

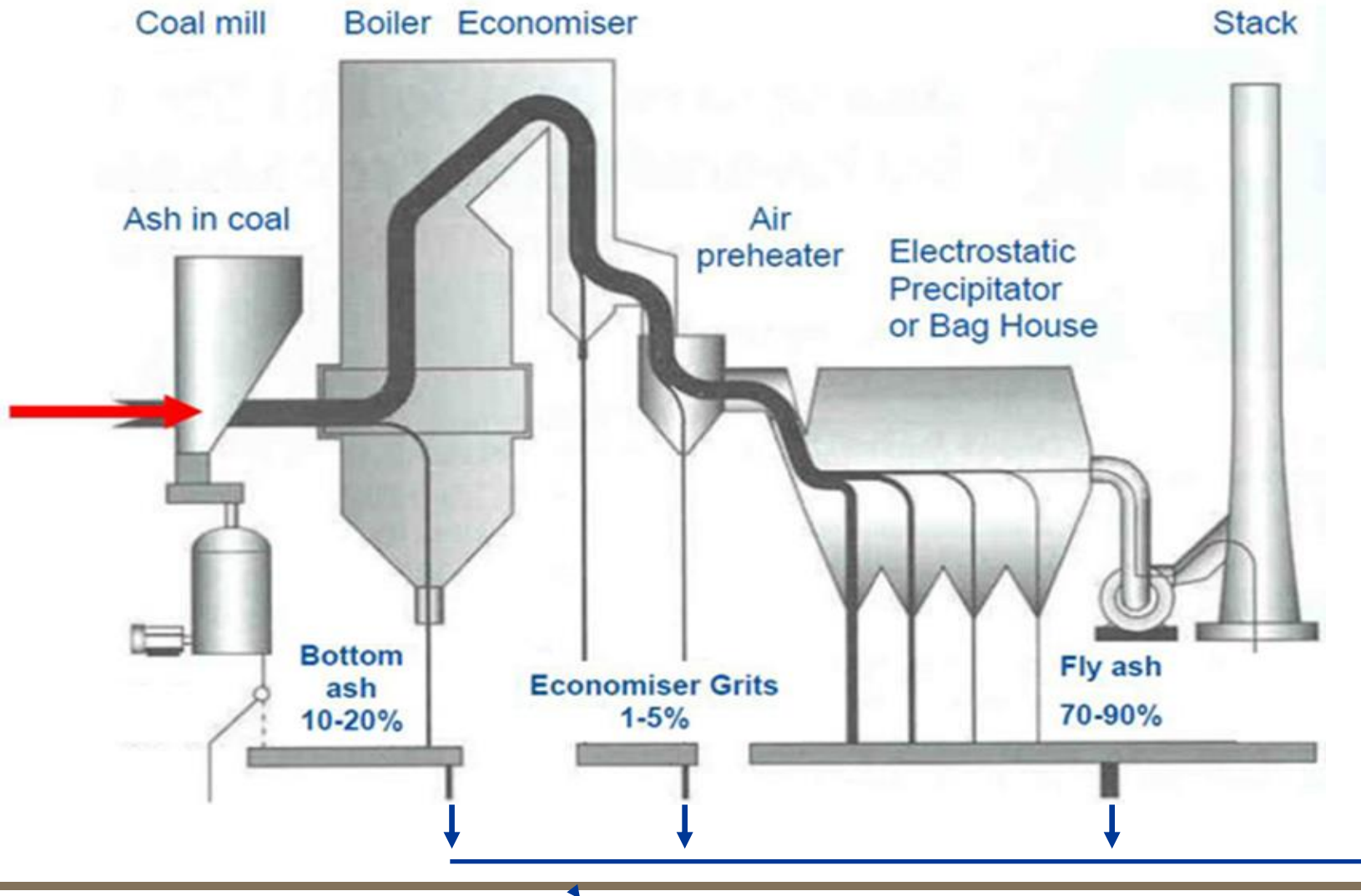


# The use of Legacy Coal Ash in Road Construction

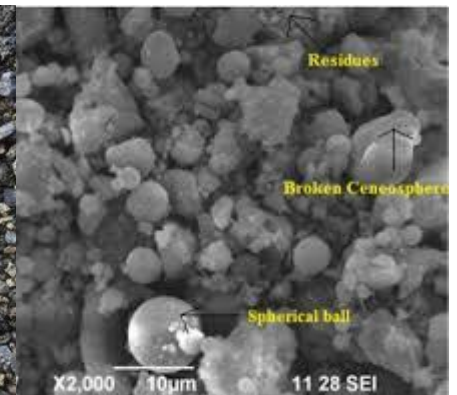
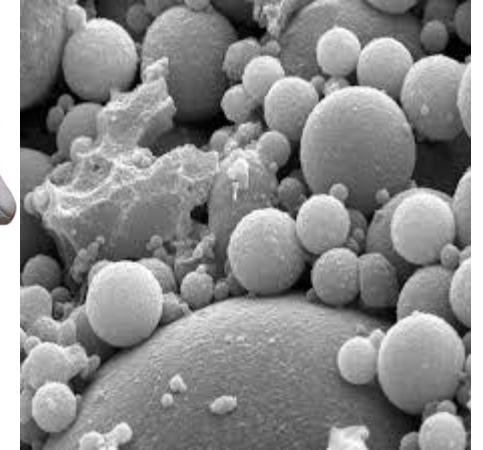
**Date:** 26 February 2025

**Venue:** DFFE Convention Centre

**Presenter:** Kelley Reynolds-Clausen

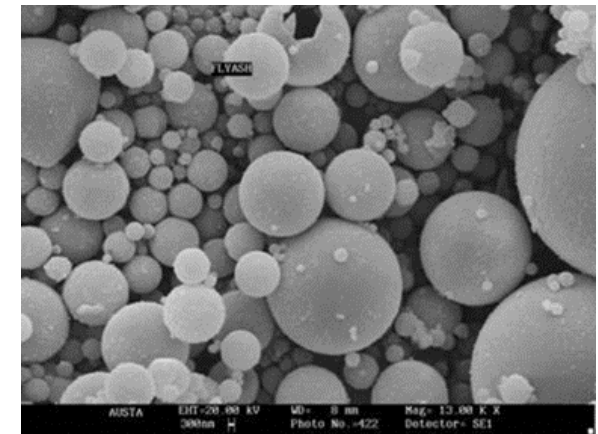


- Grey powder formed by inorganic matter after combustion of coal.
- Fly ash
  - Small, fine particles (0.01-100µm diameter)
  - 85-90%
  - Spherical glass aluminosilicate
  - Captured by ESP or bag filters
- Coarse / Bottom ash
  - Heavier particles
  - 10-15%
  - Base of the boiler
  - Collected by submerged scraper conveyor
- Legacy ash
  - Combination of 80:20 Fly ash : Bottom ash
  - Weathered
  - Reactive
  - Vast volumes



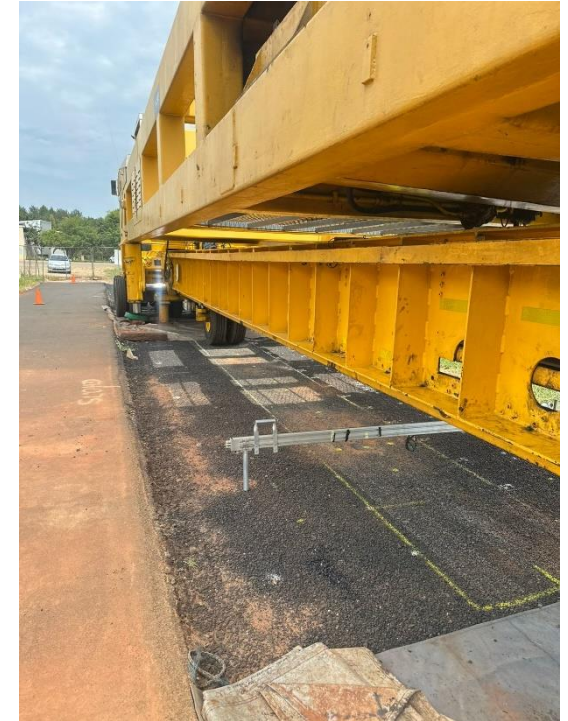
- Obtains physical and mineralogical properties from
  - Sub-bituminous parent coal
  - Combustion conditions
    - Temperature
    - Air : fuel
    - Milling
    - Rate of combustion
  - Emission control techniques
  - Climate
- Classified as Class C (W) (calcareous) or **Class F (V) (silaceous)** ashes
- Eskom ash is unique worldwide
  - Size and pressure of the boilers (combustion techniques)
  - Poor quality coal used
  - Ash
    - Highly alkaline, Low sulphur, Low carbon, Pozzolanic
- Beneficiation relies on one or more of the properties
  - Spherical shape, pH, Pozzolanicity, Variety of particle sizes

Properties	Fly Ash Classes	
Silicon dioxide, aluminium oxide, iron oxide	Class F	Class C
(SiO <sub>2</sub> + Al <sub>2</sub> O <sub>3</sub> + Fe <sub>2</sub> O <sub>3</sub> ), min, wt. %	70,0	50,0
Sulphur trioxide (SO <sub>3</sub> ), max, wt. %	5,0	5,0
Moisture content, max, wt. %	3,0	3,0
Loss on ignition, max, wt. %	6,0	6,0



## Context

- Eskom produces approximately **34 million tons of coal ash annually**.
- Currently, **only 7% to 10% of this ash is sold** through off-takers.
- Ash handling cost estimated to be **R680 million annually**, based on a cost of R20 per ton.
- This initiative offers a **cost benefit within 100km of the power plants**.
- Thus, any road upgrade in this region could result in a **significant cost reductions** by means of:
  - Minimised material costs – only logistics
  - A more durable road.
  - Environmentally safe and green methodology
  - Reduce the environmental impacts of the ash facilities in the region.

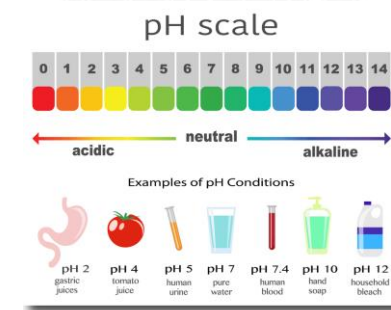
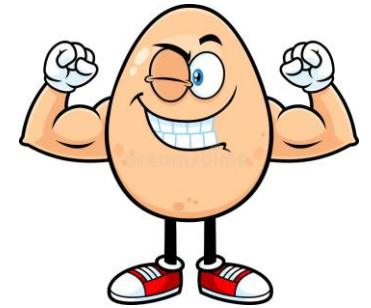


- 1990-1995 - Ash Utilisation research
  - Ash in Forestry
  - N-Viro Soil.
  - Controlled Low Strength Materials
- 2003 - Change in legislation to make ash a hazardous waste.
  - All utilisation research stopped
  - Ash Applications research initiated to understand ash holding facilities
    - Ash Salt Capacity
      - Coring for chemical, geohydrological and microbiological analysis
- 2014 – Mpumalanga government tasks Eskom and Sasol to investigate ash beneficiation for social upliftment and job creation.

- 2015 – Eskom ERI established Ash Task Team.
  - Identify gaps in Eskom technical knowledge of ash.
    - Initiate research to close the gaps and use info for legislation change.
  - Identify other stumbling blocks for ash beneficiation
    - Legislation – waste management license
      - Attempts to change legislation
        - Section 74
        - Regulation 9.
- 2018 – Ash Exclusions Regulations promulgated.
  - Beneficiated ash no longer subject to waste legislation
  - Eskom ashes and FGD gypsum approved for use in
    - Road Construction
    - Mine Backfilling
    - Cement and Block manufacture
    - Soil Amelioration
    - Encapsulation technologies
- 2019 – present
  - Several research projects
  - Consider use on dumped ashes only.

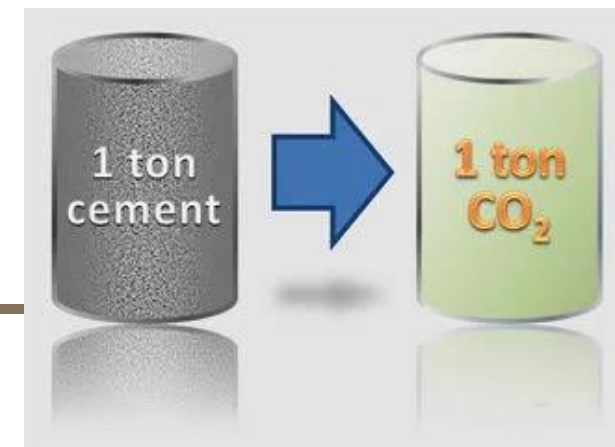
# Why Coal ash geopolymer concrete materials?

- Fly ash and slag inexpensive raw material (wastes)
- High Silica (40 – 60%) and aluminium contents (20 - 30%)
- Low calcium, sulphur, carbon (unburnt coal) and iron concentrations
- Environmentally friendly – No CO<sub>2</sub> emissions
- Considered user friendly – new activators
  - Conventional activators – hazardous, toxic and corrosive
- Can cure at a wide range of temperatures.
- Various strengths and flexibilities.
- Better heat resistance - no hydrates in structure.
- Resistant to corrosion from saline, acidic or alkaline environments - attributed to the lack of calcium in their structure.



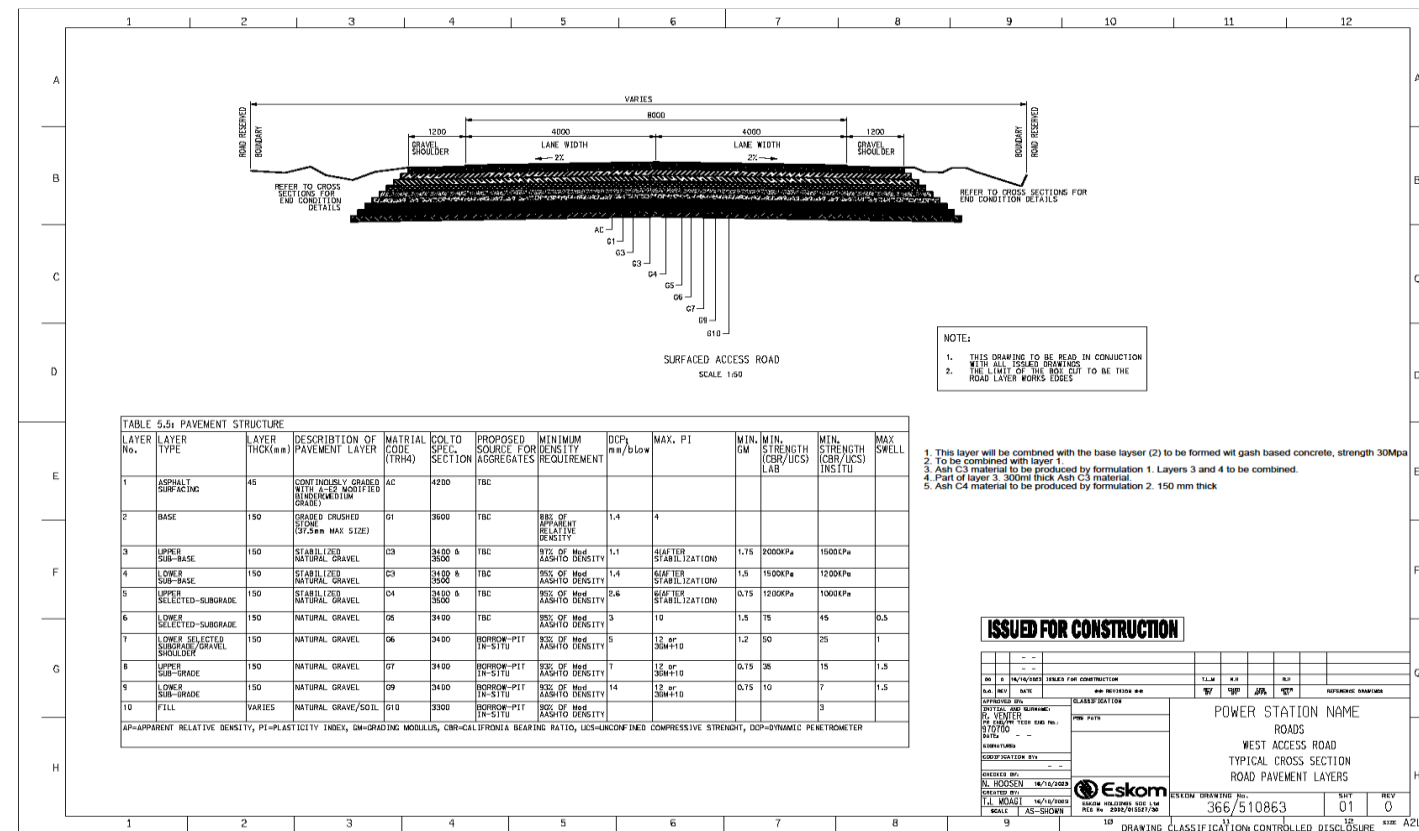
# Conventional Road Construction

- Utilise virgin aggregate (rock) material to develop the support layers.
- Material is obtained from borrow pits in the area around the road construction.
- The materials, placed in reducing size are processed and stabilised with conventional cement.
- Metal rebar reinforcing is used.
- The top layer is bitumen as a wearing course.
- Portland cement is used for material stabilisation – CO<sub>2</sub> producer.



# Geopolymer Ash Road

- Pilot demonstration project – Kusile Power Station 2 x 500m x 8m wide roads.
- Utilise legacy coal ash in the base and sub-base; C4 and C3 engineered stabilised layers.
- Reduction of cost of materials
- No use of mined virgin materials.
- Legacy Ash
- Slag
- Activators
- Aggregate
- Water – from site
- 34MPa after 7 days
- Reinforcing – plastic fibre.



## Claiming of carbon credits

- Cement: 1 ton of CO<sub>2</sub> per ton.
- Conventional road - 320 kg of cement is used per 1m<sup>3</sup>.
- Ash road cement limited to 25-46kg/m<sup>3</sup>) = 792.5 tons saving of CO<sub>2</sub>/km.
- Carbon rebate of R190/ton = R150 575/km of ash road produced.



## Reduced materials costs

- Conventional road needs 6 270 tons of imported G5 material ~ R450 per ton = R2.8 million.
- Ash road needs 3 135 tons = R1.4 million, thus a **R1.4 million saving**.



## No leaching

- Geopolymerised ash does not leach or react with water. It is a more stable material, less likely to pothole formation.

## Reduced ash disposal facility (ADF) costs

- Ash management R30/ton.
- Ash road used 2 904 tons ash/kilometer = **saving of R87 120/km by avoiding ash management.**
- Reduced ash handling, management and rehabilitation and **reduces liner development.**



## No rebar reinforcing

- Metal rebar in wearing course would cost R500 000/km conventionally.
- Plastic fibre → improved flexibility and better energy adsorption, costs R50 000/km, a 90% reduction.



# Geopolymer Ash Road – Initial pavement works





## Benefits of the geopolymer ash road to Eskom

### Kusile PS - Geopolymer Ash Road – stabilised layers

- Pilot demonstration project – Kusile Power Station 2 x 500m x 8m wide roads.
- Utilise legacy coal ash and G5 material (50:50) in the base and sub-base; C4 (CLA 4) and C3 (CLA 3) engineered stabilised layers.
- Reduction of cost of materials
- Reduced use of mined virgin materials.

- Reduced cost of construction materials.
- Reduction of ash management costs and rehabilitation.
- Can use waste-water in the construction.
- Reduced use of Cement allows for the claiming of carbon credits.
- Utilise 840 tons of legacy ash per 150mm layer of C3/C4 per kilometer.
- 50:50 ratio of ash to G5 material only due to criticality of the road – will optimise the use of ash in further research.

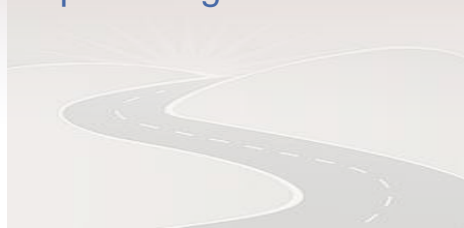
# Geopolymer Ash Road Construction (wearing course)



## Benefits of the geopolymer ash road to Eskom

### Kusile PS - Geopolymer Ash Road – Wearing Course

- Pilot demonstration project – Kusile Power Station 2 x 500m x 8m wide roads.
- Utilise legacy coal ash and metal processing waste (slag) to form a 30MPa ash concrete for the top wearing course.
- Reduction of cost of materials.
- No cement use.



- Reduced cost of construction materials.
- Reduction of ash management costs and rehabilitation.
- Can use waste-water in the ash concrete batching.
- Reduced use of Portland cement allows for the claiming of carbon credits.
- Utilise 384 tons of legacy ash per 150mm layer per kilometer in the wearing course.

# Road Construction – Final product



# Road Official Opening – 26 September 2024



# Next steps and high level milestones

## Eskom's next steps & the year

- Conduct a **business case comparison of costs for the Matla – Kriel road**, with the intent to increase the ash content in the various layers.
- Assist in JET initiatives and Air Quality offsets.

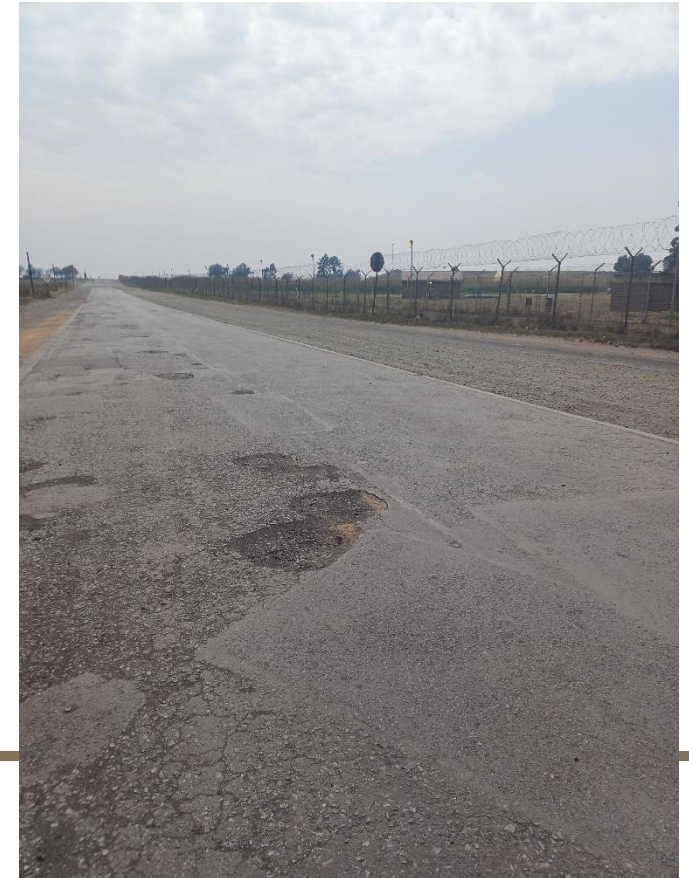
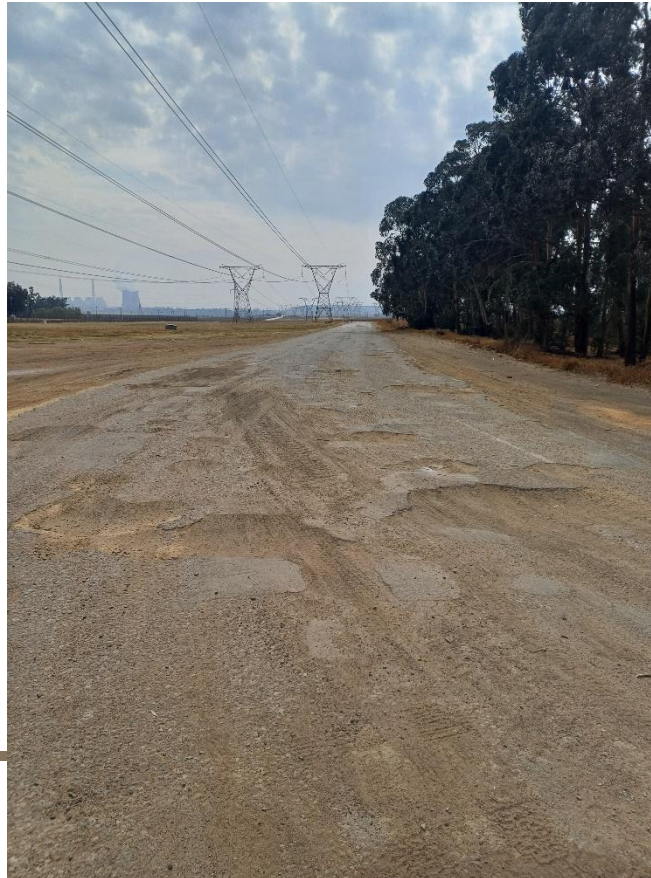


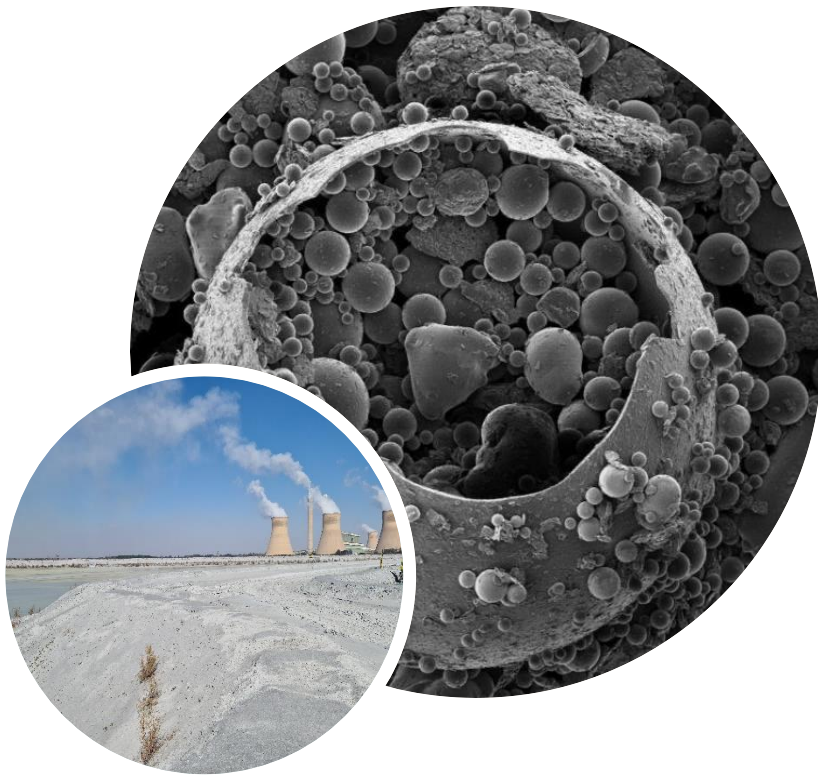
## Criteria on decisions made

- Civil Engineering have accepted the process and incorporation into Eskom specifications.



- Ash Based Rehabilitation of the Matla Kriel connecting road.
  - Using Matla legacy ash
  - Dumped slag
  - Activators (South African – environmentally friendly)
  - Wastewater (pollution control dam)





THANK-YOU

Questions?

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