Client

Tronox Mineral Sands (Pty) Ltd

Main Environmental Consultant

SRK Consulting

East OFS Project – Residue Storage Facility at the Tronox Namakwa Sands Mine

Aquatic Ecology Impact Assessment

NOVEMBER 2020

Report prepared by:

Dr Liz Day

LIZ DAY CONSULTING

Specialist River and Wetland Consultant

LIZ DAY
CONSULTING
Specialist River and Wetland Consultant

30 September 2020

DECLARATION OF SPECIALIST INDEPENDENCE

I, Elizabeth (Liz) Day as a specialist river and wetland consultant, and Director of Liz Day Consulting (Pty) Ltd, hereby confirm my independence as a specialist and declare that I do not have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which SRK Consulting (South Africa) (Pty) Ltd was appointed by Tronox Mineral Sands (Pty) Ltd as the Environmental Assessment Practitioner (EAP) in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for work performed, specifically in connection with specialist input into the Environmental Impact Assessment Report for the proposed East OFS (Orange Feldspathic Sand) project Residue Storage Facility at the Namakwa Sands Mine.

____

Full Name: Dr Elizabeth (Liz) Day
Liz Day Consulting (Pty) Ltd (trading as LDC)
lizday@mweb.co.za

Title / Position: Director

Qualification(s): BA, BSc, BSc Hons, PhD

Experience: > 24 years working on freshwater ecosystems

Relevant work experience: Liz has worked as a freshwater ecologist / aquatic ecosystems specialist for the past +24 years, primarily in the Western Cape, and has produced over 900 Technical and Environmental Impact Assessment reports, requiring the assessment of rivers and/or wetlands.

With regard to the current project, Liz has worked previously on the Tronox Namakwa Sands Mine (East), giving input into the Habitat Assessment of the Groot Goerap River at (then) planned haul road crossings over the river to facilitate mining expansion. She also provided specialist assessment of the impacts to aquatic ecosystems of the proposed extension of Tormin Mine, to the south of the current project, and has undertaken several other assessments along the West Coast between Saldanha Bay and Alexanderbaai.

Liz has experience in wetland delineation and water quality assessments, and has worked closely with geohydrologists and hydrologists in other projects (e.g. the Nuclear sites Ecological Impact Assessment) in unpacking surface / groundwater interactions.

Registrations: Member of IAIASA; Member of WISA; Registered Professional Natural Scientist by SACNASP (Reg No 400270/08) for fields of Biological Science, Ecological Science and Zoological Science.

Liz Day PhD; Pr Nat Sci
Cape Town, South Africa
e: liz@lizdayconsulting.co.za | m: +27 83 454 2309
Reg No 2019/067960/07

TABLE OF CONTENTS

ABBREVIATIONS

DWAF	Department of Water Affairs and Sanitation (now DHSWS)
DHSWS	Department of Human Settlements, Water and Sanitation
DWS	Department of Water and Sanitation (now DHSWS)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EOFS	East Orange Feldspathic Sand
EMPR	Environmental Management Plan Report
LDC	Liz Day Consulting (Pty) Ltd
MAR	Mean annual runoff
NEMA	National Environmental Management Act 107 of 1998 as amended
NWA	National Water Act 36 of 1998
PES	Present Ecological State
RAS	Red Aeolian Sand
RSF	Residual Storage Facility
SRK	SRK Consulting (South Africa) (Pty) Ltd
STF	Sand Tailings Facility
SWMP	Stormwater Water Management Plan
WULA	Water Use License Application

1 INTRODUCTION

1.1 Background

Tronox Mineral Sands (Pty) (Ltd) (Tronox) mines heavy mineral sands at the existing Namakwa Sands Mine at Brand se Baai, where the company activities comprise an East and a West mine. Tronox use open-cast, strip-mining methods at both mines, within an authorised mining area, and rehabilitate mined out areas concurrently.

The East Mine (the Mine) is currently a shallow mine, where mining of only the top Red Aeolian Sand (RAS) layer occurs. Mined material (sand ore) is processed at the Primary Concentration Plant at the East Mine (PCP East) to produce a heavy mineral concentrate. Waste products from the PCP East include sand tailings (coarser material) and fines (finer residue). Sand tailings are backfilled into the mining void(s), and slurried residue including fines is disposed of in Residue Storage Facilities (RSFs) (SRK 2020a).

Tronox is also authorised to mine and process the deeper Orange Feldspathic Sands (OFS) resource underlying the RAS material at the East Mine. This aspect of the mining process would however require modification of the approved residue disposal plan, including a single RSF to accommodate all fine reside from the project (as opposed to three smaller facilities as per the current authorization), single-stacking sand tailings in certain areas of the pit with dump trucks and backfilling sand tailings with spreaders at two Sand Tailings Facilities (STFs) (or stockpiles), an overburden RAS tailings stockpile and the upgrade of infrastructure.

As a result of the above requirements for amendments to the existing mining authorisation, Tronox appointed SRK Consulting (South Africa) (Pty) Ltd (SRK) to undertake an Environmental Impact Assessment (EIA) and associated processes for applications for the authorisation of proposed construction and operation of the above aspects for the Namakwa Sands East OFS Project (the project).

Specialist surface hydrological and geohydrological studies were conducted to assess the impacts of the proposed modifications and have informed this assessment. Since the EOFS Project would take place in proximity to both the Sout River and its tributary, the Groot Goerap River, and a hardpan area, including a wetland pan, previously demarcated by Helme (2014) as an area of conservation concern, input by an aquatic ecologist was also required, to inform the EIA process.

Liz Day Consulting (Pty) Ltd (LDC) was thus appointed by SRK to provide specialist input into the EIA process, from the perspective of aquatic ecosystems. LDC specializes in freshwater (i.e. inland) aquatic ecosystem assessment.

1.2 Terms of reference

The specialist Terms of Reference for this project were provided by SRK and required that the specialist undertake the following:

- Review previous ecological studies of the area and the model and/or other outputs of the ground and surface water impact assessments for the project, to identify habitats with potential (ephemeral) flow contributions from surface water, groundwater or interflow, or combinations thereof;
- Identify impacts of changes to surface, groundwater quality and interflow associated with the project on affected habitats;
- Undertake a site visit of habitats with flow contributions from surface, groundwater and interflow sources which may be impacted by the project;
- Assess impacts on habitats with flow contributions from surface, groundwater and interflow sources which may be impacted by the project;
- Compile a DWS mandated Risk Assessment Matrix for the project; and
- Collate the findings of the study (including literature review, impact assessment and Risk Assessment Matrix) into a freshwater impact assessment report.

1.3 Activities informing this report

Input into this assessment was informed by:

- A site visit on 4th and 5th August 2020, when the areas of the site likely to be affected by the proposed activities were visited and visually assessed, including the Groot Goerap River and the lower reaches of the Sout River and its estuary;
- Soil sampling (hand augering) was carried out in areas as depressions in the (then draft) surface hydrology report, or as a hardpan in the previous botanical survey of Helme (2014). The wetland delineation methodology outlined in DWAF (2005) and (2008) was used as the basis for identification of wetland conditions in these areas;
- Consideration of the detailed Project Description provided to specialists by SRK (SRK 2020a);
- Consideration of the findings of the specialist surface hydrology report (SRK 2020b) and specialist geohydrology report (SRK 2020c);
- Review of available past reports relating to biodiversity on and associated with the site (noting that the site has already been approved for mining); and
- Compilation of the present report.

1.4 Consultation Process

During the on-mine site visit, the specialist was escorted by Mr Martin (Masie) Maasdorp (Tronox), who identified areas on the site where the proposed activities would take place and provided general site familiarisation. In addition, a brief on-site meeting was held with Ms Esté Prinsloo (Tronox), to discuss aspects of the project.

Following the site visit, a brief telephonic discussion was had with Ms Correen Le Roux (Environmental Practitioner, Tronox) regarding the initial specialist findings.

1.5 Limitations and Assumptions

No surface water was identified on site, including in the Groot Goerap River or lower reaches of the Sout River, and no water quality samples were thus collected or analysed. This was to be expected, given that the area is arid and the rivers only flow episodically (occasionally, usually after an elapse of many years (SRK (2020b) and Mr Martin Maasdorp, Tronox, pers. comm. to Liz Day during site visit)). Standing water was evident in some pans in the estuary, downstream of the Salt Works. These were however assumed to derive directly from outflows from the saltworks.

The Sout River was assessed visually at limited accessible spot points – but the exact zone into which seepage into the river might take place was not identified, and the river was rather assessed as a whole. This is not considered a significant limitation, as the river upstream of the estuary is relatively homogeneous and the proposed activities would not result in point source inflows, but extended seepage, if any.

The wetland pans identified in the hardpan area were not individually delineated – this is because the whole hardpan area has already been delineated by Helme (2014) and excluded from the mining / project footprint. Wetland pans occur patchily in this area and where there has been past disturbance that has stripped surface soils creating depressions, allowing shallow surface water perching after rain.

This assessment did not include a botanical study – specialist botanical assessment has already informed existing authorisations for mining activities. In addition, the present study does not assess the direct impact of mining because mining (physical transformation of the project area for the East OFS project is approved (and will predominantly take place in areas that have been previously mined, and since rehabilitated). As such terrestrial systems where mining will take place are thus described cursorily in this report, unless likely to be additionally affected by the proposed infrastructure and methodology changes that underpin the need for this assessment.

1.6 Site location

Figures 1.1 and **1.2** respectively show the broad location of the Tronox Namaqua Sands Mine, and existing infrastructure on the East and West mines. These are located in the northern Western Cape Province of South Africa, at Brand se Baai in the magisterial district of Vanrhynsdorp. The Mine is accessed off the R363, some 63km north west of Lutzville.

1.7 Definitions

1.7.1 The Site and study area

For the purposes of this report, reference to "the site" means the East Mine area, while the "study area" refers to the area within the East Mine in which the proposed new infrastructure would be located (see Section 2 for a description), as well as the Sout River and Groot Goerap River, abutting the East Mine areas.

1.7.2 Wetlands and watercourses

The following definitions apply to the identification and assessment of aquatic ecosystems in this report, as per the National Water Act (Act No. 36 of 1998) (NWA):

> **Wetlands** are defined as "*land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil*."
>
> **Rivers** fall within the definition of **watercourses**, which are defined as follows:
>
> *(a) a river or spring;*
> *(b) a natural channel in which water flows regularly or intermittently;*
> *(c) a wetland, lake or dam into which, or from which, water flows; and*
> *(d) any collection of water which the Minister may, by notice in the Gazette declare to be a watercourse.*
>
> Note that:

- Reference to a watercourse includes, where relevant, its bed and banks;
- The term "watercourse" excludes artificial channels and canals; and
- "Extent of a watercourse" includes the watercourse up to the outer edge of the 1:100 year floodline, and/or the delineated riparian habitat, whichever is the greatest distance, as defined in GN509 of August 2017.

1.8 Assessment methodologies

Assessment of wetland condition and ecological importance and sensitivity

Methodologies for determining watercourse Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) are outlined in Appendices A and B.

Wetland identification

The DWAF (2008) wetland delineation protocol is used in South Africa to determine the presence and extent of wetlands. This requires consideration of the following four wetland indicators:

- The terrain unit indicator, which identifies parts of the landscape where wetlands are more likely to occur;
- The soil form indicator, which identifies soil forms that are associated with prolonged and frequent saturation;
- The soil wetness indicator, which identifies morphological signatures of the soil, developed in the soil in response to prolonged and frequent saturation – these are referred to as redoxymorphic features; and

- The vegetation indicator that identifies hydrophilic vegetation associated with frequently saturated soils.

Of the above, the soil wetness indicator is considered the most important, with the other indicators often being regarded as confirmatory rather than diagnostic (DWAF 2008).

However, vegetation indicators are also considered very useful in undisturbed sites and in “special case” areas, including sandy coastal aquifers (DWAF 2008).

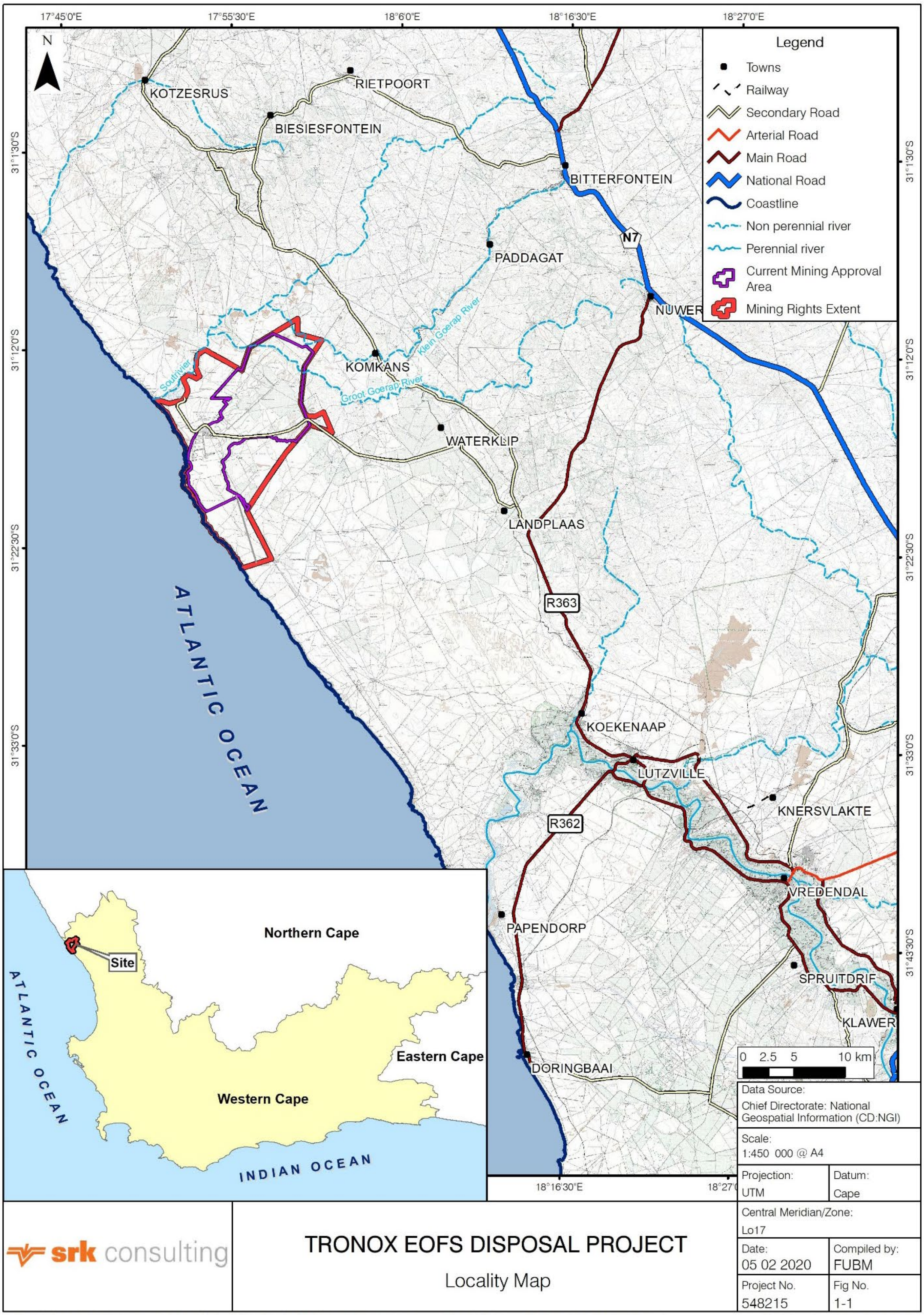


Figure 1.1
Location of the Tronox Namaqua Sands Mine (Figure courtesy SRK)

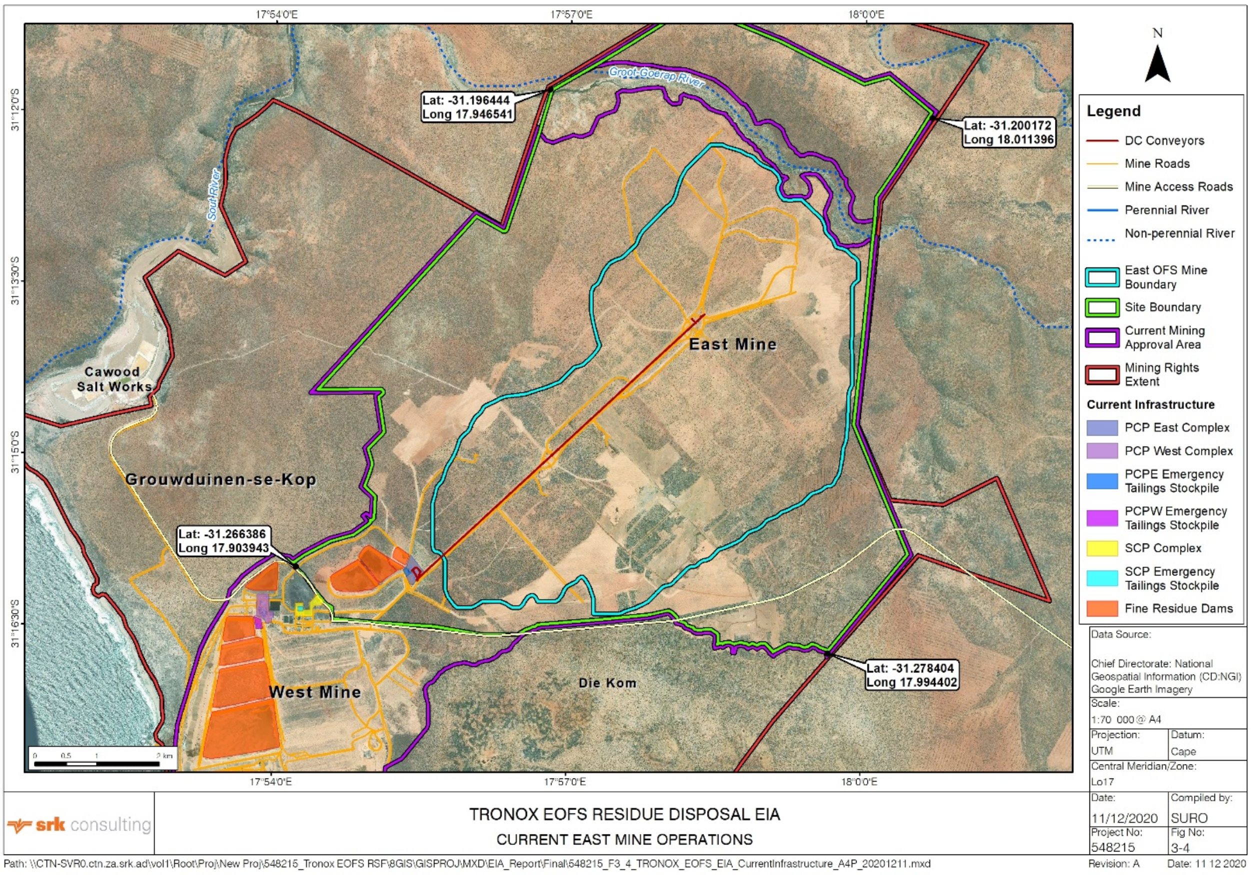


Figure 1.2
Demarcation of the East and West Mines on the Tronox Namaqua Sands Mine – this project deals only with activities on the East Mine (Figure courtesy SRK)

1.9 Content of the Report in terms of addressing EIA regulations for specialist reporting

The requirements for specialist studies in the EIA Regulations of 2014 (GNR 326) Appendix 6, promulgated under the National Environmental Management Act (Act 107 of 1998), are listed in **Table 1.1**, which includes reference to the sections in the present report where these requirements are addressed.

Table 1.1
Required Content of a Specialist Report (as per Appendix 6 of GNR 326)

Regulation 326 April 2017, as amended	Description	Section in the Report
Appendix 6 (1-a)	A specialist report prepared in terms of these Regulations must contain—details of— i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page i
Appendix 6 (1-b)	A declaration that the specialist is independent in a form as may be specified by the competent authority;	Page i
Appendix 6 (1-c)	An indication of the scope of, and the purpose for which, the report was prepared;	Sect 1.1 and 1.2
Appendix 6 (1-cA)	An indication of the quality and age of base data used for the specialist report;	Sect 1.3.; 3.8; 8.6
Appendix 6 (1-cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sect 3.8 and 5.5

Regulation 326 April 2017, as amended	Description	Section in the Report
Appendix 6 (1-d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Sect 1.3 and 3.8
Appendix 6 (1-e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Sect 1.3 and 3.8
Appendix 6 (1-f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Sect 2; Sect 5
Appendix 6 (1-g)	An identification of any areas to be avoided, including buffers;	Sect 5.2.1
Appendix 6 (1-h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Sect 6.1
Appendix 6 (1-i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Sect 1.5 and Sect 4
Appendix 6 (1-j)	A description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Sect 4 and 5
Appendix 6 (1-k)	Any mitigation measures for inclusion in the EMPr;	Tables 5.2. 5.3,5.4 and 5.5
Appendix 6 (1-l)	Any conditions for inclusion in the environmental authorisation;	Tables 5.1-5.5
Appendix 6 (1-m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Tables 5.3 and 5.4
Appendix 6 (1-n)	A reasoned opinion— i. whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 7
Appendix 6 (1-o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 1.4
Appendix 6 (1-p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
Appendix 6 (1-q)	Any other information requested by the competent authority.	N/A
Appendix 6 (2)	Where the government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

2 DESCRIPTION OF THE PROPOSED DEVELOPMENT

2.1 Background to mining activities

Noting that approval has already been obtained for the actual East OFS mining activity itself, within the area indicated as "East OFS Mine Boundary in **Figure 1.2,** this section provides a summary of the overall activities involved, as a background to assessment. The information is extracted or summarised from the Project Description provided by SRK to the EIA specialists (SRK 2020a) – notes in square brackets […] are added by this author.

- Currently only the surface RAS is mined in the East Mine to a maximum depth of about 6m, using a conventional open pit panel mining method (excavation). The RAS mining operation will extend until 2024;
- Tronox is authorised to mine the deeper OFS resource to a depth of 35m. The proposed method entails the following activities:
    - Site preparation:
        - Physically marking out area to be mined;
        - Vegetation clearing and topsoil harvesting to a depth of 5 cm; and
        - Removal of previously backfilled ~1 m RAS tailings horizon ("RAS tailings overburden");
    - Ore extraction and transport:
        - Excavation of OFS ore (no drilling or blasting is required) to an average depth of 7 m; and
        - Transport ore by front end loaders or haul trucks to the DCC and onto the PCP East;
    - Processing:
        - Primary Concentration at the upgraded PCP East; and
        - Secondary Concentration;

      [Seawater is used to process both RAS and East OFS]
    - Overburden, tailings and residue management:
        - Tailings placement
            - Backfilling tailings with conveyors and stackers at two deep filling areas (STFs);
            - Single stacking sand tailings in the remainder of the approved East OFS pit by haul truck;
        - Residue disposal in a new RSF;
        - [1]Overburden stockpiling (during initial phases) in an interim stockpile and backfill to the pit (during subsequent phases, in conjunction with sand tailings backfilling); and
        - Profiling;
    - Rehabilitation of backfilled areas:
        - Wind break establishment;
        - Topsoil placement and levelling;
        - Revegetation;
        - Monitoring (success of) rehabilitation; and
        - Maintenance and aftercare activities.

2.2 New infrastructure requirements and additional activities

For the East OFS Project to proceed, the following need to be authorised:

- An additional ~400 ha RSF with a (storage) capacity of between 34 and 40 million m^3 (Mm^3) for residue (fines) disposal (as opposed to three smaller facilities included in existing authorisations for the project);

[1] Note that overburden comprises RAS tailings

- New sand tailings disposal deposition strategy entailing backfilling tailings in the East Mine pit with a system of conveyors and stackers at two STFs and single stacking sand tailings in the remainder of the pit by haul truck (as opposed to backfilling tailings at a uniform depth throughout the pit);
- Expansion of the sea water intake;
- Fines and return water transfer pipelines;
- Overhead powerlines;
- Various changes to infrastructure at the PCPE footprint; and
- Demolition of two farmhouses.

Of the above activities, this report is concerned only with the proposed additional ~400 ha RSF, the single stacking sand tailings and the STFs in the East Mine pit. This is because these are the only activities likely to have any impact on any surface aquatic ecosystems through potential changes to surface and groundwater characteristics locally.

The following sections provide a more detailed description of the proposed activities, with information presented here extracted or summarised from the Project Description provided to specialists by SRK.

Figure 2.1 (also from SRK Project Description) presents a useful schematic to explain the proposed process

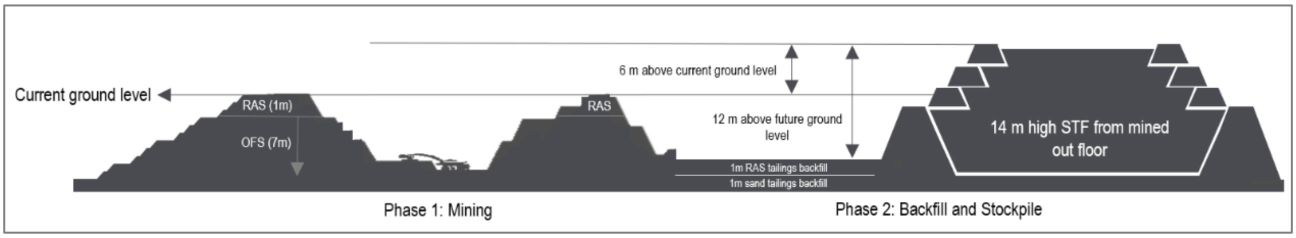


Figure 2.1
Proposed mining, backfilling and stockpiling process

2.2.1 Deep backfilling areas (Sand Tailings Facilities (STFs))

The deep filling areas proposed (STF1 and STF2 in **Figure 2.2**) would both be located within areas that have previously been mined. The following dimensions have been proposed:

- Each STF would be a maximum of ~14 m high (~13 m above the highest point of the post mining ground level, and ~7 m above the current ground level (see **Figure 2.1**), with side slopes being sloped at 35^{o} and a flat surface;
- STF 1 would cover an area of ~290 ha and a length and width of 1 700 m;
- STF 2 would cover an of ~250 ha, a length of 1 900 m and a width of 1330 m;
- STF 1 and STF 2 would have backfill approximately 97 Mm^3 and 60 Mm respectively, and the proposed backfill would be sufficient for approximately 31 years mining.

Note that sand tailings have a 20% moisture content at disposal and Tronox estimate that 12% of this water seeps out over time. Pit dewatering is required to remove the water seeping from sand tailings and back to the PCP East. The system would consist of submersible pumps in the pit pumping to transfer tanks, and transfer pumps pumping the water back to a new thickener feed tank at PCP East.

2.2.2 Residue Storage Facility (RSF)

The proposed RSF would comprise the following:

- The walls of the facility would be a maximum of 20 m high and would be built at a slope of 26.6^{o};
- The facility would have a ~400 ha footprint, located as shown in **Figure 2.2**;
- The RSF would have a volumetric capacity (for slurried fines) of 66 Mm^3, sufficient to store approximately 38.9 Mm^3 of dry-fine residue equating to approximately 20 years of fines production

from the East OFS project at a 0.56% ore cut-off grade, noting that constant dewatering would take place during operations.

Tronox anticipates that a fines density of 1.09 t/m³ would be maintained and that the volume of seawater in fines would be ~85% (by mass). It is anticipated that, on average, 900 m^3/hour of water would be recovered from the RSF supernatant pool, though pumps will have sufficient capacity to return 1 800 m^3/hour in the event that this volume is available, e.g. following a storm event.

2.2.3 The Overburden Facility

The stockpile would be an interim measure and would be used until portions of the mined out East OFS pit are able to receive RAS tailings overburden (at which stage disposal at the RAS tailings overburden facility would cease).

The stockpile would have an approximate height of 5.6 m and footprint of about 50 ha and a length and width of 700 m, at the approximate location shown in **Figure 2.2**.

2.2.4 Surface and Stormwater Management

Existing authorisations for the mine operation require that clean and dirty water streams are kept separate to prevent contamination and minimise the use of clean water. Stormwater diversion trenches and bunds would be installed to divert stormwater away from the RSF, with stormwater emanating from the east and south west of the RSF discharged to the south, and stormwater emanating from the north and west of the RSF discharged to the north west.

2.2.5 RSF Liners

Liners for waste disposal facilities are sometimes installed to reduce the infiltration of contaminants into the environment (in this case, via groundwater mainly into the sea/ocean), and as a leachate control and capture mechanism (SRK 2019c).

Three alternative treatments of the base of the RSFs have been proposed for consideration in the EIA, namely:

- A liner with the specifications of a Class C disposal facility (that is, base preparation layer and the installation of a High-density polyethylene (HDPE) liner);
- A liner with the specifications of a Class D disposal facility (that is, an engineered base compaction layer); and
- “As is” / no base preparation – although “*Assuming an in situ soil of a sandy composition, local base preparation through compaction would unlikely decrease the permeability of this in situ material to a permeability lower than that of the fine residue material”* (SRK 2020c).

As a result, the engineered base compaction layer equates to the “No liner” alternative from a groundwater infiltration perspective.

Note that the only contaminant of concern is seawater, which has higher salinities than local groundwater (SRK 2020c note that leachate quality is assumed to be primarily that of seawater (EC of ±5 000 mS/m whereas natural background water quality in the area has a mean EC of c.1000 mS/m and ranges between c.600 and c.1 500 mS/m).

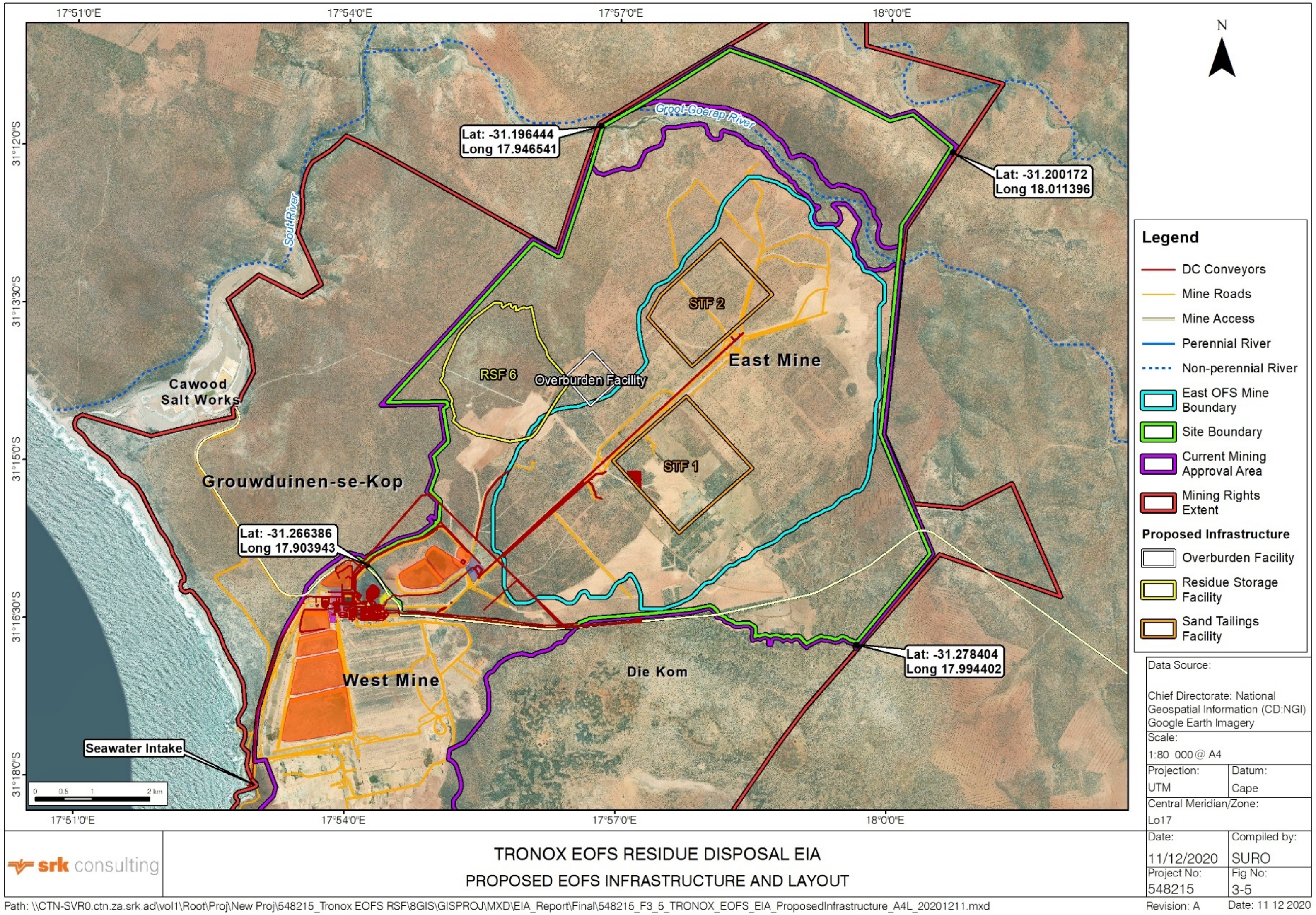


Figure 2.2
Proposed Tronox EOFS Infrastructure and Layout. Figure courtesy of SRK (2020)

3 DESCRIPTION OF (SURFACE) INLAND AQUATIC ECOSYSTEMS POTENTIALLY AFFECTED BY THE PROPOSED EAST OFS PROJECT ACTIVITIES

3.1 Catchment context

The Namakwa Sands Mine lies in the north western section of the Department of Human Settlement, Water and Sanitation (DHSWS)'s Olifants Doorn Water Management Area. The infrastructure proposed for the East OFS Project would all be located in quaternary catchments F60D and F60E, as shown in **Figure 3.1**. Of these, runoff falling into F60E drains towards the Atlantic Ocean, while runoff from F60D passes into the Sout River, just northwest of the site and the Groot Goerap River (referred to in some maps and reports as the Groot *Goeraap* River), which passes through the north eastern part of the East Mine, flowing in a north easterly direction to join the Sout River in its lower reaches.

The Sout River passes into the Atlantic Ocean via its estuary, just north of the Mining Rights boundary, and north west of the present study area.

3.2 Climate context

All of the watercourses shown in **Figure 3.1** are non-perennial. This reflects the arid nature of the study area, with hot temperatures and high rates of evaporation (1 190 mm/a) (SRK 2020c). Comments from a local farmer suggest that the most recent period of river flow was 1968 (Ms Esté Prinsloo, Tronox, pers. comm to Liz Day in 2019). SRK (2020c) notes that average annual precipitation on the site for the period 1993 to 2018 was 140 mm, with some precipitation in all months of the year. SRK (2020b) notes that the wettest months occur in winter, and that a significant portion of the moisture in the area (particularly in summer) precipitates from sea fogs.

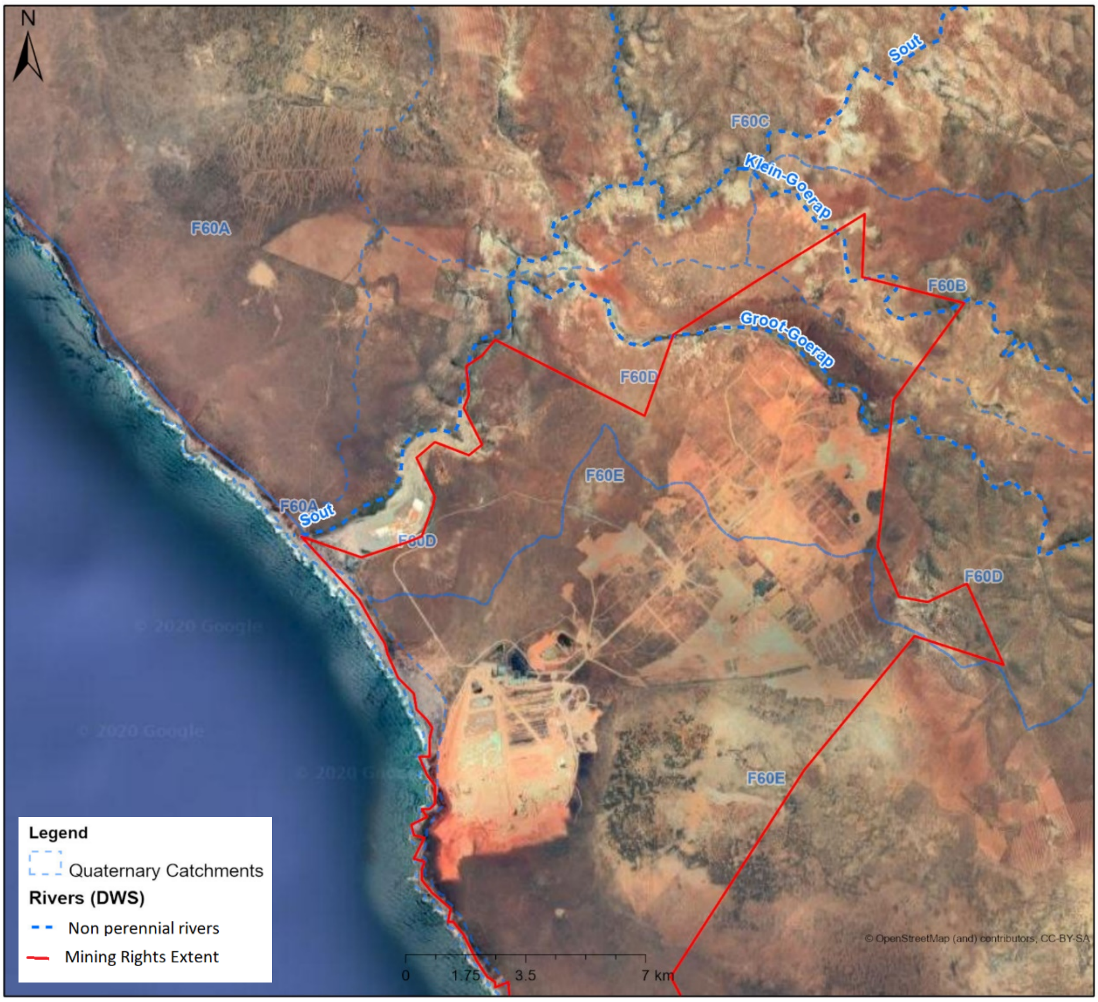


Figure 3.1
Catchment context of the site

3.3 Topography

The study area slopes from the east towards the coast in the west, and is characterised by gently undulating topography. Elevations range from >300 m above mean sea level (mamsl) along the eastern mining rights boundary down to 0 mamsl along the western coastal boundary of the study area. The inland area is covered with vegetated sand dunes aligned north to south (SRK 2020c), while the Sout River valley, to the north, is a steep-sided, wide, flat bottomed valley that extends to the estuary in the west.

South of the study area, the terrain slopes down into a naturally low lying area or depression in the landscape, referred to as Hartebeestekom in SRK (2020c) and De Kom (SRK 2020 b) and including an ephemeral wetland pan, which has formed on the underlying calcrete pan.

3.4 Geohydrology

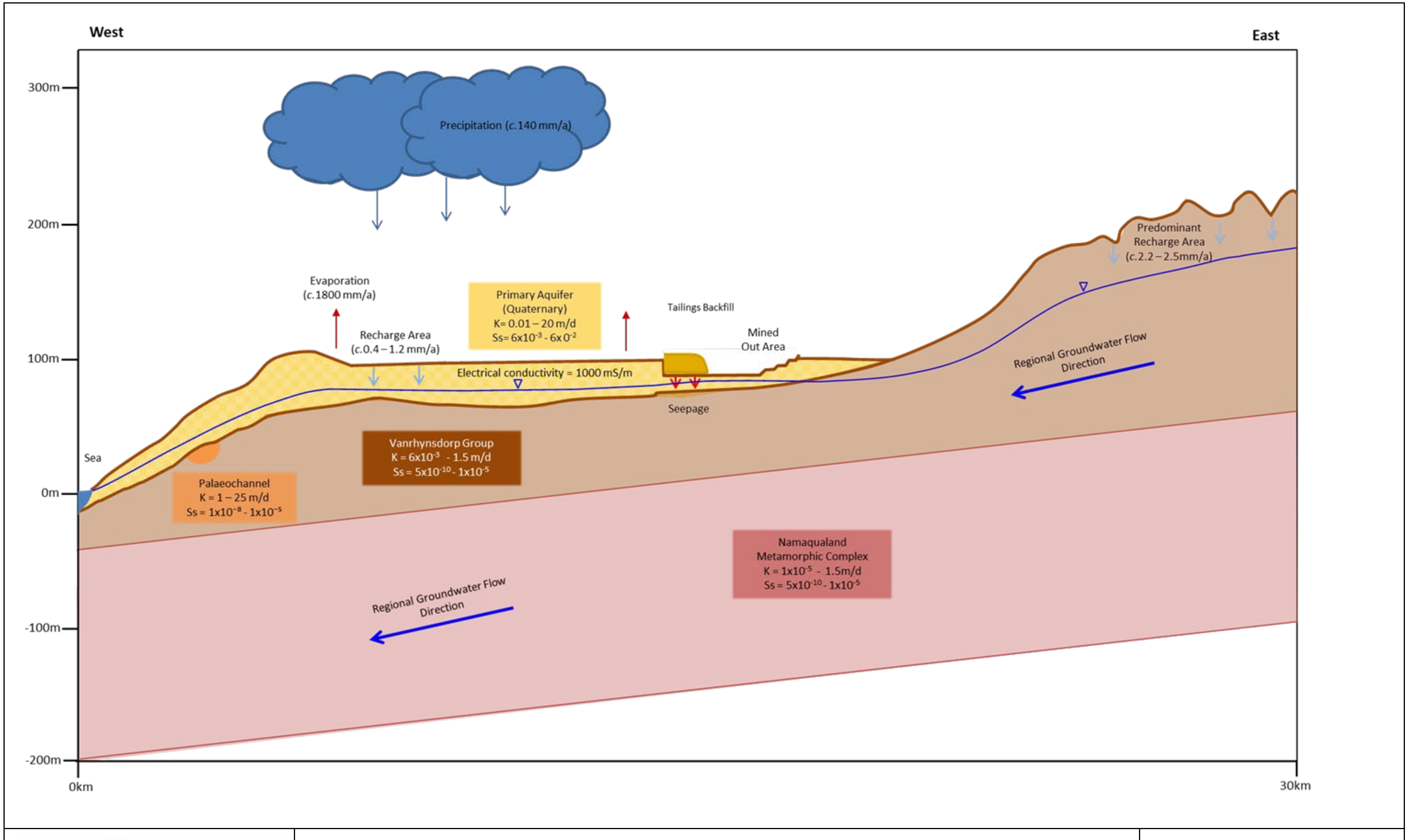
SRK (2015) describes two main aquifers in the area, namely:

- A primary, intergranular aquifer:
    - This has been formed in the unconsolidated or semi-consolidated sediments approximately 10 – 50 m thick;
    - It may include palaeochannels which could cause possible preferential pathways for groundwater to flow;
    - The aquifer is only partially saturated with varying hydraulic properties in different lithological units or rock groupings;
    - Groundwater levels vary between 5 and 90 m below ground level (mbgl) across the study area, with shallow water levels nearer the rivers and coast; and
    - Although the aquifer lies close to the bed of the Groot Goerap River in places (between 5 and 9 mbgl), surface and groundwater systems are likely to be hydraulically connected only during flooding / surface flow conditions.
- A secondary, fractured-rock aquifer:
    - This underlies the primary aquifer; and
    - This aquifer is fed by the primary aquifer, albeit at slow recharge rates.

SRK (2020c) further characterises the distribution and movement of groundwater namely:

- Regionally, the water table contours correlate to topography;
- A groundwater divide exists between quaternary catchments F60D and F60E (see **Figure 3.1**), with groundwater flow north of the divide (i.e. in F60D) being directed inland towards the Sout River and Groot Goerap River, while south of the divide (F60E) groundwater is directed towards the coast;
- Groundwater levels vary between 2 and 90 m below ground level (mbgl) across the study area, with shallow water levels nearer the rivers and coast;
- Groundwater levels average 20 to 40 mbgl at the East mine.

Based on hydrocensus of the study area and monitoring at the mine, groundwater quality in the SRK groundwater model (SRK 2020c) is given as 1000 mS/m, with the site as a whole lying in an area mapped in terms of regional groundwater quality as 300 – 1000 mS/m. The conceptual model of current surface / groundwater interactions as presented by SRK (2020c) is reproduced in **Figure 3.2** for ease of reference, because it is of significant importance in explaining groundwater links with aquatic ecosystems.



srk consulting

East OFS Project Residue Disposal Plan - Groundwater Specialist Study
Hydrogeological Conceptual Model

Project No.
548215

Figure 3.2
Hydrogeological Conceptual Model, after SRK (2020c)

3.5 Surface hydrology

SRK (2020b) notes that the mean annual runoff (MAR) of the Sout River Catchment is very low (0.7 mm per year). Surface flow is thus extremely rare and explains the low numbers of well-defined drainage lines in the area. The aquatic ecologist (this author) noted that the only relatively well-defined drainage lines in and abutting the study area comprised the Groot Goerap and the Sout Rivers themselves.

Alterations to topography from mining on the site have altered surface water flow patterns, and no natural watercourses cross the site (SRK 2020b). The latter study identified a number of subcatchments across the broader Namakwa Sands Mine site, including the current study area. The extents and locations of these are shown in **Figure 3.3** (after SRK 2020b), and comprise:

- Four sub-catchments (RC1, RC3, RC4 and RC5) that discharge into the Groot Goerap River;
- One sub-catchment (RC2) that discharges into the Sout River;
- One sub-catchment (OC1) that discharges towards the coast; and
- The "De Kom" sub-catchment, which discharges into the De Kom ephemeral pan;
- Three "non-draining" sub-catchments (NDC1, NDC2 and NDC3), defined by SRK (2020b) as "*topographically isolated from other surface water systems" such that "rain water falling in the catchment does not discharge to another catchment or to the ocean. Excessive rainwater in these systems is channeled towards a central pan-like depression, or depressions, where it would (depending on the nature of the catchment) evaporate, infiltrate or, in large events, spill into another catchment*". A depression was identified on the base of each of the non-draining catchments.

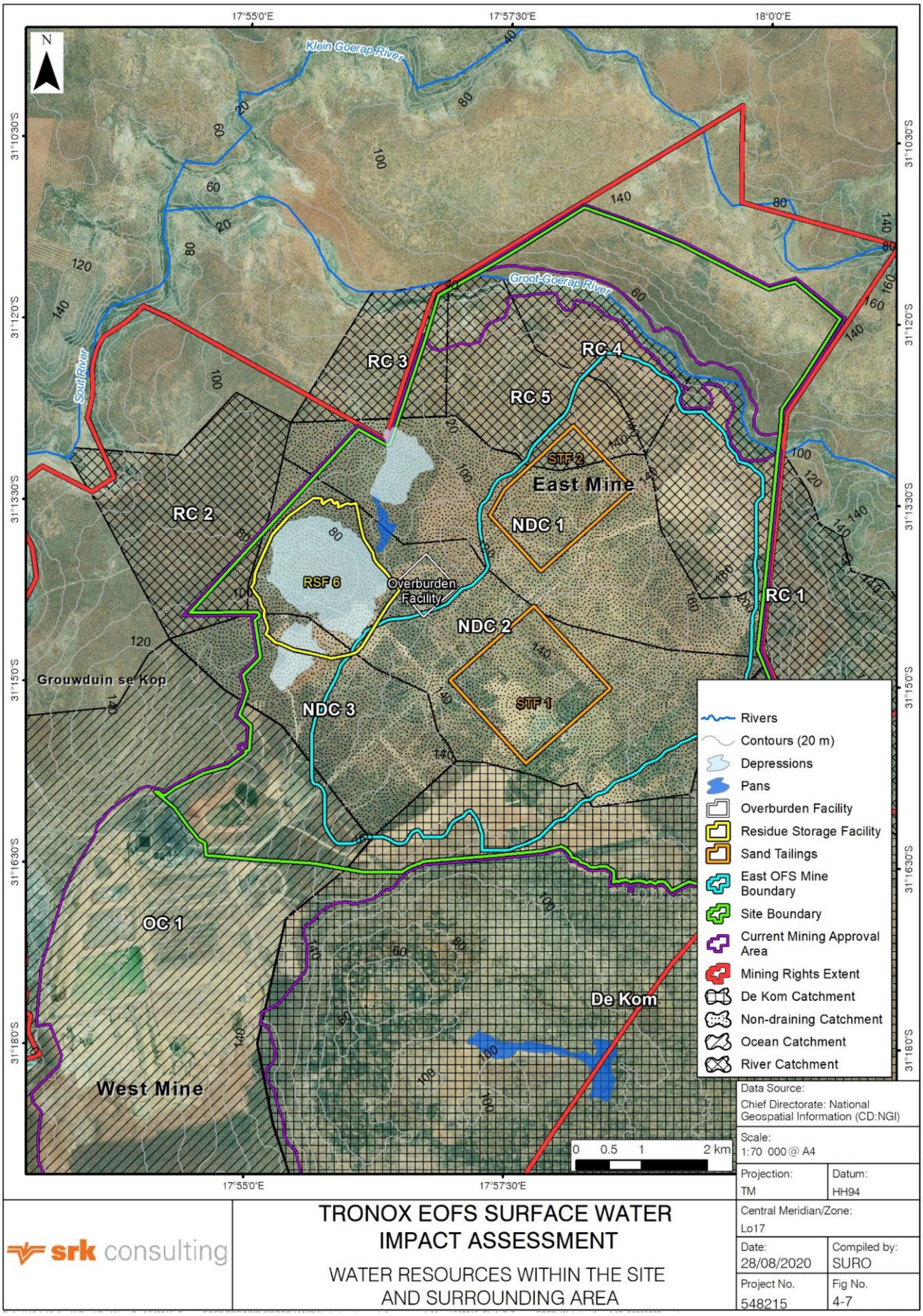


Figure 3.3
Surface water resources in the site and surrounding area – Figure extracted from SRK (2020b)

3.6 Context in Western Cape Biodiversity Spatial Plan – aquatic ecosystems

The Western Cape Biodiversity Spatial Plan (WCBSP) of Pool-Stanvliet et al (2017) was used to provide context for the site in terms of regional (provincial) biodiversity spatial planning. The WCBSP includes both terrestrial and aquatic ecosystems, which have been classified and rated in terms of their contribution to biodiversity, with the following categories included in the rating system, namely (after Pool-Stanvliet et al 2017):

- **Critical Biodiversity Areas (CBAs):** *Terrestrial (e.g. threatened vegetation type remnants) and/or aquatic features (e.g. [wetlands], rivers and estuaries), and the buffer areas along aquatic CBA features, whose safeguarding is critically required in order to meet biodiversity pattern and process thresholds;*
- **Ecological Infrastructure**: *Naturally functioning ecosystems that deliver valuable services to people, such as water and climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure and can be just as important for providing services and underpinning socio-economic development. Ecological infrastructure does this by providing cost effective, long-term solutions to service delivery that can supplement, and sometimes even substitute, built infrastructure solutions. Ecological infrastructure includes healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape;*
- **Ecological Support Areas**: *A supporting zone or area required to prevent the degradation of Critical Biodiversity Areas (CBAs) and protected areas. They can be aquatic features, e.g. specific river reaches which feed into aquatic Critical Biodiversity Areas; or terrestrial features, e.g. the riparian habitat surrounding and supporting aquatic Critical Biodiversity Areas, and are often vital.*

Figure 3.4 presents the site in the context of the WCBSP data. The figure illustrates the following aspects:

- The Sout River Estuary is classified as a CBA;
- The Groot Goerap and Sout Rivers are both classified as ESAs, largely reflecting their importance as ecological corridors;
- A number of ESAs have been mapped along low points leading down to the Sout and Groot Goerap Rivers – note that ground-truthing in the present study confirmed that these are unlikely ever to convey surface flows, and it is assumed that they result from desktop mapping;
- Restorable ESAs have been mapped along the Groot Goerap River, representing restorable aquatic ecosystems that could contribute towards conservation targets; and
- The De Kom has been classified as a terrestrial CBA, indicating its high botanical biodiversity importance, while the De Kom pan has been classified as a CBA wetland.

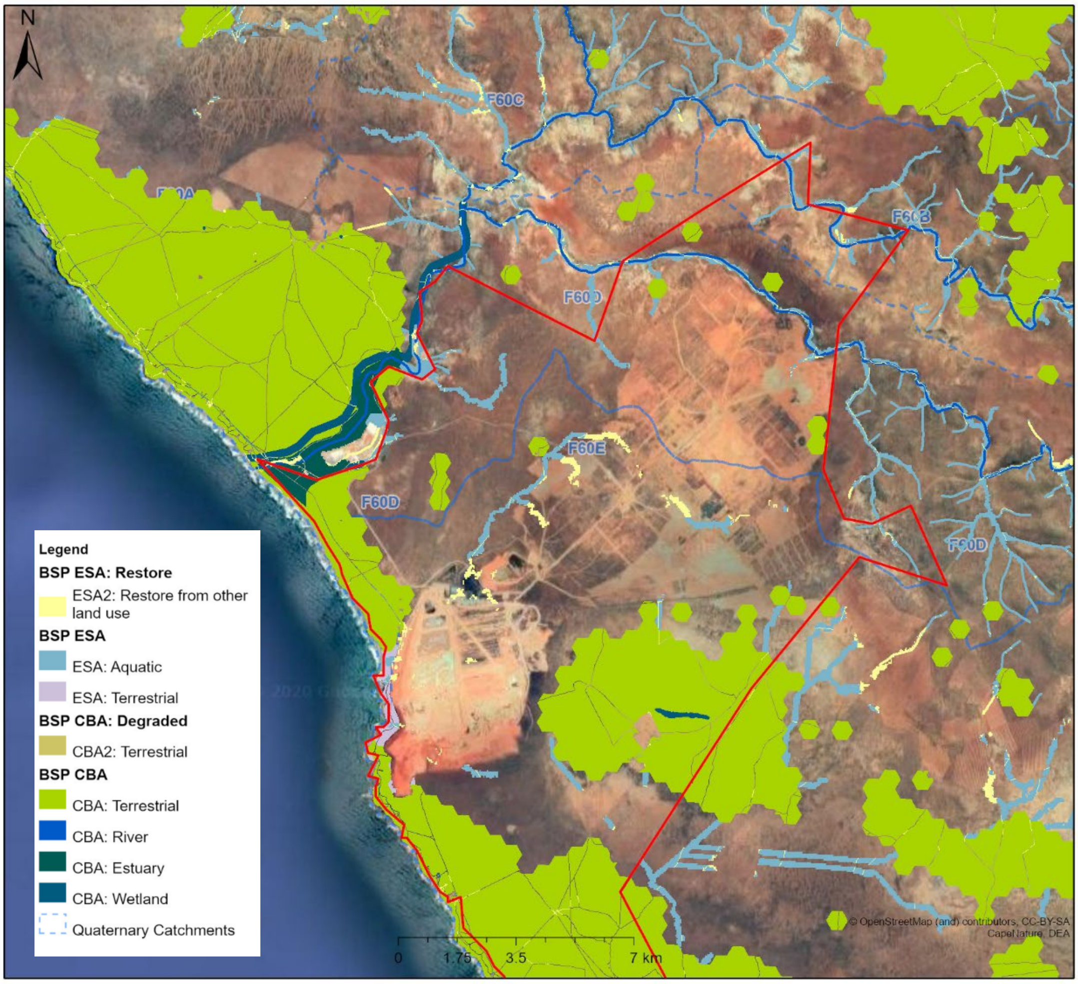


Figure 3.4
Tronox Namakwa Sands Mne in the context of the Western Cape Biodiversity Spatial Plan (WCBSP 2017) (Pool-Stanvliet et al 2017)

3.7 Vegetation

The study area is part of the Succulent Karoo biome, within what is now known as the Extra Cape Region of the Greater Cape Floristic Region (Manning & Goldblatt 2012 in Helme 2014). The (2018) National Vegetation Map of South Africa (SANBI 2006-2018) indicates that most of the site comprises Namaqualand Inland Duneveld vegetation, with patches of Namaqualand Heuweltjieveld and a swathe of Namaqualand Strandveld running from north east to southwest.

Patches of Namaqualand Sand Fynbos occur along the Groot Goerap River, and the De Kom depression, including the De Kom pan, also lie within this vegetation type.

The Groot Goerap and Sout Rivers have been mapped as azonal Namaqualand Riviere vegetation, with parts of the estuary mapped out as azonal Estuary vegetation.

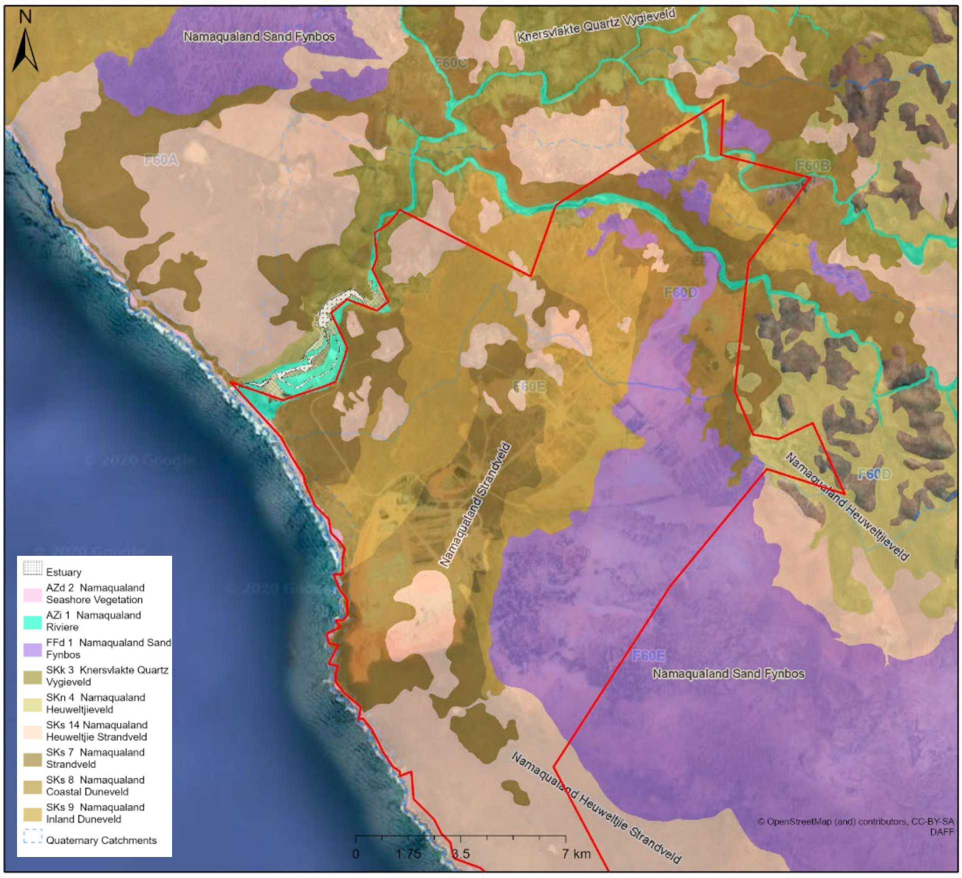


Figure 3.5
Vegetation of the site and surrounding areas – as per the (2018) National Vegetation Map of South Africa (SANBI 2006-2018). Map adapted from Cape Farm Mapper
(https://gis.elsenburg.com/apps/cfm/#)

3.8 Description of watercourses on or adjacent to the East OFS site

This section has been compiled on the basis of existing reports and maps, as well as observations made during the August 2020 site visit, towards the end of a wet winter, following a prolonged drought.

A number of aquatic ecosystem types and systems have been identified within and abutting the site. These comprise:

- The Groot Goerap River;
- The Sout River and its estuary;
- A number of perched wetland pans within the site, some of which were included in areas mapped by Helme (2014) and ground-truthed in this study;
- The De Kom pan, which lies just outside of the current study area.

In addition to these, the surface water EIA for this project (SRK 2020b) identified three depressions, which could potentially comprise watercourses.

The above systems are described and discussed in the following sections. Aquatic ecosystems and depressions that were identified have been marked in **Figure 3.3**

3.8.1 The Groot Goerap River

The course of the Groot Goerap River passes along the northern boundary of the present study area, and would be fed by surface runoff from subcatchments RC1, RC3, RC4 and RC5 (see **Figure 3.3**). Previous assessments (e.g. SAS 2014) have classified this river as a wetland system, despite the lack of soil hydromorphological features or the establishment of vegetation typical of soils with extended saturation. In this assessment, as per Day (2019), the river is rather classified in terms of Ollis et al (2013) as a Lowland River, in a Plain setting, where hydrological inputs are characterised by (any of) "Overland flow from catchment runoff, concentrated surface flow from upstream channels and tributaries, diffuse surface flow from an unchanneled upstream drainage line (i.e. an unchanneled valley-bottom wetland), seepage from adjacent hillslope or valley head seeps, and/or groundwater (e.g. via in-channel springs)" .

The system is further classified as an ephemeral river, characterised by low frequency, irregular flows and extended periods of dryness. It flows within a defined channel, prone to erosion in places. High evaporation rates and low flows are evidenced in parts of the river low flow channel, where salt crystallisation has occurred. Day (2019) attributed this in part to the possible influence of seepage of saline (seawater) water from adjacent rehabilitated areas of the Mine, but salt crystallisation is likely to be a characteristic of rivers such as this, where groundwater is naturally saline, with high evapoconcentration rates, and highly infrequent periods of flushing by dilute, flood flows (the last time the river flowed appears to have been 1968 – see Section 3.2).

The Groot Goerap River was identified by SAS (2014) as of High Ecological Importance and Sensitivity (EIS). This assessment was corroborated by the botanical specialist, who noted the sensitivity of the environment to impacts such as compaction and even shallow surface disturbance, given the reliance of many species on accessing dew from coastal mists through numerous fine roots that occur close to the surface. Ecological importance derives primarily from the role of the river as a corridor through the landscape – this role will be increasingly important as mining progresses through the study area.

Figure 3.6 illustrates the river in its reaches through the study area. Generally, the river and its floodplain are dominated by plants adapted to arid conditions with occasional short-lived water availability. Such plants include *Lebeckia* sp, the succulent shrub *Ruschia aff. versicolor*, *Zygophyllum retrofactum* and *Galenia africana* (kraalbosch) (Day 2019).

Figure 3.6
Groot Goerap River in its reaches through the site

Present Ecological State (or condition) of the river has been assessed as Category B PES by both SAS (2014) and Day (2019) and the present study confirms that there have been no reach-level changes in river condition since then, other than some localised impacts of truck crossings.

3.8.2 The Sout River

The Sout River lies outside of the Mining Right area, but could potentially be impacted by changes in groundwater flows into the system (SRK, 2020c). The Sout River flows within a clearly defined channel, edged on either sides by steep slopes up to the surrounding terrain. It is flat-bottomed and gently sloped, and its course meanders gently towards its estuary, typical of a lowland river.

The arid nature of its catchment (see Section 3.2) means however that the river rarely conveys surface flows. Nevertheless, the channel remains sandy and clear of vegetation. This is assumed to be in part the result of low water availability generally in the landscape, making the proliferation of plants unlikely, but also a reflection of high salt content in the river substrates. These are assumed to derive from evapoconcentration of surface waters accumulating in the sands (even when there is insufficient water to promote flow), resulting in the accumulation of salts in river substrates and an associated dearth of all but the most salt tolerant plant species.

Figure 3.7
View north to the Sout River from the site

PES of the Sout River was calculated, using the methodology outlined in Appendix A, which yielded the result that the river upstream of its estuary was in a PES Category B – largely natural. This reflects a river that is relatively unimpacted, with low levels of alien plant or animal invasion; (assumed) relatively intact species diversity; low levels of erosion; assumed low levels of abstraction (due to the high natural salinity of the system and the low frequency of flows); and an apparently natural geomorphology, with low levels of geomorphological change.

As in the case of the Groot Goerap River, the Sout River has been assessed as of High Ecological Importance and Sensitivity (EIS), with high sensitivity to physical disturbance (given the fact that it may be many years before a flood passes through and can (potentially) re-set damage done to the river bed). The system is also considered highly sensitive to changes in hydroperiod and, if linked to changes in hydroperiod, water quality. Thus increased flows into the system such that they resulted in prolonged saturation could alter habitat type dramatically, and would be more pronounced if accompanied by chemical changes, such as increases or decreases in salinity.

Ecological importance again derives primarily from the role of the river as a corridor through the landscape, but in addition recognises that the pronounced river corridor, and bare sandy bed is a marked feature in the landscape, which adds to its importance.

3.8.3 The Sout River estuary

The Sout River Estuary lies outside of the Namakwa Sands Mine area. A salt processing works has been established in the estuary, with the result that there has been considerable disturbance to the estuary bed and banks with multiple berms being created to contain water and allow its evaporation. Roads cross the watercourses, often with small single culverts, resulting in downstream constriction of flows and associated narrowing of wetland extent, downstream of the saltworks.

Given the low frequency of flow in the Sout River, it is not surprising that the saltworks in fact make use of groundwater rather than river flows to derive their salts. This means that the lower estuary is the only part of the Sout River system that is perennially wet. Standing water in the lower estuary promotes algal growth (*Cladophora* sp.) and provides an artificial wetland habitat that supports wading birds such as Flamingos.

Physical disturbance of the estuary and changes in its natural flow dynamics is the most significant impact affecting the Sout River Estuary. The estuary is not included in the Cape Estuaries Conservation Plan, which extends as far as the Olifants River estuary, some 65km south. An Estuary Management Plan has however been compiled for the estuary (Western Cape Government 2019). This document accords the estuary a PES Category E, with a recommended Ecological Category D. Physical disturbance (particularly the salt works but also 4x4 activity), abstraction, nutrient enrichment and salinisation of the estuary are among the issues highlighted to be addressed if rehabilitation of the estuary is to be achieved, and a buffer area of 100m from the estuary edge is recommended.

Figure 3.9
Sout River Estuary showing extensive physical disturbance as a result of the saltworks

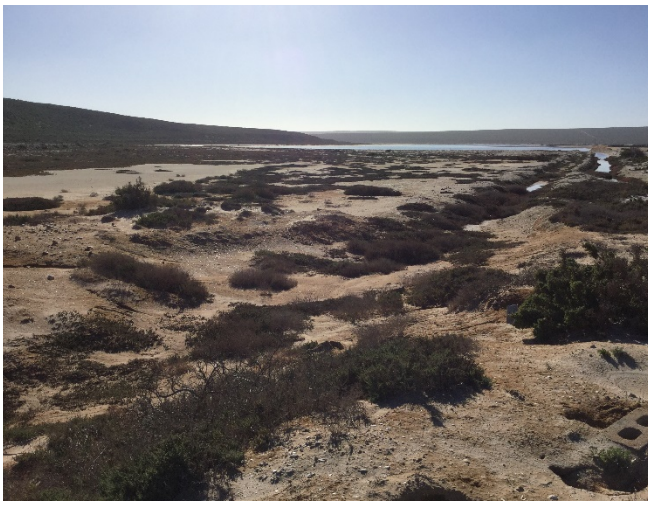


Figure 3.10
The Sout River estuary

3.8.4 Perched wetland pans

The surface water report (SRK 2020b) identifies three depressions on the site, as well as two pans – one in the north and one being the De Kom pan, in the south east (discussed in Section 3.8.5). These low-lying areas (excluding Die Pan) were ground-truthed during the site assessment, and low points were hand-augered, as per DWAF (2005) and (2008), to ascertain whether they were wetland in character or not.

Based on site ground-truthing, including hand augering of low lying areas, the following conclusions were drawn: