

South Africa

COTO

Committee of Transport
Officials

Standard Specifications for Road and Bridge Works for State Road Authorities

Committee Draft Final (CDF)

CHAPTER 3: DRAINAGE

August 2019

Confidential

**This document is confidential and may only be
distributed for purposes of obtaining comment
and not intended for use.**

Compiled under the auspices of the:

Committee of Transport Officials (COTO)
Roads Coordinating Body (RCB)
Road Materials Subcommittee (RMC)

Published by:

The South African National Roads Agency SOC Limited
PO Box 415, Pretoria, 0001

Disclaimer of Liability

Chapter 3 is provided as a Committee Draft Final (CDF) without any warranty of any kind, expressed or implied. No warranty or representation is made, either expressed or implied, with respect to fitness of use and no responsibility will be accepted by the Committee or the authors for any losses, damages or claims of any kind, including, without limitation, direct, indirect, special, incidental, consequential or any other loss or damages that may arise from the use of the document.

All rights reserved

No part of these Chapters may be modified or amended without permission and approval of the Roads Coordinating Body (RCB). Permission is granted to freely copy, print, reproduce or distribute this document for review purposes.

Existing publication:

The draft Chapters do not replace the previous COLTO "Standard Specifications for Road and Bridge Works" published in 1998.

Document Versions

Working Draft (WD). When a COTO subcommittee identifies the need for the revision of existing Standard Specifications for Road and Bridge Works, a workgroup of experts is appointed by the COTO subcommittee to develop the document. This document is referred to as a Working Draft (WD). Successive working drafts may be generated, with the last being referred to as Working Draft Final (WDF). Working Drafts (WD) have no legal standing.

Committee Draft (CD). The Working Draft Final (WDF) document will be converted to a Committee Draft (CD) and is submitted to the COTO subcommittee (RMC) and industry for consensus and comments. Successive committee drafts may be generated during the process. When approved by the subcommittee, the document is submitted to the Roads Coordinating Body (RCB) members for further consensus building and comments. Additional committee drafts may be generated, with the last being referred to as Committee Draft Final (CDF). Committee Drafts (CD) have no legal standing.

Draft Standard (DS). The Committee Draft Final (CDF) document will be converted to a Draft Standard (DS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a draft standard. This Draft Standard is implemented in Industry for a period of two (2) years, during which written comments may be submitted to the COTO subcommittee. Draft Standards (DS) have full legal standing.

Final Standard (FS). After the two-year period, comments received are reviewed and where appropriate, incorporated by the COTO subcommittee. The document is converted to a Final Standard (FS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a final standard. This Final Standard is implemented in industry for a period of five (5) years, after which it may again be reviewed. Final Standards (FS) have full legal standing.

Comments

Comments on the Chapters must be provided in writing as per the format provided on the SANRAL website www.nra.co.za and e-mailed to cotorevision@nra.co.za no later than **04 October 2019**.

CHAPTER 3: DRAINAGE	1
A3.1 DRAINS	1
PART A: SPECIFICATIONS	1
A3.1.1 SCOPE	1
A3.1.2 DEFINITIONS.....	1
A3.1.3 GENERAL.....	1
A3.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS	1
A3.1.5 MATERIALS.....	1
A3.1.6 CONSTRUCTION EQUIPMENT.....	4
A3.1.7 EXECUTION OF THE WORKS	4
A3.1.8 WORKMANSHIP.....	7
B3.1 DRAINS	8
PART B: LABOUR ENHANCEMENT	8
B3.1.1 SCOPE	8
B3.1.2 DEFINITIONS.....	8
B3.1.3 GENERAL.....	8
B3.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS	8
B3.1.5 MATERIALS.....	8
B3.1.6 CONSTRUCTION EQUIPMENT.....	8
B3.1.7 EXECUTION OF THE WORKS	8
B3.1.8 WORKMANSHIP.....	9
C3.1 DRAINS	10
PART C: MEASUREMENT AND PAYMENT	10
D3.1 DRAINS.....	17
PART D: GUARANTEES & COMPLIANCE CERTIFICATES.....	17
A3.2 CULVERTS	18
PART A: SPECIFICATIONS	18
A3.2.1 SCOPE	18
A3.2.2 DEFINITIONS.....	18
A3.2.3 GENERAL.....	18
A3.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS	19
A3.2.5 MATERIALS.....	19
A3.2.6 CONSTRUCTION EQUIPMENT.....	20
A3.2.7 EXECUTION OF THE WORKS	21
A3.2.8 WORKMANSHIP.....	26
B3.2 CULVERTS	27
PART B: LABOUR ENHANCEMENT	27
B3.2.1 SCOPE	27
B3.2.2 DEFINITIONS.....	27
B3.2.3 GENERAL.....	27
B3.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS	27
B3.2.5 MATERIALS.....	27
B3.2.6 CONSTRUCTION EQUIPMENT.....	27
B3.2.7 EXECUTION OF THE WORKS	27
B3.2.8 WORKMANSHIP.....	28
C3.2 CULVERTS	29
PART C: MEASUREMENT AND PAYMENT	29
D3.2 CULVERTS	37
PART D: GUARANTEES AND COMPLIANCE CERTIFICATES	37
A3.3 CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS	38
PART A: SPECIFICATIONS	38
A3.3.1 SCOPE	38

A3.3.2	DEFINITIONS.....	38
A3.3.3	GENERAL.....	38
A3.3.4	DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS.....	38
A3.3.5	MATERIALS.....	38
A3.3.6	CONSTRUCTION EQUIPMENT.....	39
A3.3.7	EXECUTION OF THE WORKS.....	40
A3.3.8	WORKMANSHIP.....	43
B3.3	CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS.....	44
	PART B: LABOUR ENHANCEMENT.....	44
B3.3.1	SCOPE.....	44
B3.3.2	DEFINITIONS.....	44
B3.3.3	GENERAL.....	44
B3.3.4	DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS.....	44
B3.3.5	MATERIALS.....	44
B3.3.6	CONSTRUCTION EQUIPMENT.....	44
B3.3.7	EXECUTION OF THE WORKS.....	44
B3.3.8	WORKMANSHIP.....	45
C3.3	CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS.....	46
	PART C: MEASUREMENT AND PAYMENT.....	46
D3.3	CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS.....	51
	PART D: GUARANTEES AND COMPLIANCE CERTIFICATES.....	51

CHAPTER 3: DRAINAGE

A3.1 DRAINS

CONTENTS

PART A: SPECIFICATIONS

A3.1.1 SCOPE

A3.1.2 DEFINITIONS

A3.1.3 GENERAL

A3.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A3.1.5 MATERIALS

A3.1.6 CONSTRUCTION EQUIPMENT

A3.1.7 EXECUTION OF THE WORKS

A3.1.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

PART A: SPECIFICATIONS

A3.1.1 SCOPE

Drainage under this Section covers mainly open drains as well as subsoil drains and their associated works. This Section covers the work required for adequate surface, subsurface and piped drainage to ensure that the road and ancillary structures drain freely and without damage or risk to infrastructure and road users. It covers all work, both rehabilitation and new work, in connection with the excavation and construction of open drains, channels, subsoil drainage and banks and dykes at the locations and to the sizes, shapes, grades and dimensions as shown on the drawings, or as specified by the Engineer.

It also covers the cleaning of existing open drains, as well as the test flushing of existing and new subsoil drains and the repairing of existing subsoil drainage. In particular circumstances this work may be executed outside the road reserve.

Also covered is the clearing of existing culverts, including the removal of all materials which have accumulated in and around inlet and outlet structures and in the barrels of the culverts, which is likely to adversely affect the operation of the drainage system.

Excluded are the lining of any drains such as with concrete, stone pitching, vegetation, synthetic and alternative materials and wired mesh, which are covered under Section A11.1 of Chapter 11.

A3.1.2 DEFINITIONS

No specific definitions

A3.1.3 GENERAL

No specific items

A3.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

None applicable unless specific specifications have been accepted as proposed by the Contractor or included into the Contract Documentation.

A3.1.5 MATERIALS

A3.1.5.1 General material specifications

The material specifications are the required specifications for the materials as provided, placed and/or processed in final position for the drainage elements.

It is the Contractor's responsibility to ensure that the materials delivered and utilised for the drainage elements shall meet the specified requirements.

Materials removed under this Section from existing works, except where excavated materials are specified to be reused or disposed of, or except where provision has been made in Part C for their reuse or specific disposal, shall be deemed to be the property of the Contractor.

A3.1.5.2 Subsoil Drainage Materials

a) Pipes

The pipes for subsoil drainage systems to be used shall be either unplasticised PVC (U-PVC) pipes or high-density polyethylene (HDPE) pressure pipes with smooth inner bore and internal diameters as indicated on the drawings or in the Contract Documentation. Pipes shall have the specified internal diameter, which shall be not less than 100 mm (except for composite subsoil drainage systems), and shall be one of the following types:

- U-PVC pipes complying with SANS 791 for solid wall pipes (category-heavy duty) or SANS 1601 for structured wall pipes (stiffness class 350), which may be slotted or perforated for drainage in-flow as specified. The carrier portions of pipes shall not be slotted or perforated.
- HDPE pipes to be used with aggregate filled subsoil drains systems shall be slotted or perforated for groundwater in-flow as specified. HDPE pipes shall have a ring stiffness >450 kPa and slotted / perforated with 30 % solid invert and of twin wall construction, with a smooth inner bore and ribbed outer wall. The carrier portions of pipes shall not be slotted or perforated.

The size of perforations in perforated pipes shall in all cases be 8,0 mm in diameter \pm 1,5 mm and the number of perforations per meter shall not be less than 26 for 100 mm diameter pipes and 52 for 150 mm diameter pipes. Perforations shall be spaced in two rows for 100 mm pipes and as shown on the drawings for 150 mm pipes.

Slotted pipes shall have a nominal slot width of 8,0 mm \pm 1,5 mm. The arrangement of slots shall be 240 degrees of the circumference with the flow channel invert of 120 degrees. The total slot area shall not be less than that required for perforated pipes.

- Pipes for geocomposite fin type subsoil drainage systems may be HDPE, extruded into an open lattice wall structure with a wall thickness of minimum of 5,0 mm. Of the circumference area, 70 % shall consist of an open structure, and the remaining 30 % being the invert, shall be solid. Openings in the mesh structure shall be greater than 5,0 mm but less than 12 mm in size. Alternatively, U-PVC or HDPE pipes as specified above for aggregate filled drains may be used. The water infiltration capacity of the all types of pipes under a 200 mm static head shall not be less than 20 litres per second per metre pipe length (l/s/m) for 65 mm diameter pipes; not less than 55l/s/m for 100 mm diameter pipes and not less than 80l/s/m for 150 mm diameter pipes.

All slotted or perforated pipes shall retain 30 % of the pipe invert for conveyance of drainage and the top of the pipes shall externally carry a longitudinal marker line to ensure that pipes are correctly placed during construction.

Pipes without slots or perforations required for conveying ground water from the subsoil drainage proper, to the point of discharge, shall be U-PVC or HDPE pipes of the types specified.

Pipes must be stored in a shaded area without exposure to direct sunlight, and stacked according to supplier's instructions.

b) Natural and crushed permeable material

Natural permeable filter materials for subsoil drainage shall consist of sand and/or crushed stone of suitable grading. Natural permeable materials shall conform to the following requirements:

Sand used for natural permeable material shall be clean, hard sand obtained from approved sources. The sand shall comply with the requirements of SANS 1083, Table 1: Sand, and shall be either coarse, medium or fine grade as specified. The nominal maximum particle size for the various grades shall be as shown in Table A3.1.5-1, and all sand shall be clean with not more than 5 % of the material passing through the 0,075 mm sieve.

Table A3.1.5-1: Natural permeable materials: Sand

Grade	Nominal maximum particle size (mm)
Coarse	5
Medium	2
Fine	0,2

Crushed stone used for natural permeable material shall comply with the requirements given in SANS 1083: Table 3: Stone for Concrete, and shall be either be fine (14 mm nominal size) or coarse (20 mm nominal size) as specified. Crushed stone shall be clean with not more than 5,0 % of the material passing through the 0,075 mm sieve.

When no suitable sand and/or crushed stone is available from borrow pits or designated quarries, the Engineer may require that it be procured from commercial sources.

c) Geotextiles

Should the use of geotextiles be specified in subsoil drainage systems, or as filter separation blankets, or for any other purposes, it shall comply with the requirements as specified in Section A12.11 of Chapter 12.

(i) Testing

The Contractor shall, at his own cost, submit a certificate by an approved laboratory to prove compliance with specified tests as stated in Chapter 20. Alternatively, verifiable testing by the supplier may be submitted for approval to the Engineer.

The tests to be carried out on geotextiles relate to the material and the method of manufacture and are mainly to ascertain that the correct grade and type of geo-textile is supplied, and that the material is equivalent in quality to that specified for use in the works. This includes geotextile qualities regarding soil retention; permeability; clogging; durability and strength. Compatibility testing can be done for filtration using the ASTM D5101 - Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio.

d) Polymer film sheeting

Plastic for subsoil drainage systems to be used shall be polymer film type sheeting of 150 to 250 micron (0,15 to 0,25 mm) thickness, complying with SANS 952-1.

A3.1.5.3 Geocomposite drainage systems (fin type drains)

Geo-composite in-plane drains (fin type drains) shall consist of a drainage core connected to a drainage pipe, all of which shall be enclosed in a geotextile as specified, required to fully enclose the drainage core.

The drainage core shall act as a flow net and shall include the physical characteristics as listed in Table A3.1.5-2.

Table A3.1.5-2: Physical characteristics of fin type geo-composite drain

Properties		Units	Core	Test Method
Polymer Type			HDPE	
Mass	(minimum)	g/m ²	500	SANS-9864/ISO 9864
Thickness	(minimum under 2 kPa)	mm	4,0	SANS 9863-1/ISO 9863-1
Tensile Strength	(minimum machine & across)	kN	5,0	SANS 1525/ISO 10319
Minimum Discharge Capacity of Fin type Geo-composite drain				
Discharge Capacity	(under 50 kPa)	l/s/m ²	>0,1	ISO 12958

The geotextile shall comply with the properties in Section A12.11 of Chapter 12. The Engineer shall specify the grade and type of geotextile required to fully enclose the drainage core.

a) Mesh-structured pipe component of geo-composite drain.

The drainage pipe used for this purpose shall meet the following requirements:

Pipes for in-plane subsoil drainage systems shall have an internal diameter of 65 or 100 mm, as specified. The pipe shall be manufactured from High Density polyethylene (HDPE) with a solid 5,0 mm wall thickness. It shall be extruded in an open lattice wall structure, with 70 % of the diameter consisting of open area and a 30 % solid area along the invert. Perforations in the open structure of the pipe shall be greater than 5,0 mm but less than 12 mm.

The infiltration capacity of the pipe, without geotextile, under a 200 mm static head shall not be less than the following:

- For 65mm ID pipe = 20 litres per metre per second
- For 100mm ID pipe = 55 litres per metre per second

b) Geo-composite strip drains or prefabricated vertical drains (wick drains):

Geo-composite strip drains shall consist of a drainage core enclosed in geotextile.

The drainage core shall act as a flow net and combined with the geotextile shall include the physical characteristics as listed in Table A3.1.5-3.

Table A3.1.5-3: Physical characteristics of the geo-composite strip drain

Properties			Units	Composite Strip Drain			Test Method
Drain Width			mm	100	250	330	
Manufacture			As specified in Clause A3.1.5.2c)(i)				
Core			HDPE				
Mass			g/m ²	80	200	220	SANS 9864 / ISO 9864
Thickness	Geotextile & Core	Minimum under 250kPa	mm	4,5	4,5	4,5	
Minimum Discharge Capacity Of Geo-composite strip drain							
Discharge Capacity			l/s	0,1	0,07	0,10	ISO 12958 / ASTM D4716
under 50kPa			l/s	0,05	0,06	0,09	
under 250kPa			l/s	0,02	0,03	0,04	

c) Geo-composite Panel Drains

Geo-composite panel drains shall consist of a rigid corrugated plastic core of a flat pipe configuration with a well-defined invert enclosed in a geotextile and shall be classified according to the following minimum requirements as listed in Table A3.1.5-4.

Table A3.1.5-4: Physical characteristics of the geo-composite panel drain

Properties		Units	Geo-composite Panel Drain			Test Method
Drain Depth		mm	170	315	450	ASTM D2122
Drain Width		mm	>40			
Slot Size		mm	2,8 x 30			
Compressive Strength		kPa	>200			ASTM D2412:11 Mod
Manufacture		As specified in A3.1.5.2c)(i)				
Core		HDPE				
Geotextile						
Minimum Through Flow	Under 100mm head	l/s/m ²	230			AS3706.9-12
Minimum Tensile Strength	Machine	kN/m	9,5			AS3706.2-12
Minimum Trapezoidal Tear		N	300			AS3706.3-12
Pore Size	O _{95W}	µm	110			AS3706.7-14
Geo-composite panel drain						
Minimum Discharge Capacity(vertical)	Under 200kPa at 0,01 gradient	l/s	0,35*	0,65	0,95	ASTM D4716:14

A3.1.5.4 Concrete

All concrete work shall be carried out in accordance with the requirements in Section A13.4 of Chapter 13 of these specifications, read together with the provisions of this Section. Cement shall comply with SANS 50197-1 for CEM I or CEM II with a strength class of 32.5 or greater, and a rate of strength gain of N or greater.

Unless the Contractor obtains the concrete from a commercial concrete supplier, the Contractor shall be responsible for providing suitable materials, determining the mix proportions and manufacturing the concrete of the required quality to comply with SANS 50206.

The mix design shall be based upon obtaining an average concrete compressive strength sufficiently above the specified characteristic compressive strength so that, considering the expected variability of the concrete and test procedures, no more than 5,0 % of strength tests will be expected to fall below the specified characteristic compressive strength.

Where concrete is supplied by a commercial source outside the direct control of the Engineer, the concrete supplier shall ensure compliance with the requirements of SANS50206 (SANS878), and the Contractor shall take full responsibility to implement acceptance control testing in accordance with the specification.

All concrete mixed on the site of works shall be weigh-batched unless the Contractor can demonstrate to the Engineer that his method of proportioning the concrete ingredients consistently produces uniform concrete, which meets the strength requirements.

Concrete shall be properly mixed to a uniform consistency. The total period between the times that the cement is placed into the mix until mixing starts shall not exceed 15 minutes.

Concrete shall be so transported to its final position that segregation or loss of any of the ingredients or contamination will be prevented and that the mix is of the required workability at the point and time of placing. It shall be protected against rain, heat, direct sunlight and/or evaporation by means of covers. No additional water may be added in transit or where delivered or placed.

Once the casting of concrete has begun, it shall be carried out in a continuous process between construction joints. Concrete shall be placed within 60 minutes from the start of mixing. This time may be extended by the Engineer where a retarding admixture has been used. All excavations and other contact surfaces of an absorbent nature such as timber formwork shall be damp but no standing water shall be permitted to remain on these surfaces. The formwork shall be clean on the inside.

A3.1.5.5 Mesh for subsoil drain outlets

Where specified on the drawings, the outlets of subsoil drains shall be covered by mesh built into the outlets or other material as specified. Galvanized woven wire mesh shall comply with the requirements of SANS 675.

A3.1.6 CONSTRUCTION EQUIPMENT

The Contractor shall submit his plant and equipment list for excavating, stockpiling, if specified, loading, hauling and any temporary works as part of his method statement to perform the different elements of the drainage works.

A3.1.7 EXECUTION OF THE WORKS

A3.1.7.1 Classification of Materials

All excavations for open drains and subsoil drainage systems shall be excavated in the position and to the required dimensions. Overbreak in width or depth, unless specified by the Engineer, shall be filled and compacted by the Contractor and shall not be measurable for payment.

All excavations under this Chapter shall be classified as follows for payment purposes:

Hard material:	Material which cannot be excavated except by drilling and blasting, or with the use of pneumatic tools or mechanical breakers, and Boulders exceeding 0,1 m ³ ; where more than 40 % by volume of any material consists of boulders, each exceeding 0,1 m ³ in size, the volume of material so defined shall be classified as hard material
Existing stabilised road layers:	Existing layer material which has been stabilised (irrespective of stabilising agent) and requires careful cutting and excavation without damage to surrounding existing road layers, by whichever method.
Soft material:	All material not classified as hard material or existing stabilised road layers shall be classified as soft material.

A3.1.7.2 Open Drains

Open-drain excavation shall involve the excavation of open drains and channels, including channels to direct the course of water flow, all as detailed in the Contract Documentation or as directed by the Engineer.

The classification criteria for establishing the type of drain excavation is set out in Table 3.1.7-1.

Table A3.1.7-1: Open drain excavation classification criteria

Drain	Trapezoidal shape / channel	V-shaped	Trapezoidal shape / channel	V-shape	Road prism drains
Bottom width	< 4,0 m	n/a	≥ 4,0 m	n/a	All new or existing drains within the road prism namely median drains, side drains and drains on cut or fill slopes.
Side-slope (steepest side-slope is the determining slope)	not applicable (n/a)	Steeper than 1v : 4h (v=vertical; h=horizontal)	n/a	Flatter than 1v : 4h	
Top width	n/a	≤ 5,0 m	n/a	> 5,0m	
Classification criteria	Bottom width only	Steepest side-slope or top width	Bottom width only	Steepest side-slope or top width	
Drain classification for excavation	Open drain excavation Chapter 3	Open drain excavation Chapter 3	Designated excavation Chapter 4 compliant material	Excavation to spoil Chapter 5	Shape, trim and/or clean Chapter 5
			Excavation to spoil Chapter 5		

Where clearing and/or grubbing is required for new open drains to be constructed, it shall be executed as specified in Section A1.6 of Chapter 1.

Open drains shall be constructed within 5 % true to line, grade and cross-section and shall be so maintained for the duration of the contract. Open drains shall at all points be graded to flow in the direction of intended flow without low points where water may pond.

Care shall be taken to avoid excavation below the required grades for the open drains and any excavation carried out below the required grade shall be backfilled with material of minimum G7 quality and compacted to at least 93 % of MDD by the Contractor at no cost to the Employer.

Material resulting from the excavations for open drains shall be used in the construction of fills, banks and dykes, or for other purposes, or shall be disposed of to spoil, all as specified by the Engineer.

In respect of material resulting from open-drain excavation and not taken to spoil but used elsewhere in the construction of the works, payment will be made for open drain excavation as well as for any item of temporary or permanent construction built from such material. Material from open drain excavation, which is taken to spoil will be paid for as open-drain excavation only. Where specified by the Engineer that existing open drains, but excluding new open drains constructed by the Contractor, shall be cleared and, where necessary, shaped by removing the sediment and trimming the floors and side slopes, the specified requirements for constructing new open drains shall apply similarly to clearing and shaping existing open drains.

Any concrete, stone pitched or wire mesh enclosed lining of open drains shall be done in accordance with the requirements of Clause A11.1.5 of Chapter 11.

The Contractor shall remove all materials that will adversely affect the performance of the constructed drainage, including all silt, sediment, driftwood, vegetation, debris and rubble that have accumulated in and around the culvert inlet and outlet structures and in the culvert barrels. Unless such work forms part of specified work to rehabilitate or clear existing drains, no payment shall be made for such work, as it shall be deemed to form part of normal finishing and trimming operations. All materials resulting from the clearing operations shall be disposed of at specified locations. The clearing shall preferably be done with hand tools in order to prevent damage to existing drainage and other structures.

All structures damaged by the Contractor shall be repaired and made good at no cost to the Employer, all as instructed by the Engineer.

Measurement and payment in respect of the clearing and shaping of existing open drains, as classified in Table A3.1.7-1 shall be made under the relevant items in Sections C3.1, C4.2 of Chapter 4 and C5.2 of Chapter 5.

A3.1.7.3 Banks and Dykes

Where specified by the Engineer that clearing and/or grubbing is required for new banks and dykes to be constructed, it shall be executed as specified in Section A1.6 of Chapter 1.

Mitre banks, catchwater banks and dykes shall be constructed of approved soil or gravel obtained from cut and/or open drain excavation or, if no suitable material can be obtained from those sources, from suitable approved alternative sources, and be placed in such a way that the water will flow in a shaped open drain or on the natural ground and against the bank. Where open drains with bank/dyke are constructed as combination, excavation and fill shall be measured and paid for separately.

The banks and dykes shall be properly compacted to 93 % of MDD in layers not exceeding 150 mm.

The appearance of the completed mitre bank shall present an even, tight surface.

If so specified, mitre banks facing shall be constructed of hand packed stone pitching as detailed in Clause A11.1.7 of Chapter 11.

A3.1.7.4 Subsoil drainage

a) Construction of subsoil drainage systems

(i) With natural permeable material

Trenches required for subsoil drainage systems shall be excavated to the dimensions and gradients shown on the drawings or as specified by the Engineer, neatly trimmed to line and level. In case of deeper excavations, or excavations in unstable or saturated ground, the Contractor shall take all necessary steps to assure the safety of such excavations and to ensure that specified lines and levels are complied with. Such steps may entail the provision of temporary shoring or battering of side slopes. All such steps shall be deemed to be included in the tendered rates for excavations.

A layer of natural permeable material of the grade and thickness as shown on the drawings shall be placed on the bottom of the

trench and be lightly tamped and finished to the required gradient.

Pipes of the type and size specified shall then be firmly bedded on the natural permeable material, true to line and level, and be coupled in accordance with the pipe manufacturer's requirements. Thereafter the trench shall be backfilled with the specified natural permeable material to such height above the pipes as shown on the drawings or as specified by the Engineer. The natural permeable material shall be lightly compacted and trimmed to the required level. Further layers of finer specified natural permeable material shall then be placed, in layers not exceeding 300 mm in thickness at a time lightly compacted and finished to an even surface, as specified by the Engineer. The remainder of the trench, if any, shall be backfilled with approved impermeable material and as specified by the Engineer, in layers not exceeding 150 mm, and compacted to at least the same density as the surrounding material. The trench shall be specially protected against the ingress of water until the impermeable layer has been completed. The width of the backfill as measured for payment shall not exceed the specified width of the trench.

The total thickness of each type of natural permeable material shall be carefully controlled for thickness and level, using suitable spacers where required. When successive layers are placed, the lower layer shall not be walked on and, as far as possible, shall not be disturbed. Care shall be taken to prevent the contamination of natural permeable material during construction of the subsoil drainage system and all natural permeable material contaminated by soil or silt shall be removed and replaced by the Contractor at his own cost.

Perforated and slotted pipes shall be joined by means of couplings, the provision and installation of which shall be deemed to be covered under the rates for the pipes. Perforated pipes shall be laid with perforations either at the top or bottom as specified on the drawings, specifications or specified by the Engineer.

The higher end of each subsoil drainage pipe shall be sealed off with a loose concrete cap of class C20/25-concrete, as shown on the drawings and at the lower end, the pipe shall be built into a concrete head wall providing a positive outlet, or it shall be connected to structures for stormwater pipes or concrete culverts. The complete system, together with head walls, shall be constructed in one process starting at the lower end. No continuous section of subsoil drain shall be longer than 80m long and cleaning eyes constructed in accordance with the details shown on the drawings shall be spaced at a maximum spacing of 80m.

Any section of a subsoil drainage system constructed of pipes without perforations or slots shall be backfilled with impermeable backfill material as described herein. Where suitable, the excavated material may be used for backfilling.

(ii) *With polymer film lining to trenches for subsoil drainage systems*

Where shown on the drawings or specified by the Engineer, trenches for subsoil drainage systems shall be lined with approved polymer film sheeting 0,15 mm or 0,25 mm thick as shown on the drawings or specified in the Contract Documentation. The polymer film sheet shall cover the bottom of the trench and shall extend upwards on both sides for as far as may be specified by the Engineer in each particular case, in order to form a waterproof channel. At joints the polymer film sheeting shall be heat-welded together or lapped by a minimum of 200 mm. Lapping shall be in direction of the flow of water.

Pipes of the type and size specified shall be installed as specified, true to level and grade, and be coupled in accordance with requirements.

When backfilling the trench with the specified natural permeable material, care shall be taken not to displace or damage the polymer film lining in any way. The use of plastics other than polymer film will be considered, provided that the material is proven to the Engineer to be of equal or better quality.

(iii) *With geotextiles*

Where specified that geotextiles shall be used for lining in subsoil drainage systems, it shall be procured, furnished and installed as specified and shown on the drawings. The lining shall not be displaced or damaged in any way when the trench is being filled with the specified natural permeable material. The geotextile shall be lapped both longitudinally and transversely by at least 300 mm or as specified by the manufacturers. The longitudinal lap shall be positioned on top of the box forming the drain and shall be stitched together with plastic/galvanised wire or strong synthetic thread at one metre intervals. The transverse lap shall be in the direction of flow.

Pipes of the type and size specified shall be installed as specified, true to line and grade, and be coupled in accordance with the pipe manufacturer's requirements.

(iv) *With composite in-plane drainage systems*

Wherever specified, composite in-plane drainage systems shall be constructed in accordance with the details shown on the drawings and in accordance with the manufacturer's requirements. The elements of the system shall be assembled above ground in manageable lengths, and all exposed surfaces shall be sealed with an approved geo-fibre seal. The trench sides shall be vertical, and the composite in-plane system shall be installed against the side through which the subsoil flow is expected. The trench shall then be backfilled with natural permeable sand, which shall be saturated with water after placement, up to the prescribed level. The upper part of the trench shall be backfilled with impermeable material, which shall be compacted to the density of the surrounding material, in layers not exceeding 100 mm in thickness.

(v) *With alternative drainage systems*

Alternative drainage systems, where relevant, shall be specified and detailed in the Contract Documentation.

(vi) *Proving of pipes in subsoil drainage systems*

The laying of slotted/perforated pipes supplied in coils shall be subject to providing a method statement which includes proving during installation, to ensure that the invert is accurately installed.

On completion of the pipe laying and prior to backfilling over pipes, all pipe joints shall be surveyed as proof of their installation to line and grade. After backfilling, the pipes shall be proved by pulling through a cylindrical cleaning brush followed by a wooden mandrill \pm 400 mm long and 5,0 mm in diameter less than the bore of the pipe. Proving of installed pipes shall not be paid for separately and the cost thereof shall be deemed to be included in the rate tendered for laying the pipe.

b) Test flushing

Final acceptance of longitudinal subsoil drains constructed by the contractor will be subject to satisfactory test flushing after completion and installation of the rodding eye inlets. Flushing tests shall be carried out in the presence of the Engineer's representative by flushing the drain and metering the outflow to ensure the drain is clear of blockage. Should blockages be apparent the Contractor shall locate and clear the obstruction and repeat the test.

Proving of the lack of obstructions may also be undertaken by camera equipment inserted into the subsoil drains should this be specified by the Engineer.

A3.1.7.5 Manholes, outlet structures and cleaning eyes

Outlet structures and cleaning eyes for subsoil drainage systems shall be constructed in accordance with the details shown on the drawings and/or indicated in the Contract Documentation. Manholes for subsurface drains shall be constructed as detailed and measured under Section A3.3.

The end of each subsoil outlet shall be marked with a suitable visible marker clearly indicating the position of each subsoil outlet structure in accordance with the details on the drawings or as specified by the Engineer.

A3.1.7.6 As-Built Drawings

The Contractor shall furnish the Engineer with a detailed set of relevant drawings verifying and recording the subsoil drainage systems as installed. Such records shall include accurate coordinates of all starting points, bends, cleaning eyes, manholes, junctions and outlet structures, including the depth below surface level at each such point.

A3.1.8 WORKMANSHIP

The Contractor shall determine the required frequency of testing and conduct sufficient tests on the sourced material for each type of material, in order to ensure that the quality of materials produced will meet the specified requirements for the particular layer for which it will be used.

The Engineer shall carry out quality control testing and may, at his discretion, elect to use the Contractor's test results if he is satisfied that the Contractor's process control requirements are acceptable for quality control purposes.

Any work or materials which do not comply with the specified requirements, shall be removed and replaced with work or materials which comply with the requirements or, if the Engineer so agrees, shall be repaired so that it shall comply with the specified requirements after having been repaired.

B3.1 DRAINS

PART B: LABOUR ENHANCEMENT

CONTENTS

B3.1.1	SCOPE
B3.1.2	DEFINITIONS
B3.1.3	GENERAL
B3.1.4	DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS
B3.1.5	MATERIALS
B3.1.6	CONSTRUCTION EQUIPMENT
B3.1.7	EXECUTION OF THE WORKS
B3.1.8	WORKMANSHIP

B3.1.1 SCOPE

This Part covers additional specifications for work to enhance the labour component of construction activities, over and above labour employed for conventional construction activities, where specified in Part A. This Section includes concrete mixed by hand and construction of banks and dykes.

B3.1.2 DEFINITIONS

The provisions of Part A, shall apply.

B3.1.3 GENERAL

The provisions of Part A, shall apply.

B3.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

The provisions of Part A, shall apply.

B3.1.5 MATERIALS

The provisions of Part A, shall apply.

B3.1.6 CONSTRUCTION EQUIPMENT

None applicable unless specific specifications have been accepted as proposed by the Contractor or included to the Contract Documentation.

B3.1.7 EXECUTION OF THE WORKS

B3.1.7.1 Concrete mixing by hand

Concrete may be mixed by hand or in hand-turned concrete mixers for small pours up to one (1) cubic metre. Larger pours greater than one (1) cubic metre shall be machine mixed with on-site mechanical mixers and/or batch plants.

The mix design shall be based upon obtaining an average concrete compressive strength sufficiently above the specified characteristic compressive strength so that, considering the expected variability of the concrete and test procedures, no more than 5 percent of strength tests will be expected to fall below the specified characteristic compressive strength.

All concrete mixed on the site of works shall be weigh-batched unless the Contractor can demonstrate to the Engineer that his method of proportioning the concrete ingredients consistently produces uniform concrete, which meets the strength requirements.

Concrete shall be hand-mixed on a prepared mixing floor of adequate area to facilitate proper mixing without contamination by any foreign materials.

The sand shall be measured off, tipped onto the mixing floor and spread in a circle. The cement (one or two whole sacks, as required by the mix design) shall then be spread evenly across the sand and mixed in with shovels, turning the mixture into the middle of the circle and out again. When the colour is even, the mix shall be shaped with a hollow in the centre.

Part of the mixing water shall be poured into the hollow and mixed in. More water shall be slowly added and mixed in until all the water has been

added. The materials shall be turned into the middle of the circle and out again at least twice. The mix should be soft and even with no dry patches. The mix shall then be spread in a circle.

The stone shall be measured off and spread evenly across the mortar and mixed with shovels, by turning the mixture into the middle and out again at least twice. Concrete shall be properly mixed to a uniform consistency without fatty or harsh patches. The total period between the times that the cement is placed into the mix until mixing starts shall not exceed 15 minutes.

The selection of mixing and batching locations shall be so chosen to minimise the transport of concrete placement.

B3.1.7.2 Classes of Excavation

Where excavation is done using labour enhanced construction methods, the Engineer shall classify excavated materials as either soft or intermediate for payment purposes in terms of Table B3.1.7-1 or, if the Contractor does not agree with the classification, in terms of Table B3.1.7-2. The decision of the Engineer regarding the classification of the excavated materials shall then be final and binding, subject to the provisions of the conditions of contract.

No hard material shall be measured under labour enhanced construction methods.

Table B3.1.7-1: Classification of Excavated Materials

Materials Classification	Description
Soft	Material which can be excavated by means of a suitable shovel with or without the use of a pick or other hand-swung tool.
Intermediate	Material which is difficult to excavate by hand even with the aid of a crowbar and requires the assistance of pneumatic tools for economic removal.

Table B3.1.7-2: Classification of Materials in Terms of Consistency and Shear Strength

Materials Classification	Consistency		Number of DCP blows to penetrate 100 mm ^{*1}	
	Granular soil	Cohesive soil	Granular soil	Cohesive soil ^{*2}
Soft	Very loose to dense	Very soft to stiff	≤ 15	≤ 8
Intermediate	Very dense	Very stiff	>15	>8

^{*1} Only applicable to materials comprising not more than 10 % gravel of size less than 10 mm and materials containing no cobbles or isolated small boulders.

^{*2} Classification depends on the moisture content of the cohesive material.

B3.1.7.3 Banks and Dykes

Mitre banks, catchwater banks and dykes shall be constructed of approved soil or gravel obtained from open drain excavation or, if no suitable material can be obtained from that source, from suitable approved alternative sources, and be placed in such a way that the water will flow on the natural ground and against the bank, or inside an excavated drain and bank combination.

The banks and dykes shall be properly compacted to 93 % of MDD in layers not exceeding 150 mm.

If so specified, mitre banks facing shall be constructed of hand-packed stone pitching as detailed in Clause A11.1.7 of Chapter 11.

B3.1.8 WORKMANSHIP

The provisions of Part A, shall apply.

C3.1 DRAINS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

(ii) Notes on measurement and pay Items

1. Unless otherwise ordered or stated in the Contract Documentation, open drains, subsoil drains and trenches will be measured from the surface of the ground along the centre-line of the trench to the bottom of the specified bedding layer (as applicable).
2. The ground surface will be that existing after any bulk earthworks have been carried out, i.e. the excavated surface or embankment surface, unless a different sequence of execution has been ordered.
3. Excavations will be measured as if taken out with vertical sides, regardless of whether they have been taken out with sloping sides.
4. Wherever volumetric measurement is required, the volume will be computed from the depth determined as indicated in 1. and 2. above and using the authorised width (W) determined in accordance with the specification.
5. Where shoring is specified or ordered, the length of shoring measured for payment will be the length of the centre-line of the open drain or trench.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for backfilling excess excavations, disposing of surplus material etc. or any other contingent work, unless the work is specifically specified or ordered.
2. No separate payment will be made for setting out the works.
3. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
4. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
5. No separate payment will be made for the loading of any materials.
6. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km.
7. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
8. No separate payment will be made for the removal or any surplus material imported to complete the works.
9. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

The following items of work, when specified, shall be carried out, measured and paid for in accordance with the appropriate sections of the specifications.

Table C3.1-1: Items from other Chapters or Sections

Activity	Section 3.1 reference	Section Item reference
Open drain excavation	A3.1.7.2	C4.2.5 & C4.2.12 of Chapter 4 C5.1.2 & C5.2.9 of Chapter 5
Clearing and grubbing	A3.1.7.2; A3.1.7.3	C1.6 of Chapter 1

(v) Items specifically for this section of the specifications

Item	Description	Unit
C3.1.1	Excavation for open drains:	
C3.1.1.1	Excavating all material situated within the following depth ranges below the surface level using conventional methods:	
(a)	0 m to 1,5 m	cubic metre (m ³)
(b)	Exceeding 1,5 m and up to 3,0 m	cubic metre (m ³)
(c)	Etc, in increments of 1,5 m	cubic metre (m ³)
C3.1.1.2	Extra over sub-item C3.1.1.1 for excavation in hard and boulder material, irrespective of depth	cubic metre (m ³)

C3.1.1.3	Extra over sub-item C3.1.1.1 for excavation in stabilised existing road layers, irrespective of depth	cubic metre (m ³)
C3.1.1.4	Excavating soft material situated 0 m to 1,5 m below the surface level using labour enhanced construction methods	cubic metre (m ³)
C3.1.1.5	Excavating intermediate material situated 0 m to 1,5 m below the surface level using labour enhanced construction methods	cubic metre (m ³)

The unit of measurement shall be the cubic metre of material excavated in accordance with the authorised dimensions, measured in place before excavation. Only excavation for open drains as defined in Clause A3.1.7.2 shall be measured.

Irrespective of the total depth of the excavation, the quantity of material in each depth range shall be measured and paid for separately.

Excavations shall be done using conventional construction methods and/or labour enhanced construction methods as specified.

Payment made for either hard, boulder or stabilised existing road layers shall only be measured for the one applicable extra over category.

The tendered rates shall include full compensation for the excavation of the material to the required dimensions, lines, levels and grades, the trimming of the open drain and the loading and disposal/utilisation of the material as directed, including haul of 1,0 km when using conventional construction methods.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1. Where the excavation of material is specified by means of labour enhanced construction methods, the tendered rates shall include loading and transport by wheelbarrow if the material is disposed of or utilised within a radius of 50 m, alternatively loading by hand onto transport vehicles for such disposal or utilisation elsewhere, within a haul distance of 1,0 km.

For payment purposes a distinction shall be made between materials as classified according to Clause A3.1.7.1 under Classification of Materials.

Item	Description	Unit
C3.1.2	Clearing, shaping and disposal of accumulated sediment in existing unlined open drains	
C3.1.2.1	Using conventional methods	cubic metre (m ³)
C3.1.2.2	Using labour enhanced construction methods	cubic metre (m ³)

The unit of measurement shall be a cubic metre of sediment, including accumulated existing cut slope rubble and vegetation, removed measured in place before removal. Where such measurement is impractical or impossible, as decided by the Engineer, quantity measurement shall be determined as 70 % of volume measured in haulage vehicles.

Excavations shall be done using conventional construction methods and/or labour enhanced construction methods as specified.

The tendered rate shall include full compensation for excavating the material, protecting the existing drainage structures, trimming the floors and sides of the open drains and loading and disposing of material as prescribed.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1. Where the clearing and shaping of existing unlined open drains is specified by means of labour enhanced construction methods, the tendered rates shall include loading and transport by wheelbarrow if the material is disposed of or utilised within a radius of 50 m, alternatively loading by hand onto transport vehicles for such disposal or utilisation elsewhere, within a haul distance of 1,0 km.

The clearing of existing lined side drains will be measured and paid for under item C3.1.3.

Item	Description	Unit
C3.1.3	Excavation, clearing and disposal of accumulated sediment in existing lined drains and drainage systems	
C3.1.3.1	Using conventional methods (up to 1,5 m):	
(a)	Manholes and inlet and outlet structures	cubic metre (m ³)
(b)	Culvert barrels	cubic metre (m ³)
(c)	Concrete or other lined side drains	cubic metre (m ³)
C3.1.3.2	Using conventional methods (in excess of 1,5 m):	
(a)	Manholes and inlet and outlet structures	cubic metre (m ³)
(b)	Culvert barrels	cubic metre (m ³)
(c)	Concrete or other lined side drains	cubic metre (m ³)
C3.1.3.3	Using labour enhanced construction methods:	
(a)	Manholes and inlet and outlet structures	cubic metre (m ³)
(b)	Culvert barrels	cubic metre (m ³)
(c)	Concrete or other lined side drains	cubic metre (m ³)

The unit of measurement shall be the cubic metre of material excavated and removed, measured in place before excavation. Where such

measurement is impractical or impossible, as decided by the Engineer, quantity measurement shall be determined as 70 % of volume measured in haulage vehicles.

Excavation for the clearing of existing lined drains and drainage systems up to a depth of 1,5 m shall be done using conventional construction methods and/or labour enhanced construction methods as specified and measured. Excavation in excess of 1,5 m depth shall be paid for under item C3.1.3.2.

The tendered rate shall include full compensation for excavating the material, protecting the existing linings or drainage systems, dealing with any surface or subsurface water, and loading and disposing of the excavated material.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1. Where the clearing of existing lined drains and drainage systems is specified by means of labour enhanced construction methods, the tendered rates shall include loading and transport by wheelbarrow if the material is disposed of or utilised within a radius of 50 m, alternatively loading by hand onto transport vehicles for such disposal or utilisation elsewhere, within a haul distance of 1,0 km.

Item	Description	Unit
C3.1.4	Excavation and disposal of material for subsoil drainage systems:	
C3.1.4.1	Excavating in all material situated within the following depth ranges below the surface:	
(a)	0 m to 1,5 m	cubic metre (m ³)
(b)	Exceeding 1,5 m and up to 3,0 m	cubic metre (m ³)
(c)	Etc, in increments of 1,5 m	cubic metre (m ³)
C3.1.4.2	Excavating soft material situated within 0 m to 1,5 m below the surface level using labour enhanced construction methods	cubic metre (m ³)
C3.1.4.3	Excavating intermediate material situated within 0 m to 1,5 m below the surface level using labour enhanced construction methods	cubic metre (m ³)
C3.1.4.4	Extra over sub-item C3.1.4.1 for excavation in hard and boulder material, irrespective of depth	cubic metre (m ³)
C3.1.4.5	Extra over sub-item C3.1.4.1 for excavation through stabilised existing road layers	cubic metre (m ³)
C3.1.4.6	Excavation and disposal of material for composite in-plane fin-drain type drainage systems using a trenching machine:	
(a)	Trench width ofand depth of.....	metre (m)
(b)	Etc for width ofand depth of.....	metre (m)

The unit of measurement for items C3.1.4.1 to C3.1.4.5 shall be the cubic metre of material excavated in accordance with the authorised dimensions, measured in place before excavation. Irrespective of the total depth of the excavation, the quantity of material per classification in each depth range shall be measured and paid for separately.

Excavations shall be done using conventional construction methods and/or labour enhanced construction methods as specified and measured.

The tendered rates shall include full compensation for the excavation of the material to the required dimensions, lines, levels and grades, all temporary shoring and strutting, and the loading and disposing of the excavated material.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1. For payment purposes a distinction shall be made between materials as classified according to Clauses A3.1.7.1 and B3.1.7.2 under Classification of Materials.

Item C3.1.4.6 for excavation for composite in-plane fin-drain type drainage systems using a trenching machine shall be to the required width and depth indicated. The unit of measurement shall be the linear metre of trenching excavated. No distinction shall be made between soft material and stabilised layers of existing road layers. Hard material shall not be required to be excavated by trenching machine.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1. Where excavation is specified by means of labour enhanced construction methods, the tendered rates shall include loading and transport by wheelbarrow if the material is disposed of or utilised within a radius of 50 m, alternatively loading by hand onto transport vehicles for such disposal or utilisation elsewhere, within a haul distance of 1,0 km.

Where subsoil drainage systems are adjacent to structures such as culverts, that part of the excavation for subsoil drainage systems, which can be made by widening the excavation for the structure, shall only be measured and paid for under excavation for such structure, and not under excavation for the subsoil drainage systems.

Item	Description	Unit
C3.1.5	Impermeable backfilling to subsoil drainage systems	
C3.1.5.1	Un-stabilised natural gravel obtained from approved sources on the site	cubic metre (m ³)
C3.1.5.2	G5 material obtained from commercial sources	cubic metre (m ³)
C3.1.5.3	Extra over items C3.1.5.1 and C3.1.5.2 for stabilisation with 4,0 % CEM II (32.5) cement	cubic metre (m ³)

The unit of measurement shall be the cubic metre of completed backfill, measured in place in the subsoil drainage systems and shall be calculated in accordance with the authorised dimensions.

The tendered rate for item C3.1.5.1 shall include full compensation for procuring, furnishing, placing and compacting the backfilling.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1.

The tendered rate for item C3.1.5.2 shall include full compensation for procuring, furnishing and transporting G5 material from commercial suppliers, including the cost of transporting the material to the site irrespective of haul distance, and placing the materials as specified.

The tendered extra over rate for item C3.1.5.3 shall include full compensation for all additional costs for procuring, furnishing, mixing and placing the cement stabilised backfill.

Item	Description	Unit
C3.1.6	Construction of banks and dykes:	
C3.1.6.1	Banks and dykes using conventional methods	cubic metre (m ³)
C3.1.6.2	Banks and dykes using labour enhanced construction methods	cubic metre (m ³)

The unit of measurement shall be the cubic metre of material, measured in place in the banks or dykes, and calculated in accordance with the authorised dimensions. Where open drain with bank/dyke combinations are constructed, excavation shall be measured and paid under item C3.1.1.

The tendered rate shall include full compensation for procuring, furnishing, placing, watering, compacting, shaping and trimming the material in the banks and dykes.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1. Where excavation is specified by means of labour enhanced construction methods, the tendered rates shall include loading and transport by wheelbarrow if the material is disposed of or utilised within a radius of 50 m, alternatively loading by hand onto transport vehicles for such disposal or utilisation elsewhere, within a haul distance of 1,0 km.

Item	Description	Unit
C3.1.7	Natural permeable material in subsoil drainage systems (approved crushed stone):	
C3.1.7.1	Crushed stone obtained from approved sources on the site (state grade and size)	cubic metre (m ³)
C3.1.7.2	Crushed stone obtained from commercial sources (state grade)	cubic metre (m ³)

The unit of measurement for item C3.1.7.1 shall be the cubic metre of approved crushed stone in place in the drains, calculated in accordance with the authorised dimensions. The volume occupied by the pipes shall be deducted when calculating the volume of the natural permeable material.

The tendered rate shall include full compensation for procuring, furnishing and placing the material as specified.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1.

For payment purposes a distinction shall be made between the different grades of approved crushed stone.

The unit of measurement for item C3.1.7.2 shall be the cubic metre of crushed stone in place in the drains, calculated in accordance with the authorised dimensions. The volume occupied by the pipes shall be deducted when calculating the volume of the natural permeable material.

The tendered rate shall include full compensation for procuring, furnishing and transporting approved crushed stone from commercial suppliers, including the cost of transporting the material to the site irrespective of haul distance, and placing the materials as specified.

For payment purposes a distinction shall be made between the different grades of approved crushed stone.

Item	Description	Unit
C3.1.8	Natural permeable material in subsoil drainage systems (approved natural sand):	
C3.1.8.1	Natural sand obtained from approved sources (state grade & source)	cubic metre (m ³)
C3.1.8.2	Natural sand from commercial sources (state grade)	cubic metre (m ³)

The unit of measurement for item C3.1.8.1 shall be the cubic metre of approved sand in place in the drains, calculated in accordance with the authorised dimensions. The volume occupied by the pipes shall be deducted when calculating the volume of the permeable material.

The tendered rate shall include full compensation for procuring, furnishing and placing the sand as specified.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1.

For payment purposes a distinction shall be made between the different grades of sand.

The unit of measurement for item C3.1.8.2 shall be the cubic metre of sand in place in the drains, calculated in accordance with the authorised dimensions. The volume occupied by the pipes shall be deducted when calculating the volume of the permeable material.

The tendered rate shall include full compensation for procuring, furnishing and transporting approved sand from commercial suppliers, including the cost of transporting the material to the site irrespective of distance, and placing the material as specified.

For payment purposes a distinction shall be made between the different grades of sand.

Item	Description	Unit
C3.1.9	Pipes in subsoil drainage systems:	
C3.1.9.1	U-PVC pipes and fittings, normal duty, complete with couplings (state size and whether or not perforated or slotted)	metre (m)

The unit of measurement for pipes shall be the metre of pipe, measured in place along its centreline, including the length of fittings.

The tendered rate shall include full compensation for procuring, furnishing, laying and jointing the pipes and fittings as specified.

Item	Description	Unit
C3.1.10	Polymer film sheeting or similar approved material, for lining subsoil drainage systems:	
C3.1.10.1	0,15 mm thick	square metre (m ²)
C3.1.10.2	0,25 mm thick	square metre (m ²)

The unit of measurement shall be the square metre of polymer film sheeting installed, measured net from the specified dimensions.

The tendered rate shall include full compensation for procuring, supplying, cutting, overlapping, jointing, placing and protecting the sheeting as specified, as well as for wastage.

Item	Description	Unit
C3.1.11	Geotextiles (indicate type, grade, etc.)	square metre (m ²)

The unit of measurement shall be the square metre of geotextile supplied and installed as specified in Section A12.11 of Chapter 12.

The tendered rate shall include full compensation for furnishing, procuring, cutting, overlapping, jointing, placing and protecting the geotextile as specified, as well as for wastage.

Item	Description	Unit
C3.1.12	Composite drainage systems	
C3.1.12.1	In-plane drainage systems (state size, type of core and type grade, etc. of geotextile)	metre (m)
C3.1.12.2	Vertical subsoil strip drainage systems (state size, type of core and type grade, etc. of geotextile)	metre (m)
C3.1.12.3	Panel drainage systems (state size, type of core and type grade, etc. of geotextile)	metre (m)
C3.1.12.4	Alternative drainage systems as detailed in Contract Documentation (state size, type and other details)	metre (m)

The unit of measurement shall be the metre of composite or alternative drainage system as specified, measured in place along the centre line of the system.

The tendered rate shall include full compensation for procuring, furnishing, assembling, installing and jointing the composite or alternative drainage system, including perforated or other types of drainage core, complete as specified.

Item	Description	Unit
C3.1.13	Concrete outlet structures, manhole boxes, junction boxes and cleaning eyes for subsoil drainage systems:	
C3.1.13.1	Outlet structures (specify each type and drawing reference)	number (No)
C3.1.13.2	Inspection boxes (specify each type and drawing reference)	number (No)
C3.1.13.3	Junction boxes (specify each type and drawing reference)	number (No)
C3.1.13.4	Cleaning eyes (specify each type and drawing reference)	number (No)

The unit of measurement shall be the number of outlet structures, manhole boxes, junction boxes and cleaning eyes for subsoil drainage systems constructed in accordance with the details on the drawings and the Engineer's instructions.

The tendered rates shall include full compensation for all excavation, backfilling, compacting to 93 % of MDD, disposing of surplus excavated material, keeping the excavations safe, dealing with any surface or subsurface water, procuring and furnishing all materials, providing, erecting and removing formwork, mixing, transporting, placing and curing the concrete, and all labour and constructional plant required for constructing the concrete outlet structures, subsoil drain inspection boxes, subsoil junction boxes and cleaning eyes, complete as specified.

The tendered rate shall also include full compensation for procuring and finishing the galvanised woven wire mesh, cutting, waste, installing the wire mesh at outlets and keeping the wire mesh in the pipe openings clean for the duration of the contract period.

Item	Description	Unit
C3.1.14	Caps for subsoil drain pipes:	
C3.1.14.1	Concrete caps	number (No)
C3.1.14.2	Cast metal iron caps	number (No)

C3.1.14.3 Other (Glass fibre reinforced, PVC etc.) (specify) number (No)

The unit of measurement shall be the number of caps supplied as specified, and the tendered rate shall include full compensation for supplying and installing the caps.

Item	Description	Unit
C3.1.15	Repairing or replacing existing drainage systems	Provisional sum

The provisional sum given for repairing or replacing existing drainage systems shall be expended in terms of the general conditions of contract, for unmeasured work to be undertaken as described in the Contract Documentation.

Item	Description	Unit
C3.1.16	Loading and hauling of material in excess of 1,0 km	cubic metre-kilometre (m³-km)

The measurement and payment for hauling material referred to in items C3.1.1, C3.1.2, C3.1.3, C3.1.4, C3.1.5, C3.1.6, C3.1.7, C3.1.8, C3.1.17 and C3.1.18, if any, shall be in accordance with Section A1.7 of Chapter 1.

Item	Description	Unit
C3.1.17	Backfilling existing eroded side drains	cubic metre (m³)

The unit of measurement shall be the cubic metre of approved granular material placed and compacted to 93 % of MDD, measured in place after compaction. Where such measurement is impractical or impossible, as decided by the Engineer, quantity measurement shall be determined as 70 % of the loose volume of imported material.

The tendered rate shall include full compensation for procuring, furnishing, transporting, placing and compacting the granular material and including haul of 1,0 km. Where trimming or benching of the side drains and disposal of resulting material is required, it shall be measured and paid under item C3.1.3.

Item	Description	Unit
C3.1.18	Backfilling of drains with selected material compacted to 93 % of MDD prior to construction of concrete lining and/or stone pitched lining	cubic metre (m³)

The unit of measurement shall be the cubic metre of compacted material and the quantity shall be calculated from the authorised dimensions given on the drawings or as specified by the Engineer.

The tendered rate shall include full compensation for procuring, as if from soft excavation or borrowpits, breaking down, placing and compacting the material in 150 mm layers, transporting of the material transport over a haul of 1,0 km as well as for shaping the top surface in accordance with the drawings.

Item	Description	Unit
C3.1.19	Exposing of existing subsoil drains	cubic metre (m³)

The unit of measurement shall be the cubic metre of material removed to expose the drain for the purposes of refurbishment existing drains. This item shall not be applicable in cases where complete substitution or replacement of existing drains is specified.

The tendered rate shall include full compensation for all labour and tools required for removing the material. The re-instatement of the drain elements, as may be specified, shall be paid for under the relevant items for constructing a new drain.

Item	Description	Unit
C3.1.20	Breaking into existing drainage structures and install subsoil drain pipe	number (No)

The unit of measurement shall be the number of subsoil drain pipes built into existing drainage structures in accordance with the details on the drawings or as specified by the Engineer.

The tendered rates shall include full compensation for supplying all labour, constructional plant and materials required, for all excavation, breaking into existing drainage structures, building pipes into the newly formed accesses, sealing around the pipes and making the joints watertight, breaking out existing benching and channeling where required and reconstructing them complete with granolithic rendering to suit the new pipe arrangement, backfilling and compacting to 93 % of MDD, transporting (including all haulage) and disposing of all surplus excavated material and debris to approved dumping sites provided by the Contractor, and dealing with the flows in the existing structures.

No distinction will be made between different types of structures, or diameters of subsoil drain pipes.

Item	Description	Unit
C3.1.21	Clearing of existing subsoil drains	
C3.1.21.1	Cleaning rod, brush and flushing	metre (m)
C3.1.21.2	Hydro jetting	metre (m)

The unit of measurement for clearing of existing subsoil drains shall be the metre of drain cleared with a sewer cleaning rod and brush, thorough flushing and mandrill testing.

The unit of measurement for hydro jetting will include the establishment on site, hydro jetting and vacuuming of specified drains at various locations on site.

The tendered rate shall include full compensation for all labour, equipment, tools, water and transport required for clearing existing subsoil drains and for disposal of the cleared material to approved sites.

Item	Description	Unit
C3.1.22	Test flushing of subsoil drain pipe systems	number (No)

The unit of measurement shall be the number of tests satisfactorily completed on newly installed or unblocked sections of drain system, irrespective of its length. No payment will be made for tests, which have to be repeated due to blocked pipes or faulty workmanship.

The tendered rate shall include full compensation for the provision of a water tanker, water, equipment and labour necessary to carry out the tests, complete as specified.

Item	Description	Unit
C3.1.23	Subsoil drain outlet marker (type or drawing specified)	number (No)

The unit of measurement is the number of subsoil outlet markers installed in accordance with the details on the drawings.

The tendered rate shall include full compensation for procuring and furnishing the subsoil drain outlet marker and installation in accordance with the details on the drawing.

Item	Description	Unit
C3.1.24	Submission of as built drawings by the Contractor	Provisional sum

The provisional sum given for the Contractor to provide the Engineer with as built drawings pertaining to all subsoil drains on the site. The drawings must contain the location, co-ordinates of in- and outlets, length and depth and must be provided to the Engineer prior to the site hand over.

D3.1 DRAINS

PART D: GUARANTEES & COMPLIANCE CERTIFICATES

CONTENTS

- D3.1.1 SCOPE**
- D3.1.2 GENERAL**
- D3.1.3 PERFORMANCE GUARANTEE REQUIREMENTS**
- D3.1.4 FUNCTIONAL PERFORMANCE ASSESSMENTS**
- D3.1.5 VISUALLY ASSESSED PROPERTIES**
- D3.1.6 INSTRUMENTALLY ASSESSED PROPERTIES**
- D3.1.7 EVALUATION FOR ACCEPTANCE**
- D3.1.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE**
- D3.1.9 NOTIFICATION OF REMEDIAL WORK**
- D3.1.10 REMEDIAL WORKS**

No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.

A3.2 CULVERTS

CONTENTS

PART A: SPECIFICATIONS

- A3.2.1 SCOPE
- A3.2.2 DEFINITIONS
- A3.2.3 GENERAL
- A3.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS
- A3.2.5 MATERIALS
- A3.2.6 CONSTRUCTION EQUIPMENT
- A3.2.7 EXECUTION OF THE WORKS
- A3.2.8 WORKMANSHIP

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENTS AND PAYMENTS

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

PART A: SPECIFICATIONS

A3.2.1 SCOPE

Drainage under this Section covers mainly culverts and conduits and their associated works in water courses or from natural or shaped areas, but may also cover drainage of road or bridge surfaces. This Section covers work in connection with the construction of in situ constructed and prefabricated culverts and other closed conduits to provide such drainage, together with inlet and outlet structures, manholes and other appurtenant structures. Different Road Authorities may differentiate between minor culverts, lesser culverts or major culverts. Major culverts are covered in Chapters 13 and 14.

The replacing and/or lengthening of existing culverts, modification of and repairs to existing drainage structures and catch pits as well as sleeving or lining, partly or fully, of the insides of existing culverts are also included in this Section.

A3.2.2 DEFINITIONS

Culvert: is a structure other than a bridge which provides an opening under the carriageway or median for drainage or other purposes.

Major Culvert: is a cellular structure with dimensions less than those defining a bridge but with any clear span length (as measured horizontally at the soffit perpendicular to the faces of its supports) equal to or larger than 2,1 m, or diameter equal to or larger than 2,1 m, or a culvert with a total cross-sectional opening equal to or larger than 5,0 m². (TMH19)

Minor Culvert: all culverts smaller than that defined as a Major Culvert are classified as lesser culverts. (TMH19)

A3.2.3 GENERAL

The attention of the Contractor is drawn to the requirement that information given on the drawings, longitudinal sections or drainage schedules may have to be verified and reviewed to suit actual site conditions and therefore the Contractor shall only construct these culverts after the Engineer has amended or verified the information on the drawings based on detail surveys taken on site.

Prefabricated units shall be ordered by the Contractor from actual measurements of lengths determined on site and not from lengths stated in the drainage schedules or from the schedule of quantities.

All existing stormwater culverts, which are to be extended, shall be inspected on site and any defects reported to the Engineer prior to extensions being constructed. Likewise, existing and new culverts are to be inspected for possible damage after completion of layerworks over the culverts.

A3.2.3.1 Types of culverts

For the purposes of this specification, the term "culverts" shall mean culverts constructed from-

- a) Reinforced concrete floors and roofs and reinforced concrete walls, hereinafter referred to as "rectangular concrete culverts". The reinforced concrete floors and/or roofs may be either cast in situ or prefabricated units constructed elsewhere;
- b) Reinforced concrete floors and roofs and reinforced brickwork walls, hereinafter referred to as "rectangular brickwork culverts". The reinforced concrete floors and/or roofs may be either cast in situ or prefabricated units constructed elsewhere;
- c) Prefabricated reinforced concrete pipes with circular sections, hereinafter referred to as "concrete pipe culverts";
- d) Prefabricated reinforced concrete culverts other than pipe culverts hereinafter referred to as "prefabricated portal culverts", generally of combined wall and roof prefabrication. The reinforced floors may be either cast in situ or prefabricated units constructed elsewhere. These culverts are generally of rectangular construction;

- e) Prefabricated corrugated metal pipes and pipe arches, hereinafter referred to as "metal culverts".
- f) U-PVC pipes with circular section, hereinafter referred to as "U-PVC culverts"
- g) Other types of culverts not included above, if required, shall be specified in the Contract Documentation.

A3.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

None applicable unless specific specifications have been accepted as proposed by the Contractor or included into the Contract Documentation.

A3.2.5 MATERIALS

A3.2.5.1 General material specifications

The material specifications are the required specifications for the materials as placed and/or processed in its final position.

It is the Contractor's responsibility to ensure that the materials delivered to the site shall meet these specified requirements.

Prior to the manufacture of any prefabricated units by the Contractor's manufacturer, the manufacturer shall submit his Quality Plan to the Engineer to verify that all prefabricated units will be manufactured in full compliance with the relevant SANS requirements. No prefabricated units shall be ordered until the Engineer has satisfied himself that the proposed units have been or will be manufactured to the required specifications and tolerances as well as the load bearing requirements. In particular the manufacturer shall check each prefabricated portal culvert unit for steel cover compliance, and random checking of units shall not be accepted. The Engineer's representative may visit the factory at any stage to ascertain adherence to the quality plan. Should the manufacturer fail to adhere to their Quality Plan the Engineer may exercise the right to reject the use of products from the manufacturer concerned. No claim from the Contractor for any resultant cost or delay due to such rejection, and due to procurement from a new manufacturer, shall be entertained.

Materials removed under this Section from existing works, except where excavated materials are specified to be reused or disposed of, or except where provision has been made in Part C for their reuse or specific disposal, shall be deemed to be the property of the Contractor.

A3.2.5.2 Culvert materials

a) In situ concrete

All concrete work shall be carried out in accordance with the requirements of Section A13.4 of Chapter 13 of these specifications, read together with the provisions of Clause A3.1.5.4.

b) Prefabricated portal culverts and prefabricated in/outlet, floor and roof slabs units

The prefabricated units shall comply with the requirements of SANS 986.

For durability requirements, all durability testing shall be done in accordance with Clause A20.1.5 for testing and Clause A20.1.7 for assessment in Chapter 20 and shall fall within the severe category. For units within the 5,0 km zone from the coast the very severe category shall be used and increased cover shall be as specified by the Engineer.

Portal and rectangular prefabricated units shall be transported and handled with sufficient care to prevent stressing, cracking or damage to the unrestrained elements of the units. Cracks or damage shall constitute adequate reason for rejection by the Engineer or required confirmation by the manufacturer of their serviceability.

All broken, bent, chipped, cracked, dented, corroded or otherwise damaged or substandard units shall be repaired to the Engineer's specification or, where this is not acceptable or does not comply to the SANS specification, they shall be removed and replaced with undamaged units, at the Contractor's cost.

Slab units which are thinner than the specified thickness, or which may exhibit signs of substandard work shall be removed and replaced with units which conform to the specifications.

c) Prefabricated concrete pipe culvert units

Prefabricated concrete pipe culvert units shall comply with the requirements of SANS 677. Pipes with ogee joints shall be provided, unless otherwise specified.

All broken, bent, chipped, cracked, dented, corroded or otherwise damaged or substandard units shall be repaired to the Engineer's specification or, where this is not acceptable or does not comply with the relevant SANS specification, they shall be removed and replaced with undamaged units, at the Contractor's cost.

d) Brickwork

Bricks shall be engineering bricks conforming to the requirements of SANS 227. Bricks may be manufactured on site or elsewhere.

The limit for water absorption in the 24 hour immersion test shall be 8 % maximum.

All bricks shall be unbroken, except where required as closers.

e) Plaster

Plaster shall consist of one part of CEM I class 32.5 cement to four parts of approved fine sand, and shall conform to the requirements of SANS 2001.

f) Manhole covers, grid inlets, frames, etc.

Manhole covers and frames, grid inlets and accessories of metal, or non metal composition shall be supplied and/or manufactured in accordance with the details shown on the drawings and be of the size and type indicated. Frames, grid inlets and covers which are of project specific requirements shall be manufactured and installed as indicated on the drawings, and all steel elements shall be galvanised in accordance with SANS 121. Frames, grids/gratings covers and accessories of cast iron, synthetic or composite materials shall comply with the requirements of SANS 558, SANS 1115, or SANS 50124 and be of the strength class, size and type specified,

Before fixing cast iron manhole covers and frames, they shall be dipped in an approved preservative and gratings and frames painted with two

coats of bituminous paint.

g) Corrugated metal culvert units

Corrugated metal culverts shall either be supplied fully assembled; or as unassembled nestable arch or circular segments, in which case they shall be assembled in accordance with the manufacturers specifications. The manufacturer's specifications shall be provided to the Engineer prior to the start of any assembly.

Metal culverts shall be supplied with inlet and outlet ends finished by one of the following two methods, whichever is shown on the drawings or has been specified:

Where no concrete inlet and outlet structures but only beveled pipe ends are required, inlet and outlet units shall be beveled to suit the skew angle of the culverts and the side slope of the fill and pavement. Such beveled units shall be machined and shall receive full corrosion protection treatment after such machining.

Where in situ concrete inlet and outlet structures are required, the ends of the culvert units shall be cut to the required plan skew angle (if any) and provided with anchor bolts projecting radially around the edge as shown on the drawings for bonding the metal culvert into the concrete inlet and outlet structures.

The Contractor shall not store any nestable culvert units on the site in such a manner that moisture can accumulate between the contact faces of the nested units, as this may adversely affect the spelter coating and render the units liable to rejection. Any units damaged by corrosion shall, if not rejected, be repaired by cleaning all affected areas and applying at least two coats of an approved zinc-rich epoxy primer which complies with the requirements of SANS 926, in accordance with the manufacturer's instructions, or as directed by the Engineer.

Uneven joints, distorted shapes, deviations from a straight centre line, irregular or diagonally ruptured sides, loose rivets, rivets not in line or irregularly spaced, poorly finished rivet heads, illegible trade marks, or a lack of rigidity.

h) Protective coating for metal culverts

Metal culverts shall have a protection coating as specified in the Contract Documentation or indicated on the drawings, and may be of galvanized, aluminized or polymer coatings to the specified thickness. Where soil or water conditions are likely to cause excessive corrosion of metal culverts, the Engineer may prescribe that prefabricated units be protected by the application of a mastic asphalt protective coating. The coating shall be applied to either the inside, the outside or to both sides of the metal culvert units as may be directed by the Engineer.

The mastic asphalt shall contain fibres and filler and shall be supplied as a spray or brush-grade material as prescribed.

The surfaces to be protected shall be cleaned to remove all moisture, dirt, all, paint, grease, alkalis, rust, mill scale or other deleterious matter.

The material shall be thoroughly mixed until all fibres and filler are uniformly distributed.

Spray-grade mastic shall be applied by means of an airless gun and shall be of a suitable consistency without the addition of a harmful amount of thinners.

Brush-grade mastic shall be applied with an ordinary roofing brush, with the second coat being applied at right angles to the first coat.

The final film thickness measured on the crest of corrugations shall be a minimum of 1,3 mm or such other thickness as may be specified.

Care shall be taken not to damage the protective coating, and all damage to the coating shall be repaired before the culvert is put to use.

i) U-PVC culverts

U-PVC culverts shall comply to the requirements of SANS 791 for solid wall pipes (category-heavy duty), and shall have socketed ends should joining be required.

j) Alternative culvert materials

Alternate culvert materials, if any, shall be specified and detailed in the Contract Documentation.

A3.2.5.3 Skewed ends

Where culverts are to be constructed at a skew angle, the prefabricated culvert units at the inlet and outlet of the culvert shall be supplied with skew ends by the manufacturer, if required. The cutting of skew ends on the site shall not be allowed.

Prefabricated portal and rectangular culverts placed on a skew shall be constructed with cast in-situ skewed ends as shown on the drawings. In-situ skew ends are to be constructed simultaneously with the wingwalls and headwalls.

A3.2.5.4 Prefabricated energy dissipaters in outlet structures

Where shown on the drawings, the Contractor shall supply and install in the outlet structures, prefabricated reinforced concrete energy dissipaters of class C25/30-20 concrete with dimensions as shown on the drawings. All concrete work shall comply with the requirements of Section A13.4 of Chapter 13.

A3.2.5.5 Fine granular material

Wherever the use of fine granular material is specified in this section for the bedding of the prefabricated concrete floor slabs of the culverts, it shall mean sand or other cohesionless material, all of which shall pass through a 7,0 mm sieve and not more than 10 % of which shall pass through a 0,15 mm sieve.

A3.2.5.6 Materials at joints

Joint filler and joint sealing material shall comply with the requirements of Section A13.7 of Chapter 13.

A3.2.6 CONSTRUCTION EQUIPMENT

The Contractor shall submit his plant and equipment list for excavating, stockpiling if specified, loading and hauling and compaction, erection and installation, as part of his method statement to perform the different elements of the drainage works specified in Section A3.2.

A3.2.7 EXECUTION OF THE WORKS

A3.2.7.1 Construction methods

Where clearing and/or grubbing and the removal of trees is specified by the Engineer, it shall be executed as specified in Section A1.6 of Chapter 1.

Prefabricated culverts shall be installed by either -

The "trench method", where the units are laid in a trench excavated below the existing ground level or in a trench excavated in constructed subgrade and, if necessary, subbase layers, or, in the case of an existing road, in a trench excavated through all road layers;

or

The "embankment method", where the units are laid approximately on the existing ground surface or on a prepared bedding and the subgrade is then constructed on either side and over the culvert.

If lengthening of existing culverts are specified such lengthening shall generally be according to the "embankment method". The Contractor shall at all times ensure that the existing drainage is at all times maintained and any damage caused as a result of blocked culverts during construction shall be repaired at the Contractor's cost.

All new prefabricated culverts/portals shall be installed by the "trench method", unless specified otherwise by the Engineer.

The bottom of the excavation for culverts that are to be replaced or lengthened shall be inspected by the Engineer prior to the placing of the bedding material.

Where the material is found to be unsuitable, it shall be removed to a depth specified by the Engineer and then replaced with selected material compacted to at least 93 % MDD in layers not exceeding 150 mm thickness.

Design invert levels of drainage culverts shall be verified on site by the Engineer with the assistance of the Contractor before installation of new or lengthened culverts may commence.

In all cases where soft founding material is classified as suitable for bedding construction, the in-situ material shall be scarified, moistened and compacted to a depth of 150 mm below founding level to 90 % or 93 % MDD, as specified by the Engineer. The depth of preparation and compaction of founding material shall be as indicated on the drawings or as specified by the Engineer.

The larger sizes of portal or rectangular culverts shall normally be constructed by the embankment method.

Surface drainage shall be controlled by the construction of temporary earth berms and drainage diversion channels.

The Contractor shall strictly comply with all the appropriate statutory safety provisions in regard to trench excavations.

A3.2.7.2 Excavation for construction by trench method

a) Classification of Materials

All excavation classification of materials in this Section shall be as specified in Clause A3.1.7.1.

b) Excavation

All excavations for culverts shall be excavated in the position and to the required dimensions. Overbreak in width or depth, unless specified by the Engineer, shall be in filled by the Contractor and shall not be measurable for payment.

In the case of culverts to be constructed by the trench method, the Contractor shall first construct the fill, subgrade and, if necessary, the subbase to such level as will provide a minimum cover, above the proposed level of the top of the culvert. Road base layers shall not be constructed before the culvert and backfill have been completed. Before trench excavation may commence, the minimum height of fill construction over the top of a proposed concrete culvert shall be 100 mm or such greater height as may be indicated on the drawings, whichever is the greater for metal culverts, this minimum height shall be 0,25 times the diameter of the pipes, or 0,25 times the span of pipe arches. The Contractor may then commence excavating the trench for the culvert from the downstream end. Excavation less than 1,5 m deep shall be done either by using labour enhanced construction methods or by using conventional construction methods, as specified and measured in the schedule of quantities. Excavations shall be continuously monitored and assessed for stability and safety and if any risk of instability is evident the Contractor shall not proceed with culvert excavation until safe working conditions have been re-established. The Engineer should be informed of all the actions taken in this regard.

The amount by which the excavation is to exceed the proposed level of the invert of the culvert shall be sufficient to allow the type and thickness of bedding material to be placed as specified or as indicated on the drawings.

The minimum amount by which the excavation shall be deeper than the proposed level of the bottom of the culvert floor slab shall be 75 mm in the case of culverts with prefabricated invert slabs. In the case of culverts with cast in situ invert slabs, the excavation shall exactly accommodate the floor slab.

Notwithstanding the above, the base layer shall not be constructed before the culvert and the backfill have been completed.

c) Width of excavation

The width of excavations shall be sufficient to allow the bedding, proper construction and backfilling of culverts. The width of the excavation for each size of culvert shall be as shown on the drawings or as may be prescribed by the Engineer in writing.

d) Excavation by hand

Where the circumstances prevent the use of mechanical excavators due to possible damage to existing works and soft material can only be removed by hand tools, the Engineer shall authorise the excavation by hand should he be satisfied that the Contractor had been unable to prevent the necessity for excavation by hand by proper planning and precautionary measures. Payment for this hand excavation shall be made under excavation using labour enhanced construction methods in terms of B3.2.7.2.

e) Drainage of excavations

The Contractor shall, in terms of Clause A1.2.3.19 of Chapter 1, apply suitable, effective drainage and dewatering methods for preventing the

ingress of water into the excavation and to keep them dry.

Drainage methods, with the exception of pumping, shall be maintained until the backfilling has been completed. Between various construction stages, pumping may be interrupted in consultation with the Engineer.

Any draining or pumping of water shall be done in a manner to preclude the concrete or materials or any part thereof from being eroded.

A3.2.7.3 Preparation for construction by the embankment method

Where culverts are to be constructed by the embankment method as defined in Clause A3.2.7.1 the Contractor shall level the existing ground by excavating, filling and compacting as may be necessary so as to provide exactly the required slope and a uniform density over the entire length of the culvert. Where excavation is required for the founding of culverts, such excavation shall be done in accordance with Clause A3.2.7.2.

The finished level of the ground for the bedding of the culvert shall be not lower than 75 mm in the case of culverts with prefabricated invert slabs. In the case of culverts with cast in situ invert slabs, the level shall exactly accommodate the floor slab.

A3.2.7.4 Unsuitable founding conditions

Where the bottom of the trench does not provide a suitably firm foundation for the culvert on account of soft, unstable, or otherwise unsuitable material being encountered, the unsuitable material shall be excavated to a depth below the bottom of the culvert as may be indicated by the Engineer. The Contractor shall excavate the unsuitable material to the depth indicated and shall replace it with an approved material properly compacted to provide a firm foundation layer.

The width of the excavation and foundation later shall be as prescribed by the Engineer, but in the case of culverts to be constructed by the embankment method, the width shall be wider by at least one culvert diameter on each side of the culvert or set of culverts.

Other special construction methods may be shown on the drawings or specified in the Contract Documentation in specific cases.

A3.2.7.5 Disposal of excavated material

Where excavated material does not comply with the requirements for backfilling material as specified hereinafter or is surplus to backfilling requirements, such excavated material shall be removed from the site and disposed of in approved spoil areas or at such other places as directed by the Engineer.

Material suitable for use in the works, however, shall be used as prescribed by the Engineer.

Payment for such material will be made as for excavation under item C3.2.1, and also under the appropriate item for such part of the works as may be constructed from such material.

All excavated material shall be subject to the load and haul provisions specified in Section A1.7 of Chapter 1.

A3.2.7.6 Construction of culverts

a) General requirements

The construction of culverts shall be commenced at one end of the culvert, the position of which shall be fixed as shown on the drawings or as prescribed by the Engineer.

Units which have been deformed or cracked, or which are not constructed to the required lines, levels and grades, or which become displaced in the process of the work or during the contract period, shall be removed and replaced by the Contractor at his own cost.

Prefabricated slabs shall be lifted and handled by means of approved lifting devices only. During such procedures all relevant safety regulations shall be adhered to. Lifting eyes shall be caulked with a suitable mortar after the units have been installed. All lifting holes shall be filled with cement mortar and covered with class 3 geotextile.

The Contractor shall exercise due care not to damage, overstress or displace any culvert or prefabricated slab with his own traffic or compaction equipment. Where loads exceeding those prescribed in the appropriate statutory provisions are likely to pass over completed culverts, the Contractor shall provide additional cover over the culverts so as to ensure that the design stresses on the culverts will not be exceeded.

All concrete work shall be carried out in accordance with the provisions of Section A13.4 of Chapter 13 of these specifications.

b) Rectangular concrete and brickwork culverts

(i) Cast in situ floor slabs

Cast in situ floor slabs shall be constructed to the dimensions and at the locations as shown on the drawings or as may be prescribed by the Engineer. They shall be reinforced with steel reinforcement as detailed on the drawings. Joints of the types detailed on the drawings shall be formed in the floor slabs, as well as between the floor slabs and the inlet and outlet structures. Where specified by the Engineer a screed layer shall be cast to the specified dimensions and details, prior to casting the floor slab. In addition, longitudinal construction joints as shown on the drawings between the invert slabs of each of the barrels of multiple culverts are required. Allowance for Class F1 surface finish and soft board in these joints is made in the schedule of quantities. No payment shall be made for formwork on the outside edges of invert slabs (closest to the excavated face).

(ii) Prefabricated floor slabs

A layer of fine-grained material at least 75 mm thick shall be placed on the bottom of the excavation or backfilled bedding, leveled, compacted and trimmed to line and grade, to form a bed to receive the prefabricated slabs.

The slabs shall be carefully placed on the prepared bed, true to line and grade, and so bedded that they will be uniformly supported over their whole area on the bedding.

(iii) Concrete walls for concrete culverts

Cast in situ concrete walls shall be constructed to the dimensions and at the locations as shown on the drawings or as may be prescribed by the Engineer. They shall be reinforced with steel reinforcement as detailed on the drawings. Joints of the types detailed on the drawings shall be formed in the walls, and between the wall and the inlet and outlet structures.

(iv) Brickwork walls for brickwork culverts

Culvert walls constructed from engineering bricks shall be to the dimensions as shown on the drawings or as may be prescribed by the Engineer. Brickwork may be reinforced with steel or wire reinforcement, if and as detailed on the drawings.

Brickwork shall be built in English bond in a mortar consisting of one part of CEM I class 32.5 cement and six parts of sand, or in stretcher bond where its thickness does not exceed 115 mm. It shall be well and regularly bonded without any false headers. All engineering bricks shall be unbroken, except where required as closers. Engineering bricks shall be well wetted before laying and each brick shall be pressed into its bed so as to leave a finished joint not exceeding 10 mm in thickness. All joints shall be filled solid with mortar, and joints for exposed faces shall be pointed as the work proceeds.

Where pipes enter brickwork, such pipes shall be thoroughly caulked into the wall and rendered with mortar.

(v) *Plaster for brickwork culverts*

Where the plastering of brickwork is required, all joints shall be well raked out and the brick face thoroughly wetted before plaster is applied. Plaster shall not be less than 12 mm or more than 20 mm thick. Plaster finish shall be smooth and even and shall not show any trowel marks. Unless otherwise specified, all plaster shall be finished with a steel trowel.

Plaster shall be cured for at least 48 hours, where after installation of roof slabs may commence.

(vi) *Cast in situ roof slabs*

Cast in situ roof slabs shall be constructed to the dimensions and at the locations as shown on the drawings or as may be prescribed by the Engineer. They shall be reinforced with steel reinforcement as detailed on the drawings. Joints of the types detailed on the drawings shall be formed in the roof slabs, coinciding with similar joints in the floor slabs, and between the roof slabs and the inlet and outlet structures.

(vii) *Prefabricated roof slabs*

The prefabricated concrete roof slabs shall be placed accurately and symmetrically on the concrete walls, with a thin layer of mortar of one part of CEM I class 32.5 cement and six parts of sand between the contact surfaces to ensure a firm and uniform support.

The units shall be butted end to end with butt joints, which joints shall be covered with two layers of grade 3 geotextile as specified in Section A12.11 of Chapter 12, pre-impregnated with a bituminous emulsion, or a similar approved material. The strip of geotextile shall be at least 150 mm wide and placed symmetrically over the joint. The units shall first be treated with a primer of 60 % bitumen emulsion over the width of the strip of geotextile.

Where two or more roof slabs are placed side by side to form a multi-barrel culvert, the space between the slabs, if any, shall be filled with concrete up to the level of the top of the slab. Alternatively, such joints shall be sealed as for butt joints.

A3.2.7.7 Laying and bedding of prefabricated culverts

a) Concrete pipe culverts

Prefabricated concrete pipe culverts shall be laid on Class A, B, C or D bedding as shown on the drawings or as specified. The pipe ends shall be laid hard up against each other so as to obtain tight joints. Ogee pipes shall be laid with their spigot ends pointing downstream. The joints shall be sealed on the outside with two layers of bitumen-impregnated grade 3 geotextile as specified in Section A12.11 of Chapter 12.

The insides of the culverts shall be smooth and without any displaced joints. All pipes shall be laid true to line and level.

(i) *Class A bedding*

The pipe shall be laid with its bottom part on a C20/25-20 concrete bedding cradle of specified thickness below the lower part of the pipe, which concrete shall extend upwards on both sides of the pipe to a specified portion of its height, as shown on the drawings.

Before concreting, the pipes shall be supported on suitably shaped cradles at the correct level. No longitudinal construction joints on the horizontal plane will be permitted.

(ii) *Class B and Class C beddings*

The pipe shall be laid on a bedding cradle of compacted selected granular material as specified. The bedding shall extend upwards on both sides of the pipe to a specified portion of its height, as shown on the drawings. Grooves for thickened pipe ends, if applicable, shall be formed in the bedding cradle for pipe sockets and couplings, to ensure that each pipe is fully supported throughout the length of its barrel on the bedding cradle.

(iii) *Class D bedding*

The pipe shall be laid on the in situ material in the excavation bottom after the bottom has been hand trimmed to support the pipe along the entire length of its barrel in accordance with the details shown on the drawings. Wherever necessary, the in situ material shall first be stabilised in accordance with the details shown on the drawings or as prescribed by the Engineer. Grooves for thickened pipe ends, if applicable, shall be formed in the trench bottom for pipe sockets and couplings, to ensure that each pipe is fully supported throughout the length of its barrel on the bedding cradle.

(iv) *Rock foundation*

Where rock, shale or other hard material is encountered on the bottom of excavations, the installation of pipes on Class B bedding shall proceed as follows:

The material below the pipe shall be excavated and replaced with a bed of sand or approved gravel or soil to a depth as shown on the drawings or prescribed by the Engineer. Such material shall be classed as backfill for purposes of payment.

The backfill material shall be watered and compacted to provide a firm earth foundation. Class B bedding shall then be prepared as described in Clause A3.2.7.7a(ii).

(v) *Concrete casing*

Where shown on the drawings or specified by the Engineer, pipes shall be fully encased in concrete according to class and dimensions as shown on the drawings or as ordered by the Engineer. Supports shall be provided close to the pipe ends to support the pipes during the placing of concrete. The concrete shall be so placed as to fill all spaces below and around the pipe completely.

Poker vibrators shall be used for this purpose. Concrete casing shall be cast in one continuous operation until completed.

b) Prefabricated portal culverts

(i) Cast in situ floor slabs

Cast in situ floor slabs shall be constructed to the dimensions and at the locations as shown on the drawings or as may be prescribed by the Engineer. They shall be reinforced with steel reinforcement as detailed on the drawings. Joints of the types detailed on the drawings shall be formed in the floor slabs, as well as between the floor slabs and the inlet and outlet structures. Where specified by the Engineer a screed layer shall be cast to the specified dimensions and details, prior to casting the floor slab.

In accordance with the drawings, transverse construction joints are required in cast in situ concrete invert slabs for portal culverts. In addition, longitudinal construction joints as shown on the drawings between the invert slabs of each the barrels of multiple culverts are required. Allowance for Class F1 surface finish and soft board in these joints is made in the schedule of quantities. No payment shall be made for formwork on the outside edges of invert slabs (closest to the excavated face).

(ii) Prefabricated floor slabs

A layer of fine-grained material at least 75 mm thick shall be placed on the bottom of the excavation or backfilled bedding, leveled, compacted and trimmed to line and grade, to form a bed to receive the prefabricated slabs.

The slabs shall be carefully placed on the prepared bed, true to line and grade, and so bedded that they will be uniformly supported over their whole area on the bedding.

(iii) Placing the portal portions of culverts

The portal portions of portal and rectangular culverts shall be placed accurately and symmetrically on the floor slabs, with a thin layer of mortar of one part of CEM I class 32.5 cement and six parts of sand between the contact surfaces to ensure a firm and uniform support.

The units shall be butted end to end with butt joints, which joints (both horizontally and vertically) shall be covered externally with two layers of grade 3 geotextile as specified in Section A12.11 of Chapter 12, pre-impregnated with a bituminous emulsion, or a similar approved material. The strip of geotextile shall be at least 150 mm wide and placed symmetrically over the joint. The units shall first be treated with a primer of 60 % bitumen emulsion over the width of the strip of geotextile.

Where two or more culverts are placed side by side to form a multi-barrel culvert, the space between the culverts shall be filled with concrete up to the level of the top of the culvert.

c) Metal culverts

The excavation shall be trimmed to the shape of the invert of the culvert and a bed of fine granular material not less than 75 mm thick shall be placed, compacted and shaped to enable the culverts to be bedded as shown on the drawings.

Where rock is encountered, the depth of excavation shall extend to a depth of at least 200 mm below the invert of the culvert, and shall be filled with granular material as before.

The culverts shall be assembled and installed in accordance with the manufacturer's recommendations as specified by the Engineer. Where these specifications are inconsistent with the manufacturer's recommendations, these specifications shall have preference. Anchor bolts shall be installed at the ends of metal pipe culverts in accordance with the manufacturer's instructions to bond them into inlet and outlet head walls, which head walls shall be constructed as soon as possible after installation of the culverts.

No concrete bedding or casing shall be used in the installation of metal culverts.

Where prescribed, the inner invert of metal culverts with diameters or spans exceeding 1 500 mm which are laid on steep grades shall be protected with a layer of concrete with dimensions and class as shown on the drawings.

A3.2.7.8 Extension of existing culverts

Where an existing portal or rectangular culvert requires extension, the new section shall be constructed at the same grade and, where it joins the existing structure, at the same level as the existing structure.

Any sections of existing wing walls, approach slabs and head walls, which may obstruct any new work, shall be demolished and removed. Existing culvert ends shall not be damaged, but, should damage occur, the repair work shall be done before the placement of any fresh concrete or construction of the new culverts. Loose material shall be removed and joint faces thoroughly cleaned to the satisfaction of the Engineer.

Joining shall be done in accordance with Clause A3.2.7.13. After completion of the extension of a culvert, new approach slabs, head walls, wing walls, catchpits, etc, shall be constructed in accordance with the drawings and Clause A3.2.7.11.

A3.2.7.9 Construction of culverts in half widths in existing roads

If necessary for accommodation of traffic or for any other reasons, or if so specified by the Engineer, culverts shall be constructed in half widths.

Unless otherwise prescribed, the downstream section shall be constructed first. The end of the excavation adjoining the traffic lane shall be properly supported and shored up to prevent displacement or collapse from occurring. The necessary warning signs and barriers shall be erected in accordance with the requirements of Section A1.5 of Chapter 1. No such work may be commenced with before safety barriers and traffic signs have been erected.

Where the culvert is constructed in an existing road and it has been so prescribed by the Engineer, each of the pavement layers at least shall be benched and recompacted during backfilling. The depth of benching shall equal the respective layer thicknesses, and the width shall be at least 150 mm.

A3.2.7.10 Backfilling of culverts

After the culverts have been constructed as described in Clauses A3.2.7.6 and A3.2.7.7, backfilling shall be carried out as follows:

No backfilling of a brickwork or in situ concrete structure may be done for a period of at least 7 days after the structure has been completed, unless otherwise specified or directed by the Engineer. No backfilling of a brickwork structure may be done until the roof slab has been installed.

The material used for the backfilling of those portions of culverts subject to traffic loads shall be selected material of at least subbase quality or such other lower quality as may be permitted by the Engineer. Where the excavated material is not of adequate quality, selected material shall be imported for this purpose. The Contractor shall, in advance, ascertain from the Engineer as to which portions will require selected-quality material for backfilling.

Backfilling alongside and over all culverts shall be placed at optimum moisture content and compacted in layers not exceeding 150 mm after compaction, to a density of at least the density required for the material in adjoining layers of fill, subgrade and subbase. The density of backfilling in excavations made in natural ground shall be at least 93 % of MDD.

Backfilling shall be carried out simultaneously and equally on both sides of a culvert to prevent unequal lateral forces from occurring.

Whenever specified or as may be specified by the Engineer, a wet or a stiff mixture of soil cement in lieu of a compacted gravel placed between the side of the culvert and the excavation up to the top of the culvert shall be used.

The wet mixture of soil cement shall consist of an approved soil or gravel mixed with 5,0 % of CEM II class 32.5 cement and only sufficient water to give a consistency that will permit the soil cement to be placed with vibrators, so that all voids between the culverts and the sides of excavations and between culverts in the case of multi-barrel culverts will be properly filled. A stiff mixture of soil cement shall contain 3,0 % of CEM II class 32.5 cement and just sufficient water for it to be placed and compacted like ordinary backfill material. The height to which the soil cement backfill shall be taken shall be as prescribed by the Engineer or shown on the drawings, and any remaining backfill shall be carried out as described above with selected material.

The material used for soil cement shall preferably be a sandy material but may contain larger particles up to 38 mm, and it shall not have a plasticity index exceeding 10. Detrimental percentages of silt or clay shall be avoided, and where the excavated material is not of adequate quality, the material shall be obtained from an approved source.

The soil cement shall be mixed on the site with suitable concrete mixers, and the water and cement contents shall be carefully controlled. Should the Contractor provide adequate quality control mechanisms for hand mixing, the Engineer may approve alternative mixing methods. The material shall be placed and then thoroughly compacted so that all voids are filled as described above. At culvert ends stones shall be packed to prevent the soil cement from flowing beyond the required limits.

All imported and backfill material shall be subject to the load and haul provisions specified in Section A1.7 of Chapter 1.

A3.2.7.11 Inlet and outlet structures, catchpits and manholes

Inlet and outlet structures for culverts as well as catchpits and manholes shall be constructed in accordance with the details shown on the drawings.

a) Excavation and backfilling

The specifications of Clause A3.2.7 in this Section for excavating and backfilling the culverts shall apply mutatis mutandis to inlet and outlet structures, catchpits and manholes.

No backfilling of a structure may be done for a period of at least 7 days after the structure has been completed, unless otherwise specified or directed by the Engineer.

b) Concrete work

The specifications of Clause A3.2.5.2a) in this Section for in situ concrete shall apply mutatis mutandis to inlet and outlet structures, catchpits and manholes.

The type of surface finish for in situ concrete in the culverts shall be indicated on the drawings. Generally all exposed faces shall be of Class F2 formwork and faces covered by backfill shall be Class F1. The top parapet walls and wingwall shall be finished to a Class U2 surface finish.

c) Brickwork

The specifications of Clause A3.2.7.6b)(iv) for brickwork walls shall apply mutatis mutandis to inlet and outlet structures, catchpits and manholes.

d) Plaster

The specifications of Clause A3.2.7.6b)(v) for plaster shall apply mutatis mutandis to inlet and outlet structures, catchpits and manholes.

e) Manhole covers, grid inlets, etc

The specifications Clause A3.2.5.2f) for manhole covers and frames, grid inlets and other metal accessories shall apply mutatis mutandis to inlet and outlet structures, catchpits and manholes.

f) Benching

All benching shall be rendered in 20 mm granolithic plaster and finished smooth and true with a steel trowel. Corners shall be rounded to dimensions shown on the drawings.

g) Inlet and outlet structures.

Prefabricated concrete inlets and outlets shall not be installed until the installation procedures have been approved by the Engineer. Contractor shall provide details of joining precast inlet and outlet elements to installed culverts as well as the bedding and backfill procedures to ensure that the ingress of water and undermining of inlets and outlets is avoided. Cast in situ concrete wingwall type inlets and outlets shall be constructed as indicated on the drawings and shall comply with the requirements of Section A13.4 of Chapter 13.

h) Prefabricated energy dissipaters in outlet structures

Where shown on the drawings, the Contractor shall supply and install in the outlet structures, prefabricated reinforced- concrete energy dissipaters of class C25/30-20 concrete with dimensions as shown on the drawings. All concrete work shall comply with the requirements of Section A13.4 of Chapter 13.

A3.2.7.12 Removal of existing work

Where shown on the drawings or directed by the Engineer, existing inlets or outlets to culverts shall be demolished and debris or rubbish disposed of as directed by the Engineer. Existing pipes shall be removed where necessary and saved for later use. All such work shall be carried out so as to prevent damage being done to existing work, which is to remain.

The Contractor's attention is directed to the provisions of Section A1.6 of Chapter 1 that specifies which structures have to be removed as part of the clearing and grubbing operations, the removal of which will therefore not be measured and paid for under this Section.

Undamaged recovered pipes may be re-used in the works where indicated by the Engineer. Recovered pipes which cannot be re-used shall remain the property of the Employer and shall be stacked within the road reserve or where directed by the Engineer.

A3.2.7.13 Joining new work to old

Where partial or full demolition is required for extension work to existing concrete structures, the demolition and removal work shall be executed as specified in Section A14.3 of Chapter 14. The provision of reinforcing anchoring shall be as specified in Section A14.5 of Chapter 14; and the surface repair shall be executed as specified in Section A14.4 of Chapter 14. Larger concrete extensions shall be executed as specified under the relevant concrete element for cast in situ concrete and paid under item C3.2.7.

A3.2.7.14 Sleeving or lining of existing culverts

Specifications for sleeving or lining of existing culverts, which have specific defects as well as the measurement and payment, shall be specified under the Contract Documentation.

A3.2.7.15 Culverts on steep gradients

Where culverts are constructed on gradients exceeding 1 in 4, such culverts shall be referred to as inclined culverts. Inclined culverts shall be constructed from the type of unit required, normally either circular concrete pipe units or metal culvert units as described in Clause A3.2.5.2.

Particular care shall be taken to protect excavations for inclined culverts against stormwater damage during the construction stage. The trenches shall be excavated down to firm ground, and backfilled with selected gravel or concrete if it is necessary to over-excavate for obtaining a firm floor.

After the outlet structure has first been completed, the culvert units shall be laid in the normal manner by starting from the lower end and placing successive units firmly against each other to prevent subsequent movement. The lower unit shall be securely cast into the outlet structure, and metal culverts shall be provided with the necessary anchor bolts at both inlet and outlet structures and also at all thrust and anchor blocks.

Thrust and anchor blocks shall be constructed from concrete as required in accordance with the drawings and details furnished by the Engineer. Anchor bolts, straps and other anchoring devices required at anchor and thrust blocks shall be provided.

The backfilling of trenches shall be done in horizontal layers starting at the lower end.

A3.2.7.16 Other stormwater pipes and closed conduits

Unless provided for elsewhere the specifications given in this Section for culverts, including the method of measurement and payment, shall apply mutatis mutandis to the construction of pipes in closed or urban type stormwater systems, tremies or any other closed conduits constructed in situ or from prefabricated units, whether intended for drainage or for any other purpose.

No distinction will be made in the schedule of quantities between the construction of culverts as defined elsewhere in Section A3.2 and that of the other closed conduits described in this Clause A3.2.7.16, all being classed as culverts.

Tremies constructed from prefabricated units, shall be classed as inclined culverts where laid to a grade steeper than 1 in 4.

A3.2.8 WORKMANSHIP

The Contractor shall determine the required frequency of testing and conduct sufficient tests on the sourced material for each type of material, in order to ensure that the quality of materials produced will meet the specified requirements for the particular layer for which it will be used. These required testing frequencies shall be stated in the borrow pit and quarry management and utilisation plans.

A copy of the Contractor's process control test results, which should cover all the above quality control tests, shall be submitted to the Engineer for comments.

A3.2.8.1 Construction tolerances and surface finish

a) Culverts

Culverts, inlets, outlets, catchpits and manholes shall be constructed to following tolerances:

(i) *Horizontal alignment*

The maximum deviation from the true position of the edges or centerline shall be 25 mm.

(ii) *Vertical alignment*

The invert level shall nowhere deviate by more than 25 mm from the required level and nowhere shall the inverts have an adverse grade.

(iii) *Trueness of exposed surface*

When tested with a 3,0 m straight-edge, no exposed formed or cast concrete or precast surface shall have surface irregularities exceeding 10 mm.

(iv) *Cross-sectional dimensions*

All cross-sectional dimensions shall be within 10 mm of the specified dimensions, and the average thickness of a floor, wall or roof slab shall not be less than the specified thickness.

b) Surface finish

All unformed exposed concrete surfaces shall have a class U2 surface finish and all formed exposed concrete surfaces shall have a class F2 surface finish

B3.2 CULVERTS

PART B: LABOUR ENHANCEMENT

CONTENTS

B3.2.1	SCOPE
B3.2.2	DEFINITIONS
B3.2.3	GENERAL
B3.2.4	DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS
B3.2.5	MATERIALS
B3.2.6	CONSTRUCTION EQUIPMENT
B3.2.7	EXECUTION OF THE WORKS
B3.2.8	WORKMANSHIP

B3.2.1 SCOPE

This Part covers additional specifications for work to enhance the labour component of construction activities, over and above labour employed for conventional construction activities, where specified in Part A.

B3.2.2 DEFINITIONS

The provisions of Part A, shall apply.

B3.2.3 GENERAL

The provisions of Part A, shall apply.

B3.2.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

None applicable unless specific specifications have been accepted as proposed by the Contractor or included into the Contract Documentation.

B3.2.5 MATERIALS

B3.2.5.1 General material specifications

The provisions of Part A, shall apply.

B3.2.6 CONSTRUCTION EQUIPMENT

The provisions of Part A, shall apply.

B3.2.7 EXECUTION OF THE WORKS

B3.2.7.1 Concrete mixing by hand

Concrete may be mixed by hand or in hand-turned concrete mixers for small pours up to one (1) cubic metre. Larger pours greater than one (1) cubic metre shall be machine mixed with on site mechanical mixers and/or batch plants.

The mix design shall be based upon obtaining an average concrete compressive strength sufficiently above the specified characteristic compressive strength so that, considering the expected variability of the concrete and test procedures, no more than 5 percent of strength tests will be expected to fall below the specified characteristic compressive strength.

All concrete mixed on the site of works shall be weigh-batched unless the Contractor can demonstrate to the Engineer that his method of proportioning the concrete ingredients consistently produces uniform concrete, which meets the strength requirements.

Concrete shall be hand-mixed on a prepared mixing floor of adequate area to facilitate proper mixing without contamination by any foreign materials.

The sand shall be measured off, tipped onto the mixing floor and spread in a circle. The cement (one or two whole sacks, as required by the mix design) shall then be spread evenly across the sand and mixed in with shovels, turning the mixture into the middle of the circle and out again.

When the colour is even, the mix shall be shaped with a hollow in the centre.

Part of the mixing water shall be poured into the hollow and mixed in. More water shall be slowly added and mixed in until all the water has been added. The materials shall be turned into the middle of the circle and out again at least twice. The mix should be soft and even with no dry patches. The mix shall then be spread in a circle.

The stone shall be measured off and spread evenly across the mortar and mixed with shovels, by turning the mixture into the middle and out again at least twice. Concrete shall be properly mixed to a uniform consistency without fatty or harsh patches. The total period between the times that the cement is placed into the mix until mixing starts shall not exceed 15 minutes.

The selection of mixing and batching locations shall be so chosen to minimise the transport of concrete placement.

B3.2.7.2 Classes of Excavation

Where excavation is done using labour enhanced construction methods, the Engineer shall classify excavated materials as either soft or intermediate for payment purposes in terms of Table B3.2.7-1 or, if the Contractor does not agree with the classification, in terms of Table B3.2.7-2. The decision of the Engineer regarding the classification of the excavated materials shall then be final and binding, subject to the provisions of the conditions of contract.

No hard material shall be measured under labour enhanced construction methods.

Table B3.2.7-1: Classification of Excavated Materials

Materials Classification	Description
Soft	Material which can be excavated by means of a suitable shovel with or without the use of a pick or other hand-swung tool.
Intermediate	Material which is difficult to excavate by hand even with the aid of a crowbar and requires the assistance of pneumatic tools for economic removal.

Table B3.2.7-2: Classification of Materials in Terms of Consistency and Shear Strength

Materials Classification	Consistency		Number of DCP blows to penetrate 100 mm ^{*1}	
	Granular soil	Cohesive soil	Granular soil	Cohesive soil ^{*2}
Soft	Very loose to dense	Very soft to stiff	≤ 15	≤ 8
Intermediate	Very dense	Very stiff	>15	>8

^{*1} Only applicable to materials comprising not more than 10 % gravel of size less than 10 mm and materials containing no cobbles or isolated small boulders.

^{*2} Classification depends on the moisture content of the cohesive material.

B3.2.8 WORKMANSHIP

The provisions of Part A, shall apply.

C3.2 CULVERTS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

(ii) Notes on measurement and pay Items

1. Unless otherwise ordered or stated in the Contract Documentation, trench depths will be measured from the surface of the ground along the centre-line of the trench to the bottom of the specified bedding layer (as applicable).
2. The ground surface will be that existing after any bulk earthworks have been carried out, i.e. the excavated surface or embankment surface, unless a different sequence of execution has been ordered.
3. Excavations will be measured as if taken out with vertical sides, regardless of whether they have been taken out with sloping sides.
4. Wherever volumetric measurement is required, the volume will be computed from the depth determined as indicated in 1. and 2. above and using the authorised width (W) determined in accordance with the specification.
5. Where shoring is specified or ordered, the length of shoring measured for payment will be the length of the centre-line of the trench.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for backfilling excess excavations, disposing of surplus material etc. or any other contingent work, unless the work is specifically specified or ordered.
2. No separate payment will be made for setting out the works.
3. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
4. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
5. No separate payment will be made for the loading of any materials.
6. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km.
7. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
8. No separate payment will be made for the removal of any surplus material imported to complete the works.
9. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

The following items of work, when specified, shall be carried out, measured and paid for in accordance with the appropriate sections of the specifications.

Table C3.2-1: Items from other Chapters or Sections

Activity	Section 3.2 reference	Section Item reference
Clearing and grubbing	A3.2.7.1; A3.2.7.12	C1.6 of Chapter 1
Loading and hauling	A3.2.7.5; A3.2.7.10	C1.7 of Chapter 1

(v) Items specifically for this section of the specifications

Item	Description	Unit
C3.2.1	Excavation for culvert structures:	
C3.2.1.1	Excavating in all material situated within the following depth ranges below the surface level:	
(a)	0 m to 1,5 m	cubic metre (m ³)
(b)	Exceeding 1,5 m and up to 3,0 m	cubic metre (m ³)
(c)	Etc, in increments of 1,5 m	cubic metre (m ³)
C3.2.1.2	Excavating soft material 0 m to 1,5 m below the surface level using labour enhanced construction methods, or instructed by hand under Clause A3.2.7.2d):	cubic metre (m ³)

C3.2.1.3	Excavating intermediate material 0 m to 1,5 m below the surface level using labour enhanced construction methods, or instructed by hand under Clause A3.2.7.2d):	cubic metre (m ³)
C3.2.1.4	Extra over sub-item C3.2.1.1 for excavation in hard or boulder material, irrespective of depth	cubic metre (m ³)
C3.2.1.5	Extra over sub-item C3.2.1.1 for excavation in stabilised existing road layers, irrespective of depth	cubic metre (m ³)

The unit of measurement shall be the cubic metre of material excavated within the specified widths over the lengths and depths authorised by the Engineer in each case, measured in place before excavation. Excavation in excess of the widths specified or authorised by the Engineer shall not be measured for payment.

When measuring excavation for the removal of existing culverts, the volume occupied by the culvert shall not be subtracted from the calculated volume of excavation.

In the case of manholes, catchpits and inlet and outlet structures, the dimensions for determining the volume of excavation shall be the neat outside dimensions of the structure, plus an allowance of 0,5 m of working space around the structure.

Payment made for either hard; boulder or stabilised existing road layers shall only be measured for the one applicable extra over category.

The tendered rates shall include full compensation for all excavation, temporary timbering, shoring and strutting, for preparing the bottom of the excavation for the culvert beds, the disposal of excavated material unsuitable for backfilling, keeping excavations safe, dealing with any surface or subsurface water, and for any other operations necessary for completing the work as specified.

Irrespective of the total depth of the excavation, the quantity of material in each depth range shall be measured and paid for separately.

Excavation shall be done using conventional construction methods and/or labour enhanced construction methods as specified and measured.

The tendered rates shall include full compensation for the excavation of the material to the required dimensions, lines, levels and grades, the trimming of the bottom of the excavation and the loading and disposal/utilisation of the materials directed, including haul of 1,0km when using conventional construction methods.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1. Where the excavation of material is specified by means of labour enhanced construction methods, the tendered rates shall include loading and transport by wheelbarrow if the material is disposed of or utilised within a radius of 50 m, alternatively loading by hand onto transport vehicles for such disposal or utilisation elsewhere, within a haul distance of 1,0 km.

For payment purposes a distinction shall be made between materials as classified according to Clause A3.2.7.2a) under Classification of Materials.

Item	Description	Unit
C3.2.2	Backfilling:	
C3.2.2.1	Using the excavated material	cubic metre (m ³)
C3.2.2.2	Using imported selected material:	
	(a) From commercial sources (State type)	cubic metre (m ³)
	(b) From sources on site (State type)	cubic metre (m ³)
C3.2.2.3	Extra over sub-items C3.2.2.1 and C3.2.2.2 for soil cement backfilling	
	(a) With wet mixture (specify cement content) of 3 % cement	cubic metre (m ³)
	(b) With dry mixture (specify cement content) of 3 % cement	cubic metre (m ³)
	(c) Variation in cement	kilogram (kg)
C3.2.2.4	Extra over sub-items C3.2.2.1 and C3.2.2.2 for screed layers (class of concrete indicated)	cubic metre (m ³)

The unit of measurement shall be the cubic metre of material backfilled in place after compaction. The quantity shall be calculated from the leading dimensions of the backfilling as specified or as authorised by the Engineer.

If excavations were carried out in excess of the dimensions authorised by the Engineer, the quantity of backfilling will nevertheless be based on the authorised dimensions. The volume occupied by the culvert shall be subtracted when calculating the volume of backfilling.

The tendered rates for item C3.2.2.2 shall include full compensation for backfilling under, alongside and over culvert structures, for watering, and for compacting the backfill material to the specified density. The tendered rate for item C3.2.2.2(a) shall include full compensation for procuring, furnishing and hauling G5 material from commercial suppliers, including the cost of transporting the material to the site irrespective of haul distance, and placing the materials as specified. The tendered rates for item C3.2.2.2(b) shall, in addition, include full compensation for supplying selected material of subbase quality from approved sources on site.

Loading and hauling, where applicable, including a haul of 1,0 km, shall be measured and paid under Section C1.7 of Chapter 1.

The tendered rates for item C3.2.2.3 shall be additional to the rates tendered for items C3.2.2.1 and C3.2.2.2 and shall include full compensation for all additional cost to backfill material using labour enhanced methods of construction.

The tendered rates for items C3.2.2.3 and C3.2.2.4 shall be additional to the rates tendered for items C3.2.2.1 and C3.2.2.2 and shall include full compensation for all incidentals required for the complete backfilling with soil cement or concrete screed as specified.

Variations will be dealt with in accordance with C1.1.4 of Chapter 1.

Item	Description	Unit
C3.2.3	Concrete pipe culverts:	
C3.2.3.1	On Class A bedding (type and diameter indicated)	metre (m)
C3.2.3.2	On Class B bedding (type and diameter indicated)	metre (m)
C3.2.3.3	On Class C bedding (type and diameter indicated)	metre (m)
C3.2.3.4	On Class D bedding (type and diameter indicated)	metre (m)
C3.2.3.5	Provision of skew ends of pipe culvert (type and diameter indicated)	number (No)

The unit of measurement for concrete pipe culverts shall be the metre of culvert laid as shown on the drawings or ordered by the Engineer. The length shall be measured along the soffit centre of the culvert or along each barrel for multiple barrel units. The unit of measurement for the skew ends of culverts shall be the number of skew end units provided; in- and outlets and multiple barrels shall be measured separately. The tendered rate shall include for all costs to provide the skew end unit from the manufacturer to the specified length and skew including all wastage.

The tendered rates shall include full compensation for providing, testing, loading, transporting and unloading the culverts, for providing and placing all specified bedding but excluding concrete bedding, and for the installation, laying and jointing of the culverts, as specified.

Where a half-length pipe unit is required, i.e. a pipe unit of which the length is equal to half the standard length, and provided that such half-length pipe units are normally supplied by the manufacturers, the actual length of such half-length pipe unit will be measured for payment, and no additional compensation will be paid in respect of such half-length pipe unit.

For the purposes of payment, differentiation shall be made between the various types and sizes of culverts and between the culverts placed on A, B, C and D Classes of bedding as well as the different size skew ends requirements.

Item	Description	Unit
C3.2.4	Metal and U-PVC culverts:	
C3.2.4.1	Size, wall thickness and type indicated	metre (m)
C3.2.4.2	Provision of skew or bevelled ends for metal culverts	number (No)
C3.2.4.3	Anchor bolts (size and type indicated)	number (No)
C3.2.4.4	Protective coating to metal culverts (culvert size; inside/outside/ both sides; coating type & thickness indicated)	metre (m)

The unit of measurement for metal culverts and protective coating shall be the metre of culvert laid as shown on the drawings or ordered by the Engineer. The unit of measurement for the skew/bevelled ends of culverts shall be the number of skew/bevelled end units provided; in- and outlets and multiple barrels shall be measured separately. In the case of a metal or U-PVC pipe, the culvert length shall be measured along the pipe centreline. In the case of a metal pipe arch, the culvert length shall be measured along the bottom/invert of the pipe arch. In all cases the length of bevelled and/or skew ends shall be included.

The tendered rates shall include full compensation for providing, testing, loading, transporting and off-loading the culverts, for providing and placing fine-grained material where required for the installation of culverts, and for installing, laying and jointing the culverts as specified. For the purposes of payment, a differentiation shall be made between the various types and sizes of culverts and also between culverts with differing wall thicknesses.

Payment shall be made separately for the provision of bevelled and/or skew ends for metal culverts, and the tendered rate shall include full compensation for all work in connection with the provision of specified ends. U-PVC culverts may be cut to skew ends, but no additional payment will be made for cutting skew ends.

The tendered rate per anchor bolt shall include full compensation for procuring, providing and installing the bolts.

Item	Description	Unit
C3.2.5	Rectangular culverts with prefabricated elements:	
C3.2.5.1	Prefabricated portal culverts; wall and roof combination (size and type indicated)	metre (m)
C3.2.5.2	Prefabricated floor slabs (size and type indicated)	metre (m)
C3.2.5.3	Prefabricated roof slabs (size and type indicated)	metre (m)

Payment will be made separately for cast in situ concrete wall, floor and/or roof slabs as well as formwork of culverts under item C3.2.7; and for brickwork walls and plastering under items C3.2.16 and C3.2.17.

The unit of measurement for rectangular culverts constructed of prefabricated elements shall be the metre of culvert as per the relevant item(s) constructed as shown on the drawings or as specified by the Engineer. Payment for a culvert may be made as a combination of prefabricated elements as relevant.

The length shall be measured along the centre of the soffit of the culvert or along each barrel of multiple barrel units.

The tendered rates shall include full compensation for the supply and installation of all precast materials required to complete the culverts, supplying, testing, loading, transporting and off-loading of all prefabricated portals, floor and roof slabs, providing and placing the fine-grained material where required for installing the prefabricated culvert floors, and installing, laying and jointing the prefabricated slabs as specified,

including cutting them on the site, and waste. Where precast elements are installed on cast in situ concrete floors or walls or on brickwork walls, no additional payment shall be made for any additional costs arising from the change between cast in situ and precast work.

Payment shall distinguish between the different sizes of rectangular culverts precast elements.

Payment for inlet and outlet structures shall be measured separately as specified in accordance with items C3.2.7 and C3.2.18 to C3.2.21 and such other items as may be necessary.

Item	Description	Unit
C3.2.6	Extra over items C3.2.3, C3.2.4 and C3.2.5 for constructing inclined culverts	metre (m)

The unit of measurement shall be the metre of culvert installed at a grade steeper than 1:4 as specified in Clause A3.2.7.15.

The tendered rate shall include full compensation for additional or more difficult work of any nature in regard to laying, excavating and backfilling as may be required for installing the culverts at a grade steeper than 1:4.

Item	Description	Unit
C3.2.7	Cast in situ concrete and formwork:	
C3.2.7.1	In Class A bedding, screeds, concrete backfill and the encasing for pipes, including formwork, (class of concrete indicated)	cubic metre (m ³)
C3.2.7.2	In complete in situ floor slabs for rectangular culverts, manholes and catchpits including formwork, joints and Class U2 surface finish (class of concrete indicated) (installed at a standard depth of 1,0 m)	cubic metre (m ³)
C3.2.7.3	In walls, excluding formwork but including Class U2 surface finish (class of concrete indicated)	cubic metre (m ³)
C3.2.7.4	In roof slabs for rectangular culverts, excluding formwork but including Class U2 surfacing finish and joints (class of concrete indicated)	cubic metre (m ³)
C3.2.7.5	In inlet and outlet structures including kerbs, chutes and downpipes, skewed ends, catchpits, manholes, thrust and anchor blocks, excluding formwork but including Class U2 surfacing finish (class of concrete indicated)	cubic metre (m ³)
C3.2.7.6	Formwork of concrete under items C3.2.7.3 to 5 above (Class of finish indicated)	square metre (m ²)
C3.2.7.7	Concrete linings for the inverts of metal culverts, including formwork and Class U2 surface finish (class of concrete indicated)	cubic metre (m ³)

Measurement of formwork and cast in situ concrete shall be as specified in Section A13.4 of Chapter 13 of these specifications.

Payment for formwork and cast in situ concrete shall be made as provided in Chapter 13 of these specifications, except that payment for the formwork for concreting in items C3.2.7.1 and C3.2.7.2 shall not be made separately, and the Contractor's rates for concrete shall include full compensation therefore item C3.2.7.2 shall be subject to an extra over payment under item C3.2.15.4 in the case of manholes or catchpits deeper than 1,0 m.

No separate payment shall be made for the construction of joints in culvert floor and roof slabs or at inlet and outlet structures and the tendered rates for concrete shall include full compensation for forming the joints complete in accordance with the details shown on the drawings.

The tendered rates shall also include full compensation for mixing and/or procuring concrete as indicated, curing and the transport thereof to the final placement location.

Item	Description	Unit
C3.2.8	Concrete backfill or encasement for culverts (Type and Class of concrete indicated)	cubic metre (m³)

Measurement of cast in situ concrete shall be as specified in Section A13.4 of Chapter 13 of these specifications.

The quantity shall be calculated from the dimensions of the excavation as specified or as may be authorised by the Engineer, minus the volume taken up by the culverts, irrespective of whether the actual excavation to be backfilled exceeds the specified or authorised dimensions.

The tendered rates shall also include full compensation for mixing and/or procuring concrete as specified, and the transport thereof to the final placement location.

Item	Description	Unit
C3.2.9	Prefabricated concrete inlets and outlets to culverts (size and type indicated)	number (No)

Prefabricated concrete inlets and outlets for concrete pipe culverts shall be measured per inlet or outlet, complete in position.

The tendered rate shall include full compensation for procuring, providing, loading, transporting, off-loading and installing the inlets or outlets as specified.

Item	Description	Unit
C3.2.10	Reinforcement:	
C3.2.10.1	Mild steel bars	ton (t)
C3.2.10.2	High-tensile steel bars	ton (t)

C3.2.10.3 Welded steel fabric kilogram (kg)

C3.2.10.4 Other material (specify) kilogram (kg)

Measurement and payment for steel reinforcement shall be made as specified in item C13.3.1 of Chapter 13. Measurement under this item shall be limited to steel reinforcement as specified for complete cast in situ structures as measured under item C3.2.7. Steel reinforcement for composite structures measured under other items shall be deemed to be included under such items.

Item	Description	Unit
C3.2.11	Anchoring of reinforcing steel: Reinforcing (type, bar diameter) into formed holes (hole diameter and depth stated) in (description of member)	number (No.)

The unit of measurement and tendered rate shall be as specified under item C14.5.1 of Chapter 14.

Item	Description	Unit
C3.2.12	Demolition of concrete members or elements:	
C3.2.12	Full member or element (<i>location and description</i>)	cubic metre (m ³)
C3.2.12	Partial member or element (<i>location and description</i>)	cubic metre (m ³)

The unit of measurement shall be the cubic metre of existing concrete removed according to authorised dimensions.

The tendered rates shall include full compensation for all demolition as specified in item C14.3.1 of Chapter 14.

Item	Description	Unit
C3.2.13	Removing and re-laying existing culverts:	
C3.2.13.1	Removing and stacking existing culverts for re-use (size and type indicated)	metre (m)
C3.2.13.2	Removing and re-laying existing culverts without stacking (size and type of bedding indicated)	metre (m)
C3.2.13.3	Re-laying existing culverts from stacking (size and type of bedding indicated)	metre (m)

The unit of measurement shall be the metre of existing pipe or prefabricated portal culvert removed, stacked and/or re-laid.

The tendered rate shall include full compensation for lifting, loading, transporting for a haul distance within 5,0 km without additional payment, off-loading, stacking (if required) and laying pipes according to the specifications.

Payment for any excavation and backfilling required for the removal and relaying of existing pipes or portals shall be made separately under items C3.2.1 and C3.2.2.

Item	Description	Unit
C3.2.14	Protective mastic asphalt coating for corrugated metal culvert units (state whether to be applied by brush or by spray gun)	square metre (m ²)

The unit of measurement shall be the square metre of protective coating applied as specified and as directed by the Engineer. When both inside and outside surfaces are treated, both surfaces shall be measured.

The tendered rate shall include full compensation for procuring and furnishing the mastic asphalt, applying the material, and for all other additional work and incidentals required for providing the protective coating as specified.

Item	Description	Unit
C3.2.15	Manholes and catch pits, with prefabricated elements	
C3.2.15.1	Prefabricated floors (installed at a standard depth of 1,0 m):	
(a)	Size and type indicated-	number (No)
(b)	Size and type indicated(etc)	number (No)
C3.2.15.2	Prefabricated roofs:	
(a)	Size and type indicated	number (No)
(b)	Size and type indicated(etc)	number (No)
C3.2.15.3	Prefabricated walls	
(a)	Size and type indicated	metre (m)
(b)	Size and type indicated(etc)	metre (m)

C3.2.15.4 Extra over item C3.2.15.1 and C3.2.7.2 for variations in the depths of all types of concrete manholes with prefabricated, or in situ concrete or brickwork wall combinations deeper than 1,0 m designated for tendering purposes metre (m)

The unit of measurement, in the case of items C3.2.15.1 and 2 above for prefabricated manhole or catchpit floor or roof elements, shall be the number of complete precast units as shown on the drawings or as specified by the Engineer, including covers, frames, grids and other accessories. Item C3.2.15.1 shall be subject to an extra over payment under item C3.2.15.4 in the case of manholes or catchpits deeper than 1,0 m. The unit of measurement, in the case of items C3.2.15.3 above for prefabricated manhole or catchpit wall elements, shall be the metre of full depth of complete precast units as shown on the drawings or as specified by the Engineer. Payment for a manhole or catchpit may be made as a combination of prefabricated elements as relevant.

The tendered rates shall include full compensation for the supply and installation of the complete precast units required to complete the manholes and catchpits supplying, testing, loading, transporting and off-loading of all prefabricated walls, floor and roof slabs, providing and placing the fine-grained material where required for installing the prefabricated culvert floors, and installing, laying and jointing the prefabricated elements as specified, including cutting on the site, and waste. Where precast elements are installed on cast in situ concrete floors or walls or on brickwork walls, no additional payment shall be made for any additional costs arising from the change between cast in situ and precast work. The tendered rate shall also include full compensation for connecting up to and building any conduits into the walls of the various structures.

The unit of measurement in the case of items C3.2.15.4 above shall be the metre of increased depth of each manhole or catchpit measured once only per manhole or catchpit in relation to the standard depth furnished for tendering purposes over items C3.2.7.2; or item C3.2.15.1, as applicable. The tendered rates per metre, deeper than 1,0 m, shall be an adjustment to the compensation for the standard item, payable as an increased compensation to the Contractor in relation to the standard depth. The tendered rate shall include for costs for the increase in compensation for all additional costs arising for working to greater or depths, but excluding any additional excavation, backfill, in situ concrete, brickwork or plaster. Where the above items of work cannot be conveniently standardised for payment according to complete units, the various types of work and items of material provided shall be measured separately in accordance with items C3.2.7 and C3.2.16 to C3.2.19 and such other items as may be necessary.

Measurement and payment will be made separately for cast in situ concrete for wall, floor and roof slabs as well as formwork of manholes and catchpits under item C3.2.7, and for brickwork walls and plaster under items C3.2.16 and C3.2.17.

Excavation shall be measured and paid under item C3.2.1, and backfilling under item C3.2.2.

Item	Description	Unit
C3.2.16	Brickwork (Engineering bricks):	
C3.2.16.1	115 mm thick	square metre (m ²)
C3.2.16.2	230 mm thick	square metre (m ²)
C3.2.16.3	345 mm thick	square metre (m ²)
C3.2.16.4	Specify thickness	square metre (m ²)

The unit of measurement shall be the square metre of engineering brickwork built, calculated from the leading dimensions of the brickwork. Areas in walls occupied by conduits shall not be included in the areas measured, and corners and intersections common to more than one brickwall shall be measured only once.

The tendered rates per square metre shall include full compensation for the brickwork complete as specified, including pointing and the building-in of conduits.

Concrete and steel reinforcing used in reinforced brickwork walls shall be measured separately under items C3.2.7 and C3.2.10.

Item	Description	Unit
C3.2.17	Plaster	square metre (m²)

The unit of measurement shall be the square metre of plasterwork provided.

The tendered rate shall include full compensation for raking out joints in the brickwork and applying a 1:4 plaster, as specified, to all surfaces where required.

Item	Description	Unit
C3.2.18	Benching	cubic metre (m³)

The unit of measurement shall be the cubic metre of benching, measured in plan, constructed in class C20/25-14 concrete with granolithic rendering.

The tendered rate shall include full compensation for procuring and furnishing all materials, placing the concrete benching, and rendering with the specified granolithic rendering.

Item	Description	Unit
C3.2.19	Accessories:	
C3.2.19.1	Manhole frames (description and reference to drawing)	number (No)
C3.2.19.2	Inlet grids or covers (description and reference to drawing)	number (No)
C3.2.19.3	Manhole frames (type, load bearing and SANS specification indicated)	number (No)

C3.2.19.4	Manhole covers or gratings (type, load bearing and SANS specification indicated)	number (No)
C3.2.19.5	Inlet channel frames (type, load bearing and SANS specification indicated)	number (No)
C3.2.19.6	Inlet channel gratings (type, load bearing and SANS specification indicated)	number (No)
C3.2.19.7	Step irons (description and SANS specification indicated)	number (No)
C3.2.19.8	(Etc for other accessories)	number (No)

The unit of measurement shall be the number of each type of accessory delivered and installed. Accessories shall only be measured and paid where such items are not included in unit prices for complete structures such as under item C3.2.15

The tendered rates shall include full compensation for procuring, furnishing and installing the accessories as specified.

Item	Description	Unit
C3.2.20	Anchors for pipes (description)	number (No)

The unit of measurement shall be the complete anchor installed, including straps, bolts, etc, but excluding any concrete work, which shall be measured under item C3.2.7.

The tendered rate shall include full compensation for procuring, providing and installing the anchors.

Item	Description	Unit
C3.2.21	Prefabricated reinforced-concrete skew end units for concrete culverts constructed at a skew angle (type and dimensions of unit and class of bedding indicated)	number (No)

The unit of measurement shall be the number of each type and size of prefabricated reinforced-concrete skew end unit provided and installed, irrespective of the angle of skew.

The tendered rates shall include full compensation for providing, testing, loading and unloading the units, constructing the prescribed class of bedding, and for installing, laying and joining the units, complete as specified and in accordance with the details shown on the drawings.

Item	Description	Unit
C3.2.22	Cutting of concrete pipes (diameter indicated)	number (No)

The unit of measurement shall be the number of pipes that have been cut on the instruction by the Engineer. The tendered rate shall be fill compensation for the cutting, by means of mechanical saw (angle grinder) and finishing off the pipes for the specific angle of skew at which the pipes must be laid.

Cutting of the pipes shall only be paid for if the headwall or the wingwalls are at such a skew angle in respect to the centre line of the pipes that cutting is required and where non-standard lengths are required. The maximum skew angle at which pipes are allowed to be cut shall be 30 degrees and the maximum length of pipe measured along the shortest side, shall be 1,5 m.

Item	Description	Unit
C3.2.23	Breaking into existing drainage structures and building in pipes or culverts of the following size (pipe diameter and/or culvert size to be stated)	number (No)

The unit of measurement is the number of each type and size of existing drainage structure that is being modified as shown on the drawings or as specified by the Engineer.

The tendered rates shall include full compensation for providing all labour, constructional plant and materials required, for all excavation, breaking into existing drainage structures, building into the newly formed accesses, sealing around the edges and making the joints watertight, breaking out existing benching and channelling where required and reconstructing them complete with granolithic rendering to suit the new drainage arrangement, backfilling and compacting to at least 93 % of MDD and dealing with the flows in the existing structures.

Item	Description	Unit
C3.2.24	Compaction of bedding for inlets, outlets, manholes and catchpits:	
C3.2.24.1	Preparation and compaction of in situ bedding material to 90 % of MDD (depth indicated)	cubic metre (m³)
C3.2.24.2	Extra-over sub-item C3.2.24.1 for compaction to 93 % of MDD (depth indicated)	cubic metre (m³)

The unit of measurement shall be the cubic metre of material ripped and compacted as specified.

The tendered rate shall include full compensation for the ripping of the in situ material to the specified width and depth, wetting the material to such an extent that the density can be achieved.

Item	Description	Unit
C3.2.25	Painting of exposed steel bars with two coats of zinc rich primer (Type specified)	litre (ℓ)

The unit of measurement shall be the litre of primer used as specified

The tendered rate shall include full compensation for cleaning the exposed steel as specified and providing and applying the primer in accordance with the manufacturer's specifications.

Item	Description	Unit
C3.2.26	Repair with cementitious mortar or concrete (Class) to (description)	litre (ℓ)

The unit of measurement shall be the litre of mortar or concrete as specified by the Engineer and measured in place, used for the repair of specified concrete defects, including curing.

The tendered rate shall be as specified under item C14.4.1 of Chapter 14. Payment for larger concrete extensions shall be made under item C3.2.7.

C3.2.27	Repair with epoxy mortar	litre (ℓ)
----------------	---------------------------------	------------------

The unit of measurement is the litre of epoxy mortar measured in place, of specified type used for the repair of specified concrete defects, including curing.

The tendered rate shall be as specified under item C14.4.2 of Chapter 14.

D3.2 CULVERTS

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

- D3.2.1 SCOPE**
- D3.2.2 GENERAL**
- D3.2.3 PERFORMANCE GUARANTEE REQUIREMENTS**
- D3.2.4 FUNCTIONAL PERFORMANCE ASSESSMENTS**
- D3.2.5 VISUALLY ASSESSED PROPERTIES**
- D3.2.6 INSTRUMENTALLY ASSESSED PROPERTIES**
- D3.2.7 EVALUATION FOR ACCEPTANCE**
- D3.2.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE**
- D3.2.9 NOTIFICATION OF REMEDIAL WORK**
- D3.2.10 REMEDIAL WORKS**

No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.

A3.3 CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS

CONTENTS

PART A: SPECIFICATIONS

- A3.3.1 SCOPE**
- A3.3.2 DEFINITIONS**
- A3.3.3 GENERAL**
- A3.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS**
- A3.3.5 MATERIALS**
- A3.3.6 CONSTRUCTION EQUIPMENT**
- A3.3.7 EXECUTION OF THE WORKS**
- A3.3.8 WORKMANSHIP**

PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENTS AND PAYMENTS

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

PART A: SPECIFICATIONS

A3.3.1 SCOPE

Drainage under this Section mainly covers the drainage of road and bridge surfaces into open structures or conduits. Drainage may transfer into culverts or conduits or to natural or formed drainage channels. This Section covers work in connection with the construction of concrete kerbing and its channeling, asphalt berms, kerb inlets, chutes, downpipes, and linings for open drains constructed from concrete, stone pitching, gabions, mattresses or alternative materials at the locations and to the details as shown on the drawings or specified by the Engineer. This Section also covers the replacement of damaged kerbing, channeling, asphalt berms, and lining of all types of construction.

A3.3.2 DEFINITIONS

No specific definitions.

A3.3.3 GENERAL

A3.3.3.1 Types of structures

Kerbing shall include barrier kerbs, mountable and semi-mountable types. All these elements may be prefabricated on site or elsewhere or constructed in a continuous operation using slipforms. Kerb inlets shall generally be cast in situ concrete.

Channeling may be cast in situ concrete, prefabricated units, slipform construction, stone pitched or gabion lined.

Chutes may be prefabricated units, cast in situ concrete, stone pitched or gabion lined.

Lining of open channels may be cast in situ concrete or stone pitched or gabions, except that side slabs may be precast on site or elsewhere.

Downpipes shall be prefabricated elements, of concrete, steel or U-PVC or HDPE.

Asphalt berms may be cast in situ in moulds or constructed by means of a suitable machine.

A3.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

None applicable unless specific specifications have been accepted as proposed by the Contractor or included into the Contract Documentation.

A3.3.5 MATERIALS

A3.3.5.1 General material specifications

The material specifications are the required specifications for the materials as placed and/or processed in its final position on the road.

It is the Contractor's responsibility to ensure that the materials delivered to the road shall meet these specified requirements. All precast and manufactured elements are to be tested for strength and durability.

Materials removed under this Section from existing works, except where excavated materials are specified to be reused or disposed of, or except where provision has been made in Part C for their reuse or specific disposal, shall be deemed to be the property of the Contractor.

A3.3.5.2 Drainage structure materials

a) Concrete

All concrete work shall be carried out in accordance with the requirements of Section A13.4 of Chapter 13 of these specifications, read together with the provisions of Clause A3.1.5.4.

b) Cement

Cement shall comply with SANS 50197-1 for CEM I or CEM II with a strength class of 32,5 or greater, and a rate of strength gain N or greater.

c) Kerbing and channeling

Prefabricated kerbing and channeling shall be manufactured on site or elsewhere and shall comply with the requirements of SANS 927. Cast in situ kerbing and channeling shall be of the class of concrete indicated.

d) Joint sealant

Two-part cold applied polysulphide sealing compound shall conform to the requirements of BS 4254.

Polyurethane-based joint sealants shall comply with the requirements of SANS1077.

Silicone-based joint sealants shall comply with the requirements SANS 1305 unless otherwise indicated in the Contract Documentation.

e) Bedding material

Concrete as bedding or backing material, in shall be a class C16/20-20 cast in situ concrete.

Alternative bedding shall consist of crushed stone, cinders, slag, sand or other approved porous material with a maximum particle size of 14 mm.

f) Asphalt berms

Asphalt berms shall be bedded on completed surfacing layers or primed base layers. Asphalt shall be a continuously graded fine or medium mix, as specified, with aggregate grading as specified in Table A9.1.5-5 of Chapter 9 and mix properties as specified in Table A9.1.3-2 of Chapter 9.

g) Stone

Stone for pitching shall be sound, tough and durable, with 80 % of stones more than 150 mm in minimum dimension, with smaller pieces or spalls may be used for filling spaces between the larger stones. The shapes of the rocks or stones shall be so as to form a stable protective layer of the required thickness. Rounded boulders shall not be used on slopes steeper than 2:1 unless cement grouted.

h) Sand for concrete

Sand for concrete, cement slurry and cement mortar shall comply with the requirements of SANS 1083.

i) Gabions and mattresses

The materials used for the construction of gabions and mattresses which may include rock, PVC-coated and/or galvanized wire and wire mesh shall comply with the requirements of Section A12.6 of Chapter 12.

j) Geotextiles

Geotextiles shall be of the grade and type specified in the schedule of quantities or Contract Documentation, and shall comply with the requirements of Section A12.11 of Chapter 12.

k) U-PVC pipes

U-PVC pipes shall comply to the requirements of SANS 791 for solid wall pipes (category-heavy duty), and shall have socketed ends should joining be required.

l) Bituminous binders

Should a prime coat be required, it shall conform to the specifications of the prime for the base layer.

The bond coat shall consist of a stable grade bituminous emulsion diluted to have 30 % net bitumen content

The bituminous binder to be used in the specified mix shall be a bitumen emulsion and conform to the specifications in Clause A9.1.5.2 of Chapter 9.

m) Polymer film sheeting

Plastic for drainage systems to be used shall be polymer film type sheeting of 150 to 250 micron (0,15 to 0,25 mm) thickness, complying with complying with SANS 952-1

n) Alternative materials

Alternative materials, if any, shall be specified and detailed in the Contact Documentation. Where alternative materials are proposed by the Contractor, they shall be submitted for approval, accompanied by the verification of being fit for purpose, specific performance guarantees.

A3.3.6 CONSTRUCTION EQUIPMENT

The Contractor shall submit his plant and equipment list for excavating, stockpiling if specified, manufacturing, loading, hauling and all construction as part of his method statement to perform the different elements of the Works.

A3.3.7 EXECUTION OF THE WORKS

A3.3.7.1 Drainage Structures

a) Excavation and preparation of bedding

(i) Kerbs and channels

Trenches for kerbs and channels and inlets and outlets thereto shall be excavated to the required depth and all unsuitable material shall be removed and replaced with a layer of approved bedding material at least 75 mm thick. The bedding shall be compacted and accurately shaped to the required grade and level. No in situ concrete or precast concrete units shall be placed on uncompacted or disturbed material.

(ii) Asphalt berms

If indicated on the drawings or specified by the Engineer, the base layer prime coat shall extend wider to cover the area where the berms are to be constructed. Asphalt berms should be constructed after the completion of surfacing and any vehicle restraint systems in order to minimise the risk of damage.

Before any specified berms or priming commences, the specified width of the base projecting beyond the surfacing shall be thoroughly cleaned. The shoulder material adjacent to the base shall be compacted and trimmed to match the upper level of the base, and all loose material removed.

The bond coat shall consist of a stable grade bituminous emulsion diluted to have a 30 % net bitumen content and shall be applied at a rate of 0,4 litres per square metre onto the entire berm foundation. The bond coat shall be left to dry before the berm is constructed.

Production and placement of asphalt shall be as specified in Section A9.1 of Chapter 9.

(iii) Linings for open drains

The excavation work for open drains and clearing and grubbing if required, shall be executed and paid for under and in accordance with the provisions of Section A3.1.

The excavations shall then be neatly trimmed to the lines and levels specified so as to permit the accurate construction of the linings. All loose material shall be compacted to a density of not less than 93 % of MDD.

Where the in situ material is unsuitable, the Engineer may instruct that it be removed to the required depth and replaced with selected material compacted to a density of 93 % of MDD to the required grade and level.

Where stone pitching or gabions are specified, the area shall be prepared by excavating, shaping and trimming as necessary for pitching or gabions, and by thoroughly compacting the area by hand-ramming to prevent subsequent settlement. A trench shall be excavated as directed by the Engineer along the toe of any slopes to be lined or along the unprotected edge of the linings in the beds of streams to allow the construction of a thickened edge of the specified lining.

Where excavations for open drains are in rock, overbreak shall be backfilled as specified, either with mass concrete or with selected gravel or soil compacted to a MDD of at least 93 %.

(iv) Chutes

Excavations for chutes shall be neatly trimmed. All loose material shall be thoroughly compacted, and where overbreak occurs in hard material, the excavations shall be backfilled with mass concrete.

b) Prefabricated concrete kerbing and channeling

Unless otherwise specified in the Contract Documentation, prefabricated concrete kerbs shall be laid with a class C16/20-20 cast in situ concrete bedding and support behind the kerbs in accordance with the details shown on the drawings.

Prefabricated concrete kerbing and channeling shall be laid on the approved bedding with close joints filled with 3:1 sand: cement mortar not exceeding 10 mm in thickness and neatly pointed with a pointing trowel. The exposed faces of kerbs and edging shall be constructed true to line and level. Kerbing around curves shall first be laid along the full curve length before the joints are filled, unless otherwise allowed by the Engineer. Kerbs shall be temporarily propped during construction.

Unless otherwise specified, prefabricated concrete kerb units shall be 1,0 m in length, except at curves at road junctions, where the kerb units shall be 0,5 m in length for curve radii between 5,0 m and 20 m and 0,3 m in length for curve radii between 1,0 m and 5,0 m. For curves with a radius less than one metre the kerbs shall be cast in situ. Any associated prefabricated concrete channeling units shall also comply with these length requirements.

Special care shall be taken to assure that expansion joints are constructed and sealed as shown on the drawings or specified by the Engineer.

c) Chutes and downpipes on side slopes of fills and cuts

(i) Prefabricated chutes and downpipes

Prefabricated chutes and downpipes shall be manufactured in accordance with the dimensions shown on the drawings, and the units shall fit neatly into each other. The bottom unit shall rest against the outlet structure or footing as shown on the drawings. The units shall be laid true to line and grade from the bottom up so that each unit fits neatly into the previous one. A transition section shall be constructed at the inlet to lead the water into the chute or downpipe as shown on the drawings.

Downpipe joints shall socketed into each other with the external joint facing toward the inlet of the drain.

(ii) Stone pitched chutes

Stone pitched chutes shall be constructed as specified for stone pitched open drains as specified in Clause A3.3.7.1i).

d) Slip-form kerbing

Slip-form kerbs and channels shall be placed on an approved bedding by a continuous process with an approved slip form machine. Contraction joints shall be sawn at intervals shown on the drawings or prescribed by the Engineer in a manner so as not to cause the concrete to spall at the joint. The concrete shall be cured in accordance with the requirements of Section A13.4 of Chapter 13 or as specified by the Engineer.

The kerbs and channels shall be constructed true to line and elevation and shall have a neat appearance. Where transverse cracks occur, the Contractor shall replace the entire section between the contraction joints, or as specified by the Engineer, at his own cost.

Curing shall be carried out strictly in accordance with the approved method statement, without damage to the completed kerbing or channeling. Any such damage shall be made good according to the Engineer's specification, at the Contractor's cost

Special care shall be taken to ensure that expansion joints are constructed and sealed as shown on the drawings or specified by the Engineer.

e) Cast in situ kerbs and channels

Forms for kerbs and channels shall be accurately set to line and elevation and shall be firmly held in position during the placing of the concrete. Stops and jointing material at the ends of sections shall be accurately placed so as to ensure that joints between adjacent sections are perpendicular to the surface of the concrete and at right angles to the edge of the road.

After concrete has been placed in the forms, it shall be tamped and worked until mortar entirely covers any exposed faces. Exposed faces shall then be finished to smooth and even surfaces and edges shall be rounded to the radii shown on the drawings.

Forms shall be removed from any concrete surfaces that will be exposed, within a period of 24 hours of the concrete having been placed. Minor defects shall be repaired with a 2:1 sand: cement mortar. Plastering shall not be permitted on exposed faces and all rejected portions shall be removed and replaced at the Contractor's cost. When completed, the sections shall be cured in accordance with the requirements specified in Section A13.4 of Chapter 13 or as specified by the Engineer.

Special care shall be taken to assure that expansion joints are constructed and sealed as shown on the drawing or specified by the Engineer

The completed kerbs and channels shall be true to line and elevation and shall have an even and neat appearance.

f) Cast in situ chutes on cut slopes

Cast in situ concrete chutes on cut slopes, together with the inlet and outlet structures, shall be constructed in accordance with the drawings. The class of concrete shall be as indicated on the drawings and/or indicated in the Contract Documentation. On slopes steeper than 1:2 cast in situ concrete shall be constructed by boxed shuttering.

Where specified by the Engineer, a concrete screed shall first be cast on excavations that cannot be trimmed accurately. The screed shall be accurately finished to the level of the underside of the chute floor slab and allowed to set before the floor slab is cast. Where the material being excavated cannot be accurately trimmed or where the chute sides have to extend above the surface of cut slopes, the outer faces of the sides shall be cast against formwork as specified by the Engineer

g) Asphalt berms

Berms shall be constructed with the toe of the berm not encroaching more than 25 mm into the surfacing of the adjacent roadway or shoulder.

When placed by hand, the asphalt shall be placed and shaped in situ in a rigid portable mould to form a trapezoidal berm of the dimension specified or indicated on the drawings. The asphalt mixture shall be thoroughly compacted to form a hard unyielding berm, true to level, shape and line, within the specified tolerances. The moulds may be removed as soon as the asphalt has cooled to air temperature, or, in the case of a cold asphalt mixture, as soon as the berm has hardened and the mould can be removed without damage to the berm.

A machine of approved design may be used for placing the berm. In general machine placed berms will not require additional compaction but in areas where compaction is inadequate, the machine shall be ballasted with additional mass, or other measures shall be taken to ensure that adequate compaction is achieved.

Should the berms be constructed before the construction of vehicle restraint systems, the post holes shall be excavated with care to prevent damage to the berms. Where chute or downpipe inlets are required against fills, the berm shall be discontinued until the inlet is constructed, and thereafter finished to form a tie in with the inlet.

h) Concrete-lined open drains

The exposed surfaces of the concrete linings of open drains shall have a class U2 surface finish. Concrete shall be cured in accordance with the requirements of Section A13.4 of Chapter 13.

Sealed joints in concrete shall be in accordance with the details indicated on the drawings as well as the provisions of Section A13.7 of Chapter 13. Cold joints shall be painted with a coat of approved bituminous emulsion containing 60 % of net bitumen by mass, or with an approved anti-adhesive before any adjoining slabs are cast.

Expansion joints shall be made in accordance with the drawings.

Where required, the surfaces on which concrete lining is to be cast shall, after having been trimmed, be covered with polymer film sheeting of 0.15mm thickness and all joints in the sheeting shall be overlapped by at least 150 mm. Alternatively the surface could be sprayed with invert bituminous emulsion as soon as possible after the excavations have been trimmed and compacted. The sprayed surfaces shall be maintained until the concrete lining is cast. The nominal rate of application of the emulsion shall be 0,5 litre/m² unless otherwise specified by the Engineer.

i) Stone pitched open drains

(i) Grouted stone pitching with mortar

The stones shall be thoroughly cleaned of adhering dirt or clay. Commencing from the bottom of the trench, the stone shall be moistened and embedded in freshly laid cement mortar composed of one part of cement to every six parts of sand by volume. The stones shall be firmly bedded against adjoining stones. The stones shall be laid with their longitudinal axes at right angles to the slope and with staggered joints. Any spaces between the stones shall be filled with cement grout of the same composition as the mortar. The mortar and grout shall be placed in a continuous operation for any day's run at any one location. The grout shall be worked into the pitching so as to ensure that all spaces or voids between the stones will be completely filled with grout to the depth of the stone pitching, with the approximately 20 mm of stones protruding. Grout spilt onto exposed surfaces of the stones shall be removed while still soft, and the joints between stones shall be neatly finished.

The grouted pitching shall be cured with wet sacking or other approved wet cover for a period of not less than four days after grouting, and shall not be subjected to loading until adequate strength has been developed. Where required and indicated on the drawings and/or Contract Documentation, weep holes shall be formed in the pitching.

The thickness of the pitching including the stone protrusions, measured at right angles to the surface, shall not be less than 200 mm.

The completed pitching shall have an even appearance and nowhere may the grout surface deviate by more than 25 mm from the specified lines and grades.

(ii) *Grouted stone pitching on a concrete bed*

The area to be pitched shall be prepared as described in Clause A3.3.7.1a(iii) and a concrete bed (class C16/20-20 concrete) with a thickness of at least 75 mm shall then be placed. The stone pitching shall be laid while the concrete is still workable. Openings between stones shall be filled with cement grout and stone protrusion constructed as described in Clause A3.3.7.1i(i), and care shall be taken not to spill the grout onto the finally exposed surfaces of the stones. Grout spilt onto the exposed surfaces of the stones shall be removed while still soft and the joints between stones shall be neatly finished.

Curing shall be done as described for grouted stone pitching in Clause A3.3.7.1i(i).

The thickness of the pitching including the bedding and stone protrusions, measured at right angles to the surface, shall not be less than 200 mm.

The completed pitching shall have an even appearance and nowhere may the grout surface deviate by more than 25 mm from the specified lines and grades.

j) Gabion lined open drains

Generally 0,3 m thick mattresses will be used to line open drains.

Gabions and mattresses shall be constructed in terms of the requirements of Section A12.6 of Chapter 12. The stones used in the top layer of all gabions shall be selected to resemble normal stone pitching.

k) Backfilling

After completing the concrete work, the spaces at the backs of kerbs shall be backfilled with approved material to pavement or road shoulder level. Spaces adjoining open drains and chutes shall be backfilled level with the adjacent road or embankment surface. Such backfill shall be placed in layers not exceeding 150 mm and each layer shall be thoroughly compacted at optimum moisture content before the succeeding layer is placed thereon.

Where kerbs and channels are laid after construction of the base, the spaces between the concrete and adjoining base shall be backfilled with approved premixed asphalt material.

l) Construction sequence

Where new base layers and kerb and channels are constructed, kerbs and channels shall be constructed before the construction of the adjoining base layer unless otherwise approved by the Engineer.

Where kerbs and channeling are constructed before the base:

In this case slip-form units or cast in situ units may be constructed. During working and constructing the base, precautionary measures shall be taken to prevent the concrete work from being damaged or disturbed.

Where kerbs and channeling are constructed after the granular base:

The base shall be constructed wider than the specified width, after which a neat trench shall be excavated for the kerbing or channeling. Any over-excavation shall be back filled with concrete cast simultaneously with the kerbs and channeling.

Where kerbs and channeling are constructed after the asphalt base and/or asphalt surfacing:

The asphalt base and/or asphalt surfacing shall be constructed wider than the specified width and shall then be cut back accurately with a mechanical saw to a marked line to give a neat joint line between the kerbs or channeling and the asphalt layer. The surfacing and base shall then be removed to the required depth.

m) Protection

The Contractor shall take all precautions to prevent concrete spillage onto the adjacent completed road surfacing. Any concrete spilt onto the road surface shall be removed. Where so required by the Engineer, the Contractor shall, without any additional compensation, sand blast the stained surface and treated with bitumen emulsion to get an evenly coloured surface.

During transporting and laying, care shall be taken to protect all precast units against chipping or breakage.

Concrete kerbing and channeling as well as any other structures adjacent to the road shall be protected against staining by prime or bitumen being sprayed or premix being placed. Where prime or bitumen is to be sprayed, all such work shall be completely covered with polymer film sheeting at least 0,25 mm thick, specially reinforced paper or other approved material, properly secured to prevent the sheeting from lifting during windy conditions. Any work stained by prime or bitumen shall be broken down and replaced, unless all such prime or bitumen is completely removed so as not to show any stains. Painting over stained work will not be permitted.

n) Cutting existing bituminous surfacing and pavement layers

Where kerbing, channeling or concrete-lined drains to be constructed against existing bituminous surfacing is specified, the full depth of the bituminous surfacing, and the base and subbase if necessary, shall be accurately cut with a mechanical saw to the required line and depth before the kerbing, channeling or concrete-lined drain is constructed. The cut edge shall be vertical for kerbing and channeling. The concrete shall then be cast directly against the cut edge without formwork. All material outside the cut edge shall be removed to the required depth before the concrete is cast. The debris shall be disposed of at a dumping site to be provided by the Contractor subject to the approval of the Engineer. The bituminous surfacing shall be protected and kept clean to the Engineer's satisfaction.

o) Demolition of existing kerb and channel and concrete lined drains

Where shown on the drawings and/or indicated by the Engineer, the existing kerb and channel and concrete lined drains shall be demolished to a specified maximum size, removed and transported to an approved spoil site as provided by the Contractor. All adjoining existing work shall be protected against damage during such excavation and removal. Any damage to such work shall be made good at the Contractor's cost.

A3.3.7.2 Inlet and outlet structures and transition sections

Transition sections on kerbing, kerbing-channeling combinations and concrete-lined or stone pitched open drains shall be constructed to the same standards and by the same methods as described for the uniform sections, but with the required modifications. Sections may be either precast or

cast in situ units.

Inlet and outlet structures may be either precast or partially precast concrete units or may be cast in situ concrete.

Where shown on the drawings or specified by the Engineer, the Contractor shall supply and install within the outlet structures, energy dissipaters consisting of prefabricated reinforced-concrete blocks of class C20/25-20 concrete of the dimensions shown on the drawings or listed in the schedule of quantities, or alternatively stones as detailed on the drawings shall be set in the freshly cast concrete.

Components or accessories such as grids, covers and frames shall be in accordance with the details shown on the drawings and the requirements of Clause A3.2.5.2.

A3.3.8 WORKMANSHIP

The Contractor shall determine the required frequency of testing and conduct sufficient tests on the sourced material for each type of material, in order to ensure that the quality of materials produced will meet the specified requirements for the particular purpose for which it will be used.

A3.3.8.1 Construction tolerances and surface finish

a) Concrete kerbing and channeling

Concrete kerbing and channeling shall be constructed to within the following dimensional and alignment tolerances:

(i) *Horizontal alignment*

The maximum deviation of edges, centre line, or vertical surfaces from the specified position shall be 25 mm, read together with the alignment tolerance hereunder.

The rate of deviation of edges, centre line, or vertical surfaces from the specified alignment, shall be less than 1:500 when taken over any section exceeding 10 m in length.

(ii) *Vertical alignment and level*

Unless designed as such, the inside edge of channeling shall nowhere be above the finished road level nor more than 10 mm below the finished road level. The invert level of channels and open drains and the top of kerbing shall nowhere deviate by more than 10 mm from the required level and nowhere shall channels or drains have any adverse grade. Any ponding resulting from such deviations shall be resolved as specified by the Engineer, which may include complete removal and reconstruction of the affected section.

(iii) *Trueness of exposed surfaces*

When tested with a 3,0 m straight-edge, no surface irregularities shall exceed 6mm.

(iv) *Cross-sectional dimensions*

All cross-sectional dimensions shall be within 6,0 mm of the specified dimensions except that the underside of channeling may extend up to 25 mm below the level at which it would have the required thickness.

b) Asphalt berms

Berms shall be placed true to level, shape and line. Berms shall not deviate more than 10 mm from the specified line when measured at the inner edge of either their crests or bases. The height or width of berms shall not deviate by more than 5,0 mm from the specified height or width.

c) Concrete- and stone pitched-lined open drains, chutes and downpipes

Concrete- and stone pitched lined open drains, chutes and downpipes shall be constructed to following tolerances:

(v) *Horizontal alignment*

The maximum deviation from the true position of the edges or centerline shall be 25 mm.

(vi) *Vertical alignment*

The invert level shall nowhere deviate by more than 25 mm from the required level and nowhere shall the inverts have an adverse grade.

(vii) *Trueness of exposed surface*

When tested with a 3,0 m straight-edge, no exposed formed or cast concrete or precast surface shall have surface irregularities exceeding 10 mm.

(viii) *Cross-sectional dimensions*

All cross-sectional dimensions shall be within 10 mm of the specified dimensions, and the average thickness of a floor or side slab shall not be less than the specified thickness when considering any complete slab or a slab section with a surface area of 10 m² or more, and disregarding a thickness exceeding 10 mm of the specified thickness.

d) Surface finish

All unformed exposed concrete surfaces shall have a Class U2 surface finish and all formed exposed concrete surfaces shall have a Class F2 surface finish.

B3.3 CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS

PART B: LABOUR ENHANCEMENT

CONTENTS

B3.3.1	SCOPE
B3.3.2	DEFINITIONS
B3.3.3	GENERAL
B3.3.4	DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS
B3.3.5	MATERIALS
B3.3.6	CONSTRUCTION EQUIPMENT
B3.3.7	EXECUTION OF THE WORKS
B3.3.8	WORKMANSHIP

B3.3.1 SCOPE

This part covers additional specifications for work to enhance the labour component of construction activities, over and above labour employed for conventional construction activities, where specified.

B3.3.2 DEFINITIONS

The provisions of Part A, shall apply.

B3.3.3 GENERAL

The provisions of Part A, shall apply.

B3.3.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

None applicable unless specific specifications have been accepted as proposed by the Contractor or included into the Contract Documentation.

B3.3.5 MATERIALS

The provisions of Part A, shall apply.

B3.3.6 CONSTRUCTION EQUIPMENT

The provisions of Part A, shall apply.

B3.3.7 EXECUTION OF THE WORKS

B3.3.7.1 Concrete mixing by hand

Concrete may be mixed by hand or in hand-turned concrete mixers for small pours up to one (1) cubic metre. Larger pours greater than one (1) cubic metre shall be machine mixed with on-site mechanical mixers and/or batch plants.

The mix design shall be based upon obtaining an average concrete compressive strength sufficiently above the specified characteristic compressive strength so that, considering the expected variability of the concrete and test procedures, no more than 5 percent of strength tests will be expected to fall below the specified characteristic compressive strength.

All concrete mixed on the site of works shall be weigh-batched unless the Contractor can demonstrate to the Engineer that his method of proportioning the concrete ingredients consistently produces uniform concrete, which meets the strength requirements.

Concrete shall be hand-mixed on a prepared mixing floor of adequate area to facilitate proper mixing without contamination by any foreign materials.

The sand shall be measured off, tipped onto the mixing floor and spread in a circle. The cement (one or two whole sacks, as required by the mix

design) shall then be spread evenly across the sand and mixed in with shovels, turning the mixture into the middle of the circle and out again. When the colour is even, the mix shall be shaped with a hollow in the centre.

Part of the mixing water shall be poured into the hollow and mixed in. More water shall be slowly added and mixed in until all the water has been added. The materials shall be turned into the middle of the circle and out again at least twice. The mix should be soft and even with no dry patches. The mix shall then be spread in a circle.

The stone shall be measured off and spread evenly across the mortar and mixed with shovels, by turning the mixture into the middle and out again at least twice. Concrete shall be properly mixed to a uniform consistency without fatty or harsh patches. The total period between the times that the cement is placed into the mix until mixing starts shall not exceed 15 minutes.

The selection of mixing and batching locations shall be so chosen to minimize the transport of concrete placement.

B3.3.8 WORKMANSHIP

The provisions of Part A, shall apply.

C3.3 CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

(ii) Notes on measurement and pay Items

1. Unless otherwise ordered or stated in the Contract Documentation, trench depths will be measured from the surface of the ground along the centre-line of the trench to the bottom of the specified bedding layer (as applicable).
2. The ground surface will be that existing after any bulk earthworks have been carried out, i.e. the excavated surface or embankment surface, unless a different sequence of execution has been ordered.
3. Excavations will be measured as if taken out with vertical sides, regardless of whether they have been taken out with sloping sides.
4. Wherever volumetric measurement is required, the volume will be computed from the depth determined as indicated in 1. and 2. above and using the authorised width (W) determined in accordance with the specification.
5. Where shoring is specified or ordered, the length of shoring measured for payment will be the length of the centre-line of the trench.

(iii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for backfilling excess excavations, disposing of surplus material etc. or any other contingent work, unless the work is specifically specified or ordered.
2. No separate payment will be made for setting out the works.
3. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, infrastructure or services damaged by the Contractor's activities.
4. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
5. No separate payment will be made for the loading of any materials.
6. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km.
7. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
8. No separate payment will be made for the removal or any surplus material imported to complete the works.
9. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iv) Items to be measured and paid for using items specified elsewhere in the specifications

The following items of work, when specified, shall be carried out, measured and paid for in accordance with the appropriate sections of the specifications.

Table C3.3-1: Items from other Chapters or Sections

Activity	Section 3.3 Clause reference	Section Item reference
Cast in situ concrete chutes – excavation trimming and gravel or soil backfilling	C3.3.7	C3.1
Gabion linings for open drains	A3.3.7.1j)	C11.2.3 of Chapter 11
Reinforcement	C3.3.12	C13.3.1 of Chapter 13
Reinforcement – hot dip galvanizing	C3.3.12	C13.9.3.2 of Chapter 13
Loading and hauling	C3.3.16	C1.7 of Chapter 1

(v) Items specifically for this section of the specifications

Item	Description	Unit
C3.3.1	Concrete kerbing:	
C3.3.1.1	Prefabricated kerbing (description of type of kerb and bedding with reference to drawing)	
(a)	State type of kerb and bedding with reference to drawing	metre (m)

(b)	Etc for other types	metre (m)
C3.3.1.3 Cast in situ kerbing		
(a)	State type of kerb, class of concrete with reference to drawing	metre (m)
(b)	Etc for other types	metre (m)

The unit of measurement shall be the metre of concrete kerbing complete as specified and detailed on the drawings, measured along the front face of the kerb.

The tendered rate for each metre of concrete kerbing shall include full compensation for the necessary excavation and preparation of bedding, backfilling, formwork, finishing and curing of cast in situ kerbing, alternatively for procuring, furnishing and installing all materials for prefabricated kerbing, protecting work against staining, supporting the kerbs with in situ cast concrete, and filling and pointing all construction or contraction joints, and producing and sealing all expansion joints, all complete as specified.

All concrete shall conform to the required specification.

Item	Description	Unit
C3.3.2	Concrete kerbing-channeling combination:	
C3.3.2.1	Prefabricated kerbing-channeling (description of type of channel and bedding with reference to drawing)	
(a)	State type of kerb and bedding with reference to drawing	metre (m)
(b)	Etc for other types	metre (m)
C3.3.2.3	Cast in situ kerbing-channeling (description with reference to drawing and class of concrete and finish indicated)	
(a)	State type of kerb and bedding with reference to drawing	metre (m)
(b)	Etc for other types	metre (m)

The unit of measurement shall be the metre of concrete kerbing or kerbing-channeling combination complete as constructed, measured along the front face of the kerb.

The tendered rate for each metre of concrete kerbing and/or kerbing-channeling combination shall include full compensation for the necessary excavation and preparation of bedding, backfilling, formwork, finishing and curing of cast in situ kerbs and channels, alternatively for procuring, furnishing and installing all materials for prefabricated kerbing and channeling, protecting work against staining, supporting the kerbs with in situ cast concrete, and filling and pointing all construction or contraction joints, and producing and sealing all expansion joints, all complete as specified.

All concrete shall conform to the required specification.

Item	Description	Unit
C3.3.3	Extra over items C3.3.1 and C3.3.2 for concrete kerbing or concrete kerbing and channeling on curves	
C3.3.3.1	On curves of radii more than or equal to 5,0 m but less than 20 m	metre (m)
C3.3.3.2	On curves with radii more than or equal to 1,0 m but less than 5,0 m	metre (m)
C3.3.3.3	On curves with radii less than 1,0 m	metre (m)

The unit of measurement shall be the metre of concrete kerbing or kerbing and channeling combination complete as constructed, measured along the front face of the kerb.

The tendered rate shall include full compensation for the additional costs involved in setting out, preparing and constructing as specified on curves with radii less than 20 m.

Item	Description	Unit
C3.3.4	Extra over item C3.3.2 for drop kerbs at pedestrian crossings and driveways	metre (m)

The unit of measurement shall be the meter of drop kerb installed measured from the starting point where the kerb on one side starts tapering down, across the lowered section as specified, up to the end where the kerb is at its correct level on the other side.

The tendered rate is an extra over for the extra work involved in having to excavate and construct deeper and inclined, and shall include full compensation for all the labour, excavation, materials and backfill to complete the pedestrian crossing or driveway access as specified.

Item	Description	Unit
C3.3.5	Asphalt berms	
C3.3.5.1	Asphalt berms placed where there are no vehicle restraint systems (drawing reference indicated)	metre (m)

C3.3.5.2	Asphalt berms placed at existing vehicle restraint systems (drawing reference indicated)	metre (m)
C3.3.5.3	Prime coat (type indicated)	square metre (m ²)
C3.3.5.4	Bond coat (type indicated)	square metre (m ²)

The unit of measurement for items C3.3.5.1 and C3.3.5.2 shall be the metre of asphalt berm constructed as specified.

The tendered rates shall include full compensation for procuring, furnishing, mixing and placing the material, and all other work necessary for the completing the asphalt berms as specified

The unit of measurement for items C3.3.5.3 and C3.3.5.4 shall be the square metre of completed prime or bond coat, applied in accordance with the specifications.

The tendered rates shall include full compensation for procuring and providing all material and for mixing and applying the prime and bond coats complete as specified, including cleaning, compacting and trimming the surface being primed or tacked.

Payment shall be made under this item for the prime coat only if it is specified by the Engineer, and it is applied in a separate strip independently from the prime coat of the road or shoulder surface. If prime is applied as an integral part of the prime coat of the road or shoulder surface, by that prime coat being applied over a wider area to provide for the berms, payment for the prime shall not be made under this item, but under the item for priming the road or shoulder.

Item	Description	Unit
C3.3.6	Concrete chutes (typical designs):	
C3.3.6.1	Prefabricated concrete chutes (description of type with reference to drawing)	metre (m)
C3.3.6.2	Cast in situ concrete chutes (description, with reference to drawing and class of concrete and finish indicated)	metre (m)
C3.3.6.3	Stone pitched chutes (description with reference to drawing and class of concrete indicated)	metre (m)

The unit of measurement shall be the metre of completed chute as constructed, including any overlap, measured along the slope as constructed but excluding transition sections and inlet and outlet structures measured separately.

The tendered rate per metre shall include full compensation for procuring, furnishing and installing the completed chutes as specified and for all excavation and the preparation of bedding, backfilling, formwork and finishing required.

All concrete shall conform to the required specification.

Item	Description	Unit
C3.3.7	Cast in situ concrete chutes (measured by components):	
C3.3.7.1	Concrete (class indicated)	cubic metre (m ³)
C3.3.7.2	Formwork (surface finish indicated)	square metre (m ²)
C3.3.7.3	Stone pitched chutes	
(a)	Grouted stone pitching (type of chute indicated)	square metre (m ²)
(b)	Grouted stone pitching on a concrete bed (class of concrete and type of chute indicated)	square metre (m ²)

Measurement and payment for formwork and concrete shall be as specified in Section A13.4 of Chapter 13. Payment for excavation trimming and gravel or soil backfilling shall be measured and paid for separately under Section C3.1, all applicable items.

All concrete shall conform to the required specification.

The unit of measurement for stone pitching shall be the square metre of stone pitching calculated from the drawings or as specified by the Engineer, and shall include compensation for a concrete bed where required.

The tendered rates for stone pitching shall include full compensation for all labour, plant, material, formwork, concrete, stone and other incidentals as may be required and specified on the drawings.

Item	Description	Unit
C3.3.8	Linings for open drains:	
C3.3.8.1	Cast in situ concrete lining (class of concrete and type of open drain indicated)	cubic metre (m ³)
C3.3.8.2	ClassU2 surface finish to cast in situ concrete (type of open drain indicated)	square metre (m ²)
C3.3.8.3	Stone pitched lining (200 mm thickness)	
(a)	Grouted stone pitching (type of open drain indicated)	square metre (m ²)
(b)	Grouted stone pitching on a concrete bed (class of concrete and type of open drain indicated)	square metre (m ²)

Measurement and payment under this item shall include items for inlet, outlet, transition and similar structures.

Measurement of and payment for formwork and concrete shall be as specified in Section A13.4 of Chapter 13.

The unit of measurement for surface finish shall be the square metre of finished concrete surface. The tendered rate for surface finish shall include full compensation for all labour, plant, material and other additional work and incidentals required for trimming the concrete lining as specified, and curing of the concrete.

The unit of measurement for stone pitching shall be the square metre of stone pitching calculated from the drawings or as specified by the Engineer, and shall include compensation for a concrete bed where required.

The tendered rates for stone pitching shall include full compensation for all labour, plant, material, formwork, concrete, stone and other incidentals as may be required and specified on the drawings.

Measurement and payment for gabion linings shall be as per item C11.2.3 of Chapter 11.

Item	Description	Unit
C3.3.9	Formwork to cast in situ concrete lining for open drains (Class F2 surface finish):	
C3.3.9.1	To sides with formwork on the internal face only	square metre (m ²)
C3.3.9.2	To sides with formwork on both internal and external faces (each face measured)	square metre (m ²)
C3.3.9.3	To ends of slabs	square metre (m ²)

Measurement of and payment for formwork shall be as specified in Section A13.2 of Chapter 13. Formwork under item C3.3.9.1 shall be measured and paid for only when the side slope of the slabs exceeds 1 in 2 and the slabs cannot be constructed without formwork even when a stiff concrete mix is used. When the Contractor elects to use precast side slabs, payment will be made for formwork as if cast in situ concrete had been used.

Item	Description	Unit
C3.3.10	Sealed joints in concrete and stone pitched linings of open drains (description of each type with reference to drawing)	metre (m)

The unit of measurement shall be the metre of completed joint of each type.

The tendered rate shall include full compensation for the supply of all materials and for all labour, formwork and incidentals necessary for sealing the joint as shown on the drawings or required in the Contract Documentation.

Item	Description	Unit
C3.3.11	Concrete screed or backfill below chutes (thickness and class of concrete indicated)	cubic metre (m³)

The unit of measurement shall be the cubic metre of concrete screed or backfill as may be specified by the Engineer to be placed below chutes.

The tendered rate shall include full compensation for furnishing, procuring and placing the concrete in screed or backfill.

Item	Description	Unit
C3.3.12	Reinforcement:	
C3.3.12.1	Mild steel bars	ton (t)
C3.3.12.2	High-tensile steel bars	ton (t)
C3.3.12.3	Welded steel fabric	kilogram (kg)
C3.3.12.4	Other material (specify)	kilogram (kg)

Measurement and payment shall be in accordance with the provisions of item C13.3.1 of Chapter 13.

Where hot-dip galvanized steel reinforcement is indicated, the additional costs associated with the hot-dip galvanizing shall be in terms of item C13.9.3.2 of Chapter 13.

Item	Description	Unit
C3.3.13	Polymer film sheeting (thickness specified) for concrete-lined open drains	square metre (m²)

The unit of measurement shall be the square metre of area covered with polymer film sheeting.

The tendered rate shall include full compensation for procuring, furnishing and installing the polymer film sheeting, including wastage and overlap.

Item	Description	Unit
C3.3.14	Cutting bituminous surfacing and pavement layers for concrete kerbing, channeling or concrete-lined drains	metre (m)

The unit of measurement shall be the metre of bituminous surfacing and pavement layers cut where specified by the Engineer. The depth of various layers shall not be measured separately for payment.

The tendered rate shall be regarded as an extra over to include full compensation for all labour, plant and materials required for cutting the surfacing and pavement layers to the required depth of the kerbs, channels or drains, special excavation, and protecting and keeping the surfacing clean, all as specified. The normal excavation and removing and disposing of the debris as required for kerb or channel installation shall be deemed included in the normal price for such kerbs and channels, as measured elsewhere.

Item	Description	Unit
C3.3.1.15	Energy dissipaters in outlet structures	
C3.3.15.1	Precast concrete blocks in outlet structures	number (No)
C3.3.15.2	Stones set in outlet structures	square metre (m ²)

The unit of measurement for item C3.3.15.1 shall be the number of precast concrete blocks provided and installed as shown on the drawings or specified by the Engineer.

The unit of measurement for item C3.3.15.2 shall be the square metre of area of outlet set in stones, as indicated on the drawings or specified by the Engineer.

The tendered rate for energy dissipaters shall include full compensation for supplying all the materials, including concrete blocks or stones, loading, transporting and off-loading, installing, and any other work necessary for constructing the energy dissipaters into the outlets.

Item	Description	Unit
C3.3.16	Demolition and removal of existing kerbs and/or channel (specify maximum size)	cubic metre (m³)

The unit of measurement shall be the cubic metre of material demolished measured in situ before demolition or excavation, but including any cementitious bedding removed with the kerbs and channels. Alternatively, the volume of debris will be calculated as 70 % of loose volume measured in haulage vehicles.

The tendered rate shall include full compensation for breaking up the existing kerbs and/or channel to a specified maximum size, of 300 mm x 300 mm removal from site to an approved spoil site, clearing the excavation of all loose debris and to backfill the excavation where new concrete is not required. Loading and hauling, if any, will be paid under Section C1.7 of Chapter 1.

D3.3 CONCRETE KERBING AND CHANNELING, ASPHALT BERMS, CHUTES, DOWNPIPES, AS WELL AS CONCRETE, STONE PITCHED AND GABION LININGS FOR OPEN DRAINS

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

- D3.3.1 SCOPE**
- D3.3.2 GENERAL**
- D3.3.3 PERFORMANCE GUARANTEE REQUIREMENTS**
- D3.3.4 FUNCTIONAL PERFORMANCE ASSESSMENTS**
- D3.3.5 VISUALLY ASSESSED PROPERTIES**
- D3.3.6 INSTRUMENTALLY ASSESSED PROPERTIES**
- D3.3.7 EVALUATION FOR ACCEPTANCE**
- D3.3.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE**
- D3.3.9 NOTIFICATION OF REMEDIAL WORK**
- D3.3.10 REMEDIAL WORKS**

No specific items in this Section.

Where applicable, details must be provided in the Contract Documentation.