtpa mine development (Final Study). This is the proposed main access route between Great Northern Highway and the Site which includes a section of the Nyangumarta Highway.

2.0 SITE CHARACTERISTICS

The Site is located approximately 330 km east of Port Hedland and 120 km north north-west of Telfer mine, Western Australia and is accessed via the Great Northern Highway and Nyangumarta Highway.

Situated within the Great Sandy Desert bioregion, the Site experiences an arid environment, where the climate, topography and soil conditions contribute to a unique hydrologic system. The Site is characterised by poorly defined (if any) continuous flow paths, which requires careful consideration for the flood assessment in order to adopt appropriate methodologies and assumptions for the flood risk assessment and recommended mitigation measures and designs. Climate data is described in (Golder, 2020a)

Topography across the site and more regionally is dominated by longitudinal aeolian sand dunes, which are typically oriented north-west to south-east. Dune ridgelines are separated by interdunal corridors in which a series of shallow rises and depressions are formed running along the corridors. Aeolian sand deposits extend to depths of around 20 m bgl (metres below ground level). Due to these characteristics, there are no well-defined surface water flow paths. Internal drainage systems are dominant forming soaks scattered across the region likely associated with localised areas of ephemeral, perched water table associated with high rainfall events.

3.0 FLOOD RISK OBJECTIVES

The overarching objective of this document is in line with The EPA's (Environmental Protection Authority (EPA) Western Australia, 2018) objective for Inland Water. This is, *"To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected".* This objective recognises the fundamental link between the hydrological regimes and water quality of inland waters, and the environmental values supported by or dependent on them. These environmental values may include water dependent ecosystems, amenity, cultural values, recreation, public drinking water supplies, and agricultural and industry use of water. In straightforward terms, for this strategy, it means separating clean water from potentially contaminated water.

The flood risk elements for the access route will include the following strategies and proposed water management structures to minimise disruption to mining activities due to heavy or prolonged rainfall and meet EPA objectives. Best management practices for surface water and erosion will be implemented with the main objective of separating clean flood water (non-contaminated) from mining areas and managing potentially contaminated surface water generated from the mining areas in a fully integrated approach.

The control and management of clean and potentially contaminated surface water across the access routes is essential to reduce risks to mine personnel and infrastructure, reduce risk of disruption and help protect the adjacent environment. As outlined in previous sections, the aim of the plan is to:

- Separate clean and potentially contaminated water, and
- Manage clean water safely across access route floodway and allow to infiltrate/evaporate where possible.

The definition of impacted and non-impacted stormwater generated across the site is summarised in Table 1 and after (Ausenco, 2020) and (Rio Tinto, 2020).

Table 1: Water Management Definitions

Water Type			Treatment Type	Water Management Method	Runoff Areas Included
Clean Water	Non-contaminated surface water runoff generated in uncleared/natural ground areas.		No treatment required.	Water is retained or diverted by flood protection diversion bunds or floodway.	Natural and undisturbed catchment areas.
Potentially Contaminated Water	**Suspended Sediment**	Surface water runoff that may contain entrained natural sediment but is chemically clean.	Primary treatment required (sediment removed by gravity).	Water is retained on landforms by perimeter bunds **OR** is collected at the base of landforms by unlined toe drains which is then conveyed to unlined sediment ponds before being discharged/infiltrated/ evaporated to the environment.	Waste Rock Stockpile Top Soil Stockpiles Tailings Storage Facility (external embankments).
	Other Contaminants	Surface water runoff which may contain oils, chemicals, metals etc.	Secondary and/or tertiary treatment.	Water is collected at the base of landforms by lined toe drains which is then conveyed to lined sumps/sediment ponds and then sent to the Process. This water is therefore not discharged under normal operating conditions.	Oxide Stockpile Pit Process Plant/ROM pad Mafic Stockpile High & Low-Grade Ore Stockpiles Truck Washdown Areas.

3.1 Flood Risk – Clean Water Management Strategy

As described in Table 1, all the water passing across floodways along the access route is considered clean and clean water, therefore the management strategy is to safely allow clean surface water across engineered floodways in order to:

- Passive floodways to allow the passage of clean water safely across the road access route at crossing locations.
- Minimise disruption to mining and transport activities.
- Maintain natural flow characteristics without blocking flows as far as is practicable.

4.0 DESIGN CRITERIA SELECTION

A summary of the agreed design criteria to be adopted for the development of proposed flood mitigation measures for the various infrastructure components for the Site is presented in Golder (2020a). These form the basis for the development of the mitigation measures to reduce risks associated with flooding following more extreme storm events.

4.1 Design Criteria

The selection of appropriate design criteria for flood infrastructure has been assessed with consideration of acceptable levels of project risks versus the costs. Table 2 summarises the key design parameters and recommended design basis criteria applied in the study to evaluate flood behaviour and aid in the selection of mitigation measures for the access route.

Table 2: Design Parameters and Criteria Summary (adapted from Golder (2020a))

Design Aspect	Design Basis
Haul/main access roads (floodways)	Design event: trafficable for 5% AEP with a maximum water depth of 300 mm (depth criteria based on Australian Institute for Disaster Resilience, 2014)
Haul/main access roads (culverts)	Design event: roads should be free of water up to the 10% AEP flood event and trafficable for a 5% AEP event with a maximum water depth of 300 mm (depth criteria based on Australian Institute for Disaster Resilience, 2014)
Erosion and scouring protection	Required, typically if flow velocity exceeds 2 m/s

5.0 FLOOD RISK MODELLING AND MODEL SETUP

Flood risk modelling and assessment is required to inform the Design of surface water management structures along the access route.

The TUFLOW modelling package was used to develop a catchment wide two-dimensional (2D) hydraulic model, using a rainfall-on-grid modelling approach for the access route. This approach distributes rainfall over each cell and routes water over the entire catchment area, allowing inflows into key areas to be estimated. It allows the interaction and development of 2D elements, consisting in the model extents, boundary conditions, land use classifications, terrains, and other relevant characteristics using a range of Geographic Information System (GIS) layers.

An overview of the assumptions, modelling approaches and results associated with each infrastructure facility are outlined below.

5.1 Design Rainfall Assessment

Estimation of design floods using catchment modelling involves the derivation of a catchment model and design storms. Losses are subtracted from the design storm to obtain the rainfall excess, which is then routed through the model to derive a design flow hydrograph at a subject site.

The estimation of the relevant design rainfall depths for the proposed AEPs were undertaken in accordance with the Australian Rainfall and Runoff Guidelines (ARR 2019) (Ball, et al., 2019) and is described in the following Sections.

5.1.1 Design Rainfall Data

Site-specific Intensity-Frequency-Duration (IFD) relationships were sourced from the Australian Bureau of Meteorology (BOM) online IFD system (BoM, 2020) for each catchment reporting to the relevant assessed infrastructure location.

Hydrologic modelling requires a temporal rainfall distribution to define the rainfall event behaviour over time. A wide range of temporal patterns can be observed in nature including concentrating the period of peak intensity early, centrally, or late in the storm event, thereby affecting the shape and peak of the resulting storm hydrograph. To consider this variability, ARR 2019 provides guidance on selecting a representative ensemble of temporal patterns for each AEP value, duration, region, and catchment area within Australia.

5.1.2 Rainfall Losses

Rainfall losses associated with soil infiltration are an important component in the surface runoff generated during a storm event at the Site. To estimate the rainfall losses, the Initial Loss- Continuing Loss model (ILCL) was adopted in accordance with the concepts provided in ARR 2019. This method assumes an initial amount of infiltration to the soil, followed by a constant infiltration rate through remaining period of the storm.

Rainfall losses within the 2D hydraulic model were computed subtracting the losses (either IL or CL) from the rainfall for each timestep, before applying the excess rainfalls to the 2D cells within the hydraulic model.

To provide guidance in the adoption of the rainfall losses soil infiltration testing was carried out to estimate infiltration rates across Site. However, results indicated extremely high infiltration rates (Golder, 2020b). Given the site conditions and uncertainties in the results of the soil infiltration testing, a generally conservative approach was adopted whereby the ILCL values selected were based on the highest values recommended by ARR 2019 for the study catchments, as presented in Table 3.

Table 3: Adopted Initial and Continuing Loss Values

Initial Loss (mm)	Continuing Loss (mm/hr)
80	10

ARR 2019 also states that in order to account for the initial moisture content in the catchment as a result of pre-storm rainfalls, pre-burst losses must be subtracted from the constant initial loss in order to represent complete design storms. The IFD rainfall estimates also represent point values. Site-specific areal reduction factors (ARFs) were therefore applied to reflect the reduction in the design rainfalls when these point estimates are applied over larger catchment areas. This reflects the likely reduction in storm intensities and total rainfall depths as point rainfall estimates are transposed to larger catchment areas.

The adopted pre-burst depths and ARFs were also extracted from the ARR Online Data Hub (Geoscience Australia, 2020).

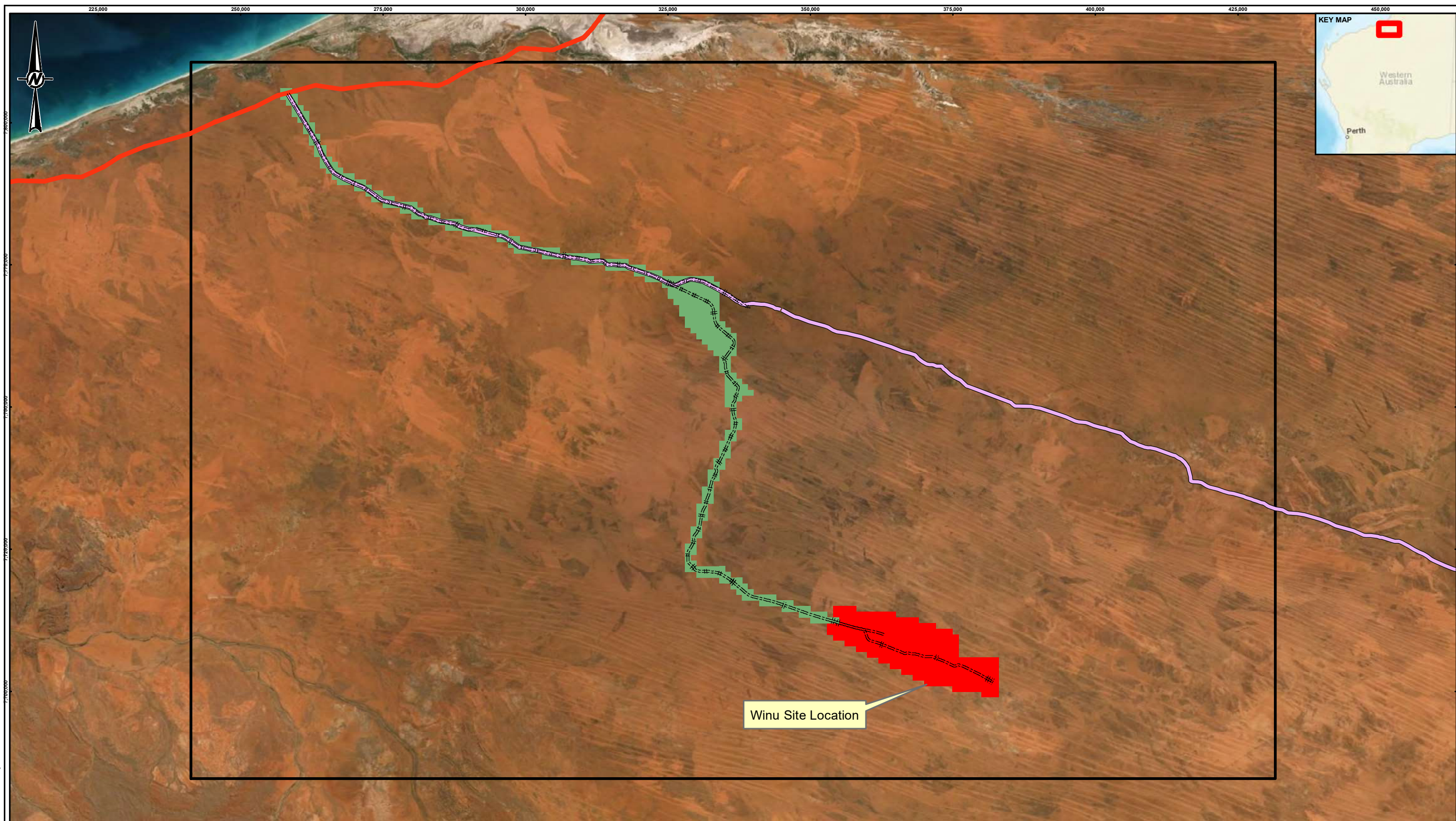
5.2 Terrain Data

The terrain surface file to be applied in the hydraulic model should represent the existing topography as accurately as possible. For the current study this was based on combining the following available terrain data covering the study area, obtained from different sources:

- Detailed LiDAR survey provided by Rio Tinto in May 2019, covering most of the immediate mine site extents.
- Detailed LiDAR survey provided by Rio Tinto in May 2020, covering the terrain along the access corridor between the Site and the Great Northern Highway.
- Shuttle Radar Topographic Mission (SRTM) derived hydrological 1-second elevation model, sourced from the Australia New Zealand Land Information Council (ANZLIC) (2020). This dataset was used to cover the remaining extents of the study catchments.

A complete terrain surface was then developed combining both LiDAR survey datasets of the Winu exploration lease and access corridor provided by Rio Tinto and SRTM. A global adjustment of the SRTM data was undertaken lowering it based on a statistical analysis of the differences between the three surfaces (Avg.: 5.09 m) and to ensure a correct fit between them, a 200 m buffer around the LiDAR was removed from the SRTM data and re-interpolated.

An overview of the terrain configuration is presented in Figure 1.



LEGEND

- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Corridor LiDAR Extents
- Immediate Mine Site LiDAR Extents
- SRTM Extents

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 12.5 25
1:650,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

CLIENT
RIO TINTO

PROJECT
WINU FINAL STUDY
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT
GOLDER

DD-MM-YYYY	05/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
OVERVIEW OF THE TERRAIN CONFIGURATION

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	01

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5.3 Flood Risk Assessment

5.3.1 Access Road Flood Assessment

The estimation of design flood discharges, water levels and flow velocities along the access road, in particular, at the access road surface water crossing locations was carried out utilising the TUFLOW modelling package. As discussed above, this was applied to develop a catchment wide, two-dimensional (2D) hydraulic model using a rainfall-on-grid modelling approach.

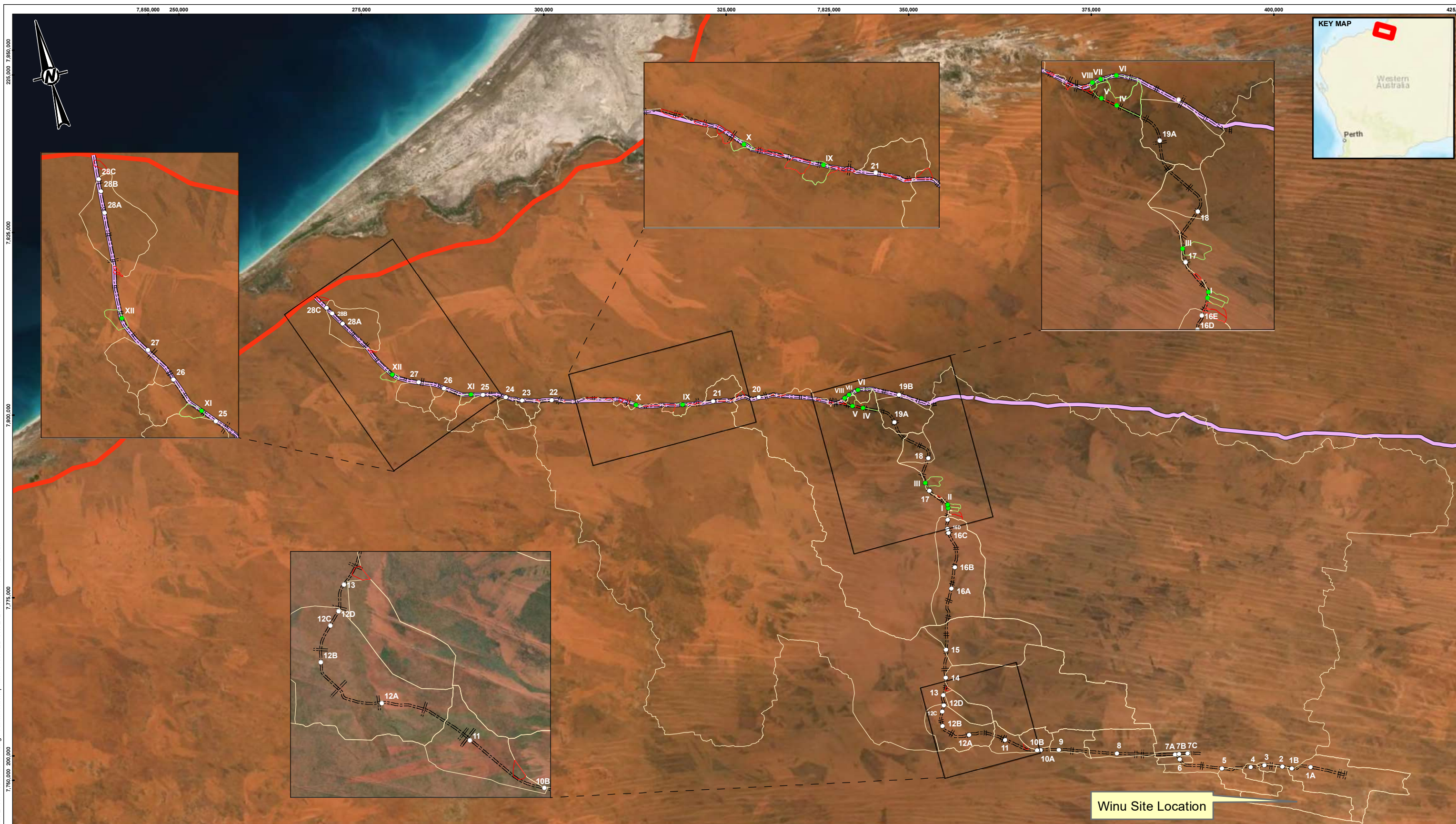
Following Golder's site visit (11 July to 16 July 2020) and the access road visual crossings confirmation and inspection, 40 additional very minor catchments were identified along the access road. These catchments are almost indistinguishable in the survey as they are mostly located where the road alignment runs close to the previously considered catchment borderline; these catchment areas are also presented in Figure 2 for completeness range from 0.04 km^2 to 3.8 km^2. The critical duration storm assessment (Section 5.3.1.3) undertaken for these catchments was used to discard those where the flow depths over the access road are considered insignificant for the 5% AEP flood event (depths below 100 mm), and the remaining 12 catchments (I to XII) were included in this analysis

5.3.1.1 Catchment Delineation

A preliminary terrain analysis suggested that the catchments impacting the access road may extend for 100s of square kilometres to the east of the Site, although this is subject to some uncertainty due to the size of the area, its flatness and available contour data. This also reflects limitations in the accuracy of the available SRTM data and significant uncertainties in the derived topographic contours. Specifically, it is not feasible at this stage to confirm if the derived topographical data accurately reflects actual catchment extents. As a result of this uncertainty, it is possible to define 'local' and 'regional' scale catchments that may or may/not interact with each another during extreme flooding conditions.

However, as presented in Golder (2020b), the regional catchment extents did not result in any differences in design flood estimates at the catchment outlet when compared with the local modelling scenario. This suggested the surface water system is likely to be localised and does not interact on a more regional scale. The design catchment delineations for the access road presented in Figure 2 was derived based on 42[1] identified potential road crossing locations along the alignment.

[1] Note: The catchment areas reporting to crossings 17, 20 and 22 include smaller catchment areas as upstream tributaries. To account for the spatial variability of the rainfall events, these catchments were simulated separately to correctly consider the ARFs and areal temporal patterns, where required. The remaining crossings, that are located within the same catchment boundaries, were grouped for this analysis.



LEGEND

- Crossing Locations
- Additional Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments
- Discarded Catchments
- Additional Catchments

NOTE(S)

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

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1:525,000 @ A3 KILOMETRES

REFERENCE(S)
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri

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PROJECT
WINU FINAL STUDY
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT
GOLDER

DD-MM-YYYY	6/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
ACCESS ROAD CROSSING CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	02

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5.3.1.2 Modelling Input Parameters

The key components of the hydraulic model developed to assess the access road included the following:

- **Digital elevation model:** A terrain surface file was developed and specified in the model based on the available surfaces listed in Section 5.2.
- **Boundary conditions:** Rainfall was applied directly onto the 2D mesh as the model inflow (representing rainfall on grid) and a downstream outflow boundary was defined by assuming normal flow conditions based on the average longitudinal ground surface slope of the final downstream flow path.
- **Design rainfall:** The respective design rainfalls for the 5% and 10% AEP events (as per the design criteria presented in Section 4.0) was applied for all catchments across the model extent.
- **Manning's roughness coefficient:** A surface roughness of 0.03 was adopted for the model according to ARR 2019, reflecting lightly vegetated soils.

2D grid resolution: The model extent comprised an area of approximately 125 km × 190 km, with a modelled cell size of 10 m × 10 m.

5.3.1.3 Critical Storm Duration Assessment

To evaluate the critical storm duration for the nominated AEP, the ensemble of all associated design temporal patterns must be simulated. The largest median flood depth among the simulated ensemble range is then adopted as a suitable estimate of the critical duration for the AEP storm event, as outlined in ARR 2019.

The flood modelling for the catchment associated with each crossing was therefore undertaken considering the respective temporal pattern ensemble for durations ranging from 30 min to 72 hours for the 5% and 10% AEP storm events. The resulting flood gridded depths among the simulated ensemble range were processed to identify the critical duration for each crossing. These are summarised in Table 4.

Table 4: Access Road Crossing Critical Design Storm Durations[2]

Crossing	10% AEP Storm – Critical Duration (h)	5% AEP Storm – Critical Duration (h)
1A	3	9
1B	3	9
2	3	9
3	9	12
4	3	9
5	3	12
6	1	1
7A	9	9
7B	9	9
7C	9	9
8	3	12
9	6	6
10A	9	12
10B	9	12
11	9	6
12A	6	6
12B	6	6
12C	6	6
12D	6	6

[2] The catchments and crossings with Roman numerals have been added subsequent to the site visit

Crossing	10% AEP Storm – Critical Duration (h)	5% AEP Storm – Critical Duration (h)
13	6	6
14	24	12
15	12	12
16A	12	18
16B	12	18
16C	12	18
16D	12	18
16E	12	18
17	3	3
18	3	12
19A	9	9
19B	9	9
20	6	12
21	1	1
22	3	3
23	9	9
24	9	9
25	6	6
26	9	12
27	9	9
28A	9	9
28B	9	9
28C	9	9
I	6	6
II	9	6
III	6	6
IV	9	6
V	9	6
VI	9	9
VII	6	6
VIII	6	6
IX	9	6
X	9	6
XI	9	12
XII	9	18

Golder acknowledges the unusual and significant differences in the estimated critical durations for the crossings. This reflects the unique nature of the hydrology. The terrain has numerous natural depressions and internally draining basins which govern the flooding characteristics within the catchments. This is atypical flooding behaviour as drainage lines are indistinct and broken.

The assessment along the entire access route has been undertaken on a catchment by catchment basis which assumes the probability of occurrence of floods at each crossing location are independent from one another. Closure of individual floodway areas is anticipated to be of relatively short duration (a few hours rather than days) from the same rainfall/cyclonic event along the entire route as is typical in the Pilbara region.

5.3.1.4 Results of Flood Estimation along Access Road – Base Case

Flood risk inundation maps have been generated from the results of the 2D hydraulic modelling. These are provided in Appendix A and include estimated maximum flood depths and velocity results. Also presented are the maximum flood depth estimates specifically for each crossing location to assist in the design of floodway process.

A long section of the access road alignment with the identified crossings and water levels for the 5% AEP flood event is presented in Appendix B.

6.0 ACCESS ROUTE SURFACE WATER MANAGEMENT PLAN

6.1 Mitigation Measures

The base case hydraulic flood modelling assessment provided the necessary inputs for a preliminary analysis of flood mitigation measures to be adopted along the access road corridor for the management of clean surface water. Given the proposed road alignment crosses several low points across different catchments, the primary focus of the mitigation measures is recommended to be the construction of flood ways at these crossing locations, providing suitable erosion and scour protection where required, based on the simulation results and the adopted design criteria (Golder, 2020a).

Golder recommends that the floodways are designed with cognisance of the criteria and guidelines in the Main Roads Western Australia (2006) document, under the assumption that these structures will act as unsubmerged broad crested weirs, with a maximum height of headwater above the floodway crest of 300 mm (for trafficability) for the 5% AEP critical duration flood.

6.1.1 Floodway Typical Design

A floodway is defined as roadway section across a shallow depression where flow is usually infrequent or of short duration, designed to act as broad-crested weirs, allowing the structure to overtop up to the pre-defined maximum depth as a limit of trafficability for a given AEP event.

The following aspects should be taken into consideration where possible when designing a floodway:

- Horizontal longitudinal profile (allows the depth of water over the flooded section to be uniform)
- Length limited to 300 m where possible (wide sections should be broken into shorter lengths)
- Two-way crossfall
- Safety signage (graduated ruler for example) will be installed at selected floodway locations to inform vehicles of depth of flooding.

It is also recommended at each floodway crossing that a number of small diameter environmental relief pipes/culverts are included at-grade to allow for higher recurrence interval surface water flows to freely pass across the structure. This will help reduce surface water environmental shadowing effects.

A long section of a typical floodway is provided in Figure 3.

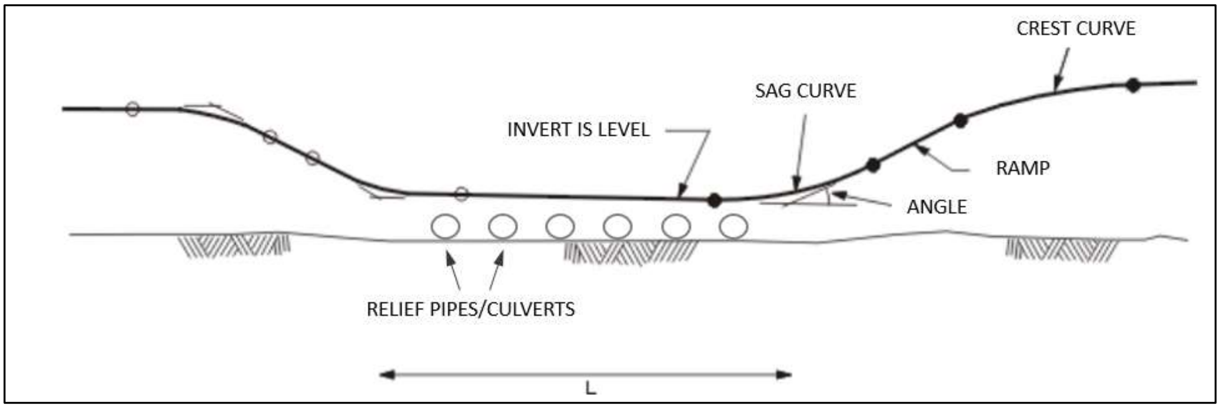

Figure 3: Long Section of Typical Floodway (adapted from Main Roads Western Australia (2006))

6.1.2 Erosion Protection

Appropriate protection works against erosion and scour damage should be provided where the flow velocities are considered significant (greater than 2 m/s). For flow velocities the critical location at a given road cross-section is the toe of the downstream batter slope, where the flow tends to assume a super-critical regime and consequently higher velocities before the area is drowned out as the downstream flood depth increases.

From the simulation results, for the 5% AEP flood events, only crossing 16B indicated a flow velocity over the road exceeding 2 m/s. It is important to note that the actual designed road alignments will present different configurations, mostly considering higher crest inverts and consequently batter heights that will alter the hydraulics and increase the flood velocity at the toe of the downstream embankments. This should be assessed in more detail at the next stage of design which may indicate a higher degree of protection is required.

The most practical and cost-effective scour protection measure for the site is the use of graded rock upon the prepared floodway embankment slopes. An additional rock pad of 1.5 times the embankment height should be provided at the base of the downstream riprap to protect the embankment against the higher flow velocities at the grade transition.

Figure 4 presents a typical floodway scour protection design.

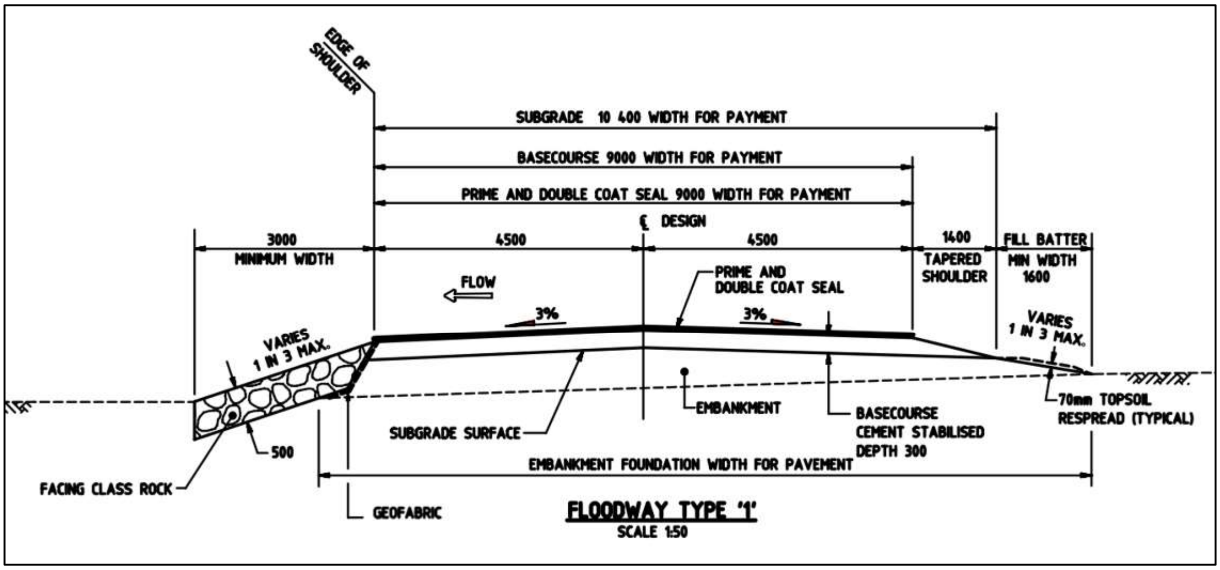

Figure 4: Typical Floodway Scour Protection Design (adapted from Main Roads Western Australia (2006))

Engineered bunds around infrastructure are considered only necessary when the flood depth is greater than 0.3 m, because according to the General Flood Hazard Vulnerability Curves, water depths below 0.3 m and flow velocities of less than 2.0 m/s, are generally safe for people, vehicles, and buildings as outlined in the Australian Institute for Disaster Resilience (2014) document (See Figure 5).

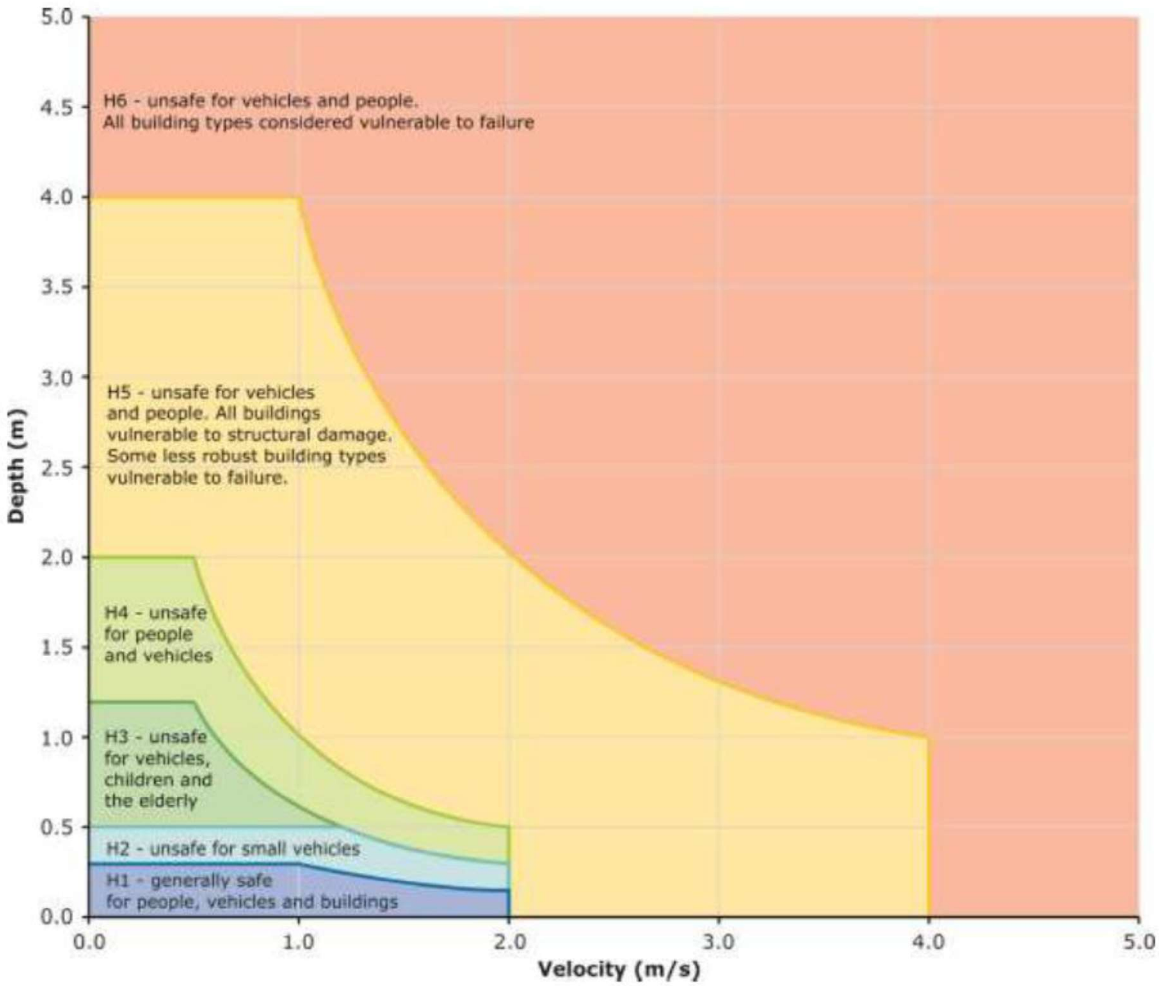

Figure 5: General Flood Hazard Vulnerability Curves (Australian Institute for Disaster Resilience, 2014)

7.0 SUMMARY

The updated flood risk assessment has been developed based on the overarching EPA objective for Inland Waters. The plan has been developed to provide clear management protocols and describe the flood dynamics and potential impacts along the proposed access road alignment and around the proposed infrastructure at the Site, along with a presentation of recommended mitigation measures and designs. If the mitigation measures are implemented as described, it is anticipated that the proposed development can be successfully delivered in accordance with the EPA objectives.

8.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled – "Important Information Relating to this Report", which is included in Appendix C of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder has under the contract between it and its client.

9.0 REFERENCES

ANZLIC. (2020). *ELVIS - Elevation and Depth - Foundation Spatial Data*. Retrieved March 17, 2020, from http://elevation.fsdf.org.au/

Ausenco. (2020). *Site Drainage Basis of Design (103946-0000-BX-BOD-0001 - Revision A).* Perth: Ausenco.

Australian Institute for Disaster Resilience. (2014). *Australian Disaster Resilience Guideline 7-3: Technical flood risk management guideline: Flood hazard.*

Babister, M., Trim, A., Testoni, I., & Tetallick, M. (2019, October 25). *The Australian Rainfall and Runoff Datahub*. Retrieved from https://data.arr-software.org/

Ball J., B. M. (2019). Autralian Rainfall and Runoff: A Guide to Flood Estimation. Commonwealth of Australia.

Ball, J., Babister, M., Nathan, R., Weeks, W., Weinmann, E., Retallick, M., & Testoni, I. (2019). *Australian Rainfall and Runoff: A Guide to Flood Estimation.* Commonwealth of Australia.

BoM. (2020). *Intensity-Frequency-Duration*. Retrieved April 20, 2020, from http://www.bom.gov.au/water/designRainfalls/ifd/

Environmental Protection Authority (EPA) Western Australia. (2018). *Environmental Factor Guideline: Inland Waters EPA.* Perth.

Geoscience Australia. (2020). *ARR Data Hub*. Retrieved March 17, 2020, from https://data.arr-software.org/

Golder. (2020a). *Hydrological Design Basis - Winu Project.* Rev0, Ref: 20136763-001-R-Rev0.

Golder. (2020b). *Winu Project Final Study - Flood Risk Assessment - Progress Update and Modelling Selection Testing.* RevA, Ref: 20136763-004-M-RevA.

IECA. (2018). *Best Practive Erosion and Sediment Control.* Brisbane: International Erosion Control Association (Australasia).

Main Roads Western Australia. (2006). *Floodway Design Guide, Doc. no: 6702020-2230.*

Rahman, A. H. (2019). *Regional Flood Frequency Estimation Model.* Sydney: University of Western Sydney. Retrieved from https://rffe.arr-software.org/

Rio Tinto. (2020). *Winu Project. Environmental Design Principles:CCC.07-0000-NH-DCR-00001.*

RTIO. (2011). *Pilbara Surface Water Management Strategy.* Perth: Rio Tinto.

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MN/MG/hn

A.B.N. 64 006 107 857

https://golderassociates.sharepoint.com/sites/120862/project files/6 deliverables/023 updated flood risk and surface water management plan/rev 0/20136763-023-r-rev0 part a.docx

APPENDIX A

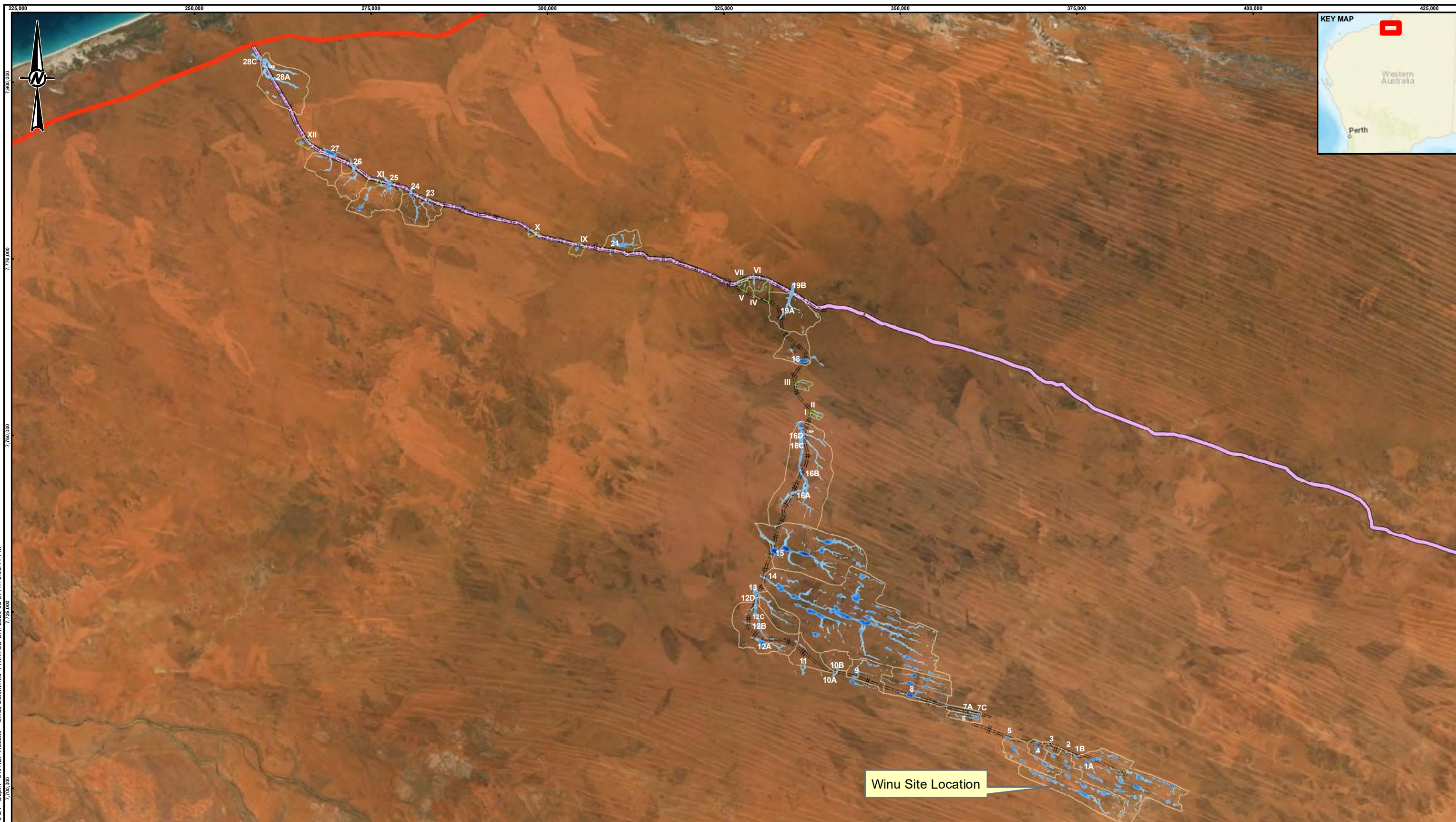
Access Road Flood Model Results

10% AEP Maximum Modelled Results												
Location	Type	Critical Duration (hs)	Peak Flow (m^3/s)	Maximum Depth at Crossing (m)	Maximum Pond Depth (m)	Reporting Volume (m^3)	Maximum Flow Velocity (m/s)	Relative Direction of Flow	Starting Coordinates		Ending Coordinates	
									Easting (m)	Northing (m)	Easting (m)	Northing (m)
1A	Pond	3	12.3	0.9	0.96	149,861	0.25	Right-Left	377653.27	7704024.32	377105.79	7704293.33
1B	Pond	3	7.45	0.5	0.82	31,454	0.12	Left-Right	374953.97	7704586.05	374505.96	7704808.06
2	Pond	3	7.83	0.3	0.74	30,462	0.04	Left-Right	373762.26	7705176.59	373380.41	7705350.71
3	Pond	9	0.61	0.1	0.53	6,523	0.35	Left-Right	371160.929	7706150.13	371027.049	7706144.84
4	Pond	3	0.54	0.4	0.7	2,177	0.09	Left-Right	369423.945	7706321.95	369173.516	7706395.38
5	Pond	3	20.5	0.9	1.09	108,500	0.09	Along the road	365493.81	7707128.05	364833.83	7707389.75
6	Crossing	1	25.4	0.3	-	125,265	1.1	Left-Right	359798.163	7709926.19	359732.017	7710119.34
7A	Crossing	9	4.64	0.1	-	35,343	0.67	Along the road	359304.185	7710828.79	359156.15	7710920.87
7B	Crossing	9	4.92	0.4	-	44,915	0.55	Along the road	360571.846	7710665.16	359297.081	7710928.69
7C	Pond	9	4.48	0.8	0.88	54,958	0.25	Along the road	361419.573	7710481.01	360660.746	7710649.29
8	Pond	3	11.0	2.3	2.11	163,824	1.02	Right-Left	353978.38	7712362.44	348923.26	7713941.66
9	Pond	6	3.74	0.4	0.62	110,875	0.35	Right-Left	344040.81	7715641.49	343118.23	7715906.58
10A	Crossing	9	16.6	0.3	-	162,166	0.62	Right-Left	341144.18	7716379.73	340881.45	7716441.96
10B	Crossing	9	6.49	0.2	-	64,680	0.57	Right-Left	340599.25	7716508.81	340492.22	7716534.16
11	Crossing	9	7.31	0.2	-	87,301	0.53	Right-Left	336623.07	7719082.03	336530.34	7719160.31
12A	Crossing	6	7.70	0.3	-	106,499	0.45	Along the road	332061.58	7721133.06	331423.87	7721109.36
12B	Crossing	6	9.80	0.2	-	128,245	0.7	Left-Right	328485.14	7723279.68	328478.75	7723419.53
12C	Crossing	6	10.9	0.3	-	148,988	0.5	Along the road	328657.17	7724757.10	329097.81	7725518.79
12D	Crossing	6	58.0	0.6	-	899,643	1.16	Along the road	329243.70	7725769.42	329596.28	7727344.09
13	Crossing	6	78.9	0.4	-	1,282,571	0.9	Right-Left	329596.28	7727344.09	329842.39	7727683.41
14	Crossing	24	16.2	0.5	-	593,801	0.6	Right-Left	330688.42	7729594.51	330737.79	7729951.02
15	Pond	12	18.1	1.3	3.16	508,988	1	Right-Left	331684.35	7733319.01	332200.19	7734787.88
16A	Crossing	12	38.6	0.5	-	460,752	1.07	Left-Right	334028.84	7740455.20	334770.53	7741999.06
16B	Crossing	12	86.4	0.6	-	1,273,021	1.86	Right-left	335864.31	7744430.88	336029.80	7744816.90
16C	Crossing	12	17.3	0.2	-	294,471	1.01	Right-left	336384.08	7749451.83	336351.05	7750020.50
16D	Crossing	12	14.2	0.1	-	242,850	1.08	Right-left	336347.86	7750140.46	336354.41	7750464.76
16E	Crossing	12	6.3	0.2	-	58,539	0.8	Right-left	336758.61	7751321.28	336768.53	7751571.09
17	Crossing	3	0.90	0.2	-	3,381	0.48	Right-left	335351.26	7755902.92	335310.23	7756029.49
18	Pond	3	53.9	2.0	2	478,583	0.34	Left-Right	336132.28	7760215.08	336496.20	7760830.53
19A	Crossing	9	7.70	0.1	-	70,566	0.33	Left-Right	333055.72	7766403.27	332997.33	7766869.63
19B	Crossing	9	49.6	0.2	-	678,897	0.7	Left-Right	334937.25	7770165.99	334307.53	7770491.33
20	Pond	6	50.8	0.2	2.04	1,098,907	0.17	Left-Right	315464.61	7775028.27	315107.43	7775054.73
21	Crossing	1	5.80	0.1	-	18,192	0.43	Right-Left	309085.57	7776208.08	308915.55	7776222.08
22	Crossing	3	22.6	0.3	-	195,009	0.41	Left-Right	287086.73	7782274.11	286763.94	7782332.32
23	Crossing	9	9.75	0.2	-	94,641	0.47	Left-Right	283008.86	7783281.22	282731.29	7783346.76
24	Crossing	9	27.0	0.2	-	329,792	0.76	Left-Right	280839.42	7784313.40	280558.30	7784511.84
25	Crossing	6	31.4	0.7	-	516,084	0.29	Left-Right	278000.49	7785467.29	277295.33	7785642.30
26	Crossing	9	28.8	0.3	-	330,782	0.84	Left-Right	272749.99	7787743.01	272235.39	7788141.90
27	Pond	9	26.6	0.4	1.89	351,732	0.74	Left-Right	269712.97	7789518.91	268601.71	7790000.45
28A	Crossing	9	20.4	0.3	-	301,472	0.47	Right-Left	261185.16	7800245.14	260915.29	7800731.97
28B	Crossing	9	24.7	0.2	-	509,636	0.53	Left-Right	260274.99	7801832.64	259851.66	7802562.89
28C	Crossing	9	36.9	0.4	-	818,690	0.6	Right-Left	259581.78	7803017.98	259243.12	7803615.94
I	Crossing	6	1.5	0.1	-	9,146	0.48	Right-Left	337213.94	7752845.96	337251.65	7753021.96
II	Crossing	9	1.3	0.1	-	14,747	0.36	Right-Left	337326.98	7753387.28	337217.65	7753700.33
III	Crossing	6	3.3	0.2	-	31,746	0.57	Right-Left	335093.79	7756889.57	335087.27	7757369.14
IV	Crossing	9	5.9	0.1	-	62,205	0.42	Right-Left	329462.01	7769708.91	328983.12	7769935.99
V	Crossing	9	4.5	0.1	-	44,942	0.62	Right-Left	328052.45	7770377.30	327709.09	7770540.12

10% AEP Maximum Modelled Results												
Location	Type	Critical Duration (hs)	Peak Flow (m^3/s)	Maximum Depth at Crossing (m)	Maximum Pond Depth (m)	Reporting Volume (m^3)	Maximum Flow Velocity (m/s)	Relative Direction of Flow	Starting Coordinates		Ending Coordinates	
									Easting (m)	Northing (m)	Easting (m)	Northing (m)
VI	Crossing	9	8.0	0.2	-	104,198	0.70	Left-Right	329358.85	7772437.81	329023.53	7772463.20
VII	Crossing	6	0.9	0.1	-	6,129	0.49	Left-Right	327954.14	7772154.4	327740.32	7772099.08
VIII	Crossing	6	1.6	0.1	-	8,648	0.64	Left-Right	327221.78	7771873.21	327084.2	7771783.25
IX	Crossing	9	1.0	0.2	-	7,085	0.12	Left-Right	304853.86	7776810.34	304541.65	7776889.72
X	Crossing	9	1.1	0.2	-	9,447	0.16	Left-Right	298392.73	7778445.47	298048.77	7778673.02
XI	Crossing	9	4.5	0.2	-	49,037	0.45	Left-Right	276331.72	7785901.45	275807.85	7786044.32
XII	Pond	9	2.1	0.4	0.51	10,936	0.08	Along the road	266198.16	7791404.79	265891.24	7791828.12

5% AEP Maximum Modelled Results												
Location	Type	Critical Duration (hs)	Peak Flow (m^3/s)	Maximum Depth at Crossing (m)	Maximum Pond Depth (m)	Reporting Volume (m^3)	Maximum Flow Velocity (m/s)	Relative Direction of Flow	Starting Coordinates		Ending Coordinates	
									Easting (m)	Northing (m)	Easting (m)	Northing (m)
1A	Pond	9	11.8	1.9	1.10	202,998	0.10	Right-Left	377653.27	7704024.32	377105.79	7704293.33
1B	Pond	9	3.92	0.6	0.94	41,838	0.03	Left-Right	374953.97	7704586.05	374505.96	7704808.06
2	Pond	9	3.94	0.4	0.89	40,087	0.01	Left-Right	373762.26	7705176.59	373380.41	7705350.71
3	Pond	12	1.50	0.2	0.97	33,722	0.16	Left-Right	371160.929	7706150.13	371027.049	7706144.84
4	Pond	9	0.29	0.5	0.81	2,776	0.07	Left-Right	369423.945	7706321.95	369173.516	7706395.38
5	Pond	12	9.56	1.1	1.22	142,933	0.06	Along the road	365493.81	7707128.05	364833.83	7707389.75
6	Crossing	1	33.5	0.3	-	148,596	1.20	Left-Right	359798.163	7709926.19	359732.017	7710119.34
7A	Crossing	9	7.71	0.2	-	67,127	0.80	Along the road	359304.185	7710828.79	359156.15	7710920.87
7B	Crossing	9	8.13	0.5	-	85,704	0.65	Along the road	360571.846	7710665.16	359297.081	7710928.69
7C	Pond	9	9.43	1.0	1.12	107,284	0.30	Along the road	361419.573	7710481.01	360660.746	7710649.29
8	Pond	12	17.9	2.7	2.61	270,041	0.80	Right-Left	353978.38	7712362.44	348923.26	7713941.66
9	Pond	6	15.04	0.5	0.66	336,410	0.55	Right-Left	344040.81	7715641.49	343118.23	7715906.58
10A	Crossing	12	31.13	0.3	-	260,352	0.80	Right-Left	341144.18	7716379.73	340881.45	7716441.96
10B	Crossing	12	10.53	0.2	-	95,768	0.70	Right-Left	340599.25	7716508.81	340492.22	7716534.16
11	Crossing	6	13.1	0.2	-	152,748	0.70	Right-Left	336623.07	7719082.03	336530.34	7719160.31
12A	Crossing	6	10.9	0.4	-	159,678	0.51	Along the road	332061.58	7721133.06	331423.87	7721109.36
12B	Crossing	6	13.5	0.2	-	192,611	0.75	Left-Right	328485.14	7723279.68	328478.75	7723419.53
12C	Crossing	6	14.6	0.3	-	219,483	0.55	Along the road	328657.17	7724757.10	329097.81	7725518.79
12D	Crossing	6	69.5	0.7	-	1,062,408	1.50	Along the road	329243.70	7725769.42	329596.28	7727344.09
13	Crossing	6	142	0.5	-	2,435,783	1.20	Right-Left	329596.28	7727344.09	329842.39	7727683.41
14	Crossing	12	33.2	0.6	-	2,496,023	0.70	Right-Left	330688.42	7729594.51	330737.79	7729951.02
15	Pond	12	37.4	2.3	4.13	1,189,497	1.20	Right-Left	331684.35	7733319.01	332200.19	7734787.88
16A	Crossing	18	71.0	0.6	-	983,299	1.50	Left-Right	334028.84	7740455.20	334770.53	7741999.06
16B	Crossing	18	172	0.8	-	2,717,245	2.30	Right-left	335864.31	7744430.88	336029.80	7744816.90
16C	Crossing	18	33.5	0.4	-	616,041	1.40	Right-left	336384.08	7749451.83	336351.05	7750020.50
16D	Crossing	18	26.0	0.4	-	532,270	1.25	Right-left	336347.86	7750140.46	336354.41	7750464.76
16E	Crossing	18	9.84	0.3	-	126,463	1.10	Right-left	336758.61	7751321.28	336768.53	7751571.09
17	Crossing	3	1.18	0.3	-	3,966	0.51	Right-left	335351.26	7755902.92	335310.23	7756029.49
18	Pond	12	37.6	2.3	2.33	671,198	0.15	Left-Right	336132.28	7760215.08	336496.20	7760830.53
19A	Crossing	9	17.2	0.1	-	167,365	0.45	Left-Right	333055.72	7766403.27	332997.33	7766869.63
19B	Crossing	9	139	0.3	-	1,586,945	0.97	Left-Right	334937.25	7770165.99	334307.53	7770491.33
20	Pond	12	86.6	0.5	2.42	1,772,042	0.13	Left-Right	315464.61	7775028.27	315107.43	7775054.73
21	Crossing	1	7.05	0.1	-	21,514	0.45	Right-Left	309085.57	7776208.08	308915.55	7776222.08
22	Crossing	3	29.7	0.3	-	238,232	0.44	Left-Right	287086.73	7782274.11	286763.94	7782332.32
23	Crossing	9	15.5	0.3	-	165,004	0.60	Left-Right	283008.86	7783281.22	282731.29	7783346.76
24	Crossing	9	55.0	0.3	-	665,057	0.95	Left-Right	280839.42	7784313.40	280558.30	7784511.84
25	Crossing	6	50.5	0.7	-	871,594	0.35	Left-Right	278000.49	7785467.29	277295.33	7785642.30
26	Crossing	12	51.8	0.3	-	680,407	1.00	Left-Right	272749.99	7787743.01	272235.39	7788141.90
27	Pond	9	53.5	0.8	2.27	657,667	0.85	Left-Right	269712.97	7789518.91	268601.71	7790000.45
28A	Crossing	9	41.2	0.4	-	542,541	0.60	Right-Left	261185.16	7800245.14	260915.29	7800731.97
28B	Crossing	9	47.5	0.3	-	877,466	0.65	Left-Right	260274.99	7801832.64	259851.66	7802562.89
28C	Crossing	9	80.1	0.6	-	1,476,955	0.80	Right-Left	259581.78	7803017.98	259243.12	7803615.94
I	Crossing	6	2.5	0.09	-	28,479	0.58	Right-Left	337213.94	7752845.96	337251.65	7753021.96
II	Crossing	6	2.3	0.11	-	19,936	0.45	Right-Left	337326.98	7753387.28	337217.65	7753700.33
III	Crossing	6	6.1	0.24	-	87,410	0.66	Right-Left	335093.79	7756889.57	335087.27	7757369.14
IV	Crossing	6	9.6	0.10	-	108,907	0.49	Right-Left	329462.01	7769708.91	328983.12	7769935.99
V	Crossing	6	8.3	0.13	-	74,590	0.74	Right-Left	328052.45	7770377.30	327709.09	7770540.12

5% AEP Maximum Modelled Results												
Location	Type	Critical Duration (hs)	Peak Flow (m^3/s)	Maximum Depth at Crossing (m)	Maximum Pond Depth (m)	Reporting Volume (m^3)	Maximum Flow Velocity (m/s)	Relative Direction of Flow	Starting Coordinates		Ending Coordinates	
									Easting (m)	Northing (m)	Easting (m)	Northing (m)
VI	Crossing	9	13.9	0.30	-	183,360	0.83	Left-Right	329358.85	7772437.81	329023.53	7772463.20
VII	Crossing	6	2.4	0.16	-	12,093	0.59	Left-Right	327954.14	7772154.4	327740.32	7772099.08
VIII	Crossing	6	3.4	0.11	-	16,013	0.80	Left-Right	327221.78	7771873.21	327084.2	7771783.25
IX	Crossing	6	1.4	0.21	-	10,589	0.13	Left-Right	304853.86	7776810.34	304541.65	7776889.72
X	Crossing	6	1.6	0.17	-	14,216	0.19	Left-Right	298392.73	7778445.47	298048.77	7778673.02
XI	Crossing	12	6.8	0.20	-	85,541	0.56	Left-Right	276331.72	7785901.45	275807.85	7786044.32
XII	Pond	18	1.7	0.60	0.66	21,140	0.12	Along the road	266198.16	7791404.79	265891.24	7791828.12



LEGEND

- Crossing Locations
- Additional Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments
- Additional Catchments

Flood Depth (m)

- < 0.10 m (Cut-off depth)
- 0.10 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 - 1.0 m
- 1.0 m - 1.5 m
- 1.5 m - 2.0 m
- 2.0 m - 2.5 m
- 2.5 m - 3.5 m
- 3.5 m - 5.0 m
- 5.0 m - 7.5 m

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri

CLIENT
RIO TINTO

PROJECT
WINU PROJECT
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT
GOLDER

DD-MM-YYYY	7/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
MAXIMUM FLOOD DEPTH - 5% AEP STORM EVENT MINOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A1

PATH: H:\20136763 - Rio Tinto 2020 Water Studies Winu\Figures\Figures\Figure B1 - Depth - 5% AEP Results - Small Catch.mxd PRINTED ON: 2020-08-07 AT: 3:08:11 PM

LEGEND

- Crossing Locations
- Additional Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments
- Additional Catchments

Flood Velocity (m/s)

- < 0.3 m/s (Cut-off velocity)
- 0.30 m/s - 0.40 m/s
- 0.40 m/s - 0.50 m/s
- 0.50 m/s - 0.75 m/s
- 0.75 m/s - 1.00 m/s
- 1.00 m/s - 1.25 m/s
- 1.25 m/s - 1.50 m/s
- 1.50 m/s - 1.75 m/s
- 1.75 m/s - 2.0 m/s
- 2.0 m/s - 2.5 m/s

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri

CLIENT	PROJECT
RIO TINTO	WINU PROJECT UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT

GOLDER

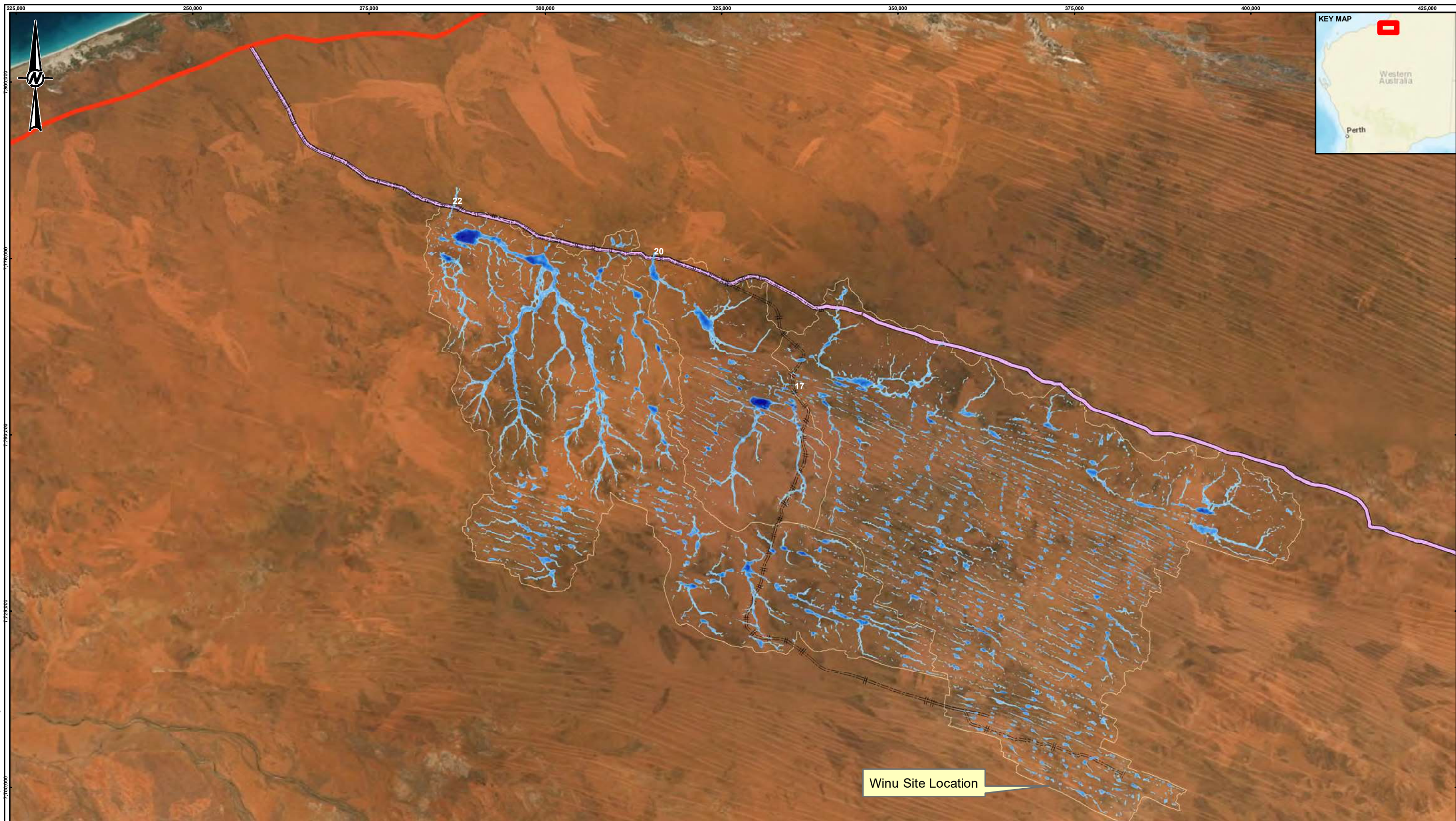
DD-MM-YYYY	7/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
MAXIMUM FLOOD VELOCITY - 5% AEP STORM EVENT MINOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A2

PATH: H:\20136763 - Rio Tinto 2020 Water Studies Winu\Figures\Figures\Figure B2 - Velocity - 5% AEP Results - Small Catch.mxd PRINTED ON: 2020-08-07 AT: 3:09:59 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED



LEGEND

- Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments

Flood Depth (m)

- < 0.10 m (Cut-off depth)
- 0.10 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 - 1.0 m
- 1.0 m - 1.5 m
- 1.5 m - 2.0 m
- 2.0 m - 2.5 m
- 2.5 m - 3.5 m
- 3.5 m - 5.0 m
- 5.0 m - 7.5 m

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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PROJECT
WINU PROJECT
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

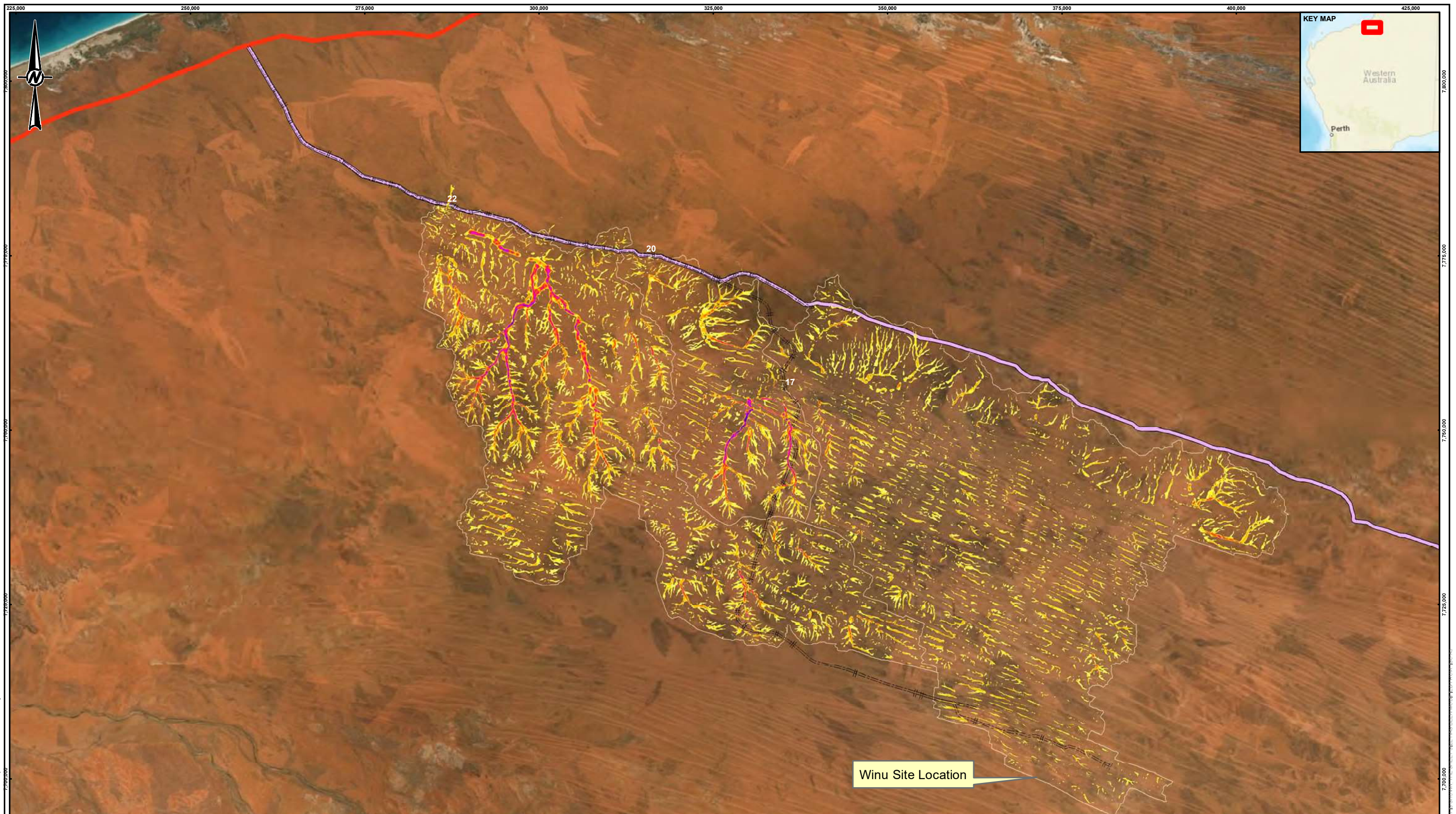
CONSULTANT
GOLDER

DD-MM-YYYY	06/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
MAXIMUM FLOOD DEPTH - 5% AEP STORM EVENT MAJOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A3

PATH: H:\20136763 - Rio Tinto 2020 Water Studies Winu\Figures\Figures\Figure A3 - Depth - 5% AEP Results - Large Catch.mxd PRINTED ON: 2020-08-26 AT: 2:49:54 PM



LEGEND

- Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments

Flood Velocity (m/s)

- < 0.3 m/s (Cut-off velocity)
- 0.30 m/s - 0.40 m/s
- 0.40 m/s - 0.50 m/s
- 0.50 m/s - 0.75 m/s
- 0.75 m/s - 1.00 m/s
- 1.00 m/s - 1.25 m/s
- 1.25 m/s - 1.50 m/s
- 1.50 m/s - 1.75 m/s
- 1.75 m/s - 2.0 m/s
- 2.0 m/s - 2.5 m/s

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

CLIENT
RIO TINTO

PROJECT
WINU PROJECT
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

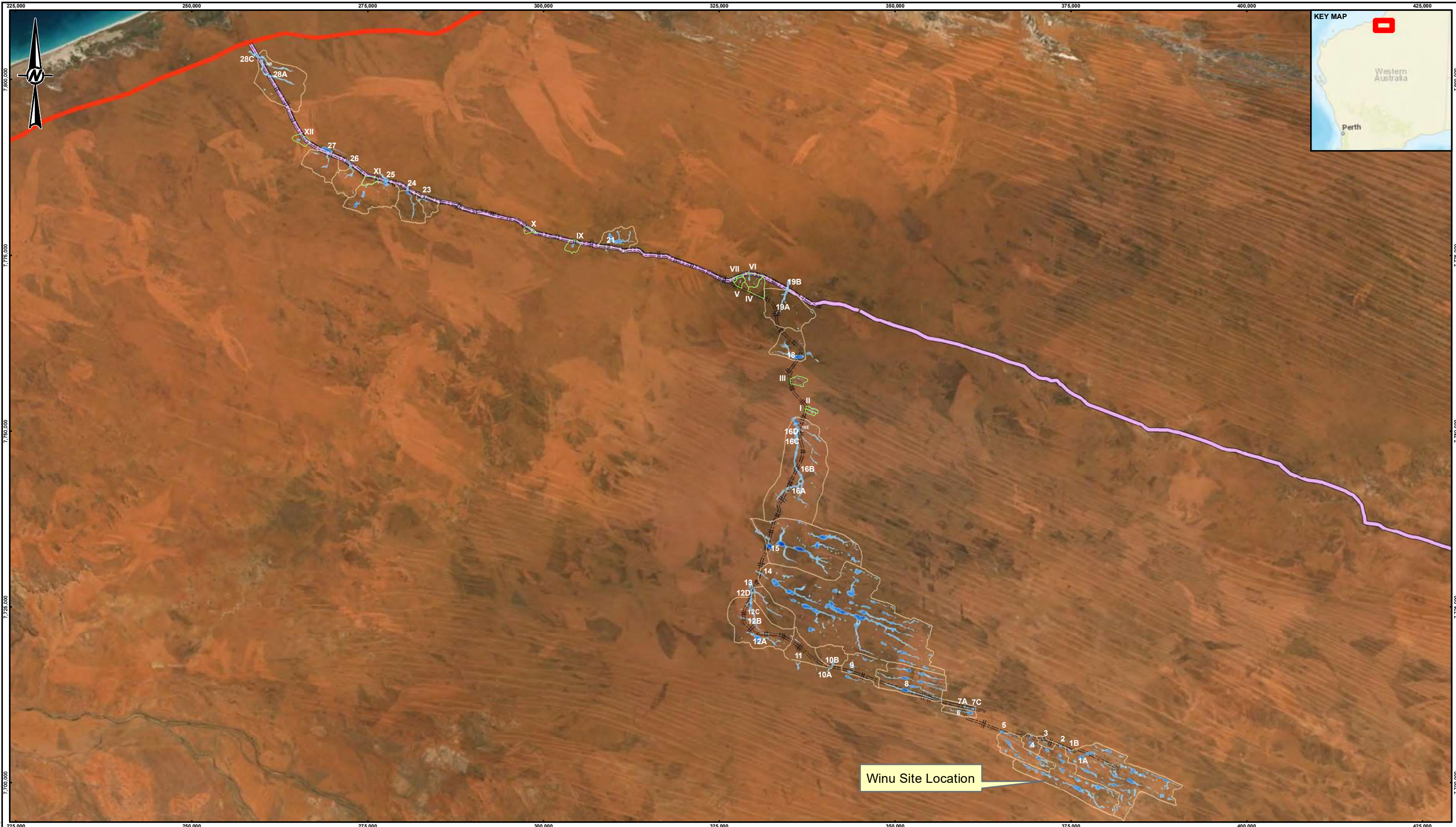
CONSULTANT
GOLDER

DD-MM-YYYY	06/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
MAXIMUM FLOOD VELOCITY - 5% AEP STORM EVENT MAJOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A4

PATH: H:\20136763 - Rio Tinto 2020 Water Studies Winu\Figures\Figures\Figure A4 - Velocity - 5% AEP Results - Large Catch.mxd PRINTED ON: 2020-06-26 AT: 4:01:00 PM



LEGEND

- Crossing Locations
- Additional Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments
- Additional Catchments

Flood Depth (m)

- < 0.10 m (Cut-off depth)
- 0.10 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 - 1.0 m
- 1.0 m - 1.5 m
- 1.5 m - 2.0 m
- 2.0 m - 2.5 m
- 2.5 m - 3.5 m
- 3.5 m - 5.0 m
- 5.0 m - 7.5 m

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri

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RIO TINTO

PROJECT
WINU PROJECT
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT
GOLDER

DD-MM-YYYY	7/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
MAXIMUM FLOOD DEPTH - 10% AEP STORM EVENT MINOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A5

LEGEND

- Crossing Locations
- Additional Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments
- Additional Catchments

Flood Velocity (m/s)

- < 0.3 m/s (Cut-off velocity)
- 0.30 m/s - 0.40 m/s
- 0.40 m/s - 0.50 m/s
- 0.50 m/s - 0.75 m/s
- 0.75 m/s - 1.00 m/s
- 1.00 m/s - 1.25 m/s
- 1.25 m/s - 1.50 m/s
- 1.50 m/s - 1.75 m/s
- 1.75 m/s - 2.0 m/s
- 2.0 m/s - 2.5 m/s

FOR DISCUSSION PURPOSES ONLY
DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri

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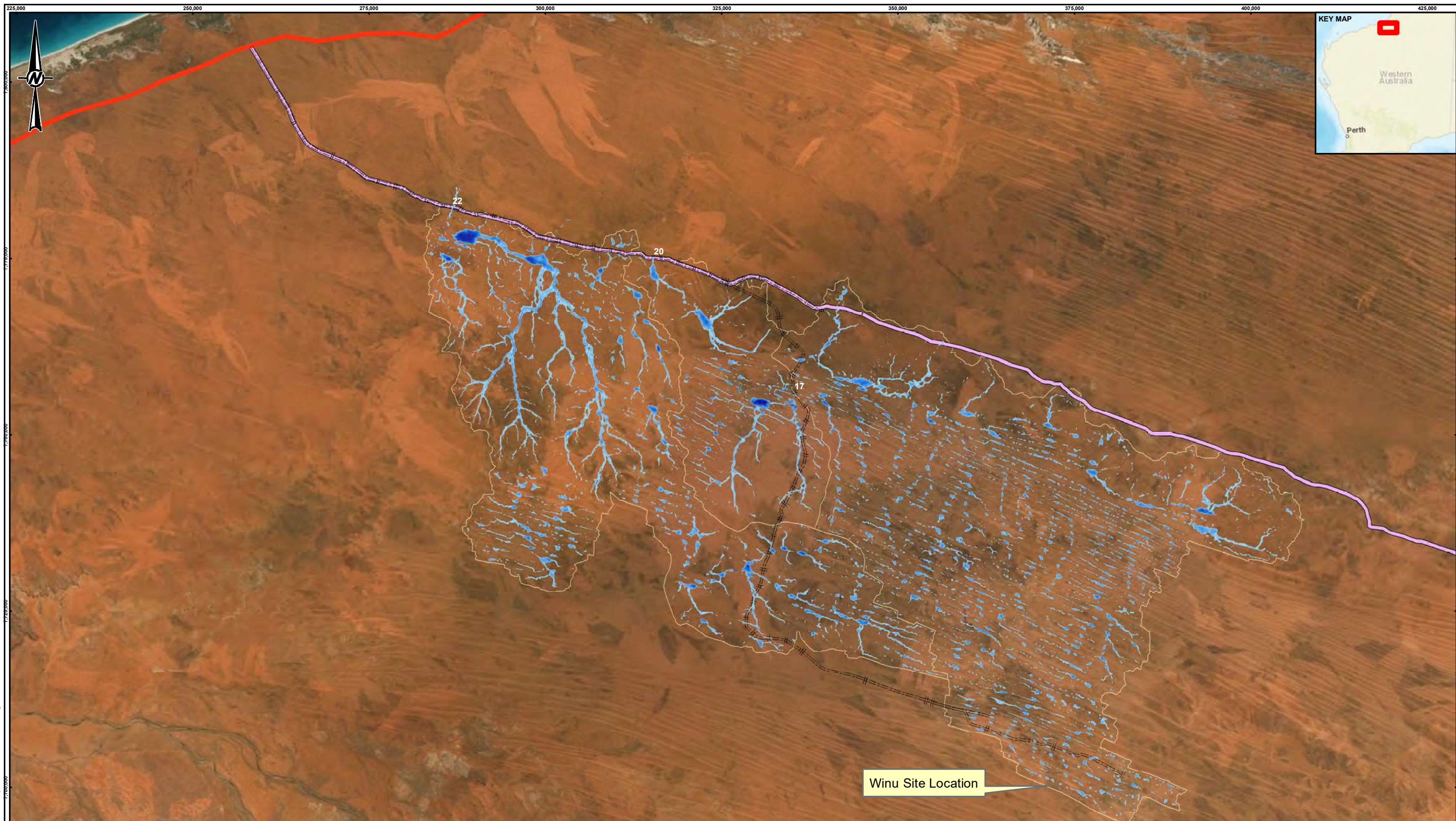
PROJECT
WINU PROJECT
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT
GOLDER

DD-MM-YYYY	7/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
MAXIMUM FLOOD VELOCITY - 10% AEP STORM EVENT MINOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A6



LEGEND

- Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments

Flood Depth (m)

- < 0.10 m (Cut-off depth)
- 0.10 m - 0.25 m
- 0.25 m - 0.50 m
- 0.50 - 1.0 m
- 1.0 m - 1.5 m
- 1.5 m - 2.0 m
- 2.0 m - 2.5 m
- 2.5 m - 3.5 m
- 3.5 m - 5.0 m
- 5.0 m - 7.5 m

FOR DISCUSSION PURPOSES ONLY
DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

CLIENT
RIO TINTO

PROJECT
WINU PROJECT
SUPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

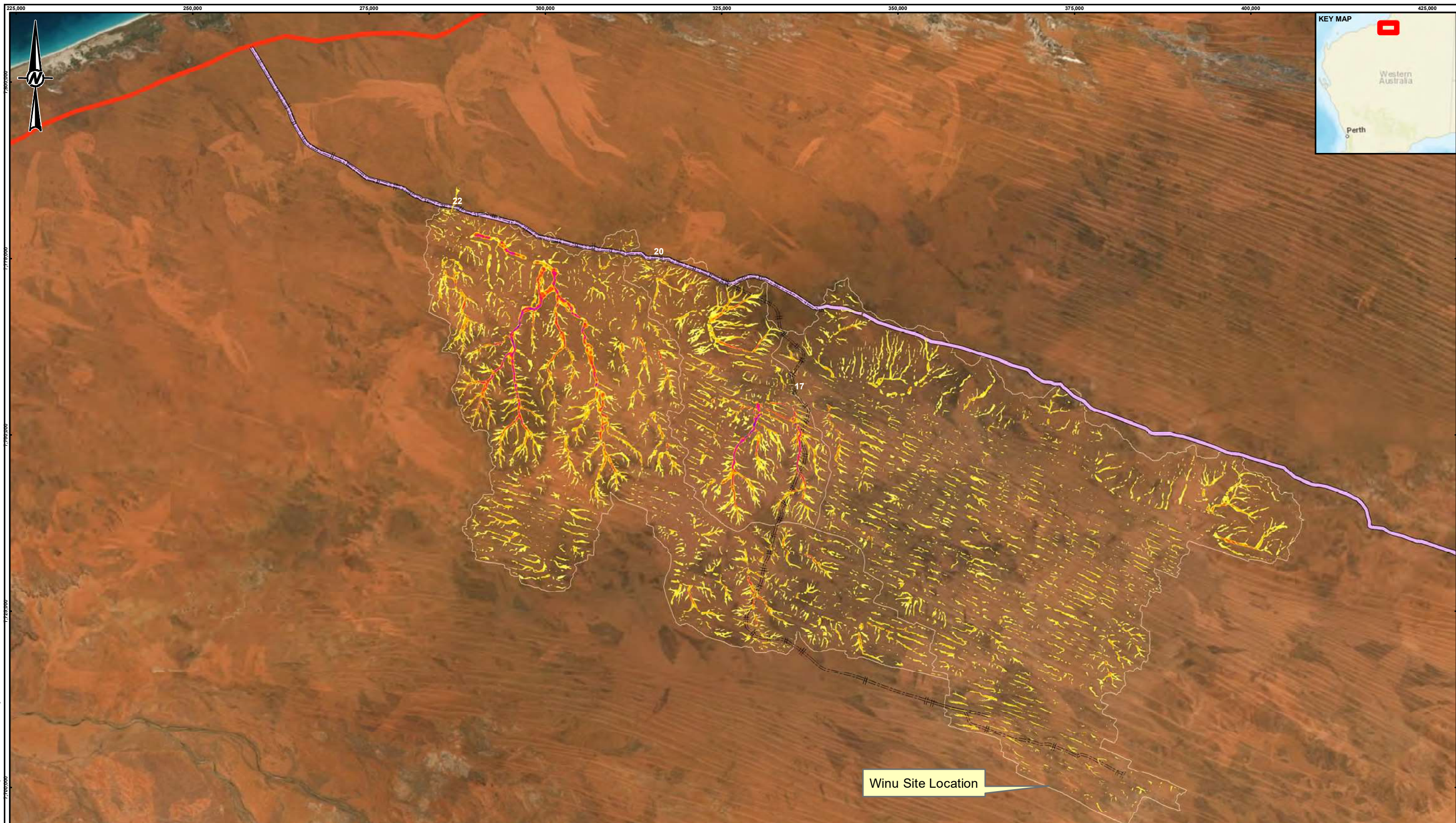
CONSULTANT
GOLDER

DD-MM-YYYY	06/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
MAXIMUM FLOOD DEPTH - 10% AEP STORM EVENT MAJOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A7

PATH: H:\20136763 - Rio Tinto 2020 Water Studies Winu\Figures\Figures\Figure A 7 - Depth - 10% AEP Results - Large Catch.mxd PRINTED ON: 2020-08-20 AT: 2:35:06 PM



LEGEND

- Crossing Locations
- Great Northern Highway
- Nyangumarta Highway
- Winu Road Alignment
- Access Road Crossing Catchments

Flood Velocity (m/s)

- < 0.3 m/s (Cut-off velocity)
- 0.30 m/s - 0.40 m/s
- 0.40 m/s - 0.50 m/s
- 0.50 m/s - 0.75 m/s
- 0.75 m/s - 1.00 m/s
- 1.00 m/s - 1.25 m/s
- 1.25 m/s - 1.50 m/s
- 1.50 m/s - 1.75 m/s
- 1.75 m/s - 2.0 m/s
- 2.0 m/s - 2.5 m/s

FOR DISCUSSION PURPOSES ONLY

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Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20
1:525,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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PROJECT
WINU PROJECT
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT
GOLDER

DD-MM-YYYY	06/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

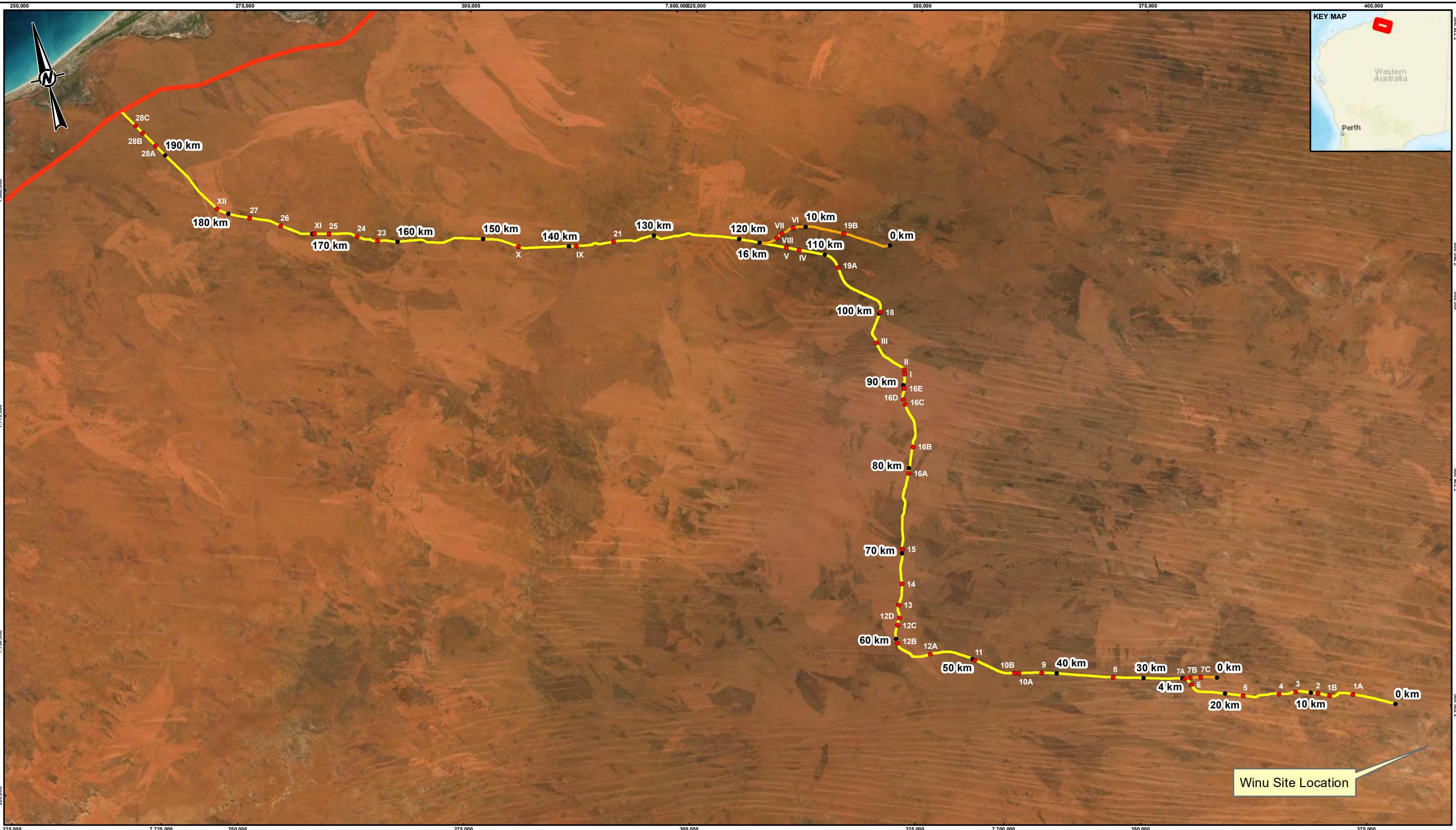
TITLE
MAXIMUM FLOOD VELOCITY - 10% AEP STORM EVENT
MAJOR CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	A8

PATH: H:\20136763 - Rio Tinto 2020 Water Studies Winu\Figures\Figures\Figure A8 - Velocity - 10% AEP Results - Largel Catch1.mxd PRINTED ON: 2020-06-26 AT: 4:07:15 PM

APPENDIX B

Access Road Alignment Long Section



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LEGEND

- Crossing Locations
- Great Northern Highway
- Main Alignment (Winu Access Road and Nyangumarta Highway)
- Minor Road Branches

FOR DISCUSSION PURPOSES ONLY

DRAFT

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

0 7.5 15

1:425,000 @ A3 KILOMETRES

NOTE(S)

REFERENCE(S)
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri

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RIO TINTO

PROJECT
WINU WATER STUDIES
UPDATED FLOOD RISK ASSESSMENT - ACCESS ROUTE

CONSULTANT

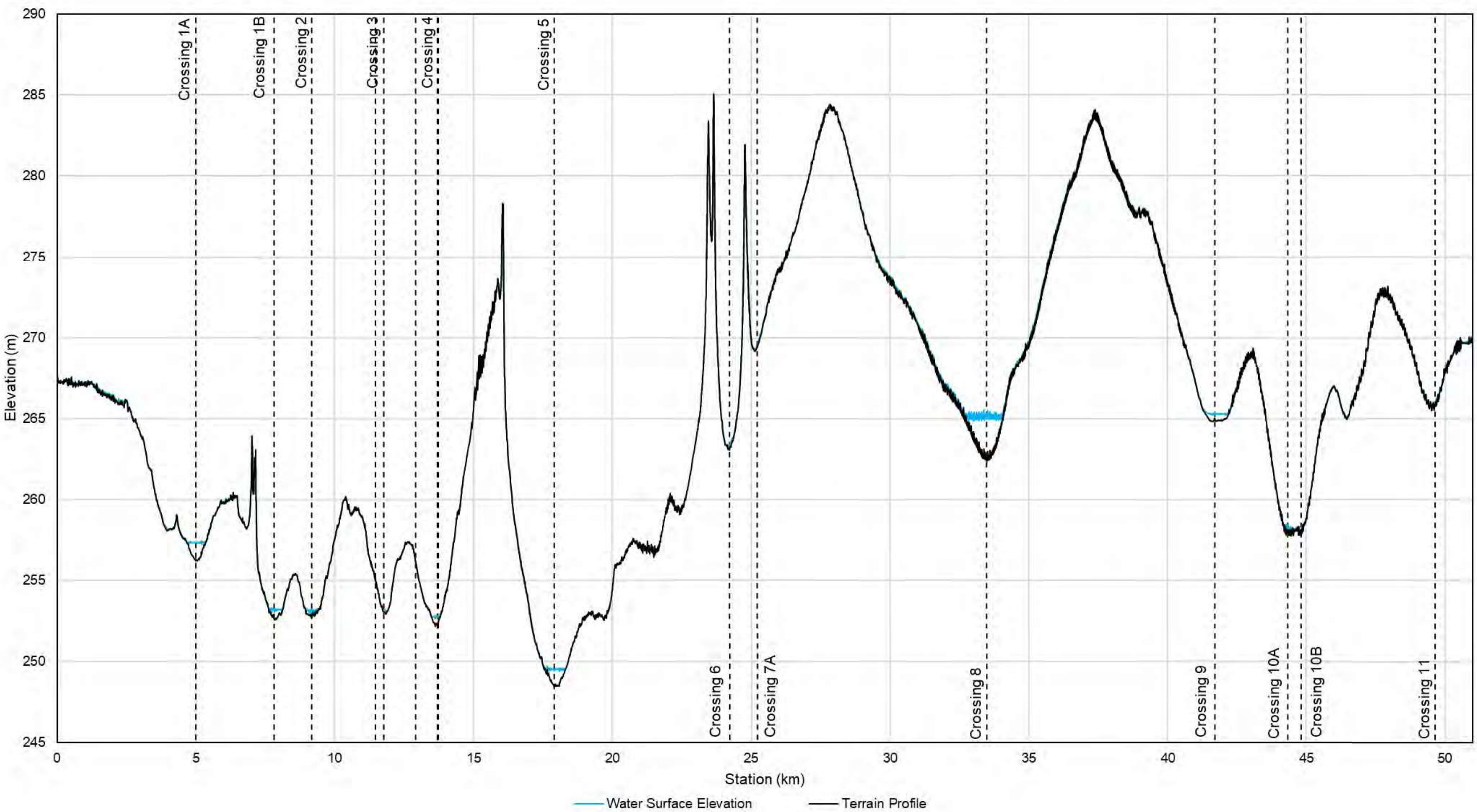
GOLDER

DD-MM-YYYY	6/08/2020
DESIGNED	MN
PREPARED	MN
REVIEWED	MG
APPROVED	MG

TITLE
ACCESS ROAD CHAINAGE MAP

PROJECT NO.	CONTROL	REV.	FIGURE
20136763	023 - Part A	0	B1

Main Alignment



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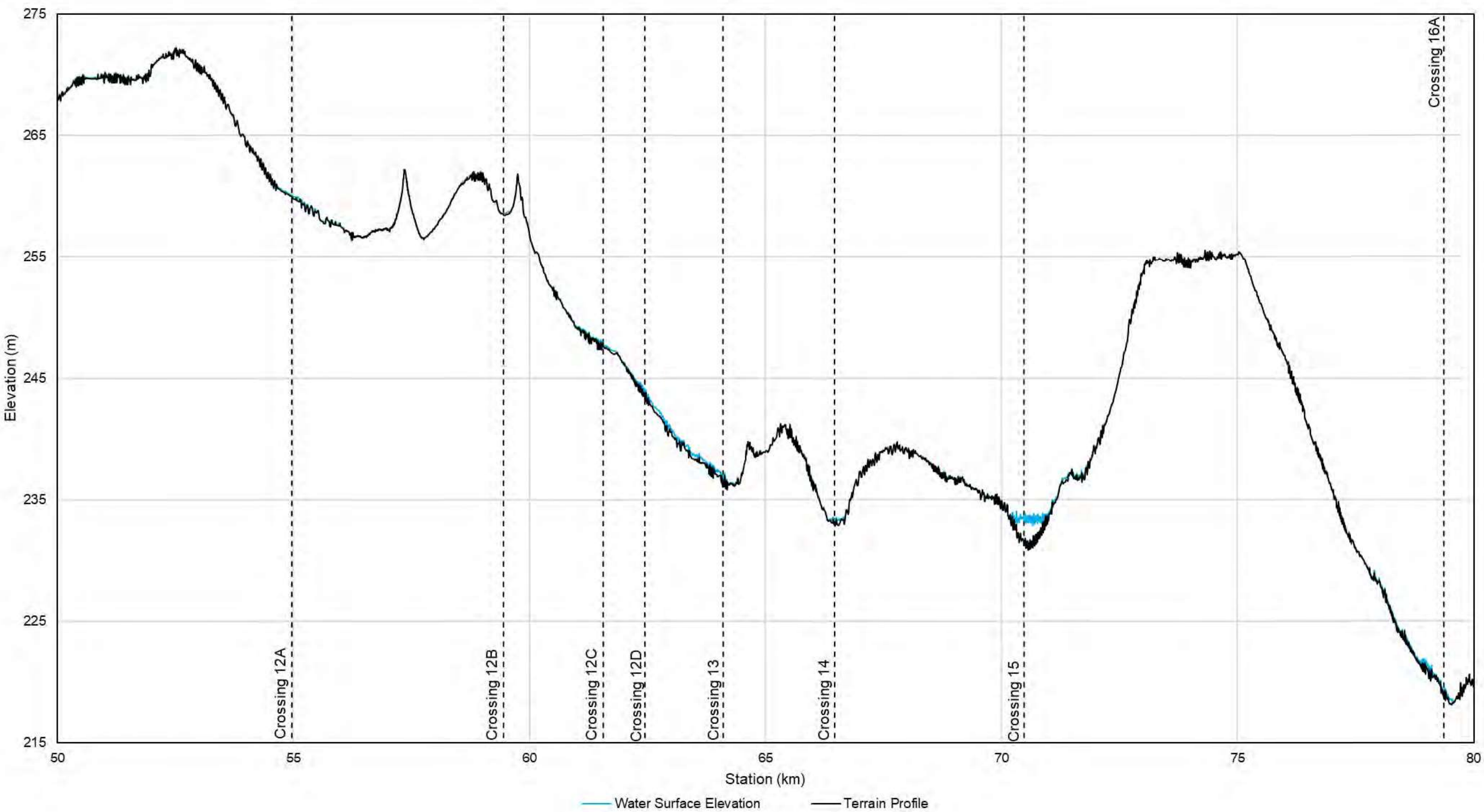
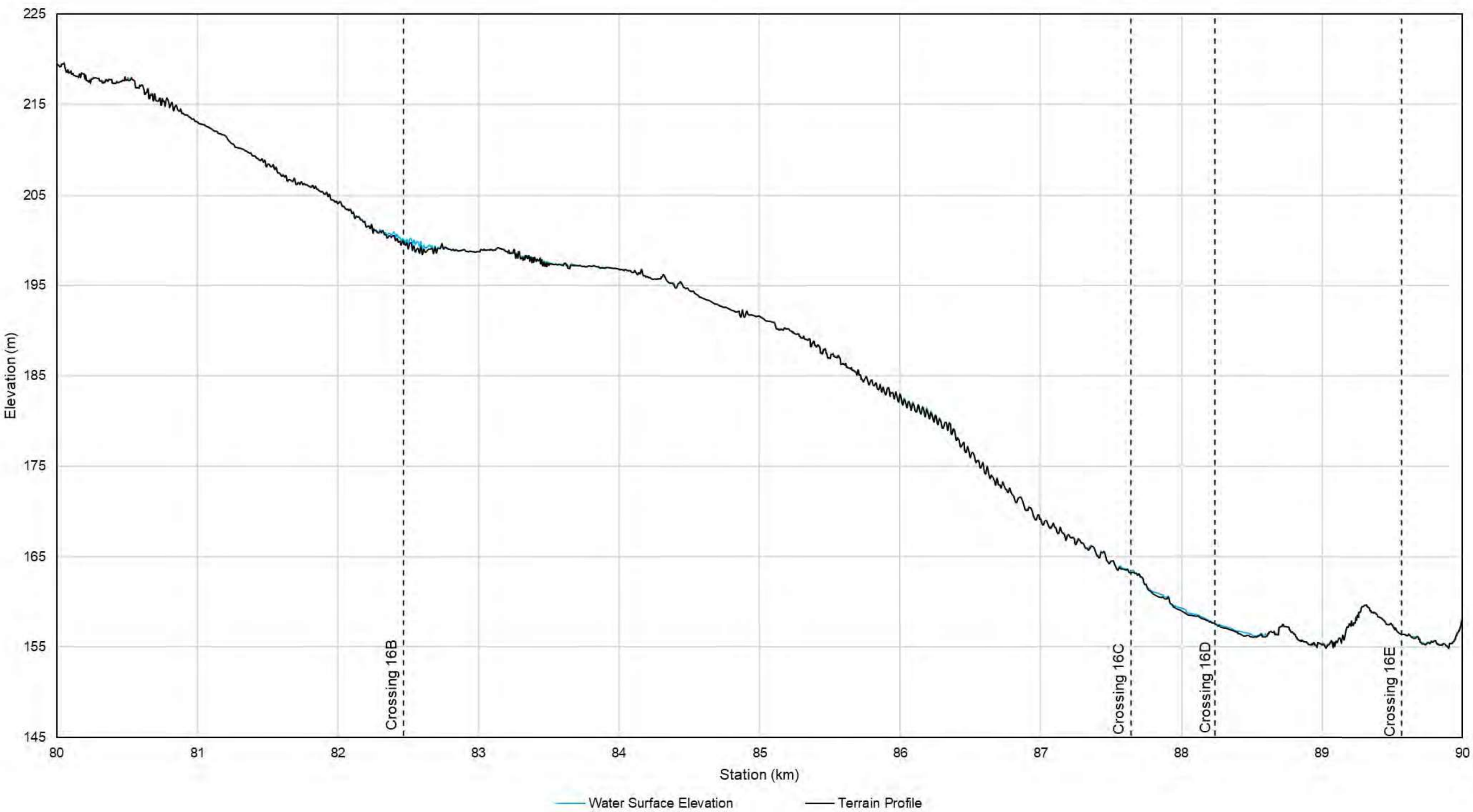
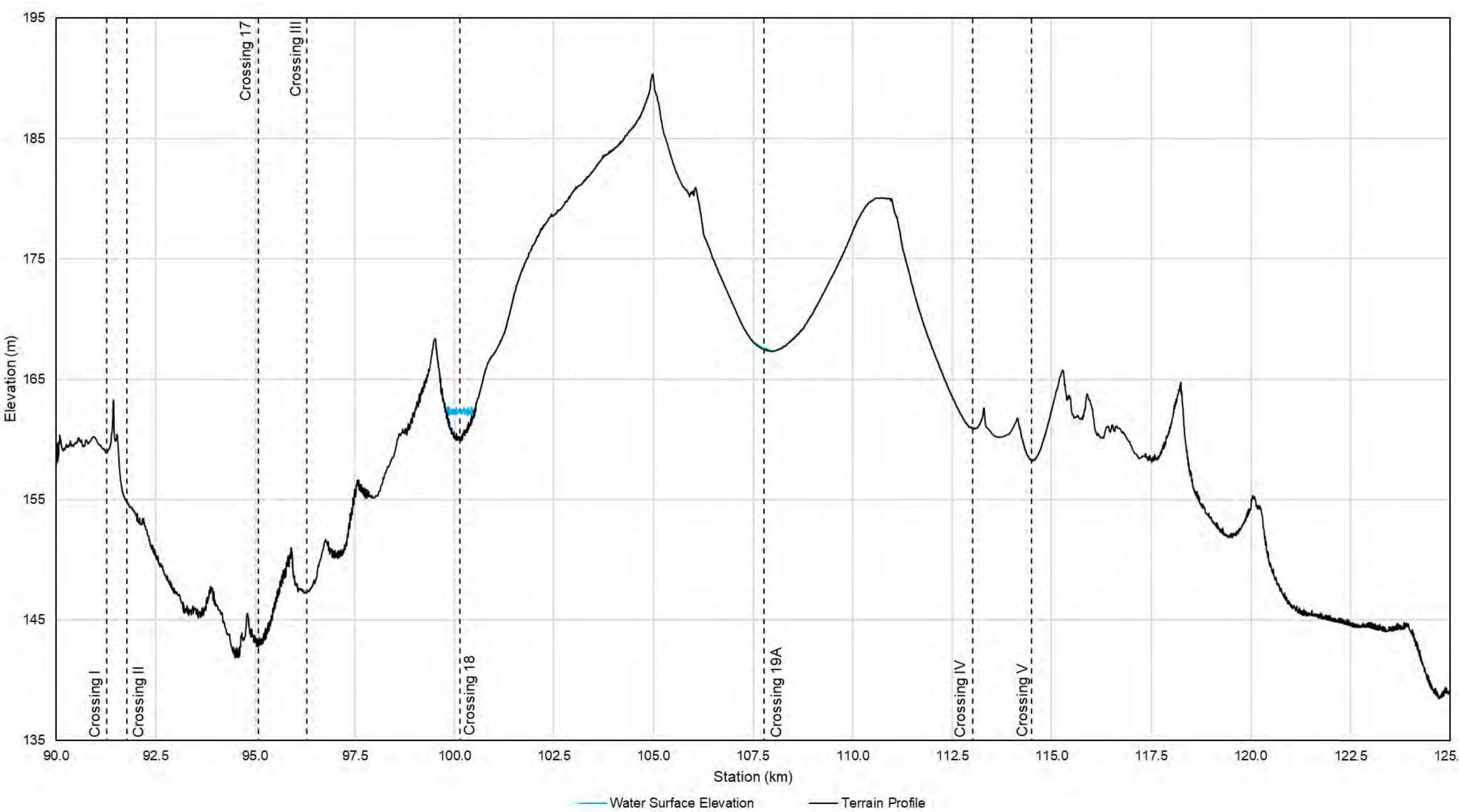


Main Alignment



Main Alignment



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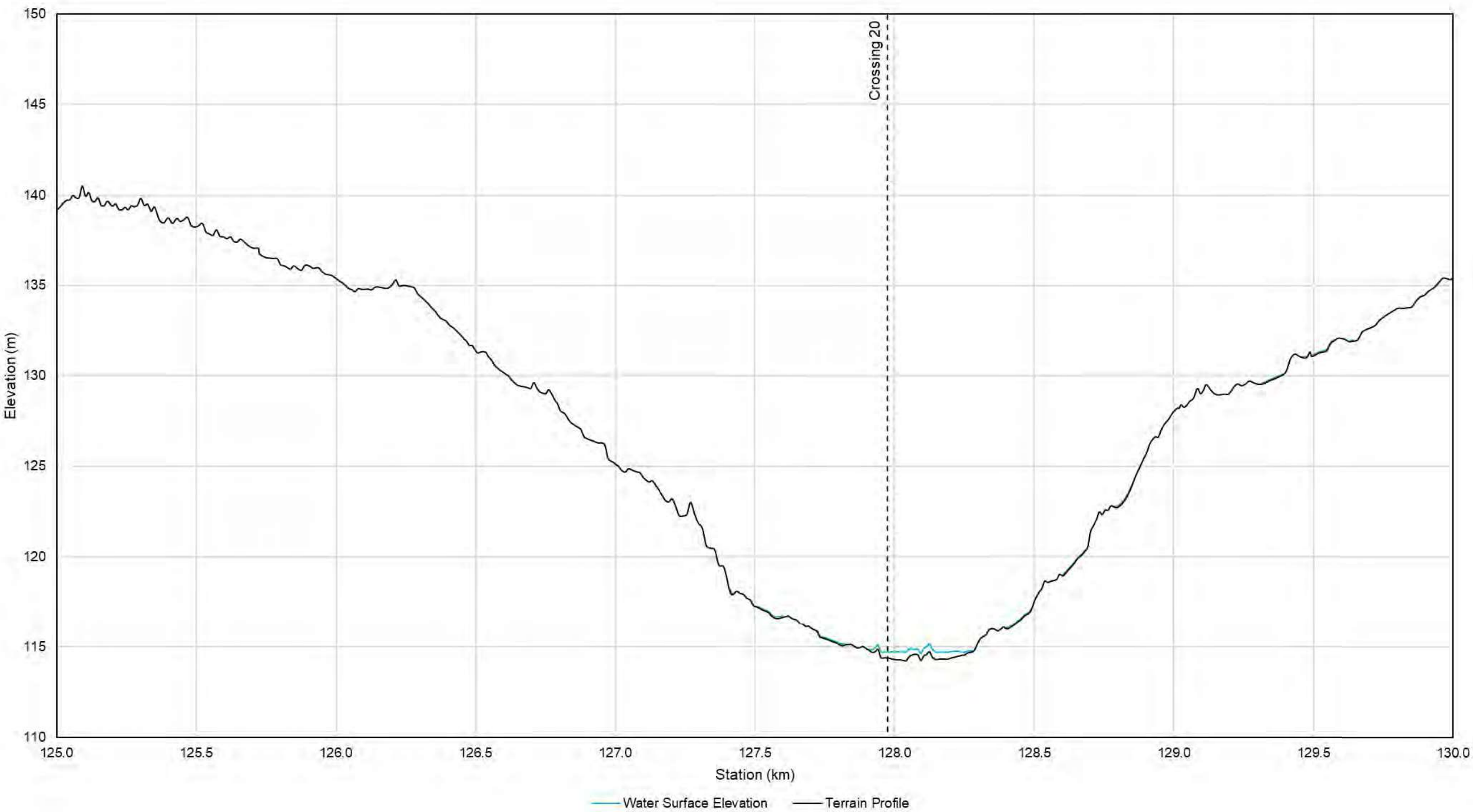
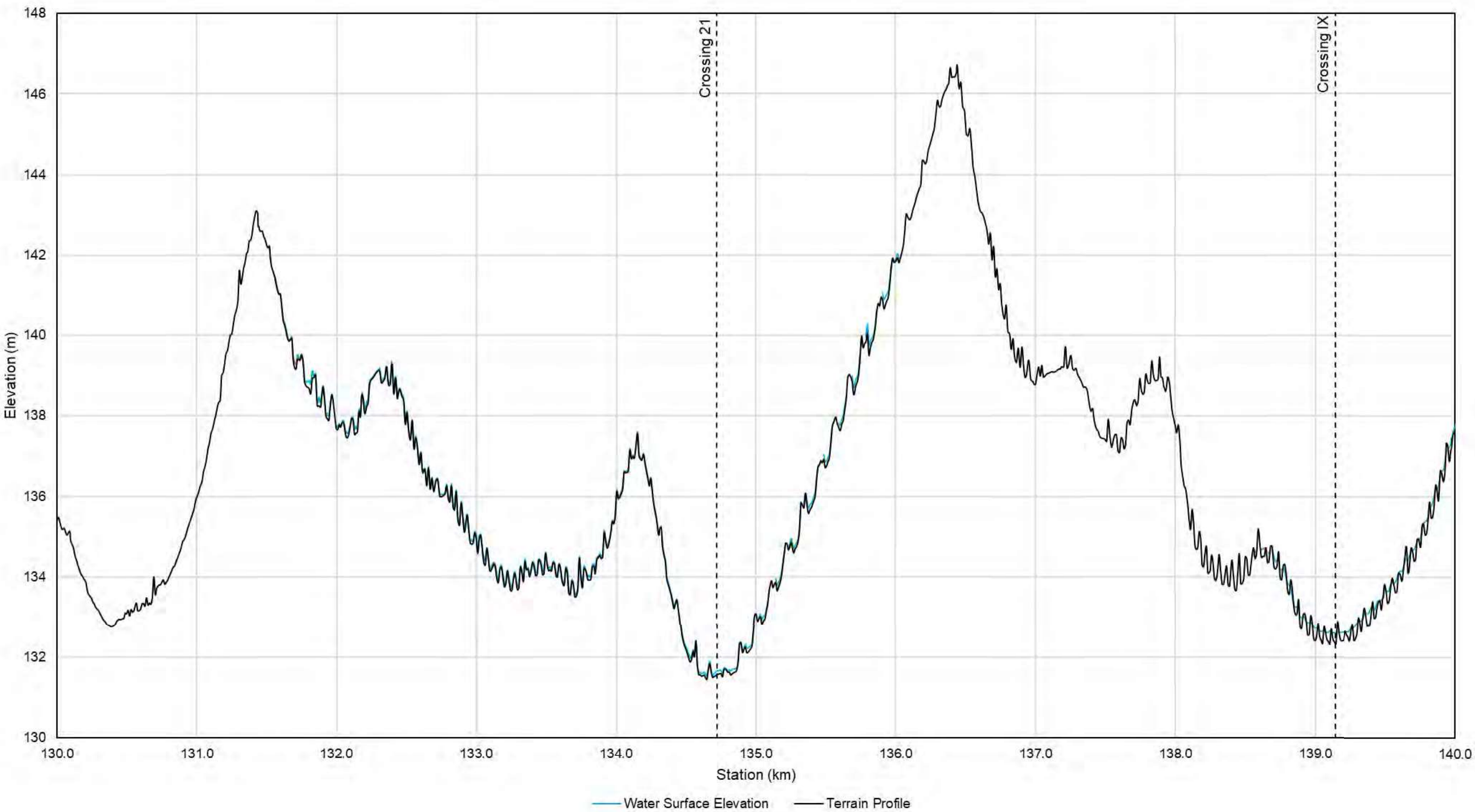
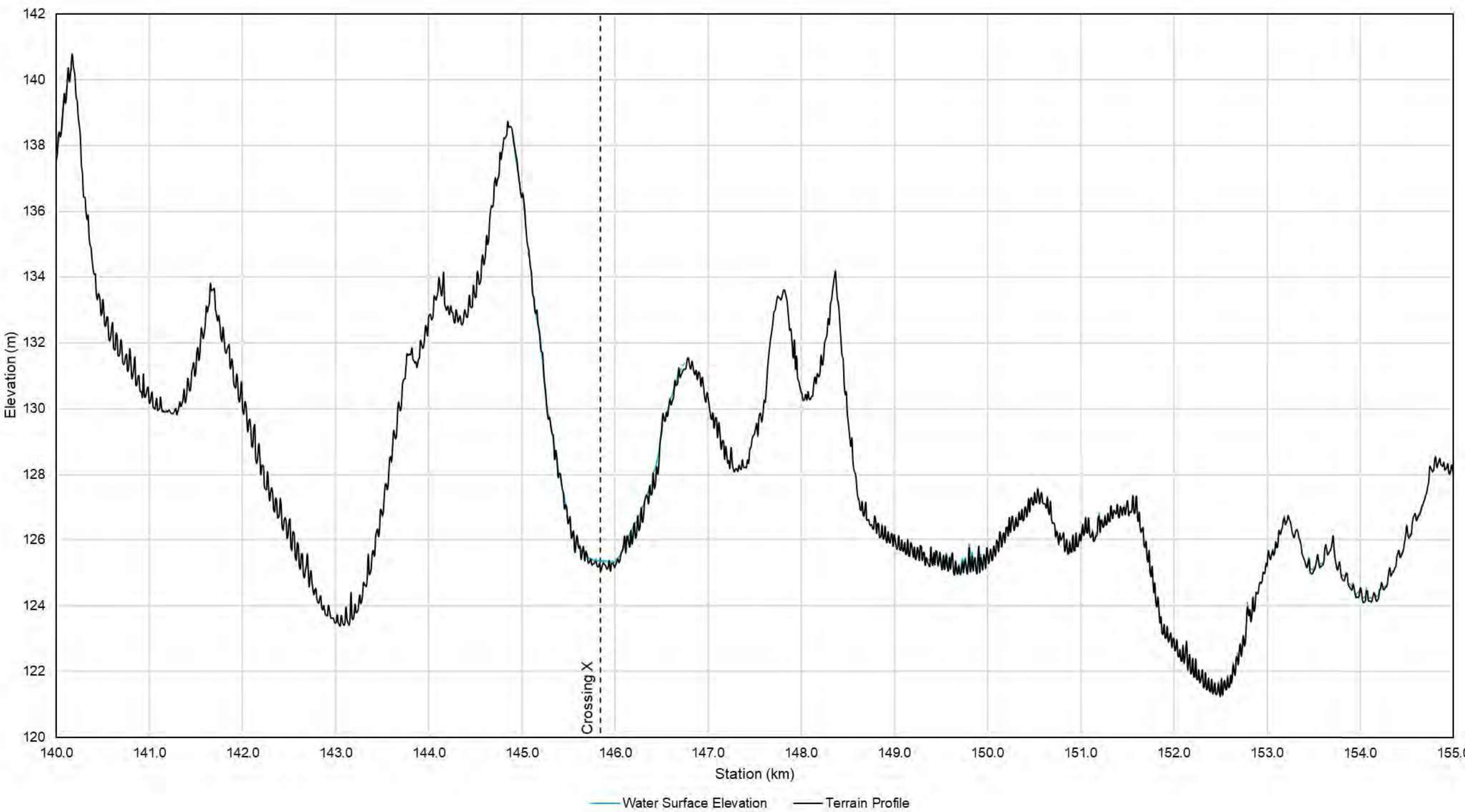


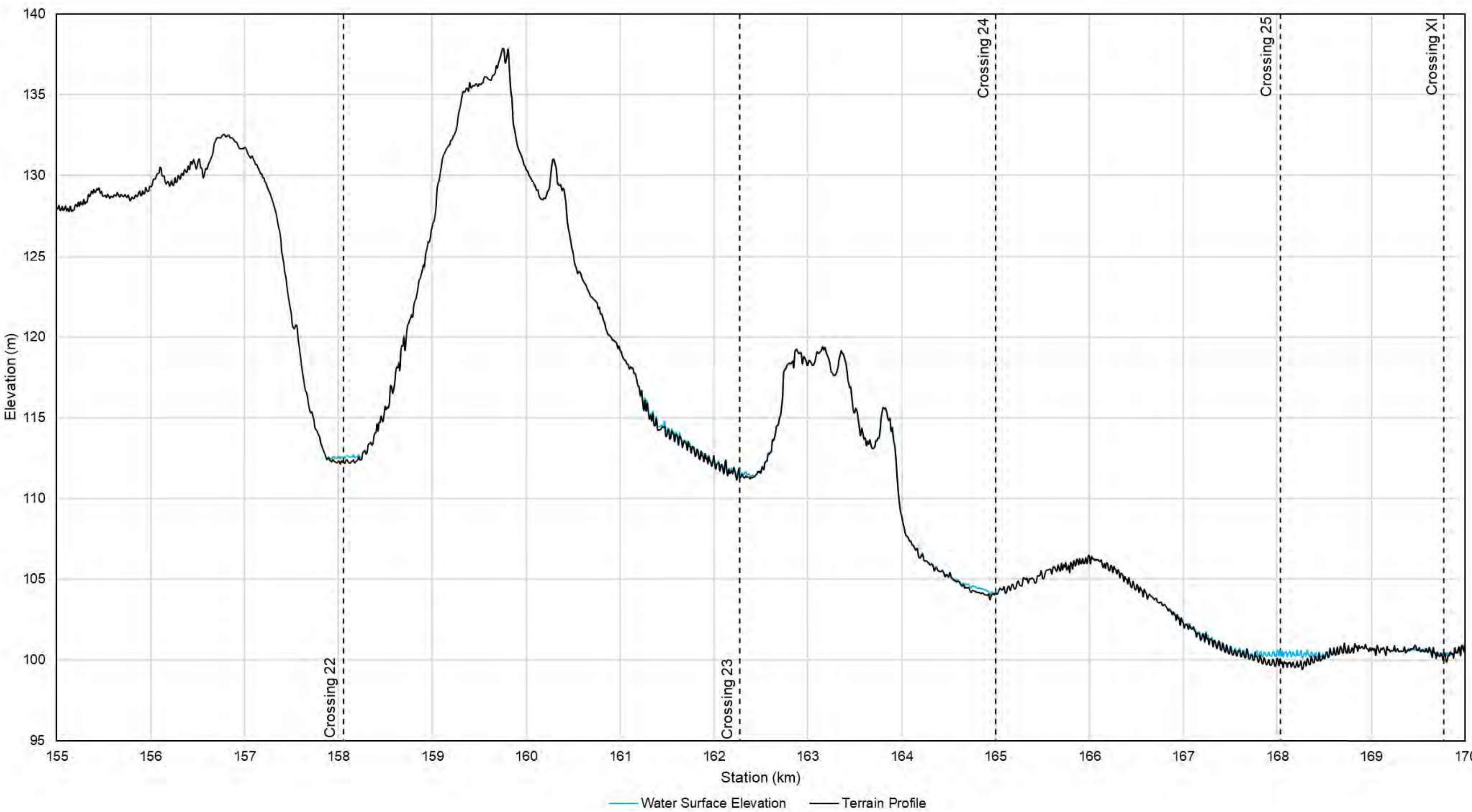
Main Alignment



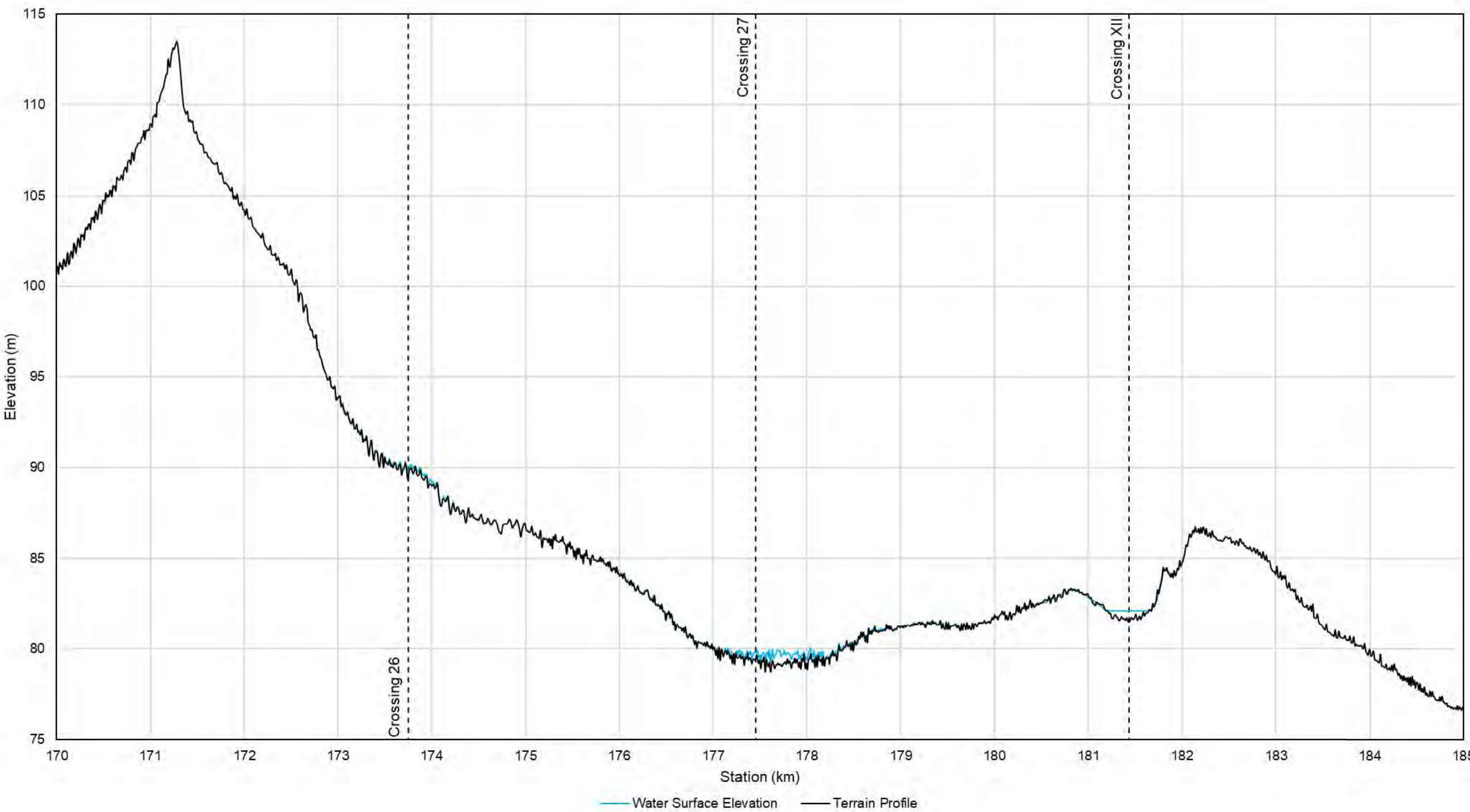
Main Alignment



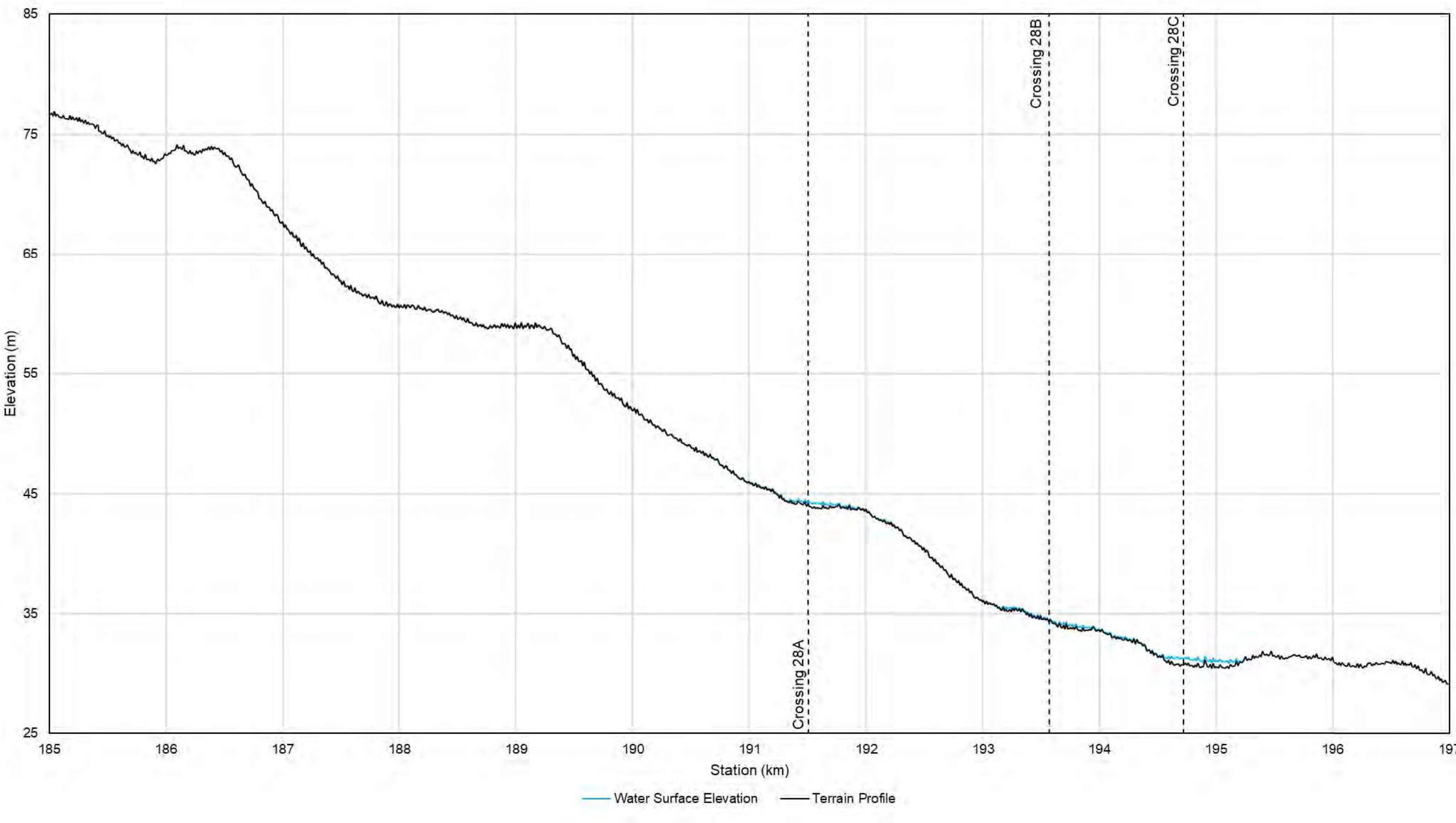
Main Alignment



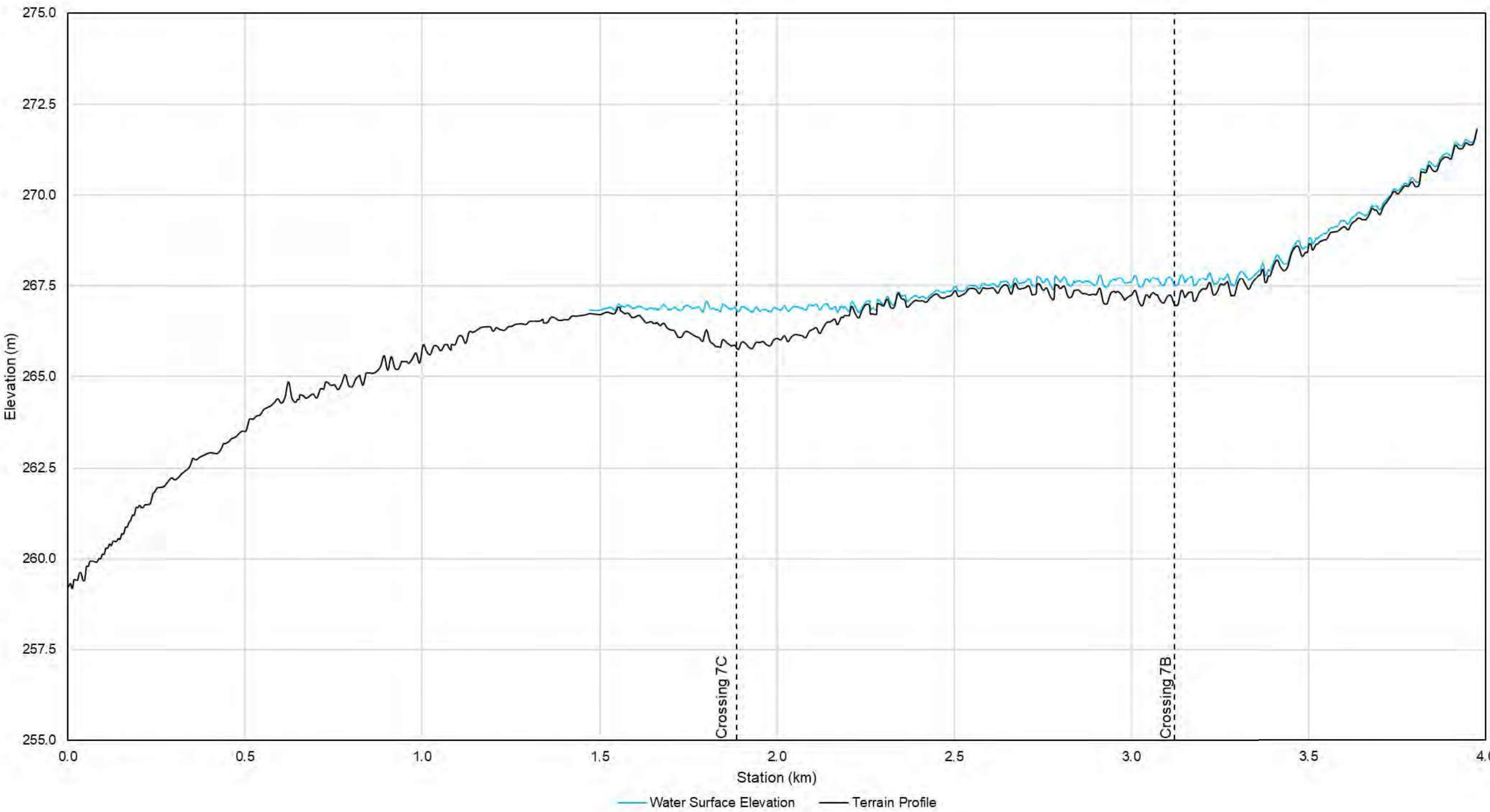
Main Alignment



Main Alignment

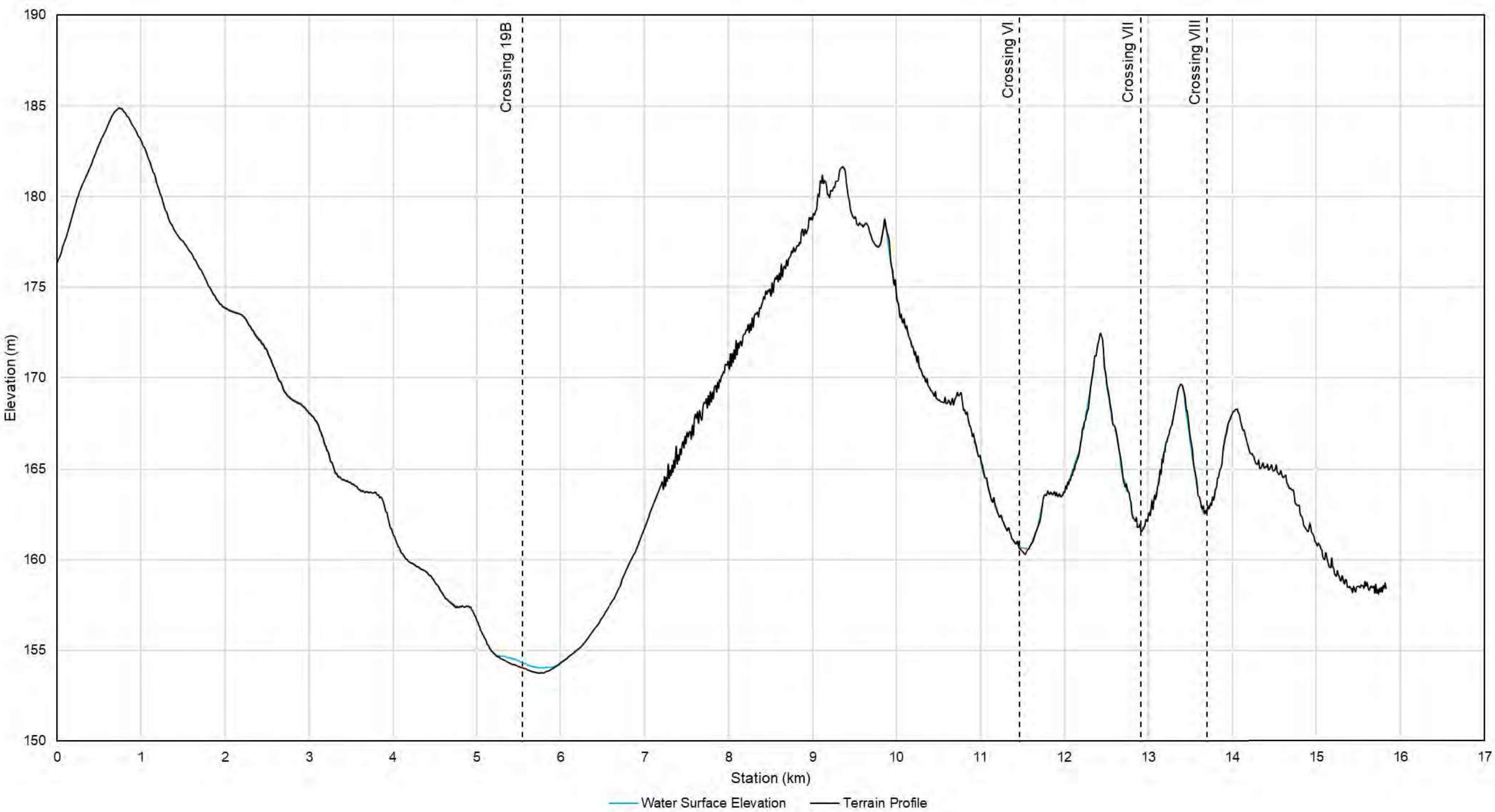


Branch 1



275.0
272.5
270.0
267.5
265.0
262.5
260.0
257.5
255.0
Elevation (m)
Crossing 7C
Crossing 7B
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Station (km)
Water Surface Elevation
Terrain Profile

Branch 2



190
185
180
175
170
165
160
155
150
Elevation (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Station (km)
Crossing 19B
Crossing VI
Crossing VII
Crossing VIII
Water Surface Elevation
Terrain Profile

APPENDIX C

Important Information

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This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

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The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

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Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

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Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

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