



Namakwa EOFS RSF 6 **Construction Quality Assurance Plan for** **Residue Storage Facility**



mine residue and environmental engineering consultants

PROJECT No. 126-005

REPORT No. 126-005-01_QC

TBC

Namakwa EOFS RSF 6

Construction Quality Assurance Plan for Residue Storage Facility

Prepared For

Tronox

PROJECT NUMBER 126-005

TBC

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Project No. 126-005

TBC

NAMAKWA EOFS RSF 6

CONSTRUCTION QUALITY ASSURANCE PLAN FOR RESIDUE STORAGE FACILITY

1. INTRODUCTION

Epoch Resources (Pty) Ltd (Epoch) have prepared this Construction Quality Assurance Plan for the construction of the preparatory works for the establishment of the Tronox EAST OFS Residue Storage Facility (the Facility). The terms of reference, scope and purpose of the Construction Quality Assurance Plan (the CQA plan) are defined below.

1.1. TERMS OF REFERENCE

The CQA plan is intended to be submitted as part of the feasibility design report for the facility and to define the structure within which the future construction quality assurance will be achieved. The plan is intended also to provide guidance to prospective tenderers / contractors in the compilation of their Quality Control (QC) Plans for the construction of the works. **It is to be specifically noted that this document is meant to supplement the feasibility design report and will need to be revised and updated once the detailed design of the facility is complete.**

The plan is intended also to make a clear distinction between the quality control processes, which are the responsibility of the contractor, and the quality assurance processes, which are intended to provide assurance that the quality control systems ensure conformance to the design and technical specifications applicable to the works.

1.2. PURPOSE OF THE CONSTRUCTION QUALITY ASSURANCE PLAN

The CQA Plan is intended to define the procedures and processes to be applied to assuring that the works are constructed in accordance with the requirements of the design as defined in the construction drawings, project and technical specifications and schedules of quantities. The CQA Plan is defined in terms of:

- The responsibilities of those involved in the construction and supervision of the works

- The project controls required to support the Quality Assurance (QA) process
- The tests and inspections required to support the QA process
- The documentation and records required to support the QA process
- Summary descriptions of the major components of the construction works and their associated QA requirements

The CQA Plan should be read in conjunction with the design report, drawings and technical specifications which define the requirements for the construction of the facility.

1.3. SCOPE OF THE CONSTRUCTION QUALITY ASSURANCE PLAN

This CQA Plan is applicable to all of the works associated with the construction of the preparatory works to the tailings storage facility and related infrastructure including:

- Site clearance and removal of unsuitable foundation materials
- The supply and installation of materials to the seepage collection system including:
 - Geotextiles
 - Drainage collection pipes and associated sand and stone drainage materials
- The construction of surface water containment works to the perimeter of the facility including toe paddocks
- The construction of the pool access wall
- The construction of a perimeter access road
- The construction of the storm water diversion works upstream of the facility.

The CQA Plan does not address the technical aspects of the works which are addressed in detail in the Technical Specifications for the project.

1.4. REFERENCES AND SUPPORTING DOCUMENTATION

The CQA Plan should be read in conjunction with the design drawings, technical specifications and schedules of quantities which define the works as described above and, specifically, the requirements for their construction. These documents include extensive references to the requirements of:

- The latest editions of South African National Standards Specification (SANS)
- Testing methods as defined in the American Society for Testing and Materials (ASTM)

1.5. ORGANIZATION OF THE CONSTRUCTION QUALITY ASSURANCE PLAN

The structure of the CQA Plan is summarized in Table 1.

TABLE 1 : STRUCTURE OF THE CONSTRUCTION QUALITY ASSURANCE PLAN

SECTION	TOPIC
2	DEFINITIONS RELATING TO CQA
3	CQA CONSULTANTS PERSONNEL ORGANIZATION AND DUTIES
4	SITE AND PROJECT CONTROL
5	CONSTRUCTION QUALITY ASSURANCE ACTIVITIES
6	DOCUMENTATION
7	DEFECT CORRECTION PROCEDURE
8	CONSTRUCTION QUALITY ASSURANCE CHECKLIST

2. DEFINITIONS RELATING TO CQA

This section of the Construction Quality Assurance Plan serves to define terms that will be used in the plan.

2.1. THE CLIENT

The Client is the owner of the mine and the residue storage facility, namely Tronox Namakwa Sands.

2.2. THE CONTRACTOR

The contractor (ECSA, 2015) is the person or juristic person under contract to the client to perform the works or part of it on a project, including a subcontractor under contract to such contractor.

2.3. THE CONSULTING ENGINEER (THE ENGINEER)

The Consulting Engineer (the Engineer) (ECSA, 2015) is the professional person registered in terms of the Engineering Profession Act, 200 (Act No. 46 of 200), or the juristic person who employs such professional, engaged by the client on a project. For the purposes of this document responsibility for the design and construction supervision of the Residue Storage Facility resides with Epoch Resources (Pty) Ltd, represented in this instance by Mr GJ Wiid Pr.Eng.

2.4. CONSTRUCTION MONITORING

Construction monitoring (ECSA, 2015) is the process of administering the construction contract and over-seeing and / or inspecting the works, to the extent of the Engineers's engagement, for the purpose of verification that the works are being completed in accordance with the requirements of the contract, that the designs are being correctly interpreted, and that appropriate construction techniques are being utilized. Construction monitoring, to whatever extent, shall not diminish the contractor's responsibility for executing and completing the works in accordance with his contract.

2.5. CONSTRUCTION QUALITY ASSURANCE (CQA)

Quality Assurance during construction (ECSA, 2015) refers to the engineering activities that are implemented to assure a client that the works are highly likely to meet the requirements. This is achieved through a combination of the quality control (QC) processes that are put in place by the contractor to control its outputs and the inspection and acceptance testing that is carried out by the engineer to confirm conformance prior to verification. While the contractor takes the ultimate responsibility for quality and meeting the design requirements, the purpose of the quality assurance plan and related construction monitoring is to inspect and satisfy the client and the consulting engineer that the risk of these requirements not being met is acceptable.

2.6. CONSTRUCTION QUALITY CONTROL (CQC)

Construction Quality Control (QC) during construction refers to the processes put into place by the contractor to control its outputs and to ensure that the works are being completed in accordance with the requirements of the contract, that the designs are being correctly interpreted, and that appropriate construction techniques are being utilized.

In the case of the supply and installation of geotextiles, pipes and other manufactured items construction quality control is a collaborative effort between the Manufacturer, the Specialist Installation Contractor, and the Contractor, who carries overall responsibility for ensuring that the materials and workmanship meet the requirements of the technical specifications.

2.7. CONSTRUCTION MANAGER

The Construction Manager is responsible for managing the construction and implementation of the *Drawings*, and *Technical Specifications* for the project work. The Construction Manager is selected/appointed by the Owner.

TABLE 2 : SUMMARY OF RESPONSIBILITIES FOR CQA PLAN

DESCRIPTION	RESPONSIBILITY	QUALIFICATION/TRAINING REQUIREMENTS
THE ENGINEER	The Engineer is responsible for the design, <i>Drawings</i> , and <i>Technical Specifications</i> for the project work.	The Professional Engineer shall be a qualified engineer, registered with ECSA. The Engineer should have expertise, which demonstrates significant familiarity with piping, geotextiles and soils, as appropriate, including design and construction experience related to these items.
CONTRACTOR	In this CQA Plan, Contractor refers to an independent party or parties, contracted by the Owner, performing the work in general accordance with this CQA Plan, the <i>Drawings</i> , and the <i>Technical Specifications</i> . The Contractor will be responsible for the installation of the soils, pipe and drainage aggregate of the drainage systems. This work will include subgrade preparation, anchor trench excavation and backfill, placement of drainage aggregate for the	Qualifications of the Contractor are specific to the construction contract. The Contractor should have a demonstrated history of successful earthworks, piping, and drainage system construction and shall maintain current state and federal licenses as appropriate.

DESCRIPTION	RESPONSIBILITY	QUALIFICATION/TRAINING REQUIREMENTS
	<p>slimes drain and the leak detection system, installation of piping, placement of cast-in-place concrete, and coordination of work with other subcontractors.</p> <p>The Contractor will be responsible for constructing the preparatory works in general accordance with the Drawings and complying with the quality control requirements specified in the Technical Specifications.</p>	
Manufacturer	The Manufacturers are responsible for the production of finished material (geotextile, and pipe) from appropriate raw materials.	The Manufacturer(s) will be able to provide sufficient production capacity and qualified personnel to meet the demands of the project. The Manufacturer(s) must be a well-established firm(s) that meets the requirements identified in the Technical Specifications.
CQA Consultant / Officer / Site Manager	The CQA Consultant / CQA Officer is a party, independent from the Owner, Contractor, and Manufacturer, who is responsible for observing, testing, and documenting activities related to the CQC and CQA of the earthwork, piping, and drainage components used in the construction of the Project as required by this CQA Plan and the Technical Specifications. The CQA Consultant will also be responsible for issuing a CQA report at the completion of the Project construction, which documents construction and associated CQA activities. The CQA report will be signed and sealed by the CQA Officer who will be a Professional Engineer	<p>The CQA Consultant shall be a well-established firm specializing in geotechnical and drainage engineering who possess the equipment, personnel, and licenses necessary to conduct the geotechnical and drainage tests required by the project plans and Technical Specifications. The CQA Consultant will provide qualified staff for the project, as necessary, which will include, at a minimum, a CQA Officer and a CQA Site Manager. The CQA Officer will be a professionally registered engineer.</p> <p>The CQA Consultant will be experienced with earthwork and drainage installation similar to those materials used in construction of the Project. The CQA Consultant will be experienced in the preparation of CQA documentation including CQA Plans, field documentation, field testing procedures, laboratory testing procedures, construction technical specifications, construction Drawings, and CQA reports.</p> <p>The CQA Site Manager will be specifically familiar with the construction of earthworks, piping, and drainage systems. The CQA Manager will be trained by the CQA Consultant in the duties as CQA Site Manager.</p>
CQA Laboratory	The CQA Laboratory is a party, independent from the Contractor and Manufacturer, that is responsible for conducting tests in general accordance with ASTM and other applicable test standards on samples of the drainage materials, soil, and in the field and in either an on-site or off-site laboratory.	The CQA Laboratory will have experience in testing soils and drainage materials and will be familiar with ASTM and other applicable test standards. The CQA Laboratory will be capable of providing test results within a maximum of seven days of receipt of samples and will maintain that capability throughout the duration of earthworks construction and drain installation.

2.8. QUALIFICATIONS

Qualifications is defined as the pass of an examination or an official completion of a course, especially one conferring status as a recognized practitioner of a profession or activity.

2.9. RESPONSIBILITIES

Responsibility is defined as the duty or obligation to satisfactorily perform or complete a task that one must fulfil, and which has a consequent penalty for failure.

2.10. LINES OF COMMUNICATION AND RESPONSIBILITIES

As part of the CQA plan, the lines of communication and responsibilities of the Owner, Contractor, Engineer and CQA Consultant / CQA Officer should be clearly defined. A detailed flow diagram with regards to the lines of communication and responsibilities should be set up as part of the CQA plan upon commencement of the construction phase of the residue storage facility.

2.11. DEFICIENCY IDENTIFICATION AND RECTIFICATION

If a defect is discovered in the work, the CQA Consultant / CQA Officer will evaluate the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant / CQA Officer will determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant / CQA Officer deems appropriate.

After evaluating the extent and nature of a defect, the CQA Consultant / CQA Officer will notify the Construction Manager and schedule appropriate re-tests when the work deficiency is corrected by the Contractor.

The Contractor will correct the deficiency to the satisfaction of the CQA Consultant / CQA Officer. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant / CQA Officer will develop and present to the Design Engineer suggested solutions for approval.

Defect corrections will be monitored and documented by CQA personnel prior to subsequent work by the Contractor in the area of the deficiency

3. CQA CONSULTANTS PERSONNEL ORGANIZATION AND DUTIES

The scope of work for the CQA Consultant includes monitoring of construction activities. The CQA Officer will provide supervision within the scope of work of the CQA Consultant.

3.1. CQA PERSONNEL

The CQA Consultant's personnel will include:

- The CQA Officer, who works from the office of the CQA Consultant and who conducts periodic visits to the site as required; and
- The CQA Site Manager, who is located at the site.

3.2. CQA OFFICER

The CQA Officer shall supervise and be responsible for monitoring and CQA activities relating to the construction of the earthworks, piping, and installation of the geosynthetic materials of the Project. Specifically, the CQA Officer:

- Reviews the project design, this CQA Plan, Drawings, and Technical Specifications;
- Reviews other site-specific documentation; unless otherwise agreed, such reviews are for familiarization and for evaluation of constructability only, and hence the CQA Officer and the CQA Consultant assume no responsibility for the liner system design;
- Attends Pre-Construction Meetings as needed;
- Administers the CQA program (i.e., provides supervision of and manages on-site CQA personnel, reviews field reports, and provides engineering review of CQA related activities);
- Provides quality control of CQA documentation and conducts site visits;
- Reviews the Record Drawings; and
- With the CQA Site Manager, prepares the CQA report documenting that the project was constructed in general accordance with the Construction Documents.

3.3. CQA SITE MANAGER

The CQA Site Manager:

- Acts as the on-site representative of the CQA Consultant;
- Attends CQA-related meetings (e.g., pre-construction, daily, weekly (or designates a representative to attend the meetings));
- Oversees the ongoing preparation of the Record Drawings;

- Reviews test results provided by Contractor;
- Assigns locations for testing and sampling;
- Oversees the collection and shipping of laboratory test samples;
- Reviews results of laboratory testing and makes appropriate recommendations;
- Reviews the calibration and condition of on-site CQA equipment;
- Reviews the Manufacturers Quality Control (MQC) documentation;
- Reviews Contractors daily diaries
- Notes on-site activities in reports to the CQA Officer and Construction Manager;
- Reports unresolved deviations from the CQA Plan, Drawings, and Technical Specifications to the Construction Manager;
- Assists with the preparation of the CQA report.
- Monitoring of the construction activities such as:
 - Subgrade preparation
 - Construction of fills and embankments
 - Excavations of trenches and box-cuts
 - Installation of drainage aggregate
 - Installation of piping
 - Installation of geotextile.

4. SITE AND PROJECT CONTROL

4.1. PROJECT COORDINATION MEETINGS

Meetings of key project personnel are necessary to assure a high degree of quality during installation and to promote clear, open channels of communication. Therefore, Project Coordination Meetings are an essential element in the success of the project. Several types of Project Coordination Meetings are described below, including: (i) pre-construction meetings; (ii) progress meetings; and (iii) problem or work deficiency meetings.

4.1.1. PRE-CONSTRUCTION MEETING

Pre-Construction Meeting will be held at the site prior to construction of the Project. At a minimum, the Pre-Construction Meeting will be attended by the Contractor, the CQA Consultant, and the Construction Manager.

Specific items for discussion at the Pre-Construction Meeting include the following:

- Appropriate modifications or clarifications to the CQA Plan;
- The Drawings and Technical Specifications;
- The responsibilities of each party;
- Lines of authority and communication;
- Methods for documenting and reporting, and for distributing documents and reports;
- Acceptance and rejection criteria;
- Protocols for testing;
- Protocols for handling deficiencies, repairs, and re-testing;
- The time schedule for all operations;
- Procedures for packaging and storing archive samples;
- Repair procedures; and
- Soil stockpiling locations.

The Construction Manager will conduct a site tour to observe the current site conditions and to review construction material and equipment storage locations. A person in attendance at the meeting will be appointed by the Construction Manager to record the discussions and decisions of the meeting in the form of meeting minutes. Copies of the meeting minutes will be distributed to all attendees.

4.1.2. PROGRESS MEETINGS

Progress meetings will be held between the CQA Site Manager, the Contractor, Construction Manager, and other concerned parties participating in the construction of the project. This meeting will include discussions on the current progress of the project, planned activities for the next week, and revisions to the work plan and/or schedule. The meeting will be documented in meeting minutes prepared by a person designated by the CQA Site Manager at the beginning of the meeting. Within 2 working days of the meeting, draft minutes will be transmitted to representatives of parties in attendance for review and comment. Corrections and/or comments to the draft minutes shall be made within 2 working days of receipt of the draft minutes to be incorporated in the final meeting minutes.

4.1.3. PROBLEM OR WORK DEFICIENCY MEETING

A special meeting will be held when and if a problem or deficiency is present or likely to occur. The meeting will be attended by the Contractor, the Construction Manager, the CQA Site Manager, and other parties as appropriate. If the problem requires a design modification, the Engineer should either be present at, consulted prior to, or notified immediately upon conclusion of this meeting. The purpose of the work deficiency meeting is to define and resolve the problem or work deficiency as follows:

- Define and discuss the problem or deficiency;
- Review alternative solutions;
- Select a suitable solution agreeable to all parties; and
- Implement an action plan to resolve the problem or deficiency.

The Construction Manager will appoint one attendee to record the discussions and decisions of the meeting. The meeting record will be documented in the form of meeting minutes and copies will be distributed to all affected parties. A copy of the minutes will be retained in facility records

5. CONSTRUCTION QUALITY ASSURANCE ACTIVITIES

5.1. EARTHWORKS

All components of the construction shall be observed and tested as required by the CQA Officer to verify that the construction is in accordance with the Construction Specifications. The CQA Site Manager shall review the work performed by the CQA Officer and identify inadequate construction methodologies or materials which may adversely impact the performance of the RSF. Visual observations and verification of the independent survey required for specific layers throughout the construction process shall be made to evaluate whether the materials are placed to the levels and grades as shown on the Construction Drawings.

The CQA Officer or CQA Site Manager will give the Project Manager sufficient notice of anticipated completion of the construction components so that related CQA documentation may be reviewed and accepted without delay to the contractor. Specific CQA observation and/or testing are required for the following:

- Engineered Fill
- Subgrade Preparation
- Drainage Sand, Gravel and Geofabric

In addition to the above components, the CQA Officer or CQA Site Manager will observe the construction of the HDPE pipes for compliance with the Construction Drawings and Construction Specifications.

5.1.1. BASE PREPARATION

The CQA Officer shall observe and document the base preparation activities and shall include:

- Monitoring of the base preparation to the required depth and compaction effort.
- Documenting levels of the ripped ground, as well as the final prepared levels.
- Compaction testing is to be carried out according to SANS and the specification outlined in Appendix B PSC23. Base preparation will be deemed to have been completed successfully if the criteria in section PSC.23.1 have been met.

5.1.2. ENGINEERED FILL/EMBANKMENT

The CQA Officer shall observe and document the construction of engineered fills and embankments and shall include:

- Monitoring of the construction to the required height and/or depth.
- Documenting levels of the fills and embankment based on surveyed levels supplied by the contractor and third-party surveyors.

- Verifying and documenting compaction test work undertaken by the contractor and third-party lab are within the specified density and moisture content.
- Verifying and documenting of tests required to approve materials from borrow areas or the source of the materials used in the fills/embankments.

5.1.3. EXCAVATIONS

The CQA Officer shall observe and document the excavations of trenches and box-cuts and shall include:

- Monitoring of the excavations to the required depths and dimensions.
- Documenting levels and dimensions of all excavations based on surveyed levels supplied by the contractor and third-party surveyors.
- In the case where excavations are to achieve a certain depth to competent materials, the CQA office must witness the testing or refusal by an excavator or any such measurement described in the specifications or design.
- Visually inspecting excavated area for moisture seeps, soft or excessively wet areas or anything else that may not have been noted during the design phases. This is to be brought to the attention of the design engineer, prior to continuing with, for example backfilling, etc.

5.1.4. DRAINAGE MATERIALS

The CQA Officer shall observe and document the placement of drainage materials and shall include:

- Monitoring of the construction of the placement of drainage materials to ensure no fines contamination occurs, as well as ensuring pipe spacing, trench.
- Documenting levels of the fills and embankment based on surveyed levels supplied by the contractor and third-party surveyors.
- Verifying and documenting compaction test work undertaken by the contractor and third-party lab are within the specified density and moisture content.
- Documentation of the drain construction and testing should be compiled and signed off for each 100 m section of drain/drain outlet.

5.2. SUPPLY AND LAYING PIPES

The CQA Officer shall observe and document installation of HDPE pipes in accordance with the construction specifications and shall include:

- Monitoring of the handling and storage procedures used to not damage the pipes.
- Monitoring of the backfill placement and light compacting to ensure correct pipe spacing and no indentations occur. During backfill placement no foreign material should enter the pipes.
- Monitoring of the jointing and connections as per the construction and manufacture's specifications, as well as the correct orientation of perforated pipes.

- Verification and documenting tests required to ensure that the pipes meet the construction specifications.
- Documentation of the pipe installation should be compiled and signed off for each 100 m section of drain/drain outlet.

5.3. CONCRETE WORKS

The CQA Officer shall observe and document construction of reinforced concrete in accordance with the construction specifications and shall include:

- Monitoring of the handling and storage procedures of steel bars/mesh.
- Verification and documenting of steel spacing and cover.
- Monitoring of the concrete placement and removal of air voids.
- Monitoring of the jointing and water stops as per the construction and manufacture's specifications.
- Verification and documenting tests required to ensure that the steel and concrete meet the required specifications.
- Monitoring of all finishes around concrete structures.

6. DOCUMENTATION

6.1. OVERVIEW

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant will document that quality assurance requirements have been addressed and satisfied.

The CQA Site Manager will provide the Construction Manager with signed descriptive remarks, data sheets, and logs to verify that monitoring activities have been carried out. The CQA Site Manager will also maintain, at the job site, a complete file of Drawings and Technical Specifications, a CQA Plan, checklists, test procedures, daily logs, and other pertinent documents.

6.2. DAILY RECORDKEEPING

Preparation of daily CQA documentation will consist of daily field reports prepared by the CQA Site Manager which may include CQA monitoring logs and testing data sheets. This information may be regularly submitted to and reviewed by the Construction Manager. Daily field reports will include documentation of the observed activities during each day of activity. The daily field reports may include monitoring logs and testing data sheets. At a minimum, these logs and data sheets will include the following information:

- The date, project name, location, and other identification;

- A summary of the weather conditions;
- A summary of locations where construction is occurring;
- Equipment and personnel on the project;
- A summary of meetings held and attendees;
- A description of materials used and references of results of testing and documentation;
- Identification of deficient work and materials;
- Results of re-testing corrected “deficient work;”
- An identifying sheet number for cross referencing and document control;
- Descriptions and locations of construction monitored;
- Type of construction and monitoring performed;
- Description of construction procedures and procedures used to evaluate construction;
- A summary of test data and results;
- Calibrations or re-calibrations of test equipment and actions taken as a result of re-calibration;
- Decisions made regarding acceptance of units of work and/or corrective actions to be taken in instances of substandard testing results;
- A discussion of agreements made between the interested parties which may affect the work; and
- Signature of the respective CQA Site Manager.

6.3. CONSTRUCTION PROBLEMS AND RESOLUTION DATA SHEETS

Construction Problems and Resolution Data Sheets, to be submitted with the daily field reports prepared by the CQA Site Manager, describing special construction situations, will be cross-referenced with daily field reports, specific observation logs, and testing data sheets and will include the following information, where available:

- An identifying sheet number for cross-referencing and document control;
- A detailed description of the situation or deficiency;
- The location and probable cause of the situation or deficiency; how and when the situation or deficiency was found or located;
- Documentation of the response to the situation or deficiency;
- Final results of responses;

- Measures taken to prevent a similar situation from occurring in the future; and
- Signature of the CQA Site Manager and a signature indicating concurrence by the Construction Manager.

The Construction Manager will be made aware of significant recurring non-conformance with the Drawings, Technical Specifications, or CQA Plan. The cause of the non-conformance will be determined and appropriate changes in procedures or technical specifications will be recommended. These changes will be submitted to the Construction Manager for approval. When this type of evaluation is made, the results will be documented and any revision to procedures or technical specifications will be approved by the Contractor and Engineer.

A summary of supporting data sheets, along with final testing results and the CQA Site Manager's approval of the work, will be required upon completion of construction.

6.4. INDEPENDENT LABORATORY TEST RESULTS

It is the Contractor's responsibility to inform the CQA Officer on who the contractor intends to use as the independent laboratory for conformance testing. Furthermore, the Contractor is to ensure that all results and CQA report from the independent laboratory is to be sent to the CQA Consultant with client copied into mail.

6.5. PHOTOGRAPHIC DOCUMENTATION

Photographs will be taken and documented in order to serve as a pictorial record of work progress, problems, and mitigation activities. These records will be presented to the Construction Manager upon completion of the project. Photographic reporting data sheets, where used, will be cross-referenced with observation and testing data sheet(s), and/or construction problem and solution data sheet(s).

6.6. DESIGN AND/OR TECHNICAL SPECIFICATIONS CHANGES

Design and/or technical specifications changes may be required during construction. In such cases, the CQA Site Manager will notify the Engineer. Design and/or specification changes will be made with the written agreement of the Engineer and will take the form of an addendum to the Drawings and Technical Specifications.

6.7. CQA REPORT

At the completion of the Project, the CQA Consultant will submit to the Owner a CQA report signed and sealed by the Professional Engineer. The CQA report will acknowledge: (i) that the work has been performed in compliance with the Drawings and Technical Specifications; (ii) physical sampling and testing has been conducted at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting information. At a minimum, this report will include:

- MQC documentation;
- A summary report describing the CQA activities and indicating compliance with the Drawings and Technical Specifications which is signed and sealed by the CQA Officer;
- A summary of CQA/CQC testing, including failures, corrective measures, and retest results;
- Contractor personnel resumes and qualifications as necessary;
- Documentation that field seams were non-destructively tested using a method in general accordance with the applicable test standards;
- Records of sample locations, the name of the individual conducting the tests, and the results of tests;
- Record Drawings as provided by the Surveyor;
- Daily field reports.

The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., plan dimensions and appropriate elevations). Record Drawings and required base maps will be prepared by a qualified Professional Land Surveyor. These documents will be reviewed by the CQA Consultant and included as part of the CQA Report

7. DEFECT CORRECTION PROCEDURE

When deficiencies (items that do not meet project technical requirements or specifications) are discovered, the CQA Officer will immediately determine the nature and extent of the problem and notify the Installer and/or Contractor. If unsatisfactory test results identify a deficiency, additional tests will be performed to define the extent of the deficient area.

The defect correction procedure for any defects encountered on site have to be corrected as described in the following sections.

7.1. DEFICIENCIES

If a defect is discovered in the earthwork product, the CQA Site Manager will immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Site Manager will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Site Manager deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or non-conforming particle sizes, the CQA Site Manager will define the limits and nature of the defect.

7.2. NOTIFICATION

After evaluating the extent and nature of a defect, the CQA Site Manager will notify the Construction Manager and Contractor and schedule appropriate re-evaluation when the work deficiency is to be corrected.

7.3. REPAIRS AND RE-TESTING

The Contractor will correct deficiencies to the satisfaction of the CQA Site Manager. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Site Manager will develop and present to the Construction Manager suggested solutions for his approval.

Re-evaluations by the CQA Site Manager shall continue until it is verified that defects have been corrected before any additional work is performed by the Contractor in the area of the deficiency.

8. CONSTRUCTION QUALITY ASSURANCE CHECKLIST

TABLE 3 : SUMMARY CONSTRUCTION QUALITY ASSURANCE (CQA) CHECKLIST

CATEGORY OF WORKS	SUMMARY DESCRIPTION OF THE WORKS	CQA CHECKLIST	HOLD POINT	WITNESS POINT
EARTHWORKS	Bulk Excavation	Monitor and document that: <ul style="list-style-type: none"> Excavations are done to designed/specified depth All excavations are done to the required width and/or slope as Technical Specifications/design All grades, trimming and levels are as per Technical Specifications/design All excavations are safe for entry/work during and after excavation activity 	X	
	Restricted Excavation			
	Excavation of unsuitable material	Monitor and document that: <ul style="list-style-type: none"> Excavation exposed underlying competent material or as approved by Engineer Unsuitable material is stockpiled as per Engineer's instruction All excavations are safe for entry/work during and after excavation activity 	X	
	Borrow Area	Monitor and document that: <ul style="list-style-type: none"> Excavation exposed underlying competent material or as approved by Engineer Unsuitable material is stockpiled as per Engineer's instruction All excavations are safe for entry/work during and after excavation activity 	x	
BASE PREPARATION	Base preparation to 300mm depth	Monitor and document that: <ul style="list-style-type: none"> Base preparation is done according to Technical Specifications The compaction requirements are reached as per design Technical Specifications The entire area is compacted evenly and uniformly All grades, trimming and levels are maintained/restored after compaction activity 	X	
	Base preparation of in-situ material using Wacker or similar approved			X
CONSTRUCTION OF EMBANKMENTS AND FILLS	Construction of engineered fills/embankments	Monitor and document that: <ul style="list-style-type: none"> The fill/embankment is constructed using the correct material as Technical Specifications/design The fill/embankment lifts are done in accordance with design/specification The compaction effort adheres to the specification of compaction of the fills/embankments The levels, grades, slopes and trimming is as per design/specification 	X	
INSTALLATION OF DRAINAGE SYSTEMS	Installation of the geotextile will require final grading and	Monitor and document that site re-grading performed meets the requirements of the Technical Specifications and the Drawings and specifically that: <ul style="list-style-type: none"> The subgrade surface is free of sharp rocks, debris, and other undesirable materials 	X	

CATEGORY OF WORKS	SUMMARY DESCRIPTION OF THE WORKS	CQA CHECKLIST	HOLD POINT	WITNESS POINT
	preparation of the area to be lined.	<ul style="list-style-type: none"> The subgrade surface is smooth and uniform by visually monitoring proof rolling activities The subgrade surface meets the lines and grades shown on the Drawings 		
	Supply and Installation of Geotextiles	<p>Monitor and document that all geotextiles delivered to site are accompanied by the manufacturers quality control (MQC) certification that the materials delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that material. The quality control certificates will include:</p> <ul style="list-style-type: none"> Roll identification numbers Results of MQC testing, including test results for <ul style="list-style-type: none"> Mass per unit area; Grab strength; Tear strength; Puncture strength; Permittivity; and Apparent opening size. <p>Monitor and document that all geotextiles delivered to site are labelled with:</p> <ul style="list-style-type: none"> Manufacturer's name; Product identification; Lot number; Roll number; and Roll dimensions. <p>Monitor and document that, during shipment and storage:</p> <ul style="list-style-type: none"> Geotextiles are protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. To that effect, geotextile rolls will be shipped and stored in relatively opaque and watertight wrappings. Protective wrappings are removed less than one hour prior to unrolling the geotextile Geotextiles are not exposed to sunlight for more than 15 days, except for UV protection geotextile, unless otherwise specified and guaranteed by the Manufacturer <p>Conformance testing of material delivered to site to be carried out by the Engineer as per the Technical Specifications to verify geotextile manufacturer's quality control documentation.</p>	X	
	Supply and Installation of HDPE Pipe and Fittings	<p>Monitor and document that:</p> <ul style="list-style-type: none"> The excavation is at design depth and trimmed/graded according to design or Technical Specifications 		X

CATEGORY OF WORKS	SUMMARY DESCRIPTION OF THE WORKS	CQA CHECKLIST	HOLD POINT	WITNESS POINT
		<ul style="list-style-type: none"> Receipt of a properties' sheet including, at a minimum, all specified properties, measured using test methods indicated in the Technical Specifications, or equivalent; and The CQA Consultant documents that the property values certified by the Manufacturer meet the Technical Specifications; and The measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable. The perforations of the HDPE pipe conform to the requirements of the Drawings and the Technical Specifications. That pipe and fittings are joined by the methods indicated in the Technical Specifications Care is taken during transportation of the pipe such that it will not be cut, kinked, or otherwise damaged. Ropes, fabric, or rubber-protected slings and straps will be used when handling pipes. Chains, cables, or hooks inserted into the pipe ends will not be used. Two slings spread apart will be used for lifting each length of pipe. Pipe or fittings will not be dropped onto rocky or unprepared ground. Pipes are handled and stored in general accordance with the Manufacturer's recommendation. The handling of joined pipe takes place in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Slings for handling the pipe will not be positioned at joints. Sections of the pipes with deep cuts and gouges will be removed and the ends of the pipe rejoined. 		
	Supply and Installation of Drainage Aggregates	<p>Monitor and document that:</p> <ul style="list-style-type: none"> Review of documentation of the material qualification test results provided by the Contractor; Sampling and testing for conformance of the materials to the specifications takes place; Documenting that the drainage aggregates are installed using the specified equipment and procedures; That the drainage aggregates are constructed to the lines and grades shown on the Drawings; and That the construction activities do not cause damage to underlying geosynthetic materials. 		X
CONCRETE WORKS	All concrete works including reinforcing steel, formwork, finishing, jointing and curing	<p>Monitor and document that:</p> <ul style="list-style-type: none"> All surfaces onto which concrete is placed is compacted as per Technical Specifications/design; All reinforcing steel adheres to Technical Specifications/design; All reinforcing steel is fixed as per Technical Specifications/design; All reinforcing steel is placed to give sufficient cover to the steel as per Technical Specifications/design; All joints are constructed as per Technical Specifications/design drawings; 	X	

CATEGORY OF WORKS	SUMMARY DESCRIPTION OF THE WORKS	CQA CHECKLIST	HOLD POINT	WITNESS POINT
		<ul style="list-style-type: none"> 500 micron heavy duty plastic liner is placed on prepared surface as per Technical Specifications/design; All concrete meets the specified design strength and all relevant conformance testing to was done in accordance with Technical Specifications/design; All concrete is placed to thickness specified in drawings/design; All formwork is constructed as per design and finishing requirements in accordance with Technical Specifications/design; All finishing is done in accordance with Technical Specifications/design or as approved by Engineer 		
CONSTRUCTION OF PERIMETER ACCESS ROAD	All works associated with perimeter access road layer works, sloping, grading etc.	<p>Monitor and document that:</p> <ul style="list-style-type: none"> Base preparation is done in accordance with Technical Specifications/design drawings; Selected waste rock material is in accordance with Technical Specifications/design drawings or as approved by Engineer; Selected waste rock fill is placed in lifts as per Technical Specifications/design drawings; Selected waste rock fill is compacted in accordance with Technical Specifications/design drawings; Grading, sloping, trimming and levels are in accordance with Technical Specifications/design drawings. 	X	

REPORT AUTHOR

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Appendix A: Performance Parameters Summary Sheet

Area	Parameter	Test Method	Performance Criteria	Minimum Frequency	Min	Max	Min Value	Number of tests	Standard Deviation	Number of Failures
Topsoil Stripping										
	Strip topsoil	Visual inspection	Organic material removed							
	Depth	Survey or depth measure	Design drawings - based on geotech info	1 test per 1000m2						
	Stockpile area/height	Survey or depth measure	Max height: 2m	1 test per 1000m2						
Base Preparation										
	Layer Thickness (rip and compact)	Survey or depth measure	Min: 150mm	1 test per 1000m2						
	MDD and OMC	SANS 3001-GR30:2015	95% STD Proctor MDD							
	Compacted Density	Troxler (Nuclear Method)	95% STD Proctor MDD	1 test per 1000m2						
			OMC+2%							
		ASTM (Sand Replacement)	95% STD Proctor MDD	Every 4th troxler replaced with SR						
			OMC+2%							
	Max Particle Sizes	ASTM D6913 / D6913M - 17 Sieve Analysis	Maximum size 25mm	1 test per 1000m2						
		ASTM D7928 - 17 Hydrometer test								
Excavation (box cut)										
	Depth	Survey and/or depth measure	Design Levels							
	Depth to competent soil	Refusal with an 20ton Excavator	-	-						
		TMH6-ST6 (Dynamic Cone Penetrometer)	Min: 250kPa	1 test per 1000m2						
Construct Embankments										
	Layer thickness	Survey	Min: 150mm	1 test per 1000m2						
	MDD and OMC	SANS 3001-GR30:2015	98% STD Proctor MDD							
	Compacted Density	Troxler (Nuclear Method)	98% STD Proctor MDD	2 tests per 200m2						
			OMC+2%							
		ASTM (Sand Replacement)	98% STD Proctor MDD	Every 4th troxler replaced with SR						
			OMC+2%							
	Atterberg Limits and Grading	SANS 3001-AG1:2014 Sieve Analysis	Test consistency	1 test per 1000m2						
		SANS 3001-GR10:2013 Atterberg Limits	Test consistency	1 test per 1000m2						
Geotextile	(Separation)									
	Mass/unit area (g/m2)									
	Trapezoidal tear strength	ASTM D 4533	0.8x1.2 kN	7500 m2						
	CBR Puncture strength	ASTM D 6241	1.2 kN	7500 m2						
	UV Str. Ret. After 500 It. Hrs exposure	ASTM D 7238		65% 1 per site/every 40 000kg						
	Overlap	Inspection	Min: 150mm	All overlaps						
Drainage material										
	Filter Sand									
	Grading	SANS 3001-AG1:2014 Sieve Analysis (Wet)	<5% passing 75um	1 test per 100m3						
			Design envelope							
	Layer thickness	Survey or depth measure	150-200mm as per drawings	1 test per 1000m2						
	6mm Stone									
	Grading	SANS 3001-AG1:2014 Sieve Analysis (Wet)	<5% passing 75um	1 test per 100m3						
			Design envelope							
	ACV	SANS 3001-AG10:2012 ACV	<21							
	Flakiness	SANS 3001-AG4:2015 Flakiness		25%						
	Layer thickness	Survey or depth measure	150-200mm as per drawings	1 test per 1000m2						
	19mm Stone									
	Grading	SANS 3001-AG1:2014 Sieve Analysis (Wet)	<5% passing 75um	1 test per 100m3						
			Design envelope							
	ACV	SANS 3001-AG10:2012 ACV	<21							
	Flakiness	SANS 3001-AG4:2015 Flakiness		25%						
	Layer thickness	Survey or depth measure	150-200mm as per drawings	1 test per 1000m2						
	Drainage Rock									
	Size	SANS 3001-AG1:2014 Sieve Analysis (Wet)	Design envelope	1 test per 100m3						
	Layer thickness	Survey or depth measure	150-200mm as per drawings	1 test per 1000m2						
Pipes	Crushing Strength	ASTM D2412		Every pipe length						
	Diameter	Measure/inspection	160mm							
	Slope	Survey	Min 2%	As per drawings						
	Slot width (where applicable)	Measure/inspection	1.8mm							
Concrete										
	Depth/size/position	Survey or measure								
	Base preparation									
	MDD and OMC	SANS 3001-GR30:2015	95% STD Proctor MDD							
	Compacted Density	Troxler (Nuclear Method)	95% STD Proctor MDD	1 test per 1000m2						
	Cover and spacers	Survey or measure	Design drawings							
	Steel spacing	Survey or measure	Design drawings							
	Concrete strength	SANS 5863:2006 Compressive strength	Design drawings (strength in MPA)	At least one set of samples shall be taken from each day's casting and from at least every 50 m3 of concrete of each grade placed.						

Appendix B: Construction Specifications

CONSTRUCTION OF THE BULK
EARTHWORKS AND PREPARATORY
WORKS FOR THE NAMAKWA
SANDS EOFS PROJECT, RSF6 AND
ASSOCIATED INFRASTRUCTURE

Contract Order No.

Epoch Reference No.

126-005

Revision

0



TRONOX (PTY) LTD

**CONSTRUCTION OF THE BULK
EARTHWORKS AND PREPARATORY
WORKS FOR THE NAMAKWA SANDS
EOFs PROJECT, RSF6 AND
ASSOCIATED INFRASTRUCTURE**

1 SCOPE OF WORK

The scope of work for Preparatory Works will include the following:

RESIDUE STORAGE FACILITY

- Dewatering of any areas before construction work starts (If required);
- Construction of the Bulk Earthworks, including:
 - Box cut of the footprint of the containment wall;
 - Removal of backfill material beneath the containment wall;
 - Construction of the earth fill pool access ramp;
 - Construction of the storm water diversion bunds;
- Construction of the toe blanket drain and outlets;
- Construction of outlet structure manholes at end of the blanket drain outfall pipes;

EXCLUSIONS

The following items are not included or covered in this scope of work:

- All electrical installations;
- Pumps;
- Transformers; and
- Return water pipelines.

2 CONSTRUCTION SPECIFICATIONS

Standards and Particular Specifications

The South African Bureau of Standards Standardised Specifications for Civil Engineering Construction (not included in this document), Project Specifications and Particular Specifications that are applicable to this contract is shown in Table 2. The Contractor shall ensure that he is in possession of the specification as listed in Table 2.

Table 1: LIST OF SANS AND PARTICULAR SPECIFICATION APPLICABLE TO THIS CONTRACT

SANS NUMBER / SPECIFICATION NUMBER	DOCUMENT TITLE
SANS 1921	Construction and Management Requirements for Works Contracts
SANS 1200 A	General
SANS 1200 AA	General (Small Works)
SANS 1200 AB	Engineer's Offices
SANS 1200 AD	General (Small Dams)
SANS 1200 AH	General (Structural)
SANS 1200 C	Site Clearance
SANS 1200 D	Earthworks
SANS 1200 DA	Earthworks (Small Works)
SANS 1200 DB	Earthworks (Pipe Trenches)
SANS 1200 DE	Small Earth Dams
SANS 1200 DK	Gabions and Pitching
SANS 1200 DM	Earthworks (Roads, subgrade)
SANS 1200 DN	Earthworks (Railway sidings)
SANS 1200 F	Piling
SANS 1200 G	Concrete (Structural)
SANS 1200 GE	Precast Concrete (Structural)
SANS 1200 GF	Prestressed Concrete
SANS 1200 H	Structural Steelwork
SANS 1200 HA	Structural Steelwork (sundry items)
SANS 1200 HB	Cladding and Sheeting
SANS 1200 HC	Corrosion Protection of Structural Steelwork
SANS 1200 HE	Structural Aluminium Work
SANS 1200 L	Medium Pressure Pipelines
SANS 1200 LB	Bedding (Pipes)
SANS 1200 LC	Cable Ducts
SANS 1200 LD	Sewers
SANS 1200 LE:	Storm water Drainage

**CONSTRUCTION OF THE BULK
EARTHWORKS AND PREPARATORY
WORKS FOR THE NAMAKWA
SANDS EOFS PROJECT, RSF6 AND
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SANS NUMBER / SPECIFICATION NUMBER	DOCUMENT TITLE
SANS 1200 LF	Erf Connections (Water)
SANS 1200 LG	Pipe Jacking
SANS 1200 M	Roads (General)
SANS 1200 ME	Subbase
SANS 1200 MF	Base
SANS 1200 MG	Bituminous Surface Treatment
SANS 1200 MH	Asphalt Base and Surfacing
SANS 1200 MJ	Segmented Paving
SANS 1200 MK	Kerbing and Channelling
SANS 1200 MM	Ancillary Roadworks
SANS 1200 NB	Railway Sidings
PSA - PSG	PROJECT SPECIFICATIONS FOR EXCAVATIONS, EARTHWORKS AND UNDERDRAINAGE
PC	PARTICULAR SPECIFICATIONS FOR GEOTEXTILES

NOTE

Where there is conflict between SANS 1200 and the Particular Specifications for Excavation, Earthworks and Under-drainage, the Particular Specifications for Excavation, Earthworks and Under-drainage shall rule.

In the event of an ambiguity or conflict between specifications the following order of precedence will apply to the above Specifications:

1. Construction Specifications
2. Construction Drawings
3. Project Specifications
4. SANS Specifications

VARIATIONS TO REQUIREMENTS OF SANS 1200 SPECIFICATIONS LISTED IN TABLE 1

PS SPECIFICATIONS FOR EXCAVATIONS, EARTHWORKS AND UNDERDRAINAGE

PSA GENERAL (SANS 1200A)

PSA.1 DEFINITIONS (CLAUSE 2.3)

The SANS 1200 Standard Specifications and the amendments refer to the “Engineer”. Where these specifications are used the “Engineer” is deemed to be the officially appointed representative of the Client. The SANS 1200 Standard Specifications and the amendments refer to either the “Client” or “Owner”. Where these specifications are used the “Client” or “Owner” is deemed to be Kamoas Copper SA (KCP).

PSA.2 MATERIALS (CLAUSE 3)

All the Contractor’s suppliers are to be approved by the Engineer prior to the award of the contract.

PSA.2.1 Quality (Sub Clause 3.1)

The following shall be an addition to Sub Clause 3.1:

No used or recycled material may be used in the Works unless authorized by the Engineer.

Where applicable all material supplied, shall bear the official standardization mark. The Engineer’s approval is based on tests conducted by the Contractor as required by the contract.

All materials proposed by the Contractor for use in the Works shall where required, be tested in accordance with the Specifications. All test results shall be submitted to the Engineer for approval prior to such materials being built into the Works. All cost involved in this testing shall be deemed to be included in the construction rates.

PSA.2.2 Delay Due To Supply of Materials (Clause 3)

The following new Sub Clause 3.3 shall be added:

The Contractor shall ensure that the Works is not delayed, due to lack of materials on site, by placing orders with suppliers for materials required in a timeously manner.

The Contractor shall, by furnishing copies of written orders or written enquiries for supplies, prove to the satisfaction of the Engineer that any delay caused by non-availability of materials has been caused by the inability of suppliers to supply materials and not by his own lack of timely ordering or lack of exhaustive inquiry for supplies, before any extensions of contract time will be allowed due to lack of such delays.

The decision of the Engineer to either allow or deny such extension of contract time shall be final.

PSA.2.3 Ordering of Materials (Clause 3)

The following new Sub Clause 3.4 shall be added:

The quantities set out in the Bill of Quantities have been carefully determined from calculations based on the available information at the time of its completion but are to be considered as approximate quantities only. Before ordering of materials of any kind the Contractor shall be responsible for determining, from the issued Construction drawings, the actual quantities of materials required for the execution of the Works.

No liability or responsibility whatsoever shall be attached to the Client or the Engineer in respect of materials ordered by the Contractor except when ordered in accordance with the issued Construction Drawings.

PSA.3 PLANT (CLAUSE 4)

The following shall be an addition to Clause 4:

All the Contractor's plant and vehicles to be used on site will be subject to, and comply with the Client's requirements.

PSA.3.1 Silencing of Plant (Sub Clause 4.1)

The following shall be an amendment to Sub Clause 4.1:

In line 2 change "Machinery and Occupational Safety Act, 1983 (Act No. 6 of 1983)" to "Occupational Health and Safety Act, 1993".

PSA.3.2 General (Clause 4)

The following new Sub Clause 4.3 shall be added:

All plant provided by the Contractor for the execution and maintenance of the Works shall be of a character comparable with the scope of works.

The Contractor shall provide and maintain sufficient plant to meet all requirements of this Contract and shall not remove any of his plant from the site without written approval of the Engineer. The Contractor shall, however, remove unsuitable, obsolete or worn out plant from the site when so instructed by the Engineer and replace these with plant approved by the Engineer.

The approval of any plant on the site by the Engineer shall in no way relieve the Contractor of any of his obligations under the Contract.

PSA.4 CONSTRUCTION (CLAUSE 5)

PSA.4.1 Setting Out (Sub Clause 5.1)

The following shall be an amendment to Sub Clause 5.1:

All surveying operations shall be completed using GPS surveying equipment. Calibration certificates of all surveying equipment to be provided to the Engineer

The Contractor shall be responsible for maintaining accurately ascertained Site datum levels at his own expense. The Contractor shall further ensure that all level control and setting out of the Works is executed in accordance with the survey data given on the construction drawings.

Immediately following the issue of the order to commence, the Contractor shall, at his own expense, carry out and record a check level grid of the Site of Works, in order to confirm the contour levels shown on the construction drawings. Any discrepancies causing non-acceptance by the Contractor of the levels shown on the construction drawings are to be pointed out to the Engineer within two weeks of the above order being given, and the alterations checked and agreed with the Engineer. Failing this, the original levels as shown on the construction drawings will be deemed correct and acceptable. In addition to the above, the following survey tasks shall be undertaken by the Contractor for agreement with the Engineer.

- Original ground levels shall be recorded at 10 m intervals on the centre line and upstream and downstream toe positions of all embankments and fills after Site clearance and again after removal of unsuitable material. In the case of large embankments or fills the Engineer may specify that the spacing of recorded levels be increased to that of a 5 m grid.
- Original ground levels shall be recorded at 2.5 m and 5 m intervals on the entire line left and right bank positions of all trenches, canals and drains prior to excavation and again on completion of the excavation to the required depths and grades.
- Original ground levels shall be recorded at 10 m intervals over material borrow areas. After removal of unsuitable material and/or topsoil and/or fill material as required, the Contractor shall re-survey the ground and record levels as described above. The grids and lines before and after soil removal shall be coincident in plan.
- Final survey of all as-built levels shall be provided for the purpose of verification and final payment purposes.
- All survey info as described above shall be supplied to the Engineer in AutoCad drawing format as well as points in an excel spreadsheet as soon as the surveys have been completed and the information compiled.

The Contractor shall allow for the above survey operations in the Preliminary and General section of the Bill of Quantities. No separate payment will be made for these surveying operations. The agreed survey data shall be the basis of all earthworks measurement.

Any survey submitted by the Contractor is to be approved in writing by the Engineer before being considered valid as a basis of measurement.

The Contractor is to inform the Engineer in writing upon the completion of impoundment walls and trenches to design elevations and cross-sections. Thereafter, a verification survey may be carried out by the Engineer's appointed surveyor to verify these elevations and cross-sections.

The cost of this verification survey will be paid for by the Employer only if the results of the survey show that the design levels and cross-sections have been achieved. The Contractor shall pay for the costs of the verification survey where the results show that the design levels and cross-sections have not been achieved.

Any further costs involved to verify that the required design levels and cross-sections have been obtained after the corrective measures have been applied shall be borne by the Contractor.

PSA.4.2 Protection of Overhead And Underground Services (Sub Clause 5.4)

The following shall replace Sub Clause 5.4 in its entirety:

PSA.4.2.1 Existing Works and Services

The Contract may include certain work involving the moving and reinstating of existing services that are affected by the construction of the Works.

The Construction drawings will include information regarding the location of known existing services. Although the Construction drawings may indicate the approximate positions of existing works and services, neither the Client nor the Engineer accepts any responsibility for the accuracy thereof nor for the omission for the Construction drawings of possible further existing works and services.

It shall be the responsibility of the Contractor to search and make himself acquainted with the actual location and ownership of existing works and services before any construction work commences.

Where the position of a service cannot be accurately determined by visual inspection, the Contractor shall open up and make further investigations before construction commences, so that the position of such services can be accurately determined to avoid damage during construction. Wherever possible the Contractor shall ascertain the exact position and type of service from the Client.

In addition, where so instructed by the Engineer, the Contractor shall also open up and search for any services not shown on the Construction drawings but which he or the Engineer may believe to exist. The Contractor shall complete such investigations well in advance of the commencement of Construction work in the said area and shall submit a report in good time to enable the Engineer to make whatever arrangements are necessary for the protection, removal or diversion of the services before commencement of Construction in said area.

Before any excavation is carried out within 10m of the approximate position of an existing service the Contractor shall notify the Engineer and the Client of the service and that the excavation is to be made and shall ascertain and comply with any conditions that are imposed by Excavation Permits.

As soon as any underground service not shown on the Construction drawings is discovered, it shall be deemed to be a known service.

PSA.4.3 Protection of Existing Works and Services

The following new Sub Clause 5.9 shall be added:

Where during the course of the Contract, services have been located and exposed, they shall be securely shored, and the Contractor shall take adequate measures to prevent damage occurring to them.

The Contractor shall take special care when excavating trenches, when trenches are open, or when carrying out any work under the Contract, not to damage any existing water mains, sewers, cables or other underground services or to disturb the stability of any poles or towers supporting overhead powerlines, telegraphs and telephone wires, etc. the Contractor shall solely be responsible for the protection of all such services and for any claims for damages arising there from.

All work or protective measures shall be subject to the approval of the Engineer.

PSA.4.4 Damage to Existing Works and Services

The following new Sub Clause 5.10 shall be added:

The Contractor shall take all reasonable precautions to protect existing services during construction and during the relocation of such services. Any damage done to existing works and services shall be reported immediately to the Engineer and the Client in writing. Any know service of any nature whatsoever that has been damaged as a result of the Contractor's operations shall be repaired and reinstated immediately by the Contractor if so directed by the Engineer. The settlement of all claims arising from damage to existing property, works and services shall be solely the responsibility of the Contractor.

In addition, the Contractor will be liable to prosecution for any wilful and/or negligent damage to services in terms of Section 88 and 111 of the Local Government Ordinance and Section 51 of the Electricity Act No. 40 of 1958. It is stressed that damage of this nature is a criminal offence.

PSA.4.5 Access to Services

The following new Sub Clause 5.11 shall be added:

Where the Client elects to carry out on its own accord any alterations or protective measures, the Contractor shall co-operate with and allow reasonable access and sufficient space and time to carry out the required work.

PSA.4.6 Alterations and Repairs to Existing Services

The following new Sub Clause 5.12 shall be added:

Unless the contrary is clearly specified in the Contract or directed by the Engineer, the Contractor shall not carry out alterations of any nature to existing services. When any such alterations become necessary, the Contractor shall promptly notify the Engineer, who will either make arrangements for such work to be executed by the owner of the service, or instruct the Contractor to make such

arrangements.

Should damage occur to any existing services, the Contractor shall immediately inform the Engineer, or when this is not possible, the relevant authority, and obtain instructions as to who should carry out repairs. In urgent cases the Contractor shall take appropriate action to minimize damage to and interruption of the service. No repairs of telecommunication cables, power lines and electrical cables shall be attempted by the Contractor.

The Client and Engineer shall accept no liability for damages due to delay in having alterations or repairs affected by respective service owners. The Contractor shall provide all reasonable opportunity and assistance to persons carrying out alterations or repairs of existing services.

PSA.4.7 Payment for Exposing Services

The following new Sub Clause 5.13 shall be added:

The cost associated with opening and searching for existing services shall be paid for as and when it is required. It shall be priced as a rate only for the meter length of trench to accurately determine the position of the existing services.

Permanent alterations to or permanent relocation of services necessitated by the execution of the Works and authorized by the Client will be paid for in terms of the conditions of contract. But no such work will be paid for if it has not been previously inspected and if proper written instructions have not been given.

Any work required to be undertaken by the Contractor for protection or moving and relocating services and for which no provision is made in the Contract Documentation, or for which no applicable construction rate exist, shall be classed and paid for as “extra work” as prescribed in the General Conditions of Contract.

PSA.4.8 Pollution (Sub Clause 5.6)

The following new Sub Clause 5.6.1 shall be added:

PSA.4.8.1 Transportation of Materials (Sub Clause 5.6.1)

Where transportation of materials outside of the site occurs is such that it has the potential to generate a nuisance, the material shall be covered during transportation.

Precautions shall be taken during the transportation of muddy and other materials to prevent the materials falling on finished construction works and roads.

Any rock or debris falling from transportation vehicles shall be removed immediately. Any and all damage occurring from rock or debris material falling from transportation vehicles shall be noted and repaired immediately. The Engineer shall be notified of any such damage immediately after it has occurred.

The cost associated with the repair of such damage shall be for the Contractor's account.

PSA.4.9 Safety (Sub Clause 5.7)

The following shall be an amendment to Sub Clause 5.7:

“Pursuant to the provisions of the Conditions of Contract, and without in any way limiting the Contractor’s obligations there under, the Contractor shall at his own expense (except only where specific provision (if any) is made in the Contract for the reimbursement to the Contractor of particular items), provide the following:

- Provide to his Employees on the site of Works, all safety materials, clothing and equipment necessary (Personal Protective Equipment) to ensure full compliance with the provisions of Mine Health and Safety Act (Act No. 29 of 1996), the Occupational Health and Safety Act (Act No. 85 of 1993) and Construction Regulations 2014, as amended at all times, and shall institute appropriate and effective measures to ensure the proper usage of such safety materials, clothing and equipment at all times.
- Provide, install and maintain all barricades, safety signage and other measures to ensure the safety of workman and all persons in, on and around the site, as well as the general public.
- Implement on site, such procedures and systems and keep all records as may be required to ensure compliance with the requirements of the Acts at all times.
- Implement all necessary measures so as to ensure compliance with the Acts by all Sub Contractors engaged by the Contractor and their employees engaged on the Works.
- Full compliance with all other requirements pertaining to safety as may be specified in the Contract.
- Comply with the Client’s Standard Practice Instruction.
- Comply with the Client’s Code of Practise: Mandatory Code of Practice for Trackless Mobile Machinery (DME 16/3/2/2-A2).
- Comply with the Client’s requirements: SHE Management Specification for Contractors.
- Comply with the Construction Regulations, 2014 as promulgated in Government Gazette No. 25207 and Regulation Gazette No. 7721 of 18 July 2003. The proposed type of works, materials to be used and the potential hazards likely to be encountered on this contract are detailed in the Project Specifications, Bill of Quantities and Construction Drawings, as well as in the Client’s health and safety requirements. The Contractor shall in terms of Regulation 5(1) provide a comprehensive health and safety plan detailing is proposed compliance with the regulations, for approval by the Client.

The Client and the Engineer shall be entitled, although not obligated, to make such inspections on the site as they shall deem appropriate, for the purpose of verifying the Contractor’s compliance with the requirements of the Acts. For this purpose the Contractor shall provide full access to all parts of the site and shall co-operate fully in such inspections and shall make available for inspection all such documents and records as the Client and/or the Engineer may reasonably require.

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Should any such investigation reveal or should it come to the Engineers attention that the Contractor is in any way in breach of the requirements of the Acts and requirements and/or failing to comply to the provisions of this Clause, the Engineer shall be entitled to suspend the Works or any part thereof until such time as the Contractor has demonstrated to the satisfaction of the Engineer, that such breach has been rectified.

The Contractor shall have no grounds for a claim against the Client for extension of time and/or additional cost if the progress on the Works or any part thereof is suspended by the Engineer in terms of this Clause. The Contractor shall remain fully liable in respect of the payment of penalties for late completion, should the Contractor fail to complete the Works on or before the specified date of completion in consequences of the suspension.

Persistent and repeated breach by the Contractor of the requirements of the Acts and requirements and/or failing to comply with the provisions of this Clause shall constitute grounds for the Engineer to act in terms of the Contract of the Conditions of Contract and for the Client to cancel the Contract in accordance with the further provisions of said Contract.

PSA.4.10 Grounds and Access to Works (Sub Clause 5.8)

The following shall be an addition to Sub Clause 5.8:

Once site establishment has been completed, the Contractor shall be responsible for maintaining the site in a neat, clean and orderly condition.

The Contractor shall be responsible for the preservation of the ecology of the area and no tress, bushes or other forms of vegetation shall be interfered with, apart from those specifically involved in the execution of the works.

Upon completion of the Contract, or when ordered in writing by the Engineer, the Contractor shall remove from the site all plant, equipment, temporary housing, offices, sheds, ablution facilities, waste material and other debris. The Contractor shall reinstate all disturbed surfaces of roads, access areas, excavations and borrow pits and shall restore the site to a neat and orderly condition. The contractor shall reinstate all fences to the satisfaction of the Engineer.

PSA.4.10.1 Access Roads on Site

The following new Sub Clause 5.8.1 shall be added:

The Contractor shall grade or construct and keep in good and constant repair all construction roads, temporary access roads to and on the site, storm water drainage systems and culverts. The Contractor is to repair, at his own cost, any damage caused to existing roads and road edges on site.

Any route the Contractor wishes to use to obtain access to the site or to any other route used by the Contractor shall be subject to the approval of the Client.

Any temporary diversions and construction roads shall be kept watered and damp or sprayed with a chemical dust suppressant, during all sealing operations and all dust shall be removed from surfaces before any binder, aggregate or slurry is applied.

Payment for dust suppression on the temporary diversions, haul and construction roads shall be deemed to be included in the construction rates.

PSA.5 TOLERANCES (CLAUSE 6)

The following new Sub Clause 6.4 shall be added:

PSA.5.1 Use of Tolerances (Sub Clause 6.4)

No guarantee is given that the full specified tolerances will be available independently of each other, and the Contractor is cautioned that the liberal or full use of any one or more tolerances may deprive him of the full or any use of tolerances relating to other aspects of the Works.

Except where the contrary is specified, or when clearly not applicable, all quantities for measurement and payment shall be determined from the 'authorized' dimensions. These are specified dimensions or those shown on the Construction drawings or, if changed, as the final dimensions prescribed by the Engineer, without any allowance for the specified tolerances. Except where otherwise specified, all measurements for determining quantities for payment shall be based on the 'authorized' dimensions.

If the work is constructed in accordance with the 'authorized' dimensions plus or minus the tolerances allowed, the calculation of quantities will be based on the 'authorized' dimensions, regardless of the actual dimensions to which the work has been constructed.

When the work is not constructed in accordance with the 'authorized' dimensions plus or minus the tolerances allowed. The Engineer may nevertheless, at his sole discretion, accept work for payment. In such cases no payment shall be made for quantities of work or materials in excess of those calculated for the 'authorized' dimensions, and where the actual dimensions are less than the 'authorized' dimensions minus the tolerances allowed, quantities for payment shall be calculated based on actual dimensions as constructed.


PSA.6 TESTING (CLAUSE 7)

PSA.6.1 Approved Laboratories (Sub Clause 7.2)

The following shall be an amendment to Sub Clause 7.2:

Unless otherwise specified in the relevant specification or elsewhere in the Specifications, the following shall be deemed to be approved laboratories in which testing in terms of a specification for the purpose of acceptance by the Engineer of the quality of materials used and/or workmanship achieved may be carried out:

- Any testing laboratory certified by the South African National Accreditation System (SANAS) in respect of the nature and type of testing to be undertaken for the purpose of the Contract.
- Any testing laboratory established and operated on site by or on behalf of the Client or the Engineer.

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All laboratories to be used for testing for the purpose of acceptance by the Engineer of the quality of materials used and/or workmanship achieved shall be approved by the Engineer. The Contractor shall ensure to supply the Engineer with all relevant documentation required to confirm the proposed laboratory SANAS accreditation prior to any materials sent for testing and/or onsite testing required for acceptance of workmanship achieved.

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PSB CLEAR SITE (SANS 1200C)

PSB.1 SCOPE (CLAUSE 1)

The following shall be an addition to Clause 1:

No site clearance will take place without the written approval of the Engineer. The Engineer reserves the right to determine which areas will be cleared and payment for site clearance will only be for the areas specified by the Engineer in writing.

PSB.2 DISPOSAL OF MATERIALS (SUB-CLAUSE 3.1)

The following shall be an addition to Sub Clause 3.1:

Material from clear and grub activities is to be placed in a neat stockpile(s) or disposed of as directed by the Engineer.

This is to be within the free haul distance of 2 000 m / 2 km.

PSC EARTHWORKS (SANS 1200D)

PSC.1 CLASSES OF EXCAVATION (SUB CLAUSE 3.1.2)

The following shall replace Sub-Clause 3.1.2:

All excavation quantities throughout in all classes of material will be measured **NETT**. Excavations shall be measured per cubic metre and divided into the following classes: (Note: Excavations shall only be paid in one of the classes of material, i.e. no extra over).

PSC.1.1 Material Class "A"

This classification shall include all kinds of ground encountered except those defined in Class "B" hereinafter and shall include made-up ground, pavings, rubbish, gravel, sand, silt, calcareous material, clay, soft rock, ground interspersed with small boulders of rock not exceeding 0,5 m³ (one half of a cubic metre), dumped waste rock material in compacted embankments and **all other materials which can, in the opinion of the Engineer, be excavated by hand or by machine without drilling and blasting.**

PSC.1.2 Material Class "B"

In the case of channel, trench and small excavation, this classification shall mean granite, quartz, dolomite or rock of similar hardness which in the opinion of the Engineer or his representative, can only be removed by drilling or blasting. Solid boulders in excess of 0.5 m³ (one half of a cubic meter) will be classified in this category. This classification shall apply whether or not blasting is authorised.

In the case of bulk excavation, this classification shall include granite, quartz, dolomite or rock of similar hardness found in its original position which cannot be loosened by a bulldozer having a minimum fly wheel power of 130 kW and an operating weight of 23 000 kg (e.g. a Caterpillar D7, Komatsu D85 or equivalent in good condition, fitted with an approved single tine ripper and driven by a competent operator). This classification shall apply whether or not blasting is authorised.

One rate has been allowed in the Bill of Quantities for Class "B" material to cover all types and depths of excavation work. Spoiling of Class "B" material shall be the same as for Class "A" material. The excavation rate for Class "B" material shall, therefore, include any extra required for spoiling the rock.

Note: If the Contractor considers that any material to be excavated is classified as Class "B" above, he shall submit a written request to the Engineer or his representative for his ruling. Failing such a request, the excavations shall be deemed to be in Class "A". The decision of the Engineer as to the classification of the material shall be final and binding.

PSC.2 MATERIALS SUITABLE FOR EMBANKMENTS AND TERRACES (SUB CLAUSE 3.2.1)

The following shall be an addition to Sub Clause 3.2.1:

Fill material for all embankments and roads shall be free of all organic matter and shall be approved by the Engineer. This material will generally be obtained from the following sources:

- Basin excavations.
- Borrow pits.
- Stockpile areas.

Should these restrictions not be adhered to, the Contractor shall, at his own expense, restore the original ground level in the areas where the material has been sourced by compacting selected material to the specification of the Engineer.

PSC.3 MATERIALS SUITABLE FOR REPLACING OVERBREAK IN EXCAVATIONS FOR FOUNDATIONS (SUB CLAUSE 3.2.2)

The following shall be an addition to Sub Clause 3.2.2:

Backfilling to over-excavation outside the levels and geometry specified in the drawings necessary to obtain the specified design levels and geometry is to be carried out to the instructions and satisfaction of the Engineer and entirely at the Contractor's expense as follows:

- Where the material excavated is not required for structural support, the over-excavation will be filled with selected material approved by the Engineer in 200 mm layers and compacted to a density not less than that of the surrounding undisturbed material. Test work required to determine
- Where the material excavated is required for structural support, the over-excavation shall be backfilled with 20 Megapascal concrete, (or concrete of other strength to be specified by the Engineer) including all necessary work to prevent its inclusion with the structural concrete.

PSC.4 SAFEGUARDING EXCAVATIONS (SUB CLAUSE 5.1.1.2)

The following shall be an addition to Sub Clause 5.1.1.2:

The Contractor shall assume full responsibility for the safety of all excavations, and shall at his own expense adopt all measures necessary to secure this end, either by planking and strutting or by side sloping of the ground provided that, the Engineer may instruct the Contractor to plank and strut banks and sides of excavations, and/or side slope such banks and sides of excavations without cost to the Employer over any surface where he may consider the excavations dangerous, and/or to conform with any safety precaution in terms of the relevant regulations.

Such instructions shall be considered final and binding.

All planking and strutting must be of sufficient strength to ensure the safety of all persons in the excavations and must be suitably arranged to permit the construction of whatever is necessary, and the Engineer's decision as to this shall be binding upon the Contractor, who shall immediately proceed to rectify any planking and strutting that is deemed by the Engineer to be unsafe or of such a character as will impede or impair the placing of concrete or the construction of the Works. The Contractor shall be held fully responsible. No under-cutting of excavations will be allowed.

No additional payment will be made for side sloping and timbering and shoring work, and these shall

be deemed to be included in the rates for excavation.

The Contractor shall be responsible for making good, or having made good, at his own expense any slips, falls, caving-in of ground, damage to walls, structures or Works cause by reason of his acts or Works, or by causes within his control and shall indemnify the Engineer against any claims made in respect of loss of life, or injury or damage to persons, animals or things, caused by reasons of his Works or through causes in his control. The Contractor's rates will be held to cover all such liabilities and the Engineer shall have the right, if the Client/Engineer shall have suffered loss by reason of the above, to deduct the value of such loss from any monies due or that may become due to the Contractor.

PSC.5 EXISTING SERVICES (SUB CLAUSE 5.1.2.1)

The following shall be an addition to Sub Clause 5.1.2.1:

The Contractor shall be responsible for any necessary diversions of existing services and drains, such will be paid for as extra work and paid for at scheduled rates.

Where existing services are crossed, care shall be taken to avoid damage to them. The position of existing services shown on the drawings is approximate and the Contractor must ascertain the true position and depth thereof. The Contractor will be responsible for any damage to existing services and shall, at his own expense, take measures to support and protect these services while exposed in excavations and trenches. Any damage to existing services during the contract shall be made good by the Contractor at his own expense.

PSC.6 STORMWATER AND GROUNDWATER (SUB CLAUSE 5.1.3)

The following shall be an addition to Sub Clause 5.1.3:

The Contractor shall provide, operate and maintain pumps, pumping equipment, well points and all other water devices necessary to properly de-water and maintain free from water all excavations and all natural ground water until completion of the works, at his own expense. No work shall be excavated in water without the written permission of the Engineer.

The Contractor shall be entirely responsible for keeping the whole of the works thoroughly drained and clear of water as long as may be required, and if considered necessary by the Engineer, continuously day and night.

The Contractor is responsible, at no extras cost over and above the rates for excavation in the priced Schedule of Rates for preventing the ingress of water or storm flow into the excavations and for the construction of proper drainage channels, sumps, supply and running of pumps and everything necessary for the exclusion of water from excavations, whether such water arises through storm flow, ground water, springs or seepage, and is likewise to be responsible for the protection and de-watering of all excavations until all construction and refilling are completed to the satisfaction of the Engineer. Rates for excavation are to include for such de-watering.

Channels or sumps excavated outside the works for de-watering purposes must be refilled and made good to a standard equivalent to original conditions, and directed by the Engineer, when they are no longer required.

The rates in the priced Bill of Quantities will be held to cover the cost of any rectification of work, whether specified under this Contract or not, which the Engineer may order or decide to be necessary as a result of the Contractor's de-watering or storm flow arrangements being negligent, inadequate or improper. The cost of all such rectification work will be at the Contractor's own expense.

PSC.7 CONSERVATION OF TOPSOIL (SUB CLAUSE 5.2.1.2)

The following shall be an addition to Sub Clause 5.2.1.2:

Topsoil from the site, excavations and borrow pits shall be stripped by 200 mm or as indicated on the drawings. The material removed shall be transported to and disposed of at a suitable Site away from the Works, as directed by the Engineer. This is to be within the free haul distance of 2 000 m / 2 km. Topsoil shall not be stockpiled to a height exceeding 2.5 m or as specified on Construction drawings.

The unit of measurement shall be the cubic metre of in situ material removed. The rate must allow for the operation as described above and haulage to within 2 000 m / 2 km of the Site area or as specified in the Bill of Quantities. The disposal area is to be left as described in Sub-Clause PSC.11.

PSC.8 PREPARATION OF APPROVED SOIL BENEATH COMPACTED EMBANKMENTS AND ROADWAYS (SUB CLAUSE 5.2.1.4)

The following new Sub Clause 5.2.1.4 shall be added:

Prior to the commencement of construction of compacted embankments and roadways, the approved natural foundation soil beneath the base areas shall be broken up by ripping or other means to a minimum depth of 200 mm (or as stated in the Bill of Quantities) and compacted to the approval of the Engineer by not less than eight passes of an approved ten metric tonne roller.

The onus is placed on the Contractor to compact this layer to such a degree to ensure that the indicated densities or such lesser densities as may be specified by the Engineer can be achieved on subsequent layers. The unit of measurement for ripping and compacting the approved founding layer is the square metre.

PSC.9 EXCAVATIONS FOR GENERAL EARTHWORKS AND FOR STRUCTURES (SUB CLAUSE 5.2.2.1)

The following shall be an addition to Sub Clause 5.2.2.1:

The Contractor shall excavate whatever materials are encountered to the depths, cross-sections and grades shown on the drawings. Excavated material not required or unsuitable for backfill and/or for embankment construction shall be transported to and disposed of at a suitable site away from the site of Works as directed by the Engineer. The unit of measurement for all excavation shall be the cubic metre of in situ material excavated (measured **NETT**). It should be noted that when excavations are cut through embankments for the placing of drains, pipes, pipe encasements, puddle flanges etc., the payment for these excavations shall be based on **NETT** dimensions with the measurable depth of excavation limited to that of the maximum vertical dimension of the drain pipe or encasement structure at each particular cross-section. Similarly the measurable width shall be the design width of

each particular cross-section. All costs associated with the excavation greater than these dimensions (i.e. including backfilling with concrete or soil as required) shall not be considered for payment.

Material from excavations that are unsuitable for backfill and/or embankment construction shall be stockpiled to the dimensions and heights as instructed by the engineer and/or indicated on the Construction drawings.

The rates must allow for the operation as described above and haulage to within 2 000 m / 2 km or as stated in the Bill of Quantities. The disposal area is to be left as described in Sub-Clause PSC.11.

PSC.10 BORROW PITS (SUB CLAUSE 5.2.2.2)

The following shall be an addition to Sub Clause 5.2.2.2:

The Contractor shall be responsible for ensuring that materials obtained from borrow pits conform to the material requirements specified by the Engineer from time to time. These criteria include in brief terms, the material particle size distribution (i.e. grading envelope) minimum density and moisture content requirements.

To this end the Contractor will be required to excavate a reasonable number of trial pits at his own cost in order to prove the suitability of each borrow area location.

The Contractor, unless otherwise directed, shall obtain the required material by borrowing in these cuttings to such widths, lengths and depths as the Engineer may direct.

Borrow from borrow pits will normally be limited to material which can be loosened by the use of mechanical rippers having a minimum fly wheel power of 130 kW and operating weight of 23 000 kg (e.g. a Caterpillar D7, Komatsu D85) in good condition and driven by a competent operator.

All borrow pits shall be excavated to ensure free drainage of runoff resulting in no ponding and borrow areas are to be left in a safe and neat condition as directed by the Engineer at no extra cost.

Should stripping of unsuitable material overlying a borrow pit be required it shall be to such depths as determined by the Engineer. This unsuitable material shall be disposed of at a suitable site away from the site of Works as directed by the Engineer. The disposal area shall be within 2 000 m/ 2 km of the area from which it was removed.

The unit of measurement for unsuitable material removed shall be the cubic metre of in situ material removed. The rate must allow for the operation as described above and haulage to within 2 000 m / 2 km. The disposal area is to be left as described in Sub-Clause PSC.11.

Payment for the opening of borrow areas not allocated by the Engineer, will not be considered.

The unit of measurement for borrow material sourced shall be the cubic metre of in situ material sourced to be used for construction. The rate must allow for the operation as described above and haulage to within 2 000 m / 2 km. The disposal area is to be left as described in Sub-Clause PSC.11.

PSC.11 DISPOSAL (SUB CLAUSE 5.2.2.3)

The following shall be an addition to Sub Clause 5.2.2.3:

Stockpile areas (which may include used borrow pits) shall be allocated for the disposal of all surplus material from clear site operations, excavations, removal of unsuitable material, and for topsoil stripped from the site. These areas shall be maintained in a neat condition and when completed, levelled off by grading to a given surface as directed by the Engineer. The rates must allow for all such levelling and trimming and for haulage to within 2 000 m / 2 km of the site or as stated in the Bill of Quantities. These areas shall be specified by the Engineer.

**PSC.12 EXCAVATIONS OF UNSUITABLE MATERIAL BELOW COMPACTED WALLS/ROADWAYS (Sub
CLAUSE 5.2.2.4)**

The following new Sub Clause 5.2.2.4 shall be added:

Unsuitable natural soil below compacted walls and roadways, shall be removed to such depths widths and lengths as the Engineer may determine after the completion of the site clearance activities. The material so removed shall be transported to and disposed of at a suitable site away from the site of Works or stockpiled for re-use as directed by the Engineer and/or as specified in the Construction drawings.

The unit of measurement for unsuitable material removal shall be the cubic metre of in situ material removed (measured **NETT**). The rates must allow for the operation as described above and haulage to within 2 000 m / 2 km or as stated in the Bill of Quantities. The disposal area is to be left as described in Sub-Clause PSC.11.

PSC.13 UNAUTHORISED EXCAVATIONS (Sub CLAUSE 5.2.2.5)

The following new Sub Clause 5.2.2.5 shall be added:

The Contractor is prohibited from making Excavations other than those approved by the Engineer as necessary for the Works.

PSC.14 BLASTING (Sub CLAUSE 5.2.2.6)

The following new Sub Clause 5.2.2.6 shall be added:

The purchase, storage, handling, transportation and use of explosives shall be strictly in accordance with the current Government regulations and to the requirements of the Government Inspector of Explosives.

From the time the explosives have been delivered to the Contractor until they are used in the Work, they shall be under the continuous control of a responsible person appointed for that purpose. The Contractor shall provide documentation in the form of training certificates / qualifications to the Engineer and/or Client as proof of competency to complete the task appointed to the responsible person to control all activities associated with the explosives delivered to site. Copies of the documentation shall be held on site and made available to the Engineer and/or Client for review as all times.

If required by the Government Inspector of Explosives, guards shall be provided by the Contractor at

his own cost.

The Contractor shall acquaint himself with the requirements regarding the supply, delivery, storage etc., of blasting materials and shall make allowance in his rates for full compliance.

All blasting shall be carried out under proper control by licensed persons and the area to be blasted shall be adequately protected by rubber or steel mats and/or other approved methods if necessary.

The Contractor shall be responsible for any damage of any nature caused by such blasting to persons, animals, materials, existing services, etc., and shall adhere to all government and local regulations.

All blasting by specialist subcontractors: The Contractor shall still be held liable for any damages resulting from the use of explosives by the specialist subcontractor.

No blasting shall be permitted until all necessary precautions have been taken and permission obtained from the Engineer, who may prohibit the use of explosives in close proximity to buildings, pipelines, sewers, cables, roads, etc., and may restrict the size of the charge used. Such permission, however, shall not absolve the Contractor from his liability as stated above.

The Contractor is to measure and inspect all building prior to blasting, noting any existing damage to the structures. The Engineer shall be informed of the existing damages noted prior to blasting. Approval for blasting shall not be given without prior inspections of all structures that could be damaged.

Blasting within 500 m of any power lines shall be limited to single shots under cover. The unit of measurement for all blasting work shall be as specified for rock excavation in Sub-Clause PSC.1.

PSC.15 OVERBREAK (SUB CLAUSE 5.2.2.7)

The following new Sub Clause 5.2.2.7 shall be added:

All excavation quantities throughout, in all classes of material will be measured **NETT**.

PSC.15.1 Excavation in Class "B" material (Sub Clause 5.2.2.7.1)

The following new Sub Clause 5.2.2.7.1 shall be added:

Items measured in square metres, of extra for overbreak in Class "B" excavation material including filling with respective classes of concrete or back-shuttering and filling with selected earth filling and compacting in 200 mm layers (the Contractor is to provide a rate for both options) have been measured to the area of vertical concrete structure abutting against Class "B" excavation material for the respective classes of concrete. These items will be measured and paid for to all vertical faces of concrete structure abutting against Class "B" excavation material faces and the rate will apply irrespective of any discrepancy between the system (as above described) and the system used in construction.

Similarly, items measured in square metres of extra for overbreak in Class "B" excavation material including filling with respective classes of concrete have been measured to the area of horizontal or sloping concrete structure abutting against Class "B" excavation material.

These items will be measured and paid for over and above the concrete structure and blinding requirements of the drawings and no extra concrete in filling will be measured, no matter what extra

depth may have been excavated and filled back. However, should the Engineer instruct that the excavation be carried out to depths greater than that required on the drawings, then the above described square metre item will not be measured, but such excavation and backfilling shall be measured and paid for.

PSC.15.2 **Excavation in Class "A" material (Sub Clause 5.2.2.7.2)**

The following new Sub Clause 5.2.2.7.2 shall be added:

- Where no Class "B" material as described is encountered in any one excavation, the excavation quantities will be measured **NETT**.
- Where Class "A" and "B" material as described are encountered in any one excavation, the excavation in Class "A", material will be measured only as stated in point above, irrespective of any over-excavation for any reason whatsoever, and the excavation in Class "B" material will be measured only as stated in PSC.15.1 previously, irrespective of any over-excavation for any reason whatsoever.

PSC.16 **EXCAVATIONS TO BE PASSED (SUB CLAUSE 5.2.2.8)**

The following new Sub Clause 5.2.2.8 shall be added:

Before any concrete is poured, all foundation surfaces must be clean and generally prepared to receive it to the satisfaction of the Engineer. The cost of this work must be included in the rate for excavation and formwork.

In no case must concrete be placed in an excavation until the consent of the Engineer has been obtained.

PSC.17 **FALL IN OF GROUND / COLLAPSE OF EXCAVATION (SUB CLAUSE 5.2.2.9)**

The following new Sub Clause 5.2.2.9 shall be added:

Should any ground or any of the excavations collapse, other than that required to be excavated owing to the omission or inefficiency of planking and strutting or any other cause, it must be dug out, and made good as outlined in Clause PSC.2.

These remedial measures will be carried out to the satisfaction of the Engineer at the Contractor's expense.

PSC.18 **EMBANKMENTS (SUB CLAUSE 5.2.3.1)**

The following shall be an addition to Sub Clause 5.2.3.1:

Embankments and fills shall be constructed by obtaining selected material from excavations, approved borrow pits or stockpiles and forming it to the dimensions and elevations given on the drawings.

Material forming the embankment and fill shall be compacted in layers as detailed in Sub-Clause PSC.21.2 or PSC.22 to form durable embankments and fill of good, regular appearance with all cross-sections having the minimum sizes detailed on drawings and having side slopes not steeper than

specified. The sides of the embankments and fill must be compacted to hard durable faces. Any spoil resulting from this operation is to be removed and disposed of at no extra cost.

The unit of measurement for embankment and fill construction shall be the design cubic metre of placed material after compaction, trimming and forming to the specified dimensions. Contractors will not be paid for embankments and fill constructed in excess of the dimensions specified. The Engineer will decide on acceptance or rejection of embankments and fill which are oversized.

The Contractor is to allow in his rate for forming and compacting an oversized embankment/fill, cutting back and compacting the sides of the embankment/fill to the correct size.

(Note: In general the preferred source of borrow material, subject to quality approval by the Engineer will be excavated material from the new water dam basin and outside the new water dam area.)

PSC.19 BACKFILLING (SUB CLAUSE 5.2.3.2)

PSC.19.1 Backfilling where compaction is not required

The following shall be an addition to Sub Clause 5.2.3.2:

The unit of measurement for all backfill shall be the **NETT** cubic metre of consolidated material placed.

PSC.19.2 Backfilling where compaction is required

The following shall be an addition to Sub Clause 5.2.3.2:

Backfilling to foundations and trenches shall be paid for under the items provided in the Bill of Quantities and shall be carried out by replacing excavated material with, either:

- Selected excavated material in uncompacted 200 mm layers, each layer being thoroughly compacted, rammed and consolidated before the succeeding layer is placed or such other ways as may be directed by the Engineer. In areas where specified compaction densities are required for backfill then the identical testing and approval procedures as outlined in Sub-Clause PSC.21.2 and PSC.22 will be enforced. Only sand replacement testing may be done near concrete foundations.
- Selected material with the addition of 12% cement by mass and sufficient water to obtain a consistency to permit the compaction by means of concrete vibrating equipment ("soilcrete")
- Loose selected material as shown on the drawings.

Any defects caused due to subsidence of the backfilling, as a result of improper workmanship shall be made good at the Contractor's expense. At the ground surface, the filling shall be banked to a height of about 100 mm above the level of the adjacent ground surface to allow for any settlements and before completion of the Works, and, if necessary, again before expiry of the maintenance period or at such other times as the Engineer may direct, all refilled excavations shall be examined and dressed

and, where depressions have occurred, these shall be made good by refilling and ramming with suitable material at the Contractor's expense.

The unit of measurement for all backfill shall be the **NETT** cubic metre of compacted material placed.

PSC.20 TRANSPORT OF EARTHWORKS (SUB CLAUSE 5.2.5)

The following shall be an addition to Sub Clause 5.2.5:

The Contractor shall at his own cost construct and maintain temporary haul roads as required along the route designated by the Engineer.

If the Contractor chooses, for reasons of his own, to transport material by a different route, the measurement of distance for transport will be along the routes designated by the Engineer.

In the case of borrow pits and stockpile areas, the Contractor shall be restricted to the routes designated by the Engineer.

Free haulage of material excavated from a borrow pit, excavation etc. or cutting shall be limited to a distance of 2000m / 2 km.

Overhaul is that portion of the total haulage beyond the free haul limit and is measured separately.

The unit of measurement for overhaul in the case of compacted fill or placed material shall be the cubic metre - kilometre being the product of distance measured in kilometres to the nearest tenth of a kilometre and the cubic metres of compacted or placed (whichever is applicable) material transported. However, in the case of cut to spoil, or stockpile the unit of measurement for overhaul shall be the cubic metre-kilometre being the product of the distance measured in kilometres to the nearest tenth of a kilometre and the cubic metre of undisturbed in situ material transported.

PSC.21 TOLERANCES (CLAUSE 6)

PSC.21.1 Position, Dimensions, Levels, Etc. (Sub Clause 6.1)

The following shall be an addition to Sub Clause 6.1:

All embankments, excavations, trenches, fill areas, channels etc. shall be neatly trimmed to the required widths, cross-sections and levels as specified on the drawings and specifications. Where not stated the tolerance is to be within + 25 mm (Degree of Accuracy I).

The width of the formation measured from the final staked centre line shall in no case be less than the specified dimension. The tolerance on the depth and location of soil replacement trenches shall be $\pm 150\text{mm}$. The average depth shall not be less than the specified depth.

PSC.21.2 Moisture Content and Density (Sub Clause 6.2)

The following shall replace Sub Clause 6.2 in its entirety:

PSC.21.2.1 General

The standards of compaction required are shown on the drawings and the Contractor shall be entirely responsible for obtaining a density not less than the minimum specified Standard Proctor density or Modified AASHTO density whichever is applicable (hereinafter referred to as specified density).

All compacted fill material is to be placed in loose horizontal layers to a thickness that will ensure that after compaction has been completed the thickness of the compacted layer shall not be greater than 200 to 300 mm, to a density not less than the minimum specified density. It should further be noted that a uniform moisture content (as per specification) is to be achieved throughout the loose layer prior to compaction.

All compaction shall be carried out in a direction parallel to the centre line of the earthworks, working on a predetermined pattern which shall ensure that the whole area of the layer receives a uniform compaction.

The moisture content shall unless otherwise specified be in the range between one per cent below and two per cent above Standard Proctor or Modified AASHTO optimum moisture content, (or any other range specified on the drawings) whichever is applicable. Compacted layers with moisture contents outside the specified range shall be deemed to have failed regardless of the densities achieved. The required moisture content shall be distributed uniformly throughout each layer of material.

Compaction shall be carried out by means of compaction equipment to be approved by the Engineer.

PSC.21.2.2 Compaction to a Performance Specification

If required and agreed with the Engineer, certain embankments and fills may be constructed by applying a performance specification to each placed layer (hereinafter referred to as normal or performance compaction). These embankments and fill shall be formed by compacting selected material in loose layers not exceeding 200 mm in thickness after compaction by applying a minimum number of passes, to be specified by the Engineer, by an approved roller. The minimum number of passes will be determined on site, jointly by the Contractor and the Engineer, and will be based on the number of passes required to obtain a compaction of 98% Standard Proctor Density ($\pm 2\%$) or any lesser density that the Engineer may specify. The Engineer reserves the right to re-execute these tests and to re-specify the minimum number of passes from time to time dependent on material variability, compactor type, moisture content, etc.

If necessary, during and/or prior to compaction, water shall be provided to bring the soil to the correct moisture contents as directed by the Engineer.

The Engineer reserves the right to stop and condemn all "performance" compaction work if, in his opinion, the Contractor is seen not to be executing the works as described above. All such remedial works shall be for the Contractor's account.

PSC.21.2.3 Preparation of Pipe Trench Floors

The floor of trenches shall be compacted to at least 95% Standard Proctor density at optimum moisture content or any other specified density and moisture content that the Engineer may authorise, to a minimum depth of 150 mm. The unit of measurement shall be the square metre of trench prepared.

PSC.22 TESTING (CLAUSE 7)

PSC.23 TAKING AND TESTING OF SAMPLES (SUB CLAUSE 7.2)

The following clause shall be an addition to Sub Clause 7.2:

PSC.23.1 Compaction Control

The Contractor shall provide an adequate SANAS accredited site laboratory, equipment, facilities and personnel for carrying out the required compaction tests. Should the Engineer at any time consider any of the above to be inadequate for this purpose, he shall instruct the Contractor to cease further work on compaction until such time as the Contractor has remedied the deficiency.

The onus shall be on the Contractor to ensure the following:

- That the state of the material when placed is such that the compaction as specified;
- That material selected for use in compacted embankments shall be approved by the Engineer on the basis of the maximum dry density (Standard Proctor or Mod AASHTO, whichever is applicable) being equal to or greater than a minimum density to be specified by the Engineer.
- Evaluate the test work on materials to confirm material properties. The frequency shall be at least one Standard Proctor or Mod AASHTO and one foundation indicator, per 1000 m² (1/1000m²). The frequency may be revised if the tests show little/no variability.

Hence with the object of controlling the selection and compaction of all materials used in the various layers of fill the Contractor shall perform grading analyses, Standard Proctor or Mod AASHTO density tests whichever is applicable on each type of material which he proposes to use, including mixed or blended materials.

In addition to the tests required for his own control the Contractor shall allow for at least two density checks per 200 square metre block of material compacted per layer or as specified by the Engineer. The recognised method of determining the density is the sand replacement test. However, the Radio Isotope or other approved method may be used (if approved by the Engineer) for density and moisture checks, provided suitable agreement is obtained between this method and the sand replacement method and provided the necessary calibration and specified tests to these instruments are undertaken at intervals as specified in applicable standards (e.g. for a nuclear density gauge SANS 3001 NG1 to NG5) or to be specified by the Engineer. If nuclear density measuring devices are used,

they shall be calibrated against sand replacement tests.

If an alternative method of density determination is accepted, the sand replacement method shall be used to check every fourth density determination, and the moisture content of the sample shall be determined by oven drying as specified for the Modified AASHTO and Standard Proctor compaction methods.

To account for material variability, approved density tests will be accepted based on the following:

- **Walls/Fill compacted to 100% Standard Proctor Density or Modified AASHTO Density**
 - Two density tests per 200m² block is below 95% and not as specified, the entire block will be re-ripped, re-watered and re-compacted.
 - If any one or both of the two density tests per 200 m² block is between 95% and 98% then two more tests will be undertaken in the particular 200 m² block. If the average of the four density tests is greater than or equal to 98% then the block will be passed. If the average is less than 98% then the entire block will be re-ripped, re-watered and re-compacted.
 - If both of the two density tests per 200 m² block lie between 98% and 102% then the block will be passed (i.e. a range of $\pm 2\%$). Tests achieving densities in excess of + 2% will not be accepted. In this case the block will have to be re-ripped, re-watered and re-compacted.
- **Walls/Fill compacted to 98% Standard Proctor Density or Modified AASHTO Density**
 - If any one of the two density tests per 200 m² block is below 98% then the entire block will be re-ripped, re-watered and re-compacted.
 - Any one density test will be deemed to have passed if a density of + 2% is achieved. Tests achieving densities in excess of + 2% will not be accepted and the entire block will be re-ripped, re-watered and re-compacted.
- **Walls/Fill compacted to 95% Standard Proctor or Modified AASHTO Density**
 - If any one of the two density tests per 200 m² block is below 93% then the entire block will be re-ripped, re-watered and re-compacted.
 - If any one or both the density tests per 200 m² block is between 93% and 95% then two or more tests will be undertaken in the particular 200 m² block. If the average of the four density tests is greater than or equal to 95% then the block will be passed. If the average is less than 95% then the entire block will be re-ripped, re-watered and re-compacted.
 - Any one density test will be deemed to have passed if a density of + 2% is achieved. Tests achieving densities in excess of + 2% will not be accepted and the entire block will be re-ripped, re-watered and re-compacted.
- **Optimum moisture content of compacted walls/fills**
 - Should the tested block indicate density has been achieved, but the optimum moisture content of the tested block is below or +2% of the specified OMC,

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the layer shall be deemed to have failed the test and be re-ripped, re-watered or left to dry and re-compacted.

The compaction control tests shall be carried out as laid down in "South African National Standards - SANS 3001 - Civil Engineering Test Methods" published by the SABS Standards Division, Pretoria. Should no specification for a particular test be available within the SANS 3001 Civil Engineering Test Methods, the Contractor shall carry out compaction control tests as laid down in "Standard Methods of Testing Materials" published by the Department of Transport, Pretoria or as specified by the Engineer.

Field density and moisture content tests are to be carried out within twelve hours after the completion of each section of the layer. If such tests are not carried out by the Contractor within this period then the Engineer may fail a layer or section of the layer regardless of any test results which may then or subsequently be provided and this decision shall be final.

When the compaction of any section of any layer, for which a density and moisture content is specified, is completed, the Contractor shall supply to the Engineer copies of test results whether successful or otherwise within 6 hours of determination.

The Contractor is to note that no subsequent layer is to be placed until such time as the previous layer has been approved by the Engineer in writing.

The Contractor shall maintain updated, accurate records of all compaction control tests, i.e. test data, chainage, offset and layer elevation.

These records shall be available on site for inspection by the Engineer at all times.

Where tests reveal that the density or moisture content of any layer, at any depth, is not to specification, the Contractor shall rip, re-compact and re-water if necessary such material. If the specified density cannot be obtained by further compaction of the material such material shall be removed and replaced by material capable of yielding the specified density.

All such testing and corrective work shall be undertaken at the Contractor's cost.

The Engineer may instruct the Contractor to carry out tests to check the density, moisture content and particle size distribution of the compacted material and/or to check the testing procedures of the Contractor as described above. The costs of these tests will be paid for by the Employer only if the results of the tests show that the specified density has been obtained.

The Contractor shall pay for all such tests where the results show that the specified density has not been obtained; also he shall pay for any further tests to check if the required density, moisture content and particle size distribution has been obtained after the specified corrective measures have been carried out.

PSD SMALL EARTH DAMS (SANS 1200DE)

PSD.1 RIP-RAP (CLAUSE 5.2.3.3)

The following shall be an addition to Sub Clause 5.2.3.3:

The Contractor shall supply and install as indicated on the Construction drawings broken hard rock having an average rock size D_{50} of 200 mm. The rip-rap shall be well graded from a maximum size at least 1.5 times the average rock size to 30 mm spalls suitable to fill voids between rocks. Individual rock fragments shall be dense, sound and resistant to abrasion and shall be free from cracks, seams and other defects that would tend to increase unduly their destruction by wave action. The rip-rap need not be compacted but shall be placed to grade in a manner to insure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the larger rock fragments in such a manner as will result in well-keyed, densely placed, uniform layers of rip-rap of the specified thickness. Hand placing will be required only to the extent necessary to secure the results specified. All rip-rap material shall comply with the following requirements:

- Be hard, dense, durable rock that is free from weathering, cracks, seams and other defects that will cause rapid or excessive deterioration or degradation during service.
- Contain not more than 5% by mass in total impurities (undesirable material) such as individual pieces of rip-rap which do not meet the quality requirements as specified and which can be visually differentiated from satisfactory pieces, plus dirt, sand, clay, rock fines and material of low density.
- The specific gravity of the individual particles shall be greater than 2.55.
- The dry 10% Fines Aggregate Crushing Test (FACT) value determined in accordance with SANS 5842 shall be not less than 110 kN.
- The wet 10% FACT value determined in accordance with SANS 5842 shall be not less than 75% of the determined dry value.
- The loss after 5 cycles measured by the sodium sulphate soundness test shall not be greater than 10%.

The basic principles for determining the soundness of selected rip-rap material shall be in accordance with SANS 5839, adapted as stated below:

- Initially the sample shall be broken into an approximate uniform grading and shall be screened. The portion passing the 19 mm sieve but retained on the 13.2 mm sieve shall be used in the test.
- The test sample shall weight 1 000 grams \pm 2% and shall be washed as described in SANS 5839.
- The procedure specified in Section 3 of SANS 5839 shall be followed for 5 cycles.
- The sample shall then be sieved using an 11.2 mm sieve as defined in table 3 of SANS 5839.

- The percentage loss shall be determined from the mass of the material retained on the sieve and mass of the original sample.

Rip-rap is to be selected from approved sources or the waste rock dumps either by locating pockets of coarse material with not more than 10% fines or by progressively pushing material from the top of the dump over the crest to facilitate gravitational sorting and thereafter systematically removing the above material from the toe. The area and final method of obtaining rip-rap will be indicated by the Employer. No undermining of waste rock dumps will be allowed in sourcing material for rip-rap.

The price for installing the rock material in the works will include all the costs of obtaining, loading, transporting the material from the approved source or dump to the works, complying with any security regulations or any arrangements the Plant may impose upon entering the area of the dump, or any other work necessary to obtain, supply and place the rock in the locations indicated on the drawings. **No overhaul will be paid for.** The Contractor is to allow in his rates for keeping the rock dump safe during loading periods. The Contractor is to obtain the Engineer's written approval regarding the safety of the dump on completion of the rock loading exercise.

The unit of measure shall be the design cubic metre of rock placed in the works or the works as specified.

PSD.2 PERMEABLE MATERIAL (SUB CLAUSE 3.2.2)

The following shall be an addition to Sub Clause 3.2.2:

The Contractor's attention is specifically drawn to the importance of obtaining consistent supplies of permeable drainage material in accordance with this specification. Each drainage layer is classed as a structural entity. Stringent quality control checks on the grading of the material, material thickness, and the dimensional correctness will be applied to ensure the integrity of each drainage layer.

The following quality control measures will be applied by the Contractor to all permeable materials at no additional cost.

Generally, one grading analysis is to be carried out by the Contractor for every 100 m³ of material brought to Site. However, if materials are observed to be variable, then the Engineer reserves the right to insist that one grading analysis per truck load be undertaken. The grading analyses are to be submitted to the Engineer for approval which must be obtained prior to placement of the permeable material. Any material which fails to meet with the specification will be rejected, removed from Site and replaced at the Contractor's expense.

Stockpiles are to be formed on approved areas rendered free of vegetation and loose contaminant matter. Furthermore, in order to ensure an acceptable level of quality assurance and to minimise contamination, the number of stockpiles used, and their location is to be approved by the Engineer.

Notwithstanding the criteria stipulated below, the Engineer reserves the right to approve the use of any materials proposed for the filter.

As a guide, he may work on the basis of the performances of the material in an actual flexible wall permeameter test (ASTM D5084-90).

Permeable material as used in the filter drains shall comply with the following:

PSD.2.1 **Crushed stone**

The stone shall be in accordance with SANS 1083, except that the stone shall be thoroughly **cleaned and washed**, and the grading requirements shall be as prescribed below:

PSD.2.1.1 **Nominal 6 mm (Intermediate Stone)**

Sieve Size (mm)	Percentage Passing (min)	Percentage Passing (max)
37.5		100
28		90
20		55
14	100	45
10	100	36
5	62	16
2	15	0
1	0	

PSD.2.1.2 **Nominal 19 mm (Coarse Stone)**

Sieve Size (mm)	Percentage Passing (min)	Percentage Passing (max)
75		100
63		90
50		70
37.5		39
28	100	13
20	93	0
14	55	
10	30	
5	0	

(Note: Noted following grading envelopes are subject to change depending on the final approved filter material used and proposed during construction)

Hardness: When tested in accordance with SANS 3001: Part AG10, the aggregate crushing value shall **not exceed 21**.

Flakiness: The maximum flakiness index when testing in accordance with SANS 3001: Part AG4 shall be **25%**.

The unit of measurement shall be the design cubic metre of approved stone in place in the drains. The rate shall cover the cost of supply, delivery, wastage, placing and light compaction of the stone.

PSD.3 **UNDERDRAIN CONSTRUCTION (SUB CLAUSE 5.2.6)**

The Following New Sub Clause 5.2.6 shall be added:

Underdrains shall be constructed as shown on the drawings.

Excavation for the underdrains shall be to the specified tolerances. The geotextiles as specified in Clause PE of this Specification shall be carefully and neatly laid on the ground and shall be pinned to

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the trench walls with 150 mm nails fitted with 30 mm diameter, 2 mm thick galvanised washers placed at approximately 1 000 mm centres. (The Contractor may propose other fixing methods to be approved by the Engineer).

Pipelines shall be laid to straight grades between vertical bends and shall be to the routes, levels and grades indicated on the drawings.

Before placing any permeable material over and adjacent to the pipes the Contractor is to obtain the approval of the Engineer.

The permeable materials shall be placed as shown on the drawings. The finished thickness of each layer of permeable material shall nowhere vary below the specified thickness. Care should be exercised when placing the permeable materials so as not to damage the subsurface drainage pipes.

The Contractor shall carry out tests from time to time to ensure that the permeable material conforms to the minimum requirements set out in Sub-Clause PSD.2. The Engineer may, at his discretion require further tests to be conducted to ensure the permeable material conforms to the minimum requirements set out in Sub Clause PSD.2.

Any material placed as permeable material not conforming to the minimum requirements as set out in Sub-Clause PSD.2 above shall, at the discretion of the Engineer, be removed and replaced with suitable material at the Contractor's expense.

At all junctions with outfall drains or at any other section where required by the Engineer, no permeable material shall be placed until the junction has been inspected and approved by the Engineer. The Contractor shall undertake the necessary rodding and/or water testing as required by the Engineer. All such costs shall be borne by the Contractor and be deemed to be included in the construction rates.

PSD.3.1 DUST SUPPRESSION (Sub Clause 5.2.6.1)


The following new Sub Clause 5.2.6.1 shall be added:

Dust suppression is to be carried out to the Engineers satisfaction in the vicinity of the drain construction to ensure no contamination of the filter drains. All cost for dust suppression in the vicinity of the drain construction shall be borne by the Contractor and deemed to be included in the underdrainage construction rates.


PSD.4 EROSION CONTROL (SUB CLAUSE 5.2.7)

The following new Sub Clause 5.2.7 shall be added:

Any runnels or erosion channels greater than 50 mm deep which are formed during the construction period shall be backfilled and compacted and the surfaces returned to their original condition. This shall apply to outside embankment faces, embankment crests, inside slopes, berms and canals. During the rehabilitation process, should any erosion take place prior to vegetation being established, the Contractor shall reinstate the area as per Clause PA of this Specification, until such time as vegetation has been established and the maintenance period is completed.

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The Contractor will receive no payment for repairing erosion damage as specified above and be deemed to be included in the construction rates.

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PSE GABIONS AND PITCHING (SANS 1200DK)

PSE.1 MATERIALS (SUB CLAUSE 3.1)

The following shall be an addition to Sub Clause 3.1:

The Contractor shall supply the relevant specification for the reno mattresses and/or gabion baskets from the supplier the Contractor intends to use for the works to the Engineer for approval. Failing this, the Engineer reserves the right to condemn any gabion baskets and/or reno mattresses installed on site and the Contractor shall at his own expense, replace the gabion baskets and/or reno mattresses to gabion baskets and/or reno mattresses as approved by the Engineer. Stone to be used in the gabion baskets shall be approved by the Engineer.

PSE.2 CONSTRUCTION (SUB CLAUSE 5.4)

The following new Sub Clause 5.4 shall be added:

The Contractor submits a copy of the manufacturer's installations guidelines (from supplier) to the Engineer for approval thereof.

PSF CONCRETE (STRUCTURAL) (SANS 1200G)

PSF.1 AGGREGATES (SUB CLAUSE 3.4.2)

The following shall replace Sub Clause 3.4.2 in its entirety:

“Plums” shall not be used.

PSF.2 REINFORCEMENT (SUB CLAUSE 3.6)

The following shall be an addition to Sub Clause 3.6:

Reinforcement shall be as indicated on the Construction drawings.

PSF.3 REINFORCEMENT FIXING (SUB CLAUSE 5.1.2)

The following shall be an addition to Sub Clause 5.1.2:

No welding of reinforcement shall be allowed. Where MESH reinforcement is to be used in the works, MESH shall be supplied welded from the supplier. No site welds on MESH reinforcing shall be allowed. MESH reinforcement with damaged welds shall not be used in the works without written approval of the Engineer.

PSF.4 REINFORCEMENT COVER (SUB CLAUSE 5.1.3)

The following shall be an addition to Sub Clause 5.1.3:

The cover of concrete over reinforcement shall be as indicated on the Construction drawings and/or as specified by the Engineer.

PSF.5 STRENGTH CONCRETE (SUB CLAUSE 5.5.1.7)

The following shall be an addition to Sub Clause 5.5.1.7:

All concrete in this contract shall be deemed strength concrete. The grade of concrete and position on the Works shall be shown on the drawings, and as described in the Bill of Quantities or as directed by the Engineer from time to time. The maximum nominal size of coarse aggregate shall be 19 mm. Ready mix concrete shall comply with the requirements set out in SANS 878:2012 - Ready-mixed Concrete.

PSF.6 CONSTRUCTION JOINTS (SUB CLAUSE 5.5.7.3)

The following shall be an addition to Sub Clause 5.5.7.3:

The unit of measurement shall be the metre squared of concrete surface placed and prepared in accordance with SANS 1200G, as specified on the drawings or as directed by the Engineer. The Contractor shall submit details of the filler and sealant to be used in the construction joints to the

Engineer for approval thereof. The Contractor shall inform the Engineer once a construction joint position is ready to receive the approved filler and sealant to allow the Engineer to inspect the joint prior to placement of the approved filler and sealant. The Engineer reserves the right to allow the Contractor to place approved filler and sealant without prior approval. It remains the Contractors responsibility to ensure all construction joints are completed to specification and Construction drawings supplied.

The Contractor shall supply the Engineer, on completion, an as-built drawing indicating the position of all construction joints. The drawing shall be supplied in AutoCad format.

The cost of all construction joints and works required to ensure construction joints are as per Specifications and Construction drawings are for the Contractors account and deemed to be included construction rates for concrete.

PSF.7 CONCRETE SURFACES (SUB CLAUSE 5.5.10.4)

The following new Sub Clause 5.5.10.4 shall be added:

Wood and steel float finishes will only be paid to the items listed in the Bill of Quantities. All other floating or striking off shall be deemed to be covered in the shutter and concrete rates.

PSF.8 TOLERANCES (SUB CLAUSE 6.1.1)

The following shall replace Sub Clause 6.1.1 in its entirety:

Degree of Accuracy II applicable.

PSF.9 TEST (CLAUSE 7)

The following shall be an addition to Clause 7:

Concrete shall be cured and testing in accordance with SANS 1200G - Concrete (Structural).

Prior to commencement of concrete works on site the Contractor shall submit to the Engineer, mix designs and compression test results for the proposed mixes for each class of concrete specified together with the grading analysis reports of the aggregates used.

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PSG SEWERS (SANS 1200LD)

PSG.1 MATERIALS (CLAUSE 3)

PSG.1.1 Underdrainage/ Leakage Detection Pipes, Fittings and Pipe Joints (Sub Clause 3.1.8)

The following new Sub Clause 3.1.8 shall be added:

Underdrainage/leakage detection pipes to be slotted drainex piping or similar approved unless otherwise specified on the Construction Drawings or by the Engineer. The diameter of the pipes shall be as specified in the Bill of Quantities and Construction Drawings. The unit of measure shall be the metre of pipe in place. The construction price shall include the furnishing and placing of the pipes to the required grades and elevations and shall be inclusive of the joints and special make-up pieces.

PSG.1.2 Underdrainage / Leakage Detection Outlet Pipes, Fittings and Pipe Joints (Sub Clause 3.1.9)

The following new Sub Clause 3.1.9 shall be added:

All underdrainage outlet piping to be non-slotted drainex piping or similar approved unless otherwise specified in the Bill of Quantities and the Construction Drawings or as specified by the Engineer. The diameter of the pipes shall be as specified in the Bill of Quantities and Construction Drawings. The unit of measurement shall be the metre of pipe in place. The construction price shall include furnishing and placing of the pipes to the required grades and elevations inclusive of joints and special make-up pieces.

PARTICULAR SPECIFICATIONS

PA SPECIFICATIONS FOR GEOTEXTILES

PA 1 GENERAL

PA 1.1 SCOPE

The following geotextile/ geosynthetic specification covers the technical requirements for the manufacturing and installation of the geotextiles to be used for leachate collection/detection works, separation and geomembrane protection and geotextiles to perform hydraulic and mechanical roles as filter, drainage separation materials.

All materials must meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided.

PA 1.2 STANDARD SPECIFICATIONS

The materials used in manufacturing the lining geomembrane shall comply in all respects with the standard specification (where applicable) as shown in TABLE 2, the latest revision at date of issue of this specification document which shall be held to apply. Any contradictions between publications shall be submitted to the Engineer for decision.

- Project Technical Specifications.
- Project Construction Drawings.
- Project Construction Assurance Plan.

Table 2: Standard Specifications Applicable to Geotextile Materials

PUBLISHER	REFERENCE NUMBER	DESCRIPTION
South African Bureau of Standards (SABS)	SANS 1525:2013	Geosynthetics - Wide-width tensile test
	SANS 9862:2013	Geosynthetics - Sampling and preparation of test specimens
	SANS 9863-1:2013	Geosynthetics - Determination of thickness at specified pressure Part 1: Single layers
	SANS 12236:2013	Geosynthetics - Static puncture test (CBR test)
	SANS 11058:2013	Geotextiles and geotextile-related products - Determination of water permeability characteristics normal to the plane, without load
	SANS 12958:2014	Geotextiles and geotextile-related products - Determination of water flow capacity in their plane
	SANS 13433:2013	Geosynthetics - Dynamic perforation test (Cone drop test)

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WORKS FOR THE NAMAKWA
SANDS EOFS PROJECT, RSF6 AND
ASSOCIATED INFRASTRUCTURE**

Contract Order No.

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PUBLISHER	REFERENCE NUMBER	DESCRIPTION
	SANS 12956:2013	Geotextiles and geotextile-related products - Determination of the characteristic opening size
International Organization for Standards (ISO)	10319:2008	Geosynthetics - Wide-width tensile test
	9862:2005	Geosynthetics - Sampling and preparation of test specimens
	9863-1:2005	Geosynthetics - Determination of thickness at specified pressures, Single layers
	12236:2006	Geosynthetics - Static puncture test (CBR test)
	13433:2006	Geosynthetics - Dynamic perforation test (Cone drop test)
	11058:2010	Geotextiles and geotextile-related products - Determination of water permeability characteristics normal to the plane, without load
	12958:2010	Geotextiles and geotextile-related products - Determination of water flow capacity in their plane
International Organization for Standards (ISO)	12956:2010	Geotextiles and geotextile-related products - Determination of the characteristic opening size
American Society of Testing and Materials (ASTM)	D 4632	Standard test method for grab breaking load and elongation of geotextiles
	D 4533	Standard test method trapezoidal tearing strength of geotextiles
	D 4354	Practice for Sampling of Geosynthetics for Testing
	D 4355	Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
	D 4439	Terminology for Geotextiles
	D 4491	Test Methods for Water Permeability of Geotextiles by Permittivity
	D 4595	Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
	D 4751	Test Method for Determining Apparent Opening Size of a Geotextile
	D 4759	Practice for Determining the Specification Conformance of Geosynthetics
	D 4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
	D 4873	Guide for Identification, Storage, and Handling of Geotextiles
	D 5261	Test Method for Measuring Mass per Unit Area of Geotextiles
	D 6241	Test Method for Static Puncture Strength of Geotextiles and Geotextile Related Product Using a 50-mm Probe
Geosynthetic Research Institute (GRI)	GRI GT 7	Standard practise for determining long term design strength of geotextiles
	GRI GT 12(a)	Standard Specification for test methods and properties for nonwoven geotextiles used as protection (or cushioning) materials
	GRI GT 12(b) - ISO Version	Standard specification for test methods and properties for nonwoven geotextiles used as protection (or cushioning) materials

PUBLISHER	REFERENCE NUMBER	DESCRIPTION
	GRI GT 13	Standard specification for test methods and properties for geotextiles used as separation between subgrade soil and aggregate
	GRI GT 13(a) ASTM Version	Standard specification for test methods and properties for geotextiles used as separation between subgrade soil and aggregate
	GRI GT 13(b) ISO Version	Standard specification for test methods and properties of geotextiles used as separation between subgrade soil and aggregate
AASHTO Standards	M288-96	Geotextile Specification for Highway Applications

PA 2 APPLICATION

Geotextiles shall consist of a synthetic polymer material manufactures in a continuous homogeneous sheet. The synthetic polymers used during the manufacturing process may be one or more of the following:

- Polyester.
- Polypropylene.

The geotextile material is specified in three categories, Type A, B and C.

- 1) Type A – Separation, sediment or erosion control application
- 2) Type B – Stabilization, sediment or erosion control applications
- 3) Type C – Reinforcement applications

This specification covers non-woven needle punched polyester or polyprop geotextile test properties (Type A) for subsequent use as protection (or cushioning) materials.

This specification covers geotextile test methods properties for subsequent use as separation between subgrade soil and aggregate predominantly in pavement systems.

PA 3 DEFINITIONS

For the purposes of this specification, the definitions given in the Contract and the following definitions shall apply:

- **“According to ASTM D4439, a Geotextile”** is a permeable geosynthetic comprised solely of textiles. Geotextiles are used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human made product, structure, or system.
- **"Minimum Average Roll Value (MARV)"** is the property value calculated as Typical Roll Value minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed the Minimum Average Roll Value.
- **Separation**, The placement of a flexible porous geosynthetic between dissimilar materials so the integrity and functioning of both materials can remain intact or be improved.

PA 4 MATERIALS

PA 4.1 QUALIFICATIONS

PA 4.1.1 QUALIFICATION OF GEOTEXTILE MANUFACTURER

The geotextile shall be manufactured by the following:

- Reputable manufacturers, that meet all the technical and experience requirements as set out in the Project Specifications.
- Manufacturers whose product was tested and satisfied technical performance needs of the project during design phase.
- Details of the Manufacturer shall be provided by the Installer.
- The Manufacturer shall be approved by the Engineer and the Client.

PA 4.1.2 QUALIFICATION OF GEOTEXTILE INSTALLER

The geotextile Installer must meet the following criteria, and supporting documents to the following criteria must be submitted to the Engineer for approval prior to the commencement of works:

- Be an accredited current member of the International Association of the Geosynthetics Installers (IAGI) association, and should have been a member in the previous 3 years consecutively without interruption in membership.
- Provide their maximum installation capacity per day and number of teams they are willing to mobilise to the project.
- Provide the relevant quality management system used in their work during liner installation i.e. SABS/ISO 9001.
- Should have a minimum experience of geotextile installation of 3,000,000 square meters.
- Provide workmanship warranty against defects in the installation and workmanship for 1 year commencing with the date of final acceptance or in line with project or Client requirements.
- Provide a minimum of two referee contacts of previous projects carried out in the last 15 months of similar size to the intended project. The details should include a contact name and number.

The following information is to be submitted to the Engineer for approval prior to the commencement of works:

- Manufacturer name and track record in the South African and Democratic Republic of Congo markets listing completed successful projects for which the Manufacturer has manufactured geotextile materials from the same type as that proposed to be used for this Contract.

- Manufacture capabilities:
- Information on plant size, equipment, number of shifts per day, capacity per shift, quality control manual for manufacturing.
- List of material properties, including certified test results.
- Manufacturer quality control manuals and related documentation.
- Long term service life information in the cases where the geomembrane is to be used in an exposed application of the manufacturer's products in similar applications and tested post installation to be provided to Engineer.

PA 4.2 MANUFACTURING PROCESS

Manufacturing of the geotextile shall be to the largest possible sheet size to minimise jointing. Adequate tests and controls must be performed to ensure a good quality of raw material for sheet production and the sheet production process shall be accurately monitored and shall be such as to insure homogeneous sheets.

The Engineer may perform an audit of the manufacturing and quality control procedures used by the Manufacturer at the cost of the Contractor, specifically for the production of the geotextile to be used for installation at the Client's facility. The Manufacturer shall give the Engineer at least one month's notice of the start of production of geotextile for the project. Quality control test shall be performed as the geotextiles are manufactured.

The Manufacturer shall make available to the Engineer, Manufacturing Quality Control Manuals, which outline all quality procedures, to be implemented for the manufacturing of geotextiles.

The Engineer shall monitor production and testing of the geotextiles material allocated for this project. If material for this project has already been manufactured, the Engineer shall monitor production of the same type of geotextile on the same production line to verify that manufacturing controls are in place. Additional tests by one independent approved accredited laboratory are also required before the material will be approved.

The Engineer shall review the quality control certificates and notify the Manufacturer in writing which geotextile rolls are approved for shipping/transport. The Engineer shall be allowed to monitor the loading of the geotextiles for shipping/transport.

Production data and test reports of all tests done on each batch of material in accordance with the submitted quality control programme are to be kept and compiled in a Sheet Report and submitted to the Engineer with each delivery to Site.

The Engineer reserves the right to perform any test at any time on either the raw material or the manufactured sheet at a cost to the Contractor.

The following information must be delivered with every batch of sheet or rolls. This information must be presented in such a way as to allow identification of particular rolls at any time.

PA 4.3 SUBMITTALS

The following shall be submitted to the Engineer and QA Officer. The submissions shall include the following information:

1. Certification: The contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, chemical composition of the filaments or yarns and other pertinent information to fully describe the geotextile.
2. The Certification shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the Manufacturer's quality control program.
3. The QA Officer/Engineer will verify that:
4. The property values certified by the Manufacturer are properly documented, the test methods used are acceptable and the geotextile meets the Project Specifications.
5. The manufacturer's certificate shall state that the finished geotextile meets the requirements of the specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.

Where materials, which have already been manufactured and have been delivered to storage, the Engineer shall be furnished with the test results from an independent approved laboratory and the quality control certificates and will notify the Manufacturer in writing which geotextile rolls are approved for shipping/transport from storage.

The Contractor/Installer shall obtain approval from the Engineer before the geotextile material is loaded for shipping/transport.

PA 4.4 SHIPMENT AND LABELLING

Geotextile labelling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style, and roll number.


Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate

Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.

Sheets with manufacturing process defects shall not be delivered to Site. If any such sheets are delivered to Site, they shall be rejected forthwith and all costs involved with such sheets shall be for the Contract's account.

PA 4.5 STORAGE

The geotextile shall be stored under cover and out of direct sunlight at all times. To this end the Contractor is to satisfy the Engineer of suitable covering facilities, e.g. shed or adequate canvas covers etc. The manufacturer's wrappings shall not be removed until just prior to installation.

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During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (71°C), and any other environmental condition that may damage the property values of the geotextile.

All geotextiles shall be root-proof and shall be resistant to bacteria, algae and fungi. All geotextiles shall maintain at least 70% of the original tensile strength after direct exposure to sunlight for 1000 hours as specified in ASTM D 4355.

The Contractor shall be responsible to ensure all the geotextiles intended for use in the works shall comply with all the above requirements.

PA 4.7.1 GEOTEXTILES

PA 4.8 MATERIAL SPECIFICATION

PROPERTY	TEST METHOD	UNIT	MASS/ UNIT AREA (G/M ²)					
Mass Per Unit Area	ASTM D 5261	g/m ²	340	406	545	812	1080	2000
Grab Tensile Strength	ASTM D 4632	kN	1.02	1.33	1.64	2.00	2.25	2.80
Grab Tensile Elongation	ASTM D 4632	%	50	50	50	50	50	50
Trapezoidal Tear Strength	ASTM D 4533	kN	0.42	0.51	0.64	0.89	0.96	1.27
Puncture (Pin) Strength	ASTM D 4833	kN	0.53	0.62	0.75	1.11	1.33	1.71
UV Resistance	ASTM D 4355	%	70	70	70	70	70	70

Notes:

1. All values are MARV except UV resistance; it is a minimum value
2. Evaluation to be on 50mm strip tensile specimens after 500 hours exposure.

PA 4.8.2 SEPARATION BETWEEN SUBGRADE SOIL AND AGGREGATES

For the intended purpose the geotextile can be classified as a class 2 or 3 as defined in the AASHTO Standards: M288-96 - Geotextile Specification for Highway Applications.

- Class 1: For severe or harsh survivability conditions where there is greater potential for geotextile damage.
- Class 2: For typical survivability conditions; this is the default classification to be used in the absence of site specific information.
- Class 3: For mild survivability conditions where there is little or no potential for geotextile damage.

In accordance with ASTM D4632, the non-woven needle punched polyester or polyprop geotextile must fail at elongation (strains) greater than 50%, and shall comply with the following material specifications as a separation application when placed on firm strength sub grades.

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Table 4: Geotextile Properties Class 1 (High Survivability)

PROPERTY	TEST METHODS	UNITS	ELONGATION < 50%	ELONGATION > 50%
Grab strength	ASTM D 4632	N	1400	900
Trapezoid Tear Strength	ASTM D 4533	N	500	350
CBR Puncture Strength	ASTM D 6241	N	2800	2000
Permittivity	ASTM D 4491	Sec ⁻¹	0.02	0.02
Apparent Opening Size	ASTM D 4751	Mm	0.60	0.60
Ultraviolet stability	ASTM D 4738	% Str. Ret. @ 500 lt. hrs.	50	50
Notes: <ol style="list-style-type: none"> All Values are minimum average roll values (MARV) except apparent opening size which is a maximum average roll value (MaxARV) and UV stability which is a minimum average value. Evaluation to be on 50mm strip tensile specimens after 500 hours exposure. 				

Table 5: Geotextile Properties Class 2 (Moderate Survivability)

PROPERTY	TEST METHODS	UNITS	ELONGATION < 50%	ELONGATION > 50%
Grab strength	ASTM D 4632	N	1100	700
Trapezoid Tear Strength	ASTM D 4533	N	400	250
CBR Puncture Strength	ASTM D 6241	N	2250	1400
Permittivity	ASTM D 4491	Sec ⁻¹	0.02	0.02
Apparent Opening Size	ASTM D 4751	Mm	0.60	0.60
Ultraviolet stability	ASTM D 4738	% Str. Ret. @ 500 lt. hrs.	50	50
Notes: <ol style="list-style-type: none"> All Values are minimum average roll values (MARV) except apparent opening size which is a maximum average roll value (MaxARV) and UV stability which is a minimum average value. Evaluation to be on 50mm strip tensile specimens after 500 hours exposure. 				

Table 6: Geotextile Properties Class 3 (Low Survivability)

PROPERTY	TEST METHODS	UNITS	ELONGATION < 50%	ELONGATION > 50%
Grab strength	ASTM D 4632	N	800	500
Trapezoid Tear Strength	ASTM D 4533	N	300	180
CBR Puncture Strength	ASTM D 6241	N	1700	1000
Permittivity	ASTM D 4491	Sec ⁻¹	0.02	0.20
Apparent Opening Size	ASTM D 4751	Mm	0.60	0.60
Ultraviolet stability	ASTM D 4738	% Str. Ret. @ 500 lt. hrs.	50	50
Notes: <ol style="list-style-type: none"> All Values are minimum average roll values (MARV) except apparent opening size which is a maximum average roll value (MaxARV) and UV stability which is a minimum average value. Evaluation to be on 50mm strip tensile specimens after 500 hours exposure. 				

The various classes of the corresponding typical usage above shall be regarded as a guideline only. The actual class of geotextile to be used on the works will be as shown on the Construction drawings and stated in the Bill of Quantities.

PA 4.9 ACCEPTANCE OF SHEET OR ROLLS

The type of geotextiles to be used shall be as indicated on the Construction drawings or and approved equivalent. The Engineer reserves the right to approve the make and grade of any alternative type of geotextiles considered.

The Contractor shall carry out a visual inspection of the sheets or rolls on arrival at Site for possible transport damage. Sheets or rolls showing damage shall be singled out and clearly labelled as such.

A further inspection by the lining Contractor is required prior to fabrication or installation. Any faults not previously catalogued in the report must then be catalogued on the same.

The Engineer must be notified of any damage and damaged material shall be set aside until approval for repair and use is received from the Engineer.

PA 4.10 TESTS

The geotextile material shall be tested by the manufacturer for compliance with the specifications listed in this specification or CQA plan by the test methods and frequencies indicated. The costs of these tests are to be included for in the contractor's construction price.

Conformance Testing shall be carried out as set out below to a third party external independent

laboratory (MQA laboratory) not associated with the Manufacturer, earthworks or lining contractor or as directed by the Project Engineer.

Conformance testing is not an opportunity to reproduce the QC testing program. It is a check to provide confirmation that satisfactory material is delivered to the site. The testing frequency shall be at the discretion of the Engineer or as set out in the CQA plan.

The name and address of the laboratory shall be approved by the Engineer. The Engineer has a right to reject any roll or production batch if the samples do not pass the conformance testing.

Conformance Testing will be performed before material is shipped from the Manufacturer's plant so that it may be used immediately on arrival at the site as listed below.

Contractor to ensure he is familiar with the duration of conformance. The contractor shall submit a conformance testing schedule to the Project Engineer prior to the commencement of works and part of the overall project work breakdown schedule.

The following listed tests will be performed on the samples by an accredited laboratory, to maintain quality control.

- Thickness.
- Grab strength.
- Sewn seam strength.
- Trapezoidal tear strength.
- Tensile strength.
- Static puncture strength.
- Puncture resistance.
- Normal through flow.
- Permeability.
- In-plane through flow.
- Pore Size.

All the above tests shall be completed as per the standard test method supplied in Sub-Clause PA 1.2 above.

The Contractor shall include in his rate the cost of verifying the material as per CQA plan, for samples required for testing at an accredited approved independent laboratory not associated with the Manufacturer. The costs associated with verifying material used in the manufacturing of the geomembrane shall be borne by the Contractor and deemed to be included in the construction rates.

PA 4.10.1 ACCEPTANCE

The batch of sheets or rolls shall not be released for use in fabrication or installation unless the results for the above tests are within the project specification requirements.

Should the results fail another set of samples must be drawn and the tests repeated. If these results

corroborate the first set of results the particular batch of sheeting will not be used.

Should this sample, however, show results that pass a third set of samples must be drawn and tested. The results, if pass leads to acceptance or, if fail, to rejection of the particular batch.

PA 5 INSTALLATION OF GEOTEXTILES

PA 5.1 GENERAL

Only approved geotextiles as per project specifications shall be used. Only approved Installers/Contractors shall install the geotextiles for use with impermeable linings. The Engineer reserves the right to allow the Contractor to install geotextiles where drainage is the applicable application of the material.

The Installer must present to the Engineer a method statement prior to starting the works, providing information on how they intent to do the works. Along with the method statement, the Contractor must also provide the following:

- Installer's Geosynthetic Field Installation Quality Assurance Plan.
- Storage methodology of the geotextiles once they arrive on site.
- Panel installation layout plan.

Upon completion, the Installer must furnish the Engineer, within 14 days, with the following documents:

- Certificate stating the geotextile has been installed in accordance with the project specifications and requirements.
- Material and installation warranties as requested in project specifications
- Red line drawings showing actual geotextiles placement and seams including typical anchor trench detail.

Irrespective of the liner system used, the geotextile sheets shall be laid and seamed down the slope and adequate arrangements must be made for anchorings at the top and bottom of the embankment.

The Contractor shall ensure adequate anchoring of the geotextile at the top of both sides of trenches.

The geotextile shall not be exposed to direct sunlight for prolonged periods, and shall be protected from mechanical damage and contamination during the installation and construction.

The geotextile material shall be overlapped both longitudinally and transversely. The longitudinal overlaps shall be in the direction of flow. Geotextile overlapping shall comply with the properties as shown in Table 7.

Table 7: Geotextile Overlapping Requirements

APPLICATION	SOIL STRENGTH (CBR)	OVERLAP UNSEWN (MM)	OVERLAP SEWN (MM)
Filtration and Drainage	1 - 3	200	25
Separation and Stabilisation	< 1	Not Recommended	225
	1 - 2	950	200
	2 - 3	750	75
	> 3	400	25

PA 5.2 PREPERATION BEFORE LAYING

Unless otherwise specified, the surface area shall be trimmed to provide a uniform surface prior to placing any geotextiles.

The Installer/Contractor will be required to sweep the finished earthworks surface ahead of installing the geotextile to ensure that no particles remain that could damage the geotextile. No protruding sharp edged stones will be allowed.

Agreement in writing must be done between the Contractor, Installer and the Engineer that the surface is suitable to place the liner. An example of the surface acceptance form can be found in SANS 10409.

PA 5.3 ANCHOR TRENCH

In some cases the geotextile can be anchored in the same trench as any adjacent geosynthetic liner components (if used). Dimensions and location of the anchor trench shall be as indicated on the Construction drawings. The front edge of the trench is to be rounded, so as to prevent stress concentration on the geotextile. Care should be taken to preserve the integrity of the sides of the trench during geotextile installation.

The geotextile is to be placed in the trench such that it covers the entire trench area (Sides and floor) and extends no less than 50 mm outside the back edge of the trench. When the geotextile is placed in position, the anchor trench must be loosely backfilled to a sufficient height to prevent movement or loaded with appropriate ballast to prevent movement until compaction commences. The anchor trench is to be backfilled and compacted with selected material in layers not exceeding 150 mm.

PA 5.4 PROCEDURE

The geotextiles must be installed in accordance with the installation panel layout plan agreed with the Engineer.

Deployment of geotextiles panels shall be performed in a manner that will comply with the following guidelines:

- Each panel shall be assigned a panel number (i.e. GT1, GT2, GT3, etc.);

- Panel numbers shall be recorded in a panel placement log book. This is to also include the respective roll number; and
- Should a partial roll of geotextile remain after deployment, it remains imperative that the roll be clearly marked with its corresponding number so as to identify the roll after usage.

Furthermore:

- The surface on which the geotextile is placed shall be properly inspected before deployment occurs.
- The pattern of sheets laid must be such that no more than three sheets shall lap at any place. This can be achieved by staggering adjacent strips of sheet forming T-joints instead of "+" joints. A full record of work done with respect to date and position must be kept and forwarded on a weekly basis to the Engineer.
- Unroll geotextile using methods that will not damage the geotextile and will protect underlying surface from damage (spreader bar, protected equipment bucket).
- The geotextile shall be held in place with sandbags to prevent wind uplift. Should the geotextile be displaced by wind or any other force, the Engineer shall inspect the geotextile for damage and can instruct the installer to remove the damaged geotextile and deploy anew roll at the Installer's own cost
- Personnel walking on geotextile shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geotextile.
- No vehicles of any kind shall be allowed onto the geotextile.
- Protect geotextiles in areas of heavy traffic by placing protective cover over the geotextile.
- The programme of construction shall be such as to minimise exposure of the sheets before placement of the material atop the geotextile is commenced.
- The Contractor must ensure that sheets may not be installed transverse to the slope.

Where a joint runs transverse to the slope, the laps must be such that the higher sheet overlaps the lower sheet.

PA 5.5 WELDING/STITCHING PROCEDURE

The method used to weld/stitch the various geotextile sheets together shall be presented to the Engineer for approval prior to commencement. The procedure to be followed shall be clearly defined and the Contractor shall provide the Engineer details on Quality Assurance Procedure that will be followed to ensure the welding/stitching procedure is successfully completed.

PA 5.6 CORRECTIVE MEASURES

Any damage caused to the geotextile during installation or during the placement of filter material

and/or rip-rap material shall render it unsuitable for use. Should the damage be localized, the Engineer may direct the Installer/Contractor to repair the damaged geotextile. This shall occur only once the Engineer has given permission.

Remove damaged geotextiles and replace with acceptable geotextile materials if damage cannot be satisfactorily repaired. Repair any portion of unsatisfactory geotextile or welding/stitching area. Installer/Contractor shall be responsible for repair of defective areas.

Agreement upon the appropriate repair method shall be decided between Engineer and Installer/Contractor by approved methods

Each repair shall be numbered and logged in a repair log book. The position of each repair shall be indicated on a red line drawing and supplied to the Engineer along with the log book as well as a certificate stating repair has been completed as per approved methods. All repair work of physical damage will be to the cost of the Contractor.

PA 5.7 PROTECTION DURING INSTALLATION

The Contract shall take adequate steps to ensure that the geotextiles is protected at all times from any damage. No vehicles of any kind shall be allowed to drive over the geotextiles. Installed geotextiles shall be covered as soon as possible after installation to ensure no prolonged exposure to direct sunlight.

PA 5.8 TOLERANCES

The works shall be finished to a Degree of Accuracy II as described in SANS 1200A Sub Clause 6.2.

Verification of Permissible Deviations (PDs) shall be as per Degree of accuracy II described in Table 8 for finished levels: (Shall apply to liner subgrade and anchor trenches.)

Table 8: Positions, Dimensions, Levels Etc.

		PERMISSIBLE DEVIATION (PD)		
		DEGREE OF ACCURACY		
		III	II	I
		MM	MM	MM
1)	Finished levels			
	PD from designated levels with reference to nearest transferred benchmark		± 25	

PA 6 AS BUILT DRAWINGS

The geotextile Installer shall provide the Engineer with the following:

- Red line drawings once certain sections/areas are approved.

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- Red line drawings indicating geotextile panels and panel numbers as well as the last four digits of the roll number.
- Panel and roll numbers on the red line drawings are to correspond to the information logged in the panel placement log book.
- All repair locations shall be recorded on the red line drawings.

PA 7 MEASUREMENT

The construction rate for the supply of the geotextile shall include full compensation for all materials, plan, labour and other incidental required to manufacture, purchased, transport, deliver, store the material on and / or off site, test or comply with all manufacturing and construction quality assurance and controlled requirement in full accordance with the relevant specifications, irrespective of the source of point of manufacture. Waste allowance, overlap etc. shall be deemed to be included in the construction rate. The quantity measured for payment will be the net area placed.

The costs of freight, duty landing charges and rates of exchange shall be included in the construction rate as well as an allowance for waste and overlap. Variations in these costs are dealt with under special materials (if applicable).