APPENDIX K: SURFACE WATER MANAGEMENT PLAN AND WATER BALANCE REPORT

COZA IRON ORE PROJECT

JENKINS MINE HYDROLOGICAL SPECIALIST STUDY REPORT

March 2016

REVISION 03

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JENKINS MINE

HYDROLOGICAL SPECIALIST STUDY

REPORT

VERIFICATION PAGE		Form 4.3.1 Rev 01
REPORT NO. : 01	DATE : 23 March 2016	STATUS: **Final**

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO9001: 2008 which has been independently certified by DEKRA Certification under certificate number 90906882

Verification	Capacity	Name	Signature	Date
By Author	Hydrologist	Phillip Hull		07/08/2015
Checked by	Associate	Ryan Gray		07/08/2015
Authorised by	Director	Simon Johnson		07/08/2015

TABLE OF CONTENTS

1 INTRODUCTION

Jeffares & Green (Pty) Ltd (J&G) have been appointed by SLR Africa (Pty) Ltd to undertake a series of hydrological specialist studies for the proposed COZA Iron Ore project located on Farm Driehoekspan 435 (Remaining Extent), Doornpan 445 (Portion 1) and Jenkins 562 in the Tsantsabane Local Municipality in the Northern Cape Province. This report covers the specialist studies required as part of the Jenkins Mine project. The hydrological studies have been undertaken to satisfy the requirements of the Minerals and Petroleum Resources Development Act (No 28 of 2002), the Environmental Management Act (No 107 of 1998) and the National Water Act (No 36 of 1998). The specialist studies included in this report consist of the following:

- A baseline hydrological description of the project area,
- Delineations of the 1:50 and 1:100 year return period floodlines for all drainage lines intersecting with the proposed mining precinct,
- A stormwater management plan, compiled in line with the requirements stipulated in General Notice 704 of the National Water Act (Act 36 of 1998), and
- A water balance of the proposed mining activities.

1.1 Declaration of Independence

This report has been compiled in accordance to the requirements listed in Appendix 6 of the Environmental Impact Assessment Regulations, 2014 from the National Environmental Management Act, 1998 (Act no. 107 of 1999). J&G have been appointed to conduct independent hydrological specialist studies for the proposed Jenkins Mine. J&G have therefore undertaken these studies in an objective manner, even if this results in views and findings that are not favourable to the applicant or client. J&G have the expertise required to undertake the necessary studies and the resultant report presents the results in an objective manner. The main author of the report (Phillip Hull) is a Senior Hydrologist at J&G and has a MSc. in Hydrology, is professionally registered and 9 years of relevant project experience. Any assumptions made during the respective specialist studies have been presented in the relevant sections. In addition, **Annexure A** of this report provides a summary letter compiled in accordance to Appendix 6 of the Environmental Impact Assessment Regulations, 2014 from the National Environmental Management Act, 1998 (Act no. 107 of 1999), in which assumptions and limitations have been listed.

2 SITE DESCRIPTION

The proposed Jenkins mine is located approximately 45 km north of the town Postmasburg within the Northern Cape Province, as depicted in **Figure 2-1**. It is approximately 180 km east from Upington and 180 km west of Kimberly. Other small towns in close proximity to the study site are Kathu, Sesheng and Dingleton. A site plan presenting the location of the proposed mine infrastructure in relation to the Jenkins Mine study area is provided in **Figure 2-2**. **Figure 2-3** is a higher scale site plan presenting the main drainage lines in the vicinity of the mine precinct and the location of weather stations used in the study.

Drainage lines in the vicinity of the Jenkins mine precinct are generally undefined, and the floodplains flanking the drainage lines are generally very flat. The only clearly defined drainage line within the mine precinct is that of the unnamed drainage line on the south-western boarder of the property, as depicted in **Figure 2-2** and **Figure 2-3**. Based on the Lidar survey provided, three other drainage lines within the mine precinct were identified for this floodline study. **Figure 2-3** presents a high scale site plan the drainage lines identified, as well as their contributing catchment areas.

J&G conducted a site assessment of the Jenkins Mine site on the 23rd of June 2015. The objective of this site visit was to assess topographical, soil and land cover characteristics of the project area. These site characteristics form the basis for understanding the hydrology of the project area. **Photographs 1** and **2**, taken during the site visit, presents the general topography and vegetation cover at the proposed mine. The topography of the mine property changes from generally flat on the western portion of the property to hilly on the eastern portion of the property (this is where the open pit will be located), as indicated by the contours in **Figure 2-2**.

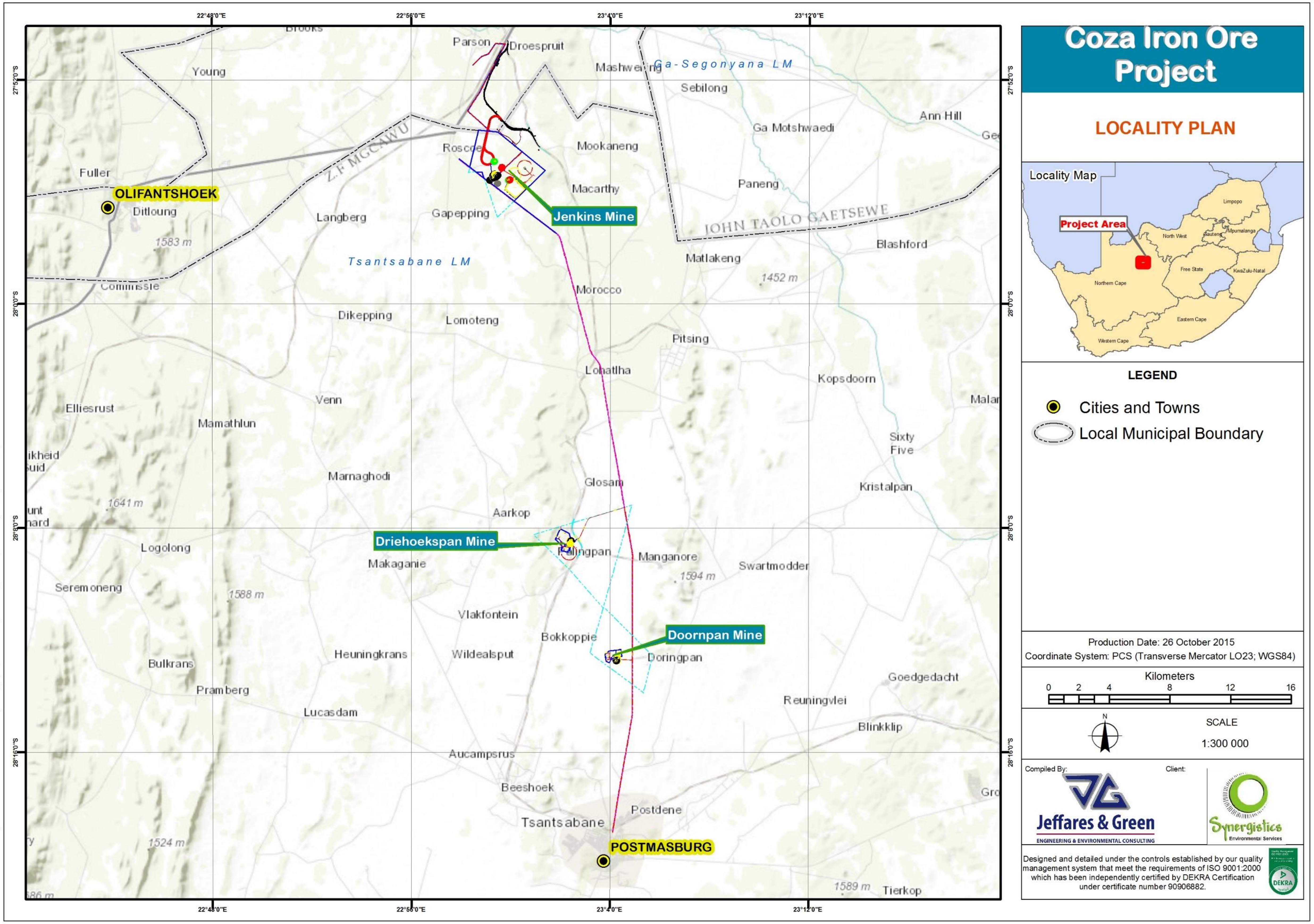


Figure 2-1 Jenkins Mine Locality Map

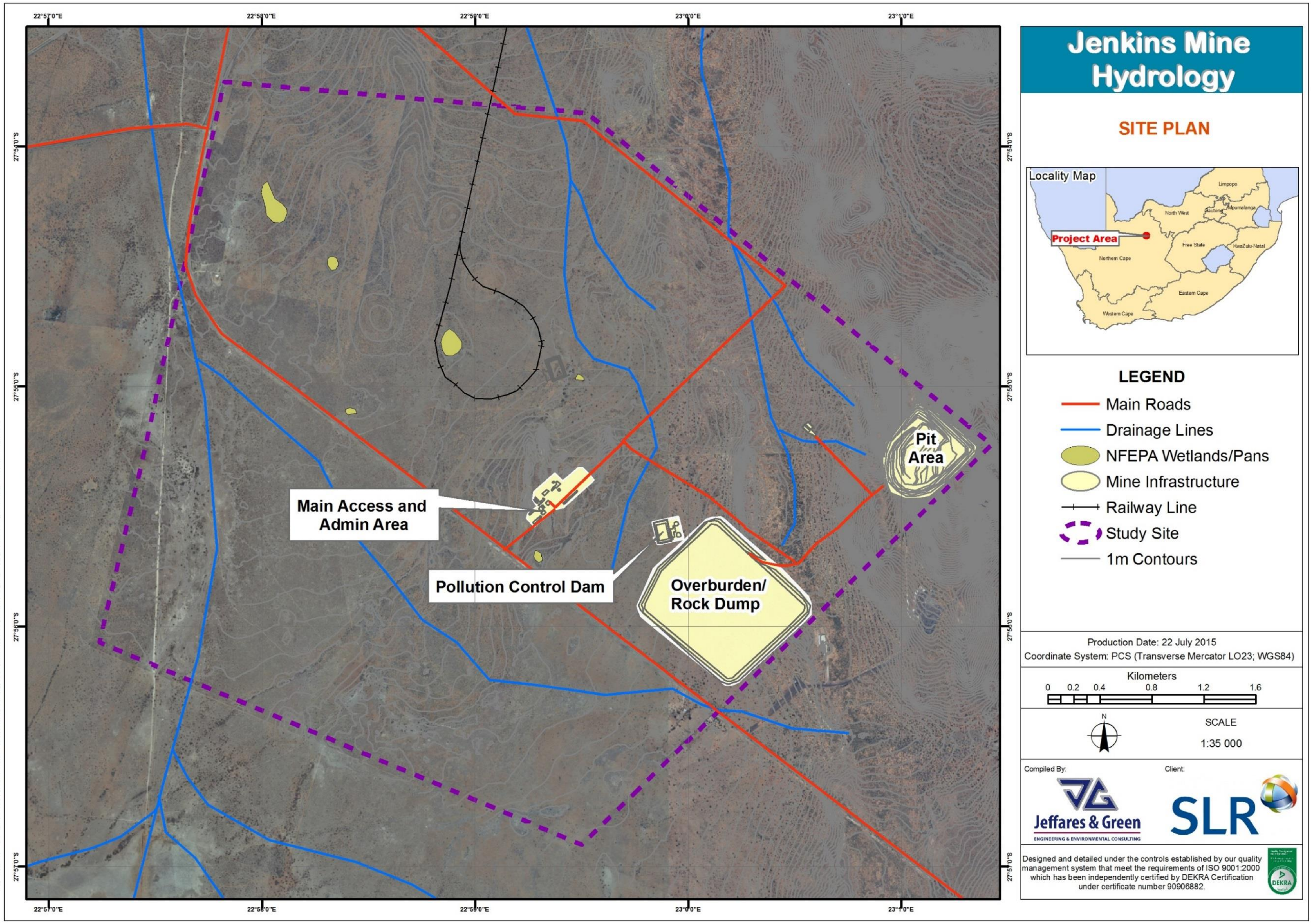


Figure 2-2 Jenkins Mine Site Plan 1

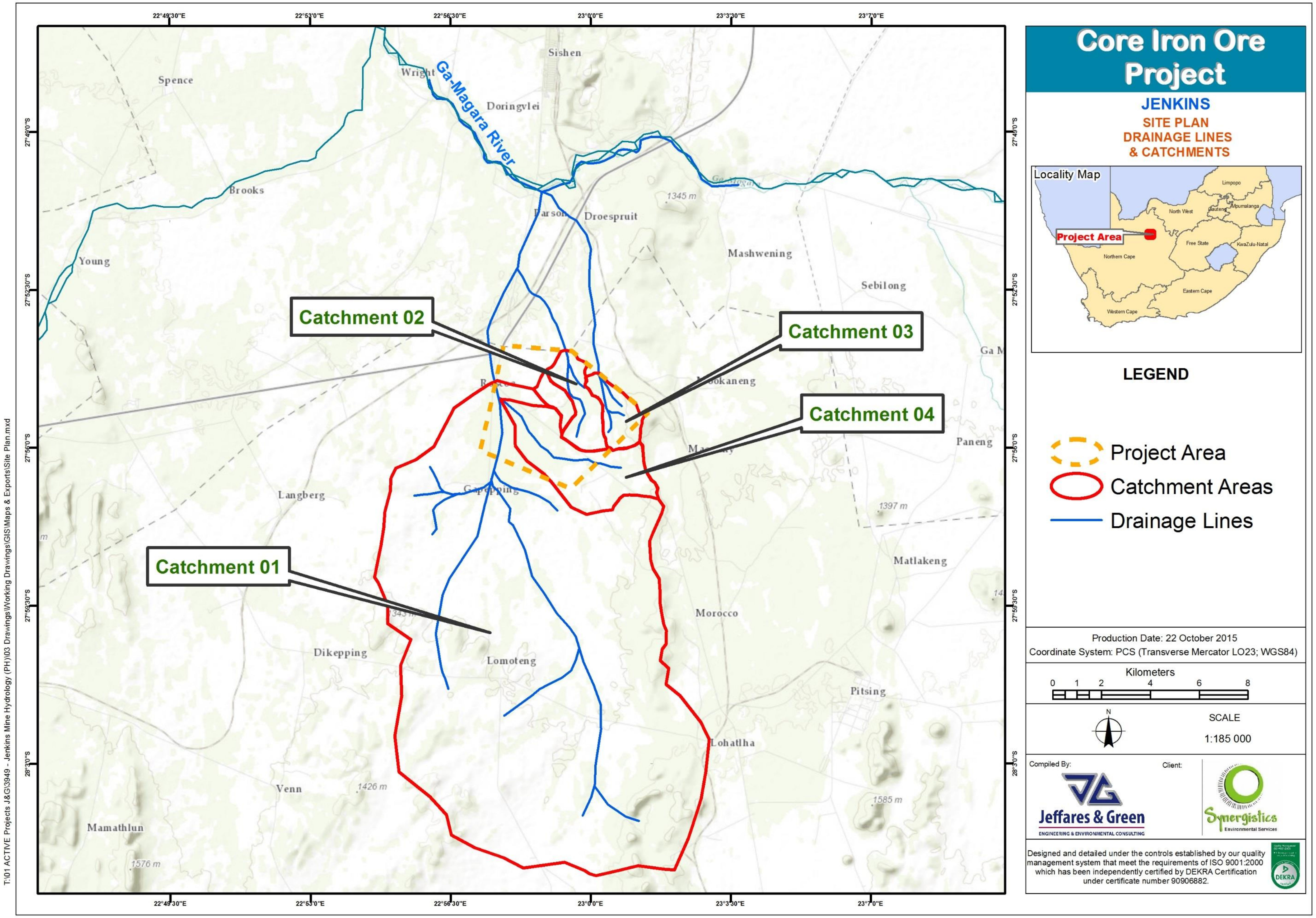
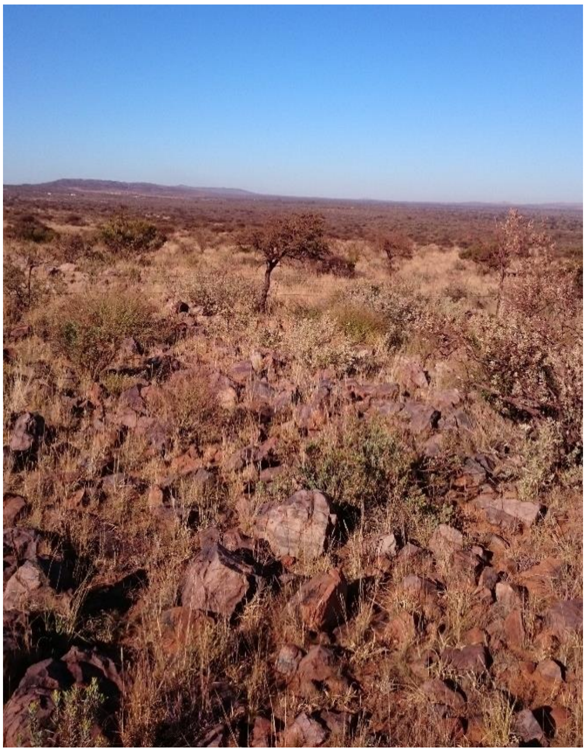


Figure 2-3 Jenkins Mine Site Plan 2



Photograph 1 and 2 Depiction of the General Topography and Vegetation at the Proposed Jenkins Mine

2.1 Climatic Conditions

The COZA Iron Ore project area falls within the steppe climate zone, as per the Kőppen BS classification. This climate category can be described as semi-arid, and is able to support short scrubby vegetation, predominantly including shrubs and grasslands, as depicted in **Photographs 1** and **2**.

Temperature data for the project area was obtained from the South African Weather Service (SAWS) station 0321141 W. This station is located approximately 50 km south of the Jenkins Mine project area. This climate station was chosen based on the length of reliable temperature data and proximity to the site. The average monthly maximum and minimum temperatures for the project area, calculated using weather data spanning the period 1950 to 2000, are presented in **Table 2-1**. The maximum temperature recorded at this weather station is 46.5 ºC and the minimum is -8.4 ºC.

Table 2-1 Monthly Average Maximum and Minimum Temperatures Recorded For Years 1950 – 2000 at Station 0321141 W

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum Temperature (ºC)	16.2	15.1	13.8	10.3	6.0	2.1	1.9	4.4	6.9	10.0	13.4	15.6
Maximum Temperature (ºC)	32.0	29.3	28.6	25.0	22.3	17.1	18.0	20.7	24.4	27.0	29.7	31.2

Rainfall data for the project area was obtained from the SAWS rainfall station 0320828 W. This rainfall station is located approximately 54 km south of the project site and was also selected based on the record period and the reliability of the historical rainfall data. The details of this rainfall station are presented in **Table 2-2**. The mean monthly rainfall amounts over the period 1950 to 2000 are presented in **Table 2-3**. From **Table 2-3**, it is evident that most of the rainfall falls over the summer period (November to April). Rainfall over this period is predominately convectional. It is also noted that low rainfall values are recorded over the winter months (May to October). Rainfall falling over this period is predominantly frontal.

Table 2-2 Rainfall Station Details

Station Number	Station Name	MAP (mm)	Years Assessed	Reliability (%)	Longitude	Latitude
0320828 W	Aucampsrus	318	1950 - 2000	99.2	22° 58′	28° 17′

Table 2-3 Average Rainfall Depths Recorded For Years 1950 – 2000 at Rainfall Station 0320828 W

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAP
Rainfall Depth (mm)	48	60	62	34	13	5	2	6	7	19	24	38	318

While rainfall is generally variable on a month-to-month basis, this is not the case with evaporation. Evaporative demands do not vary significantly from one year to next (i.e. evaporation in one October-month, for example, is similar to evaporation in the next October-month). Therefore, it is generally considered to be acceptable to apply 12 average monthly evaporation values over the year. The evaporation data used for the Coza Iron Ore Project was obtained from evaporation zone **7A** (Middleton and Bailey, 2008). Catchment evapo-transpiration is calculated by applying 12 monthly evapotranspiration conversion factors, as presented in **Table 2-4**. Similarly, evaporation losses from an exposed water body are calculated by applying 12 monthly lake evaporation conversion factors, as presented in **Table 2-4**. The annual potential evaporation rate for the COZA Iron Ore study area is 2 450 mm. From **Table 2-4**, the highest evaporation rates occur during the hotter summer months of October to March.

Table 2-4 COZA Iron Ore Potential Evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Evaporation Rate (mm)	333	256	221	154	111	85	98	133	184	247	292	336	2 450
Lake Evaporation Factor	0.84	0.88	0.88	0.87	0.85	0.83	0.81	0.81	0.81	0.81	0.82	0.83	
Evapotranspiration Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.80	0.80	0.80	1.00	1.00	

3 BASELINE HYDROLOGY

Drainage lines, wetlands and pans located within the project area need to be managed such that all mining activities are compliant with relevant legislation. It is therefore important to highlight sections of the legislation that may be relevant to the COZA Iron Ore project.

The *National Water Act, Act No. 36 of 1998* (NWA) was created in order to ensure the protection and sustainable use of water resources (including wetlands and pans) in South Africa. The NWA recognises that the ultimate aim of water resource management is to achieve the sustainable use of water for the benefit of all users. Bearing these principles in mind, there are a number of stipulations within the NWA that are relevant to the potential impacts on surface water resources that may be associated with the COZA Iron Ore project and, in particular, the Jenkins Mine. These stipulations are explored below and are discussed in the context of the proposed development.

Firstly, it is important to discuss the type of water resources (surface) protected in the NWA. Under the NWA, a 'water resource' includes a watercourse, surface water or aquifer. Specifically, a watercourse is defined as (*inter alia*):

- a river or spring;
- a natural channel in which water flows regularly or intermittently; or
- a wetland, pan, lake or dam into which, or from which, water flows.

In this context, it is important to note that reference to a watercourse includes, where relevant, its bed and banks. Furthermore, it is important to note that water resources, including wetlands and pans, are protected under the NWA. 'Protection' of a water resource, as defined in the NWA entails the:

- maintenance of the quality and the quantity of the water resource to the extent that the water use may be used in a sustainable way;
- prevention of degradation of the water resource; and
- rehabilitation of the water resource.

Based on the context that the proposed project is mining and, therefore, its associated potential impacts on the surface water resources, the definition of pollution and pollution prevention contained within the NWA is relevant. 'Pollution', as described by the NWA, is the direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it (*inter alia*):

- less fit for any beneficial purpose for which it may reasonably be expected to be used; or
- harmful, or potentially harmful, to the welfare or human beings, to any aquatic or nonaquatic organisms, or to the resource quality.

The inclusion of physical properties of a water resource within the definition of pollution entails that any physical alterations to a water body, for example the excavation of a wetland or changes to the morphology of a water body, can be considered to be pollution. Activities that cause alteration of the biological properties of a watercourse, i.e. the fauna and flora contained within that watercourse, are also considered pollution.

In terms of section 19 of the NWA, owners/managers/people occupying land on which any activity or process undertaken which causes, or is likely to cause, pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring. These measures may include measures to (*inter alia*):

- cease, modify, or control any act or process causing the pollution;
- comply with any prescribed waste standard or management practice;
- contain or prevent the movement of pollutants;
- remedy the effects of the pollution; and
- remedy the effects of any disturbance to the bed and banks of a watercourse.

The *National Environmental Management Act 107 of 1998* (NEMA) was created essentially to establish:

- principles for decision-making on matters affecting the environment;
- institutions that will promote co-operative governance; and
- procedures for co-ordinating environmental functions exercised by organs of the state to provide for the prohibition, restriction or control of activities which are likely to have a detrimental effect on the environment.

It is stipulated in NEMA, *inter alia*, that everyone has the right to an environment that is not harmful to his or her health or well-being. Moreover, everyone has the right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Accordingly, several of the principles of NEMA, applicable to wetlands and pans, stipulate that:

- development must be socially, environmentally and economically sustainable;
- sustainable development requires the consideration of all relevant factors including the following:
  - That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
  - That pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
  - That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.
- the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment; and
- sensitive, vulnerable, highly dynamic or stressed ecosystems such as wetlands and pans, require specific attention in management and planning procedures.

3.1 General Catchment Hydrology

The project site is located within quaternary catchment D41J, which in turn forms part of the greater Orange River catchment area. The Orange River is located approximately 140 km southwest of the project site, however, water draining from quaternary catchment D41J drains northwards along the Ga-Mogara River, a tributary of the Kuruman River, which eventually drains southwards along the Molopo River and joins the Orange River at Augrabies Falls. According to the Water Resources of South Africa 2012 study (WR2012), quaternary catchment D41J has a Mean Annual Runoff (MAR) of 1.75 million m^3 (MCM). The total catchment area of the quaternary catchment is 3 878 km^2, however, only 2 518 km^2 of this catchment area contributes to flows out of the catchment. The remainder of the catchment is described as endorheic (catchment area with no outlet, i.e. rainfall falling on the catchment does not exit the catchment as surface flow, but may only leave as evaporation or seepage). Details of the quaternary catchment D41J including its associated MAR volume and MAR depth are provided in **Table 3-1** (WR, 2012). The MAR depth is particularly low due to the arid nature of the catchment, relatively flat topography and largely sandy soils.

Table 3-1 Quaternary Catchment Details

Quaternary Catchment	Catchment Area (km²)	Evaporation Zone	Rain Zone	Water Management Area	MAR (MCM)	MAR Depth (mm)	MAP (mm)
D41J	3 878	8A	D4A	10	1.75	1.3	358

3.1.1 Wetland/Pan Identification

The identification of wetlands and pans within the Jenkins Mine precinct has been undertaken using Geographic Information System (GIS) software developed by ESRI. The collection of data source information encompasses the National Freshwater Priority Areas (NFEPA, 2011) database and the Environmental Potential Atlas (ENPAT, 2000 & 2002). The use of Ortho Photo imagery has also been used to supplement these data sources. Colour satellite imagery depicting specifically soil colour has been used as a means of delineating wetland/pan boundaries. For example, wetland soil colours are often 'greyer' in hue, reflecting the gleyed soils that typically occur within wetlands. These can be differentiated from the orange/brown/yellow more oxidised non-wetland soils that exist outside of the wetland.

Utilising the above-mentioned sources, several pans were identified within the Jenkins mine precinct, as presented in **Figure 2-2** in **Section 2**. During the site visit undertaken in June 2015, a number of these pan areas were verified, as presented in **Photographs 3** and **4**. As presented in these photos, the identified pan areas are depressions in the general landscape. There were no obvious signs of wetland plants, or waterlogged areas.

The mine lies within the Griqualand West Centre of Endemism within the Savanna Biome (Northern Cape PSDF, 2012). However, it is not within a Biodiversity Priority Area or a Critical Biodiversity Area and, so, is not accorded any especial status in regard to its conservation value. SANBI mapping (SANBI, 2014) indicates fewer than five (probably zero) taxa of conservation concern as possibly being present per quarter degree square in the area.

The highly ephemeral nature of the pans has resulted in there being no documented aquatic or semi-aquatic vertebrate species being present (Minter *et al*, 2004), although some terrestrial species will make use of the water when it is available. While bird diversity in the area is rich with desert-adapted species, the nearest Important Bird Area is at Spitzkop Dam some 150 km away and the nearest nature reserve is Witsand Nature Reserve, which is 100 km away. On the basis of the above, it is concluded that the ephemeral pans are of no significant biodiversity conservation value.

Photographs 3 and 4 Depiction of Pan Areas within the Jenkins Mine Area

3.1.2 Drainage Line and Catchment Area Delineation

As presented in **Figures 2-2** and **2-3**, the most significant drainage line in the vicinity of the Jenkins property is that of the Ga-Mogara River, which is located approximately 6.5 km north of the Jenkins Mine boundary and flows just south of the Sishen mining area. Based on the distance and difference in elevation between the Jenkins property and this drainage line, the likelihood of Jenkins mining operations being affected by flooding from this river is very small.

Drainage lines and the catchment areas contributing to overland and defined flow of the Jenkins Mine area have been delineated, as depicted in **Figure 2-3**. Drainage lines and catchment areas have been delineated based on a combination of 1 m interval contour lines provided by the client and 20 m contour interval information for the catchment areas outside of the Jenkins mine precinct. Based on the available contour information, it was found that several drainage lines traverse the proposed Jenkins Mine area. The drainage line located in the south western corner of the property boundary has a large catchment area of approximately 199 km^2. The remainder of the drainage lines falling within the precinct have smaller catchment areas of less than 15 km^2. The majority of the flows across the site are undefined, which is largely due to the flat topography of the project area.

3.1.3 Water Quality and Water Use

Surface water quality in and downstream of the project area is not likely to be an issue if correct water management principals are employed. This assumption has been made based on the lack of surface water as a result of the arid nature of the project site. It is assumed that stormwater runoff from the proposed mining area will managed correctly, i.e. as per the Department of Water Affairs (DWA) Best Practice Guidelines A1 (2006), which in turn are based on the requirements of General Notice 704 (GN 704) of the National Water Act (Act 36 of 1998), as presented in **Section 5**. If these guidelines are adhered to, water quality downstream of the proposed COZA Iron Ore project is not likely to be negatively affected.

Only one registered water user was identified in the vicinity of the proposed Jenkins Mine. This registered water user is located within the Khumani Mine area, approximately 5 km north of the proposed Jenkins Mine. The licenced water use (registration number 250571170) is for a total volume of 20 652 m^3/annum from a borehole

4 FLOODLINE DELINIATIONS

In order to determine the 1:50 and 1:100 year return period floodlines for the project area, the 1:50 and 1:100 year return period peak discharge values need to be calculated. The methodology used in the calculation of these values, as well as the resultant floodline delineations, are presented in the following sections.

4.1 Peak Discharge Calculation Methodology

The appropriate methodology to be applied in calculating peak discharge values depends largely on the size of the contributing catchment and the level of hydrological data available (including gauged streamflow values and design rainfall data for example) for a particular catchment. In the case of this floodline study, the size of the four catchment areas varied greatly. The catchment contributing to the drainage line located in the south western corner of the property boundary (Catchment 1 as depicted in **Figure 2-3**) has a large catchment area equal to approximately 199 km^2, while catchments 2, 3 and 4 all have relatively small catchments areas of less than 15 km^2. The methodology used to calculate the peak discharge values associated with Catchment 1 is therefore different to that adopted for Catchments 2, 3 and 4. The Unit Hydrograph Method, as described in **Section 4.1.1**, was used to calculate the peak discharge values of Catchment 1, and the Rational Method, as described in **Section 4.1.2**, was used to calculate the peak discharge values of Catchments 2, 3 and 4.

4.1.1 Unit Hydrograph Method

The Unit Hydrograph method is suitable for the determination of flood peaks as well as flood hydrographs for catchments of between 100 and 5 000 km^2. The method is based mainly on regional analyses of historical hydrological data, and is independent of personal judgement. The results are reliable, although some natural variability in the hydrological occurrences is lost through the broad regional divisions and the averaged form of the hydrographs (Road Drainage Manual, 2006). A detailed description of the method is presented in Report 1/72 of the Hydrological Research Unit (Pitman and Midgley, 1971).

Catchment specific variables used as inputs to Unit Hydrograph Method are presented in **Table 4-1**. The resultant peak discharge values are presented in **Table 4-2**.

Table 4-1 Unit Hydrograph Catchment Parameters

Catchment Variable	Catchment 01 (to River 01)
Catchment Area (km^2)	198.89
Length of Longest Water Course (km)	21.97
Distance to Catchment Centroid (km)	10.94
Catchment Mean Annual Precipitation (mm)	358
Veld Type Zone	6
Lag Time (hours)	3.73
Catchment Index	3 734.2
Coefficient (Ku)	0.265

Table 4-2 Unit Hydrograph Peak Discharge Calculation Results

Catchment	Peak Discharge (m^3/s) (Years)	
	1:50	1:100
Catchment 01 (To River 01)	200.1	270.9

4.1.2 Rational Method

The Rational Method was used in the calculation of the 1:50 and 1:100 year return period peak discharge values for Catchments 2, 3 and 4. The Rational Method is widely used throughout the world for both rural and urban catchments (Alexander, 2001; Pilgrim and Cordery, 1993) and is the most commonly used method of estimating design flood peak discharge values. It is sensitive to design rainfall intensity and the selection of the runoff coefficient (C factor). The method assumes that the peak discharge occurs when the duration of the rainfall event is equal to the Time of Concentration (Tc), and that the rainfall intensity is distributed uniformly over the catchment. As a consequence of these assumptions, the Rational Method is best suited to catchments with areas of less than100 km^2 (HRU, 1972).

4.1.2.1 Design Rainfall

Design rainfall is required as an input into the Rational Method for calculating design flood peak discharge values associated with various recurrence interval storm events (floods). Design rainfall for the study site was obtained from the Design Rainfall Estimation Program (Smithers and Schulze, 2003). This Design Rainfall Estimation software calculates the design rainfall depths using regionalised L-moment Algorithm and scale invariance at any 1’ × 1’ grid interval in South Africa. The design rainfall depths for various return periods used in calculating the design peak discharge calculations are presented in **Table 4-3**.

Table 4-3 Design Rainfall Values

Duration	Return Period (Years) Design Rainfall Depth (mm)	
	1:50	1:100
5 min	19.2	21.8
10 min	28.7	32.5
15 min	36.2	41.0
30 min	47.8	54.2
45 min	56.3	63.8
1 hour	63.2	71.6
1.5 hour	74.3	84.2
2 hour	83.4	94.5
4 hour	96.4	109.2
6 hour	104.9	118.9
8 hour	111.4	126.2
10 hour	116.7	132.2
12 hour	121.2	137.3
16 hour	128.7	145.8
20 hour	134.8	152.8
24 hour	140.1	158.7
1 day	112.7	127.8
2 day	136.9	155.1
3 day	153.3	173.7
4 day	164.4	186.3
5 day	173.5	196.6
6 day	181.4	205.5
7 day	188.3	213.4

4.1.2.2 C-Factor Calculation

Catchment C factors required as input into the Rational Method, are determined by accounting for a combination of catchment landcover types (C_v), soil types (C_p) and catchment slopes (C_s). The land cover of the contributing catchments, based on aerial photography and notes taken during the site visit were classed as predominantly light bush and grassland, as presented in **Table 4-4**. The texture class associated with the soils of the contributing catchments are Sandy. These soils were therefore classed as permeable, as presented in **Table 4-4**. The surface slope for each catchment was estimated using a digital terrain model (DTM) of the respective catchment, based on the Lidar survey data provided by the client. The results of this assessment are presented in **Table 4-4**.

Table 4-4 Land Cover Information

Area distribution	Catchment 02	Catchment 03	Catchment 04
	Percentage of Catchment Area (%)		
Urban	0	0	0
Rural area	100	100	100
Surface slope (%)	**Percentage of Catchment Area (%)**		
Y < 3	90	51	89
3 - 10	9	36	11
10 - 30	1	13	0
30 - 50	0	0	0
Soil Permeability	**Percentage of Catchment Area (%)**		
Very permeable	0	0	0
Permeable	100	100	100
Semi-permeable	0	0	0
Impermeable	0	0	0
Vegetation	**Percentage of Catchment Area (%)**		
Thick bush & forests	0	0	0
Light bush	93	89	91
Grasslands	6	9	8
Bare	1	3	1

4.1.2.3 Peak Discharge Calculation – Rational Method

Table 4-5 presents a summary of the Rational Method inputs required for the calculation of the 1:50 and 1:100 year return period peak discharge values. The slope of the stream channel, which was used to calculate the time of concentration, was determined using the ArcMAP 9.3 software, based on the Lidar Survey provided. The Rational formula is defined as:

$$Q_p = CIA/3.6 \qquad \textbf{Equation 1}$$

Where:

Q_p = peak flow (m^3/s)

C = run-off coefficient (dimensionless)

I = average rainfall intensity over catchment (mm/hour)

A = effective area of catchment (km^2)

The resultant 1:50 and 1:100 year return period peak discharge values are presented in **Table 4-6.**

Table 4-5 Summary of Hydrology Inputs for Design Peak Discharge Calculations

Catchment Name	Catchment Area (km^2)	Length of Longest Water Course (m)	Watercourse Average Slope (m/m)	Time Of Concentration (hours)	C Factor
Catchment 02	5.20	4 448	0.004	1.74	0.15
Catchment 03	4.02	3 258	0.007	1.09	0.19
Catchment 04	13.68	7 964	0.005	2.44	0.16

Table 4-6 Summary of the Rational Method Design Peak Flows Calculated

Catchment Name	Peak Discharge (m^3/s) (Years)	
	1:50	1:100
Catchment 02	8.2	11.3
Catchment 03	10.3	14.1
Catchment 04	17.3	23.6

4.2 Floodline Delineations

4.2.1 Hydraulic modelling

The HEC-RAS model was used to undertake the 1-dimensional hydraulic modelling to determine the extent of the 1:50 and 1:100 year return period flood events. Spatial information consisting of Lidar survey data (which was scaled down to 1m contour intervals using Spatial Analysis, an ArcMAP 9.3 extension tool) was used in the hydraulic modelling. The contour data was input into ArcMAP and used to create a DTM. This allows for the cross-sectional elevations and other topology to be extracted from the DTM utilising HEC-GeoRAS (an ArcMAP 9.3 extension that links directly with the hydraulic model). This data was subsequently exported into the HEC-RAS model for hydraulic modelling of the previously calculated peak discharge values.

The roughness of the channel and floodplain surfaces needs to be accounted for within the hydraulic model. In this case, Manning's n values (Chow, 1959) were used to describe the surface roughness within HEC-RAS. **Table 4-7** presents the general Manning's n values for the river reaches and the surrounding floodplain that were modelled.

Table 4-7 Manning's n Values used in the Hydraulic Modelling (Chow, 1959)

Location	Manning's n	Description
Channel	0.040	Sluggish reaches, weedy
Floodplain	0.045	Medium to dense brush

4.2.2 Results

The resultant 1:50 and 1:100 year return period floodline delineations, based on Lidar survey information provided by the client, are presented in **Figure 4-1.** Due to the flat nature of the topography associated with the project area, the extent of the floodlines presented is relatively large, especially when considering the peak discharge rates calculated for the respective catchments. The flooded areas pertaining to catchments 2, 3 and 4 are shallow and flow velocities are low (generally less than 0.5 m/s), as presented in **Annexure B**. The result of this is that these flooded areas are associated with low risk for damage to mine infrastructure. Drainage line 1 in Catchment 1 is associated with increased velocities and flow depths and is therefore associated with a higher risk for damage to mine property, mainly due to the high peak discharge values associated with the larger catchment area.

As presented in **Figure 4-1**, most of the proposed mine infrastructure is located outside of the delineated 1:50 and 1:100 year floodline areas. During the 1:50 and 1:100 year flood events, infrastructure likely to be affected includes road and drainage line crossings, and a portion of the railway loop located adjacent to the most significant pan within the Jenkins Mine precinct. The location of the railway loop is likely to affect the floodline, however, this was not modelled as the dimensions of the railway line and its associated infrastructure are not known. It is expected that the impact of the flood events on this infrastructure will be negligible due to the low velocities and shallow flow depths associated with the flood events.

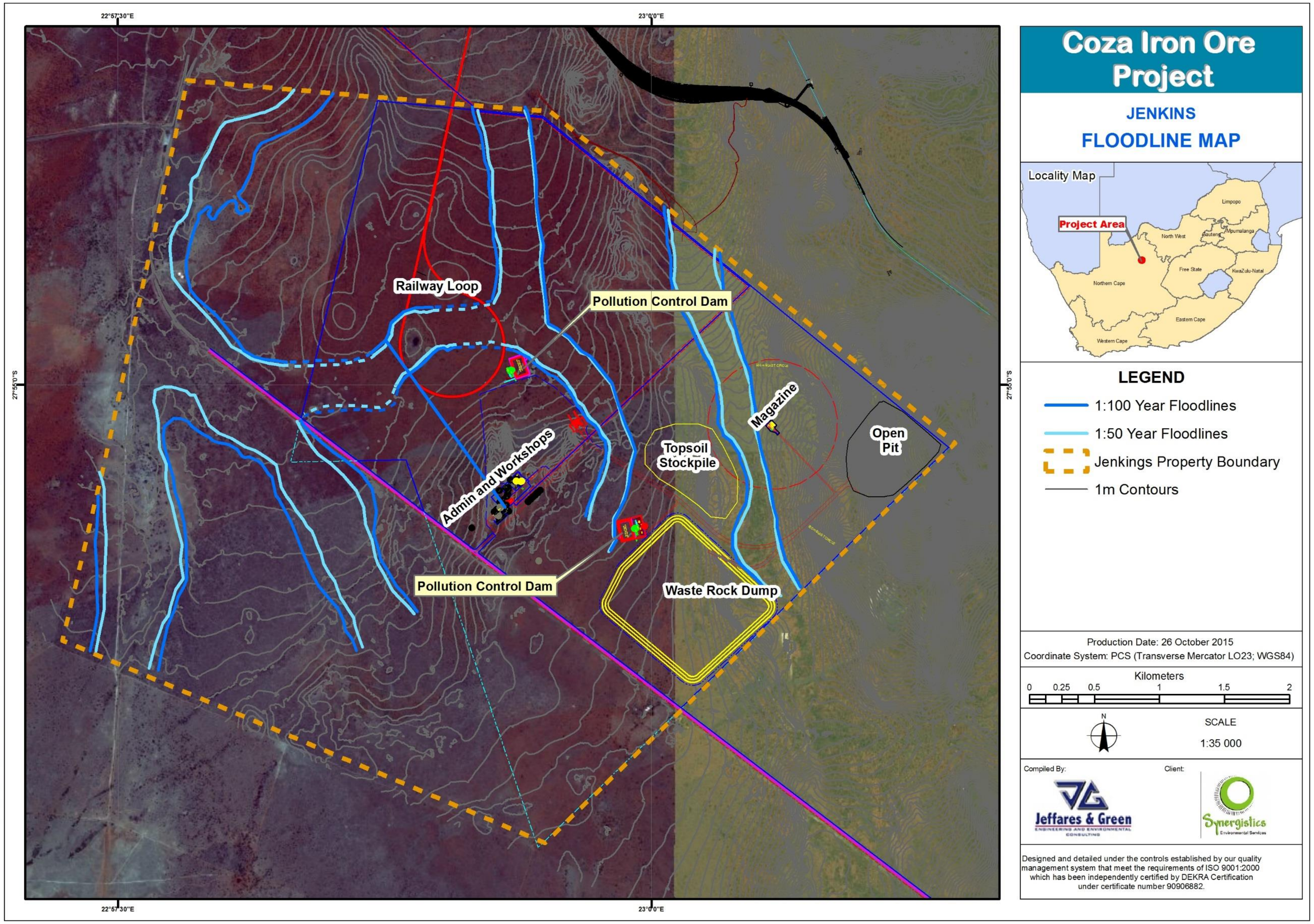


Figure 4-1 1:50 and 1:100 Year Floodline Delineation Results

5 STORMWATER MANAGEMENT

5.1 Methodology

The Department of Water Affairs (DWA) Best Practice Guidelines A1 (2006), which were developed specifically for stormwater management in small-scale mining and based on the GN 704 stipulated stormwater management requirements, was used as a basis for recommendations for the development of the SWMP. From these guidelines (and those stipulated in the GN 704), there are four primary principles that need to be considered and applied when formulating a SWMP, these include:

1. Clean water must be kept clean and be routed to a natural watercourse by a system separate from the dirty water system, while preventing or minimising the risk of spillage of clean water into dirty water systems.
2. Dirty water must be collected and contained in a system separate from the clean water system and the risk of spillage or seepage into clean water systems must be minimised.
3. The SWMP must be sustainable over the life cycle of the mine and over different hydrological cycles and it must incorporate principles of risk management.
4. The statutory requirements of various regulatory agencies and the interests of stakeholders must be considered and incorporated.

In order for the SWMP to be compliant with statutory requirements (GN 704), the sizing of the stormwater management infrastructure must be done using the 1:50 year return period storm event. The method used to determine the 1:50 year return period peak discharge values was the Rational Method, as described in **Section 4.1.2**.

5.2 Stormwater Management Plan

Due to the space between the various sections of the mine, as depicted in the proposed Jenkins Mine layout site plan (**Figure 2-2**), this SWMP has been sub-divided into three areas, namely:

- The Staff Parking, Administration, Change House, Canteen, Water Treatment Works and Workshop area;
- The Crusher and Run of Mine (ROM) stockpile area; and
- The mining area which includes the Waste Rock Dump, Soil Stockpiles and the Open Pit area.

For each of these areas, the SWMP consists of two parts, namely, clean stormwater runoff management and dirty stormwater management.

5.2.1 Clean Stormwater Runoff Management

As per principal one of the DWA Best Practice Guideline - A1 (Small-Scale Mining) and the GN 704, clean stormwater runoff must be kept clean and be routed to a natural watercourse by a system separate from the dirty water system, while preventing or minimising the risk of mixing clean and dirty stormwater runoff. In order to accomplish this at the Jenkins mining site, several clean water diversion berms and stormwater channels are proposed.

As depicted in **Figure 5-1**, which presents the proposed stormwater management infrastructure around the Admin and Workshop areas, stormwater runoff generated from the Staff Parking, Change House, Canteen, Water Treatment Works, Admin Buildings and Stores area is considered clean. It is assumed that there will be no storage or dispensing of hydrocarbon or similar potential contaminants in this area. Based on this assumption, it is recommended that the stormwater management infrastructure conveys stormwater runoff to the north of the Admin area, from which it will be allowed to flow naturally in a northerly direction. In addition to the clean stormwater channels proposed for the Admin area, two diversion berms are recommended to be constructed adjacent to the proposed Pollution Control Dam, as depicted in **Figure 5-2**. These two diversion berms (Berm E1 and E2) are proposed to divert clean stormwater runoff around the Crusher and Stockpile areas.

As mentioned previously, in order to meet with statutory requirements, stormwater management infrastructure need to be sized to accommodate the 1:50 year design flood event. The method used to calculate the 1:50 year peak discharge for the diversion berms was the Rational Method, as described in **Section 5.1**. The catchment characteristics, C Factor calculation and resultant peak discharge values are presented in **Tables 5-1** and **Table 5-2**. Based on the calculated 1:50 year peak discharge values, dimensions of the proposed stormwater management infrastructure are presented in **Table 5-3**.

Table 5-1 Clean Stormwater Channel Catchment Characteristics

Catchment	Catchment Area (km^2)	Stream Length (m)	Slope (m/m)	Time of Concentration (hrs)
Channel A1 & A2	0.0093	135	0.002	0.16
Channel A3	0.0138	185	0.002	0.20
Channel A4	0.0041	50	0.002	0.07
Channel A5	0.0060	280	0.002	0.27
Channel A6	0.0037	60	0.002	0.08

Channel A7	0.0064	105	0.002	0.13
Channel A8	0.0191	330	0.002	0.31
Channel A9	0.0015	50	0.002	0.07
Channel A10	0.0221	380	0.002	0.34
Channel A11	0.0031	90	0.002	0.11
Channel A12	0.0252	400	0.002	0.36
Channel C1	0.0093	95	0.002	0.12
Channel C2	0.0138	65	0.002	0.09
Channel E1	0.0116	230	0.010	0.13
Channel E2	0.0091	305	0.020	0.12

Table 5-2 Clean Stormwater Management Infrastructure Peak Discharge Calculation Results

Channel Name	1:50 Year Average Rainfall Intensity (mm) (PI)	Catchment C Factor	1:50 Year Peak Discharge (m^3/s)
Channel A1 & A2	143.6	0.85	**0.262**
Channel A3	143.6	0.85	**0.389**
Channel A4	143.6	0.85	**0.116**
Channel A5	135.5	0.85	**0.160**
Channel A6	143.6	0.85	**0.105**
Channel A7	143.6	0.85	**0.181**
Channel A8	124.8	0.85	**0.468**
Channel A9	143.6	0.85	**0.042**
Channel A10	116.6	0.85	**0.506**
Channel A11	143.6	0.85	**0.086**
Channel A12	113.8	0.85	**0.562**
Channel C1	143.6	0.70	**0.032**
Channel C2	143.6	0.70	**0.099**
Channel E1	143.6	0.45	**0.270**
Channel E2	143.6	0.45	**0.211**

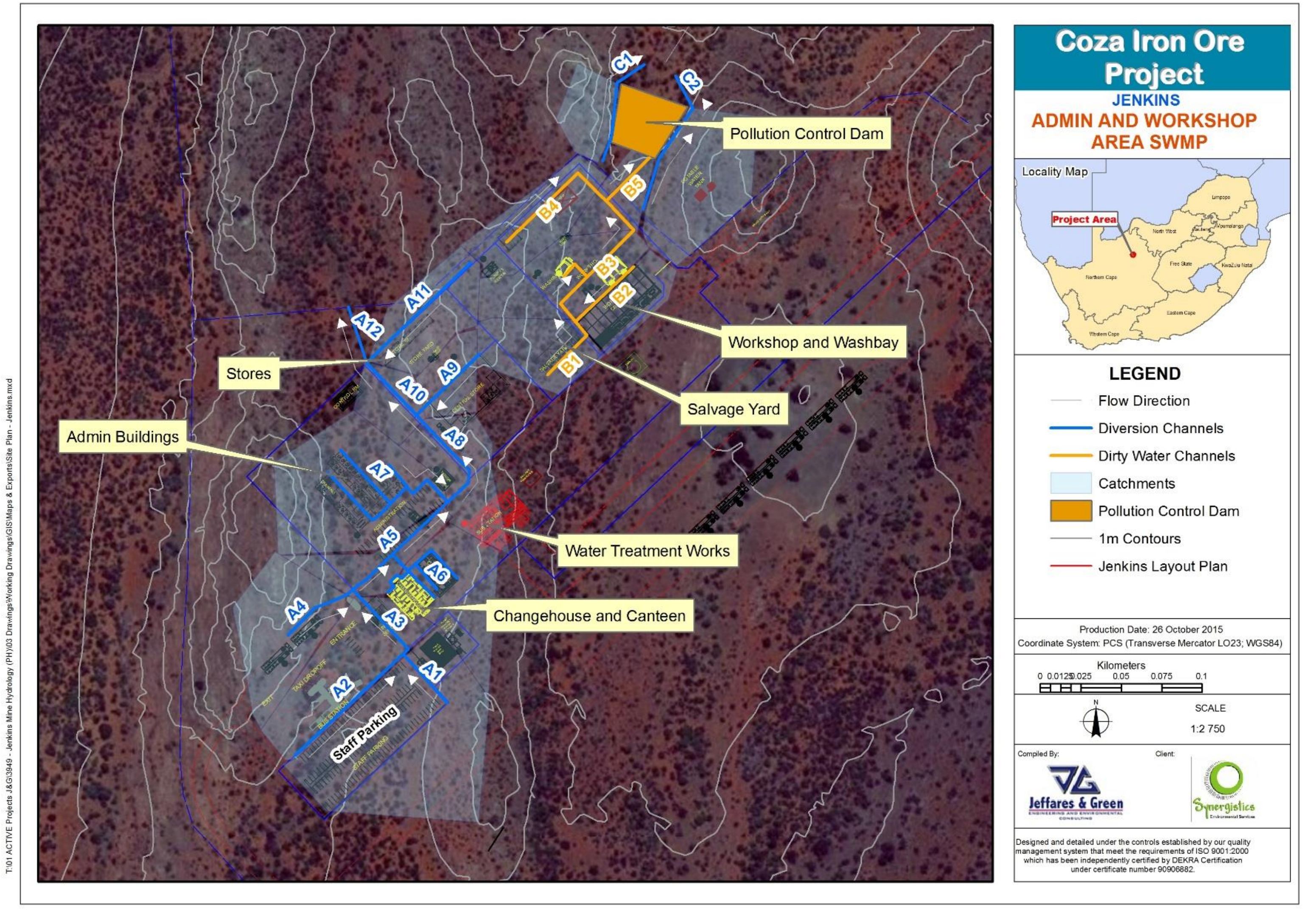


Figure 5-1 Admin and Workshop Area Proposed SWMP Infrastructure

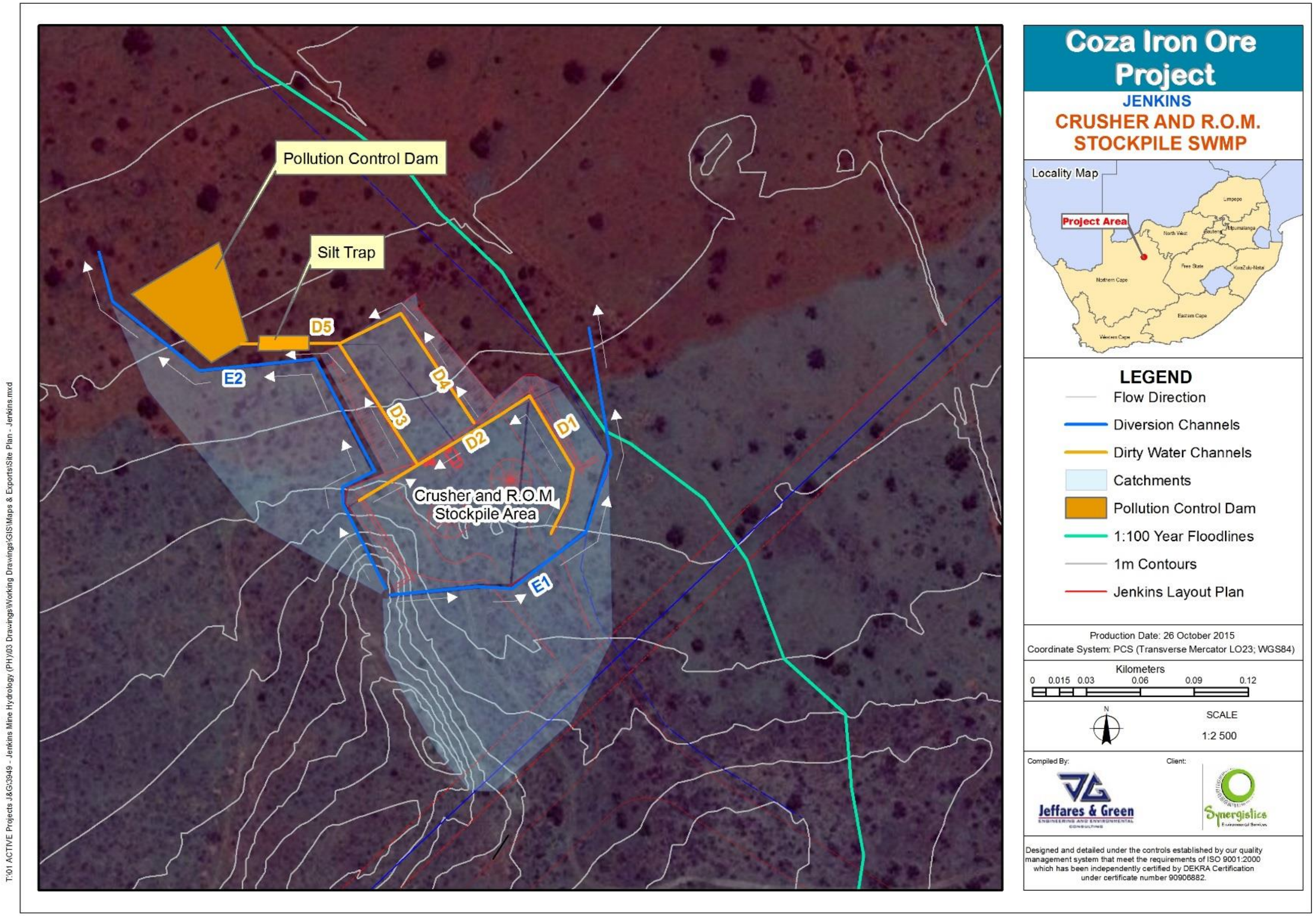


Figure 5-2 Crusher and ROM Stockpile Area Proposed SWMP Infrastructure

Table 5-3 Proposed Clean Stormwater Management Infrastructure Dimensions

Channel Name	Channel Shape	Bottom Width (m)	Top Width (m)	Height/Depth (m)
Channel A1 & A2	Trapezoidal	0.5	1.5	0.5
Channel A3	Trapezoidal	0.7	1.9	0.6
Channel A4	Trapezoidal	0.4	1.2	0.4
Channel A5	Trapezoidal	0.4	1.2	0.4
Channel A6	Trapezoidal	0.4	1.2	0.4
Channel A7	Trapezoidal	0.4	1.3	0.45
Channel A8	Trapezoidal	0.6	1.8	0.6
Channel A9	Trapezoidal	0.4	1.2	0.4
Channel A10	Trapezoidal	0.7	1.9	0.6
Channel A11	Trapezoidal	0.4	1.2	0.4
Channel A12	Trapezoidal	0.7	2.1	0.7
Channel C1	Diversion Berm (earthen embankment)	1.5	0.5	0.5
Channel C2	Diversion Berm (earthen embankment)	1.5	0.5	0.5
Channel E1	Diversion Berm (earthen embankment)	1.5	0.5	0.5
Channel E2	Diversion Berm (earthen embankment)	1.5	0.5	0.5

5.2.2 Dirty Stormwater Runoff Management

As per principle two of the Best Practice Guideline - A1 (Small-Scale Mining) compiled by the DWA and the requirements of GN 704, dirty water must be collected and contained in a system separate from the clean water system and the risk of spillage or seepage into the clean water systems must be minimised. The containment of dirty or polluted water will minimize the impact of the proposed mining operations on the surrounding environment. The proposed stormwater management infrastructure for dirty or contaminated stormwater runoff includes a series of stormwater channels around the Workshop Area and Crusher/ROM Stockpile area, as depicted in **Figures 5-1** and **5-2** (orange coloured channels). For each of these areas, it is proposed that a separate pollution control dam is constructed. It is understood that initially Coza Project engineers have proposed a central Pollution Control Dam to service both areas. There are, however complications associated with this proposal. The first is that by having the proposed Pollution Control Dam far from the expected sources of pollution, the likelihood and volume of clean and dirty stormwater runoff mixing is significantly increased. In addition to this, the flat nature of the project site will make it difficult to efficiently transfer contaminated stormwater runoff to a central pollution control dam (there is a high probability that stormwater channels will be blocked by sediment). Based on this, as part of the SWMP it is proposed that separate pollution control dams are constructed at each of the respective potential dirty stormwater runoff areas.

5.2.2.1 Workshop Area and Crusher/ROM Stockpile Area Stormwater Channels

In order to meet with statutory (GN 704) requirements, the stormwater channels and pollution control dams need to be sized to accommodate the 1:50 year design flood event. The catchment characteristics, C Factors and resultant peak discharge values are presented in **Table 5-4** and **Table 5-5**. Based on the calculated 1:50 year peak discharge values, dimensions of the proposed stormwater management infrastructure are presented in **Table 5-6**.

Table 5-4 Dirty Stormwater Channel Catchment Characteristics

Catchment	Catchment Area (km^2)	Stream Length (m)	Slope (m/m)	Time of Concentration (hrs)
Channel B1	0.0026	45	0.002	0.07
Channel B2	0.0018	48	0.002	0.07
Channel B3	0.0037	150	0.002	0.17
Channel B4	0.0030	85	0.002	0.11
Channel B5	0.0015	195	0.002	0.21
Channel D1	0.0034	85	0.013	0.11
Channel D2	0.0098	190	0.010	0.11
Channel D3	0.0122	268	0.020	0.05
Channel D4	0.0030	110	0.020	0.14
Channel D5	0.0152	378	0.020	0.11

Table 5-5 Dirty Stormwater Management Infrastructure Peak Discharge Calculation Results

Channel Name	1:50 Year Average Rainfall Intensity (mm) (PI)	Catchment C Factor	1:50 Year Peak Discharge (m^3/s)
Channel B1	143.6	0.85	**0.061**
Channel B2	143.6	0.85	**0.050**
Channel B3	143.6	0.85	**0.105**
Channel B4	143.6	0.85	**0.085**
Channel B5	143.6	0.85	**0.043**
Channel D1	143.6	0.85	**0.096**
Channel D2	143.6	0.85	**0.276**
Channel D3	143.6	0.85	**0.342**
Channel D4	143.6	0.85	**0.084**
Channel D5	143.6	0.85	**0.427**

Table 5-6 Proposed Clean Stormwater Management Infrastructure Dimensions – Admin and Workshop Area

Channel Name	Channel Shape	Bottom Width (m)	Top Width (m)	Height/ Depth (m)
Channel B1	Trapezoidal	0.30	0.90	0.30
Channel B2	Trapezoidal	0.30	0.90	0.30
Channel B3	Trapezoidal	0.30	1.10	0.40
Channel B4	Trapezoidal	0.30	1.10	0.40
Channel B5	Trapezoidal	0.30	0.90	0.30
Channel D1	Trapezoidal	0.30	1.10	0.40
Channel D2	Trapezoidal	0.50	1.50	0.50
Channel D3	Trapezoidal	0.50	1.70	0.60
Channel D4	Trapezoidal	0.30	1.10	0.40
Channel D5	Trapezoidal	0.50	1.70	0.60

5.2.3 Pollution Control Dam Sizing

As depicted in **Figure 5-1** and **Figure 5-2**, pollution control dams are proposed at the low points of the Workshop area (Pollution Control Dam 1) and Crushing/ROM Stockpile area (Pollution Control Dam 2). In order to meet with statutory requirements, the pollution control dams at a minimum, need sufficient capacity to accommodate the volume of water generated during the 1:50 year design flood storm event. The method used to calculate the volume of stormwater runoff generated during a storm of this recurrence interval was the SCS Stormflow Equation (Schulze *et al.,* 1992). The SCS Stormflow Equation is defined as:

$$Q = ((P - I_a)^2)/(P - I_a + S) \qquad \textbf{Equation 2}$$

Where

Q = stormflow depth (mm),

P = daily rainfall depth (mm), usually input as a one-day design rainfall for a given return period,

S = potential maximum soil water retention (mm)

I_a = initial losses (abstractions) prior to the commencement of stormflow comprising of depression storage, interception and initial infiltration (mm)

The minimum required capacities of the Pollution Control Dams, based on the depth of runoff emanating from the project site in the 1:50 year return period storm event, are presented in **Table 5-7**.

Table 5-7 Proposed Pollution Control Dam Capacities

	Catchment Area (km²)	Rainfall Depth (mm)	Curve Number	Maximum Soil water Retention (S) (mm)	Initial Losses (I_a)	Runoff Depth (mm)	Runoff Volume (m³)
Pollution Control Dam 1 (Workshop Area)	0.0182	114.8	90	28.2	2.82	89.43	**1 630**
Pollution Control Dam 2 (ROM Stockpile)	0.0198	114.8	90	28.2	2.82	89.43	**1 770**

Based on experience in the mining industry, pollution control dams are seldom managed such that they are empty prior to a rainfall event and therefore generally don't have capacity to contain stormwater runoff during the 1:50 year return period storm event at all times (as per statutory requirements). It is therefore recommended that an additional operational volume is allowed in the sizing of the Pollution Control Dams. An additional operational capacity of 40 % of the calculated 1:50 stormflow volume is recommended for the dams. Based on this, the recommended capacities of the dams are **2 300 m³** for Pollution Control Dam 1 (Workshop Area) and **2 500 m³** for Pollution Control Dam 2 (ROM Stockpile and Crusher Area). This additional operational capacity will allow for storage of operational water, such as water from the Washbay reporting to Pollution Control Dam 1. It should be noted that by building the two separate Pollution Control Dams, the required storage capacity of the dam will be less as the respective catchment areas will be less. It is expected that this will allow for a cost saving to the mine. It is also recommended that a silt trap is constructed upstream of the ROM Stockpile and Crusher Area. The sizing of the silt trap is based on the average size of the silt particles reporting to the dam, and therefore will be appropriately sized during the detailed design phase of the project.

5.2.4 Stormwater Management around the Mining Area

As presented in **Figure 5-4**, it is proposed that paddock walls are constructed around the Waste Rock Dump and Topsoil Stockpile. The purpose of the paddock walls is to prevent stormwater runoff from Waste Rock Dump and Topsoil Stockpile from entering the downstream environment. Due to the location of the open pit, it is not necessary to construct diversion berms around the outside of the pit as stormwater runoff will naturally run away from the pit. Stormwater falling directly into the pit will be collected in a sump from which excess water will be pumped to the Raw / Process Water Dam.

It is understood that initial layout plans included a Pollution Control Dam adjacent to the Waste Rock Dump. However, based on the anticipated quality of stormwater runoff from this area, it is proposed that instead of a pollution control dam, paddock walls are constructed to manage stormwater in this area (significantly cheaper than constructing a pollution control dam). Due to the significantly negative environmental water balance (mean annual evaporation demand is six times greater than the mean annual rainfall), the paddock walls will serve as an effective means of control for preventing runoff to the downstream environment. The proposed height of the paddock walls are based on the following assumptions:

- Waste dump height of 30 m;
- SCS-SA curve number of 70;
- 1:50 year 24 hour design rainfall of 115 mm;
- Mean Annual Precipitation of 322 mm;
- Mean Annual Evaporation of 2250 mm;
- Minimum Paddock Length of 15 m; and
- Width of Paddock 250 m.

Based on the above assumptions, a minimum earthen paddock wall height of **0.6 m** is required. Please refer to **Figure 5-3** for a cross-sectional view of a typical paddock wall and waste dump construction. The final design and location of the paddock walls will need to be designed by the project engineers, based on the dimensions proposed above.

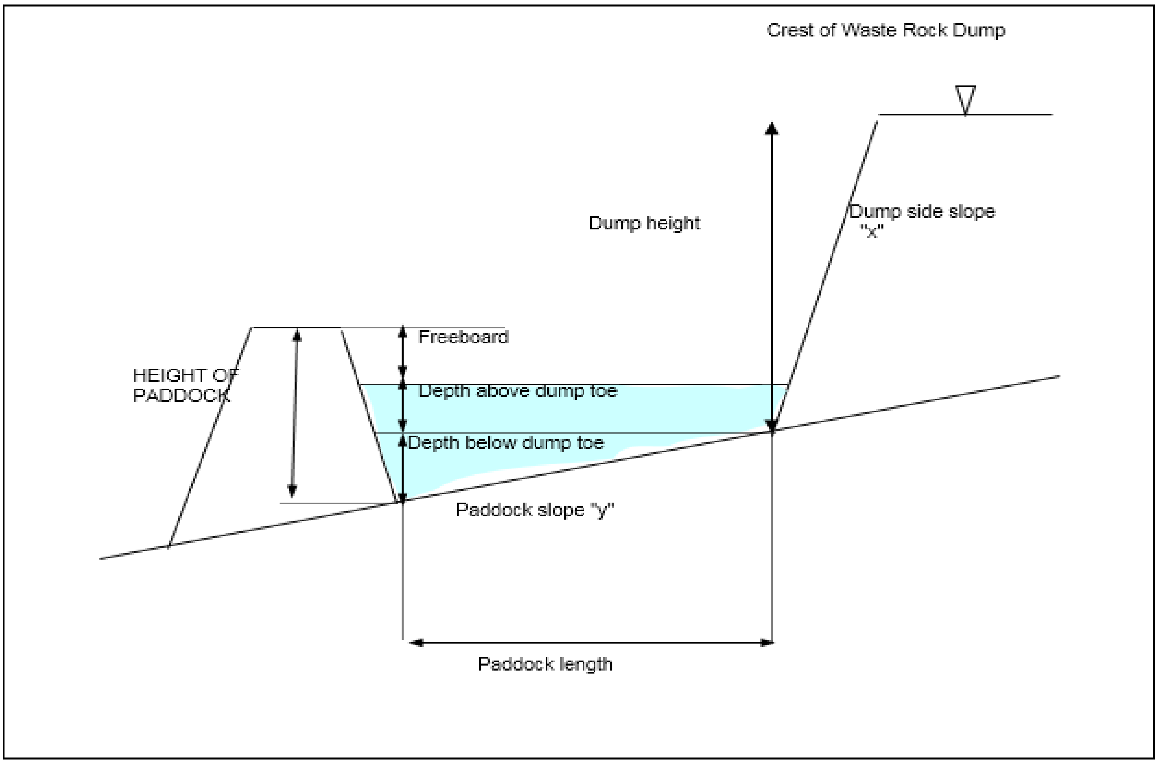


Figure 5-3 Typical Section of Paddock Wall Construction for Waste Dumps

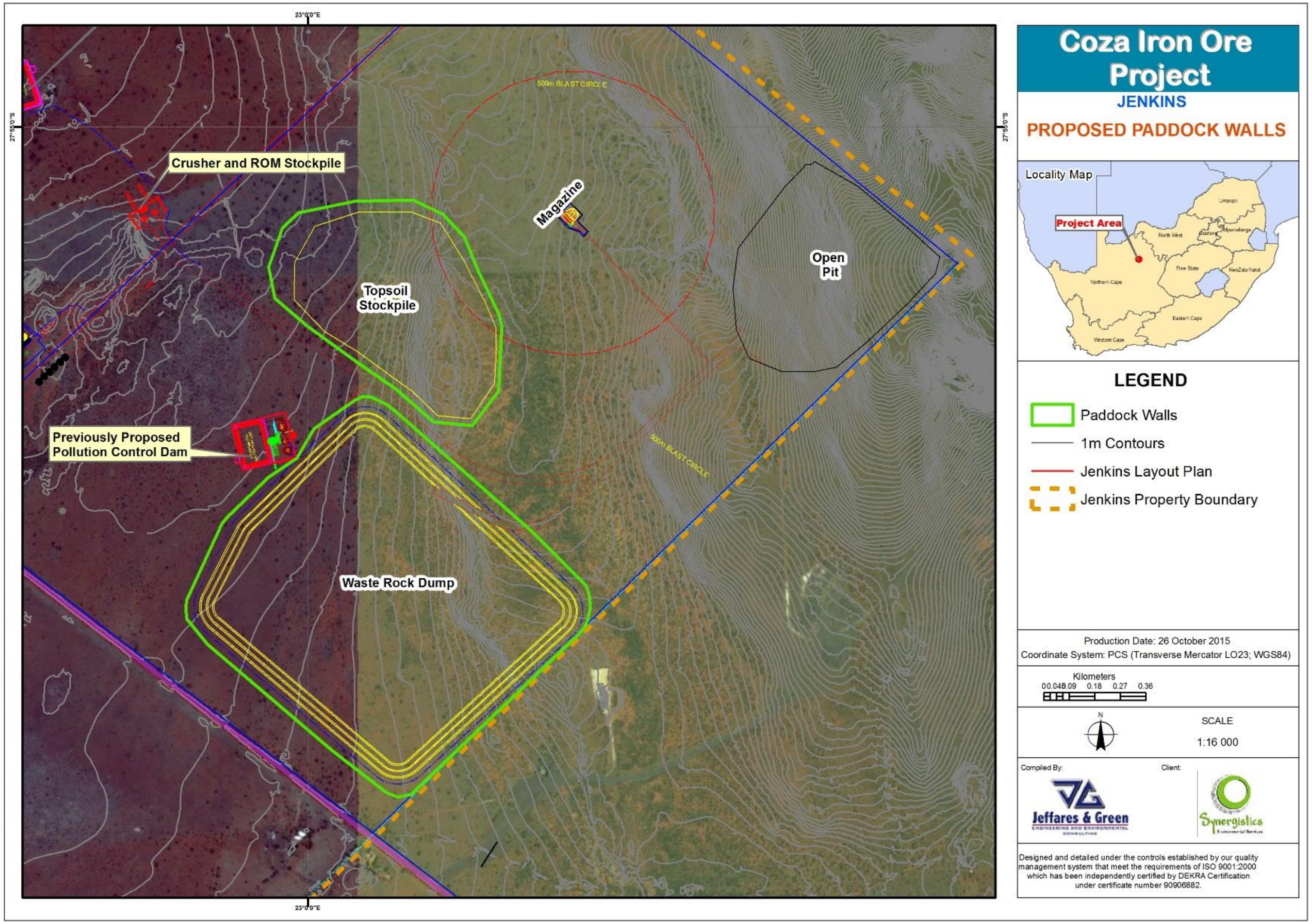


Figure 5-4 Proposed Paddock Wall Locations

6 WATER BALANCE STUDY

The monthly water balance for the Jenkins mining area was compiled based on the methodology outlined by the Department of Water Affairs (DWA) best practice guidelines G2 for water and salt balances. As per the guidelines, the water balance was compiled using the following steps and methodology:

- Define the objectives of the water balance,
- Define the boundaries for the individual balances,
- Identify all water circuits and develop a schematic flow diagram,
- Develop and solve balances for the respective units,
- Develop an output format,
- Assess the level of detail required, and
- State assumptions.

6.1 Methodology

Step 1: Define the objectives of the balances

The objectives of the study are to prepare a water balance to simulate:

- Average monthly water requirements for:
  - Dust suppression,
  - Drilling rigs,
  - Working faces and shovel,
  - Wash bay requirements, and
  - Potable water consumption.
- The storage of water in the Raw / Process Water and Pollution Control Dams; and
- The movement of water between the different sections of the mine.

Step 2: Define the boundaries for the individual balances

The following individual balances have been identified and solved for the proposed Jenkins mining area:

- Open Pit,
- Raw / Process Water Reservoir,
- Wash-bay,
- Pollution Control Dam (sizing based on GN 704 requirements as presented in **Section 5**),
- Potable Water Reservoir,
- Offices, Changehouse and Workshop, and

- Waste Water Treatment Works.

Step 3: Identify all water circuits and develop a schematic flow diagram

The third step in creating the Jenkins water balance was to develop a schematic of the assumed water reticulation for the mine. A schematic depicting the future mine situation is provided in **Figure 6-1**. This schematic is based on expected water use information provided by the client and the proposed layout plan of the mine. As per the information provided, the following water reticulations have been included in the water balance schematic:

- Fissure water and rainfall falling into the pit will be pumped to the Raw / Process Water Dam to augment water supply to the mine,
- The main water supply to the mine will be borehole water pumped to the Raw / Process Water Reservoir,
- Water required for dust suppression, working faces, drill rigs and the washbay will be supplied from the Raw / Process Water Reservoir,
- Water from the washbay will be directed to the pollution control dam from which excess water should be used for dust suppression, and
- Treated waste water from the sewage treatment works is directed to the pollution control dam for reuse.

Step 4 and 5: Develop and solve balances for the respective units, and develop an output format

The **Figure 6-1** shows the resulting water balance for the mine. Inputs into the various infrastructure are given on the left of the diagram and outflows are given on the right of the diagram. All figures presented in the balance are provided as cubic meters per month (m^3/month).

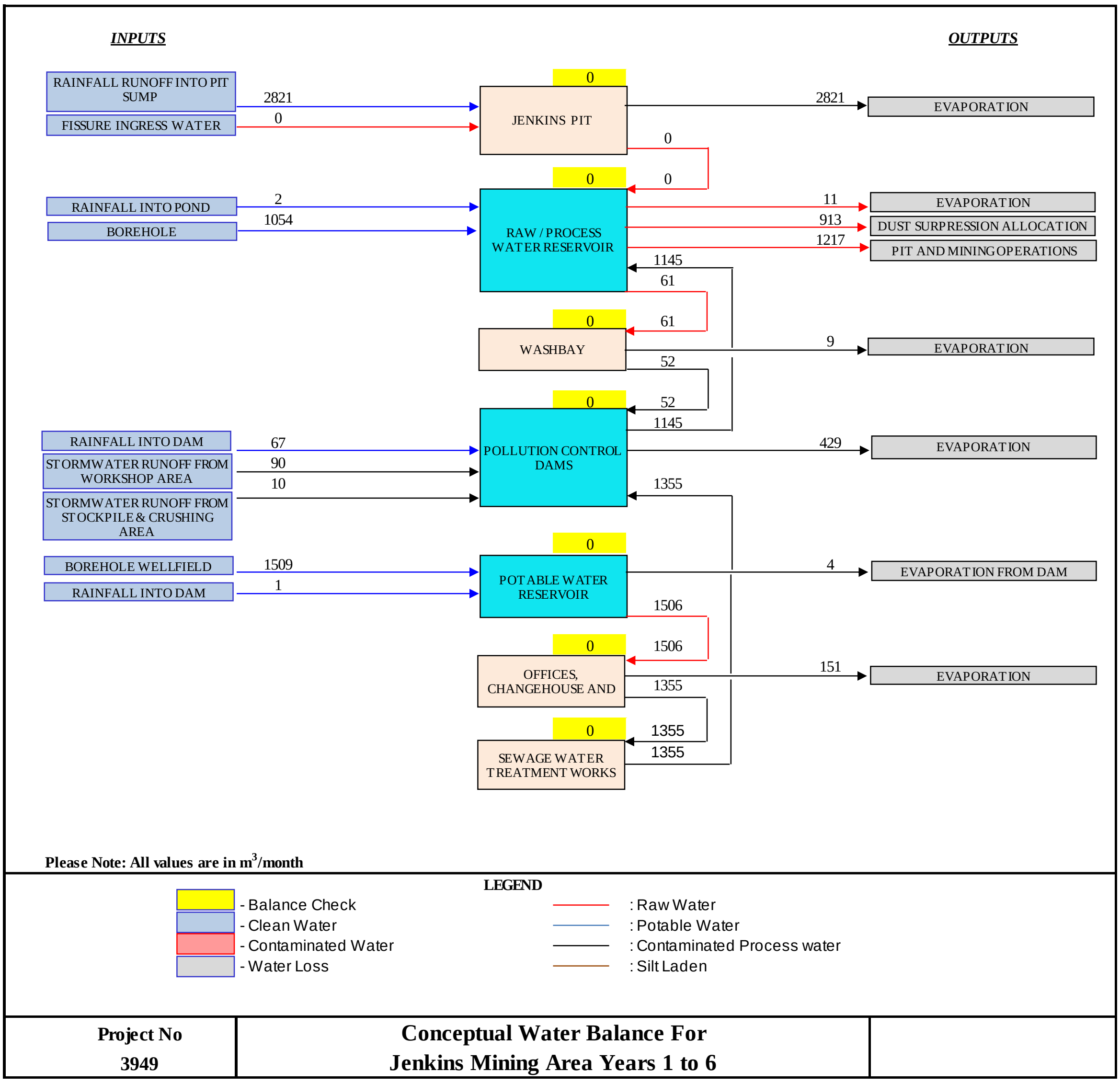


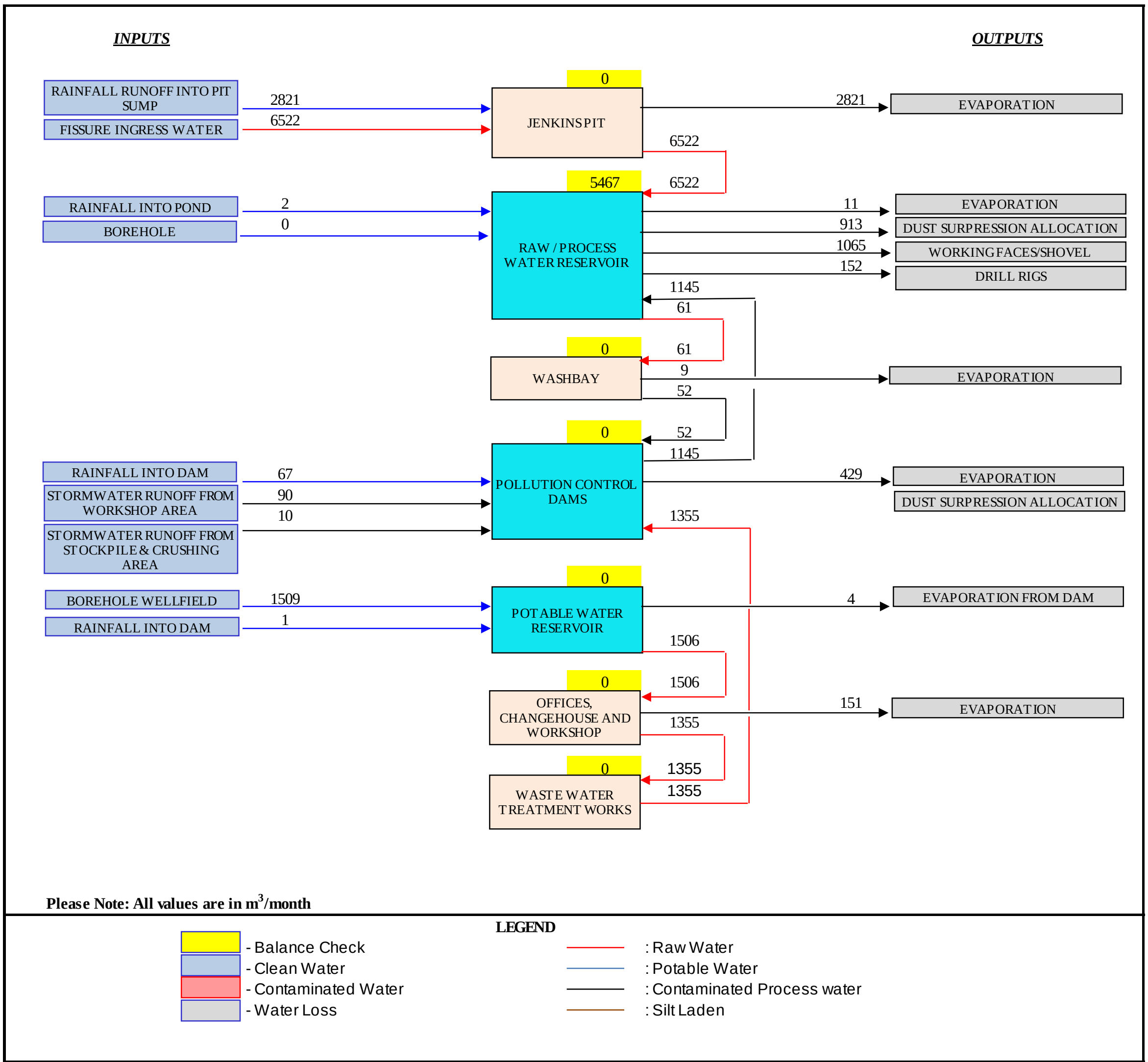
Figure 6-1 Jenkins Year 1 to Year 6 Conceptual Water Balance

Step 6: Assess the level of detail required

The level of detail provided in the water balance is based on average monthly values in cubic meters. This level of detail is sufficient for this study, as the input variables used to calculate the water balance have been provided on a monthly basis. Five water balance diagrams have been provided in this study. Changes in the water balance diagrams are largely due to the anticipated changes in ground water ingress at the open pit during the life of mine. The water balance scenarios solved in this study include:

- The water balance representative of the first six years of the life of mine. During this time, it is expected that there will be no groundwater ingress into the open pit, as depicted in **Figure 6-1**.

- During year seven, information provided by the groundwater specialists indicate groundwater ingress at the open pit will be between 160 and 270 m^3/day. Based on this, an average groundwater ingress rate of 215 m^3/day was used in the formulation of the water balance, as depicted in **Figure 6-2**. All other water uses, such as process water requirements (working faces, drilling and dust suppression) and potable water requirements will stay the same.
- During year eight, the expected groundwater ingress at the open pit will be between 140 and 240 m^3/day. Based on this, an average groundwater ingress rate of 190 m^3/day was used in the formulation of the water balance, as depicted in **Figure 6-3**. All other water uses, such as process water requirements (working faces, drilling and dust suppression) and potable water requirements will stay the same.
- During year nine, information provided indicates that groundwater ingress at the open pit will be between 130 and 230 m^3/day. Based on this, an average groundwater ingress rate of 180 m^3/day was used in the formulation of the water balance, as depicted in **Figure 6-4**. All other water uses, such as process water requirements (working faces, drilling and dust suppression) and potable water requirements will stay the same.
- During year ten, information provided by the groundwater specialists indicate groundwater ingress at the open pit will be between 250 and 500 m^3/day. Based on this, an average groundwater ingress rate of 375 m^3/s was used in the formulation of the water balance, as depicted in **Figure 6-2**. All other water uses, such as process water requirements (working faces, drilling and dust suppression) and potable water requirements will stay the same.



Project No	CONCEPTUAL WATER BALANCE FOR	
3949	Jenkins Mining Area Year 7	

Figure 6-2 Jenkins Year 7 Conceptual Water Balance

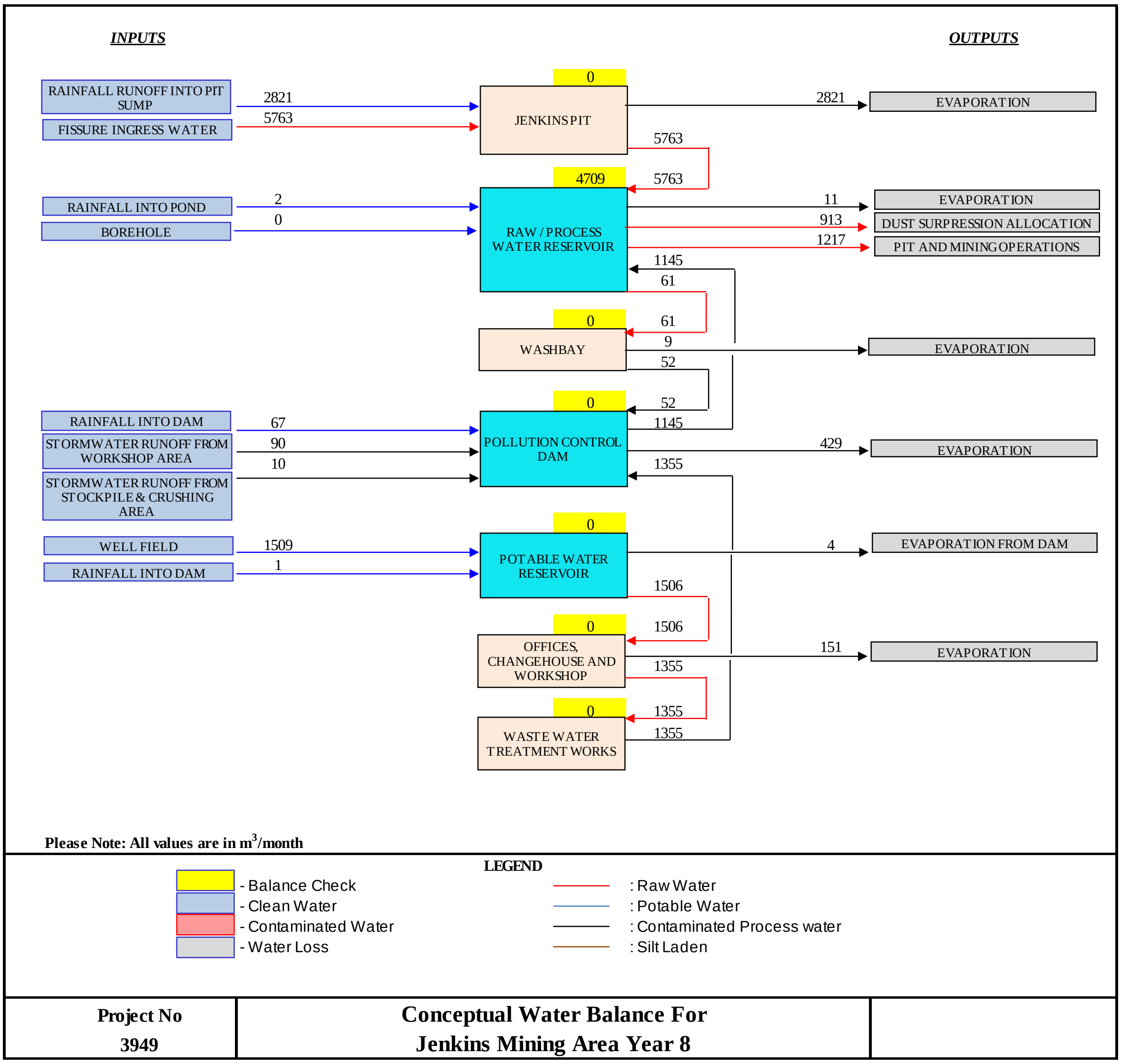


Figure 6-3 Jenkins Year 8 Conceptual Water Balance

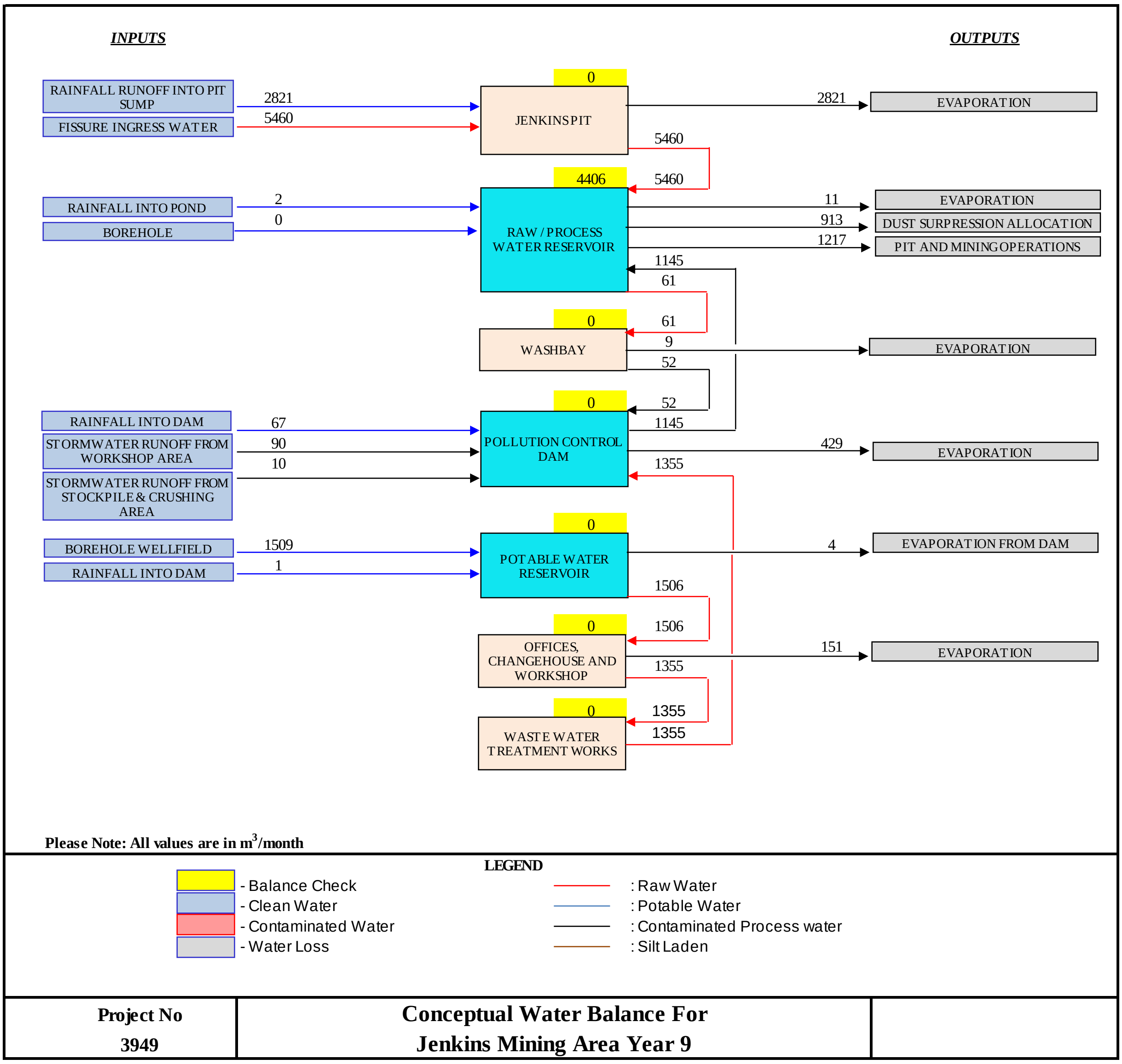


Figure 6-4 Jenkins Year 9 Conceptual Water Balance

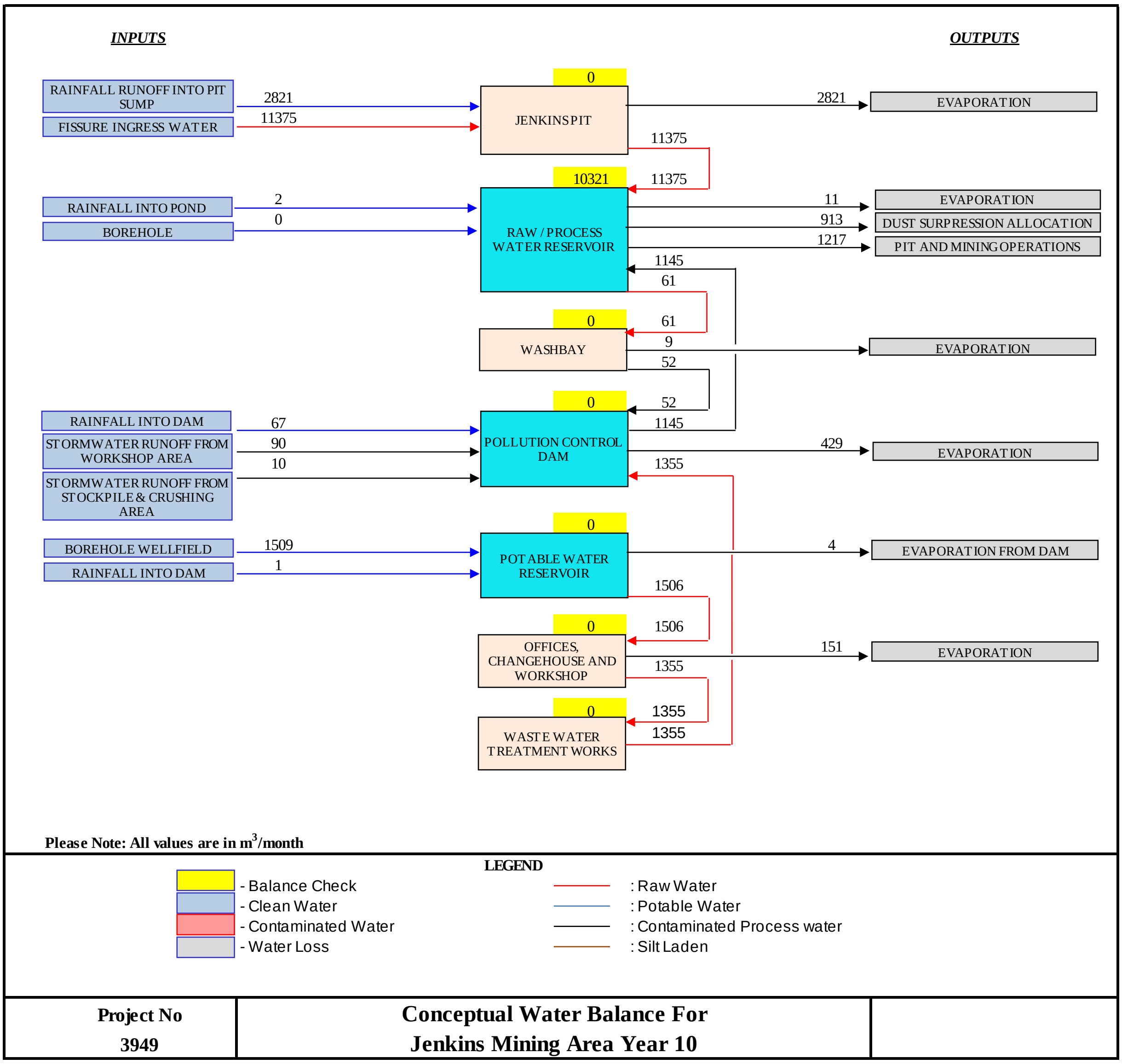


Figure 6-5 Jenkins Year 10 Conceptual Water Balance

Step 7: Assumptions

Due to the fact that the mine does not yet exist, it was necessary to make a number of educated assumptions for the water balance. **Table 6-1** describes the assumptions made in developing the water balance.

Table 6-1 Assumptions Made for the Water Balance

Variable	Value	Comment
Climate		
Mean Annual Rainfall (mm)	322	Obtained from WR2012 for Quaternary Catchment D73A
Mean Annual Evaporation (mm)	2 450	Obtained from WR2012 for Evaporation Zone 7A
Mine Layout		
Pollution Control Dam Area (m^2)	2 500	Based on Stormwater Management Plan Recommendations
Raw / Process Water Dam Area (m^2)	64	Information Provided (Diameter of 20 m)
Potable Water Dam Area (m^2)	24	Information Provided (Diameter of 8 m)
Jenkins Pit Area (m^2)	350 460	Measured from layout plan provided
Crushing, Screening & Stockpile Area (m^2)	1 325 000	Measured from layout plan provided.
Workshop Area (m^2)	18 000	Measured from layout plan provided
Pollution Control Dam Volume (m^3)	5 000	Combined capacity of both Pollution Control Dams
Jenkins pit surrounding catchment area	-	Assumed diversion berms will be placed around the open pit
Water Requirements		
Dust Suppression (m^3/month)	915	Provided by the Client
Wash Bay (m^3/month)	61	Assumed individual area uses, however, the figure of 75 m^3/day or 2 350 m^3/month for process water demands (i.e. water used at the washbay, working faces and drill rigs) was provided by the client.
Working Faces/shovel (m^3/month)	1 067.5	
Drill Rigs (m^3/month)	152.5	
Potable Water (m^3/month)	1 510	As provided by the client. 180 staff using 50 ℓ per person per day and 270 staff using 150 ℓ per day
Groundwater Ingress – Jenkins Pit		
Average Ground Water Ingress Years 1 to 6 (m^3/day)	0	Provided by the client.
Average Ground Water Ingress Year 7 (m^3/day)	215	
Average Ground Water Ingress Year 8 (m^3/day)	190	
Average Ground Water Ingress Year 9 (m^3/day)	180	
Average Ground Water Ingress Year 10 (m^3/day)	375	

6.2 Results

The water balance for the proposed Jenkins mining area was undertaken using a number of assumptions, based largely on information supplied by the client. The water balance provides average monthly water requirements in cubic meters for the various sections of the mine. These water requirements are summarised as follows:

- Based on information supplied, process water requirements for the mine are approximately 2 190 m^3/month. This is based on a daily water requirement of 42 m^3/day for the mining operations (open faces and drill rigs for example) and approximately 30 m^3/day used for dust suppression.
- Potable water requirements were based on a staff compliment of 180 people each using approximately 50 litres of water a day, and an additional 270 people using approximately 150 litres per day. This equates to a potable water demand of approximately 50 m^3/day or 1 509 m^3/month.
- During years 1 to 6, the water demand from the boreholes will be an average of 1 054 m^3/month for process water. During the dry periods (April to October) of years 1 to 6, the maximum water demand that will need to be supplied from the borehole / boreholes will be 1 253 m^3/month.
- Borehole water demand figures decrease to zero for the remainder of years 7 to 10. This is due to the volume of water that enters the mine water system (therefore supplement borehole water supply) as fissure water pumped from the open pit to the Raw / Process Water Dam.
- During year seven, it is expected that an average of 6 522 m^3/month will be pumped to the Raw / Process Water Dam from the open pit. The maximum volume that will need to be pumped from the Open Pit will be 6 665 m^3/month during the months December and January of year 7. This will result in an excess volume of water equal to approximately 5 467 m^3/month at the Process Water Dam (water that doesn't have a scheduled use at the mine, indicated in the yellow box above the Raw / Process Water Dam in **Figure 4-2**). If this water cannot be used at the mine, it will most likely be required that the excess water is treated to a water quality level acceptable to DWS standards so that it can be discharged to the environment.
- During years 8, 9 and 10 the volume of water to be pumped from the open pit will be an average of 5 763 m^3/month, 5 460 m^3/month and 11 375 m^3/month respectively. The maximum water to be pumped from the open pit during this period will be 11 625 m^3/month during year 10. This will result in excess water in the mine water system, which may be required to be treated for discharged, equal to 4 709 m^3/month, 4 406 m^3/month and 10 321 m^3/month for years 8, 9 and 10 respectively.

- Based on the volume of water that needs to be pumped from the open pit, it is recommended that the capacity of the Raw / Process water dam is sized based on the volume of water pumped from the Open Pit during two consecutive months where the pumping requirements are highest. Based on this, during months July and August of year 10, the volume of water pumped from the open pit is equal to 21 235 m^3. It is therefore recommended that the Raw / Process Water Dam capacity is **21 235 m^3**. This storage requirement may change based on the capacity of Jenkins Mine to treat and discharge excess water i.e. the higher the capacity of the treatment works the lower the storage requirement of the Raw / Process Water Dam.

7 CONCLUSION AND RECOMMENDATIONS

As part of the initial baseline hydrological assessment, it was found that a number of pans and drainage lines are located within the proposed Jenkins Mine area. The most significant drainage line is located on the western portion of the property. This drainage line has a catchment area of approximately 199 km^2. Based on the proposed mine infrastructure layout plan, no mine infrastructure is located in the vicinity of this drainage line. Other drainage lines within the mining area were associated with significantly smaller catchment areas (less than 15 km^2). In addition to the drainage lines, several pans were identified within the study area, based on various wetland databases (i.e. NFEPA). The location of these pans were verified though the assessment of aerial photography, contour information and confirmed during the site visit. The most significant pan likely to be affected by mining activities is that located within the railway loop. Careful management of mining infrastructure around these pan locations is recommended so that potential impacts of the mine are minimised. It should, however, be noted that the ephemeral pans are of no significant biodiversity conservation value. Only one registered water user was identified in the region of the proposed Jenkins Mine. This user is the Khumani Mine, located approximately 5 km north of the Jenkins Mine area.

The 1:50 and 1:100 year return period floodline extents were determined for all drainage lines located within the Jenkins Mine precinct. Based on catchment areas, the Unit Hydrograph method was used to calculate the peak discharge values associated with Drainage Line 1 located on the south western boundary of the mine. For the remainder of the drainage lines, peak discharge calculations were undertaken using the Rational Method, as these catchments are relatively small (less than 15 km^2). The flood inundation areas (floodlines) were simulated using the HEC-RAS model. This model provided high water flood levels associated with the calculated design flood peak discharge values. The resultant floodlines where plotted using GIS. The floodline results indicated that most of the proposed mine infrastructures is located outside of the delineated 1:50 and 1:100 year floodline areas. During the 1:50 and 1:100 year flood events, infrastructure likely to be affected includes roads and a portion of the railway loop. It is expected that the impact of the flood events on this infrastructure will be negligible due to the low velocities and shallow flow depths associated with the flood events in the study area. It is recommended that all future mine developments are limited to areas outside of the delineated 1:100 year floodlines.

As per principal one of the DWA Best Practice Guideline - A1 and requirements stipulated in the GN 704, clean stormwater runoff must be kept clean and be routed to a natural watercourse by a system separate from the dirty water system, while preventing or minimising the risk of mixing clean and dirty stormwater runoff. Based on this principle several clean water diversion berms and stormwater management channels around areas likely to result in clean stormwater runoff have been proposed for the Jenkins mining area. In addition to this, as per principle two of the Best Practice Guideline - A1 and requirements stipulated in the GN 704, which states that dirty water must be collected and contained in a system separate from the clean water system and the risk of spillage or seepage into the clean water systems must be minimised, dirty stormwater channels around the Workshop Area and Crusher/ROM Stockpile area have been proposed. All stormwater channels were sized based on the 1:50 year return period storm event.

Two Pollution Control Dams have been proposed to contain stormwater runoff from the Workshop area and the Crusher/ROM Stockpile area. The minimum capacity requirements of the two Pollution Control Dams were calculated using the SCS stormflow equation and based on the 1:50 year return period storm event. In addition to the calculated 1:50 stormflow volume calculated for each of the respective Pollution Control Dams, an additional storage capacity to account for operational water requirements have been recommended. The resultant recommended pollution control dam capacities equates to **2 300 m^3** for Pollution Control Dam 1 (Workshop Area) and **2 500 m^3** for Pollution Control Dam 2 (ROM Stockpile and Crusher Area).

Instead of a pollution control dam located at the Waste Rock Dump (as indicated in initial mine layout plans), it was recommended that Paddock Walls are constructed around the Waste Rock Dump and Topsoil Stockpile. The proposed paddock walls will ensure contaminates and sediments from the dump and stockpile will not enter the downstream receiving environment.

As part of the hydrological assessment, a high level conceptual water balance for the proposed Jenkins mining area was undertaken using a number of assumptions, based largely on information supplied by the client. A summary of the results obtained from the water balance is as follows:

- Based on information supplied, process water requirements for the mine are approximately 2 190 m^3/month. This is based on a daily water requirement of 42 m^3/day for the mining operations (open faces and drill rigs for example) and approximately 30 m^3/day used for dust suppression.
- Potable water requirements were based on a staff compliment of 180 people each using approximately 50 litres of water a day, and an additional 270 people using approximately 150 litres per day. This equates to a potable water demand of approximately 50 m^3/day or 1 509 m^3/month.

- During years 1 to 6, the water demand from the boreholes will be an average of 1 054 m^3/month for process water. During the dry periods (April to October) of years 1 to 6, the maximum water demand that will need to be supplied from the borehole/s will be 1 253 m^3/month.
- Borehole water demand figures decrease to zero for the remainder of years 7 to 10. This is due to the volume of water that enters the mine water system as fissure water pumped from the open pit to the Raw / Process Water Dam.
- During year seven, it is expected that an average of 6 522 m^3/month will be pumped to the Raw / Process Water Dam from the open pit. The maximum volume that will need to be pumped from the Open Pit will be 6 665 m^3/month during the months December and January of year 7. This will result in an excess volume of water equal to approximately 5 467 m^3/month at the Process Water Dam (water that doesn't have a scheduled use at the mine, indicated in the yellow box above the Raw / Process Water Dam in **Figure 4-2**). If this water cannot be used at the mine, it will most likely be required that the excess water is treated to a water quality level acceptable to DWS standards so that it can be discharged to the environment.
- During years 8, 9 and 10 the volume of water to be pumped from the open pit will be an average of 5 763 m^3/month, 5 460 m^3/month and 11 375 m^3/month respectively. The maximum water to be pumped from the open pit during this period will be 11 625 m^3/month during year 10. This will result in excess water in the mine water system, which may be required to be treated for discharged, equal to 4 709 m^3/month, 4 406 m^3/month and 10 321 m^3/month for years 8, 9 and 10 respectively.
- Based on the volume of water that needs to be pumped from the open pit, it is recommended that the capacity of the Raw / Process water dam is sized based on the volume of water pumped from the Open Pit during two consecutive months where the pumping requirements are highest. Based on this, during months July and August of year 10, the volume of water pumped from the open pit is equal to 21 235 m^3. It is therefore recommended that the Raw / Process Water Dam capacity is **21 235 m^3**. This storage requirement may change based on the capacity of Jenkins Mine to treat and discharge excess water i.e. the higher the capacity of the treatment works the lower the storage requirement of the Raw / Process Water Dam.

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Annexure A

Summary Letter Compiled in Accordance to Appendix 6 of the Environmental Impact Assessment Regulations, 2014 from the National Environmental Management Act, 1998 (Act no. 107 of 1999)

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ENGINEERING & ENVIRONMENTAL CONSULTING

Your Ref.: COZA Project
Our Ref.:JobNo.3949

Phillip Hull (Senior Hydrologist)

Jefffares & Green (Pty) Ltd
P. O. Box 794
Hilton
3201

Contract Number: 0087

23 March 2016

SPECIALIST REPORTING REQUIREMENTS AS PER APPENDIX 6 OF THE EIA REGULATIONS 2014

This letter has been prepared to report on the compliance of Jeffares & Green (Pty) Ltd (J&G) as part of the specialist reporting requirements listed in Appendix 6 of the Environmental Impact Assessment Regulations, 2014 from the National Environmental Management Act, 1998 (Act no. 107 of 1999).

1.(a)(i) Details of the specialist who prepared the report

J&G has undertaken the following specialist studies as part of the proposed Doornpan, Driehoekspan and Jenkins mining operations:

- Baseline Hydrological Study.
- Stormwater Management Plan.
- Water Balance Study.
- Floodline Analysis.

These studies have been undertaken and/or lead by the following specialist:

- Phillip Hull, MSc Hydrology

1.(a).(ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Jeffares & Green (Pty) Ltd
Name / Contact person:	Phillip Hull
Postal address:	P. O. Box 794, Hilton

Branches

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Maun
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Qualifications	*MSc (Hydrology), Pr. Sci. Nat.*		
Registration / Associations	Registration as a Professional Natural Scientist (Hydrological Scientist) Reg No: 400144/11		

1.(b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Phillip Hull , declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

----

Signature of the Specialist

1.(c) an indication of the scope of, and the purpose for which, the report was prepared

The scope of work for this study includes an assessment of the impact of the project on the surface water environment including changes to surface water flow and water quality conditions. In order to satisfy these objectives, the study has been divided into four sections, including a baseline hydrological study, a flood hydrology study, a stormwater management study and a water balance study.

1.(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment

Site visit/investigation
Date: July 2015
Season: Winter
Relevance of the season to the outcome of the assessment: No relevance to the season of the site assessment. Topographical and soil conditions assessed.

1.(e) A description of the methodology adopted in preparing the report or carrying out the specialised process

The following describes the methodologies undertaken as part of this study:

Baseline Hydrology Characterisation

- A site visit was undertaken so as to gain understanding of site conditions, surface water features and drainage lines within the study area.
- A desktop level assessment of the site was undertaken. This included:
  - The assessment of climatic conditions for the site including monthly rainfall, monthly average maximum and minimum temperatures and evaporation characterisation.
  - The determination of design rainfall to be used in flood estimation and the stormwater management plan.
  - The delineation of streams and rivers within the study area as well as their respective contributing catchment areas.
  - Landuse and topographical characterisation of the contributing catchment areas.
  - The identification of wetlands and pans falling within the study area (does not involve the delineation of wetland or pan areas), and assessing the potential impacts of mining activities on the wetlands and pans identified. Recommendations will also be made so as to reduce any potential impacts of the mine on the wetlands and pans identified.
  - Mean Annual Runoff (MAR) for the larger catchment area.
  - Flood trend analysis.

Flood Hydrology

The site visit undertaken during the baseline hydrology characterisation fed into this study. For the determination of the 1:50 year and 1:100 year flood lines, the following activities were undertaken:

- Determine the 1:50 year and 1:100 year peak discharge for the various rivers and tributaries within the study area.
  - Peak discharge calculations were undertaken using an accepted Department of Water Affairs method appropriate to the contributing catchment to determine the required flood peak values.
- The 1:50 and 1:100 year peak discharge for each river and tributary were used in conjunction with contour data to hydraulically simulate the floodlines.

    - The client provided Lidar survey information covering the areas that require floodline delineations.
- Existing hydraulic structures (e.g. low-level causeways, culverts, bridges, etc.) were assessed during the site visit in order to ensure that the effects of these structures are taken into account in the results.
- The hydraulic modelling was undertaken using the HEC-Ras model, using the HEC-GeoRas GIS interface to increase the accuracy of the results.
- A final floodline map for the project site was produced.
- Areas with potential flooding risks were identified, and recommendations were made to reduce the risk.

Stormwater Management Plan

A stormwater management plan was compiled in line with the requirements of the General Notice 704 of the water act (Act 36 of 1998). This included:

- The preparation of a plan that indicates areas of potentially "dirty" stormwater runoff and "clean" stormwater runoff, based on the infrastructural plan provided by the client.
- The sizing and positioning of "dirty" stormwater channels, pollution control dams and recommendations on bunding around areas containing potential hydrocarbon spills.
    - Dirty stormwater channels and bunding walls was sized to contain runoff generated during the 1:50 year storm event, as per the Regulation 704 requirements.
    - Pollution control dams were sized to contain runoff generated during the 1:50 year storm event, as per the Regulation 704 requirements.
- The sizing and positioning of clean stormwater diversion channels or berms so as to keep "clean" stormwater runoff from mixing with "dirty" stormwater runoff.
    - "Clean" stormwater runoff diversion infrastructure was sized to divert runoff generated during the 1:50 year storm event as per the Regulation 704 requirements.
- Reference was made to the floodline study to ensure that all mining infrastructure is located outside of the 1:100 year floodline, as per the requirements of the Regulation 704.
- All infrastructure on site (including rock dumps, stock piles, opencast mining areas, workshops, water management infrastructure, change houses and offices) was accounted for in the stormwater management plan.

Environmental Water Balance

A site wide water balance was compiled. This was based on the mine infrastructural plan provided by the client, climatic characteristics of the site (rainfall and evaporation) and information arising from the Geohydrological Investigation. The water balance was formulated using Microsoft Excel and will be structured such that it can be updated (as more information becomes available) once this study has been completed. It was also developed so that "what if" scenarios can be run. Information pertaining to projected water use (for dust suppression and any other mining related activity) was provided by the client.

1.(f) The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure

Please refer to Section 3 of the Specialist Hydrological Study report for the identification of sensitive areas.

1.(g) An identification of any areas to be avoided, including buffers

Please refer to Section 3 (Baseline Hydrological Study) and Section 4.2 of the Floodline Study report for reference of areas to be avoided.

1.(h) A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers

Please refer to Section 3, and Figure 4-1 of Section 4 for reference of areas to the delineated floodlines and therefore areas to be avoided

1.(i) A description of any assumptions made and any uncertainties or gaps in knowledge

Please refer to Section 6.1 of the Water Balance Study for reference of assumptions made for the water balance study. It is assumed that the values presented in Table 6-1 are accurate and representative of the mine water uses and losses. Further assumptions on the Rational Method presented in Section 4.1.2.

1.(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment

Please refer to Section 4 of the Baseline Hydrology Study Report for identified impacts and mitigation measures.

1.(k) Any mitigation measures for inclusion in the EMPr

Clean and dirty water separation measures presented in Section 5 should be implemented. All mining infrastructure needs to me limited to areas outside of the delineated floodlines.

1.(l) Any conditions for inclusion in the environmental authorisation

None.

1.(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation

No Monitoring was undertaken.

1.(n)(i) A reasoned opinion as to whether the proposed activity or portions thereof should be authorised

Based on the studies undertaken, if due diligence is adopted relating to stipulated legislative requirements, such as GN 704 of the National Water Act 36 of 1998 (as presented in the Stormwater Management Plan Section 5 and Floodline Study Section 4), which provides guidance on the management and location of mine infrastructure, there is no reason to deny authorisation.

1.(n)(ii) A reasoned opinion if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan

Recommendations provided in the Stormwater Management Plan (Section 5) need to be adhered to. Mining infrastructure should be limited to outside of the delineated floodlines (Section 4 of the main report).

1.(o) A description of any consultation process that was undertaken during the course of preparing the specialist report;

No consultation was undertaken as part of the specialist studies.

1.(p) A summary and copies of any comments received during any consultation process and where applicable all responses thereto

No consultation was undertaken as part of the specialist studies.

1.(q) any other information requested by the competent authority.

No information requested.

If you have any queries regarding the above, please do not hesitate to contact me.

Yours Sincerely

Phillip Hull
For: Jeffares & Green (Pty) Ltd.

Annexure B

HEC-RAS Simulation Output Tables

River	Cross Section	Return Period (years)	Q m³/s	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 01	2057.90	50.00	200.00	1230.00	1230.70	0.0063	1.57	157.58	274.54	0.60
River 01	2057.90	100.00	270.86	1230.00	1230.84	0.0062	1.75	195.15	293.50	0.61
River 01	1928.74	50.00	200.00	1229.15	1230.31	0.0020	1.17	251.42	408.79	0.36
River 01	1928.74	100.00	270.86	1229.15	1230.46	0.0020	1.27	314.28	440.66	0.37
River 01	1840.08	50.00	200.00	1229.00	1230.15	0.0016	1.08	277.82	432.80	0.32
River 01	1840.08	100.00	270.86	1229.00	1230.30	0.0016	1.17	344.36	458.72	0.33
River 01	1792.96	50.00	200.00	1229.00	1230.10	0.0011	0.88	337.50	499.46	0.27
River 01	1792.96	100.00	270.86	1229.00	1230.25	0.0011	0.96	414.86	529.38	0.27
River 01	1732.39	50.00	200.00	1229.00	1230.03	0.0013	0.92	284.83	369.95	0.29
River 01	1732.39	100.00	270.86	1229.00	1230.17	0.0014	1.05	338.72	384.81	0.31
River 01	1599.78	50.00	200.00	1229.00	1229.86	0.0013	0.81	305.79	419.68	0.28
River 01	1599.78	100.00	270.86	1229.00	1229.99	0.0014	0.92	360.38	430.34	0.30
River 01	1523.30	50.00	200.00	1229.00	1229.74	0.0019	0.88	277.90	439.33	0.33
River 01	1523.30	100.00	270.86	1229.00	1229.86	0.0020	1.01	330.41	453.81	0.35
River 01	1432.01	50.00	200.00	1228.81	1229.48	0.0040	1.15	220.38	443.61	0.47
River 01	1432.01	100.00	270.86	1228.81	1229.59	0.0041	1.28	267.90	461.54	0.48
River 01	1344.54	50.00	200.00	1228.08	1229.24	0.0022	1.17	273.69	540.54	0.37
River 01	1344.54	100.00	270.86	1228.08	1229.34	0.0023	1.28	328.15	540.54	0.39
River 01	1270.12	50.00	200.00	1228.00	1229.06	0.0028	1.23	269.75	619.37	0.41
River 01	1270.12	100.00	270.86	1228.00	1229.16	0.0027	1.30	334.44	635.17	0.41
River 01	1182.37	50.00	200.00	1228.00	1228.73	0.0049	1.42	210.57	479.94	0.53
River 01	1182.37	100.00	270.86	1228.00	1228.82	0.0052	1.58	256.95	521.26	0.56

River	Cross Section	Return Period (years)	Q m³/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 01	1146.57	50.00	200.00		1227.67	1228.57		1228.62	0.0048	1.36	209.38	479.34	0.52
River 01	1146.57	100.00	270.86		1227.67	1228.62		1228.70	0.0060	1.61	237.28	489.34	0.59
River 01	1071.28	50.00	200.00		1227.00	1228.03		1228.16	0.0074	2.14	157.42	389.93	0.69
River 01	1071.28	100.00	270.86		1227.00	1228.25		1228.33	0.0039	1.78	249.45	455.93	0.52
River 01	1037.48	50.00	200.00		1227.00	1227.85		1227.95	0.0056	1.68	149.10	224.11	0.58
River 01	1037.48	100.00	270.86		1227.00	1228.01		1228.16	0.0076	2.20	189.74	389.72	0.70
River 01	989.70	50.00	200.00		1226.63	1227.45		1227.60	0.0105	2.10	120.13	208.35	0.78
River 01	989.70	100.00	270.86		1226.63	1227.62		1227.79	0.0088	2.21	157.36	227.47	0.74
River 01	899.66	50.00	200.00		1225.54	1226.68		1226.86	0.0073	2.26	115.03	150.84	0.69
River 01	899.66	100.00	270.86		1225.54	1226.86		1227.08	0.0077	2.56	143.64	179.33	0.73
River 01	844.19	50.00	200.00		1225.00	1226.50		1226.58	0.0027	1.51	172.25	218.30	0.43
River 01	844.19	100.00	270.86		1225.00	1226.67		1226.77	0.0029	1.73	212.79	242.19	0.46
River 01	799.84	50.00	200.00		1225.00	1226.43		1226.48	0.0019	1.36	218.38	287.63	0.36
River 01	799.84	100.00	270.86		1225.00	1226.60		1226.67	0.0020	1.52	270.85	319.01	0.38
River 01	718.77	50.00	200.00		1225.00	1226.34		1226.36	0.0010	0.96	297.75	359.02	0.27
River 01	718.77	100.00	270.86		1225.00	1226.50		1226.54	0.0011	1.09	359.77	388.80	0.28
River 01	680.28	50.00	200.00		1225.00	1226.30		1226.33	0.0009	0.91	312.09	372.45	0.25
River 01	680.28	100.00	270.86		1225.00	1226.46		1226.49	0.0010	1.04	374.75	401.87	0.27
River 01	623.02	50.00	200.00		1225.00	1226.23		1226.26	0.0013	1.04	291.28	406.60	0.30
River 01	623.02	100.00	270.86		1225.00	1226.39		1226.43	0.0013	1.14	358.17	434.34	0.31
River 01	588.07	50.00	200.00		1225.00	1226.17		1226.21	0.0016	1.10	256.59	362.68	0.32
River 01	588.07	100.00	270.86		1225.00	1226.33		1226.37	0.0016	1.19	313.76	362.68	0.33

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 01	498.67	50.00	200.00		1225.00	1226.00		1226.04	0.0022	1.17	220.33	294.09	0.37
River 01	498.67	100.00	270.86		1225.00	1226.14		1226.20	0.0024	1.35	269.46	349.31	0.40
River 01	439.60	50.00	200.00		1225.00	1225.84		1225.89	0.0031	1.25	208.66	331.25	0.43
River 01	439.60	100.00	270.86		1225.00	1225.97		1226.03	0.0032	1.39	253.03	348.68	0.45
River 01	396.85	50.00	200.00		1224.91	1225.63		1225.71	0.0062	1.49	168.31	321.19	0.59
River 01	396.85	100.00	270.86		1224.91	1225.76		1225.85	0.0060	1.65	213.09	358.97	0.59
River 01	329.61	50.00	200.00		1224.30	1225.40		1225.45	0.0025	1.23	235.26	398.09	0.40
River 01	329.61	100.00	270.86		1224.30	1225.55		1225.60	0.0024	1.32	294.40	423.90	0.40
River 01	275.42	50.00	200.00	0.67	1224.11	1225.31	1224.78	1225.34	0.0015	0.99	291.67	466.18	0.31
River 01	275.42	100.00	270.86	0.79	1224.11	1225.45	1224.90	1225.49	0.0015	1.09	362.83	502.61	0.32
River 02	3642.49	50.00	8.24	0.04	1239.00	1239.18	1239.05	1239.18	0.0004	0.16	61.94	390.94	0.12
River 02	3642.49	100.00	11.25	0.05	1239.00	1239.21	1239.05	1239.21	0.0004	0.18	73.07	404.65	0.13
River 02	3607.94	50.00	8.24		1239.00	1239.17		1239.17	0.0004	0.15	64.84	436.45	0.12
River 02	3607.94	100.00	11.25		1239.00	1239.19		1239.19	0.0004	0.18	76.52	450.11	0.13
River 02	3504.68	50.00	8.24		1239.00	1239.07		1239.07	0.0046	0.27	33.07	501.27	0.34
River 02	3504.68	100.00	11.25		1239.00	1239.08		1239.09	0.0040	0.30	41.84	509.79	0.33
River 02	3405.55	50.00	8.24		1238.57	1238.74		1238.74	0.0023	0.25	26.23	193.14	0.26
River 02	3405.55	100.00	11.25		1238.57	1238.77		1238.77	0.0024	0.31	32.32	213.76	0.28
River 02	3358.59	50.00	8.24	0.08	1238.38	1238.47	1238.46	1238.50	0.0264	0.50	10.78	127.87	0.77
River 02	3358.59	100.00	11.25		1238.38	1238.49		1238.52	0.0241	0.57	14.06	146.08	0.77
River 02	3289.40	50.00	8.24		1238.09	1238.28		1238.29	0.0011	0.27	35.79	225.03	0.20
River 02	3289.40	100.00	11.25		1238.09	1238.32		1238.33	0.0011	0.30	45.12	237.18	0.20

River	Cross Section	Return Period (years)	Q m³/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 02	3266.98	50.00	8.24		1238.00	1238.27		1238.27	0.0004	0.20	49.91	236.39	0.13
River 02	3266.98	100.00	11.25		1238.00	1238.31		1238.31	0.0004	0.24	59.58	248.17	0.14
River 02	3235.91	50.00	8.24		1238.00	1238.26		1238.26	0.0004	0.21	48.05	225.96	0.13
River 02	3235.91	100.00	11.25		1238.00	1238.29		1238.30	0.0005	0.24	56.96	237.30	0.14
River 02	3191.64	50.00	8.24		1238.00	1238.23		1238.23	0.0008	0.26	37.19	189.11	0.17
River 02	3191.64	100.00	11.25		1238.00	1238.27		1238.27	0.0009	0.30	43.97	197.05	0.19
River 02	3160.57	50.00	8.24		1238.00	1238.20		1238.20	0.0010	0.27	36.14	201.87	0.19
River 02	3160.57	100.00	11.25		1238.00	1238.23		1238.24	0.0011	0.31	42.57	208.72	0.21
River 02	3130.54	50.00	8.24		1238.00	1238.17		1238.17	0.0015	0.29	32.51	213.67	0.23
River 02	3130.54	100.00	11.25		1238.00	1238.19		1238.20	0.0017	0.34	38.39	219.25	0.25
River 02	3097.52	50.00	8.24		1238.00	1238.08		1238.09	0.0047	0.32	24.73	254.60	0.36
River 02	3097.52	100.00	11.25		1238.00	1238.10		1238.11	0.0047	0.37	30.23	258.32	0.37
River 02	3024.81	50.00	8.24		1237.58	1237.71		1237.73	0.0065	0.51	17.74	147.28	0.46
River 02	3024.81	100.00	11.25		1237.58	1237.74		1237.76	0.0062	0.57	22.09	154.62	0.46
River 02	2992.50	50.00	8.24		1237.34	1237.54		1237.55	0.0041	0.42	19.08	120.18	0.37
River 02	2992.50	100.00	11.25		1237.34	1237.59		1237.60	0.0036	0.45	24.78	131.71	0.35
River 02	2964.12	50.00	8.24		1237.20	1237.46		1237.47	0.0022	0.31	22.11	111.07	0.27
River 02	2964.12	100.00	11.25		1237.20	1237.51		1237.52	0.0022	0.35	27.99	123.13	0.28
River 02	2927.28	50.00	8.24		1237.16	1237.39		1237.40	0.0016	0.24	24.21	109.88	0.23
River 02	2927.28	100.00	11.25		1237.16	1237.44		1237.45	0.0017	0.28	29.91	121.09	0.24
River 02	2879.36	50.00	8.24		1237.00	1237.32		1237.33	0.0014	0.29	26.53	119.94	0.22
River 02	2879.36	100.00	11.25		1237.00	1237.37		1237.37	0.0015	0.33	32.20	130.79	0.24

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 02	2847.43	50.00	8.24		1237.00	1237.27		1237.27	0.0016	0.27	25.71	125.98	0.23
River 02	2847.43	100.00	11.25		1237.00	1237.30		1237.31	0.0018	0.31	30.86	134.59	0.25
River 02	2806.32	50.00	8.24	0.20	1236.83	1237.03	1237.03	1237.06	0.0344	0.59	11.89	193.69	0.88
River 02	2806.32	100.00	11.25	0.21	1236.83	1237.04	1237.04	1237.08	0.0359	0.71	14.39	196.33	0.94
River 02	2771.17	50.00	8.24	0.22	1235.77	1235.99	1235.99	1236.04	0.0254	1.14	8.72	80.04	0.93
River 02	2771.17	100.00	11.25	0.25	1235.77	1236.02	1236.02	1236.08	0.0237	1.18	11.58	99.45	0.91
River 02	2733.22	50.00	8.24	0.25	1235.11	1235.39	1235.35	1235.43	0.0107	0.91	10.83	88.87	0.64
River 02	2733.22	100.00	11.25		1235.11	1235.42		1235.47	0.0120	1.04	13.63	105.45	0.68
River 02	2690.47	50.00	8.24		1235.00	1235.11		1235.12	0.0048	0.41	22.42	198.07	0.38
River 02	2690.47	100.00	11.25		1235.00	1235.14		1235.15	0.0047	0.46	27.37	200.86	0.39
River 02	2662.30	50.00	8.24		1234.89	1234.94		1234.96	0.0120	0.25	13.93	124.92	0.48
River 02	2662.30	100.00	11.25		1234.89	1234.97		1234.99	0.0116	0.32	17.39	134.55	0.50
River 02	2616.68	50.00	8.24		1234.30	1234.48		1234.50	0.0098	0.66	15.58	175.72	0.57
River 02	2616.68	100.00	11.25		1234.30	1234.50		1234.52	0.0103	0.74	19.26	184.59	0.60
River 02	2554.78	50.00	8.24		1234.00	1234.10		1234.11	0.0045	0.36	23.37	217.44	0.37
River 02	2554.78	100.00	11.25		1234.00	1234.12		1234.13	0.0043	0.41	28.84	222.84	0.37
River 02	2533.37	50.00	8.24	-0.06	1233.92	1233.94	1233.87	1233.96	0.0086	0.10	15.16	184.61	0.34
River 02	2533.37	100.00	11.25	-0.03	1233.92	1233.98	1233.90	1233.99	0.0087	0.29	22.67	229.58	0.44
River 02	2508.14	50.00	8.24		1233.69	1233.67		1233.69	0.0113		12.37	82.71	0.00
River 02	2508.14	100.00	11.25		1233.69	1233.70		1233.73	0.0106	0.13	16.58	184.67	0.39
River 02	2466.77	50.00	8.24		1233.30	1233.38		1233.39	0.0041	0.27	21.57	205.05	0.33
River 02	2466.77	100.00	11.25		1233.30	1233.40		1233.41	0.0045	0.34	26.59	215.41	0.36

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 02	2377.30	50.00	8.24		1232.74	1232.95		1232.96	0.0059	0.55	20.24	228.38	0.45
River 02	2377.30	100.00	11.25		1232.74	1232.98		1232.99	0.0052	0.58	27.17	265.08	0.43
River 02	2313.58	50.00	8.24	0.15	1232.29	1232.48	1232.44	1232.50	0.0090	0.70	14.25	150.86	0.56
River 02	2313.58	100.00	11.25	0.17	1232.29	1232.49	1232.47	1232.52	0.0112	0.83	16.91	173.19	0.63
River 02	2264.31	50.00	8.24		1232.00	1232.08		1232.08	0.0077	0.40	23.15	315.18	0.46
River 02	2264.31	100.00	11.25		1232.00	1232.10		1232.11	0.0065	0.43	29.75	325.72	0.44
River 02	2235.03	50.00	8.24		1231.88	1231.96		1231.96	0.0030	0.18	27.67	248.28	0.26
River 02	2235.03	100.00	11.25		1231.88	1231.98		1231.98	0.0032	0.21	33.41	262.89	0.28
River 02	2187.18	50.00	8.24	0.10	1231.49	1231.59	1231.59	1231.63	0.0456	0.71	9.66	134.00	1.03
River 02	2187.18	100.00	11.25	0.12	1231.49	1231.61	1231.61	1231.65	0.0355	0.67	13.38	186.03	0.92
River 02	2124.73	50.00	8.24	0.09	1231.05	1231.22	1231.14	1231.23	0.0025	0.34	29.66	251.92	0.29
River 02	2124.73	100.00	11.25	0.11	1231.05	1231.25	1231.15	1231.25	0.0028	0.39	35.10	259.83	0.31
River 02	2089.32	50.00	8.24	0.08	1230.90	1231.01	1230.97	1231.02	0.0158	0.47	16.56	295.87	0.62
River 02	2089.32	100.00	11.25		1230.90	1231.03		1231.04	0.0134	0.52	22.11	300.62	0.60
River 02	2046.53	50.00	8.24	0.11	1230.55	1230.73	1230.66	1230.74	0.0039	0.40	23.02	194.44	0.36
River 02	2046.53	100.00	11.25		1230.55	1230.75		1230.76	0.0040	0.46	28.20	206.07	0.37
River 02	2009.33	50.00	8.24	0.13	1230.25	1230.38	1230.38	1230.42	0.0344	0.98	9.70	126.69	1.00
River 02	2009.33	100.00	11.25	0.15	1230.25	1230.40	1230.40	1230.45	0.0320	1.07	12.44	141.91	1.00
River 02	1944.42	50.00	8.24	0.06	1230.00	1230.20	1230.07	1230.21	0.0008	0.24	42.25	258.60	0.17
River 02	1944.42	100.00	11.25	0.08	1230.00	1230.23	1230.08	1230.24	0.0009	0.28	50.34	272.14	0.18
River 02	1892.28	50.00	8.24		1230.00	1230.17		1230.17	0.0005	0.17	55.74	353.80	0.13
River 02	1892.28	100.00	11.25		1230.00	1230.20		1230.20	0.0006	0.20	65.25	362.35	0.14

River	Cross Section	Return Period (years)	Q m³/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 02	1803.32	50.00	8.24		1230.00	1230.11		1230.11	0.0014	0.21	45.07	441.23	0.20
River 02	1803.32	100.00	11.25		1230.00	1230.13		1230.13	0.0014	0.24	54.03	447.72	0.21
River 02	1762.17	50.00	8.24		1229.89	1230.00		1230.01	0.0047	0.32	23.11	419.97	0.36
River 02	1762.17	100.00	11.25		1229.89	1230.02		1230.03	0.0049	0.37	30.97	426.37	0.38
River 02	1714.79	50.00	8.24		1229.70	1229.81		1229.82	0.0044	0.38	27.85	326.49	0.36
River 02	1714.79	100.00	11.25		1229.70	1229.84		1229.84	0.0040	0.41	35.01	339.54	0.36
River 02	1662.93	50.00	8.24		1229.44	1229.56		1229.57	0.0035	0.29	26.63	250.52	0.31
River 02	1662.93	100.00	11.25		1229.44	1229.59		1229.59	0.0036	0.35	32.68	276.89	0.33
River 02	1586.43	50.00	8.24		1229.18	1229.27		1229.27	0.0047	0.33	29.31	391.34	0.36
River 02	1586.43	100.00	11.25		1229.18	1229.29		1229.30	0.0044	0.37	37.91	442.21	0.36
River 02	1520.66	50.00	8.24		1229.00	1229.13		1229.14	0.0012	0.22	49.18	501.76	0.20
River 02	1520.66	100.00	11.25		1229.00	1229.15		1229.15	0.0012	0.25	58.90	510.94	0.21
River 02	1470.86	50.00	8.24		1228.93	1229.05		1229.05	0.0027	0.26	41.53	615.41	0.28
River 02	1470.86	100.00	11.25		1228.93	1229.06		1229.06	0.0027	0.29	50.55	630.53	0.29
River 02	1429.04	50.00	8.24		1228.66	1228.76		1228.79	0.0213	0.52	12.34	147.05	0.71
River 02	1429.04	100.00	11.25		1228.66	1228.78		1228.81	0.0181	0.61	16.23	198.64	0.70
River 02	1313.03	50.00	8.24		1228.09	1228.19		1228.19	0.0023	0.25	32.59	312.49	0.26
River 02	1313.03	100.00	11.25		1228.09	1228.21		1228.22	0.0025	0.29	39.16	317.73	0.28
River 02	1272.27	50.00	8.24		1228.00	1228.09		1228.09	0.0029	0.26	35.89	437.06	0.28
River 02	1272.27	100.00	11.25		1228.00	1228.10		1228.11	0.0030	0.30	43.19	443.23	0.30
River 02	1199.04	50.00	8.24		1227.53	1227.65		1227.67	0.0167	0.62	14.64	187.74	0.68
River 02	1199.04	100.00	11.25		1227.53	1227.67		1227.69	0.0148	0.68	18.69	198.62	0.67

River	Cross Section	Return Period (years)	Q m³/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 02	1125.15	50.00	8.24		1227.07	1227.25		1227.25	0.0028	0.40	26.15	216.79	0.31
River 02	1125.15	100.00	11.25		1227.07	1227.27		1227.28	0.0029	0.45	32.11	229.27	0.32
River 02	1069.42	50.00	8.24	0.13	1226.91	1227.07	1227.04	1227.08	0.0036	0.41	29.04	338.97	0.35
River 02	1069.42	100.00	11.25	0.13	1226.91	1227.09	1227.04	1227.10	0.0037	0.45	35.28	345.97	0.36
River 02	1020.34	50.00	8.24	0.11	1226.52	1226.63	1226.63	1226.65	0.0395	0.86	11.57	204.51	1.02
River 02	1020.34	100.00	11.25	0.12	1226.52	1226.64	1226.64	1226.67	0.0370	0.94	14.53	216.37	1.02
River 02	942.45	50.00	8.24	0.09	1226.01	1226.18	1226.09	1226.18	0.0017	0.30	35.08	292.15	0.24
River 02	942.45	100.00	11.25	0.10	1226.01	1226.20	1226.11	1226.21	0.0019	0.34	41.38	298.45	0.26
River 02	901.63	50.00	8.24	0.09	1225.92	1226.03	1226.01	1226.04	0.0113	0.51	20.83	378.26	0.56
River 02	901.63	100.00	11.25	0.10	1225.92	1226.05	1226.02	1226.06	0.0089	0.52	27.99	385.94	0.52
River 02	837.49	50.00	8.24	0.09	1225.48	1225.63	1225.57	1225.63	0.0040	0.40	26.29	298.53	0.36
River 02	837.49	100.00	11.25	0.10	1225.48	1225.64	1225.58	1225.65	0.0047	0.46	30.91	307.30	0.39
River 02	797.00	50.00	8.24		1225.22	1225.30		1225.31	0.0243	0.65	15.54	278.94	0.79
River 02	797.00	100.00	11.25		1225.22	1225.32		1225.33	0.0172	0.65	21.13	288.39	0.70
River 02	770.88	50.00	8.24		1225.04	1225.18		1225.18	0.0019	0.29	35.59	327.11	0.25
River 02	770.88	100.00	11.25		1225.04	1225.20		1225.21	0.0021	0.33	42.42	342.28	0.27
River 02	723.85	50.00	8.24		1224.94	1225.03		1225.04	0.0057	0.36	27.25	386.09	0.40
River 02	723.85	100.00	11.25		1224.94	1225.05		1225.05	0.0055	0.40	33.53	390.63	0.40
River 02	666.26	50.00	8.24		1224.65	1224.75		1224.75	0.0039	0.30	26.73	280.84	0.33
River 02	666.26	100.00	11.25		1224.65	1224.77		1224.78	0.0040	0.35	32.76	293.83	0.35
River 02	617.24	50.00	8.24		1224.40	1224.55		1224.55	0.0052	0.45	22.97	249.29	0.41
River 02	617.24	100.00	11.25		1224.40	1224.57		1224.58	0.0052	0.50	28.47	265.66	0.42

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 02	590.63	50.00	8.24		1224.28	1224.41		1224.42	0.0049	0.43	23.76	250.66	0.39
River 02	590.63	100.00	11.25		1224.28	1224.44		1224.44	0.0047	0.47	29.62	262.67	0.39
River 02	571.66	50.00	8.24		1224.19	1224.33		1224.33	0.0045	0.42	23.86	240.06	0.38
River 02	571.66	100.00	11.25		1224.19	1224.35		1224.36	0.0045	0.47	29.98	266.05	0.39
River 02	555.90	50.00	8.24		1224.11	1224.24		1224.25	0.0062	0.48	21.16	230.66	0.44
River 02	555.90	100.00	11.25		1224.11	1224.27		1224.28	0.0057	0.52	27.24	255.82	0.44
River 02	524.82	50.00	8.24		1224.00	1224.15		1224.16	0.0017	0.30	35.30	305.75	0.24
River 02	524.82	100.00	11.25		1224.00	1224.18		1224.18	0.0019	0.34	42.27	326.90	0.26
River 02	486.56	50.00	8.24		1223.91	1224.04		1224.05	0.0056	0.45	25.54	359.67	0.42
River 02	486.56	100.00	11.25		1223.91	1224.06		1224.07	0.0055	0.48	31.95	373.67	0.42
River 02	438.05	50.00	8.24		1223.68	1223.78		1223.79	0.0050	0.37	24.81	273.88	0.38
River 02	438.05	100.00	11.25		1223.68	1223.80		1223.81	0.0051	0.42	30.27	284.02	0.40
River 02	381.69	50.00	8.24		1223.39	1223.48		1223.49	0.0056	0.37	23.34	254.88	0.40
River 02	381.69	100.00	11.25		1223.39	1223.51		1223.51	0.0054	0.42	28.81	262.73	0.41
River 02	348.30	50.00	8.24		1223.22	1223.33		1223.33	0.0042	0.36	26.41	275.84	0.35
River 02	348.30	100.00	11.25		1223.22	1223.34		1223.35	0.0045	0.41	31.37	281.82	0.38
River 02	321.94	50.00	8.24		1223.07	1223.17		1223.18	0.0092	0.46	21.35	306.38	0.51
River 02	321.94	100.00	11.25		1223.07	1223.19		1223.20	0.0076	0.49	27.73	315.92	0.48
River 02	309.68	50.00	8.24		1223.02	1223.13		1223.13	0.0016	0.24	39.13	353.71	0.22
River 02	309.68	100.00	11.25		1223.02	1223.15		1223.15	0.0017	0.27	46.29	359.03	0.24
River 02	290.92	50.00	8.24		1223.00	1223.09		1223.09	0.0032	0.28	33.13	385.58	0.30
River 02	290.92	100.00	11.25		1223.00	1223.11		1223.11	0.0033	0.32	39.54	390.06	0.32

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 02	239.44	50.00	8.24		1222.71	1222.83		1222.84	0.0084	0.49	19.99	269.92	0.50
River 02	239.44	100.00	11.25		1222.71	1222.85		1222.86	0.0075	0.53	26.17	298.57	0.49
River 02	185.21	50.00	8.24	0.09	1222.36	1222.51	1222.44	1222.51	0.0043	0.43	23.17	219.61	0.37
River 02	185.21	100.00	11.25	0.10	1222.36	1222.53	1222.46	1222.54	0.0047	0.50	27.76	230.77	0.40
River 02	152.68	50.00	8.24		1222.17	1222.26		1222.27	0.0160	0.62	16.37	242.02	0.67
River 02	152.68	100.00	11.25		1222.17	1222.28		1222.29	0.0134	0.65	21.39	257.39	0.64
River 02	127.61	50.00	8.24	0.06	1222.02	1222.16	1222.08	1222.16	0.0020	0.28	33.38	295.24	0.25
River 02	127.61	100.00	11.25	0.07	1222.02	1222.18	1222.09	1222.18	0.0020	0.32	41.14	312.39	0.26
River 03	2992.87	50.00	10.34	0.15	1253.74	1253.91	1253.89	1253.95	0.0224	0.99	11.01	87.83	0.86
River 03	2992.87	100.00	14.11	0.18	1253.74	1253.94	1253.92	1254.00	0.0192	1.07	14.24	96.02	0.83
River 03	2942.98	50.00	10.34		1253.26	1253.48		1253.49	0.0049	0.56	19.74	117.97	0.42
River 03	2942.98	100.00	14.11		1253.26	1253.51		1253.53	0.0054	0.66	23.54	125.10	0.45
River 03	2888.67	50.00	10.34		1252.94	1253.08		1253.10	0.0109	0.60	19.07	184.05	0.58
River 03	2888.67	100.00	14.11		1252.94	1253.11		1253.13	0.0100	0.66	23.82	187.33	0.57
River 03	2857.07	50.00	10.34		1252.69	1252.90		1252.90	0.0038	0.46	25.57	182.04	0.36
River 03	2857.07	100.00	14.11		1252.69	1252.93		1252.94	0.0038	0.52	31.39	194.01	0.38
River 03	2817.46	50.00	10.34	0.12	1252.35	1252.47	1252.47	1252.52	0.0378	0.82	11.03	118.38	0.99
River 03	2817.46	100.00	14.11	0.14	1252.35	1252.50	1252.50	1252.55	0.0374	0.93	13.69	126.08	1.02
River 03	2756.09	50.00	10.34	0.09	1252.00	1252.29	1252.09	1252.29	0.0006	0.27	46.68	205.54	0.16
River 03	2756.09	100.00	14.11	0.11	1252.00	1252.34	1252.12	1252.34	0.0007	0.31	56.06	214.63	0.17
River 03	2713.41	50.00	10.34		1252.00	1252.28		1252.28	0.0003	0.19	64.65	265.14	0.11
River 03	2713.41	100.00	14.11		1252.00	1252.32		1252.32	0.0003	0.22	76.24	273.91	0.12

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 03	2691.13	50.00	10.34		1252.00	1252.27		1252.27	0.0002	0.16	74.37	302.71	0.10
River 03	2691.13	100.00	14.11		1252.00	1252.31		1252.31	0.0003	0.19	87.37	310.41	0.11
River 03	2616.54	50.00	10.34		1252.00	1252.26		1252.26	0.0002	0.12	93.95	383.05	0.08
River 03	2616.54	100.00	14.11		1252.00	1252.30		1252.30	0.0002	0.15	109.55	387.79	0.09
River 03	2571.15	50.00	10.34		1252.00	1252.25		1252.25	0.0001	0.11	107.33	442.49	0.07
River 03	2571.15	100.00	14.11		1252.00	1252.29		1252.29	0.0001	0.13	125.06	446.47	0.08
River 03	2529.54	50.00	10.34		1252.00	1252.25		1252.25	0.0001	0.12	106.53	503.85	0.08
River 03	2529.54	100.00	14.11		1252.00	1252.28		1252.28	0.0002	0.13	126.37	506.13	0.08
River 03	2490.31	50.00	10.34		1252.00	1252.24		1252.24	0.0002	0.14	84.28	390.60	0.09
River 03	2490.31	100.00	14.11		1252.00	1252.28		1252.28	0.0002	0.17	99.76	411.57	0.10
River 03	2451.41	50.00	10.34		1252.00	1252.23		1252.23	0.0003	0.16	71.21	338.52	0.11
River 03	2451.41	100.00	14.11		1252.00	1252.26		1252.27	0.0003	0.19	84.21	357.90	0.12
River 03	2420.31	50.00	10.34		1252.00	1252.21		1252.22	0.0005	0.21	55.48	267.55	0.14
River 03	2420.31	100.00	14.11		1252.00	1252.25		1252.25	0.0006	0.24	65.09	270.32	0.16
River 03	2393.24	50.00	10.34		1252.00	1252.19		1252.20	0.0010	0.27	44.56	250.57	0.20
River 03	2393.24	100.00	14.11		1252.00	1252.23		1252.23	0.0011	0.31	53.04	253.52	0.21
River 03	2362.89	50.00	10.34		1252.00	1252.14		1252.14	0.0037	0.40	28.61	215.59	0.35
River 03	2362.89	100.00	14.11		1252.00	1252.17		1252.18	0.0035	0.45	35.46	218.34	0.35
River 03	2323.30	50.00	10.34	-0.02	1251.88	1251.94	1251.86	1251.95	0.0066	0.18	19.11	131.36	0.36
River 03	2323.30	100.00	14.11	0.00	1251.88	1251.97	1251.89	1251.99	0.0073	0.25	22.94	143.87	0.40
River 03	2304.26	50.00	10.34	0.01	1251.62	1251.63	1251.63	1251.69	0.0439	0.12	9.91	95.80	0.65
River 03	2304.26	100.00	14.11	0.03	1251.62	1251.66	1251.66	1251.72	0.0333	0.34	13.32	110.63	0.76

River	Cross Section	Return Period (years)	Q m³/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 03	2256.13	50.00	10.34	-0.27	1251.47	1251.52	1251.20	1251.52	0.0008	0.06	34.75	106.75	0.12
River 03	2256.13	100.00	14.11		1251.47	1251.58		1251.59	0.0008	0.11	42.19	117.05	0.14
River 03	2225.39	50.00	10.34		1251.52	1251.49		1251.49	0.0010		31.49	99.96	0.00
River 03	2225.39	100.00	14.11		1251.52	1251.55		1251.56	0.0011	0.05	38.20	109.28	0.13
River 03	2190.72	50.00	10.34		1251.54	1251.44		1251.45	0.0015		27.23	93.57	0.00
River 03	2190.72	100.00	14.11		1251.54	1251.50		1251.51	0.0017		33.12	102.30	0.00
River 03	2169.90	50.00	10.34		1251.46	1251.41		1251.42	0.0015		27.18	94.67	0.00
River 03	2169.90	100.00	14.11		1251.46	1251.47		1251.48	0.0017	0.02	32.81	102.63	0.13
River 03	2144.25	50.00	10.34		1251.29	1251.37		1251.38	0.0018	0.12	25.42	92.26	0.20
River 03	2144.25	100.00	14.11		1251.29	1251.42		1251.43	0.0020	0.18	30.36	98.98	0.23
River 03	2104.12	50.00	10.34		1251.00	1251.32		1251.32	0.0011	0.32	32.44	121.09	0.21
River 03	2104.12	100.00	14.11		1251.00	1251.36		1251.37	0.0013	0.39	38.03	126.43	0.23
River 03	2037.05	50.00	10.34		1251.00	1251.20		1251.21	0.0031	0.46	24.42	133.30	0.34
River 03	2037.05	100.00	14.11		1251.00	1251.23		1251.24	0.0033	0.53	29.30	136.45	0.35
River 03	1997.44	50.00	10.34	0.06	1250.77	1250.83	1250.83	1250.90	0.0345	0.47	9.21	73.93	0.84
River 03	1997.44	100.00	14.11	0.10	1250.77	1250.87	1250.87	1250.94	0.0301	0.59	12.13	84.86	0.84
River 03	1935.64	50.00	10.34	0.19	1250.00	1250.37	1250.19	1250.38	0.0028	0.50	20.39	77.61	0.33
River 03	1935.64	100.00	14.11	0.23	1250.00	1250.42	1250.23	1250.44	0.0031	0.56	24.67	84.07	0.35
River 03	1910.65	50.00	10.34		1250.00	1250.30		1250.31	0.0025	0.48	22.80	93.94	0.31
River 03	1910.65	100.00	14.11		1250.00	1250.34		1250.36	0.0027	0.54	27.26	99.34	0.33
River 03	1886.78	50.00	10.34		1250.00	1250.23		1250.24	0.0031	0.51	22.99	121.96	0.34
River 03	1886.78	100.00	14.11		1250.00	1250.27		1250.29	0.0031	0.57	28.38	129.38	0.36

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 03	1837.99	50.00	10.34	0.31	1249.51	1249.81	1249.81	1249.89	0.0308	1.28	8.72	61.71	1.03
River 03	1837.99	100.00	14.11	0.34	1249.51	1249.85	1249.85	1249.94	0.0288	1.38	11.22	70.69	1.02
River 03	1776.21	50.00	10.34	0.14	1249.00	1249.27	1249.14	1249.28	0.0034	0.54	20.06	88.56	0.36
River 03	1776.21	100.00	14.11	0.17	1249.00	1249.31	1249.17	1249.33	0.0043	0.60	23.87	106.71	0.41
River 03	1740.46	50.00	10.34		1249.00	1249.07		1249.08	0.0125	0.47	22.99	313.14	0.57
River 03	1740.46	100.00	14.11		1249.00	1249.09		1249.10	0.0115	0.53	28.58	318.03	0.57
River 03	1718.28	50.00	10.34		1248.81	1248.74		1248.78	0.0191		12.52	124.53	0.00
River 03	1718.28	100.00	14.11		1248.81	1248.77		1248.81	0.0193		16.61	150.11	0.00
River 03	1670.80	50.00	10.34		1248.06	1248.41		1248.42	0.0040	0.38	27.18	212.74	0.35
River 03	1670.80	100.00	14.11		1248.06	1248.44		1248.45	0.0040	0.44	33.70	245.17	0.37
River 03	1609.43	50.00	10.34		1247.96	1248.08		1248.09	0.0073	0.43	23.78	231.60	0.46
River 03	1609.43	100.00	14.11		1247.96	1248.10		1248.11	0.0075	0.50	28.58	232.92	0.48
River 03	1584.86	50.00	10.34		1247.68	1247.76		1247.79	0.0232	0.51	13.47	154.38	0.73
River 03	1584.86	100.00	14.11		1247.68	1247.78		1247.82	0.0217	0.64	17.30	171.33	0.76
River 03	1562.49	50.00	10.34		1247.46	1247.57		1247.58	0.0059	0.45	23.03	182.16	0.43
River 03	1562.49	100.00	14.11		1247.46	1247.60		1247.61	0.0059	0.52	28.12	186.89	0.44
River 03	1495.69	50.00	10.34		1247.00	1247.11		1247.12	0.0082	0.51	22.22	208.60	0.50
River 03	1495.69	100.00	14.11		1247.00	1247.13		1247.14	0.0084	0.59	26.62	210.66	0.52
River 03	1467.89	50.00	10.34		1246.71	1246.84		1246.86	0.0121	0.70	18.25	179.03	0.62
River 03	1467.89	100.00	14.11		1246.71	1246.86		1246.88	0.0112	0.76	22.87	185.67	0.62
River 03	1436.08	50.00	10.34	0.13	1246.33	1246.50	1246.45	1246.52	0.0096	0.71	18.19	154.07	0.57
River 03	1436.08	100.00	14.11	0.15	1246.33	1246.52	1246.48	1246.55	0.0106	0.81	21.67	159.67	0.61

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 03	1388.12	50.00	10.34	0.16	1245.83	1246.05	1245.99	1246.07	0.0096	0.46	21.99	263.98	0.52
River 03	1388.12	100.00	14.11	0.21	1245.83	1246.07	1246.04	1246.09	0.0089	0.52	27.84	266.02	0.52
River 03	1328.49	50.00	10.34	0.28	1245.17	1245.51	1245.45	1245.53	0.0087	0.73	16.35	144.39	0.55
River 03	1328.49	100.00	14.11	0.31	1245.17	1245.54	1245.49	1245.57	0.0089	0.81	20.94	169.35	0.58
River 03	1273.88	50.00	10.34	0.26	1244.44	1244.70	1244.70	1244.77	0.0262	1.19	9.21	71.46	0.95
River 03	1273.88	100.00	14.11	0.29	1244.44	1244.73	1244.73	1244.81	0.0238	1.27	12.06	81.85	0.93
River 03	1240.52	50.00	10.34	0.22	1244.00	1244.29	1244.22	1244.31	0.0074	0.76	16.02	107.00	0.53
River 03	1240.52	100.00	14.11	0.25	1244.00	1244.32	1244.25	1244.35	0.0076	0.83	20.62	132.77	0.55
River 03	1181.76	50.00	10.34	0.13	1243.32	1243.44	1243.44	1243.50	0.0369	0.87	10.41	100.16	1.00
River 03	1181.76	100.00	14.11	0.15	1243.32	1243.47	1243.47	1243.53	0.0363	1.00	12.98	106.94	1.03
River 03	1160.84	50.00	10.34	0.12	1243.00	1243.20	1243.12	1243.21	0.0057	0.58	20.55	142.07	0.45
River 03	1160.84	100.00	14.11	0.14	1243.00	1243.23	1243.14	1243.24	0.0059	0.66	25.19	153.93	0.47
River 03	1116.57	50.00	10.34	0.17	1242.49	1242.67	1242.67	1242.72	0.0309	0.96	10.29	94.47	0.96
River 03	1116.57	100.00	14.11	0.20	1242.49	1242.69	1242.69	1242.76	0.0293	1.08	12.96	105.26	0.97
River 03	1089.49	50.00	10.34	0.22	1241.88	1242.14	1242.10	1242.16	0.0117	0.76	15.07	113.06	0.63
River 03	1089.49	100.00	14.11	0.24	1241.88	1242.17	1242.12	1242.20	0.0098	0.81	19.39	116.34	0.60
River 03	1045.14	50.00	10.34		1241.16	1241.55		1241.59	0.0147	0.91	11.54	69.97	0.71
River 03	1045.14	100.00	14.11		1241.16	1241.59		1241.63	0.0176	0.89	14.75	93.17	0.76
River 03	1022.85	50.00	10.34	0.15	1241.06	1241.24	1241.20	1241.27	0.0139	0.41	13.83	118.25	0.57
River 03	1022.85	100.00	14.11		1241.06	1241.28		1241.31	0.0119	0.54	18.52	127.30	0.58
River 03	981.82	50.00	10.34		1240.27	1240.45		1240.49	0.0236	0.61	11.43	91.31	0.77
River 03	981.82	100.00	14.11	0.19	1240.27	1240.47	1240.46	1240.53	0.0300	0.73	13.06	96.36	0.88

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 03	963.84	50.00	10.34	0.16	1239.93	1240.10	1240.09	1240.13	0.0201	0.81	14.53	154.84	0.78
River 03	963.84	100.00	14.11	0.18	1239.93	1240.13	1240.11	1240.16	0.0163	0.85	19.04	161.55	0.73
River 03	925.91	50.00	10.34	0.30	1239.02	1239.34	1239.32	1239.40	0.0174	1.05	10.80	76.33	0.79
River 03	925.91	100.00	14.11	0.34	1239.02	1239.37	1239.36	1239.44	0.0209	1.22	12.80	81.82	0.88
River 03	910.10	50.00	10.34	0.29	1238.79	1239.10	1239.08	1239.13	0.0140	0.86	13.50	105.57	0.69
River 03	910.10	100.00	14.11	0.31	1238.79	1239.14	1239.10	1239.18	0.0113	0.90	17.72	110.17	0.65
River 03	869.22	50.00	10.34	0.29	1238.25	1238.58	1238.54	1238.61	0.0119	0.84	13.62	103.57	0.65
River 03	869.22	100.00	14.11	0.32	1238.25	1238.60	1238.57	1238.64	0.0152	1.01	15.70	111.74	0.74
River 03	858.65	50.00	10.34	0.25	1238.10	1238.35	1238.35	1238.40	0.0354	1.10	10.43	120.41	1.05
River 03	858.65	100.00	14.11	0.28	1238.10	1238.38	1238.38	1238.44	0.0261	1.12	14.52	133.05	0.94
River 03	847.55	50.00	10.34	0.11	1238.00	1238.18	1238.11	1238.19	0.0070	0.54	18.88	130.97	0.48
River 03	847.55	100.00	14.11	0.13	1238.00	1238.21	1238.13	1238.23	0.0067	0.61	23.38	140.32	0.48
River 03	796.79	50.00	10.34	0.10	1237.34	1237.44	1237.44	1237.48	0.0323	0.86	11.22	112.06	0.95
River 03	796.79	100.00	14.11	0.12	1237.34	1237.46	1237.46	1237.52	0.0373	1.02	13.18	116.47	1.05
River 03	776.77	50.00	10.34	0.11	1237.00	1237.17	1237.11	1237.19	0.0059	0.59	20.58	179.49	0.46
River 03	776.77	100.00	14.11	0.14	1237.00	1237.21	1237.14	1237.22	0.0056	0.65	26.78	206.75	0.46
River 03	730.90	50.00	10.34	0.21	1236.43	1236.65	1236.64	1236.69	0.0294	0.77	12.13	130.88	0.89
River 03	730.90	100.00	14.11	0.23	1236.43	1236.67	1236.67	1236.72	0.0348	0.92	14.37	140.02	0.99
River 03	687.64	50.00	10.34	0.04	1236.00	1236.08	1236.04	1236.10	0.0078	0.42	21.82	194.28	0.46
River 03	687.64	100.00	14.11	0.05	1236.00	1236.11	1236.05	1236.13	0.0067	0.47	27.72	196.19	0.45
River 03	669.24	50.00	10.34	0.07	1235.75	1235.87	1235.83	1235.90	0.0155	0.46	13.01	96.63	0.62
River 03	669.24	100.00	14.11	0.11	1235.75	1235.90	1235.86	1235.94	0.0188	0.60	16.32	119.54	0.71

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 03	645.97	50.00	10.34	0.14	1235.34	1235.49	1235.49	1235.53	0.0373	0.83	11.96	139.15	0.99
River 03	645.97	100.00	14.11	0.16	1235.34	1235.52	1235.50	1235.56	0.0291	0.83	16.03	151.74	0.90
River 03	605.61	50.00	10.34		1235.00	1235.16		1235.16	0.0034	0.39	27.82	191.87	0.34
River 03	605.61	100.00	14.11		1235.00	1235.18		1235.19	0.0037	0.45	32.99	196.28	0.36
River 03	578.68	50.00	10.34		1234.81	1235.02		1235.03	0.0089	0.44	21.92	222.95	0.49
River 03	578.68	100.00	14.11		1234.81	1235.04		1235.06	0.0087	0.51	26.84	226.50	0.51
River 03	535.10	50.00	10.34		1234.47	1234.55		1234.57	0.0171	0.36	15.25	140.15	0.60
River 03	535.10	100.00	14.11		1234.47	1234.57		1234.60	0.0173	0.44	18.60	146.24	0.63
River 03	507.27	50.00	10.34		1234.19	1234.20		1234.22	0.0102	0.08	17.85	139.79	0.34
River 03	507.27	100.00	14.11		1234.19	1234.23		1234.25	0.0097	0.18	22.14	151.56	0.41
River 03	477.00	50.00	10.34		1233.83	1233.85		1233.87	0.0117	0.14	15.88	115.49	0.41
River 03	477.00	100.00	14.11		1233.83	1233.88		1233.91	0.0126	0.24	19.05	122.73	0.48
River 03	444.64	50.00	10.34		1233.53	1233.61		1233.63	0.0185	0.40	15.45	160.70	0.63
River 03	444.64	100.00	14.11		1233.53	1233.63		1233.66	0.0166	0.45	19.69	172.64	0.63
River 03	406.37	50.00	10.34		1233.05	1233.28		1233.29	0.0050	0.55	22.70	166.52	0.42
River 03	406.37	100.00	14.11		1233.05	1233.31		1233.32	0.0053	0.61	27.66	174.47	0.44
River 03	379.96	50.00	10.34		1233.00	1233.13		1233.14	0.0052	0.46	24.30	193.42	0.41
River 03	379.96	100.00	14.11		1233.00	1233.16		1233.17	0.0054	0.53	29.22	197.35	0.43
River 03	352.08	50.00	10.34	0.20	1232.66	1232.87	1232.87	1232.90	0.0298	0.97	12.96	156.12	0.95
River 03	352.08	100.00	14.11	0.22	1232.66	1232.88	1232.88	1232.93	0.0302	1.07	15.84	160.53	0.98
River 03	292.85	50.00	10.34	0.10	1232.00	1232.18	1232.10	1232.19	0.0048	0.51	21.93	140.17	0.41
River 03	292.85	100.00	14.11	0.12	1232.00	1232.22	1232.12	1232.23	0.0046	0.56	27.31	147.63	0.41

River	Cross Section	Return Period (years)	Q m³/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 03	249.53	50.00	10.34	0.08	1231.67	1231.79	1231.75	1231.83	0.0148	0.46	13.34	99.80	0.61
River 03	249.53	100.00	14.11	0.11	1231.67	1231.82	1231.79	1231.86	0.0170	0.61	15.84	103.88	0.68
River 03	195.29	50.00	10.34		1231.00	1231.12		1231.14	0.0106	0.63	18.15	158.87	0.58
River 03	195.29	100.00	14.11		1231.00	1231.15		1231.17	0.0095	0.69	22.83	163.29	0.57
River 03	171.29	50.00	10.34		1230.69	1230.91		1230.93	0.0061	0.51	18.92	114.90	0.44
River 03	171.29	100.00	14.11		1230.69	1230.95		1230.97	0.0062	0.57	23.39	125.08	0.46
River 03	143.88	50.00	10.34	0.17	1230.41	1230.58	1230.58	1230.63	0.0374	1.07	10.11	94.59	1.06
River 03	143.88	100.00	14.11	0.19	1230.41	1230.61	1230.61	1230.67	0.0361	1.17	12.65	101.34	1.07
River 03	94.96	50.00	10.34	0.12	1230.00	1230.28	1230.12	1230.28	0.0020	0.39	27.52	128.25	0.27
River 03	94.96	100.00	14.11	0.15	1230.00	1230.33	1230.15	1230.34	0.0020	0.43	34.08	137.64	0.28
River 04	4953.45	50.00	17.30	0.12	1241.33	1241.54	1241.45	1241.55	0.0043	0.55	38.89	254.76	0.40
River 04	4953.45	100.00	23.61	0.15	1241.33	1241.58	1241.48	1241.59	0.0041	0.61	48.75	272.14	0.40
River 04	4811.29	50.00	17.30		1240.86	1241.07		1241.07	0.0028	0.43	52.42	381.12	0.32
River 04	4811.29	100.00	23.61		1240.86	1241.09		1241.10	0.0029	0.48	63.26	391.79	0.33
River 04	4731.76	50.00	17.30		1240.57	1240.75		1240.76	0.0060	0.57	38.71	333.03	0.45
River 04	4731.76	100.00	23.61		1240.57	1240.78		1240.79	0.0055	0.62	49.54	351.85	0.45
River 04	4583.60	50.00	17.30		1240.01	1240.31		1240.31	0.0018	0.42	54.65	326.43	0.27
River 04	4583.60	100.00	23.61		1240.01	1240.34		1240.35	0.0019	0.47	67.46	347.36	0.28
River 04	4477.11	50.00	17.30		1239.81	1240.06		1240.07	0.0029	0.51	48.14	365.15	0.33
River 04	4477.11	100.00	23.61		1239.81	1240.09		1240.10	0.0029	0.56	59.67	383.70	0.35
River 04	4365.33	50.00	17.30		1239.37	1239.64		1239.66	0.0055	0.61	31.53	193.24	0.45
River 04	4365.33	100.00	23.61		1239.37	1239.69		1239.71	0.0048	0.67	41.55	220.64	0.43

River	Cross Section	Return Period (years)	Q m³/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m²	Top Width (m)	Froude Number
River 04	4204.82	50.00	17.30		1239.03	1239.32		1239.32	0.0011	0.22	59.77	251.35	0.19
River 04	4204.82	100.00	23.61		1239.03	1239.36		1239.37	0.0012	0.27	71.47	269.12	0.21
River 04	4134.75	50.00	17.30		1239.00	1239.24		1239.25	0.0009	0.28	70.77	336.37	0.19
River 04	4134.75	100.00	23.61		1239.00	1239.28		1239.28	0.0010	0.33	83.38	349.64	0.20
River 04	4067.80	50.00	17.30		1239.00	1239.13		1239.14	0.0037	0.39	50.13	405.70	0.35
River 04	4067.80	100.00	23.61		1239.00	1239.16		1239.17	0.0035	0.44	62.20	416.10	0.35
River 04	3983.23	50.00	17.30		1238.06	1238.50		1238.56	0.0136	1.14	16.16	74.76	0.74
River 04	3983.23	100.00	23.61		1238.06	1238.56		1238.62	0.0127	1.20	21.04	85.31	0.73
River 04	3889.07	50.00	17.30	0.13	1237.52	1237.73	1237.64	1237.75	0.0054	0.49	33.15	196.48	0.42
River 04	3889.07	100.00	23.61	0.16	1237.52	1237.77	1237.67	1237.79	0.0060	0.59	39.88	209.54	0.46
River 04	3787.56	50.00	17.30		1236.75	1236.93		1236.96	0.0133	0.86	24.37	189.11	0.68
River 04	3787.56	100.00	23.61		1236.75	1236.97		1237.00	0.0113	0.91	31.77	202.45	0.65
River 04	3744.29	50.00	17.30	0.15	1236.45	1236.71	1236.60	1236.71	0.0031	0.49	41.91	239.12	0.34
River 04	3744.29	100.00	23.61	0.17	1236.45	1236.74	1236.62	1236.75	0.0036	0.58	49.17	248.63	0.38
River 04	3653.23	50.00	17.30		1236.00	1236.10		1236.12	0.0213	0.77	25.09	268.82	0.79
River 04	3653.23	100.00	23.61		1236.00	1236.13		1236.15	0.0155	0.79	33.61	275.70	0.71
River 04	3559.51	50.00	17.30		1235.28	1235.61		1235.62	0.0024	0.50	43.51	235.91	0.31
River 04	3559.51	100.00	23.61		1235.28	1235.65		1235.66	0.0026	0.57	52.88	247.84	0.33
River 04	3463.09	50.00	17.30	0.09	1234.98	1235.08	1235.07	1235.11	0.0238	0.76	25.25	304.45	0.82
River 04	3463.09	100.00	23.61	0.11	1234.98	1235.11	1235.09	1235.13	0.0195	0.81	33.04	316.10	0.77
River 04	3384.24	50.00	17.30		1234.31	1234.63		1234.64	0.0026	0.55	41.69	240.29	0.33
River 04	3384.24	100.00	23.61		1234.31	1234.67		1234.69	0.0026	0.61	52.99	280.61	0.34

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 04	3276.24	50.00	17.30		1233.76	1233.94		1233.99	0.0239	1.01	17.01	116.63	0.88
River 04	3276.24	100.00	23.61	0.19	1233.76	1233.98	1233.96	1234.04	0.0224	1.15	21.39	125.94	0.89
River 04	3209.77	50.00	17.30	0.11	1233.26	1233.47	1233.37	1233.48	0.0036	0.48	39.21	216.18	0.36
River 04	3209.77	100.00	23.61	0.13	1233.26	1233.51	1233.39	1233.52	0.0038	0.55	47.43	223.99	0.38
River 04	3145.88	50.00	17.30	0.23	1232.71	1232.94	1232.94	1232.99	0.0281	0.82	18.44	177.26	0.89
River 04	3145.88	100.00	23.61	0.26	1232.71	1232.97	1232.97	1233.03	0.0263	0.96	23.57	187.27	0.90
River 04	3095.66	50.00	17.30	0.24	1232.20	1232.57	1232.44	1232.59	0.0026	0.56	38.15	191.80	0.33
River 04	3095.66	100.00	23.61	0.27	1232.20	1232.62	1232.47	1232.63	0.0028	0.63	46.81	205.07	0.35
River 04	3022.87	50.00	17.30	0.12	1231.95	1232.07	1232.07	1232.11	0.0364	1.03	20.34	246.13	1.04
River 04	3022.87	100.00	23.61	0.14	1231.95	1232.09	1232.09	1232.14	0.0354	1.13	24.93	249.02	1.05
River 04	2962.83	50.00	17.30	0.06	1231.28	1231.44	1231.34	1231.45	0.0039	0.37	39.20	230.77	0.35
River 04	2962.83	100.00	23.61	0.09	1231.28	1231.47	1231.37	1231.48	0.0041	0.45	47.26	236.22	0.37
River 04	2923.99	50.00	17.30	0.06	1231.00	1231.06	1231.06	1231.09	0.0379	0.72	21.77	300.31	0.96
River 04	2923.99	100.00	23.61	0.07	1231.00	1231.07	1231.07	1231.12	0.0393	0.85	26.18	301.69	1.02
River 04	2862.15	50.00	17.30	0.10	1230.16	1230.34	1230.26	1230.36	0.0041	0.38	37.60	232.71	0.36
River 04	2862.15	100.00	23.61	0.13	1230.16	1230.38	1230.28	1230.39	0.0043	0.46	45.87	242.56	0.38
River 04	2810.84	50.00	17.30	0.21	1229.74	1229.96	1229.95	1230.00	0.0145	0.98	23.82	218.43	0.73
River 04	2810.84	100.00	23.61		1229.74	1229.99		1230.03	0.0136	1.05	30.51	230.43	0.72
River 04	2767.76	50.00	17.30	0.24	1229.16	1229.44	1229.40	1229.49	0.0101	0.97	21.88	142.99	0.63
River 04	2767.76	100.00	23.61	0.28	1229.16	1229.48	1229.44	1229.53	0.0102	1.08	27.71	160.86	0.65
River 04	2722.39	50.00	17.30		1228.97	1229.21		1229.22	0.0037	0.54	39.02	228.12	0.37
River 04	2722.39	100.00	23.61		1228.97	1229.24		1229.26	0.0038	0.61	47.56	242.46	0.39

Jeffares & Green

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 04	2652.11	50.00	17.30		1228.72	1228.89		1228.90	0.0056	0.53	38.99	319.59	0.44
River 04	2652.11	100.00	23.61		1228.72	1228.92		1228.94	0.0055	0.59	48.73	345.23	0.44
River 04	2512.42	50.00	17.30		1228.15	1228.31		1228.32	0.0031	0.32	43.36	276.66	0.31
River 04	2512.42	100.00	23.61		1228.15	1228.35		1228.36	0.0031	0.39	54.37	304.67	0.32
River 04	2471.42	50.00	17.30		1228.00	1228.21		1228.21	0.0021	0.35	53.14	329.54	0.27
River 04	2471.42	100.00	23.61		1228.00	1228.24		1228.25	0.0023	0.41	63.92	350.78	0.29
River 04	2399.17	50.00	17.30		1227.88	1228.02		1228.02	0.0030	0.26	50.56	397.63	0.29
River 04	2399.17	100.00	23.61		1227.88	1228.05		1228.06	0.0026	0.31	65.85	419.20	0.28
River 04	2323.81	50.00	17.30		1227.73	1227.88		1227.88	0.0011	0.15	67.21	363.88	0.18
River 04	2323.81	100.00	23.61		1227.73	1227.91		1227.92	0.0013	0.19	81.23	395.51	0.19
River 04	2190.48	50.00	17.30		1227.58	1227.65		1227.65	0.0044	0.21	46.17	399.67	0.31
River 04	2190.48	100.00	23.61		1227.58	1227.68		1227.69	0.0041	0.28	58.65	442.91	0.33
River 04	2077.52	50.00	17.30		1227.24	1227.35		1227.36	0.0017	0.20	62.21	426.01	0.22
River 04	2077.52	100.00	23.61		1227.24	1227.39		1227.39	0.0017	0.25	77.68	460.16	0.23
River 04	1952.06	50.00	17.30		1227.00	1227.16		1227.16	0.0014	0.28	73.84	518.46	0.22
River 04	1952.06	100.00	23.61		1227.00	1227.19		1227.19	0.0015	0.32	88.76	537.17	0.24
River 04	1911.95	50.00	17.30		1226.96	1227.09		1227.10	0.0021	0.27	65.94	539.06	0.26
River 04	1911.95	100.00	23.61		1226.96	1227.12		1227.12	0.0022	0.32	79.92	552.94	0.27
River 04	1750.00	50.00	17.30		1226.49	1226.66		1226.67	0.0032	0.41	48.33	348.39	0.33
River 04	1750.00	100.00	23.61		1226.49	1226.70		1226.71	0.0029	0.45	61.91	373.07	0.33
River 04	1578.24	50.00	17.30		1226.08	1226.27		1226.28	0.0015	0.27	58.61	336.85	0.23
River 04	1578.24	100.00	23.61		1226.08	1226.31		1226.32	0.0016	0.32	72.23	364.50	0.24

River	Cross Section	Return Period (years)	Q m^3/s	Water Depth (m)	Minimum Channel Elevation mAMSL	Water Surface Elevation mAMSL	Critical Water Surface mAMSL	Energy Grade Elevation mAMSL	Energy Grade Slope (m/m)	Channel Velocity (m/s)	Flow Area m^2	Top Width (m)	Froude Number
River 04	1524.60	50.00	17.30		1226.00	1226.21		1226.21	0.0009	0.24	80.54	458.99	0.18
River 04	1524.60	100.00	23.61		1226.00	1226.24		1226.25	0.0009	0.28	95.92	486.07	0.19
River 04	1439.18	50.00	17.30	0.12	1225.91	1226.10	1226.04	1226.11	0.0018	0.34	73.38	638.97	0.26
River 04	1439.18	100.00	23.61		1225.91	1226.13		1226.13	0.0020	0.38	87.77	649.67	0.27
River 04	1348.03	50.00	17.30		1225.65	1225.82		1225.84	0.0060	0.55	37.63	327.12	0.45
River 04	1348.03	100.00	23.61		1225.65	1225.87		1225.88	0.0047	0.57	51.80	361.15	0.42
River 04	1301.17	50.00	17.30		1225.53	1225.73		1225.74	0.0011	0.27	61.73	353.96	0.20
River 04	995.22	100.00	23.61		1225.00	1225.17		1225.18	0.0016	0.31	89.21	565.18	0.24
River 04	913.55	50.00	17.30		1224.74	1224.95		1224.96	0.0033	0.41	43.36	278.02	0.33
River 04	913.55	100.00	23.61		1224.74	1224.99		1225.00	0.0032	0.47	55.24	307.25	0.34
River 04	566.25	50.00	17.30		1224.00	1224.22		1224.22	0.0004	0.19	107.04	535.31	0.13
River 04	566.25	100.00	23.61		1224.00	1224.26		1224.26	0.0005	0.22	125.85	551.87	0.14
River 04	480.42	50.00	17.30		1224.00	1224.18		1224.18	0.0007	0.21	99.38	597.83	0.15
River 04	480.42	100.00	23.61		1224.00	1224.21		1224.21	0.0007	0.24	117.54	616.35	0.17
River 04	428.34	50.00	17.30		1223.99	1224.13		1224.13	0.0019	0.28	72.77	609.14	0.25
River 04	428.34	100.00	23.61		1223.99	1224.15		1224.16	0.0019	0.31	89.46	626.80	0.25
River 04	376.81	50.00	17.30	0.21	1223.61	1223.82	1223.82	1223.87	0.0262	1.28	17.84	160.34	0.97
River 04	376.81	100.00	23.61	0.24	1223.61	1223.85	1223.85	1223.91	0.0246	1.38	23.17	181.84	0.96
River 04	314.73	50.00	17.30	0.04	1223.18	1223.34	1223.21	1223.35	0.0033	0.39	39.92	224.01	0.33
River 04	314.73	100.00	23.61	0.07	1223.18	1223.39	1223.25	1223.40	0.0032	0.46	50.92	250.91	0.34