LICHTENBURG LAFARGE CEMENT PLANT

BASELINE HYDROLOGY AND IMPACT ASSESSMENT

August 2022

REVISION 01

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SYNOPSIS

Specialist baseline hydrological study and impact assessment required as part of the Water Use Licence Application.

KEY WORDS:

Lafarge Lichtenburg, Cement Plant, National Water (Act 36 of 1998), Baseline Hydrology and Impact Assessment

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO 9001: 2015 which has been independently certified by DEKRA Certification.

Verification	Capacity	Name	Signature	Date
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LICHTENBURG LAFARGE CEMENT PLANT BASELINE HYDROLOGICAL AND IMPACT ASSESSMENT SPECIALST STUDY

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1 INTRODUCTION

JG Afrika (Pty) Ltd were appointed by Lafarge Industries South Africa (Pty) Ltd to undertake a Baseline Hydrology and Impact Assessment for the Lichtenburg Lafarge Cement Plant in the North West Province. The Cement Plant is located on Portion 61 of Lichtenburg Town Farm No 27. This hydrological specialist study is required as part of a Water Use Licence Application (WULA) for the Cement Plant, based on the requirements of the National Water Act (Act 36 of 1998). The objectives of this baseline hydrological study are to:

- Describe the climatic, hydrological, landuse and topographical conditions of the study area by defining the general catchment conditions of the study site.
- Identify and delineate stream and river channels and their associated catchment areas in the vicinity of the plant.
- Determine the Mean Annual Runoff (MAR) for the project area and any contributing catchments in the vicinity of the plant.
- Undertake an impact assessment of the plant, focusing on the potential risks associated with the site related specifically to local and regional hydrology. Using the impact assessment, mitigation measures have been provided to reduce the risks associated with the identified potential impacts.

1.1 Declaration of Independence

It should be noted that JG Afrika have been appointed to conduct an independent baseline hydrology and impact assessment for the Lafarge Cement Plant. JG Afrika have undertaken this study in an objective manner, even if this results in views and findings that are not favourable to the Applicant or Client. JG Afrika have the expertise required to undertake the necessary studies and the resultant report presents the results in an objective manner. The main author of the report, Ms Jédine Govender, is a professionally registered Hydrologist at JG Afrika with an MSc. in Hydrology. Ms Govender has undertaken this study under the guidance of Mr. Phillip Hull, who is an Executive Associate and Senior Hydrologist at JG Afrika, has an MSc. in Hydrology, is professionally registered and has an excess of 14 years of relevant project experience.

2 SITE DESCRIPTION

2.1 Locality

The location of the Lafarge Cement Plant is presented in **Figure 2-1**. As depicted in this map, the cement plant is located 2 km northeast of Lichtenburg town, within the Ditsobotla Local Municipality of the North West Province. A site plan of the project site presenting the Cement Plant and unnamed drainage line are provided in **Figure 2-2**. As depicted in **Figure 2-2**, the small drainage line is located along the eastern boundary of the Cement Plant. This drainage line is a tributary of an unnamed perennial stream, which flows into the Harts River, located approximately 15 km downstream of the project site.

Hydrologically, the study area is located in Quaternary Catchment C31A, within the Lower Vaal Water Management Area (WMA No. 10). The Mean Annual Precipitation (MAP) of the study area is 614 mm and the Mean Annual Evaporation (MAE) of the study area is 1 860 mm, as per the Water Resources of South Africa 2012 (WR2012) study. The land uses within the study catchment were identified using Google Earth aerial imagery and classed according to the South African National Landcover Database (NLC, 2018) which predominantly consisted of natural grassland followed by mine extraction pits and quarries.

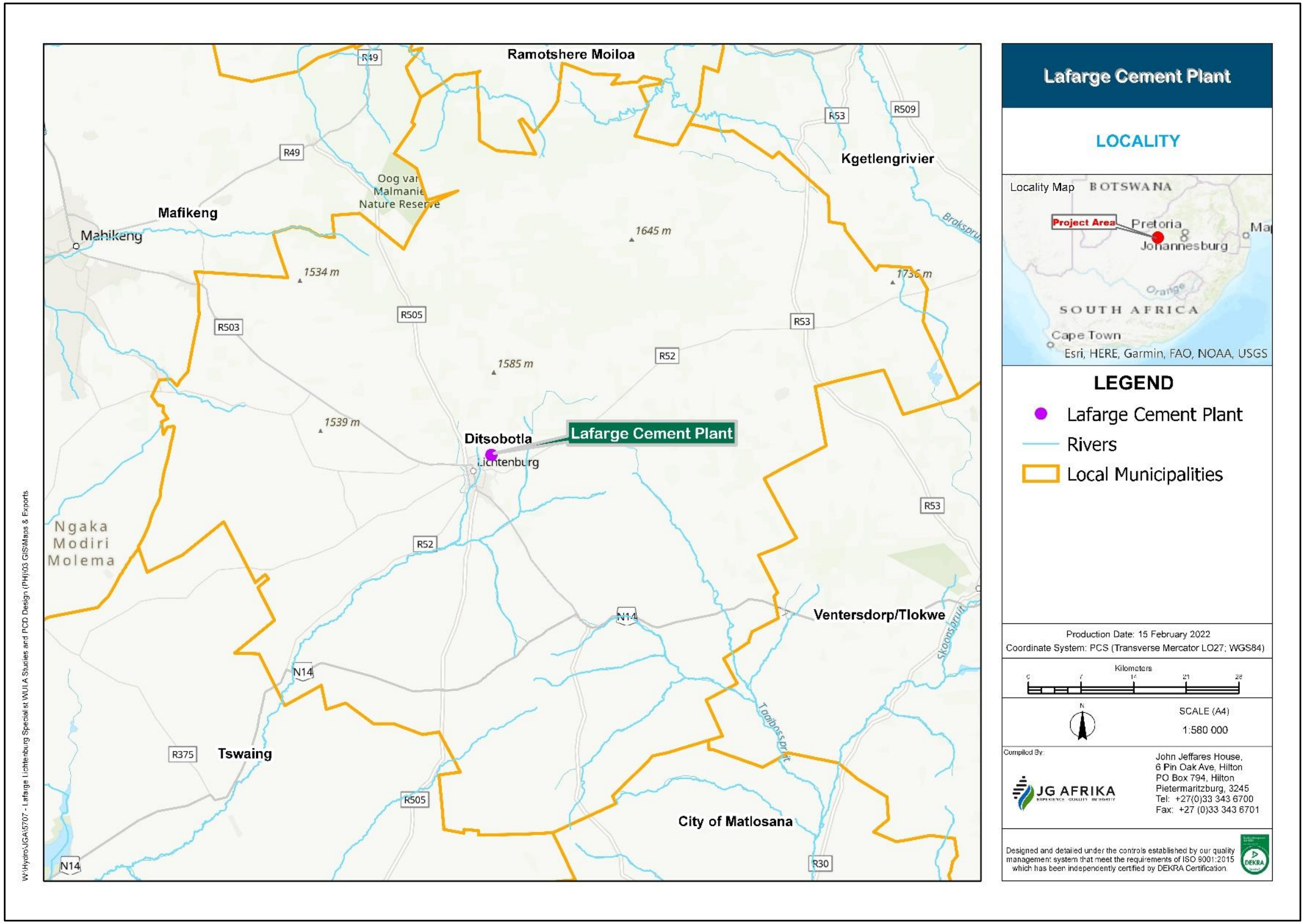

Figure 2-1 Lafarge Cement Plant Locality Map

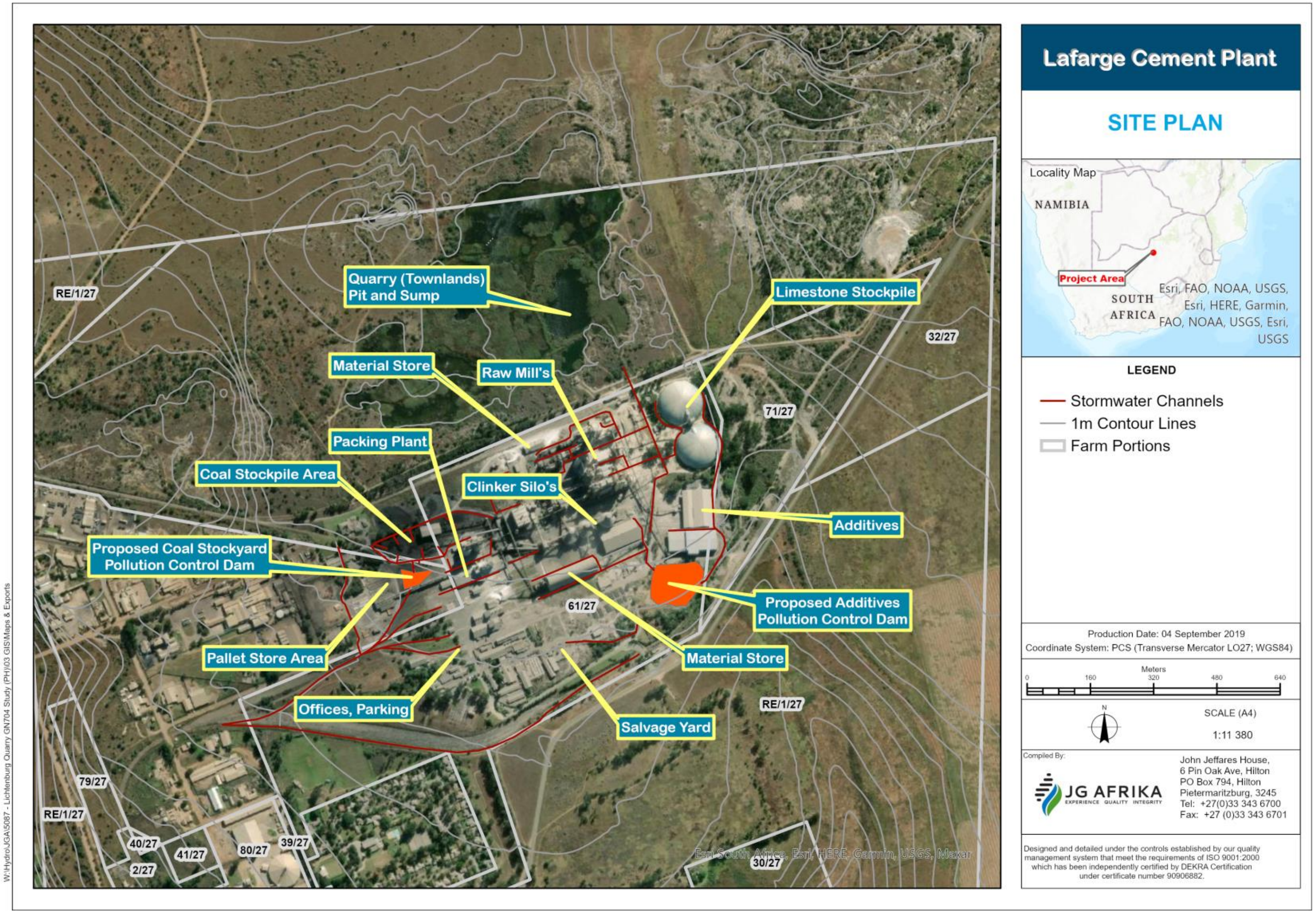

Figure 2-2 Lafarge Cement Plant Site Plan

2.2 Lafarge Cement Plant Operations Description

A process of grinding and burning takes place at the cement plant. Fine grinding produces a fine powder (known as raw meal) which is preheated and then sent to a Kiln. The material is heated to approximately 1 500°C before being rapidly cooled. This produces clinker, the basic material required for the production of all cements. The final manufacturing process involves cement grinding and shipping. A small amount of gypsum (3-5%) is added to the clinker to regulate how the cement will set. The mixture is then very finely ground to obtain “pure cement”. During this phase, different mineral materials, called “cement additives”, may be added alongside the gypsum. Used in varying proportions, these additives, which are of natural or industrial origin, give the cement specific properties such as reduced permeability, greater resistance to sulphates and aggressive environments, improved workability, or higher-quality finishes. Finally, the cement is stored in silos before being shipped in bulk or in bags to the sites where it will be used.

2.3 Climate Description

The Cement Plant lies within an arid to temperate climatic region (Köppen-Geiger Climate Classification Maps, 2018). Rainfall occurs mostly during the summer and the climate category can be described as dry and hot during the summer months and cold during the winter months.

Temperature data for the project area was obtained from the South African Weather Services (SAWS) meteorological station 0472280 A, as presented in **Table 2-1**. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures range from 18.9°C in June to 28.7°C in January. The region is the coldest during June when the mercury drops to -0.4°C on average during the night.

Table 2-1 Temperature Recorded for Years 1950 – 1999 at SAWS 0472280 A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temperature (°C)	22.2	21.6	20.0	16.7	12.8	9.3	9.4	12.2	16.7	19.3	21.0	21.8
Min. Temperature (°C)	15.7	15.1	13.2	8.7	3.7	-0.4	-0.3	2.5	7.6	11.4	13.6	15.1
Max. Temperature (°C)	28.7	28.0	26.8	24.6	22.0	18.9	19.2	21.9	25.7	27.3	28.4	28.4

2.3.1 Rainfall and Evaporation

Rainfall data for the project area was obtained from the SAWS rainfall station 0472455 W. This rainfall station is located approximately 3.2 km northeast from the project site and was selected based on its record period and the reliability of the historical rainfall data. The details of this rainfall station are presented in **Table 2-2**. The mean monthly rainfall amounts over the period 1950 to 1999 are presented in **Table 2-3**. From **Table 2-3**, it is evident that most of the rainfall falls over the summer period (November to March). It is also noted that low rainfall values are recorded over the winter months (May to September).

Table 2-2 Rainfall Station Details

Station Number	Station Name	MAP (mm)	Years Assessed	Reliability (%)	Longitude	Latitude
0472455 W	Manana	614	1950 - 1999	91	26^0 13' E	26^0 6' 1" S

Table 2-3 Average Rainfall Depths Recorded for Years 1950 – 1999 at Rainfall Station 0472455 W

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAP
Rainfall Depth (mm)	108.9	89.8	89.1	58.4	17.8	5.9	4.0	6.7	16.6	47.2	74.4	94.9	614

A high degree of variation in the annual rainfall data obtained from rainfall station 0472455 W has been noted. The lowest recorded annual rainfall value over the assessed period is 254.7 mm, recorded in the year 1965. **Table 2-4,** which presents the 10 wettest years over the 1950 to 1999 period, indicates the wettest recorded year over this period was 1 017.3 m in 1967.

Table 2-4 Ten Wettest Years Recorded for Period 1950 – 1999

Ranking	Year	MAP (mm)
1	1967	1 017.3
2	1957	894.5
3	1975	885.2
4	1976	831.9
5	1997	814.7
6	1989	773.3
7	1991	749.0
8	1995	747.4
9	1979	717.6
10	1977	700.0

While rainfall is generally variable on a month-to-month basis, this is not the case with evaporation. Evaporative demands do not vary significantly from one year to next (i.e. evaporation in one October-month, for example, is similar to evaporation in the next October-month). Therefore, it is generally considered to be acceptable to apply 12 average monthly evaporation values over the year. The evaporation data used for the Cement Plant was obtained from Evaporation Zone 8A (Middleton and Bailey, 2008). Catchment evapotranspiration is calculated by applying 12 monthly evapotranspiration conversion factors, as presented in **Table 2-5**. Similarly, evaporation losses from an exposed water body are calculated by applying 12 monthly lake evaporation conversion factors, as presented in **Table**

2-5. The annual potential evaporation rate for the area is 1 860 mm (WR, 2012). From **Table 2-5**, the highest evaporation rates occur during the hotter summer months of November to March.

Table 2-5 Cement Plant Potential Evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Evaporation Rate (mm)	214	167	151	118	98	78	91	130	173	207	213	221	1 860
Lake Evaporation Factor	0.84	0.88	0.88	0.88	0.87	0.85	0.83	0.81	0.81	0.81	0.82	0.83	
Evapotranspiration Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.80	0.80	0.80	1.00	1.00	

2.3.2 Design Rainfall

The 24-hour design rainfall depths (point rainfall) for the 1:2, 1:10, 1:20, 1:50, 1:100 and 1:200 year recurrence intervals were extracted using the Design Rainfall Estimation Utility (Smithers and Schulze, 2003) and are shown in **Table 2-6**, below.

Table 2-6 24-hour Design Rainfall Depths

Duration (hr)	Rainfall Depth (mm)						
	1:2	**1:5**	**1:10**	**1:20**	**1:50**	**1:100**	**1:200**
24	62	84.3	99.7	114.9	135	150.6	166.5

2.4 Hydrology

As presented in **Figure 2-3**, the project site is located in the Harts River Catchment within the Quaternary Catchment C31A of the Lower Vaal Water Management Area (WMA No. 10). Based on Department of Water and Sanitation (DWS) river coverages and 5 m contours, a drainage line (unnamed drainage line) alongside the eastern boundary of the Cement Plant drains into an unnamed tributary and eventually into the Harts River (*cf*. **Figure 2-3**). The Harts River is located approximately 15 km downstream of the project site.

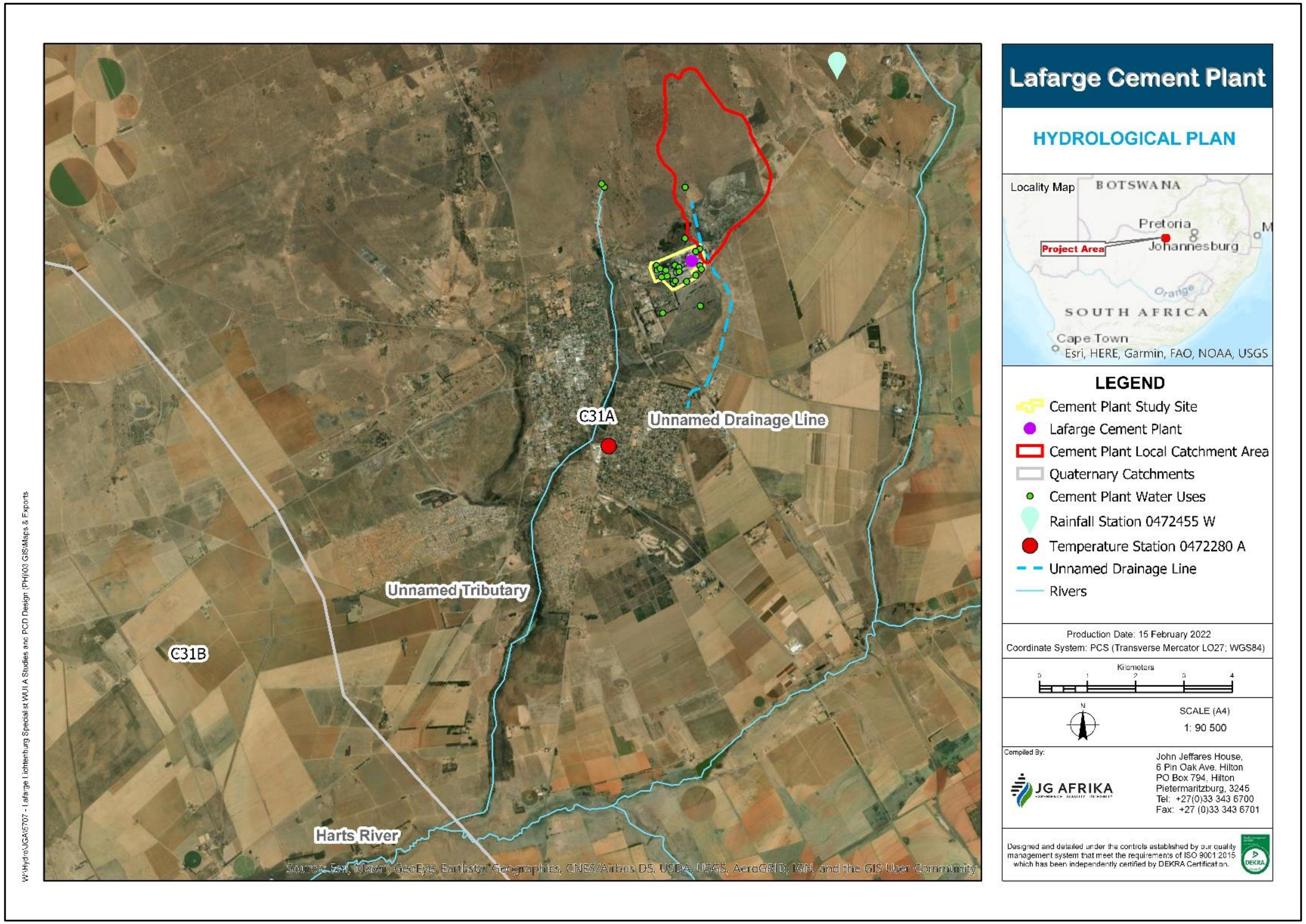

Figure 2-3 Hydrological Plan of the Cement Plant Site

The catchment area of the unnamed drainage line, within the vicinity of Portion 61 of Lichtenburg Town Farm No 27 and the Cement Plant, is approximately 5.48 km^2, as depicted in **Figure 2-3**. For the purposes of this study, this is considered the local catchment area. Quaternary Catchment C31A (considered as the regional catchment for the purposes of this study), within which the Cement Plant is located, has a catchment area of 1 403 km^2 and a Mean Annual Runoff (MAR) of 8.11 million cubic meters (MCM). Details of the Quaternary Catchment C31A, including its associated MAR volume and MAR depth are provided in **Table 2-7** (WR, 2012).

Table 2-7 Quaternary Catchment Details

Quaternary Catchment	Catchment Area (km^2)	Evaporation Zone	Rain Zone	Water Management Area	MAR (MCM)	MAR Depth (mm)
C31A	1 403	8A	C3A	10	8.11	5.78

3 HYDROLOGICAL IMPACT ASSESSMENT

3.1 Risk Assessment Methodology

In order to be compliant with statutory requirements, a hydrological impact assessment was undertaken as per the DWS Risk Assessment Matrix (2016).

The risk rating matrix methodology used is based on the following quantitative measures:

- The severity of each impact.
- The spatial extent or geographic sense of each impact occurring.
- Duration of occurrence.
- The frequency of each activity.
- The frequency of each impact.
- Legal issues of the activity.
- Detection of the impact.

In order to determine the significance of each identified potential impact, a numerical value has been linked to the respective factor. **Table 3-1** provides the ranking scales used in this assessment.

Table 3-1 Risk Rating Matrix

RISK ASSESSMENT KEY (Referenced from DWA RISK-BASED WATER USE AUTHORISATION APPROACH AND DELEGATION GUIDELINES)	
RATINGS	
SEVERITY	
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
SPATIAL SCALE	
Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5
DURATION	
One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
FREQUENCY OF THE ACTIVITY	

RISK ASSESSMENT KEY (Referenced from DWA RISK-BASED WATER USE AUTHORISATION APPROACH AND DELEGATION GUIDELINES)	
RATINGS	
Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5
FREQUENCY OF THE INCIDENT/IMPACT	
Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5
LEGAL ISSUES	
No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
DETECTION	
Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Based on the ranking scales presented in **Table 3-1**, the significance of each impact is calculated using the following formula:

Significant Value = (Severity + Spatial Scale + Duration) x (Frequency of Activity + Frequency of Incident +Legal Issues + Detection).

The risk significance rating has been subdivided into three categories, as presented in **Table 3-2**. This ranking system is based on the DWS risk assessment requirements and has therefore been used to determine risk significances in this study.

Table 3-2 Risk Assessment Significance Value

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

3.2 Impact Assessment

The following potential hydrological impacts were identified to be associated with the Cement Plant and, therefore, included as part of this impact assessment:

- Changes in catchment water resources;
- Changes in catchment water quality; and
- Changes in catchment flood hydrology.

Table 3-3 presents the results of the significance ratings attributed to each of the identified potential impacts for both the pre- and post-mitigation scenarios.

Table 3-3 Significance Ratings of Identified Potential Impacts

Nature of Impact	Severity	Spatial Scale	Duration	Frequency of Activity	Frequency of Incident	Legal Issues	Detection	Significance Score	Significance / Comment / Mitigation Measure
Pre-Mitigation									
Changes in Catchment Water Resources due to:									
An increase in impervious areas	1	2	4	3	4	1	1	**63**	**Moderate**. It is noted that a significant portion of the cement factory is impervious through roofed or concrete lined areas. These areas limit infiltration to the groundwater reserves and increase runoff, therefore resulting in the hydrology of the immediate area being impacted on. These impacts are for the lifespan of the factory. Although the impact of this on the local and regional catchment area are relatively insignificant, the permanent nature of the impact raises it from a "low" to a "moderate" significance rating.
Impeding or altering the flow of water in a drainage line	4	3	4	3	4	5	5	**187**	**High**. This impact relates to materials that have been deposited in the unnamed drainage line located to the east of the factory, resulting in the natural flow of water through the project site being impeded. This is likely to alter the hydrology of the downstream environment and so is associated with a high significance rating.
Abstractions	1	1	4	5	1	1	2	**54**	**Low.** No water is abstracted from a nearby stream or river for water supply to the cement factory. Water is currently sourced from boreholes, the Townlands Quarry Sump, and will in the future be augmented from water stored in the Additives Pollution Control Dam (PCD) and Coal Stockyard PCD. These abstractions have no obvious impact on the downstream catchment area or regional catchment area, hence the low significance rating.
Limiting Flow (capturing of contaminated stormwater)	1	2	4	2	2	1	2	**49**	**Low**. The volume of water to be captured in the Coal Stockyard and Additives PCD's are insignificant compared to local and regional runoff volumes.

Nature of Impact	Severity	Spatial Scale	Duration	Frequency of Activity	Frequency of Incident	Legal Issues	Detection	Significance Score	Significance / Comment / Mitigation Measure
Reduction in Catchment Water Quality due to:									
Erosion from the project site and sedimentation of downstream water resources	4	3	4	3	4	5	3	**143**	**Moderate**. Largely due to the fact that there are currently no PCD's on site preventing the transport of fine materials or contaminated stormwater runoff from the factory to the downstream environment.
Discharging waste or contaminated water (i.e., contamination from the coal stockyard and, additives areas, pit dewatering and sewage spills)	4	3	4	3	5	5	3	**176**	**Moderate**. Currently there are limited means of limiting contaminated stormwater discharge from the factory site. It is noted that a number of areas with the potential to contaminate stormwater runoff are located under roofed areas (for example the Additives Area), however, there are areas that are not covered and will result in the contamination of the downstream environment (such as the coal stockyard). This impact is therefore associated with a high significance rating.
Changes in Flood Hydrology due to:									
An increase in impervious areas	3	2	4	1	3	1	2	**63**	**Moderate**. It is likely that there will be an increase in the stormwater runoff discharge rate, when compared to natural catchment conditions. However, due to a significant portion of the stormwater runoff from the project site being directed to the Townlands Quarry Sump (which has no outlet), the significance of this impact is considered as moderate to low.
Altering the bed, banks, course or characteristics of a water course	4	1	4	3	4	5	1	**117**	**Moderate**. As noted above, the drainage line to the east of the project site has been blocked by materials from the cement factory. This has resulted in an impediment to the natural flow of water. During a flood, this will change the dynamics of flooding downstream of the factory site. This is therefore associated with a moderate significance.
Post-Mitigation									
Changes in Catchment Water Resources due to:									
An increase in impervious areas	1	2	4	3	4	1	1	**63**	**Moderate**. No mitigation measures are recommended, as this would require the impervious areas to be removed. It should, however, be noted that the impact of the impervious areas on the local and regional hydrology is insignificant (refer to **Section 3.2.1** for more details).
Impeding or altering the flow of water in a drainage line	1	1	1	1	1	1	1	**12**	**Low**. There are currently projects in place for the rehabilitation of the drainage line and the incorporation of culverts to ensure that there is no impediment to the natural flow of water. Once these projects are completed, there will be no impact on catchment water resources and therefore this significance rating has gone from high to low.
Abstractions	1	1	2	4	2	5	1	**48**	**Low**. No mitigation measures are required as there are no current or planned abstractions from surface water resources (refer to **Section 3.2.1** for more details on this impact assessment).

Nature of Impact	Severity	Spatial Scale	Duration	Frequency of Activity	Frequency of Incident	Legal Issues	Detection	Significance Score	Significance / Comment / Mitigation Measure
Limiting Flow (capturing of contaminated stormwater)	1	1	1	3	2	5	1	**33**	**Low**. The implementation of PCD's at the project site will reduce the volume of water to the downstream environment, however, in the context of the local and regional catchment this impact is low (refer to **Section 3.2.1** for more details).
Reduction in Catchment Water Quality due to:									
Erosion from the project site and sedimentation of downstream water resources	1	1	2	1	2	5	1	**36**	**Low**. There are currently projects in place that include the design and construction of PCD's downstream of the Coal Stockpile and Additives areas. Once implemented the likelihood of sediment discharging from the Cement Factory will be significantly reduced, hence the reduction in the significance rating of this identified potential impact. See **Section 3.2.2** for more details on the analysis of this impact.
Discharging waste or contaminated water (Hydrocarbon spills, pit dewatering and sewage spills)	1	1	4	2	1	5	1	**54**	**Low.** As stated above, the incorporation of PCD's for the management of contaminated stormwater runoff from the project site will significantly reduce the risks associated with the contamination of downstream water resources. Please refer to **Section 3.2.2** for more details on this impact.
Changes in Flood Hydrology due to:									
An increase in impervious areas	1	1	1	1	1	5	1	**24**	**Low**. Due to the incorporation of PCD's to the stormwater management infrastructure at the factory site, the impact of impervious areas increasing the discharge rate from the project site will be reduced. It is also noted that a stormwater management plan is currently being developed for the project site, which will also assist in limiting the impact of the factory site on the downstream flood hydrology. See **Section 3.2.3** for more details on this impact.
Altering the bed, banks, course or characteristics of a water course	1	1	3	1	1	5	1	**40**	**Low**. As noted above, there is currently a project that has been initiated to aid in the rehabilitation of the drainage line. Once implemented, the drainage line will be restored to its natural condition, which result in the stream to flow freely across the project site. See **Section 3.2.3** for more details.

3.2.1 Changes in Catchment Water Resources

A hydrological analysis of the local (unnamed drainage line adjacent to the Cement Plant) and regional (C31A quaternary catchment) catchment hydrology was undertaken to determine the potential impact of the Cement Plant on the local and regional hydrology. The hydrological analysis consisted of assessing catchment Mean Annual Evaporation (MAE), MAP and MAR, based on results obtained from the Water Resources of South Africa Study (WR2012) undertaken in 2012.

Details of the local catchment (unnamed drainage line within the vicinity of the Cement Plant) and regional catchment (Quaternary Catchment C31A) hydrology are presented in **Table 3-4**. Based on the respective catchment areas and information provided in the WR2012 study, the MAR of the local catchment (i.e. which includes the unnamed drainage line catchment area), in the vicinity of the Cement Plant equates to 0.03 MCM (million cubic meters), and the MAR of the regional catchment (C31A) equates to 8.11 MCM. This is based on an average runoff depth of 5.78 mm/annum for the respective catchments. In order to determine the anticipated impact of the Cement Plant on the catchment water resources (volume of water), the catchment area of the overall Cement Plant site was compared to the local and regional catchment areas. Based on this, the Cement Plant, with an area of approximately 0.61 km^2, comprises approximately 11.04 % of the local catchment area and approximately 0.04 % of the regional quaternary catchment area (C31A). The resulting impact on local and regional catchment resources is 11.04 % and 0.04 %, respectively. Based on this, the anticipated impact of the Cement Plant on the local and regional catchment water resources (from a water volume perspective), as a result of an increase in impervious areas are considered to be negligible.

Table 3-4 Comparison of Regional to Local Catchment Hydrology

	Local Catchment	**C31A Quaternary Catchment**
Catchment Area (km^2)	5.48	1 403.00
MAR (MCM/annum)	0.03	8.11
Average Quaternary Runoff Depth (mm/annum)	5.78	
Catchment Area of Cement Plant (km^2)	0.61	
Percentage of Quaternary Catchment Affected by the Cement Plant	11.04	0.04
Flow Volume Traversing the Cement Plant (m^3/annum) Based on Affected Local Catchment Areas	3 500	
Average Daily Flow Rate Traversing the Cement Plant Site (m^3/s), Based on Annual Flow Volumes	**0.000111**	

As presented in **Table 3-4**, the most significant impact of the Cement Factory on the local catchment hydrology is as a result of the current blockage on the unnamed drainage line to the east of the factory. This blockage is as a result of materials that were dumped over the drainage line. This impact was, however, identified several years ago and so significant steps have been undertaken to remediate the affected area. This includes the development of a rehabilitation plan, which details how the drainage line is going to be restored and how culverts along road and rail crossings will be constructed to allow for the unhindered flow of water across the site. Currently, the proposed rehabilitation plan is with the Department of Forestry, Fisheries and the Environment (DFFE) and the DWS for approval. Once the rehabilitation plan has been approved and implemented, the impact of the blockage will go from a "high" impact rating to a "low" impact rating.

It is our understanding that there are no plans to abstract water from the local unnamed drainage line for the purposes of augmenting water supply to the Cement Plant. Therefore, the impact of taking water from the drainage line, and the subsequent potential impact on the downstream environment and water resources was classed as "low".

As part of the assessment of the hydrology of the project area, an analysis of the licensed water abstractions downstream of the Cement Plant, within the C31A Quaternary Catchment, was undertaken using the 2022 DWS Water Authorisation and Registration Management System (WARMS) database. The database indicated that there were no licenced water users located downstream of the study area, between the Cement Plant and the Harts River. Although there are no current licences pertaining to the Cement Factory and downstream users, it is noted that Lafarge Lichtenburg are in the process of applying for a number of water uses at the Cement Plant. These applications largely pertain to the following (as presented in **Table 3-4** and presented in **Figure 2-3**):

- Taking water from water resource (Section 21 (a) Application). This includes pumping from three boreholes on site and pumping from the Townlands Quarry Sump, located to the north of the factory site.
- Disposing of waste in a manner which contains waste from or which has been heated in any industrial or power generation process – water is used for cooling purposes (Section 21 (h) Application). This includes the discharge of water from the cooling process at the Kilns to the Townlands Quarry Sump.
- Waste discharge related water use (Section 21 (g) Application). This application pertains to water that is potentially contaminated, discharging from the coal stockpile area, additives area, Kilns and from septic tanks.
- Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities (Section 21 (e) Application).

Table 3-5 Summary of Current Lafarge Lichtenburg Water Use Licence Applications

Water Use	Water Source	Volume m³/year	Sector	Quaternary	Location
Section 21 (a) Taking water from water resource	Lichtenburg Plant Borehole 1	75 727	Drinking water for village and plant	C31A	26°07'06.00"S 26°10'04.01"E
Section 21 (a) Taking water from water resource	Lichtenburg Plant Borehole 2	27 941	Domestic and garden use and processing	C31A	26°07'03.7"S 26°10'02.0"E
Section 21 (a) Taking water from water resource	Lichtenburg Plant Borehole 3	452 077	Borehole 3 is used to top up the Townlands Quarry Sump – water will be used in processing and watering livestock	C31A	26° 7'8.10"S 26°11'4.14"E
Section 21 (a) Taking water from water resource Section 21 (h) Disposing of waste in a manner which contains waste from or which has been heated in any industrial or power generation process – water is used for cooling purposes	Townlands Quarry Sump	Processing: 454 536 Kiln 3: 407 340 Kiln 4: 10 220 Evaporation: 474 852 Total: 505 486	The water is then used for cooling purposes. Above pipe leading to Quarry pump. *Kiln 1 and 2 no longer in use*	C31A	Processing: 26° 7'42.42"S 26°11'2.58"E Kiln 3: 26° 04' 59 .70"S 25 ° 48'12.14"E Kiln 4: 26° 04'59.70"S 25°48'12.14"E
Section 21 (g) Waste discharge related water use	Coal Stockpiles:	25 000 tonne	Stockpile areas	C31A	26° 8'0.12"S 26° 8'0.12"S
Section 21 (g) Waste discharge related water use	Gypsum Stockpiles	20 000 tonne	Stockpile areas	C31A	26° 8'5.10"S 26°10'55.32"E
Section 21 (g) Waste discharge related water use	additive Stockpiles:	30 000 tonne	Stockpile areas	C31A	26° 8'1.14"S 26°11'12.90"E
Section 21 (g) Waste discharge related water use	Limestone Stockpiles:	160 000 tonne	Stockpile areas	C31A	26° 7'49.97"S 26°11'13.21"E
Section 21 (g) Waste discharge related water use	PCD 1- SWMP coal stockpile area	3 268	Coal stockpile	C31A	26°8'4.78'' S 26°10'46.88'' E
Section 21 (g) Waste discharge related water use	PCD2 – SWMP additives area	13 071	Additives	C31A	26°8'3.5'' S 26°11'14.01'' E
Section 21 (g) Waste discharge related water use	Townlands Quarry Sump	454 536	Water pumped from the Townlands Quarry Sump will be used for cooling purposes (i.e. processing)	C31A	26° 7.707'S 26° 11.043'E
Section 21 (g) Waste discharge related water use	Septic Tank – B works	Maximum quantity: 30	Septic Tank	C31A	26° 8'28.18"S 26°11'12.10"E
Section 21 (g) Waste discharge related water use	Septic Tank – palletiser ablution	Maximum quantity: 10	Septic Tank	C31A	26° 8'7.84"S 26°10'44.01"E
Section 21 (g) Waste discharge related water use	Septic Tank – packing plant ablution	Maximum quantity: 20	Septic Tank	C31A	26°8' 0.16"S 26°10'54.38"E
Section 21 (g) Waste discharge related water use	Septic Tank – electrical workshop	Maximum quantity: 10	Septic Tank	C31A	26° 8'1.85"S 26°10'57.30"E

Water Use	Water Source	Volume m³/year	Sector	Quaternary	Location
Section 21 (g) Waste discharge related water use	Septic Tank – limestone tip ablution	Maximum quantity: 10	Septic Tank	C31A	26°7'51.55"S 26°11'10.14"E
Section 21 (g) Waste discharge related water use	Septic Tank – main road reception	Maximum quantity: 10	Septic Tank	C31A	26° 8'32.06"S 26°10'43.93"E
Section 21 (g) Waste discharge related water use	Septic Tank – Swart Dam	Maximum quantity: 10	Septic Tank	C31A	26° 8'7.48"S 26°11'9.59"E
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 1	16.5	Garden irrigation/non-edible	C31A	26° 8'0.02"S 26°10'40.58"E
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 2	16.5	Garden irrigation/non-edible	C31A	26° 8'3.04"S 26°10'41.01"
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 3	16.5	Garden irrigation/non-edible	C31A	26° 8'2.06"S 26°10'43.20"E
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 4	16.5	Garden irrigation/non-edible	C31A	26° 8'3.39"S 26°10'47.49"E
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 5	16.5	Garden irrigation/non-edible	C31A	26° 8'7.40"S 26°10'48.31"E
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 6	16.5	Garden irrigation/non-edible	C31A	26° 8'10.81"S 26°10'52.48"E
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 7	16.5	Garden irrigation/non-edible	C31A	26° 8'12.29"S 26°10'52.89"E
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 8	16.5	Garden irrigation/non-edible	C31A	26° 8'10.76"S 26°10'54.18"E
Section 21 (e)	Garden patch 9	16.5	Garden irrigation/non-edible	C31A	26° 8'11.42"S 26°11'2.62"E

Water Use	Water Source	Volume m^3/year	Sector	Quaternary	Location
Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities					
Section 21 (e) Irrigation with water containing waste, artificial recharge of aquifer, modification of atmospheric precipitation and in-stream power generation activities	Garden patch 10	16.5	Garden irrigation/non-edible. Effluent from wastewater treatment works will be used for irrigation in gardens.	C31A	26°8'4.71"S 26°10'57.32"E

3.2.2 Reduction in Catchment Water Quality

Although there are no registered water users downstream of the Cement Plant, any reduction in water quality for any un-registered water users (such as farmers and stock watering) and the environment is associated with a high significance level. Potential types and sources of surface water contamination are as follows:

- The coal stockpiles and materials stored at the additives area. Further to this, any piles of fine materials that are spilled or dumped in the vicinity of the factory are considered hazardous to the downstream environment.
- Hydrocarbons from spillages around fuel and hydrocarbon stores and workshop areas.
- Spillages of untreated sewage.

In order to mitigate against these identified impacts, the following is proposed:

- As indicated previously, Lafarge have appointed JG Afrika to undertake the design of two PCD's at the factory site. These PCD's are positioned to manage stormwater runoff from the coal stockyard and from the additives areas. These dams will ensure that both sediment and contaminated water do not enter the downstream environment from these areas.
- In addition to the PCD's, it is recommended that berms are constructed upslope and downslope of any area that contains fine materials that may block drains and emanate into the downstream environment. Upslope berms will ensure limited surface flows through areas associated with sediment and downslope berms will ensure that sediments eroded from areas associated with sediment loss will be trapped, therefore reducing the impact to the downstream receiving environment. It is recommended that the berms are constructed out of a non-erodible material.
- Machinery should be regularly (at least daily) checked for oil leaks. During periods where the machinery is not in use, drip trays should be placed under the machinery to contain any spillages.
- The sizing and positioning of "dirty" stormwater channels and recommendations on bunding around areas containing potential for surface water contamination should be designed such that:
  - Dirty stormwater channels and bunding walls will contain runoff generated during the 1:50 year storm event, as per the requirements stipulated in General Notice 704 (GN704) of the National Water Act (Act 36 of 1998).
- Areas that may result in the contamination to groundwater should be sufficiently lined to meet with regulatory requirements (such as the Coal Stockyard).

- The sizing and positioning of clean stormwater diversion channels or berms so as to keep "clean" stormwater runoff from mixing with "dirty" stormwater runoff should be designed such that:
  - "Clean" stormwater runoff diversion infrastructure will be sized to divert runoff generated during the 1:50 year storm event as per the GN704 requirements.
- All domestic waste should be regularly removed from the Cement Plant site on a regular basis and dumped in appropriate waste handling facilities.
- Long-term sewage containment management and/or treatment facilities implemented at the Cement Plant should be sufficiently sized, such that spillages of untreated sewage to the environment are unlikely.
- Fuels and hydrocarbon stores should be lined and bunded such that spills from the store areas will not enter the receiving environment.
- Water downstream of Cement Plant should be monitored to ensure no degradation of water quality occurs.

3.2.3 Changes in Flood Hydrology

Currently, the most significant impact of the Cement Factory on catchment flood hydrology is located in the area where materials have been deposited over the unnamed drainage line located to the east of the factory. The result of the blockage is that the natural flow of water down the drainage line has been impeded. This will exacerbate flooding upstream of the blockage, which may result in flooding of infrastructure associated with the Cement Factory. As mentioned previously, Lafarge has appointed JG Afrika to develop a rehabilitation plan, which is aimed at restoring the drainage line to its natural state. This plan has been submitted to the DFFE for approval. Once approved, it is understood that Lafarge will remove all materials dumped in the drainage line and install culverts at road and rail crossings, which will allow for the free flow of flood waters across the project site. Once the rehabilitation measures have been implemented, the significance rating of the identified impact will go from "high" to "low".

Due to an increase in impervious areas and changes in catchment landcover characteristics associated with the Cement Plant, there is a possibility that this will result in an increase in the peak discharge rates from the catchment in which the Cement Plant is located. It is, however, noted that the majority of stormwater runoff from the cement plant is directed into the Townlands Quarry Sump (old pit). There are no discharge points from this sump and pit area and so there will be no increased discharge rates to the downstream environment. Further to this, a portion of the area that currently discharges to the downstream environment (in the western half of the project site) will soon discharge into a PCD (downstream of the Coal Stockyard. Therefore, the increase in discharge rates from the cement plant is associated with a low risk and significance level.

4 DISCUSSIONS AND CONCLUSION

As part of this assessment, a general hydrological characterisation of the area in which the Lichtenburg Lafarge Cement Plant is located was undertaken. This included defining the MAP, MAR and MAE for the project site. In order to determine the impact of the Cement Plant on the local and regional hydrology, the catchment areas corresponding to these regions were defined. The local catchment area was defined as the catchment area of the unnamed drainage line located on the eastern boundary of the Cement Plant. The regional catchment area was defined as the Quaternary Catchment C31A, in which the Cement Plant is located.

In addition to the hydrological characterisation of the Cement Plant, an impact assessment of the plant on the local and regional hydrology was undertaken. Mitigation measures to reduce the significance of the identified potential impacts were provided. The potential impacts and mitigation measures identified included:

- Changes in catchment water resources. The most significant impact associated with changes in water resources is associated with materials that have been deposited along the drainage line located to the east of the Cement Factory, which has resulted in impeding the natural flow of water across the site. It is, however, noted that a process of rehabilitation of the affected drainage line has been initiated. The proposed rehabilitation plan is currently with the DFFE and is awaiting approval from the relevant authorities. Once the proposed rehabilitation has been implemented, the impact of the blocked drainage line on the catchment water resources will be significantly reduced, resulting in the post-mitigation impact rating going from “high” to “low”.
- Changes in catchment water quality. The potential sources of contamination were identified as the fine sediment located throughout the project site and especially in the area of the Additives Stores, contaminated runoff from the Coal Stockpiles, hydrocarbon spills (through fuel stores and machinery on site) and domestic and sewage waste. In order to reduce the risk of surface water contamination, numerous recommendations were made, largely with respect to management of contaminants at their source. It is noted that Lafarge have appointed JG Afrika to undertake the design of two PCD’s, located downstream of the Coal Stockpile and Additives areas. Once constructed, the risk of contamination of surface water resources will be significantly reduced.
- Changes in catchment flood hydrology. The impact of the blocked drainage line on the eastern boundary of the project site is a significant change in the flooding dynamics of the project site. It was noted that during a flood event, the flooding in the area in which the stream has been blocked will be exacerbated. However, the rehabilitation of the drainage line and the

implementation of proposed culverts along road and rail crossings will ensure that the impact of the impeded flows is mitigated against. The proposed culvert crossings have been based on transferring flows associated with the 1:50 year flood event. Therefore, once implemented, the significance of the changes in flood hydrology, as a result of the blocked drainage line, will reduce from “high” to “low”.

- Changes in peak discharge rates from the Cement Plant. It was noted that as a result of stormwater runoff from the cement plant being directed to the Townlands Quarry Sump (with no point of discharge) and considering the proposed construction of PCD’s downstream of the Coal Stockpile and Additives stores, the risk of increase discharge rates from the cement plant is largely reduced. The significance of changes in the flood hydrology of stormwater discharging from the project site is associated with a low significance.

Based on the baseline hydrology and impact assessment study, it is noted that there are a number of significant impacts associated with the Cement Plant, particularly on the local hydrology. These impacts are associated with the current blockage of the unnamed drainage line to the east of the project site. Further to this, there is currently a risk of contaminated stormwater discharge to the downstream environment, particularly from the Coal Stockyard and Additives areas. It is, however, noted that Lafarge are taking significant steps to alleviate the identified impacts. In line with this, they are in the process of obtaining approval for the rehabilitation of the drainage line that has been blocked and have also appointed engineers to design PCD’s that will be located downstream of the Coal Stockyard and Additives areas. This will limit any contamination to the downstream environment.

Once the proposed mitigation measures have been implemented, the impact of the Cement Plant on the local and regional hydrology will be limited.

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