APPENDIX D

Specialist Reports

APPENDIX D_1

Heritage Report

Heritage Impact Assessment of the De Put de-sludge area, Sandspruit, Senekal, Setsotso Local Municipality, FS Province.

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31 August 2021

Summary

A phase 1 Heritage Impact assessment was conducted for proposed de-sludging of a 0.6 ha area behind a 105 m – long concrete weir in the Sandspruit near Senekal in the FS Province. The survey area is primarily underlain by medium to coarse-grained sandstones and intercalated mudstones of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup), capped by younger and well-developed, fluvial / alluvial deposits of Quaternary age . The affected area lies within a 240 m long section of the fluvial range of the Sandspruit and terminates at a concrete weir in the north. The concrete weir and an accompanying berm was constructed in the 1970's as part of the De Put Water Scheme for water retention in the Sand Spruit in order to alleviate an acute water shortage in town. The site has been severely degraded by previous and ongoing construction work. There is no evidence for the accumulation and preservation of intact fossil material within the Sandspruit fluvial sediments impacted by the development. There are no indications of Stone Age artifacts, prehistoric structures, graves or rock art within the footprint. There is also no evidence of historical structures within the confines of the study area.The development primarily affects late Quaternary fluvial deposits, which occurs within the normal course of the Sandspruit under a regime of continuously flowing water. Thus, given the nature of the footprint (active river), potential for palaeontological and archaeological impact is considered very low. There are no major archaeological grounds to suspend the proposed development, provided that all excavation activities are confined to within the (fluvial) confines of the development footprint and not adjacent alluvial deposits (sediments that are laid down when the river goes beyond its normal boundaries, i.e. ancient floodplains, terraces or overbank deposits). The study area is considered to be of low archaeological significance and is assigned a site rating of Generally Protected C.

Introduction

A phase 1 Heritage Impact assessment was conducted for proposed de-sludging of a 0.6 ha area behind a 105 m – long concrete weir in the Sandspruit near Senekal in the FS Province. The extent of the proposed development (over 5000 m2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African National Heritage Resources Act (Act No. 25 of 1999). The region's unique and non-renewable archaeological and palaeontological heritage sites are 'Generally' protected in terms of the National Heritage Resources Act (Act No 25 of 1999, Section 35) and may not be disturbed at all without a permit from the relevant heritage resources authority. As many such heritage sites are threatened daily by development, both the environmental and heritage legislation require impact assessment reports that identify all heritage resources within the area to be developed, and that make recommendations for protection or mitigation of the impact of the sites.

The assessment involved identification of possible archaeological and paleontological sites or occurrences in the proposed zone, an assessment of their significance, possible impact by the proposed development and recommendations for mitigation where relevant.

Methodology

The palaeontological and archaeological significance of the affected area was based on existing field data, database information, published literature and maps. This was followed up with a field assessment by means of a pedestrian survey and investigation within the footprint. A Garmin Etrex Vista GPS hand model (set to the WGS 84 map datum) and a digital camera were used for recording purposes. Site significance classification standards prescribed by SAHRA (2005) were used to indicate overall significance and mitigation procedures where relevant (**Table 1**).

Site Information

Maps: 1:50 000 topographical 2827BC Senekal

1:250 000 geological map 2826 Winburg

General Site Coordinates:

A) 28°21'28.53"S 27°37'15.96"E
B) 28°21'28.19"S 27°37'17.67"E
C) 28°21'29.80"S 27°37'20.99"E

D) 28°21'33.78"S 27°37'23.92"E
E) 28°21'34.57"S 27°37'22.37"E
F) 28°21'30.88"S 27°37'20.28"E

The site is located about 4km due south of the Senekal CBD on the farm De Put 298 and within a 1.6 ha section of the Sandspruit next to the Matwabeng Dam **(Fig. 2**).

Background

Geology

The survey area is primarily underlain by medium to coarse-grained sandstones of the Adelaide Subgroup (*Pa*, Beaufort Group, Karoo Supergroup) (Nolte 1995; Johnson *et al*. 2006) (**Fig. 3**). Sedimentary rocks form the base on which younger, fluvial / alluvial deposits of Quaternary age have been deposited by the Sandspruit (**Fig. 3**, *flying bird symbol*; **Fig. 4**).

Palaeontology

The Karoo sedimentological strata underlying the site and surrounding area are generally accepted to be Late Permian in age, and are assigned to the *Dicynodon* and overlying *Lystrosaurus* Assemblage Zones (Kitching 1977; Groenewald & Kitching 1995) (**Fig. 5**). The sediments assigned to the *Dicynodon* AZ are associated with stream deposits consisting of floodplain mudstones and subordinate, lenticular channel sandstones. Therapsids and other vertebrate fossils from the *Dicynodon* AZ are usually found as dispersed and isolated specimens in mudrock horizons, associated with an abundance of calcareous nodules. *Dicynodon lacerticeps* have been found on the Senekal commonage. Vertebrate fossils of the *Lystrosaurus* Assemblage Zone are primarily found in the mudrock sequences between channel sandstones. Fossils are frequently preserved as articulated skeletons within well-defined blue-grey or red-brown calcareous nodules. Burrow casts have been described from several localities within the biozone (Groenewald, 1991). Fossils of *Lystrosaurus* have been recorded on the farms Kruis Vlei 279, Halfweg 356, Brandfort 320 and Magdala 97. Plant fossils (*Dadoxylon, Glossopteris*) and trace fossils (arthropod trails, worm burrows) are also present (Groenewald 1991). Fossil trees of the *Dadoxylon* genus are common in the Winburg and Harrismith districts. A high occurrence of fossil wood has been recorded on the farms Waterloop 698, Langlaagte 398, Helderwater 701, Onze Rust 700 and Blinkwater 702 (**Fig. 6**). Partially consolidated Quaternary alluvium found along the Sandspruit southeast of Senekal are characterized by extensive erosion in the form of dongas, and are known to occasionally contain late Pleistocene vertebrate remains (Rossouw pers comm) and even localized death assemblages, e.g. densely packed, large mammal bone beds at Heelbo, which

includes 3600 year old articulated skeletons of black wildebeest *Connochaetes gnou* (Backwell et al. 2018)(**Fig. 6 & 7**).

Archaeology

The South African central plateau is distinctive in that it supported Stone Age people over thousands of years, who were also prolific makers of stone tools until relatively recent times. This can be seen in the high density of Stone Age archaeological traces visible on the landscape today. The range of archaeological sites encountered in the Free State is extensive, in terms of both typology and chronology. This include Early Stone Age bifaces, and retouched blades and trimmed points from the Middle Stone Age to the microlithic Wilton and Smithfield Complexes from the Holocene. Surface scatters of Later Stone Age and Middle Stone Age artifacts are frequent archaeological components along erosional gullies (dongas) of rivers and streams in the region. The incidence of surface scatters usually decreases away from localized areas such as riverine sites and dolerite-shale contact zones. Away from riverine contexts, Stone Age artifacts generally occur as contextually derived individual finds in the open veld. Ephemeral, LSA open sites have been mapped near alluvial contexts, e.g. on the banks of the Tom Schutte Spruit located about 8km south–west of Senekal on the N5 national road and the Sandspruit south of Paul Roux (Rossouw 2013, 2014) (**Fig. 8 & 9**). Several rock art localities, containing depictions of human figures, have been recorded in the Witteberge southeast of Paul Roux and at Langlaagte and Niekerksrust north and southeast of Senekal, respectively (van Riet Low 1941). Late Iron Age stonewalled complexes primarily dominate the archaeological footprint in the region (Breutz 1956; Maggs 1976) (**Fig. 10**). Stone enclosures found on and around dolerite koppies along the river valley between Winburg and Paul Roux, exhibit telltale signs of basic structural units including huts, large enclosures, and pieces of walling and stone circles related to Late Iron Age settlements in the area (**Fig. 11**). These sites were occupied from as early as the sixteenth to seventeenth centuries and represent a system that can be broadly attributed to groups ancestral to the Sotho-speaking people of today (Maggs 1976) (**Fig. 12**). Subsequent occupation of the Free State by trekboers and the British government culminated in the establishment of the Orange River Sovereignty (1848–1854) and the Orange Free State in 1854. This was followed by a period of ongoing territorial conflict between Boer and Basuto, with the site that would eventually become Senekal, situated about 50 km north of much disputed territories (**Fig. 13**). Senekal was founded in 1877 after farmers in the area appointed a committee to select suitable area (farm De Put) for construction of a new church in 1873 (Oberholzer & Stemmet 1977) (**Fig. 14**).

Field Assessment

The affected area lies within a 240 m long section of the fluvial range of the Sandspruit and terminates at a concrete weir in the north (**Fig. 15**). The concrete weir and an accompanying berm was constructed in the 1970's as part of the De Put Water Scheme for water retention in the Sand Spruit in order to alleviate an acute water shortage in town (Oberholzer & Stemmet 1977) (**Fig. 16**). The site has been severely degraded by previous and ongoing construction work (**Fig. 17**). There is no evidence for the accumulation and preservation of intact fossil material within the Sandspruit fluvial sediments impacted by the development. There are no indications of Stone Age artifacts, prehistoric structures, graves or rock art within the footprint. There is also no evidence of historical structures within the confines of the study area.

Impact Statement and Recommendations

The development primarily affects late Quaternary fluvial deposits, which occurs within the normal course of the Sandspruit under a regime of continuously flowing water. Thus, given the nature of the footprint (active river), potential for palaeontological and archaeological impact is considered very low. There are no major archaeological grounds to suspend the proposed development, provided that all excavation activities are confined to within the (fluvial) confines of the development footprint and not adjacent alluvial deposits (sediments that are laid down when the river goes beyond its normal boundaries, i.e. ancient floodplains, terraces or overbank deposits). The study area is considered to be of low archaeological significance and is assigned a site rating of Generally Protected C (**Table 1**).

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DECLARATION OF INDEPENDENCE

I, Lloyd Rossouw, declare that I act as an independent specialist consultant. I do not have or will not have any financial interest in the undertaking of the activity other than remuneration for work as stipulated in the terms of reference. I have no interest in secondary or downstream developments as a result of the authorization of this project.

Tables and Figures

Table 1. Field rating categories as prescribed by SAHRA.

Field Rating	Grade	Significance	Mitigation
National Significance (NS)	Grade 1	-	Conservation; national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation; mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A (GP.A)	-	High/medium significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium significance	Recording before destruction
Generally Protected C (GP.C)	-	Low significance	Destruction

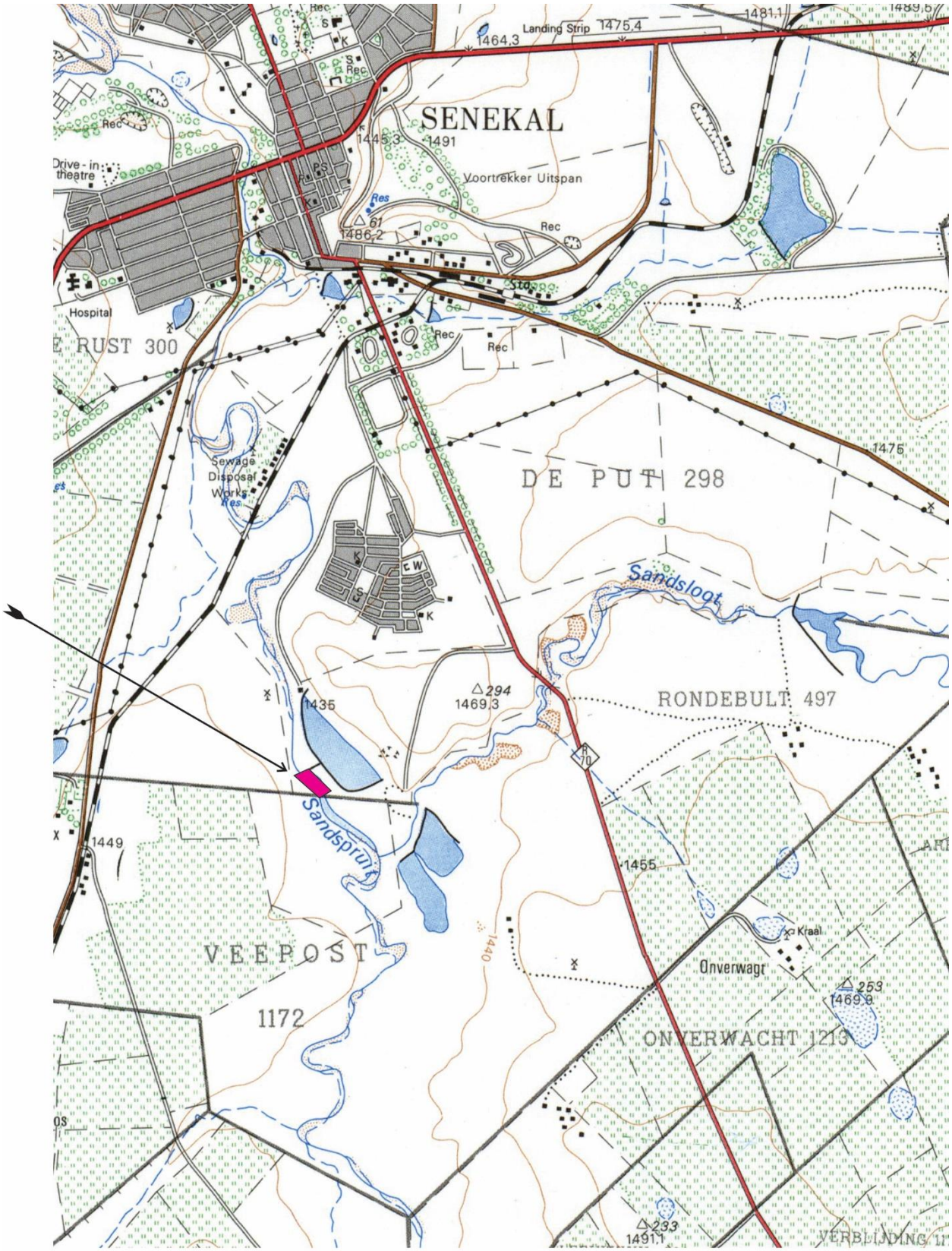
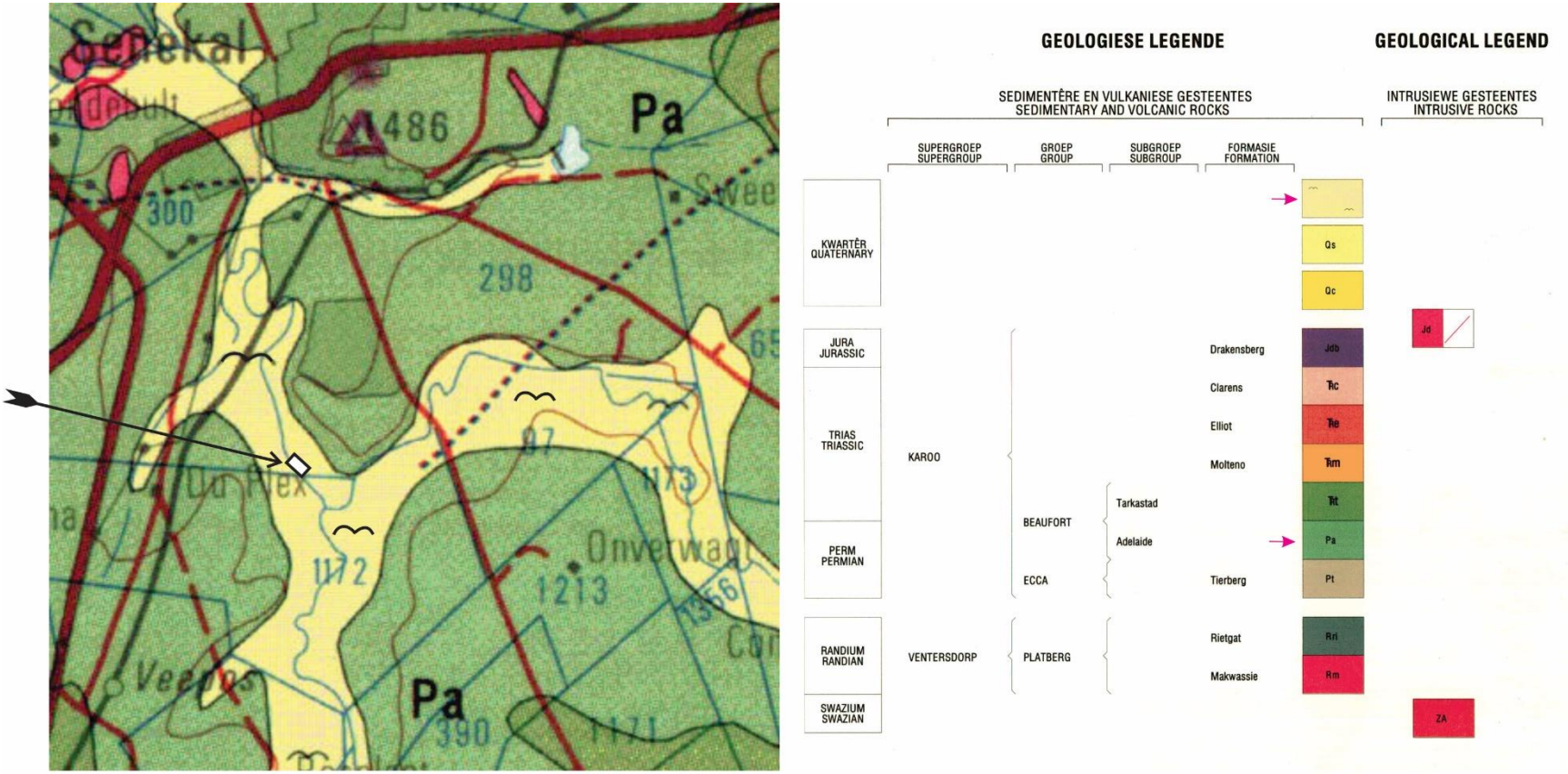


Figure 1. Map of the study area marked on portion of 1:50000 scale topographic map 2827 BC Senekal.

Figure 2. Aerial view of the study area.



Study area marked on portion of 1:250 000 scale geological map 2826 Winburg. The site lies within the outcrop area of the Permian Adelaide Subgroup (*Pa*, Beaufort Group, Karoo Supergroup) and is capped by fluvial / alluvial deposits of the Sandspruit (*flying bird symbol*).

Figure 4. Adelaide Subgroup sandstones and mudstones exposed by river action (left and above right) and geologically recent overbank sediments (below right), located downstream and upstream from the weir, receptively. Scale 1 = 10 cm.

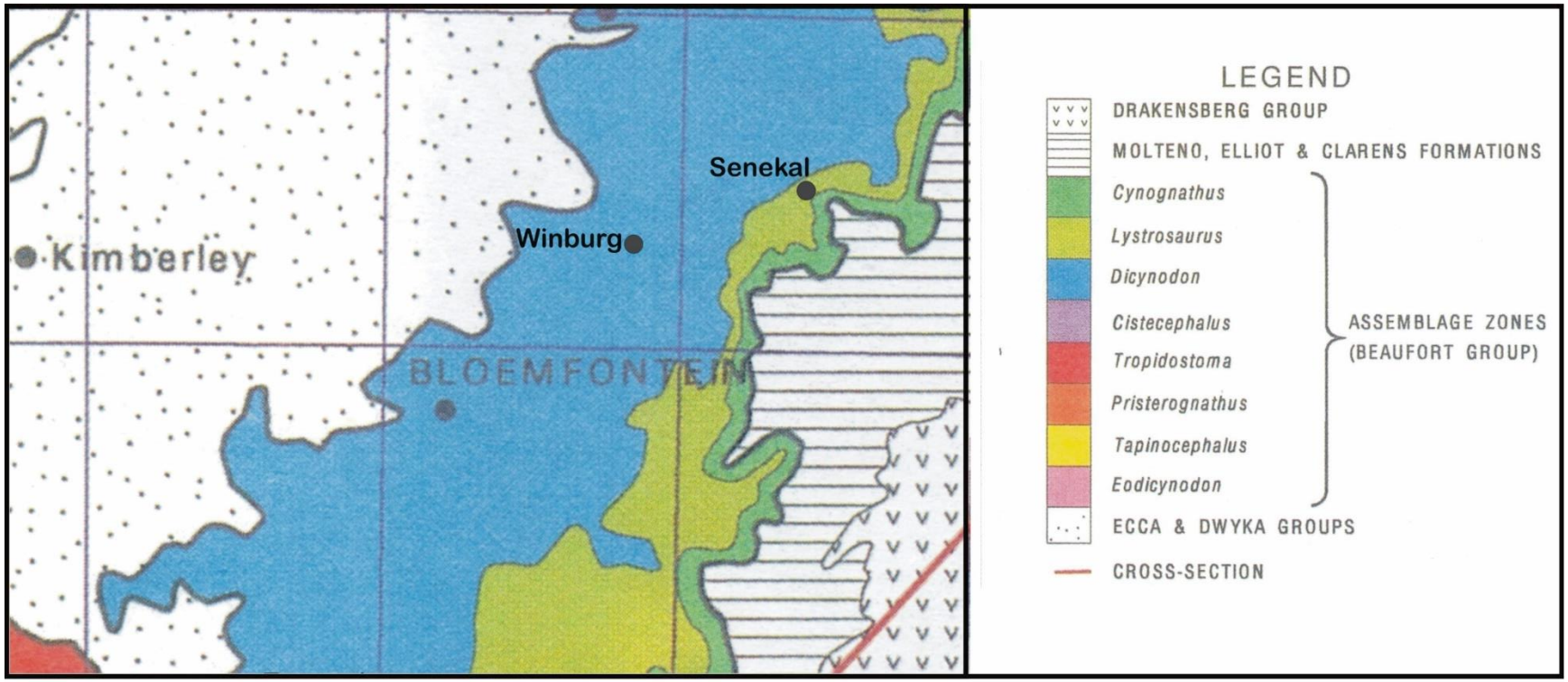


Figure 5. Geographic distribution of the vertebrate biozones (Assemblage Zones) of the Beaufort Group (after Rubidge 1995).

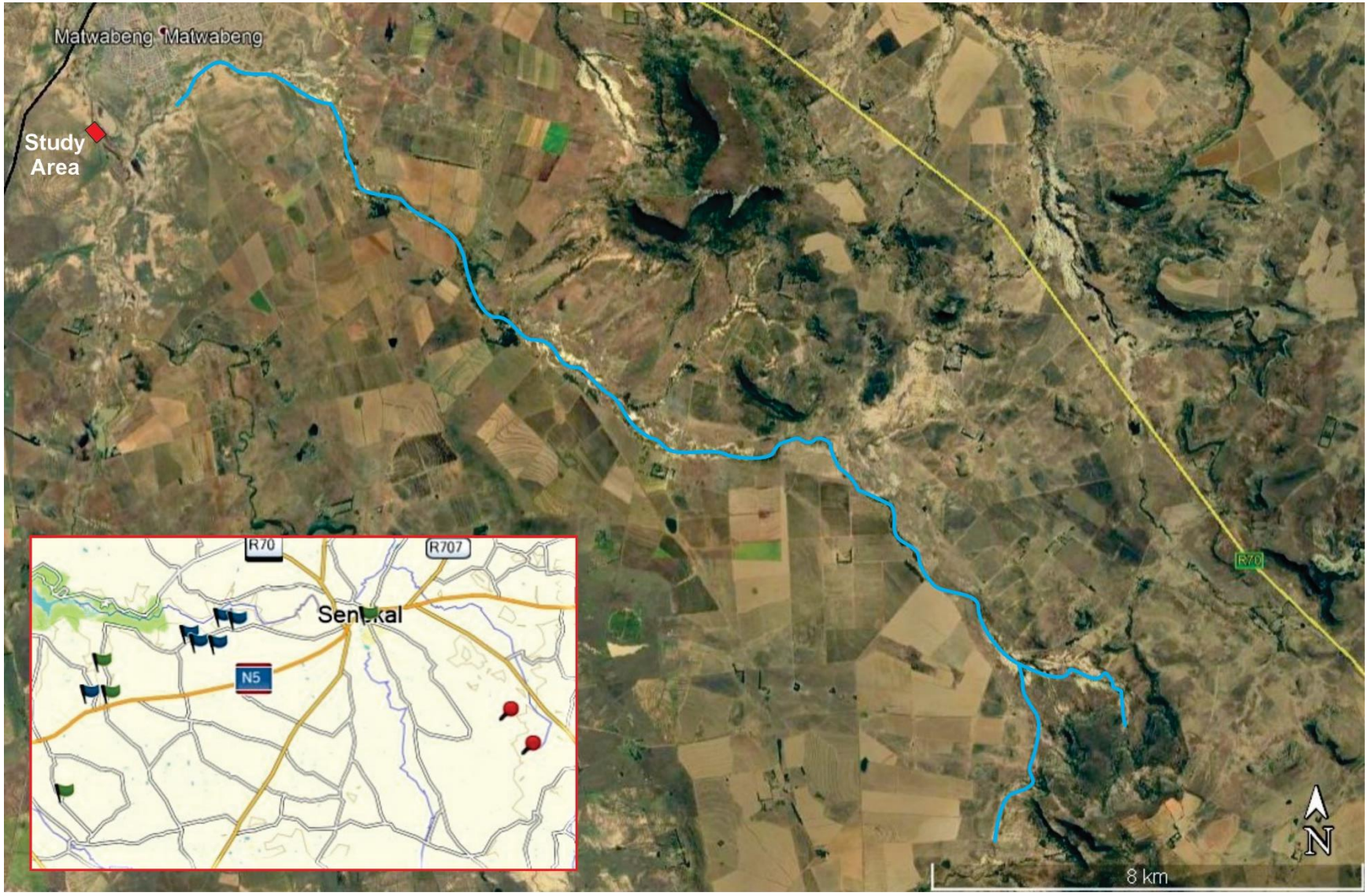


Figure Palaeontologically significant Sandspruit and map insert of Karoo vertebrate fossil sites (green flags) petrified wood localities (red flags) and late Quaternary fossil sites (red pins), mentioned in text.

Figure 7. Late Pleistocene (top) and Holocene (center & bottom) mammal fossils eroding from ancient, Sandspruit - associated overbank sediments.

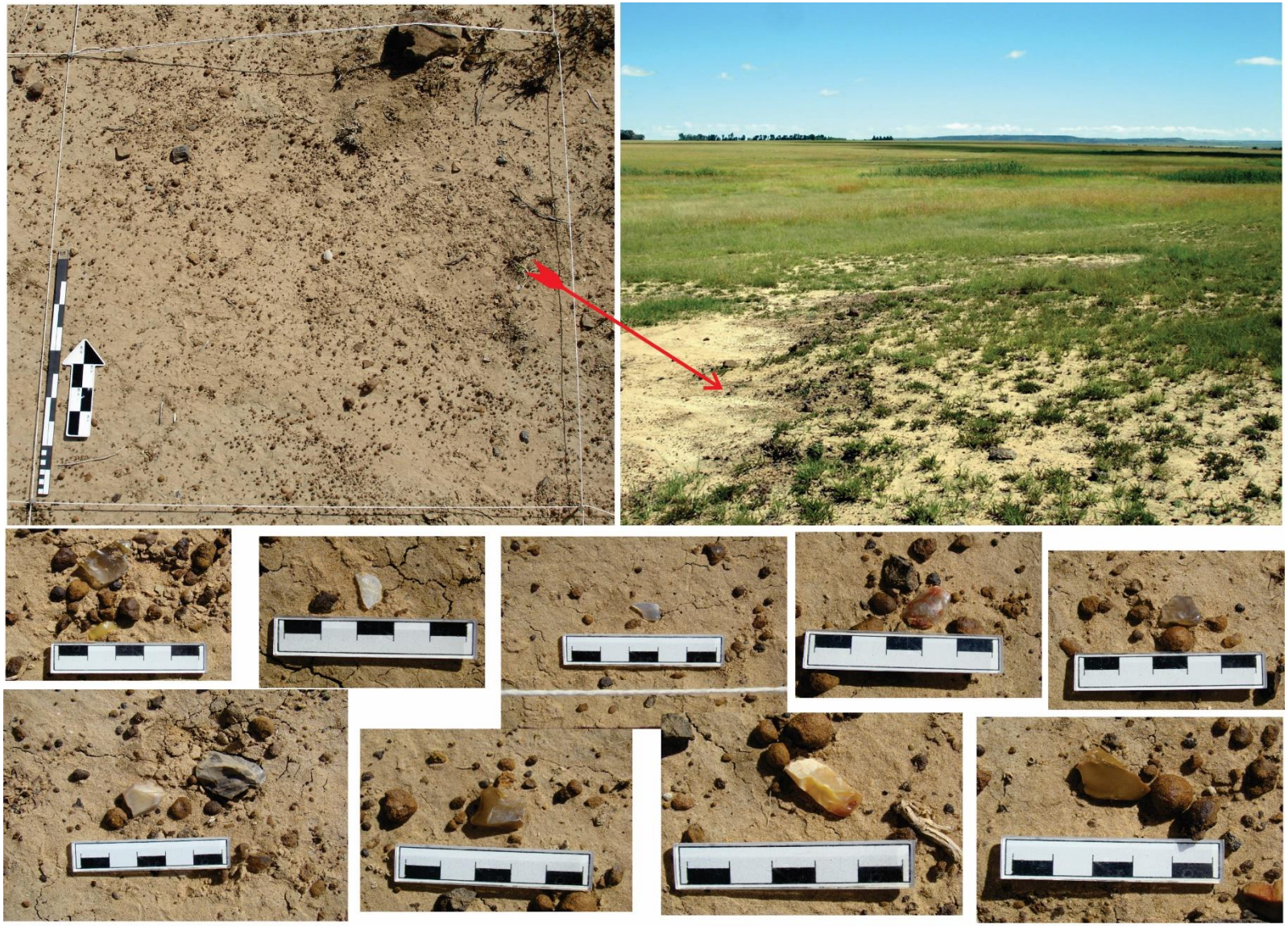


Figure 8. Later Stone Age open site located within overbank sediments of the Tom Schutte Spruit, about 8km south–west of Senekal on the N5 national road. Dense concentration of microliths made from cryptocrystalline quartz and petrified wood (*Dadoxylon*).

Figure 9. Partially intact Later Stone Age site on old palaeosurface, Sand River south of Paul Roux.

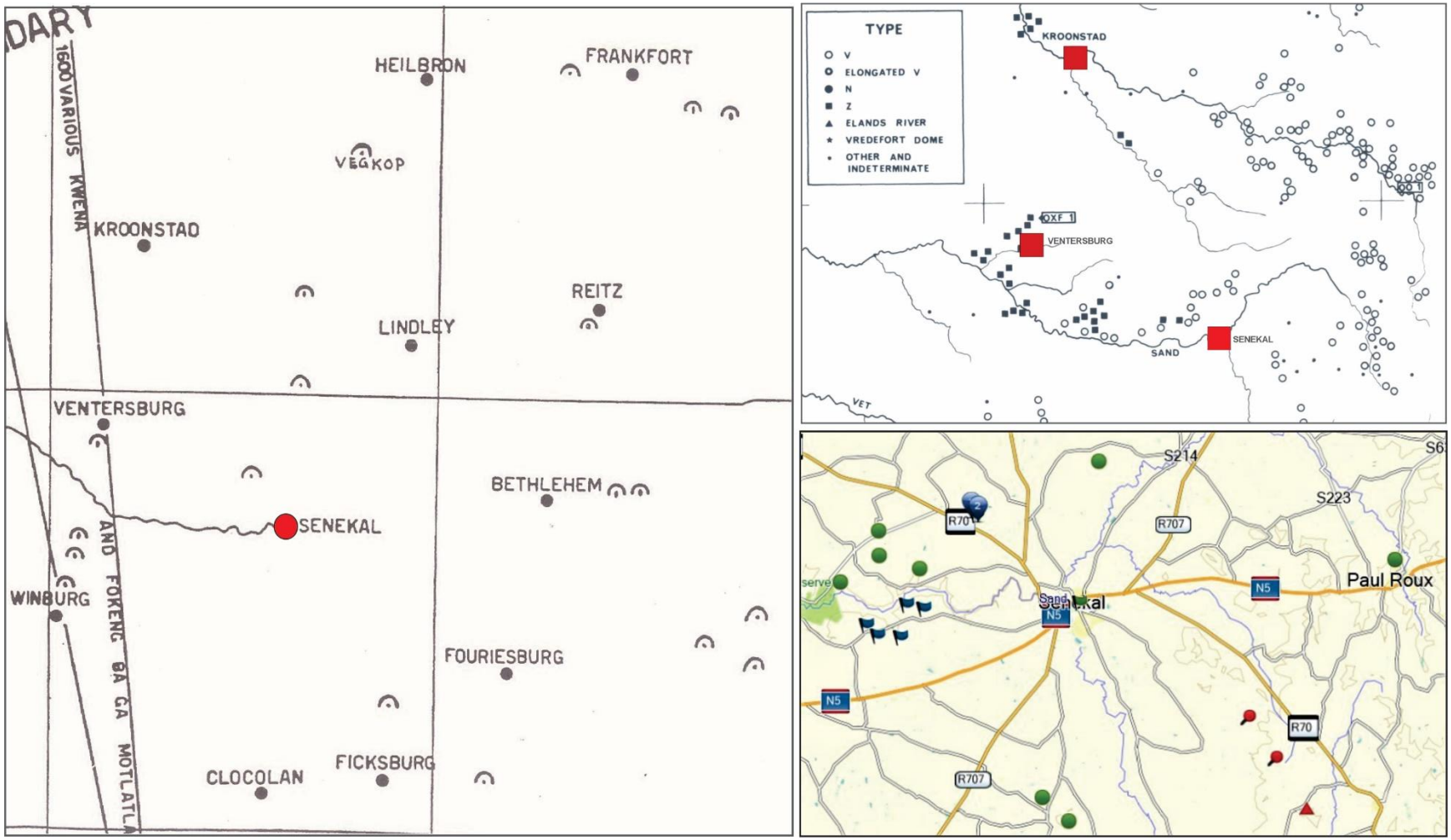


Figure 10. Distribution of Late Iron Age stonewalled settlements in the region after Breutz 1956 (left) and Maggs 1976 (above right). Position of previously recorded IA sites around Senekal indicated by green circles (below right).

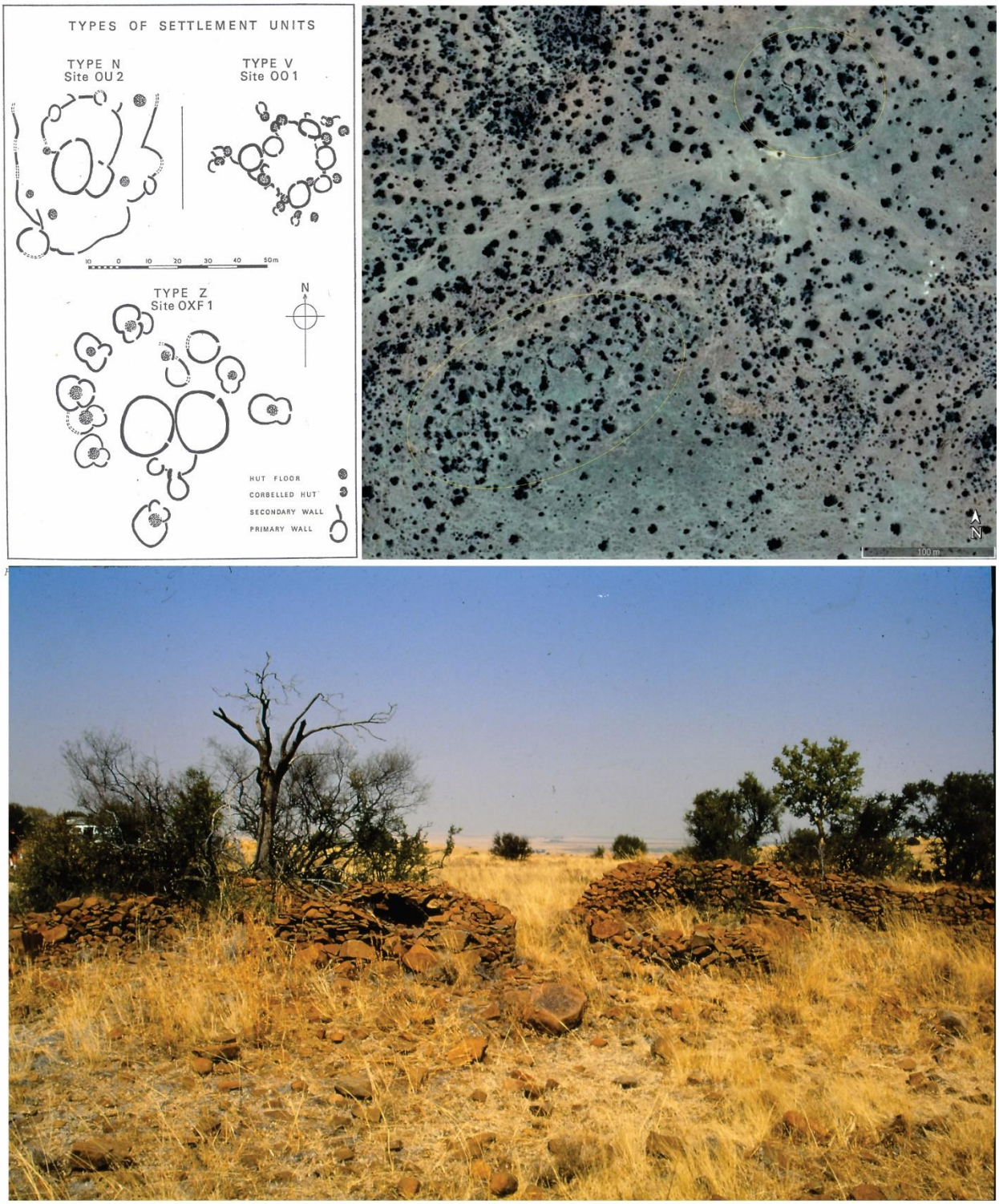


Figure 5. Late Iron Age settlement types from the region (above left) according to classification by Maggs (1976). Aerial and general view (above right & below) of bilobial dwellings located on high ground between Winburg and Senekal.

Figure 12. Erosional surfaces with signs of Iron Age occupation and localized concentrations of pottery and associated animal remains, near Paul Roux.

Figure 13. Map of Basuto territories east of the Orange River Sovereignty ca 1850.

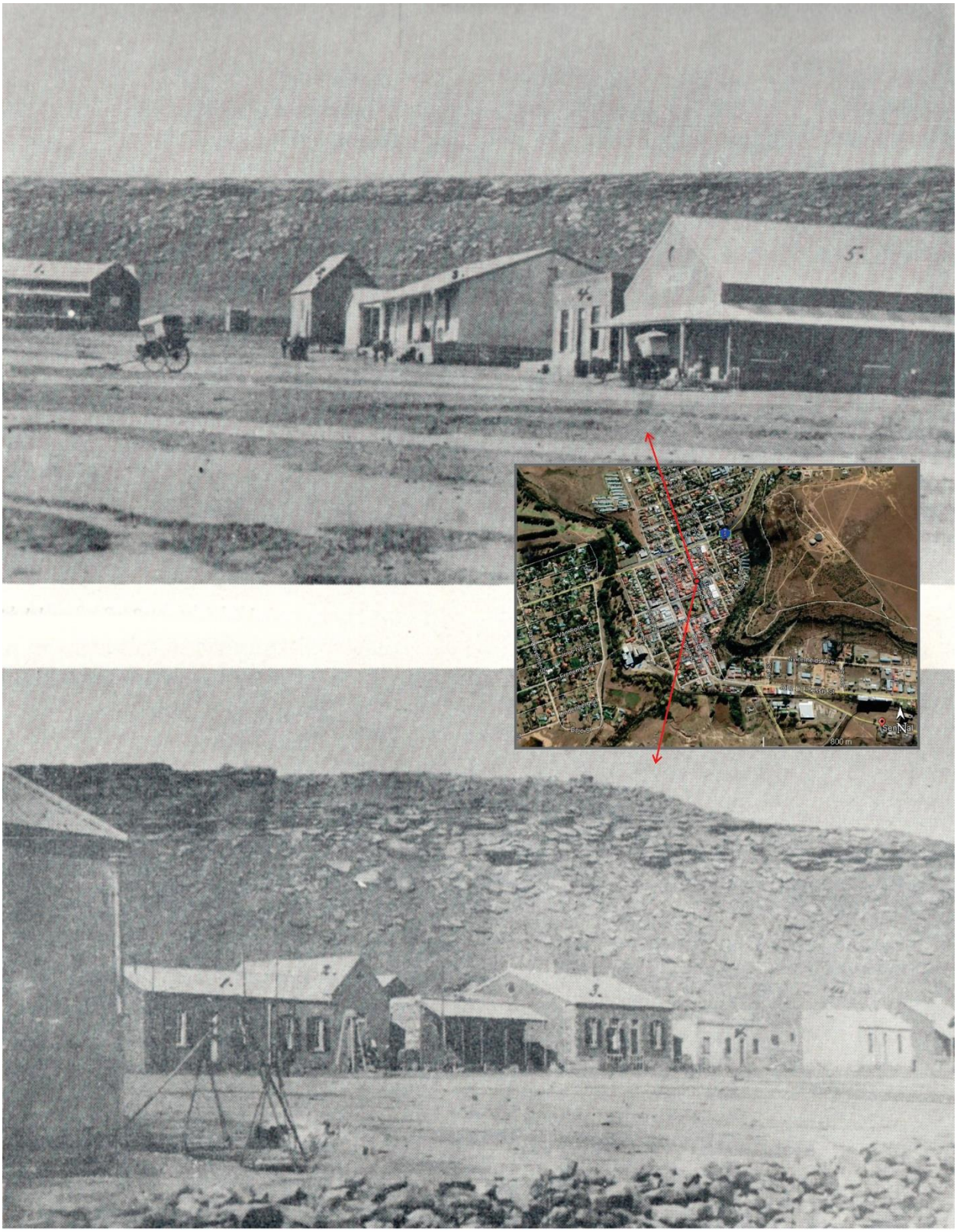


Figure 14. Corner of Van Riebeeck and Berg Street in Senekal ca. 1880's, looking northeast (above) and southeast (below).

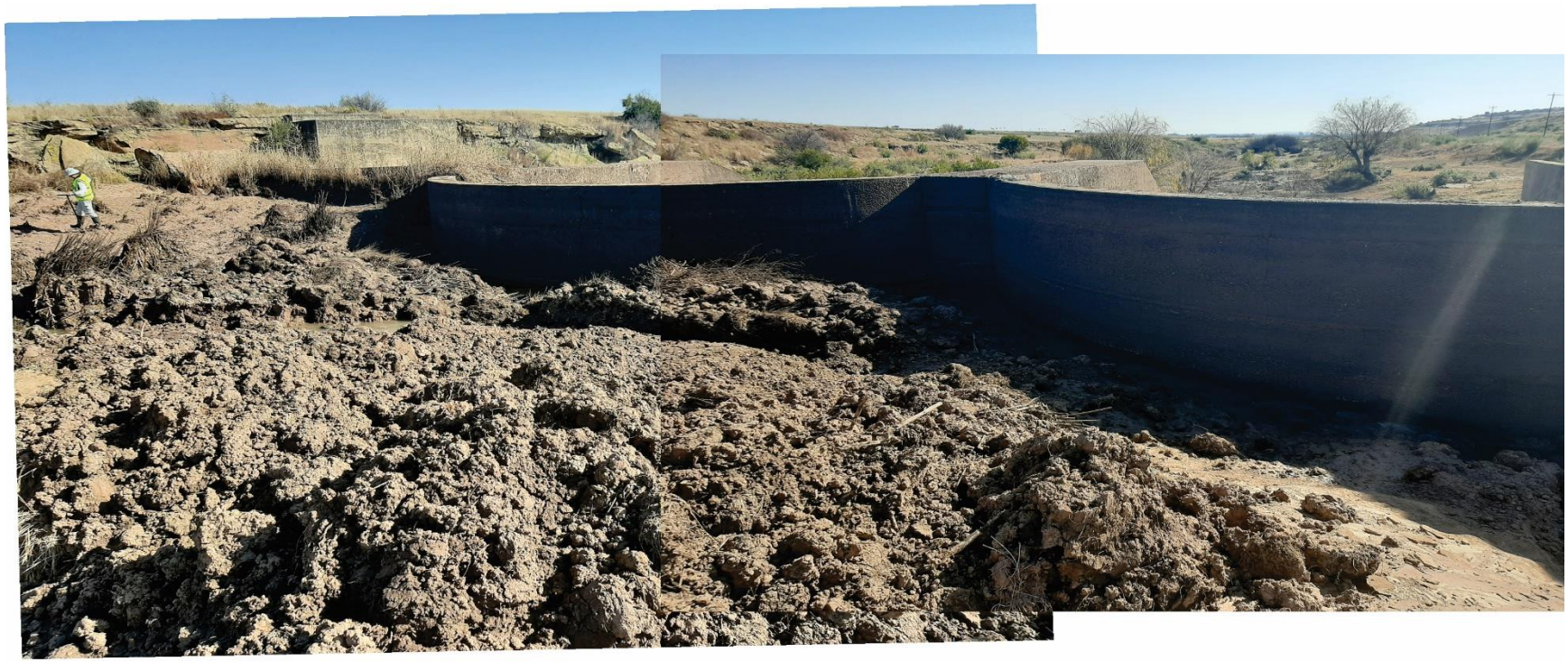


Figure 15. Concrete weir at the northern boundary of the study area, looking west.

Figure 16. The concrete weir and an accompanying berm (below), looking west-southwest and east-northeast, respectively.

Figure 17. General view of the study area, looking northwest (above) and south (below).

APPENDIX D_2

Ecological Report

Wetland and Ecological Assessment for the proposed dredging of the Sandspruit at the De Put Dam in Senekal, Free State Province.

November 2021

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DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

Report Version	**Final 1.2**		
Title	**Wetland and Ecological Assessment for the proposed dredging of the Sandspruit at the De Put Dam in Senekal, Free State Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Nov'21**

Executive Summary

The proposed dredging will take place within the Sandspruit at the abstraction point for the De Put containment dam at the small town of Senekal (Appendix A: Map 1). The De Put containment dam is an off-channel dam which is therefore not located within the channel of the Sandspruit, but adjacent to it. The dam has a weir and extraction point in the Sandspruit adjacent to the dam. Sedimentation upstream of this weir has increased over the years and dredging will attempt to clear a portion of the main channel of the Sandspruit, upstream of this weir to allow for the construction of a new extraction point.

Despite the somewhat modified condition of surrounding natural vegetation it does still consist of Eastern Free State Clay Grassland, a Threatened Ecosystem, which should therefore be avoided by the proposed dredging operations (Appendix A: Map 2). This is particularly applicable to the western banks and surrounding areas to the west of the river.

Although the area is somewhat modified it was notable that along the banks of the Sandspruit, several specimens of the protected *Crinum bulbispermum* occurs. This species is not common but is normally associated with the floodplain of river systems. Though relatively widespread and not considered rare or endangered it still retains a significant conservation value. The species should remain largely unaffected by the dredging operations as long as the remaining natural vegetation along the western banks of the river is not affected by dredging or associated activities such as a laydown area or stockpiles. Should any specimens require removal for the dredging operations, the necessary permits will have to be obtained to do so. Any removed specimens should be transplanted to an adjacent area where it will remain unaffected.

Soil samples taken across the Sandspruit are indicative of a permanent zone of wetness and it is considered that saturated soil conditions exist year-round (Appendix C). These wetland conditions now occur from the toe of the De Put Dam to the main channel of the Sandspruit and across to the sandstone floodbench on the western banks of the river. Obligate wetland vegetation dominates the river, main channel and entire floodplain adjacent to it. This all confirms the extensive wetland areas associated with it. The terrestrial surroundings or border of the riparian zone is indicated by an exposed sandstone ridge along the western banks forming a floodbench and the presence of terrestrial plant species.

The off-channel De Put storage dam, abstracts water from the main channel and in so doing decreases the baseflow of the river which alters the flow regime significantly (Appendix A: Map 1). The weir associated with this dam also act as flow barrier, and although not as significant as an in-channel storage dam, would also cause retardation of flow and obstruct flooding events and would therefore impact on the flow and flooding regime of the river. The weir would also cause sedimentation upstream while preventing sediment deposition downstream. This will also have a significant impact on the river.

The floodplain and wetland areas adjacent to the Sandspruit and weir are currently being affected by construction of a new abstraction point, this has resulted in the clearance of vegetation, disturbance of the soils surface and which clearly contributes to sedimentation of the river at the site as well as downstream of the weir. This also indicates that any disturbance of the river, riparian vegetation and soils surface will result in downstream impacts and should also be taken into consideration for the proposed dredging of the river upstream of the weir.

Several significant impacts has quite significantly affected the river at the site and the bed and bank morphology has also been significantly modified. Despite the modifications affecting the Sandspruit, it is still regarded as a highly sensitive system providing numerous vital ecosystem functions including water transportation, aquatic and wetland habitat, flood attenuation and bioremediation functions.

The Sandspruit which will be affected by the dredging operations is still natural to a significant extent although moderately modified by large impacts associated with the De Put Dam and weir and upstream dryland crop cultivation. An Index of Habitat Integrity (IHI) was conducted and indicated that the river has an Instream and Riparian IHI of Category C: Moderately Modified. A summary of these results are included in Appendix D. The EI&S of the Sandspruit has been rated as being Moderate.

A Risk Assessment for the proposed dredging operations within the Sandspruit has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Despite the modified condition of the river, it is still likely that dredging will cause several significant impacts. The existing weir and abstraction point clearly has significantly modified the river here and the continuous sediment deposition upstream of the weir is clearly resulting in the modification of the river, especially in terms of the geomorphology and riparian composition. The proposed dredging operations may therefore be considered as a form of river rehabilitation. This proposed rehabilitation may however still result in significant impacts and in order to obtain a better understanding of what these may entail the following guideline was consulted:

Day, L., King, H. & Rountree, M. 2016. The Development of a Comprehensive Manual for River Rehabilitation in South Africa. WRC Report TT 646/15.

Sediment erosion, transport and deposition are important processes that create habitat diversity in rivers. However, where high rates of deposition occur, as is the case upstream of the weir, this results in reduced channel depth. In general, the direct removal or excavation of sediment form rivers is not a good idea due to the risks of initiating instability and the loss and degradation of riparian and wetland habitats. However, in some instances the management of sedimentation is not possible without the direct removal of sediments. Where the direct removal of sediment is found to be justified, best practise must be used to carry out the necessary work to minimise adverse effects on the environment (Day *et al* 2016).

Comprehensive mitigation should be implemented in order to decrease the impact that dredging operations will have on the Sandpsuit (Refer to Section 4.4).

Taking into consideration all of the above and provided that adequate mitigation as recommended is implemented at the site, the proposed dredging operations should be limited to a moderate risk activity.

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Ecological and Wetland Assessment

1. Introduction

1.1 Background

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

Though vegetation may seem to be uniform and low in diversity it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered the development should be moved to another location or cease altogether.

South Africa has a large amount of endemic species and in terms of biological diversity ranks in the top ten in the world. This has the result that many of the species are rare, highly localised and consequently endangered. It is our duty to protect our diverse natural resources.

South Africa's water resources have become a major concern in recent times. As a water scarce country we need to manage our water resources sustainably in order to maintain a viable resource for the community as well as to preserve the biodiversity of the system. Thus, it should be clear that we need to protect our water resources so that we may be able to utilise this renewable resource sustainably. Areas that are regarded as crucial to maintain healthy water resources include wetlands, streams as well as the overall catchment of a river system.

Water is essential and crucial to the survival of all living organisms as well as ecosystem processes. This also applies to the survival of humans as we need daily intake of water. We, as humans, also utilise water for a range of other daily tasks and it is considered an essential component of our daily lives. It is therefore necessary for a community to have easy access to a potable water supply. The provision of water to a community must therefore take priority.

The proposed dredging will take place within the Sandspruit at the extraction point for the De Put containment dam at the small town of Senekal (Appendix A: Map 1). The De Put containment dam is an off-channel dam which is therefore not located within the channel of the Sandspruit, but adjacent to it. The dam has a weir and extraction point in the Sandspruit adjacent to the dam. Sedimentation upstream of this weir has increased over the years and dredging will attempt to clear a portion of the main channel of the Sandspruit, upstream of this weir to allow for the construction of a new extraction point. The footprint of this dredging will cover an area of approximately 1.1 hectares. The weir, off-channel dam and extraction point all contribute to some modification of the system though it is evident that extensive wetland areas are also associated within the river here, both historically and currently.

A site visit was conducted on 17 June 2021. The study area consisted of the dredging area within the Sandspruit and immediate surroundings and was surveyed by means of lateral transects across the river. The survey was undertaken during mid-winter and although many plants were

dormant at this time a sufficient vegetation composition could still be surveyed. An active hydrological regime was still present and also contributed toward accurate wetland delineation.

For the above reasons it is necessary to conduct an ecological assessment of an area proposed for development.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed development.

1.1 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes.

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

1.2 Details and expertise of specialist

DPR Ecologists and Environmental Services (Pty) Ltd.
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Professional registration:
South African Council for Natural Scientific Professions No. (400284/13) (Ecological Science).

Membership with relevant societies and associations:

- South African Society of Aquatic Scientists (SASAQS0091)
- South African Association of Botanists
- South African Wetlands Society (3SLY4IG4)

Expertise:

- Qualifications: B.Sc. (Hons) Botany (2008), M.Sc. in Vegetation Ecology (2012) with focus on ephemeral watercourses.
- Vegetation ecologist with over 10 years experience of conducting ecological assessments.
- Founded DPR Ecologists & Environmental Services (Pty) Ltd in 2016.
- Has conducted over 200 ecological and wetland assessments for various developments.
- Regularly attend conferences and courses in order to stay up to date with current methods and trends:

  2017: Kimberley Biodiversity Symposium.
  2018: South African Association of Botanists annual conference.
  2018: National Wetland Indaba Conference.
  2019: SASS5 Aquatic Biomonitoring Training.
  2019: Society for Ecological Restoration World Congress 2019.
  2019: Wetland rehabilitation: SER 2019 training course.
  2020: Tools For Wetlands (TFW) training course.

2. Scope and limitations

- To evaluate the present state of the vegetation and ecological functioning of the Sandspruit site proposed for dredging operations.
- To provide a description of watercourses, wetlands and riparian vegetation included within the study area.
- Identify watercourses including rivers, streams, pans and wetlands and determine the presence of wetland conditions within these systems.
- Where wetland conditions have been identified the classification of the wetland system will be given.
- To identify possible negative impacts that could be caused by the proposed dredging operations.
- To evaluate the present state of the wetlands and riparian vegetation in close proximity to the site. The importance of the ecological function and condition will also be assessed.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the watercourses in close proximity to operations.
- Conduct a risk assessment and determine the likelihood that watercourses and wetlands will be adversely affected by the development.

2.1 Riparian Vegetation

Aspects of the riparian vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the study area.
- The overall status of the riparian vegetation along the wetlands and watercourses in the study area.
- Species composition with the emphasis on dominant-, rare- and endangered species.
- Presence of wetland conditions and riparian vegetation using obligate wetland and riparian species.

The amount of disturbance present on the study area assessed according to:

- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna occurring in the region using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc.). This will be based on terrestrial fauna and focused on species observed at the watercourses.
- The overall condition of the habitat.

2.3 Wetlands and watercourses

Aspects of the wetlands and watercourses that will be assessed include:

- Identification of watercourses including rivers, streams, pans and wetlands.

- Determine the presence of wetland conditions and riparian vegetation using obligate wetland and riparian species.
- Describe watercourses and wetlands and importance relative to the larger system.
- Conduct habitat integrity assessment of watercourses to inform the condition and status of these systems.

2.4 Limitations

- Several bulbous and herbaceous species may have finished flowering and may have been overlooked or not identifiable.
- Although a comprehensive survey of the site was done it is still likely that several species were overlooked.
- Due to time constraints only limited surveys of watercourses were done.
- Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
- Some animal species may not have been observed as a result of their nocturnal and/or shy habits.
- Some fauna may not have been observed due to being in a dormant state or overwintering in egg or embryo form.

3. Methodology

3.1 Several literature works were used for additional information.

General ecology:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- NBA 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE).
- NBA 2018 Technical Report: Inland Aquatic (Freshwater) Realm.
- NBA 2018 Technical Report Volume 1: Terrestrial Realm.
- National Freshwater Ecosystem Priority Areas 2011 (NFEPA).
- Strategic Water Source Areas 2018 (SWSA).
- SANBI (2011): List of threatened ecosystems.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).
- Biodiversity Plan Free State Province (2018).

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- Field guides used for species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al* 2015, Gerber *et al* 2004, Gibbs-Russell *et al* 1990, Griffiths & Picker 2015, Manning 2009, Moffett 1997, Pooley 1998, 2003, Retief & Meyer 2017, Van Ginkel & Cilliers 2020, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997, Venter & Joubert 1985).

Terrestrial fauna:

- Field guides for species identification (Smithers 1986, Child *et al* 2016, Cillié 2018).

Wetland methodology, delineation and identification:

- Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Duthie 1999, Kleynhans *et al* 2008, Marnewecke & Kotze 1999, Nel *et al* 2011, SANBI 2009.

3.2 Survey

The site was assessed by means of transects and sample plots. Observation w.r.t. the general ecology of the area includes:

- Noted species include rare and dominant species.
- The broad vegetation types present at the site were determined.
- The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.
- The state of the habitat was also assessed.

Animal species were also noted as well as the probability of other species occurring on or near the site according to their distribution areas and habitat requirements.
The state of the habitat was also assessed.

All rivers, streams, pans and wetlands were identified and surveyed where they occurred in the study area. These systems were determined by use of topography (land form and drainage

pattern) and riparian vegetation with limited soil sampling (Appendix B & C). The following outlines the process applied during the on-site survey in order to obtain all required data:

- Perform desktop overview of the study area utilising available resources (Section 3.1). From the desktop overview identify the different landscape forms, possible wetland areas, watercourses and their relative flow patterns. Using this information, identify transects and sample plots for possible on-site survey. This should be both representative of the wetland or watercourse as a whole but should also include any prominent or significantly unique features.
- Possible sites identified during the desktop overview should be surveyed on-site. Where access is not possible or where desktop features are considered poor representatives of the wetland or watercourse the survey site or transect should be moved to another location, without compromising a comprehensive overview of the system.
- Where a lateral transect is taken of a watercourse this is done from the water's edge, across the marginal, lower and upper zones and extended across the floodplain until the edge of the riparian zone is reached.
- Where a transect is taken of a wetland system, this should preferably be taken across the entire wetland at its widest part or where it is most relevant to the proposed development, from the terrestrial surroundings, across the temporary, seasonal and perennial zones across the wetland.
- Soil samples are taken at 10 meter intervals along the survey transect, or where a distinct transition into a different zone is observed.
- A survey of the plant species within each distinct riparian or wetland zone is undertaken and includes the identification of obligate wetland species, riparian species, terrestrial species, exotic species and the general species composition and vegetation structure which allows for an accurate description of the watercourse or wetland.
- Visual survey of the general topography which substantiates the presence of riparian zones and wetland forms.
- Other general observations include any impacts observed, the overall ecosystem function, presence of fauna, surrounding land uses and the overall condition of the watercourse or wetland.
- Data is recorded by means of photographs with GPS coordinates taken at all relevant soil sampling sites and borders of riparian and wetland zones.

Data obtained during the on-site survey is utilised to provide the following information on the system:

- Desktop overview and assimilation of information on the likely impacts and functioning of the wetland system.
    - Review all available spatial data and resources in order to provide an estimate of the likely impacts and condition of the wetland or watercourse system.
- Confirm the presence of the wetland or watercourse system and provide an estimate of its borders.
    - The border of wetland conditions or the edge of the riparian zone will be confirmed by using soil sampling, obligate wetland vegetation and topography. This will also include the delineation of any temporary, seasonal or perennial zones of wetness along wetlands and the marginal, lower, upper and riparian zones along watercourses.
- Provide a description of the wetland or watercourse.

    - Provide the hydrogeomorphic setting of the wetland, a longitudinal profile which will aid in determining the erodibility of the wetland and provide an overall description of the wetland and impacts affecting it.
    - Provide a general description of the lateral zonation of the watercourse banks including the marginal, lower, upper and riparian zones and a description of the riparian vegetation along the banks of the watercourse. This will also include the description of any impacts or modification of the watercourse.
- Assess the current condition of the wetland or watercourse.
    - Utilising information obtained from the assessments listed above, determine the condition of this portion of the wetland by applying the WET-Health 2 tool.
    - Utilising information obtained from the assessments listed above, determine the condition of the relevant section of the watercourse by applying the Index of Habitat Integrity (IHI) tool.
- Utilising all of the information obtained from the assessment, provide recommendations to mitigate anticipated impacts that the development will have.

The following guidelines and frameworks were also used to determine the presence of the rivers, streams, pans and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

The following guidelines and frameworks were used to determine the sensitivity or importance of these identified watercourses or wetlands in the study area:

- Nel *et al.* (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

- Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

- Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

These guidelines provide the characteristics which can be utilised to determine if a wetland or watercourse is present and also aids in determining the boundary of these systems.

The following were utilised to inform the condition and status of watercourses:

- Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity. Joint

Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08.

The following were utilised to inform the condition and status of wetlands:

- Macfarlane, D.M., Ollis, D.J. & Kotze, D.C. 2020. WET-Health (Version 2.0): a refined suite of tools for assessing the present ecological state of wetland ecosystems. WRC Report No. TT 820/20.

A Risk Assessment will be conducted for the proposed development in or near watercourses and wetlands in accordance with the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use.

3.3 Criteria used to assess sites

Several criteria were used to assess the study area and determine the overall status of the environment.

3.3.1 Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

3.3.2 Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practises (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.
Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:
Scoring: No or very slight infestation levels by weeds and invaders – 1, Medium infestation by one or more species – 2, Several weed and invader species present and high occurrence of one or more species – 3.

Degree of grazing/browsing impact:
Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs shows signs of browsing, grass layer grazed though still intact – 2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent – 3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low.	29 – 30
Advanced Degraded (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low.	26 – 28
Degraded (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low.	21 – 25
Good Condition (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance.	11 – 20
Sensitive/Pristine (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high.	0 - 10

4. Ecological and Wetland Assessment

For the purpose of this report the general ecology of the study area will first be discussed followed by a discussion of the watercourses and wetland systems.

4.1 Ecology and description of the study area

Refer to the list of species encountered on the site in Appendix B.

According to Mucina & Rutherford (2006) the area consists of Eastern Free State Clay Grassland (Gm 3). The vegetation type is listed as being Vulnerable (VU) and therefore a Threatened Ecosystem according to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (Appendix A: Map 2). It is affected by transformation as a result of crop cultivation, urban areas and dam construction and therefore listed as a Threatened Ecosystem. Portions of the vegetation type around the site has been transformed by dam construction and the current construction of new abstraction infrastructure. The majority of the surrounding are still natural though also affected by high levels of communal overgrazing by domestic livestock.

The Free State Province Biodiversity Management Plan (2015) has recently been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The dredging site is listed as being an Ecological Support Areas 2 (ESA 2) (Appendix A: Map 3). This indicates that the area is recognised as being largely transformed by the surrounding landuse but forms part of the functioning of the Sandspruit and as a result does still function in the support of this system.

The proposed dredging will take place within the Sandspruit at the abstraction point for the De Put containment dam at the small town of Senekal (Appendix A: Map 1). The De Put containment dam is an off-channel dam which is therefore not located within the channel of the Sandspruit, but adjacent to it. The dam has a weir and extraction point in the Sandspruit adjacent to the dam. Sedimentation upstream of this weir has increased over the years and dredging will attempt to clear a portion of the main channel of the Sandspruit, upstream of this weir to allow for the construction of a new extraction point. The footprint of this dredging will cover an area of approximately 1.1 hectares. The weir, off-channel dam and extraction point all contribute to some modification of the system though it is evident that extensive wetland areas are also associated with the river here, both historically and currently.

Figure 1: Portion of the Sandspruit proposed for dredging operations (red). Note current construction activities to the left of the site.

Figure 2: General view of the surrounding area with an undulating topography and low ridges and sandstone outcrops.

The areas surrounding the dredging site is still largely natural though has been affected by several land uses. This is confirmed, for the most part, by the National Biodiversity Assessment (2018), which indicates the portions to the north of the Sandspruit has been transformed by the existing off-channel De Put Dam though the areas to the south are still largely natural (Appendix A: Map 2). Areas around the Sandspruit are also disturbed due to the current construction of a new extraction point in the river. This was also largely confirmed by the on-site survey. Overgrazing by domestic livestock also cause significant modification of the remaining natural vegetation. The riparian vegetation within the Sandspruit has been modified by sedimentation of the river but is considered to be largely intact. From the above, it should be clear that the general ecology of the area is still intact to some degree though significantly modified by surrounding land uses.

Figure 3: View of the weir (red) at the site. Extensive sediment deposition is visible in the foreground.

Figure 4: The off-channel De Put Dam is situated adjacent to the site and abstracts from the Sandspruit.

Figure 5: The area adjacent to the site is also affected by extensive construction of a new abstraction point.

The topography of the site and surroundings are dominated by undulating plains with low ridges, formed by sandstone outcrops. The site itself is being dominated by the Sandspruit, main channel, associated wetlands and floodplain (Appendix A: Map 1). The Sandspruit, especially upstream of the weir, forms an extensive wetland area. This may have been modified by continuous sediment deposition, though historical images indicate that wetland conditions were already quite extensive, prior to the construction of the weir. The topography to the east of the weir is quite modified by the existing De Put Dam as well as the current construction operations.

The mean annual rainfall for Senekal is given as 638 mm. Temperatures range from an average of 21.6°C in January to an average of 8.3°C in July.

The underlying geology of the region consists of mudstones and sandstone of the Adelaide Formation (Beaufort Group). Sandstone outcrops, resistant to weathering, form isolated hills and ridges.

As indicated, the surrounding area still consists largely of natural vegetation but which has been modified to a significant extent by the existing De Put Dam and overgrazing by domestic livestock. Grassland dominates the undulating terrain with scattered shrubs occurring along sandstone ridges and outcrops. Weeds and pioneer plants are abundant in most areas and indicates significant disturbance of the natural vegetation. A sparse grass layer is prominent in the surrounding area and include *Hyparrhenia hirta, Cymbopogon pospischillii Digitaria eriantha, Aristida congesta, Sporobolus fimbriatus, Eragrostis lehmanniana* and *Themeda triandra*. This is

a mixture of pioneer and climax species. The dwarf karroid shrubs, *Felicia muricata* and *Meolobium candicans* are also abundant and is an indicator of overgrazing. Though these dwarf karroid shrubs would be present in natural grassland, they respond positively to overgrazing and an abundance can be used to indicate a high level of overgrazing. Along the sandstone ridges and outcrops shrubs are scattered. These include *Asparagus larcinus, Searsia pyroides* and *Diospyros lycioides*. These outcrops also contain grass species adapted to the shallow soils over rock. These grasses include *Aristida diffusa* and *Triraphis andropogonoides*. From the description of the vegetation still present in the surrounding areas it evidently still contains natural vegetation but with some modification present.

Despite the somewhat modified condition of surrounding natural vegetation, it does still consist of Eastern Free State Clay Grassland, a Threatened Ecosystem, which should therefore be avoided by the proposed dredging operations (Appendix A: Map 2). This is particularly applicable to the western banks and surrounding areas to the west of the river.

Although the area is somewhat modified it was notable that along the banks of the Sandspruit, several specimens of the protected *Crinum bulbispermum* occurs. This species is not common but is normally associated with the floodplain of river systems. Though relatively widespread and not considered rare or endangered it still retains a significant conservation value. The species should remain largely unaffected by the dredging operations as long the remaining natural vegetation along the western banks of the river is not affected by dredging or associated activities such as a laydown area or stockpiles. Should any specimens require removal for the dredging operations, the necessary permits will have to be obtained to do so. Any removed specimens should be transplanted to an adjacent area where it will remain unaffected.

Figure 6: The western riverbank of the site contains numerous specimens of the protected *Crinum bulbispermum.* It is deciduous and not easily visible at the time of the survey (left) though is quite prominent during summer (right).

The study area consists of the Sandspruit upstream of the weir, adjacent to the De Put Dam, as well as the surrounding associated wetland areas (Appendix A: Map 1). The river here is affected by several impacts, especially those impacts associated with the weir, water abstraction and upstream agricultural areas. This will result in significant modification of the flow and flooding regime while agricultural runoff (fertiliser and pesticides) will also have a significant affect.

From the above it should be clear that the area is still dominated by natural vegetation though has been modified to a significant extent. The Sandspruit is imbedded in this largely natural area and therefore though largely natural, is affected by several significant impacts. However, any remaining natural vegetation will still consist of the threatened Eastern Free State Clay Grassland and should be avoided by the proposed dredging operations, this is particularly applicable to the western bank and surroundings of the river (Appendix A: Map 2). Furthermore, the banks of the Sandspruit also contain several specimens of the protected *Crinum bulbispermum*. The species should remain largely unaffected by the dredging operations as long the remaining natural vegetation along the western banks of the river is not affected by dredging or associated activities such as a laydown area or stockpiles. Should any specimens require removal for the dredging operations, the necessary permits will have to be obtained to do so.

4.2 Overview of terrestrial fauna (actual & possible)

Signs and tracks of mammals are present along the banks of the Sandspruit. Burrows of an unidentified small mammal was also observed on the banks of the river. Watercourses provide a high biomass, perennial foraging and a large prey base and are therefore able to sustain a larger and more diverse mammal population. The mammal population around the site is however anticipated to be somewhat modified from the natural condition. High levels of overgrazing by domestic livestock will degrade the condition of available habitat to some degree, which will also affect the mammal population on the site. Furthermore, herding dogs and hunting by the local community will also have a high impact on the local mammal population. As a consequence it is also considered unlikely that any species of conservation concern would remain in the area. These species normally require pristine habitat and are sensitive to human induced disturbances. The likelihood that such a species may occur can however not be discounted.

The impact the proposed dredging operations in the Sandspruit will have is mainly concerned with the loss of habitat. However, as previously indicated the habitat which will be affected has already been modified to some degree by surrounding land uses. Furthermore, the footprint of the development will not be extensive and should therefore limit the impact on mammals. The impact would also be mostly temporary as long as adequate rehabilitation is undertaken.

The hunting, capturing or harming in any way of fauna on the site must be prohibited. In the event of venomous animals, such as snakes, encountered on the site an experienced snake handler should be contacted to remove it from the site.

Table 2: Red Listed mammals likely to occur in the study area (Mammalmap & Child *et al* 2016).

Scientific name	Common name	Status
Damaliscus lunatus lunatus	(Southern African) Tsessebe	Vulnerable
Damaliscus pygargus pygargus	Bontebok	Vulnerable
Hippotragus niger niger	Sable	Vulnerable
Kobus leche	Lechwe	Near Threatened
Pelea capreolus	Vaal Rhebok	Near Threatened
Equus zebra hartmannae	Hartmann's Mountain Zebra	Vulnerable

From historical records (Table 2) it is evident that the area contains numerous Red Listed mammals. However, these consist of larger mammals and are historical records and would currently only be found within conservation areas, they are not of consequence to the development. The likelihood that Red Listed species may occur can however not be discounted.

Figure 7: Signs of mammals along the Sandspruit include several burrows of unidentified small mammals.

4.3 Wetland and Watercourses Assessment

4.3.1 Introduction

The proposed dredging operations will affect a portion of the Sandpsruit adjacent to the De Put off-channel dam (Appendix A: Map 1). The Sandspruit and section which will be affected by the proposed dredging will be discussed in the following sections.

The term watercourse refers to a river, stream, wetland or pan. The National Water Act (NWA, 1998) includes rivers, streams, pans and wetlands in the definition of the term watercourse. This definition follows:

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005).

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification:

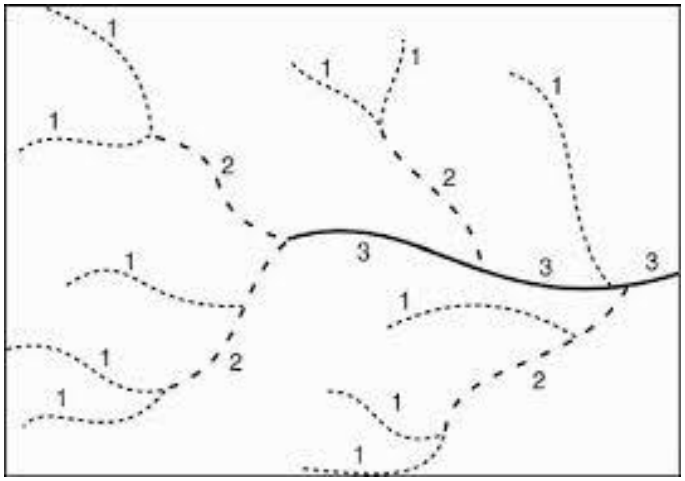


Figure 8: The classification of stream orders from 1 to 3 (Strahler 1952)

4.3.2 Wetland and riparian indicators

Obligate wetland vegetation was utilised to determine the presence and border of wetland conditions along the banks of the river, as well as within its floodplain. The survey was undertaken by means of a lateral transect immediately upstream of the weir. Soil samples were used to determine the border and also to confirm the presence of wetland soils where obligate wetland vegetation indicated wetland conditions (Appendix C). Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Soil samples taken across the Sandspruit are indicative of a permanent zone of wetness and it is considered that saturated soil conditions exist year-round (Appendix C). Due to continuous sediment deposition, these wetland conditions extend across the entire main channel of the river and across the adjacent floodplain (Appendix A: Map 1). These wetland conditions now occur from the toe of the De Put Dam to the main channel of the Sandspruit and across to the sandstone floodbench on the western banks of the river. The extent of these wetland conditions may have been modified by continuous sediment deposition, although imagery prior to the construction of the weir also indicate extensive wetland conditions in this area. The geomorphology of the river and its main channel would however be modified significantly by sediment deposition. The continuous deposition of sediment slowly increases the elevation of the riverbed and cause the modification of the banks and associated geomorphology. Obligate wetland vegetation dominates the river, main channel and entire floodplain adjacent to it. This all confirms the extensive wetland areas associated with it. These species will be listed in Section 4.3.7. Obligate wetland species are confined to wetlands and cannot occur in conditions outside of these systems. As a result, where they occur, wetland conditions can be considered to occur. The terrestrial surroundings or border of the riparian zone is indicated by an exposed sandstone ridge along the western banks forming a floodbench and the presence of terrestrial plant species.

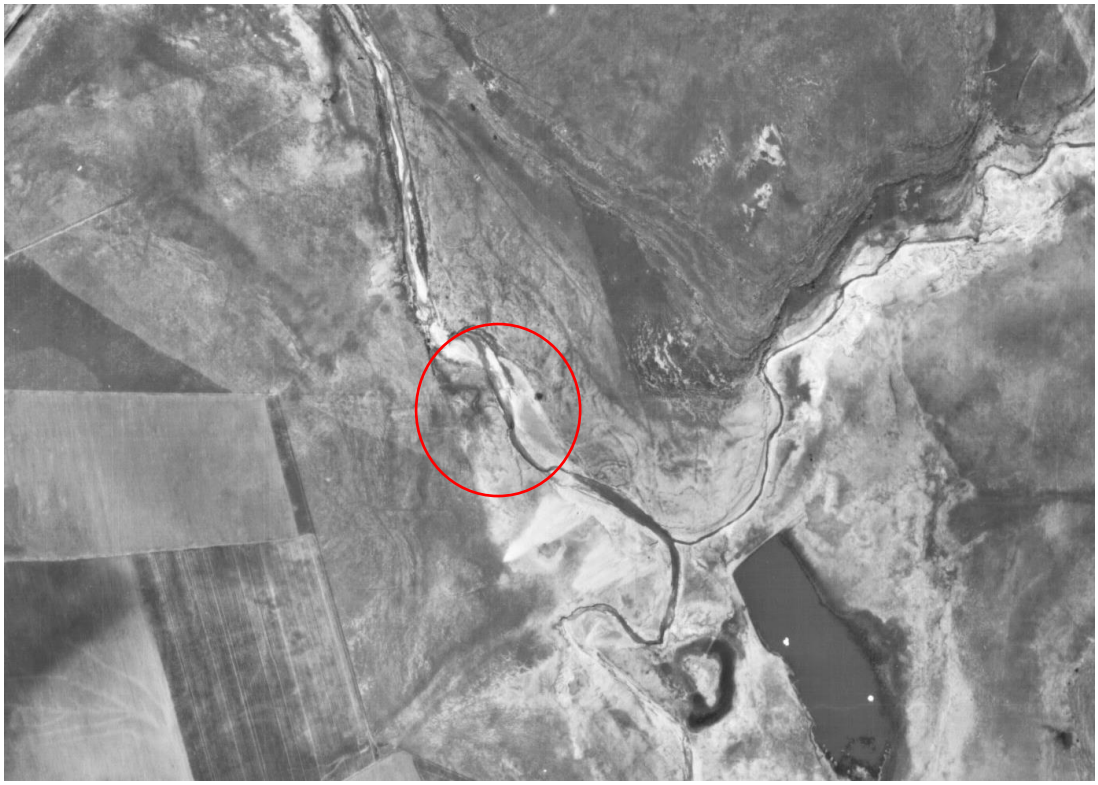


Figure 9: Even prior to the construction of the weir the Sandspruit and floodplain was associated with extensive wetland areas (1969, National Geospatial Database).

Figure 10: Currently the area upstream of the weir is still associated with extensive wetland conditions (Google Earth 2019).

4.3.3 Classification of wetland systems

The Sandspruit at the site can be classified into a specific wetland type.

The wetland conditions associated with the banks of the Sandspruit can be characterised as a channel wetland system (SANBI 2009):

"An open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchannelled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. An active channel is a channel that is inundated at sufficiently regular intervals to maintain channel form and keep the channel free of established terrestrial vegetation. These channels are typically filled to capacity during bankfull discharge (i.e. during the annual flood, except for intermittent rivers that do not flood annually)."

The wetland conditions adjacent to river and within the floodplain may be characterised as a floodplain wetland (SANBI 2009):

"A floodplain wetland and lowland river floodplain: the mostly flat or gently sloping wetland area adjacent to and formed by a lowland floodplain river and subject to periodic inundation by overtopping of the channel bank of the river. The location of the wetland adjacent to the river in the lowland floodplain zone is the key criterion for distinguishing a floodplain wetland from a channelled valley-bottom wetland. Water and sediment input to floodplain wetland areas is mainly via overtopping of a major channel, although there could be some overland or subsurface flow from adjacent valley side-slopes (if present). Water movement through the wetland is dominantly horizontal and bidirectional, in the form of diffuse surface flow and interflow, although there can be significant temporary containment of water in depressional areas (within which water movement is dominantly vertical and bidirectional). Water generally exits as diffuse surface flow and/or interflow, but infiltration and evaporation of water from a floodplain wetland can also be significant, particularly if there are a number of depressional areas within the wetland."

This accurately described the wetland conditions within and around the Sandspruit. While wetland conditions are clearly present within the main channel and forms a channel wetland system, those wetland conditions adjacent to the Sandspruit are clearly a result of the floodplain and there forming a floodplain wetland (Appendix A: Map 1).

4.3.4 Description of the riparian zones of watercourses

River systems can be divided into different riparian zones within the lateral section of the system. These zones are as follows:

The marginal zone is the lowest zone and is always present in river systems while the other two zones may not always be present. The zone is situated from the water level at low flow, if present, up to the features that are hydrologically activated for the most of the year (Figure 11). The marginal zone of the Sandspruit is relatively uniform at the site and is relatively narrow with a width of 1 to 2 meters. The marginal zone has been modified and degraded to a significant extent. It is evidently affected by long periods of inundation due to the flooding and the higher water levels upstream of the weir. This results in the submergence of marginal vegetation which

significantly increases the disturbance within this zone. High levels of sediment deposition is clearly present as a result of the weir at the site. Vegetation is dominated by sedges, reeds and grasses adapted to waterlogged soils.

The lower zone is characterised by seasonal features and extends from the marginal zone up to an area of marked elevation. This area may be accompanied by a change in species distribution patterns. The lower zone consists of geomorphic features that are activated on a seasonal basis (Figure 11). The lower zone of the river at the proposed site consists of a relatively steep bank which is normally associated with larger watercourses where significant flooding events are common. However, it is also evident that continuous sediment deposition has altered this zone, made it narrower and increased the slope adjacent to the main channel incision. Riparian vegetation is dominated by grasses and sedges.

The upper zone is characterised by ephemeral features as well as the presence of both riparian and terrestrial species. The zone extends from the lower zone to the riparian corridor. The upper zone contains geomorphic features that are hydrologically activated on an ephemeral basis (Figure 11). The upper zone of the Sandspruit at the site is visible as a decrease from a steep slope to a gentle slope along the western banks where a sandstone ridge is also evident and forms the floodbench of the river. The eastern banks consists of the floodplain wetland associated with the river and has also been heavily disturbed by current construction activities and here the river zonation is no longer clearly evident.

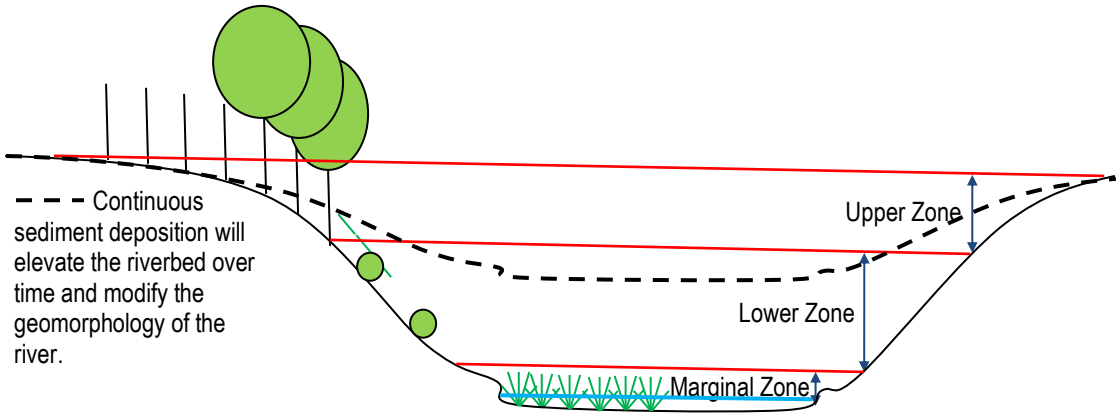


Figure 11: Illustration showing the different riparian zones of the Sandspruit at the site. This also illustrates the effect that sediment deposition has in modifying the geomorphology of the river.

4.3.5 Current impacts on the affected wetlands

The Sandspruit at the proposed dredging site has been affected by several significant impacts which has caused moderate modification of the system. The river has been affected by the De Put Dam, a large off-channel storage dam and associated weir which would undoubtedly have altered the flow and flooding regime (Appendix A: Map 1). Associated with the dam and weir is also the current construction activities which also has a significant impact on the river. The extensive agricultural crop cultivation upstream has also contributed significant impacts on water quality, sediment load and geomorphology of the river. Though not as much as downstream areas, the urban areas of Senekal would also entail some impacts on the river.

The off-channel De Put storage dam, abstracts water from the main channel and in so doing decreases the baseflow of the river which alters the flow regime significantly. The weir associated with this dam also act as flow barrier, and although not as significant as an in-channel storage dam, would also cause retardation of flow and obstruct flooding events and would therefore impact on the flow and flooding regime of the river. The weir would also cause sedimentation upstream while preventing sediment deposition downstream. This will also have a significant impact on the river.

Figure 12: Upstream of the weir (red), sediment accumulation is evidently quite high and this will certainly affect the flow, flooding and sediment regime of the river, at least at the site.

Figure 13: Upstream of the weir the river has a shallow main channel with high volumes of sediment being evident.

Figure 14: Downstream of the weir the river has a deeper channel with much more varied bank morphology. This should also give an indication of the impact that the weir has on the river.

The floodplain and wetland areas adjacent to the Sandspruit and weir are currently being affected by construction of a new abstraction point, this has resulted in the clearance of vegetation, disturbance of the soils surface and which clearly contributes to sedimentation of the river at the site as well as downstream of the weir. This also indicates that any disturbance of the river, riparian vegetation and soils surface will result in downstream impacts and should also be taken into consideration for the proposed dredging of the river upstream of the weir.

Figure 15: Construction adjacent to the river and within the floodplain and associated wetland areas clearly cause significant disturbance and impacts.

Figure 16: The construction activities also entail dewatering of construction areas which contain sediment loads.

Figure 17: Water released from the construction area into the river clearly contains a sediment load which will also have an impact on the river. This should also provide an indication of the anticipated impacts that dredging will have.

Several upstream and surrounding impacts will also affect the condition of the river:

Several low-water dirt road crossings occur over the river upstream of the site. These will also act as flow obstructions though not to the same extent as the weir but will still affect the flow and flooding regime.

The upstream areas are subjected to extensive dryland crop cultivation and this would undoubtedly also contribute significant impacts on the river (Map 1). These fields clear the natural vegetation and significantly contributes to increased runoff velocity which in turn increases erosion and sedimentation of watercourses. Also associated with this is fertiliser, pesticide and herbicide runoff and its effect on water quality.

Sections of the river upstream of the site also contains numerous exotic trees which may form dense stands in some areas. It will have a limited impact on the river at the site but may influence baseflow as a result of high evapotranspiration.

The proposed dredging site is located largely upstream of the urban area of Senekal and Matwabeng though a small section does flow past the urban fringe and will contribute some impacts mostly in terms of runoff with poor water quality, increased nutrient levels and some urban refuse. A more significant impact associated with the surrounding urban areas is the utilisation of the area as communal grazing. The river and surrounding catchment is subjected to high levels of overgrazing. This significantly decreases vegetation cover which in turn increases runoff velocity and erosion which increases the sediment load within the Sandspruit. Trampling will also disturb the soil surface and further increase sediment load in the river. In addition, manure will increase the nutrient load within the river.

Several significant impacts has quite significantly affected the river at the site and the bed and bank morphology has also been significantly modified. Despite the modifications affecting the Sandspruit, it is still regarded as a highly sensitive system providing numerous vital ecosystem functions including water transportation, aquatic and wetland habitat, flood attenuation and bioremediation functions.

4.3.6 Condition and importance of the affected watercourses

The determination of the condition of the Sandspruit at the proposed dredging site will be based on an overall determination of the Index of Habitat Integrity (IHI) (Appendix D). This will also take into account upstream impacts as well as impacts within the catchment. This is considered to give a good representation of the condition of this system. The IHI will be taken as representative of the Present Ecological State (PES) of the Sandspruit river system

Table 3 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 4 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 3: Ecological categories for Present Ecological Status (PES).

Ecological Category	Description
A	Unmodified, natural
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominately unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem function has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

Table 4: Ecological importance and sensitivity categories.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very High Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

According to Kleynans (2000) a desktop assessment of the Sandspruit is considered to have a PES of Category C: Moderately Modified. On site observations indicate that this is relatively accurate as this study has also calculated the Sandspruit as having a PES of Category C: Moderately Modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominately unchanged. The system therefore still provides vital functions including water transportation, storm water, instream and riparian habitat and groundwater recharge. The entire system should therefore still be considered as sensitive and the proposed dredging should not lead to any further alteration to it.

The Sandspruit which will be affected by the dredging operations is still natural to a significant extent although moderately modified by large impacts associated with the De Put Dam and weir and upstream dryland crop cultivation. An Index of Habitat Integrity (IHI) was conducted and indicated that the river has an Instream and Riparian IHI of Category C: Moderately Modified. A summary of these results are included in Appendix D.

The EI&S of the Sandspruit has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

4.3.7 Site specific descriptions

The proposed dredging within the Sandspruit will occur upstream of the weir in the main channel situate adjacent to the De Put off-channel storage dam (Appendix A: Map 1). A short description will be provided of the riparian vegetation along the river at the site and its general condition.

Where FW or OW is indicated it refers to Facultative or Obligate Wetland species. A facultative wetland species is often associated with wetlands but is also able to occur in non-wetland areas. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine FW and OW species:

- Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

- DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Table 5: Description of the specific dredging site within the Sandspruit (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species).

Watercourse name: Sandspruit (Map 1)	**Coordinates of crossing:** S 28.358019°, E 27.621577°	**Order:** Second Order
Description of watercourse at point of crossing: The dredging of a portion of the main channel of the Sandspruit is proposed, upstream of the weir adjacent to the De Put off-channel storage dam. A clearly defined main channel is present which flows from south to north across the site. The channel has a width of 40 meters here, a		

consequence of the weir which cause the damming of the main channel. An existing weir is present at the site and this also results in the accumulation of large volumes of sediment upstream of the weir. This also results in the elevation of the riverbed and it is clear from the survey, when comparing the site with the downstream areas, that the marginal zone has become elevated, the lower zone is narrower and is not much lower than the upper zone. The accumulation of sediment over time gradually causes the blending of the different riparian zones. Also refer to Section 4.3.4 for a description of the current impacts on the river. Extensive wetland conditions are also evident in the surrounding floodplain. These have also been modified to some degree by the De Put dam and weir though it is also evident from historical images that extensive wetland areas were also present prior to the construction of these impoundments.

Obligate wetland vegetation dominates the marginal zone and floodplain of the river to the east of the dredging site, between the main channel and the dam wall. Wetland sedges, reeds and grasses are common here. The lower zone or banks of the river contains many wetland plants although some terrestrial species are also evident here. This is however only apparent along the western banks while the eastern banks blend into floodplain wetland areas to the east. The lower zone along the western bank can however be regarded as indicating a seasonal zone of wetness and the border of wetland conditions. Soils also confirm wetland conditions and indicate the border of wetland conditions as the lower zone. The upper zone contains only terrestrial plant species but with many of the grasses, shrubs and trees being well known riparian species, this was also confirmed by soil samples. This indicates the border between the river and surrounding terrestrial areas, though only to the west. To the east the damwall should be taken as the border of the floodplain of the river.

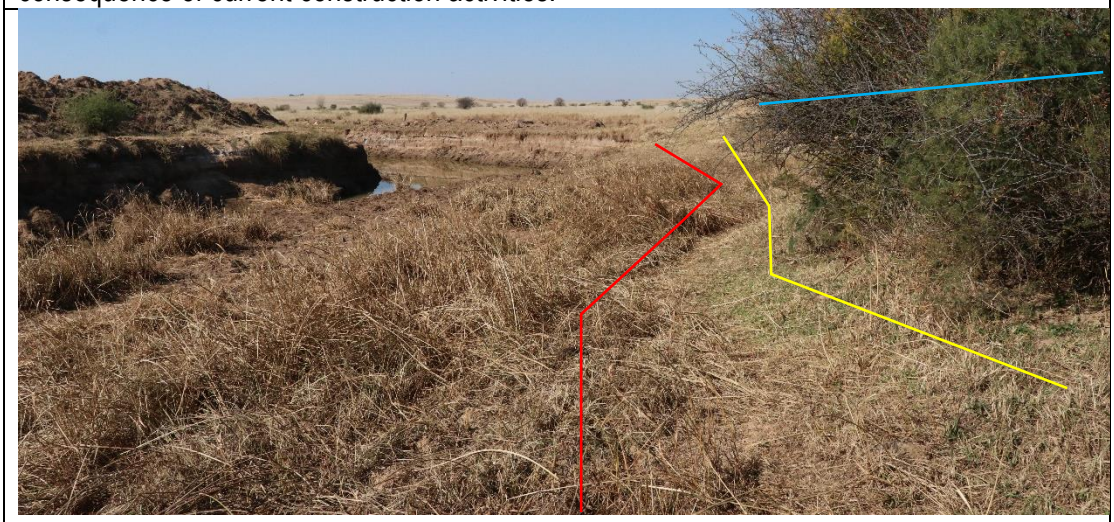
Dominant plant species:
Terrestrial surroundings and sandstone ridge: *Aristida diffusa, Aristida congesta, Eragrostis lehmanniana, Felicia muricata, Triraphis andropogonoides, Cymbopogon pospischillii, Searsia pyroides, Asparagus larcinus, Melolobium candicans.*

Marginal Zone: *Phragmites australis* (OW), *Cyperus marginatus* (OW), *Marsilea sp., Cyperus sexangularis* (OW), **Xanthium spinosum, *Argemone ochroleuca.*

Lower Zone: *Equisetum ramosissimum* var. *ramosissimum, Cynodon dactylon, Crinum bulbispermum, *Pennisetum clandestinum, Mohria sp., Cyperus longus* (OW), **Sesbania punicea, Moraea pallida, Leptochloa fusca* (OW).

Upper Zone: *Diospyros lycioides, Asparagus larcinus, *Bidens bipinnata, *Ligustrum lucidum, Diospyros austro-africana, *Rosa rubignosa, Scolopia zeyheri, Vachellia karroo.*

View of the main channel of the Sandspruit at the proposed dredging site. A clear channel is present leading up to the weir (red). Note high volumes of sediment though this is also a consequence of current construction activities.



The zonation of the western river banks are distinct though continuous sediment deposition does cause the narrowing of the lower and upper zones (Red – marginal zone, Yellow – lower zone, Blue – upper zone).

Another view of the main channel where the effect of sediment accumulation is also clearly visible.

The eastern floodplain also contain extensive wetland areas though is currently also being affected by construction activities.

4.4 Risk Assessment

A Risk Assessment for the proposed dredging operations within the Sandspruit has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Despite the modified condition of the river it is still likely that dredging will cause several significant impacts.

The existing weir and abstraction point clearly has significantly modified the river here and the continuous sediment deposition upstream of the weir is clearly resulting in the modification of the river, especially in terms of the geomorphology and riparian composition. The proposed dredging operations may therefore be considered as a form of river rehabilitation. This proposed rehabilitation may however still result in significant impacts and in order to obtain a better understanding of what these may entail the following guideline was consulted:

Day, L., King, H. & Rountree, M. 2016. The Development of a Comprehensive Manual for River Rehabilitation in South Africa. WRC Report TT 646/15.

Sediment erosion, transport and deposition are important processes that create habitat diversity in rivers. However, where high rates of deposition occur, as is the case upstream of the weir, this results in reduced channel depth. In general, the direct removal or excavation of sediment form rivers is not a good idea due to the risks of initiating instability and the loss and degradation of riparian and wetland habitats. However, in some instances the management of sedimentation is not possible without the direct removal of sediments. Where the direct removal of sediment is found to be justified, best practise must be used to carry out the necessary work to minimise adverse effects on the environment (Day *et al* 2016).

Instances where the direct removal of sediment would be justified includes areas of reduced conveyance such as bridges, culverts or weirs which result in the build up of sediment upstream of the constriction. The proposed dredging of the main channel of the Sandspruit upstream of the weir would therefore seem to be justified though this will also result in significant disturbance of the river and associated riparian and wetland habitats which will have to be mitigated, managed and rehabilitated.

The backwaters, floodplain and associated wetland areas of a river are well known to provide important wetland habitats and numerous vital ecosystem functions. These areas are also

affected where sediment removal from the main channel is undertaken. Such habitats are also present at the site, especially between the main channel and the toe of the damwall (Appendix A: Map 1). It will therefore be important to retain these habitats without any disturbance associated with the proposed dredging and to restrict the removal of sediment to the area upstream of the weir and only within the main channel of the river.

The direct removal of sediment within the river should be limited in extent as far as possible. The current proposal for dredging involves an area of 1.1 hectares which will occupy 250 meters of the main channel of the river (Appendix A: Map 1). This will likely lead to significant impacts including channel destabilisation which has a detrimental impact on downstream areas (Day *et al* 2016). In this instance the weir should aid in restricting riverbed disturbance to the upstream areas, however, given the significant length of river channel to be dredged (250 meters), comprehensive measures will have to be implemented to retain high sediment loads upstream of the weir. The dredging of sediments causes sediment disturbance which in turn results in the release of high sediment loads downstream. The implementation of attenuation areas upstream of the weir should aid in retaining sediments at the site.

Additional mitigation which should be considered in order to decrease the impact that dredging operations will have include:

- Limiting the extent of dredging the main channel of the Sandspruit, immediately upstream of the weir, and to a maximum section of 250 meters upstream of the weir (Appendix A: Map 1).
- Avoiding the western bank of the river completely and also retaining the floodplain and associated wetland areas intact (these areas occurring between the main channel and the toe of the damwall (Appendix A: Map 1).
- Avoiding the removal of vegetation as far as possible and avoiding the removal of vegetation outside the main channel completely.
- Undertaking of dredging should be limited to winter months (May to September) when dredging operations will be least likely to be affected by flooding and disturbance will also be limited.
- Vehicles will have to access the main channel. This should be limited to a single access road into and out of the main channel.
- Excavated sediment should be removed from the area and disposed of or used in agricultural activities and should not be stockpiled at the site. Current construction operations contain a stockpile area in the floodplain of the river which results in direct wetland loss. This should be avoided by dredging operations.
- Following the dredging operations, any disturbance of the banks, vegetation or wetland areas should be rehabilitated. It is important that riparian vegetation be re-established where they were removed. This can be attained by removing sods of the indigenous sedges and grasses as listed for the river and replanting these in disturbed areas
- Areas where dredging and disturbance takes place is normally susceptible to the establishment of exotic weeds and invaders. It will therefore be important to monitor and eradicate any invasive weeds.
- A comprehensive monitoring and rehabilitation programme should be initiated, which should be maintained at least for the duration of dredging, when impacts are anticipated to be most significant.
- Given the significant extent of dredging (1.1. hectares) additional monitoring should include monthly monitoring of sediment release upstream, at the site and downstream

in order to determine the extent to which dredging is causing sedimentation which should also allow for remediation where high impacts are observed.

- Biomonitoring should be conducted at least every three months and should include indices such as WET-Health and SASS5 or a combination thereof.

Taking into consideration all of the above and provided that adequate mitigation as recommended is implemented at the site, the proposed dredging operations should be limited to a moderate risk activity.

Moderate Risks: Risk and impact on watercourses are notable and require mitigation measures on a higher level.

Low Risks: Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.

Mitigation as recommended should be implemented as far as possible.

For the complete risk assessment please refer to Appendix E.

No.	Phases	Activity	Aspect	Impact	Risk Rating	Confidence level	Control measures
1	Mostly Operational Phase but extending after dredging	Dredging of a section of the main channel of the Sandspruit upstream of the weir.	Excavation of sediment from the main channel.	Excavation of sediment within the main channel of the Sandspruit will remove riparian vegetation and disturbance of the soil surface which will result in destabilisation of the riverbed and increase the downstream sediment load. Increased establishment of exotic weeds and invaders due to disturbance caused by dredging is also probable.	**M**	80	This impact will occur mainly during the dredging operations but may extend after completion of dredging due to the destabilisation of the riverbed. Mitigation as stipulated within Section 4.4 should be implemented in order to reduce the anticipated impacts associated with the dredging operations.
	Mostly Operational Phase		Construction of an access road within the floodplain and the banks of the Sandspruit in order to gain access to the main channel.	Construction of an access road across the floodplain and the banks of the river will also cause disturbance although on a local scale. The road will require the removal of riparian vegetation. Increased erosion, sediment load and exotic weed establishment is also likely.	**L**	80	The impact will be largely confined to the dredging operations as long as the access road is removed and rehabilitated afterwards. This is likely reversible impact and therefore has a low risk. It is still important that adequate rehabilitation and monitoring takes place. Mitigation as stipulated within Section 4.4 should be implemented in order to reduce the anticipated impacts associated with the dredging operations.

5. Ecological description of immediate area

Habitat diversity and species richness:
Habitat diversity is relatively high and represented by a varied topography including undulating plains, sandstone ridges as well as the Sandspruit, floodplain and associated wetland areas. Despite the variety of habitat the species diversity is only regarded as moderate.

Presence of rare and endangered species:
Several protected species are known to occur in the surrounding area. Although the area is somewhat modified it was notable that along the banks of the Sandspruit, several specimens of the protected *Crinum bulbispermum* occurs. This species is not common but is normally associated with the floodplain of river systems. Though relatively widespread and not considered rare or endangered it still retains a significant conservation value.

Ecological function:
The ecological functioning of the Sandspruit has been moderately modified though still intact and provide ecological services in terms of water transportation, storm water, instream and riparian habitat and groundwater recharge. Furthermore, adjacent portions of remaining natural areas still sustain the threatened Eastern Free State Clay Grassland and these areas still have an important ecological function (Appendix A: Map 2).

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the area consists of Eastern Free State Clay Grassland (Gm 3). The vegetation type is listed as being Vulnerable (VU) and therefore a Threatened Ecosystem according to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (Appendix A: Map 2). The conservation value of the portions of remaining natural vegetation in the surroundings can therefore be considered to be high.

The Sandspruit, floodplain and wetland areas remain highly sensitive in spite of their moderately modified character and therefore has a high conservation value.

Percentage ground cover:
The overall percentage ground cover is considered to be relatively low. This is considered largely a result of communal overgrazing in the area which reduces the natural vegetation cover.

Vegetation structure:
The vegetation structure of surrounding natural vegetation is still largely natural although exotic weeds, shrubs and trees do modify this where they occur.

Infestation with exotic weeds and invader plants:
Exotic weeds and invaders are common on and around the site though do not form any dominant stands (Appendix B).

Degree of grazing/browsing impact:
Overgrazing and browsing is high due to the communal grazing in the surrounding area. Trampling is also evident and will contribute to erosion and decreasing the vegetation cover.

Signs of erosion:
The impact of the weir at the site, sediment accumulation and the subsequent erosion thereof is regarded as quite high.

Terrestrial animals:
Signs and tracks of mammals are present along the banks of the Sandspruit. Burrows of an unidentified small mammal was also observed on the banks of the river. Watercourses provide a high biomass, perennial foraging and a large prey base and are therefore able to sustain a larger and more diverse mammal population. The mammal population around the site is however anticipated to be somewhat modified from the natural condition. High levels of overgrazing by domestic livestock will degrade the condition of available habitat to some degree, which will also affect the mammal population on the site. Furthermore, herding dogs and hunting by the local community will also have a high impact on the local mammal population. As a consequence it is also considered unlikely that any species of conservation concern would remain in the area. These species normally require pristine habitat and are sensitive to human induced disturbances. The likelihood that such a species may occur can however not be discounted.

Table 6: Biodiversity Sensitivity Rating for the proposed dredging operations in the Sandspruit.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness			1
Presence of rare and endangered species		2	
Ecological function			1
Uniqueness/conservation value			1
Vegetation condition			
Percentage ground cover	3		
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact	3		
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species	3		
Sub total	12	6	3
Total		21	

6. Biodiversity sensitivity rating (BSR)

Table 7: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Rating	Value
Sandspruit dredging operations	21	Degraded	3

7. Discussion and conclusions (Appendix A: Map 1 - 3)

The proposed dredging will take place within the Sandspruit at the abstraction point for the De Put containment dam at the small town of Senekal (Appendix A: Map 1). The De Put containment dam is an off-channel dam which is therefore not located within the channel of the Sandspruit, but adjacent to it. The dam has a weir and extraction point in the Sandspruit adjacent to the dam. Sedimentation upstream of this weir has increased over the years and dredging will attempt to clear a portion of the main channel of the Sandspruit, upstream of this weir to allow for the construction of a new extraction point. The footprint of this dredging will cover an area of approximately 1.1 hectares. The weir, off-channel dam and extraction point all contribute to some modification of the system though it is evident that extensive wetland areas are also associated with the river here, both historically and currently.

According to Mucina & Rutherford (2006) the area consists of Eastern Free State Clay Grassland (Gm 3). The vegetation type is listed as being Vulnerable (VU) and therefore a Threatened Ecosystem according to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (Appendix A: Map 2). The majority of the surrounding area is still natural though also affected by high levels of communal overgrazing by domestic livestock. According to the Free State Province Biodiversity Management Plan (2015) the dredging site is listed as being an Ecological Support Area 2 (ESA 2) (Appendix A: Map 3). This indicates that the area is recognised as being largely transformed by the surrounding landuse but forms part of the functioning of the Sandspruit and as a result does still function in the support of this system.

The areas surrounding the dredging site is still largely natural though has been affected by several land uses. This is confirmed, for the most part, by the National Biodiversity Assessment (2018), which indicates the portions to the north of the Sandspruit has been transformed by the existing off-channel De Put Dam though the areas to the south are still largely natural (Appendix A: Map 2). Areas around the Sandspruit are also disturbed due to the current construction of a new abstraction point in the river. This was also largely confirmed by the on-site survey. Overgrazing by domestic livestock also cause significant modification of the remaining natural vegetation. The riparian vegetation within the Sandspruit has been modified by sedimentation of the river but is considered to be largely intact. From the above, it should be clear that the general ecology of the area is still intact to some degree though significantly modified by surrounding land uses.

Despite the somewhat modified condition of surrounding natural vegetation it does still consist of Eastern Free State Clay Grassland, a Threatened Ecosystem, which should therefore be avoided by the proposed dredging operations (Appendix A: Map 2). This is particularly applicable to the western banks and surrounding areas to the west of the river.

Although the area is somewhat modified it was notable that along the banks of the Sandspruit, several specimens of the protected *Crinum bulbispermum* occurs. This species is not common but is normally associated with the floodplain of river systems. Though relatively widespread and not considered rare or endangered it still retains a significant conservation value. The species should remain largely unaffected by the dredging operations as long as the remaining natural vegetation along the western banks of the river is not affected by dredging or associated activities such as a laydown area or stockpiles. Should any specimens require removal for the dredging operations, the necessary permits will have to be obtained to do so. Any removed specimens should be transplanted to an adjacent area where it will remain unaffected.

Signs and tracks of mammals are present along the banks of the Sandspruit. Burrows of an unidentified small mammal was also observed on the banks of the river. Watercourses provide a high biomass, perennial foraging and a large prey base and are therefore able to sustain a larger and more diverse mammal population. The mammal population around the site is however anticipated to be somewhat modified from the natural condition. High levels of overgrazing by domestic livestock will degrade the condition of available habitat to some degree, which will also affect the mammal population on the site. Furthermore, herding dogs and hunting by the local community will also have a high impact on the local mammal population. As a consequence it is also considered unlikely that any species of conservation concern would remain in the area. These species normally require pristine habitat and are sensitive to human induced disturbances. The likelihood that such a species may occur can however not be discounted.

Soil samples taken across the Sandspruit are indicative of a permanent zone of wetness and it is considered that saturated soil conditions exist year-round (Appendix C). Due to continuous sediment deposition, these wetland conditions extend across the entire main channel of the river and across the adjacent floodplain (Appendix A: Map 1). These wetland conditions now occur from the toe of the De Put Dam to the main channel of the Sandspruit and across to the sandstone floodbench on the western banks of the river. The extent of these wetland conditions may have been modified by continuous sediment deposition, although imagery prior to the construction of the weir also indicate extensive wetland conditions in this area. The geomorphology of the river and its main channel would however be modified significantly by sediment deposition. The continuous deposition of sediment slowly increases the elevation of the riverbed and cause the modification of the banks and associated geomorphology. Obligate wetland vegetation dominates the river, main channel and entire floodplain adjacent to it. This all confirms the extensive wetland areas associated with it. The terrestrial surroundings or border of the riparian zone is indicated by an exposed sandstone ridge along the western banks forming a floodbench and the presence of terrestrial plant species.

The Sandspruit at the proposed dredging site has been affected by several significant impacts which has caused moderate modification of the system.

The off-channel De Put storage dam, abstracts water from the main channel and in so doing decreases the baseflow of the river which alters the flow regime significantly (Appendix A: Map 1). The weir associated with this dam also act as flow barrier, and although not as significant as an in-channel storage dam, would also cause retardation of flow and obstruct flooding events and would therefore impact on the flow and flooding regime of the river. The weir would also cause sedimentation upstream while preventing sediment deposition downstream. This will also have a significant impact on the river.

The floodplain and wetland areas adjacent to the Sandspruit and weir are currently being affected by construction of a new abstraction point, this has resulted in the clearance of vegetation, disturbance of the soils surface and which clearly contributes to sedimentation of the river at the site as well as downstream of the weir. This also indicates that any disturbance of the river, riparian vegetation and soils surface will result in downstream impacts and should also be taken into consideration for the proposed dredging of the river upstream of the weir.

Several upstream and surrounding impacts will also affect the condition of the river. The extensive agricultural crop cultivation upstream has also contributed significant impacts on water quality, sediment load and geomorphology of the river. Though not as much as downstream areas, the urban areas of Senekal would also entail some impacts on the river.

Several significant impacts has quite significantly affected the river at the site and the bed and bank morphology has also been significantly modified. Despite the modifications affecting the Sandspruit, it is still regarded as a highly sensitive system providing numerous vital ecosystem functions including water transportation, aquatic and wetland habitat, flood attenuation and bioremediation functions.

The Sandspruit which will be affected by the dredging operations is still natural to a significant extent although moderately modified by large impacts associated with the De Put Dam and weir and upstream dryland crop cultivation. An Index of Habitat Integrity (IHI) was conducted and indicated that the river has an Instream and Riparian IHI of Category C: Moderately Modified. A summary of these results are included in Appendix D. The EI&S of the Sandspruit has been rated as being Moderate.

A Risk Assessment for the proposed dredging operations within the Sandspruit has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Despite the modified condition of the river, it is still likely that dredging will cause several significant impacts. The existing weir and abstraction point clearly has significantly modified the river here and the continuous sediment deposition upstream of the weir is clearly resulting in the modification of the river, especially in terms of the geomorphology and riparian composition. The proposed dredging operations may therefore be considered as a form of river rehabilitation. This proposed rehabilitation may however still result in significant impacts and in order to obtain a better understanding of what these may entail the following guideline was consulted:

Day, L., King, H. & Rountree, M. 2016. The Development of a Comprehensive Manual for River Rehabilitation in South Africa. WRC Report TT 646/15.

Sediment erosion, transport and deposition are important processes that create habitat diversity in rivers. However, where high rates of deposition occur, as is the case upstream of the weir, this results in reduced channel depth. In general, the direct removal or excavation of sediment form rivers is not a good idea due to the risks of initiating instability and the loss and degradation of riparian and wetland habitats. However, in some instances the management of sedimentation is not possible without the direct removal of sediments. Where the direct removal of sediment is found to be justified, best practise must be used to carry out the necessary work to minimise adverse effects on the environment (Day *et al* 2016).

Additional mitigation which should be considered in order to decrease the impact that dredging operations will have include:

- Limiting the extent of dredging the main channel of the Sandspruit, immediately upstream of the weir, and to a maximum section of 250 meters upstream of the weir (Appendix A: Map 1).
- Avoiding the western bank of the river completely and also retaining the floodplain and associated wetland areas intact (these areas occurring between the main channel and the toe of the damwall (Appendix A: Map 1).
- Avoiding the removal of vegetation as far as possible and avoiding the removal of vegetation outside the main channel completely.

- Undertaking of dredging should be limited to winter months (May to September) when dredging operations will be least likely to be affected by flooding and disturbance will also be limited.
- Vehicles will have to access the main channel. This should be limited to a single access road into and out of the main channel.
- Excavated sediment should be removed from the area and disposed of or used in agricultural activities and should not be stockpiled at the site. Current construction operations contain a stockpile area in the floodplain of the river which results in direct wetland loss. This should be avoided by dredging operations.
- Following the dredging operations, any disturbance of the banks, vegetation or wetland areas should be rehabilitated. It is important that riparian vegetation be re-established where they were removed. This can be attained by removing sods of the indigenous sedges and grasses as listed for the river and replanting these in disturbed areas
- Areas where dredging and disturbance takes place is normally susceptible to the establishment of exotic weeds and invaders. It will therefore be important to monitor and eradicate any invasive weeds.
- A comprehensive monitoring and rehabilitation programme should be initiated, which should be maintained at least for the duration of dredging, when impacts are anticipated to be most significant.
- Given the significant extent of dredging (1.1. hectares) additional monitoring should include monthly monitoring of sediment release upstream, at the site and downstream in order to determine the extent to which dredging is causing sedimentation which should also allow for remediation where high impacts are observed.
- Biomonitoring should be conducted at least every three months and should include indices such as WET-Health and SASS5 or a combination thereof.

Taking into consideration all of the above and provided that adequate mitigation as recommended is implemented at the site, the proposed dredging operations should be limited to a moderate risk activity.

8. Recommendations

- No littering must be allowed and all litter must be removed from the site.

- No hunting, harming, capturing or trapping must be allowed and this must be strictly prohibited.

- Monitoring of dredging and compliance with recommended mitigation measures must take place.

- The necessary authorisations must be acquired from Department of Water and Sanitation (DWS) for the proposed dredging operations in the Sandspruit as listed in Table 5 (Appendix A: Map 1).

- Surrounding natural vegetation still consist of Eastern Free State Clay Grassland, a Threatened Ecosystem, which should therefore be avoided by the proposed dredging operations (Appendix A: Map 2). This is particularly applicable to the western banks and surrounding areas to the west of the river.

- Although the area is somewhat modified it was notable that along the banks of the Sandspruit, several specimens of the protected *Crinum bulbispermum* occurs:

    - Dredging operations including any associated disturbance should avoid the natural vegetation along the western banks of the river in order to minimise the impact on these plants.
    - Should any specimens require removal for the dredging operations, the necessary permits will have to be obtained to do so. Any removed specimens should be transplanted to an adjacent area where it will remain unaffected.

Additional mitigation which should be considered in order to decrease the impact that dredging operations will on the Sandspruit include:

- Limiting the extent of dredging the main channel of the Sandspruit, immediately upstream of the weir, and to a maximum section of 250 meters upstream of the weir (Appendix A: Map 1).
- Avoiding the western bank of the river completely and also retaining the floodplain and associated wetland areas intact (these areas occurring between the main channel and the toe of the damwall (Appendix A: Map 1).
- Avoiding the removal of vegetation as far as possible and avoiding the removal of vegetation outside the main channel completely.
- Undertaking of dredging should be limited to winter months (May to September) when dredging operations will be least likely to be affected by flooding and disturbance will also be limited.
- Vehicles will have to access the main channel. This should be limited to a single access road into and out of the main channel.
- Excavated sediment should be removed from the area and disposed of or used in agricultural activities and should not be stockpiled at the site. Current construction operations contain a stockpile area in the floodplain of the river which results in direct wetland loss. This should be avoided by dredging operations.

- Following the dredging operations, any disturbance of the banks, vegetation or wetland areas should be rehabilitated. It is important that riparian vegetation be re-established where they were removed. This can be attained by removing sods of the indigenous sedges and grasses as listed for the river and replanting these in disturbed areas
- Areas where dredging and disturbance takes place is normally susceptible to the establishment of exotic weeds and invaders. It will therefore be important to monitor and eradicate any invasive weeds.
- A comprehensive monitoring and rehabilitation programme should be initiated, which should be maintained at least for the duration of dredging, when impacts are anticipated to be most significant.
- Given the significant extent of dredging (1.1. hectares) additional monitoring should include monthly monitoring of sediment release upstream, at the site and downstream in order to determine the extent to which dredging is causing sedimentation which should also allow for remediation where high impacts are observed.
- Biomonitoring should be conducted at least every three months and should include indices such as WET-Health and SASS5 or a combination thereof.

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Annexure A: Maps

Wetland delineation map, including watercourses and wetlands for the proposed dredging operations within the Sandspruit at the De Put dam in Senekal, Free State Province.

Legend:

Dredging site

Wetlands areas

Riparian zone

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:5 000

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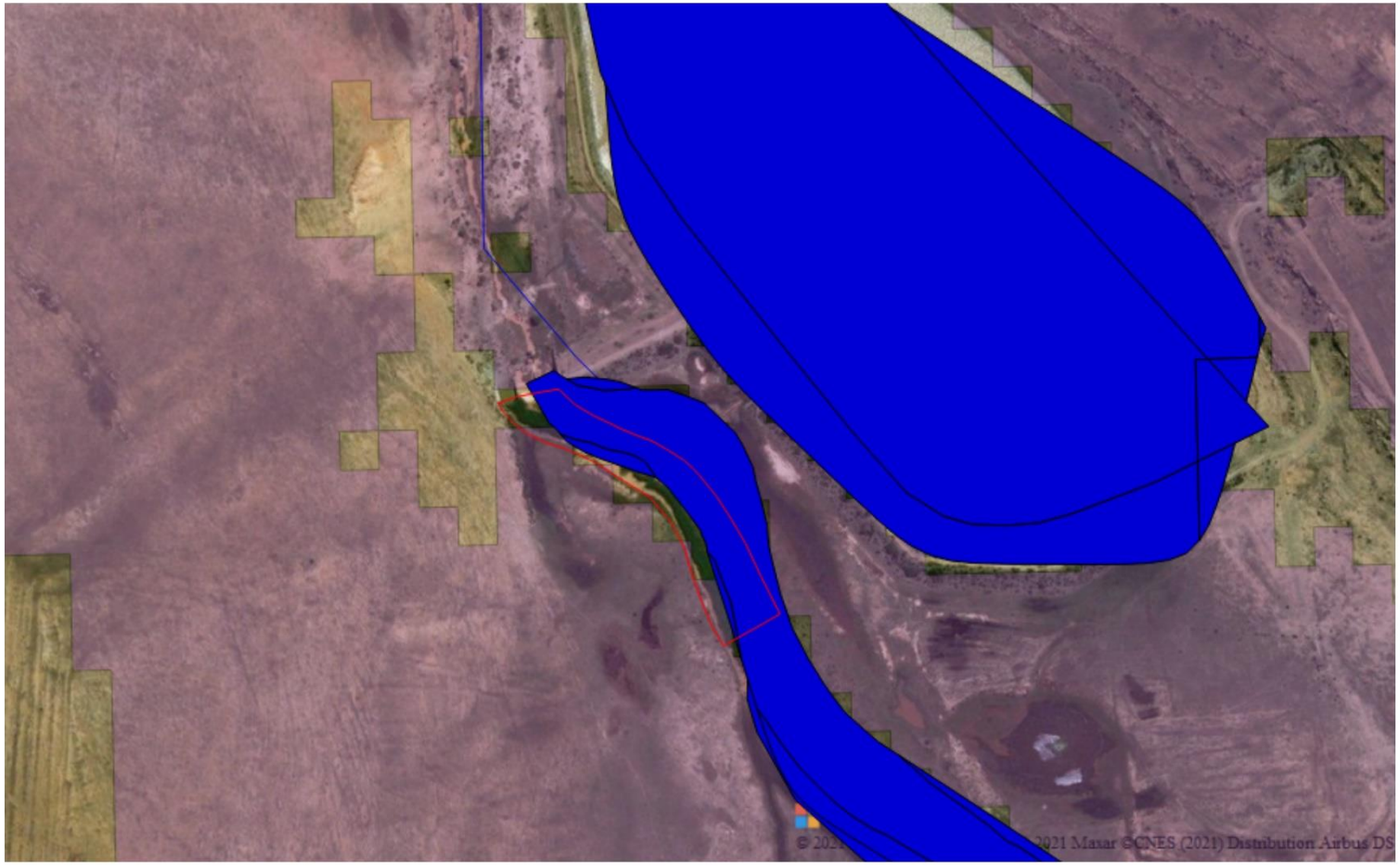
Map 1: Wetland delineation map for the proposed dredging operations within the Sandspruit. The De Put off-channel dam and associated weir is clearly visible. The course of the Sandspruit and the footprint of the proposed dredging operations are also indicated. Note the extensive wetland areas associated with the river. The wetland areas around the proposed dredging site has been delineated and cover the entire floodplain, up to the toe of the damwall. Note also the section of riparian zone along the western banks of the river which is indicative of the border of the floodplain and surrounding terrestrial areas.

General ecology map, including watercourses and wetlands for the proposed dredging operations within the Sandspruit at the De Put dam in Senekal, Free State Province.



Legend:

- Dredging site
- Watercourses
- Wetlands and impoundments
- Eastern FS Clay Grassland
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:5 000

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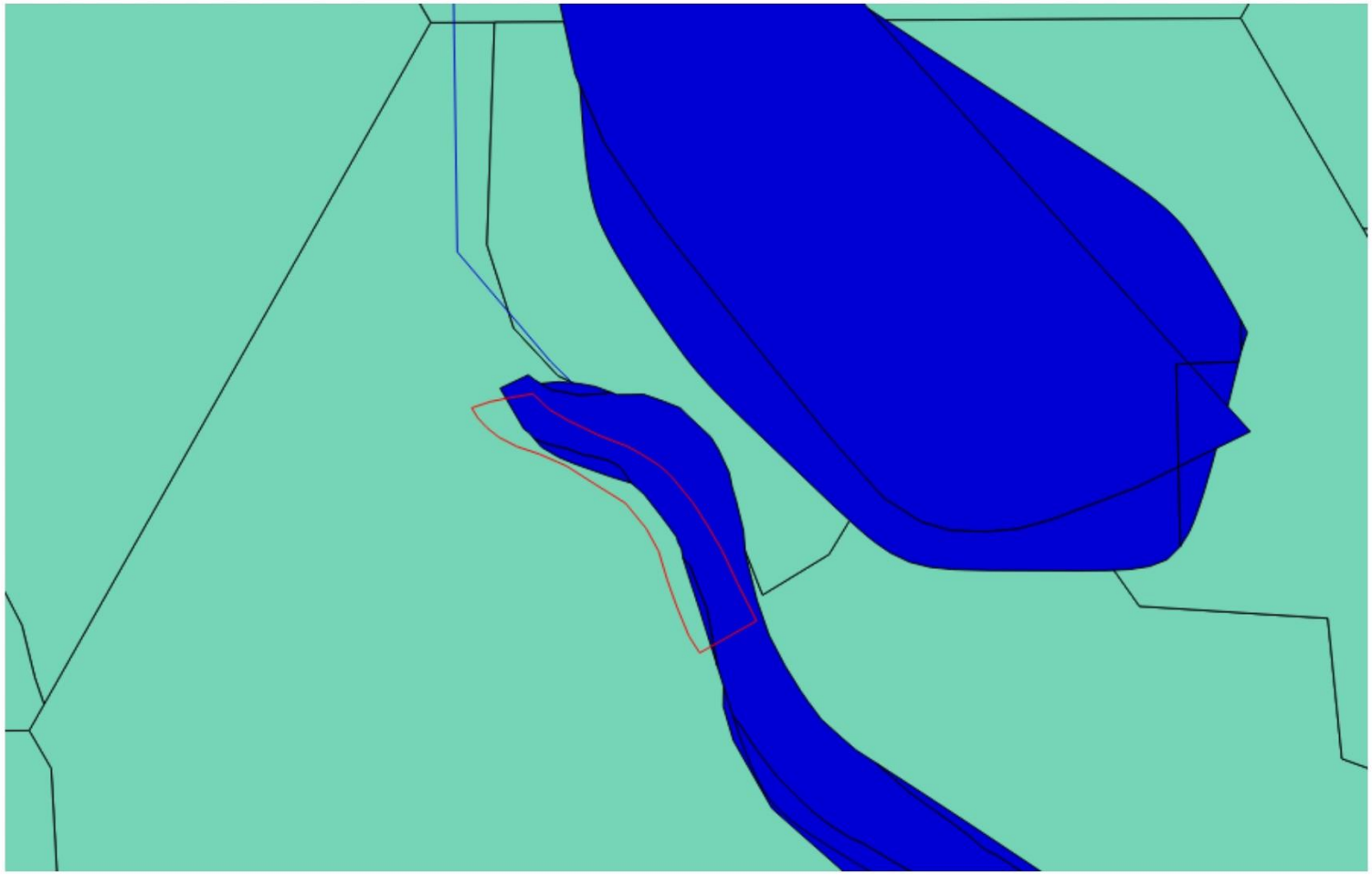
Map 2: General ecology map for the proposed dredging operations within the Sandspruit. The portions of remaining natural vegetation in the surroundings are indicated and consist of Eastern Free State Clay Grassland, a Threatened ecosystem. The De Put off-channel dam and wetland areas upstream of the weir is also indicated.

Free State Biodiversity Management map, including watercourses and wetlands for the proposed dredging operations within the Sandspruit at the De Put dam in Senekal, Free State Province.



Legend:

- Dredging site
- Watercourses
- Wetlands and impoundments
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area 1
- Ecological Support Area 2
- Degraded

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:5 000

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Map 3: Free State Biodiversity Management map for the proposed dredging operations within the Sandspruit. The site itself is considered an EcologicalSupport Area 2 and functions in aid of the Sandspruit and its surrounding natural areas. The De Put off-channel dam and wetland areas upstream of the weir is also indicated.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Argemone ochroleuca*	Herb
**Bidens bipinnata*	Herb
**Ligustrum lucidum*	Tree
**Pennisetum clandestinum*	Grass
**Rosa rubiginosa*	Shrub
**Sesbania punicea*	Shrub
**Xanthium spinosum*	Herb
Aristida congesta	Grass
Aristida diffusa	Grass
Asparagus larcinus	Shrub
Crinum bulbispermum	Geophyte
Cymbopogon pospischillii	Grass
Cynodon dactylon	Grass
Cyperus longus	Sedge
Cyperus sexangularis	Sedge
Diospyros austro-africana	Shrub
Diospyros lycioides	Shrub
Equisetum ramosissimum var. *ramosissimum*	Fern
Eragrostis lehmanniana	Grass
Felicia muricata	Dwarf shrub
Leptochloa fusca	Grass
Marsilea sp.	Fern
Melolobium candicans	Dwarf shrub
Mohria sp.	Fern
Moraea pallida	Geophyte
Phragmites australis	Reed
Scolopia zeyheri	Shrub
Searsia pyroides	Shrub
Triraphis andropogonoides	Grass
Vachellia karroo	Tree

Appendix C: Soil Samples Methodology

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to confirm the wetland conditions in the study area. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Within wetlands the hydrological regime differs due to the topography and landscape. For instance; a valley bottom wetland would have a main channel that is below the water table and consequently permanently saturated, i.e. permanent zone of wetness. As you move away from the main channel the wetland would become dependent on flooding in order to be saturated. As a result along this hydrological regime areas of permanent saturation, seasonal and temporary saturation would occur. At some point along this gradient the saturation of the soil would be insufficient to develop reduced soil conditions and therefore will not be considered as wetland.

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result available oxygen is consumed by microbes and plantroots and due to the slow rate of oxygen diffusion oxygen is depleted and biological activity continues in anaerobic conditions and this causes the soil to become reduced.

Reduction of wetland soils is a result of bacteria decomposing organic material. As bacteria in saturated soils deplete the dissolved oxygen they start to produce organic chemicals that reduce metals. In oxidised soils the metals in the soil give it a red, brown, yellow or orange colour. When these soils are saturated and metals reduced the soil attains a grey matrix characteristic of wetland soils.

Within this reduction taking place in the wetland soils there may be reduced matrix, redox depletions and redox concentrations. The reduced matrix is characterised by a low chroma and therefore a grey soil matrix. Redox depletions result in the grey bodies within the soil where metals have been stripped out. Redox concentrations result in mottles within the grey matrix with variable shape and are recognised as blotches or spots, red and yellow in colour.

Soil wetness indicator is used as the primary indicator of wetlands. The colour of various soil components are often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix.

Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell). According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Table 1: Soil samples taken along a lateral transect of the Sandspruit at the proposed dredging site (S 28.358019°, E 27.621577°).

	
Soil sample taken in the floodplain between the main channel and toe of the damwall. Soils are sandy but also with some clay. A grey matrix is not prominent though distinct mottling clearly indicate the presence of at least seasonal wetland conditions.	Soil sample taken along the marginal zone of the eastern banks of the river. A prominent grey matrix (>10%) and quite clear mottling indicate a perennial zone of wetness.
	
Soil sample taken along the marginal zone of the western banks of the river. A prominent grey matrix (>10%) and quite clear mottling indicate a perennial zone of wetness.	Soil sample taken in the lower zone of the western banks of the river. Soils are sandy but also with some clay. A grey matrix is not prominent though distinct mottling clearly indicate the presence of at least seasonal wetland conditions.

	
Soil sample taken within the upper zone along the sandstone ridge along the western banks of the river. The soil characteristics enable accurate delineation between the riverbank and surrounding terrestrial areas. Note brownish colouration, absence of clay and organic material and high sand content.	

Appendix D: Index of Habitat Integrity (IHI) Summary

For the complete IHI please contact the author of this report.

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	Sandspruit weir dredging
UPPER LATITUDE	
UPPER LONGITUDE	
UPPER ALTITUDE	
LOWER LATITUDE	
LOWER LONGITUDE	
LOWER ALTITUDE	
SURVEY SITE (if applicable)	Sandspruit
SITE LATITUDE (if applicable)	S 28.358019
SITE LONGITUDE (if applicable)	E 27.621577
SITE ALTITUDE (if applicable)	1434 m
WMA	Middle Vaal
QUATERNARY	C42C
ECOREGION 2	11_3
DATE	17/06/2021
RIVER	Sandspruit
TRIBUTARY	
PERENNIAL (Y/N)	**Y**
GEOMORPH ZONE	**FOOTHILL**
WIDTH (m)	**>0-2**

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY MODIFICATION	2.1	2.0
PHYSICO-CHEMICAL MODIFICATION	1.3	3.0
BED MODIFICATION	1.8	4.0
BANK MODIFICATION	2.0	3.0
CONNECTIVITTY MODIFICATION	2.0	4.0
INSTREAM IHI%	63.5	
CATEGORY	C	
CONFIDENCE	3.2	

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY	2.08	3.00
BANK STRUCTURE MODIFICATION	1.80	4.00
CONNECTIVITY MODIFICATION	1.50	4.00
RIPARIAN HABITAT INTEGRITY (%)	63.50	
CATEGORY	C	
CONFIDENCE	3.67	

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

	MRU
INSTREAM IHI	
Base Flows	-2.0
Zero Flows	2.0
Floods	2.5
HYDROLOGY RATING	**2.1**
pH	1.0
Salts	1.0
Nutrients	2.0
Water Temperature	1.5
Water clarity	1.5
Oxygen	1.0
Toxics	1.0
PC RATING	**1.3**
Sediment	2.0
Benthic Growth	1.5
BED RATING	**1.8**
Marginal	2.0
Non-marginal	2.0
BANK RATING	**2.0**
Longitudinal Connectivity	2.0
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.0**
INSTREAM IHI %	**63.5**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**3.2**

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	2.0
Moderate Floods	2.0
Large Floods	2.5
HYDROLOGY RATING	**2.1**
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	1.0
Invasive Alien Vegetation (non-marginal)	3.0
Erosion (marginal)	1.0
Erosion (non-marginal)	2.0
Physico-Chemical (marginal)	1.5
Physico-Chemical (non-marginal)	3.0
Marginal	1.5
Non-marginal	3.0
BANK STRUCTURE RATING	**1.8**
Longitudinal Connectivity	1.5
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.5**
RIPARIAN IHI %	**63.5**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.7**

Appendix E: Risk Assessment Matrix

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP REGISTERED PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE

					Severity															
No.	**Phases**	**Activity**	**Aspect**	**Impact**	**Flow Regime**	**Physico & Chemical (Water Quality)**	**Habitat (Geomorph+Vegetation)**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**Risk Rating**	**Confidence level**	**Control Measures**
1	Mostly Operational Phase but extending after dredging	Dredging of a section of the main channel of the Sandspruit upstream of the weir.	Excavation of sediment from the main channel.	Excavation of sediment within the main channel of the Sandspruit will remove riparian vegetation and disturbance of the soil surface which will result in destabilisation of the riverbed and increase the downstream sediment load. Increased establishment of exotic weeds and invaders due to disturbance caused by dredging is also probable.	**3**	**4**	**4**	**4**	**3.75**	**4**	**2**	**9.75**	**4**	**4**	**5**	**1**	**14**	**136.5**	**M**	**80**	This impact will occur mainly during the dredging operations but may extend after completion of dredging due to the destabilisation of the riverbed. Mitigation as stipulated within Section 4.4 should be implemented in order to reduce the anticipated impacts associated with the dredging operations.
	Mostly Operational Phase		Construction of an access road within the floodplain and the banks of the Sandspruit in order to gain access to the main channel.	Construction of an access road across the floodplain and the banks of the river will also cause disturbance although on a local scale. The road will require the removal of riparian vegetation. Increased erosion, sediment load and exotic weed establishment is also likely.	1	2	3	2	**2**	1	2	5	2	2	5	1	**10**	**50**	**L**	80	The impact will be largely confined to the dredging operations as long as the access road is removed and rehabilitated afterwards. This is likely reversible impact and therefore has a low risk. It is still important that adequate rehabilitation and monitoring takes place. Mitigation as stipulated within Section 4.4 should be implemented in order to reduce the anticipated impacts associated with the dredging operations.

APPENDIX D_3

Preliminary Design Report

aurecon

Senekal Bulk Water Supply

De Put Abstraction Works: Sand Spruit Abstraction and De Put Off-Channel Storage Dam Raw Water Booster Pump Station - Detail Design Report

Reference: 111826

Prepared for: Setsoto Local Municipality

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Approval			
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Senekal Bulk Water Supply

De Put Abstraction Works: Sand Spruit Abstraction and De Put Off-Channel Storage Dam Raw Water Booster Pump Station - Detail Design Report

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1 Introduction

1.1 Background

The Senekal Bulk Water Supply Scheme seeks to improve the treated drinking water supply to the town of Senekal/Matwabeng, situated in the Setsoto Local Municipality.

Raw water will be abstracted from the two existing sources namely the Sand River, to the north of Senekal/Matwabeng, and the Sand Spruit, to the south of Senekal/Matwabeng. From the Sand River and Sand Spruit abstraction pump stations, the raw water will be transported to the Cyferfontein and De Put off-channel storage dams respectively. From the Cyferfontein and De Put off-channel storage dams raw water will be transported via a new raw water booster pump stations and rising main pipelines to the new centralised water treatment works (11Ml per/day) in Senekal/Matwabeng.

The option of pumping surplus raw water from the Cyferfontein off-channel storage dam to the De Put off-channel storage dam will also be possible by the implementation of a bi-directional pipeline. The surplus raw water from the Cyferfontein off-channel storage dam will be diverted into either the water treatment works inlet or the bi-directional pipeline by the implementation of a bi-directional take-off valve chamber before the Inlet works of the new centralized water treatment works. This valve chamber will be situated at the water treatment works inlet. The above-mentioned option will allow for additional storage capacity in the De-Put off-channel storage dam should the need arise.

From the water treatment works clear water will be stored in the existing 2 x 2.5 Mℓ, 1 x 5 Mℓ and new 11 Mℓ clear water storage reservoirs. The total storage capacity of the above-mentioned reservoir will allow for the required minimum 48 hours storage capacity. From the clear water storage reservoirs, clear water will be distributed to the town of Senekal/Matwabeng.

It was agreed that both the Sand River and Sand Spruit sources should be able to supply the full average daily demand of 15 515 Kℓ/day (Including all losses). This is to allow for the full average daily demand to be supplied from both sources should one of the sources be out of operation. This should however only be implemented over short periods of time as the annual yield does not allow for the long term full average annual demand supply from the sources respectively. Please refer to the water demand calculations attached under **Appendix A**.

To ensure adequate maintenance time of the pumping equipment, it was assumed that pumps should not operate more than 20 hours per day. The full average daily demand to be abstracted from each of the sources can be calculated as 180 ℓ/s over a 20-hour operational day.

This Concept Report will focus on the Sand Spruit Abstraction and De Put off channel storage dam raw water booster pump station.

1.2 Aim of the Report

The purpose of this report is to document the client's requirements, detail design assumptions and the detail design process of abstracting water from the Sand Spruit and transporting it to the new centralised water treatment works.

Section 1 provides background on the Senekal Bulk Water Supply project

Section 2 provides a description of the scope of works and the demand calculations

Section 3 discusses the information used for design: raw water data, existing or reference records, survey information and geotechnical information.

Section 4 discusses all the civil aspects of the detail design of the Sand Spruit abstraction, De Put off-Channel Dam abstraction and the De Put booster pump station. All civil work (structural, pipework, pumps etc) will be covered in this section.

Section 5 discusses all structural aspects of the detail design including design overview, applicable standards and requirements, specifications, design loads and materials

Section 6 discusses the Electrical Scope of Works

Section 7 discusses al the electrical aspects of the detail design including control and instrumentation, bulk (main) power and small power supply.

Section 8 discusses permission and regulatory requirements.

Section 9 will take an in depth look at the security concerns faced and measures to counter these concerns.

Section 10 discusses the Start-up of the existing WTW in Senekal/Matwabeng

Section 11 will provide conclusions and recommendations.

Section 12 is the Detail Design Approval page to be signed by all parties.

1.3 Project Locality

The project is located in Senekal/Matwabeng within the Free State province and falls within the boundaries of the Setsoto Local Municipality.

Figure 1, overleaf, illustrates the project's locality, Cyferfontein off-channel storage dam, De Put off-channel storage dam

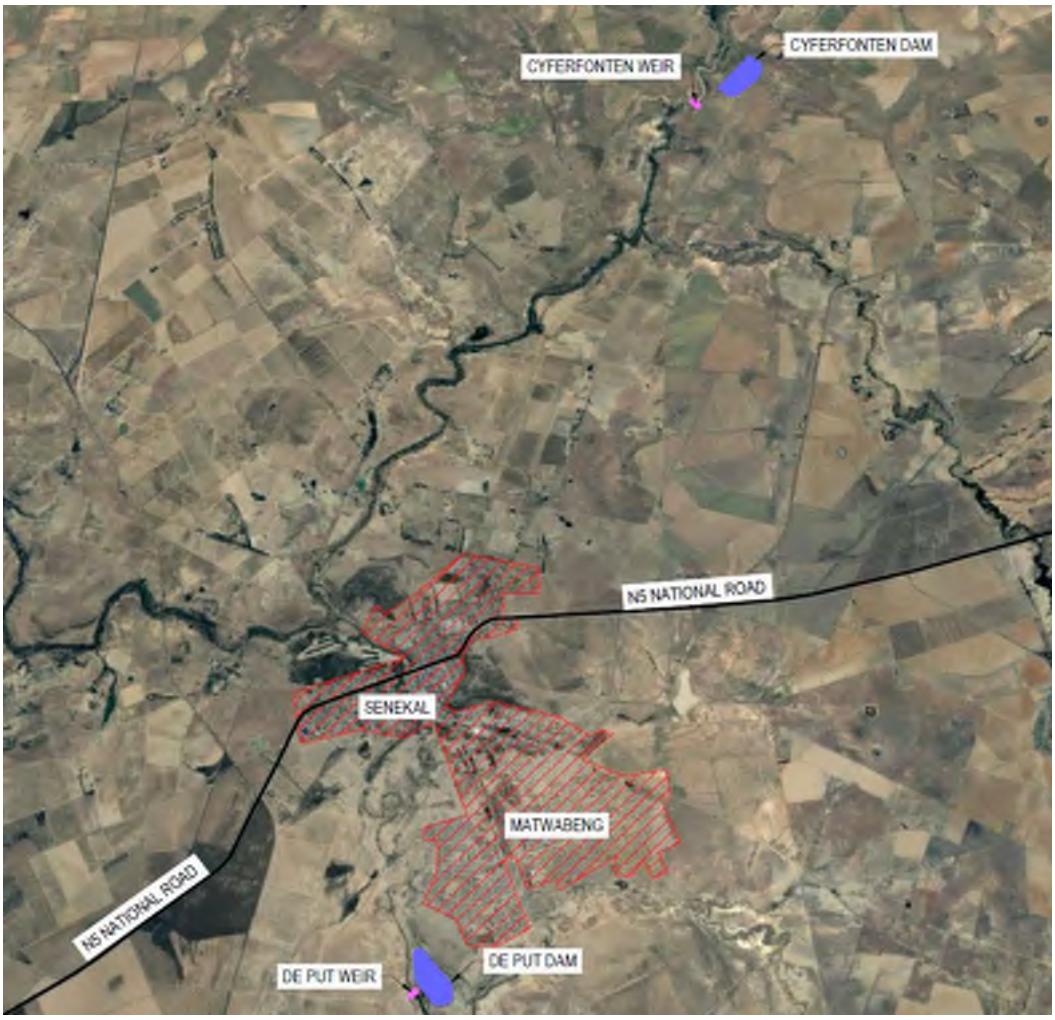


Figure 1 - Locality of Project

2 Scope of Works

2.1 Overall Scope of Works

The Overall scope of the project comprises of 3 stages, in order they are as follows:

1. Raw water will be abstracted from the Sand Spruit and transported to the existing approximately 1 million m^3 De Put off-channel storage dam. This will be done by the construction a gabion inlet/intake channel in the Sand Spruit. A screw type abstraction pump station will abstract the raw water and deposit it via a concrete channel over the De Put dam wall embankment into the De Put off-channel storage dam.
2. The raw water will be abstracted from the De Put off-channel storage dam via a HDPE floating device. The raw water will then gravitate through a 710mm dia. HDPE pipe to the manifold of the new raw water booster pump station.
3. Raw water will be pumped to the new centralized water treatment works (WTW) in Senekal/Matwabeng via the new booster pump station and 500/400 mm diameter De Put pipeline/rising main.

Figure 2: Flow diagram De Put Abstraction works

2.2 Water Demand Calculations

An investigation using figures/estimates provided by the Department of Water and Sanitation (All Town Study Reports) revealed that, after all losses have been included, a total daily demand of 15 515 kl/day would be required for the town of Senekal/Matwabeng, this amounts to approximately 180l/s over a 20-hour operational day. Losses allowed for includes, but is not limited to:

- Allowance for 9% Water treatment losses (Senekal WTW)
- Allowance for farmers use of 2%
- Allowance for 8% for transmission losses
- Allowance for 2 transmission losses from WTW to Storage Tanks
- Allowance for 25% Municipal Water Network losses in town

This is discussed in depth in the Water Treatment Works Concept Design Report issued to Setsoto Local Municipality during May 2019. As mentioned before this demand is to be supplied by two (2) sources, The Sand River and the Sand Spruit. These sources should be able to supply the full demand independently as this would ensure that the full demand will be met should one of the sources be out of operation.

3 Base Data

3.1 Water Quality

The water quality of the two (2) water sources as well as required/proposed treatment is discussed in-depth in the Water Treatment Works Concept Design Report. The quality of the water itself of the Sand Spruit was not used as a consideration or influential factor in the design of the abstraction process, however potential debris was a consideration in the design of the river abstraction and associated pump station.

3.2 Survey Information

A topographical survey received in October 2019 as well as a Lidar Survey received May 2019 was used for all designs.

3.3 Site Geology

A geotechnical report was compiled by SGE (Southern Geotechnical Engineering) in July 2019 and investigated 3 study areas namely:

- the new centralized water treatment works site in Senekal/Matwabeng,
- De Put off-channel storage dam and abstraction site (Gabion Channel) and the
- Cyferfontein off-channel storage dam.

This report focused and advised on 5 aspects of the study areas:

- Site Geology
- Site Geohydrology
- Founding Conditions
- Excavation Conditions
- Material Utilization Potential

For the De Put abstraction works 2 rotary core boreholes were drilled, numbered 26 and 27. Borehole 26 was drilled to the immediate west of the existing De Put abstraction pump station building at the new proposed abstraction pump station and inlet channel, borehole 27 was drilled as close as possible to the existing booster pump station site to the immediate north of the De Put off-channel storage dam. This will also be the site for the new booster pump station.

Detailed results can be seen in Appendix A.2 (Test Pit 26 and 27) of the Geotechnical Report, which is available. During construction of both the river abstraction as well as the booster pump station, provision should be made for the dewatering of the excavated areas. The investigation recommended that both

new pump stations at the De Put off-channel storage dam be founded on/within a soft rock or harder material. Conventional spread footings would be preferable at an allowable bearing capacity which does not exceed 300kPa. The structures of these new pump stations should be anchored to the bedrock as a result of the buoyancy effect of the groundwater.

The Geotechnical evaluation for borehole 26 and 27:

- **Borehole 26:**

The upper 1.0m of the soil profile at this position comprises a soft to firm, silty CLAY material expected to be HIGH in potential expansiveness. The remainder of the soil profile up to a depth of 5.4m comprises a clayey SILT material expected to be MEDIUM in potential expansiveness. Based on the borehole drilled at this positions, 'soft' excavation conditions must be expected to a depth of at least 5.4m below current ground level ('Soft' excavation conditions as used here implying readily excavatable by hand, TLB or tracked excavator up to say 20 ton without the need for extensive ripping, hammering of blasting operations). Deep excavations into the soft to very stiff clayey SILT material will, in conjunction with the expected shallow groundwater level, be inherently unstable. Deep excavations will require a combination of de-watering, battering of excavation sidewalls and/or a mechanically applied lateral support system (such as soil nails / rock bolts and/or steel mesh reinforced shotcrete).

- **Borehole 27:**

The upper 2.0m of the soil profile at this position comprises a soft to firm, sandy CLAY material expected to be HIGH in potential expansiveness. The remainder of the soil profile up to a depth of approximately 7.5m comprises a stiff, sandy CLAY which is expected to be HIGH in potential expansiveness. Medium hard rock sandstone will be encountered at a depth of around 7.6m. Based on the borehole drilled at this positions, 'soft' excavation conditions must be expected to a depth of at least 7.5m below current ground level ('Soft' excavation conditions as used here implying readily excavatable by hand, TLB or tracked excavator up to say 20 ton without the need for extensive ripping, hammering of blasting operations). Deep excavations into the soft to stiff sandy CLAY material will, in conjunction with the expected shallow groundwater level, be inherently unstable. Deep excavations will require a combination of de-watering, battering of excavation sidewalls and/or a mechanically applied lateral support system (such as soil nails / rock bolts and/or steel mesh reinforced shotcrete).

4 Detail Design

4.1 Abstraction Pump Station and Gabion Inlet/Intake Channel

4.1.1 Design Overview

The purpose of the Sand Spruit abstraction pump station is to abstract raw water from the Sand Spruit and transfer it to the De Put off-channel storage dam. The duty point for the raw water abstraction pump station was calculated as 86 (approx. 40% of total daily demand) to 180ℓ/s (100% of total daily demand) @ +- 10.830 m.

After the elimination of the unfeasible concepts (in the Concept Design Report), it was decided that the abstraction works be constructed so that the intake is set back from the river's edge with a connecting gabion inlet/intake channel. The channel will act as a trap to larger debris. The inlet of the structure would be covered with a screen (Grizzly screens) in order to prevent the larger material entering and possibly damaging the raw water screw pumps. Any objects able to enter through the grid would be considered when specifying the required pumps. Advantages of this type of construction would be:

- A large variation in water levels could be accommodated
- Convenient access to the installation (as opposed to installation situated in the river itself)
- Installation can be accessed during flood events. Except during the most severe floods
- Installation would not severely impact any river traffic

The abstraction pump station would be located on the outside of the bend closest to the dam wall. Locating the abstraction on the outside of the channel as this would minimise the amount of sediments and debris that would collect in the gabion channel leading up to the pump station. This is also conveniently situated as the De Put off-channel storage dam is located on the same side of the river and would negate the need for a pump line to cross the river. Access to the abstraction pump station will be from a platform constructed next to the dam embankment as well as from the embankment itself.

The raw water enters the structure where the pumps are housed from the gabion channel and through the inlet screens. The pump station structure houses 2 screw pumps (duty/standby), each capable of supplying the full demand for the new centralised water treatment works in Senekal/Matwabeng. The separated channels for each screw pump accommodate a grizzly inlet screen, sluice gate and bottom bearing for the screw pump. These sluice gate control wheels (opening and closing) are positioned above the fibreglass moulded grating platform to allow easy access for opening and closing of sluice gates.

From the abstraction pump station, raw water would be transported via a rectangular culvert type channel through the dam embankment where it would discharge into the De Put off-channel store dam.

An open concrete channel with riprap/gabion protection at the bottom will be used to discharge the water from the rectangular transport channel into the De Put off-channel storage dam.

A coffer dam would first be constructed to allow for construction to take place (Figure 5, 6 and 7). This would allow the construction area to remain dry during construction. Although some form of water extraction would be required to remove ground water.

Designs/Drawings for the De Put abstraction pump station can be seen in Figures 3-4 and 8-14 below.

The Detail Design Drawings of the main aspects discussed can be seen in **Appendix C.**

4.1.1.1 Gabion Inlet/intake Channel

The gabion Inlet/intake channel level was determined according to the requirements of the screw pump. This amounted to a minimum of 0.792 m between the touch point and filling point of the screw pump. A site survey was conducted by Aurecon on the existing intake channel, where the deepest level was determined as ±1424.002 mamsl (existing intake sump).

The top of gabion mattress level of the gabion inlet/intake channel was evaluated, and it was determined that the best level for this sill be equal to the existing channel intake sump, level ±1424.002m. The gabion inlet/intake channel in new inlet sump is also protected by means of 650mm dia. gabion sacks, gabion walls and gabion reno-mattress floor. The channel is relatively accessible as the gabion walls have been constructed in a stepped fashion. See figure 3 and 4 for Gabion channel layout and section.

The intake channel tappers from 4.50 m wide at the intake sump to 11.00 m at the Sand Spruit's edge A wingwall type design was implemented at the gabion channel's inlet (at the river's edge) in order to minimise the force acting on the wall and to create better flow characteristics for raw flowing into the channel.

Adequate high resistant abrasion protection provides protection for the gabion box/matrass wires that could be damaged by the sediment transport, debris and large particles that could enter the intake channel.

A shear stress and velocity analysis were conducted by the gabion matrass/box supplier. This resulted in an increase of matrass thickness from 300mm to 500mm (as mentioned in the Concept design report) in order to withstand higher tractive forces resulting from the changes in parameters (bed slope, area, flow and velocity).

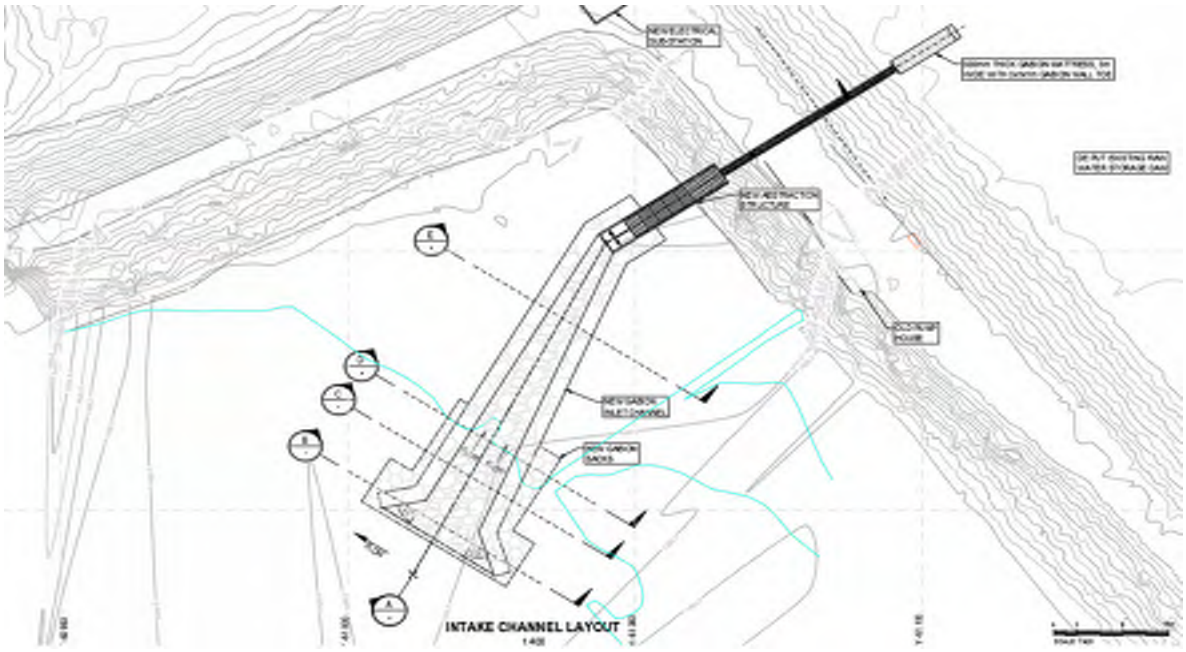


Figure 3 - Gabion channel layout

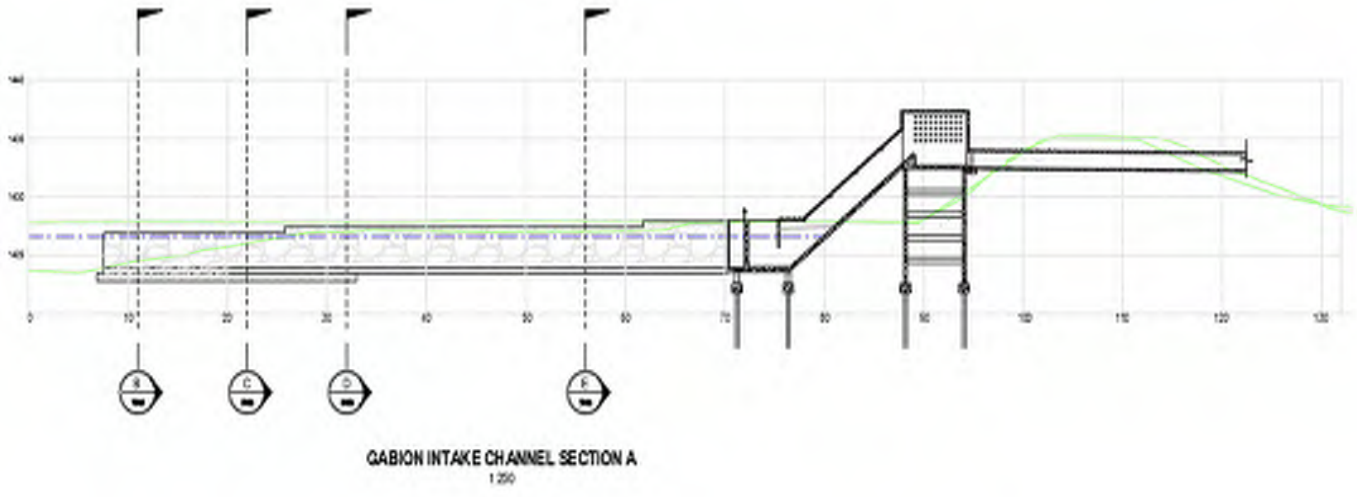


Figure 4 – Gabion channel section

4.1.1.2 Coffer Dam

In order to allow the appointed Contractor to conduct construction works on the gabion inlet/intake channel as well as well as the abstraction pump station a coffer dam is required. A coffer dam is an enclosure built within, or across, a body of water to allow the enclosed area to be pumped dry. This enclosed area that is pumped out creates a dry area for the any construction works to be conducted safely and without the concern of water from the adjacent Sand Spruit affecting the construction works. The coffer dam must be pumped out by the Contractor as and when required to ensure construction is not affected.

The coffer dam has a clay core to ensure the dam is impermeable. The Coffer dam has a crest length of approximately 140 m and a total crest width of approximately 10 m. The clay core will be constructed at a slope of 0.5 m:1 m (H: V) with a top width of 7 m and a bottom width of 1.45 m. The side slope of the coffer dam will be 1.5 m:1 m (H: V). The crest of the coffer dam will be at a level of 1428.50.

After the completion of the construction works it is the Contractors responsibility to remove the constructed coffer dam and to ensure the riverbed is reinstated to its original levels.

The figures below indicate the proposed coffer dam layout as well as section through the coffer dam.

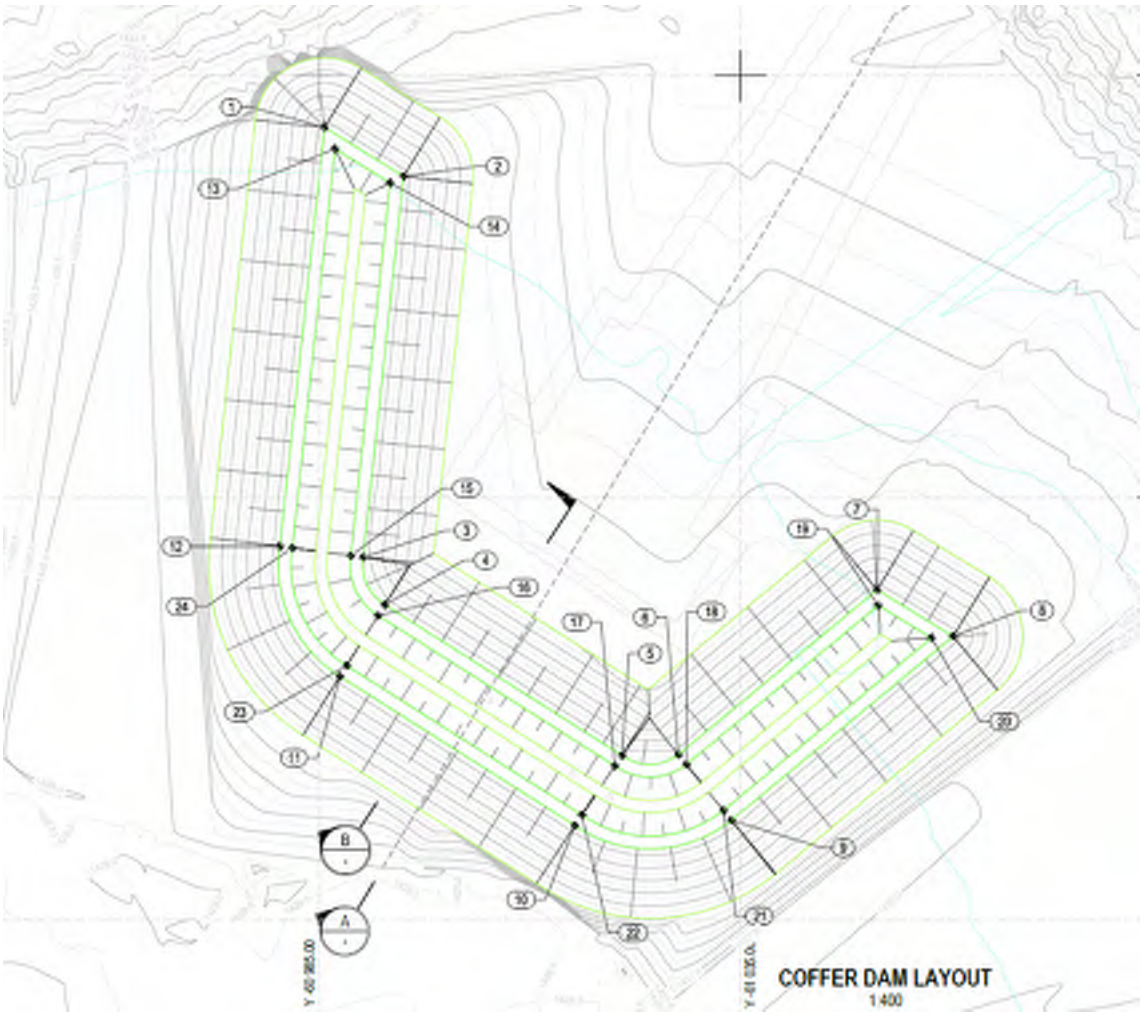


Figure 5 – Coffer Dam Layout

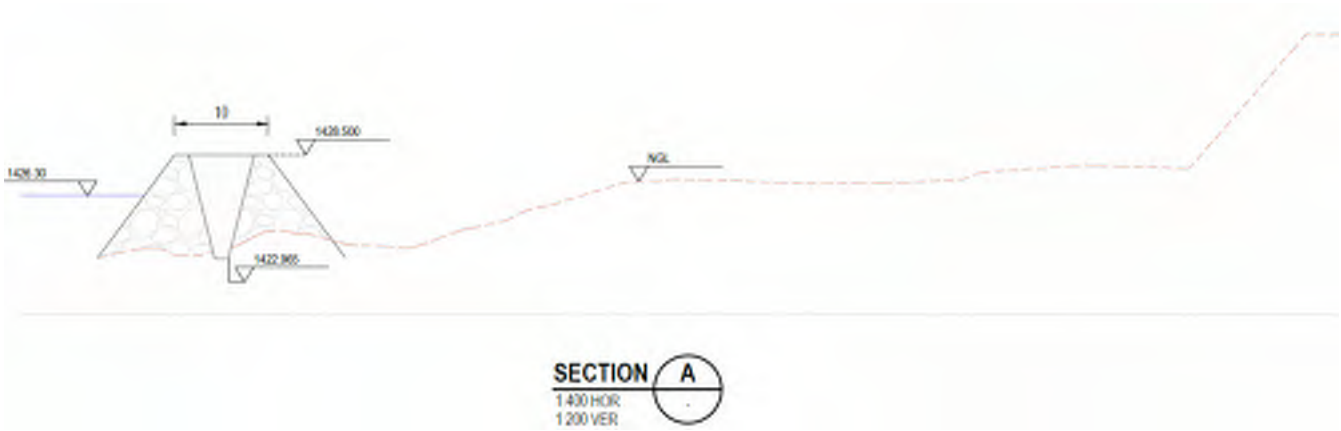


Figure 6 – Coffer dam Section Including Natural Ground Level of Gabion inlet/Intake Channel

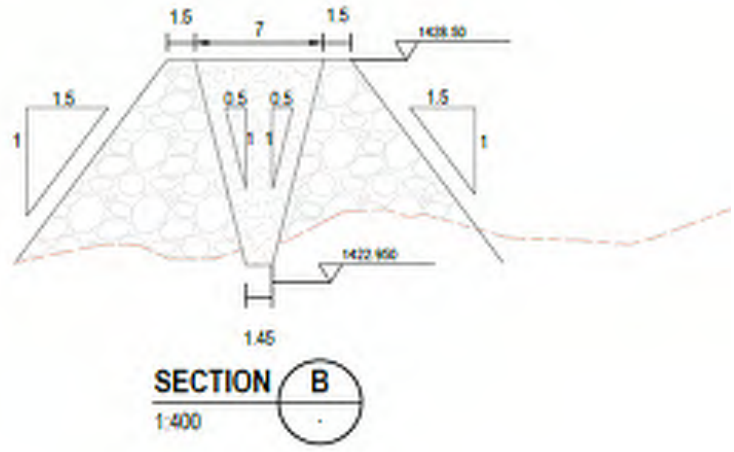


Figure 7 – Coffer Dam Section of Embankment, Including Clay Core

4.1.1.3 Abstraction Screw Pump Station

The intake sump has been divided into two intake compartments, to allow for the maintenance of one side while the other remains in operation. To this end, each inlet has its own isolating sluice gate to isolate the inflow of water to the pump station. The isolating sluice gates are operated by handwheels mounted on top of the pump station. The raw water will gravitate from the inlet/grizzly screens into the two separate screw pump station compartments (where the bottom bearing will also be situated) through 750mm x 500mm openings, see figure 10 below.

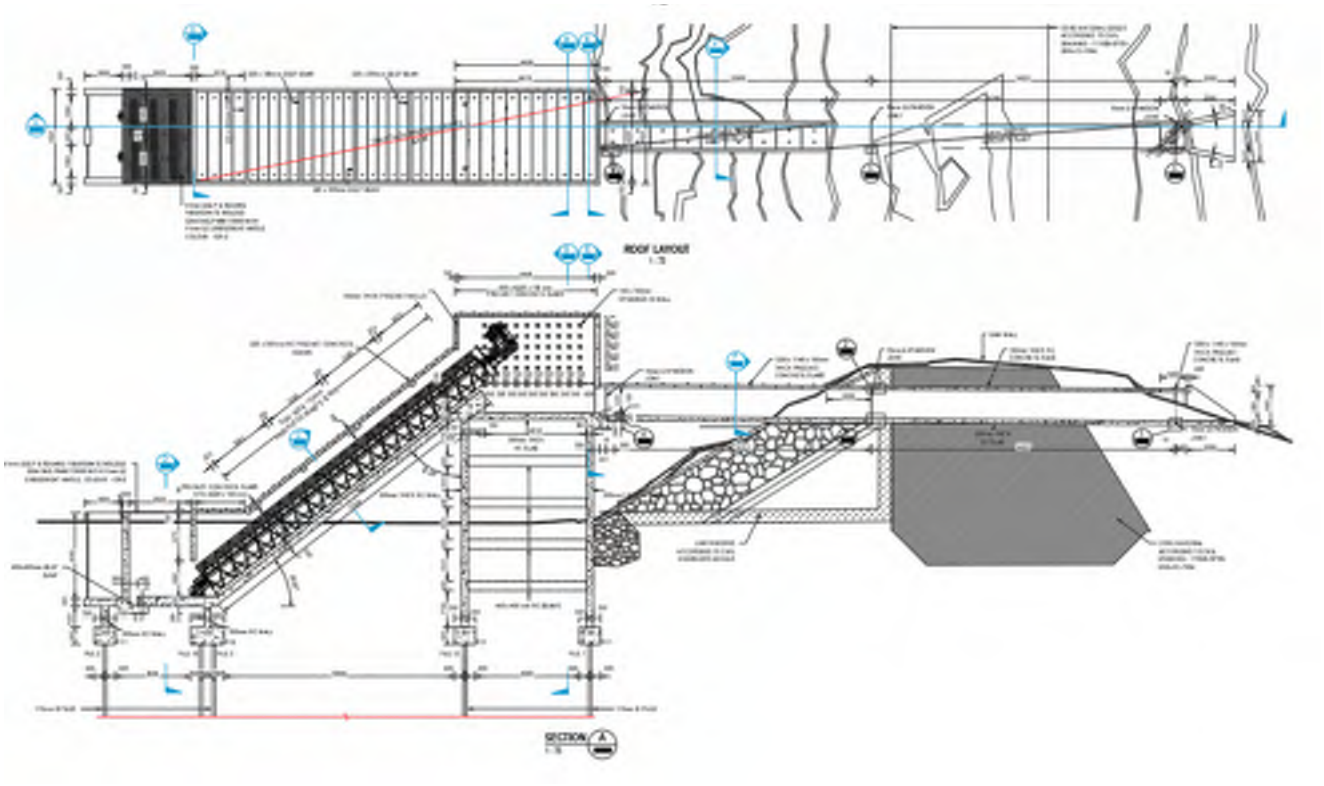


Figure 8 – Screenshot form Detail Design Drawing (For drawing please refer to Appendix C)

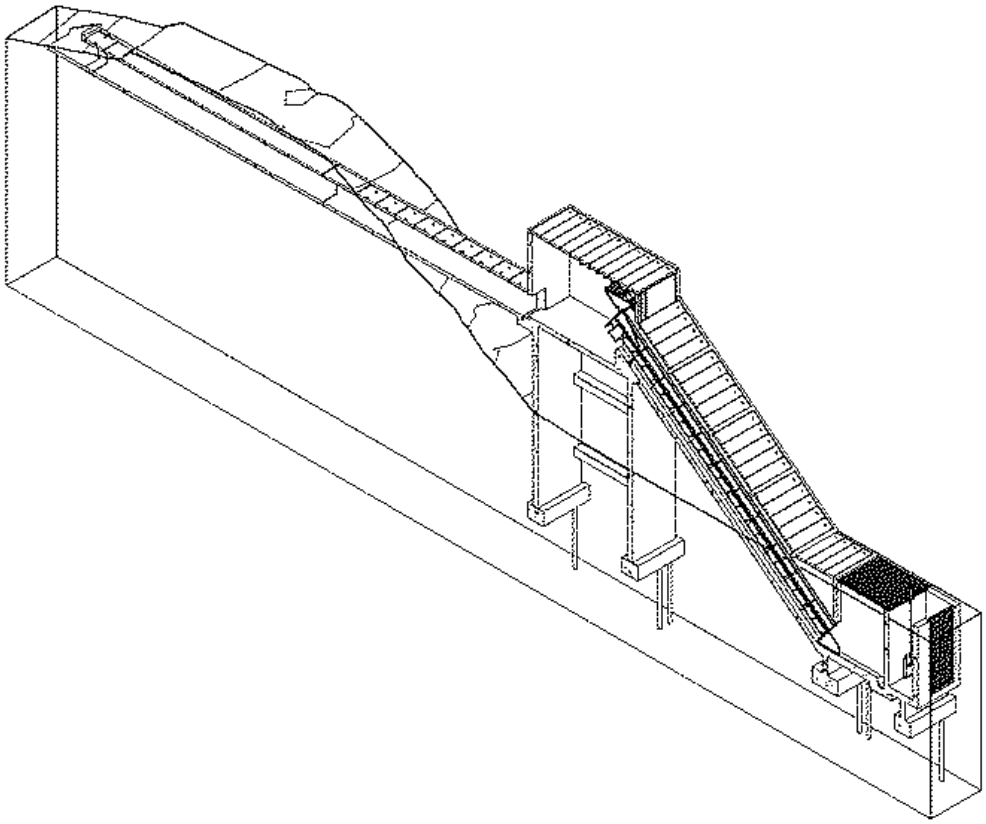


Figure 9 – Isometric View of De Put Abstraction Screw Pump Station and Outlet Channel Through Dam

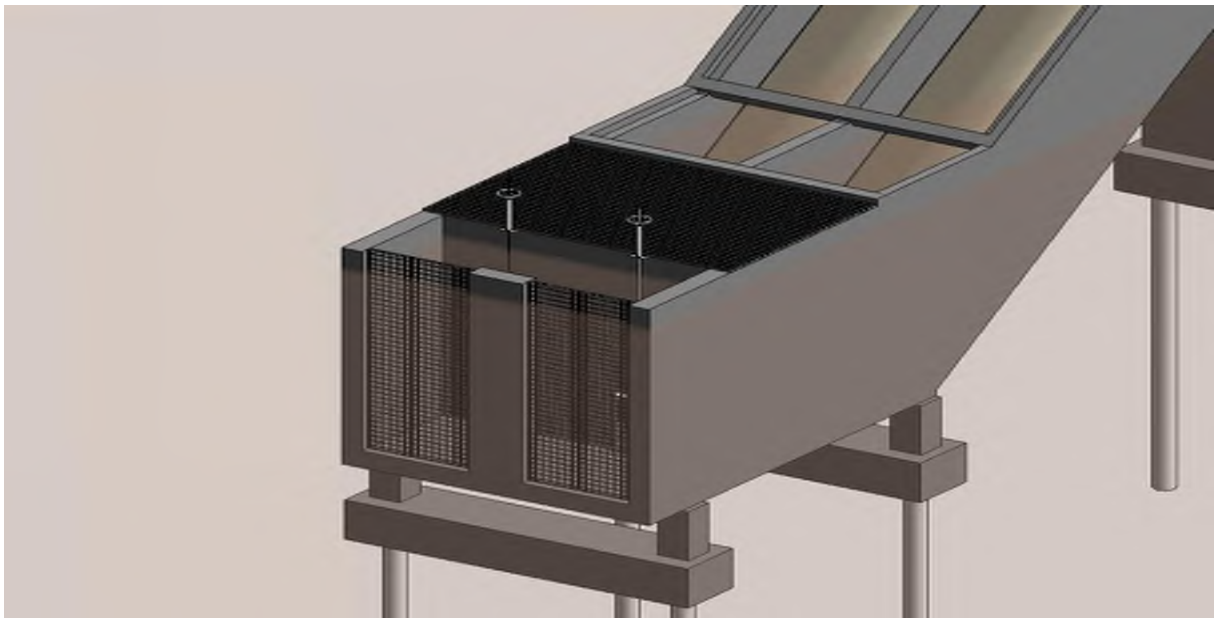


Figure 10 – Isometric Views of Inlet/Grizzly Screens at Inlet from Gabion Channel

The top of wall level for the intake sump of the abstraction pump station is situated at approximately 1428.202 mamsl, while the top of floor level (discharge sump) and motor level for the screw pumps are situated at approx. 1432.750 and approx.1435.750 respectively. It was determined with a flood line analysis, as no weir data is available, that the 1:100 flood line is at a level of approx. 1433.90. From this flood line and screw pump motor level it is evident that all important equipment was placed above the required 1:100-year flood line.

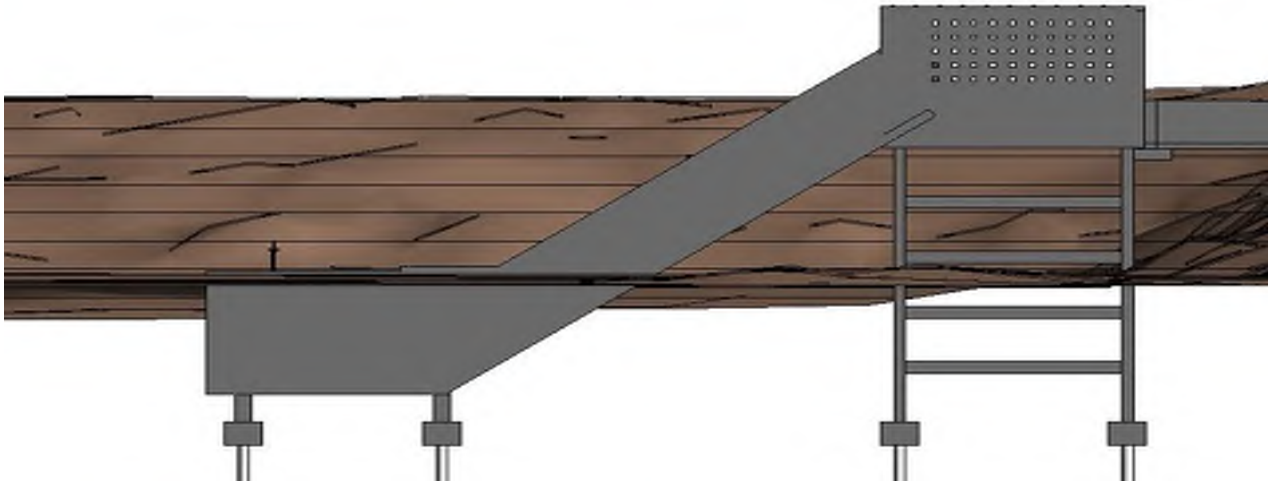


Figure 11 – Side View of Screw Pump Station

In all areas of the abstraction pump station where access is required, but where no sensitive equipment prone to theft and vandalism, is situated removable Fibregrate gratings were specified. This Fibregrate grating is manufactured from fibreglass and has no re-sell value. Where access is required, but sensitive equipment, prone to theft and vandalism is situated removable pre-cast concrete slabs (600 mm x 4220 mm x 150 mm) will be installed. These slabs can be removed should access be required. However, these slabs were designed as such that special equipment e.g. TLB or mobile crane is required to remove them.

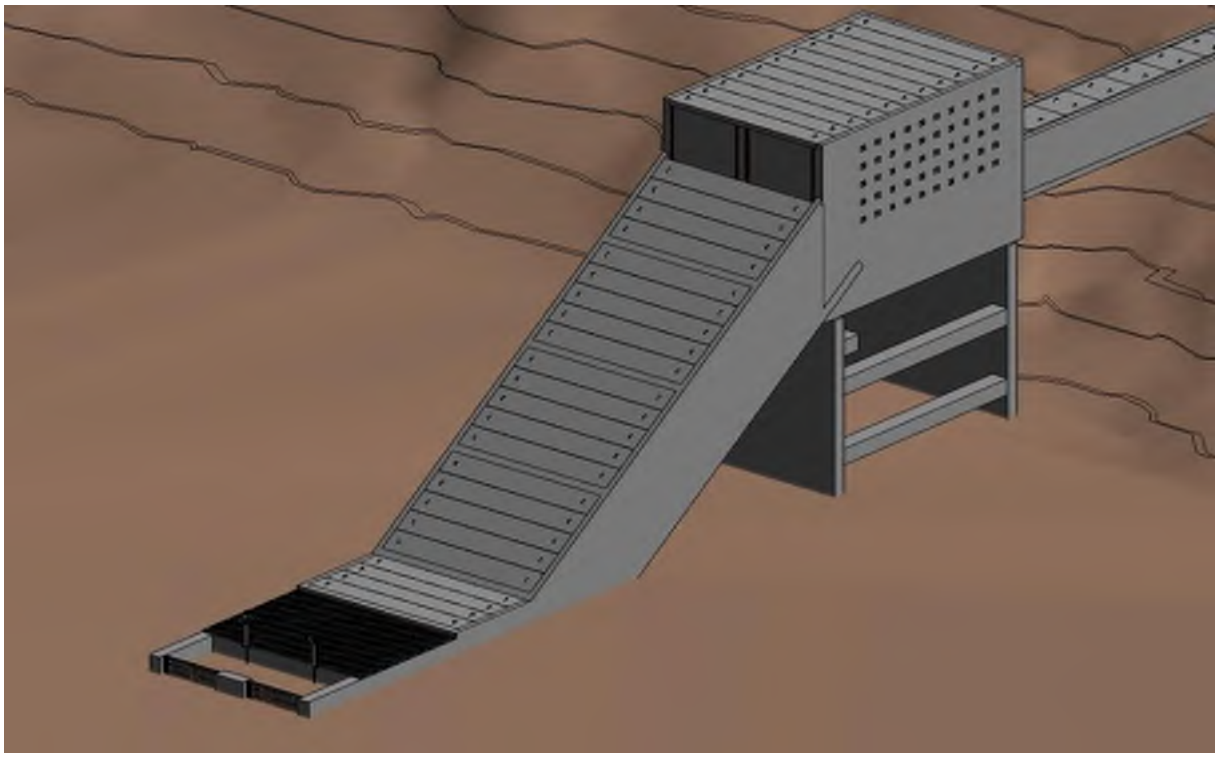


Figure 12 – Isometric View of Screw Pump Station with the Pre-Cast Slabs in Place

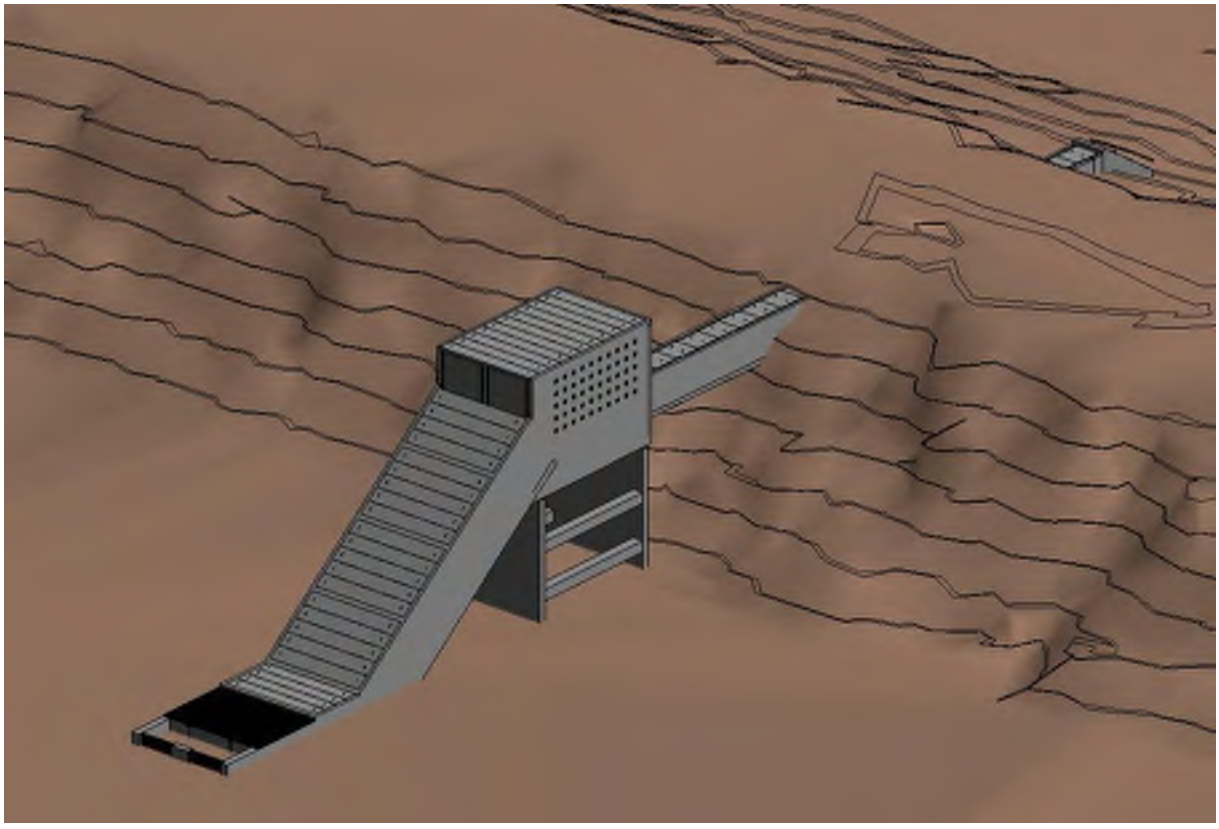


Figure 13 - Isometric View of Proposed Screw Pump Station Including Outlet Channel

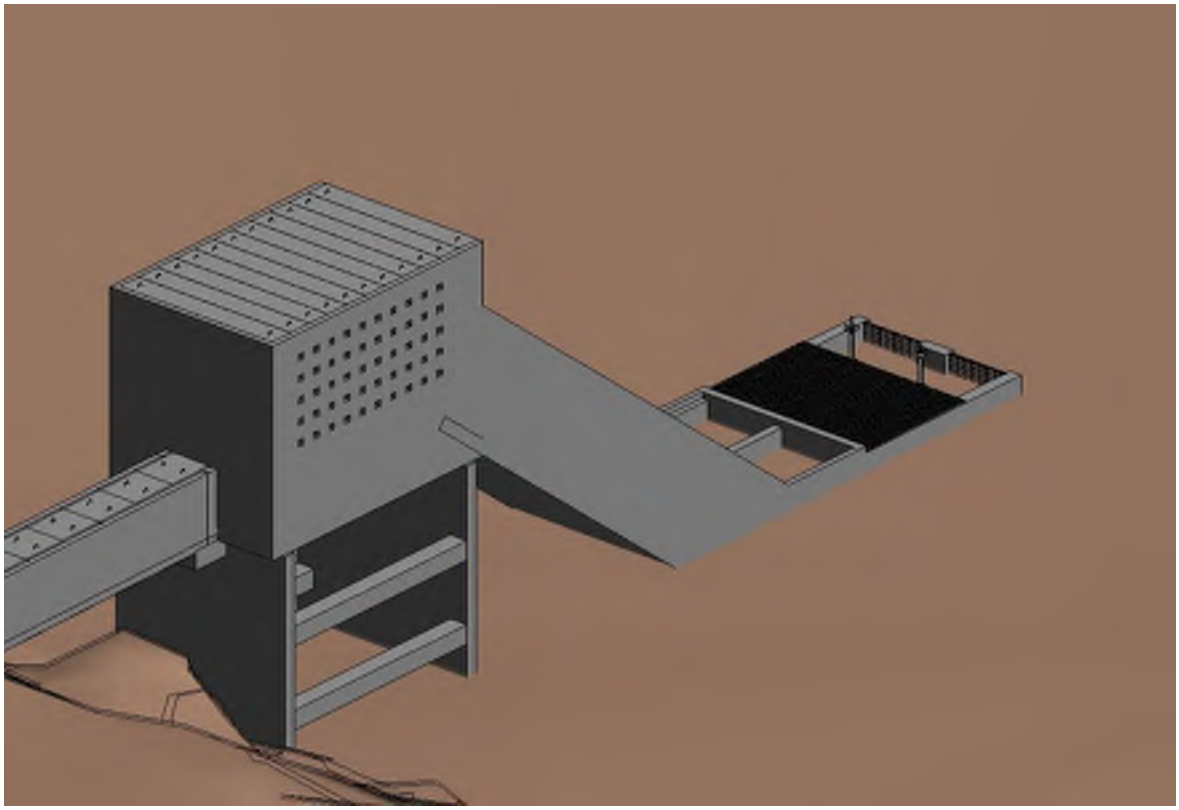


Figure 14 – Isometric View of De Put Abstraction Pump Station

4.1.2 Summary of Sand Spruit Abstraction Pump Station and Gabion Inlet/Intake Channel:

1. Raw water flows through a gabion inlet/intake channel to the abstraction pump station
2. The water enters the structure through two (2) inlet/grizzly screens.
3. Screw type water pumps pump water approximately 10.830m high into the discharge sump from where the raw water will gravitate into the De Put off-channel storage dam through a rectangular culvert type channel.
4. Duty point will be 86 l/s to 180 l/s at 10.830m
5. Duty/standby setup with both the duty and standby pumps being able to supply 40% of the total daily demand each (86 l/s) as well as 100% of the total daily demand (180 l/s). This means that variable speed drive will be implemented to vary the speed at which the screw pumps will operate to ensure variable demands/duties are met.
6. Please refer to the attached System Curves for this pump station under **Appendix B.**
7. Screw Pump Motors to be variable speed drive with, capable of handling solids of up to 40mm.
8. The discharge channels will have erosion protection as well as energy dissipaters to be incorporated at point of discharge into the De Put off-channel storage dam. This will eliminate any erosion at this point.
9. Areas where access is required will be enclosed with heavy duty pre-cast concrete slabs.
10. There will be no visible equipment.
11. New and improved electrical security fence; with beams, pepper spray etc will be implemented to protect against theft and vandalism.
12. All telemetry and communication to the main SCADA (at the new WTW) to be incorporated, this will allow for automatic stop/start, level control, flow control etc.

4.1.3 Key Constraints

The following factors were key constraints and considerations for the abstraction pump station's location and design:

4.1.3.1 Appropriate river flow dynamics (e.g. a good location along river) for sustainable long-term raw water abstraction.

- Pump Station was located just upstream of weir to assure water would be at its deepest. The take-off channel was also located on the outside bend to ensure minimal sediment and debris which could possibly collect at the abstraction location.

4.1.3.2 Expected low water levels in the Sand Spruit (drought periods).

- The abstraction facility will be located at a level to ensure that abstraction can still take place during unusually low flow (drought) periods.

4.1.3.3 Expected flood levels and durations for the Sand Spruit.

- The abstraction pump station facilities will need to be protected from certain flood events. To minimise the effect of a potential flood, valves that might require maintenance or are not best suited for being submerged for extended periods of time are all positioned above possible flood water levels.

4.1.3.4 Anticipated sediment and debris carried or entrained in the river water.

- The position of the abstraction on the outer bend as well the construction of the gabion channel leading up to the abstraction pump station will minimise the potential effect of any large amounts of sediment and debris.

4.1.3.5 Accessibility of the facilities for operation and maintenance purposes, during certain river flood events.

- The access platform will be constructed at a level sufficiently high enough to accommodate most flood scenarios. This will allow access to the facility in most flood situations. However, should flood levels be too high, the abstraction pump station can also be accessed from the De Put Dam Embankment.

4.1.3.6 Theft and Vandalism

- The facilities will be protected against theft and vandalism and access to expensive equipment is limited to facilitate this.

Design solutions took these key constraints into account in order to develop the required facilities.

4.1.4 Summary

Based on all considerations mentioned above it was concluded that the off-channel screw type river abstraction design along with the concrete channel discharging raw water into the De Put off-channel storage dam as set out in the sections above, was the most efficient design.

4.2 De Put Raw Water Booster Pump Station

4.2.1 Design Overview

The overall objective of the De Put raw water booster pump station is to transport raw water from the De Put off-channel storage dam via a new 500mm dia. and 400mm dia. rising main to the new centralised water treatment works in Senekal/Matwabeng. The duty point for the abstraction pump station was calculated as 86 l/s @ 75.9 m and 180 l/s @ 86.956 m.

A new raw water supply pipeline from the new floating mechanism to the new raw water booster pump station will be a DN 710 mm HDPE pipeline. This pipeline will be encased in reinforced concrete to ensure the pipe is properly protected and to ensure the pipe does not move under the weight of the dam. Just before the new pump station the HDPE pipeline will transition to a 600mm dia. steel pipe. A knife gate valve is also installed just outside the pump station in order to ensure that the pump station can be isolated if required. The 600 mm dia. steel pipeline will act as the pump station manifold from which raw water will be abstracted by the booster pumps.

To install the new 710 mm HDPE pipeline through the existing De Put off-channel storage dam embankment, excavation into the De Put off-channel storage dam wall is required. This work needs to be done in accordance to a specification written by a Professional Dam Engineer to ensure that the dam strata is reinstated correctly, inspections will also be conducted by the Dam Engineer during construction. It would be ideal to do this work while the De Put dam is empty (current conditions) as this will ensure effective construction conditions as well minimum water losses. The above-mentioned has been discussed with one of the Aurecon Professional Dam Engineers who confirmed the process. A licence to construct has also been issued by the Department of Water and Sanitation and therefor the designs have been approved by their Dam Safety Offices. The Detail Design Reports for all work to be conducted on the dam embankment has been completed as part of the Department of Water and Sanitation dam safety office submissions and requirements. The licence to construct has been issued by the Department of Water and Sanitation for all work on the De Put off-channel storage dam.

The existing intake float is currently in a poor condition and the size of the outlet pipes is not adequately sized to supply the new increased daily demand to be abstracted from the De Put off-channel storage dam. A new floating device will be placed in the De Put off-channel storage dam. This floating device is designed to abstract raw water from above the muddy/silted De Put off-channel storage dam floor. The float will be manufactured from HDPE material in will connect directly to the flexible 710 mm dia. HDPE pipeline. The float was designed to move freely with the varying water level in the De Put off-channel store dam. The float was also designed to ensure that a vortex will not form at the inlet holes, this ensures better efficiency intake. The number and size of intake holes were designed in such a way to still allow enough water intake even if some holes are blocked with debris.

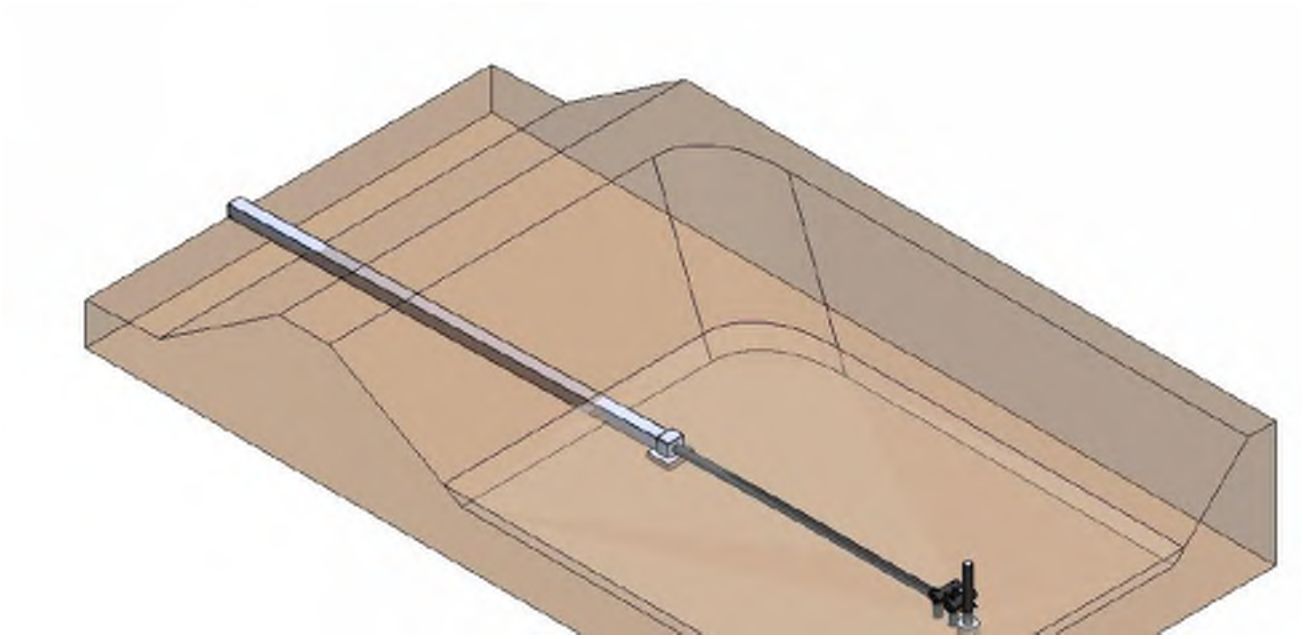


Figure 15 – PE100 DN 710mm HDPE Through Dam Embankment – Encased in Concrete and attached to the floating device for water abstraction

Figure 16 – Isometric View of HDPE Floating device for Water Abstraction – with Stub Flange for Connection to PE 100 DN 710mm HDPE Pipe

Figure 17 – Isometric View of HDPE Floating device for Water Abstraction – with Stub Flange for Connection to PE 100 DN 710mm HDPE Pipe

Due to the nature of the raw water and the contents thereof, which includes solid objects such as sand, stones, plant material etc. and due to the large volume of water, high static lift and long distance it is end suction centrifugal pumps were selected for the new booster pump station. The selected pump has a free passage to allow for the free passing of solid objects e.g. stones through the pumps. The following pumps were selected:

- Cornell 6NHT B19 RP-F18DB Self Priming Pump (Redi prime) coupled to a WEG Motor
- 160kW at 1490 rpm (4 Pole) High Efficiency (IE3)
- Duty Point 1 – 86 l/s @ 79.696 m @ 87.7kW at 1440 rpm – Duty/Standby operation
- Duty point 2 (180 l/s) – 90 l/s @ 91.304 m at 120kW at 1560 rpm each (Both pumps will operate together to produce the required 180l/s) – Duty/Duty operation on Variable speed drive and soft starters.
- Solids handling up to 50mm
- NPSH required 1.86 m Duty//Standby operation and 2.87 m Duty/Duty operation

The Detail Design Drawings of the main aspects discussed can be seen in **Appendix C.**

4.2.2 Description of Proposed De Put Booster Pump Station:

1. Raw water is abstracted from the De Put off-channel storage dam by means of a newly designed HDPE floating devise. The abstracted raw water then gravitates through a newly installed 710mm HDPE pipe, encased in reinforced concrete, to the 600 mm dia. steel manifold pipe in the Booster pump station from where it is pumped to the new centralized water treatment works via n 500mm and 400mm diameter PVC-O (Class PN16) rising main.
2. Duty Point 1 – 86 l/s @ 79.696 m @ 87.7kW at 1440 rpm – Duty/Standby operation
3. Duty point 2 (180 l/s) – 90 l/s @ 91.304 m at 120kW at 1560 rpm each (Both pumps will operate together to produce the required 180l/s) – Duty/Duty operation on Variable speed drive and soft starters.
4. Please refer to the attached System Curves for this pump station under **Appendix G.**
5. Bidirectional pipeline by-pass pipework to regulate and control the bi-directional flow. This done by the opening and closing of manually operated gate valves in the pump station building. Non-Return Valves will also ensure water cannot flow in reverse through the water meter and pumps when reverse flow through the De Put pipeline and pump station is enabled.
6. Pumps to be variable speed drive with soft starters, capable of handling solids of up to 50mm
7. Discharge pipeline is proposed as DN 500 mm and 400 mm dia., PVC-O Class 16.
8. New and improved electrical security fence; with beams, pepper spray etc.
9. All telemetry and communication to the main SCADA (at centralized water treatment to be incorporated, this will allow for automatic stop/start, level control, flow control etc.

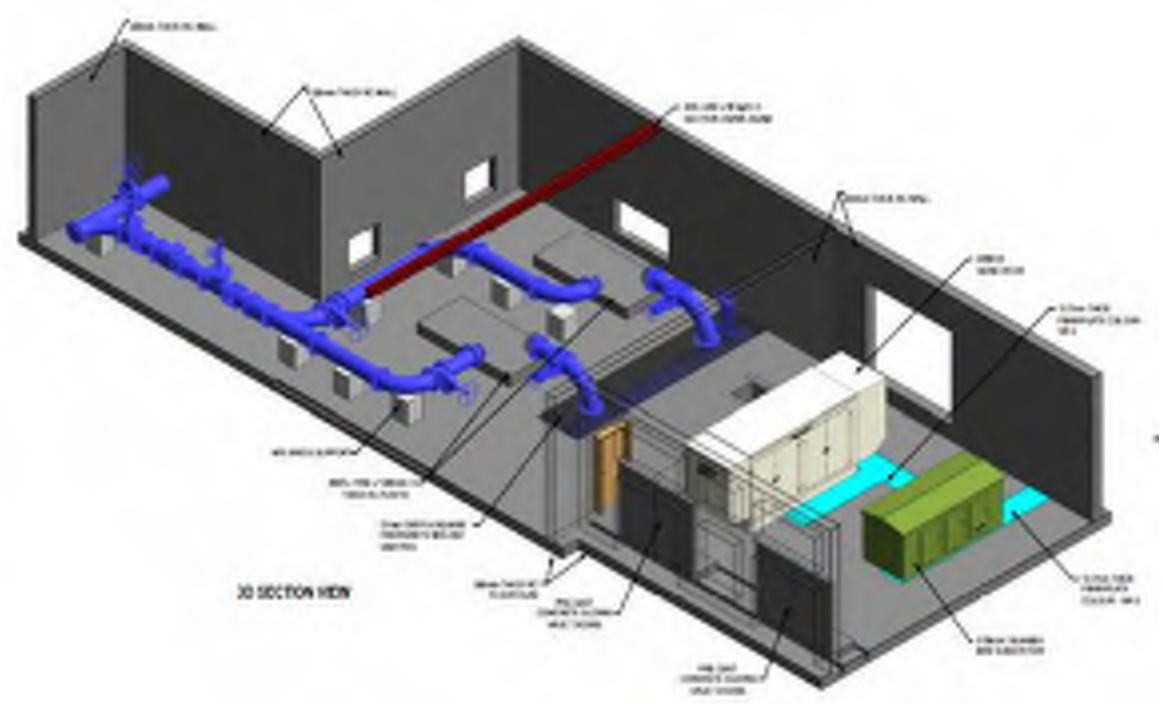
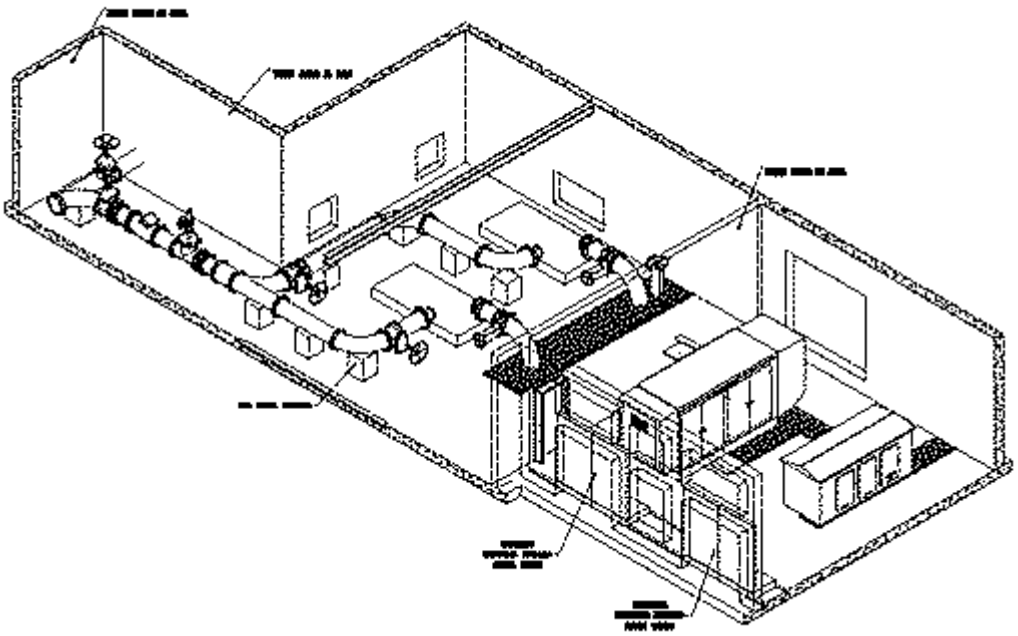


Figure 18 – 3D view of Booster Pump Station and Bi-Directional Flow Chamber



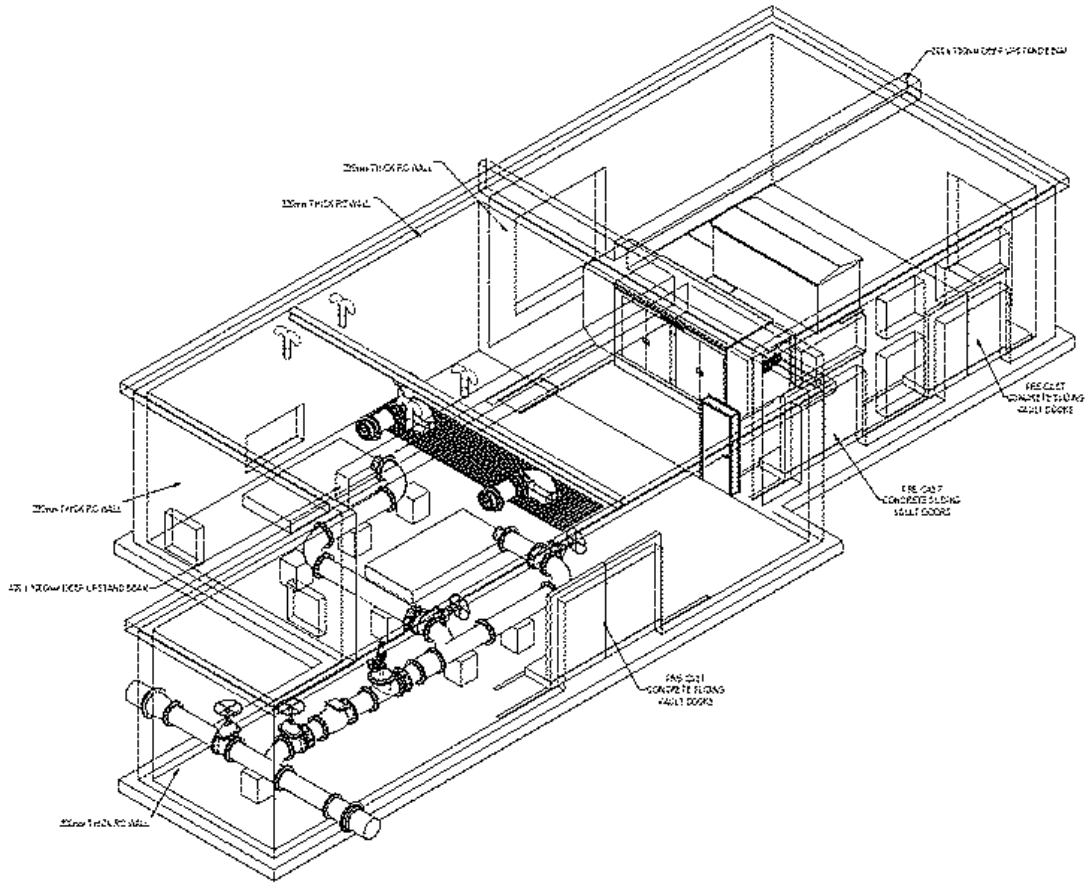


Figure 19 & 20 – Isometric View of De Put Booster Pump Station

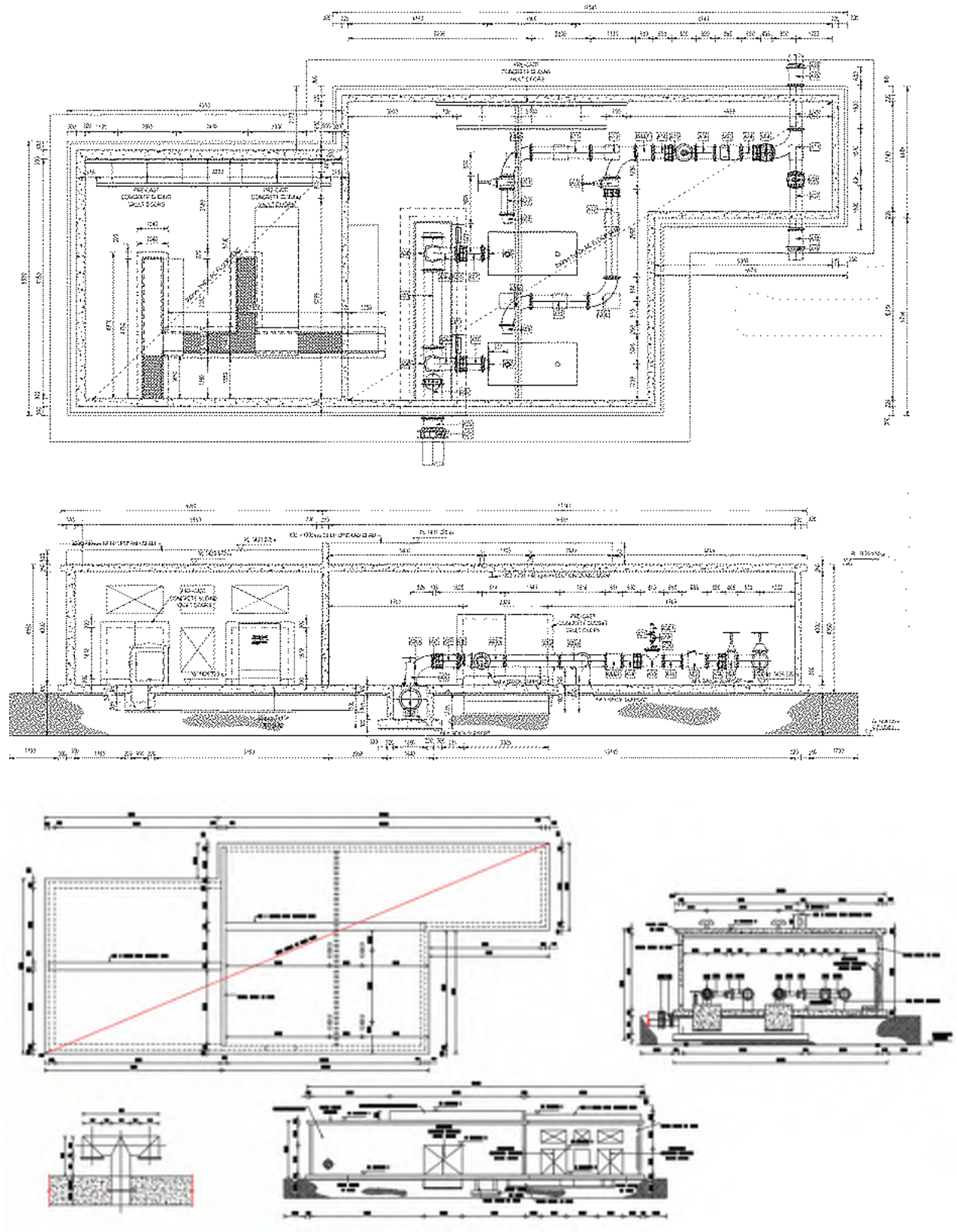


Figure 21,22 & 23 – Screenshots from Detail Design Drawings for the De Put Booster Pump Station E.g. Plan View and Sections (Refer to Appendix C for Detail Design Drawings)

4.2.3 Key Constraints

The location and design of the facilities for the new De Put Raw water booster pump station are constrained by the following key factors:

4.2.3.1 Expected low water levels in the De Put off-channel storage dam (drought periods).

- The floating device was designed in order to ensure efficient abstraction during water level fluctuations and to ensure that abstraction can still take place during unusually low dam level (drought) periods.
- The devise was also designed to minimize the abstraction of the mud/silt in the dam basin.

4.2.3.2 Anticipated sediment and debris carried or entrained in the De Put off-channel storage dam water.

- The floating device and raw water booster pump station was designed to be able to deal with the sediment and debris that is likely to be encountered in the water.

4.2.3.3 Theft and Vandalism

- The facilities are protected against theft and vandalism and access to expensive equipment is limited to facilitate this. A reinforced concrete building will be constructed. This structure will include a concrete reinforced vault door. Please refer to **Appendix D** for details.

Design solutions took these key constraints into account in order to develop the required facilities

4.2.4 Summary

Based on all considerations mentioned above it was concluded that the De Put off channel dam booster pump station design, along with the 710mm HDPE gravity pipe and HDPE floating device in the De Put off-channel storage dam as set out in the sections above, was the most efficient design.

4.3 Bi-Directional Control Chamber at the Centralized Water Treatment Works as well as the De Put Booster Pump Station

With the bi-directional capabilities of the De Put pipeline a bi-directional control chamber had to be implemented at both the centralized water treatment works as well as at the De Put booster pump station. As the Cyferfontein off-Channel storage dam has a larger catchment area and is considered the more reliable source between the two (2) sources, Sand River and Sand Spruit, the system was designed to enable surplus water to be pumped from the Cyferfontein off-channel dam to the centralized water treatment works in Senekal/Matwabeng, from where it will gravitate towards the De Put off-Channel storage dam. The raw water from the Cyferfontein off-Channel storage can therefore either flow into the inlet works at the new centralized water treatment works or the raw water can be diverted into the De Put pipeline to facilitate gravitational flow to the De Put off-channel storage dam. This will allow additional storage capacity and the utilization of the De Put off-channel storage dam should the Sand Spruit be dry in drought conditions. Please note that this functionality is only possible from the Cyferfontein off-channel storage dam to the De Put off-channel storage dam. It is not possible to do this from the De Put off-Channel storage dam to the Cyferfontein off-channel storage dam. The De Put booster pump station was designed to allow for bi-directional flow diversion.

This operation will work as follows:

1. Surplus raw water is pumped from the Cyferfontein off-channel storage dam Booster pump station to the new centralized water treatment works.
2. Water is manually diverted, by the closure of manually operated gate valves in the Bi-Directional diversion chamber, to either flow into the water treatment inlet works or to bypass the inlet works.
3. If the gate valves in the Bi-Directional diversion chamber are closed in order to facilitate the bypass of raw water into the De Put pipeline, raw water will gravitate to the De Put Booster pump station.
4. In the De Put Booster pump station there are also manually operated gate valves to facilitate this bi-directional functionality. The gate valve on the delivery pipework, just after the water meter and air valve, needs to be closed, while the gate valve on the bi-directional bypass pipe needs to be opened.
5. This will facilitate raw water to be diverted to the De Put off-channel storage dam.
6. A 400 mm dia. Non return check valve was also implemented to ensure water does not flow back to the De Put booster pump during the bi-directional operation.
7. Please refer to the figures below for further details.

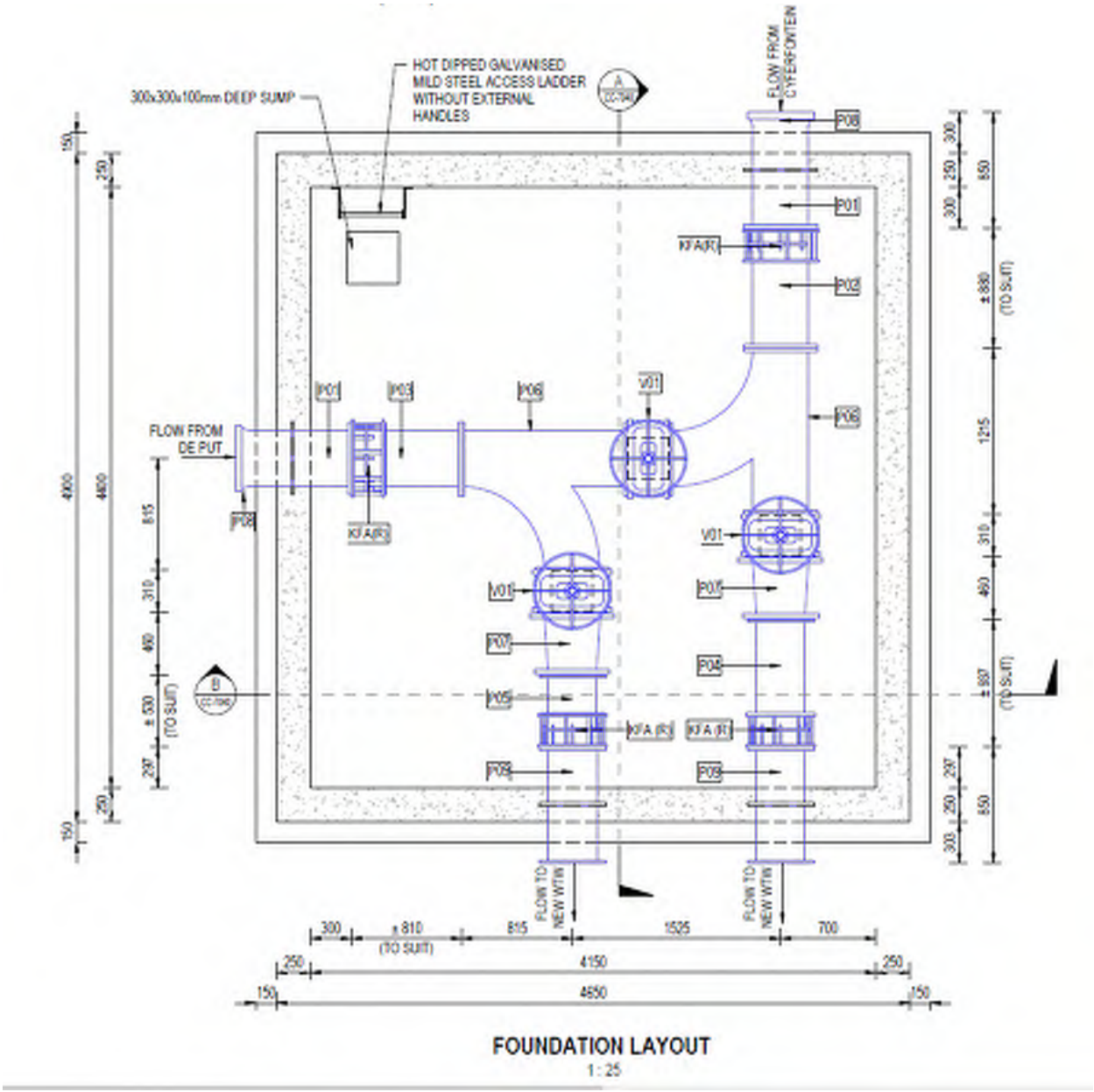


Figure 24 – Screenshots from Detail Design Drawings for the Bi-Directional Diversion Chamber Including Flow from Cyferfontein, Flow from De Put, and flow to WTW

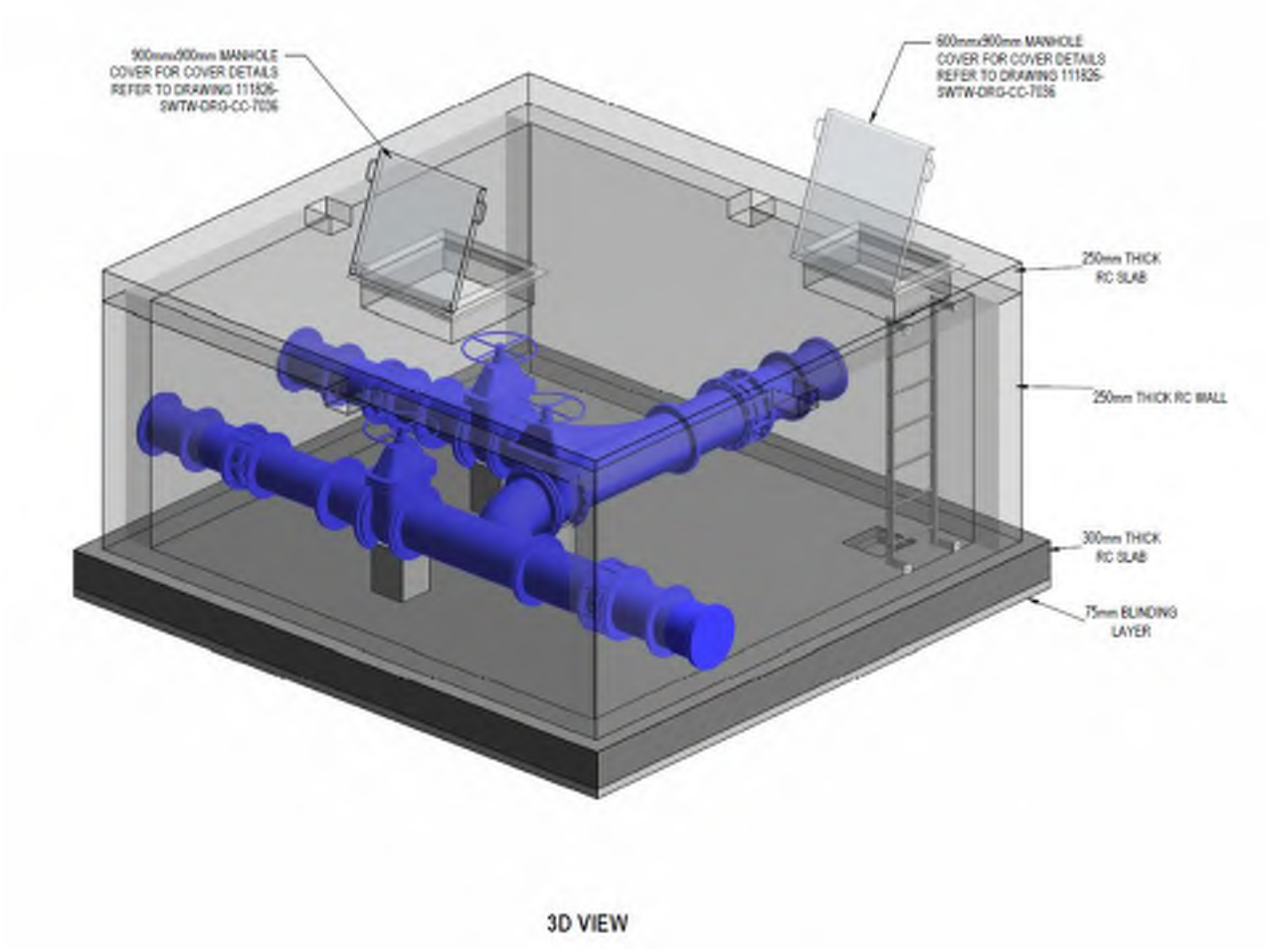


Figure 25 – 3D View of Bi-Directional Diversion Chamber

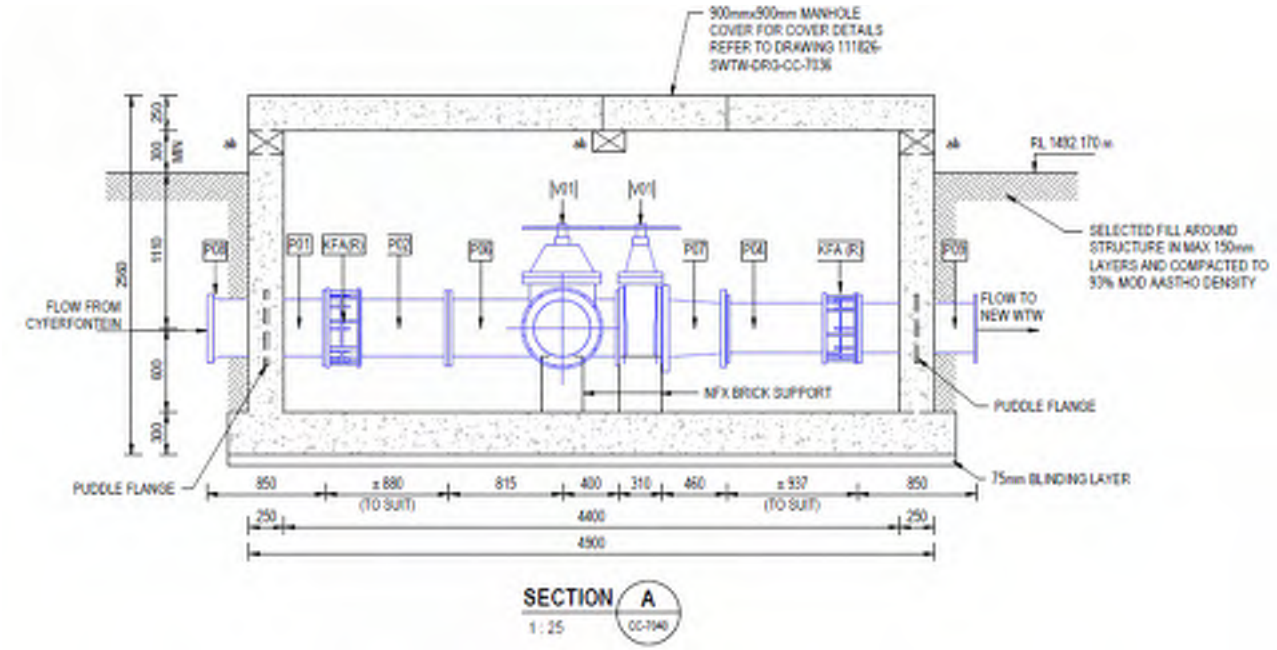


Figure 26 – Sectional View of Bi-Directional Diversion Chambe

4.4 Pump Service Life Considerations

The sediment content in the raw water will have significant impact on the service life of a pump. The wear on the impellers and pump casing increase dramatically with an increase of sediment content in the water. **Error! Reference source not found.** (published by Grundfos Pumps) illustrates the severe nature of pump wear due to sand content in the water being pumped. The operating pressure of the pump further aggravates pump wear as sediment content increases.

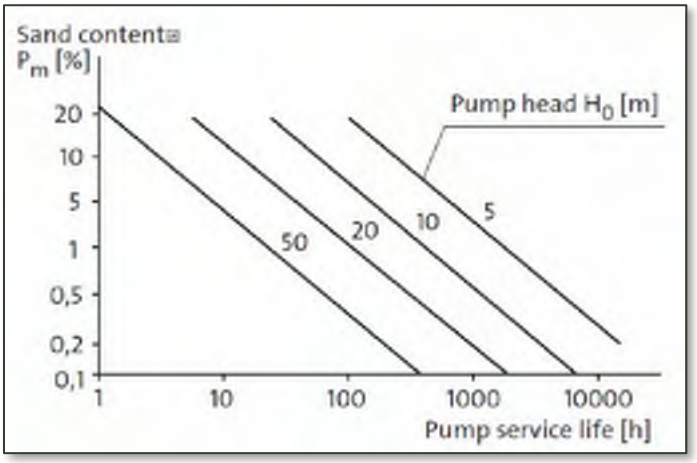


Figure 27 - Typical Pump Service Life Curves (Grundfos)

The service life of a pump can be mitigated in these circumstances by use of hardened materials and specialised hardening coatings for the impeller and casing.

In order to protect the pumps – especially the high-pressure booster pumps supplying the raw water to the water treatment works in Senekal – the sediment content of the raw water should be reduced to as far as possible. This will be facilitated by the De Put off-channel storage dam.

However, in the attempt to reduce sediment content, sight should not be lost of the relationship between the cost of reducing sediment in the water versus the cost of regular pump refurbishment or replacement. In other words, it may be more cost effective to accept some degree of wear to the pumps due to sediment content, rather than building a very expensive facility to eliminate virtually every sediment particle in the water.

4.5 Water Quality Considerations

Seasonal Sand Spruit raw water quality testing was carried out on raw water samples. These raw water quality test results were submitted to the process design team in order for an in-detail analysis to be conducted.

It should be noted that the water quality in a river system, such as the Sand Spruit, will have fluctuations over time, as impacted by runoff from various storms in the catchment areas. High turbidity transported

sediment and other floating/buoyant debris are to be expected during high flows and must be catered for in the design of an abstraction works.

The water quality of the two (2) water sources as well as required/proposed treatment is discussed in-depth in the Water Treatment Works Concept Design Report. The quality of the water itself of the Sand Spruit was not used as a consideration or influential factor in the design of the abstraction process, however potential debris was a consideration in the design of the river abstraction and associated pump station.

4.6 Specifications

4.6.1 Applicable SANS 1200 Standardized Specifications

For the purpose of this contract the following SANS 1200 Standardized Specifications for Civil Engineering Construction shall apply:

SANS 1200 A : General

SANS 1200 AB : Engineer's Office

SANS 1200 C : Site Clearance

SANS 1200 D : Earthworks

SANS 1200 DB : Earthworks (pipe trenches)

SANS 1200 DE : Small Earth Dams

SANS 1200 DK : Gabions and Pitching

SANS 1200 G : Concrete (structural)

SANS 1200 H : Structural Steelworks

SANS 1200 HA : Structural Steelworks – Sundry Items

SANS 1200 HC : Corrosion Protection of Structural Steelwork

SANS 1200 L : Medium-pressure pipelines

SANS 1200 LB : Bedding (pipes)

SANS 1200 LK : Valve Installations (08/06)

SANS 1200 LQ : Manufacture of medium pressure steel pipes (08/06)

SANS 1200 LR : Corrosion protection of steel pipes and cast-iron fittings (05/96)

4.6.2 Particular Specifications

Specification AUR 0003 : General Corrosion Protection for Pipelines, Water and Wastewater Works.

Specification AUR 0005 : Quality Control

Specification AUR 7001 : Design and Manufacture of medium pressure Steel Specials

Amendments to AUR 7001 : Design and Manufacture of medium pressure Steel Specials

Specification AUR 7002 : Manufacturing of Medium Pressure Steel Pipelines

Amendments to AUR 7002 : Manufacturing of Medium Pressure Steel Pipelines

Specification AUR 7003 : Laying and Jointing of Medium-Pressure Steel Pipes and Specials

Specification AUR 7005 : Corrosion Protection for Valves

Specification AUR 7007 : Sluice Gates

Specification AUR 7016 : Resilient Seal Gate Valve

Specification AUR 7023 : Pipe Couplings and Flange Adaptors

Specification AUR 7024 : Pipework Supports

Specification LK : Valve Installation

Specification PD : Building Work

Specification PA : Fencing

Specification ME1 : Structural Steelwork

Specification LE01 : Plain and Reinforced Concrete

Specification LE04 : Piling

Specification LE05 : Smooth Surface and Exposed Aggregate Surface Finishes

Specification LE06 : Concrete Screed

Specification LE10 : Concrete for Aqueous Liquid-Retaining Structures

Specification LE11 : Structural Concrete - Minor Works

Specification LE13A : Concrete Surface Beds

5 Structural Detail Design

5.1 Design Overview

5.1.1 Screw pump station

5.1.1.1 Foundation design

The screw pump station will be founded on piles. Geopile Africa is responsible for the pile design.

Geopile Africa proposed that a driven ductile iron pile will be used. The ductile iron has a diameter of 170mm with a wall thickness of 9mm. The piles will be driven to refusal on bedrock. The safe working load of a pile is 950kN. Below the pile serviceability loads tabled, loads indicated are applicable on each pile, thus pile 1 has a vertical load of 550kN and so thus pile 2.

PILE LOADS - SLS (kN)	
REFERENCE	VERTICAL LOAD (kN)
1 & 2	550
3 & 4	550
5 & 6	500
7 & 8	600
9 & 10	550
11 & 12	500

5.1.1.2 Pump station structure

The intake sump will be below natural ground level. The 300mm thick external RC walls of the sump will be designed to span horizontally between then the internal dividing walls. The 350mm thick RC floor slab will span between the pile caps.

The discharge sump will be elevated and supported on two, 300mm thick RC walls braced with 600x600mm RC beams spanning between the walls. See figure 8 to 11. The sump will have a 350mm thick RC floor and 300mm thick RC walls, spanning between the supporting RC walls.

The intake sump and discharge sump are connected with a RC channels that houses the screw pumps. The 300mm thick RC walls of the channel will be designed to span between the intake – and discharge sumps. The discharge sump and channels will house sensitive equipment that is prone to vandalism and thus the structure will be covered with removeable precast concrete panels, these slabs were designed as such that special equipment e.g. TLB or mobile crane is required to remove them.

The discharge channel will span between the discharge sump and dam wall. The channel will be supported on a RC corbel with a Kilcher Teflon sliding bearing and thus form an expansion joint between the channel and the sump. The expected differential movement between the support on the dam wall and pump station structure will absorbed at this point. To ensure the water tightness of the expansion joint a water bar will be cast in over the joint and a Flexothane G sealant applied in the expansion joint. See detail below:

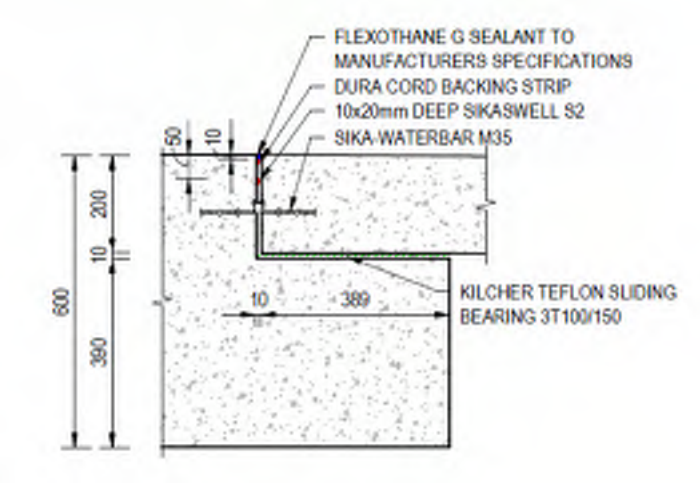


Figure 28 – Kilcher Teflon Sliding Bearing 3T (100/150) Detail

5.1.1.3 De Put Booster Pump Station/Sub Station

The new reinforced concrete booster pump station will be founded on top of the final bulk earthworks level which will be close to natural ground level. The footprint of the total structure is approximately 26m x 11m.

According to the Geotechnical report very dense, clayey sand is encountered to around 7.5m below natural ground level, which is not a suitable founding material for the structure, however groundwater was encountered at a depth of 2 m below natural ground level. Excavation will be done between 3m to 4m deep, the first 1.5 m of the excavation will be backfilled with dump rock and choked with a layer of 19mm gravel/stone. The upper 1.5m portion of the excavation will be backfilled with G6/G7 material in layers of 150mm, each layer compacted to 95% MOD AASHTO.

Concrete foundation slabs will generally be 300mm thick, with 300mm thick foundation slabs for the pump and generator room individually. No spread foundations will be provided.

The concrete walls will vary from 220 mm – 350 mm thick. Predefined vertical and horizontal construction joints will be set out for the contractor to assist with the construction of the walls.

A 250 mm thick roof slab is proposed over the pump room and generator room areas spanning between the walls. Upstand concrete beams are provided at mid-span to reduce the span length of the roof slab.

Pre-cast sliding vault doors are provided for all entrances which will help in preventing vandalism of the equipment inside the pump station. The door into the pump room will be wide enough for a vehicle to enter to load/offload equipment. Boxed out openings will be provided in the walls for the post installation of high security ventilation pre-cast panels.

A 203 x 203 x 46 kg/m I-section crawl beam will be fixed to the soffit of the roof slab, centred over the pump units.

All walkways above channels will be covered with Fibregrate moulded grating. The Fibregrate moulded grating replaces the conventional galvanized Rectagrid grating as they have a reduced risk of being stolen.

5.2 Applicable Statutory and Regulatory Requirements

- SANS 10400: "Code of Practice for the application of the National Building Regulations"
- SANS 10160: "General Procedures and Loadings for the design of buildings"
- SANS 10161: "The design of foundations for buildings"
- SANS 10162: "Structural Use of Steel"
- SANS 10100: "Structural Use of Concrete"
- BS 8007: "Code of Practice Design of concrete structures for retaining aqueous liquids"

5.3 Structural Specifications

- LE 1 – Specification for Plain & Reinforced Concrete
- LE 5 – Specification for Smooth Surface and Exposed-aggregate Surface Finishes
- LE 6 – Specification for Concrete Screed
- LE 10 – Specification for Concrete for Aqueous Liquid-Retaining Structures
- LE 11 – Specification for Structural Concrete - Minor Works
- LE 16 – Specification for Soilcrete
- ME1 – Specification for Structural Steelwork
- TE1 – Specification for Alternative Designs of Structures or Structural Elements

5.4 Design Loads

All loads are calculated in accordance with SANS10160.

5.4.1 Wind Loads

A mean return period of 100 years will be used.

5.5 Materials

The following structural materials and their corresponding strengths will be adopted in the design:

5.5.1 Concrete

All structures to be constructed with Class 35/19 concrete or as outlined below:

- Piles : Class 35/19
- Pile caps : Class 35/19
- Pad Foundations : Class 35/19
- Beams : Class 35/19
- Foundation Slabs : Class 35/19
- Columns/Walls : Class 35/19
- Plinths : Class 35/19
- Roof Slabs : Class 35/19
- Mass Concrete : Class 15/19
- Blinding Layers : Class 15/19

5.5.2 Concrete Mix

Cement and water content of the concrete

The specification requires a minimum cement (OPC) content of 325kg/m3 with maximum water: cement ratio of 0.55 for ordinary Portland cement (OPC), CEM 1 42,5 to ensure a durable and watertight concrete water retaining structures. Minor hair line cracks that may appear due to mainly shrinkage once the reservoir is filled up will cause limited wet spots or slight seepage on the walls, but the high cement content ensures that these cracks seal themselves within the first few months.

5.5.3 Reinforcement

All reinforcement and bending schedules will be to the relevant SANS standards and design strength (fy) will conform to the following:

- High tensile reinforcement (Y): 450 MPa
- Mild steel reinforcement (R): 250 MPa

5.5.4 Structural Steel

Structural steelwork will be specified to SANS standards. Hot rolled steel sections shall be Grade S355JR minimum. Cold formed sections shall be 200MPa

5.6 Durability

5.6.1 Concrete

The exposure conditions for the site as defined in clause 2.4.1 of SANS 1200G is assumed to be as follows for all concrete elements.

Structural Concrete Elements:	**Exposure Condition:**
All concrete elements will be exposed to:	Severe Conditions

For concrete elements, durability will be achieved by adopting a combination of the following measures:

Specifying high quality, dense, low permeability concrete

Specifying adequate w/c ratio as per SANS 1200G

Specifying adequate reinforcement cover

Using SANS10100 as guide the proposed cover for reinforcement are as follows:

- Foundation Slabs - 50mm
- Roof Slabs - 40mm
- Beams - 40mm
- Walls - 40mm

5.6.2 Structural Steelwork

The corrosion protection on the exposed structural steelwork will be either paint protected or galvanized (as appropriate).

All steelwork (including bolts) except for gantry beams which will be hot-dipped galvanized, will be treated with ABE Rustopak Red Penetrant sealant and ABE Rustopak Top Coat or a similar approved product.

5.7 Temporary Works

All temporary works shall be designed and constructed to produce concrete/structural steel elements which will conform within the specified tolerances to the shapes lines, levels, dimensions and surface finish required by the Design Documents.

The responsibility for the sufficiency and design of the whole temporary works (inclusive of any crane lifts) rest entirely with the Contractor.

Computations where required shall be prepared by a **registered professional engineer, experienced in the design of formwork and falsework**.

The Contractor is to ensure that all temporary loading, for materials storage, etc, during the construction stage is limited to the design loading for the permanent conditions.

6 Electrical Design - Scope of Works

The Scope of Works for the Electrical Installation of De Put comprises of the following Components:

- Medium Voltage Connection to the Booster and Abstraction Works;
- Booster Pump Station installation of Miniature Substation, MCC, Standby Diesel Generator, Instruments and Control;
- Abstraction Pump Station with separate Substation building to house the Miniature Substation, MCC, Standby Diesel Generator, Instruments and Control;
- Temporary rectification of the Power Supply, standby Generator, MCC and control with Instrumentation at the existing Water Treatment Works.

The Abstraction works power will be able to supply the two 45kW Screw Pumps with Duty/Duty configuration even in main power supply failure. The intake water level will be monitored for dry run protection and the screw pumps bottom load bearings will be automatically lubricated with an automated grease pump.

Figure 29 – Automated Grease Pump

The Booster Pump Station power will be able to supply the two 160kW Booster Pump Motors with Duty/Duty configuration even in main power supply failure or in the event of load shedding. Clearances from the 11kV overhead line to the fencing and buildings are compliant to the Machinery Act.

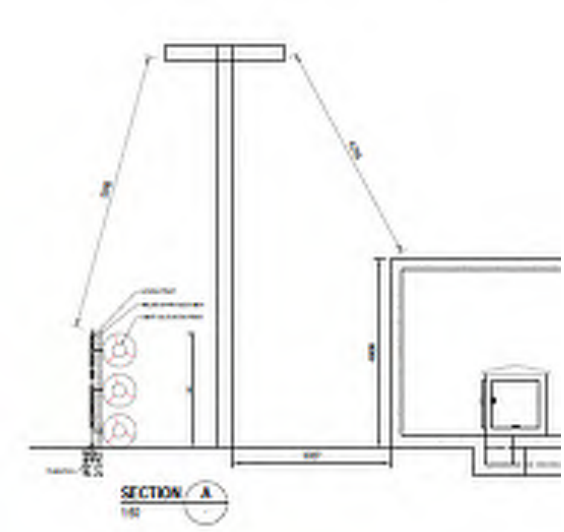


Figure 30 – Clearances from the 11kV overhead line to the fencing and buildings are compliant to the Machinery Act

The security arrangement to protect all equipment from vandalism and theft will include a ClearVu fence equipped with a welded ripper razor edge, a three-role smart coil electric fence and a pepper intrusion security system situated inside the buildings itself. All motor protection and security alert indications will be relayed to the existing WTW and at a later stage to the new WTW.

Only 100% new equipment and/or material will be utilized.

As far as possible, all new products shall be of the same manufacturer as similar existing products utilized by Setsoto Local Municipality.

All material shall comply with the relevant part of the specifications. In case of there being no specification for an item, the engineer needs to approve before installation.

The equipment and installation supplied under this project shall be guaranteed for a minimum period of twelve months. The defects notification period will commence on issue of the Taking-over certificate and shall be terminated by issue of a Performance certificate.

Load Requirement

Load Requirement per hectare	100kVA
Maximum Medium Voltage Drop Allowed	2%
Maximum Low Voltage Drop Allowed (Transformer Source to Energy Point)	5%
Maximum Low Voltage Drop to end utilization	10%
Connection Configuration	Three Phase 50Hz
Medium Voltage Distribution	Fox Overhead Line & Underground Cable 1000 mm
Low Voltage Distribution	Underground Cable 750 mm & In Cable Sleeves
Lighting	See Lighting Schedule
Miniature Substations Size	200 / 400kVA
Diesel Standby Plant Size	200 / 400kVA
Control System	Radio UHF
Pump Station Lighting Levels	300 lx

7 Detail Design - Electrical

7.1 Design Overview - Standards, Specification & Regulatory Compliance

National Statutory Regulations

ACT No. / Year issued	Description
41	Electricity Act
85/1993	Occupational Health and Safety Act
29/1996	Mines Health and Safety Act
50/1991	Minerals Act
73/1989	Environmental and Conservation Act
31/1963	Fencing Act
122/1984	Forest Act
63/1970	Mountain Catchment Areas Act

All designs comply with the various SANS standards and NRS codes and on completion all installations will be certified with the issuing of Certificates of Compliance in terms of SANS 0142-1 & 2. All voltage drop calculations will be within the required ±10% from source to supply point. Lighting designed levels comply with the Machinery Regulations and supplementary SANS standards. DigSilent (Power Factory) and Dialux programs are utilized to verify design requirements.

Guidelines and Recommended and Standard Codes of Practices:

No. / Year Issued	Description
SAIC/1990	SA Steel Construction Handbook
NWP 3109	Standard Drawing Practice
TMH1/1986	Standard Methods of testing Road Construction Materials
CSRA / 1987	Standard Specification for Road and Bridge Works
SANS 0157	Quality Management System
SANS 03	Code of Practice – Protection of structures against lightning
SANS 0292	Code of practice for the application of CNE on low voltage distribution systems
DTS 0060	Power line crossings of proclaimed roads, railway lines, tramways and important communication lines
SANS 10280	Code of Practice for Overhead Power Lines for Conditions Prevailing in South Africa

SANS/SANS/NRS/BS/ANSI/IEC and Other Specifications

SANS/SANS	Other Spec	Description
ELECTRICAL		
SANS 1418, Part 1 tot 3 DTS 0105 (NRS 018)		Aerial Bundled Conductor
	NRS 051	ABC – Suspension and Strain fittings
SANS 135		Bolts and Nuts
SANS 178		Bolts, Eye
SANS 1195		Busbars
SANS 1632	BS 6290	Batteries
SANS 1652		Battery Charger
	BSS 3858	Binding/Identification Sleeves for Cables and Wires
SANS 1268: 1979 NRS 016: 1991		CNE
SANS 0198: 1988		Cables, installation of electric
NRS 012: 1991 SANS 1507		Cables, low voltage - Solid Dielectric Insulation (PVC) 300/500 to 1900/3300V
SANS 150 - 1970		Cables – PVC Insulated and Flexible Cords
NRS 013: 1991		Cables, medium voltage
		Cables – Cross-Linked Polyethylene (XLPE) 3.8/6.6 to 19/33kV
SANS 97/91		Cables – PILC 3.3/3.3 to 19/33kV
SANS 1213 SANS/IEC 60529		Cable Glands
	NRS 028	Cable lugs and ferrules
	NRS 075	Cable lugs and ferrules – Mechanical Torque sheer connectors
SANS 808		Cable Ties
DTS 0086 (NRS 020)		Clamps (strain for split concentric)
DTS 0086 (NRS 020)		Clamps (suspension for split concentric)
SANS 178		Clamps Strain
SANS 178		Clevis Tongue Adaptor (twisted)
SANS 10142		Clips for Wiring
SANS 1091		Colors - Standard
	BS 3288 Part 1 (Tests)	Compression Fittings
SANS 470	DTS 0106	Concrete Poles

SANS 182		Conductor ACSR/AAC and AAAC
DTS 0087 (NRS 021)		Conductor, Covered
		Conduit Saddles
		Conduit
NRS 028		Connectors, lug/termination
EDF 6737/HN 33 E60 (Main cable 350 mm² to 70 mm² take off 6 mm ²to 35 mm ²)		Connectors, insulation piercing
	BS 3288 (Tests)	Connectors, mid-span/full tension
SANS 0162		Connectors, mid-span/no tension
SANS 1200 H/HA		Connectors
SANS 1092		Contactors
SANS 0162		Cross Arm Braces
SANS 1200 H/HA		Cross Arms
SANS 1063		D Fuses
	IEC 60529	Degrees of Protection of Enclosures for LV SG en Control
SANS 0199 SANS 1063 SANS 1524-1		Earthing rods, couplers & clamps
	NRS 009-1	Electricity Dispenser
	BSS 152	Electric Power Switchgear and Associated Apparatus
SANS 1222		Enclosures for electrical equipment classified by IP code
	NRS 008	Enclosures to Cable terminations in Air: For rated AC voltages of up to 7.2kV and up to 36kV
	BSS 1767	Grommets
SANS 8528		Generators – Diesel Alternators Sets
SANS 0198/1988		Installation of electric cables
SANS 177		Insulators for Overhead Lines above 1000V
SANS 950		Impulse Tests for Power Cables
	NRS 068	Indicator – Earth Fault
	NRS072	Indicator – Overhead line fault path indicator

	BSS 158	Marking and Arrangement for Switchgear Busbars Main and Auxiliary Wiring
SANS 156		Moulded Case Circuit Breakers
SANS 1029		Miniature Substations
SANS 1091		National Color Standards for Paint
SANS 0200		Neutral earthing in medium voltage industrial power systems
SANS 555		Oil – Mineral for Transformers, Switchgear

	BSCP 1014	Protection of Electrical Power Equipment against Climatic Conditions
SANS 1619		Ready Boards
	NRS 036	Re-closers – Pole Mounted
	DTS 0104 (NRS 032)	Service box
		Stainless Steel Straps and Buckles
SANS 0162	BS 16	Stay Assemblies
SANS 0162	BS 16	Stay Attachment Brackets
SANS 0162	BS 16	Stay Insulators
SANS 182, Part 5		Stay Wires
SANS 1507		Suffix Wiring
SANS IEC 99-4	NWS 1108 BS 2914	Surge Diverters
SANS 171		Surge Arresters – Low Voltage
	NRS 039	Surge Arresters – Medium Voltage
SANS 1186 / 1978		Symbolic Safety Signs
	NRS 036	Switchgear: Metal Clad – 1 to 24kV AC RMS
SANS1874	NRS 006 BS 5227	Switchgear: Metal Enclosed Ring Main Units – 1kV AC to 24kV AC RMS
SANS 60439		Switchgear and Control Gear Assemblies – Low Voltage – Requirements for Type testing
SANS 60947		Switchgear and Control – Low Voltage Part 1 General Rules Part 2 Circuit Breakers Part 3 Switches/Isolators/Switch Isolators and Combination switches
SANS IEC 947-4-1		Switchgear & Control Gear – Low Voltage
	NRS 035-1	Switchgear – Drop-out Fuse link, Solid Links, Pole mounted – up to 33kV
	NRS 036	Switchgear: Sectionalisers and Reclosers – Pole Mounted
	NRS 046	Switchgear: Load-break Disconnectors, Pole mounted, to 36KV
	BS 464	Thimbles
SANS 780		Transformers, Self-protected
	NRS 054, BS 171 IEC 60076; NWS 1532	Transformer - Power
SANS 780		Transformer - Distribution (2 MVA Max)
	NRS 02 IEC 44 IEC 185	Transformers – Current: 3,6kV to 420kV
	NRS 030 IEC 44 IEC 185	Transformers - Voltage

	NWS 1827	Transmission line hardware
SANS 60-2		Test Techniques for High Voltage – Measuring Systems
SANS 135		Washers
SANS 182		Wire, PVC Covered
BS 462		Wire Rope Grips
		Wire, Stranded Copper, bare
SANS 753		Wood Poles – Pine
SANS 754		Wood Poles – Gum
		Zinc coatings, hot dipped galvanized
	IEC 60871-1	Shunt Capacitors
	IEC664	Insulation Coordination - LV Networks
	IEC 71	Insulation Coordination – above 1kV
	IEC 273	Dimensions of Post Insulators
	IEC 168	Tests on Insulators
	IEC 815	Guide for selection of insulators for polluted conditions
	IEC 62271-200 (Prev 60298 & 60694)	Construction of medium voltage switchgear and control gear assemblies
	IEC 62271-100	Construction of medium voltage circuit breakers
	IEC 62271-102	High voltage alternating current disconnectors and earthing switches
	IEC 60076-6	Iron Core Reactors
	IEC 60549	High Voltage fuses for external protection of power capacitors
	IEC 60420	High Voltage Contactors
SANS / IEC 694		Common Clauses for HV switchgear & control gear standards
	IEC 44-4	Tests – Partial Discharge - Measurement
	IEC 270	Test – HV Testing methods, measurements of partial discharge
	IEC 60-1,2 & 3	Tests – HV – Test Techniques
	IEC 70	Capacitors

7.2 Main Power Supply & Small Power:

- Demolish existing bundle overhead line with 37 x 11m 180mm top Wooden poles with pigtail and bracket for MV bundle conductor, 2 x 11m Steel poles, 1 x 11m steel H pole structure, 22 x MV stay wires, 4 x Eskom shared poles and 2788m x MV bundle conductor.
- Replace 11kV Protection on Pump Station Feeder circuit breaker to include OC/EF Sensitive Earth Fault and Auto Reclose functionality in Abattoir Substation.
- Replace 11kV underground cable with 70mm² XLPE 6,35/11 kV screened copper conductor cable utilizing existing railroad crossing to new Overhead “Fox” Line.
- First pole to be protected by ClearVu 2.4m high fence equipped with welded ripper razor mesh.
- Last pole will terminate inside substation yard.
- Erect Fox conductor T-Pole (12m pole) construction overhead line on route to booster pump station. The configuration shall be a horizontal X-arm line construction using a 2,5m cross arm and pin insulators. Long rod type insulators shall be applied as strain and terminal points. Post top Insulators shall be Cyclo-aliphatic resin filled with salinized silica.

Lighting Design Schedule:

TYPE	APPLICATION	LUMINAIRE	DESCRIPTION
A1	Pump stations & power stations		BEKA Vapourline 2x58W
A2	Pump stations & power stations		BEKA Vapourline 2x36W
B1	Exterior		BEKA Bulk 18W with wire guard

7.3 Booster Pump Station:

- Civil Works will erect substation with pump station.
- Install BCEW earth mat and lightning protection.
- Supply and install 400kVA 11/0.4kV Miniature Substation.
- Supply and Install 400kVA Diesel Standby Generator.
- Supply and Install MCC for 2 x 160kW Duty/Standby (and Duty/Duty) Raw water pumps including VSD's, measurement and control systems with PLC.
- Supply and Install Building small power as specified.
- Supply ClearVu 2.4m high fence with one truck gate around adding welded ripper razor mesh and smart coil electric fence.
- Supply and install Pepper Gas Intrusion system.
- Supply and Install all Low Voltage Cables.

7.4 Abstraction Works Station (Sand Spruit):

- Civil Works will erect substation with abstraction pump station.
- Install BCEW earth mat and lightning protection.
- Install 11kV underground cable with 35mm² XLPE 6,35/11 kV screened copper conductor cable from 400kVA Miniature substation on route to 200kVA miniature substation.
- Supply and install 200kVA 11/0.4kV Miniature Substation.
- Supply and Install 200kVA Diesel Standby Generator.
- Supply and Install MCC for 2 x 45kW Standby/Duty (and Duty/Duty) Raw water screw pumps including VSD's, measurement and control systems with PLC.
- Supply and Install Building small power as specified.
- Supply and Install all Low Voltage Cables as specified.

7.5 Control Telemetry and SCADA:

The scope of works for the electronic installation (Control & Instrumentation equipment) is the design, supply, delivery, installation, testing, commissioning and upholding during the trial operation period and the defects notification period of the following equipment and materials:

1) Telemetry system as main communication medium between Sand Spruit abstraction, De Put booster pump station and the new centralised water treatment works inclusive of a repeater station.
2) Three HMI (Human Machine Interface) including Programmable Logic Controllers (PLCs) installed in MCCs (Motor Control Centre) at Abstraction and Booster pump stations.

3) Control System Functional Design Specification (describing how the PLC and SCADA will be programmed to meet the Process Control Philosophy) before programming commences.
4) Programming of the PLCs and HMIs.
5) Uninterruptible power supplies for the control system.
6) Process Instrumentation, level and flow sensors installed at Abstraction and Booster pump stations.
7) Protection instrumentation, pressure sensors at Booster pump station.
8) Control and instrumentation cables including data communications cables.
9) Earthing and surge protection for power, instrumentation and control components.

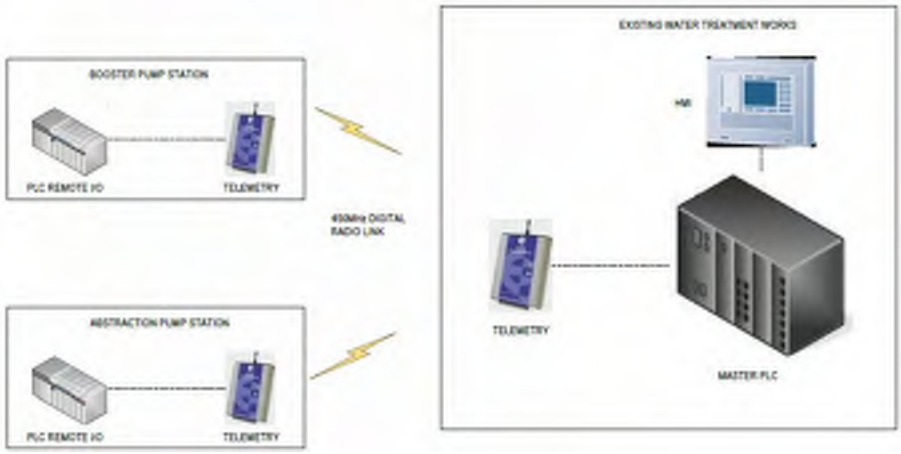


Figure 31 – Control Telemetry and SCADA

7.6 Drawings

Record Drawings:

(a) It is a requirement of this contract that detailed “as-built” drawings of the Works must be provided by the Contractor after completion thereof, on which all details regarding the final installation are clearly indicated. Three-sets of drawings printed to their original size shall be provided by the Contractor. Drawings larger than A3, shall be printed with reduced scaling, but without omitting any information from the printed area, to A3 size.

(b) All drawings and schematics shall have been generated by a computer aided design (CAD) package (handwritten documents will not be accepted). The drawings and schematics shall be (where applicable) to scale and must be formatted and styled in accordance to the client and/or Engineer’s requirements (with regards to title blocks, text heights, drawing

names, etc.). A compact disc containing these files, in both CAD and printable document (pdf) format, as well as any and all available electronic versions of relevant data sheets etc. must also be handed over to the Engineer.

(c) All “as-built” drawings and schematics must be submitted not later than two (2) weeks after the work has been completed.

(d) These drawings need to be approved by the Engineer prior to completion of the Works.

Manufacturing Drawings:

The contractor shall submit manufacturing drawings for comments and approval as soon as possible. These manufacturing drawings shall at least include the following:

(e) General layout drawings of the different equipment to be installed under this contract;

(f) The internal construction of the different equipment to be installed under this contract;

(g) Complete wiring diagrams of the equipment to be installed under this contract;

(h) A detailed parts list containing all components of the different equipment that will be installed under this contract. This parts list shall contain detail such as serial numbers, supplier detail, etc.

Manufacturing drawings for approval shall be provided on A3 paper copies. No manufacturing shall proceed without the approval of the drawings.

7.7 Operation and Maintenance Manuals

(a) The contractor will submit operating and maintenance manuals in triplicate format. These manuals should contain all the relevant literature, drawings, schedules of installed equipment, procedures, write-ups, type and routine test certificates, etc. which are applicable on the installed equipment and material.

(b) These manuals should be properly indexed and shall be in A4 format.

(c) The manuals shall be properly labelled with the contract details and a complete description of the works.

(d) A sample manual will be submitted to the engineer for approval before the final copies will be compiled.

(e) The manuals will be bind in durable format with suitable plastic covering

for protection.

(f) No First Taking-over Certificate will be issued before all the manuals have not yet been received.

(g) In each manual a CD of the complete manuals including as built drawings will be included in suitable pockets. The contractor will submit operating and maintenance manuals in triplicate format. These manuals should contain all the relevant literature, drawings, schedules of installed equipment, procedures, write-ups, type and routine test certificates, etc. which are applicable on the installed equipment and material.

(h) These manuals should be properly indexed and shall be in A4 format.

(i) The manuals shall be properly labelled with the contract details and a complete description of the works.

(j) A sample manual will be submitted to the engineer for approval before the final copies will be compiled.

(k) The manuals will be bind in durable format with suitable plastic covering for protection.

(l) No First Taking-over Certificate will be issued before all the manuals have not yet been received.

(m) In each manual a CD of the complete manuals including as built drawings will be included in suitable pockets.

8 Permissions/Regulatory Requirements

8.1 Wayleaves

No wayleaves required. Pump stations are situated on Municipal property (town grounds)

8.2 Water Use Licence Application (WULA)

An updated Water Use License will need to be submitted to the Department of Water and Sanitation for the increased water abstraction. This Process is already underway and is being conducted by MDA

8.3 Servitudes and Land Acquisition

No land acquisition or servitudes required as all works are situated on Municipal property (town grounds)

8.4 Occupational Health and Safety

A Site-specific Occupational Health and Safety Specification as well as Baseline Risk Assessment has been conducted and compiled for this project. The above-mentioned documentation includes al particular hazards foreseen for the construction work, which the construction contractors must comply with.

9 Security:

The current site security of the infrastructure, mechanical and electrical equipment as well as the operators and maintenance teams are a great concern. This concern was also raised during the Inception Meeting by both the Department of Water and Sanitation as well as the Setsoto Local Municipality. Extensive evidence of theft as well as vandalism to the existing infrastructure and equipment is visible on site. Although it should be noted that some of the infrastructure was only vandalised and burgled after it was not operational (De Put off-channel storage dam booster and abstraction pump stations and electrical overhead cable).

At the existing Sand Spruit (De Put off-channel storage dam) source there has been major visible damage caused to infrastructure and equipment because of vandalism and theft. The De Put off-channel storage dam's abstraction pump station as well as booster pump station is situated in a vulnerable area susceptible to vandalism and theft.

Even though security is a major concern, certain measures was implemented and put in place to ensure the safeguard of the infrastructure, mechanical and electrical equipment as well as operators/personnel.

After a consultation with colleague's in the bulk water supply industry in Gauteng (Johannesburg), we raised the concern of the excessive theft and vandalism on the infrastructure and equipment in Senekal. During this consultation they informed us that they are currently implementing "Fortress Pump Stations" with great success in areas of high security concern. These pump stations are constructed entirely from reinforced concrete, with no windows, louvres etc. Heavy concrete sliding doors constructed of 60Mpa concrete with extremely robust locking mechanisms are also specified. Aurecon was also recently involved during the construction of a similar pump station in Botshabelo close to Bloemfontein. A typical detail drawing and example of such a "Fortress Pump Station" is attached under **Appendix D**. The option of constructing the pump stations in underground "bunker like" pump stations can also be considered.

Implementing a centralised main SCADA and Motor Control Centre (MCC) for controlling the entire scheme, at the WTW, will also be utilized to move expensive equipment away from the pump stations at the sources where security is problematic. This means that only a small theft prove kiosk (with pump relays) will be installed at each pump station. As the expensive equipment is located at one centralised position at the WTW in town, these relays and kiosks are quick and easy to replace/repair should vandalism or theft ever occur. This will also assist in moving expensive equipment above the flood line levels which will also protect the equipment during floods. Communication between the main MCC and SCADA will be done remotely. This also means that an operator will only ever need to visit the pump stations should a fault occur, and an inspection be required. A line of sight investigation has already been conducted to determine if it would be possible to operate the entire system remotely from the

centralised WTW. Please refer to a typical detail drawing and example of the kiosks mentioned above under **Appendix E.**

Additional measures that can be implemented at the new pump stations, boreholes and water treatment works to safeguard equipment and operators/personnel:

- Vandal proof stainless steel doors.
- Concrete vault doors to ensure access control into all pump houses etc.
- The positioning of structures and infrastructure should be considered.
- Security system installation, including an alarm system, cameras, beams, pepper spray (tear gas) etc.
- Better security fencing and access control e.g. Clearvu Fencing with electrical fencing on top of the Clearvu Fencing.
- Due to the remote location of Senekal and the works, armed response poses a challenge. Several recognized Security companies advised that only monitoring is possible, and once alarms are triggered, they then contact South African Police Service (SAPS) to attend to the alarm.

10 Start-up of the existing WTW in Senekal/Matwabeng

Aurecon's process designers have visited the water treatment works to the South of town where they have evaluated the plant and has written a Memorandum (**See Appendix F**) explaining the findings. The works were visited by Aurecon and the operators of Senekal where the following conclusions could be made:

1. Currently the plant was found slightly deteriorated because of it not being in use the last 24 months. The filters and clarifiers were found full of weeds and grass growth – it is recommended that the plant be quantified and cleaned accordingly.
2. The filter media can be utilised, but some media were found contaminated due to the non-operation the last 24 months. This too can be quantified and replaced.
3. The operations of the plant can still be utilised for a small period as indicated by the operators, but they need do the following:
    a. The clarifier needs to be cleaned
    b. The filter needs to be cleaned and quantify the media
    c. The pump will be evaluated and might need to be refurbished once raw water is pumped into the operations again
4. A concern would be the seals on all the mechanical operations of the plant due to not being serviced in the past 24 months and not being operational.

The main comment from the operators were that better findings can be made about the plant once raw water comes into the plant again. Allowances must be made for the following:

1. cleaning the plant and operations,
2. restoring valves and items that are lost due to theft or vandalism,
3. seal watertight units,
4. repair to inlet works,
5. replace dosing pumps,
6. refurbish delivery pumps
7. small repairs which can be quantified.

11 Engineer's Cost Estimate

Cyferfontein Abstraction Works – CIVIL WORKS: Cost Estimate			
SECTION A:	Preliminary and General	R	6 560 100.00
SECTION B:	Site Clearance and Earthworks	R	9 499 900.00
SECTION C:	Booster Pump Station	R	6 445 357.30
SECTION D:	Abstraction Works	R	12 623 575.00
	Total Priced Items:	R	35 128 932.30
	Allow 10% Contingencies:	R	3 512 893.23
	Net Total for Project:	R	**38 641 825.53**
	Add 15% for Value Added Tax:	R	5 796 273.83
	Gross Total Estimate for Project:	R	**44 438 099.36**

Cyferfontein Abstraction Works – MECHANICAL & ELECTRICAL WORKS: Cost Estimate			
SECTION A:	Preliminary and General	R	3 297 800.00
SECTION B:	Small Civil Works	R	802 665.00
SECTION C:	Civil, Structural & Mechanical – WTW (South) Refurbishment	R	1 767 800.00
SECTION D:	Mechanical Works	R	8 385 990.00
SECTION E:	Small Electrical Works	R	315 597.00
SECTION F:	Bulk Electrical Works	R	6 843 435.00
SECTION G:	Electronic Installation	R	891 410.00
SECTION H:	Electrical Installation – WTW (South) Refurbishment	R	218 200.00
	Total Priced Items:	R	22 522 897.00
	Allow 10% Contingencies:	R	2 252 289.70
	Net Total for Project:	R	**24 775 186.70**
	Add 15% for Value Added Tax:	R	3 716 278.01
	Gross Total Estimate for Project:	R	**28 491 464.71**

12 Conclusions and Recommendations

Based on this Concept Report it is recommended that the Sand Spruit abstraction pump station facilities and the De Put raw water booster pump station be implemented as follows:

12.1 Proposed Abstraction Pump Station at Sand Spruit:

1. Raw water flow through coarse screens into the abstraction sump.
2. The screw pumps will abstract raw water from the sump and pump it via the screw pump and screw pump chute to the top of the De Put off channel storage dam.
3. The screw pumps will discharge the raw water into a collection sump at the top of the De Put off-channel storage dam.
4. Raw water will then gravitate through a 1m wide x 1.5m high concrete channel from the discharge sump into the De Put off-channel storage dam.
5. The discharge area will be protected against erosion by implementing concrete spillway and rip-rap around it.
6. This whole system will be enclosed by a reinforced concrete structure to protect it against theft and vandalism.
7. Areas where access is required will be enclosed with heavy duty pre-cast concrete slabs.
8. There will be no visible equipment.
9. New and improved electrical security fence; possibly with beams, pepper spray etc.
10. All telemetry and communication to the main SCADA to be incorporated, this will allow for automatic stop/start, level control, flow control etc.

12.2 Proposed De Put Raw Water Booster Pump Station:

1. Design and construction of a new floating abstraction device in the De Put off-channel storage dam
2. The floating device is connected to a newly constructed PE100 ND 710mm HDPE outlet pipe.
3. Design and construction of a new reinforced concrete pump station building. This building will also be equipped with a reinforced concrete vault door. This is to ensure minimal theft and vandalism of the equipment and structures. Please refer to **Appendix D** for details.
4. The suction and delivery pipework in the pump station will be coupon coated (to 300 micron) 400mm dia. steel pipes. The pump station will also include the required valves e.g. non-return valves, air valves, isolation valves etc. Please refer to the proposed raw water booster pump station layout under **Appendix C.**
5. As the 500mm dia. pipeline to the water treatment works will be utilised as a bi-directional pipeline, a new bi-directional by-pass valve chamber will be designed and constructed adjacent

to the new raw water booster pump station. This chamber will allow the pump station to be by-passed when gravitational flow from the water treatment works is applied.

6 There will be no visible equipment.

7 New and improved electrical security fence; possibly with beams, pepper spray etc.

8 All telemetry and communication to the main SCADA to be incorporated, this will allow for automatic stop/start, level control, flow control etc.

13 Detail Design Report Approval

1. **Signed: Setsoto Local Municipality:**

_____	_____	_____
Signature:	Date:	Position Held:

2. **Signed: Department of Water and Sanitation:**

_____	_____	_____
Signature:	Date:	Position Held:

3. **Signed: Consulting Engineer - Aurecon:**

_____	_____	_____
Signature:	Date:	Position Held:

Appendix A

Water Demand Calculations

Project	Senekal Bulk Water Supply	**Proj No**	111826
Subject	Senekal Population Figures and Daily Demand Calculations - EXCLUDING BOREHOLES	**Date**	07/02/2019
Prepared By	EP Horn	**Page No**	1
Checked By	W BARNARD		

	Census Figures	Dwa Figures		IDP Figures
Area	**Population 2015**	Scenario	**Population 2015**	**Population 2011**
Senekal	26853	Low	28585	25543
		High	29464	

IDP Population Figures 2011 (Base year) - 2040

Description	**Growth Rate**	**Population**						
		2011	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
Scenario 1	1.04%	25543	28036	29524	31092	32743	34481	36312

Census Estimated population Figures 2015 (Base year) - 2040

Description	**Growth Rate**	**Population**						
		2015	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
Scenario 1	1.26%	26853	28586	30432	32396	34488	36714	39084

DWS Estimated population Figures 2015 (Base year) - 2040

Description	**Growth Rate**	**Population**						
		2015	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
Low Scenario	0%	28585	28585	28585	28585	28585	28585	28585
High Scenario	1.13%	29464	31173	32981	34894	36918	39059	41324

							Census Figures				DWS Figures				IDP Figures			
Category	**Dwelling Type**		**Average Water Consumption l/c/d**	**% Population per Category**			**2015**		**2045**		**2015**		**2045**		**2011**		**2045**	
							Population	**Water Requirements (Kl/d)**	**Population**	**Water Require**	**Population**	**Water Requirements (Kl/d)**	**Population**	**Water Requirements**	**Population**	**Water Requirements (Kl/d)**	**Population**	**Water Requirements**
1	Flats		226	0.5			124	28	180	41	136	31	190	43	117	27	167	38
2	Clusters		255	0.4			118	30	172	44	130	33	182	46	112	29	160	41
3	Single Residential	Low income	101	22.3	50.3	Formal	5994	605	8724	881	6576	664	9224	932	5701	576	8105	819
4		Medium Income	189	25.9			6955	1314	10123	1913	7631	1442	10703	2023	6616	1250	9405	1777
5		High Income	304	1.1			290	88	422	128	318	97	446	136	276	84	392	119
6		Very High Income	442	0.1			38	17	55	24	41	18	58	26	36	16	51	22
7	Informal	RDP Level	40	49.7	49.7	Informal	13335	533	19409	776	14632	585	20522	821	12685	507	18032	721
8		No Service	12	0.0			0	0	0	0	0	0	0	0	0	0	0	0
Total				100.0			26853	**2616**	39084	**3808**	29464	**2870**	41324	**4026**	**25543**	**2488**	**36312**	**3538**

	Census	**DWS**	**IDP Report**
	AADD (kl/d)	AADD (kl/d)	**AADD (kl/d)**
Residential	3808	4026	3538
Non Residential (30%)	4950	5234	4599
Network Losses (25%)	6187	6542	5749
Peak	9900	10467	9198

SIZE OF CLEAR WATER RESERVOIR AT WTW:		Census	DWS	IDP
TOTAL PEAK WATER DEMAND IN SENEKAL WITH NETWORK LOSSES (kl/d):		**9900**	10467	9198
TOTAL COMBINED STORAGE CAPACITY OF RESERVOIRS **WITHOUT** 48 HOURS STORAGE CAPACITY (kl):		9900	10467	9198
TOTAL COMBINED STORAGE CAPACITY OF RESERVOIRS **WITH** 48 HOURS STORAGE CAPACITY (kl):		19800	20935	18395
LESS EXISTING STORAGE TANKS				
Senekal (kl)		9080	9080	9080
Storage Required				
Senekal Storage Shortfall (kl)		10720	11855	9315
SENEKAL PEAK FLOW(kl/d):		9900	10467	9198
LOSSES : TRANSMISSION LOSSES FROM WTW TO STORAGE TANKS (%):	2	198	209	184
AMOUNT OF WATER TO CLEAR WATER RESERVOIR FROM WTW OUTLET:		**10,098**	**10,677**	**9,382**
LOSSES: WATER TREATMENT LOSSES AT WTW (%):	9	909	961	844
WATER TO BE PUMPED TO WTW				
WATER TO BE TREATED AT WTW (INLET) OVER A **24 HOUR DESIGN PERIOD** (kl/d):	24 HOUR PERIOD	11007	11638	10226
WATER TO BE TREATED AT WTW (INLET) OVER A **2O HOUR DESIGN PERIOD** (kl/d):	20 HOUR PERIOD	13208	13965	12271
LOSSES: TRANSMISSION LOSSES FROM DAM TO WTW (%):	8	1057	1117	982
LOSSES : FARMERS USE (%):	2	264	279	245
WATER TO BE EXTRACTED FROM THE STORAGE DAMS (CYFERFONTEIN AND DE PUT):				
WATER TO BE PUMPED TO WTW FROM STORAGE DAMS (CYFERFONTEIN AND DE PUT) (kl/d):		14529	15362	13498
LOSSES: ALLOWANCE FOR SLUDGE DISCHARGE AT ABSTACTION (%):	1	145	154	135
WATER TO BE EXTRACTED FROM THE DAMS (CYFERFONTEIN AND DE PUT) (kl/d):		**14674**	**15515**	**13633**

TOTAL WATER TO BE ABSTRACTED AT THE DAMS TO ENSURE THAT DEMANDS ARE MET IN SENEKAL AFTER ALL THE LOSSES HAVE BEEN TAKEN INTO ACCOUNT (kl/d):	**14674**	**15515**	**13633**
TOTAL WATER TO BE ABSTRACTED AT THE DAMS (CYFERFONTEIN AND DE PUT) TO ENSURE THAT DEMANDS ARE MET IN SENEKAL AFTER ALL THE LOSSES HAVE BEEN TAKEN INTO ACCOUNT (l/s)	170	180	158

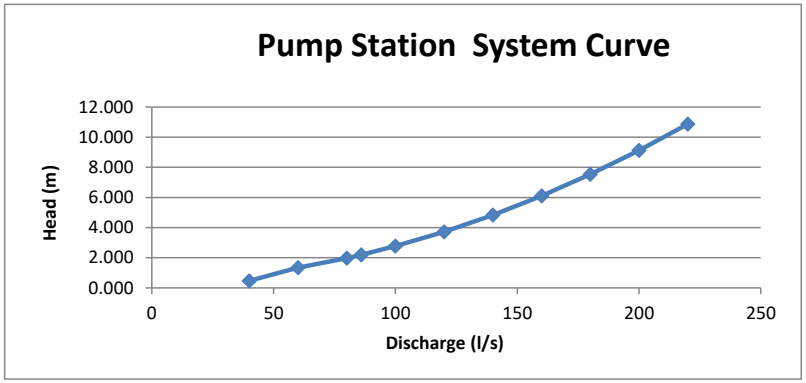
Appendix B

Pump Station System Curves

PROJECT NO:	111826	CALCULATED BY:	EP Horn	DATE:	19/02/2020
SUBJECT :	PUMP STATION SYSTEM CURVE DESIGN FOR DE PUT DAM BOOSTER PUMP STATION				

Note: From start of De Put Contract, T17(18/19) to end @ 86 l/s

DEMAND	86	l/s
Diameter	0.4728	m
Area	0.17556778	m^2
Viscosity	0.00000113	
K/D	0.00015	
	0.333333333	
Length	3369.71	m
Pump elevation	1424.52	m
Destination	1424.99	m
Static Lift	0.47	m
Pump Type		
Minor loss coeff.	24.1	
Head friction	& L V^2/2 x g D	



Q (Discharge l/s)	40	60	80	86	100	120	140	160	180	200	220
Velocity(m/s)	0.228	0.342	0.456	0.490	0.570	0.683	0.797	0.911	1.025	1.139	1.253
Re (Reynolds)	95326.621	142989.931	190653.242	204952.235	238316.552	285979.863	333643.173	381306.484	428969.794	476633.105	524296.415
Lamda		0.017	0.017	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.015
h_f(Friction Head)		0.736	1.253	1.433	1.900	2.675	3.579	4.610	5.769	7.055	8.468
Minor loss	0.064	0.143	0.255	0.295	0.399	0.574	0.781	1.020	1.291	1.594	1.929
Head	**0.470**	**1.349**	**1.978**	**2.198**	**2.768**	**3.719**	**4.830**	**6.100**	**7.530**	**9.119**	**10.867**

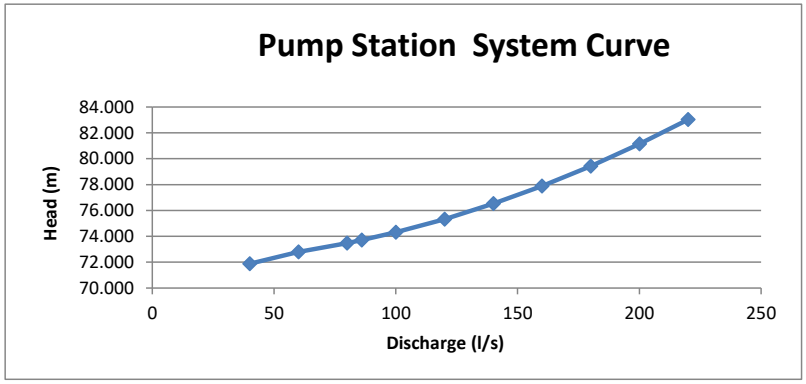
Operating point	86	l/s
	2.198	m

FITTINGS	LOSS COEFFICIENT	No of fittings	Total
Globe Valve	10		0
Angle valve	5		0
Swing check valve	2.5	1	2.5
Gate Valve	0.2	3	0.6
Short Radius elbow	0.9		0
Medium Radius elbow	0.8		0
Long Radius elbow	0.6	8	4.8
45 degree elbow	0.4	10	4
Closed return bend	2.2		0
Standard Tee- flow through run	0.6	17	10.2
Standard Tee- flow throught branch	1.8		0
Square entrance	0.5	2	1
Exit	1	1	1
		TOTAL	24.1

PROJECT NO:	111826	CALCULATED BY:	EP Horn	DATE:	19/02/2020
SUBJECT :	PUMP STATION SYSTEM CURVE DESIGN FOR DE PUT DAM BOOSTER PUMP STATION				

Note: From end of De Put Contract to new 11Ml per/day WTW @ 86 l/s

DEMAND	86	l/s
Diameter	0.3784	m
Area	0.112458461	m^2
Viscosity	0.00000113	
K/D	0.00015	
	0.333333333	
Length	1110.58	m
Pump elevation	1424.12	m
Destination	1496.00	m
Static Lift	71.88	m
Pump Type		
Minor loss coeff.	14.3	
Head friction	& L V^2/2 x g D	



Q (Discharge l/s)	40	60	80	86	100	120	140	160	180	200	220
Velocity(m/s)	0.356	0.534	0.711	0.765	0.889	1.067	1.245	1.423	1.601	1.778	1.956
Re (Reynolds)	119107.892	178661.838	238215.784	256081.968	297769.730	357323.676	416877.622	476431.568	535985.514	595539.460	655093.406
Lamda		0.017	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.015	0.015
h_f(Friction Head)		0.714	1.220	1.397	1.856	2.620	3.512	4.532	5.679	6.955	8.357
Minor loss	0.092	0.207	0.369	0.426	0.576	0.830	1.130	1.475	1.867	2.305	2.789
Head	**71.880**	**72.801**	**73.469**	**73.704**	**74.312**	**75.330**	**76.521**	**77.887**	**79.427**	**81.140**	**83.026**

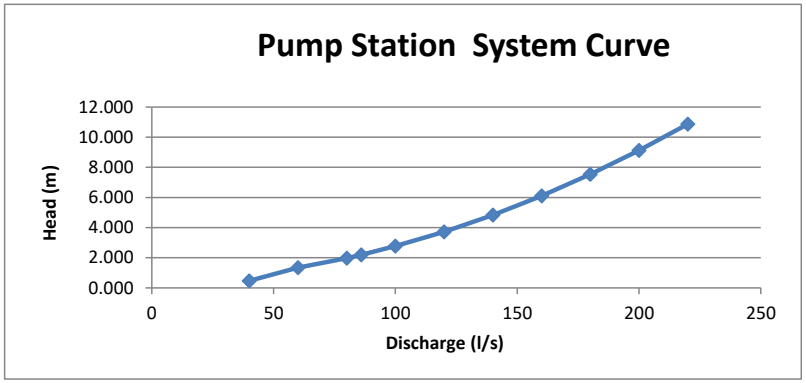
Operating point	86	l/s
	73.704	m

FITTINGS	LOSS COEFFICIENT	No of fittings	Total
Globe Valve	10		0
Angle valve	5		0
Swing check valve	2.5	0	0
Gate Valve	0.2	4	0.8
Short Radius elbow	0.9		0
Medium Radius elbow	0.8	4	3.2
Long Radius elbow	0.6	7	4.2
45 degree elbow	0.4	4	1.6
Closed return bend	2.2		0
Standard Tee- flow through run	0.6	5	3
Standard Tee- flow throught branch	1.8		0
Square entrance	0.5	1	0.5
Exit	1	1	1
		TOTAL	14.3

PROJECT NO:	111826	CALCULATED BY:	EP Horn	DATE:	19/02/2020
SUBJECT :	PUMP STATION SYSTEM CURVE DESIGN FOR DE PUT DAM BOOSTER PUMP STATION				

Note: From start of De Put Contract, T17(18/19) to end @ 180 l/s

DEMAND	180	l/s
Diameter	0.4728	m
Area	0.17556778	m^2
Viscosity	0.00000113	
K/D	0.00015	
	0.333333333	
Length	3369.71	m
Pump elevation	1424.52	m
Destination	1424.99	m
Static Lift	0.47	m
Pump Type		
Minor loss coeff.	24.1	
Head friction	& L V^2/2 x g D	



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Velocity(m/s)	0.228	0.342	0.456	0.490	0.570	0.683	0.797	0.911	1.025	1.139	1.253
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Head	**0.470**	**1.349**	**1.978**	**2.198**	**2.768**	**3.719**	**4.830**	**6.100**	**7.530**	**9.119**	**10.867**

Operating point	180	l/s
	7.530	m

FITTINGS	LOSS COEFFICIENT	No of fittings	Total
Globe Valve	10		0
Angle valve	5		0
Swing check valve	2.5	1	2.5
Gate Valve	0.2	3	0.6
Short Radius elbow	0.9		0
Medium Radius elbow	0.8		0
Long Radius elbow	0.6	8	4.8
45 degree elbow	0.4	10	4
Closed return bend	2.2		0
Standard Tee- flow through run	0.6	17	10.2
Standard Tee- flow throught branch	1.8		0
Square entrance	0.5	2	1
Exit	1	1	1
		TOTAL	24.1

PROJECT NO:	111826	CALCULATED BY:	EP Horn	DATE:	19/02/2020
SUBJECT :	PUMP STATION SYSTEM CURVE DESIGN FOR DE PUT DAM BOOSTER PUMP STATION				

Note: From end of De Put Contract to new 11Ml per/day WTW @ 180 l/s

DEMAND	180	l/s
Diameter	0.3784	m
Area	0.112458461	m^2
Viscosity	0.00000113	
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	0.333333333	
Length	1110.58	m
Pump elevation	1424.12	m
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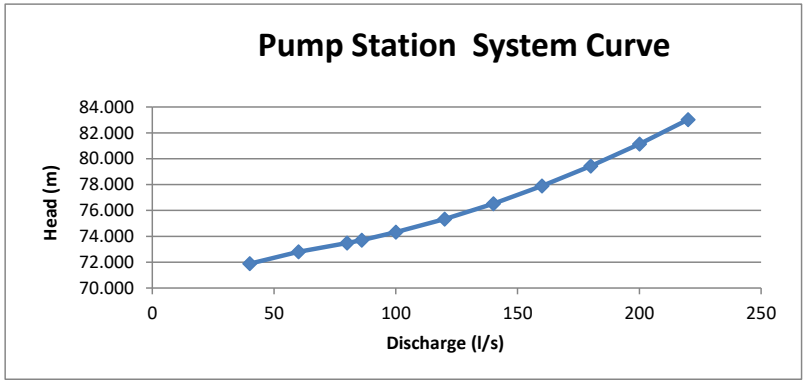
Static Lift	71.88	m
Pump Type		
Minor loss coeff.	14.3	
Head friction	& L V^2/2 x g D	



Q (Discharge l/s)	40	60	80	86	100	120	140	160	180	200	220
Velocity(m/s)	0.356	0.534	0.711	0.765	0.889	1.067	1.245	1.423	1.601	1.778	1.956
Re (Reynolds)	119107.892	178661.838	238215.784	256081.968	297769.730	357323.676	416877.622	476431.568	535985.514	595539.460	655093.406
Lamda		0.017	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.015	0.015
h_f(Friction Head)		0.714	1.220	1.397	1.856	2.620	3.512	4.532	5.679	6.955	8.357
Minor loss	0.092	0.207	0.369	0.426	0.576	0.830	1.130	1.475	1.867	2.305	2.789
Head	**71.880**	**72.801**	**73.469**	**73.704**	**74.312**	**75.330**	**76.521**	**77.887**	**79.427**	**81.140**	**83.026**

Operating point	180	l/s
	79.427	m

FITTINGS	LOSS COEFFICIENT	No of fittings	Total
Globe Valve	10		0
Angle valve	5		0
Swing check valve	2.5	0	0
Gate Valve	0.2	4	0.8
Short Radius elbow	0.9		0
Medium Radius elbow	0.8	4	3.2
Long Radius elbow	0.6	7	4.2
45 degree elbow	0.4	4	1.6
Closed return bend	2.2		0
Standard Tee- flow through run	0.6	5	3
Standard Tee- flow throught branch	1.8		0
Square entrance	0.5	1	0.5
Exit	1	1	1
		TOTAL	14.3

System Curve for De Put Booster Pump STation Pump Station:

Duty Point At 40% of Total Daily Demand - 86 l/s

Duty Point for T17 (18/19) - CH 0 to 3369.71:

Duty Point:	86	l/s	@	2.19803996	meters Total Dynamic Head

System Curve for T02 (19/20) - CH 0 to 11150.58:

Duty Point :	86	l/s	@	73.70359209	meters Total Dynamic Head
Total Dynamic Head:				75.90163205	
Include 5% Safety Factor for possible changes on site:				3.795081603	

Total Duty Point:	**86**	**l/s**	@	**79.69671366**	**meters Total Dynamic Head**	**Duty Point No.1**

Duty Point At 100% of Total Daily Demand - 180 l/s

Duty Point for T17 (18/19) - CH 0 to 3369.71:

Duty Point:	180	l/s	@	7.529878165	meters Total Dynamic Head

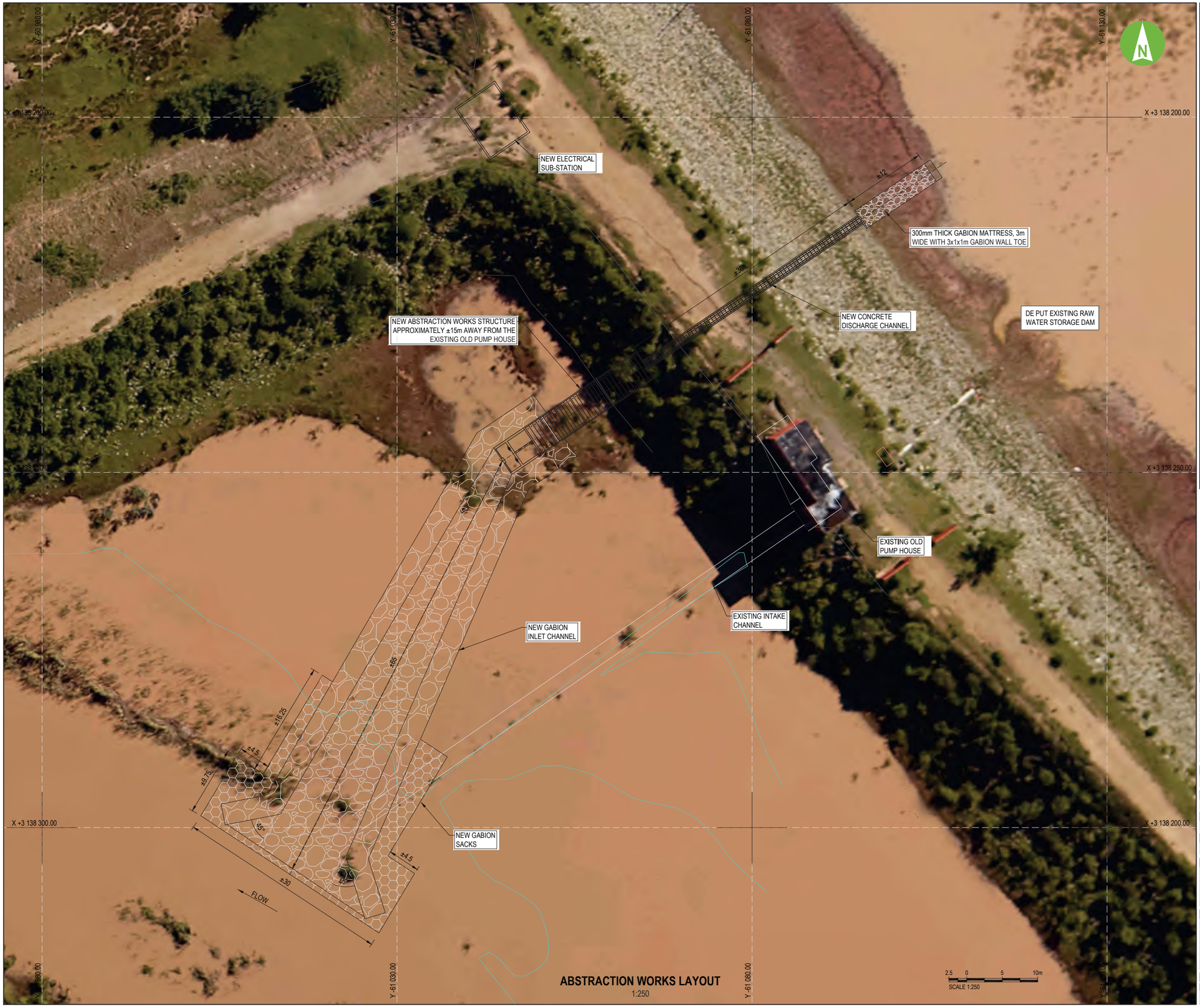
System Curve for T02 (19/20) - CH 0 to 11150.58:

Duty Point :	180	l/s	@	79.42667698	meters Total Dynamic Head
Total Dynamic Head:				86.95655514	
Include 5% Safety Factor for possible changes on site:				4.347827757	

Total Duty Point:	**180**	**l/s**	@	**91.3043829**	**meters Total Dynamic Head**	**Duty Point No.2**

Appendix C

Detail Design Drawings For De Put Abstraction and Booster Pump Station – Main Aspects Only



ABSTRACTION WORKS LAYOUT
1:250

NOTES:

1. REFER TO DRAWING 111826-SPSS-DRG-CC-7001 FOR SECTIONS AND DETAILS.
2. REFER TO MACCAFERRI AFRICA DRAWING NUMBER: FRS-19-0102/01 FOR TENDER PURPOSES ONLY.

LEGEND:

WATER EDGE

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Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

TENDER
NOT FOR CONSTRUCTION

DRAWN	APPROVED
M THWALELA	DATE
DESIGNED	
M THWALELA	
REVIEWED	
EP HORN	W BARNARD Pr Tech Eng 20097086

PROJECT

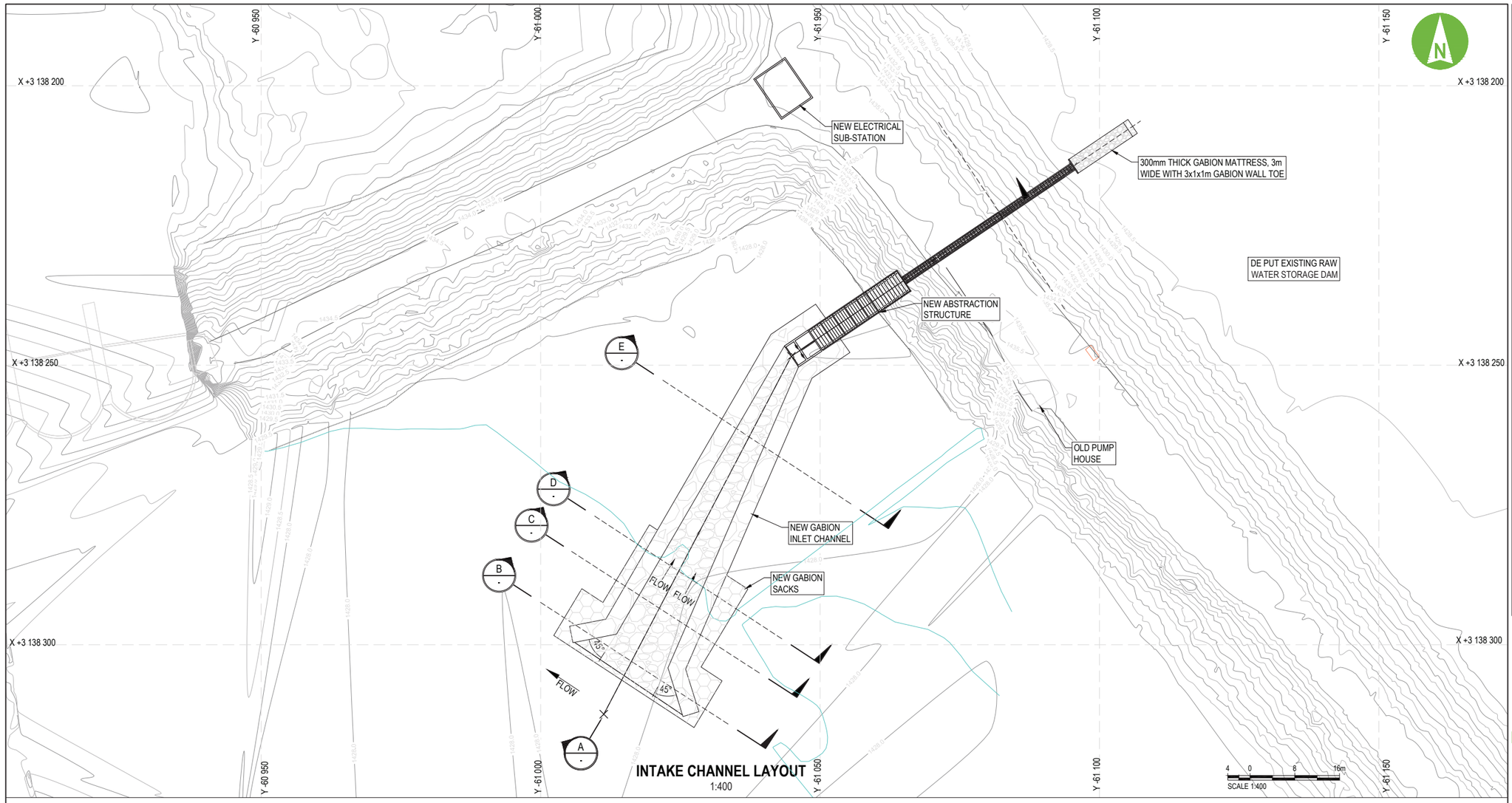
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

TITLE

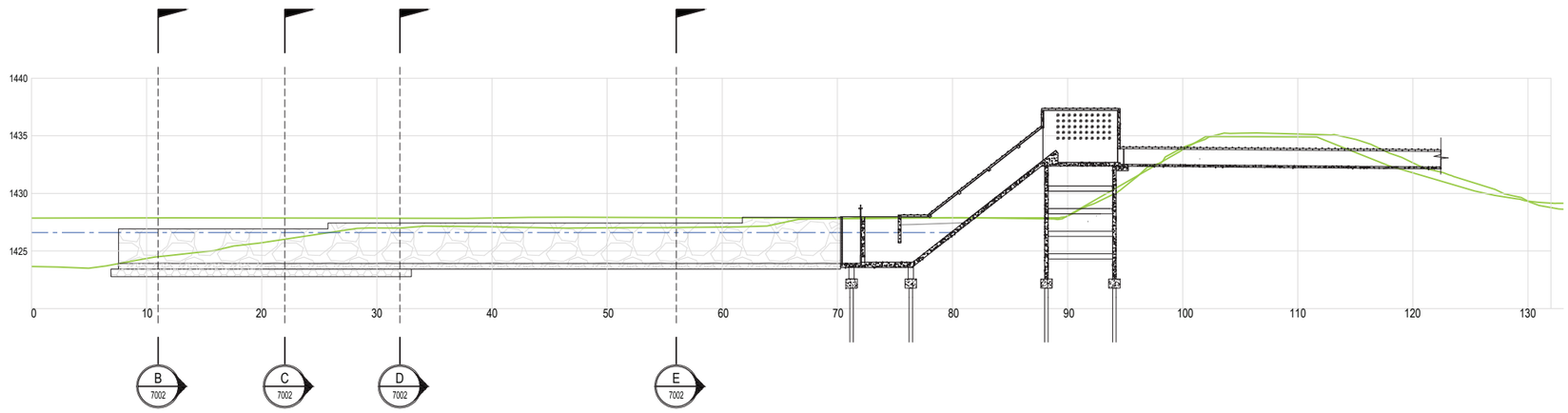
SANDSPRUIT ABSTRACTION WORKS LAYOUT

DRAWING NUMBER

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826 -	SPSS -	DRG -	CC -	7000	- T0



INTAKE CHANNEL LAYOUT
1:400



GABION INTAKE CHANNEL SECTION A
1:250

NOTES:

1. REFER TO DRAWING 111826-SPSP-DRG-CC-7002 FOR GABION SECTIONS.

LEGEND:

- GABION WALL
- 500mm GABION MATTRESS
- 0.65m Ø SACK GABION
- CURRENT AVERAGE WATER LEVEL 1426.3
- NATURAL GROUND LEVEL
- WATER EDGE

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Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

TENDER
NOT FOR CONSTRUCTION

DRAWN: M THWALELA
DESIGNED: M THWALELA
REVIEWED: EP HORN

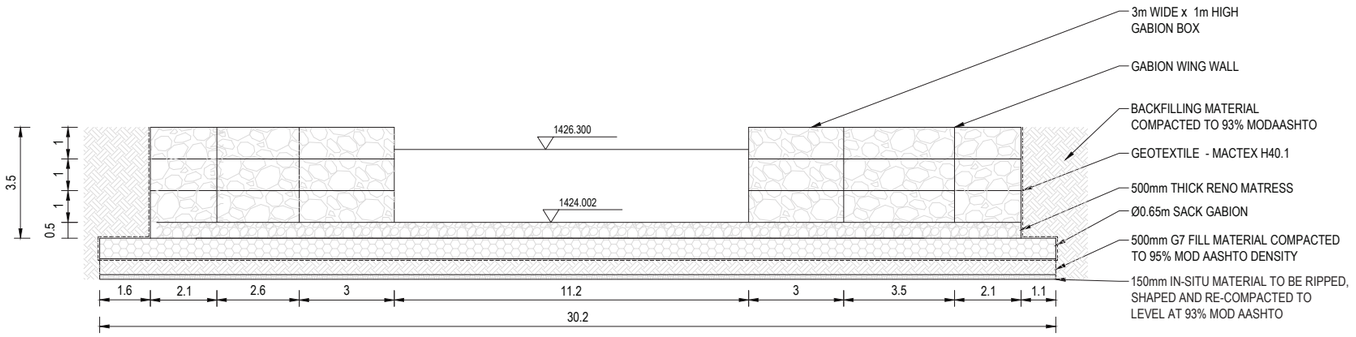
APPROVED
DATE
W BARNARD
Pr Tech Eng 200970086

PROJECT
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

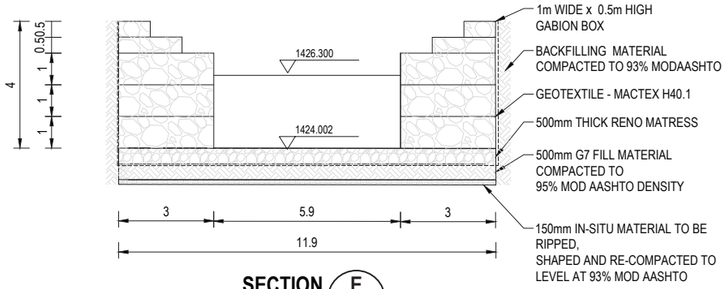
TITLE
SANDSPRUIT INTAKE CHANNEL LAYOUT & SECTION

DRAWING NUMBER

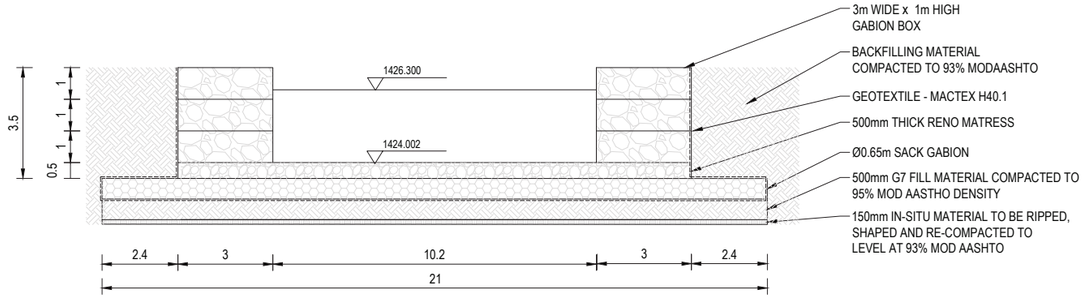
PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826	SPSS	DRG	CC	7001	T0



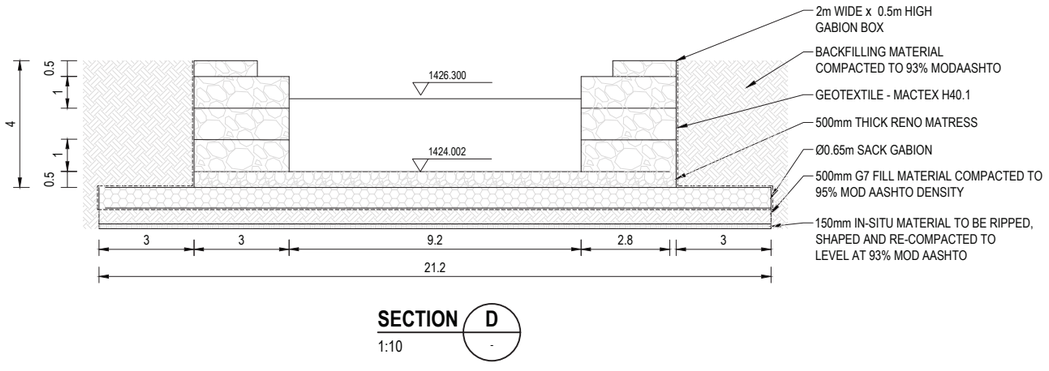
SECTION B
1:10



SECTION E
1:10



SECTION C
1:10



SECTION D
1:10

NOTES:

1. BRICKWORK IS TO CONSIST OF GOOD QUALITY BURNT CLAY BRICKS (FBX) IN ACCORDANCE WITH SABS 227 SPECIFICATION, OR CEMENT BRICKS IN ACCORDANCE WITH SABS 987 SPECIFICATION.
2. BRICKFORCE IS TO BE PLACE EVERY 4TH COURSE LAYER.

LEGEND:

- GABION WALLS
- 500mm GABION MATTRESS
- 0.65m Ø GABION SACKS
- CURRENT WATER LEVEL 1426.3
- GEOTEXTILE - MACTEX H40.1

The Master held at Aurecon bears the signature of approval

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Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

TENDER
NOT FOR CONSTRUCTION

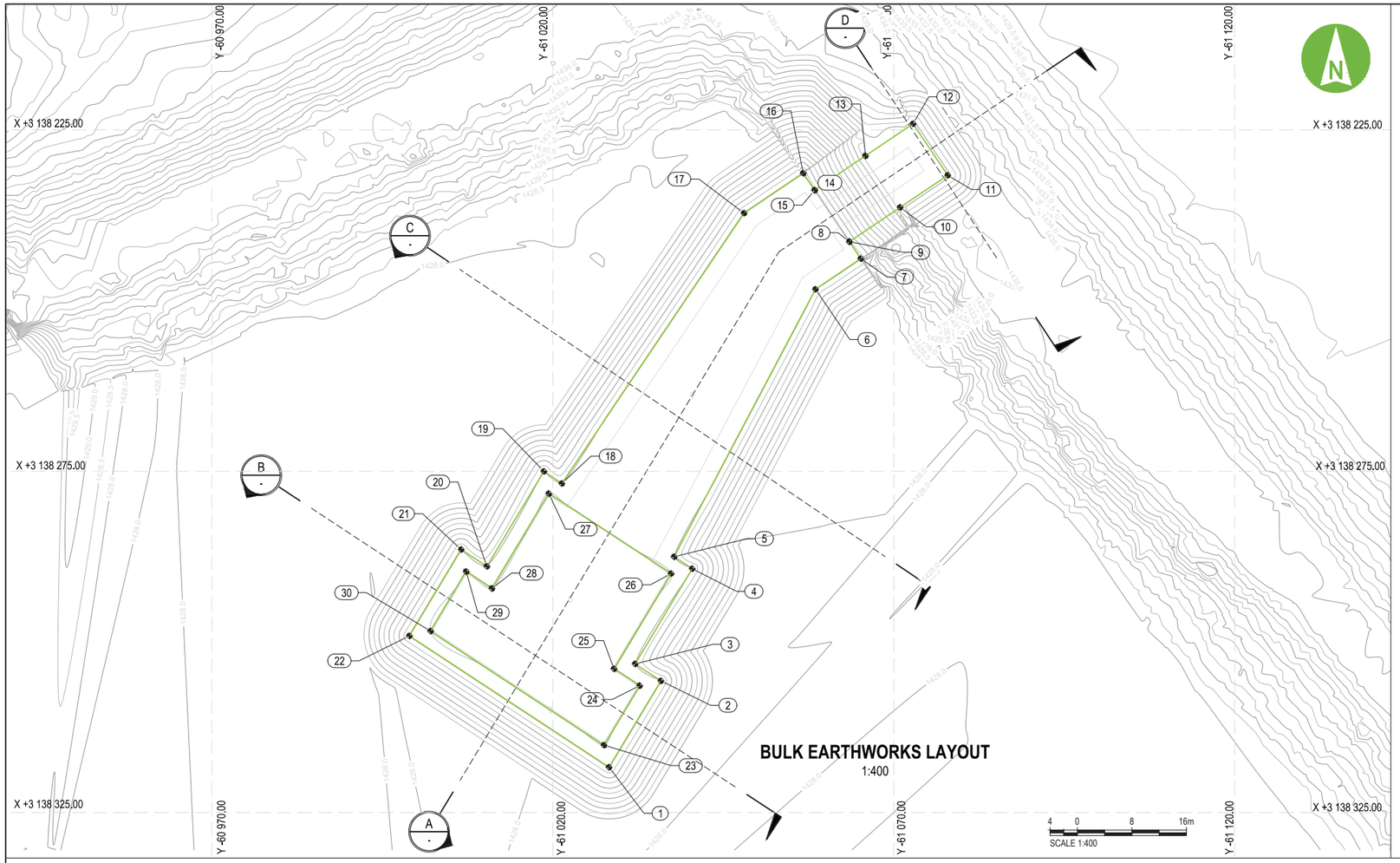
DRAWN: M THWALELA
DESIGNED: M THWALELA
REVIEWED: E.P HORN
APPROVED: DATE
W BARNARD — Pr Tech Eng 200970086

PROJECT
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

TITLE
GABION INTAKE CHANNEL SECTIONS

DRAWING NUMBER

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826	SPSS	DRG	CC	7002	T0



BULK EARTHWORKS LAYOUT
1:400

POINT TABLE			
POINT	Y	X	LEVEL
1	-61028,251	3138318,354	1422,952
2	-61035,848	3138305,696	1422,952
3	-61032,084	3138303,223	1422,952
4	-61040,453	3138289,278	1422,952
5	-61037,790	3138287,528	1422,952
6	-61058,518	3138248,341	1422,952
7	-61065,165	3138243,858	1422,997
8	-61063,488	3138241,371	1422,952
9	-61063,496	3138241,365	1425,427
10	-61070,943	3138236,342	1431,750
11	-61077,911	3138231,642	1431,750
12	-61072,823	3138224,097	1431,750
13	-61065,855	3138228,797	1428,948
14	-61058,407	3138233,821	1422,959
15	-61058,399	3138233,826	1422,952
16	-61056,723	3138231,342	1422,952
17	-61048,044	3138237,196	1422,952
18	-61021,332	3138276,788	1422,952
19	-61018,694	3138275,008	1422,952
20	-61010,337	3138288,934	1422,952

POINT TABLE			
POINT	Y	X	LEVEL
21	-61006,573	3138286,460	1422,952
22	-60998,976	3138299,118	1422,952
23	-61027,512	3138315,116	1422,352
24	-61032,740	3138306,406	1422,352
25	-61028,976	3138303,933	1422,352
26	-61037,345	3138289,987	1422,352
27	-61019,417	3138278,274	1422,352
28	-61011,076	3138292,171	1422,352
29	-61007,312	3138289,698	1422,352
30	-61002,085	3138298,408	1422,352

NOTES:

1. ALL EARTHWORKS AND SERVICES TO BE SET OUT BY A COMPETENT AND QUALIFIED SURVEYOR ACCORDING TO CO-ORDINATES ON PLANS.
2. PRIOR TO ANY FILL BEING DONE, AT LEAST 150mm TOPSOIL TO BE REMOVED AND STOCKPILED ON SITE AS DIRECTED BY THE ENGINEER.
3. REMOVE IN-SITU MATERIAL AS INDICATED.
4. SPOIL MATERIAL TO BE SPOILED TO AN APPROVED SITE LOCATED BY THE CONTRACTOR.
5. EXCAVATED MATERIAL TO BE USED AS DIRECTED BY THE ENGINEER.
6. RIP AND RECOMPACT IN-SITU BASE TO 90% OF MOD. AASHTO MAX. DENSITY TO A MINIMUM DEPTH OF 150mm.
7. FINISHED LEVELS SHALL ENSURE THAT THERE IS NO PONDING OF WATER ON PERIMETER PLATFORM.
8. PROCESS CONTROL TESTS MUST BE DONE ON EVERY 150mm LAYER. THE CONTRACTOR IS REQUIRED TO FURNISH THE ENGINEER WITH A DRAWING INDICATING THE COORDINATED POSITION WHERE TESTS HAS BEEN DONE.
9. THE WORK SHALL BE FINISHED TO DEGREE OF ACCURACY II.

LEGEND:

FEATURE LINE
SECTION
SETTING OUT POINT

The Master held at Aurecon bears the signature of approval

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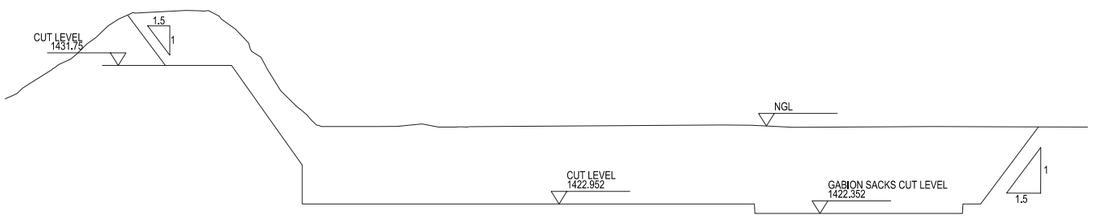
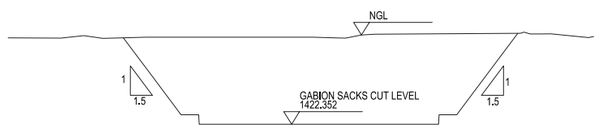
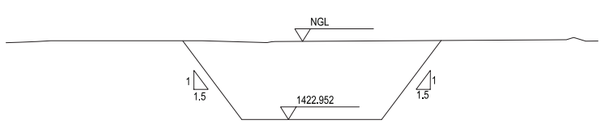


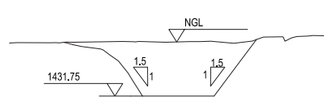
SECTION A
1:400 HOR
1:200 VER



SECTION B
1:400 HOR
1:200 VER



SECTION C
1:400 HOR
1:200 VER



SECTION D
1:400 HOR
1:200 VER

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

TENDER
NOT FOR CONSTRUCTION

DRAWN: M THWALELA
DESIGNED: M THWALELA
REVIEWED: E.P HORN

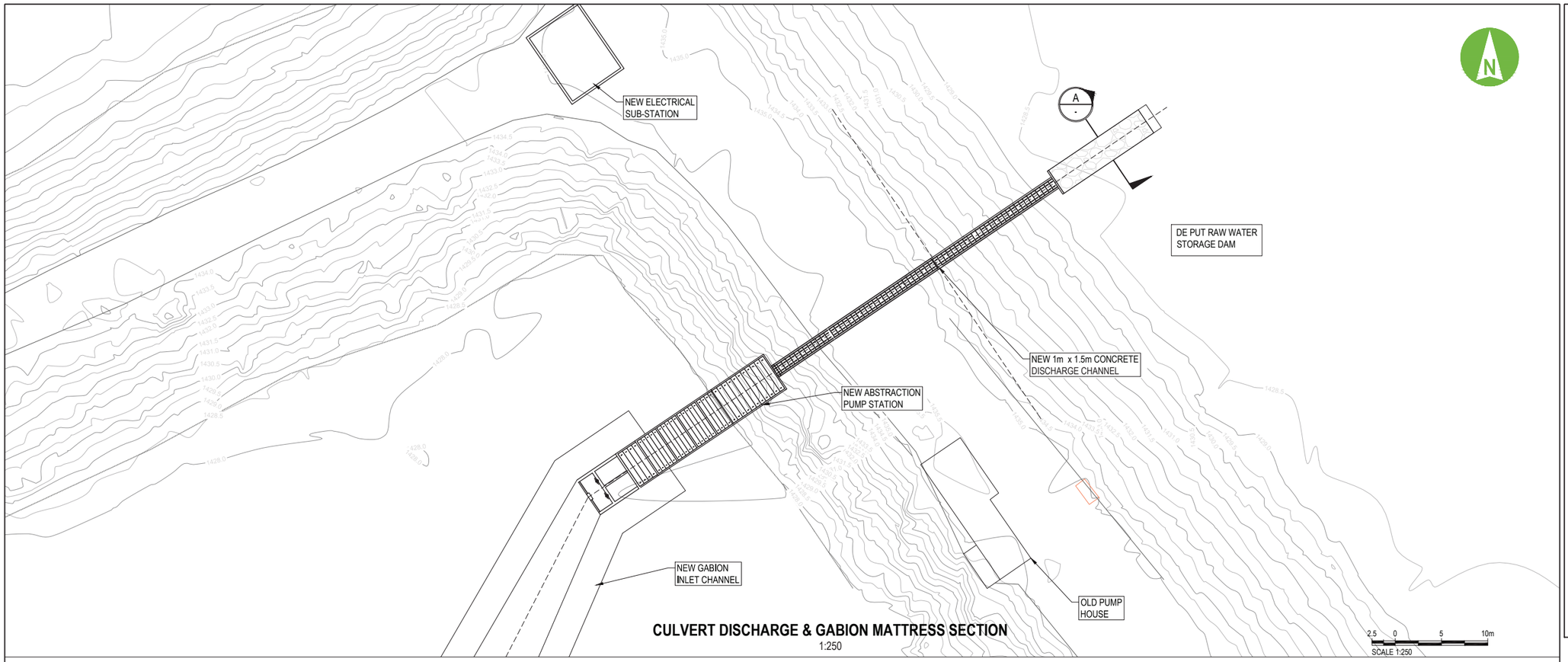
APPROVED
DATE
W BARNARD
Pr Tech Eng 200970086

PROJECT
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

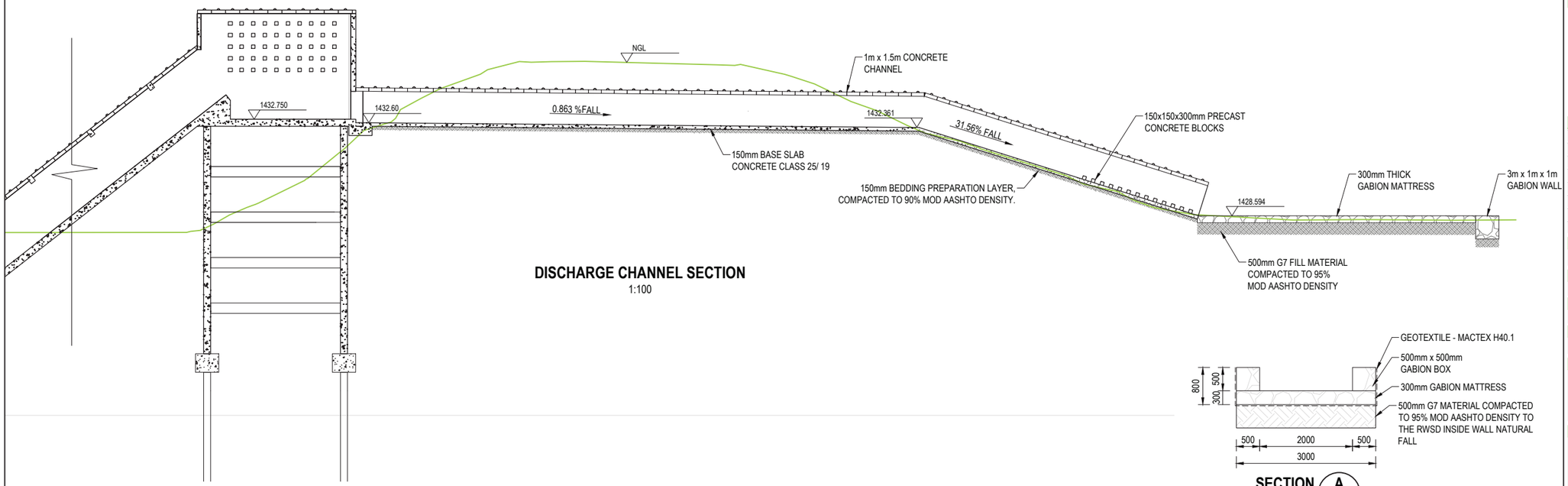
TITLE
INTAKE CHANNEL & ABSTRACTION STRUCTURE: BULK EARTHWORKS

DRAWING NUMBER

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826	SPSS	DRG	CC	7003	T0



CULVERT DISCHARGE & GABION MATTRESS SECTION
1:250



DISCHARGE CHANNEL SECTION
1:100

SECTION A
1:50

NOTES:

1. ONCE EXCAVATION LEVEL HAS BEEN OBTAINED FOR THE CONCRETE CHANNEL THE UNDERLYING MATERIAL MUST BE EXAMINED BY THE ENGINEER TO DETERMINE WHETHER IT IS SUITABLE BEFORE THE RIPPING AND RE-COMPACTION COMMENCES TO SHAPE OF THE FALL.
2. IF THE MATERIAL IS DEEMED UNSUITABLE, IT SHALL BE EXCAVATED TO A DEPTH OF 100mm BELOW THE CHANNEL BASE SLAB AND REPLACED WITH G7 MATERIAL COMPACTED TO 90% MOD AASHTO. UNSUITABLE MATERIAL TO BE DISPOSED OF IN APPROVED AREA BY THE ENGINEER.
3. MATERIAL USED FOR BACKFILLING AROUND THE CHANNEL SHALL COMPLY WITH THE REQUIREMENT OF THE SANS 1200 DB.
4. DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NUMBER: 111826-SPSS-DRG-SS-9051.

LEGEND:

300mm GABION MATTRESS

NATURAL GROUND LEVEL

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Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

TENDER
NOT FOR CONSTRUCTION

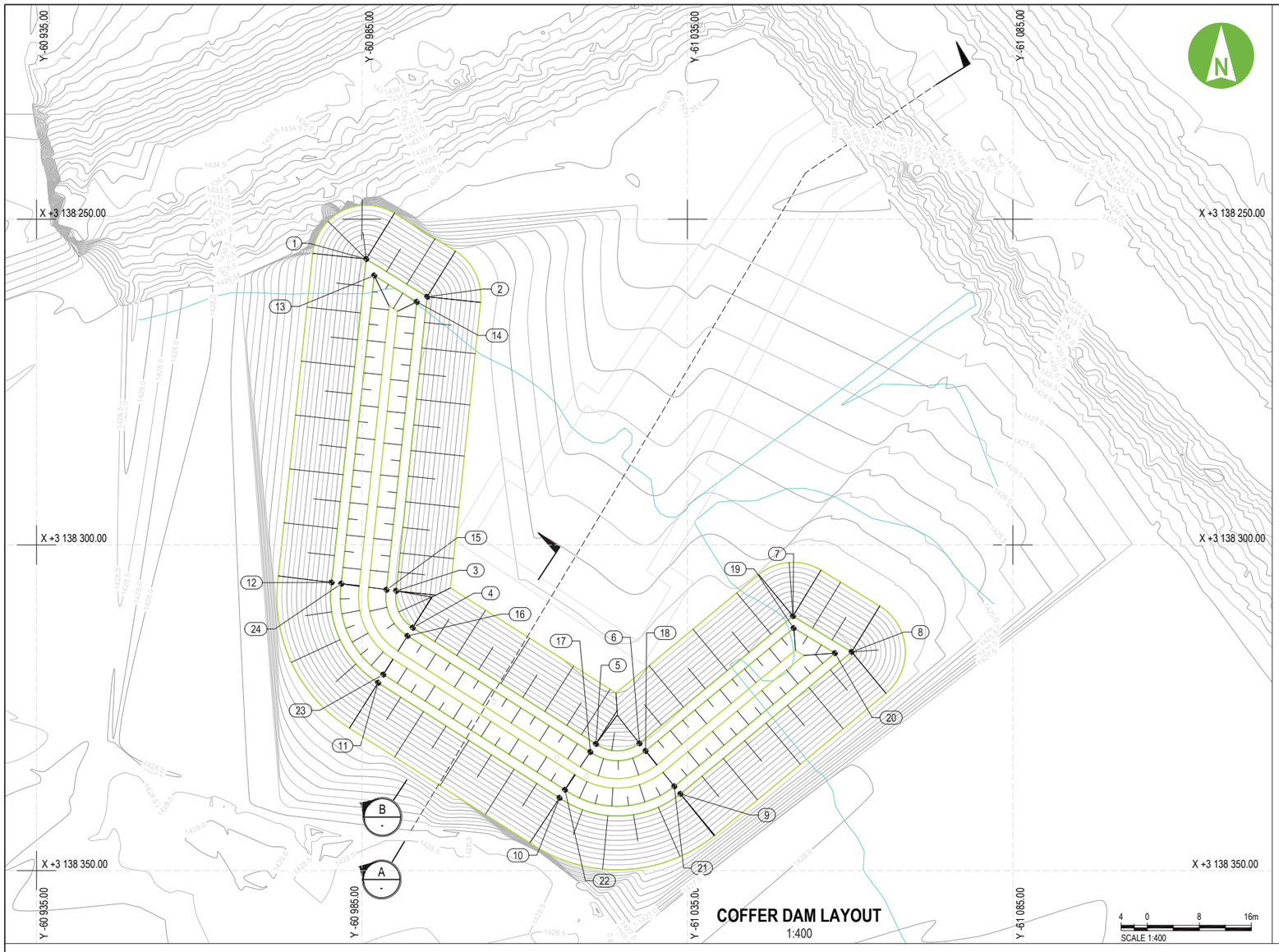
DRAWN	APPROVED
M THWALELA	DATE
DESIGNED	
M THWALELA	
REVIEWED	
EP HORN	W BARNARD Pr Tech Eng 20097086

PROJECT
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

TITLE
SANDSPRUIT DE PUT DAM CHANNEL & GABION MATTRESS SECTION

DRAWING NUMBER

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826 -	SPSS -	DRG -	CC -	7004	- T0



COFFER DAM LAYOUT
1:400

POINT TABLE			
POINT	Y	X	LEVEL
1	-60985.641	3138256.098	1428.500
2	-60995.015	3138261.896	1428.500
3	-60990.257	3138307.058	1428.500
4	-60992.798	3138312.699	1428.500
5	-61020.938	3138330.550	1428.500
6	-61027.632	3138330.464	1428.500
7	-61051.218	3138310.918	1428.500
8	-61060.237	3138316.431	1428.500
9	-61033.931	3138338.231	1428.500
10	-61015.352	3138338.849	1428.500
11	-60987.479	3138321.167	1428.500
12	-60980.338	3138305.766	1428.500
13	-60986.879	3138258.627	1428.500
14	-60993.424	3138262.676	1428.500
15	-60988.765	3138306.886	1428.500
16	-60992.002	3138313.970	1428.500
17	-61020.091	3138331.789	1428.500
18	-61028.574	3138331.632	1428.500
19	-61051.308	3138312.761	1428.500
20	-61057.663	3138316.616	1428.500

POINT TABLE			
POINT	Y	X	LEVEL
21	-61032.984	3138337.068	1428.500
22	-61016.184	3138337.600	1428.500
23	-60988.278	3138319.897	1428.500
24	-60981.826	3138305.954	1428.500

NOTES:

1. DEVIATIONS FROM SETTING OUT COORDINATES OF COFFER DAM TO BE AT THE CONTRACTORS OWN RISK.
2. CONTRACTOR MAY USE PROPOSAL OF SHEETING OR SIMILAR APPROVED IN COFFER DAM FOR LINING.
3. COFFER DAM TO BE CONSTRUCTED BY END TIPPING ROCKFILL MATERIAL FROM RIVER BANK.
4. CUT OFF TRENCH TO BE EXCAVATED INTO ROCKFILL WHILST END TIPPING CORE MATERIAL FROM OPPOSITE SIDE.
5. COFFER DAM TO BE REMOVED ON COMPLETION OF APPROACH CHANNEL.
6. ROCKFILL GRADING SHALL BE AS FOLLOWS:
   D100 = 250mm
   D50 = 150mm
   D20 = 50mm
7. CORE MATERIAL TO BE OBTAINED FROM WEATHERED SHALE/ MUDSTONE IN ESSENTIAL EXCAVATION MINIMUM P.I. TO BE 10%

LEGEND:

- ROCKFILL MATERIAL
- CORE MATERIAL
- CURRENT WATER LEVEL 1426.30
- WATER EDGE
- NGL (TOPOGRAPHICAL SURVEY)
- FEATURE LINE
- SECTION
- SETTING OUT POINT

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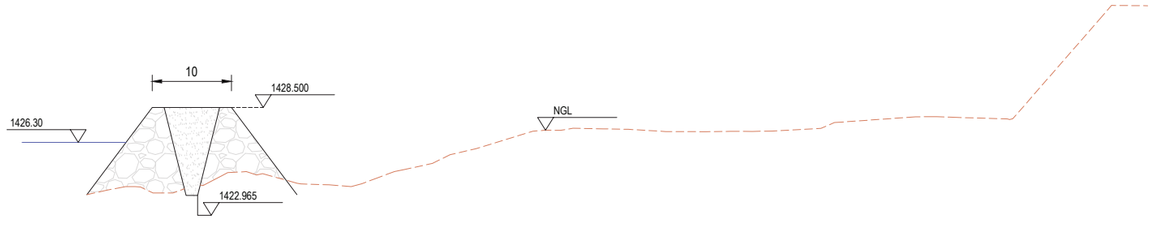
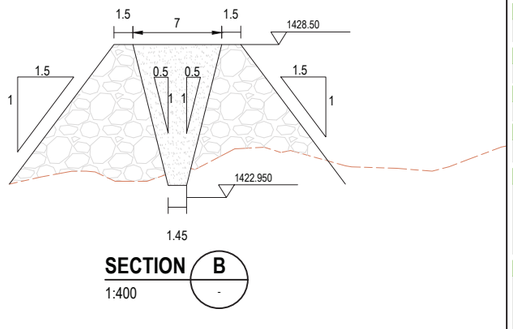


SECTION A
1:400 HOR
1:200 VER



SECTION B
1:400

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

TENDER
NOT FOR CONSTRUCTION

DRAWN: M THWALELA
DESIGNED: M THWALELA
REVIEWED: E.P HORN
APPROVED: W BARNARD — DATE — Pr Tech Eng 200970086

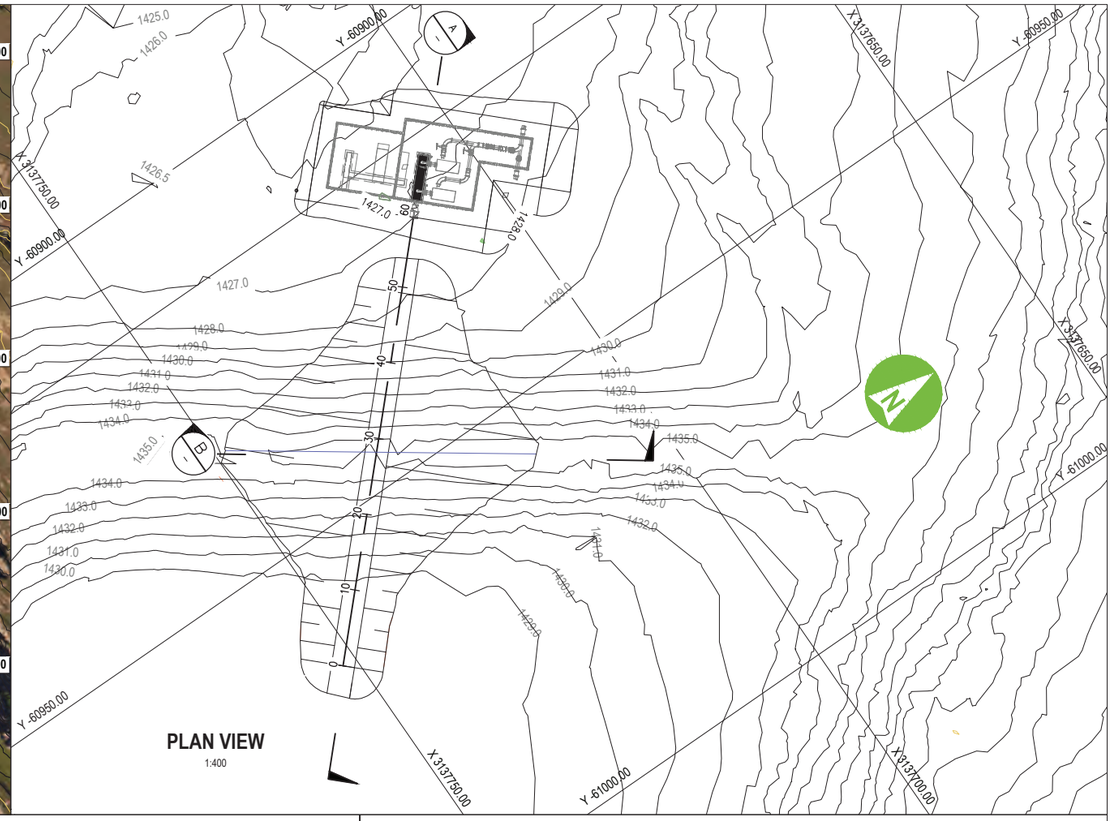
PROJECT
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

TITLE
SANDPSRUIT COFFER DAM LAYOUT AND SECTION

DRAWING NUMBER

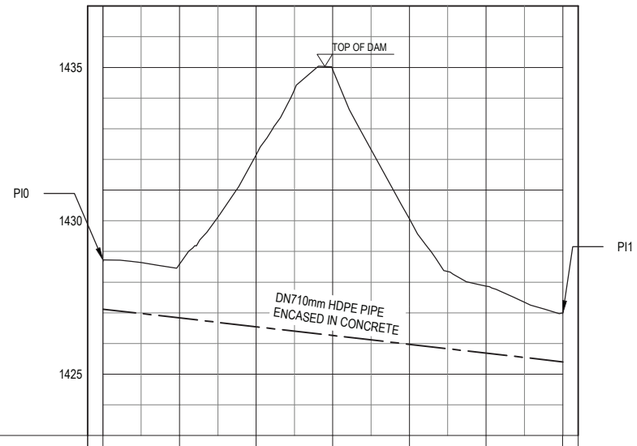
PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826	SPSS	DRG	CC	7005	T0

PLAN VIEW
NTS



PLAN VIEW
1:400

CO-ORDINATES: WGS LO 27 HORIZONTAL ALIGNMENT		
POINT	Y	X
PI0	-60 965.896	3 137 751.862
PI1	-60 922.446	3 137 710.470

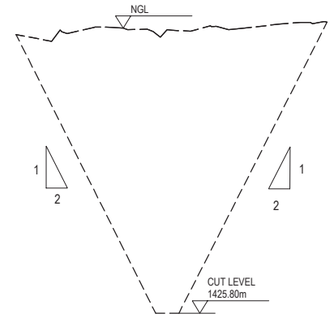


SCALES:
HORIZONTAL 1:400
VERTICAL 1:100

DATUM 1423.000

CHAINAGE (m)	0.00	10.00	20.00	30.00	40.00	50.00	60.00
GROUND LEVEL (m)	1428.73	1428.58	1432.14	1434.93	1430.06	1427.87	1427.00
PIPE INVERT LEVEL (m)	1427.12	1426.83	1426.55	1426.26	1425.97	1425.69	1425.40
TRENCH DEPTH (m)	2.11	2.25	6.10	9.17	4.58	2.69	2.10
SLOPE & SLOPE DISTANCE (m)	-2.87% 60.03						

SECTION A
1:400



SECTION B
HORIZONTAL 1:400
VERTICAL 1:100

LEGEND: (PLAN VIEW)

- GRIDLINE
- FENCE
- ESKOM OVERHEAD POWER LINE AND POLE
- ROAD
- BENCHMARK

LEGEND: (LONG SECTION)

- NATURAL GROUND LEVEL
- NEW DN710mm HDPE PIPELINE

The Master held at Aurecon bears the signature of approval

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CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	ISSUED FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

TENDER
NOT FOR CONSTRUCTION

DRAWN	APPROVED
T. MOHAPI	DATE
DESIGNED	20/04/19
T. MOHAPI	
CHECKED	W.BARNARD Pr Tech Eng 200970086
E. HORN	

PROJECT

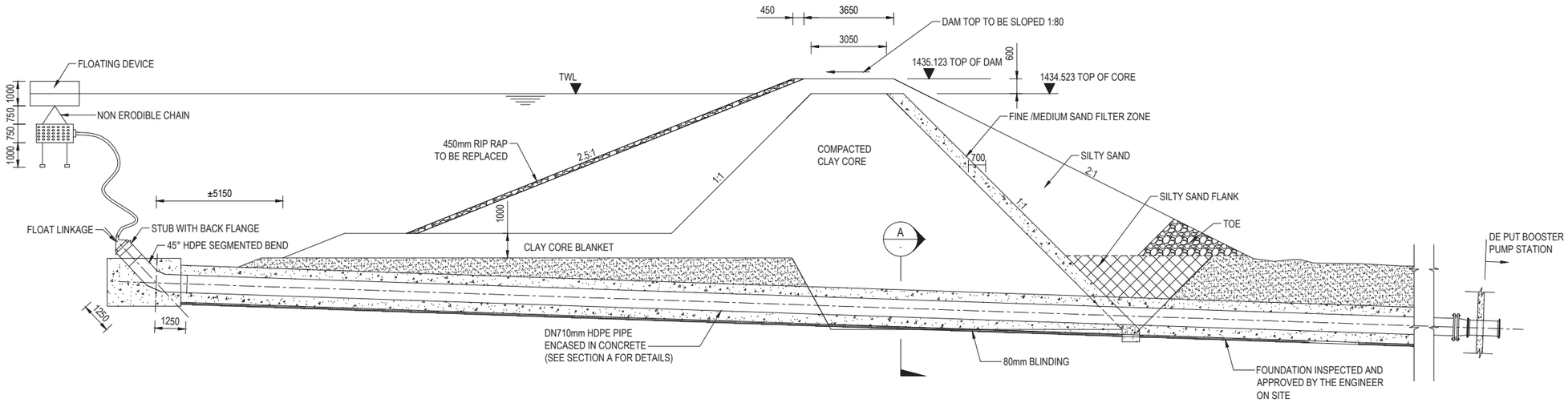
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

TITLE

DE PUT DAM CROSSING
DN710mm HDPE PIPE
FROM DE PUT DAM
TO BOOSTER PUMP STATION

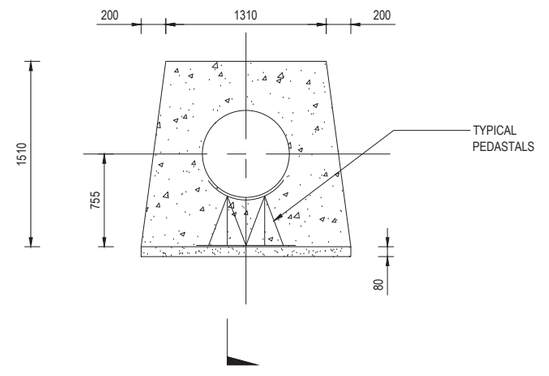
DRAWING NUMBER

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826	SPSS	DRG	CC	7030	T0

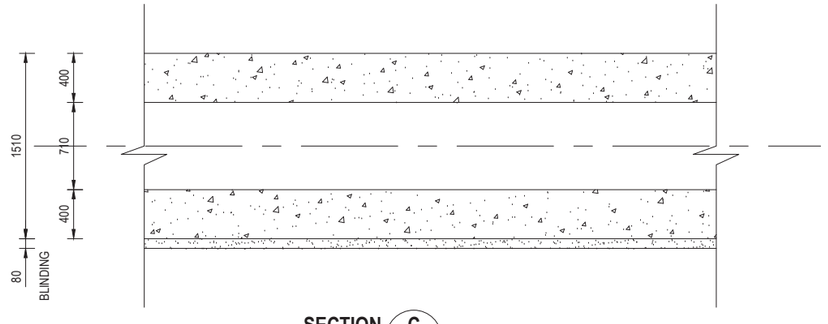


SECTION B
1:100

C



SECTION A
1:25



SECTION C
1:25

LEGEND :

- SAND
- SILTY SAND
- ROCK

NOTES :

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. ALL LEVELS IN METRES ABOVE SEA LEVEL.
3. FA CONCRETE GRADE IS AS FOLLOWS: 25MPa/38mm TO CONCRETE ENCASEMENT
4. MINIMUM CONCRETE COVER 50mm
5. CARE EXERCISED TO ACHIEVE THOROUGH COMPACTION OF BACKFILLING MATERIAL AGAINST CONCRETE ENCASEMENT.

The Master held at Aurecon bears the signature of approval

aurecon
www.aurecongroup.com

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	07/06/19	ISSUED FOR TENDER	W BARNARD

SCALE	SIZE
AS SHOWN	A1

FOR TENDER
NOT FOR CONSTRUCTION

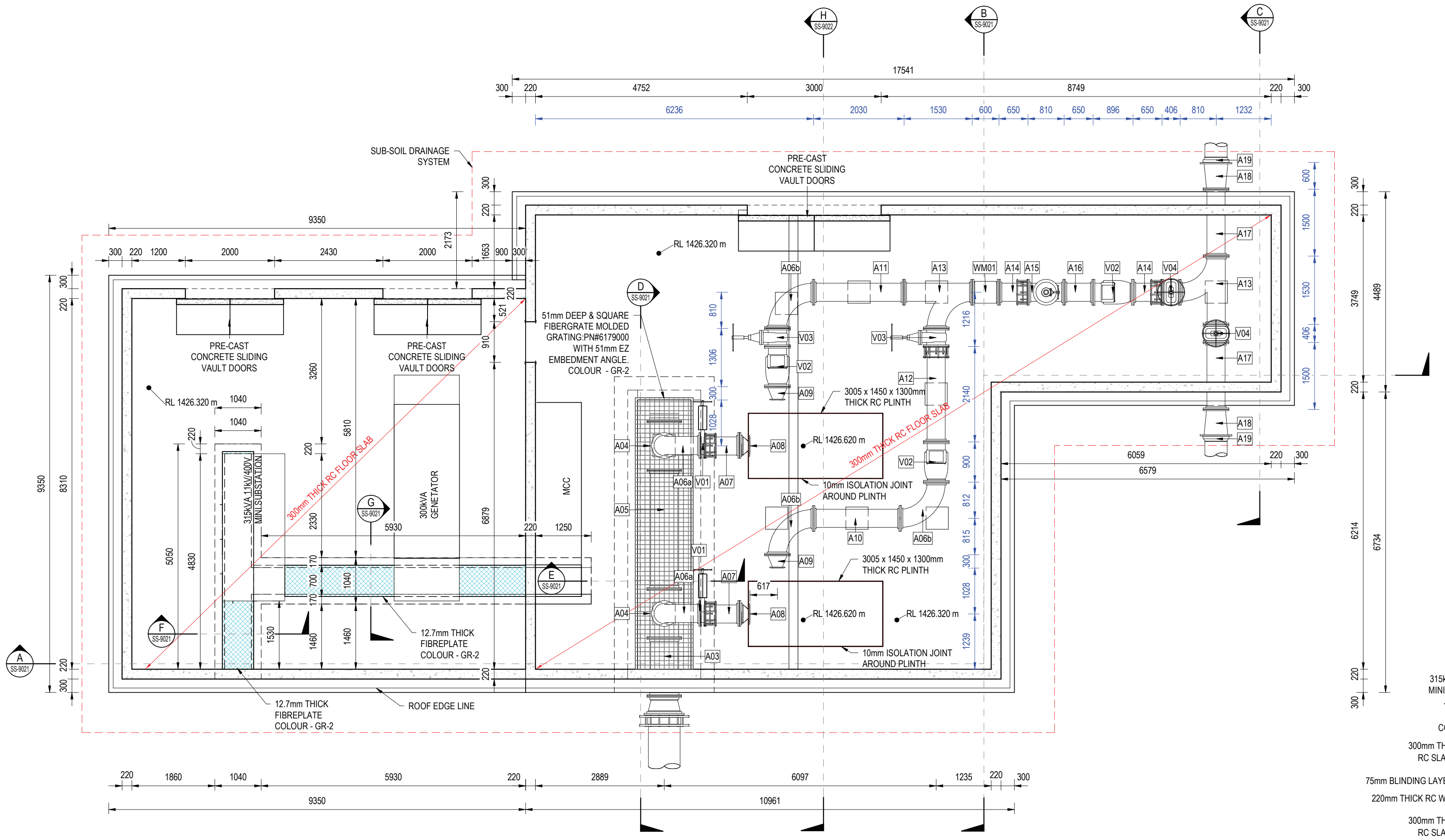
DRAWN: T MOKOENA
DESIGNED: T MOHAPI
CHECKED: E HORN
APPROVED: DATE
W BARNARD — Pr Tech Eng 200970086

PROJECT
UPGRADING OF BULK WATER SUPPLY IN SENEKAL

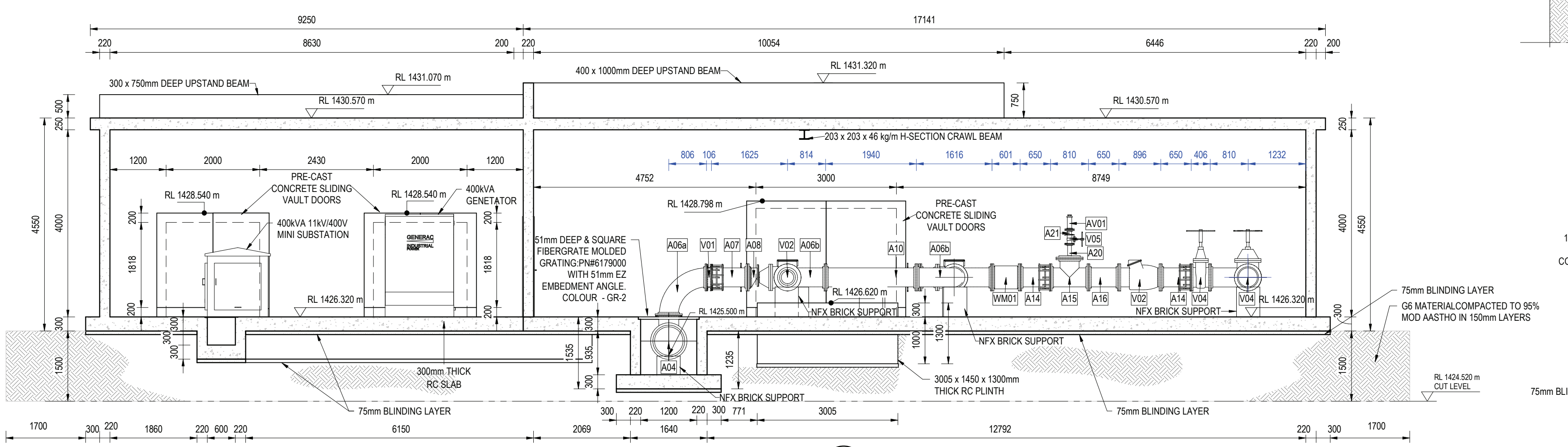
TITLE
DE PUT DAM
BULK EARTHWORKS

DRAWING NUMBER

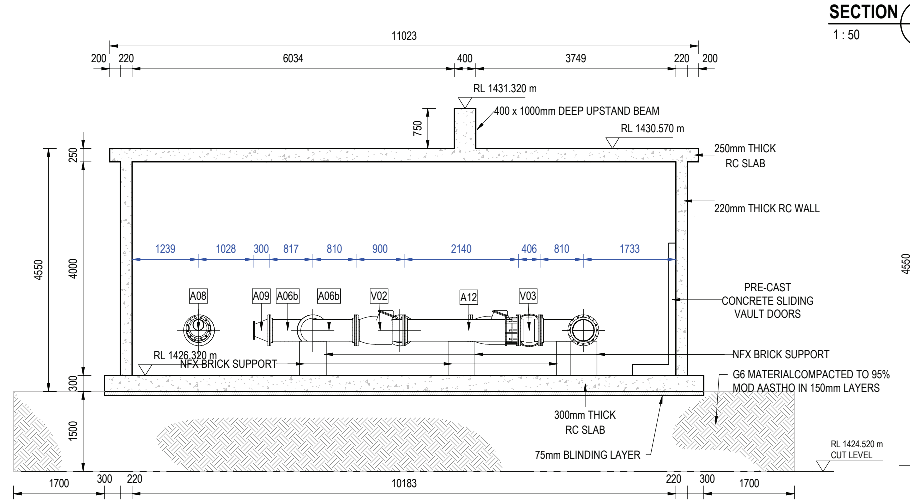
PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
111826 -	SPSS -	DRG -	CIV -	7031 -	T0



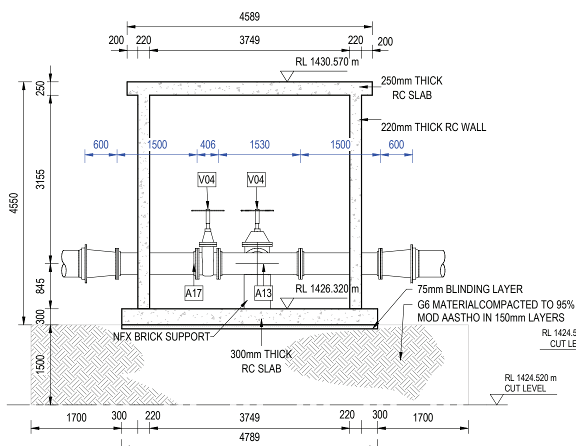
DE PUT BOOSTER PUMP STATION LAYOUT
1 : 50



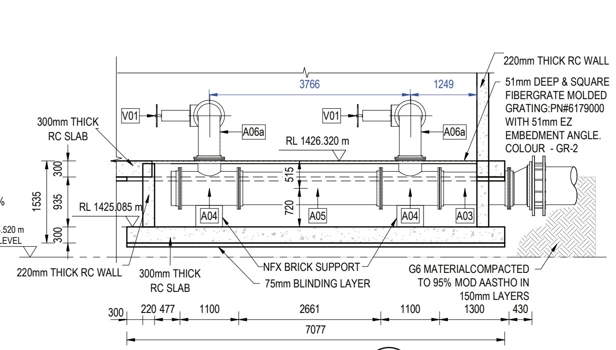
SECTION A 1 : 50 SS-9021



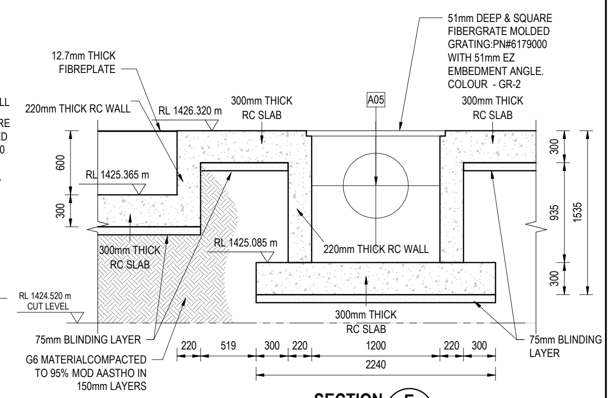
SECTION B 1 : 50 SS-9021



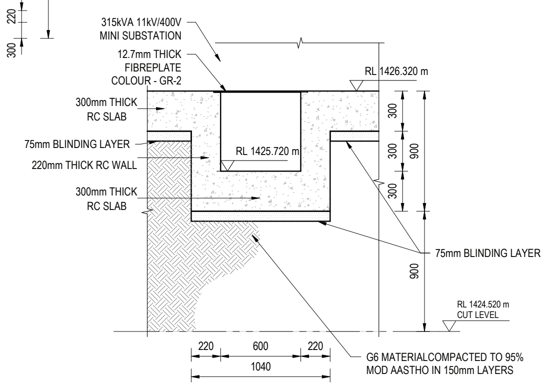
SECTION C 1 : 50 SS-9021



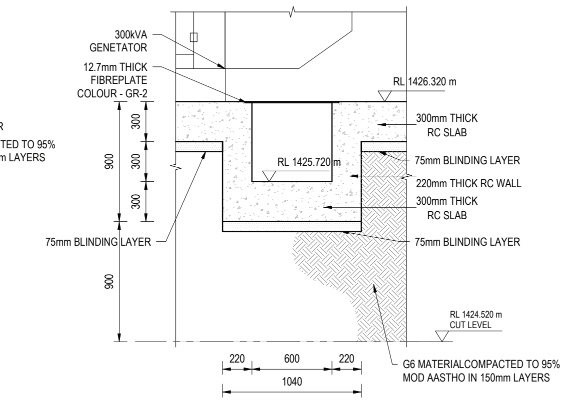
SECTION D 1 : 50 SS-9021



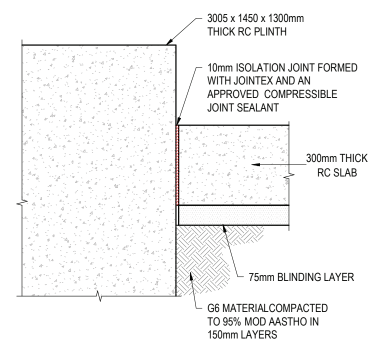
SECTION E 1 : 25 SS-9021



SECTION F 1 : 20 SS-9021



SECTION G 1 : 20 SS-9021



TYPICAL ISOLATIOJN JOINT
1 : 10

PIPE FITTINGS

ITEM NUMBER	NO.	SIZE	DESCRIPTION
A01	1	710ø-710ø	FLANGED ADAPTOR COUPLING(HDPE TO MILD STEEL) (PN10)
A02	1	710ø-600ø	MILD STEEL, EPOXY COATED, FLANGED ECCENTRIC REDUCER/ (LENGHT= 430mm) (PN10)
A04	2	600ø-600ø-400ø	FLANGED MILD STEEL, EPOXY COATED, REDUCING TEE PIECE (MAIN BRANCH 600mm Ø) (PN10)
A06a	2	400ø-400ø	FLANGED MILD STEEL, EPOXY COATED, 90° MEDIUM RADIUS BEND (PN10)
A06b	3	400ø-400ø	FLANGED MILD STEEL, EPOXY COATED, 90° MEDIUM RADIUS BEND (PN16)
A08	2	400ø-200ø	MILD STEEL, EPOXY COATED, FLANGED ECCENTRIC REDUCER/ (LENGHT= 210mm) (PN10)
A09	2	400ø-200ø	MILD STEEL, EPOXY COATED, FLANGED CONCENTRIC REDUCER/ (LENGHT= ±300) (PN16)
A15	1	400ø-400ø-400ø	MILD STEEL, EPOXY COATED, FLANGED EQUAL TEE/ (MAIN LENGHT= ±810mm) (PN16)
A18	2	500ø-400ø	MILD STEEL, EPOXY COATED, FLANGED CONCENTRIC EXPANDER/ (LENGHT= ±600mm) (PN16)
A19	2	500ø-500ø	FLANGED ADAPTOR COUPLING(MILD STEEL TO PVC-O) (PN16)
KFA 1 (R)	2	400ø-400ø	KLAMFLEX FLANGED ADOPTER (RESTRAINED) (PN10)
KFA 1 (R)	3	400ø-400ø	KLAMFLEX FLANGED ADOPTER (RESTRAINED) (PN16)

PIPE SCHEDULE

ITEM NUMBER	NO.	SIZE	DESCRIPTION
A03	1	600ø	MILD STEEL, EPOXY COATED, BOTH ENDS FLANGED ANCHOR PIPE WITH PUDDLE FLANGE (PN10)/ (LENGTH ±1300mm)
A05	1	600ø	MILD STEEL, EPOXY COATED, STRAIGHT DISTANCE PIECE, BOTH ENDS FLANGED (PN10)/ (LENGTH ±2660mm)
A07	2	400ø	MILD STEEL, EPOXY COATED, STRAIGHT DISTANCE PIECE, ONE END FLANGED OTHER END PLAIN ENDED (TO SUITE KFA (R)) (PN10)/ (LENGTH ±800mm)
A10	1	400ø	MILD STEEL, EPOXY COATED, FLANGED STRAIGHT DISTANCE PIECE (PN16)/ (LENGTH ±1940mm)
A11	1	400ø	MILD STEEL, EPOXY COATED, FLANGED STRAIGHT DISTANCE PIECE (PN16)/ (LENGTH ±2020mm)
A12	1	400ø	MILD STEEL, EPOXY COATED, STRAIGHT DISTANCE PIECE, ONE END FLANGED OTHER END PLAIN ENDED (TO SUITE KFA (R)) (PN16)/ (LENGTH ±2140mm)
A13	2	400ø	FLANGED MILD STEEL, EPOXY COATED, LONG RADIUS SWEEP TEE PIECE (PN16)/ (LENGTH ±1530mm)
A14	2	400ø	MILD STEEL, EPOXY COATED, STRAIGHT DISTANCE PIECE, ONE END FLANGED OTHER END PLAIN ENDED (TO SUITE KFA (R)) (PN16)/ (LENGTH ±650mm)
A16	1	400ø	MILD STEEL, EPOXY COATED, STRAIGHT DISTANCE PIECE, BOTH ENDS FLANGED (PN16)/ (LENGTH ±650mm)
A17	2	400ø	MILD STEEL, EPOXY COATED, BOTH ENDS FLANGED ANCHOR PIPE WITH PUDDLE FLANGE (PN16)/ (LENGTH ±1500mm)
A20	1	80ø	MILD STEEL, EPOXY COATED, BOTH ENDS FLANGED RAISER PIECE, ONE END WITH 400mm Ø FLANGE, OTHER END WITH MALE THREADS TO SUIT 80mm Ø FEMALE THREADED GATE VALVE. (PN16)/ (LENGTH ±250mm)
A21	1	80ø	MILD STEEL, EPOXY COATED, STRAIGHT PIPE DISTANCE PIECE, ONE END WITH MALE THREADS TO SUITE 80mm Ø FEMALE THREADED GATE VALVE, OTHER END TO SUIT 80mm AIR VALVE (PN16)/ (LENGTH ±100mm)

VALVES

ITEM NUMBER	NO.	SIZE	DESCRIPTION
AV01	1	80ø	VENT-O-MAT 3 STAGE, RBX AIR VALVE TO SUITE 80mm FEMALE THREADED GATE VALVE (PN16)
V01	2	400ø-400ø	FLANGED KNIVE GATE VALVE "AVK (PN10)
V02	3	400ø-400ø	AVK NOZZLE TYPE NON RETURN VALVE (PN16)
V03	2	400ø-400ø	AVK SERIES 02/20 RESILIENT SEATED FLANGED GATE VALVE (PN16)
V04	2	400ø-400ø	AVK METAL SEATED FLANGED GATE VALVE (PN16)
V05	1	80ø-80ø	THREADED GATE VALVE TO SUITE A20 & A21 (PN16)
WM01	1	400ø-400ø	KROHNE WATERFLUX 3100 ELECTROMAGNETIC FLOW METER (PN16)

CONCRETE COVER

UNLESS NOTED OTHERWISE ON DRAWINGS OR BENDING SCHEDULES THE CONCRETE COVER TO REINFORCEMENT TO BE AS FOLLOWS:

ELEMENT	BOTTOM	TOP	SIDE
DESCRIPTION	mm	mm	mm
FOUNDATIONS	75	50	50
COLUMNS	-	40	40
SLABS, BEAMS, WALLS	40	40	40
FOUNDATION SLABS	50	50	50

NOTE:

CONCRETE COVERS ARE THE MINIMUM DISTANCE TO ANY REINFORCING STEEL. INCLUDING STIRRUPS AND TIES FROM NEAREST CONCRETE EDGE.
DEGREE OF ACCURACY II APPLIES TO ALL CONCRETE WORKS

NOTES:

1. KFA(R): KLAMFLEX ADAPTOR (RESTRAINED)
2. ALL DIMENSIONS TO BE CONFIRMED BY THE CONTRACTOR ON SITE.
3. ALL PIPE FITTINGS LENGTH'S AND SPECIALS TO BE CONFIRMED BY THE CONTRACTOR ON SITE .
4. ALL SUCTION PIPEWORK FITTINGS & VALVE'S TO BE CLASS PN10 (ALL PIPEWORK BEFORE PUMPS).
5. ALL DELIVERY PIPEWORK & FITTINGS AND VALVES TO BE CLASS PN16 (ALL PIPEWORK, FITTING & VALVES AFTER PUMPS).

THIS DRAWING TO BE READ IN CONJUNCTION WITH THE GENERAL NOTES AND DETAILS DRAWINGS.

BULK EARTH WORKS TO CIVIL ENGINEERS DRAWINGS.

The Master held at Aurecon bears the signature of approval

aurecon
www.aurecongroup.com

CONTRACT NO: 3/1

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	03/06/19	ISSUED FOR TENDER	W BARNARD

SCALE: As indicated — SIZE: A0

TENDER
NOT FOR CONTRUCTION

DRAWN: D VISAGIE
DESIGNED: T MOHAPI
CHECKED: E HORN

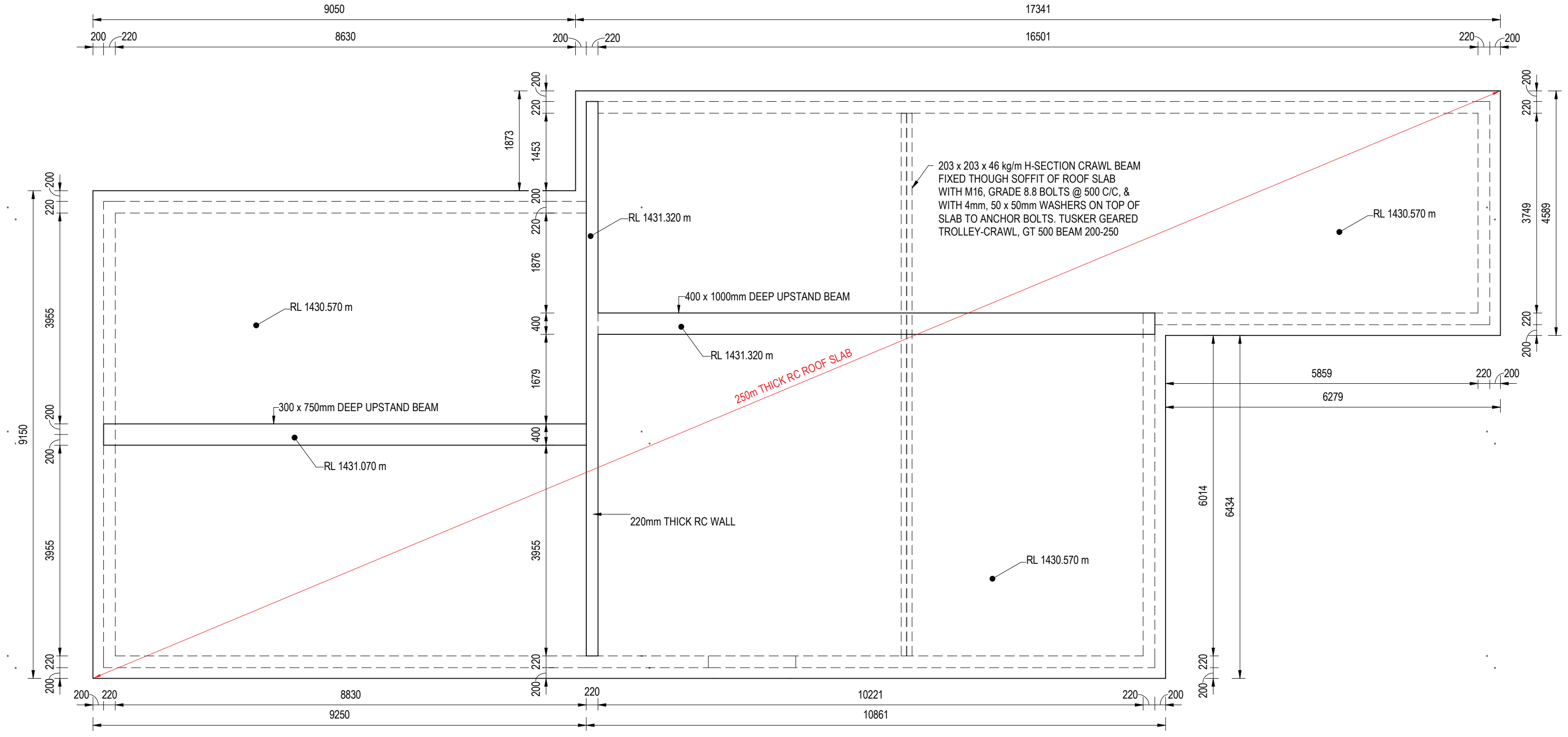
APPROVED: W BARNARD — Pr Tech Eng 200970086 — DATE

PROJECT: UPGRADING OF SENEKAL BULK WATER SUPPLY

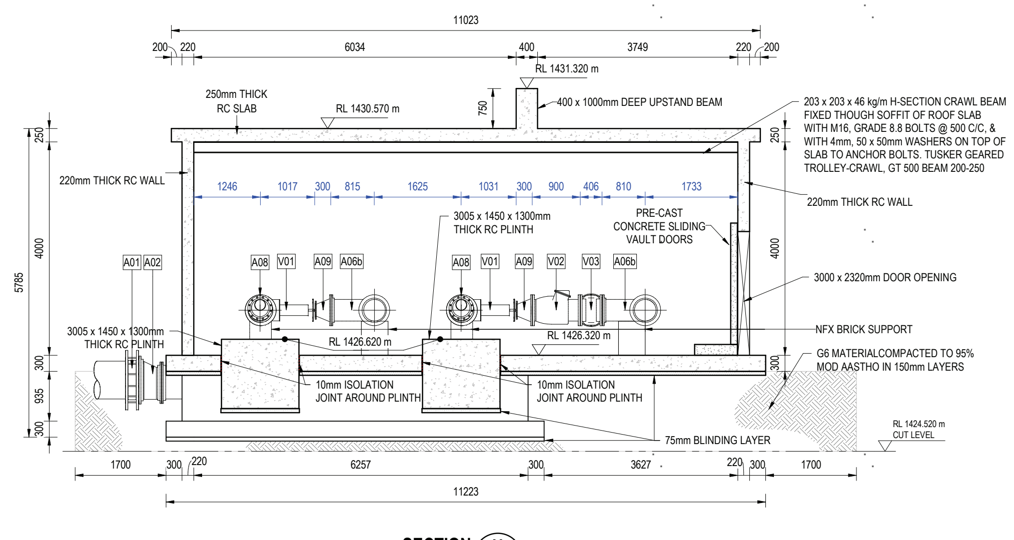
TITLE: DE PUT RAW WATER WORKS SITE AIR VALVE BOOSTER PUMP STATION-LAYOUT

DRAWING NUMBER

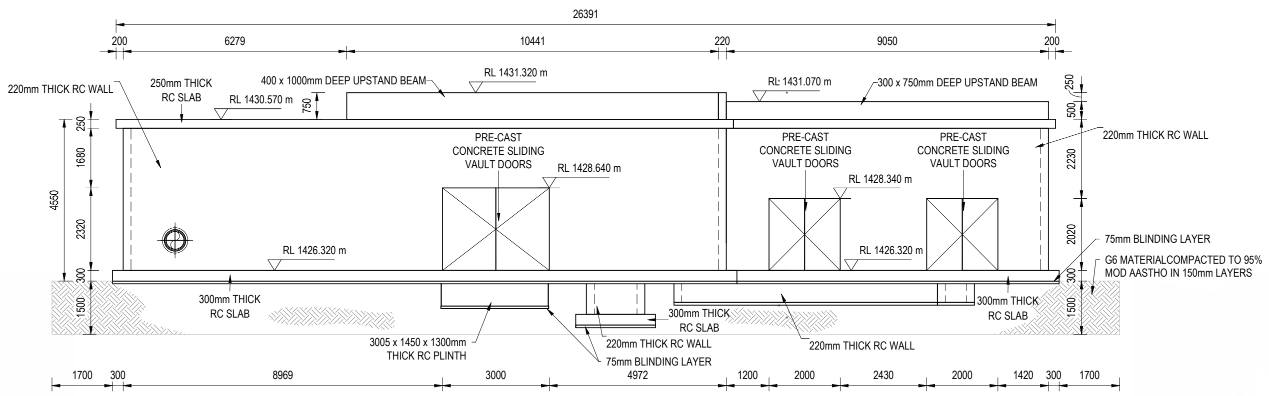
PROJECT No	WBS	TYPE	DISC - NUMBER	REV
111826	SPSS	DRG	SS-9021	T0



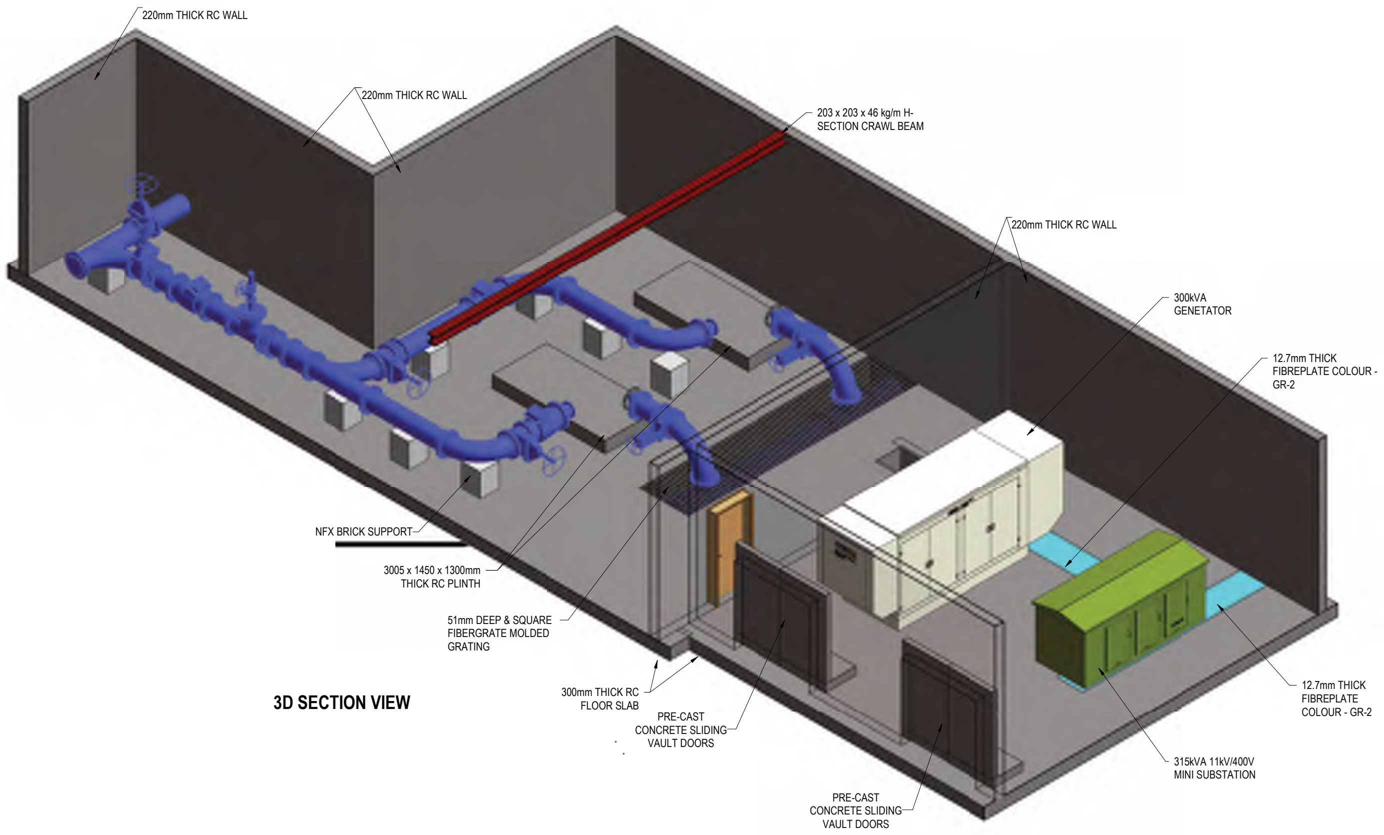
ROOF LAYOUT
1 : 50



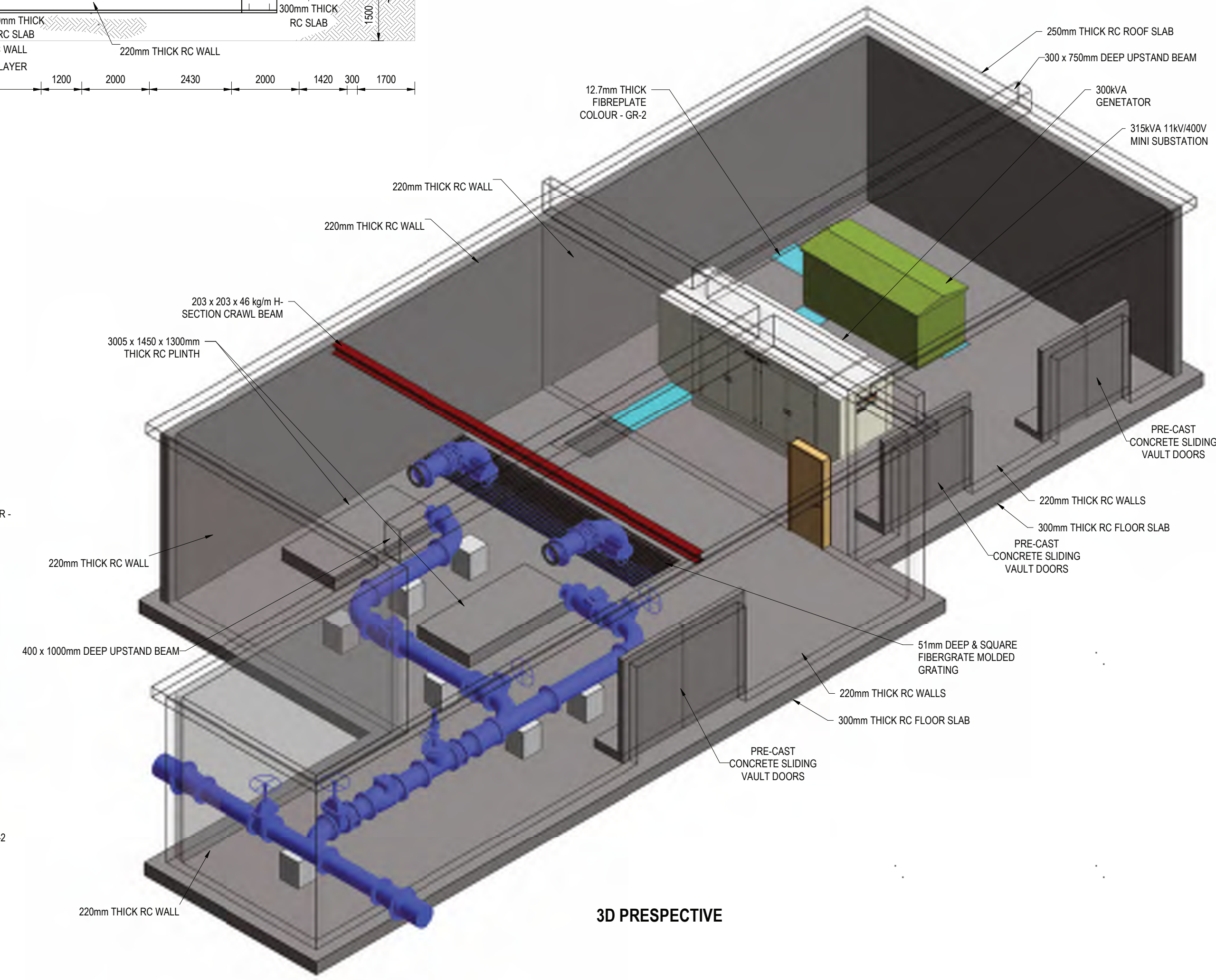
SECTION H
1 : 50



ELEVATION VIEW
1 : 75



3D SECTION VIEW



3D PRESPECTIVE

CONCRETE COVER			
UNLESS NOTED OTHERWISE ON DRAWINGS OR BENDING SCHEDULES THE CONCRETE COVER TO REINFORCEMENT TO BE AS FOLLOWS:			
ELEMENT	BOTTOM	TOP	SIDE
DESCRIPTION	mm	mm	mm
FOUNDATIONS	75	50	50
COLUMNS	-	40	40
SLABS, BEAMS, WALLS	40	40	40
FOUNDATION SLABS	50	50	50

NOTE:

CONCRETE COVERS ARE THE MINIMUM DISTANCE TO ANY REINFORCING STEEL. INCLUDING STIRRUPS AND TIES FROM NEAREST CONCRETE EDGE.
DEGREE OF ACCURACY II APPLIES TO ALL CONCRETE WORKS

NOTES:

1. KFA(R): KLAMFLEX ADAPTOR (RESTRAINED)
2. ALL DIMENSIONS TO BE CONFIRMED BY THE CONTRACTOR ON SITE.
3. ALL PIPE FITTINGS LENGTH'S AND SPECIALS TO BE CONFIRMED BY THE CONTRACTOR ON SITE .
4. ALL SUCTION PIPEWORK FITTINGS & VALVE'S TO BE CLASS PN10 (ALL PIPEWORK BEFORE PUMPS).
5. ALL DELIVERY PIPEWORK & FITTINGS AND VALVES TO BE CLASS PN16 (ALL PIPEWORK, FITTING & VALVES AFTER PUMPS).

THIS DRAWING TO BE READ IN CONJUNCTION WITH THE GENERAL NOTES AND DETAILS DRAWINGS.

BULK EARTH WORKS TO CIVIL ENGINEERS DRAWINGS.

The Master held at Aurecon bears the signature of approval

aurecon
www.aurecongroup.com

CONTRACT NO: 3/1

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	03/06/19	ISSUED FOR TENDER	W BARNARD

SCALE	SIZE
As indicated	A0

TENDER
NOT FOR CONTRUCTION

DRAWN: D VISAGIE
DESIGNED: T MOHAPI
CHECKED: E HORN

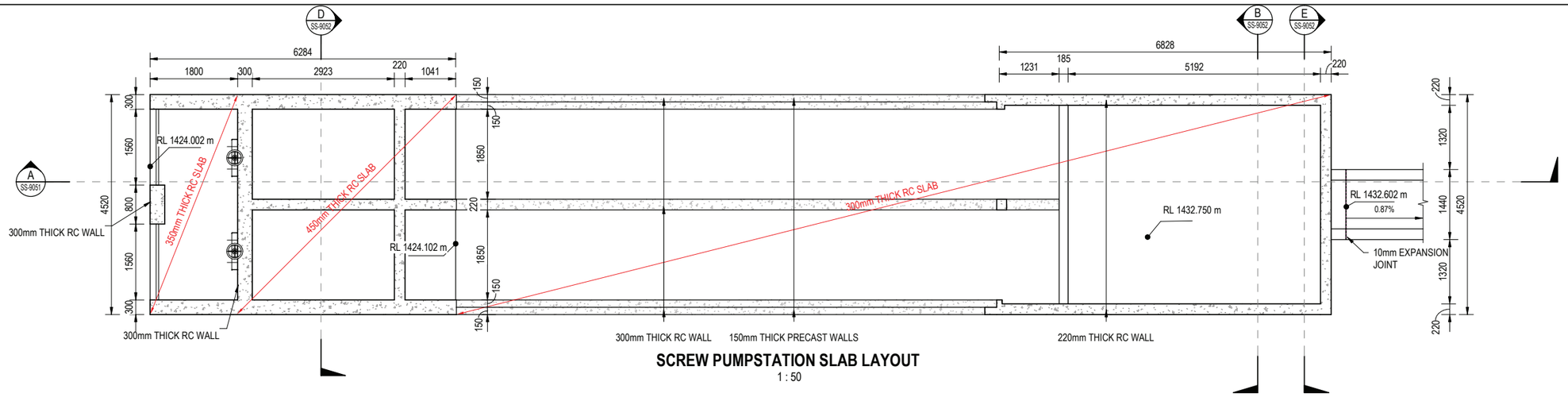
APPROVED: W BARNARD — DATE — Pr Tech Eng 200970086

PROJECT
UPGRADING OF SENEKAL BULK WATER SUPPLY

TITLE
DE PUT RAW WATER WORKS SITE AIR VALVE BOOSTER PUMP STATION-ROOF LAYOUT, SECTIONS & DETAILS

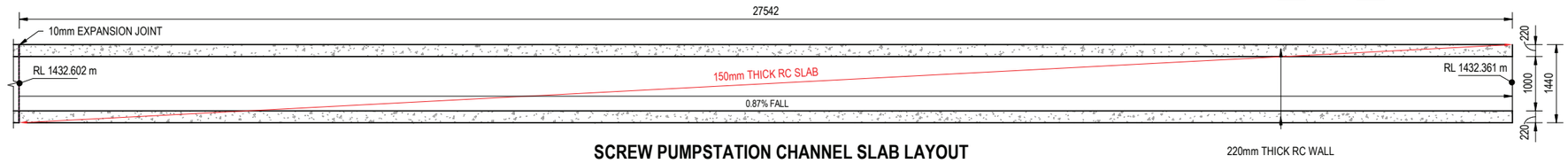
DRAWING NUMBER

PROJECT No	WBS	TYPE	DISC - NUMBER	REV
111826	SPSS	DRG	SS-9022	T0



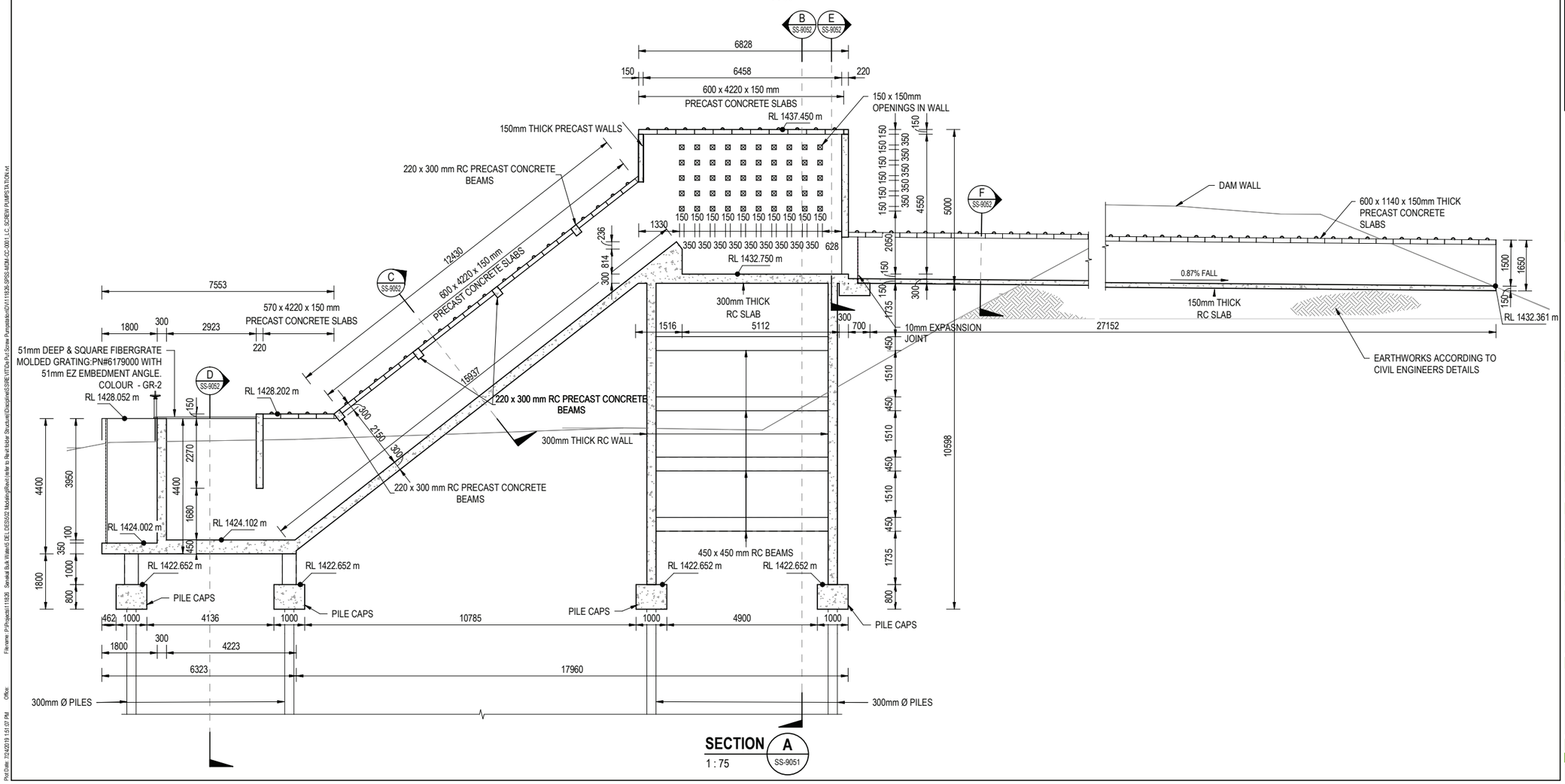
SCREW PUMPSTATION SLAB LAYOUT

1 : 50



SCREW PUMPSTATION CHANNEL SLAB LAYOUT

1 : 50



SECTION A

1 : 75

SS-9051

CONCRETE COVER			
UNLESS NOTED OTHERWISE ON DRAWINGS OR BENDING SCHEDULES THE CONCRETE COVER TO REINFORCEMENT TO BE AS FOLLOWS:			
ELEMENT	BOTTOM	TOP	SIDE
DESCRIPTION	mm	mm	mm
FOUNDATIONS	75	50	50
COLUMNS	-	40	40
SLABS, BEAMS, WALLS	40	40	40
FOUNDATION SLABS	50	50	50

NOTE:

CONCRETE COVERS ARE THE MINIMUM DISTANCE TO ANY REINFORCING STEEL. INCLUDING STIRRUPS AND TIES FROM NEAREST CONCRETE EDGE.
DEGREE OF ACCURACY I APPLIES TO ALL CONCRETE WORKS

NOTE:

THIS DRAWING TO BE READ IN CONJUNCTION WITH THE GENERAL NOTES, DETAILS DRAWINGS AND CIVIL DRW No. 111826-SPSS-DRG-CC-7004.

BULK EARTH WORKS TO CIVIL ENGINEERS DRAWINGS.

The Master held at Aurecon bears the signature of approval

aurecon

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CONTRACT NO: 3/1

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	22/07/19	ISSUED FOR TENDER	S PRETORIUS

SCALE	SIZE
As indicated	A1

TENDER
NOT FOR CONSTRUCTION

DRAWN: D VISAGIE

DESIGNED: J FOUCHÉ

CHECKED: J GREEFF

APPROVED: S PRETORIUS — DATE — Pr Tech Eng 201470298

PROJECT

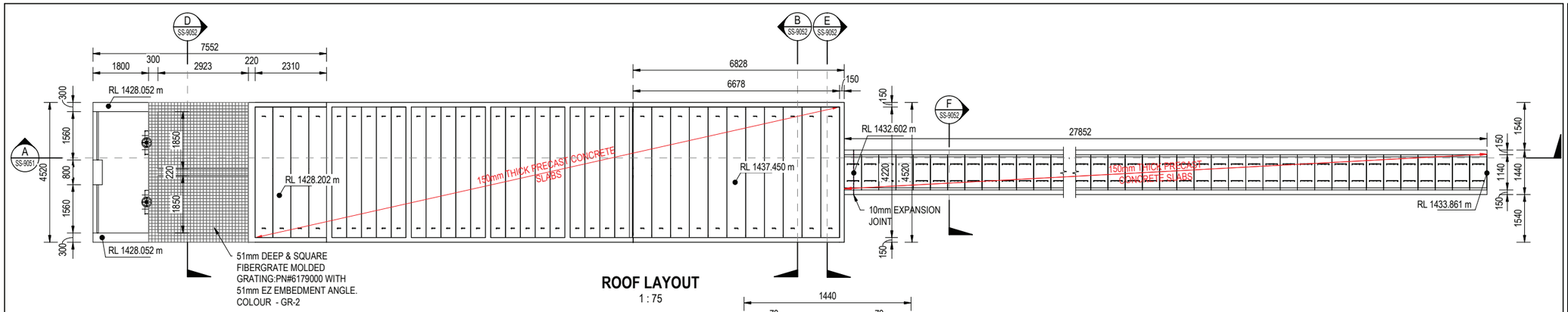
UPGRADING OF SENEKAL BULK WATER SUPPLY

TITLE

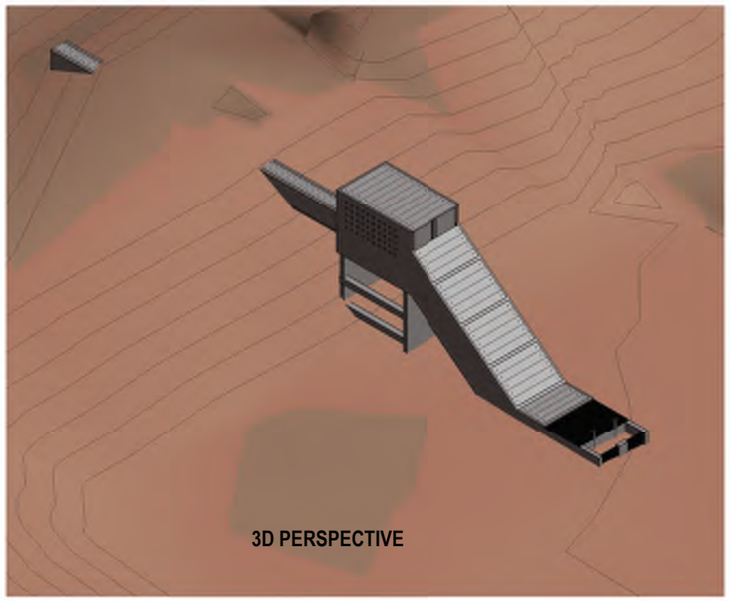
DE PUT RAW WATER
SCREW PUMPSTATION LAYOUT
AND SECTION

DRAWING NUMBER

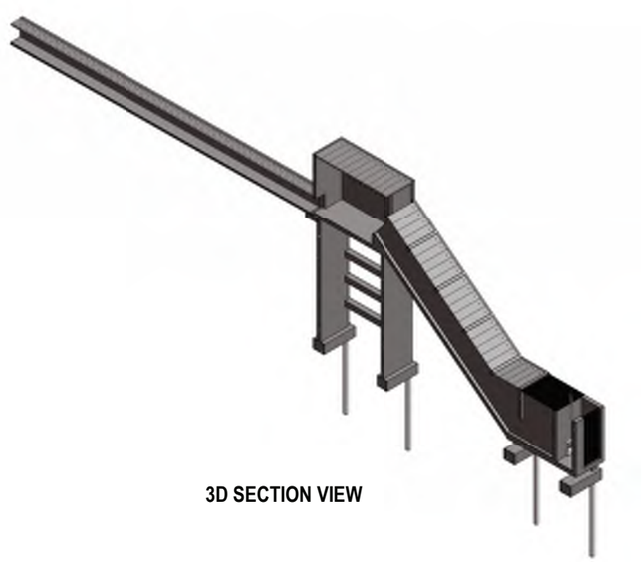
PROJECT No	WBS	TYPE	DISC - NUMBER	REV
111826	SPSS	DRG	SS-9051	T0



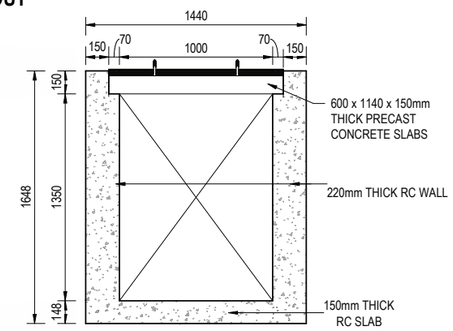
ROOF LAYOUT
1 : 75



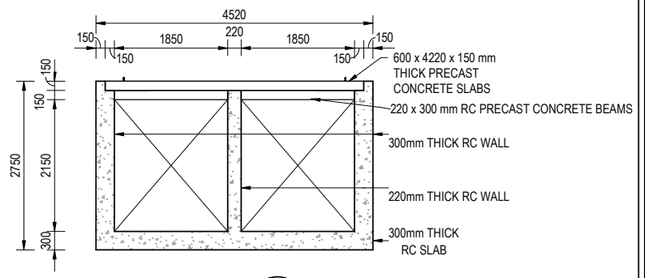
3D PERSPECTIVE



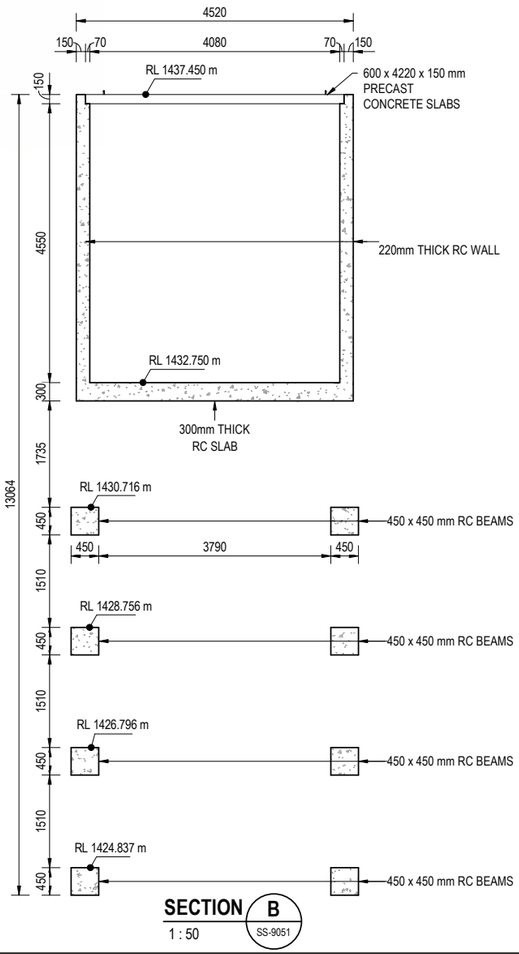
3D SECTION VIEW



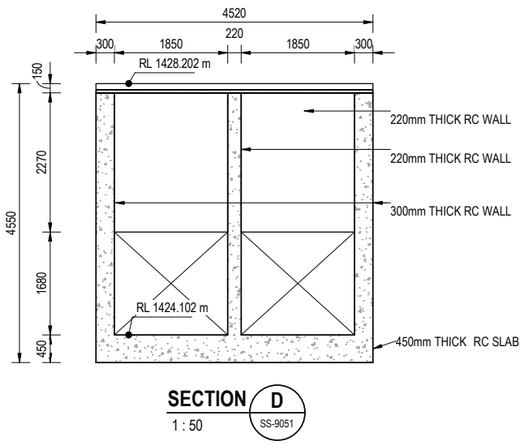
SECTION F
1 : 20 — SS-9051



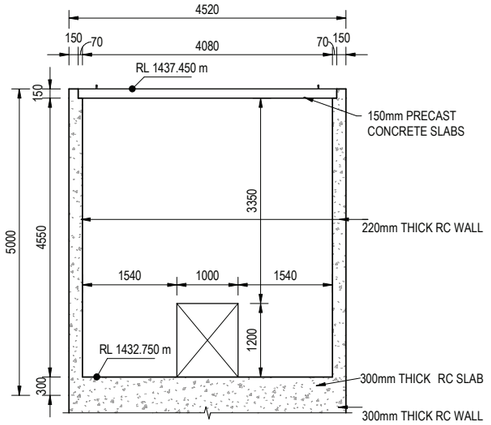
SECTION C
1 : 50 — SS-9051



SECTION B
1 : 50 — SS-9051



SECTION D
1 : 50 — SS-9051



SECTION E
1 : 50 — SS-9051

CONCRETE COVER			
UNLESS NOTED OTHERWISE ON DRAWINGS OR BENDING SCHEDULES THE CONCRETE COVER TO REINFORCEMENT TO BE AS FOLLOWS:			
ELEMENT	BOTTOM	TOP	SIDE
DESCRIPTION	mm	mm	mm
FOUNDATIONS	75	50	50
COLUMNS	-	40	40
SLABS, BEAMS, WALLS	40	40	40
FOUNDATION SLABS	50	50	50

NOTE:

CONCRETE COVERS ARE THE MINIMUM DISTANCE TO ANY REINFORCING STEEL. INCLUDING STIRRUPS AND TIES FROM NEAREST CONCRETE EDGE.
DEGREE OF ACCURACY I APPLIES TO ALL CONCRETE WORKS

NOTE:

THIS DRAWING TO BE READ IN CONJUNCTION WITH THE GENERAL NOTES, DETAILS DRAWINGS AND CIVIL DRW No. 111826-SPSS-DRG-CC-7004.

BULK EARTH WORKS TO CIVIL ENGINEERS DRAWINGS.

The Master held at Aurecon bears the signature of approval

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CONTRACT NO: 3/1

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	22/07/19	ISSUED FOR TENDER	S PRETORIUS

SCALE	SIZE
As indicated	A1

TENDER
NOT FOR CONSTRUCTION

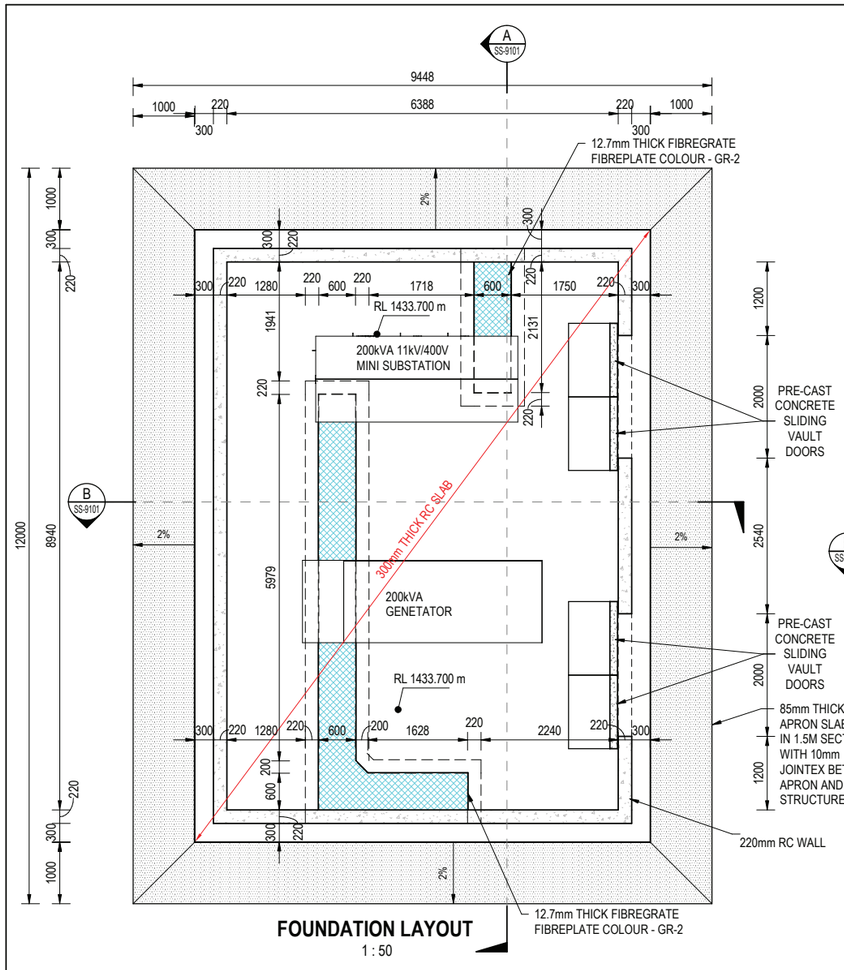
DRAWN: D VISAGIE
DESIGNED: J FOUCHÉ
CHECKED: J GREEFF
APPROVED: DATE
S PRETORIUS — Pr Tech Eng 201470298

PROJECT
UPGRADING OF SENEKAL BULK WATER SUPPLY

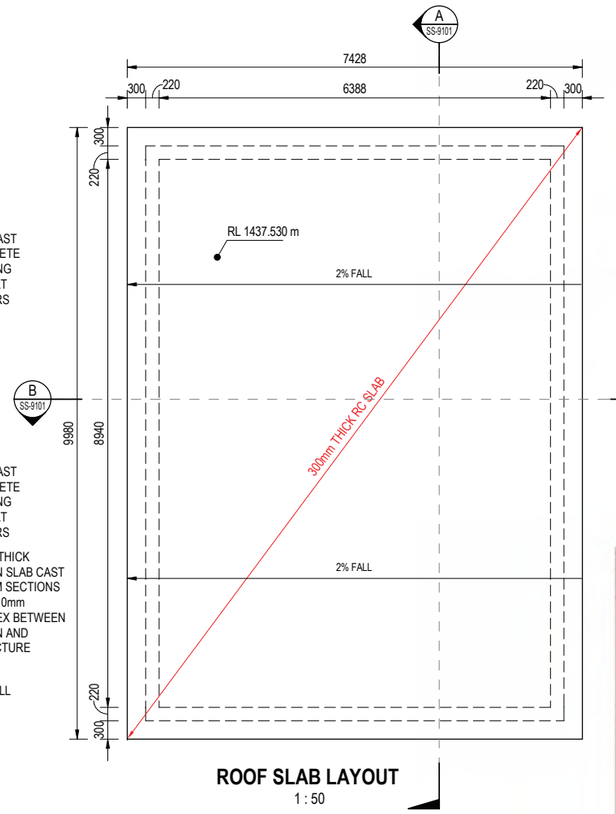
TITLE
DE PUT RAW WATER SCREW PUMPSTATION
ROOF LAYOUT, SECTIONS AND DETAILS

DRAWING NUMBER

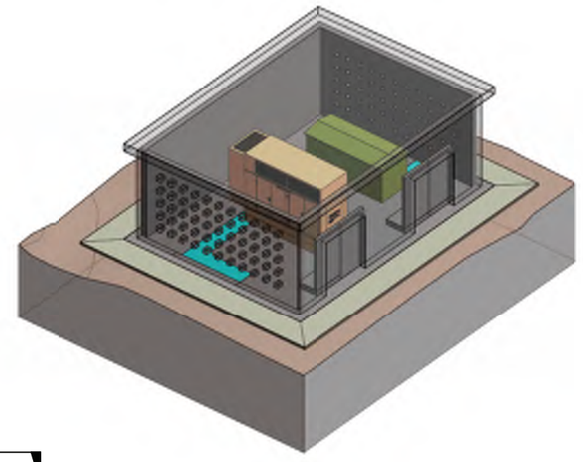
PROJECT No	WBS	TYPE	DISC - NUMBER	REV
111826	SPSS	DRG	SS-9052	T0



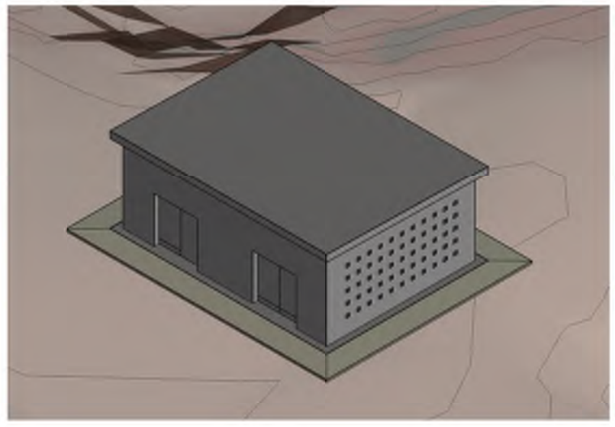
FOUNDATION LAYOUT
1 : 50



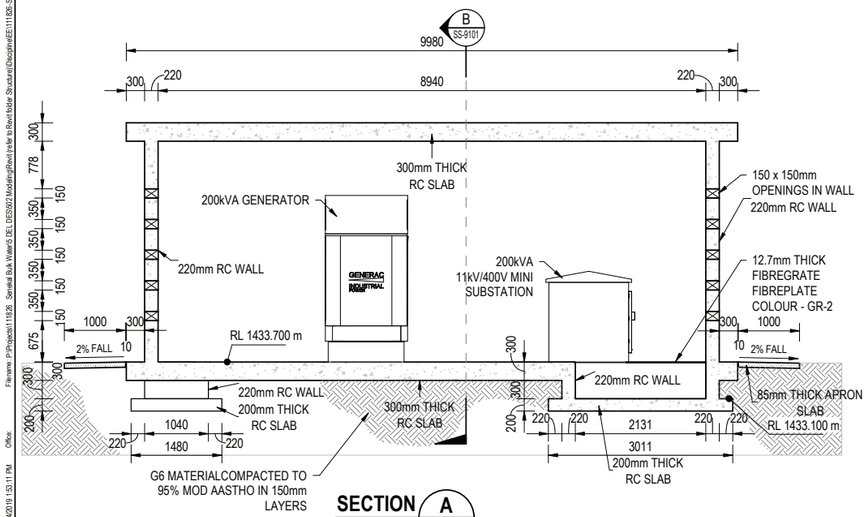
ROOF SLAB LAYOUT
1 : 50



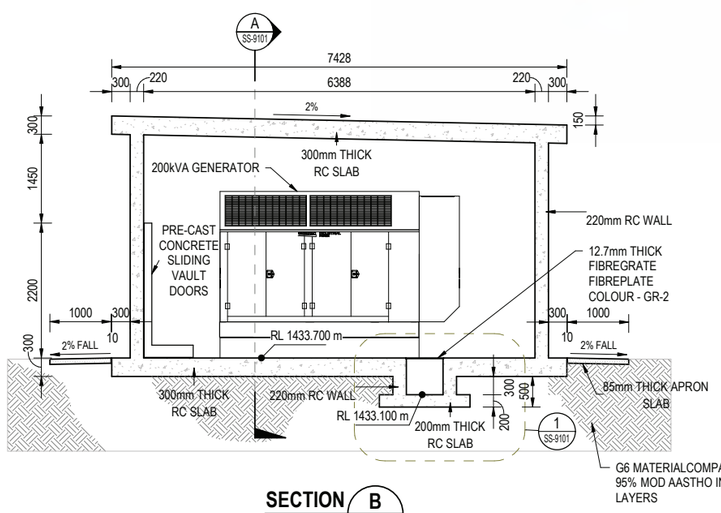
3D PERSPECTIVE 1



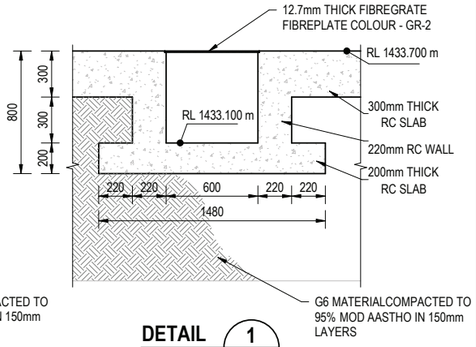
3D PERSPECTIVE 2



SECTION A
1 : 50 — SS-9101



SECTION B
1 : 50 — SS-9101



DETAIL 1
1 : 20 — SS-9101

CONCRETE COVER			
UNLESS NOTED OTHERWISE ON DRAWINGS OR BENDING SCHEDULES THE CONCRETE COVER TO REINFORCEMENT TO BE AS FOLLOWS:			
ELEMENT	BOTTOM	TOP	SIDE
DESCRIPTION	mm	mm	mm
FOUNDATIONS	75	50	50
COLUMNS	-	40	40
SLABS, BEAMS, WALLS	40	40	40
FOUNDATION SLABS	50	50	50

NOTE:

CONCRETE COVERS ARE THE MINIMUM DISTANCE TO ANY REINFORCING STEEL. INCLUDING STIRRUPS AND TIES FROM NEAREST CONCRETE EDGE.
DEGREE OF ACCURACY II APPLIES TO ALL CONCRETE WORKS

NOTE:

THIS DRAWING TO BE READ IN CONJUNCTION WITH THE GENERAL NOTES AND DETAILS DRAWINGS.

BULK EARTH WORKS TO CIVIL ENGINEERS DRAWINGS.

The Master held at Aurecon bears the signature of approval

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CONTRACT NO: 3/1

CLIENT

Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	22/07/19	ISSUED FOR TENDER	S PRETORIUS

SCALE	SIZE
As indicated	A1

TENDER
NOT FOR CONSTRUCTION

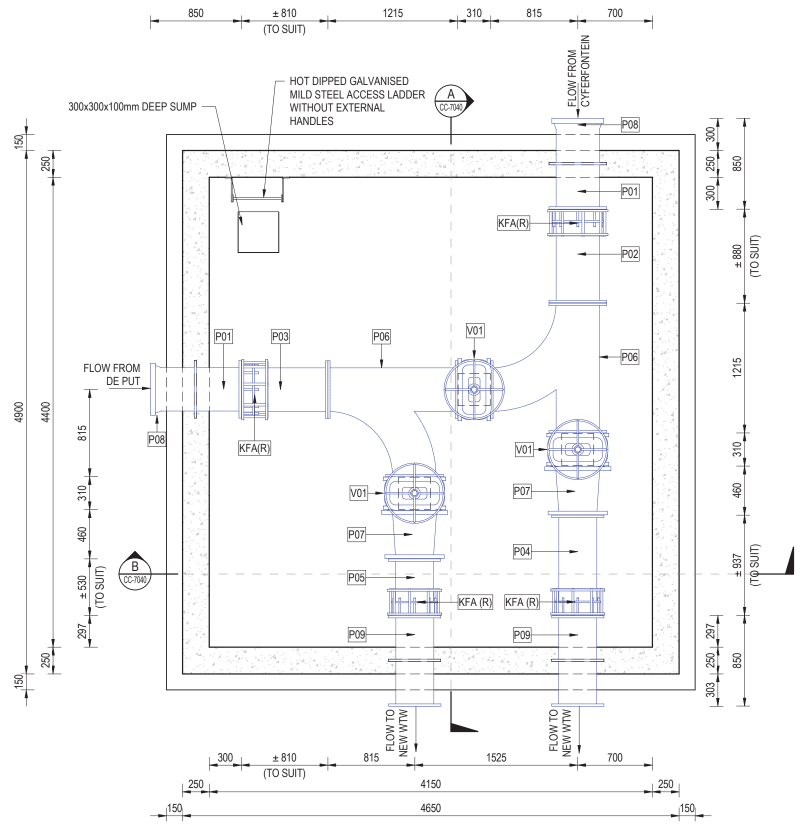
DRAWN: D VISAGIE
DESIGNED: J FOUCÉ
CHECKED: J GREEFF
APPROVED: S PRETORIUS — DATE — Pr Tech Eng 201470298

PROJECT
UPGRADING OF SENEKAL BULK WATER SUPPLY

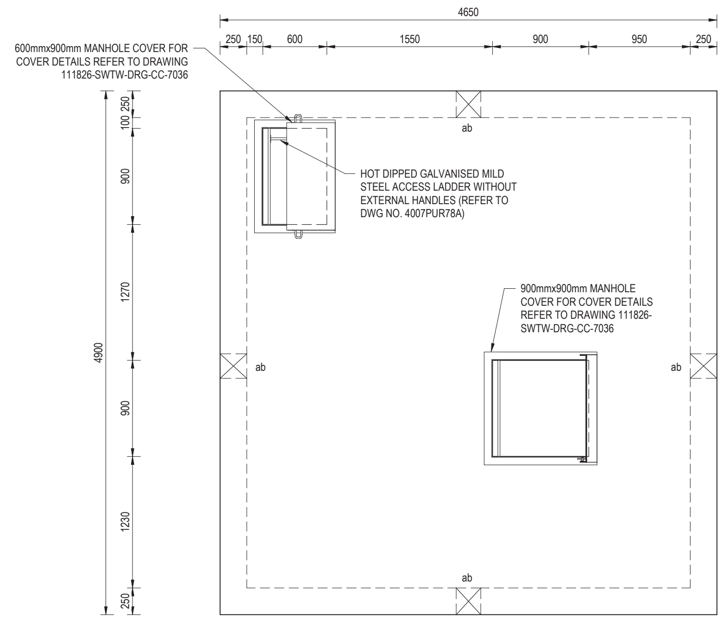
TITLE
DE PUT RAW WATER
SUB STATION LAYOUT, SECTIONS AND DETAIL

DRAWING NUMBER

PROJECT No	WBS	TYPE	DISC - NUMBER	REV
111826	SPSS	DRG	SS-9101	T0



FOUNDATION LAYOUT
1 : 25



ROOF LAYOUT
1 : 25

PIPE SCHEDULE

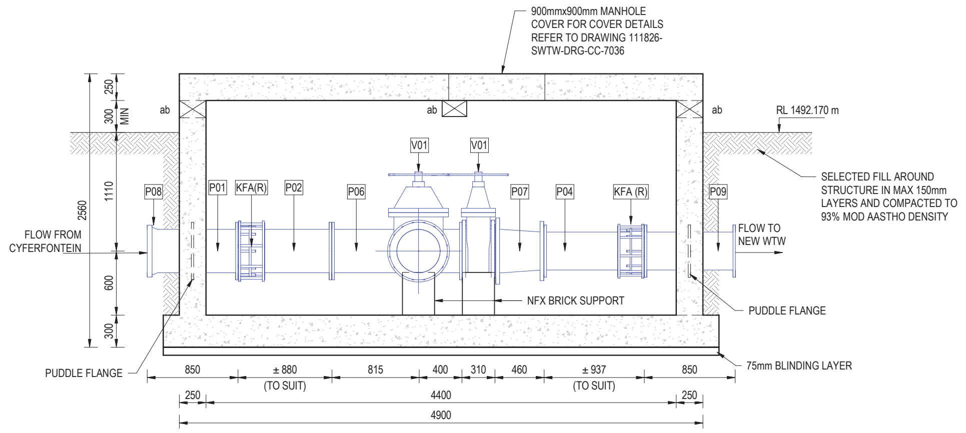
ITEM NUMBER	NO.	SIZE	DESCRIPTION
P01	2	400ø	DN 400 mm DIA. x 6 mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED PIPE DISTANCE PIECE FLANGED ON BOTH ENDS, WITH PUDDLE FLANGE WELDED TO THE PIPE AND POSITIONED IN THE CENTER OF THE CONCRETE WALL. DRILLED ACCORDING TO SANS 1123 TABLE 1600/3./ (LENGTH ±850mm)
P02	1	400ø	DN 400 mm DIA. x 6 mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED PIPE DISTANCE PIECE FLANGED ON ONE END OTHER END PLAIN ENDED WITH RESTRAINING FLANGE TO SUIT K.F.A (R). DRILLED ACCORDING TO SANS 1123 TABLE 1600/3./ (LENGTH ±880mm)
P03	1	400ø	DN 400 mm DIA. x 6 mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED PIPE DISTANCE PIECE FLANGED ON ONE END OTHER END PLAIN ENDED WITH RESTRAINING FLANGE TO SUIT K.F.A (R). DRILLED ACCORDING TO SANS 1123 TABLE 1600/3./ (LENGTH ±810mm)
P04	1	350ø	DN 350 mm DIA. x 6 mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED PIPE DISTANCE PIECE FLANGED ON ONE END OTHER END PLAIN ENDED WITH RESTRAINING FLANGE TO SUIT K.F.A (R). DRILLED ACCORDING TO SANS 1123 TABLE 1600/3./ (LENGTH ±937mm)
P05	1	350ø	DN 350 mm DIA. x 6 mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED PIPE DISTANCE PIECE FLANGED ON ONE END OTHER END PLAIN ENDED WITH RESTRAINING FLANGE TO SUIT K.F.A (R). DRILLED ACCORDING TO SANS 1123 TABLE 1600/3./ (LENGTH ±530mm)
P09	2	350ø	DN 350 mm DIA. x 6 mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED PIPE DISTANCE PIECE FLANGED ON BOTH ENDS, WITH PUDDLE FLANGE WELDED TO THE PIPE AND POSITIONED IN THE CENTER OF THE CONCRETE WALL. DRILLED ACCORDING TO SANS 1123 TABLE 1600/3./ (LENGTH ±850mm)

PIPE FITTINGS

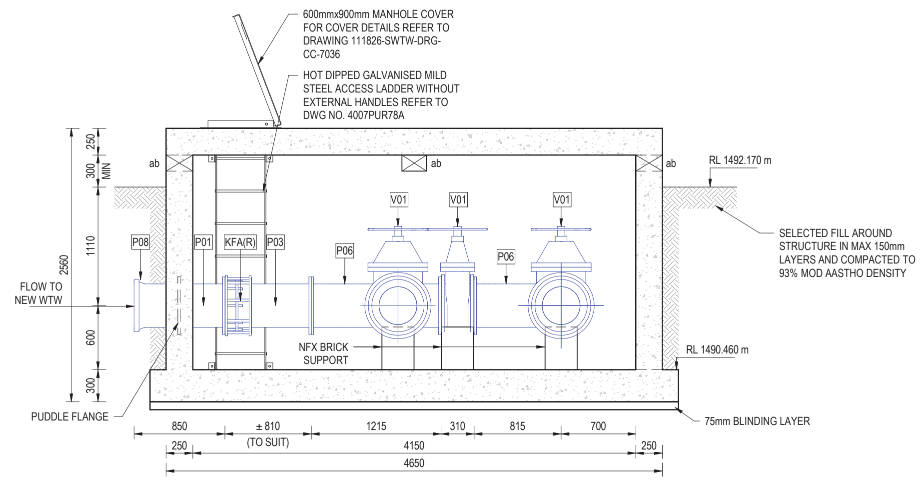
ITEM NUMBER	NO.	SIZE	DESCRIPTION
KFA (R)	2	350ø-350ø	DN 350mm KLAMFLEX FLANGE ADAPTOR (RESTRAINED)
KFA(R)	2	400ø-400ø	DN 400mm KLAMFLEX FLANGE ADAPTOR (RESTRAINED)
P06	2	400ø-400ø	DN 400 mm DIA. x 90°x 6 mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED, FLANGED MEDIUM RADIUS SWEEP TEE. DRILLED ACCORDING TO SANS 1123 TABLE 1600/3. (MAIN BRANCH LENGTH = ± 1215mm) (BRANCH LENGTH = ± 815mm)
P07	2	400ø-350ø	DN 400 mm DIA. to DN 350 mm dia. x 6mm, PN 16, SANS 719 GRADE C MILD STEEL, EPOXY/COUPON COATED CONCENTRIC REDUCER, FLANGED BOTH ENDS. TO SUITE. DRILLED ACCORDING TO SANS 1123 TABLE 1600/3. (LENGHT= ± 460mm)
P08	2	400ø-400ø	DN 400 mm, PN 16, MILD STEEL TO PVC-O LONG BARREL FLANGED ADAPTOR. DRILLED ACCORDING TO SANS 1123 TABLE 1600/3.

VALVES

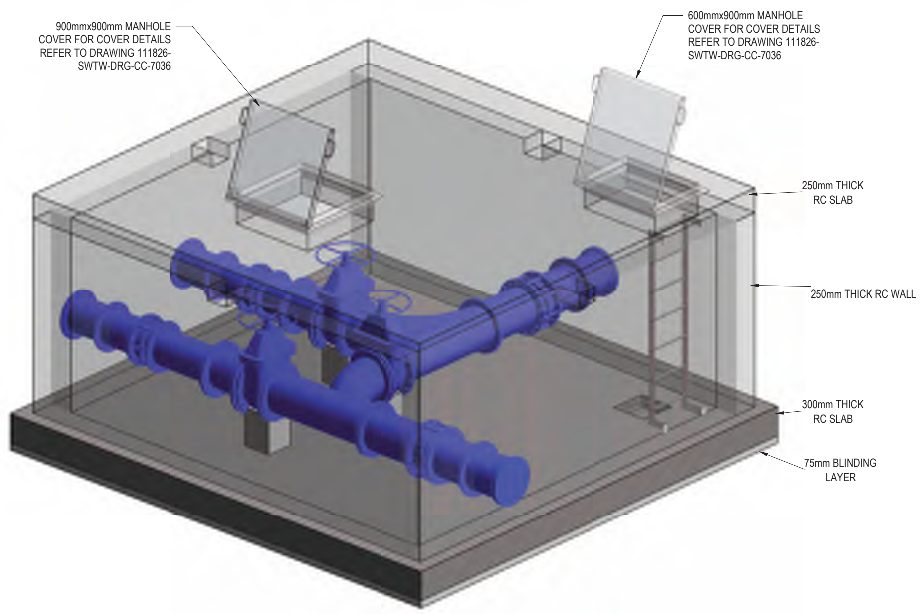
ITEM NUMBER	NO.	SIZE	DESCRIPTION
V01	3	400ø-400ø	DN 400mm FLANGED METAL SEATED GATE VALVE WITH HANDWHEEL. "AVK SERIES 06/30 OR SIMILAR APPROVED." (LENGTH = 310mm F/F)



SECTION A
1 : 25



SECTION B
1 : 25



3D VIEW

NOTES:

1. ALL CONCRETE EDGES ABOVE GROUND LEVEL TO BE FINISHED WITH 20mm CHAMFERS .
2. "ab" = AIR BRICK (230mm x 150mm HIGH)
3. ALL STEEL PIPES TO BE SANS 719 GRADE C, 6mm THICKNESS AND MILD STEEL EPOXY COATED.
4. ALL FLANGED DRILLED ACCORDING TO SANS 1123: TABLE 1600/3

NOTE:
THIS DRAWING TO BE READ IN CONJUNCTION WITH THE GENERAL NOTES AND DETAILS DRAWING.

The Master held at Aurecon bears the signature of approval

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CLIENT
Setsoto Local Municipality

REV	DATE	REVISION DETAILS	APPROVED
T0	27/03/20	ISSUED FOR TENDER	W BARNARD

SCALE: As indicated | SIZE: A0
TENDER
NOT FOR CONTRUCTION
DRAWN: D VISAGIE
DESIGNED: E HORN
CHECKED: E HORN
APPROVED: W BARNARD | DATE | Pr Tech Eng 200970086

PROJECT
UPGRADING OF BULK WATER SUPPLY SENEKAL

TITLE
BI-DIRECTIONAL CHAMBER SECTION AND DETAILS WTW & DE PUT

DRAWING NUMBER
PROJECT No: 111826 - WBS: SWTW - TYPE: DRG - DISC - NUMBER: CC-7040 - REV: T0

Appendix D

Reinforced Concrete Pump Station and Vault Doors

Fortress Pump Stations


Fig 1

The Platform Door is manufactured and installed by Concrete Doors and Vaults (Pty) Ltd. Please direct enquiries to Dr Nicholas Papenfus at nicholas@damsforafrica.com, or 011 472 1520/8, or 082 416 8958.

A variety of other concrete products such as vaults and lockable lids also offer extreme protection to for example valve chambers, sub-stations, borehole installations, stand alone control panels, etc. These products may be viewed at www.concretedoorsandvaults.com.


Fig 2


Fig 3

Pump stations are increasingly being built like fortresses (see figs 1 to 4), complete with thick reinforced concrete walls and roofs, and with small ventilation holes in the walls instead of steel louvres (which are vulnerable to attack by angle grinders and oxy-acetylene torches). Consistent with these measures heavy sliding concrete doors (*SA Patent 2008/06587*) are now being specified, made from 60MPa concrete, and with extremely robust locking mechanisms. The concrete is completely immune to attack by oxy-acetylene torch, and the steel reinforcing in the doors is too dense (see fig 5) for chisels to penetrate. The pump station in fig1 was built in 2012 after vandals had stripped the previous structure twice at a cost of several R100 000s. The new structure remains secure to this day.


Fig 4

Such 'fortress' pump houses do not require perimeter fencing. Nor do they require 24 hr security which saves the client at least R15 000 per month – and clearly this accumulates to a very substantial saving over the life of the pump station. Depending on the size of the doorway, the additional expense of installing a sliding concrete door will typically be paid by the first three to four months of not having to pay for security guards. Thereafter the owner, such as for example a municipality, will be able to use the monthly R15000 saving more productively to fund water infrastructure, roads, etc. – and in the process create meaningful jobs and skills. Guards are in any case not always effective - fig 6 shows two security guards at a construction site in Mogale City that were found in the morning tied up in an excavator bucket – meanwhile the thieves had made off with R400 000 of equipment.


Fig 5

Fig 7 to 10 are views inside two typical pump stations equipped with sliding concrete doors. The cost of replacing such mechanical and electrical equipment in the event that it is vandalised is several times the cost of the door! It therefore does not pay to economise by using a cheap door that is easily cut up with an angle grinder or oxy-acetylene torch – and then sold for scrap!

Finally a pump house that is stripped clean will take several months to recommission. In the interim water must be brought to the community by tankers at great expense! To conclude: If vandalism is a concern, then 'fortress' pump stations equipped with sliding concrete doors are a wise investment.


Fig 6

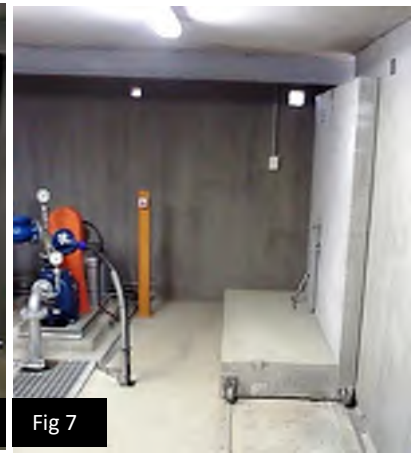


Fig 7


Fig 8


Fig 9


Fig 10

Appendix E

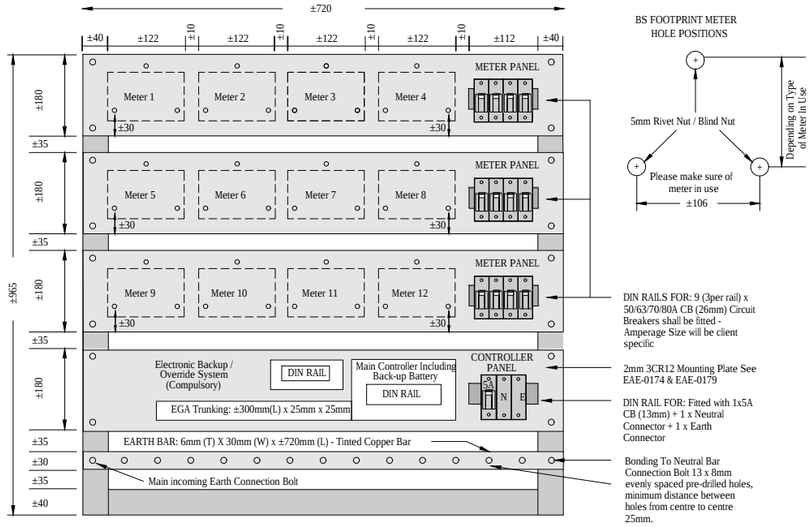
Proposed Anti-Theft Kiosk Photo's and Typical Detail Drawing

PROPOSED ELECTRICAL KIOSK/MCC:

Photo 1: Vandal/Theft Proof Kiosk/MCC

Photo 2: Vandal/Theft Proof Kiosk/MCC

NOTE: Bus-bar must be per hole supplied / fitted with a M8 x 30mm (L) Stainless Steel Bolt with 2x spring washers, 2x normal flat washers & 1x nut (See EAE-0183)



DIN RAILS FOR: 9 (3per rail) x 50/63/70/80A CB (26mm) Circuit Breakers shall be fitted - Amperage Size will be client specific

2mm 3CR12 Mounting Plate See EAE-0174 & EAE-0179

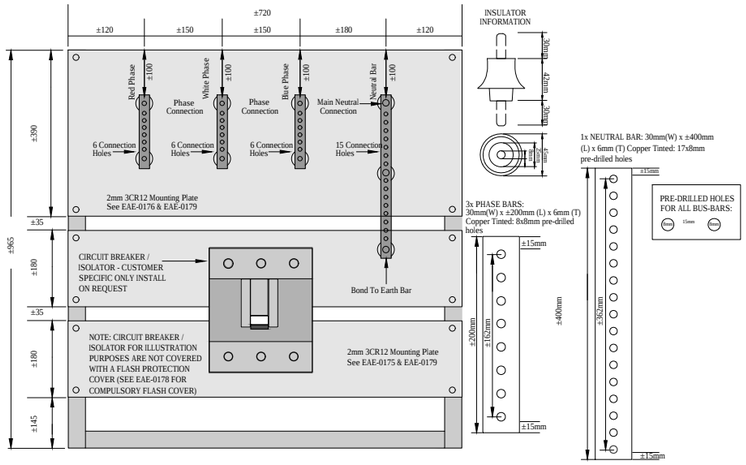
DIN RAIL FOR: Fitted with 1x5A CB (13mm) + 1 x Neutral Connector + 1 x Earth Connector

Bonding To Neutral Bar Connection Bolt 13 x 8mm evenly spaced pre-drilled holes, minimum distance between holes from centre to centre 25mm.

12 WAY GROUND MOUNTED BS FOOTPRINT METER ENCLOSURE: METER SIDE LAYOUT

N.T.S

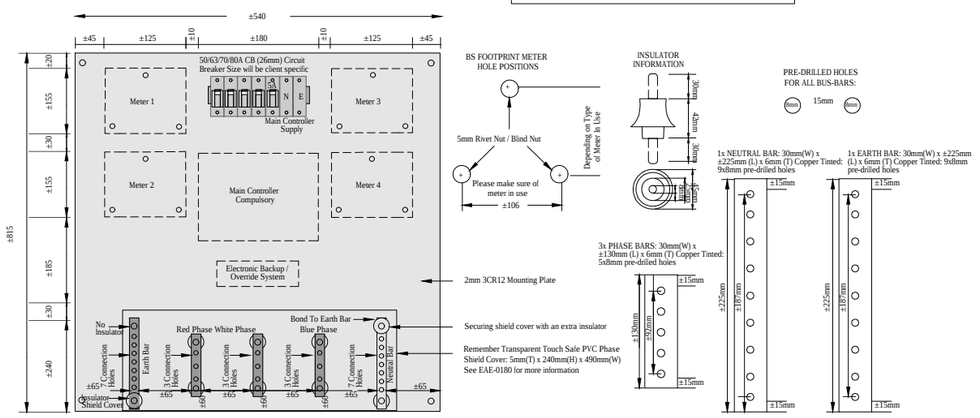
NOTE: All bus-bars must be per hole supplied/fitted with a M8 x 30mm (L) Stainless Steel Bolt with 2x spring washers, 2x normal flat washers & 1x nut (See EAE-0183)

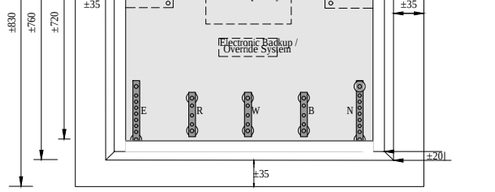


12 WAY GROUND MOUNTED BS FOOTPRINT METER ENCLOSURE: BUS-BAR / BMAIN SUPPLY SIDE EQUIPMENT LAYOUT

N.T.S

NOTE: The bus-bars must be per hole supplied/fitted with a M8 x 30mm (L) Stainless Steel Bolt with 2x spring washers, 2x normal flat washers & 1x nut (See EAE-0183)



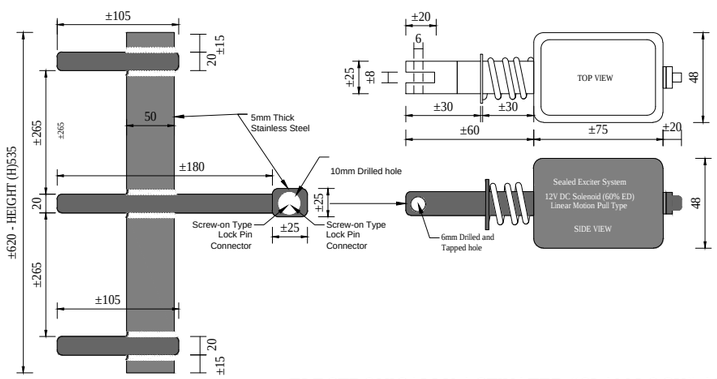


REMOTE CONTROLLED ELECTRONICALLY ACTIVATED SINGLE POLE MOUNTED METER ENCLOSURES: TYPE “A” (4-WAY BS FOOTPRINT) ACCESS OPENING - DOOR REMOVED

N.T.S

REMOTE CONTROLLED ELECTRONICALLY ACTIVATED SINGLE POLE MOUNTED METER ENCLOSURES: TYPE “A” (4 WAY BS FOOTPRINT METER) - INTERNAL EQUIPMENT PROPOSED LAYOUT ON 2MM 3CR12 MOUNTING PLATE

N.T.S



NOTE: When Locking Pin Connector & Solenoid Connection Pins are connected there should be at least a 4mm play to allow the solenoid to pull freely for 4mm before it starts pulling the locking pin arrangement

Stroke: 15-20mm
Input Voltage: 12V DC
Coil Voltage: 12V DC B
Insulating Class: B
Frame Material: Robust Metal
Frame Type: Closed Frame
Actuator Plunger: Quality Magnetic Steel, (Nickel Plated)
On-Time (Duty Cycle): 60% ED
Product Life-Time: At least $10^{\wedge}7$ Circuits Product Guarantee: 3 Years+

NOTE:
Pin cut at 45° (Striking Side)

The front tip of the lock pins shall be neatly and precisely grind / cut-off at a 45° angle to ensure the “slam lock” action is smoothly achieved.

The 45° angle side is the side that should “strike” the strike plate of the enclosure and start pushing the pins back until door is fully closed, then the pins need to returned to their normal position and the non-grinding side is the side keeping the pins in a locked position

(Locking Side)

ELECTRONICALLY ACTIVATED “SLAM LOCK” ARRANGEMENT: LOCKING ARRANGEMENT + SOLENOID MECHANICAL CONNECTION + SOLENOID DIMENSIONS & DESCRIPTIONS

N.T.S

NOTES:

1. ALL INSTALLATIONS ACCORDING TO COE STANDARDS AND SPECIFICATIONS.
2. CONSTRUCTION WORK TO COMPLY WIT OHS ACT 85 AND CONSTRUCTION REGULATIONS (2014)

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CLIENT

REV	DATE	REVISION DETAILS	APPROVED
A	21/11/18	INCEPTION	CJ JOHNSON

SCALE	SIZE	
N.T.S	A1	NOT FOR CONSTRUCTION

DRAWN	APPROVED
J GREYVENSTEIN	DATE
DESIGNED	
H BADENHORST	
REVIEWED	
W KRUGER	CJ JOHNSON Pr. Eng. Tech 200570064

PROJECT

TITLE

TYPICAL PROTECTIVE STRUCTURE ARRANGEMENT (EXAMPLE)

DRAWING NUMBER

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
11826	DET	DRG	EE	0004	A

Appendix F

Memorandum: Existing WTW (South of Town)

Aurecon South Africa (Pty) Ltd
Reg No 1977/003711/07

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W aurecongroup.com

Technical Memorandum 02

To	**Werner Barnard**	From	**Tebaco Lejake & Daniel Petrie**
Copy	**Brendon Theunissen**	Reference	**111826**
Date	**19 February 2019**	Pages (including this page)	**8**
Subject	**Reinstatement of De Put WTW**		

1 Purpose of memorandum

The Setsoto Local Municipality has requested Aurecon to perform a condition assessment of the De Put Water Treatment Work (WTW) as part of the appointment for Design and Contract Administration of the Senekal Bulk Water Supply scheme. It is anticipated that the De Put WTW will be reinstated in order to provide an interim supply (<5 years) of potable water to the town of Senekal, while the proposed new Central Water Treatment Works is being designed and constructed.

The purpose of this memorandum is therefore to document the condition of the existing civil, mechanical and electrical infrastructure and to recommend appropriate actions to reinstate the De Put WTW.

2 Process summary

The existing De Put WTW sources water from the Sand Spruit (via the De Put off-channel storage dam). The water is pumped from the storage dam to the WTW which is designed for the following treatment process units:

- Coagulation / pH control
- Sedimentation
- Rapid gravity sand filtration (Moore air-lift)
- Disinfection with chlorine gas

The treatment plant comprises an integrated filter block, clear well and control/machine room building, with a separate circular reinforced concrete sedimentation tank. The process relies on the following mechanical and electrical equipment:

- Chemical storage tanks and dosing pumps
- Chemical mixing agitator (vertical shaft)
- Lime dosing hopper
- Sedimentation tank jet pump
- Backwash blower (Roots)
- High-lift pumps
- Motor control centre
- Telemetry link with De Put dam transfer pumps and Senekal command reservoir

3 Condition Assessment of WTW and recommended refurbishment

Table 1 and Table 2 provide a summary of the condition of the De Put WTW infrastructure and equipment and provide recommendations of the interventions required to enable *interim* operation (<5 years).

The condition assessment was preliminary, and relied purely on visual inspections conducted by Aurecon's process and civil engineers on the 4th February, 2019.

Colour coded markers indicate the overall condition of infrastructure/equipment according to the following levels:

	Good condition	Operational without intervention
	Fair condition	Requires servicing / maintenance
	Poor condition	Requires refurbishment / replacement
	Condition not assessed	

The condition of the works is also illustrated by the photographs presented in Figure 1 to Figure 10.

Table 1 Civil infrastructure

Civil Infrastructure		
Description	**Condition**	**Recommended action**
Inlet works and chemical dosing	Poor (exposed aggregate)	Repair concrete in mixing chamber/channel Repair brickwork
Sedimentation tank	Fair (exposed aggregate)	Cleared tank of all weeds and sand Repair minor cracks and apply protective coating (if necessary)[1] Provide safe access, handrails and kick plates
Filters	Fair (exposed aggregate, minor cracks in concrete)	Clear the filters of weeds Empty filters, repair cracks and apply protective coating (if necessary)[1] Supplement filter media Replace tiles in control weirs Provide handrails and kick plates
Chlorine contact tank	Not assessed	
Equipment room	Fair	Repaint the area and repair the floor
Chemical storage	Fair	Replace the doors and the some of the roof sheeting Empty shed of unnecessary items (lime, tanks) Paint shed
Chlorine room	Fair	Repaint walls Replace door

[1] To be confirmed by structural engineer

Civil Infrastructure		
Description	**Condition**	**Recommended action**
General building condition	Fair	Doors and locks to be replaced (with door seal/brush to prevent drafts/dust) Windows and panes to be repaired Walls and floors to be repainted Lights to be replaced throughout building (internal and external) Replace balustrade on external stairway
Toilets / ablutions	Poor (No toilets provided)	Build and plumb toilet extension to building
Security	Fair (Fence and gate in good condition)	Replace doors, burglar bars Install beams/alarms
Amenities & furniture	Poor	Replace sink / joinery in control room and allow space for kettle/microwave Provide heavy curtains Provide shelving for files/equipment Provide floor mats in Control room Provide wall-mounted (Econo-Heat) heaters in Control room

Table 2 Mechanical and electrical equipment

Mechanical and electrical equipment		
Description	**Condition**	**Recommended action**
Inlet works and chemical dosing	Fair	Remove lime dosing hopper Replace dosing pipework Service mixing agitator
Sedimentation tank	Not assessed	Service rotating arm (remove, repair, paint, replace scraper blades) Service drainage valves
Filters and backwashing equipment	Fair	Service inlet clack valves Service blower Inspect filter underdrainage and refurbish/replace (if necessary) Replace filter outlet valve control hydraulic control pipework
Chlorine equipment	Fair	Check pipework, and pressure safety valve Provide basic gas leak detector/alarm and breathing apparatus Provide chlorine gas cylinder
Jet pump	Fair	Service jet pump
Treated water pumps	Poor	Service pumps and refurbish/replace (if necessary)[2]
Chemical storage	Dosing equipment missing Tanks are good	Replace dosing pump (consider transfer pump/day tank/gravity dosing system)

[2] To be confirmed by mechanical engineer

Mechanical and electrical equipment		
Description	**Condition**	**Recommended action**
Sampling equipment	Broken	Replace sampling valves and secure against theft
Electrical Control and Instrumentation equipment	MCC good (recently upgraded) Motors fair Control consoles fair	Check MCC and service (if necessary)[3] Service/replace motors on treated water pumps Check filter control consoles and refurbish/replace (if necessary)[2] Check Telemetry links and refurbish/replace (if necessary)[2] Service/calibrate flow meters
Laboratory and sampling equipment	Fair	Calibrate all turbidity/pH/Cl_2 meters and provide calibration solutions for on-site calibration Provide rechargeable batteries with charger for portable instruments Provide distilled water, bottle brushes and wash bottles Provide shelving/drying rack for glassware Provide waste drum for laboratory wastewater Provide sample jars Provide sludge level sampler (Sludge Judge)
PPE & Signage	Poor	Provide clothing for plant operators that is suitable for site weather conditions (Overalls, warm jackets, beanies, gloves, hats/caps) Provide signage to indicate: Filter Numbers, Pipework commodities (air/raw water/treated water/chlorine)

[3] To be confirmed by electrical engineer

Figure 1 | Exposed aggregate in inlet channel

Figure 2 | Sedimentation tank

Figure 3 Filters (with exposed aggregate and weeds)

Figure 4 | Filter control weir and outlet valve (with missing tiles and hydraulic control pipework)

Figure 5 | Treated water pumps

Figure 6 | Sedimentation tank jet pump

Figure 7 | Filter control console

Figure 8 | MCC

Figure 9 | Telemetry link

Figure 10 | Chemical storage tanks

4 Conclusions and recommendations

The preliminary inspections conducted of the De Put WTW indicate that much of the infrastructure and equipment requires servicing, maintenance, repair and/or replacement in order for the works to be reinstated for interim operation (<5 years).

Since most of the works is in a 'fair' condition, it may not be necessary to employ a contractor to refurbish the works. It is therefore recommended that the Setsoto Municipality's own operations and maintenance departments undertake an initial exercise to inspect and service all of the equipment as best as possible, engaging with Aurecon's mechanical, electrical and structural engineers during that process to determine if any further repair/replacement of equipment is required.

Following this initial exercise, any outstanding items that are described in this memorandum, or that are identified during the municipality's initial inspections, can be addressed externally, under the earliest of the Bulk Water Supply scheme contracts (the De Put abstraction works and pipeline).