Draft Surface Water Specialist Study for Kudumane Manganese Resources Expansion Project, near Hotazel in the Northern Cape Province

Report Prepared for

Kudumane Manganese Resources (Pty) Ltd

Report Number 574378/01

Report Prepared by

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List of abbreviations

AML	Asia Minerals South Africa (Pty) Limited
AWS	Automatic Weather Station
DENC	Northern Cape Province Department of Environment and Nature Conservation
DMRE	Department of Mineral Resources and Energy
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EMPrs	Environmental Management Programmes
GN	Government Notices
KMR	Kudumane Manganese Resources (Pty) Limited
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mamsl	Meters Above Mean Sea Level
MPRDA	Mineral and Petroleum Resources Development Act, Act No. 28 of 2002
NASA	National Aeronautics and Space Administration
NEMA	National Environmental Management Act, Act 107 of 1998
NEM:WA	National Environment Management: Waste Act, Act 59 of 2008
NWA	National Water Act, Act 36 of 1998
NWRS	National Water Resources Strategy
SANS241:2015	South African National Standard for drinking water
SAWQG	South African Water Quality Guidelines
SAWS	South African Weather Service
SRK	SRK Consulting (South Africa) (Pty) Ltd
TSF	Tailings Storage Facility
POWER	Prediction of Worldwide Energy Resources project
WMA	Water Management Area
WRSM2000	Pitman Water Resources Simulation Model
WR2005	Water Resources of South Africa 2005 Study
WR2012	Water Resources of South Africa 2012 Study
WUL	Water Use License

1 Introduction and Scope of Report

Kudumane Manganese Resources (Pty) Ltd (KMR) is situated approximately 3 km south-west of the town of Hotazel within the John Taolo Gaetsewe District Municipality in the Northern Cape.

The KMR mining operations commenced in June 2013 under the Mining Right NC/30/5/1/2/2/0268 MR covering the farms York A 279 and Telele 312. The initial operation included the following mining related infrastructure:

- An opencast and future underground mining operation;
- Associated residue handling and disposal facilities;
- A crushing and screening plant;
- Rail and road infrastructure;
- Water and electrical reticulation infrastructure; and
- Various other supporting infrastructure and services, such as offices, waste storage areas and sewage treatment facilities.

In 2015, the mine expanded its operation through the application of another mining right (Mining Right Ref: NC/ 30/5/1/2/2/10053 MR) over the farms Devon 277, Hotazel 280 and Kipling 271. Under this mining right, the following main mining related activities and infrastructure were approved:

- Mining and removal of manganese ore from a historical pit and tailings storage facility (TSF) on the farm Devon 227;
- Mining and removal of manganese ore from an historical pit on the farm Hotazel 280, along with the establishment of haul road, utilisation of existing roads including the establishment and utilisation of a conveyor system between the farms Hotazel 280 and York A 279; and
- Potential future mining on the farm Kipling 271.

The KMR mining operation therefore operates under two Environmental Management Programmes (EMPrs) as approved by the Northern Cape Province Department of Environment and Nature Conservation (DENC) in June 2013 and October 2015 respectively. KMR also has a Water Use Licence (WUL) that was issued in 2016 by the Department of Water and Sanitation (DWS) and an amended WUL authorised in 2018.

1.1 Proposed project activities

It is the intension of KMR to expand its existing operations and construct additional infrastructure in order to improve production capacity. The EMPrs and associated environmental authorisations (EA) therefore need to be amended. The proposed expansion will be located within the existing KMR mining rights on York A 279, Telele 312, Kipling 27, Devon 277 and Hotazel 280.

The infrastructure and activities associated with the proposed KMR Expansion Project requires a new Environmental Authorisation, the amendment of the mine’s existing EMPrs, a Waste Management Licence (WML) and a WUL to authorise the following key infrastructure:

- A new opencast pit mine on Kipling;
- Expansion of the Hotazel and York opencast mines; and
- Two attenuation dams on the Ga-Mogara River, to allow for the expansion of the York and Hotazel Pits.

The above key infrastructure will have secondary infrastructure and activities associated with them, which includes:

- Establishment of water storage tank and pipelines;
- Development and expansion of waste rock dumps;
- Establishment and expansion of ore stockpiles;
- New roads and expansion of existing roads;

- Development and expansion of sewerage treatment plants;
- Supporting infrastructure such as admin offices ancillary infrastructure;
- Waste and fuel storage areas;
- Pollution control dams;
- Diversion of a tarred, provincial road including the development of a bridge over the Ga-Mogara River;
- Contractor’s camp; and
- Extension of existing powerlines.

The infrastructure and activities associated with the proposed KMR Expansion Project will take place on the following farms and associated farm portions:

- York A 279: Portion 2/279 & Portion 11/279;
- Telele 312: Portion RE/312 & Portion 1/312;
- Devon 277: Portion RE/277;
- Hotazel 280: Portion RE/280 & Portion 4/280;and
- Kipling 271: Portion RE/271.

Before KMR can commence with the proposed expansion activities, the mine needs to obtain the necessary authorisations from the Department of Mineral Resources and Energy (DMRE) in respect of the listed activities that will be triggered by the proposed project in respect of the National Environmental Management Act (Act No. 107 of 1998) (NEMA) and National Environmental Management: Waste Act (Act No. 36 of 1998) (NEM:WA). In addition to the integrated environmental authorisation (EA) requirements, KMR will also need to apply for a WUL through DWS in respect of the water uses that will be associated with the proposed project in terms of the National Water Act (Act No. 36 of 1998) (NWA).

The mine also intends to consolidate the two Mining Rights and associated approved EMPrs into a single Mining Right and Consolidated EMPr, in accordance with Section 102 of the Mineral Petroleum Resources Development Act (Act 28 of 2002) (MPRDA). The Section 102 application to consolidate the Mining Rights will be undertaken by the mine in conjunction with this integrated EA process, which will also include the consolidation and amendment of the EMPrs. The purpose of the consolidated EMPr will be to provide KMR with a more effective environmental management tool to manage their current and proposed operations. The objectives of the consolidated and amendment of the EMPr are to:

- Describe the existing approved and proposed infrastructure and activities associated with the KMR mine in one document;
- Holistically describe the environment within which KMR operates;
- Update the status of the operation and associated management measures implemented at the mine;
- Allow for a greater level of alignment between the different EMPrs in terms of management measures and monitoring reporting requirements; and
- Rationalise repeated information and management measures contained within the approved EMPrs.

1.2 Project Location

KMR is located approximately 5 km west of the R31 road that links Hotazel to the regional town of Kuruman, about 60 km south-east of Hotazel on the N14 to Upington.

The mine is located along the eastern edge of the Kalahari Manganese Field on the farms York A 279, Telele 312, Kipling 271, Devon 277 and Hotazel 280. The mine is part of the Lower Vaal Water Management and is located in the quaternary catchment D41K.

1.3 Scope of Work

The general understanding of the client's requirement is summarised as follows:

- Determination of the relationship of the planned open pits with the Ga-Mogara stream bed, finalization of the derivation/attenuation dam project;
- Surface water specialist study that includes updating the water balance, stormwater management plan, and GN704 assessment report;
- Surface water impact assessment and monitoring plan.

2 Expertise of the Surface Water Specialist

The qualifications of the surface water specialists that undertook the work are provided for in Table 2-1, and copies of the qualifications are provided in Appendix A and B.

Table 2-1. Surface water specialist qualifications

Specialist Name	Qualifications	Professional Registration	Years' Experience
Peter Shepherd	BSc (Hydrology and Geography) BSc (Honours) in Hydrology	Pr. Sci Nat, SACNASP Reg no. 400104/95	29 years
Mehmetcan Ozkadioglu	BSc (Honours) in Hydrogeological Engineering MSc (Hydrogeological Engineering)	Cand.Sci.Nat., SACNASP Reg no. 120662/19 TMMOB-Chamber of Geological Engineers, Ankara, Turkey	8 years
Byron Gray	BSc (Hydrology and Geography) BSc (Honours) in Hydrology MSc (Hydrology)	None	3 months

3 Background and Brief

3.1 Kudumane's proposed Expansion Project

KMR is now exploring the viability of a possible further extension of the open pit mining operations in a westerly direction at the Hotazel Pit, beyond the 1:100-year floodline. It is apparent that opencast mining of the orebody beyond the 1:100-year floodline will trigger the requirement to obtain various environmental authorisations for the realignment of the river, or an alternative engineering intervention to allow access to the ore reserves underneath the current drainage channel of the Ga-Mogara River.

3.2 Data sources

The following additional information was obtained from KMR:

- Climate data from the AWS located at mine offices at York farm for the period from July 2019 to July 2021.
- Additional rainfall data from rain gauges located across the mine sites
- Monitoring borehole data from the mine site as well as the Kudumane Mine groundwater monitoring program and associated reports.
- Drone images of the mine site.
- Geological data compiled by Allan Saad along with the mining work program for York 279.
- A detailed layout of the Kudumane mine with proposed infrastructure and developments
- Water consumption and precious conceptual 2020 water and salt balance report for the Kudumane mine conducted by ENVASS.
- Previous surface water study conducted by SLR Consulting (Africa) (Pty) Ltd in 2014.
- Pollution Control Dam (PCD) design information from MCJ Engineering supplied in 2021.

4 Legal Review

4.1 National legislation

National legislation applicable to surface water management in the context of this study includes:

- **Constitution of the Republic of South Africa, 1996 (No. 108 of 1996)** – The Bill of Rights states that everyone has the right to an environment that is not harmful to their health or well-being;
- **National Water Act, Act 36 of 1998 (NWA)** – Provides for the protection of the quality of water and water resources in South Africa. The strategy, guidelines and regulations under the NWA applicable to this study are described in the remainder of this section;
- **Water Services Act, Act 108 of 1997** – Provides for the regulation of water boards and the settling of national water quality standards;
- **National Environmental Management Act, Act 107 of 1998 (NEMA)** – This Act sets out the duty of care principle (Sections 28 (1) and (3) of NEMA), which is applicable to all types of pollution and must be taken into account in considering any aspects of potential environmental degradation. Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment. The listed activities in terms of NEMA Government Notices (GN) numbers GN R982, R983, R984 and R985, December 2014 are of relevance to the Environmental Impact Assessment (EIA) and Environmental Management Program/Plan (EMP) Amendment process;
- **National Environment Management Act: Waste Management Act, Act 59 of 2008 (NEM:WA)** – Provides for the regulation of waste and the prevention of pollution from the waste generated at a specific site. NEM:WA follows the principle that waste generation should be avoided, or if it cannot be avoided, that it is reduced, re-used, recycled or recovered, and as a last resort treated and/or safely disposed of. The waste management activities which require a License and those that require a Basic Assessment (Schedule 1 of the NEM:WA) have been reviewed. Although the Minister of Mineral Resources is the licensing authority for residue stockpiles and residue deposits, their management must be in accordance with the NEM:WA Regulations as prescribed by the Minister of Environmental Affairs (DEA). The list of Waste Management Activities that may require licensing in terms of NEM:WA has been revised as follows:
    - On 29 November 2013 (Government Notice (GN) 921, Government Gazette No 37083) and exclude treatment of effluent, wastewater or sewage;
    - On 2 May 2014 (GN332, Government Gazette No. 37604) to exclude remediation of contaminated land, now covered under Norms and Standards; and
    - On 24 July 2015 (Government Gazette GG 39020, GN: R633) to include residue stockpiles and residue deposits
- **Mineral and Petroleum Resources Development Act, Act 28 of 2002 (MPRDA)** – Provides for equitable access to and sustainable development of South Africa's mineral resources. The MPRDA requires that the environmental management principles set out in NEMA shall apply to all mining operations and serves as a guideline for the interpretation, administration and implementation of the environmental requirements of NEMA; and
- **Promotion of Access to Information Act, Act 2 of 2000** – Gives effect to the constitutional right to access information held by the State, such as information on water resources.

4.2 National water resource strategy

The Department of Water and Sanitation (DWS) has developed the National Water Resource Strategy (NWRS) to give effect to Section 5 of the NWA. The section edition of the NWRS (NWRS2, DWA 2013) is the primary mechanism to manage water across all sectors towards achieving national government's development objectives. The water sector vision for the NWRS2 is "Sustainable equitable and secure water for a better life and environment for all" and is aligned with the vision of South Africa 2030. Towards achieving this vision, the overall goals is: "Water is efficiently and effectively managed for equitable and sustainable growth and development". The NWRS2 strives to achieve three main objectives (DWA, 2013):

- Water supports development and the elimination of poverty and inequality;
- Water contributes to the economy and job creation; and
- Water is protected, used, developed, conserved, managed and controlled sustainably and equitably.

4.3 Regulation 704

Section 26 (1) of the NWA provides for the development of regulations that:

- Require that the use of incoming and discharging water from a water resource be monitored, measured and recorded;
- Regulate or prohibit any activity in order to protect a water resource or in-stream or riparian habitat;
- Prescribe the outcome or effect that must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited into or allowed to enter a water resource.

Regulation 704 (GN704) (Government Gazette 20118, 4 June 1999) was drawn up to address these issues in relation to mining activities. The principal conditions are:

- Condition 4 describes the location of infrastructure and mining activities. Any residue deposit, dam, reservoir, together with any associated structure must not be located within the 1 in 100-year floodline or within 100 m of any watercourse or borehole;
- Regulation 5: Restriction on use of any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource.
- Condition 6 deals with capacity requirements of clean and dirty water systems. Clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated such that these systems do not spill into each other more than once in 50 years; and
- Condition 7 describes the measures which must be taken to protect water resources. All dirty water or substances which cause or are likely to cause pollution of a water resource either through natural surface flow or by seepage must be contained.

4.4 Other water management guidelines and standards

Other guidelines and standards applicable to surface water management in the context of this study, are described below:

- Water quality monitoring data are compared to the WUL quality limits, South African Water Quality Guidelines (SAWQG), Department of Water Affairs and Forestry (DWAF, 1996) for general fitness for use and the South African National Standard for drinking water (SANS241:2015) to assess potential health impacts if the water were to be used for drinking purposes.
- Best Practice guidelines for the mining sector, DWAF 2006, 2008, dealing with the following:
    - Integrated mine water management;
    - Aspects of the DWS water management hierarchy, namely, pollution prevention and minimization of impacts, water reuse and reclamation and, as a last resort, water treatment;
    - General water management strategies, techniques and tools which could be applied cross-sectorial and deal with stormwater management, water and salt balances, water monitoring systems, impact prediction; and
    - Specific mining activities, addressing the prevention and management of impacts from small scale mining, water management for mine residue deposits, PCDs, water management for surface mines, and water management for underground mines.

5 Site Description

This section provides a description of the hydrological baseline for the rivers and climate in the area.

5.1 Regional description

The KMR mine is located within the Orange River Basin and falls within the Lower Vaal Water Management Area. The KMR mine is situated within quaternary catchment D41K which is located downstream of quaternary catchment D41J. The total catchment area of the ephemeral Ga-Mogara River is about 8094 km^2 and joins the Kuruman River in the north and downstream of the KMR mine. All runoff generated within the Ga-Mogara River catchment eventually flows into the Orange River.

5.2 Climate

A description of the regional climate, as well as rainfall and evaporation for the site is presented below.

5.2.1 Regional climate

The KMR mine falls within the Northern Steppe climatic zone as defined by the South African Weather Service (SAWS). The general characteristics of the area is defined as a semi-arid region, which is associated with low rainfall, but high temperatures and evaporation. The Ga-Mogara catchment is classified as endoreic, with large areas which do not contribute to the overall catchment runoff within the water course. Based off temperature data from The Prediction of Worldwide Energy Resource (POWER) Project which is funded through the NASA Applied Sciences Program, the average annual temperature in the region is around 19 ºC. As evident from the KMR mine Automatic Weather Station (AWS), temperatures can reach as high as 41 ºC during summer and can be as low as -5 ºC during the middle of winter. The mean, maximum and minimum monthly temperatures are presented in Table 5-1 for the period from July 2019 to July 2021 from the KMR mine's AWS. The prevailing wind direction at the KMR is from the south (17 %) and south west (12 %). The southern wind vector prevails 54 % of the time, with the northern wind vector prevailing 38 % of the time.

Table 5-1. The monthly average, maximum, and minimum temperatures and windspeed observed at the Kudumane Manganese Resources mine automatic weather station from the 5th of July 2019 till the 21st of July 2021.

Month	Average Temperature (ºC)	Maximum Temperature (ºC)	Minimum Temperature (ºC)	Average Windspeed (m/s)
January	27.9	40.9	14.1	3.40
February	26.8	39.4	13.9	3.03
March	24.9	37.4	11.2	2.79
April	22.1	36.3	8.6	1.90
May	16.4	30.8	-1.8	1.45
June	13.5	30.6	-4.3	2.01
July	13.0	28.7	-5.2	2.24
August	15.8	33.3	-1.7	2.42
September	21.0	37.7	-0.4	3.39
October	25.8	41.1	5.8	3.66
November	27.9	42.5	12.6	4.27
December	27.5	41.7	11.8	3.45

5.2.2 Rainfall and evaporation

Rainfall data was only available from the AWS located at the KMR mine from July 2019 till July 2021, with a total of 121.6 mm recorded for the 2019 hydrological year (October to September). Due to the short data record, rainfall data was sourced from rainfall stations located within the upstream catchment. Five SAWS stations were located within the quaternary catchments D41K and D41J, with records available from 1920 to 2009. These records were abstracted from the daily rainfall utility software and the Water Resources of South Africa 2012 Study (WR2012) database, which both utilises the same SAWS data record. According to the WR2012, quaternary catchments D41K and D41J have a Mean Annual Precipitation (MAP) of 344 mm and 358 mm respectively. A decrease in the MAP is prevalent from east to west. Western rainfall stations beyond the boundary of the Ga-Mogara catchment have a higher MAP greater than 450 mm, while rainfalls stations to the east of the Ga-Mogara catchment have a MAP of less than 300 mm. Topographical patterns and elevation changes affect the spatial distribution of the rainfall characteristics. The majority of rainfall (85 %) falls between November and April during the wet season, while only 15 % falls during the dry season. On average, it can be expected to have 4 rain days a month during the wet season and 1 rain day a month during the dry season.

The monthly average rainfall for each of the five SAWS stations as well as the WR2012 rainfall database for quaternaries D41K and D41J is presented in Table 5-2. The 3 wettest months of the year are January, February, and March.

Table 5-2. The average monthly precipitation for the five SAWS stations located within the Ga-Mogara River catchment, as well as the WR2012 quaternary catchment rainfall dataset for D41K and D41J.

Month	0393083 W (Milner) 1931-2009	0392148 W (Winton) 1926-2009	0356636 W (Deben) 1925-2009	0356285 W (Hopkins) 1920-2009	0357592 W (Branksea) 1920-2009	WR2012 (D41K) 1920-2009	WR2012 (D41J) 1920-2009
October	20.4	17.1	21.0	19.5	15.2	19.0	19.7
November	33.8	26.1	27.2	27.3	33.0	30.0	31.3
December	47.4	44.2	40.7	44.3	46.0	44.7	46.5
January	68.4	62.3	57.9	60.6	58.8	61.5	64.0
February	61.6	61.2	52.6	61.8	66.4	60.1	62.6
March	67.1	57.4	58.8	67.8	71.7	63.6	66.1
April	35.6	31.4	28.1	34.9	35.6	32.3	33.7
May	15.9	13.6	12.3	14.7	17.9	14.2	14.8
June	6.3	4.1	5.3	4.7	5.6	5.0	5.2
July	1.9	2.5	2.3	3.0	1.9	2.3	2.4
August	4.0	4.8	6.6	6.1	4.8	5.2	5.4
September	6.0	6.8	7.4	6.8	6.6	6.7	7.0
Annual	368.4	331.5	320.3	351.5	363.6	344.6	358.7

No evaporation data was available from the KMR mine or from any of the SAWS stations within the catchment area. Thus, the WR2012 database was used for the assessment of evaporation within the region. Both quaternary catchments D41J and D41K fall within evaporation zone 8A with a Mean Annual Evaporation (MAE) of 2351 mm. Average monthly S-Pan evaporation from the WR2012 database is presented in Table 5-3.

Table 5-3. The average monthly Evaporation and Lake Evaporation (S-pan) for zone 8A from the WR2012 database.

Month	Evaporation WR2012 (mm)	Lake Evaporation (mm)
October	269.7	218.4
November	284.0	232.9
December	294.6	244.5
January	276.9	232.6
February	209.9	184.8
March	193.3	170.1
April	144.1	126.8
May	114.7	99.8
June	91.0	77.3
July	106.0	88.0
August	153.8	124.5
September	213.0	172.5
Annual	2351.0	1972.3

5.2.3 Design rainfall

The design rainfall depths of 24-hour to 7-day duration storm events for return periods from 2-years to 200-years were obtained from the design rainfall database (Smithers and Schulze, 2002) for the closest rainfall station 0393083 W (Milner), located 20 km south east of the KMR mine. The design rainfall depths for the various duration storm events and return periods used in this study are provided in Table 5-4.

Of the five SAWS stations within the Ga-Mogara River catchment, the station 0393083 W (Milner) showed the highest (131.4 mm) design rainfall in 24-hour duration for 1:100-year recurrence interval storm. The rainfall-intensity-duration curves for different return periods are presented in Figure 5-1, below.

Table 5-4. The design rainfall for the station 0393083 W (Milner) determined from the design rainfall database (Smithers and Schulze, 2002).

Duration	Return Period Rainfall (mm) (1:x years)						
	2	**5**	**10**	**20**	**50**	**100**	**200**
24-hour	47.8	68.0	82.2	96.5	116.0	131.4	147.5
2-day	56.7	81.6	99.3	117.4	142.4	162.5	183.7
3-day	62.0	89.4	109.0	129.1	157.0	179.5	203.3
4-day	65.2	94.7	116.1	138.3	169.4	194.7	221.8
5-day	69.4	100.8	123.7	147.4	180.7	207.9	236.9
6-day	73.0	105.9	129.7	154.1	188.2	215.9	245.3
7-day	75.9	110.2	134.9	160.3	195.6	224.0	254.2

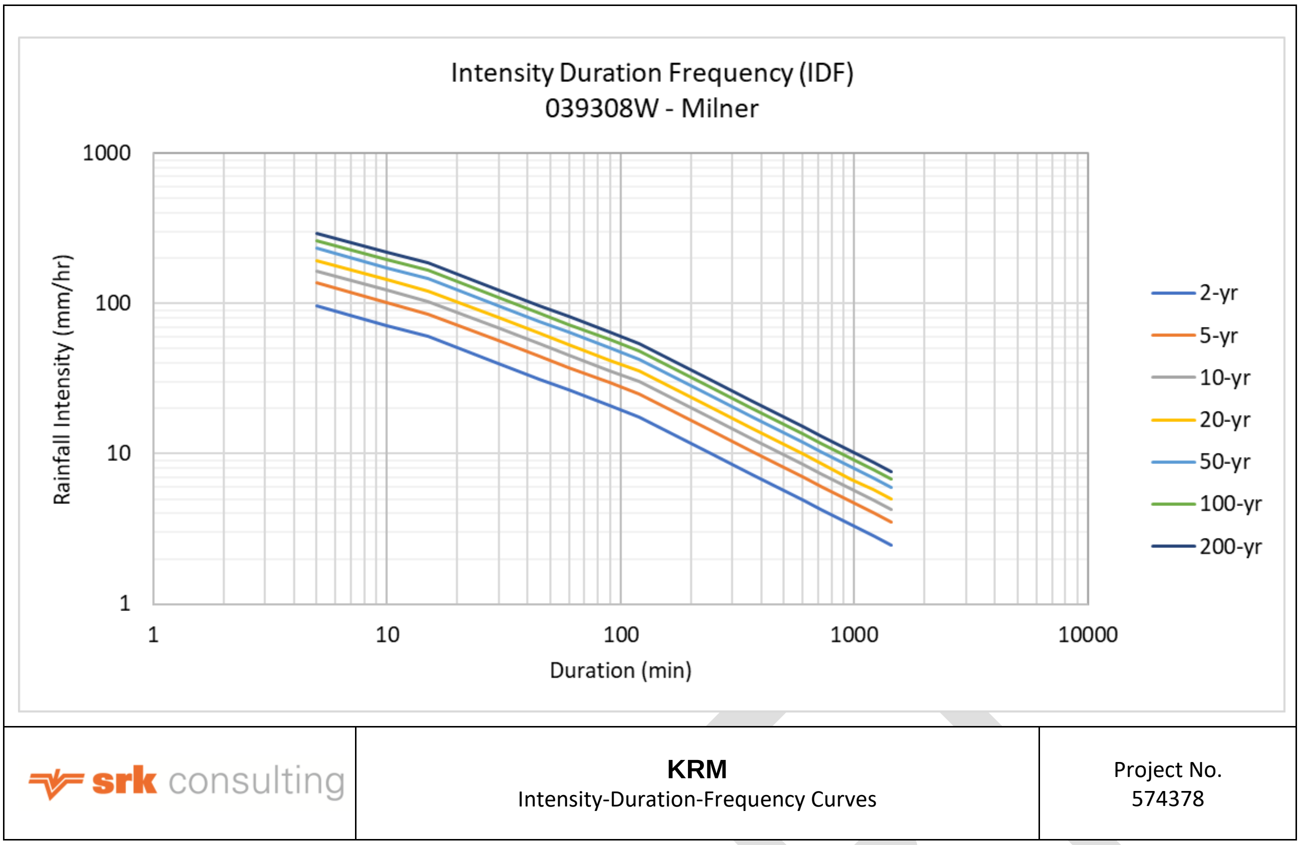

Figure 5-1. Intensity-Duration-Frequency Curves (039308W - Milner)

5.3 Water management area

The KMR mine is located within the Lower Vaal water management area in quaternary catchment D41K which has a total catchment area of 4216 km^2. The site is located within the Ga-Mogara River catchment which consists of the quaternary catchment D41K, and upstream quaternary catchment D41J. The Ga-Mogara River is a non-perennial river and flows into the Kuruman River downstream of the KMR mine, which then flows in a north-west direction joining into the Orange River. The Ga-Mogara River catchment sits within the primary Orange River basin.

The Ga-Mogara River enters the KMR mine area on the southern boundary and flows along the western boundaries of the York, Hotazel and proposed location of the Kiplig open-pit mines before exiting the KMR mine area on the north boundary, from where it then flows into the Kuruman River. The proposed expansion of the York and Hotazel open-pit mines will cause mining activities to cross the Ga-Mogara River, which will require a diversion option to prevent flooding of the open-pit mines and allow for the continuation of flow despite the disturbance caused through mining across the watercourse. .

The catchment area of which D41K and D41J form a part is classified as endoreic, which identifies that the rivers in the area do not produce runoff for the wider catchment areas, as the rivers tend to end in flat areas of inland pans.

The Ga-Mogara River basin is characterised by higher elevated areas along the boundaries on the eastern and western sides. The headwater regions in quaternary catchment D41J are characterised by elevations exceeding 1800 m.a.s.l. which are reduced with progression downstream. At the confluence where the Ga-Mogara River flows into the Kuruman River, the elevation is around 1000 m.a.s.l. The higher elevations found around the headwaters within quaternary catchment D41J are due to the surrounding steep outcrop hills which are characteristic of the river basin boundary. The majority of the Ga-Mogara River basin is characterised by flat surroundings with a very low topographical gradient. The flat landscape characteristic lends to natural areas of ponding in depressions which can occur during periods of high rainfall which are associated with storm events. As a result, it is understood that within this catchment, runoff within the river course is a result of groundwater rise, rather than storm runoff generated by overland flow. The Ga-Mogara river in the locality of the KMR mine has not flowed in recent years, with the most recent available evidence of flow being the accounts of Farmers in 1988. Upstream of the KMR mine, during the heavy rainfall event of January 2021, the town of Deben (47 km upstream of KMR mine) was flooded, with flow visible in the Ga-Mogara river approximately 25 km upstream of the KMR mine. Despite the two days of heavy rainfall, no flow was evident in the Ga-Mogara River in the vicinity of the KMR mine.

5.4 Surface water use

Domestic use

The KMR mine has one main water source which is from the Sedibeng Municipal inlet. Domestic water use is the KMR mines main water consumption. The KMR lodge located on the York Farm utilises the water from the Sedibeng pipeline. The KMR mine reservoir is also filled from the Sedibeng pipeline, and then used to provide water for domestic use in the Change Houses, Stores and Offices.

Industrial use

The KMR mine industrial water use component is related to mine operation. The main use is for dust suppression.

6 Surface Water Hydrology

In order to evaluate the different diversion options of Ga-Mogara River in the vicinity of the York and Hotazel Open Pit areas, an understanding of the baseline hydrology and meteorological characteristics are required. This section presents a comprehensive review of the general hydrological characteristics of the study area and the representative catchment by using different information sources.

The project area is located in the Orange River Basin, in quaternary catchment D41K and downstream of D41J. The total catchment area of the ephemeral Ga-Mogara River is about 8000 km² and joins the Kuruman River at the north and downstream of the project site.

The Kudumane Manganese Mine site falls within the Northern Steppe climatic zone as defined by the South African Weather Bureau. The general characteristics of the area is defined as a semi-arid region, which shows low rainfall, but high temperature and evaporation. Thus, the project site catchment is classified as endoreic with large areas, which do not contribute to runoff as the watercourses. The typical view of Ga-Mogara river bed and vegetation characteristics are presented in Figure 6-1.

srk consulting	**KUDUMANE EIA** Typical View of Ga-Mogara Riverbed	Project No. 574378

Figure 6-1. Typical View of Ga-Mogara Riverbed in Project Site

6.1 Topography

The attenuation dam and stormwater management plan studies and related analysis were performed by mostly using the Laser Imaging Detection and Ranging (LIDAR) data obtained in 2019, where available. The Digital Terrain Model (DTM) for LIDAR dataset was evaluated with a 0.5 m resolution by using the LAS point cloud provided by KMR .

Another LIDAR survey data which focused on York Trail Loop Area was obtained in 2021. The up-to-date partial LIDAR survey was used for the hydrological studies focused on the area at the east of the York Open Pit.

The topography and the available topographical data of the study area in vicinity of the mine site is presented in Figure 6-2.

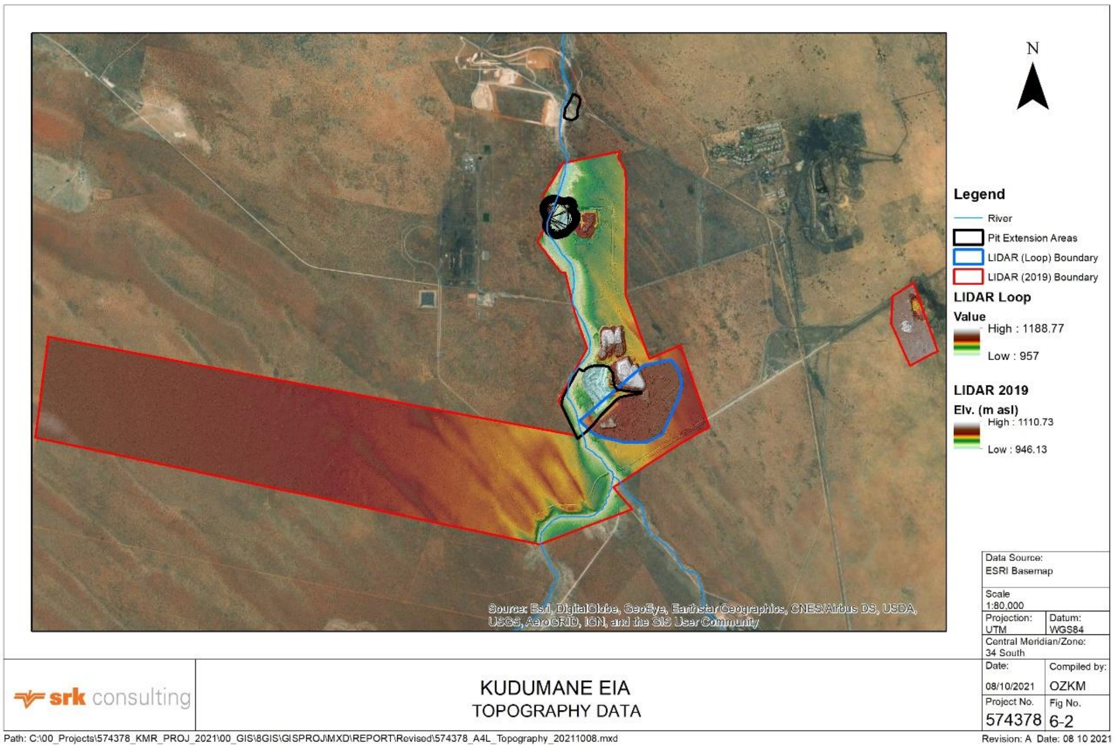

Figure 6-2. Available Topography Data at Project Site

Where the study extended to the area outside of the LIDAR boundaries, the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model provided by NASA (National Aeronautics and Space Administration) was used in large scale hydrological analysis and mine focused analysis where local data is not available. The SRTM dataset has 30 m resolution.

6.2 Catchment characteristics

To develop a general understanding of soil characteristics and hydrological properties of the catchment of Ga-Mogara River, soil texture information is required. Soil texture data and spatial distribution was obtained from a remote sensing programme called SoilGrids 250 m Database of International Soil Reference and Information Centre (ISRIC, 2017). The general soil characteristics that affect the rainfall runoff relationship in this catchment area (Figure 6-3) is dominated by Sandy Loam and Loamy Sand. Some Sandy Clay Loam and Sand type of soil is also prevalent in the study area. In addition to the available data, the site observations also support that the catchment soil is formed with high sandy texture, that allows for a high infiltration rate and a low water holding capacity.

In addition to the soil characteristic, the land cover classification of the catchment was also evaluated by using the National Land Cover database (NLC, 2009). The majority of the catchment area is classified as a natural land cover of semi-arid scrub. Due to the dry climate condition of the site, plantation and cultivation areas is minimal. Secondary land cover classes are presented by mine sites and degraded areas. The land cover classification over the catchment is presented in Figure 6-4, below.

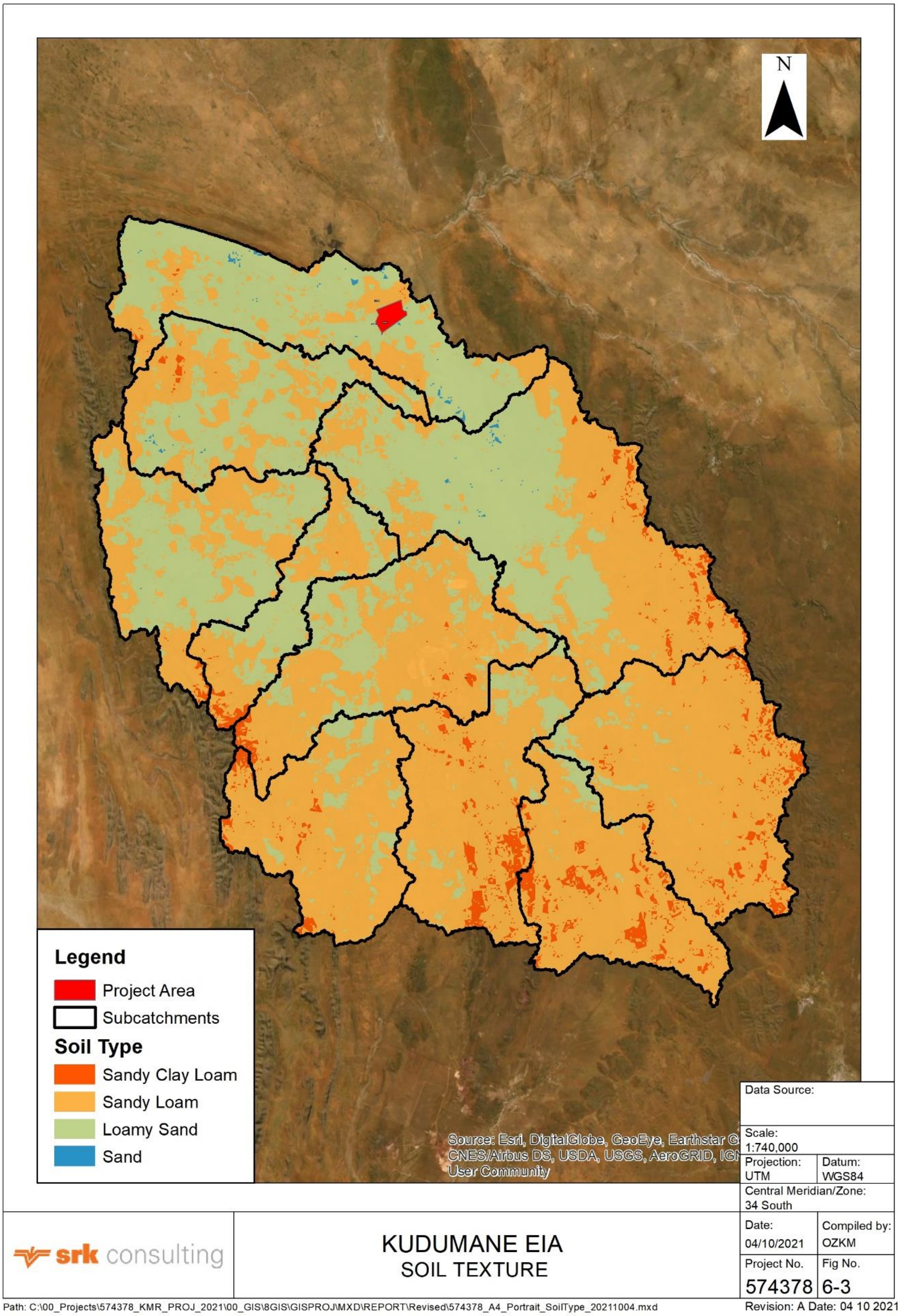

Figure 6-3. Soil Texture of Ga-Mogara Catchment (ISRIC, 2017)

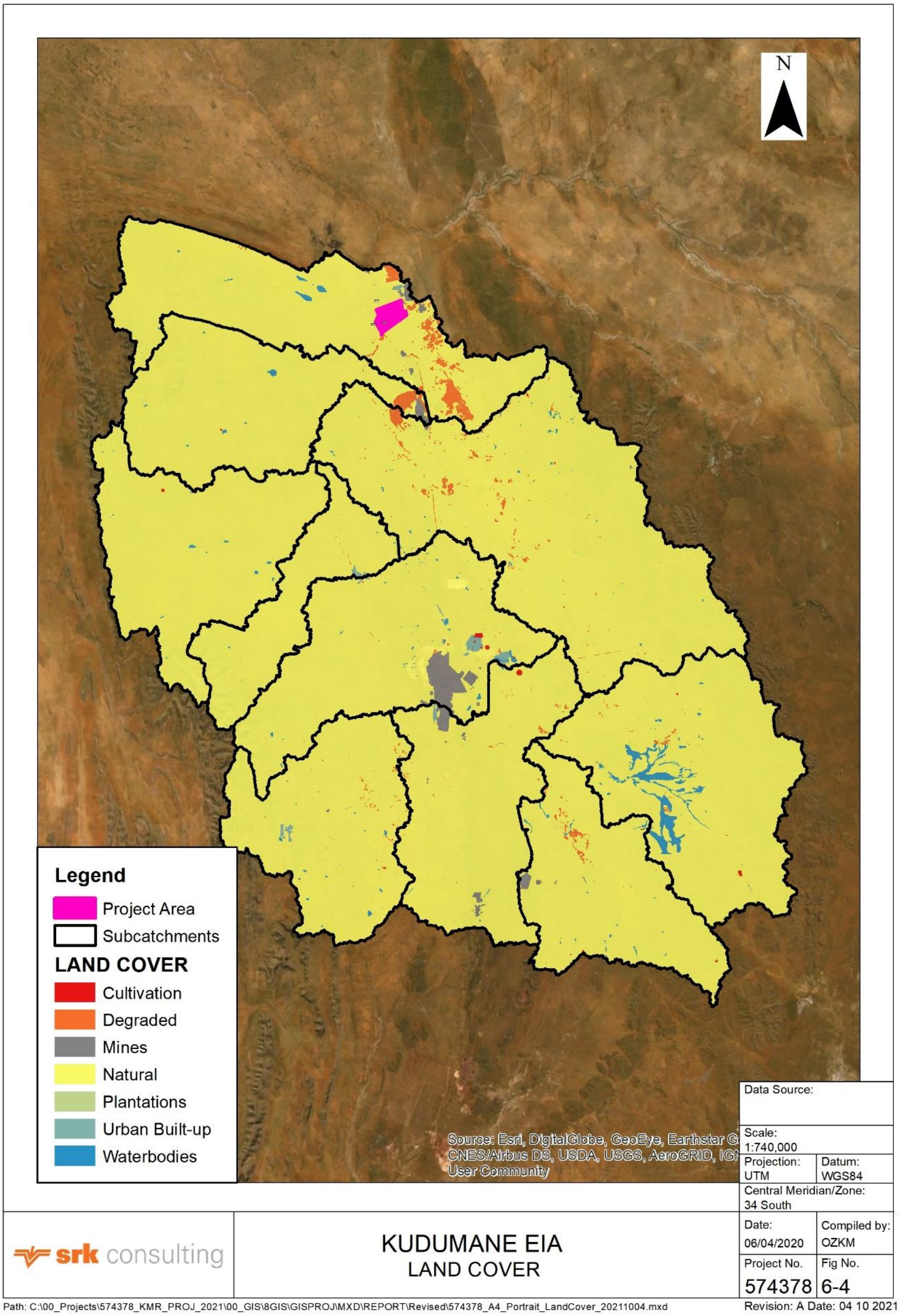

Figure 6-4. Land Cover of Ga-Mogara Catchment (NLC, 2019)

6.3 Flood peaks

The current study carried out by SRK to evaluate the different diversion options at Ga-Mogara River course for KMR does not cover any peak flow and floodline analysis. The design flow rate information was obtained from the previous hydrological studies as listed below:

- The Hydrological Assessment for the Proposed Kudumane Mine (Metago Environmental Engineers, 2010);
- The Integrated Waste and Water Management Plan (SLR Consulting, 2012);
- The New Mining Right Application for Devon, Kipling and Hotazel Surface Water Study, (SLR Consulting, 2014); and
- The Water Use Licence Application (WULA) Storm Water Management Design (SLR Consulting, 2015).

The initial hydrological assessment study carried out by Metago presents flood peak numbers that are determined by using the Regional Maximum Flood (RMF) method, as implemented in the Utility Programs for Drainage (UPD) software (SANRAL, 2006). Accordingly, 402.7 m³/s was calculated for 1:50-year and 517.7 m³/s for the 1:100-year design storm. Related floodlines were modelled by using the HEC-RAS software.

The probability of the flow in any one year is estimated to be 1:13 and the approximate peak flow was calculated as 35 m³/s at the cross section by developing a HEC-RAS model at the ungauged river.

In addition to the historical flood events based on farmers observation, the floodline study was supported by using the aerial images. 100 m³/s and 250 m³/s Floodlines were evaluated and a comparison was made based on the border of the darker brown alluvial soils and dense grass cover at the river banks. As a result, the largest peak flow is estimated to be likely less than 250 m³/s at the study area.

In addition to the flood assessment based on the historical flow observations in the ungauged catchment, SLR Consulting (SLR) also carried out peak flow analysis by using the RMF method, which is an emprical method based on maximum peak flow records all around Southern Africa. Due to recorded flood flow rates and catchments, a regional K Value was related through the catchments.

In the 2010 studies performed by Metago, the K value was taken as 2.8 with the result of 403 m³/s for a 1:50-year and 517.7 m³/s for the 1:100-year. Based on the peak flow estimations based on catchments C3H004 and C3H017, the K value was mentioned a better representation with 1.7. As a result of revised peak flow estimations by SLR, estimated flow rates are presented in Table 6-1, where the numbers also participated in the WULAs.

Table 6-1. RMF Method Peak Flow Estimations (SLR, 2014)

Event	Peak Flow (m³/s)
	K=1.7
Regional Maximum Flow (RMF)	400
1:200	251
1:100	198
1:50	154

Regarding to the previous studies, the following diversion option studies are evaluated based on 1:100-year design flow of 198 m³/s calculated by SLR and presented in the previous Environmental Impact Assessment (EIA) and WULA reports.

6.4 Floodlines

This section outlines the floodlines calculated for the site. The 1:50 and 1:100 year floodlines determined for the Ga-Mogara River and presented in Figure 6-4: The floodlines were calculated using the HEC-RAS model by SRL in 2017 within the scope of EIA works. Within the scope of current work, floodline study did not performed.

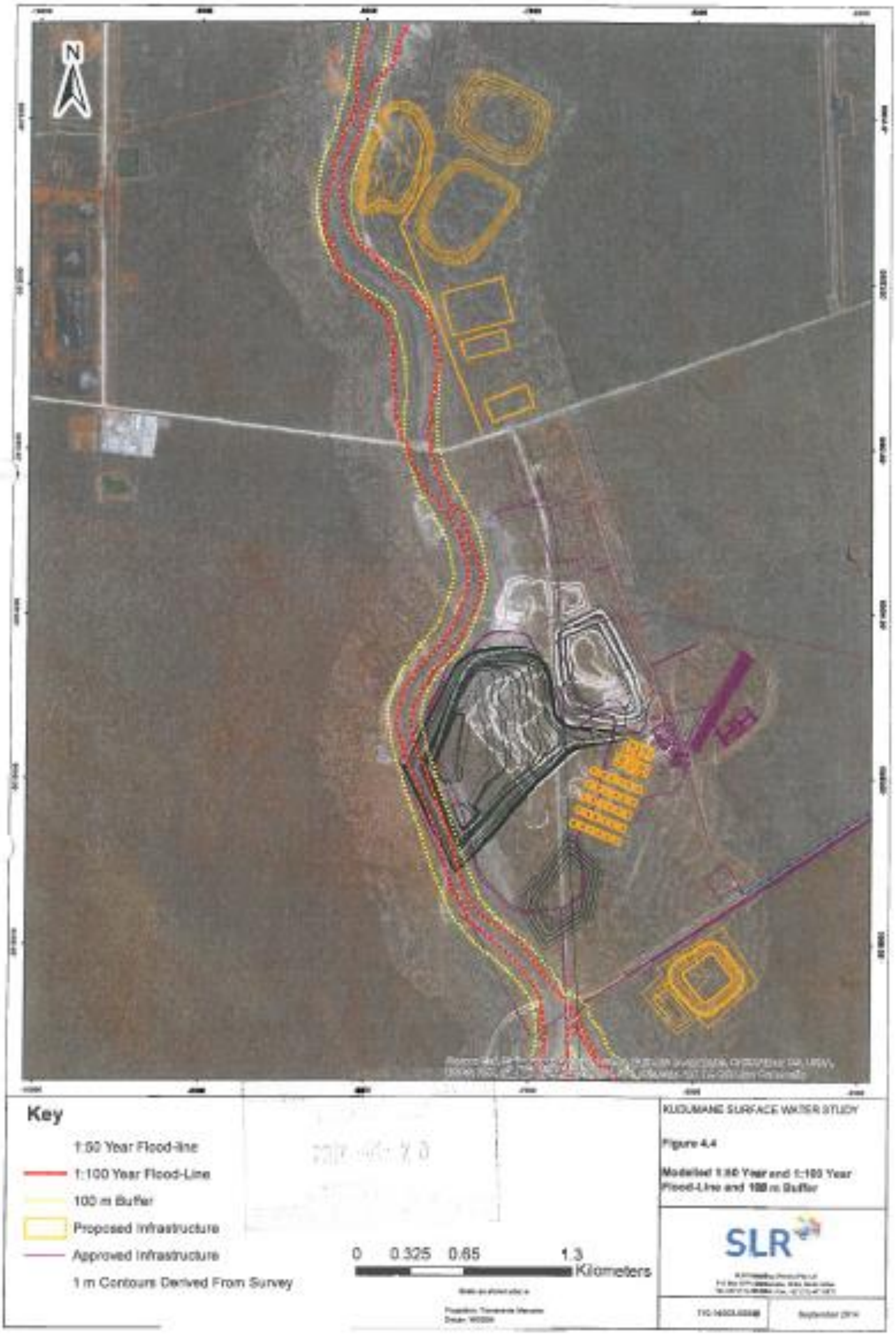

Figure 6-5. Modelled Floodline for 1:50 and 1:100 Storm Events (SLR, 2017)

6.5 Normal dry weather flows

The normal dry weather flow is defined as the flow which occurs 70 % of the time in the three driest months (June, July, August). The system has negligible flow during the dry season and can therefore be classified as non-perennial.

6.6 Mean annual runoff

The KMR mine is located in quaternary catchment D41K which has a gross catchment area of 4216 km^2. According to WR2012, the catchment has a Mean Annual Runoff (MAR) of 6.53 million m^3 per annum. This was increased from the Water Resources of South Africa 2005 study (WR2005) MAR of 1.92 million m^3 per annum as when the WRSM2000 model was revisited, more realistic Sami groundwater parameters were applied. The challenge with modelling this catchment area, is that no streamflow gauges are available for calibration, and therefore MAR estimates are based on similarities with areas where streamflow gauges are available. Following a site visit, it was determined that the average flow within the Ga-Mogora River at the outlet of D41K would more likely be zero, with the occasional flow as reported during events of 1974, 1976 and 1988 as confirmed by local accounts. For modelling purposes, the MAR of 1.92 and 1.75 million m^3 per annum for quaternary catchments D41K and D41J as determined by WR2005, were used as a guide as they were deemed more realistic than the WR2012 MAR. A previous Surface Water Study by SLR Consulting (Africa) (Pty) Ltd in 2014 concluded that even the WR2005 MAR values appear incorrect and do not correspond with local observations. The report stated that the probability of flow within the river in any one year is estimated to be 1:13.

The WRSM2000 model was used to simulate the annual runoff at the outlet of quaternary catchment D41K from 1920 to 2009. The annual hydrograph is presented in Figure 6-6.

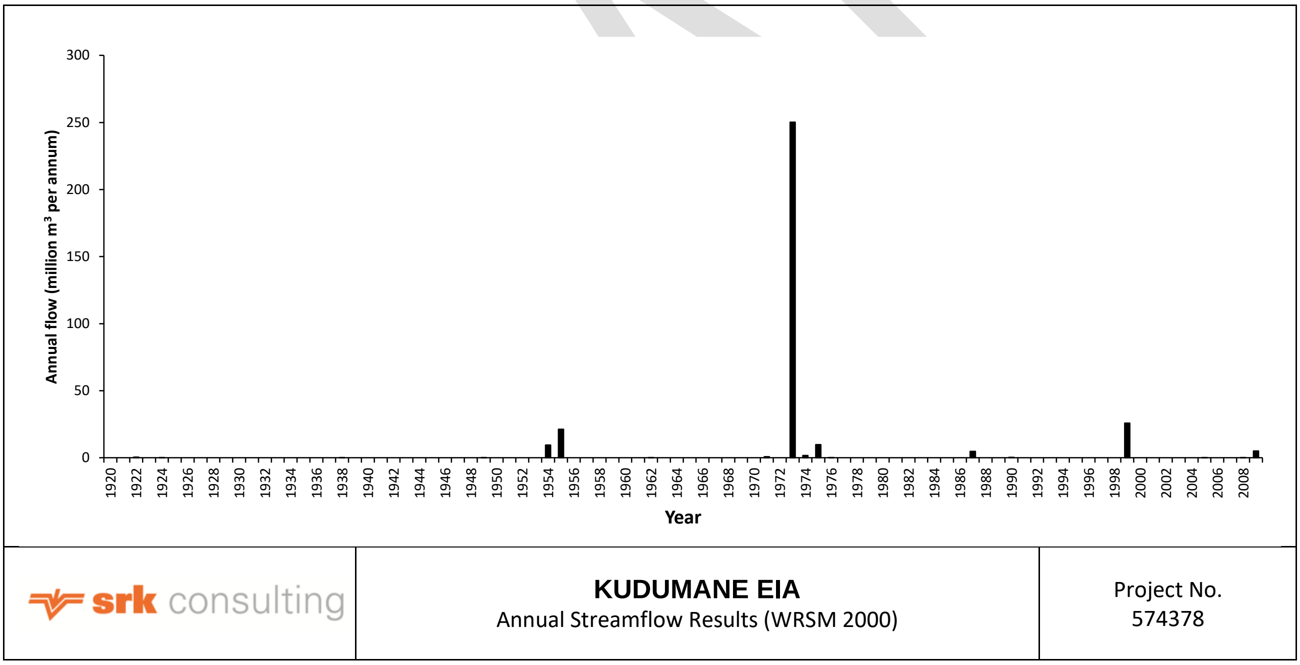

Figure 6-6: The annual streamflow for the Ga-Mogara River catchment from 1920 to 2009 as determined using the WRSM2000 model

The highest annual flow simulated was 250.3 million m^3 and occurred during the 1973 hydrological year, which is considered to be driven by the four months of high rainfall (December, January, February, March) which occurred in 1974. As no streamflow gauge is available for comparison, previous accounts from farmers were used to verify the simulated runoff. It is known that flooding did occur during this period, and flow was seen within the river. Notable flows were also witnessed in 1976 and 1988 within the Ga-Mogara River, which were simulated by the model. There is no evidence to account for flows before 1974. The flows simulated in 1999 and 2009 are one or two months of flow between December and February. No accounts of flow within the Ga-Mogara River have been accounted for during these periods. The possible reason for the simulation of these events, is due to a single month of high rainfall. Within the model, this generates runoff. It is understood, that within this catchment, flow is not generated by a single high intensity storm event or storm runoff, but rather a continued period of high rainfall sustained over time. This is suggested to be due to the freely draining soils of the area and the flat terrain. Shorter storm events are more local, while longer duration rainfall events may not be as intensive but, would be more evenly spread across the entire catchment generating runoff through groundwater response. As was witnessed during the recent 2021 floods near Deben, flow may occur within the river basin, but remain localised and subsides before reaching the catchment outlet. Although the accuracy of the annual streamflow values cannot be determined as no streamflow values for the Ga-Mogara River catchment are available, the simulation provides a confirmation and representation of the non-perennial nature of the river and the catchments response to months of continued above average rainfall.

7 Ga-Mogara River Flood Assessment

7.1 Flood in Deben

With the lack of stream gauge and historical records on Ga-Mogara river, previous flow events were based on anectodal evidences since the Ga-Mogaro River does not flow regularly. Notes from local farmers showed that notable flow at Ga-Mogara River occurred between 1974 and 1976 and again in 1988 (SLR, 2014).

The latest major flow observed in Ga-Mogara river occurred during the hurricane Eloise, which affected South Africa in January 2021. It was recorded that Ga-Mogara river was flooded and affected the township Deben which is approximately 45 km upstream along the river from the Kudumane project site. Drone images from the flood area at Deben township is given in Figure 7-1.

srk consulting	**KUDUMANE EIA** Drone Image from Deben Flood	Project No. 574378

Figure 7-1. Drone Image from Deben Flood, January 2021. (sowetanlive, 2021)

According to the newspaper, 117 mm rainfall was recorded before the flood at Deben which is nearly a 1:50 year design storm magnitude calculated for KMR project site. However, on-site rainfall gauges were measured 62 mm and 58 mm in York and Hotazel area on 26 January 2021, respectively.

In the interviews made with the local people in Deben, it was stated that the flood water spreads 20-30 km downstream from the town at most and disappeared by infiltrating into the groundwater. KMR employees also noted that no flood water reached the KMR project area during the flood period.

During the site visit, the part of the Ga-Mogara river between the KMR project area and the town of Deben was examined, and it was observed that the flood traces only reached a certain area at downstream. Since the findings obtained during the site visit were months after the event of the flood, the statement supported with Satellite images of Deben and the project area by comparing before and after the event images in Figure 7-2 and Figure 7-3.

Accordingly, Sentinel-2 satellite images also shows no evidence that Ga-Mogara flood in January 2021 did reached to the KMR project site.

Figure 7-3

srk consulting	**KUDUMANE EIA** Sentinel-2 L2A Image of Deben	Project No. 574378

Figure 7-2. Sentinel-2 L2A Image of Deben (22/01/2021 – 01/02/2021)

srk consulting	**KUDUMANE EIA** Sentinel-2 L2A Image of KMR Project Site	Project No. 574378

Figure 7-3. Sentinel-2 L2A Image of KMR Project Site (22/01/2021 – 01/02/2021)

7.2 Attenuation Dam Design

KMR is exploring the viability of extending the open pit mining operations in a westerly direction at the Hotazel Pit, beyond the 1:100-year floodline. The extension of the pits is restricted by a drainage channel of the Ga-Mogara River on the western side. In the previous "Option Analysis" study performed in 2020 by SRK (SRK, 2020), various diversion options were evaluated to identify the most feasible option to mine through the river. The possible diversion options include attenuation ponds, diversion channels with different alignments and the combination of the channels and ponds.

Within the option analysis study, both diversion and attenuation dam options were studied for Hotazel and York open pit areas at Ga-Mogara riverbed. Some of the options include only diversion channels, and also the combining the channels and attenuation dams were also evaluated. With the scope of option analysis study, conceptual costing of each alternative was prepared. Considering the river inlet and bank elevation differences are reaching up to 20 - 25 m, required side slope distance, excavation and construction costs make those options unfeasible and technically impractible.

As a final finding of the previous study, the recommended option is to construct attenuation dams along the Ga - Mogara River upstream of the site and store the local runoff from the immediate area surrounding the pits. It is not practical to store the flood water from the greater Ga-Mogara catchment.

Since the project area is located in the low-rainfall zone and the soil is very sandy, the rainfall-runoff is minimal in the vicinity of the project area. The most recent flow in the stream bed was observed in the late 1970s and 1980s at project area. As described below, recent flood event occurred in Ga-Mogara river in January 2021 did not reached to KMR project site and infiltrated into groundwater within 20 – 30 km distance after township of Deben.

The capture and attenuation of the flowing upstream ponds is technically a good option and if the ponds overflow, the open pit operation can be suspended until the storm has abated. The mitigation measure will be to monitor upstream flows and give sufficient time to evacuate the pit. If the water flows into the pit, then the pit can be pumped dry, and mining can commence.

Planned attenuation dam information is summarized in Table 7-1, and locations are shown in Figure 7-4.

Table 7-1. Attenuation Dam Summary Information

Dam ID	Crest Elv. (m a.s.l)	Dam Length (m)	Max Dam Wall Height (m)	Pond Surface Area (m^2)	Storage Volume (m^3)	Location
Attenuation Dam-1	1032	184.9	4.14	301434.0	430260.8	Upstream of York Open Pit
Attenuation Dam-2	1023	90.2	3.28	68534.4	59542.1	Between the York and Hotazel Open Pits

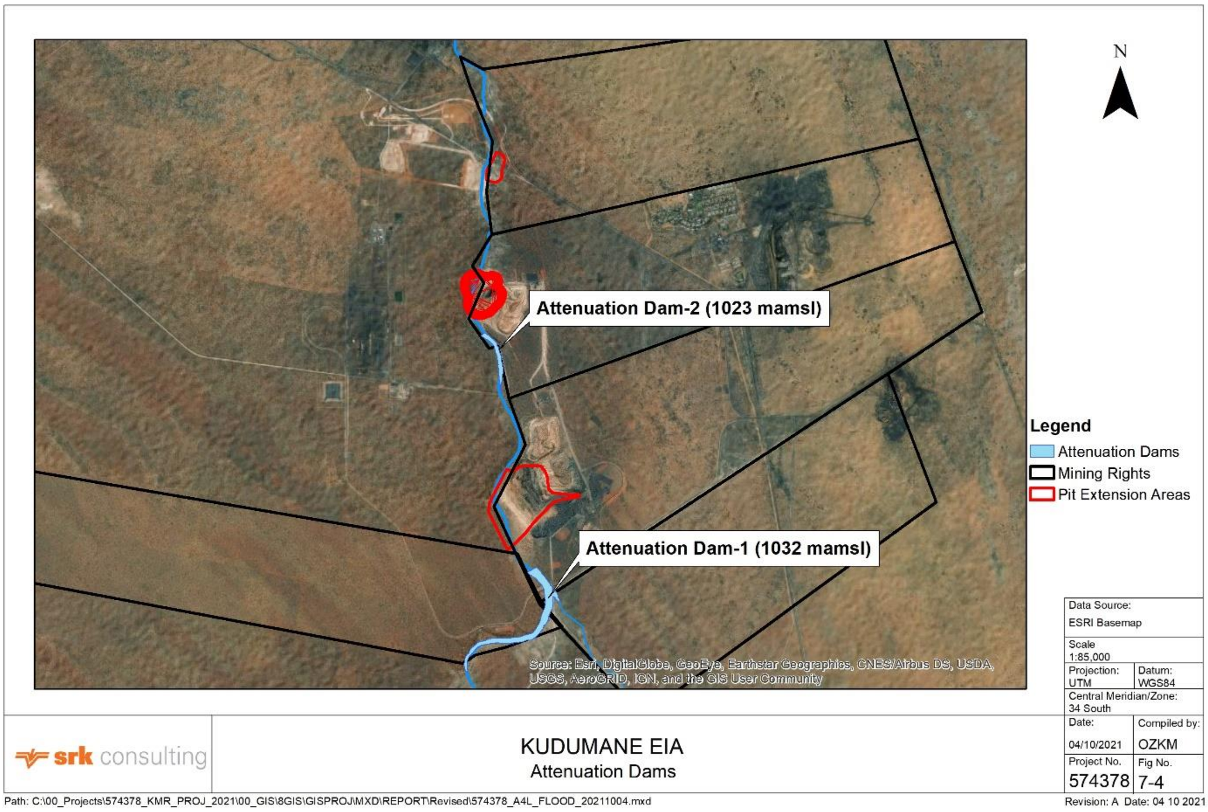

Figure 7-4. Attenuation Dam General Layout

During a storm event with potential flow in the river, attenuation dams will eventually overflow and the water could fill into the pits. The attenuation dams will give the mine sufficient time to evacuate the pit.

The open pit site planned in the Kipling license area is located downstream of the KMR project area. If the York and Hotazel open pits move beyond the Ga-Mogara river as planned, the watershed that will affect the Kipling area will be very limited. In the evaluations made with the information obtained during the site visit and supported with the satellite images, it was determined that a diversion channel was built on the right-hand side of the river within the scope of the open pit work carried out by the Kalagadi Manganese Mine. Current conditions on Kipling area is presented in Figure 7-5.

Figure 7-5. Current Conditions at Kipling Area (Sentinel-2)

8 Stormwater Management Plan (SWMP)

The Stormwater Management Plan (SWMP) has been developed for the infrastructure associated with the proposed expansion project components. The conceptual SWMP has been prepared according to the following guidelines and legislative requirements:

- DWS Best Practice Guideline G1: Storm Water Management,
- DWS BPG A4: Pollution Control Dams,
- DWS BPG A5: Water Management for Surface Mines, and
- GN704: Regulations on the use of water for mining and related activities aimed at the protection of water resources.

In order to comply with best practice stormwater principles, areas of clean and dirty (contact) water need to be identified and managed accordingly. This involves separating the clean water areas from the dirty water areas using a series of berms and channels and collecting dirty water around clean areas and finally into a Pollution Control Dam (PCD). Typical areas of dirty water would be any areas where activities pose a pollution risk to surface water resources. Typical areas of clean water include the natural environment, such as areas around streams and rivers (CSIR, 1995). Runoff from clean water areas must be diverted around dirty water areas.

Runoff from dirty water areas must be collected and contained and may not spill from the dirty water area more than once, on average, in 50 years. Dirty water areas should be managed as a closed separate system regulated by a collection point or PCD. All dirty water should be directed to this collection point and then be managed accordingly, either by re-use in the dirty system, evaporation, or treatment and discharge downstream.

Within the current report section, findings from the desktop study and site visits and proposed conceptual stormwater management layout were summarized. The conceptual layout plan will indicate potential clean and dirty water storm water management measures (infrastructure) that are required to ensure the separation of these different water areas. Where there is no LIDAR image, the global elevation data set SRTM is used.

8.1 York

The stormwater management at York site is mostly managed by earth berms that separate the clean and dirty runoff areas. Apart from the berms, two existing PCDs were constructed on York site to manage the contact water that produced from the open pit dewatering and surface flow from the operation areas.

One of the PCD is located to the south west (SW PCD) of open pit and one of them located in the York Rail Loop area (YRL PCD). The SW PCD does not capture any surface flow due to as-built conditions on site with higher inlet level than natural ground level. In addition, the designed dirty water channels and separation berms are not in place (REDKEM, 2019).

The Rail Loop PCD is also not able to capture any contact runoff due to the higher inlet elevation than the ground level. Based on the previous specialist reports, it was addressed that the proposed terraces and berms were not constructed (REDKEM, 2019). The Rail Loop PCD, the upstream topography is constantly changing due to activities at crushing at stockpile areas. The current capacity of the dam is 2.790 m^3. Inflow into the Trail Loop PCD is York Open Pit dewatering water that is used for dust suppression.

Based on the planned developments in vicinity of the York site, the following items were studied in terms of the stormwater management plan:

- Extension of the Rail Loop Area and relocation of the existing PCD,
- Extension of the existing Manganese Stockpile
- Upgrade of the office area
- Upgrade of the Lilliput Treatment Plant

8.1.1 York Rail Loop Area (YRL)

The YRL area is hydrologically divided into three sub-catchments. The sub-basins in the YRL area are given in Figure 8-1.

Surface runoff from the sub-catchment A reaches and accumulates in the low elevation zone in the northwest. Sub-catchment C surface flow is accumulated in the low-elevation zone and joining to the sub-catchment D via existing culvert. Sub-Catchment J surface flows also accumulated within the boundary.

The rest of the sub-catchments and their flow pattern shows southernly flow pattern dominated by the existing berms, stockpile areas, and dumps in the trail loop area. Only the YTL-H sub-catchment is reporting to the existing rail loop PCD. Any surface runoff and potential spillage from PCD would discharge to the crushing area via the culvert located at the west. The stormwater controls for future conditions that refers to northern part of rail loop area are illustrated in Figure 8-2, below.

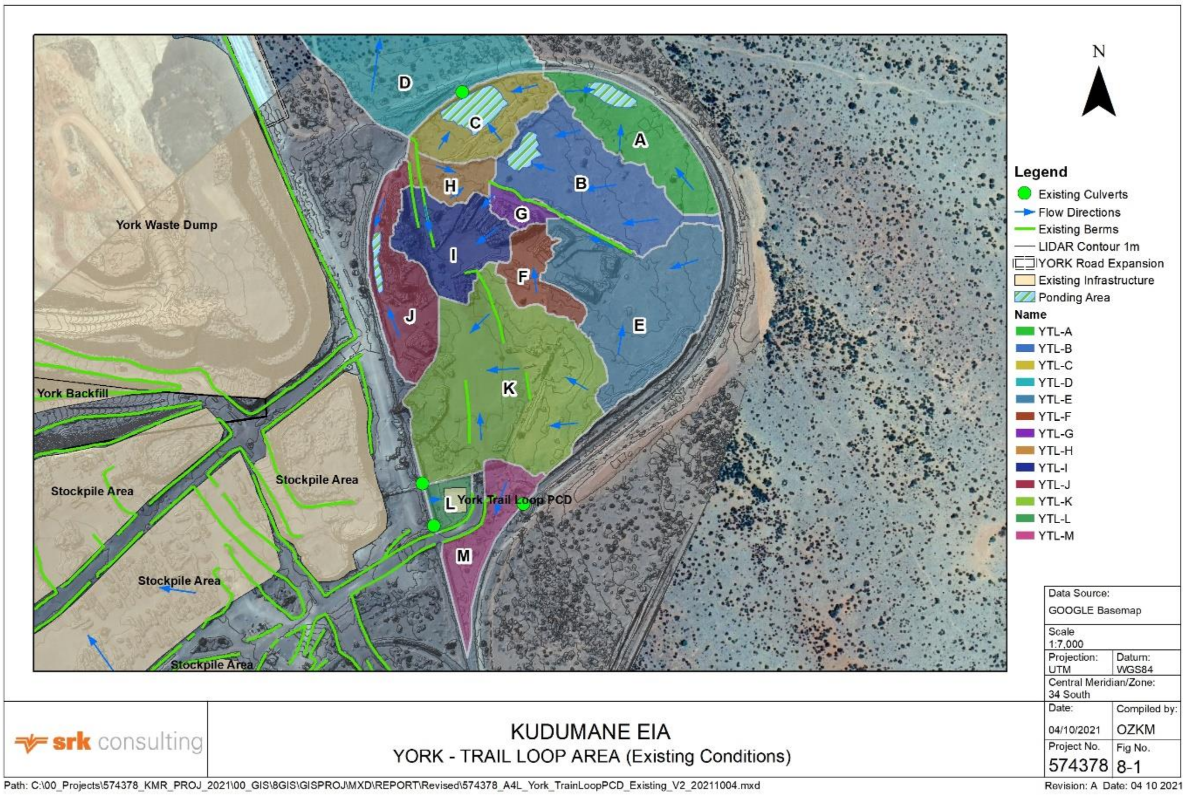

Figure 8-1. Existing Stormwater Management Conditions at York Rail Loop Area

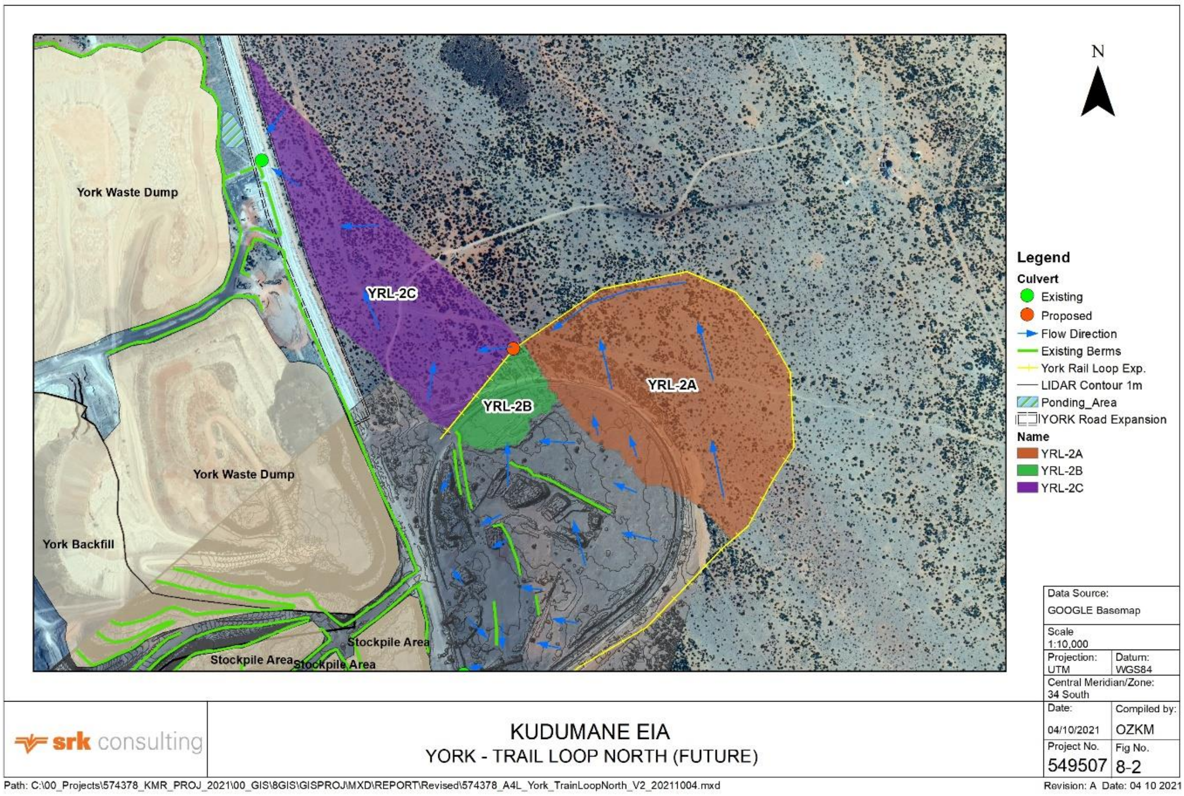

Figure 8-2. Proposed Stormwater Management Plan at York Rail Loop North

8.1.2 Trail Loop Pollution Control Dam (PCD)

In order to capture the contact water from the trail loop area, a new PCD was planned by MCJ (MCJ, 2021) and this is indicated in Figure 8-3. The design capacity of the new proposed trail loop PCD is 1093 m3 with 1210.4 m2 surface area and meets regulations 704.

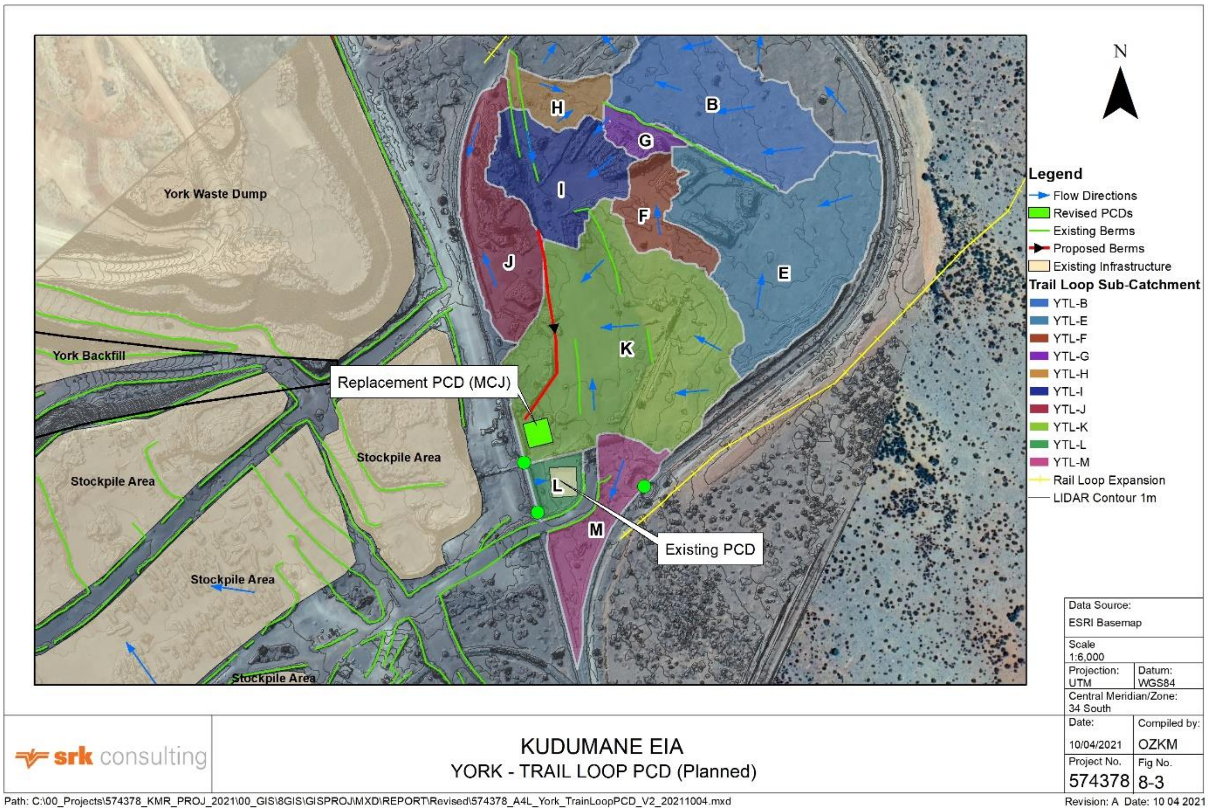

Figure 8-3. Proposed Stormwater Management Plan at York Rail PCD

8.1.3 Extension of York Stockpile

Conceptual stormwater management for the stockpile extension area is presented in Figure 8-4. This controls include berms, PCD's in order to meet the regulation of 704.

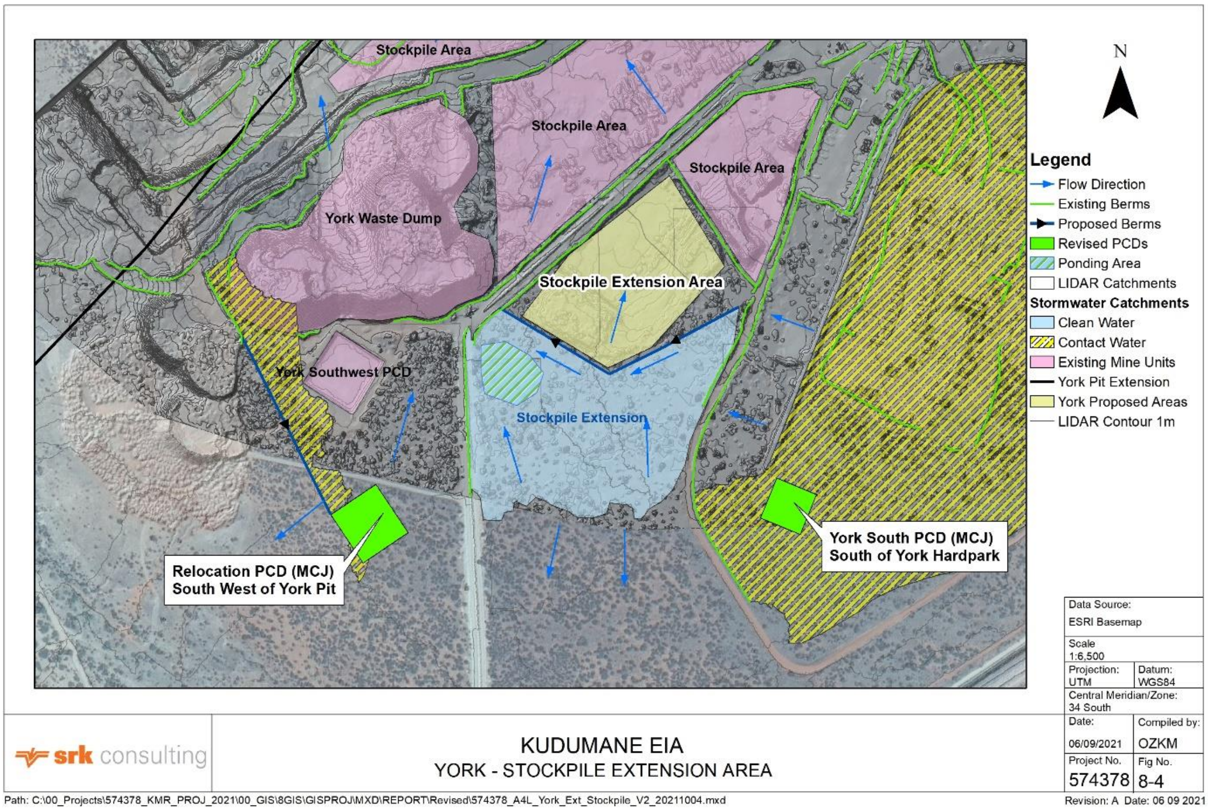

Figure 8-4. Proposed Stormwater Management Plan at York Stockpile Extension Area

8.1.4 Upgrade of Office Area

Conceptual stormwater management for the office area is presented in Figure 8-5 and the measures are summarised as below:

- **Temporary Waste Storage:** A berm and a diversion channel system is required to divert the clean water away from the site. Polluted water will be collected within berms constructed at the lowest point of the site.
- **York Salvage Yard:** A berm and a diversion channel system is required to divert the clean water away from the site. Polluted water will be collected within berms constructed at the lowest point of the site.
- **Parking Area** The parking area is located at the most upper portion of the catchment and no clean water diversion are required.
- **York Mine Clinic** The mine clinic area is located at the most upper portion of the catchment and no clean water diversion are required.

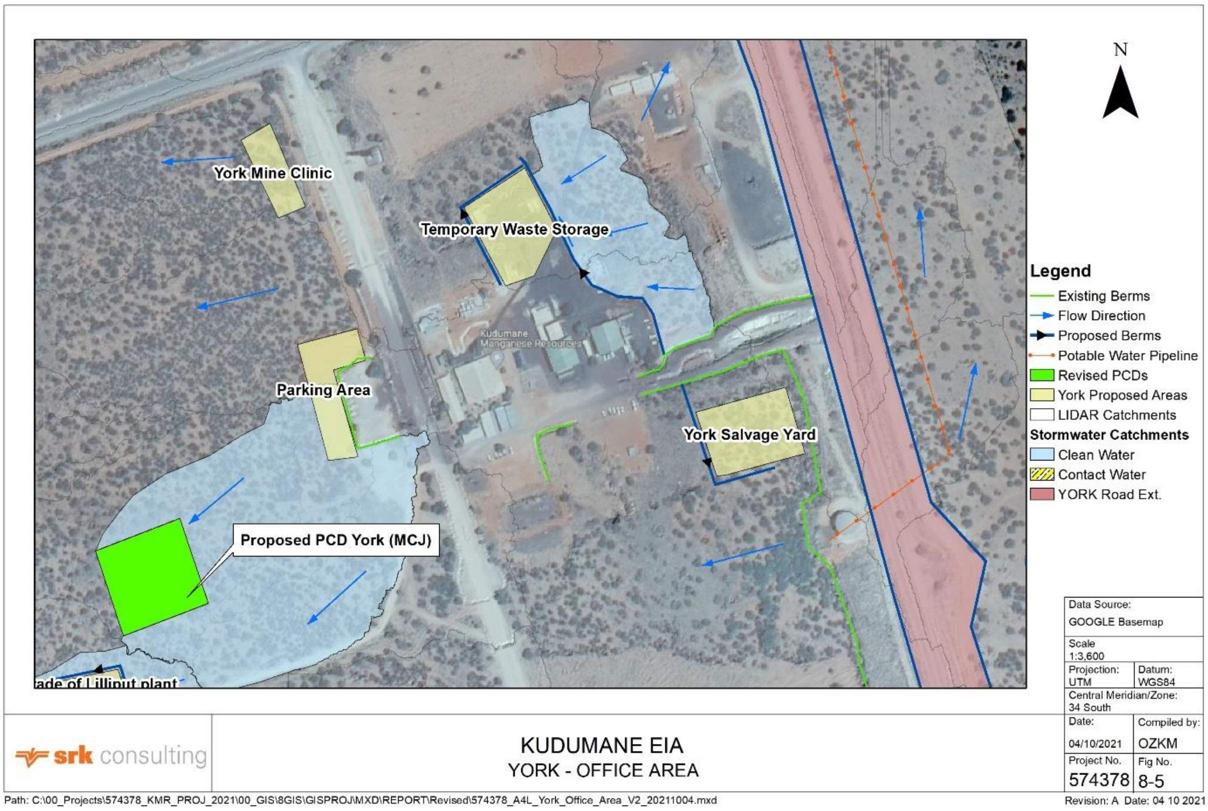

Figure 8-5. Proposed Stormwater Management Plan for York Office Area Upgrade

8.1.5 Upgrade of Lilliput Plant

Lilliput Sewage Water Treatment area at York licence area will be upgraded. Clean water will be diverted away from the site as indicated in Figure 8-6.

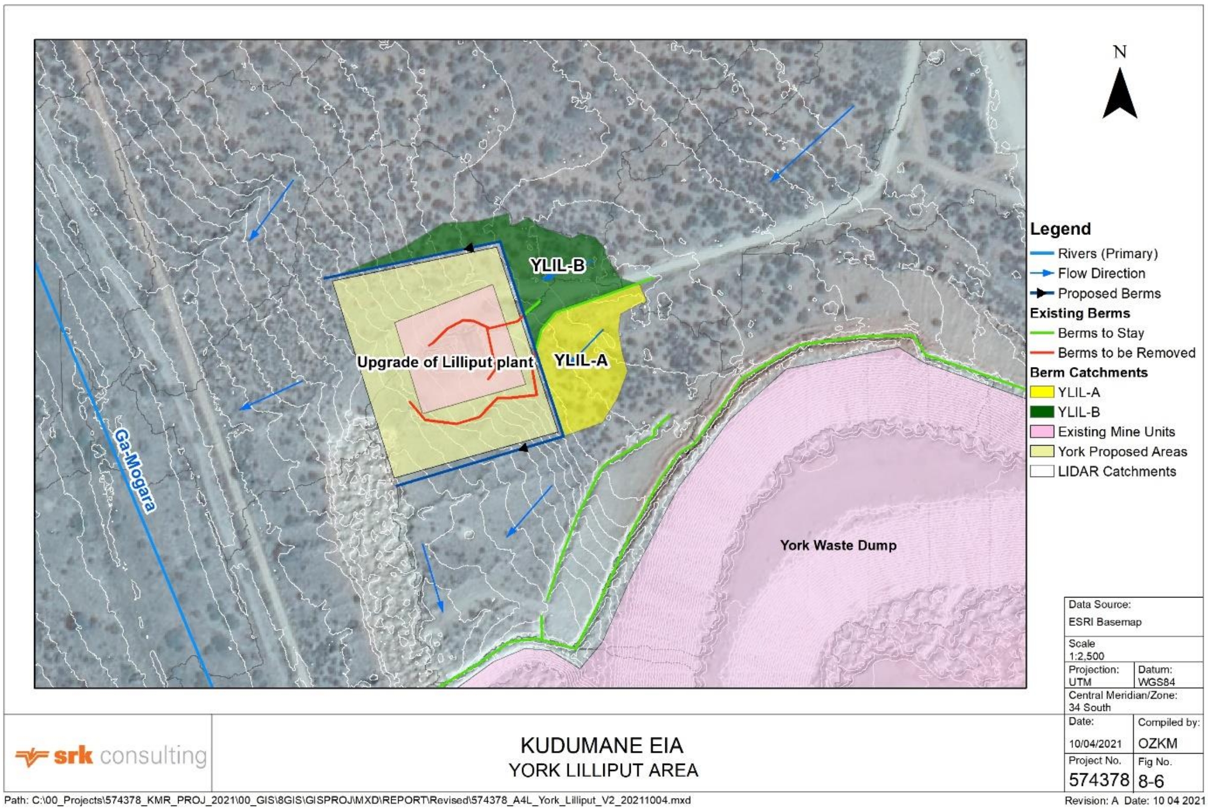

Figure 8-6. Proposed Stormwater Management Plan for York Lilliput Plant Upgrade

8.1.6 Truck Parking Area

The area north of the York Open Pit is reserved for Truck parking within the new proposed mine plan. The northern borders of this area are currently surrounded by earth berms. Clean water will be diverted away from the site as indicated in Figure 8-7.

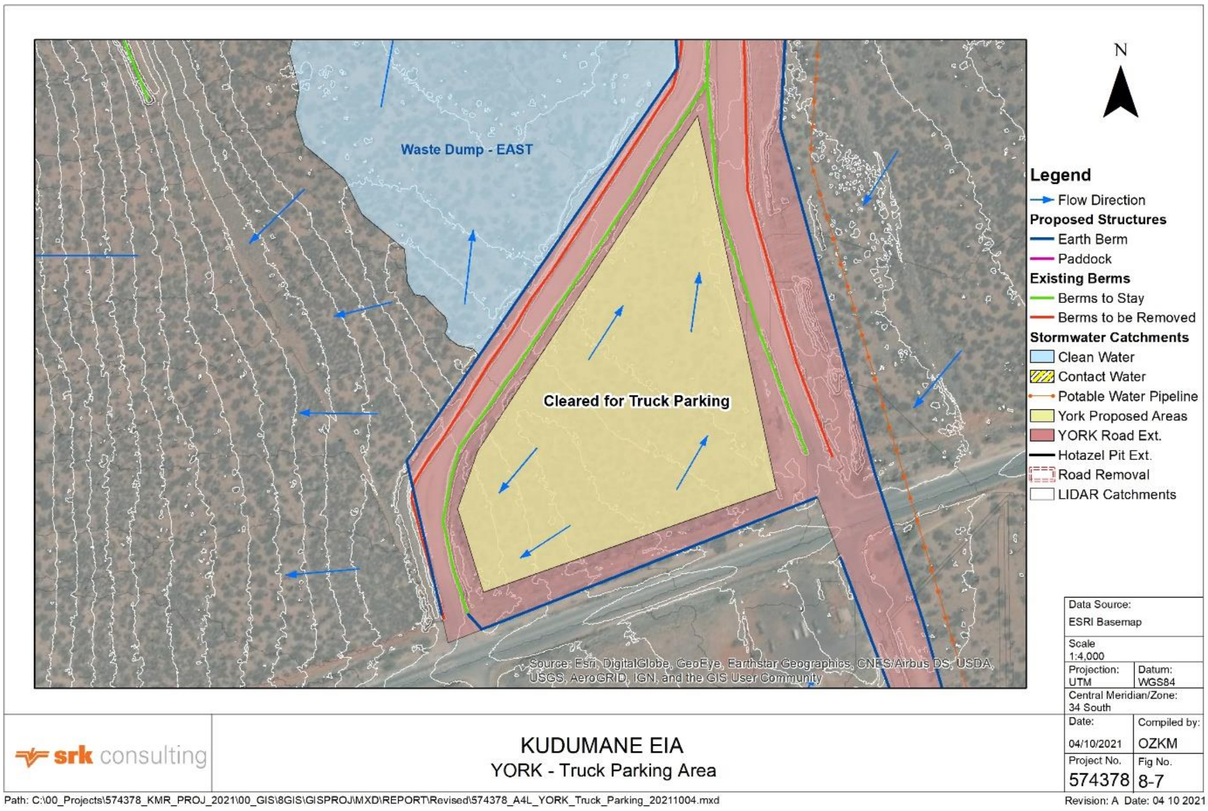

Figure 8-7. Proposed Stormwater Management Plan at York Truck Parking Area

8.2 Hotazel

The existing stormwater management at Hotazel site controlled with earth berms to separate the clean and dirty runoff areas. The Hotazel area does not have a Pollution Control Dam.

The following items were studied in terms of the stormwater management plan:

- Waste Dump East & Waste Dump South
- Waste Dump North, RoM Stockpile and Crushing Area
- Hotazel Lilliput WWTW
- Extension of the Hotazel Pit

8.2.1 Waste Dump East & Waste Dump South

The waste rock from the open pit will be deposited onto the new Waste Rock Dumps. Two blocks that will be used are south of the current WRD are named as "Waste Dump – South" and "Waste Dump – East". These WRD's are located in the lower area of the surrounding topography. The clean water diversions are required to divert water away from the site (Figure 8-8).

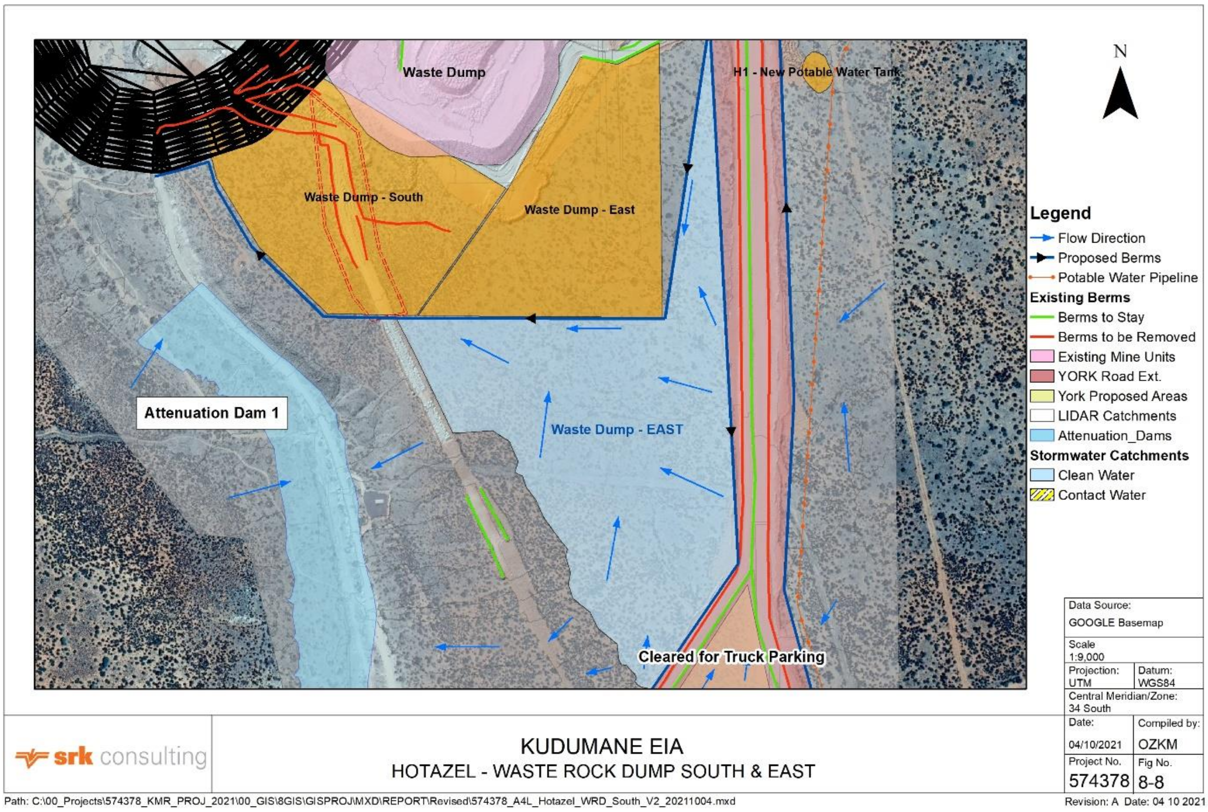

Figure 8-8. Proposed Stormwater Management Plan at Hotazel Waste Dump South and East

8.2.2 Waste Dump North, RoM Stockpile, and Crushing Area

The waste rock storage will extend north of the existing WRD, this area will be named "Waste Dump - North". In addition, on the eastern border of WRD-North, the existing RoM Stockpile area will expand to the north. The clean water diversions are required to divert water away from the site (Figure 8-9). The dirty water at RoM stockpile area will be collected at the proposed Hotazel PCD.

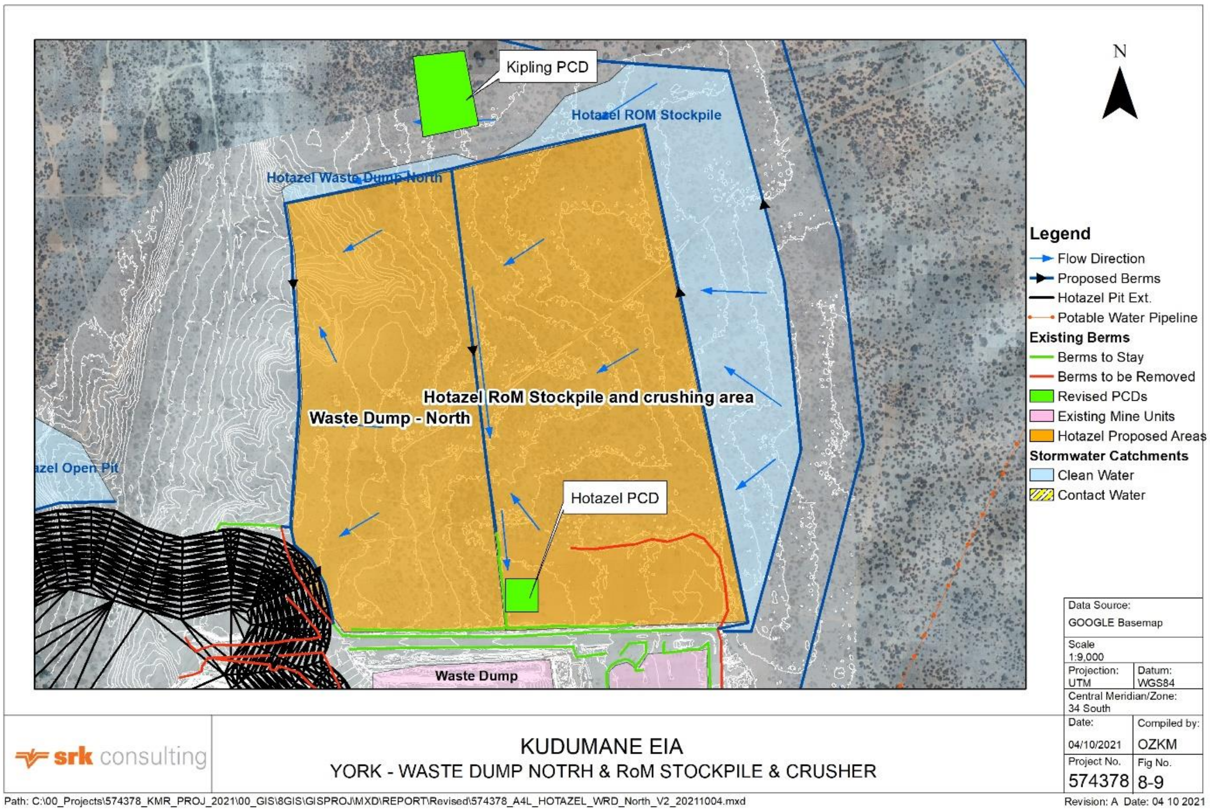

Figure 8-9. Proposed Stormwater Management Plan at Hotazel Waste Dump North and Stockpile Area

8.2.3 Hotazel Lilliput WWTW

Clean water upstream of the Lilliput WWTW area will be diverted away from the site with berms and diversion structure as indicated in Figure 8-10.

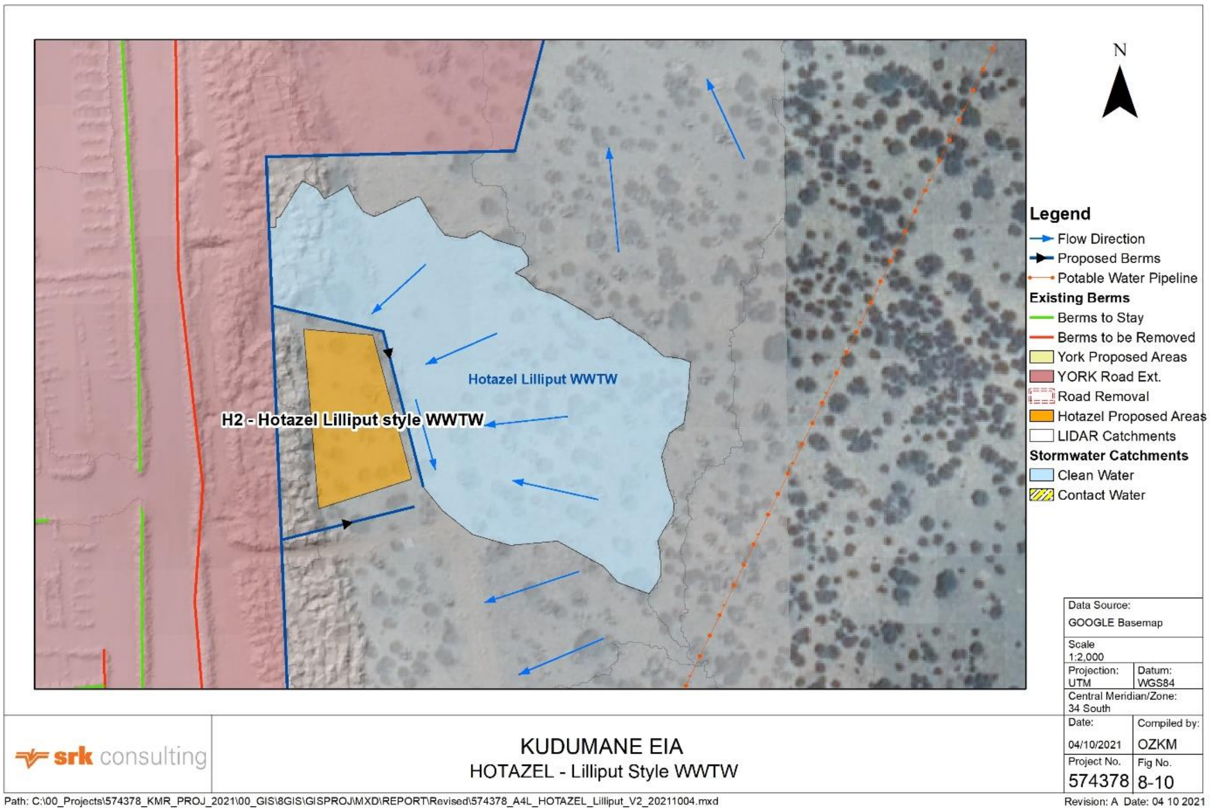

Figure 8-10. Proposed Stormwater Management Plan at Hotazel Lilliput WWTW

8.2.4 Extension of Hotazel Pit

The existing Hotazel open pit will expand beyond the Ga-Mogara riverbed and the 1:100 floodline. To prevent surface water runoff to the open pit from left bank, an earth diversion channel following the topographic slope is proposed (Figure 8-11).

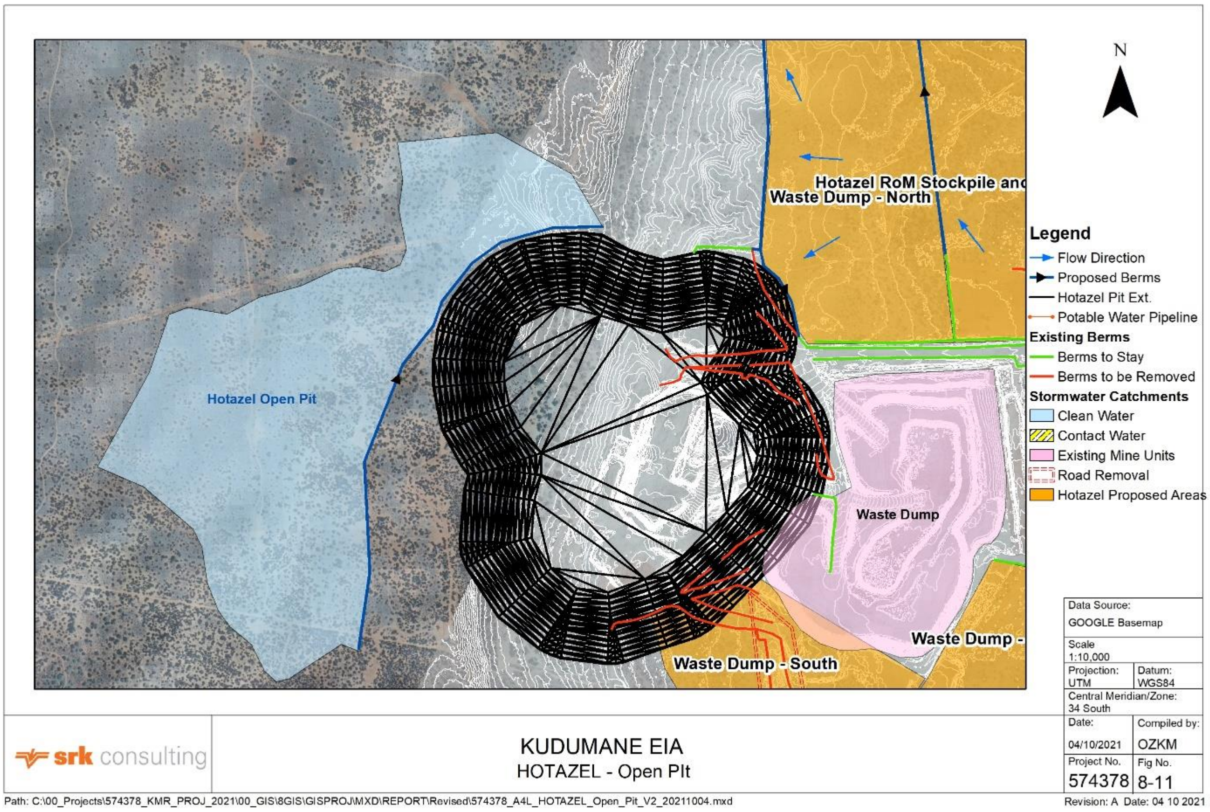

Figure 8-11. Proposed Stormwater Management Plan at Hotazel Pit Extension Area

8.3 Kipling

Based on the planned developments in vicinity of the new Kipling site, the following items were studied in terms of the stormwater management plan:

- Kipling Office Area
- Open Pit, WRD, Stockpile and PCD

8.3.1 Office Areas

The clean water will be diverted away from the office area. The areas with a potential to produce the polluted water will be bunded as illustrated in Figure 8-12. Units in the office area with the potential to produce polluted water are Crushing, Temporary Waste Storage, Diesel Bay and Fuel Storage, and Sewerage Treatment areas

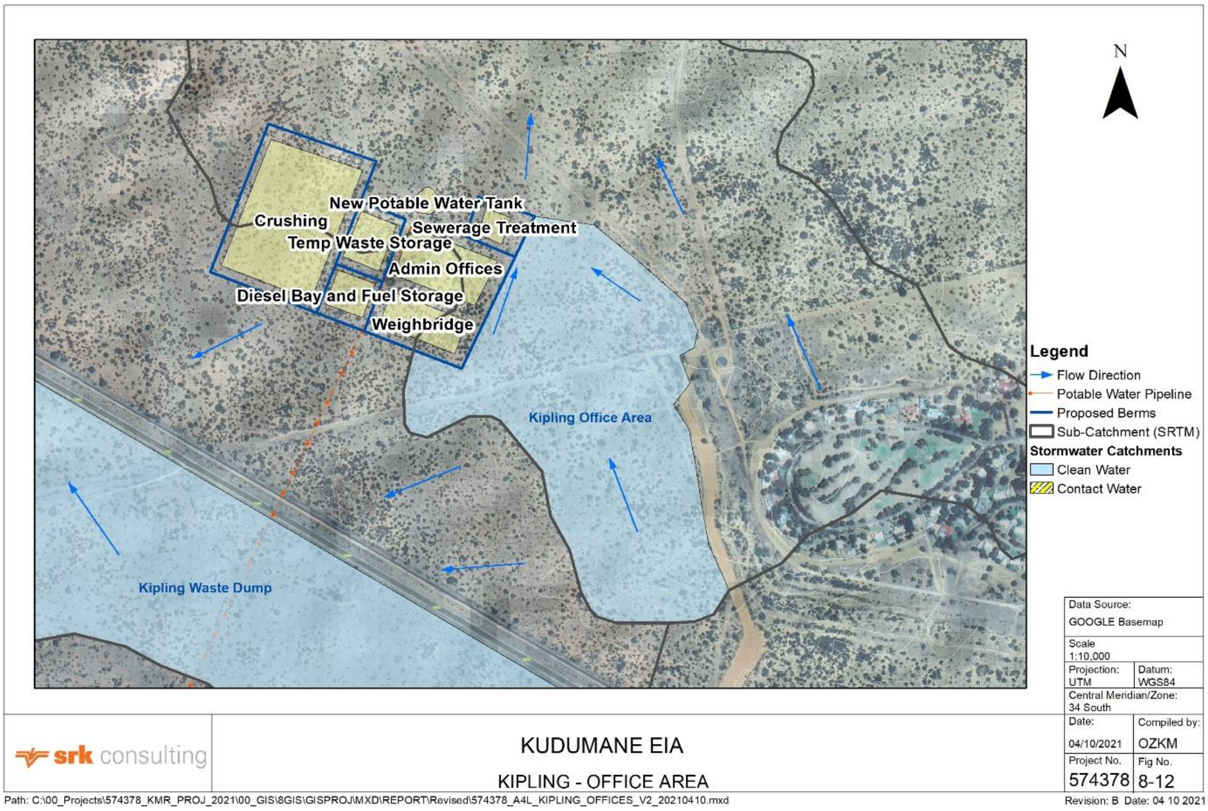

Figure 8-12. Proposed Stormwater Management Plan at Kipling Office Area

8.3.2 Open Pit, Waste Rock Dump, Stockpile and PCD

The clean water will be diverted away from the open pit, waste rock dump, and stockpile area using the berms and earth channels. The seepage and contact runoff from the waste dump area, will be collected and contained with a berm barrier.

Possible dewatering waters from the open pit and contact waters from the RoM Stockpile area will be collected in the proposed Kipling PCD.

The proposed stormwater management system for Kipling mining area is given in Figure 8-13.

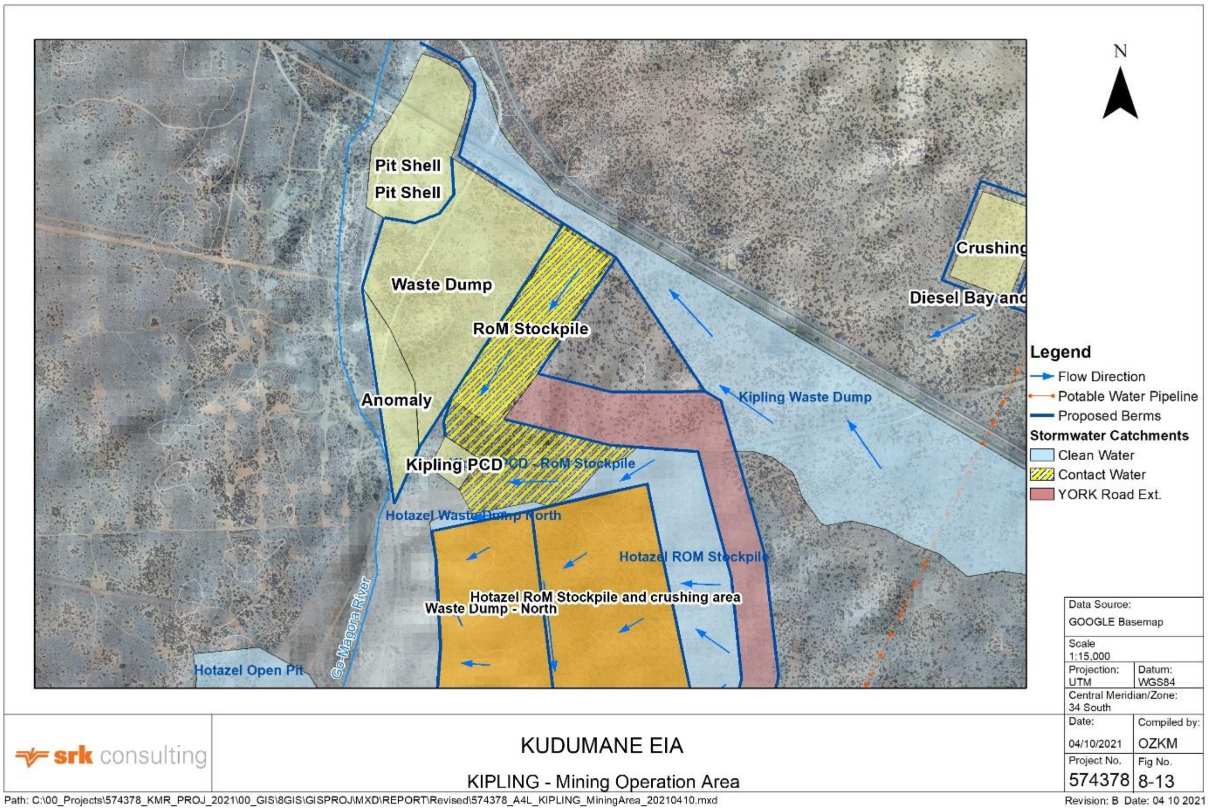

Figure 8-13. Proposed Stormwater Management Plan at Kipling Mine Operation Area

8.4 Hydrological Analysis and Conceptual Design

Hydrological analysis and conceptual sizing studies related to PCDs, berms, diversion channels and paddocks mentioned in previous subsections are evaluated in this section.

8.4.1 PCD Capacity Analysis

Design parameters for PCDs designed by MCJ is summarised in Table 8-1.

Table 8-1. Design Details of Proposed PCDs (MCJ, 2021)

INFRASTRUCTURE	REQUIREMENTS FOR DWS PRESENTATION	MCJ RESPONSE
KIPLING PCD	Size/Footprint (Hectares)	0.1971
	Capacity (m3)	5558
	Motivation	Pit water and stormwater run off
	Liner	2mm thick HDPE lining (UV resistant) on top of 2 x 150mm Clay Layers
HOTAZEL PCD	Size/Footprint (Hectares)	0.1971
	Capacity (m3)	5558
	Motivation	Run off from hardpark and run off from WRD's
	Liner	2mm thick HDPE lining (UV resistant) on top of 2 x 150mm Clay Layers
PROPOSED YORK PCD (NEXT TO ADMIN AREA)	Size/Footprint (Hectares)	0.3181
	Capacity (m3)	9090
	Motivation	Pit water and Run off from York WRD
	Liner	2mm thick HDPE lining (UV resistant) on top of 2 x 150mm Clay Layers
RELOCATION PCD (SOUTH WEST OF PIT)	Size/Footprint (Hectares)	0.3463
	Capacity (m3)	9941
	Motivation	Run off from Manganese stockpile area south of pit
	Liner	2mm thick HDPE lining (UV resistant) on top of 2 x 150mm Clay Layers
REPLACEMENT PCD (INSIDE LOOP)	Size/Footprint (Hectares)	0.0458
	Capacity (m3)	1093
	Motivation	Dirty water run off from crushing plant and stockpiles
	Liner	2mm thick HDPE lining (UV resistant) on top of 2 x 150mm Clay Layers
YORK SOUTH PCD (SOUTH OF YORK HARDPARK)	Size/Footprint (Hectares)	0.1714
	Capacity (m3)	4789
	Motivation	Run off from York hardpar
	Liner	2mm thick HDPE lining (UV resistant) on top of 2 x 150mm Clay Layers

8.4.2 Diversion Channels

The peak flows for the diversion channels that will occur as a result of the 1:50-year flood were calculated using the Rational method and are given in Table 8-2.

Table 8-2. Design Flow Summary Table

Sub-Catchment	Catchment Area (m2)	Time of Concentration - Tc (hr)	Rainfall Intensity (mm/hr)	Rational Runoff Coefficient - c	Design Flow (m3/s)
Stockpile Extension	0.070	0.22	157.3	0.3	0.9
Rail Loop PCD	0.081	0.08	323.3	0.3	2.2
Lilliput Plant A	0.003	0.03	665.4	0.3	0.1
Lilliput Plant B	0.003	0.03	667.8	0.3	0.2
Temporary Waste Storage	0.012	0.04	480.0	0.3	0.5
Waste Dump East	0.278	0.42	102.1	0.3	2.4
Hotazel Lilliput	0.015	0.09	281.0	0.3	0.3
Hotazel ROM Stockpile	0.176	0.11	257.0	0.3	3.8
Hotazel Waste Dump North	0.010	0.02	718.7	0.3	0.6
Kipling PCD	0.223	0.96	59.0	0.3	1.1
Kipling Open Pit	0.418	0.32	124.0	0.3	4.3
Kipling Office Area	0.296	0.97	58.7	0.3	1.4
Kipling WRD	0.688	0.22	158.0	0.3	9.1

The diversion channels that will safely carry the determined peak flow rates have been calculated conceptually. Within the study, the calculated peak flow rates were organised as 4 main groups according to their magnitude and typical design criteria were determined for each group.

In the calculations, no linear system was foreseen for the existing channels, and it was considered as an excavated earth channel. For this reason, the "Manning Coefficient of Friction n" was accepted as 0.035 in the dimensioning studies. Typical design parameters and sizing criteria is given in Table 8-3.

Table 8-3. Conceptual Design Summary for Diversion Channels

<table>
<tr><th>Sub-Catchment</th><th>Group</th><th>Type</th><th>Roughness Coefficient - n</th><th>Channel Slope (m/m)</th><th>Normal Depth (m)</th><th>Side Slopes H:V (m/m)</th><th>Bottom Width (m)</th><th>Design Flow (m3/s)</th></tr>
<tr><td>Lilliput Plant A</td><td rowspan="4">Group 1</td><td rowspan="13">Trapezoidal Channel (Earth Material)</td><td rowspan="13">0.035</td><td rowspan="4">0.04</td><td rowspan="4">0.5</td><td rowspan="4">0.5</td><td rowspan="4">0.5</td><td rowspan="4">0.81</td></tr>
<tr><td>Lilliput Plant B</td></tr>
<tr><td>Temporary Waste Storage</td></tr>
<tr><td>Hotazel Lilliput</td></tr>
<tr><td>Stockpile Extension</td><td rowspan="4">Group 2</td><td rowspan="4">0.05</td><td rowspan="4">0.6</td><td rowspan="4">1</td><td rowspan="4">0.5</td><td rowspan="4">1.89</td></tr>
<tr><td>Hotazel Waste Dump North</td></tr>
<tr><td>Kipling PCD</td></tr>
<tr><td>Kipling Office Area</td></tr>
<tr><td>Rail Loop PCD</td><td rowspan="4">Group 3</td><td rowspan="4">0.01</td><td rowspan="4">1.2</td><td rowspan="4">1</td><td rowspan="4">1</td><td rowspan="4">5.37</td></tr>
<tr><td>Waste Dump East</td></tr>
<tr><td>Hotazel ROM Stockpile</td></tr>
<tr><td>Kipling Open Pit</td></tr>
<tr><td>Kipling WRD</td><td>Group 4</td><td>0.02</td><td>1.2</td><td>1.5</td><td>1</td><td>10</td></tr>
</table>

9 Mine Water Balance

A water balance has been developed focused on the main mine operation areas that includes existing open pits of York, Hotazel, Devon and planned open pit mining operation area of Kipling by including the existing and planned CPD facilities.

The integrated water balance, created in GoldSim, combines rainfall water, surface water runoff and mine water operations as inflow and evaporation, seepage, makeup, and other transfer items to evaluate the flow of water within the mining system. The balance represents the conceptual relationship in between the mine units and evaluated in monthly basis.

The water balance was developed to meet the following objectives:

- To provide an estimate of the make-up water requirement,
- To provide an estimate of whether the Control Pollution Dams can contain water during wet periods.

The water balance described is based on the principles of conservation of mass which is a state in a closed system that all the transfers (inputs and outputs) of matter and energy must remain constant over time, ideally.

9.1 Methodology and Assumptions

The water balance study and results presented within this report is prepared by using the GoldSim model software. KMR facilities and water inflow – outflow relations were set with the model. The water balance model set up for 12 months of period with 1-day simulation step and monthly reporting period settings. In order to evaluate the dry and wet period conditions for mine water parameters, a stochastic rainfall approach was applied.

The information used in the water balance modelling study includes:

- **Meteorological Data:**
  - **Precipitation:** Monthly historical records of 0393083-W Milner station for the period of 1931 – 2009 applied into model to create stochastic rainfall input that represents different climate conditions.
  - **Evaporation:** WR2012 database regional evaporation data was applied into model. The quaternary catchments D41J and D41K fall within evaporation zone 8A with annual 2351 mm evaporation.
- **Open Pit Parameters:**
  - The boundary of the existing open pits in Hotazel, York and Devon, therefore the rainfall capture area, the largest planned boundaries received by KMR was used.
  - Planned open pit area at Kipling was used as designed conditions.
  - Groundwater Inflow rates into existing open pits were obtained from the most up to date specialist reports supplied by KMR.
  - Any surface runoff addressed to open pit areas from the related external catchment was obtained using the LIDAR dataset from 2019.
  - Water abstraction volumes from the pit lakes were obtained from the KMR’s historical recordings.

- **Pollution Control Dams (PCD):**
  - PCD design parameters from MCJ were applied into model for planned PCD's (apart from the Kipling PCD).

The following assumptions were accepted:

- All the mining facility areas accepted as fully developed and does not change through the time.
- Rainfall and evaporation will occur from the biggest area from open pits. Therefore, pit lake direct rainfall and pit wall runoff flow conditions were not separated since there is no final design and depth-storage-area relationships.
- Groundwater inflow into pits and water abstraction volumes from the pit considered stable for each month.
- External catchment areas addressing into mine facilities are constant and surface developments and changes did not consider.
- Based on the site observation, York SW PCD is out of use. Therefore, only rainfall and evaporation mechanism were evaluated in the model.

9.2 Available Data and Input Parameters

The integrated water balance was developed using the long-term monthly dataset. The model was set up with stochastic rainfall approach for the main input of the water balance model. The main target to use stochastic approach with rainfall data is to evaluate all the dry and wet conditions through the time and see the impact of different conditions to water balance elements.

The rainfall series obtained from the SAWS 0393083-W Milner station for the period of 1931 – 2009 with 78 years of historical record. Monthly precipitation values of each year are prepared to be input to the model.

In order to evaluate different climate conditions at a particular time of the model, Monte Carlo simulations were applied to projection model. For each model run, one of those annual packages was randomly selected which is called 1 realization. In the model, 200 different realization scenarios were run during the 1-year model period to evaluate water balance results with a different statistical range.

Within the report, %10 percentile (dry conditions), %50 percentile (median of the statistical records), and %90 percentile (wet conditions) results were reported. The monthly rainfall depths are given in Table 9-1, and presented in Figure 9-1.

Table 9-1. Monthly Rainfall Depths for Different Percentile

Rainfall Percentile	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
10%	7.4	12.4	11.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.3
%50 (Median)	49.1	55.8	50.5	25.4	6.9	0.0	0.0	0.0	0.0	13.3	21.8	31.9	254.5
Mean	67.4	67.6	67.1	36.1	15.5	6.7	1.9	3.6	5.9	20.1	34.2	46.8	372.7
90%	139.4	118.2	140.4	79.6	42.2	24.4	5.9	12.5	26.4	54.5	92.3	104.6	840.4

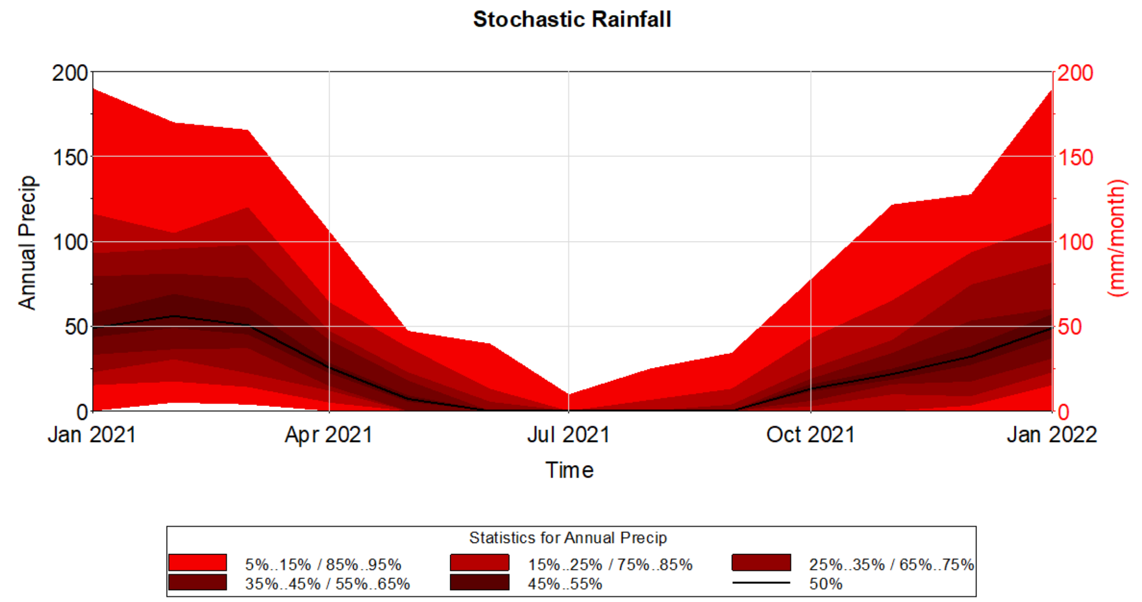

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Figure 9-1. Stochastic Rainfall Distribution for Water Balance

Water balance model input parameters such as groundwater inflow rates, water consumption, dust suppression usage rates etc. were obtained several sources includes the previous specialist studies and the information obtained from KMR. Key assumptions and design criteria of mine facilities used in the preparation of the integrated water balance are listed in Table 9-2. Reference information of all individual parameter was summarized below.

Table 9-2. Water Balance Input Parameters

Area	Value	Unit	Sources
YORK OPEN PIT			
Area of Open Pit	1,074,994.66	m^2	KMR Drawings.
GW Inflow	1.7	L/sec	Delta-H Water Systems Modelling PTY (Ltd), March 2021
Water Abstraction	1,304.0	m3/month	KMR Water Consumption (2020 Average)
External Catchment Runoff Area	50,666	m2	Based on LIDAR 2019.
CN - External Runoff Catchment	60		SRK, 2018.
HOTAZEL OPEN PIT			
Area of Open Pit	545,389.00	m^2	KMR Drawings
GW Inflow	3.8	L/sec	Delta-H Water Systems Modelling PTY (Ltd), March 2021
Water Abstraction	187	m3/month	KMR Water Consumption (Average of Monitored Months)
External Catchment Runoff Area	51,475	m3	Based on LIDAR 2019.
CN - External Runoff Catchment	60		SRK, 2018.
KIPLING OPEN PIT			
Area of Open Pit	174376.9	m^2	KMR Drawings.
GW Inflow	0	m^3/month	Information is not available.
Water Abstraction	0	m^3/month	Information is not available.
External Catchment Runoff Area	0	m^2	Based on SRK SWMP.
DEVON OPEN PIT			
Area of Open Pit	1860340	m^2	KMR Drawings.
GW Inflow	6,118	m^3/month	ENVASS Environmental Assurance (Pty) Ltd, 2020.
Water Abstraction	0	m^3/month	ENVASS Environmental Assurance (Pty) Ltd, 2020.
External Catchment Runoff Area	89,321	m^2	Based on LIDAR 2019.
CN - External Runoff Catchment	76	-	SLR, 2017.
YORK Proposed PCD			
Capacity	9,090	m^3	MCJ, 2021.
Surface Area	4426	m^2	MCJ, 2021.
Runoff Catchment Area	3.13	m^2	Based on LIDAR 2019.
CN - External Runoff Catchment	76	-	SLR, 2017.
YORK South-West PCD			
Capacity	9,941	m^3	MCJ, 2021.
Surface Area	5605	m^2	MCJ, 2021.
Runoff Catchment Area	1.88	m^2	Based on LIDAR 2019.
CN - External Runoff Catchment	76	-	SLR, 2017.
YORK Trail Loop PCD (Replacement)			
Capacity	1,093	m^3	MCJ, 2021.
Surface Area	1210	m^2	MCJ, 2021.
Runoff Catchment Area	22.8	m^2	Based on LIDAR 2019.
CN - External Runoff Catchment	76	-	SLR, 2017.
YORK Propoes South PCD			
Design Capacity	4,789	m^3	SRK, 2021. (DRAFT)
Surface Area	3295	m^2	Assumed same as Rail Loop PCD.
Runoff Catchment Area	28.7	ha	Based on LIDAR 2019.
CN - External Runoff Catchment	76	-	SLR, 2017.
HOTAZEL Proposed PCD			
Capacity	5,558	m^3	MCJ, 2021.
Surface Area	3649.2	m^2	MCJ, 2021.
Runoff Catchment Area	35.97	ha	Based on LIDAR 2019.

Area	Value	Unit	Sources
CN - External Runoff Catchment	76	-	SLR, 2017.
KIPLING PCD (Planned DRAFT)			
Design Capacity	15,000	m^3	SRK, 2021. (DRAFT)
Surface Area	13317.1	m^2	KMR Drawings.
Runoff Catchment Area	223	ha	Based on LIDAR 2019.
CN - External Runoff Catchment	76	-	SLR, 2017.

9.3 Water Balance Results

Water balance model results with annual totals were illustrated with the flow diagram for %10, %50, and %90 percentile of rainfall scenarios in Figure 9-2, Figure 9-3, and Figure 9-4, respectively.

There is still some uncertainty regarding the exact groundwater inflow into open pit areas, evaporation rates as no records have been kept on the site, and draft design of the PCDs. Several water optimization measures are also to be considered by the mine, such as the addition. Except for Kipling PCD, all PCD dimensions are taken from MCJ's current work, and an initial value for Kipling is transferred to the model. The water balance represents the major mine facilities, therefore the allowance of water from Sedibeng did not included.

Reference information of all individual parameter was summarized below.

- There is sufficient water in dry and wet conditions for the water to be pumped into the Storage Tank from Hotazel Open Pit.
- Only the extreme wet seasons (%90 percentile) shows spillage from the existing and planned PCD's. The only exception is that by reducing the volume of the new planned PCD in the York Trail Loop area, it is calculated that there will be 50% and 90% overflow.

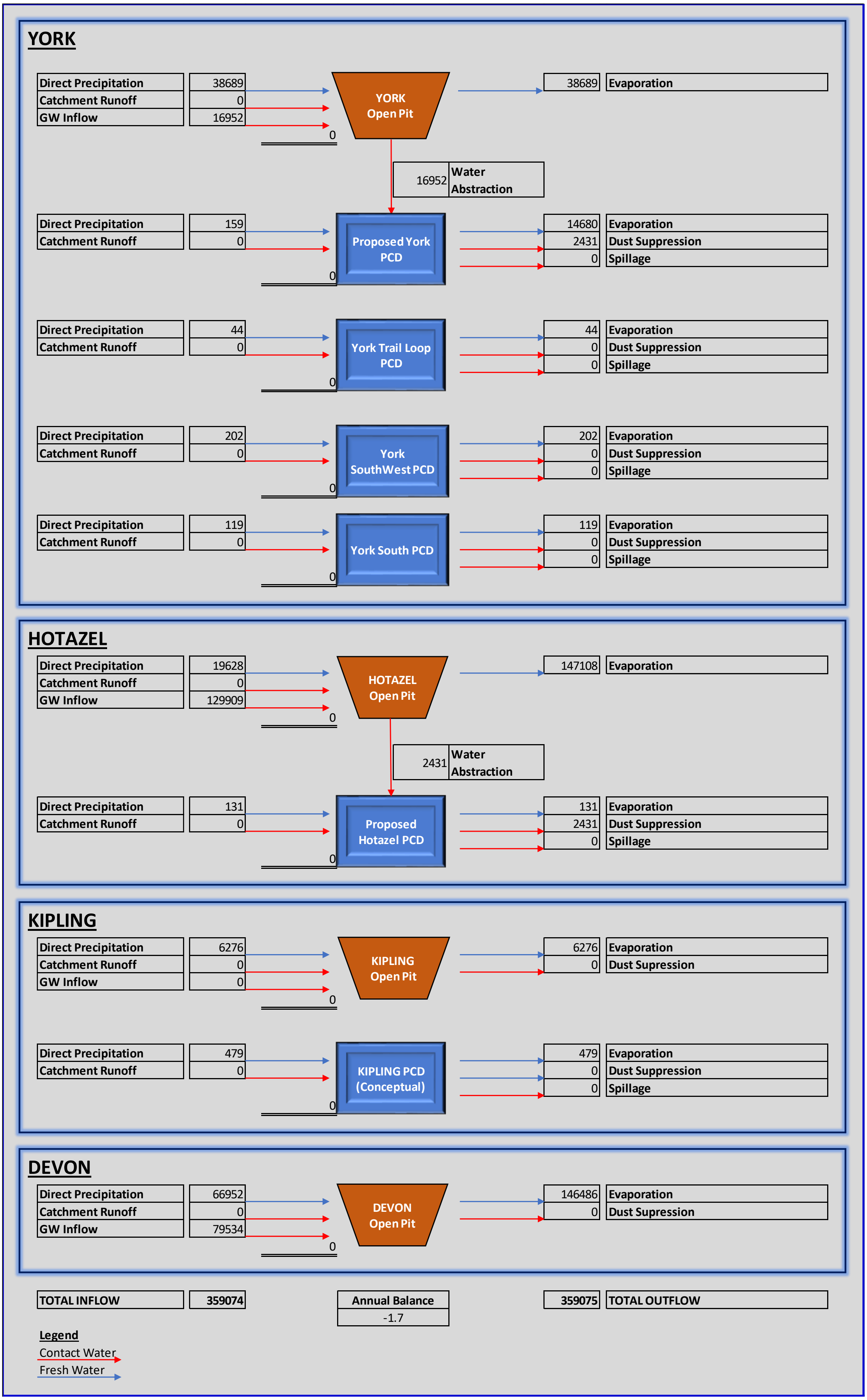

Figure 9-2. Mine Water Balance Flow Diagram - %10 Percentile Dry Conditions (m³/year)

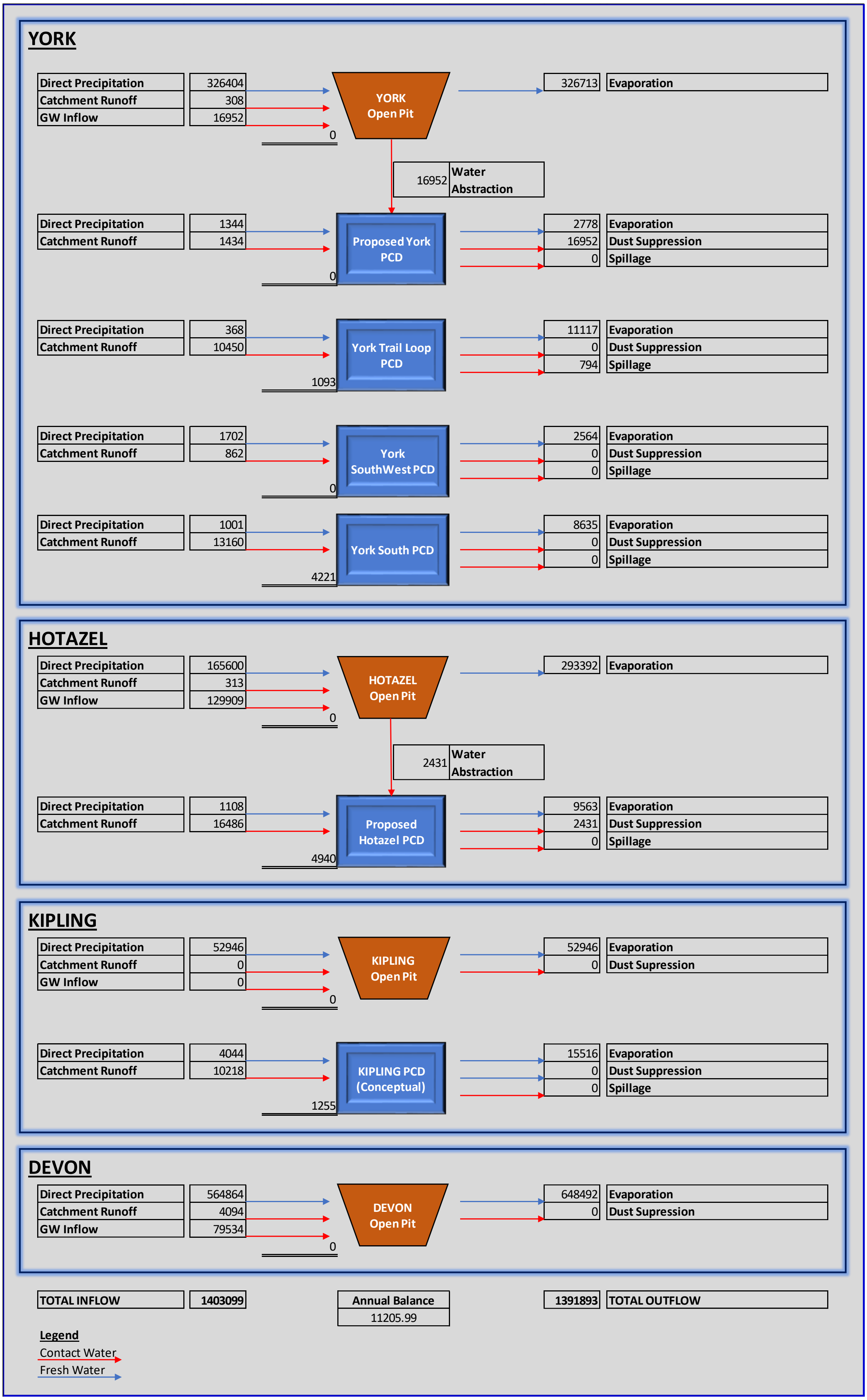

Figure 9-3. Mine Water Balance Flow Diagram - %50 Percentile Conditions (m³/year)

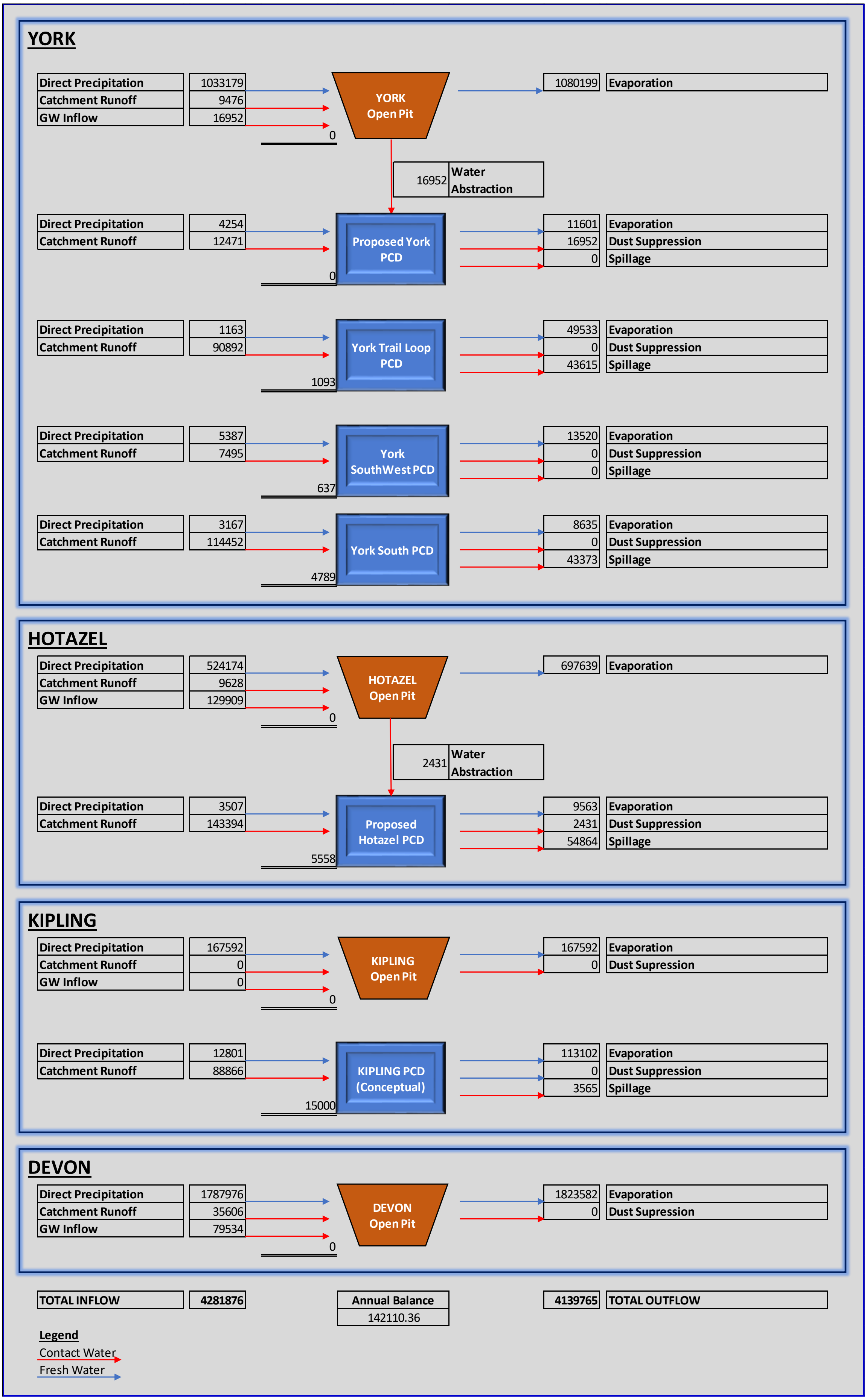

Figure 9-4. Mine Water Balance Flow Diagram - %90 Percentile Wet Conditions (m³/year)

10 Impact Assessment

This section provides an overview of the impact assessment methodology, findings, and recommendations as per the Environmental Impact Assessment and Environmental Management Programme Report (SRK Report No. XXXXX/EIA, XXXX). Findings of the impact assessment phase include both positive and negative impacts on the water resources identified for the various phases of the project (pre-construction, construction, operation and decommissioning and closure). For all existing infrastructure, the impacts from this infrastructure within the 1:50 and 1:100 flood lines and 100 m from the watercourse/s have been assessed for the operational, closure and post-closure phases only as construction is not applicable. Impacts from the construction phase have however been assessed for the proposed infrastructure together with anticipated impacts from the operational, closure and post-closure phases.

10.1 Impact Assessment Methodology

All impacts are analysed with regard to their extent, intensity, duration, probability and significance. The significance of potential impacts that arise or may arise from both existing and proposed infrastructure within the 1:50 and 1:100 flood lines and 100 m from the watercourse/s are included to assist the Department of Water and Sanitation (DWS) with a decision. The significance of an impact is defined as a combination of the consequence of the impact occurring (described as magnitude below) and the probability that the impact will occur.

The impact assessment methodology used, has been formalised to comply with Regulation 31(2)(I) of the National Environmental Management Act (Act 107 of 1998) as amended (NEMA), which states the following:

"(2) An environmental impact assessment report must contain all information that is necessary for the competent authority to consider the application and to reach a decision, and must include:

(i) An assessment of each identified potentially significant impact, including –

(i) Cumulative impacts;

(ii) The nature of the impact;

(iii) The extent and duration of the impact;

(iv) The probability of the impact occurring;

(v) The degree to which the impact can be reversed;

(vi) The degree to which the impact may cause irreplaceable loss of resources; and

(vii) The degree to which the impact can be mitigated."

Based on the above, the impact assessment methodology will require that each potential impact identified is clearly described (providing the nature of the impact) and be assessed in terms of the following factors:

- Extent (spatial scale) – will the impact affect the national, regional or local environment, or only that of the site?;
- Duration (temporal scale) – how long will the impact last?;
- Magnitude (severity) – will the impact be of high, moderate or low severity?;
- Probability (likelihood of occurring) – how likely is it that the impact may occur?

To enable environmental significance (importance) of each identified potential impact to be quantified, a numerical value has been linked to each factor. The ranking scales applicable are shown in Table 10-1.

Table 10-1: Impact Ranking Scales

Occurrence	Duration	Probability
	5 - Permanent	5 – Definite/don't know
	4 – Long-term (ceases with the operational life)	4 – Highly probable
	3 – Medium-term (5-15 years)	3 – Medium probability
	2 – Short-term (0-5 years)	2 – Low probability
	1 – Immediate	1 - Improbable
		0 - None
Severity	Extent/Scale	Magnitude
	5 - International	10 – Very high/uncertain
	4 - National	8 - High
	3 - Regional	6 - Moderate
	2 - Local	4 - Low
	1 – Site only	2 - Minor
	0 - None	

Once the above factors had been ranked for each identified potential impact, the environmental significance of each impact can be calculated using the following formula:

Significance = (duration + extent + magnitude) x probability

The maximum value that can be calculated for the environmental significance of any impact is 100.

The environmental significance of any identified potential impact is then rated as either: high, moderate or low on the following basis:

- More than 60 significant value indicates a high (H) environmental significance impact;
- Between 30 and 60 significance value indicates a moderate (M) environmental significance impact; and
- Less than 30 significance value indicates a low (L) environmental significance impact.

In order to assess the degree to which the potential impact can be reversed and be mitigated, each identified potential impact will need to be assessed twice.

- Firstly, the potential impact will be assessed and rated prior to implementing any mitigation and management measures; and

- Secondly, the potential impact will be assessed and rated after the proposed mitigation and management measures have been implemented.

The purpose of this dual rating of the impact before and after mitigation is to indicate that the significance rating of the initial impact is and should be higher in relation to the significance of the impact after mitigation measures have been implemented. In order to assess the degree to which the potential impact can cause irreplaceable loss of resources, the following classes (%) will be used:

- 5 100% - Permanent loss;
- 4 75% - 99% - significant loss;
- 3 50% - 74% - moderate loss;
- 2 25% - 49% - minor loss; and
- 1 0% - 24% - limited loss.

10.2 Summary of environmental and social impacts identified during the EIA process

Table 10-2: Expected impacts arising from project related activities during different project phases as a result of existing and proposed infrastructure at KMR mine.

Project Phase	Activity
Pre-construction	Disturbance of soils due to site clearing and preparation Sedimentation of rivers due to preparation of the site for clearing
Construction	Natural vegetation loss, loss of habitat, impact on the flows of rivers located in close proximity to proposed infrastructure areas, impact on migration options for animals and birds in the area Possible impacts to groundwater from seepage, reduced recharge of groundwater due to increased run-off Pollution to rivers from hydrocarbon spills from construction machinery, deterioration of surface water quality
Operation	Natural vegetation loss, loss of habitats, impact on the flows of rivers located in close proximity to proposed infrastructure areas, impact on migration options for animals and birds in the area Possible impacts to groundwater from seepage and spillages such as hydrocarbons and tailings slurry Flooding of the river could potentially cause erosion and/or damage to the existing and proposed river crossings Reduced availability of water to downstream water users Sedimentation of water courses due to operational activities
Closure/Rehabilitation	Pollution to surface water from hydrocarbon spillage from rehabilitation equipment
Post-closure	Post closure surface water and groundwater quality impacts

10.3 Environmental and social impacts and mitigation measures

The identified impacts associate with the existing and proposed infrastructure within the 1:50 and 1:100 flood lines and 100m from the watercourse/s are provided in Table 9-3 to Table 9-6. The rating of impacts, as per the methodology described in section 4.1 is also provided. In addition, mitigation measures that may alleviate or result in avoidance of the potential impacts have been included.

The following sections provide further details on the potential impacts (negative and positive), in terms of the various existing and proposed infrastructure.

The potential identified impacts were rated, as discussed in Section 9.1, in terms of the Probability, Duration, Extent and Magnitude that may be associated with the potential impact. The following abbreviations were used in the Impact Assessment Tables to indicate the said impact assessment aspects:

- Pr → Probability;
- D → Duration;
- E → Extent;
- M → Magnitude; and
- LoR → Loss of Resource.

Table 10-3 lists the main project related activities that will trigger GN 704 Regulation 4(a), 4(b) and 5 and their associated impacts and management measures during the pre-construction phase. Applicable infrastructure includes the attenuation dams, the relocation of Pollution Control Dam (PCD) and the extension of the open-pits at York, Hotezal and Kipling mine sites.

Table 10-3: Pre-construction surface water impacts applicable to all the proposed activities/infrastructure at KMR mine

Proposed project related activities during pre-construction phase of the project	Site clearing and grubbing of the footprint areas associated with the proposed infrastructure in preparation of the construction of these infrastructures.

Aspect	Nature of the impact		Significance of potential impact BEFORE mitigation							Mitigation measures	Significance of potential impact AFTER mitigation							Degree of mitigation (%)
			P	D	E	M	LoR	Significance			P	D	E	M	LoR	Significance		
Pre-construction impacts applicable to the attenuation dams																		
Surface water	Impact on water quality due to an increase in runoff from cleared and stripped areas in close proximity to water courses	-	3	2	1	4	2	21	Low	The footprint of the proposed infrastructure area must be clearly demarcated to restrict vegetation clearing activities as far as practically possible	2	2	1	4	1	14	Low	33.3
										Vegetation clearing activities will be restricted to demarcated infrastructure footprint area								
										Vegetation clearance will be undertaken in a phased manner.								
										Clean water diversion bunds will be constructed upstream of the construction site prior to clearing areas for new infrastructure								
										Areas disturbed by activities should be rehabilitated immediately on completion of each area.								
										Bunded containment and settlement facilities will be provided for hazardous materials, such as fuel and oil								
										Spill-sorb or a similar product will be kept on site and used to clean up hydrocarbon spills in the event that they will occur								
										The groundwater and surface water quality monitoring programme will continue in line with requirements of the Water Use License								
										Sufficient on-site ablution, sanitation and waste management facilities will be provided								
	Increased erosion from areas of exposed soils during site clearing resulting in potential increase in sedimentation of surface water resources.	-	3	2	1	4	2	21	Low	Where practical activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact.	2	2	1	4	1	14	Low	33.3

										Areas disturbed by activities should be rehabilitated immediately on completion of each area.								
										Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction.								
Pre-construction impacts applicable to the relocation of Pollution Control Dam (PCD)																		
Surface water	Increased erosion from areas of exposed soils during site clearing resulting in potential increase in sedimentation of surface water resources.	-	4	2	2	6	2	40	Moderate	Where practical activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact.	2	2	2	4	2	16	Low	60.0
										Areas disturbed by activities should be rehabilitated immediately on completion of each area.								
										Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction.								
Pre-construction impacts applicable to the extension of Open-Pit (York, Hotazel, Kipling)																		
Surface water Surface water	Impact on water quality due to an increase in runoff from cleared and stripped areas in close proximity to water courses	-	4	2	2	8	3	48	Moderate	The footprint of the proposed infrastructure area must be clearly demarcated to restrict vegetation clearing activities as far as practically possible	3	2	2	4	2	24	Low	50.0
										Vegetation clearing activities will be restricted to demarcated infrastructure footprint area								
										Vegetation clearance will be undertaken in a phased manner								
										Clean water diversion bunds will be constructed upstream of the construction site prior to clearing areas for new infrastructure								
										Areas disturbed by pre-construction activities, which will not be required for construction, will be rehabilitated immediately on completion of construction area								
										Bunded containment and settlement facilities will be provided for hazardous materials, such as fuel and oil								
										Spill-sorb or a similar product will be kept on site and used to clean up hydrocarbon spills in the event that they will occur								
										The groundwater and surface water quality monitoring programme will continue in line with requirements of the Water Use License								
										Sufficient on-site ablution, sanitation and waste management facilities will be provided								

	Increased erosion from areas of exposed soils during site clearing resulting in potential increase in sedimentation to surface water resources	-	4	2	2	8	3	48	Moderate	Where practical activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact Areas disturbed by activities should be rehabilitated immediately on completion of each area Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction.	2	2	1	4	2	14	Low	70.8

Table 10-4 lists the main project related activities that will trigger GN 704 Regulation 4(a), 4(b) and 5 and their associated impacts and management measures during the construction phase. Applicable infrastructure includes construction of the attenuation dam, relocation of the Pollution Control Dam (PCD), and extension of the open-pits at York, Hotazel and Kipling mine sites.

Table 10-4: Construction surface water impacts applicable to all proposed activities/infrastructure at KMR mine.

Proposed project related activities during construction phase of the project	Construction of the attenuation dam walls.
	Construction of the Pollution Control Dam and associated infrastructure including water management and containment and protection infrastructure.
	Construction of the York, Hotazel and Kipling open-pits across the Ga-Mogara river.

Aspect	Nature of the impact	Significance of potential impact BEFORE mitigation								Mitigation measures	Significance of potential impact AFTER mitigation							Degree of mitigation (%)
			P	D	E	M	LoR	Significance			P	D	E	M	LoR	Significance		
Construction impacts applicable to the attenuation dams																		
Surface water	Contamination of surface water from potential hydrocarbon spills from construction machinery when constructing the dam walls resulting in a reduced water quality	-	3	2	1	4	2	21	Low	Contaminated runoff should be contained and reused as necessary e.g. for dust suppression.	2	2	1	4	1	14	Low	33.3
										Hazardous substances and potentially polluting materials should be stored in appropriately bunded areas located outside of the riparian zone.								
										Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages.								
										Emergency action plans should be developed to deal with spillages								
	Increased erosion from areas of exposed soils during site clearing resulting in loose materials being washed into the surface water resources and reducing water quality	-	3	2	1	4	2	21	Low	Vegetation clearing activities will be restricted to the demarcated infrastructure foot print area.	2	2	1	4	1	14	Low	33.3
										Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact								
										Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction								
										Areas disturbed by construction activities should be rehabilitated immediately on completion of construction of each area								
Construction impacts associated with relocation of Pollution Control Dam (PCD)																		
Surface water	Increased erosion from areas of exposed soils during site clearing resulting in loose materials being washed into the surface water resources and reducing water quality	-	4	2	2	6	2	40	Moderate	Vegetation clearing activities will be restricted to the demarcated infrastructure footprint area	2	2	2	4	2	16	Low	-150
										Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact								
										Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction								

										Areas disturbed by construction activities should be rehabilitated immediately on completion of construction of each area								
	Contamination of surface water from potential hydrocarbon spills from construction machinery reducing water quality	-	2	2	1	4	2	14	Low	Contaminated runoff should be contained and reused as necessary e.g. for dust suppression	2	2	1	4	2	14	Low	0.0
										Emergency action plans should be developed to deal with spillages								
										Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages								
										All machinery and substances used on the site will be checked for leaks and otherwise properly maintained. Where leaks are found immediate action must be taken to stop leaks. All contamination from leaks will be immediately removed and remediated								
	Increased potential for damming and flooding and subsequent damage to property and infrastructure due to hardstanding.	-	4	4	2	8	2	56	Moderate	Areas should be appropriately graded to prevent ponding. Stormwater measures should be appropriately designed to allow for free flow of water as per the Stormwater Management Plan	2	4	2	4	1	20	Low	-180.0
										Paddocks should be constructed to minimise uncontrolled runoff from the site entering the clean water system								
Construction impacts associated with extension of Open-Pit (York, Hotazel, Kipling)																		
Surface water	Increased erosion from areas of exposed soils during site clearing resulting in loose materials being washed into the surface water resources and reducing water quality	-	4	2	2	8	3	48	Moderate	Vegetation clearing activities will be restricted to the demarcated infrastructure footprint area	2	2	2	4	2	16	Low	-200.0
										Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact								
										Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction								
										Areas disturbed by construction activities should be rehabilitated immediately on completion of construction of each area								
	Contamination of the Ga-Mogara River from potential hydrocarbon spills from construction machinery reducing surface water quality	-	3	2	3	6	2	33	Moderate	Contaminated runoff should be contained and reused as necessary e.g. for dust suppression	2	2	2	4	2	16	Low	106.3
										Emergency action plans should be developed to deal with spillages								
										Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages								

Table 10-5 lists the main project related activities that will trigger GN 704 Regulations 4(a), 4(b) and 5 and their associated impacts and management measures during the operation phase. Applicable infrastructure includes the operation of the attenuation dams, the Pollution Control Dam (PCD) at its new location, and the extended open-pits at York, Hotazel and Kipling mine sites.

Table 10-5: Operations surface water impacts applicable to all proposed activities/infrastructure at KMR mine.

Operation	Operation of the attenuation dams
	Extension and operation of the open-pits at York, Hotazel and Kipling
	Operation of the new Pollution Control Dam (PCD)

Aspect	Nature of the impact		Significance of potential impact BEFORE mitigation							Mitigation measures	Significance of potential impact AFTER mitigation							Degree of mitigation (%)
			P	D	E	M	LoR	Significance			P	D	E	M	LoR	Significance		
Operation phase impacts applicable to attenuation dams																		
Surface water	Flooding risk of upstream areas, especially private land upstream of the 1st attenuation dam, and potential flooding of the York open-pit by the 2nd attenuation dam	-	4	1	2	8	4	44	Moderate	Early warning system installed upstream to identify the potential for a flood behind attenuation dam where private land is located allowing for prewarning and evacuation. Design dam and select location to reduce flooding of private land as far as possible.	2	4	2	4	2	20	Low	54.5
	Potential flooding of the nearby open-pits through increasing the water head upstream of the pit during a flood event promoting an increase in seepage into the nearby open-pit	-	3	1	1	6	3	24	Low	Early warning systems installed upstream to identify the potential for a flood which would exceed the attenuation dam volume allowing for pit evacuation. Design the attenuation dams to hold a 1:50 year event.	2	4	2	4	2	20	Low	16.7
	Reduction in downstream streamflow and available water to downstream water users	-	5	4	3	8	4	75	High	Allow for water to spill over or be released following the filling of the dam.	2	4	3	4	2	22	Low	70.7
Operation phase impacts applicable to relocation of Pollution Control Dam (PCD)																		
Surface water	Potential of flooding following an extreme rainfall event which could exceed the storage capacity of the PCD	-	4	4	2	8	2	56	Moderate	The PCD should be designed to hold a 1:50 year event with a minimum freeboard of 0.8 metres above the fill supply level.	2	4	2	4	2	20	Low	64.3
	Reduced availability of water to downstream water users due to dirty runoff from site	-	3	4	3	6	2	39	Moderate	During normal operations dirty water should be contained in (pollution control dams) PCDs designed to handle the 1:50 year event and enable settlement of solids in the contained water prior to reuse Clean water diversions, designed to handle the 1:50 year storm event, should be constructed to divert water away from PCD and return it to the natural environment	2	4	2	4	2	20	Low	48.7
					Operation phase impacts applicable to extension of Open-Pit (York, Hotazel, Kipling)													

Surface water	Reduced availability of water to downstream water users due to changes in MAR and potential decreased water quality	-	4	4	3	8	4	60	High	During the operational phase of the mine, implement a storm water management plan which adheres to GN 704 requirements in terms of separation of clean and dirty water is required so as to ensure no mixing of clean and dirty water occurs. Maintain all channels to prevent any obstruction of flow.	3	4	3	6	3	39	Moderate	35.0
	Potential flooding of the open-pit due to surface runoff, exposure to rainfall, and increased expansion across the water course exposing the open-pit to a higher groundwater table	-	4	4	2	8	3	56	Moderate	Construction of attenuation dams to prevent the flooding of the pit following an extreme rainfall event.	3	4	2	4	2	30	Moderate	46.4
										Design and implementation of storm water management plan to divert all water away from the open-pit								
										Design and implement a pumping strategy of sufficient capacity to pump out the intruding ground water, surface water and direct rainfall out of the pit.								

Table 10-6 lists the main project related activities that will trigger GN 704 Regulations 4(a), 4(b) and 5 and their associated impacts and management measures during the closure and rehabilitation phase. Applicable infrastructure includes the closure and rehabilitation of areas impacted by the attenuation dams, the new location of the Pollution Control Dam and the extended open-pits at York, Hotazel and Kipling mine sites.

Table 10-6: Closure and rehabilitation surface water impacts applicable to all proposed activities/infrastructure at KMR mine.

Closure/Rehabilitation	Decommissioning and demolition of project related infrastructure
	Handling of contaminated soils

Aspect	Nature of the impact		Significance of potential impact BEFORE mitigation							Mitigation measures	Significance of potential impact AFTER mitigation							Degree of mitigation (%)
			P	D	E	M	LoR	Significance			P	D	E	M	LoR	Significance		
Closure/Rehabilitation Phase impacts applicable to attenuation dams																		
Surface water	Infrastructure not required after closure should be removed and the footprint areas rehabilitated. All rehabilitation activities should be monitored until vegetation is well established	-	3	4	2	6	3	36	Moderate	All rehabilitation activities should be monitored until vegetation is well established and no further surface water quality impacts are deemed likely.	2	1	2	6	2	18	Low	50.0
Closure/Rehabilitation phase impacts applicable to relocation of Pollution Control Dam (PCD)																		
Surface water	Infrastructure not required after closure should be removed and the footprint areas rehabilitated. All rehabilitation activities should be monitored until vegetation is well established	-	3	4	2	6	2	36	Moderate	All rehabilitation activities should be monitored until vegetation is well established and no further surface water quality impacts are deemed likely.	2	1	2	4	1	14	Low	61.1
Closure/Rehabilitation phase impacts applicable to the extension of Open-Pit (York, Hotazel, Kipling)																		
Surface water	Infrastructure not required after closure should be removed and the footprint areas rehabilitated. All rehabilitation activities should be monitored until vegetation is well established	-	3	4	2	6	2	36	Moderate	All rehabilitation activities should be monitored until vegetation is well established and no further surface water quality impacts are deemed likely.	2	1	2	4	1	14	Low	61.1

Post closure is a period of maintenance and monitoring of the various structures and infrastructure closed during the time of rehabilitation. The activities are limited to monitoring activities and maintenance or repairing or erosion and vegetation if necessary. Table 10-7 lists the post-closure impacts and management measures associated with the project related activities triggering 4(a), 4(b) and 5 regulations of the GN 704 Regulations.

Table 10-7: Post-closure surface water impacts applicable to all the proposed activities and infrastructure at KMR mine.

Aspect	Nature of the impact		Significance of potential impact BEFORE mitigation							Mitigation measures	Significance of potential impact AFTER mitigation							Degree of mitigation (%)
			P	D	E	M	LoR	Significance			P	D	E	M	LoR	Significance		
Post-closure impacts associated with attenuation dams																		
Surface water	All infrastructure will have been removed, therefore the surface water quality should not be further impacted by any of the post-closure activities.	-	2	1	2	2	1	10	Low	Surface water quality should not be further impacted by any of the post closure activities. Implemented post closure monitoring.	2	1	2	6	2	18	Low	50.0
Post-closure impacts associated with relocation of Pollution Control Dam (PCD)																		
Surface water	All infrastructure will have been removed, therefore the surface water quality should not be further impacted by any of the post-closure activities.	-	2	1	2	2	1	10	Low	Surface water quality should not be further impacted by any of the post closure activities. Implemented post closure monitoring.	2	1	1	2	1	8	Low	20.0
Post-closure impacts associated with extension of Open-Pit (York, Hotazel, Kipling)																		
Surface water	All infrastructure will have been removed, therefore the surface water quality should not be further impacted by any of the post-closure activities.	-	3	1	2	2	1	15	Low	Surface water quality should not be further impacted by any of the post closure activities. Implemented post closure monitoring.	2	1	1	2	1	8	Low	46.7

Prepared by	**Reviewed by**
Hydrologist	Partner

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendices

Appendix A:

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