TECHNICAL SPECIFICATIONS FOR HAMUYUNDI COMMUNITY IRRIGATION PROJECT

CONTENTS

Chapter	Description		Page
1	**GENERAL**		**1-1**
	1.1	General Description of the Works	1-1
	1.2	Location of the Works	1-1
	1.3	Climatic Conditions	1-3
	1.4	Drawings and Documents	1-3
	1.5	Drawings Designed by the Contractor	1-3
	1.6	“As Built” Drawings	1-4
	1.7	Standard Specifications	1-4
	1.8	Site Meetings	1-5
	1.9	Progress Photographs	1-5
	1.10	Level Datum	1-5
	1.11	Setting Out	1-5
	1.12	Construction and Checking of Work	1-6
	1.13	Supervision and Labour	1-6
	1.14	Works Executed by the Employer or by other Contractors	1-6
	1.15	Contractor’s Site Offices, Workshops, Storage and Working Areas	1-6
	1.16	Definition and Use of the Site	1-8
	1.16.1	Definition of the Site	1-8
	1.16.2	Use of the Site	1-8
	1.17	Possession of the Site	1-8
	1.18	Interference with the Works	1-9
	1.19	Material for the Works	1-9
	1.20	Rejected Materials and Defective Work	1-10

1.21	Existing Works and Services	1-10
1.22	Existing Access	1-11
1.23	Liaison with Police and other Officials	1-11
1.24	Water and Power for Use on the Works	1-11
1.25	Employer as a Supplier of Water and Power	1-11
1.26	Inspection by Engineer during Period of Maintenance	1-12
1.27	Site Offices	1-12
1.28	Survey Instruments and Chainmen for the Engineer	1-12
1.29	Material Testing	1-13
1.30	Sign Boards	1-13
1.31	Tracked Plant	1-15
1.32	Fuel Supplies	1-15
1.33	Telephone and Communications	1-15
1.34	Preservation of Trees	1-15
1.35	Protection from Water	1-15
1.36	Protection against Fires	1-16
1.37	Safety Precautions	1-16
1.38	Explosives and Fuels	1-17
1.39	Watching, Fencing and Lighting	1-18
1.40	Soil Conservation	1-19
1.41	Dust Abatement	1-19
1.42	Noise Control	1-19
1.43	Sanitation	1-20
1.44	First Aid and Medical Services	1-20
1.45	HIV/AIDS Awareness	1-22
1.46	Pollution	1-22
1.47	Maintenance of Irrigation Water Supplies	1-22
1.48	Restoration of Drains, Streams etc.	1-22

	1.49	Site Clearance	1-22
	1.50	Units and Abbreviations	1-23
2	**EARTHWORKS**		**2-24**
	2.1	Site Clearance	2-24
	2.2	Surface Levels	2-26
	2.3	Definition of Earthwork Materials	2-26
	2.4	Removal of Unsuitable Material	2-27
	2.5	Excavation General	2-27
	2.6	Blasting	2-28
	2.7	Excavation Beyond Line or Level	2-28
	2.8	Approval of Excavation	2-28
	2.9	Excavation for Structures	2-28
	2.10	Excavation for Fill Foundation	2-29
	2.11	Trench Excavation	2-29
	2.12	Channel Excavation	2-30
	2.13	Disposal of Excavated Material	2-30
	2.14	Spoil Tips	2-31
	2.15	Borrow Pits and Quarries	2-31
	2.16	Earth Filling	2-32
	2.17	Backfilling of Structural Excavations	2-33
	2.18	Frequency of Testing	2-33
	2.19	Granular Bedding	2-33
	2.20	Slopes and Batters	2-34
	2.21	Trial Pits	2-34
3	**CONCRETE**		**3-34**
	3.1	Concrete General	3-34
	3.2	Cement	3-34
	3.3	Supply of Cement	3-35

3.4	Storage of Cement	3-35
3.5	Testing of Cement	3-35
3.6	Aggregate for Concrete	3-36
3.6.1	General	3-36
3.6.2	Fine Aggregates	3-36
3.6.3	Coarse Aggregates	3-37
3.6.4	Test for Organic Impurities	3-39
3.6.5	Total Chloride and Sulphate Contents	3-39
3.7	Admixtures	3-39
3.8	Water for Concrete	3-40
3.9	Concrete Mixes	3-40
3.10	Trial Mixes	3-40
3.11	Testing of Concrete	3-41
3.11.1	General	3-41
3.11.2	Cement Content	3-42
3.11.3	Workability	3-42
3.11.4	Water/Cement Ratio	3-42
3.11.5	Compressive Strength	3-42
3.12	Failure to Comply with Specified Requirements	3-43
3.13	Concrete Returns and Records	3-43
3.14	Plant, Equipment and Construction Procedure	3-43
3.15	Batching	3-44
3.16	Mixing Concrete by Machine	3-44
3.17	Mixing Concrete by Hand	3-44
3.18	Preparation of Surface to Receive Concrete	3-44
3.19	Authority to Commence Placing of Concrete	3-45
3.20	Dimension of Concrete Pours and Programme of Placing	3-45
3.21	Transport and Deposition of Concrete	3-45
3.22	Distribution and Spreading of Concrete	3-46
3.23	Compaction of Concrete	3-46
3.24	Protection of Concrete	3-47
3.25	No Partially Set Concrete shall be used	3-47

3.26	Plum Concrete	3-47
3.27	Concreting in Adverse Weather	3-48
3.28	Concreting at Night or in the Dark	3-48
3.29	Concreting in High or Low Ambient Temperature	3-48
3.30	Curing and Protection	3-48
3.31	Steel Reinforcement	3-49
3.31.1	Materials	3-49
3.31.2	Fabricating Reinforcement	3-49
3.31.3	Fixing Reinforcement	3-49
3.31.4	Splicing and Lapping	3-50
3.32	Cover to reinforcement	3-50
3.33	Formwork	3-50
3.33.1	Definitions	3-50
3.33.2	Materials	3-50
3.33.3	Forms	3-51
3.33.4	False work and Centering	3-52
3.33.5	Forms for Joints	3-53
3.33.6	Release Agents	3-53
3.34	Removal of Formwork	3-53
3.35	Surface Finishes	3-54
3.35.1	General	3-54
3.35.2	Formed Surfaces	3-54
3.35.3	Unformed Surfaces	3-55
3.35.4	Surface Tolerances	3-55
3.36	Conduits, Box-outs and Apertures	3-56
3.37	Construction joints	3-57
3.38	Movement joints	3-57
3.39	Pre-cast Concrete Units(marker posts)	3-59
3.40	Breaking out Existing Concrete or Block work	3-59
3.41	Cement Grout	3-59
3.42	Cement Mortar	3-59
3.43	Concrete Block and Bricks Masonry	3-60
3.44	Rendering Work	3-61
3.44.1	Material	3-61
3.44.2	Waterproof cement mortar(intake/headworks)	3-61
3.44.3	Application	3-61

	3.45	In Situ Concrete Chambers	3-62
	3.46	Chamber Covers and Slabs	3-62
4	**STONEWORK**		**4-62**
	4.1	Stones	4-62
	4.2	Stone Masonry	4-63
	4.3	Types of Masonry	4-63
	4.4	Bedding of Stone Masonry	4-64
	4.5	Special Stonework	4-64
	4.6	Pointing of Joints in Masonry	4-64
	4.7	Hand Placed Rubble Filling	4-64
	4.8	Tipped Rock / Pitching	4-65
	4.9	Gabions	4-66
	4.10	Hardcore	4-67
5	**PIPEWORK**		**5-67**
	5.1	General	5-67
	5.2	Storage and Protection of Materials	5-68
	5.3	Handling Pipes and Fittings	5-68
	5.4	Cutting Pipes	5-69
	5.5	Pipes and Fittings	5-69
	5.5.1	Steel pipes	5-69
	5.5.2	PE Pipes (HDPE)	5-69
	5.6	Valves	5-70
	5.6.1	Gate valves	5-70
	5.6.2	Butterfly valves	5-70
	5.6.3	Check valves	5-70
	5.6.4	Float ball valves	5-70
	5.6.5	Painting of valves	5-70
	5.7	Laying Pipes in Trenches and Headings	5-70
	5.8	Pipes Laid on Natural Ground	5-71
	5.9	Pipes laid on Granular Bedding	5-72
	5.10	Pipes with Concrete Bedding and Surround	5-72

	5.11	Joints in Pipelines	5-72
	5.11.1	Steel pipes	5-72
	5.12	Connections to Existing Pipelines	5-73
	5.13	Pipes through Structures	5-73
	5.14	Pipelines within Concrete Structures	5-73
	5.15	Pipes under Roads	5-73
	5.16	Cleaning	5-74
	5.17	Pressure Testing of Pipelines	5-74
	5.18	Painting of Exposed Pipes and Fittings	5-74
	5.19	Maker Posts	5-75
6	**STEELWORK**		**6-75**
	6.1	General	6-75
	6.2	Bolts, nuts and fastenings	6-75
	6.3	Electrodes	6-75
	6.4	Contractor’s Shop Drawings	6-75
	6.5	Fabrication and Erection of Steelwork	6-76
	6.6	Welding	6-76
	6.7	Painting General	6-77
	6.8	Painting other steelwork	6-78
	6.9	Galvanising	6-78
	6.10	Gates	6-78
	6.11	Stop-logs	6-79
	6.12	Drainage Works	6-1
	6.12.1	Mitre Drains and Catch Water Drains	6-1
	6.12.2	Side Drains	6-1
	6.12.3	Cleaning of Existing Drains	6-1
	6.12.4	Repair of Existing Drains	6-1
7	**MATERIALS**		**7-1**
	7.1	Materials	7-1
	7.1.1	Submission of Samples	7-1
	7.1.2	Cement	7-2

7.1.3	Aggregates for Concrete	7-2
7.1.4	Sand for Mortar	7-3
7.1.5	Stone Dust	7-3
7.1.6	Murram	7-4
7.1.7	Water for Cement Treated Materials	7-4
7.1.8	Cement Mortar	7-4
7.1.9	Hydrated Lime	7-4
7.1.10	Calcium Chloride	7-4
7.1.11	Lime Mortar	7-4
7.1.12	Cement-Lime Mortar	7-4
7.1.13	Cement Grout	7-5
7.1.14	Concrete Building Blocks	7-5
7.1.15	Building Stone	7-5
7.1.16	Steel Reinforcement	7-5
7.1.17	Granular Material for Pipe Beddings	7-5
7.1.18	Concrete Pipes and Specials	7-5
7.1.19	Concrete Porous Pipes	7-6
7.1.20	Concrete Drain Invert Blocks	7-6
7.1.21	Concrete Slabs for Open Drains	7-6
7.1.22	Drainage Ditch Warning Posts	7-6
7.1.23	Agricultural Tiles and Pipes	7-6
7.1.24	Manhole Covers and Frames	7-6
7.1.25	Gully Gratings and Frames	7-6
7.1.26	Pre-cast Concrete Manholes and Inspection Chambers	7-7
7.1.27	Pre-cast Concrete Gullies	7-7
7.1.28	Manhole Step-irons	7-7
7.1.29	Timber	7-7
7.1.30	Aggregates for Surface Dressing	7-7
7.1.31	Dry Rubble Backing	7-7
7.1.32	Paint	7-7
7.2	Masonry and Block work	7-8
7.2.1	General	7-8
7.2.2	Workmanship	7-8
7.3	Walling	7-8
7.3.1	Materials	7-8
	(a) Cement	7-8
	(b) Lime	7-8
	(c) Sand	7-9
	(d) Water	7-9
	(e) Stone	7-9
7.3.2	Workmanship	7-10
	(a) Cement Mortar	7-10
	(b) Mixing of Mortar	7-10
	(c) General Construction	7-10
	(i) Setting out	7-10
	(ii) Building in Wood Frames	7-10
	(iii) Building in Metal Windows and Doors	7-11
	(iv) Walls to Receive Plaster & Similar Finishes	7-11
	(d) Building Walling	7-11
	(i) Laying and Jointing	7-11

	(ii)	Bonding	7-11
	(iii)	Tolerances	7-11
	(iv)	Curing	7-12
	(v)	Cavities	7-12
	(vi)	Backfilling	7-12
	(e)	Fair Face	7-12
	(f)	Pointing	7-12
7.4	Painting and Decorating		7-13
7.4.1	Materials		7-13
	(a)	Manufacturers	7-13
	(b)	General	7-13
	(c)	Emulsion paints	7-13
	(d)	Gloss paint	7-13
	(e)	Blucheuring paint	7-13
	(f)	Automotive paint	7-13
	(g)	Bituminous solution	7-14
	(h)	Traffic paint	7-14
	(i)	Lead based paints	7-14
	(j)	Clear finishes	7-14
	(k)	Varnish	7-14
	(l)	Primers and undercoats	7-14
	(m)	Knotting	7-14
	(n)	White spirit	7-14
	(o)	Timber stain	7-14
	(p)	Textured coating	7-14
	(q)	Stopping	7-15
	(r)	Fillers	7-15
7.4.2	Workmanship		7-15
	(a)	General	7-15
	(b)	Brushwork	7-16
	(c)	Stopping and filling	7-16
	(d)	Stirring	7-16
	(e)	Inspection	7-16
	(f)	Paint application	7-16
	(g)	Drying	7-17
	(h)	Un-primed woodwork	7-17
	(i)	Primed woodwork	7-17
	(j)	Plywood and block board	7-17
	(k)	Clear finished woodwork	7-17
	(l)	Bare metalwork	7-17
	(m)	Galvanized metalwork	7-17
	(n)	Primed metalwork	7-18
	(o)	Copper	7-18
	(p)	Brickwork, concrete etc.	7-18
	(q)	Colours	7-18
	(r)	Toxic wash	7-18
	(s)	Protection	7-18
	(t)	Damage	7-18
	(u)	Cleanliness	7-19
	(v)	Performance	7-19
	(w)	Packaging, delivery and storage	7-19

		(x) Vinyl emulsion paint	7-20
		(y) Gloss finish paint	7-20
		(z) Clear polyurethane varnish	7-20
		(aa) Textured Coating	7-20
	7.5	Painting	7-20
	7.5.1	General	7-20
	7.5.2	Block Work	7-21
	7.5.3	Metalwork	7-21
8	**SUPPLY OF PLANT AND WORKSHOP EQUIPMENT**		**8-22**
	8.1	General	8-22
	8.2	Workshop equipment to be supplied by the Contractor	8-22
	8.3	Operation and Maintenance of Plant and Equipment	8-23
9	**ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN**		**9-1**
	9.1	General	9-1
	9.1.1	Environmental Responsibility	9-1
	9.1.2	Updated Environmental Management Plan	9-1
	9.1.3	Method Statements	9-1
	9.2	Control of Construction Processes	9-2
	9.2.1	Supervision of Construction Activities	9-2
	9.2.2	Inspection of Other Operational Impacts	9-2
	9.2.3	Inspections by the Environmental Team	9-2
	9.2.4	Environmental Inspection and Reporting	9-3
	9.2.5	Environmental Monitoring	9-3
	9.2.6	Control of non-conformance	9-3
	9.2.7	Communication and Co-ordination	9-3
		(a) Monthly Project Environmental Review	9-3
	9.2.8	Environmental due diligence during construction	9-3
10	**CONSTRUCTION TOLERANCES**		**10-1**
	10.1	General	10-1
	10.1.1	Earthworks	10-1
	10.1.2	Concrete Structures	10-1
	10.1.3	Stonework	10-2
Appendix A	**Engineers office and Housing – floor areas**		
Appendix B	**Furniture for the Engineer's Office and Accomodation**		

1 GENERAL

1.1 General Description of the Works

The Works under this Contract comprise the construction, installation, testing, commissioning, and handover of a community-managed pressurised irrigation scheme designed to serve 320 beneficiary farmers. The scheme includes river abstraction, sediment control, pumped water conveyance, storage and water distribution

The Technical Specifications herein define the materials, workmanship, construction methods, installation procedures, testing requirements, and operational provisions necessary to execute the Works in accordance with the approved designs and Bills of Quantities. The Specifications focus on *how* the Works shall be carried out, rather than restating the scope of the Works.

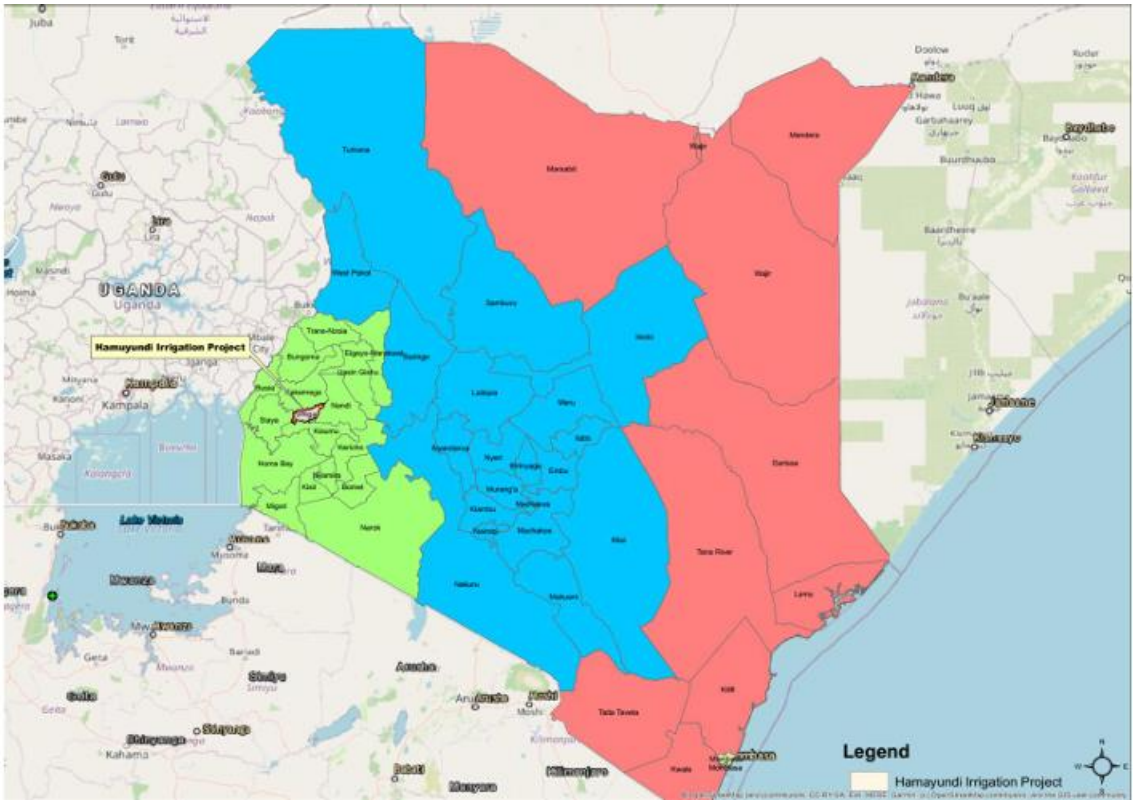
1.2 Location of the Works

Hamuyundi Irrigation Project is located in Hamuyundi Sub-location of West Sabatia Ward, Sabatia Constituency, Sabatia Sub County of Vihiga County. The proposed Headworks (Diversion Weir, Intake Structure etc.) situated on River Mwitumbui at GPS UTM Coordinates:

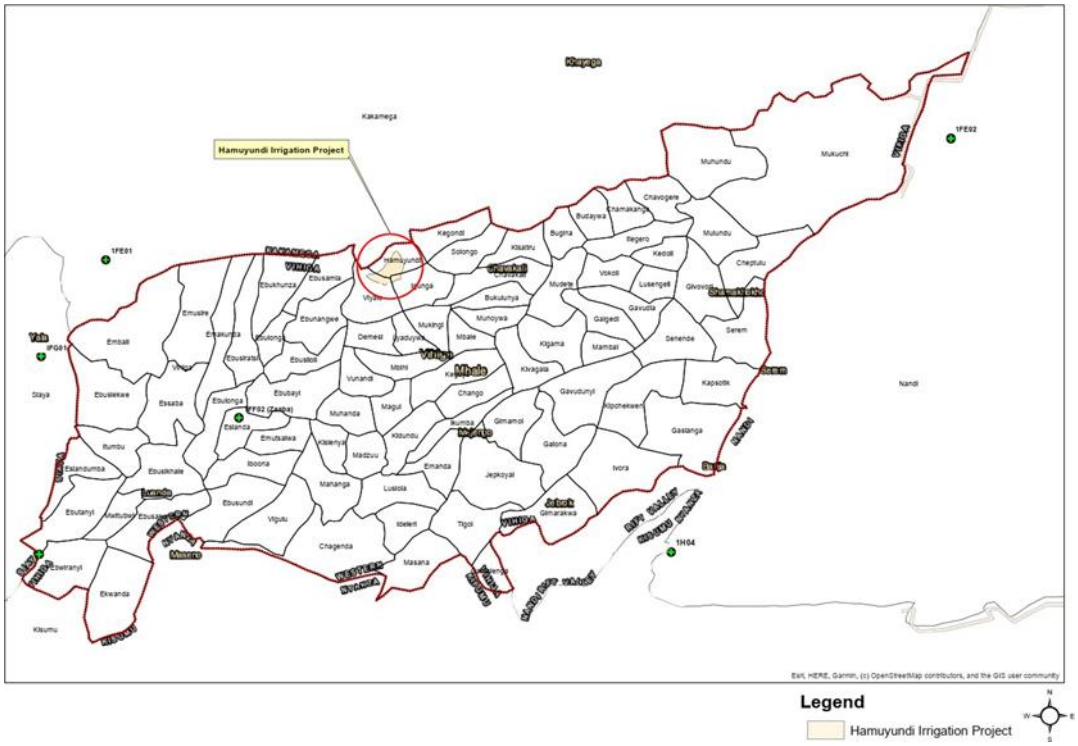
• Eastings – 688986.39m

• Northing – 14428.121m

The proposed irrigation areas lie between Latitudes 0° 7'53.14" and 0° 6'42.49" North and Longitude 34°41'3.27" and 34°42'3.76" East. The project areas straddle four (4) villages namely Hamuyundi to the right and Itemere, Lotenga and Selelwe to the left The proposed Headworks Site (Headworks, SB and Solar Pumping System) is approximately 6km North West of Sitendikisa Market (3km North East of Kilingiri Centre). The Tail-end of project is bounded by Sitendikisa – Kilingiri tarmac approximately about 1.7km from the Headworks. The project area can be accessed via Hamuyundi – Kaluni murram road off the Sitendikisa – Kilingiri Tarmac. There are a number of well-maintained murram roads running through/within the project area. The project location within the Country is as shown in Figures below.



Project location within Vihiga County



1.3 Climatic Conditions

Hamuyundi lies in the Upper Midland Agro-Ecological Zone (UM1), characterized by reliable rainfall averaging 1,600 mm annually, with two main rainy seasons (March–May and October–December). Temperatures range between 14°C and 27°C, while mean annual evapotranspiration exceeds rainfall for several months, making irrigation necessary to sustain crop production.

1.4 Drawings and Documents

The drawings listed in Part 2, Section VII of the Tender Documents and any modifications to those drawings and any other drawings that may be prepared by the Contractor and approved by the Engineer shall subsequently become the Contract Drawings.

For the purpose of carrying out the Contract, the Contractor will be provided with sets of the Contract Documents and full size (A2 & A3) Contract Drawings.

1.5 Drawings Designed by the Contractor

All drawings, calculations, plans, reports, instruction manuals, pamphlets, data and all other documents required to be submitted by the Contractor under the Contract shall be clear and readable. The Contractor shall submit these drawings and documents in a logical order to the Engineer for review or approval at least thirty (30) calendar days prior to execution of the Works.
All shop drawings, including field erection, layout and construction details shall be furnished by the Contractor for the approval of the Engineer.

All the drawings and calculation to substantiate the design shall be checked, signed and approved by the Contractor prior to submission. The drawings shall also be signed by a qualified engineer responsible for the design.

Approval of the drawings by the Engineer shall not be construed as a complete check but will indicate only that the general method and detailing is satisfactory. The approval by the Engineer shall not relieve the Contractor of the requirements of the Contract or responsibility for correct installation and assembly of parts in final position or responsibility for the adequacy of the method of construction.

All the cost thereof will be deemed to be included in the Contractor's unit rates and Contract Price.

1.6 “As Built” Drawings

Within sixty (60) days after the receipt of the Completion Certificate, the Contractor shall submit to the Engineer all the approved drawings and documents (including operation and maintenance manuals), clearly revised and brought up to date by the Contractor to show the permanent construction actually made. The submission shall be made in the following manner and quantity:

(a) One (1) set of the A1 size reproducible drawings on high quality polyester transparent film or similar material,
(b) One (1) bound set of reduced size, clearly photocopied drawings with hard cover (A3 size).

The submission shall contain the drawing index.
No separate payments will be made for the provision of the drawings as the cost thereof shall be deemed to be included in the unit rates and the Contract Price.

1.7 Standard Specifications

For convenience, and in order to establish the necessary standards of quality, reference will be made to specifications issued by national or other widely recognised bodies. Such specifications shall be referred to as “Standard Specifications” and shall be the latest editions of such Standard Specifications issued prior to the issue of Tender Documents, together with such additions and amendments as may have been issued prior to the same date.

Subject to the written approval of the Engineer, any other internationally accepted standard which requires an equal quality of work may be used.

In referring to Standard Specifications, the following abbreviations are used:

BS	British Standard
ISO	International Organisation for Standardisation
AASHTO	American Association of State Highways and Transportation Officials
ASTM	American Society for Testing and Materials
ASA	American Standards Association
KS	Kenya Standard
EN	Normalised European Standards

In cases where no particular Specification or Standard is given for any article or material to be used in the Contract the relevant Specification of the British Standards Institution or other relevant Standard shall apply unless otherwise stated. The latest version of the standards referred to shall be used where applicable.

If the Contractor proposes to use a Standard Specification other than that specified, three copies of the proposed Standard Specification, in the English Language, shall be submitted to the Engineer not less than 28 days before approval of the Standard Specification is required.

1.8 Site Meetings

The Contractor shall be obliged to attend all meetings at the appointed time. The discussions of such meetings shall include but not be limited to the progress of work and problems having direct bearing on the immediate and long term activities (construction, procurement, transport, labour etc.).
The Engineer shall invite the Employer for such meetings.

1.9 Progress Photographs

The Contractor shall furnish the Engineer with coloured photographs (not less 8 cm x 120 cm size) of the work in progress throughout the Contract period. The photographs shall be taken at the start, during and at the completion of each major task of the work as directed by the Engineer. A brief description and date of each photograph shall be included.

The Contractor shall make a soft copy of all the photos. This copy will be retained on the site and on completion of the Works the negatives shall become the property of the Employer.

1.10 Level Datum

The survey control points and bench marks shown on the drawings shall be handed over to the Contractor as basis for surveying and setting out of the Works. The Contractor shall be responsible for carrying out the field surveys for the performance of the Works.

Before using the control points and bench marks for setting out of the Works, the Contractor shall carry out a check survey thereon and satisfy himself as to their accuracy. The Employer shall bear no responsibility for the accuracy of any control point or bench mark.

The Contractor may establish additional temporary bench marks for his own convenience but each temporary bench mark shall be of a design and in a location approved by the Engineer and shall be accurate in relation to the bench marks established by the Engineer.

The Contractor shall protect the reference points and level bench marks and in the event of any damage he shall re-survey and re-establish the points and bench marks all to the satisfaction of the Engineer.

1.11 Setting Out

The Contractor shall appoint and employ the necessary qualified and experienced staff to set out the Works accurately. The Contractor shall establish and locate all lines and levels and be responsible for the correct location of all Works.

Where directed by the Engineer, the Contractor shall take such levels and dimensions as may be required for the purposes of measurements prior to disturbance of the ground. These shall be agreed between the Contractor and the Engineer in writing before any of the surface is disturbed or covered up.

1.12 Construction and Checking of Work

The Contractor shall be solely responsible for and shall provide all labour, tools, lifting tackle and other equipment required for the construction and checking of the Works.

No operatives shall be allowed to execute any type of work, which is normally carried out by a skilled tradesman, unless the operative is thoroughly experienced and proficient in the trade concerned. Supervisors and operatives may be required to demonstrate their proficiency or produce certificate of competence to the satisfaction of the Engineer.

As each part of the work is carried out it shall be subject to the approval by the Engineer.

1.13 Supervision and Labour

The Contractor will be required to maintain a competent supervising Site Agent and staff on site throughout the construction period until completion of the Works, and thereafter as may be required during the period of maintenance. The Engineer shall give prior approval to the appointment of this supervising Site Agent and shall have authority to withdraw this approval at any time in accordance with the Conditions of Contract.

All staff and labour employed on the Works shall be employed in accordance with the local labour and employment laws and regulations.

1.14 Works Executed by the Employer or by other Contractors

The Employer reserves the right to execute, on the site, works not included under this Contract and to employ for this purpose his/her own employees under this Contract, or an entirely separate contract. The Contractor shall ensure that neither his own operations nor trespass by his employees shall interfere with the operations of the Employer, employed on such works and the same obligations shall be imposed on the Employer or other contractors in respect of work being executed under this Contract.

1.15 Contractor’s Site Offices, Workshops, Storage and Working Areas

The Contractor shall establish the office, housing, workshop, stores, accommodation and camp for himself and his employees. In which case, the Contractor shall provide erect, service and maintain

all necessary buildings as offices, housing or workshop/stores for himself, his staff and his employees. These buildings shall form the time of their erection until the completion of the Contract is the property of the Employer and the Contractor shall not demolish or remove any buildings or part of any buildings without the written permission of the Engineer.
All huts, buildings, fixtures and fittings provided by the Contractor shall be removed and the site reinstated at the end of the Contract.

The location of all the offices, stores and the like shall be to the approval of the Engineer.
The Contractor shall be deemed to have included for the costs thereof in his Tender.

1.16 Definition and Use of the Site

1.16.1 Definition of the Site

The Site shall include all those areas of land which, being public or private:

(a) Are being provided by the Employer for the purpose of constructing the permanent works.

(b) Are being provided by the Employer or leased by the Contractor for Temporary Works, including camps, offices and stores.

(c) Are acquired, leased, or operated by the Contractor as borrow pits or spoil tips for the Permanent Works, including all access roads.

1.16.2 Use of the Site

The lands and other places outside the Site which are the property of or under the control of the Employer shall not be used except with the approval of the Engineer.

The Contractor shall at any time remove any vehicle or vessel or any other obstruction under his control that may be required to be removed by the Engineer for any purpose. The Contractor shall move such obstruction promptly on instruction being given.

The Contractor shall maintain access for the inspection, operation and maintenance of any of the Employer's plant or works which lies within the Site or elsewhere.

The Contractor shall not use any portion of the Site for any purpose not connected with the Works unless the written permission of the Engineer has been obtained.

Except with the written permission of the Employer, to be given when necessary for the execution of the Works, the Contractor's employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of other contractors or the Engineer. The Contractor shall warn his employees that any person found within such buildings or sites without authority is liable to be removed from the Works in accordance with the Conditions of Contract.

1.17 Possession of the Site

The Contractor shall restrict his activities to those areas of the Site adjacent to the works being executed and shall avoid any encroachment upon lands outside the areas for which possession has been given. Any trespass or damage or any claim arising from such encroachment shall be the Contractor's sole responsibility and he shall hold the Employer indemnified against all claims arising from such trespass or damage.

1.18 Interference with the Works

The Contractor shall not interfere in any way with any existing works, whether the property of the Employer or of a third party, whether or not the position of such works is indicated to the Contractor by the Engineer, except where such interference is specifically described as part of the Works, either in the Contract or in an instruction from the Engineer.

1.19 Material for the Works

All material shall comply with appropriate Standard Specifications unless otherwise required hereinafter.

The Contractor shall, before placing any order of materials, manufactured articles or machinery for incorporation in the Works, submit for the approval of the Engineer the names of the suppliers from whom he proposes to obtain such materials, manufactured articles or machinery, together with a list of the same, giving the origin, quality, weight, strength, description and other relevant details. No materials, manufactured articles or machinery shall be ordered or obtained from any suppliers which the Engineer has not approved in writing.

All materials shall be delivered to the Site a sufficient period of time before they are required for use in the Works, to enable the Engineer to take such samples as he may wish for testing and approval.

Notwithstanding the fact that approval has been given to the source of supply, the Engineer may forbid the use of any materials if, upon delivery, they are found to be defective, or he considers them unsuitable for incorporation in the Works. Such rejected materials shall be removed from the site forthwith.

The Contractor may propose alternative materials of equivalent quality to those specified, and subject to the approval, such materials may be used in the Works.

The Contractor shall have no claim against the Employer in respect of any financial loss which he may suffer as a result of the rejection of any such materials, and he shall also bear the cost of removing them from the Site.

The Engineer shall have the right to inspect materials and plant for the permanent works during the course of manufacture. The Contractor shall arrange for the right of access to manufacturing premises for the Engineer and his staff during normal working hours. The Engineer shall be given sufficient notice by the Contractor to allow him to observe the testing of any materials for the works at the place of manufacture. The Engineer shall also be given the opportunity to inspect any material or plant in their completed state prior to packing for transport to the site.

If requested by the Engineer, the Contractor shall provide to the Engineer copies of orders for the supply of goods or materials required in connection with the works.

1.20 Rejected Materials and Defective Work

Materials or work which, in the opinion of the Engineer, do not comply with the Specification, shall be classified as rejected materials or defective work, and shall be cut out and removed from the Works and replaced as directed by the Engineer.

1.21 Existing Works and Services

The Contractor shall acquaint himself with the positions of all existing works and services including water mains, storm water drains, cables, and service poles before any excavation are commenced.

The Contractor will be held responsible for any damage, however caused, in the course of the execution of the Works, to such existing works and services.

Such existing works and services, where exposed by the execution of the works, shall be properly shored, hung-up and supported to the satisfaction of the Engineer and of the authority concerned.

Poles supporting cables and the like adjacent to the Works shall be kept securely in place until the Works are completed and shall then be made as safe and permanent as before.

Notwithstanding the foregoing requirements and without lessening the Contractor's responsibility, the Contractor shall inform the Engineer immediately any existing works have been exposed and shall comply with any requirements of the authority concerned.

Only when and as directed by the Engineer shall the position of existing works or services be changed by the Contractor to meet the requirements of the proposed work.

The Contractor shall make adequate provision so that when carrying out his work, no interference, damage or pollution is caused to roads and footpaths, or to any mains, drains, and the like or other parts of the Works. Wherever loads have to be carried over ground in which pipes, valves, culverts, and the like are buried, the Contractor shall take all precautions including where necessary, the provision and use of sleeper roads, light gauge railways or other means to prevent damage occurring to such underground works. The Contractor shall not store any plant or materials or spoil heaps over existing water mains, or in such positions that interference with access to the mains, control gates and the like, is created. Approval by the Engineer to the means of protection employed shall not relieve the Contractor of any responsibility in respect of damage occasioned by his operations.

The laying of pipework, ducts, drains, and the like shall be arranged so as to cause as little interference as possible with the smooth operation of existing works.

When breaking out and making good existing structures, the Contractor shall disturb the existing structures as little as possible. All structures shall be made good with materials similar to those used in the existing works, or such materials which are considered by the Engineer to be of similar appearance and suitable in all other respects.

1.22 Existing Access

Existing access to lands, property and all other places shall be maintained by the Contractor during the continuance of the Works to the Engineer's satisfaction.

1.23 Liaison with Police and other Officials

The Contractor shall keep in close contact with the police and other officials in the areas concerned regarding their requirements for the control of workmen, movement of traffic, or other matters and shall provide all assistance and facilities which may be required by such officials in the execution of their duties.

1.24 Water and Power for Use on the Works

The Contractor shall be solely responsible for the location, procurement and maintenance of a water supply adequate in quality and quantity to meet his obligations under the Contract.

The Contractor shall be solely responsible for the location and continuity of the supply of water for use on the Works. Supplies may be derived from rivers and streams, but shall in all cases to be to the Engineer's approval, and the abstraction of water from any sources shall not interfere with any permanent water supply and be to the requirements and permitted by Water Resources Management Authority (WRMA). The Contractor shall be solely responsible for the transporting of water from its source to the point at which it is required for construction purposes, and in such quantities and quality as to enable the Works to proceed without hindrance due to the shortage of adequate water supplies.

The Contractor shall make his own arrangements for power supplies and shall be solely responsible for the location, procurement and maintenance of a power supply, adequate to meet his obligations under the Contract.

The Contractor shall make his own arrangements for the supply of adequate safe drinking water, electricity and other services to the Permanent Works, Temporary Works and plant and shall provide and maintain all pipes, cables and fittings which may be necessary to carry such services to his operations

1.25 Employer as a Supplier of Water and Power

The position of the Employer or his Agent as a supplier of water or power shall be identical with that of other suppliers, and quite separate from his position as Employer under the Contract. As in the case of a supplier, a failure on the part of the Employer or his Agent to supply water or power will not relieve the Contractor of any of his obligations under the Contract, nor, in respect of any such failure, shall the Contractor have any claim under the Contract against the Employer.

1.26 Inspection by Engineer during Period of Maintenance

The Engineer will give the Contractor due notice of his intention to carry out any inspection during the period of maintenance. The Contractor shall, upon receipt of such notice, arrange for responsible representatives to be present at the times and dates named by the Engineer. This representative shall render all necessary assistance and shall take note of all matters and things to which his attention is directed by the Engineer.

1.27 Site Offices

The Contractor shall maintain offices for the sole use by staff for the duration of the Contract in a position to be designated by the Engineer.

The offices shall be fully weatherproof. The exterior and interior faces of walls and ceilings shall be of approved finish. The offices shall be made dust, insect and vermin proof as far as possible.

The Contractor shall arrange, provide and pay, all charges in connection with water, electricity and telephone supplies to the offices.

1.28 Survey Instruments and Chainmen for the Engineer

The Contractor shall provide and maintain in first class working order, for the sole use of the Engineer and his staff for the duration of the Contract, the following minimum survey instruments complete with all accessories, tapes, poles, staves, stagings, moulds, templates, profiles, and requisites necessary for checking and setting out, and measurement of the Works. The equipment shall revert to the Contractor at the end of the Contract Period.

The survey equipment shall include those shown in Table 1.13 or similar approved as a minimum:

Table 1.13 Survey equipment

Description	Quantity
Automatic Level Machine	1
Tripod Stand	4
Leveling Staff	2
Total Station	1
RTK	1
Single Prism and Target	3
Plumbing Pole Tripod with Bubble	3
50m Measuring Tape	4

2m Pocket Tapes	4
Helmet	6
Life jackets	6
Dusk proof Mask	6

1.29 Material Testing

The Contractor shall organise for testing of all samples taken to a recognized laboratory approved by the Engineer. The Contractor shall allow for all the necessary labour and equipment necessary for the sampling and testing of the materials.

The existence of the laboratory shall in no way relieve the Contractor of the responsibility for carrying out his own tests in order to maintain the degree of control of quality hereinafter specified. These tests must however be approved by the engineer.

The Contractor is required to keep at the project site, the following minimum equipment at all times during the Contract period:

(a) Two (2) complete set of sieves of 200 mm or 300 mm diameter including cover, pan and brush;
(b) Two (2) pan type weighing scale complete with weights, to weigh up to ten kilograms (10kg) with sensitivity one gramme (1 g);
(c) Two (2) galvanized steel slump test cone apparatus complete with standard tamping rod and base plate;
(d) Six (6) steel 15cm cube moulds, complete with two (2) tamping rods, base plates and trowels;
(e) One (1) chemical balance to weigh up to two hundred and fifty grammes (250 g) with weight box and sensitivity of one tenth of a gramme (0.1 g);

All mechanical equipment's to be used for measurement or weighing shall be calibrated as required and calibration certification issued by the calibrating body.

1.30 Sign Boards

Before the erection of any sign boards or posters by the Contractor, the Contractor shall obtain the approval of the Employer and the Engineer to the size, location and wording of such sign boards or posters.

Unless otherwise agreed, the signboard shall be in three sections. Section One shall contain:

Name of Financing Governments

In white lettering on a blue background

The Second section shall bear the words:

Names of the Program and Project

In white lettering on a blue background

The Third section shall bear the words:

Contract name and number

In white lettering on a blue background

The Third section shall bear the words:

Name of the Financier

In white lettering on a blue background

The Fourth section shall bear the words:

Name of the Employer

In white lettering on a blue background

The Fifth section shall bear the words:

Name of the Implementing Agency

In white lettering on a blue background

The Sixth section shall bear the words:

Name of the Executing Agency

In white lettering on a blue background

The Seventh section (Contractors Board) shall bear the words:

Name of the Contractor

In white lettering on a blue background

The Eighth section shall bear the words:

Name of the Supervising Consultancy

In white lettering on a blue background

Further boards may be added with the names of sub-contractors.

Lettering on these boards shall be as directed by the Engineer

Further boards may be added with the names of sub-contractors.

1.31 Tracked Plant

The Contractor's tracked plant may not be run on any public or private road without the written permission of the owner or authority concerned.

1.32 Fuel Supplies

The Contractor shall arrange for obtaining, storing and distributing all fuel oils required for the completion of the Works. The storage of fuel on site shall comply with the Petroleum Act and Factories Act applicable in Kenya. Copies of this can be purchased by the Contractor at the Government Printers.

1.33 Telephone and Communications

The Contractor shall obtain suitable means of communications during the course of the Contract. The use of radio communications may be permitted but the Contractor shall be responsible for obtaining all the necessary permission and licences.

1.34 Preservation of Trees

No tree shall be removed without prior written permission of the Engineer who will limit the removal of trees to the minimum necessary to accommodate the Permanent Works.

If trees are removed or damaged by the Contractor or his employees, without approval, then the Contractor shall replace such trees.

Replacement of trees shall not be with seedlings less than two years of age, obtained from a reputable nursery and of a species approved by the Engineer. The Contractor shall plant, water and ensure that the replacement trees are properly established, all at his own costs.

1.35 Protection from Water

The Contractor shall keep the whole of the Works free from water and shall be deemed to have included in his Contract Sum all costs for pumping, shoring, temporary drains, sumps and other measures and provisions necessary for such purposes and for clearing away and making good to the satisfaction of the Engineer any damage caused thereby.

1.36 Protection against Fires

The Contractor is advised that, at all times, it is necessary to guard against fires starting within the Site or in the environs thereof, particularly as the result of the Works or from the actions of his employees. The Contractor shall have available, at all times, a trained fire-fighting team provided with adequate fire-fighting equipment and shall deal with all fires on the Site howsoever caused.

The Contractor shall be responsible for maintaining qualified fire fighting crew on the Site at all times as well as maintaining an efficient fire alarm system. The Contractor shall also submit a fire prevention and fire fighting program for the Engineer's approval.

The Contractor shall provide suitable and adequate fire fighting equipment, to the satisfaction of the Engineer, for ready use at all the times in all the Engineer's site establishment including Contractor's residential quarters, labour camps and ancillary buildings. These shall be maintained until the completion of the construction and handing over of the works to the Employer.

The Contractor shall comply with laws and regulations such as Occupational Health and Safety Act 2007 legislation and any other legislations and regulations regarding fires and with respect to the prevention of fires. No fire may be lit in the dry season without written permission from the Engineer and/ or the relevant Authority.

1.37 Safety Precautions

The Contractor shall adhere to the current legislative requirements from Factories Inspectorate, Ministry of Labour, in respect of the appointment of Safety Supervisors on Building and Works of Engineering Construction. In accordance with these requirements, the Contractor shall appoint a Safety Supervisor who shall be qualified in safety and familiar with the works being performed. The Safety Officer shall ensure that adequate measures and rules for the protection of health and safeguarding against accidents are enforced.

The Contractor shall take all necessary precautions against risks of loss of life or of injury to any person employed on the Works or to employees of the Employer and to the Engineer or to visitors or to persons having good and sufficient reasons to be about the Works, and to this end he shall properly safeguard the Works to the satisfaction of the Engineer and in accordance with the Occupational Health and Safety Act 2007 legislation and any other legislations that govern safety at construction sites in Kenya.

The Contractor shall at all times comply with any accident prevention regulations and any safety regulations peculiar to the various trades employed on the Works, and any safety regulations published by the Government.

The Contractor shall report promptly to the Engineer all accidents involving the death of or serious injury to any person on the Site or resulting from the Contractor's operations.

The Contractor shall, at his own expense, educate all his employees on safety precautions based on good practice on site. This shall be done in both English and Kiswahili languages. Safety instructions shall deal with all safety measures including but not be limited to the following;

protective clothing, helmets and footwear, use of lifting equipment, precautions against electrical shock, welding, routine procedures in case of accidents, fires, etc., watchmen, warning notices and barriers, use of drilling equipment and dust suppression and use and storage of explosive.

1.38 Explosives and Fuels

The Contractor shall make arrangements to transport, store and handle explosives and fuels in a safe manner for protecting the public in accordance with the laws and security regulations in force in the Republic of Kenya. In this regard, he shall submit a program to the Engineer for approval for the safe handling and storage of explosives and fuels. The programme shall be accompanied by material data sheets for each of the explosives and fuels. When approved, the Contractor shall issue a copy to each of his personnel involved with the handling of explosives and fuels.

The Contractor shall obtain all necessary licenses and shall pay all fees and charges in respect of the same as may be necessary for the purpose of moving explosives and fuels from place to place and storing the same, and shall make all applications and obtain approvals from the relevant authorities of the Government of Kenya.

The Contractor shall construct his explosives magazines at locations and in a manner complying with the relevant regulations of Kenya and approved by the Engineer. Detonators and fuse shall be stored in a separate magazine away from explosives. In no case shall they be transported in the same vehicle with explosives.

The Contractor shall provide adequate protective facilities to safely store and to prevent the loss or theft of explosives. Overnight storage of explosives and detonators outside of the magazines will not be permitted. Magazines shall be securely locked when not in use.

The Contractor shall maintain an inventory record of storage and withdrawal of all explosives including detonators. This record shall be available to the Engineer, and the Engineer shall be promptly notified of any loss or theft of explosives.

The Contractor shall supply and install sirens and loudspeakers systems, so that adequate warning may be given to all persons who may be endangered when explosives charges are to be fired. The Contractor shall ensure, prior to discharging explosives, that the area to be blasted is clear of all workmen, residents, pedestrians etc. in addition he shall post flagmen on each of the roads entering the said area so as to stop and prevent any traffic from entering into the area until “all clear” notification is given.

During thunderstorms and other electrical disturbances, no charging and firing will be permitted.

1.39 Watching, Fencing and Lighting

The Contractor shall employ competent watchmen to guard the Works both by day and night.

Any excavations, material dumps, spoil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and at night marked by red warning lights.

Fences shall consist of at least three 15 millimetres diameter hemp ropes or 4mm diameter wires, or more if required, stretched tightly between poles, and standards securely planted in solid ground, well clear of the excavation. The poles, and standards shall not be more than 15 metres apart, and where circumstances require, they shall be placed closer. Ropes or wires shall be stretched tight approximately 0.4 metres, 0.8 metres and 1.2 metres respectively above the ground. Banks of spoil may be accepted by the Engineer in lieu of fencing if of suitable height and form.

Fences and spoil banks shall be clearly marked at the ends, all corners, and along the length at intervals of not more than 15 metres by means of white limewashed boards, discs, stones or oil drums during the daytime and by red lamps burning at night. Markers shall be freshly limewashed at regular intervals to ensure that they are white and clean.

If a road is closed, or partly closed to traffic, temporary traffic and barricades shall be erected by the Contractor to the satisfaction of the Engineer and the police, or other relevant authority, to give proper warning to traffic and the public. Lettering on road signs shall be black on a yellow background and shall incorporate reflective material. The signs shall be adequately illuminated at night.

1.40 Soil Conservation

All precautions shall be taken by the Contractor to prevent the erosion of soil from any lands used or occupied by the Contractor for the purpose of the execution of the Temporary Works.

If in the opinion of the Engineer, the Contractor's operations in areas other than the permanent works caused soil erosion, the Contractor shall undertake soil conservation measures in these areas as directed by the Engineer. The details of the proposed soil conservation measures shall be submitted by the Contractor for the Engineer's approval prior to the execution of the said works.

All soil conservation measures shall be carried out at the earliest possible time, as approved by the Engineer, to ensure that the required protection is established most effectively during the progress of Works.

No separate payment will be made for the soil conservation measures and such costs shall be deemed to be included in the respective unit rates and the Contract Sum

1.41 Dust Abatement

During the performance of the work the Contractor shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance resulting from his operations. Measures shall include, but not be limited, to installation of dust suppression units on his rock drilling equipment, watering down of excavated material during loading operations, and use of water tankers to sprinkle access roads, disposal areas, etc.

The Contractor shall be held liable for any damage to crops, cultivated fields and dwellings of persons in the neighbourhood of the Works resulting from his operations.

In addition, the Contractor shall provide his employees, visitors or any other individual on site with personal protective equipment against dust at all times so that they are not exposed to the dust hazard.

No separate payment will be made for the dust abatement measures and the costs thereof shall be deemed to be included in the respective unit rates and the Contract Sum

1.42 Noise Control

All work shall be carried out without unreasonable noise. Compressors used on site shall be silenced either by using only full silenced models or fitted with effective exhaust silencers and properly lined and scaled acoustic covers all to the design of the manufacturers of the compressor or by the use of effective acoustic screens to enclose the noise source. Pneumatic percussion tools

used on Site shall be fitted with silencers of a type recommended by the manufacturers of the tools. Compressors, silencers or other equipment shall be maintained in good and efficient working order.

Additionally, where noise from the equipment cannot be minimised using silencers and other equipment related measures, the Contractor shall at all times provide the correct Personal protective equipment for the employees, visitors and any other person on site working within the noise range.

No separate payment will be made for noise suppression measures and the costs thereof shall be included in the unit rates and the Contract Sum.

1.43 Sanitation

The Contractor shall provide adequate sanitation and refuse collection and disposal facilities complying with state laws and local by-laws for all houses, offices, workshops, and the like, erected on the site, all to the satisfaction of the Engineer.

The toilet facilities provided at the site by the Contractor shall be made available, free of charge, to the employees of the Contractor and any of his subcontractors.

The Contractor shall warn his employees and sub-contractors that any employee found fouling the site shall be removed from the site immediately in accordance with the Conditions of Contract.

The Contractor shall remove all rubbish and to this end shall provide adequate number of covered garbage bins/containers placed at convenient points around the site establishments. The Contractor shall institute and maintain a regular garbage collection and disposal system. Garbage shall be disposed of by burning, by burial or by other means approved by the Engineer.

No separate payment will be made for such sanitary arrangements and all such costs will be deemed to be included in the unit rates and Contract Sum.

1.44 First Aid and Medical Services

The Contractor shall provide and maintain all equipment necessary to render first aid in case of accidents, snake bites or other emergencies according to Occupational Health and Safety Act 2007 legislations regarding workplace health and safety and any other relevant legislation. This equipment shall be kept in readiness at the sites of the works, at camps and wherever the Contractor's staff may regularly live and work. The Contractor shall ensure that there are persons available to all such places with knowledge of simple first aid procedures and able to administer snake bite treatment.

In addition, the Contractor shall provide at his own cost, training to the relevant employees on ways and means of preventing snake bites.

In general, the contractor shall be guided by the following,

- Where the number of workers exceeds 25 - provide a stretcher and a vehicle that can carry a person on a stretcher
- Where the number of workers exceeds 250 - provide first aid room with a qualified nurse to be on duty during all shifts.

Notwithstanding the minimum requirements prescribed above, the Contractor shall be responsible for the adequacy of all the arrangements made.

1.45 HIV/AIDS Awareness

The Contractor shall implement an HIV/AIDS awareness programme for his Personnel.

1.46 Pollution

During the execution of the Works, the Contractor shall ensure that no pollution of existing watercourses is allowed to take place as a result of his operations. The Contractor shall take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to persons or to property of the republic or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

1.47 Maintenance of Irrigation Water Supplies

The Contractor shall be responsible for maintaining perennial irrigation water supplies so that the supply may be used in any part of the command area at all times unless otherwise agreed in advance with the Irrigation Water Users Association and approved by the Engineer.

1.48 Restoration of Drains, Streams etc.

Subject to any requirement of the Works whereby a permanent change is to be effected, all drains, pipes, channels, water-courses or streams temporarily cut through or disturbed by the excavation of the Works are to be restored so that the water flowing in them may continue to flow in as full and free manner as it did before the disturbance.

1.49 Site Clearance

On completion of the Works, the Contractor shall clear the site and remove all temporary buildings, equipment and debris. The Contractor shall level off and grade all areas used for haul roads and all building, store and workshop areas. The whole of the site shall be left in a clean and tidy condition.

1.50 Units and Abbreviations

The units of measurement used in these Contract Documents are metric.

The following abbreviations have been used for units and for other words or phrases as indicated.

Abbreviations in the Contract Documents shall have the following meanings:

mm	millimetre
m	meter
km	kilometre
sq.m,m^2	square metre
ha	hectare
cu m,m^3	cubic metre
sec,s	second
hr	hour
min	minute
wk	week
l	litre
gm	gram
kg	kilogram
t	tonne
No	Number
nr	Number (in bill of quantities)
dia	diameter
max	maximum
min	minimum
AD	above datum (levels in metres)
ch	chainage (distance in metres)
eo	extra over
e	exceeding
ne	not exceeding
PQ	Provisional Quantity
PS	Provisional Sum
Do	Ditto
fob	free on board
cif	cost, insurance, freight
wt	weight
%	percent
mh	manhole
ic	inspection chamber
HYS	high yield steel
PCC	precast concrete
GMS	galvanised mild steel
DI	ductile iron
SV	sluice valve
ISO	International Standards Organisation
KS	Kenyan Standard
BS	British Standard
KES.	Kenya Shillings

2 EARTHWORKS

2.1 Site Clearance

Site clearance is defined as the clearing, grubbing, removal and disposal of all vegetation, grass, debris, bushes, dense bush, trees, hedges, undergrowth, stumps, roots, shrubs plants and backfilling of holes left by the removal of stumps and roots.

The widths and length over which site clearance is to be carried out shall be instructed by the Engineer. Site clearance over the area of quarries, borrow pits, stockpiles and spoil tips shall be carried out where instructed by the Engineer. The Engineer may give instructions that specific trees, stumps or objects shall not be removed during site clearance operation.

If termite moulds are excavated, the whole of the mould shall be removed.

Where the Engineer instructs that site clearance is required, the entire area shall be cleared and all materials thus cleared shall become the property of the Employer. Unless otherwise instructed, vegetation and perishable materials shall be disposed of by burning. Where material or debris cannot be burnt, it shall be carted to spoil areas, which spoil areas shall be provided in accordance with requirement of this Specification.

If the Contractor clears the Site in advance of the main Works such that the grass and other vegetation re-grows prior to the main Works commencing at any particular location then any additional, or repeating of, site clearance required shall be at the Contractor's expense.

When instructed by the Engineer, the Contractor shall demolish wholly or in part, remove and dispose of all buildings, foundations, structures, fences and any other obstructions which have not been designed to remain.

The Contractor shall carefully take down such buildings, structures; fences etc. and the components shall be dismantled, cleaned and stacked in separate heaps. All materials which, in the opinion of the Engineer, are not fit for re-use shall be removed from the site to spoil areas provided in accordance with the requirements of this Specification. All materials, which are re-usable, shall remain the property of the Employer and shall be preserved and protected by the Contractor until removed by the Employer or until the expiry of the Period of Maintenance.

All existing paths, fences, walls, hedges, trees, shrubs, lawn and other features which the Engineer instructs not to be removed or otherwise dealt with, shall be protected from the damage, and any damage which occurs due to the Contractor's failure to take adequate precautions shall be repaired at the Contractor's expense.

Site clearance shall be measured in square metre, calculated as the plan area instructed by the Engineer to be cleared. The rate for the site clearance shall include for the cost of complying with the requirements of Clauses 2.1, 2.13 and 2.14.

Stripping work shall basically consist of removal of top soil, grasses, vegetative material to a depth of 200 mm below ground level and its disposal to a stockpile. Stripping shall include for removal, stockpiling and for reinstatement or spreading as directed by the Engineer. Measurement and payment of this shall be in square metres, calculated as the plan area instructed by the Engineer.

2.2 Surface Levels

After the area of any section of the Works has been cleared and after trees have been felled, stumps removed and termite moulds excavated to the satisfaction of the Engineer, but before any other work is commenced, surface levels of the ground shall be taken. The levels shall be taken at spacings agreed with the Engineer. Levels shall similarly be taken on the surface of the ground after the removal of unsuitable overburden prior to placing fill and at the interface between natural ground, rock or artificial hard material layers. The levels shall be agreed with the Engineer. The Contractor shall prepare plans and sections which shall, when finally and mutually agreed, be signed by the Engineer and Contractor as truly representing the configurations of the areas in question at the commencement of excavation or fill construction.

2.3 Definition of Earthwork Materials

The following definitions of earthworks materials shall apply to this and other Clauses of the Specification in which reference is made to the defined materials:

(a) "Top soil" shall mean the top layer of soil that can support vegetation

(b) “Normal soil" shall mean the layer of soil rather than the top soil.

(c) "Suitable material" shall comprise all material which arises from excavations within the Site and which is approved by the Engineer as acceptable for use in the Works

(d) "Unsuitable material" shall mean material other than suitable material and shall comprise:

- Material from swamps, marshes and bogs
- Logs, stumps and perishable materials
- Material susceptible to spontaneous combustion
- Clay of liquid limit exceeding ninety (90) and/or plasticity index exceeding sixty five (65)

(e) "Rock" or "hard material

Rock or hard material shall be material which cannot be ripped to an average depth of greater than 300mm by a track type crawler tractor complying with the following:

- In good order complete with all equipment and accessories as supplied;
- Rated 300 BHP flywheel power or over;
- With an operating weight of not less than 37.2 tonnes;
- Equipped with a hydraulically operated single tine ripper compatible with the tractor used; and
- Operated by a qualified operator in accordance with the manufacturer's recommendations and to the satisfaction of the Engineer.

Where it is impractical to prove hard material by the above method then the quantity of hard material, if any, shall be determined by the Engineer.

Where excavation contains individual boulders of hard material greater than 0.3 m^3 each in volume then such boulders shall be classified as hard material.

(d) "Soft material" material shall mean all material other than that defined as "rock" or "hard material".
(e) Removal of Unsuitable Material

Where directed by the Engineer the Contractor shall remove unsuitable material to the depth as ordered or agreed with the Engineer and shall dispose of it in approved spoil tips.

2.4 Excavation General

Excavation shall be carried out with the allowances for working space given in the Method of Measurement to the Bill of Quantities, unless otherwise shown as lines, levels and profiles on the Drawings or to such other lines, levels and profiles as the Engineer may direct or approve in writing. The work shall be carried out by the Contractor in such a way as to avoid disturbance to the surrounding ground. Particular care shall be taken to maintain stability when excavating in close proximity to existing works.

The work shall be carried out in a careful manner to ensure that the exposed surfaces are as sound as the nature of the material permits and that no point shall protrude inside the lines shown on the Drawings except as otherwise specified or agreed by the Engineer. In soft excavation, which is to remain open permanently, exposed faces shall be formed accurately to the required slopes and profiles. Excavations in rock where the faces shall remain open permanently shall be trimmed so that no point protrudes within the required profile.

The Contractor shall examine all excavated faces regularly and shall remove all insecure material or materials resulting from any falls. Where instructed in writing by the Engineer, the Contractor shall wash down exposed surfaces of excavated rock for inspection.

The Contractor shall dispose of all material arising from excavations. If it is suitable and required for the Permanent Works it shall be placed directly in such Works or set aside for use as and when required in suitable approved dumps, otherwise it shall be removed to tips provided by the Contractor unless otherwise provided or directed by the Engineer.

The Contractor shall be responsible for keeping all excavations free from water from whatever cause arising and shall provide such pumping capacity and other measures as may be necessary for this purpose. The Contractor shall make good any damage that may result from his failure to keep the excavations free from water.

All excavation shall be carried out with care and the method and plant to be used in execution thereof shall be to the satisfaction of the Engineer. The Contractor shall be responsible for the safety and security of all excavations at all times during the execution of the contract and where necessary shall provide timbering, shoring or other measures required by the Engineer to prevent movement or loss of ground outside the boundaries, settlement of or damage to property, or injury to persons. The Contractor shall make good any damage to structures, services or other properties caused by such movement, loss of ground and settlement. The Contractor shall also take precautions to route his plant in such a manner as to minimise the likelihood of slips occurring due to vibration or surcharge from the working or movement of heavy machinery.

The Contractor will be permitted, subject to the approval of the Engineer, to adjust side slopes of excavations in soft materials which are to remain open temporarily in preference to shoring or strutting. However no payment shall be made for extra excavation volume as a result of these measures.

The Contractor shall notify the Engineer without delay of any permeable strata, fissures or unusual ground encountered during excavation.

2.5 Blasting

The Contractor shall not be permitted to use explosives for rock excavation without the approval of the Engineer. The Contractor shall only employ suitably qualified and experienced personnel to manage and supervise blasting operations. For each blasting operation, the Contractor shall submit to the Engineer for approval a statement detailing the type of explosives to be used, method of transport, storage, blasting procedures, safety precautions to be observed and the names and experience of the personnel who will supervise the work. Notwithstanding the Engineer's approval, the Contractor will be responsible for the blasting operations and shall accept full and absolute liability for any claims resulting either directly or indirectly from the use of explosives on the Site.

The blasting operations shall comply in every respect with the regulations and laws covering the use of explosives and the Contractor shall be responsible for obtaining all necessary permits.

2.6 Excavation Beyond Line or Level

If from any cause whatsoever excavations are carried out beyond their true line and level other than on the instructions of the Engineer, the Contractor shall make good to the required line and level with the appropriate grade of filling to be contained in the true excavation, or with concrete or other approved material in such a manner as the Engineer may direct. This shall be at the Contractor's expense.

2.7 Approval of Excavation

When excavations have been taken out accurately to the profiles or dimensions required for the work the Contractor shall inform the Engineer who shall carry out an inspection of the excavation. If, after his inspection the Engineer requires additional excavation to be carried out, the Contractor shall do so to such new profiles or dimensions as the Engineer may direct.

2.8 Excavation for Structures

Open excavation to form a foundation for a structure shall be carried out to the lines necessary to permit the proper construction of the structure to the approval of the Engineer.

Where a structure is to be founded on soft ground, the excavation shall be taken down until the required formation is exposed and prepared to the approval of the Engineer. Where concrete has

to be placed on a soft foundation, the Engineer may direct that a blinding layer of lean concrete be placed beneath the structural concrete immediately after completion and approval of the excavation, or require the Contractor to remove the last 100 mm of excavation immediately prior to placing the concrete. If foundation conditions are very soft the Engineer may instruct that additional material be excavated and replaced with compacted gravel or hardcore. Where a structure is required to be founded on rock but is not required to penetrate into it, all soft overburden shall be removed and the surface of the rock cleared of any loose material by barring and wedging. Where the foundation is required to penetrate into the rock, excavation of the rock may be carried out by blasting but in such a manner as to prevent the shattering of the rock which is to remain. The Engineer may direct that the last 300 mm of rock be left and be removed by barring and wedging or by the use of approved pneumatic tools so that the exposed surface is sound.

The Contractor shall report to the Engineer whenever excavations are ready to receive concrete. No concrete shall be placed in the foundations until the Contractor has obtained the Engineer's agreement that a secure foundation has been reached and that the excavation has been carried out to the lines and levels required.

2.9 Excavation for Fill Foundation

Foundations for embankments shall be excavated to the depths or to the soil or rock grade indicated on the Drawings or described in the Specification. The suitability of each part of the foundation for placing fill thereon shall be determined by the Engineer. No fill shall be placed before acceptance of the foundation by the Engineer and recording of the geology.

Where specified in the Drawings or Specification or directed by the Engineer, seams and other defects below the general level of the foundations shall be excavated and filled or covered with materials including mortar and concrete to the satisfaction of the Engineer before fill is placed thereon.

Where embankments are to be constructed on sloping ground, and where shown on the Drawings, benches shall be excavated in the foundations to the dimensions shown on the Drawings.

Except where specifically permitted by the Engineer all foundations for fill shall be kept free of water when placing fill thereon.

2.10 Trench Excavation

Trench excavation shall be performed by the use of hand tools and approved mechanical equipment, in such manner as to minimise disturbance of the sides and bottom of the excavation.

Trenches for pipes shall be excavated to a sufficient depth to enable the pipe and the specified joint, bedding, haunching and surround to be accommodated. Unless otherwise stated, the width of the trench shall be equal to the nominal diameter of the pipe plus 600 mm.

The Contractor shall fill any over excavation beneath the pipe or bedding at his own cost with well rammed selected general excavation material as per requirement of this Specification. The Contractor shall dispose of surplus excavated material not required for backfill to spoil tips.

The sides of trenches shall be adequately supported at all times. Alternatively where the Contractor has to excavate the trenches in open cut the Contractor shall ensure that the side slopes of the excavation are sufficient for stability.

Where rock or boulders are present in the sides or base of a trench in which a pipe is to be installed, the trench shall be trimmed so that when the pipeline is laid, no projection of rock comes within 200 mm of the outside of the pipe at any point. The over excavated portion shall be backfilled as set out in this Specification with approved granular material at the Contractor's expense.

The Contractor shall be entirely responsible for the sufficiency of all temporary supports and side slopes to the excavations. The excavation shall be carried out in such a way as to maintain the stability of all roads and other adjacent structures or works.

2.11 Channel Excavation

The excavation of all channels shall be executed in such a manner as to ensure that the stability of side slopes is not endangered. Should slips or undercutting occur for reasons attributable to the Contractor's negligence or method of working, the Engineer will give instructions for remedial works to be carried out by the Contractor at the expense of the Contractor.

Where channels are to be reshaped, cleared and trimmed, the width, depth, side slopes and centre line radius shall be as shown on the Drawings. The Contractor shall clear all weeds and growth from existing channels and grade the beds to required levels. The area of waterway shown is the minimum required and sides of channels shall be trimmed to the required slope so as to provide widths not less than those shown on the Drawings.

Any channels, streams, drains or pipes taking water to or from cultivated land shall be diverted so as to maintain their flow before being moved or broken into unless express permission to the contrary is given by the Engineer. All diversions and their subsequent reinstatement are to be carried out to the satisfaction of the Engineer. The Contractor shall be deemed to have included the cost of dealing with this in his rates.

Side banks of channels shall be trimmed to a neat appearance and even surface.

In the construction of channels and embankments a local balance of cut and fill shall be maintained as far as possible unless the cut is unsuitable material or is specified in the drawings that the fill should be imported. A deficiency of fill material shall be made up by bed borrow or gleaning. Surplus material, if suitable and approved by the Engineer may be used for an increased width of embankment otherwise it may be spread at the toe of the embankment or placed on spoil tips as directed by the Engineer.

Where required the Contractor shall control the rates of filling and draw-down of water in channels so as not to endanger the stability of earthworks.

2.12 Disposal of Excavated Material

Material obtained from excavations which are suitable for forming embankments or other fill areas shall be placed directly in the Works or set aside for use as and when required in suitable approved dumps. Any such suitable material which may be surplus to the total requirements of the Works shall be taken to spoil in tips provided by the Contractor, unless otherwise provided or permitted by the Engineer.

If the Contractor is permitted to remove suitable material from the site to suit his operational procedure or to take such material for purposes other than forming embankments or other fill areas, he shall make good any consequent deficit of filling arising there from, unless otherwise agreed by the Engineer.

All material not suitable for embankments or other filling shall, unless otherwise directed by the Engineer, be taken to separate spoil tips provided by the Contractor.

The cost of disposal of surplus or unsuitable materials shall be deemed to be included in the respective unit rates for the excavation work and the Contract Sum.

2.13 Spoil Tips

The Contractor shall be responsible for the provision and sufficiency of tips for the permanent disposal of spoil and shall select their location within the general areas as designated or approved by the Engineer. The Contractor shall submit his proposals for the locations and detailed treatment of tips to the Engineer for approval, which will in no way relieve the Contractor of his responsibilities and obligations under the Contract, whether or not locations are shown on the Drawings or otherwise designated.

No spoil shall be permanently deposited elsewhere than on approved spoil tips unless approved by the Engineer. Spoil tips shall be built up and compacted and trimmed and regulated to levels and profiles approved by the Engineer. Where directed by the Engineer, upper surfaces and slopes of the tips shall be soiled to specified thickness.

2.14 Borrow Pits and Quarries

Where there may be an insufficiency of suitable material from excavations for filling or is specified on the drawings, the Contractor shall obtain such material from borrow pits or quarries approved by the Engineer where the filling is required for Permanent Works. The Engineer may propose a borrow pit for exploration by the Contractor, however, it shall be entirely the responsibility of the Contractor to locate suitable sources of borrow material for fills.

The Contractor shall investigate the site or sites which they propose to open up and shall provide full and detailed information by means of boreholes, trial pit testing reports, etc. to satisfy the Engineer that the quality of the material meets Specification requirements and that the quantity is adequate for the Works.

Notwithstanding the foregoing, the Engineer shall have the right to order the Contractor to obtain materials from a particular designated source or by widening cuttings for permanent works beyond specified profiles.

The Contractor shall provide plant and equipment and make all other arrangements for excavating, loading and transporting material of the specified quality for completion of the Works in accordance with the agreed programme. These provisions shall include where necessary for any operations involving selection, stockpiling and rehandling of suitable material, the disposal of unsuitable material or overburden and any other operations which may be found necessary due to the nature and disposition of the excavated materials.

The pits and quarries shall be operated in a safe manner provided with ample drainage leaving no stagnant pools. On completion of the Works they shall be left free-draining and in a tidy and regular state. All loose material shall be barred down and no face shall be left overhanging except with the approval of the Engineer.

The removal of vegetation, topsoil and overburden at the borrow pits shall not be paid for separately. Contractor will be deemed to have allowed for the costs elsewhere in his rates. The same applies to any works required to access the borrow pits.
The rate for fill shall include for the supply, processing and compaction of material inclusive of extraction, loading and transportation to Site for a maximum haulage distance of 30 km, one way. Where suitable borrow pit is not available within this distance, overhaul will be paid for. Measurement shall be the product of the volume of compacted material in situ and the haulage distance in excess of 30 km, one way, along the shortest route, as determined by the Engineer. The Contractor shall be responsible for the maintenance of this selected route, at his own cost.

2.15 Earth Filling

Material for filling shall be obtained from approved sources and shall not contain more than 1% of vegetation matter, rubbish and humus material and shall contain no boulders or rock of a size greater than half the compacted thickness of the layer. No material shall be used which is so uniformly graded that D60 divided by D10 is 4 or less, where D60 and D10 are sizes such that 60% and 10% by width of the particles are finer than D60 and D10 respectively.

Unless otherwise specified the fill material for the canal and stilling basin embankments shall meet the following requirements:

(a) CBR after 4 days soaking compacted to 100% of AASHTO T99 at optimum moisture content of not more than 3%.

(b) Plasticity Index (PI) of not more than 40%.

(c) Permeability of less than 1×10^{-6} mm/s

Prior to commencement of filling, the Contractor shall submit in writing to the Engineer for approval his proposals for carrying out the work such that the optimum use may be made of excavated material as far as possible. The proposals shall include the compaction plant and methods for adjusting the moisture content of the material which he intends to use. No filling shall be carried out until the proposals and the material intended to be used are approved by the Engineer.

Fill shall be placed in layers not exceeding 150 mm compacted thickness, each layer being scarified and thoroughly compacted to obtain a dry density of not less than 95% of the maximum dry density as determined by AASHTO T99. The moisture content shall be adjusted as necessary to achieve the compaction standards. All silt or mud shall be removed from the base and sides of canals before

the commencing the filling. Fill on canal side slopes shall allow benching of a minimum 500mm width for each two successive 150mm compacted layers.

The Contractor shall take all necessary measures to prevent any damage or defects to the Works which may be caused by settlements, slips or falls of embankments and shall make good such damage or defects as may occur to the satisfaction of the Engineer, all at his own cost.

Any instability of any adjacent excavation resulting from the embankment not being formed to the lines, levels and profile shown in the Drawings or as ordered by the Engineer will be the responsibility of the Contractor. Where double - handling of excavated material is necessary, the Contractor will be responsible for the temporary disposition of the material such that it does not endanger the stability of the excavation.

2.16 Backfilling of Structural Excavations

Backfilling of structural excavations shall be carried out with excavated material selected or approved by the Engineer. The material shall be placed in layers not exceeding 150 mm compacted thickness or such other thickness as the Engineer may approve or direct and shall be compacted as specified in Clause 2.16.

When material is filled up to or over any structure, the filling shall be brought up equally on each side or as otherwise agreed by the Engineer so that no unequal pressures likely to cause damage to the structure are applied.

2.17 Frequency of Testing

Testing will be carried out as instructed by the Engineer with the following being the minimum testing frequencies:

- Field Dry Density Moisture Content Test. Every 500 square meters of compacted fill layer placed or at least 3 tests in any one length of compacted fill, whichever is greater.
- Particle Size Sieving Analysis, Atterberg Limits and AASHTO T180 test. Every 1000 cubic meters of compacted fill or at least 3 tests in any one length of compacted fill, whichever is greater.

The apparatus for these tests and the manner in which they are carried out will be as described in BS 1377/1990 and AASHTO T99. All results of these tests shall be submitted to the Engineer with the least possible delay.

2.18 Granular Bedding

Granular bedding material shall comply with BS 882 for aggregates within the sizes range 14 mm to 5 mm. Material complying with BS 882 except in respect of grading may be used provided that it has a maximum size not exceeding 14 mm.

2.19 Slopes and Batters

Where a slope is given in the Specification or on the Drawings as a ratio of vertical and horizontal components, it shall be understood that the first component is vertical in all cases e.g. a "slope of 1 in 2" will mean one vertical in two horizontal and a "batter of 4 to 1" will mean four vertical to one horizontal. This meaning will be attributed to all other terms such as "inclination" and "gradient".

2.20 Trial Pits

The Contractor shall excavate, maintain and afterwards refill any trial pits ordered by the Engineer. The sides of the pits shall, where deemed necessary by the Engineer for safety purposes, be supported by sheeting or boarding with adequate framing. A ladder shall be provided for inspection purposes.

3 CONCRETE

3.1 Concrete General

Concrete shall consist of cement, graded aggregate (coarse and fine) and water carefully proportioned, thoroughly mixed, placed and compacted as specified.

The Contractor shall obtain formal approval from the Engineer before pouring any concrete for the permanent works. The Engineer shall allow concreting after ascertaining the required lines and levels, suitability of formwork, availability of required plant and labour, proper fabrication and spacing of the steel bars and quality and quantity of cement and aggregates.

3.2 Cement

Cement for use in the permanent works shall be Ordinary portland Cement from an approved manufacture and shall comply with BS 12. Where sulphate-resisting cement is specified, it shall comply with BS.4027.

All cements shall be certified by the manufacturers as complying with the requirements of the specification. Before orders are placed the Contractor shall submit details of the proposed supplier(s) together with such information on the proposed methods of transport, storage and certification so that the Engineer may satisfy himself that the quantity and quality required can be supplied and maintained throughout the construction period. Where necessary the Engineer may require representative samples of the proposed cement to be taken and forwarded to a nominated laboratory for analysis and testing before the source is approved.

No cement shall be used in the Works until deemed satisfactory by the Engineer.

3.3 Supply of Cement

Cement shall be obtained from one manufacturer unless otherwise authorised by the Engineer. Should the use of cement from different manufacturers be authorised, the different supplies of cement shall be stored separately and shall not be mixed.

The Contractor shall supply to the Engineer copies of the manufacturer's test certificates certifying that each consignment of cement has been tested and analysed in accordance with Clause 3.5 of the specifications, and that the results comply in all respects with the above standards. Each certificate shall state clearly the date of despatch and the number of bags despatched in each consignment.

Bagged cement shall be delivered in sealed 50 kilogramme sacks. Each bag shall be marked with the parcel number of the cement contained. Bagged cement shall be transported so that at no time is it exposed to damp and so that moisture cannot be absorbed from the atmosphere. Cement in bulk shall be transported in totally enclosed water tight and sealed containers.

If cement is obtained from an intermediate agent, such agent's arrangements for transporting and storing cement shall be to the approval of the Engineer.

3.4 Storage of Cement

The Contractor shall provide sufficient storage capacity on Site to ensure that his anticipated programme of work is not interrupted due to lack of cement. Factors outside the Contractor's control such as transport, weather conditions, holidays and breakdowns shall be taken into account.

Cement delivered to the Site in bulk shall be stored in dry, well ventilated weather proof silos or bins which shall be self clearing. Cement delivered to the Site in bags shall be stored in dry, weather-proof sheds which shall have floors of damp proof construction raised at least 150 millimetres above the surrounding ground.

Cement of different consignments shall be stored separately and consignments shall be used in the same order as they are delivered to the site. No cement shall be stored on the site for longer than three months from the date of despatch by the manufacturer. If not used within that period, the cement shall be removed from the site.

Any bag of cement which is damaged or found to contain cement which has set or partly set, shall be discarded and not used in the permanent works.

3.5 Testing of Cement

Cement shall be tested by the manufacturer. If the manufacturer's test certificate is not made available, representative samples shall be taken from different bags or containers of each

consignment. They shall be suitably packed and sent to an approved laboratory for testing to prove the cement's compliance with the specified standards.

The Engineer may require cement to be tested after its delivery to the site. Any cement which has been in store at the site for longer than one month shall be re-tested.

The Engineer may take samples of cement from cement bins or bagged cement, from a parcel of cement after its delivery to the site, or from a parcel of cement which has been stored at the site for longer than one month.

In addition to the manufacturer's tests the Engineer may require the following tests to be carried out:

(a) Comprehensive strength on mortar cubes in accordance with Method 1 of Clause 6A of BS.12

(b) Soundness in accordance with Clause 9 of BS.12.

Any cement which fails to meet the specified requirements shall not be used in the Permanent Works.

3.6 Aggregate for Concrete

3.6.1 General

Aggregates for concrete shall comply with BS 822, and shall be obtained from a source or sources approved by the Engineer and shall be transported and stored in such a manner as will prevent:

(a) Contamination of the aggregates from the ground, rubbish, vegetation, dust or any other foreign material.

(b) Segregation.

(c) Intermixing of aggregates of differing characteristics.

Before aggregates from each source are approved for use in the Permanent Works, tests shall be carried out at an approved testing laboratory on representative samples submitted by the Contractor to check that the aggregates comply with the requirements of the Specification.

During concreting operations, tests shall be carried out to check that aggregates delivered for use in the Permanent Works comply with the requirements of the Specification.

Sampling and testing of aggregates for concrete shall be carried out in accordance with the requirements of BS 812 except where described otherwise.

Moisture contents of aggregates shall be determined as the moisture content of the aggregate compared with that of the aggregate in the saturated surface-dry condition. Specific gravities of aggregate shall be determined on aggregate in the saturated surface-dry condition.

Aggregates shall be stored on a clean, free draining surface. The various types and sizes of aggregates shall be kept separate from each other and each stockpile shall be kept as large as possible to maintain a reasonably uniform content in the aggregate.

3.6.2 Fine Aggregates

Fine aggregates shall be clean and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with BS 882. All the material shall pass through a 5 millimetre BS sieve and the grading shall be in accordance with Zones 1, 2 or 3 of BS 882. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source.

As an alternative, fine aggregate for mortar only shall comply with BS 1199 and 1200.

The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials unless the Contractor can show by tests on finished concrete as set out in BS 1881 that the presence of such materials does not adversely affect the properties of the concrete.

The proportion of clay, silt and other impurities passing a 75 microns BS sieve shall not exceed three per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand. The shell content shall not exceed 15 per cent by weight.

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in BS 812, subject to the further restriction given in the note on total chloride content in sub-clause 3.5.5.

Soundness: After five cycles of the test set out in ASTM C88-76, the aggregate shall not show a weight loss of more than 10 per cent.

Samples taken from the fine aggregate shall pass the colour test for organic impurities described in sub-clause 3.6.4.

Tests on fine aggregates shall be carried out daily or as required by the Engineer on site during concreting operations as follows:

(a) Sieve analysis

(b) Moisture content. An approved "rapid" test may be used for this test.

(c) Percentage of material passing a 75 microns BS sieve by the Field Settling Test, checked when necessary by the Decantation Method.

(d) Test for organic impurities as described in sub-clause 3.5.4.

The Contractor shall arrange to carry out the following tests when requested by the Engineer:

(e) Specific gravity and water absorption.

(f) Bulk density.

(g) Other tests described in BS 812.

3.6.3 Coarse Aggregates

Coarse aggregates shall be clean, hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of BS 882. The material shall be frost resistant and shall not contain any iron pyrites, iron oxides, flaky or laminated material, hollow shells, coals or other soft or porous material, or organic matter. The pieces shall be predominantly angular, rounded or irregular as defined in BS 812.

Coarse aggregate shall be supplied in the nominal sizes called for in the Contract and shall be graded in accordance with BS 882 for each nominal size.

The proportions of clay, silt and other impurities passing a 75 microns BS sieve shall be not more than one per cent by weight.

The content of hollow and flat shells shall not be such as will adversely affect the concrete quality when tested as set out in BS 1881. The total shell content shall not be more than the following:

40mm nominal size and above	2 per cent of dry weight
20mm nominal size	5 per cent of dry weight
10mm nominal size	15 per cent of dry weight

Chlorides soluble in a 10 percent solution by weight of nitric acid shall not exceed 0.03 per cent by weight, expressed as chloride ion when tested as set out in BS 812 but subject also to the further restriction on total chloride content given in sub-clause 3.5.5.

When tested in accordance with ASTM C289, the aggregate shall be non-reactive.

Soundness: After 5 cycles of the test set out in ASTM C88-76, the aggregate shall not show a weight loss of more than 12 per cent.

Flakiness Index: When tested in accordance with BS 812 shall be as set out hereunder:

40mm nominal size and above	Not more than 40
20mm nominal size and below	Not more than 34

If the flakiness index of the coarse aggregate varies more than five units from the average value of the aggregate used in the approved trial mix, a new set of trial mixes shall be carried out in the workability of the mixes have been adversely affected by such variation.

Impact Value: Not more than 45 per cent when tested in accordance with BS 812.

Ten per cent fines value: Not less than 50 kilonewtons when tested in accordance with BS 812.

Shrinkage: When mixed with other ingredients in the approved proportions for concrete and tested as set out in BS 1881, the shrinkage factor shall not exceed 0.05 per cent.

Water absorption: The aggregate shall not have a water absorption of more than 2.5 per cent when tested as described in BS 812.

Tests on coarse aggregate shall be carried out daily or as required by the Engineer on site during concreting operations as follows:

(a) Sieve analysis

(b) Moisture content: An approved "rapid" test may be used for this test.

(c) Percentage of materials passing a 75 microns BS sieve by the Field Settling Test, checked when necessary by the Decantation Method.

The Contractor shall arrange to carry out the following tests when requested by the Engineer:

(d) Determination of flakiness index.

(e) Specific gravity and water absorption.

(f) Determination of "ten per cent fines" and of Los Angeles Abrasion.

(g) Other tests described in BS 812.

3.6.4 Test for Organic Impurities

Aggregates shall be tested for organic impurities by means of discoloration of a sodium hydroxide solution as follows:

A 340 millilitres graduated prescribed bottle shall be filled to the 123 millilitres mark with a sample of the aggregate to be tested. A 3 per cent solution of sodium hydroxide in water shall be added until the volume of the aggregate and liquid after shaking gives a total volume of 194 millilitres. The bottle shall be stoppered, shaken thoroughly and allowed to stand for 24 hours. Should the liquid then be darker than the standard colour solution the aggregate shall not be used for making concrete.

The standard colour solution shall be prepared in a 340 millilitres prescription bottle as follows:

2.5 millilitres of a 2 per cent solution of tannic acid in 10 per cent alcohol shall be added to 97.5 millilitres of a 3 per cent solution of sodium hydroxide in water. The mixture shall be shaken and allowed to stand for 24 hours.

A glass of the standard colour may be used in place of the standard solution.

3.6.5 Total Chloride and Sulphate Contents

The total chloride content arising from all ingredients in a mix, expressed as chloride ions as a percentage of the weight of cement in a mix, shall not exceed 0.5 per cent in any one sample nor 0.3 per cent in 95 per cent of the samples tested. For pre-stressed concrete, steam cured concrete or concrete containing sulphate resisting cement or super sulphated cement, the total chloride content shall not exceed 0.5 per cent of the weight of cement in the mix.

The total sulphate content arising from all ingredients in a mix shall not exceed 0.4 per cent by weight of the aggregates or 4 per cent of the weight of cement in the mix, whichever is less. For this purpose the sulphate contents shall be expressed as SO_3 and shall be calculated form the sulphate contents of the cement, aggregates and any admixtures. Where applicable, sulphate contents shall be determined in accordance with tests described in BS 1047 and 3892.

Pulverised fuel ash shall not be used in conjunction with a cement complying with the requirements of BS 4027 in concrete required to be resistant to sulphates.

3.7 Admixtures

Admixtures for improving workability, accelerating or retarding setting of concrete, or for any other purpose, shall only be used with the Engineer's written approval. Calcium chloride or admixture containing chlorides will, however, not be approved. The Contractor shall submit samples of the

admixtures he proposes to use to the Engineer for testing. If an admixture is approved for use it shall be obtained from an approved supplier and the Contractor's arrangement for measuring, mixing and adding the admixture to the concrete batch shall be strictly in accordance with the manufacturer's instructions or recommendations and subject to the approval of the Engineer.

The proportions of the concrete mixes and water/cement ratio shall be adjusted to the satisfaction of the Engineer so that the strength of the concrete with admixture is at least equal to the strength of the equivalent concrete without admixture.

3.8 Water for Concrete

Clean fresh water is to be used for the mixing of all concrete and mortar, and is to be from a source approved by the Engineer. If required by the Engineer, samples shall be taken from the proposed source of supply and submitted to a nominated laboratory for testing in accordance with BS 3148, "Methods of test for water for making concrete" and on the results of these tests the Engineer will decide whether the source is acceptable.

3.9 Concrete Mixes

The design of concrete mixes shall be the sole responsibility of the Contractor, but may be undertaken in conjunction with the Engineer. Concrete mixes shall be designed mixes in accordance with the requirements of BS 5328 having the characteristics specified in Table 3.1 of this Specification. Concrete for use in water retaining structures shall comply with BS 8007.

Evidence shall be submitted to the Engineer, for all classes of concrete to be used, showing that at the intended workability the proposed mix proportions and production methods will produce concrete of the required quality.

The following information shall be provided before any designed mix is supplied:

(a) Nature and source of each material.

(b) Full details of tests on trial mixes including workability.

(c) Proposed quantities of each ingredient for one cubic metre of fully compacted concrete.

No change in the approved mix design will be permitted, unless the Contractor carries out trials on the proposed mix design to show that compliance with this Specification can be maintained.

Mix design shall in all cases be subject to the approval of the Engineer, but such approval shall in no way relieve the Contractor of his responsibility for the design and production of concrete in compliance with this Specification.

3.10 Trial Mixes

At least six (6) weeks before commencing the placing of any concrete in the works, trial mixes shall be prepared for each class of concrete to be used on the works. Three (3) batches of each class of concrete shall be made using materials typical of the proposed supply and under full scale production conditions.

The workability of each of the trial batches shall be determined and three (3) cubes made from each batch for testing at 28 days. A further three (3) cubes made from each batch may be made for tests at an earlier age if required.

The trial mix proportions shall be approved if the average compressive strength of the nine (9) cubes tested at 28 days exceeds the specified characteristic strength by 3 Newtons per square millimetre, or if nine tests at an earlier age indicate that it is likely to be exceeded by this amount.

To demonstrate that the maximum free water/cement ratio is not exceeded, two batches of concrete shall be made in a laboratory with cement and surface-dry aggregate known from past records of the supplier of the material to be typical. The proposed mix proportions will not be accepted unless both batches have the cement content specified and free water/cement ratio below the maximum specified in Table 3.1.

Table 3.1 - Classes of Concrete

Class	Characteristic Compressive Strength N/mm^2	Maximum Free Water/cement Ratio	Minimum Cement Content kg/m^3	Maximum Cement Content kg/m^3	Maximum Aggregate Size mm
C25/10/A	25	0.55	360	400	10
C25/20/A	25	0.55	360	400	20
C25/20/B	25	0.55	290	400	20
C25/20/C	25	-	240	540	20
C20/20/B	20	0.55	290	400	20
C20/40/B	20	0.55	260	400	40
C20/40/C	20	-	220	540	40
C15/40/C	15	-	180	540	40
C15/20/C	15	-	180	540	20
C10/40/C	10	-	150	540	40

A, B and C denote exposure conditions for the finished concrete as defined in BS 8007.

3.11 Testing of Concrete

3.11.1 General

All concrete shall be sampled and tested in accordance with the requirements of BS 1881 unless otherwise stated in this Specification or instructed by the Engineer.

The Contractor shall allow for all the necessary labour, materials, plant and equipment necessary for the regular sampling and testing of concrete to be placed in the Works.

3.11.2 Cement Content

Tests shall be carried out as required by the Engineer to determine the cement content of the mix. The cement content of any batch of concrete shall not be less than the specified minimum value minus 5 per cent of that value nor more than the specified maximum value plus 5 per cent of that value.

3.11.3 Workability

The workability of the concrete shall be measured as required by the Engineer by slump tests or compaction factor tests and shall be within the following limits:

Slump	±	25mm or ± one third of required value whichever is greater.
Compacting	±	0.03 where required value is 0.90 or more
Factor	±	0.04 where required value is 0.90 to 0.80
	±	0.05 where required value is 0.80 or less

The required value shall be that which has been accepted under Clause 3.8 of this Specification.

3.11.4 Water/Cement Ratio

The water/cement ratio shall be determined as required by the Engineer and shall not exceed the specified maximum value by more than 5 per cent of that value.

3.11.5 Compressive Strength

Samples of concrete shall be taken for compressive strength at a rate of one sample per 15 cubic metres of concrete placed or 15 batches of concrete placed whichever is the lesser volume. A greater frequency of sampling may be instructed by the Engineer until compliance with specified strength requirements has been confirmed for each class of concrete used in the Works.

Two test specimens shall be prepared from each sample and shall be cured for 28 days, or by any other method approved by the Engineer that enables the prediction of 28 day strength at an earlier time.

On completion of curing, the two test specimens shall be tested. Provided the difference between the two results does not exceed 14 per cent of the mean of the two results, the mean shall be taken as the test result. Where the difference between the two results exceeds 14 per cent of their mean, the lower of the two results shall be taken as the test result.

Compliance with the specified strength may be assumed if the conditions given in both (a) and (b) below are satisfied.

(a) The average compressive strength determined from any one group of four consecutive 28 day test results exceeds the specified characteristic strength by not less than 3 Newtons per square millimetre for classes of concrete C20, C25 and C30 and not less than 2 Newtons per square millimetre for class C15 concrete.

(b) Each individual 28 day test results is greater than the specified characteristic strength minus 3 Newtons per square millimetre for classes of concrete C20, C25 and C30 or 2 Newtons per square millimetre for class C15 concrete.

If only one tests result fails to meet the second requirement then that result may be considered to represent only the particular batch of concrete from which that sample was taken provided the average strength of the group satisfies the first requirement.

If more than one result in a group fails to meet the second requirement or if the average strength of any group of four consecutive test results fails to meet the first requirement, then all the concrete in all the batches represented by all such results shall be deemed not to comply with the strength requirements. For the purposes of this Clause, the batches of concrete represented by a group of four consecutive test results shall include the batches from which samples were taken to make the first and the last tests in the group of four, together with all the intervening batches.

3.12 Failure to Comply with Specified Requirements

Failure of concrete to comply with the specified requirements will result in it being classified as defective work. Immediately on notification by the Engineer that concrete work is defective, the Contractor shall take all measures necessary to improve concrete quality before further concrete is placed in the Works. If required by the Engineer, the rate of sampling of concrete shall be increased until adequate control is again established. Tests shall be carried out on the defective concrete or test cores taken from it to establish its in-situ strength. If the results of these tests satisfy the Engineer that the defective concrete will fulfil its design function then it may be accepted. If not, the Contractor shall propose strengthening or remedial work where possible or shall remove the defective concrete from the Works.

3.13 Concrete Returns and Records

The Contractor shall send weekly to the Engineer a return showing the quantities of cement and the number of mixings of each class of concrete used in each section of the Works.

Records shall be kept by the Contractor of the positions in the Works of all batches of concrete, of their class and of all test cubes or other specimens taken from them. Copies of these records shall be supplied to the Engineer.

3.14 Plant, Equipment and Construction Procedure

The design, layout, installation and operation of plant and equipment for processing, handling, transporting, storing and proportioning concrete ingredients and for mixing, transporting and placing concrete shall be to the satisfaction of the Engineer. Before the plant and equipment is ordered or delivered to site, the Contractor shall submit to the Engineer drawings showing the proposed arrangements of the plant together with detailed descriptions of the equipment proposed

3.15 Batching

The aggregates and cement shall be proportioned by means of efficient weigh batching machines except when the Engineer has approved the use of volume batching. The machines shall be carefully maintained and cleaned and they shall be provided with simple and convenient means of checking the accuracy of the weighing mechanism, and they shall be checked when required by the Engineer.

For volume batching suitable gauge boxes shall be used.

3.16 Mixing Concrete by Machine

Where the concrete is to be mixed in machines, these shall be of the batch mixing or other approved type. The machines shall ensure that all the concreting materials including the water are thoroughly mixed together before any portion of the mixture is discharged. The mixing time shall not be less than thirty seconds per cubic foot (30sec/cft) of concrete, with a minimum of three minutes (3min) mixing time per batch. The machines must be capable of discharging their contents while running.

3.17 Mixing Concrete by Hand

Where it is not possible to employ machine mixing and approval has been obtained from the Engineer, concrete shall be mixed by hand as near as practicable to the site where it is to be deposited. Clean mixing bankers or platforms of sufficient area for the proper execution of the work shall be provided. These platforms if constructed of timber shall consist of planks closely jointed so as to avoid the loss of any grout or liquid from the wet concrete. The whole of the aggregate and cement shall be turned over on the banker in a dry state at least twice. The water shall then be added gradually through a rose head, after which the materials shall again be entirely turned over in a wet state at least three times.

3.18 Preparation of Surface to Receive Concrete

Foundations which are to receive concrete shall be properly drained and dewatered so that no water runs over or stands on a surface on which concrete is being placed. If required by the Engineer drains provided through or beneath concrete for the temporary conveyance of water shall afterwards be completely sealed to the Engineer's approval.

Before deposition of concrete against rock, the rock surface shall be thoroughly wetted and cleaned by the application of water, or of water and air, under pressure. No concrete shall be deposited until the surface has been cleaned and passed as satisfactory by the Engineer.

Faults or seams in the rock shall be cleaned to a depth satisfactory to the Engineer and if necessary stemmed with cement mortar of an approved mix.

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

3.19 Authority to Commence Placing of Concrete

The Contractor shall give the Engineer at least 24 hours' notice of his intention to place concrete in a particular section of the Works. Before concrete is placed the Contractor shall apply to the Engineer for approval of the cleanliness, alignment and suitability of surfaces against which the new concrete is to be placed and of the fixing of formwork, reinforcement, embedded parts and the like and he shall obtain written permission from the Engineer to proceed with concreting.

The Contractor shall carefully plan his concreting operation to ensure, where possible, that these operations are completed within the normal working day.

3.20 Dimension of Concrete Pours and Programme of Placing

Unless otherwise approved by the Engineer concrete shall be cast in one operation between external faces of concrete and joints shown on the Drawings or between construction joints or both.

The Contractor shall submit and obtain the Engineer's approval to a detailed concreting programme and his proposals for the location of construction joints.

3.21 Transport and Deposition of Concrete

Concrete shall be transported and deposited in such manner as to prevent segregation, loss of materials or contamination with foreign matter. The means of transport of concrete shall be subject to the approval of the Engineer. The containers for conveying the concrete shall be thoroughly cleaned immediately after use and sides dampened before work is started or restarted to prevent cement and fine material in the first batch adhering to the sides. Adequate precautions shall be taken to protect the concrete against wetting or drying out through exposure to the weather and to prevent segregation and consolidation of the mix due to prolonged jolting of the concrete. Concrete shall be placed in its final position and fully compacted before the onset of initial set. Wherever possible, concrete shall be deposited vertically in the final position required and shall not be dropped through a greater height than 1.5 m. Where necessary, bins, drop chutes, down pipes or baffles shall be provided to prevent segregation of the material. Drying out of fresh concrete before deposition shall be prevented by the provision where necessary of suitable covers. Loss of slump during transport and deposition of the concrete shall not exceed 25 millimetres.

Concrete shall not be placed in standing or running water unless so specified. Where concrete has to be placed under water, the Contractor shall submit to the Engineer his proposals indicating the methods and equipment to be employed. The concrete shall be deposited by bottom discharging watertight containers or through funnel shaped tremies which are kept continuously full with concrete up to a level above the water and which shall have the discharging bottoms immersed in the concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation and additional cement of about 25% must be added.

3.22 Distribution and Spreading of Concrete

Concrete shall be placed in layers not exceeding 500 millimetres in depth approximately parallel to the horizontal or inclined construction joint planes. These layers shall be deposited from one face to the other until the full height of the lift is reached. Each layer shall be deposited on the previous one before the latter has taken its initial set and the exposed area of fresh concrete shall be maintained to the practical minimum. In order to accomplish this timing a new layer may be started before the previous layer is completed.

The face from which placing of concrete is to commence shall be selected so that if an emergency should occur which prevents the layer being completed the vertical construction joint will be formed in a structurally acceptable position.

Concrete shall not be placed during rain sufficiently heavy or prolonged to wash mortar form coarse aggregate on the exposed sloping faces of fresh concrete unless adequate shelter is provided.

Concrete shall not be placed against any surface (including formwork, reinforcement, embedded steelwork, adjacent concrete or rock) which during hot weather is not adequately dampened to prevent excessive absorption of water from the fresh concrete.

Once commenced, concreting shall be carried on as continuous operation between pre-arranged construction, expansion or contraction joints save only if an emergency occurs and interruption is unavoidable. The Contractor shall have readily available suitable prefabricated formwork for stop ends to form emergency vertical construction joints and, in the event of such an interruption occurring, the concrete already placed shall be properly finished up to the stop end and to a horizontal or inclined surface as directed by the Engineer. In water retaining structures the Contractor shall propose methods of making the joint watertight.

Concrete shall be placed carefully so as not to displace the formwork or reinforcement.

3.23 Compaction of Concrete

The Contractor shall thoroughly compact all concrete immediately after it has been placed in position. Unless otherwise authorised by the Engineer, compaction shall be accomplished with the aid of immersion vibrators as specified below, together, if necessary, with rods, shovels and the like. Particular care shall be taken to fill all voids and to work the concrete against rock and existing concrete surfaces, round any reinforcement and embedded fixtures and into the corners of the formwork.

If the Contractor does not wish to use immersion vibrators for any portion of the works he shall submit his proposals for alternative vibrators or compaction equipment and shall receive the Engineer's approval to the equipment before commencing to concrete the portion concerned.

Vibrators shall be of a type and size adequate for the portion placed. Vibrators shall operate at a frequency of between 7000 and 10000 impulses per minute. The Contractor shall ensure that vibrators are operated at pressures and voltages not less than those recommended by the manufacturer in order to ensure that the compactive effort is not reduced.

A sufficient number of vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period and in addition stand-by vibrators shall be available for instant use at each concreting place. The length and diameter of the vibrating element of immersion vibrators shall be sufficient to penetrate through the layer of concrete being placed and re-vibrate the upper portion of the underlying layer of concrete.
Only men experienced in the use of vibrators shall be employed on this type of work.

Vibration shall be continued at each point until the concrete ceases to contract, a thin layer of mortar has appeared on the surface and air bubbles have ceased to appear. The period of vibration necessary shall be determined by trial in the presence of the Engineer. Vibration shall then be continued for this period at each point before any further concrete is superimposed.

Immersion vibrators shall be inserted vertically to penetrate into the layer underneath at regular intervals, which shall not exceed the distance from the element over which vibration is visibly effective and in any case shall not exceed 700 millimetres. Vibrators shall not be used to move concrete laterally and shall be withdrawn slowly to prevent the formation of voids. Vibrators shall not be applied to reinforcement or other embedded items.

3.24 Protection of Concrete

Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from this cause.

No traffic shall be allowed on any concrete surface until such time as it is hard enough to resist damage by such traffic.

Concrete placed in the Permanent Works shall not be subjected to any structural loading until it has attained at least its nominal strength.

If the Contractor desires to impose structural loads on newly placed concrete, he shall make at least three test cubes and cure them in the same conditions as the concrete they represent. These cubes shall be tested singly at suitable intervals in order to estimate the time at which the nominal strength is reached.

3.25 No Partially Set Concrete shall be used

All concrete must be placed and compacted in its final position within thirty minutes (30min) of discharge from the mixer unless otherwise approved. No partially set material shall be used in this work.

3.26 Plum Concrete

Plums shall be hard clean natural stones embedded in mass concrete during the placing of the concrete. Unless otherwise shown on the drawings, the plums shall not be larger than one third of the cross section of the concrete and should not be placed closer than 150 mm to each other vertically and 100mm horizontally. The volume of plums shall unless otherwise specified, not

exceed forty per cent (40%) of the mass concrete volume and care shall be taken to ensure that the minimum cover over any plums is 100mm.

3.27 Concreting in Adverse Weather

No concreting will be allowed to take place in the open during storms or heavy rains. Where strong winds are likely to be experienced additional precautions to ensure protection from driving rain and dust shall also be taken.

The Engineer may withhold approval of commencement of concreting until he is satisfied that full and adequate arrangements have been made.

3.28 Concreting at Night or in the Dark

In general, concrete works will not be permitted to be carried out at night.

Where approval has been given to carry out concreting operations at night or in places where daylight is excluded, the Contractor is to provide adequate lighting at all points where mixing, transportation and placing of concrete are in progress.

3.29 Concreting in High or Low Ambient Temperature

Where the ambient temperature exceeds thirty two degrees Celsius (32°C), the Contractor shall take special measures in the mixing, placing and curing of concrete. The temperature of the concrete when deposited shall not exceed thirty degrees Celsius (30°C). The Contractor shall carry out all necessary special measures to ensure that the maximum concrete temperature after placing shall not exceed fifty degrees Celsius (50°C) or thirty degrees Celsius (30°C) above the concrete temperature at the time of placing, whichever is lower.

During placing suitable means shall be provided to prevent premature stiffening of the concrete placed in contact with hot surfaces.

The Contractor shall not mix and place concrete when the ambient temperature falls below three degrees Celsius (3°C).

3.30 Curing and Protection

Concrete shall be protected during the first stage of hardening from the harmful effects of sunshine, drying winds, cold, rain or running water. The Contractor shall pay particular attention to the need to protect concrete immediately after the finishing operation and prior to its final set and shall submit their proposals to achieve this protection for the Engineer's approval. Protection of concrete which has achieved its final set shall consist of one or more of the following:

(a) A layer of sacking, canvas, hessian, straw mats or similar absorbent material or a layer of sand, kept constantly moist by spraying with water as necessary for fourteen (14) days or such periods as may be directed by the Engineer.

(b) After thoroughly wetting, a layer of approved waterproof paper or plastic membrane kept in contact with the concrete for fourteen (14) days or such period as may be directed by the Engineer.

The use of saline water for curing purposes will not be permitted.

3.31 Steel Reinforcement

3.31.1 Materials

Unless otherwise directed or otherwise shown on the Drawings, hot rolled high yield reinforcement shall be used throughout the works.

Where required, mild steel reinforcement, medium tensile steel reinforcement and high tensile steel reinforcement shall comply with BS 4449. Cold twisted steel wire for the reinforcement of concrete shall comply with BS 4482.

All reinforcement shall be sourced from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate of the rollings. The Contractor shall, when requested by the Engineer, provide sample pieces 1.0 metre long for testing.

Tying wire shall be 1.6 mm diameter soft annealed iron wire.

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

3.31.2 Fabricating Reinforcement

Bar reinforcements shall be bent to the shapes shown on the Drawings and bending schedules. All bars shall be bent cold, unless otherwise permitted by the Engineer. All hooks, bends, and the like, unless otherwise shown on the Drawings, shall be to BS 8666. The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall provide all reinforcement in accordance with the Drawing. Bar reinforcement shall be bundled and each bundle of steel shall be tagged with identifying tags, showing the size and mark of the bar. The bundles shall be stacked clear of the ground in easily accessible positions that do not in any way hinder the progress of work and shall be kept clean.

3.31.3 Fixing Reinforcement

When placed in the work reinforcement shall be free from coatings or dirt, detrimental scale, paint, oil or other foreign substances. When steel has on its surface rust, loose scale and dust which is easily removable, it may be cleaned by a method approved by the Engineer.

All reinforcing bars, ties, links and fabric shall be fixed in the positions shown on the Drawings within the tolerances specified in BS 8666. In no case shall the cover specified on the Drawings be increased by more than 5 millimetres.

Displacement of reinforcement beyond the specified tolerance shall be prevented by supporting the bars sufficiently and securely fixing them together at intersections where necessary.

The ends of all tying wires shall be turned into the body of the concrete and not allowed to project towards the surfaces of the concrete.

Spacers shall be used to maintain the cover to all steel and shall be made of dense cement mortar of one part cement and two parts sand.

Spacers shall be triangular in section and only one acute edge shall bear against the formwork, the flat side shall bear against the steel. Wire cast into the blocks to fix them to the reinforcement shall be 1.6 millimetres diameter soft annealed iron. Spacers shall not be used on the wet face of water retaining or water excluding structures. Chairs, stools, etc. shall be used to maintain clearance between two or more layers of reinforcement.

Nothing shall be allowed to interfere with the specified position of reinforcement. The fixing of reinforcement shall be checked before and during concreting, and particular attention shall be given to the position of top steel in cantilever sections. During concrete placing a competent steel fixer shall be in attendance to adjust and correct the position of any reinforcement which may be displaced.

3.31.4 Splicing and Lapping

All reinforcement shall be provided in full lengths as indicated on the Drawings or bending schedules. Splicing of bars, except where shown on the Drawings, shall not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible. Bar reinforcement shall not be welded without the Engineer's written permission.

In lapped splices, the bars shall be placed in contact and wired together in such manner as to maintain a clearance between bars of not less than 50 millimetres.

Mesh or bar reinforcement shall overlap sufficiently to maintain a uniform strength and shall be securely fastened at ends and edges. The edge lap shall not be less than 40 diameters of the mesh reinforcement bar or two mesh widths whichever is greater.

3.32 Cover to reinforcement

The concrete cover to reinforcement shall be 50 mm unless otherwise shown on the Drawings. The Contractor shall provide any necessary concrete pads for ensuring the cover is attained and in no case shall timber packing be used.

3.33 Formwork

3.33.1 Definitions

Forms, formwork or shuttering shall mean all temporary moulds forming the concrete to the required shape together with any special lining that may be required to produce the concrete finish specified.

False work or centering shall mean the furnishing, placing and removal of all temporary construction such as framing, props and struts required for the support of forms.

3.33.2 Materials

The formwork may of seasoned, planed, tongued and grooved timber, plywood, block board, tempered hardboard, steel or as specified on the Drawings.

All timber used for formwork shall be sound wood, well-seasoned and free from loose knots, shakes, large checks, warping and other defects. Before use on the work, it shall be properly stacked and protected from injury from any source. Any timber which becomes badly warped or cracked, prior to the placing of concrete shall be rejected. All formwork for outside surfaces before final ground level shall be either tongued and grooved or provided with a suitable lining to produce a smooth surface finish.

3.33.3 Forms

All forms shall be of wood or metal and shall be built grout-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the openings of joints due to shrinkage of the timber.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.

All formwork shall, unless otherwise directed, be provided with 25 millimetres by 25 millimetres angle fillets (chamfers) so as to form splays on internal and external angles.
A grout check formed from 25 millimetres square hardwood timber shall be incorporated in the formwork to provide a clean, level, horizontal joint on exposed concrete surfaces at the top of each lift.

All joints in the formwork shall be either horizontal or vertical. End formwork shall be square across the mass of concrete.

Where concrete is to be deposited to a slope steeper than 20 degrees to the horizontal, top formwork shall be used to enable the concrete to be properly compacted unless the Engineer agrees otherwise.

Openings for the inspection and cleaning of the inside of formwork for walls, piers and columns shall be formed in such a way that they can be closed conveniently before commencing to place concrete.

Form clamps, tie bolts and anchors shall be used to fasten forms. The use of wire ties to hold forms in position during placing of concrete will not be permitted. Tie bolts and clamps shall be positive in action and of sufficient strength and number to prevent spreading or springing of the forms. They shall be of such type that no metal part shall be left within the specified concrete cover. For water retaining sections, methods of fixing the forms which result in holes through the concrete section when the formwork is removed shall not be used and built-in wall ties shall be fitted with water baffles.

All forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.

The shape, strength, rigidity, grout tightness and surface smoothness of forms which are re-used shall be maintained at all times. Any warped, bulged or otherwise damaged timber shall be replaced. Forms which are unsatisfactory shall not be re-used. If the surface finish on the formed concrete deteriorates as a result of deterioration of the faces of the forms, the Engineer shall instruct that forms be resurfaced, or discarded.

All forms shall be treated with approved mould or similar oil or be soaked with water immediately before placing concrete to prevent adherence of concrete. Any materials which adhere to or discolour concrete shall not be used.

All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be as specified in Clause 3.34. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer shall order the work stopped until the defects have been corrected.

All formwork shall be approved by the Engineer before concrete is placed within it. The Contractor shall, if required by the Engineer, provide copies of calculations of the strength and stability of the formwork and false work. Notwithstanding the Engineer's approval of these calculations, the Contractor shall be held responsible for the safety and adequacy of formwork.

3.33.4 False work and Centering

Detailed plans for a false work or centering shall be supplied by the contractor to the Engineer at least 14 days in advance of the time the Contractor begins construction of the false work. Notwithstanding the approval of the Engineer of any designs for false work submitted by the Contractor, the Contractor shall be solely responsible for the strength, safety and adequacy of the false work or centering.

All false work shall be designed and constructed to provide the necessary rigidity and to support the loads from the weight of green concrete and shuttering and incidental construction loads.

False work or centering shall be founded upon a solid footing safe against undermining and protected from softening. False work which cannot be founded on satisfactory footings shall be supported on piling which shall be spaced, driven and removed in a manner approved by the Engineer. The Engineer may require the Contractor to employ screw jacks, or hard wood wedges to take up any settlement in the formwork either before or during the placing of concrete.

False work shall be set to give the finished structure the required grade and camber shown on the Drawings.

3.33.5 Forms for Joints

Where permanent or temporary joints are to be made in horizontal or inclined members, stout stopping off boards shall be securely fixed across the mould to form a water-tight joint. The form of the permanent joint shall be as shown on the Drawings.

Where reinforcement or water stops pass through the face of a joint the stopping off board shall be drilled so that the bars or water stop can pass through, or the board shall be made in sections with a half round indentation in the joint faces for each bar so that when placed the board is neat and accurate fit and no grout leaks from the concrete through the bar holes, joints or around the water stop.

3.33.6 Release Agents

Only approved chemical release agents, mould creams (emulsions of water in oil) or oils containing a proportion of surfactant not exceeding 2 percent will be permitted. Water soluble emulsions and oils without surfactant shall not be used. Oil based release agents shall be applied at a rate of 7 square metres per litre one day in advance of concreting, preferably by spray or roller. Chemical release agents shall be applied in accordance with the manufacturer's recommendations.

New timber face work shall be given three coats of release agent before use on the work to ensure uniformity of porosity on the surface.

On no account shall the release agent come into contact with the reinforcement.

3.34 Removal of Formwork

Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected.

The minimum periods which shall elapse between completion of placing concrete and removal of forms are given in the following Table 3.2, and apply to ambient temperatures higher than 10°C. At lower temperatures or if cements other than ordinary portland are involved, the Engineer may instruct longer periods.

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until such removal can be completed without damage to the concrete.

Table 3.2 – Formwork striking time

Position of formwork	Striking Time
Beam sides, walls and columns	1 to 2 day
Slab soffits - props remain undisturbed	4 days
Beam soffits - props remain undisturbed	7 days
Removal of slab props	14 days
Removal of beam props	21 days

3.35 Surface Finishes

3.35.1 General

After removal of the formwork no treatment of any kind other than that required for curing the concrete shall be applied to the concrete faces until after inspection by the Engineer. All honeycombed areas, deformed surfaces or other defective surfaces shall then be repaired at the direction of the Engineer. Immediately following the Engineer's inspection of surface finish, all tie bolt cavities shall be filled with sand cement mortar and the surface left smooth, sound, even and uniform in colour.

Should the finishes surface either as-stuck or after repair exhibit a non uniform colour or texture, the Engineer shall have the right to order that the surface be given a skim coat and then painted.

3.35.2 Formed Surfaces

All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets.

For warped surfaces, facings shall be built up of laminated splines cut to make a tight surface which shall then be dressed and sanded to the required curvature.

Type F1: This finish is for surfaces against which backfill or further concrete will be placed. Formwork shall consist of sawn boards, sheet metal or any other suitable material which will prevent the loss of grout when the concrete is being placed.

Type F2: This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Type F2 finish shall be faced with wrought thicknesses tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

Type F3: This finish is for surfaces which will be in contact with water flowing at high velocity and for surfaces permanently exposed to view where good appearance and alignment are of importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood complying with BS 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved, uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface. Suitable joints shall be provided between sheets

to maintain accurate alignment in the place of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Type F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.

Type F4: This finish is similar to that required for type F3 but is used in places where a first class alignment and a dense surface free from air holes and other defects is required, suitable for the application of decorative finishes, in very high velocity water channels and in other similar circumstances.

3.35.3 Unformed Surfaces

Type U1: This is screed finish for surfaces of roads of foundations, beds, slabs, and structural members to be covered by backfill, subsequent stages of construction, bonded concrete topping or cement mortar beds to receive pavings, and on exposed surfaces of paving where a superior finish is not required. It is also the first stage of Type U2 and U3 finishes. The finishing operations shall consist of levelling and screeding the concrete to produce a uniform, plane or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

Type U2: This is a floated finish for exposed surfaces where a hard smooth steel trowelled surface is not required. Floating shall be done only after the concrete has hardened sufficiently, and may be by hand or machine. Care should be taken that the concrete is worked no more than is necessary to produce a uniform surface free from float marks.

Type U3: This is a hard smooth steel trowelled finish for surfaces exposed to water flowing at high velocity. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. The surface shall be trowelled under firm pressure and left free from trowel marks.

Type U4: This finish is similar to Type U3 finish but the permissible tolerances are smaller.

3.35.4 Surface Tolerances

All parts of concrete surfaces shall be in the positions shown on the Drawings within the tolerances set out in Table 3.3 or Table 3.4.

In cases where the Drawings call for tolerances other than those given in Table 3.3 or Table 3.4, the Drawings shall rule.

Where precast units have been set to a specified tolerance, further adjustments shall be made as necessary to provide a satisfactory straight or curved line. When the Engineer has approved the alignment, the Contractor shall fix the units so that there is no possibility of further movement.

Table 3.3 - Surface Tolerances for Formed Surfaces

Type of Finish	Tolerance in Millimetres (See Note 1)		
	A	B	C
FI	10	10	+25 to -10
F2	5	10	+15 to -15
F3	2	5	+10 to -10
F4	See Note 2	2	+5 to -5

Note 1:

The tolerances, A, B and C given in the table are defined as follows:

A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork.

B is a gradual deviation from a plane surface as indicated by a straight edge 3 metres long. In the case of curved surfaces, the straight edge shall be replaced by a correctly shaped template.

C is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the Drawings.

Note 2:

Abrupt irregularities are not permitted in a Type F4 finish. Any residual irregularities which remain after removal of formwork shall be removed by grinding to achieve a transition of 1 in 50 between the surfaces adjacent to the irregularity.

Table 3.4 - Surface Tolerances for Unformed Surfaces

Type of Finish	Tolerance in Millimetres (See Note 1)		
	D	**E**	**F**
U1	-	10	+20 to -10
U2	Nil	10	+20 to -10
U3	Nil	5	+12.5 to -7.5
U4	Nil	2	+6 to -4

Notes:

D is the maximum allowable value of any sudden change of level in the surface.

E is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a 3 metres long straight edge or correctly shaped template placed on the surface.

F is the maximum allowable value of the difference in level or position between a straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

3.36 Conduits, Box-outs and Apertures

The layout of conduits, box-outs, grooves, apertures and the like shall be as shown on the Drawings or as directed by the Engineer, and shall be subject to inspection and approval by the Engineer before commencing concreting.

Conduits shall be placed as near the centres of members as possible and sufficient space shall be provided between adjacent conduits to prevent difficulties in the placing of concrete.

Box-outs, holes grooves, apertures and the like shall be accurately set out in the formwork prior to placing the concrete. Fixing blocks, ends of brackets, bolts and, where possible, built in parts shall be cast into the concrete at the time of placing. No part of the concrete works shall be cut out for any such item, or for any other reason, without the Engineer's permission.

The Contractor shall ensure that all sub-contractors are informed of his programme for the structural works at the commencement of the Contract and that such sub-contractor's requirements relating to concrete members are approved well in advance. The Contractor shall obtain from all such sub-contractors complete information of their requirements regarding conduits, pipes, fixing blocks, ducts, holes and any other items to be cast into or formed in the concrete members. Failure of a sub-contractor to sub-contractor to supply such information shall not be allowed to delay the progress of the Works.

3.37 Construction joints

Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be as indicated on the Drawings or as previously approved by the Engineer. The Contractor is to allow for working beyond the ordinary working hours where necessary in order that each section of concrete may be completed without any lapse while the work is in hand. All construction joints are to be formed square to the work.
Where vertical construction joints are required, the joint face of the first stage concrete shall be finished against a stopping-off board, or vertical end shutter, suitably notched to pass the reinforcement. When the concrete is hard and the shutter is removed, the whole joint surface shall be thoroughly hacked and roughened or scabbled with suitable tools so that no smooth skin of concrete is visible and that all aggregates and solid matrix around them is exposed.

For horizontal or slightly inclined construction joints, the surfaces shall preferably be prepared when the concrete has set but not hardened by jetting with a fine spray of water and brushing with a stiff brush to remove the smooth skin and expose the aggregate without disturbing it. Where this treatment is impractical and work is resumed after the concrete surface has hardened, a similar procedure shall be adopted as on vertical joints.

If, in the opinion of the Engineer, any deleterious material has come into contact with the concrete of the construction joint or if the concrete is honeycombed or unsound for any reason, the concrete shall be cut back to such a depth as the Engineer shall order and the roughened surfaces shall be thoroughly cleaned by compressed air and water jets or other approved means.

Immediately before concreting is resumed, the roughened joint surface shall be thoroughly cleaned with compressed air and water jets and slightly wetted and cement grout placed The Contractor shall take precaution to avoid segregation of the concrete along the joint plane and to obtain thorough compaction.

3.38 Movement joints

Movement joints shall be formed in the position and manner shown on the Contract Drawings or instructed by the Engineer. In the case of water retaining structures, joints shall be made water-tight by the provision of a continuous water stop, with suitable water resistant filler material and sealant. The materials and workmanship utilised in movement joints shall comply with the following:

(a) Compressible filler shall be self-expanding cork filler consisting of cork granules bonded together with an insoluble, synthetic resin. When subject to wet or moist conditions the filler shall be capable of swelling to occupy a larger volume than that of the material supplied. The expansion properties of the filler shall not be less than one hundred and forty per cent (140%)

when immersed in boiling water for one hour (1hr). The filler shall be supplied and stored in sealed moisture resistant wrappings. Compressible filler shall be secured to the first cast concrete surface using an approved adhesive.

(b) Water stops, either centrally or externally placed, shall be Polyethylene (HDPE) of the dimensions and type shown on the Drawings. PE/HDPE water stops shall have an elongation of at least 300% at rupture with a tensile strength of more than 12.3 N/mm^2. Gluing temperature shall be about 150°C. The PE(HDPE) water stop shall accommodate a transverse movement of at least 50 mm. For expansion joints the water stops shall incorporate a centre bulb or box to allow movement to be accommodated. Centrally placed water stops shall have reinforced eyelets on the outer flange to facilitate the positioning of the water stops by wiring to the surrounded steelwork. Externally placed water stops shall include a wide reinforced nailing flange for positive fixing to formwork or adjacent concrete faces.

Water stop shall be firmly supported by split stop-end shuttering where appropriate, and in no case shall the water stops be pierced to assist in fixing. Special care should be taken to ensure that the concrete is well worked against the embedded part of the water stops and is free from honeycombing. Precautions shall be taken to protect any projecting portions of the water stops from damage during the progress of the work and from sunlight and heat. Where water stops are required to be jointed, this shall be undertaken using approved heat welding equipment. The water stops shall be installed in accordance with the manufacturer's instructions and to the approval of the Engineer.

(c) Joint sealant shall be bitumen-rubber sealing compounds and shall be pourable and in accordance with BS 2499 for horizontal joints and shall be an approved solvent type gun grade applied by suitable for vertical joints.

(d) Miscellaneous materials necessary for the installation of movement joints such as adhesives for securing filler materials, bond breaking tapes, bituminous paints for creating a discontinuity between concrete surfaces and primers shall be compatible with the compressible filler, water stops and sealant specified previously.

Contraction joints where specified shall be formed in the position and manner shown on the Drawings. The reinforcement shall be discontinuous across the joint. Dowel bars, water stops and sealant shall be provided as shown. The face of the first stage concrete shall be finished fair faced and after curing painted with two coats of bituminous paint. Casting of water stops and sealing of joints is to be carried out in accordance with the manufacturer's instructions. Dowel bars shall be round mild steel of the dimensions shown on the Drawings. The bars shall be cast into the first stage concrete and the protruding part shall be painted with two coats of bituminous paint.

Expansion joints where specified shall be formed in the position and manner shown on the Drawings. The reinforcement shall be discontinuous across the joint. Dowel bars, water stops, compressible filler and sealant shall be provided as shown. The face of the first stage concrete shall be finished fair faced and after curing the compressible filler shall be fixed in position in a manner to the approval of the Engineer. Casting in of water stops and sealing of joints is to be carried out in accordance with the manufacturer's instructions. Dowel bars shall be round mild steel of the dimensions shown on the drawings. The bars shall be cast into the first stage concrete and the protruding part shall be painted with two coats of bituminous paint. An end cap shall be fixed to the end of each bar prior to pouring the second stage concrete, in order to create a void at the end of the bar to accommodate any movement.

3.39 Pre-cast Concrete Units

Pre-cast concrete units shall be provided by an approved specialist supplier or may, subject to the Engineer's written approval, be manufactured by the Contractor. The Engineer may require the Contractor to supply samples of pre-cast concrete units for testing prior to the approval of the proposed supply for each type of unit and such samples shall be supplied and tested as directed by the Engineer.

Pre-cast concrete units shall be made in accordance with the provisions of this Specification covering concrete work. Pre-cast concrete units shall be manufactured under shed roofs and protected from the weather. The units shall remain in the moulds for seven days and shall remain protected for a further seven days, during which periods the concrete shall be shielded by sacking or other approved material which shall be kept wet. The units shall then be moved from the sheds and stacked in the open for at least a further seven days to season before being set in position.

Pre-cast concrete work shall be tested as directed by the Engineer and work failing to meet the requirements of the Specification shall be rejected. Pre-cast units that become damaged during handling shall likewise be rejected.

The Contractor shall, when required, make arrangements with his supplier for access to the supplier's work for the Engineer to inspect and carry out tests on pre-cast concrete units.

All pre-cast units shall be marked with individual identification. Lifting hooks are to be attached only to those positions shown on the Drawings or detailed by the Engineer. The Contractor shall be deemed to have included in their rates for all measures required to handle and stack units safely and without undue stressing.

3.40 Breaking out Existing Concrete or Block work

Well in advance of the commencement of the work the Contractor shall seek the approval of the Engineer regarding the proposed method of breaking out existing concrete or block work in the positions shown on the Drawings or as directed by the Engineer.

3.41 Cement Grout

Cement grout for general purposes shall consist of portland cement and water mixed in the proportion of one (1) part by volume of cement and one and a half (1.5) parts by volume of water. The grout shall be used within one hour (1hr) of mixing.

3.42 Cement Mortar

Cement mortar shall be machine mixed and unless otherwise specified, consist of three (3) parts of sand to one (1) part of Ordinary portland cement and mixed and thoroughly incorporated together. Just enough water will be added to give a workability appropriate to its use. The above proportions are by volume. Mortar shall be used whilst freshly mixed and no softening or re-tempering will be allowed.

3.43 Concrete Block and Bricks Masonry

Concrete blocks and bricks shall comply with BS 6073: Part 1 and shall have a minimum 28 days compressive strength of 3.5 N/mm^2 and 7 N/mm^2 respectively. The concrete blocks and bricks shall be laid in a staggered pattern such that the vertical joints between two consecutive layers are offset by half a block length. Joints on the inside faces shall be rendered in which case the joints shall be raked out at a depth of 5 mm. Rendering shall consist of 1:2 mortar applied to a thickness so as to ensure professional finish

The mix used to manufacture concrete blocks shall not be leaner than 1:9 by volume and the maximum size of aggregate shall be 10mm. The standard size of the concrete block shall be 400 mm x 200 x 200 mm and 300 x 100 x 100 for bricks. However blocks and bricks of other sizes may be used if approved by the Engineer for proper bonding at corners and openings

The concrete blocks and bricks shall be wetted before laying and shall be set in mortar, which complies with the specifications given in Clause 3.42. Unless otherwise stated, the maximum joint thickness shall be 12 mm and the horizontal and vertical joints shall be filled with mortar. Joints shall be finished flush with the face of the blocks and bricks. The Concrete block and brick masonry shall be cured for a period of seven days by covering the work with two layers of Hessian, which is kept permanently saturated. Provision shall be made to clean all exposed faces both as the work proceeds and on completion so that they are left in a neat, tidy and clean condition.

Building masonry will not be permitted in heavy rain without the approval of the Engineer. In such instances the Contractor shall make provision to protect materials and the newly placed mortar from the rain.

Concrete blocks shall either be obtained from an approved manufacture or made on site in approved block making machines. When casting of the concrete blocks is done at site, these shall be removed from the casting machine and deposited on edge on covered racks and left for 3 days, during which time they shall be kept constantly wet. Afterwards they may be placed on racks in the open provided they are protected by Hessian cloth or similar and kept wet for a further 5 days. Thereafter they shall not be moved or used in the works until they are 28 days old.

Chambers shall be constructed after pipes have been laid, except the bases may be constructed earlier to avoid deterioration of the formation.

Backfilling around completed chambers shall be with suitable material deposited equally all round and compacted in accordance with the Specifications.

Where any pipes are built into concrete or block work the pipe shall be surrounded in two layers of polythene sheeting unless a puddle flange has been shown on the Drawings.

3.44 Rendering Work

3.44.1 Material

Cement, water and fine aggregate shall conform to the requirements specified in the concrete works. Mesh reinforcement shall be plain diamond expanded steel lathing to BS 1369 where specified. Lime shall be to BS 980 and shall be mixed with water and allowed to stand prior to use according to the manufacturer's recommendations.

The mix proportion of the cement mortar by volume shall be as follows:

- For rendering coat, Cement : Sand = 1:5
- For finishing coat, Cement : Sand = 1:3

Lime putty may be mixed in mortar for finishing coat at 10% of sand by volume.

3.44.2 Waterproof cement mortar(intake/headworks)

Waterproof mortar shall be made by mixing a waterproof agent into ordinary cement mortar. The Contractor shall be responsible for selection and quality of the waterproof agent and this shall be approved by the Engineer before use. The mixing and application shall be in accordance with the manufacturer's instructions.

3.44.3 Application

The surfaces which are to receive a rendering coat shall be free from all laitance, scum, loose carbonate scale, loose aggregate dirt and other foreign matters. Concrete block, brick or stone surfaces shall be sufficiently and uniformly damped immediately before application of mortar. Concrete surfaces shall be kept thoroughly wet for 24 hours prior to the application of mortar.

Where shown on the drawings or directed by the Engineer, steel wire lath shall be fixed to the brick, concrete block or concrete walls before applying cement mortar plaster.

Cement mortar shall be used within 30 minutes from the time of mixing. Re-tempering shall not be permitted.

The total thickness of rendering plus finishing coat shall be 30 mm for the floors and 20 mm for wall. Cement mortar finish shall be trowel finished unless otherwise specified. When the finishing coat is applied, the entire surface of floor or wall shall be finished in one operation in order to minimise joint marks.
When expansion and control joints exist in the base structure, provision shall be made to prevent cracking of the mortar by inserting metal expansion beads within the coating thickness in a manner approved by the Engineer.

The finished surface shall be perfectly plumb or level as the case may be except where otherwise specified without any bulging, runs, bruises or stains.

After application of the finishing coat, the surfaces shall be kept continuously damp for not less than 48 hours and then allowed to become thoroughly dry. Moistening shall be started as soon as the surface has hardened sufficiently not to cause displacement or damage.

3.45 In Situ Concrete Chambers

In situ concrete chambers shall be constructed generally in accordance with Section 3 of this Specification.

3.46 Chamber Covers and Slabs

Covers and slabs shall be the type, size and weight shown in the drawings. Care shall be taken to see that slabs are even so that the cover can seat without rocking.

Covers and frames shall be provided as shown on the drawings. The tops of the covers shall be flush at all points with the surrounding surface of paved areas or as directed in unpaved areas. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete.

4 STONEWORK

4.1 Stones

Stone for all purposes shall be the best of its kind, sound and durable, free from flaws and from soft, weathered or decomposed parts. The stone and the quarry from which it is obtained shall be subject to the approval of the Engineer, samples shall be submitted by the Contractor of the stone he proposes to use in the Works and the Engineer's approval shall be obtained before such stone is used or any order is placed. The stone used shall be clean and must be washed if deemed necessary in the opinion of the Engineer.

Stones for face work shall be as far as possible quarry split and not bullnosed or hammer dressed. A moderate amount of dressing to trim off large projections will however be permitted. Exposed

faces of stones for masonry shall be free from tool marks except such as are inherent in the nature of any dressing that may be specified. In rock-faced work the roughness on the surface shall not project more than 40 mm for stone less than 0.3 m^2 face area and not more than 60 mm for large stones.

4.2 Stone Masonry

Masonry shall be built to the lines and levels shown on the Drawings.

For face work the stones shall show a face of not less than 0.025 m^2 and not more than 0.1 m^2 in area and none shall be less than 100 mm in depth; they shall be laid to give a uniformly random appearance and shall be selected in laying so as to present an even distribution of large and small stones on the face.

For the arises, stones shall be roughly squared, quarry split and of a size to give out bands varying from 300 mm to 500 mm in length and in bands from 150 mm to 250 mm. The alignment of arises shall be set true to the required lines.

The stones shall be set in mortar with their natural bedding plane (if any) as near normal as possible to the face or normal to the line of thrust in the case of load bearing structures. Particular care must be given to obtaining a sound bond both longitudinally and transversely and there shall be at least one bonder, or length not less than two-thirds of the wall thickness, in each square yard of wall face.

The mortar, unless otherwise specified, shall be machine mixed cement and sand in the proportion of one part to three (1:3) parts generally as described in the specification. Mortar shall completely fill all interstices between the stones.

The face joints in rubble masonry may vary in thickness from 10 mm to 20 mm. They shall be finished as a neat weathered joint with mortar while the work proceeds where the masonry is specified to be "un-pointed". Where pointing is specified, the joints in each day's work shall be raked out to a depth of not less than 25 mm before the mortar has set. Subsequently the joint shall be filled with mortar and finished in accordance with Clause 4.6. The face of the masonry is to be kept wet while the pointing is proceeding. Provision shall be made to clean all exposed faces both as work proceeds and on completion so that they are left in a neat, tidy and clean condition.

Building of masonry will not be allowed in heavy rain without the written consent of the Engineer. Building shall only proceed when suitable precautions to the satisfaction of the Engineer shall be taken against the action of rain on newly placed mortar. If for any reason of urgency the consent of the Engineer should be desired to a departure from these provisions, the Contractor shall submit to the Engineer for approval their proposals for protecting the materials and work from the weather.

4.3 Types of Masonry

The arrangement of the stones on the exposed face or faces of the masonry shall be as described below according to which type is called for on the Drawings.

(a) Random rubble un-coursed masonry shall be built with stones of irregular shapes taken generally as they come from the quarry, preparation being limited to the removal of inconvenient corners and excrescences. They shall be selected as the work proceeds to give a uniformly random appearance and no attempt shall be made to form courses.

(b) Random rubble masonry brought to courses shall be generally as the preceding type except that it shall be levelled up to courses between 300 mm to 400 mm in depth and coinciding with the quoin stones.

(c) Squared rubble coursed masonry shall be built in courses between 100 mm to 250 mm in depth of stones squared to rectangular shapes and selected so that all stones in one course are of approximately the same height.

4.4 Bedding of Stone Masonry

Unless otherwise directed by the Engineer, all masonry stones, when incorporated in the Works shall be laid on its natural bed, except in the case of arches where the natural bed shall be radial.

4.5 Special Stonework

Special stonework shall consist of approved stones dressed to the shapes and dimensions and with the faces tooled, all as shown on the Drawings. All stones shall be laid true to line and centre with mortar joints as shown on the Drawings.

4.6 Pointing of Joints in Masonry

Unless otherwise shown on the Drawings, pointing to masonry joints shall be flush and shall be formed by raking the joint clean and then filling it with pointing consistency mortar which shall be given a flush face with a steel trowel.

4.7 Hand Placed Rubble Filling

Hand placed rubble filling shall consist of stones individually selected and placed by hand firmly in place in bearing contact with each other or with the sides of the space to be filled; the voids shall be carefully filled with small rocks and spalls wedged together to form a compact mass. The sides of stones shall be roughly trimmed if necessary with a spalling hammer to obtain a reasonably close fit. On the exposed face the stones shall be placed with their flattened sides uppermost and in the plane of the face.

4.8 Tipped Rock / Pitching

Rock protection on embankment slopes and around structures shall be to the lines and levels shown on the contract Drawings. The terms "tipped rock" and "pitching" refer to the manner in which the rock is placed.

The different classes of rock are specified on the Drawings according to nominal size and the maximum and minimum size of the individual particles. Within the size limits of each class, the rock fragments shall be well graded with not more than forty per cent (40%) of the rocks being smaller than the stated nominal size. The shape of the rock shall be roughly uniform with no dimension less than sixty percent (60%) of the largest dimension. The individual rock pieces shall be dense, durable and abrasion resistant.

The Contractor shall submit bulk samples of not less than 2 m^3 of each class of rock for approval by the Engineer prior to placing. These samples shall be retained for comparison with material being placed in order to ensure a reasonable degree of uniformity within each class.

The base on which rock protection is to be placed shall be compacted and trimmed to the lines and levels shown on the drawings. Where two or more classes of rock are specified, the lower layers shall be completed to the Engineer's approval before the placing of subsequent layers.

Tipped Rock shall be tipped directly into place and roughly trimmed to the required profile. The thickness, lines and levels of each class of tipped rock is shown on the Drawings.

Pitching will be used where a finished horizontal or inclined surface is required. It shall consist of hand placed stones, with spalls wedged into the interstices to produce an even surface, without projection above the neat lines shown on the Drawings. Care shall be taken to ensure that the stones are well bedded and the percentage of spalls shall not exceed forty percent (40%) of the total rock volume. Pitching on slopes shall be built upwards from the toe, unless otherwise directed by the Engineer. A coping consisting of large flat stones shall be laid along the top of stone pitching on slopes to produce a firm edge.

Tipped Rock and Stone Pitching shall consist of selected hard durable rock free from weathered or decomposed parts to the approval of the Engineer, containing no flaky stone and being well graded within the limits shown below. The class and the thickness of the layer shall be as shown on the drawings.

Class	Size of stone d (mm)	Percentage by weight smaller than stone sized
A	300	100
	125	40-55
	45	0
B	150	100
	63	40-55
	31.5	0
C	63	100
	22	60-85

	8	20-40
	4	0

Class	Size of stone d (mm)	Percentage by weight smaller than stone sized
D	31.5	100
	16	50-80
	8	20-50
	4	0
E	350	100
	200	0
F	225	100
	90	35-55
	45	0
G	850	100
	500	30-60
	300	0

Tipped rock / stone pitching shall be placed in an approved manner in order to produce a uniform well knit un-segregated layer in which all sized are held in position.

4.9 Gabions

Gabions shall be of the types and sizes shown on the Drawings. The cages shall be constructed from mild steel wire complying with BS 1052, "Specification for mild steel wire for general engineering purposes", galvanised in accordance with BS 443, "Specification for testing zinc coatings on steel wire and for quality requirements". The wire shall be 3mm diameter formed into a fabric having a mesh of 75 mm x 100 mm for baskets and 60 mm x 80 mm for mattresses.

Stone filling for gabions shall consist of hard durable rock, free from weathered or decomposed parts. The minimum dimensions of each stone shall not be less than half its maximum dimension. For mattresses the stone shall be 200 mm to 150 mm for baskets the stone shall be 300 mm to 200 mm. The stone shall be obtained from a source approved by the Engineer. No stone shall be smaller than the size of the gabion mesh. In carrying out the filling, selected pieces of stone of elongated shape shall be placed with their flatter and elongated faces in contact with the mesh wherever possible.

The empty gabions shall be placed to line and level as shown on the Drawings or as directed by the Engineer and then stretched so that the gabions regain their shape on being filled. Diaphragms shall be provided at not more than 1m intervals for baskets and not more than 0.6 m intervals for mattresses. A gabion shall not be completely filled until the adjacent basket or mattress has been half filled, unless otherwise directed, in order not to cause displacements from bulging during filling.

For baskets at least two horizontal connection wires shall be tied between front and back of the gabion in each 1m compartment, at a height of 300 mm and 600 mm from the bottom as the stone

fill reaches these levels. Additional tie wires shall be provided if necessary and in no case shall the gabion basket bulge by more than 40 mm. Where a continuous line of gabions is required, adjacent gabions shall be securely tied together at the top and bottom of the gabions with tying wire.

The gabions shall be filled to a level just sufficient to require the lid to be forced into place with a bar. The lid and all joints between baskets and between diaphragms and baskets shall each be tied down with a continuous running wire.

Where gabions are to be shaped, the shape shall be formed by folding the mesh internally and tying it with a continuous running wire.

All tying wire shall be galvanised and of same gauge as specified for the cages above.

The surface upon which gabions are to be laid shall be compacted to a minimum dry density of 95% of the maximum dry density (AASHTO T99).

4.10 Hardcore

Hardcore shall consist of broken rock, concrete or other approved hard material, clean and free from extraneous matter, having a maximum particle size of 100 mm. It shall be spread and levelled, watered and compacted, and then blinded with a layer of fine material of grading 3 mm to dust, watered and compacted all to the Engineer's approval.

5 PIPEWORK

5.1 General

The Contractor shall construct pipelines to the lines and levels using grades, classes, or designs of pipe, bedding, haunching and surrounding as shown on the Drawings or directed by the Engineer.

Unless otherwise described in the Contract or agreed by the Engineer only one type of pipe shall be used within any individual length.

All materials shall be subject to the approval of the Engineer prior to procurement and delivery. Upon delivery, the Engineer shall inspect the delivered material for compliance with the specifications. In case of non-conformity, the Contractor shall replace the material at his own cost.

The pipes and fittings shall comply in all respects with British Standards and jointing of pipes and fittings shall be carried out in accordance with the manufacturers' instructions and to the approval of the Engineer.

5.2 Storage and Protection of Materials

Pipes shall be stacked on a firm base using two timber packers only under the barrel of rigid pipes such as concrete or steel.

Flexible pipes such as HDPE shall be stacked closely side by side on a firm plane base so that the whole length of the barrel is uniformly supported and sockets are clear of the ground. Each succeeding layer shall be placed at right angles to the previous layers. The height of any stack shall be not more than six layers of pipes and in the case of steel, not more than two layers.

Fittings and specials of any type shall be stored in a single layer only.

Pipes and fittings shall at all times be adequately protected from damage during transport, storage and handling. Cracked or chipped pipes shall not be used in the permanent works. Steel and large diameter plastic pipes shall be fitted in the factory with end caps or reinforcement adequate to prevent distortion during transport, storage and handling.

Plastic pipes and fittings shall be protected from direct sunshine and excessive heat. Deformed pipes and fittings shall not be used in the permanent works.

Rubber rings and other pipe jointing material shall be stored under cover from direct sunshine.

Granular bedding shall be stored on a firm impermeable base so that it does not become contaminated with deleterious matter.

5.3 Handling Pipes and Fittings

Before any pipes are delivered to site the Contractor shall submit details to the Engineer of his proposals for handling pipes during transport, in store and during laying.

During transport and in store, pipes shall not rest on narrow traverse supports likely to cause damage to the pie or its coating. Pipes shall not be unloaded from a vehicle by tipping or dropping.

Pipes shall be lifted by flat braided wire slings or band slings except in the case of externally coated pipes and plastic pipes for which band slings having a width of at least 300 mm shall be used. Wire rope sling shall not be used for any pipes. No pipes shall be lifted by means of hooks applied to the ends of the pipe or by means of appliances such as grabs and togs.

In making arrangements for handling pipes, the Contractor shall take into account any recommendations made by the pipe manufacturer.

Where appropriate the requirements of this Clause shall apply to fittings and other components.

5.4 Cutting Pipes

The cutting of pipes for making up lengths shall be carried out by a method which leaves a clean square end.

Concrete pipes shall be cut with a concrete saw or by hand. If cut by hand the end of the pipes shall be trimmed even and square and if reinforced, the steel shall be cut flush with the face of the concrete. If instructed by the Engineer the exposed ends of the steel shall be protected with bitumen or a cement grout.

Steel pipes to be cut shall have the line to be cut clearly marked round the pipe. Cutting shall be carried out by cutting disc or by oxy-acetylene and the cut end shall subsequently be ground to the correct profile for the method of jointing in use.

5.5 Pipes and Fittings

5.5.1 Steel pipes

Steel pipes and specials for water and sewerage shall comply with BS 534.

Galvanised mild steel pipes and fittings shall comply with BS 1387 Class B or"Medium Grade" and complying with ISO 65. Threading for screwed and socketed joints shall be in accordance with the requirements of BS 21.

Joints shall be made with an approved pipe-jointing compound in accordance with the manufacturer's instructions. Red lead compounds shall not be used. Joints in underground piping shall be coated with bitumen or other approved composition.

All underground sections of pipework to be protected against corrosion by treating with "COLAS primer, and wrapped with fibreglass and coated with two coats of 'COLAS' bituminous tap coats all to manufacturers specification.

The bituminous paint is to be manufactured to ASTM D1187-82.

All fittings for galvanised steel water pipework shall be galvanised heavy weight fittings in accordance with BS 1740, BS 5153 and BS 5154. All fittings shall be subject to the approval of the Engineer.

Brass or gunmetal fittings shall be subject to the approval of the Engineer.

5.5.2 PE Pipes (HDPE)

Polyethylene (PE) pipes and fittings shall comply with ISO 4427:1996.

5.6 Valves

5.6.1 Gate valves

Gate valves shall conform to BS 5153 for cast iron and BS 5154 for copper alloy “valves for general purposes".

All gate valves shall close in a clockwise direction and the direction of opening and closing shall be cast on the hand wheels or valve casing with the words 'OPEN' and 'CLOSE' respectively. All gate valves shall be capable of being operated manually with a maximum applied torque of 100 Nm for valves with a nominal diameter less than 450mm. The Contractor shall ensure that the gate valves supplied are fitted with appropriate thrust bearing guides and gearing to fulfil these requirements, ensuring that when reduction gearing is employed, the gear ratio shall not exceed 4:1.

Isolating gate valves shall permit manual closing off of the raw water supply.

5.6.2 Butterfly valves

Butterfly valves shall conform to BS 5155 “Specification for butterfly valves". The use of butterfly valves as main line valves shall not be permitted.

5.6.3 Check valves

Cheek valves shall conform to BS 5153 for cast iron and BS 5154 for copper alloy “check valves for general purposes".

The valves shall be installed in a horizontal position to avoid malfunctioning of the check.

5.6.4 Float ball valves

Float operated valves shall comply with BS 1212 and BS 1968 and BS 2456 “specifications for float ball valves”.

Ball valves shall be the plastic diaphragm type or similar approved with seatings to suit the working pressure of 5 bars with plastic float to BS 2456 and internal overflow.

5.6.5 Painting of valves

All valves shall be painted internally and externally to give the same standard of protection as for steel pipes and fittings. Surface protection shall be all to the approval of the Engineer.

5.7 Laying Pipes in Trenches and Headings

Immediately before pipes are placed in any trench, the bottom shall be cleared of all stones and other debris and shall be in a condition acceptable to the Engineer. Prior to placing in the trench, all pipes shall be inspected for damage. Damaged pipes which in the opinion of the Engineer cannot satisfactorily be made good shall not be used in the permanent works. End caps or discs placed

on the pipes for protection during transit shall not be removed until immediately before the pipes are jointed.

Pipes shall be laid in straight lines unless otherwise shown on the drawings. No pipe shall deviate from the true line and level by more than 5 mm. Pipes shall be firmly bedded throughout their length to the required alignment and level so that they are concentric at each joint. All pipes shall be suitably wedged, shored or otherwise restrained to prevent movement during testing and backfilling but such restraints shall not be left in place permanently unless instructed or agreed by the Engineer.

Pipes which are to receive a concrete bed and haunch or surround shall be sent on suitable concrete blocks or bricks with a pad of Hessian based damp proof course two millimetres thick interposed between the pipe and the block. Setting blocks shall not be used with other forms of bedding.

Unless otherwise agreed by the Engineer a close fitting brush or swap shall be placed in pipelines having nominal diameters of 650 mm or less and shall be drawn forward progressively as pipe laying proceeds by means of a suitable rope which shall be threaded through each pipe as it is laid. Pipelines having nominal diameters greater than 650 mm shall be kept clean by suitable means as pipe laying proceeds. No debris of any kind shall be allowed to remain in the pipeline. Where the pipeline has internal lining, persons entering shall wear rubber boots and equipment trolleys shall have rubber tyred wheels. Pipes and joints shall be kept free of dirt, mud and other deleterious matter at all times. If pipe laying is stopped at any time, a cap shall immediately be placed on the end of the last pipe laid to exclude dirt.

Suitable precautions shall be taken to prevent the floating of pipes due to flooding of trenches. If floating should occur, the whole of the pipe run affected shall be removed and trench prepared again. No pipes shall be re-laid in trenches which have flooded until the trenches and the pipes have been inspected by the Engineer. The Contractor shall be entirely responsible for the sufficiency of all temporary supports and side slopes to the excavations. The excavation shall be carried out in such a way as to maintain the stability of all roads and other adjacent structures or works.

Pipes having integral sockets shall be laid with sockets facing upstream unless otherwise agreed or instructed by the Engineer.

Pipes in headings shall be laid in accordance with the requirements of this clause but pipe lengths shall not exceed 1.5 m unless otherwise agreed by the Engineer.

5.8 Pipes Laid on Natural Ground

Filling shall commence with selected fill consisting of easily compacted material from which all stones larger than 25 mm and all lumps of clay larger than 75 mm have been removed. The selected fill shall be deposited equally on each side of the pipe carefully compacted in layers not more than 150 mm thick. Care shall be taken to ensure that no voids are left under the pipe. The filling shall be continued to a level of 300 mm above the crown of the pipe

In the case of steel, ductile iron and plastic pipes, the Contractor shall ensure that no distortion of the pipe takes place during the backfilling operation.

The remainder of the trench shall be filled with excavated material and compacted in 150 mm thick layers by means of a vibrating plate compactor or a mechanical rammer. The trench shall be filled flush with the surrounding ground surface.

5.9 Pipes laid on Granular Bedding

Granular bedding material shall be placed and compacted generally on both sides of the pipe up to the horizontal diameter of the pipe. Care shall be taken to ensure that no voids are left under the pipe. Thereafter the selected fill shall be as described in Clause 5.8 above.

5.10 Pipes with Concrete Bedding and Surround

The configuration of the concrete bedding, surround or arch shall be as shown on the drawings including the location of reinforcement if any is required. Pipes to be set in concrete shall be supported as set out in Clause 5.7. Small diameter pipes in short lengths shall be supported behind pipe socket. Large diameter pipes and long lengths shall be supported on two packers.

After jointing and testing as set out in the appropriate parts of this section, concrete of the class shown on the drawings shall be carefully placed and compacted under the pipes making sure that no voids are left, and brought up to the configuration shown on the drawings. The Contractor shall ensure that the pipes do not float or are in any way disturbed during concrete placing. The remainder of the backfill shall be placed as set out in Section 2 of this Specification.

Where pipes, which are laid on a bed of granular material, are to be protected by a concrete arch, the laying and jointing shall proceed as set out in the appropriate parts of the Specification and granular material shall be brought up to the horizontal diameters of the pipes.

After testing, concrete shall be placed over the pipes to the configuration shown on the drawings and the remainder of the backfill shall hereafter be placed as set out in Section 2 of this Specification.

Flexible joints shall be formed in concrete beddings, arches or surrounds in the location shown on the drawings. Such joints shall coincide with the pipe joint in such a way that the end of the socket is flush with one face of the joint and the socket faces into the joint space.

Joints in concrete beddings, arches and surrounds shall be 18 mm wide unless otherwise instructed by the Engineer and shall be filled with a compressible material such as a sheet of cane fibre board or cork board. The material used shall be subject to the approval of the Engineer.

5.11 Joints in Pipelines

5.11.1 Steel pipes

These shall be caulked in thread seal for rigid joints. Flexible joints incorporating rubber O-rings shall be made in accordance with the manufacturer's instructions. Joints incorporating bolted or screwed glands or couplings shall be made in accordance with the manufacturer's instructions.

Components of flexible joints from different manufacturers shall not be used together.

5.12 Connections to Existing Pipelines

Where a connection is to be made to an existing water pipe other than that at a chamber, a pipe saddle of the correct size shall be used for this purpose. The hole in the pipe shall be cut precisely to fit the saddle.

5.13 Pipes through Structures

Where a pipeline passes into or out of a structure, including a manhole cover or similar chamber, two flexible joints shall be formed. The flexible joint shall consist of a 500 mm long pipe section connected along the main pipe, with the nearest end 500 mm from the face of the structure. One joint will be made on the incoming pipe and another joint on the outgoing pipe.

When the structure is less than one pipe length wide, the above requirement shall not apply and a sleeve shall be formed through the structure so that there is a clear space at least 75 mm wide all-round the pipe. Adequate means shall be provided to prevent soil from entering this gap.

5.14 Pipelines within Concrete Structures

Sections of pipelines which are to be cast into concrete may be installed in advance of the remaining parts of the pipeline subject to the agreement of the Engineer. Such sections shall be placed accurately into position and fixed so that they cannot move during placing of concrete around them.

5.15 Pipes under Roads

All pipes at the crossing of driveways and roads shall be surrounded with concrete for the entire length of crossing before trench backfilling.

Concrete surround shall be approved by the Engineer on satisfactory compliance with protection of pipes as detailed in Section 5.9.

5.16 Cleaning

The insides of all pipes, valves, tanks and fittings shall be clean, smooth, and free form blister, loose scale and dirt when erected. All lines shall be cleaned after all installation work.

When pipes are installed all ends shall be suitably plugged until final fixing of fixtures can be carried out. Pieces of cloth or stone will not be permitted.

5.17 Pressure Testing of Pipelines

As the installation of the pipework proceeds, the various sections shall be tested before they are built in, concealed, or finally connected. The Contractor shall advise the Engineer in writing at least three days in advance of the carrying out of such tests, and such tests shall, if considered necessary by the Engineer, be carried out in his presence.

All tests shall be at the expense of the Contractor and it shall be the responsibility of the Contractor to make all necessary records of the tests and results and submit these to the Engineer in the final form agreed

All pipe systems shall be tested hydraulically for a period of one hour to not less than one and a half times the design working pressure. Testing shall comply with BS 8010 for standard field testing of pipelines.

If preferred, the Contractor may test the pipelines in sections. Any such section found to be satisfactory need not be the subject of a further test when the system has been completed, unless specifically requested by the Engineer.

During the test, each branch and joint shall be examined carefully for leaks and any defects observed shall be made good by the Contractor and the section re-tested.

5.18 Painting of Exposed Pipes and Fittings

All metal surfaces within chambers shall be mechanically wire brushed to remove all loose scale, grease etc. Within two hours of cleaning a primer shall be applied, followed after two hours by a first coat of heavy consistency bitumen paint all to the approval of the Engineer. A second coat of the heavy consistency paint shall be applied after 24 hours. The final coating thickness shall not be less than 250 microns.

Preparation and application of the coating system shall be strictly in accordance with the Manufacturer's instructions.

This clause shall not be applied to chemically or thermally bonded coatings on steel pipes.

5.19 Maker Posts

Precast concrete marker posts shall be set in concrete and fixed near valves, fire hydrants, washouts, changes in direction of the mains and where directed by the Engineer. The posts shall be detailed as directed by the Engineer.

6 STEELWORK

6.1 General

Except where otherwise specified, structural steel shall be Grade 43, complying with BS 7668, "Specification for weldable structural steels".

All structural rolled steel members shall comply in dimension, weight and tolerance with that shown on the drawings and with BS 4, "Structural steel sections" and BS EN 10056, 10067 and 10210.

6.2 Bolts, nuts and fastenings

Bolts, studs, nuts and washers etc, shall be of mild steel unless otherwise specified. The dimensions and tolerances of nuts and bolts shall comply with BS 4190, "Specification for ISO metric black hexagon bolts, screws and nuts" or where specified to BS 3692, "Specification for ISO metric precision hexagon bolts, screws and nuts" and the threads shall be to BS 3643, "ISO metric screw threads". The heads of the bolts shall be forged out of the solid bar and the ends shall be cleanly cut with standard threads and the nuts must fit the bolts accurately and tightly. Washers of the shape and type indicated on the drawings shall comply with BS 4320, "Specification for metal washers for engineering purposes".

Where nuts, bolts and washers are required to be galvanized, the galvanizing shall be to BS 3382, "Specification for electroplated coatings on threaded components".

6.3 Electrodes

Electrodes used in welding mild steel shall comply with the requirements of BS 639, "Specification for covered carbon and carbon manganese steel electrodes for manual metal-arc welding".

6.4 Contractor’s Shop Drawings

Where the Contractor is required to undertake the detailed design of the steelwork components, he shall provide the Engineer with copies of detailed shop drawings for approval at least fourteen (14) days before commencing fabrication. The Contractor shall be responsible for the detailed design

of all connections and these shall be fully detailed on the shop drawings together with all dimensions, clearances, welding details and procedures, machining, marking, etc. The Contractor shall not commence fabrication until he has received the Engineer's written approval of the shop drawings. Approval of such drawings shall in no way relieve the Contractor of his responsibility for accuracy or the correct operation of the component.

6.5 Fabrication and Erection of Steelwork

The standard of workmanship and engineering practices to be adopted for fabrication and erection shall conform to BS 449, "Specification for the use of structural steel in building" and BS 5531, "Code of practice for safety in erecting structural frames".

The Contractor shall supply samples of materials and standards of workmanship as required by the Engineer. All samples approved by the Engineer shall be retained and shall be considered as setting the standard for all subsequent work.

Inspection of work will be carried out by the Engineer and the Contractor shall give sufficient notice of the date when fabricated steelwork is ready for inspection. The Contractor shall provide particulars of places and dates of manufacture of all materials for the Permanent Works and the names of the manufactures. Copies in duplicate of all orders for materials shall be sent to the Engineer at the time of placing such orders.

The Contractor shall ensure that all foundation bolts and supports including built-in bolts, etc upon which the steelwork is to be erected are in the correct position and that the steelwork fits correctly in required positions without forcing or straining in any way. Any check by the Engineer of the Contractor's measurements shall not relieve him of his responsibility for obtaining this fit unless any errors in position are clearly not attributable to him.

No permanent bolting or site welding shall be done until proper alignment has been obtained. The Contractor may use temporary jigs, anchors or supports during erection, but must allow for thermal movement to take place freely at all times.

If the Contractor wishes to drill holes in or fix attachments to the steelwork to carry temporary work such as shuttering, he shall obtain the Engineer's approval of the positions and details of all such holes or attachments and shall close such holes and remove the attachments to the satisfaction of the Engineer.

On completion of erection of any part of the steelwork on which the Contractor wishes to add further works, such as roofing, he shall first obtain the Engineer's approval of the steelwork and remedy any defects required by the Engineer. Any approval given shall in no way relieve the contractor of his responsibility for ensuring the subsequent correct positioning and behaviour of the steel work of other parts of the structure.

6.6 Welding

All shop welds shall be carried out by qualified welders who shall be under competent supervision. All welding is to be carried out in accordance with BS 5135, "Specification for arc welding of carbon

and carbon manganese steels". The Contractor's proposals for welding shall be submitted to the Engineer for approval before any work is undertaken.

The Engineer may call for a test of a welder's capabilities in accordance with BS 4872, "Specification for approval testing of welders when welding procedure is not required".

In the case of site welds, the welding procedure for making each type of joint shall be approved by the Engineer before the work is commenced and the Contractor shall make such trial welds as the Engineer may require to demonstrate the soundness of the proposed method and the competence of his workmen.

Where site welding is used all welded joints shall be subject to inspection by the Engineer. Any welds that are in the opinion of the Engineer defective shall be cut out and the welds remade to the satisfaction of the Engineer. The cost of such corrective measures including any resultant delays, shall be borne by the Contractor.

6.7 Painting General

The Contractor shall submit to the Engineer for his approval details of the types and manufacturers of paints he is proposing to use, together with the manufacturer's recommendations concerning preparation of surfaces, primers and undercoats, application methods, safety precautions and drying times for each type of paint. All paints used in the Works must be supplied ready-mixed in unbroken, sealed containers, which clearly show the type, colour and manufacturer of the paint and carry detailed "instructions for use".

All metal surfaces on which paint is to be applied shall be blast cleaned as laid down in BS 7079, "Preparation of steel substrates before application of paints and related products", or other mechanical means and fully prepared in accordance with the manufacturer's recommendations. Applications of paint coatings on external work shall not be carried out or continued in mist, rain or excessively damp conditions. The Contractor shall take all necessary precautions to prevent dust and dirt coming into contact with freshly applied paint before it has dried.

Paints shall be applied either by brushing or spraying in accordance with the manufacturer's instructions. The thinning of paints shall not be permitted without the approval of the Engineer. Unless otherwise recommended by the manufacturer, the minimum interval between the application of a first coat of paint and the second shall be twenty four hours (24hrs). Special care shall be taken to ensure complete coverage of all corners, arises and openings without causing an excessive build-up of paint and avoiding runs.

Steelwork to be painted shall be clean and free from all rust, grease, oil and mill scale.

The Contractor Shall provide all the relevant employees, visitors and any other persons who shall be exposed to the painting works, with personal protective equipment for the entire duration of their exposure to the paint works.

No separate payment will be made for the dust abatement measures and the costs thereof shall be deemed to be included in the respective unit rates and the Contract Sum.

6.8 Painting other steelwork

Where steelwork, which is not galvanized and not subject to immersion in water is required to be painted, it shall be thoroughly cleaned and painted prior to leaving the factory with:

(a) one coat of zinc phosphate or similar compatible metallic inhibitive primer with a minimum dry film thickness of 50 microns.

(b) one coat of red lead primer with a minimum dry film thickness of 50 microns.

(c) two coats of micaceous iron oxide undercoat paint with a minimum dry film thickness per coat of 50 microns.

After erection, damaged areas of steelwork shall be mechanically cleaned and touched up with primer and under coat to fully restore the factory applied coating system and thickness.

Finally, one overall finish coat of enamel gloss micaceous iron oxide paint with a minimum dry film thickness of 50 microns giving an overall minimum dry film thickness for the complete coating system of 250 microns.

6.9 Galvanising

All steel and ironwork of whatever kind required to be galvanised is to be pickled in dilute hydrochloric acid and then washed, fluxed and stoved and coated with zinc by dipping in a bath of molten zinc. All components are to be immersed in the bath only for the time sufficient for them to attain the temperature of the bath, they are then to be withdrawn at such a speed that a coating of 80 microns thickness is achieved, or such other practical maximum thickness for the component as defined in BN EN ISO 1461:1999, "Specification for hot dip galvanised coatings on iron and steel articles".

The galvanising is to be carried out after all drilling, chipping, trimming, filing; fitting and bending operations are complete and shall cover all faces evenly.

After erection of galvanised steel components, damaged or welded areas shall be painted immediately after cleaning with two coats of metallic zinc primer with each coat having a thickness of 50 microns. The paint shall be applied strictly on accordance with the manufacturer's instructions and shall be compatible with any subsequent paint systems to be applied.

6.10 Gates

Gates of the types and sizes shown on the drawings shall be supplied and installed where indicated on the drawings. The gate shall be drop-tight and shall be suitable in all respects for use in raw water. The gates shall have flush inverts.

Gates shall be supplied complete with all frames, cills, seals, spindles, hand wheels and headstocks as required. The frames and gates shall be fabricated in galvanized steel as per WATERMAN Industries Ltd, or equivalent approved. The contact address for WATERMAN Industries as at the time of this tender are:

WATERMAN Industries, P O Box 458, Exeter, CA 93221, USA.
Web site: www.watermanusa.com

All gates shall have rising spindles with protection tubes, headstock, hand wheel etc. and intermediate supports where the spindle is longer than 1500 mm. Intermediate guide brackets are to be located 600 mm above the gate frame, 400 mm below the base of the headstock and at a maximum spacing of 1500 mm, to suit or as recommended by the manufacturer and as approved by the Engineer.

All gates on structures in the link, main and branch canals having a base gate width of 500mm or more shall be of Type A (Sluice gate with a control rising spindle and wheel) as shown on the book of drawings. All gates on structures in the link, main and branch canals with a base gate width of less than 500mm shall be of Type B (slide gate or "Hand pull") as shown on the book of drawings. All gates on structures on the main feeder canals shall be Type B.

The gates shall conform to the following specifications or equivalent:

- Self-contained frame;
- Rising stainless steel frame;
- Flat back for wall mounting
- Maximum on seating pressure, measured from invert – 1.5 m
- Material for leaf, arms, hoist is: carbon steel Din 17100 St. 37-2(EN 10025 S235 JR)
- Non- geared hand wheel manual lift, mounted on the top of the frame
- Material of side rubbing plates, sill plate and pivot pins: Stainless steel ASTM A-276 type 304
- Side and bottom seals: Neoprene to ASTM D-200
- Mill finish on all stainless steel surfaces
- Epoxy paint on carbon steel surfaces

The contractor shall examine gate shape, measure and confirm all gate sizes on site. The contractor shall then obtain approval of the Engineer prior to purchase of the gates.

6.11 Stop-logs

Where shown on drawings, the stop-logs shall be hardwood of the stated dimensions and shall be approved by the Engineer before supplying to site. Where shown on the drawings stop logs shall be bolted to steel frames of stated dimensions to form hardwood gates.

6.12 Drainage Works

6.12.1 Mitre Drains and Catch Water Drains

These will be formed at the locations and the lines and levels shown on the drawings or instructed by the Engineer.

6.12.2 Side Drains

These will be formed to the lines and levels as shown in the drawings and at locations as instructed by the Engineer. Material excavated from the side drains may be incorporated into the reshaped road if suitable. Otherwise, it shall be spoiled in approved spoil areas.

6.12.3 Cleaning of Existing Drains

The Contractor shall clean existing blocked culverts and clear side drains as may be directed by the Engineer.

6.12.4 Repair of Existing Drains

The Contractor shall replace broken culverts, and repair or reconstruct broken wingwalls and headwalls as directed by the Engineer.

7 MATERIALS

7.1 Materials

7.1.1 Submission of Samples

As soon as possible after the Contract has been awarded, the Contractor shall submit to the Engineer a list of the suppliers from whom he proposes to purchase the materials necessary for the execution of the Works. Each supplier shall be willing to admit the Engineer, or his representative, to his premises during ordinary working hours for the purpose of obtaining samples of the materials in question. Alternatively, if desired by the Engineer, the Contractor shall deliver the samples of the materials to the Engineer's office, without charge. Samples of materials to be used as aggregates shall be taken and tested in accordance with the provisions of British Standard 812: Sampling and Testing of Mineral Aggregates, Sands and Fillers. Subsequent supplies shall conform, within the specified tolerances, to the quality of approved samples.

The information regarding the names of the suppliers may be submitted at different times, as may be convenient, but not source of supply shall be changed without the Engineer's prior approval.

Samples of materials approved will be retained at the Engineer's office until the completion of the Contract. Samples may be tested to destruction.

All materials delivered to Site must be at least equal in all respects to approved samples.

7.1.2 Cement

Ordinary portland Cement and rapid-hardening portland cement shall comply with the relevant section of the “Concrete Specification” or other standards as given in Concrete Specification.

Sulphate resisting cement shall comply with the physical requirements of British Standard 12: portland cement (Ordinary and Rapid-hardening).

High alumina cement shall comply with the requirements of British Standard 915: High Alumina Cement.

White or coloured cement shall be of approved quality and chemical composition, and shall comply with the physical requirements of British Standard 12: portland cement (Ordinary and Rapid-hardening).

Cement shall be delivered in broken bags, barrels or by an approved bulk delivery vehicle.

Cement shall be stored in a dry weatherproof shed with a raised wooden floor, or in a silo, and shall be delivered in quantities sufficient to ensure that there is no suspension or interruption of the work of concreting at any time and if in sheds, each consignment shall be kept separate and distinct. Any cement which shall have become injuriously affected by damp or other causes shall at once be removed from the Site. Cement should be used in rotation.

The Contractor shall furnish as directed by the Engineer test certificates relating to the cement to be used on the work. Each certificate shall indicate that the sample has been tested and analysed by an approved laboratory and that it complies in all respects with the requirements of the appropriate Specification for the particular type of cement.

7.1.3 Aggregates for Concrete

Aggregates for concrete shall consist of naturally occurring material complying with the requirements of British Standard 882: Concrete Aggregates from Natural Resources.

A certificate as to compliance with the British Standard shall be provided by the supplier to the aggregate. Tests for the determination of impurities in the sand shall be made once daily, until the Engineer is satisfied that the specified compressive strength is being regularly obtained, when, with his approval, such tests shall be made once weekly and at other times as directed by the Engineer.

The coarse aggregate, unless otherwise authorised by the Engineer, shall be delivered to the Site in separate sizes (two sizes when the maximum size is 20mm and three sizes when the maximum size is 38mm or more).

The Flakiness Index when determined by the sieve method described in British Standard 812 shall not exceed 20 for 65mm and 38mm aggregates nor shall it exceed 35 for 20mm and 10mm aggregates.

All aggregates brought upon the Site shall be kept free from contact with deleterious matter and in the case of aggregates passing a 5mm sieve they shall have been deposited in the site of mixing for not less than 16 hours before further use; aggregates of different sizes shall be stored in different hoppers, or different stacks on a clean hard surface and shall be separated from each other as approved by the Engineer.

7.1.4 Sand for Mortar

a) Sand for mortar shall be natural or crushed stone sand and shall be in accordance with BS 1198-1200 where applicable to sands for general purpose mortars.

b) The source of the sand is to be approved by the Engineer.

c) At the Works the sand is to be stored on a clean, hard surface.

All building stone shall be capable of withstanding when wet a crushing stress of 10N/mm2. The source of stone shall be approved by the Engineer and stone supplied there from shall be free from Magadi, overburden, mudstone, cracks, sand holes, veins, laminations or other imperfections. The stone shall be chisel-dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surfaces, to the size specified. For exposed stonework the maximum permissible variation of any of the specified dimensions shall be 6mm provided that cut stone, supplied as 'rock face' stone may be hammer dressed on one face only, or on one face and one end, if in other respects it conforms with this Specification. Stones shorter than 375mm will not be accepted.

Unless the Engineer allows otherwise the Contractor shall at his own expense provide and dress four 100mm cubes of stone for testing.

The stone shall be sound when tested in accordance with BS 1438: Media for Biological Percolating Filters, (Sodium Sulphate Soundless test) except that:

i) The treatment shall be repeated for 10 cycles only; and
ii) The second criterion of failure shall be amended to allow for a loss weight of not more than 20% of its original weight.

7.1.5 Stone Dust

Stone duct for blinding shall be black trap screened to the following grading:

- Passing 10mm sieve 100%
- Passing No. 4 sieve 85% - 100%
- Passing No. 100 Sieve 5% - 25%.

7.1.6 Murram

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, topsoil or clay. The California Bearing Ratio of the murram, as determined for a sample compacted to maximum density (as defined under Bs 1377) and allow to soak in water for four days, shall not be less than 30. This CBR is a guide to quality only and the compaction in the work will be judged by density.

7.1.7 Water for Cement Treated Materials

If water for the Works is not available from the Public Mains the Engineer's approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter and other deleterious substances. If the water is required to be tested, this shall be done in accordance with the requirements of British Standard 3148: Tests for Water for Making Concrete.

7.1.8 Cement Mortar

Cement mortar shall consist of proportions by volume as specified of portland cement and natural sand or crushed natural stone of a combination of both as specified in British Standard 1198-1200: Building Sands from Natural Sources. The constituent materials shall be accurately gauged and mixed in an approved manner.

Cement mortar shall be made in small quantities only as and when required, and any mortar which has begun to set or which has been mixed for a period of more than one hour shall be rejected.

7.1.9 Hydrated Lime

Hydrated Lime shall comply with British Standard 890: Building Lime, and shall be Class B of the semi-hydrated type.

7.1.10 Calcium Chloride

Calcium Chloride shall be of a good industrial grade, and shall be obtained from an approved source.

7.1.11 Lime Mortar

Lime mortar shall consist of proportions by volume as specified of hydrated lime and natural sand or crushed natural stone or a combination of both as specified for cement mortar in clause 14.10. The constituent materials shall be accurately gauged and mixed in an approved manner.

7.1.12 Cement-Lime Mortar

Cement-lime mortar shall consist of portland cement, hydrated lime and natural sand or crushed natural stone or a combination of both, as specified for cement mortar in Section 3 of this Specification. The constituent materials shall be accurately gauged and mixed by volume in an approved manner in the proportions specified.

Cement-lime mortar shall be made only in small quantities as and when required and any mortar which has begun to set or which has been mixed for a period of more than two hours shall be rejected.

7.1.13 Cement Grout

Cement grout shall consist of portland cement and water mixed in the proportion of one part by volume of cement and one-and-a-half parts by volume of water. The grout shall be used within one hour of mixing.

7.1.14 Concrete Building Blocks

Pre-cast concrete building blocks shall be in accordance with BS 2028 for Type A blocks from an approved source.

The faces of the blocks shall be smooth, true to shape with sharp arrises and be free from pitting and other surface defects.

7.1.15 Building Stone

Stone used for building shall be the best quality hard local stone obtained from approved quarries and shall be sound throughout so as to ring when struck and shall be free from all defects. Stones shall be dressed into true rectangular blocks with each surface even and at right angles to all adjoining surfaces and equal to samples submitted to and approved by the Engineer.

7.1.16 Steel Reinforcement

Mild steel and hot-rolled high tensile steel rod reinforcement for concrete shall be as specified in British Standards 4449, 4482: Rolled Steel Bars and Hard Drawn Wire for Concrete Reinforcements. Cold-twisted high tensile bars shall be as specified in British Standard 4461 Metric Units: Cold-twisted Steel Bars for Concrete Reinforcement. Steel fabric reinforcement shall be as specified in British Standard 4483 : Steel Fabric for Concrete Reinforcement, and shall be delivered to the Site in mats, unless the Engineer allows otherwise, and free from any permanent set tending to make it curl under vibration.

The Contractor shall furnish the Engineer with copies of the manufacturer's certificates of test for the steel reinforcement to be supplied. The Engineer, may however, order independent tests to be made and any steel which does not comply in all respects with the appropriate foregoing Specifications will be rejected.

7.1.17 Granular Material for Pipe Beddings

Granular material for pipe beddings shall consist of well and evenly graded material such as gravel or broken stone, having a grading of 19mm to 5mm, free from fines, readily compactible and free draining. The grading of supplies will be frequently checked.

7.1.18 Concrete Pipes and Specials

Concrete pipes and specials shall comply with the requirements of British Standards 5591. They shall carry the British Standards Institution registration certificate trade mark, or test certificates shall be furnished by the manufacturers.

7.1.19 Concrete Porous Pipes

Concrete porous pipes shall comply with the requirements of British Standard 5911: Concrete porous Pipes for Under-drainage.

7.1.20 Concrete Drain Invert Blocks

Pre-cast concrete invert blocks shall be 150 mm dia. half round manufactured to the detail Drawings supplied from concrete of the appropriate Class specified in Section 3 of this Specification using maximum 12mm size aggregate. If required, cube test certificates shall be supplied by the manufacturer.

7.1.21 Concrete Slabs for Open Drains

Pre-cast concrete slabs for lining open drains shall be manufactured to the detail Drawings supplied from concrete of the appropriate Class as specified in Tables 14.2, 14.3 and 14.4 using maximum 12mm size aggregate. If required, cube test certificates shall be supplied by the manufacturers.

7.1.22 Drainage Ditch Warning Posts

Pre-cast concrete drainage ditch warning posts shall be manufactured to the detail drawings from concrete of the appropriate Class specified in Section 3 of this Specification. If required, cube test certificates shall be supplied by the manufacturers.

7.1.23 Agricultural Tiles and Pipes

Agricultural tiles and pipes shall be best well burnt earthenware, true and circular in bore and with an externally flat bottom and plain ends suitable for laying with open or butt joints.

7.1.24 Manhole Covers and Frames

Manhole covers and frames shall be basically in accordance with the requirements of BS EN 124: Cast Manhole Covers, Road Gully Gratings and Frames for Drainage Purposes, except that manhole covers shall be constructed of mild steel, concrete filled, and set in grease/bitumen for water tightness in accordance with the Local Authority's standard detail drawings.

Foul water sewer manholes shall have triangular Grade 'A' heavy duty covers and frames. Circular manhole covers and frames shall be used on surface water sewer manholes, and also heavy duty covers where indicated on the drawings.

7.1.25 Gully Gratings and Frames

Gully gratings and frames shall be basically in accordance with the requirements of BS EN 124 497, nominal size 500mm x 350mm, except that the gully gratings shall be constructed of mild steel, concrete filled in accordance with the Local Authority's standard detail Drawings.

7.1.26 Pre-cast Concrete Manholes and Inspection Chambers

Pre-cast concrete manholes and inspection chambers shall comply with the requirements of British Standard 5911: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies, and they carry the British Standard Institution registered certification trade mark, or test certificates shall be furnished by the manufacturers.

7.1.27 Pre-cast Concrete Gullies

Pre-cast concrete gullies shall be un-reinforced and shall comply with the requirements of British Standard 5911: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies.

7.1.28 Manhole Step-irons

Step-irons of general-purpose type shall comply in all respects with BS 1247: Malleable Step Irons.

7.1.29 Timber

Timber shall be sound, well-seasoned and entirely free from worm, beetle, warps, shakes, splits, and all forms of rot and deadwood. Where required, all timber shall be treated with creosote, as specified in British Standard 144: Coal Tar Creosote for the Preservation of Timber, or an alternative approved timber preservative.

7.1.30 Aggregates for Surface Dressing

Aggregates for surface dressing shall consist of hard, rough, clean crushed rock (blacktrap) as approved by the Engineer. It shall be of approved nominal size and quality and otherwise in conformity with the requirements of British Standard 63: Single Sized Road Stone and Chippings.

7.1.31 Dry Rubble Backing

Dry rubble backing shall consist of broken stone of approved quality, graded from 100mm to 50mm.

.

7.1.32 Paint

All priming, undercoating and finishing paints shall be in accordance with British Standard 2521/4: Ready Mixed Oil-based Priming Paints, or British Standard 2525/32: Ready Mixed Oil-based Undercoating and Finishing Paints (Exterior Quality), as appropriate.

7.2 Masonry and Block work

7.2.1 General

All masonry work shall be constructed from building stone as specified in Part 4 or approved concrete block work as specified in Part 4.

For culvert headwalls and other small works, the stone shall, unless otherwise specified, be rough dressed. For walls, facing and other exposed works the stone shall, unless otherwise specified, be medium chisel-dressed.

7.2.2 Workmanship

All masonry work is to be constructed in compliance with BS 5.

The Contractor shall provide and use proper setting-out rods for all work.

Stones and blocks shall be well soaked before use and the tops of walls shall be kept wet as the work proceeds. The stones and blocks shall be properly bonded so that no vertical joint in a course is within 115mm of a joint in the previous course. Alternate courses of walling at angles and intersections shall be carried through the full thickness of the adjoining walls. All perpends; reveals and other angles of the walling shall be built strictly true and square.

The stones and blocks shall be bedded, jointed and pointed in mortar (1:3) in accordance with Part 4, with beds and joints 9mm thick flushed up and grouted solid as the work proceeds.

All work shall be cured in accordance with the relevant requirements of Part 4.

7.3 Walling

7.3.1 Materials

(a) Cement

Cement used for making mortar shall be as described in the Engineering specifications for “Materials”.

(b) Lime

The lime for making mortar shall be obtained from an approved source and shall comply with BS 890 Class A for non-hydraulic lime. The lime to be run to putty in an approved lined pit or container. The water to be first run into the pit or container and the lime to be added until it is completely submerged, stirred vigorously until all lumps are disintegrated and shall be kept constantly covered with water and regularly stirred for at least four weeks. The resulting milk-lime then to be run through a fine sieve and run into

a pit or other container and kept clean and moist for not less than two weeks before being used in the works.

(c) Sand

Sand used for making mortar shall be clean well graded siliceous sand of good sharp hard quality equal to samples which shall be deposited with and approved by the Architect. It shall be free from lumps of stone, earth, loam, dust, salt, organic matter and other deleterious substances, passed through a fine sieve and washed with clean water if so directed by the Architect.

(d) Water

Shall be as described in "Concrete Work".

(e) Stone

All stone shall comply with the requirements of CP 121.202 for masonry and rubble walls respectively except where amended or extended by the following clauses.

Unless otherwise noted, all masonry walls shall be coursed squared rubble walling with mortar joints.

The size of stones for rubble walling shall be such that the length of stone does not exceed three times its height. For coursed squared rubble walls blocks shall not exceed 300 mm in height and shall be not less than 150 mm in height.

Where snecked rubble walls are specified, the snecks shall not be less than 100 mm square on the exposed face.

Stone for masonry shall have a minimum compressive strength of 10 N/mm2. (Stone shall not be required to be tested to failure). The density of stone for masonry shall be not less than 2300 kg/m3. The drying shrinkage of stone shall not exceed 0.05%

Samples of stone provided for testing shall be tested for the following in accordance with the methods given in BS 2028, 1364 and the test results shall comply with the requirements of this specification.

(a) Compressive strength
(b) Density
(c) Drying shrinkage

The colour and texture of stone shall be uniform and consistent. Prior to delivering any stone to site, the Contractor shall supply the Architect with a sample of stone in order that he may approve the colour and texture. The Contractor shall ensure that sufficient suitable stone is available for the whole of the project prior to ordering the stone.

Where cast stone including stone described as artificial stone, reconstructed stone, etc., is specified the stone shall comply with the requirements of BS 1217.

Masonry shall be of stone, having no irregular faces and only the back face if not visible shall be left as from the saw.

Prior to ordering dry stone the Contractor shall demonstrate that the stone is durable. This may be done by supplying details of buildings constructed with stone from the same quarry and which has been exposed to the same environmental condition for at least ten years.

The maximum projection from the face of stone for rubble walls shall be 20 mm beyond the specified face of the wall.

The Contractor shall provide six samples of stone measuring 150 mm x 150 mm for testing prior to delivering any stone to site. As work proceeds the Contractor shall provide six samples 150 x 150 x 150 mm for testing from every 300 m2 of work.

All stone shall be stacked on prepared dry areas free of clinker, ashes and sulphate bearing strata.

7.3.2 Workmanship

(a) Cement Mortar

Mortar described as cement mortar 1:4 shall be composed of 1 cubic metre (1498 Kgs.) of portland cement and 4 cubic metres of sand. Other mixes such as 1:3, 1:5 etc. shall be similarly construed.

(b) Mixing of Mortar

The constituent materials shall be measured separately when dry in specially prepared gauge boxes of sizes to give the proportions specified without consolidation of the contents by ramming and shaking. The mortar shall be mixed in an approved power driven mixer for not less than two minutes per batch and using the minimum quantity of water necessary to obtain a working consistency. The mixer shall be used as close as practicable to the works and mortar shall be used within 30 minutes of mixing. No partially or wholly set mortar will be allowed to be used or re-mixed.

(c) General Construction

(i) Setting out

The Contractor shall provide proper setting out rods and set out all work on same for course, openings, heights etc., and shall build the walls, piers etc., to the widths, depths and heights indicated on the Drawings and as directed by the Architect.

(ii) Building in Wood Frames

Openings for doors, ventilators etc., are to be set out and left un-built until the wooden frames have been fixed in position.

(iii) Building in Metal Windows and Doors

Openings for metal frames are to be wide enough for the frames to fit without being forced into position. Build the lugs into the joints of the walling and fill in the space between the walling and frame with cement mortar well tamped into the channel of the frames and point all round externally.

All frames must be set plum and level and free from twist.

(iv) Walls to Receive Plaster & Similar Finishes

All faces of walls to be plastered etc., to have all projections dressed off and joints raked out as key.

(d) Building Walling

(i) Laying and Jointing

All blocks shall be well wetted before being laid and the top of walling where left off shall be well wetted before commencing building. Walls to be kept wet three days after building. All walls throughout the works shall be carried up evenly in 200 mm courses except where courses of less depth are required to bring walling up to level of floors, windows and the like and where otherwise described, no part being allowed to be carried up more than one metre higher at one time than any other part and in such cases the joining shall be made in long steps so as to prevent cracks arising and all walls shall be levelled round at each stage. Not more than 3 metre height of wall shall be laid in any one day.

(ii) Bonding

The blocks shall be properly bonded together and in such manner that no vertical joint in any one course shall be within 115 mm of a similar joint in the courses immediately above or below. All walling of 300 mm thickness or less shall be built in single thickness of blocks. Walling exceeding 300 mm in thickness shall be built with through bonders not more than 1070 mm apart in each course as directed by the Architect.

Alternate courses of walling at all angles and intersections shall be carried through the full thickness of the adjoining wall. All perpends, reveals and other angles of the walling shall be built strictly true and square.

(iii) Tolerances

All courses of walls shall be level with a maximum deviation of +/- 3 mm in any one metre length and a maximum overall deviation of 10 mm for lengths of wall exceeding 3 metres. Walls shall be plumb with a maximum deviation of +/- 3 mm in any metre height of wall with a maximum deviation of +/- 10 mm in the total height of the wall or any storey.

All corners of walls which are shown as being at right angles shall be square with a maximum deviation of 3 in 1000. All walls shall be straight with a maximum deviation of

+/- 3 mm in any one metre length and a maximum overall deviation of 10 mm in any length exceeding 3 metres.

All bed and vertical joints shall be an average of 10 mm thick with a maximum deviation of +/- 3 mm of block work, and stone rubble walls. Joints for stone masonry walls shall be 6 mm +/- 1 mm thick.

(iv) Curing

All walls shall be maintained in a damp condition for at least 24 hours after laying. Walls under construction shall be dampened by applying water with a brush and no hosing directly on to the wall shall be permitted. When work ceases on any section of wall polythene or Hessian shall be draped over the wall, for at least 24 hours. If Hessian is used, it shall be maintained continuously wet.

(v) Cavities

Cavity walls shall be of the overall thickness shown on the drawings.

Cavities above ground level between leaves of block or masonry shall be free of mortar droppings or other debris. The Contractor shall take proper precautions to prevent mortar or debris entering the cavity.

Cavities below ground level shall be filled with mortar for cavities up to 75 mm wide and for cavities over 75 mm wide filling shall be concrete mix 1:3:6. Cavities shall be filled such that there is maximum of three times the thickness of the thinner leaf of the wall filled with wet mortar or concrete unless the wall is continuously supported for the depth.

(vi) Backfilling

Earth backfilling against walls shall be carried out such that the level of the backfill is always equal on each side of the wall.

When a wall has filling material on one side only to a fill width of more than three times the wall thickness, the wall shall be continuously supported during backfilling.

Backfilling shall not be carried out until at least seven days have elapsed since the laying of the blocks or stone.

(e) Fair Face

All concrete and hollow clay block work described as finished with a fair face is to be built to a true and even face with the joints finished as specified hereinafter.

(f) Pointing

Pointing of walls shall be carried out as the work proceeds wherever possible. When coloured mortar is specified for pointing only the pointing shall be carried out after work has been completed.

Existing walls shall be prepared for pointing by raking out all loose friable material to a minimum depth of 15 mm to form a square recess. The joints shall then be wetted and new mortar shall be forced into the joints and finished as directed.

7.4 Painting and Decorating

7.4.1 Materials

(a) Manufacturers

Except where stated all materials shall be obtained from approved manufacturers. The Contractor shall state the name and address of the manufacturer whose materials he proposes to use. Once approval has been given the Contractor shall not obtain materials from other sources without the prior written agreement of the Architect.

All paints shall be grade A quality.

(b) General

Each succeeding coat of priming, undercoating and finishing (pigment) or clear coating shall be sufficiently different in colour as to be readily distinguishable.

All primers and paints in one system upon a particular surface shall be obtained from the same manufacturer.

The mixing of paints, etc., of difference brands before or during application will not be permitted.

(c) Emulsion paints

Emulsion paints shall be matt or satin finish vinyl emulsion paint. Silk vinyl finish shall be used where specified. The first (mist) coat shall be thinned in accordance with the manufacturer's instructions.

(d) Gloss paint

Gloss paint shall be hard gloss finish oil paint.

(e) Blucheuring paint

Blucheuring paint for door handles and gutters is to achieve a wrot iron effect to be obtained from Sadolin paints or equal approved.

(f) Automotive paint

Automotive paint is to be two pack epoxy paint on specified surfaces factory applied, with baked finish, by Sadolin or other approved manufacturer. Colour selection is to be to the Architects approval.

(g) Bituminous solution

Bituminous solution for use on coated pipes, RC and block work faces beneath ground level shall be obtained from a manufacturer approved by the Architect.

(h) Traffic paint

To be as Crown Paints, Road Paint or other approved for use on concrete block paving.

(i) Lead based paints

The use of lead based paints will not be permitted.

(j) Clear finishes

Clear finishes internally shall be clear polyurethane varnish one or two pack as specified.

(k) Varnish

Varnish is to be an imported water based varnish/stain by Sadolin Paints or other equal approved.

(l) Primers and undercoats

Unless otherwise specified, primers and undercoats shall be the type recommended by the manufacturer of the finishing coats specified for a particular surface. Primer for external bare metalwork surfaces shall comply with B.S. 2523.

(m) Knotting

Shellac knotting shall comply with B.S. 1336.

(n) White spirit

The white shall comply with B.S. 245.

(o) Timber stain

Timber stain shall be oil based pigmented stain. The application of this material shall be strictly in accordance with the manufacturers written instructions. Tint and degree of application shall be to the approval of the Architect.

(p) Textured coating

Textured coating is to be of proprietary manufacture approved by the Architect of an approved colour.

Technical information concerning the coating is to be submitted to the Architect before ordering, but the minimum qualities of the coating are to be as follows:-

(i) Suitable for application internally and externally to plastered, rendered, concrete,
(ii) block, stone, brick, asbestos and timber surfaces.
(iii) Minimum durability of 10 years even in exposed conditions.
(iv) Maintenance free.
(v) Built-in mould resistant fungicide.

(q) Stopping

The stopping shall be as follows: -

(i) Plasterwork shall be plaster based filler.
(ii) Concrete and brickwork shall be similar material to the background and finished in a similar texture.
(iii) Internal woodwork, plywood and block board shall be putty complying with B.S. 544.
(iv) External woodwork shall be white lead paste complying with B.S. 2029.
(v) Internal clear wood finishes: the stopping shall be that recommended by the clear lacquer manufacturer.

(r) Fillers

The fillers for internal joinery shall be the type recommended by the paint manufacturer for use with his type of paint or lacquer.

Stopper and fillers shall be tinted to match the undercoat, and shall be compatible with both undercoats and primers.

All materials shall be used strictly in accordance with the manufacturer's instructions.

7.4.2 Workmanship

(a) General

Workmanship generally shall be carried out in accordance with B.S. C.P. 231, unless otherwise specified.

Before painting is commenced floors shall be swept and washed over; surfaces to be painted shall be cleaned before applying paint as specified, and all precautions taken to keep down dust whilst work is in progress.

No paint shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation, efflorescence, etc., before the application of each coat.

No painting shall be carried out externally during humid, rainy, damp, foggy or freezing conditions or conditions where surfaces have attained excessively high temperatures or during dust storms.

No new, primed or undercoated woodwork and metalwork shall be left in an exposed or unsuitable situation for an undue period before completing the process.

No dilution of paint materials shall be allowed except strictly as detailed by the manufacturer's own direction, either on the containers, or their literature, and with the special permission of the Architect. For external work dilution of paints will not be allowed whatsoever. For internal work, where permitted by the Architect, undercoats may be thinned by the addition of not more than 5% thinners. Gloss finish shall not be thinned at all.

Metal fittings such as ironmongery etc., not required to be painted shall first be fitted and then removed before the preparatory processes are commenced. When all painting is completed the fittings shall be cleaned as necessary and re-fixed in position.

(b) Brushwork

Unless otherwise specified, all primers and paints shall be brush applied. Written permission must be obtained from the Architect's if an alternative method of application is to be used.

(c) Stopping and filling

Unless otherwise specified by the manufacturer all primers and undercoats shall be stopped flush and rubbed down to a smooth surface with an abrasive paper and all dust removed before each succeeding coat is applied. Care shall be taken to prevent burnishing of the surface.

(d) Stirring

Unless otherwise specified by the paint manufacturer all paint materials shall be thoroughly mixed and/or stirred before and during use, and suitably strained as and when necessary.

(e) Inspection

No priming coats shall be applied until the surfaces have been inspected and the preparatory work has been approved by the Architect. No undercoats or finishing coats shall be applied until the previous coat has been similarly inspected and approved.

(f) Paint application

Each coat of paint shall be so applied as to produce a film of uniform thickness. All paint shall be applied in accordance with the manufacturer's instructions. Special attention

shall be given to ensure that all surfaces including edges, corners, crevices, welds and rivets receive a film thickness equivalent to that of adjacent painted surfaces.

(g) Drying

All coats shall be thoroughly dried before succeeding coats are applied. Allow a minimum of 24 hours between applications on any one surface, unless otherwise specified by the manufacturer.

(h) Un-primed woodwork

Un-primed woodwork scheduled to be painted shall be rubbed down with abrasive paper and dusted off. Care shall be taken to prevent `burnishing' of the surface. All knots and resinous areas shall be coated with two coats of knotting. Pitch on large, open unseasoned knots and all other beads or streaks of pitch shall be scraped off, or if still soft, shall be removed with white spirit before applying the knotting. Apply one coat of priming to all surface, two coats to all end grain, to be subsequently painted. Backs of all wood frames in contact with concrete, brickwork, block work and metalwork or similar materials shall be primed before fixing. After priming all joints, holes, cracks shall be stopped and filled, rubbed down and dusted off.

(i) Primed woodwork

Woodwork delivered primed shall be lightly rubbed down with abrasive paper, and dusted off. Touch up bare areas with a similar priming including open grained ends. After touch priming all joints, holes, cracks and open grained ends shall be stopped and filled, rubbed down and dusted off.

(j) Plywood and block board

Edges of exterior plywood and block board shall be sealed with two coats of aluminium primer and the backs treated with a lead primer.

(k) Clear finished woodwork

All woodwork scheduled to receive a clear finish shall be well sanded with the grain removing all dirt etc., to give as smooth a surface as possible. Resinous timber shall be swabbed down with white spirit and dried thoroughly. Split or end grain shall be filled with suitable filler recommended by the clear lacquer manufacturer, in accordance with their instructions, and of the appropriate shade.

(l) Bare metalwork

Bare metalwork shall be thoroughly cleaned off all dirt, grease, rust and scale by means of chipping, scrapping and wire brushing; particular attention should be given to the cleaning of welded, brazed and soldered joints. Wash down with white spirit and wipe dry with clean rags. Apply a coat of metal primer immediately the cleaned surfaces have been approved by the Architect.

(m) Galvanized metalwork

Galvanized metalwork scheduled for painting shall be thoroughly cleaned of dirt, grease, dusted and washed down with white spirit and wiped dry with clean rags. Any minor areas of rust shall be removed by wire brushing and spot primed with a zinc rich primer. Apply at least one coat of calcium plumbate primer to all surfaces subsequently to be painted.

(n) Primed metalwork

If the priming coat of pre-primed metalwork has suffered damage in transit, or during erection on site, the affected areas shall be cleaned off by wire brushing, abrading and dusting off, the bared patches touched up with a primer of a similar type to that already applied.

(o) Copper

Copper scheduled for painting shall be lightly abraded with emery cloth, washed with white spirit and wiped dry with clean rags. Apply a coat of etch primer immediately the cleaned surfaces have been approved.

(p) Brickwork, concrete etc.

All brickwork, block work, concrete, rendered and plaster surfaces scheduled to be painted shall be brushed down, all holes and cracks filled, all projections such as plaster, or mortar splashes etc., removed to leave a suitable dust free surface. All traces of mould oil shall be removed from concrete surfaces by scrubbing with water, detergent and rinsing with clean water. All these surfaces shall be thoroughly dry before any primer or pains are applied. Apply a coat of alkali resisting primer where surfaces are to be finished with oil paints or alkyd resin type emulsion.

Asbestos cement surfaces scheduled for painting shall be brushed down to remove powdery deposits, and a coat of alkali resisting primer applied where such surfaces are to be finished with oil paints or alkyd resin type emulsion.

(q) Colours

The colours will be selected by the Architect from the paint manufacturer's standard colour range.

(r) Toxic wash

Concrete, block work, plaster and timber surfaces which are to be painted shall be washed down prior to painting with a toxic wash applied by brush or spray. A second wash shall be applied two days after the first wash. The surfaces shall be then allowed to dry out completely before application of paint.

(s) Protection

Proper care must be taken to protect surfaces while still wet by using of screens and 'wet paint' signs where necessary.

(t) Damage

Care must be taken when preparing surfaces, or painting etc., not to stain or damage other work. Dust sheets and covers to the satisfaction of the Architect shall be used to protect adjacent work. Any such stains or damage shall be removed and made good at the Contractor's expense.

(u) Cleanliness

All brushes, tools, pails, kettles and equipment shall be clean and free from foreign matter. They shall be thoroughly cleaned after use and before being used for different colours, types or classes of material. Painting shall not be carried out in the vicinity of other operations that may cause dust. Waste liquids, oil soaked rag, etc., shall be removed from the building each day. Waste liquids shall not be thrown down in any sanitary fittings or drains.

(v) Performance

If, while the work is in progress, the paint appears to be faulty, such as consistency of colour, drying time, or quality of finish, the work shall be stopped at once and the manufacturer consulted.

The manufacturer's of the materials shall be given every facility for inspecting the work during progress in order to ascertain that the materials are being used in accordance to their directions, and to take samples of their products from the site if they so desire for tests.

The finishing coats of the various paints or surface finishings shall be free from sags, brush marks, runs, wrinkling, dust, bare or 'starved' patches, variations in colour and texture, and other blemishes.

When the work has been completed, the finished surfaces shall not be inferior in quality, colour and finish to the samples approved by the Architect, and imperfections in manufacture shall not be apparent through these finished surfaces.

In the event that the Architect is not satisfied that the quality of finish does not comply with the required standards and/or the sample panel the Contractor will be required to repaint at his own expense, such work to the satisfaction of the Architect. If in the opinion of the Architect it is necessary to remove completely the unsatisfactory paintwork this shall also be done under the direction of the Architect at the expense of the Contractor.

(w) Packaging, delivery and storage

All paints and surface coatings shall be delivered in sound sealed containers, labelled clearly by the manufacturers, the label or decorated container must state the following:-

(i) The type of product.
(ii) The brand name and colour
(iii) The use for which it is intend

(iv) The manufacturer's batch number

(v) The B.S. number if applicable

(vi) All labels shall be printed - containers bearing type written labels will not be acceptable.

Materials shall be stored under cover in accordance with the manufacturer's instructions, and with local fire and safety regulations. The store itself must be maintained at a temperature of not less than 50 degrees F (10 degrees C) and must not be subjected to extreme changes of temperature.

The batch deliveries are to be dated and used strictly in order of delivery.

(x) Vinyl emulsion paint

Surfaces to be painted shall receive one mist coat followed by two full coats of vinyl emulsion paint. Application may be by means of rollers or brushes.

(y) Gloss finish paint

Surfaces to be painted shall be primed then painted with two undercoats followed by one coat gloss finish paint.

(z) Clear polyurethane varnish

Surfaces to be clear varnished shall be treated with two coats water based as Sadolins (UK) Ltd or equal approved.

(aa) Textured Coating

The manufacturer’s instructions concerning application of the coating are to be strictly followed under the direction of the Architect.

All surfaces to receive textured coatings are to be clean and dry with surfaces scraped and brushed before application of the coating.

Application of the coating is to be with textured roller or fibre brush as directed by the Architect with a minimum spreading capacity of 1 kilogramme per square metre. Under no circumstances is the coating to be thinned.

7.5 Painting

7.5.1 General

The Contractor shall supply all paints, primers, varnishes, distemper, oil, etc. ready mixed in original sealed containers bearing the brand maker's name identifying the contents and giving directions for its proper use.

Painting materials shall be of the best quality products of recognised manufacturers, and shall be subject to the approval of the Architect. The quality of the finishing colours shall be capable of giving three years' minimum satisfactory performance under tropical conditions with high temperatures and humidity, and capable of withstanding temperatures of up to 60 Deg. C for long periods without colour change. Paints shall also be resistant to oils, acids and alkalis.

All surfaces to be painted shall be adequately cleaned and prepared to the satisfaction of the Engineer's Representative and shall be dry and free from any oils, greases, stains or other marks prior to being painted. The paint shall be well and evenly applied. Where sprays are used, markings of the edges of the painted area shall be carried out to provide a definite edge. Brushes and sprays shall be the correct size and type for the work being executed.

For painting applied in several coats each coat shall be of a different shade or colour from the others. Each coat shall be allowed to dry thoroughly and sufficiently harden before the next coat is applied.

All colours shall be selected and approved by the Architect.

All hardware and furniture for doors and windows, together with any exposed electrical installation in walls shall be removed before painting commences. Upon completion of all paintwork all such hardware and furniture etc. shall be re-installed and left in good working order. Floors shall be covered as protection against staining by paint.

7.5.2 Block Work

Surfaces of concrete and rendering to be painted shall first be washed down and then allowed to dry. Any efflorescence present shall be thoroughly removed, and the areas so affected shall be given a coat of porous alkali-resistant primer. After any traces of grease have been removed the surfaces shall be painted with two coats of emulsion paint of the copolymer acrylic type. Any cracks in walls shall be cleaned, filled and puttied up then left to dry before application of paint.

Plastered surfaces shall be left as long as possible to dry out before being painted and after any efflorescence has ceased to form and has been removed, they shall be painted with two coats of an approved porous emulsion paint. When a gloss paint finish is called for, this coat or coats should only be applied over the emulsion paint after an interval of at least six months.

7.5.3 Metalwork

Galvanised metal surfaces shall first be treated with one coat of mordant solution which shall in due time be carefully washed off. The surface shall then be primed with a calcium plumbate primer. When this has dried thoroughly, the surfaces shall be given one coat of undercoat and one of a gloss finishing paint.

All metalwork shall be cleaned free from all rust, scales, grease, oils and any other surface stains, and shall be given one coat of an approved primer compatible with the metal to be painted, two applications of undercoat and one application of a gloss finishing coat.

The Contractor shall seek specific instructions to paint any non-ferrous metal surface.

All metalwork which has been supplied with bituminous protection or painting prior to despatch from the place of manufacture, such as pipes, tubes, valves, manhole covers, etcetera, shall have all exposed surfaces painted after erection.

The manufacturer's primer or coating shall be made good to the same standard and specification as supplied, and shall then be given two coats of paint as follows:-

(a) Pipes, valves, manhole covers, and fittings, etc. exposed to view shall be painted with two coats of an approved "bitumastic aluminium paint" or similar approved paint.

(b) Pipes, valves and fittings, etcetera in manholes, or chambers shall be painted with two coats of bitumastic paint or other approved paint.

8 SUPPLY OF PLANT AND WORKSHOP EQUIPMENT

8.1 General

The Contractor shall supply and commission plant and equipment listed under this section unless otherwise specified or directed by the Engineer. The Contractor, through his appointed personnel, shall train the Employer's staff on the operational and maintenance of the plant and equipment such that this shall be a prerequisite for the issuance of the certificate of completion by the Engineer. The Contractor shall also provide operation and maintenance manual of all the machines and moving parts supplied. The Contractor shall include in his tender method statement to demonstrate his ability to comply with this clause.

The Contractor shall indicate in his programme, repair and maintenance schedule for all the plant and equipment under the contract and the progress achieved on this shall be evaluated on daily basis or as directed by the Engineer along side other works.

The Contractor is encouraged to visit the site at his own costs, during tender in order to acquaint and ascertain himself with the nature and the extent of work to be undertaken under the contract.

8.2 Workshop equipment to be supplied by the Contractor

When instructed by the Engineer the Contractor shall supply the equipment shown in Table 9.2 or similar approved and shall train employer's staff on their operation and maintenance. The Contractor shall submit with his tender, catalogue and/or specifications of the items that he proposes to supply. The Contractor shall install commission and maintain the equipment as recommended by the dealers for the period before the completion of the works.

Table 9.2: Workshop equipment to be supplied

Item	Description	Quantity
1	Roller floor jack, 10 ton capacity.	1
2	Mobile jib crane hydraulically operated 1.5 ton capacity.	1
3	Mobile air compressor, 3.0 HP, maximum pressure 9.6/16 kg/cm^2.	1
4	Battery charger, 24 volt capacity.	2
5	Power hacksaw, 24” round capacity.	1
6	Universal milling machine.	1
7	Mobile generating set for pump station.	1
8	Air compressor of pressure 16kg/cm^2.	1

A provisional item has been provided for in the bills of quantities for this purpose. The Contractor shall submit in his tender, cost breakdown of all the equipment to be supplied. This shall be included in Schedule **J2** of Section 2 of the tender documents. The breakdown shall indicate the cost of equipment at the dealer / manufacturer, transport costs, overhead, profits etc.

8.3 Operation and Maintenance of Plant and Equipment

The Contractor shall propose spare parts and lubricants in his tender as recommended by the manufacturers, for the continuous operation of all the plant and equipment supplied and / or repaired as detailed in Sections 9.2 and 9.3 above. These shall be of quality and quantity recommended by the manufacturers and sufficient to last for a minimum of two years (24 months) after the end of Defects Liability Period. The Contractor shall cost for each spare part and lubricants proposed and include these as Schedule **J3** of Section 2 of the tender documents. A sum of these shall be posted as a provisional item in the bills of quantities.

The cost of operation and maintenance, including spare parts, up to the date of issuance of Taking-Over certificate by the Engineer for the whole works has not been provided for separately in the bills of quantities and the cost thereof is deemed to be included in other rates.

9 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9.1 General

9.1.1 Environmental Responsibility

The Contractor will be required to include in his site staff an Environmental Specialist in his team to co-ordinate all aspects of the environment during project implementation. This will include following the construction to monitor, review and verify the implementation of the project's Environmental and Social Management Plan (ESMP).

During construction, the Environmental Specialist will be responsible but not limited to the following tasks:

- Update environmental aspects (not covered in the ESIA / ESMP);
- Report to the Engineer on environmental issues that were included in the ESMP and the emerging ones during construction;
- Audit environmental and safety aspects at the work sites;
- Participate in the definition of the no working-areas and the location of campsite, borrow pits, quarries and other areas;
- Recommend solutions for specific environmental problems;
- Liaise with Community Liaison Groups with regard to compliance of the social clauses of the Contract, in terms of local labour force and HIV/AIDS campaign;
- Oversee strategies for sensitising Contractor' staff on health and safety problems;
- Attend consultations held at key stages of the project with the community and interested parties;
- Liaise with the respective Environmental Authorities on the level of compliance with the ESMP achieved by the Contractor on a regular basis for the duration of the contract;
- Control and supervise the implementation of the ESMP;
- Prepare quarterly environmental and social progress or "audits" reports on the status of implementation of measures and management of work sites.

9.1.2 Updated Environmental Management Plan

An updated Environmental Management Plan will be required to be prepared to identify emerging and sequence environmental activities that are needed in order to complete a required construction process.

The Environmental Management Plan would identify reference documentation, the approval required to complete that activity and the verification documentation to be produced as evidence of satisfactory completion. The Environmental Management Plan would also identify where "hold points" would be required. These are where continuation of subsequent activity is prohibited unless a former activity has been signed-off. The ESMP would be broken down into various activities as listed in ESIA Report will be undertaken.

9.1.3 Method Statements

Method statements would be completed on behalf of the Main Contractor or Sub Contractor by the Environmental Specialist, in consultation with on-site Engineering staff. The method

statements would include a review of the environmental risks and commitments, as identified in the ESMP and risk assessment, so that appropriate control measures are developed and included within the construction process. Method statements would be reviewed by the Consultants Environmental Manager. Where necessary, all method statements would be submitted to the enforcement agencies (EMA and District Assembly.) as appropriate. Method statements would contain as a minimum:

- Location of the activity and access/egress arrangements.
- Work to be undertaken and methods of construction.
- Plant and materials to be used.
- Labour and supervision requirements.
- Health, safety and environmental considerations.
- Any permit or consent requirements.

9.2 Control of Construction Processes

9.2.1 Supervision of Construction Activities

All construction and installation activities including those carried out by subcontractors and suppliers would be supervised, or regularly checked through the completion of site inspections by the Contractors Environmental Specialist, to ensure that requirements identified in risk assessments or method statements have been implemented. The frequency and extent of this supervision will vary according to the degree of competence displayed by the workforce and the level of risk to the environment.

9.2.2 Inspection of Other Operational Impacts

Appointed environmental representatives would carry out weekly inspections of their respective construction areas, to verify that housekeeping or supporting controls are being implemented effectively. These inspections would utilise the site environmental standards as the minimum standards that should be achieved, with necessary actions being recorded and raised at weekly progress meetings. Subsequent inspections would commence with a review of all outstanding actions from previous reports to verify that they have been completed.

9.2.3 Inspections by the Environmental Team

Environmental deliverables required by the Construction Environmental Management Plan (CEMP) will be subject to regular independent inspections by either the Environmental Manager or the relevant environmental specialists. These inspections will be used to confirm that:

- Construction works are progressing in accordance with the agreed method statements';
- Agreed protection or mitigation measures are in place, prior to or during the implementation of construction activities;
- Construction works have been completed in accordance with the design and;
- Commitments made during the statutory process.

9.2.4 Environmental Inspection and Reporting

The Contractors Environmental Manager would carry out an assessment of the Project's environmental performance, based upon the reports from the environmental management representatives during the period, reports from the environmental specialists and from his own site inspections. This would be carried out at a frequency at no greater than monthly intervals but could be held more regularly depending on the nature of the construction activity. An assessment of the performance over the month would be made and quantified. A monthly report detailing performance for the period would be provided to the Engineer and would include a summary of environmental inspections completed, audits undertaken, complaints and incidents.

9.2.5 Environmental Monitoring

Monitoring of noise, vibration, dust and water quality would be carried out in accordance with the specialist environmental procedures and environmental commitments made.

9.2.6 Control of non-conformance

Non-conforming products or processes would initiate a Non-Conformance Report, which would identify the nature of the problem, the proposed corrective action, action taken to prevent recurrence of the problem and verification that the agreed actions have been carried out.

9.2.7 Communication and Co-ordination

Internal project communications would be via one processe:

- A monthly Project Environmental Review;

(a) Monthly Project Environmental Review

Environmental issues will be primarily discussed at a monthly Project Environmental Review, chaired by the Contract Manager and attended by the Contractors Environmental Manager, the Clients Environmental Manager, relevant sub-contractors environmental representatives and, when necessary, environment specialists and representatives from statutory consultees. The Project Environmental Review will:

- Consider past performance from inspections, audit reports and monitoring data.
- Plan actions required to mitigate forthcoming risks.
- Disseminate best practice.

9.2.8 Environmental due diligence during construction

During the construction phase, environmental due diligence will be incorporated into the Project implementation mainly to:

- Control the residual risk of accidental environmental damage;
- Prevent the negative environmental impacts during construction.

The contractor will be required to include environmental considerations in the monthly progress reports and indicate progress in the implementation of mitigation measures as outlined in the ESMP.

The Construction risks to be monitored will include, but not be limited to the following issues:

- Handling of hazardous materials as part of construction activities;
- Movement of machinery;
- Management of borrow areas;
- Sedimentation of watercourses
- Collection and disposal of wastes;
- Management of pollution incidents.

Tables 10.1, gives a summary of the Environmental and Social Management Plans during Construction phase of the project.

Table 10.1 Environmental and Social Management Plan

Project Activity/ environmental concern	Possible Impacts	Mitigation Measures	Time Frame
Land Take	Permanent and temporary loss of land	• Compensation of land lost at Full Replacement Cost; • Transition allowance for land tenants of three month yield costs; • Provision with an alternative land of the same or more reproductive value within the project area.	Before construction
	Economically displaced people	• Include valuation report on the extent of economic loss by PAPs in the full RAP for compensation. • Measures to reduce instances of loss of income or livelihoods during the transition period to the new system. • Where possible, skip areas where crops are almost mature for harvesting during canal construction.	Before construction
	Full or partial loss of structures	• Cash compensation of the affected structure at Full Replacement cost; • Allowance to repair the remaining part of the structure for partial damage.	Before construction
Flooding	Destruction of crops and homes	• Strive to construct most of the canals to completion during the dry season. • Regularise checks and inspection of the canals to avert blockages or leaks.	During Construction
Vegetation Loss	Reduced biodiversity and loss of indigenous trees and shrubs	• The clearing of vegetation and trees, especially indigenous trees, should be strictly controlled and only done if it's absolutely necessary. • Disturbed areas adjacent to the canals should be re-vegetated with locally occurring grasses, shrubs and trees after completion of each section. □	During Construction

10 CONSTRUCTION TOLERANCES

10.1 General

The following are the tolerances within which the works are to be executed or as directed by the Engineer:

10.1.1 Earthworks

Channel or Excavation cutting	+20/ -20 mm	
Channel Water Way Area	- 0	
Horizontal Alignment of Channels:	Maximum	300 mm
	Over 20 m length	100 mm
Formation Level for Structures	+0/ -ve filled with concrete	
Formation Level for Gabions	+0/ -100 mm	

10.1.2 Concrete Structures

The following tolerances shall apply to all wrought formed and fair or fine unformed finishes.

Tolerance from Specified Position

Maximum departure of plan position of structure	150 mm

Tolerance from Specified Dimension

Maximum departure in thickness, cross-sectional dimension or position of columns, beams, walls, footings and the like	+25/ -10 mm

Surface Tolerance on Straightness or Departure from Specified Curve

General Surfaces

Maximum deviation in horizontal or vertical direction

- gradual over a 10m length 25 mm

- abrupt 10 mm.

Surfaces in Contact with Flowing Water

Maximum deviation in direction of flow or normal to flow

- gradual over a 10m length 15 mm
- abrupt 5 mm

Reinforcement

Maximum departure in required spacing 15 mm

Minimum lap length shall be:

- In the case of mild steel reinforcing 40 times bar diameter
- in the case of high yield steel reinforcing 50 times bar diameter

10.1.3 Stonework

Pitching and Masonry over a 2 m length	+100/ -25 mm
Face of gabion basket	+ 75/ -25 mm
Thickness of tipped rock or filter layer	+100/ - 0 mm

11 SOLAR PHOTOVOLTAIC (PV) SYSTEMS

11.1 Scope of Works

This Section covers the design (where applicable), supply, delivery, installation, testing, commissioning, training, documentation, and defects liability obligations for Solar Photovoltaic (PV) systems forming part of the Works.

The Works shall include, but shall not be limited to, photovoltaic modules, mounting structures, DC cabling and connectors, string combiner boxes, DC isolators, surge protection devices, inverters, AC distribution boards, earthing and bonding systems, lightning and surge protection, monitoring and control systems, labels and safety signage, and all ancillary works necessary for a complete, safe, and operational solar PV installation.

The solar PV system may be off-grid, grid-connected, or hybrid, as specified in the Drawings and Bill of Quantities.

11.2 Standards and Regulatory Requirements

All solar PV works shall comply with the latest applicable editions of the following, unless otherwise approved by the Engineer:

a) Kenya Bureau of Standards (KEBS) adopted photovoltaic standards, including but not limited to:
KS IEC 61215 – Photovoltaic module design qualification and type approval
KS IEC 61730 (Parts 1 and 2) – Photovoltaic module safety qualification
KS IEC 62930 – Electric cables for photovoltaic systems (up to 1.5 kV DC)

b) Electrical installation standards as applied in Kenya, including principles of BS 7671 and IEC 60364 for electrical installations.

c) Energy (Solar Photovoltaic Systems) Regulations, 2012, and all requirements of the Energy and Petroleum Regulatory Authority (EPRA).

d) Ministry of Works (Kenya) standard practice for electrical and mechanical installations.

e) FIDIC Conditions of Contract relating to quality, testing, commissioning, documentation, training, and defects liability.
Where conflicts occur, the more stringent requirement shall apply.

11.3 Contractor's Responsibilities

The Contractor shall be responsible for:
a) Ensuring that all solar PV equipment supplied complies with KEBS standards and is approved by the Engineer prior to installation;
b) Engaging qualified and EPRA-compliant personnel for installation and commissioning;
c) Coordinating all solar works with civil, electrical, and mechanical components of the project;
d) Protecting installed equipment from damage during construction;
e) Rectifying, at his own cost, any defects arising during construction or within the Defects Liability Period.

11.4 SUBMITTALS FOR APPROVAL

Prior to procurement and installation, the Contractor shall submit the following to the Engineer for approval:
a) Manufacturer's datasheets and KEBS/IEC compliance certificates for PV modules;
b) Inverter datasheets showing ratings, protections, and environmental classification;
c) Mounting structure drawings, material specifications, and corrosion protection details;
d) Single-line diagrams, string sizing calculations, voltage drop calculations, protection coordination, and earthing layouts;
e) Method statements for installation, testing, commissioning, and safety procedures;
f) Quality control and inspection and test plans.
No installation shall commence until written approval is obtained.

11.5 PHOTOVOLTAIC MODULES

Photovoltaic modules shall be new, unused, and certified to comply with KS IEC 61215 and KS IEC 61730. Modules shall be suitable for outdoor installation under Kenyan climatic conditions.

11.6 Performance and Warranty

Modules shall have:
a) A minimum product warranty as specified in the Contract;
b) A performance warranty guaranteeing not less than 80% of rated output at 25 years, unless otherwise specified;
c) Unique serial numbers for traceability.

11.7 Installation

Modules shall be installed in accordance with the manufacturer's instructions and approved drawings. Modules shall be securely fixed to mounting structures and aligned to achieve the specified tilt and orientation.

12 MOUNTING STRUCTURES

12.1 General

Mounting structures shall be designed to withstand wind loads, dead loads, and operational loads at the Site. Structures shall be fabricated from corrosion-resistant materials such as hot-dip galvanized steel or anodized aluminium.

12.2 Fixings

All bolts, nuts, and fasteners shall be stainless steel or approved corrosion-resistant material. Roof penetrations, where applicable, shall be properly sealed and made watertight.

13 DC CABLING AND PROTECTION

13.1 Cables

DC cables shall comply with KS IEC 62930, be UV-resistant, and rated for the system voltage and current. Cables shall be neatly routed, supported, and protected against mechanical damage.
X.5.2 DC Isolation and Surge Protection
DC isolators shall be provided at the array and inverter locations as specified. Surge protection devices shall be installed on the DC side in accordance with risk assessment and design requirements.

14 INVERTERS AND AC SYSTEM

14.1 Inverters

Inverters shall be of approved manufacture and suitable for the specified system configuration. Inverters shall incorporate protections against over-voltage, under-voltage, over-frequency, under-frequency, earth faults, and over-temperature.

15 AC Distribution

AC cabling, breakers, and distribution boards shall comply with applicable electrical installation standards. Isolation shall be provided for safe operation and maintenance.

16 EARTHING, BONDING AND LIGHTNING PROTECTION

All exposed metallic parts of the PV system, including module frames, mounting structures, inverter enclosures, and cable containment, shall be effectively bonded and earthed. Earthing resistance values shall meet the requirements of applicable standards and the Engineer's approval.

Surge and lightning protection shall be integrated with the site earthing system.

17 INSTALLATION WORKMANSHIP

All works shall be executed neatly and safely. DC and AC cables shall be clearly segregated and labelled. Penetrations through walls or roofs shall be sealed to prevent water ingress.

18 TESTING AND COMMISSIONING

18.1 Pre-Commissioning

Before commissioning, the Contractor shall carry out visual inspections, torque checks, earthing continuity tests, polarity checks, and insulation resistance tests.

19 Commissioning

The Contractor shall commission the system in the presence of the Engineer, demonstrating correct operation of the PV array, inverters, protections, monitoring system, and shutdown procedures.

20 Documentation

Upon completion, the Contractor shall submit:

a) Test and commissioning certificates;

b) As-built drawings and system layouts;

c) Operation and Maintenance manuals;

d) Warranty certificates;

e) Training records.

21 TRAINING AND HANDOVER

The Contractor shall provide training to the Employer's personnel on system operation, safety, routine maintenance, and basic troubleshooting prior to handover.

22 DEFECTS LIABILITY

During the Defects Liability Period, the Contractor shall be responsible for repairing or replacing, at his own cost, any defects arising from faulty materials, workmanship, or non-compliance with the Specifications. All warranties shall be honoured and administered by the Contractor.

23 ANTI-TERMITE TREATMENT – STANDARDS AND CHEMICALS

All anti-termite treatment materials, chemicals, and related works shall comply with the latest standards issued or adopted by the Kenya Bureau of Standards (KEBS) and with recognised international standards, to the satisfaction of the Engineer.

Standards

Anti-termite treatment chemicals shall be KEBS-approved and registered for use in Kenya and shall conform to the relevant Kenyan Standards (KS), East African Standards (EAS), and internationally recognised specifications adopted by KEBS.

The manufacture, supply, handling, storage, transportation, and application of anti-termite chemicals shall comply with the applicable requirements of:

KS standards and KEBS requirements governing pesticides, public health chemicals, labelling, packaging, and certification.

WHO specifications and guidelines for public health pesticides, including classification, safety, toxicity, and approved use.

FAO specifications for plant protection and pest control products relating to formulation quality, performance, and consistency.

ISO 9001 requirements for quality management systems of manufacturers and suppliers of anti-termite chemicals.

ISO 14001 requirements for environmental management systems, where applicable.

ISO 45001 requirements for occupational health and safety management systems relating to the handling and application of chemical products.

Where any conflict arises between standards, the decision of the Engineer shall be final.

Approved Chemicals

Anti-termite treatment shall be carried out using approved chemical termiticides effective against subterranean termites and suitable for soil and foundation treatment. The chemicals shall be non-repellent or repellent types as appropriate and shall provide long-lasting residual protection.

Approved active ingredients shall include, but not be limited to:

Chlorpyrifos-based termiticides formulated for soil application.
Imidacloprid-based non-repellent termiticides.
Fipronil-based non-repellent termiticides.
Bifenthrin-based synthetic pyrethroid termiticides.

Only products registered for use in Kenya and approved by KEBS shall be permitted. Substitution of approved chemicals shall not be allowed without prior written approval of the Engineer.

Chemical Quality and Formulation

Anti-termite chemicals shall be supplied as emulsifiable concentrates, suspension concentrates, or other approved formulations suitable for soil and structural treatment. The chemicals shall be stable, effective, and capable of maintaining their protective properties for the design life required under the Contract when applied in accordance with the manufacturer's instructions.

The chemicals shall not adversely affect concrete, masonry, reinforcement, foundations, or soil bearing capacity and shall not contaminate groundwater or pose undue risk to human health or the environment when properly applied.

Safety, Handling, and Environmental Requirements

All anti-termite chemicals shall be handled, mixed, applied, and disposed of strictly in accordance with KEBS requirements, manufacturer's instructions, and recognised health and safety practices.

The Contractor shall provide and enforce the use of appropriate personal protective equipment for all personnel involved in handling and application of chemicals. All works shall be carried out in a manner that minimises risk to workers, occupants, livestock, water sources, and the surrounding environment.

Empty containers and chemical waste shall be disposed of in an approved manner in accordance with Kenyan environmental regulations and to the satisfaction of the Engineer.

24 PHOTOVOLTAIC (PV) MODULES

25 Scope of Application

This specification sets out the standards, performance requirements, testing, certification, supply, handling, installation, inspection, and acceptance criteria for photovoltaic (PV) modules used in solar power systems for irrigation, water supply, and associated electrical installations. The specification applies to crystalline silicon and other approved PV module technologies intended for outdoor installation under site climatic conditions.

---

26 Applicable International Standards

Photovoltaic modules and associated documentation shall comply with the latest editions of the following standards, as applicable to the module technology supplied:
International Electrotechnical Commission IEC 61215 for terrestrial photovoltaic modules design qualification and type approval.
International Electrotechnical Commission IEC 61730 for photovoltaic module safety qualification, including construction and testing requirements.
International Electrotechnical Commission IEC 61701 for salt mist corrosion testing, where installations are in aggressive or saline environments.
International Electrotechnical Commission IEC 62716 for resistance to ammonia corrosion, where installations are in agricultural or livestock environments.
International Electrotechnical Commission IEC 62804 for potential induced degradation resistance testing.
International Electrotechnical Commission IEC 61853 for photovoltaic module performance testing and energy rating.
International Electrotechnical Commission IEC 60068 series for environmental testing, including temperature cycling, humidity freeze, and damp heat tests.
Where equivalent international or regional standards are proposed, they shall be subject to the Engineer's prior written approval.

---

27 Electrical and Performance Requirements

PV modules shall meet the rated electrical characteristics declared by the manufacturer under standard test conditions. Modules shall be capable of continuous operation at the maximum system voltage

specified for the project and shall maintain stable performance under high temperature and high irradiance conditions typical of the project location.
The rated power tolerance shall be positive only or otherwise approved by the Engineer. Modules shall exhibit low degradation rates and stable long-term performance consistent with international best practice.

28 Mechanical and Environmental Requirements

PV modules shall be designed for outdoor use and capable of withstanding mechanical loads due to wind, handling, and installation. The module construction shall provide adequate protection against moisture ingress, dust, ultraviolet radiation, and temperature variations.
Modules shall demonstrate resistance to environmental stresses including humidity, heat, thermal cycling, and mechanical impact in accordance with the applicable IEC standards. Where required by site conditions, modules shall be certified for resistance to salt mist, ammonia, and other corrosive agents.

29 Materials and Construction

PV modules shall consist of high-quality photovoltaic cells encapsulated in durable materials suitable for long-term outdoor exposure. The front surface shall be made of tempered safety glass with high light transmission and adequate impact resistance.
Module frames, where provided, shall be manufactured from corrosion-resistant materials such as anodized aluminium. Junction boxes shall be weatherproof, UV-resistant, and suitably rated for outdoor use, with secure cable terminations and strain relief.

30 Safety Requirements

PV modules shall comply with electrical safety requirements for protection against electric shock, fire hazards, and mechanical risks. Insulation resistance, creepage distances, and protective measures shall conform to the applicable safety standards.
Modules shall be clearly labelled with permanent and legible markings indicating manufacturer’s name, model type, serial number, rated power, voltage, current, and applicable certifications.

31 Quality Assurance and Certification

PV modules shall be supplied from manufacturers operating certified quality management systems. Each module type shall be supported by valid type-test certificates issued by accredited testing laboratories demonstrating compliance with the applicable IEC standards.
The Contractor shall submit copies of all relevant test reports, certificates of conformity, and manufacturer’s technical datasheets for approval prior to delivery to site.

32 Handling, Transport, and Storage

PV modules shall be handled, transported, and stored in accordance with the manufacturer’s recommendations to prevent mechanical damage, micro-cracks, or degradation. Modules shall be protected from moisture, impact, and excessive stacking loads during transport and storage.
Any module damaged during handling or storage shall be rejected and replaced at no additional cost.

33 Installation Compatibility

PV modules shall be compatible with the mounting structures, inverters, and electrical components specified for the project. Mounting hole locations, frame dimensions, and electrical connectors shall allow secure installation without inducing mechanical stress on the modules.
Electrical connections shall be made using approved connectors and cables suitable for photovoltaic applications and outdoor exposure.

34 Inspection and Acceptance

PV modules shall be subject to inspection upon delivery and after installation. Acceptance shall be based on compliance with this specification, approved drawings, submitted certifications, and absence of visible defects such as cracks, delamination, or frame damage.
The Engineer reserves the right to reject any module not complying with the specified standards or exhibiting signs of damage or substandard workmanship.

35 PUMP CONTROLLERS – APPLICABLE STANDARDS

Pump controllers shall comply with the latest applicable standards issued or adopted by Kenya Bureau of Standards (KEBS) and the corresponding international standards, as applicable to the type of controller supplied.

Kenyan and Adopted Standards

KS IEC 60947 series – Low-voltage switchgear and controlgear, including contactors, motor starters, overload and short-circuit protection devices.
KS IEC 60204-1 – Safety of machinery, electrical equipment of machines.
KS IEC 60529 – Degrees of protection provided by enclosures (IP Code).
KS IEC 61439 – Low-voltage switchgear and controlgear assemblies.
KS IEC 60364 series – Low-voltage electrical installations.
KS IEC 60034 series – Rotating electrical machines, where controllers interface with electric motors.
KS IEC 61800 series – Adjustable speed electrical power drive systems, where variable speed or soft-start controllers are used.

International Standards (Recognised by KEBS)

International Electrotechnical Commission (IEC)
IEC 60947 – Low-voltage switchgear and controlgear.
IEC 60204-1 – Electrical equipment of machines.
IEC 60529 – Ingress protection ratings.
IEC 61439 – Low-voltage assemblies.
IEC 61800 – Power drive systems (VFDs and soft starters).

International Organization for Standardization (ISO)
ISO 9001 – Quality management systems for manufacturers.

Environmental and Performance Requirements (Referenced Standards)

Controllers shall be suitable for continuous operation under site environmental conditions and shall meet temperature, humidity, dust, and vibration requirements in accordance with the applicable IEC environmental and enclosure protection standards.

Certification and Compliance

Pump controllers shall be supplied with valid certificates of conformity demonstrating compliance with the applicable KS (KEBS-adopted IEC) standards. Test reports and manufacturer's declarations shall be issued by accredited testing bodies and shall be submitted for approval prior to delivery.

36 PUMP UNITS AND ELECTRIC MOTORS – APPLICABLE STANDARDS

Pump units and associated electric motors shall comply with the latest applicable standards issued or adopted by Kenya Bureau of Standards (KEBS) and the corresponding international standards, as applicable to the equipment supplied.

Kenyan and Adopted Standards (KS)

KS ISO 5199 – Technical specifications for centrifugal pumps, Class II.
KS ISO 2858 – End-suction centrifugal pumps with rated duty point and dimensions.
KS ISO 9906 – Rotodynamic pumps, hydraulic performance acceptance tests, grades of accuracy.
KS ISO 10816 / KS ISO 20816 – Mechanical vibration evaluation of machines, including pumps and motors.

KS IEC 60034 series – Rotating electrical machines, including ratings, performance, efficiency, temperature rise, protection, and testing of electric motors.
KS IEC 60034-1 – Rating and performance of rotating electrical machines.
KS IEC 60034-5 – Degrees of protection provided by enclosures (IP Code) for motors.
KS IEC 60034-6 – Methods of cooling for rotating electrical machines.
KS IEC 60034-7 – Classification of types of construction and mounting arrangements.
KS IEC 60034-30 – Efficiency classes of line operated AC motors (IE classes).

KS IEC 60529 – Degrees of protection provided by enclosures (IP Code).
KS IEC 60072 – Dimensions and output series for rotating electrical machines.

International Standards (Recognised by KEBS)

International Organization for Standardization (ISO)
ISO 5199 – Centrifugal pumps, technical specifications.
ISO 2858 – End-suction centrifugal pumps, dimensions and duty points.
ISO 9906 – Pump performance testing and acceptance criteria.
ISO 10816 / ISO 20816 – Mechanical vibration limits for machines.

International Electrotechnical Commission (IEC)
IEC 60034 series – Rotating electrical machines.
IEC 60529 – Ingress protection ratings (IP).
IEC 60072 – Motor frame sizes and mounting dimensions.

Efficiency and Performance Requirements (Referenced Standards)

Electric motors shall meet the minimum efficiency classes specified under the applicable IEC 60034-30 requirements or higher where specified. Pump hydraulic performance shall comply with acceptance tolerances defined under ISO 9906.

Certification and Compliance

Pump units and motors shall be supplied with valid certificates of conformity demonstrating compliance with the applicable KS (KEBS-adopted ISO/IEC) standards. Manufacturer's test certificates, performance curves, motor nameplate data, and declarations of conformity shall be issued by accredited bodies and submitted for approval prior to delivery.

37 DAMP PROOFING AND WATERPROOFING

All damp proofing and waterproofing materials, systems, workmanship, and associated works shall comply with the latest standards issued or adopted by the Kenya Bureau of Standards (KEBS) and with recognised international standards, to the satisfaction of the Engineer.

Standards

Damp proofing and waterproofing materials and systems shall conform to the relevant Kenyan Standards (KS) and internationally recognised standards adopted by KEBS, including but not limited to the following:

British Standards BS 8102 for protection of below ground structures against water from the ground.

British Standards BS 8215 for design and installation of damp-proof courses in masonry construction.

British Standards BS EN 13967 for flexible sheets for waterproofing, including plastic and rubber damp-proof sheets.

British Standards BS EN 13707 for reinforced bitumen sheets for roof waterproofing.

British Standards BS EN 1504 series for products and systems for the protection and repair of concrete structures, where liquid-applied waterproofing or protective coatings are used.

British Standards BS EN 14891 for liquid-applied waterproofing products under ceramic tiling.

ISO standards applicable to quality management, environmental management, and occupational health and safety of manufacturers and installers.

Where discrepancies arise between standards, the Engineer's interpretation shall prevail.

Damp Proof Courses and Membranes

Damp proof courses and damp proof membranes shall be manufactured from approved materials such as polyethylene sheets, bituminous felt, mastic asphalt, or other approved proprietary systems. Materials shall be durable, impervious to moisture, and resistant to deterioration, chemical attack, and biological degradation.

Damp proof membranes shall be of adequate thickness and strength to resist puncture and tearing during installation and service. Joints and laps shall be properly formed to ensure continuity and effectiveness of the moisture barrier.

Waterproofing Systems

Waterproofing systems shall consist of approved bituminous membranes, liquid-applied coatings, cementitious waterproofing compounds, or other proprietary systems approved by the Engineer. Systems shall be suitable for the intended exposure conditions and capable of withstanding hydrostatic pressure, moisture ingress, and environmental effects.

All waterproofing materials shall be compatible with the substrate and adjacent construction materials. Multiple-layer systems shall be applied strictly in accordance with the manufacturer's recommendations.

Materials Quality and Performance

All damp proofing and waterproofing materials shall be supplied by approved manufacturers operating certified quality management systems. Materials shall be delivered to site in original, unopened containers bearing the manufacturer's name, product identification, batch number, and application instructions.

Materials shall be free from defects and shall achieve the required performance characteristics for resistance to water penetration, vapour transmission, and durability under site conditions.

Workmanship

All damp proofing and waterproofing works shall be carried out by competent personnel experienced in the installation of the specified systems. Substrates shall be clean, sound, and properly prepared before application of membranes or coatings.

Membranes shall be laid flat, without wrinkles, air pockets, or damage. Liquid-applied systems shall be applied in uniform coats to the specified thickness. Particular care shall be taken at joints, corners, penetrations, and interfaces with other construction elements.

Protection and Curing

Damp proofing and waterproofing systems shall be adequately protected during and after installation to prevent damage from construction activities, weather, or mechanical impact. Where required, protective screeds, boards, or coverings shall be provided.

Curing times recommended by the manufacturer shall be strictly observed before covering, backfilling, or placing finishes.

Inspection and Testing

The Engineer shall be afforded full opportunity to inspect damp proofing and waterproofing works at all stages. Any defective workmanship or materials shall be removed and replaced at the Contractor's expense.

Where required, water tightness tests or flood tests shall be carried out to demonstrate the effectiveness of the waterproofing system to the satisfaction of the Engineer.

Health, Safety, and Environmental Requirements

All damp proofing and waterproofing works shall be carried out in accordance with applicable health, safety, and environmental regulations. Adequate ventilation shall be provided when using solvent-based or bituminous materials.

Waste materials, empty containers, and surplus products shall be disposed of in an approved manner in accordance with Kenyan environmental regulations.

38 ELECTRICAL POWER SYSTEMS

All electrical power systems, materials, equipment, installation, testing, commissioning, and associated works shall comply with the latest standards issued or adopted by the Kenya Bureau of Standards (KEBS) and with recognised international standards, to the satisfaction of the Engineer.

Standards

Electrical power systems shall conform to the relevant Kenyan Standards (KS) and internationally recognised standards adopted by KEBS, including but not limited to the following:

KS IEC 60364 series – Low-voltage electrical installations, including design, selection of equipment, erection, verification, and safety requirements.

KS IEC 61439 – Low-voltage switchgear and controlgear assemblies.

KS IEC 60947 series – Low-voltage switchgear and controlgear, including circuit breakers, contactors, motor starters, and protective devices.

KS IEC 60529 – Degrees of protection provided by enclosures (IP Code).

KS IEC 60204-1 – Safety of machinery, electrical equipment of machines.

KS IEC 60034 series – Rotating electrical machines, where applicable to generators and motors within the power system.

KS IEC 61800 series – Adjustable speed electrical power drive systems, where variable speed drives are used.

KS IEC 62305 series – Protection against lightning, where applicable.

KS IEC 61000 series – Electromagnetic compatibility (EMC) requirements.

KS IEC 60502 – Power cables with extruded insulation and accessories for rated voltages up to and including 30 kV, where applicable.

Where any conflict arises between standards, the Engineer’s decision shall be final.

System Components and Materials

All electrical power system components, including generators, transformers, switchboards, distribution boards, circuit breakers, cables, control panels, protective devices, earthing systems, and accessories, shall be of approved manufacture and suitable for the specified voltage, current, frequency, and environmental conditions.

All equipment shall be rated for continuous operation and shall be robust, durable, and resistant to dust, moisture, heat, and corrosion as applicable to the site conditions.

Switchgear and Distribution Equipment

Switchgear and distribution equipment shall be factory-assembled or site-assembled as approved and shall comply with the relevant KS IEC standards. Enclosures shall be of adequate strength and protection class and shall be clearly labelled.

Protective devices shall be properly coordinated to ensure selectivity and discrimination under fault conditions. All live parts shall be adequately enclosed to prevent accidental contact.

Cabling and Wiring Systems

All power cables and wiring systems shall comply with the applicable KS IEC cable standards and shall be sized to carry the design current without excessive voltage drop or overheating.

Cables shall be installed neatly and securely in approved conduits, trunking, ducts, trays, or trenches. Joints and terminations shall be mechanically and electrically sound and adequately insulated.

Earthing and Bonding

Earthing and bonding systems shall be provided in accordance with KS IEC 60364 and shall ensure effective protection against electric shock, fault currents, and lightning where applicable.

All metallic enclosures, equipment frames, cable trays, and exposed conductive parts shall be effectively bonded to the earthing system. Earth resistance values shall comply with the specified limits and shall be verified by testing.

Installation Workmanship

All electrical installation works shall be carried out by qualified and competent personnel experienced in similar installations. Workmanship shall be neat, orderly, and in accordance with approved drawings and manufacturer's instructions.

Penetrations through walls, floors, and structures shall be properly sealed to maintain fire resistance, waterproofing, and structural integrity.

Testing and Commissioning

Upon completion of installation, the electrical power system shall be inspected, tested, and commissioned in accordance with KS IEC 60364 and other applicable standards.

Testing shall include continuity tests, insulation resistance tests, polarity tests, earth resistance tests, functional tests of protective devices, and operational tests of the complete system. All test results shall be recorded and submitted to the Engineer for approval.

Safety Requirements

All electrical works shall be carried out in compliance with applicable occupational health and safety regulations. Temporary power supplies, lock-out procedures, warning notices, and protective equipment shall be provided as necessary to ensure safety of personnel and the public.

Certification and Approval

All electrical power system equipment and materials shall be supplied with certificates of conformity demonstrating compliance with applicable KEBS standards. Manufacturer's technical data sheets, test certificates, and as-built documentation shall be submitted for approval.

No electrical equipment or system shall be energised without prior approval of the Engineer.

39 ROOFING MATERIALS STANDARDS

All roofing materials, timber members, fascia boards, accessories, and associated works shall comply with the latest standards issued or adopted by the Kenya Bureau of Standards (KEBS) and with recognised international standards, to the satisfaction of the Engineer.

General Roofing Standards

Roof coverings, accessories, and fixings shall comply with the relevant Kenyan Standards (KS) and internationally recognised standards adopted by KEBS, including applicable British Standards (BS), European Standards (EN), and ISO standards. Where discrepancies occur between standards, the decision of the Engineer shall be final.

Corrugated Galvanised Steel Roofing Sheets

Corrugated galvanised steel roofing sheets shall comply with:

BS EN 10346 – Continuously hot-dip coated steel flat products, including zinc coatings.
BS EN 508-1 – Roofing products from metal sheet, specification for steel.
KS standards for galvanised steel sheets as adopted by KEBS.

Aluminium Roofing Sheets

Aluminium roofing sheets shall comply with:

BS EN 485 series – Aluminium and aluminium alloys, sheet, strip, and plate.
BS EN 508-2 – Roofing products from metal sheet, specification for aluminium.
Applicable KS standards adopted by KEBS.

Pre-Painted / Colour-Coated Steel Roofing Sheets

Pre-painted or colour-coated steel roofing sheets shall comply with:

BS EN 10169 – Continuously organic-coated steel flat products.
BS EN 10346 – Metallic coated steel substrates.
BS EN 508-1 – Roofing products from metal sheet.

Aluminium-Zinc Coated Steel Roofing Sheets

Aluminium-zinc coated steel roofing sheets shall comply with:

BS EN 10346 – Continuously hot-dip coated steel flat products.
BS EN 508-1 – Roofing products from metal sheet.
Manufacturer’s certified coating performance standards approved by KEBS.

Stone-Coated Steel Roofing Tiles

Stone-coated steel roofing tiles shall comply with:

BS EN 508-1 – Roofing products from metal sheet.
BS EN 10346 – Metallic coated steel substrates.
Manufacturer’s proprietary standards certified by accredited testing bodies and approved by KEBS.

Clay Roofing Tiles

Clay roofing tiles shall comply with:

BS EN 1304 – Clay roofing tiles and fittings.

KS standards for clay roofing products adopted by KEBS.

Concrete Roofing Tiles

Concrete roofing tiles shall comply with:

BS EN 490 – Concrete roofing tiles and fittings.
BS EN 491 – Test methods for concrete roofing tiles.
Applicable KS standards adopted by KEBS.

Asphalt Roofing Shingles

Asphalt roofing shingles shall comply with:

BS EN 544 – Bitumen shingles with mineral reinforcement.
BS EN 1297 – Artificial ageing of roofing membranes.
Manufacturer's certified standards approved by KEBS.

Bituminous Roofing Felt and Membranes

Bituminous roofing felts and membranes shall comply with:

BS EN 13707 – Reinforced bitumen sheets for roof waterproofing.
BS EN 13969 – Bitumen sheets for damp-proofing.
BS 8217 – Code of practice for built-up felt roofing.

Fibre Cement Roofing Sheets

Fibre cement roofing sheets shall comply with:

BS EN 494 – Fibre-cement profiled sheets and fittings.
KS standards for fibre cement products adopted by KEBS.

Polycarbonate Roofing Sheets

Polycarbonate roofing sheets shall comply with:

BS EN 16240 – Plastic roofing sheets for external use.
ISO standards for thermoplastic roofing materials adopted by KEBS.
Manufacturer's UV-stability and impact-resistance certifications.

PVC Roofing Sheets

PVC roofing sheets shall comply with:

BS EN 16240 – Plastic roofing sheets.
ISO standards applicable to PVC construction products adopted by KEBS.
Manufacturer's certified performance data approved by the Engineer.

Standing Seam Metal Roofing Systems

Standing seam metal roofing systems shall comply with:

BS EN 508 series – Roofing products from metal sheet.
BS EN 10346 – Metallic coated steel substrates.
Manufacturer's proprietary system standards certified by accredited bodies and approved by KEBS.

Composite Roofing Panels and Insulated Sandwich Panels

Composite roofing panels, including insulated sandwich panels, shall comply with:

BS EN 14509 – Self-supporting double skin metal faced insulating panels.
BS EN 508 – Metal sheet roofing products.
Manufacturer's certified fire, thermal, and structural performance standards approved by KEBS.

Thatch Roofing Materials

Thatch roofing materials shall comply with:

BS 5534 – Code of practice for slating and tiling, where applicable to thatch fixing principles.
Traditional construction standards and approved local specifications acceptable to KEBS and approved by the Engineer.

Timber for Roofing Works

Timber used for roof trusses, rafters, purlins, battens, fascia boards, and other roofing components shall comply with:

BS EN 14081 – Structural timber with rectangular cross-section.
BS EN 338 – Structural timber strength classes.
BS 5268 – Structural use of timber (where still referenced).
KS standards for timber grading and preservation adopted by KEBS.

All timber shall be properly seasoned and treated against termites, fungal decay, and insect attack in accordance with approved preservative treatment standards.

Fascia Boards

Fascia boards, whether timber, metal, uPVC, or composite, shall comply with:

BS EN 927 – Paints and varnishes for exterior wood, where timber fascia boards are used.
BS EN 14782 – Self-supporting metal sheet for roofing and external cladding.
ISO standards applicable to uPVC and composite construction products adopted by KEBS.

Fascia boards shall be suitable for external exposure and capable of supporting rainwater goods without deformation or deterioration

40 SQUARE HOLLOW SECTIONS (SHS)

40.1 Applicable Standards

All Square Hollow Sections and associated works shall comply with the latest editions of the following standards, unless otherwise approved by the Engineer:
British Standard EN 10210 for hot finished structural hollow sections of non-alloy and fine grain steels.
British Standard EN 10219 for cold formed welded structural hollow sections of non-alloy and fine grain steels.

British Standard EN 10204 for inspection documents and material certification.
British Standard EN 1993 (Eurocode 3) for the design of steel structures, including members and joints.
British Standard EN ISO 15614 for welding procedure qualification.
British Standard EN ISO 9606 for qualification of welders.
British Standard EN ISO 5817 for quality levels of weld imperfections.
British Standard EN 1011 for welding recommendations for metallic materials.
British Standard EN ISO 1461 for hot-dip galvanizing of fabricated steelwork.
British Standard EN ISO 12944 for corrosion protection of steel structures by protective paint systems.
Where discrepancies arise between standards, the Engineer's interpretation shall take precedence.

40.2 Materials

Square Hollow Sections shall be manufactured from structural steel of grade S355J2H unless otherwise specified on the Drawings or approved by the Engineer. The steel shall exhibit the required strength, ductility, and toughness suitable for structural applications in the prevailing environmental conditions.
Sections shall be either hot finished in accordance with BS EN 10210 or cold formed welded in accordance with BS EN 10219, as specified or approved. Substitution between hot finished and cold formed sections shall not be permitted without prior written approval.

40.3 Dimensions and Tolerances

All Square Hollow Sections shall conform to the dimensional requirements and tolerances specified in the relevant product standard. These include tolerances for external dimensions, wall thickness, corner radii, straightness, squareness of faces, and twist. Sections exceeding permissible tolerances shall be rejected and removed from site at the Contractor's expense.

40.4 Testing and Certification

All Square Hollow Sections shall be supplied with mill certificates in accordance with BS EN 10204 Type 3.1, clearly indicating steel grade, chemical composition, mechanical properties, impact test results where applicable, and traceability to the production heat.
The Engineer may require additional testing, including tensile tests and Charpy impact tests, to verify compliance with the specified standards. All testing shall be carried out at approved laboratories and shall be deemed to be included in the Contract rates.

40.5 Fabrication

Fabrication shall be carried out in an approved workshop by competent personnel using suitable equipment. All cutting, drilling, welding, and forming shall be executed accurately to achieve the required geometry and fit.
Cutting shall be performed by sawing, machining, or approved thermal methods. Thermal cut edges shall be ground smooth and free from defects. Holes shall be drilled or machine-cut, and flame-cut holes shall only be permitted with the Engineer's approval.

40.6 Welding

All welding shall be carried out in accordance with approved welding procedure specifications qualified to BS EN ISO 15614. Welders shall hold valid qualifications in accordance with BS EN ISO 9606.
Weld quality shall comply with the requirements of BS EN ISO 5817, with workmanship appropriate to structural steel construction. Welds shall be continuous where required for structural integrity or corrosion protection, and shall be free from cracks, porosity, lack of fusion, or other unacceptable defects.

40.7 Connections

Connections involving Square Hollow Sections shall be designed and executed to ensure full transfer of design loads and overall structural stability. Connection detailing shall avoid stress concentrations and allow for proper drainage and corrosion protection.
Bolted connections shall use approved high-strength bolts and shall be tightened to the specified torque. Welded connections shall be executed in accordance with approved drawings and procedures.

40.8 Surface Protection

Where galvanizing is specified, Square Hollow Sections shall be hot-dip galvanized in accordance with BS EN ISO 1461 after fabrication unless otherwise approved. All vent and drain holes necessary for galvanizing shall be provided.
Where painting is specified, surface preparation and paint application shall comply with BS EN ISO 12944. The selected coating system shall achieve the specified durability and corrosion protection class. Internal surfaces of hollow sections shall be protected or sealed where required to prevent internal corrosion.

40.9 Handling, Storage, and Transport

Square Hollow Sections shall be handled, transported, and stored in a manner that prevents distortion, mechanical damage, or corrosion. Sections shall be stored off the ground on suitable supports and protected from contamination.
Any section damaged during handling or storage shall be repaired or replaced to the satisfaction of the Engineer at no additional cost.

40.10 Erection

Erection shall be carried out using approved methods and equipment by experienced personnel. Members shall be accurately aligned, levelled, and temporarily supported until the structure is stable and all permanent connections are completed.
Any misalignment, distortion, or damage occurring during erection shall be corrected by the Contractor at their own expense.

40.11 Inspection and Acceptance

All Square Hollow Section works shall be subject to inspection by the Engineer at any stage of manufacture, delivery, fabrication, or erection. Acceptance of the works shall be based on compliance with this specification, approved drawings, test certificates, and overall quality of workmanship.

40.12 Measurement and Payment

Measurement and payment for Square Hollow Sections shall be in accordance with the Bills of Quantities. Rates shall be deemed to include for supply of materials, fabrication, testing, surface protection, transport, erection, connections, and all incidental works necessary for completion.

41 PLASTIC STORAGE TANKS

This specification covers the supply, delivery, installation, testing, commissioning, and completion of plastic storage tanks for potable water, irrigation water, and service water storage. The works include all associated fittings, accessories, bases, supports, inlet and outlet connections, overflows, vents, valves, covers, anchorage systems, and all incidental works necessary to provide fully operational storage tanks as shown on the Drawings or directed by the Engineer.

41.1 Applicable Standards

Plastic storage tanks and associated works shall comply with the latest editions of the following standards, unless otherwise approved by the Engineer:
British Standard BS 6920 for suitability of non-metallic products in contact with potable water. British Standard BS EN 12573 for thermoplastics tanks for above-ground storage of chemicals and water.

British Standard BS EN ISO 9001 for quality management systems of manufacturers. World Health Organization guidelines for drinking-water quality, where tanks are used for potable water storage.
Manufacturer's recommendations and installation manuals, provided they do not conflict with the project specifications.
Where conflicts arise between standards, the Engineer's decision shall prevail.

42 CHAIN-LINK AND BARBED WIRE FENCING

All chain-link fencing and barbed wire fencing works shall comply with the latest standards issued or adopted by the Kenya Bureau of Standards (KEBS), including KS 261:2007, and shall be executed to the satisfaction of the Engineer.

42.1 Chain-Link Fencing

Chain-link fencing shall be provided and installed to a height of 2.1 metres measured from finished ground level. The chain-link mesh shall be manufactured from galvanised steel wire of gauge 10, having a nominal wire diameter of 3.2 millimetres, and shall comply with the requirements of KS 261:2007 (Kenya Standards).

The chain-link mesh shall have a nominal aperture size of 80 by 80 millimetres and shall be uniformly woven, free from defects, and adequately protected against corrosion.

The fencing shall be securely strained and fixed to approved posts, straining posts, and intermediate supports using galvanised straining wires, binding wires, clips, ties, and tensioning devices. All posts shall be properly aligned, plumbed, and set in approved concrete foundations.

42.2 Barbed Wire Stays to Chain-Link Fencing

The chain-link fencing shall be stayed with four strands of galvanised barbed wire of gauge 16, complying with KS 261:2007 (Kenya Standards). The barbed wire shall be fixed above the chain-link mesh and tensioned uniformly to provide additional security and stability.

All barbed wire stays shall be securely strained and fixed to posts using approved galvanised fittings, staples, or ties. The spacing and arrangement of barbed wire strands shall be as approved by the Engineer.

42.3 Barbed Wire Fencing over Cranked Fence Sections

Where fencing is constructed over cranked or inclined fence sections, four strands of galvanised barbed wire of gauge 16 complying with KS 261:2007 (Kenya Standards) shall be provided and installed.

The barbed wire fencing over cranked sections shall follow the alignment of the fence and shall be securely strained and fixed to the supporting posts. The installation shall maintain uniform tension and alignment throughout the length of the fence.

42.4 Materials and Components

All materials used in the fencing works, including chain-link mesh, barbed wire, posts, straining wires, binding wires, ties, clips, bolts, nuts, and concrete for post foundations, shall be new, of approved quality, and protected against corrosion.

All straining and fixing components necessary for the complete installation of the fencing system shall be deemed to be included in the works.

42.5 Workmanship and Installation

Fencing shall be erected true to line and level, with all posts firmly embedded and adequately braced. Straining shall be carried out to ensure the fence is taut and free from sagging. Any damaged or defective materials shall be replaced at the Contractor's expense.

42.6 Inspection and Acceptance

All fencing works shall be subject to inspection by the Engineer. Acceptance shall be based on compliance with this specification, KS 261:2007 requirements, approved drawings, and the quality of workmanship.