anne bindoff CONSULTANCY

Reg no: 2014/011805/07

MOTIVATION IN SUPPORT OF THE APPLICATION TO EXCLUDE COMPOSITE BOILER ASH WASTE FROM THE DEFINITION OF WASTE

for

ILLOVO SUGAR (SOUTH AFRICA) (PTY) Ltd - SEZELA SUGAR MILL & DOWNSTREAM PRODUCTION PLANT

by

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September 2023

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DETAILS OF THE SPECIALIST

Name of Company: Anne Bindoff Consultancy.
Name: Anne Bindoff: Director/Owner.
Qualifications: MSc (Eng. – Enviro) UKZN, BSc (Chem and App Chem) UKZN, HED UNISA. RMPASA and Plant Science Consultants Association (PSCA) attendance for GHS training.
Professional Affiliations: RPMASA, IWMSA, PSCA.
Professional Registration: SACNASP: application pending
Company Specialities: Environmental Management, specialising in Waste Management, Hazardous Waste, Legal aspects, GHS: UN Standards Safety Data Sheet Compilations for Hazardous chemicals, Agri-Remedies (New standards) and fertilizers (New standards).

Experience:

- **Regulatory DAEA/EDTEA:** Pollution and Waste Management: Acting Assistant Manager iLembe DM 2006 - 2009.
- **Corporate: SAPPI Mandeni:** 2009 – 2013: Environmental Specialist: SHEQ systems, landfill site management, waste management, legal compliance for permits licences, waste classifications, water permits, waste permits, etc.
- **Own Business: Anne Bindoff Consultancy: As above**
  Clients:
  - **Sappi Mandeni:** Hazardous waste removal.
  - **INDIFLORA: Brookdale Assessment Centre** - Rehabilitation: Waste removal for legal compliance.
  - **Aquasol:** SDS and labels, HCA and DALRD new requirements.
  - **NCP Chlorchem**: Waste assessment.
  - **Intellichem:** Tremcards supply.
  - **IFF:** Tremcards supply.
  - **SAPREF:** Tremcards supply.
  - **Bowisolve:** Legal requirements for road transportation of waste/Hazardous waste.
  - **Andermatt Madumbi:** Agri-remedies SDS assessments and advisory.
  - **RPMASA:** GHS training for Safety Data Sheets.
  - **IWMSA:** Hazardous waste management training.
  - **ECOGUARD:** Agri-remedies SDS compilations – new requirements and advisory.
  - **Aquasolve:** Supply of Safety Data Sheets: Fertilizers, new agricultural standards as per Dept of Labour HCA requirements.
  - **Dow/Corteva:** SDS advisory and tremcards supply.
  - **BPL**: Tremcards Supply.
  - **WALLACE AND GREEN ENVIRONMENTAL SPECIALISTS**: Waste Specialist
    - Motivation in support of the removal of Sumitomo Mill waste ash and rubber compound from definition of waste.
    - Motivation in support of the removal of various waste streams from Illovo mills: Eston, Noodsberg, Gledhow mills.

- Motivation in support of the removal of various waste streams from Umfolozi Sugar Mill.

- **ILLOVO SUGAR MILL:**
  - Motivation in support of the removal of various waste streams from Illovo Sezela Sugar Mill:

1. INTRODUCTION

Sezela is a small town on the mouth of iSezela River in KwaZulu-Natal, South Africa. The town is 78.7 km south of Durban. It is notable for its large sugar mill. In 1915, the Reynolds Brothers opened a sugar mill at Sezela. In 1974 the Furfural plant was built. This was later purchased by C. G. Smith, then by Illovo Sugar Ltd in 1994, and finally by Associated British Foods. (Reference: https://en.wikipedia.org/wiki/Sezela#:~:text=following%20a%20trail.-,History,finally%20by%20Associated%20British%20Foods, and correspondence from Sezela Mill.)

The Illovo Sezela Sugar Mill (ISSM) is located in the Sezela Village, which was built around the mill to house the employees. The Sezela Village is located in the Umdoni local municipality within the Ugu District municipality Kwazulu Natal province. (Reference: https://www.cogta.gov.za/cgta_2016/wp-content/uploads/2021/02/Umdonii-Municipality-20202021-IDP-1-2.pdf.). Sezela is classed as a Natal Coastal cane growing area.

The total population of Umdoni as of 2017 was recorded at 154 427. This constitutes 22% of the total population of the Ugu district. The population in Umdoni grew significantly after 2009 due to in-migration driven by perceived employment opportunities. The Park Rynie industrial development attracted people from surrounding municipalities who sought employment due to the development. The majority of people who are of working age in Umdoni are not economically active. This means that 54% are neither employed nor unemployed. The Municipality is dominated by young people, who are the main driving force behind economic activity in terms of the labour force composition. 11,5% of the economic sector are from agriculture, forestry and fishing activities. 16% constitutes manufacturing of which ISSM forms a big component. (Reference: https://www.cogta.gov.za/cgta_2016/wp-content/uploads/2021/02/Umdonii-Municipality-20202021-IDP-1-2.pdf.).

Figure 1: Google Earth photo of the Illovo Sezela Sugar Mill in Umdoni local municipality within the Ugu District Municipality: KZN; shows the location of the mill and the surrounding areas. The mill is surrounded by:

- The Sezela River Estuary,
- Small village of Sezela,
- Sugar cane.

The mill lies within the Maputaland-Pondoland-Albany Hotspot Region an area described by Conservation International as “Biodiversity Hotspot. The hotspot’s vegetation is comprised mainly of forests, thickets, bushveld and grasslands. It is for this reason that any activities within this area be careful assessed for possible risks and be appropriately managed.

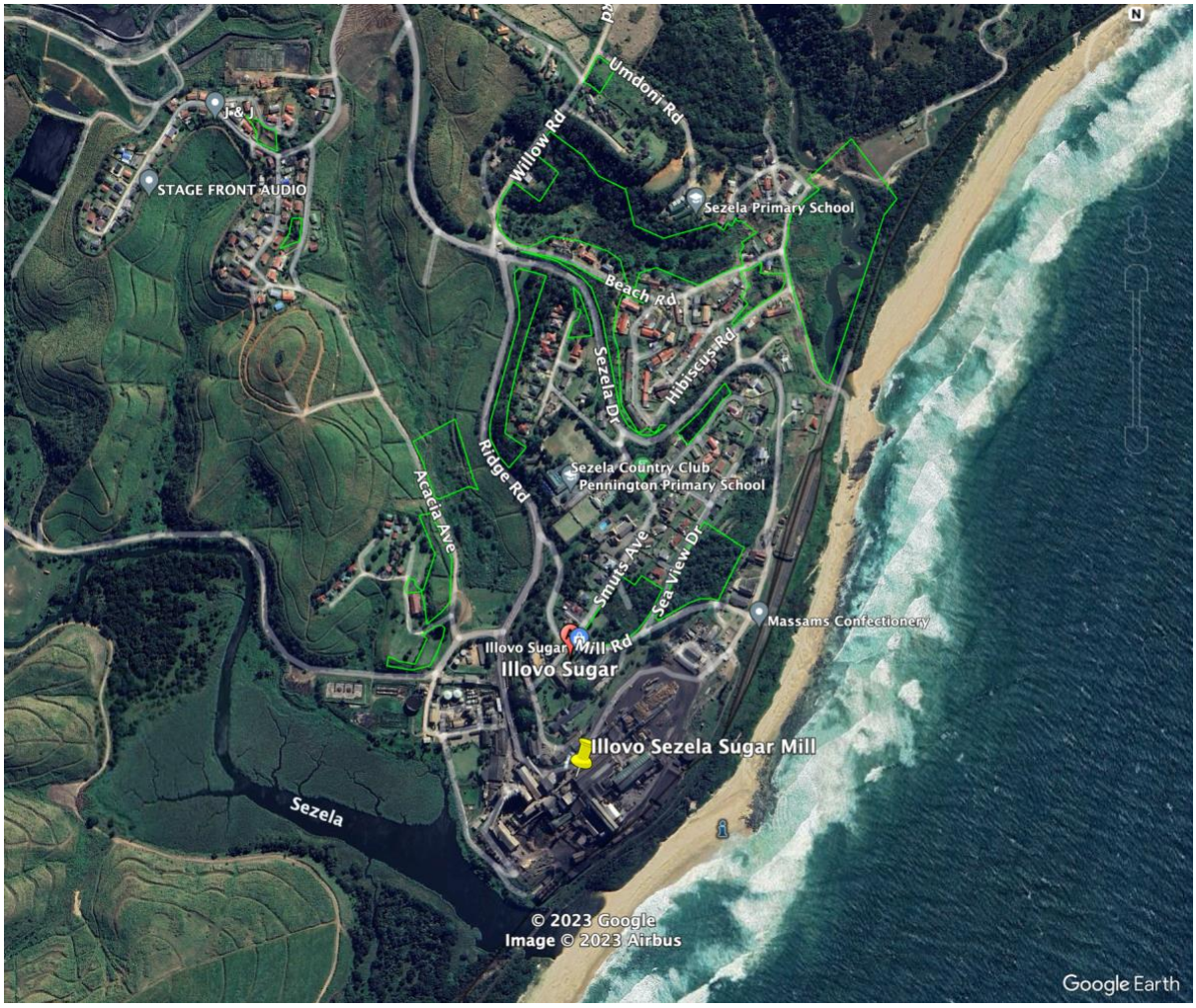

Figure 1: Google Earth photo of the Illovo Sezela Sugar Mill in Umdoni local municipality within the Ugu District Municipality: KZN.

ISSM GPS coordinates 30°24'42.85"S. 30°40'38.96"E.

There are around 72 commercial growers that supply about 721,000 tons of cane and around 3051 small scale growers which supply about 114 000 tons to the mill. The mill crushes approximately 2.05 million tons of sugar cane per annum to produce raw sugar. The Downstream Factory produces approximately 19 500 tons of Furfural and approximately 7000 tons of Furfural Alcohol and smaller quantities of other by-products (Diacetyl, 2.3 PD) dependent on orders. The sugar making process is typically a 38 week crushing season which allows for breakdowns, scheduled maintenance stops and weather interrupted cane supply. The factory is shut down for the rest of the off-season ("off-crop") for maintenance.

The following figure, Figure 2 shows the Google Maps image of the point locations identifying the boundaries of the ISSM ash dam, the source of the ash.

Figure 2: Google Maps image of the point locations of the ISSM ash dam.

The dirty water dam (or ash dam) is shown below in figure 3a: Photo of the dirty water ash dam in the foreground showing the steam from the mill in the background.

Figure 3a: Photo of the dirty water ash dam in the foreground showing the steam from the mill in the background.

Figure 3b: Photo taken from the dirty water dam wall facing the Clean Water dam. The Clean Water Recovery Plant is shown in the background, shows the Clean Water dam with water coming from the dirty water dam, to be taken to the recovery plant to prepare the water for return back to the mill process.

Figure 3b: Photo taken from the dirty water dam wall facing the Clean Water dam. The Eskom power station is shown in the background.

Table 1: GPS co-ordinates of the ash storage location in the ISSM dirty water ash storage dam follows below:

Table 1: GPS co-ordinates of the ash storage location in the ISSM dirty water ash storage dam.

	Pin Locations	LATITUDE			LONGITUDE		
GPS CO-ORDINATES AT CORNERS OF WASTE GENERATING FACILITY (i.e., BOILER ASH STORAGE DAM)	A	30°	24'	0.34"S	30°	40'	1.44"E
	B	30°	24'	1.95"S	30°	40'	8.40"E
	C	30°	23'	58.67"S	30°	40'	16.65"E
	D	30°	23'	58.19"S	30°	40'	17.03"E
	E	30°	23'	57.45"S	30°	40'	16.32"E
	F	30°	23'	57.53"S	30°	40'	15.85"E
	G	30°	23'	55.12"S	30°	40'	16.76"E
	H	30°	23'	54.45"S	30°	40'	14.40"E
	I	30°	23'	53.43"S	30°	40'	12.51"E
	J	30°	23'	51.92"S	30°	40'	10.99"E
	K	30°	23'	51.83"S	30°	40'	8.79"E
	L	30°	23'	50.22"S	30°	40'	9.71"E
	M	30°	23'	48.67"S	30°	40'	8.72"E
	N	30°	23'	47.26"S	30°	40'	9.15"E
	O	30°	23'	45.25"S	30°	40'	8.36"E
	P	30°	23'	45.50"S	30°	40'	6.74"E
	Q	30°	23'	44.61"S	30°	40'	6.49"E
	R	30°	23'	43.99"S	30°	40'	5.87"E
	S	30°	23'	40.94"S	30°	40'	5.51"E
	T	30°	23'	40.83"S	30°	40'	4.53"E
	U	30°	23'	42.43"S	30°	40'	2.77"E
	V	30°	23'	41.42"S	30°	40'	1.08"E
	W	30°	23'	43.14"S	30°	40'	0.51"E
	X	30°	23'	46.83"S	30°	40'	1.71"E
	Y	30°	23'	48.16"S	30°	40'	59.01"E
	Z	30°	23'	50.63"S	30°	40'	59.37"E
	AA	30°	23'	52.95"S	30°	40'	0.66"E
	BB	30°	23'	53.00"S	30°	40'	58.81"E
	CC	30°	23'	55.38"S	30°	40'	56.55"E
	DD	30°	23'	58.12"S	30°	40'	55.90"E
	EE	30°	23'	59.18"S	30°	40'	57.96"E
	FF	30°	23'	59.96"S	30°	40'	57.96"E

This report serves as a basis for the application to remove the ash from the definition of waste as per the NEM:WA legal requirement. It is compiled as the basis for the risk assessment and the risk management plan to beneficiate various waste streams. This report focuses on managing the composite boiler ash waste stream as a beneficiated product.
This report fulfils the requirements as set out in the legislative framework given in Section 2 below.

2. LEGISLATIVE FRAMEWORK

2.1. Acts:

- The Constitution of the Republic of South Africa, Act 108 of 1996.
- National Environmental Management Act (NEMA): Act No 107, 1998. 27 November 1998. (NEMA)
- National Environmental Management: Waste Act. (NEM:WA) No. 59 of 2008.
- The National Environmental Management: Waste Amendment Act (NEM:WAA), 2014 (Act No 26 of 2014).
- National Environmental Management: Waste Act (59/2008): National Waste Management Strategy, 2020 (NWMS).
- National Road Traffic Act (RTA), No. 93 of 1996.
- Occupational Health and Safety Act (OHSA) no: 85 of 1993.

2.2. National Norms and Standards. Listed Activities and other relevant documents

- NEM:WA Regulation 331 National Norms and Standards for the Remediation of Contaminated Land and Soil Quality. 2013
- The Framework for the Management of Contaminated Land, Department of Environmental Affairs (DEA), May 2010
- National Norms and Standards for the Storage of Waste. 2013.
- NEM:WA (Act 59 of 2008) Government Notices (23 August 2013):
    - R.634 Waste classification and Management Regulations
    - R.635 National norms and standards for the assessment of waste for landfill disposal
    - R.636 National norms and standards for disposal of waste to landfill
- National Environmental Management: Waste Act (59/2008): Regulations regarding the exclusion of a waste stream or a portion of a waste stream from the definition of waste (18 July 2018)
- **SANS 10234 (2019)(2nd ed):** Globally Harmonized System (GHS) of Classification and Labelling of Chemicals
- **GHS:** UN Standards Purple Book 9th ed

3. ILLOVO SEZELA SUGAR MILL CONTACT DETAILS

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4. ILLOVO INTEGRATED MANAGEMENT SYSTEM

As part of the mill operations, the Illovo Integrated Management System which includes the SHERQ Management Systems has been adopted for best practice in the industry and is adhered to by all its sugar mills. In relation to environmental responsibility, the following is an extract from Illovo's Code of Conduct and Business Ethics (see Attachment 1: Illovo Group Code of Conduct and Business Ethics).

4.1. Environmental management

Excerpts from the Illovo Group Environmental Management document are given as follows:

- Illovo supports and encourages operating, manufacturing, farming and agricultural practices and production systems that are sustainable.
- As an environmentally sensitive business, Illovo supports a precautionary approach to environmental challenges and is committed to promoting environmental responsibility and encouraging the development and diffusion of environmentally friendly technologies in our operations.
- Suppliers should adopt a precautionary approach to environmental challenges and continually strive towards improving the efficiency and sustainability of their operations, including water conservation programmes, initiatives to promote greater environmental responsibility and encourage the development and diffusion of environmentally friendly technologies.
- The following aspects of environmental management will be included in the assessments of Suppliers:-
    - they should be aware of, and be able to demonstrate compliance with all current environmental legislation that may affect their activities;
    - they should conduct an environmental review of all aspects of their products and services.
- Any enforcement, improvement or prohibition notices served on a Supplier within the last three years by any competent authority must be disclosed and will be reviewed.

Illovo has developed its own Integrated Risk Management System (IIRMS) to ensure that the standards to which the business conforms are unified under a single platform, guiding and measuring compliance.

IIRMS guidelines have been developed from best practices in the Illovo Group, and from best practice in their industry where necessary. IIRMS assists in the management of environmental risks at Illovo and ensures that these standards are implemented by the whole group.
Many of the Illovo Group sugar factories already operate to high environmental standards through a circular economy model where outputs such as molasses, vinasse, condensed molasses solids (CMS), bagasse, bagash/boiler ash, and filter cake are turned into co-products; such as energy feedstock, fertiliser, soil conditioning nematodes and bioethanol. This is aligned to the circular economy, meaning that, as much as possible, we eliminate waste, and re-use resources, putting them back into the process.

5. FACILITY WASTE GENERATING PROCESS

Refer to Figure 4: Sezela Process Flow. This illustrates the overall process flow diagram of the mill to produce sugar and the accompanying waste streams: bagasse, filter cake and ash. It must be noted that for the purpose of this report and the application for waste exclusion of ash from the definition of waste, a brief overview of the main processes that generate the waste streams have been discussed below.

5.1. Brief overview

The purpose of this section is to satisfy the legal requirement for the description of the components that make up the ash waste stream.

5.2. Waste stream - boiler ash

1. The generation of the ash waste stream is described in greater detail in section 5.5: steam and power generation. Briefly; Pea coal and some excess bagasse is burnt in 4 boilers to generate energy for electricity and steam generation. Most of the boiler fuel is coal. The fine ash from the stacks, collected by water wet scrubber and the bottom ash are combined and quenched. The resultant ash slurry is transferred to a dirty water ash storage dam. The Ash Dam is a water recovery dam that allows residence time for the ash sediment from the ash slurry to settle out. The overflow from this dam is sent to a Clean Water dam and returned back into the system for use. The ash remaining in the Dirty Water Dam is estimated to consist of 1,2 million m^3 of ash. The dam wall height is being reached by the settled ash and hence the need to source avenues to beneficiate the waste. This dam has already experienced a failure in the past. (ref: White, J., Bowes, C., Sinovuyo, M., March 2017. Version 1.0. p 5).

Boiler ash is the waste stream relevant to this waste exclusion application, as the proposal for beneficiating use is for:

- blockmaking by:
    - the local community for empowering them for business opportunities and for employment of others, as well as
    - commercial blockmaking for employment opportunities within the area,
- the construction industry: uses in concrete to replace sand and other appropriate uses,

- soil enhancement/fertilizer.

5.3. Process description to produce sugar

Refer to Attachment 3: Sezela Mill Process Description.docx

The following section briefly describes the sugar milling processes to produce raw sugar. The purpose of this section is to given an overall viewpoint of the process to show the inputs into the process to show where and how the various waste streams are generated. The boiler ash produced has various waste streams indirectly added to its generation due to the quench water and the scrubber water streams. These water streams are affected by the production process due to the closed water loop system used at Sezela Mill production process. Details too are included due to the need to show the various economic activities affected by the sugar milling process, illustrating the importance of the need for this waste stream to be beneficiated.

Refer to Figure 4: Sezela Process Flow. The following is the process description obtained from the Sezela Sugar Mill directly. Refer to Attachment 3: Sezela Mill Process Description.docx, for a full description of the process.

5.3.1. Delivery

Sugar cane comes in from the growers by vehicle. The majority of the growers make use of contract haulers while some of the large commercial growers haul their own cane.

The vehicles cross into the mill over a weigh bridge where they are check weighed and logged through the cane procurement system. The vehicles are weighed on the way out, after dropping off their cane and the difference in the in and out weights is the amount of cane delivered.

On entering the mill the vehicles may be off loaded by Hilo unloader cranes onto spiller tables.

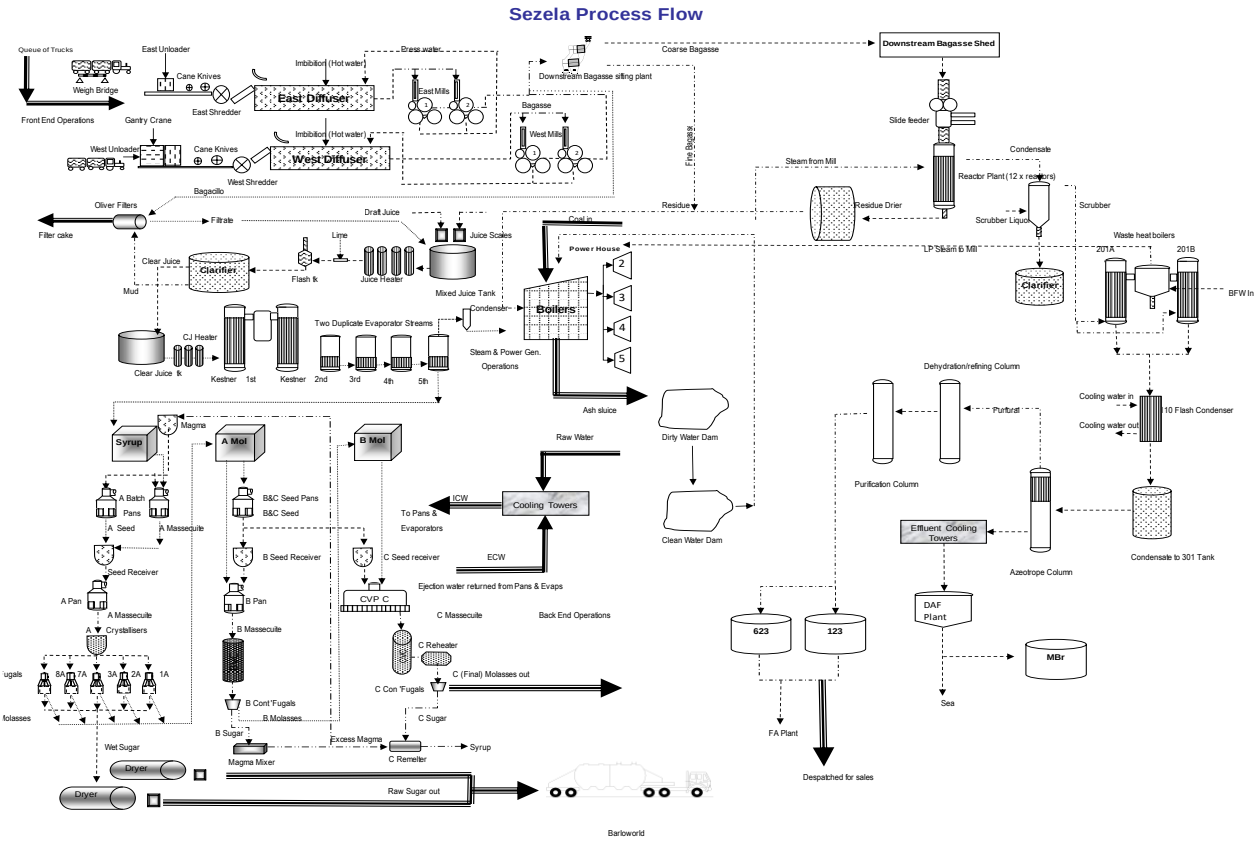

Figure 4: Sezela Process Flow.

5.3.2. Juice Extraction

There are 4 conveyors between the spiller table and the Diffuser.

The third conveyor is a metal slat conveyor and conveys the cane from the "Cane preparation" section where the cane is among others:

- chopped up into manageable pieces,
- then shredded.
- The "Shredder has a series of hammers, which flatten the cane to expose the cells in the cane for the diffusion process.
- From the third carrier the cane drops down again onto the fourth carrier which feeds cane evenly across the diffuser inlet.

The diffuser is a long steel housing. It has a chain and slat conveyor inside which carries the cane through the diffusion process:

- The diffuser is like a:
    - multi stage percolator with hot water passing through the prepared cane bed in each stage and
    - extractes the sucrose from the cane fibre.

The pulp leaving the diffuser is now known as "Bagasse". The bagasse passes from the diffuser to dewatering mills. Approximately 60% of the bagasse passes through the first mill with the remaining 40% through the second mill. The mill presses the water out which is called "press water" which is collected and sent back to the diffuser.

The bagasse conveyors carry the bagasse downstream where it is processed in the reactors for Furfural production. The processed bagasse exiting the reactors is called "Residue" and this is then transported via conveyors to the boilers and the excess is rejected and stored in the Bagasse/Residue shed.

5.3.3. Raw Sugar Process

The juice exiting the diffusers which requires further processing is pumped to the mixed juice tank. From the mixed juice tank the juice passes through heaters and then clarifiers to remove the ash and mud from the mixed juice. Clarification is done by heating the juice, adding:

- heat,
- Milk-of-lime,
- Flocculant,
- Allowing the resulting mud (Miala) to settle out in large decanting vessels called Clarifiers.

The clear juice, now free of mud is returned to the process. The thin, clear juice is then concentrated into a heavy syrup in evaporators.

Sugar is made in Vacuum Pans, with molasses as a useful by-product .

Sezela produces approximately 85,000 tons of molasses per season and approximately 225,000 tons of Raw Sugar per season.

Figure 4: Sezela Process Flow, is a useful reference to illustrate the potential inputs into the waste ash stream due to the water feeding back into the system. The quenching of the ash stream and the water being used as water scrubber for the flue gas exposes the ash to the process streams.

The following section briefly describing the downstream processes also gives an indication of the exposure that ash has in this process.

5.4. Downstream products Process.

A portion of the bagasse leaving the cane sugar juice extraction process is used in the ‘Downstream products process’. The remaining portion is sent for use as fuel in steam and power generation. The bagasse entering the Downstream process is separated into coarse and fine fractions. The coarse fraction is processed further and the fine fraction is sent for use as fuel in steam and power generation.

The coarse fraction of the bagasse is fed into one of several reactors where steam is introduced. This process extracts Furfural from the bagasse. The ‘cooked’ bagasse is discharged as bagasse residue which is returned for use as fuel in steam and power generation.

5.5. Steam and power generation

Bagasse, bagasse residue and coal are used as fuel sources in the steam generation plant which consists of four boilers:

- Boiler 1 is fuelled with bagasse only,
- boilers 2, 3, 4 use mixed fuel. :

Approximately:

- 640,000 tons of bagasse and
- 40000 tons of coal are burnt

per 38 week season (3-year average).

- Boiler ash generation: approximately 100 tons per day, based on a 1 day sample.

5.6. Downstream processing Furfural production

The Furfural Plant production season is directly linked to the Sezela Sugar Mill, refer to Figure 5: Furfural Plant process flow, to follow the waste streams used and generated from this process.

FURFURAL PLANT FLOW DIAGRAM

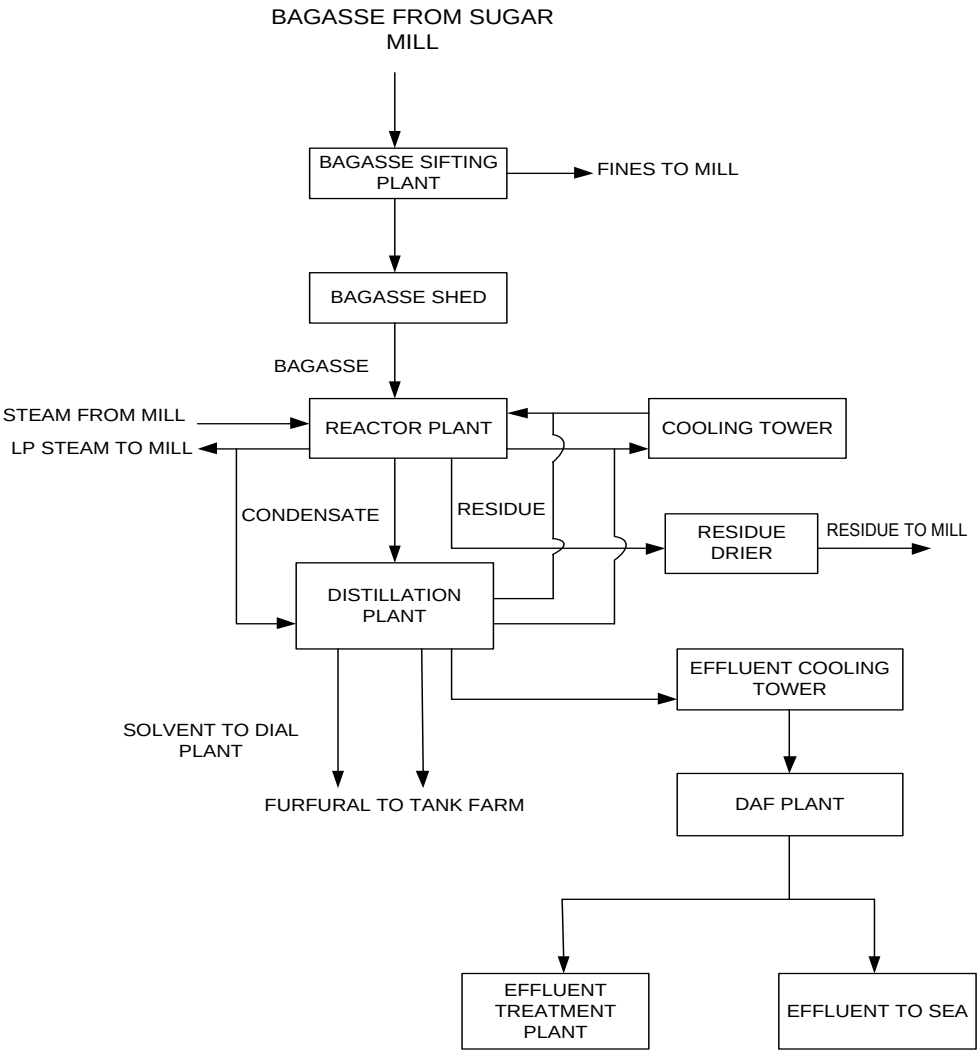

Figure 5: Furfural Plant process flow

Bagasse is received from the Sezela Sugar Mill. It is then sifted in the Sifting Plant and seperated into:.

- Coarse bagasse which is conveyed to the Reactor Plant where the furfural manufacturing process begins.
- fine bagasse - which is returned to the Mill
- excess bagasse is conveyed from the reactors to the bagasse shed.

Bagasse is fed into the reactors through various feeders and processes. These are pressurised with steam, a chemical reaction takes place in the bagasse and furfural is produced. The spent bagasse is discharged from the base of the reactor as residue. The furfural leaves the reactors in a steam/vapour phase which then enters the scrubbers.

The furfural rich vapour from the reactors carries over small particles of bagasse and waxes. These are removed in scrubbers as the vapour passes through the scrubber liquor. The scrubber liquor has three main sources;

- cooling tower blow down,
- raw water (used in emergency situations) and
- process recycle liquor.
    - This liquor is the cleaned effluent from the Dissolved Air Flotation (DAF) Plant.

The solids in a slurry are discharged from the bottom of the scrubbers to the clarifier.

5.7. Waste and Effluent streams

5.7.1. Ash

Has been described in the previous sections 5.2 Waste stream - boiler ash, and section 5.5 Steam and power generation.

5.7.2. Filter cake

Solid waste from the cane juice clarifier is sent to the Oliver mud filters and the waste after the Oliver filters is called filter cake.

5.7.3. Liquid effluent

Refer to Figure 6a: Google Earth screen shot from the WULA showing the main features of the effluent treatment plant, and Figure 6b: Sezela Mill effluent treatment plant, show the details and location of the features for liquid treatment as given in the following sections.

.

Water from the factory is let down to dams via different processes depending on it's type and after filtration is used for cooling and "Scrubbing" of boiler flue gasses. Very little water is used as 70% of the cane is water.

The Sezela Waste Water Recovery Plant consists of two Waste Water Treatment Plants which are separate, the Effluent Treatment Plant (ETP) and a Membrane Bio-Reactor (MBR).

5.7.3.1. Effluent Treatment Plant (ETP)

The ETP is a conventional activated sludge Plant (CAS). It accepts effluent that emanates from site plant:

- wash downs,
- sewage and
- storm water.

The ETP receives waste water from six different sources around the Sezela Complex. These are the:

- North Outfall which is situated on the North side of the Sugar Mill's molasses tank, the
- Stores Sump which is located near the Main Stores on the North side of the East Diffuser,
- the Boilers Sump along the main factory road near Boiler 4,
- New East Drain situated at the bottom of an embankment below the Downstream Boilershop.
    - The East drain is a collection point for the Furfural plant:

        - washing,
        - filtration plant washing,
        - cooling tower,
        - the Boilers emergency dam and
        - storm water from all these areas.
- the 50 ton tank collects effluent streams from the:
    - FA Plant and
    - Diketones Plant and finally
- sewage from the village.

The effluent activated sludge treatment plant clarifier allows the activated sludge to settle out of the mixed liquor. Clear treated effluent water (final effluent) is recovered from the top of the clarifier. The final effluent is either discharged to the Maturation River or directly to the final effluent pump station which will transfer it to one or more of its destinations i.e. the Boilers for use in the scrubbers or to sea.

- During the season the final effluent is pumped to the Sugar Mill Boilers to be used as scrubber water for the boiler stacks.
- During off-crop the final effluent is pumped to the sea.

5.7.4. Membrane Bio-Reactor (MBR)

The MBR is a modern activated sludge plant capable of treating higher COD (Chemical Oxygen Demand) effluents. It is dedicated to the treatment of the:

- Furfural Plant Effluent from the Azeotrope column via Effluent Cooling Towers and
- the DAF Plant.

The MBR is a biological Activated Sludge Treatment Plant built to treat Acid Water from the Furfural Plant Effluent which is currently being discharged to the sea under the licence issued from DEA — Oceans and Coast. The treated effluent is pumped to sea during off-crop and in season joins final effluent to the mill.

Sezela has 2 raw water supply dams and a boiler scrubber water recovery dam system which catches the solids and passes the clear water on to the clear water dam. Clear water dam is a holding dam from where water is fed back to the factory for reuse in the boiler scrubber system.

The effluent plant discharge water is fed into the Boiler scrubber water recovery system. Figure 6a: Google Earth screen shot from the WULA showing the main features of the effluent treatment plant, and Figure 6b: Sezela Mill effluent treatment plant, show the details and location of the features for treatment as given above.

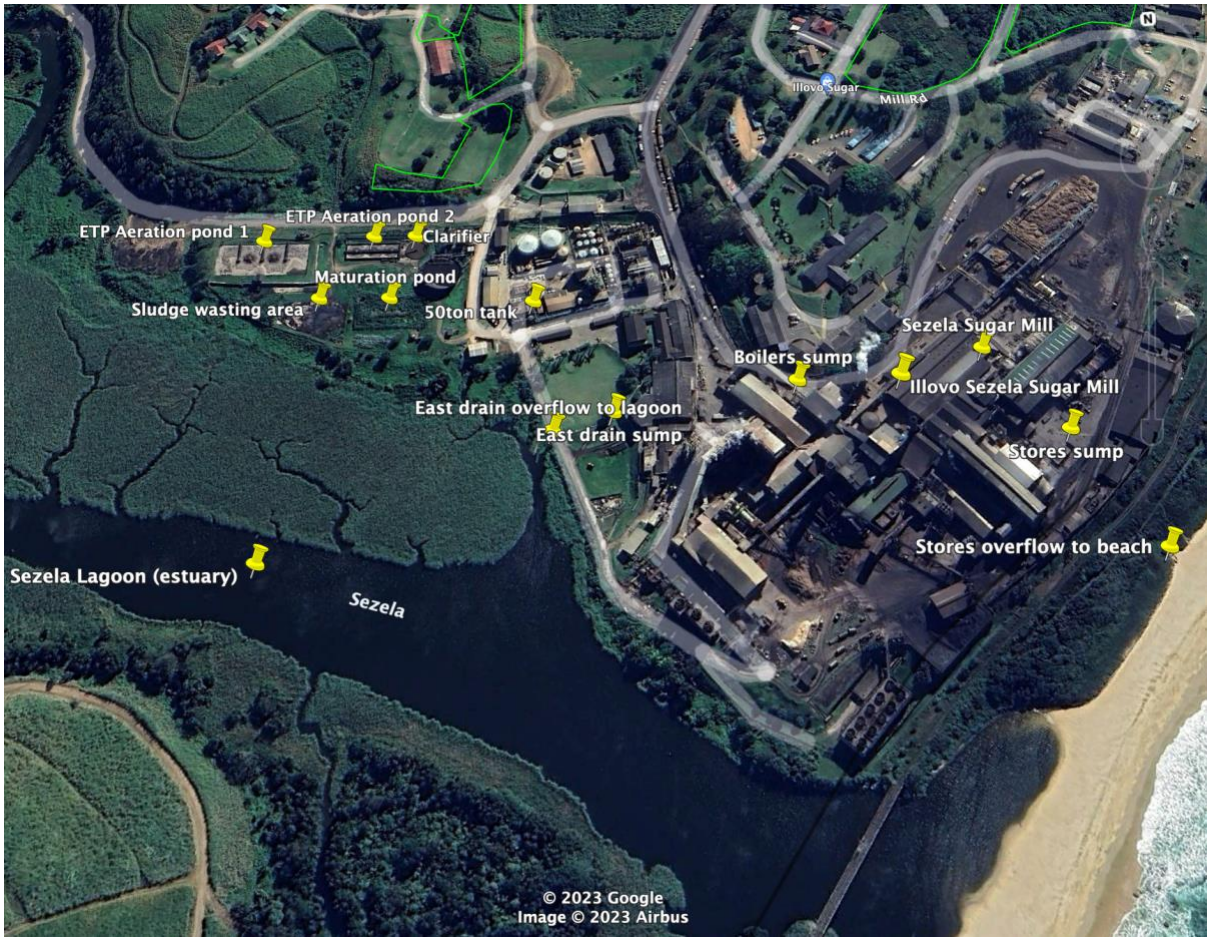

Figure 6a: Google Earth screen shot from the WULA showing the main features of the effluent treatment plant

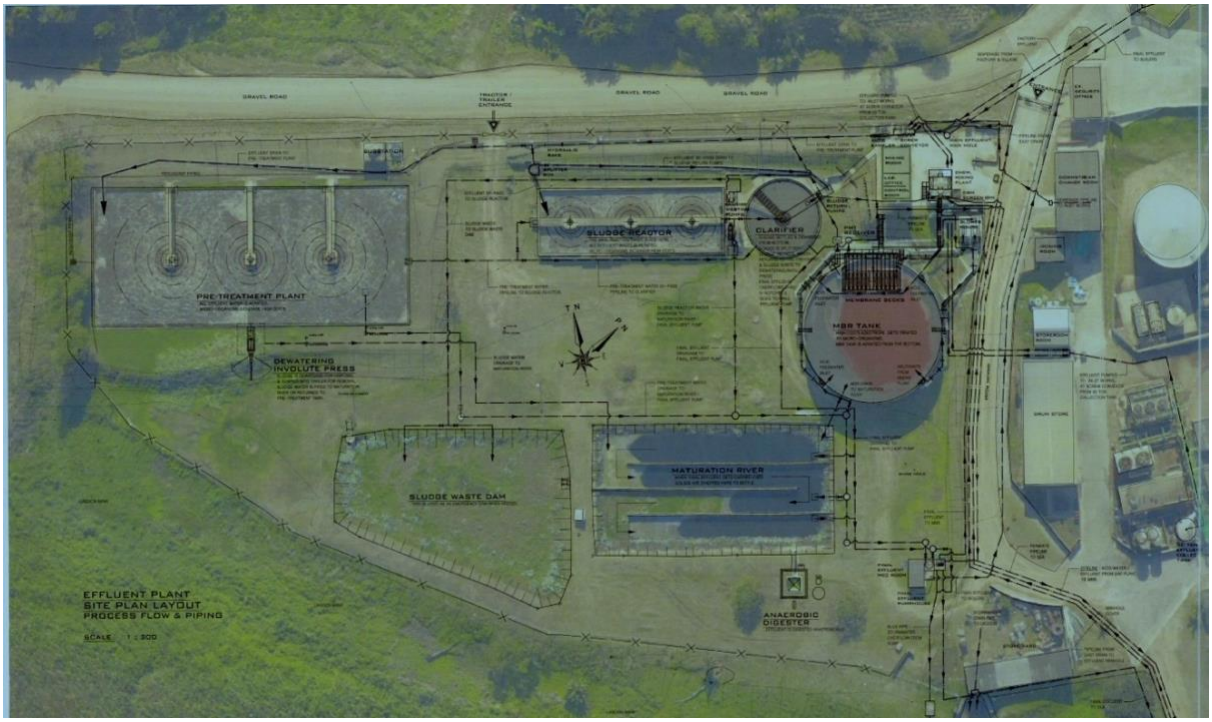

Figure 6b: Sezela Mill effluent treatment plant showing the different processing plants.

6. WASTE STREAM - ASH

6.1. Ash uses

The following citation is a reflection of the source of bottom and the uses thereof, from Singh, M., Siddique, R., March 2013. (Website: https://www.sciencedirect.com/science/article/abs/pii/S0921344912002200.)

"Coal bottom ash (CBA) is formed in coal furnaces. It is made from agglomerated ash particles that are too large to be carried in the flue gases and fall through open grates to an ash hopper at the bottom of the furnace. Bottom ash is mainly comprised of fused coarser ash particles. These particles are quite porous and look like volcanic lava. Bottom ash forms up to 25% of the total ash while the fly ash forms the remaining 75%. One of the most common uses for bottom ash is as structural fill.

Published literature shown that there is a strongly possibility of coal bottom ash being used as substitute/replacement of fine aggregate (sand). Its use in concrete becomes more significant and important in view of the fact that sources of natural sand as fine aggregates are getting depleted gradually, and it is of prime importance that substitute of sand be explored."

"Bottom ash has the appearance and particle size distribution similar to that of natural fine aggregate i.e. river sand. Because of these properties it attracted to be used as sand replacement in concrete. Recently research works have been focused on usage of bottom ash as partial sand replacement in concrete. The published research data indicate that bottom ash is a viable material as sand replacement in concrete. Therefore its suitability as sand replacement material in concrete and the ways in which bottom ash affects the fresh, hardened as well as durability properties of concrete has been critically evaluated in this review.

Bottom ash can be beneficially utilized in a variety of manufacturing and construction applications. At present in America, coal bottom ash is predominantly used for the following applications:

- Road base and sub-base
- Structural fill
- Backfill
- Drainage media
- Aggregate for concrete, asphalt and masonry
- Abrasives/traction
- Manufactured soil products

Published literature shown that there is a strongly possibility of coal bottom ash being used as substitute/replacement of fine aggregate (sand). Its use in concrete becomes more significant and important in view of the fact that sources of natural sand as fine aggregates are getting depleted gradually, and it is of prime importance that substitute of sand be explored."

The use of fly ash also has a multitude of uses, described in a number of research papers. The following citation from the website: https://civilwale.com/fly-

ash/#:~:text=Fly%20ash%20is%20also%20used%20for%20embankment%20construction%2C%20it%20has,of%20fly%20ash%20in%20embankments. The different uses are given for construction purposes as a specific portland cement, clay bricks, as a few examples of many available.

The key factors would be their chemical, physical and mechanical properties to determine their use. For the purposes of this report, the focus would be on the use that would not impact the environment by exposure to soils, surface and ground water by possible long term leaching potential.

6.2. Waste recipients

- Poor socio economically, historically disadvantaged individuals, particularly the low income and no income groups.
- Construction companies,
- Farmers and nurseries for soil beneficiation.

6.3. Waste generated

Ash: +- 100 000kg per day (should be more than this – based on 1 day sample)
Filter cake:

- Tons cane crushed 2022: 1 457 766 tons,
- 2000 tons per month

Sludge: 45tons/day (15000tons per annum – desludging is done annually) from sludge dam.

6.4. Waste Removed

Ash: The intention is to use all waste generated to divert from landfill.
Filter Cake: +- 25 tons per day during season
Sludge: The intention is to use all waste generated to divert from landfill.

7. CONSEQUENCES OF NOT RECYCLING OR REUSING THE ASH PRODUCED

The only recourse for ash if it is not reused or recycled is to store in the ash dam. However, this is filling up to wall height capacity, hence the ash must eventually be disposed of to landfill. Refer to the photographs in figures 2b Photos of the ash dam from different locations showing the dirty dam and the clear water dam. These show the current status of the dirty water dam where the ash slurry is collected and ash is dewatered. The ash has been accumulating for about 15 years. This practice is not sustainable and eventually the dewatered ash will need to be landfilled.
Landfilling is the option chosen by many to dispose of waste as the most convenient option. Unfortunately landfilling as a waste management practice contributes to high airspace use. This leads to very costly sourcing and development requirement for more landfill space. So, in line with the NEM:WA: National Waste Management Strategy (NWMS - 2020); the focus is on amongst others to divert waste from landfilling and to implement the circular economy principles to beneficiate the waste as a resource in a safe and responsible manner.

Should the ash not be permitted to be used for blockmaking or in concrete construction products:

- That percentage which is used to make up the materials for the concrete formulation:
    - Sand + ash + cement + water, where the ash replaces the sand used by a convenient percentage, becomes
    - Sand + cement + water.

    - Referring to the need for sand in the development requirements of our communities the impacts of traditional sand sources was undertaken in a 2008 study by the CSIR. They found that 12 large dams on major rivers around eThekwini trapped at least one third of normal river sand flow. Sand supply had been reduced by a further 33 percent by more than 30 sand mining operations on eThekwini's rivers. This study calculated that sand miners removed at least 400 000m3 of sand in 2008 alone, whereas the current natural replenishment was around 140 000m3 a year. The CSIR study raised concerns that some beaches south of Durban had been retreating at a rate of almost 1m a year since the early 1970s. (White, J., Bowes, C., Sinovuyo, M., March 2017. Version 1.0.). Thus, if the ash were not made available, the need would be for the sand, with the briefly mentioned impacts on the environment and eventually on the communities that rely on a healthy river system to get food by catching fish or other sources of food.

- Opportunities to earn an income for those with no or low income:
    - youth,
    - women and
    - entrepreneurs in general

- The Umvoti area has very high unemployment particularly among the youth. The intended users which would be towards the youth of this waste stream require the ash to create income generating opportunities for themselves at no cost to themselves. Only the cost of the other materials including less sand required. Hence if this waste stream is not allowed to be beneficiated, the opportunities may be lost due to the cost of buying the extra sand, and income generation would be missed. This would lead to other means of income in the underdeveloped area to be sourced, by redirecting the unemployed from the potential to give them dignity to earn income themselves with honest labour towards committing crime.
- The requirement would be for more sand from the river sand mining source. The ash does also add to the chemical makeup of the concrete medium.
- The requirement of Sezela Sugar Mill to dispose of the ash to a permitted and properly managed landfill site costs the company in terms of:
    - Landfilling fees; unless there is no charge for potential cover material,
    - Fuel which is changing and generally increasing monthly in 2023,
    - Driver salaries,
    - Truck fees and maintenance.
    - Possible greater distances to be covered due to the need to dispose to a properly managed and licenced landfill site.

7.1. Benefits of reuse and recycling

7.1.1. Intended use of ash

The ash use considered:

- as a medium to replace some sand to include into the sand (+ ash), cement and water mix to make concrete blocks.
- to include into the construction projects to replace some sand in the concrete mix to construct structures.
- To be used in places where there will be no impact on the health of humans in residential areas, on the aquatic environment, and the environment.
- As a soil enhancer either directly or as a mix with organic waste such as filter cake or sugar mill sludge.

7.1.2. Benefits of Reuse and recycling

The benefits of reusing and recycling the ash aligns with the objectives of the South African National Waste Management Strategy (NWMS) - 2020 and are also aligned with the Sustainable Development Goals (SDG) 2030. Examples of the relevant SDG's:

- **SDG 3**: To avoid/minimize waste related environmental factors that prevent ill-health and disease.
- **SDG 8**: Promoting the waste management sector as a key contributor to overall economic growth and development.
- **SDG 9**: Use of natural resources to improve people's standard of living without damaging the environment.
- **SDG 12**: Through: ensuring production patterns, implementing initiative that reduce waste, promote re-cycling, re-use.

The NWMS 2020 strategy is directing South Africa to a future with zero waste in landfills. This will be achieved through eight strategic goals, two of which are relevant for this report namely:

- **Goal 1:** Promote waste minimisation, re-use, recycling and recovery of waste. Focuses on implementing the waste management hierarchy, and with the ultimate aim of diverting waste from landfill.
- **Goal 8:** Establish effective compliance with and enforcement of the Waste Act. Ensures that everyone adheres to the regulatory requirements for waste management, and builds a culture of compliance.

The re-use of the ash benefits:

- Sezela Sugar Mill by the cost savings of diverting these waste streams from landfilling.
- It promotes independence within the disadvantaged community by being able to generate an income by making concrete blocks,
    - to sell to their community and,
    - also enabling them to employ people within the community.
- Business creation and thus job creation because of the benefits derived from greater economic activity in the area.

- Replacement of sand with a renewable resource: ash in their blockmaking businesses.
- Ash contributes to desired effects on the concrete characteristics through the chemical nature by adding to the physical, and mechanical nature of the item being made.
- Growth and development potential within the Umvoti area realised.
- Supporting businesses would then be supported and thrive,
- increased income base for the municipality to develop infrastructure and services within the area.
- Replacing some of the sand that is used in concrete mixture, thus ultimately benefitting the environment and community over a broad spectrum of activities directly on downstream in the marine environment.

By correct management of the waste, the potentially hazardous components will be managed to minimize any hazards presented.

To be able to benefit from this opportunity, the ash will need to be characterised to understand the chemical and physical nature of the waste stream. It is then assessed for landfilling using the standard criteria and classified by Globally Harmonised Standards (GHS) aligned to the United Nations standard for health and environmental risk. understanding these characteristics of the ash will help to minimise the risk for use for the purpose of making concrete blocks and use. The following section describes this process and the results describe the nature of the waste.

8. METHODOLOGY USED TO ASSESS THE CHEMICAL/HAZARDOUS NATURE OF THE WASTE TO BE EXCLUDED.

8.1. Rationale

Research work has been done for the use of the various ashes within the civils and building industry. There are promising results that this may be successful with proper understanding of the chemical makeup of the ash. This section focuses on the chemical makeup of the ash pre-beneficiation and the potential hazards and risks on health and the environment together with any possible physical risk these pose in its proposed application.

The perception by some stakeholders is that ash is a hazardous waste and needs to be rejected outright from beneficial use. To be able to properly address the perception, measures must be put in place on how it is to be managed. The risk assessment and a risk management plan can be formulated to minimise any harm to people and the environment.

8.2. Characterisation of the waste ash

The waste sample taken at the ISSM on 17/10/2022, was received at Talbot and Talbot accredited laboratories on 20/10/2022, and testing commenced on the same day. It was tested using the **NEM:WA Norms and standards Regulations** for assessment and classification of waste. See:

- Attachment 2a: Certificate of Analysis,
- Attachment 2b: Waste Assessment and Classification, and

- Attachment 2c: Safety Data Sheet - SDS.

This gives:

- the chemical composition from a prescribed list,
- the assessment of the waste for
  - waste type
  - the landfill class
- the GHS classification for any hazards from
  - the physical nature of the waste with any risks associated with it,
  - any risk to health, and
  - any risk to the environment.

The second approach is to determine the hazard thresholds of the chemicals in soils and hence the effect on the environment and the health of the community. The following was used:

- **The Framework for Contaminated Land Rehabilitation (DEA- May 2010) guideline** was used, and compared with the Total Concentration values (TC) obtained as well as the Leachable Concentration (LC) results from the laboratory analyses obtained.

The ash is then managed appropriately using the mitigation/management provided from the identified risks.

8.3. Results

Note: refer to:

- Attachment 2a: Certificate of Analysis,
- Attachment 2b: Waste Assessment and Classification, and
- Attachment 2c: Safety Data Sheet - SDS.

for the full details of the analyses and assessments.

8.3.1. Waste assessment to landfill

- GN 636 S5(1)(q)(ii): Current Prohibition/Restriction from Disposal: None.
- GN R636 S5 (1)(r)(iv): Future Prohibition/Restriction from Disposal: None.
- GN R635 S7, the waste is chemically assessed as a Type 3 waste, which is Low risk. Class C Landfill (GLB+).

Table 2: Preliminary and chemical assessment for prohibitions and restrictions, waste type and landfill class.

GN R634 A1.2(a)	Listed General Waste	None identified
GN R634 A1.2(b)	Listed Hazardous Waste	None identified
GN R636 (5)	Disposal Prohibitions, Restrictions	None identified.
GN R636 (5)	Future Prohibitions, Restrictions	None identified.

GN R634	Overall Waste Disposal to Landfill	**Type 3 Waste Class C Landfill (GLB+)**. Low risk
GN R635 (7)	Waste Type (Chemistry only)	Type 3 Waste
GN R636 (4)(1)	Landfill Class (Chemistry only)	Class C Landfill (GLB+)

8.4. Globally harmonised system (GHS) classification

8.4.1. Relevant use/s of the mixture and restriction on use.

Intended use/s: disposal.

Uses advised against: WASTE: if a commercial product residue, not intended for original use. KEEP AWAY FROM clothing. DO NOT eat, drink or smoke when using this product. AVOID release to the environment. Collect spillage.

8.4.2. Hazards identification.

Table 3: Summary of ash GHS hazard classification

Classification in accordance with SANS 10234:2019:		
Physical		Not classified
Health:	H315: Cat 2: Skin irritation.	Causes skin irritation
	H318: Cat 1: Serious eye damage	Causes serious eye damage
	H334 Cat 1: Respiratory Sensitization	May cause allergy or asthma symptoms or breathing difficulties if inhaled
Environment		Not classified
Overall classification:		**HAZARDOUS - HEALTH**

NOTE: from the SDS (refer to Section 8.3 below):

- **Physical Hazards:** No applicable waste constituent, characteristic, property, or hazard was identified.
- **Health Hazards:** H315, Category 2, by means of Cut-off value(s) exceeded by additivity method. European Chemicals Agency (ECHA), CLP Classification for CaO (0.83%), European Chemicals Agency (ECHA), CLP Classification for K2O (0.50%), Sigma Aldrich MSDS for P2O5 (0.11%), PubChem MSDS for Na2O (0.51%) H318, Category 1, by means of Cut-off value(s) exceeded by additivity method. European Chemicals Agency (ECHA), CLP Classification for CaO (0.83%), European Chemicals Agency (ECHA), CLP Classification for K2O (0.50%), Sigma Aldrich MSDS for P2O5 (0.11%), PubChem MSDS for Na2O (0.51%) H334, Category 1, by means of Existing hazard classification. Based on client (Sezela Sugar Mill) provided information.
- **Environmental Hazards:** No applicable waste constituent, characteristic, property, or hazard was identified.

8.4.3. Hazards not otherwise classified:

In the event that the waste is utilised in a manner that results in significant dust generation, potential health hazards may arise from dust exposure via inhalation.

Inhalation (acute): Inhalation of dust may cause irritation to the respiratory tract and/or chest pain.
Inhalation (chronic): Repeated inhalation of dust containing respirable crystalline silica is associated with silicosis, lung cancer and autoimmune disorders. Long term exposure to aluminium oxide dust can lead to lung damage, long term exposure to iron oxide dust can lead to pneumoconiosis (siderosis) and long term exposure to titanium oxide dust can cause lung fibrosis (potential occupational carcinogen).

8.4.4. Composition or information on ingredients in ash

Table 4: Composition of ash.

Ingredient(s) - Metal oxides	**[C/I/SA] %**	**GHS Classification (Regulation)**
Mixture	100%	H334
Silicon dioxide (SiO_2). -	50,57%[NS]	-
Aluminium oxide (Al_2O_3). -	6,84%[NS]	-
Calcium oxide (CaO). -	0,83%[NS]	H315 H318
Chromium oxide (Cr_2O_3)	0,12%[NS)	-
Iron oxide (Fe_2O_3). -	3,38%[NS]	-
Potassium oxide (K_2O). -	0,50%[NS]	H315 H318
Magnesium oxide (MgO). - Sodium Oxide (Na2O). -	0.40%[NS]	-
Phosphorous pentoxide (P_2O_5). -	0,51%	H315 H318
Titanium dioxide (TiO_2). -	0,11%	H315 H318
	0,38%[NS]	-

Notes to above table: [C] Constituent component; [I] Impurity; [SA] Stabilising Additive; [NS] Not Specified; [O]

8.4.5. Precautionary measures

Prevention:

- KEEP AWAY FROM clothing.
- AVOID breathing dust, fume, gas, mist, vapours, spray.
- DO NOT get in eyes, on skin, or on clothing.
- Wash skin thoroughly after handling.
- DO NOT eat, drink or smoke when using this product.
- AVOID release to the environment.

Responses:

- IMMEDIATELY call a POISON CENTRE or doctor / physician.
- Get medical advice / attention if you feel unwell.
- Fight fire with normal precautions from a reasonable distance.
- Collect spillage.
- IF SWALLOWED: Call a POISON CENTRE or doctor/physician if you feel unwell.
- IF ON SKIN: Wash with plenty of water.
- IF INHALED: Call a POISON CENTRE or doctor/physician if you feel unwell.
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- If exposed or concerned: Call a POISON CENTRE or doctor/physician.
- Take off contaminated clothing and wash it before reuse.

Disposal

Dispose of contents/container to an approved facility in accordance with all applicable regulations and landfill requirements per the safety data sheet's Section 13.

8.4.6. First-aid measures

- **Immediate actions:** IMMEDIATELY call a POISON CENTRE or doctor / physician. If exposed or concerned: Call a POISON CENTRE or doctor/physician.
- **Actions to be avoided:** DO NOT eat, drink or smoke when using this product. AVOID release to the environment.

- **Inhalation:** AVOID breathing dust, fume, gas, mist, vapours, spray. IF INHALED: Call a POISON CENTRE or doctor/physician if you feel unwell. Take off contaminated clothing and wash it before reuse.
- **Skin Contact:** KEEP AWAY FROM clothing. DO NOT get in eyes, on skin, or on clothing. Wash skin thoroughly after handling. IF ON SKIN: Wash with plenty of water.
- **Eye Contact:** DO NOT get in eyes, on skin, or on clothing. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- **Ingestion:** DO NOT get in eyes, on skin, or on clothing. IF SWALLOWED: Call a POISON CENTRE or doctor /physician if you feel unwell.

Anticipated effects and symptoms summaries:

- **Acute effects:** On contact is expected to cause skin irritation and serious eye damage. Inhalation of dust may cause irritation to the respiratory tract.
- **Delayed effects**: Repeated exposure to dust can result in lung damage or disease.

Protection of first-aiders and notes for attending physicians

- **Physician notes:** Get medical advice / attention if you feel unwell.

8.4.7. Fire Fighting

- **Extinguishing media and methods:** Use extinguishing media suitable to the surrounding fire.
- **Protection of fire-fighters:** KEEP AWAY FROM clothing. AVOID breathing dust, fume, gas, mist, vapours, spray. Fight fire with normal precautions from a reasonable distance.

8.4.8. Accidental release measures

- **Personal precautions, PPE:** KEEP AWAY FROM CLOTHING
- **Environmental precautions:** AVOID release to the environment. Collect spillage.
- **Methods and materials for containment and for clean-up:** Contain and collect as any solid. Avoid actions that cause dust to become airborne. Do not breathe dust, and do not allow large quantities of dust or wetted material to contact skin or eyes.

8.4.9. Safe Handling and Storage

- **Safe handling:** DO NOT get in eyes, on skin, or on clothing. DO NOT eat, drink or smoke when using this product. AVOID release to the environment.
- **Additional information:** Eating, drinking and smoking in work areas is prohibited. Remove contaminated clothing and protective equipment, and wash hands after use and before entering eating areas.

8.4.10. Exposure controls and personal protection

- **Engineering controls:** Activities that generate dust require the use of general ventilation and/or wet suppression methods to maintain exposure.

- **PPE:**
  - **Respiratory:** Use **respiratory protection** approved under appropriate government standards
  - **Hand/Arm:** Handle with **gloves** approved under appropriate government standards.
  - **Eye/Face:** Use equipment for **eye protection** tested and approved under appropriate government standards.
  - **Skin/Body:** Wear protective clothing
  - **Hygiene:** Handle in accordance with good hygiene and safety practice. Wash hands before and after handling.

  - **Special conditions posing a hazard**
  - Keep away from clothing.
  - Activities that generate dust should be avoided.

8.4.11. Stability and reactivity

- **Conditions to avoided:** avoid dust generation.

8.4.12. Disposal

- **Landfill Class (RSA) (subject to treatment):** Type 3 Waste: Class C Landfill (GLB+) per: GN R635 (7)(2)(d) - strictly subject to treatment due to GN R636 (5)(1) prohibited disposal: see sections above

- **Safe, environmentally preferred disposal:** Dispose of contents/container to an approved facility in accordance with all applicable regulations and landfill requirements per this safety data sheet's Section 13.
- **Additional information:** Do not fly tip. Do not dispose into sewer, stormwater, or environment. Do not burn unless by means of compliant incineration practices.

9. CHEMICAL AND TECHNICAL SPECIFICATIONS – PRE-BENEFICIATION

(Chemical analysis: Interpretation of results in terms of leachability potential, contamination of soils)

9.1. Introduction

Prior to being used in the proposed activities, e.g., manufacture of concrete blocks, concrete structures, fertilizers, etc., the ash chemical composition, risks and the hazards these present are shown in the laboratory analyses results. The basis of the leachability test of the ash was in anticipation of the environment within the landfill body containing putrescible waste and hence low pH conditions (pH of 5). Low pH conditions are conducive to easier leaching out of metallic components of the salts. The ash is a stable mixture of inorganic salts. It is presented preferably moist to prevent any easy dust formation. There are salts which do leach out in a minimal concentration under the leachate testing conditions which do not reflect the conditions in which it will be used. The ash will be used in the manufacture of concrete structures or as a soil enhancer, so, the components of the ash will be either:

- bound in the structures made once the concrete mix has dried. The concrete structures subjection to leaching will be largely limited due to this nature of the concrete once set.
- the ash will be ploughed into soils, thus diluting the impacts on the environment,

However, the storage of the ash on site may affect the environment to some degree should it spill out of the storage containment area or be blown about by the wind. Management systems of the ash will be required generally, but principally at the storage stage due to potential for exposure to humans and the environment. The chemical and hazardous nature of the ash is given in the analyses conducted on the ash. Refer to:

- Attachment 2a: Certificate of Analysis,
- Attachment 2b: Waste Assessment and Classification and
- Attachment 2c: Safety Data Sheet - SDS.

Total concentrations for the elements within the ash were determined as per NEM:WA - National norms and standards for the assessment of waste for landfill disposal. The quantitative results present the hazard risk to all stakeholders when exposed directly to the ash. These exposures have been given toxicity values. The GHS classification for the hazard of ash is presented in Table 3: Summary of ash GHS hazard classification.

The results for the Total Concentration (TC) and the Leachability Concentration (LC) are presented in Table 5: LC and TC laboratory results for the ISSM ash. These values were used for the Framework for the Management of Contaminated Land database of the Soil Screening values. The Soil Screening Values (SSV) are the soil quality values, expressed as mass of contaminant per mass of soil, that are:

For SSV1: protective of both human health and ecotoxicological risk for multi-exposure pathways, inclusive of contaminant migration to the water resource. Soil Screening Values 1 are applicable to all land-uses, and thus represent an 'acceptable-risk' situation, with no adverse effects on human health and the aquatic environment.
For SSV2: that are protective of risk to human health in the absence of a water resource. Soil Screening Values 2 are land-use specific and have been calculated for three key land-uses namely, standard residential, informal residential settlements and commercial/industrial land-uses.

This approach was followed because ISSM has the intention of beneficiating the ash waste stream as described above.
The ash will be:

- stored and prepared for loading
- loaded at the mill dam site,
- transported to the users' site,
- offloaded,
- stored, and
- worked with for the required end users to manufacture the blocks, or the particular item being constructed,

so, information is needed on the potential risks to the people and to the environment to manage this material for safety at each step.

9.2. Laboratory results

Table 5: LC and TC laboratory results for the ISSM ash for classification and waste assessment.

SEZELA ASH/BAGASH		
Date sampled 17/10/2022	**Date received and testing commenced** by T n T 20/10/2022	
Chemical	**LC. (mgX/l)**	**TC. (mgX/kg)**
Antimony	<0,05	<5+U7:U23
Arsenic	<0,08	<8
Barium	0,53	45
Boron	<0,16	<16
Cadmium	<0,17	<17
Chromium Cr^{+3}	<0,16	25
Hexavalent Chromium	0,0031	<0,031
Cobalt	<0,17	<17
Copper	<0,17	<17
Lead	**0,31**	<8
Manganese	**1,87**	77
Mercury	<0,0031	<0,31

Molybdenum	<0,31	<31
Nickel	<0,18	<18
Selenium	**<0,63**	**<63**
Vanadium	<0,02	11,3
Zinc	0,18	9,2

Chloride	4,29	-
Cyanide (Total)	0,02	<10
Flouride	0,7	2,6
Nitrate	<0,25	-
Sulphate	<2,5	-
TDS	1951	-

CV	-	
Flashpoint at 22, 60 93 °C	-	
pH (Aq Leach)@25	6.2	
Moisture %	8,5	
Sample description	**Brown/grey pieces of ash**	
Odour	Odourless	

Note: Bold highlighted analytical results exceed at least the lowest applicable concentration threshold per Appendix 1 of the T and T analytical report. for the assessment of waste to landfill.

9.3. Total concentration and leachable concentration of components in ash as a characterisation of the hazard nature of the ash.

The GHS classification for the hazards that the ash would pose in terms of its physical nature, health and environmental hazards were made based on the oxides of each component for hazardous risk. The ash was determined to be hazardous to human health considering the different routes of exposure. The risks presented to human health if exposed were:

- skin irritation and
- serious damage to the eyes,
- may cause allergy or asthma symptoms or breathing difficulties if inhaled.

There was no risk to the environment as assessed by the GHS method. These health hazards are mitigated using the management measures as outlined in the Safety Data Sheet to protect human health.

The waste is CHEMICALLY assessed as low risk (Type 3 waste) when assessed for landfill.

There is thus a need to be aware of the effect of these components in the ash on the people at risk of exposure when working with the ash. The following are the sources of information for the possible effects that may be encountered to assess the risk of these components:

- Department of Environmental Affairs: Framework for the Management of Contaminated Land. May 2010.
- Department of Environmental Affairs, Government Notices.
  - R. 634: National Environmental Management: Waste Act (59/2008): Waste Classification and Management Regulations.
  - R. 635: National norms and standards for the assessment of waste for landfill disposal.
  - R. 636: National norms and standards for disposal of waste to landfill.

9.4. Soil Screening Values as a basis for developing risk assessment and risk management plans.

The remediation of contaminated land is being used as a base from which to determine the effects on the environment and related stakeholders.

This work is used to show the values used to assess the risk to the affected areas when the ash is applied to the fields.
This approach will be a useful tool to manage the use of the ash in the environment of the intended end users.

TABLE 6: Summary of the TC and LC values when compared to the soil screening values for protection of water resources. Metals only; shows the soil screening values required to achieve DWA Water Quality Guidelines levels for aquatic ecosystems protection and domestic water use. (Framework for the Management of Contaminated Land. 2010. p 33).

Table 6: Summary of the TC and LC values when compared to the soil screening values for protection of water resources. Metals only. (Note, the highlighted numbers from these thresholds represent exceedances of the components in their total concentration and/or their leachable concentrations. NO leachable components were exceeded)

Parameter	**SSV1**	**SSV2**	**SSV2**	**SSV2**	**Protection of water Resource**	
	All Land-Uses Protective of the Water Resource (mg/kg)	**Informal Residential** (mg/kg)	**Standard Residential (mg/kg)**	**Commercial/ Industrial (mg/kg)**	**Protection of Human Health (Drinking water usage) (mg/kg)**	**Protection of Ecosystem Health (mg/kg)**
Metals and metalloids						
Antimony	-	-	-	-		-

Arsenic	**5,8**	23	48	150	**5,8**	580
Barium	-	-	-	-	-	-
Boron	-	-	-	-	-	-
Cadmium	**7,5**	**15**	32	260	**7,5**	37
Chromium Cr^{+3}	46000	46000	96000	790000	N/A	N/A
Hexavalent Chromium	6,5	6,5	13	40	19	260
Cobalt	300	300	630	5000	-	22000
Copper	**16**	1100	2300	19000	200	**16**
Lead	20	110	230	1900	20	100
Manganese	740	740	1500	12000	10000	36000
Mercury	0.93	0,93	1	4,5	1	4,1
Molybdenum	-	-	-	-	-	-
Nickel	91	620	1200	10000	91	1400
Selenium	-	-	-	-	-	-
Vanadium	150	150	320	2600	2000	-
Zinc	240	9200	19000	150000	3700	240

Anions	**SSL (mg/kg)**
Chlorides	12 000
Fluorides	30
Nitrate/Nitrite	120
Sulphates	4000

Note: refer to Table 5: LC and TC laboratory results for the ISSM ash for classification and waste assessment. This table was used to assess the SSV 1 and 2 values.

- < The laboratory detection limit for a test is higher than the required specification limit
- < The bold highlighted results show the upper value assumption of the data for waste management purposes.

Two tiers of Soil Screening Value have been defined as follows:

- **Soil Screening Value (SSV) 1** represents the lowest value calculated for each parameter from both the Human Health and Water Resource Protection pathways calculations as detailed under the preceding sections. SSV1 values are not land-use specific.
- **Soil Screening Value (SSV) 2** represents the land-use specific soil value calculated following the methods as detailed under the preceding sections. SSV2 values are land-use specific and are appropriate for screening level site assessment in cases where protection of water resource is not an applicable pathway for consideration.

Interpretation: The indication here is that the total concentration values presented some exceedances, but no leachable components were exceeded. Hence caution needs to be exercised in exposure of the material to people in all residential areas through water sources and the ecosystem. The use needs to be protective of people and the environment, away from possible run-off to water sources.
Using the assessments for human and environmental health in the GHS classification, the ash is hazardous for human use, however can be mitigated by correct procedures outlined in the SDS to follow.

9.5. Long term stability and functionality

The SDS indicated that there were no issues with the stability and reactivity of the ash, other than to avoid dust generation. The ash must be kept moist and/or covered with a tarpaulin to prevent dust formation. Currently the moisture content is 8,5%.

The ash being inorganic will have long term stability and hence its functionality will remain consistent for use. It must not be stored for any length of time before being utilised for its proposed use. This will minimise the potential for dust generation and any impacts to the environment.

There is no data for incompatible materials for ash however general care is needed when handling it.

9.6. Reactivity with environmental factors

The following section gives an indication of the responses of the receptors to the concentrations of the exceeded components in the ash in leachate. The system in total remains stable under natural environmental conditions.

9.6.1. Leaching potential showing long term stability and functionality, reactivity with environmental factors.

The leachability testing is done as per requirement for waste management at a landfill site. The sample was subjected to an Australian Standard Leaching Procedure (ASLP2 Acetate pH 5.0 (P/NP)) as per National Environmental Management Waste Act 59 2008, for the National norms and Standard for the assessment for waste for landfill disposal. The resultant leachate was analysed for various components. However, the requirement is for the ash to be used in the concrete aggregate to manufacture concrete structures, or as a soil enhancer. The stored ash (pH 6.2) may be exposed to rain water intermittently. Rain is only slightly acidic (pH 5,6). This may affect the solubilities of the chemical compounds resulting in a possibly lower leachability than the acidic leachability test solution at pH 5,0 submerged over 24 hours. However, the leachability given would be a conservative approach to what may be presented to the environment should there be spillages. The possibility of the lower pH conditions may be reached if any accompanying organic materials would be allowed to decompose under anaerobic conditions resulting in an acidic environment. This however, is unlikely, other than in the soils, however, these processes are conducive to releasing the components as nutrients into the soil for good crop growth. The leachable components from the leachability testing were not exceeded in the SSV1 and SSV2 test thresholds. However, caution is needed because of the potential to leach out lead, manganese and selenium. There were some total

concentration exceedances for barium, mercury and selenium as per the TC and LC test results for assessment to landfill. This implies that the ash would need management to reduce any potential impacts. However, there were no environmental concerns and human risks would be to eyes, and skin. These can be managed. The appointment of an agronomist is required in good agriculture practice to ensure that no negative impacts would be seen in the crops or soils.

10. CHEMICAL AND TECHNICAL SPECIFICATIONS – POST-BENEFICIATION

The overall outcome of the various guidelines used was that the ash is a low risk waste stream to be used in the intended applications. The impacts from the respective uses will be as follows:

- The concrete items once manufactured and dried will encase all the components within the dried block. Even if there was rain, the leaching out of the components in a harmful concentration is minimal because of the surface area presented to the elements.
- The soils will disperse the components and hence dilute any negative impacts. The monitoring of the soils and the crops are required to ensure that these are safe.

10.1. Intended users of the waste stream

The intended users are given in Section 5.2.

10.2. Long term stability and functionality

Ash is stable in the long term in its end use and remains functional.

10.3. Reactivity with environmental factors

No adverse reactivity nor instability are expected in the long term. The SDS report noted no concerns and had no data to make any comment.

11. IDENTIFICATION OF POTENTIAL RISKS AND THE MANAGEMENT THEREOF

Refer to: Attachment 4: Risk Assessment Ash ISSM and Attachment 5**:** Risk management plan for ISSM boiler ash. Attachment 7: Sezela Mill WULA Sensitivity map, shows the sensitive areas to consider for the management of the ash waste beneficiation project.

12. REFERENCES

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13. DECLARATION BY SPECIALIST – ANNE BINDOFF

All information and instructions provided in this report in respect of the Risk Assessment and Risk Mitigations/Management Plan substance is given in terms of the provisions of the National Environmental Management: Waste Act (59/2008): Regulations regarding the exclusion of a waste stream or a portion of a waste stream from the definition of waste. Information and data is based on available information given by Illovo Sezela Sugar Mill and is the best information available through general research based on this information as at the date of this report. It is presented in good faith, to be correct.

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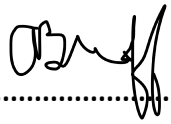
Signature:  **Date:** 17th September 2023

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